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17 – 26 April 2007

ICES Headquarters

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Executive summary

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) met for 10 days in April 2007 to assess the following stocks:

- Sole in Division IIIa
- Cod in Kattegat, Cod in SD 22-24 and Cod in SD 25-32
- Herring in SD 25-27, 28.2, 29 and SD 32, Gulf of Riga Herring (SD 28.1), Herring in SD 30 and Herring in SD 31
- Sprat in SD 22-32
- Flounder in SD 24-25

During the WGBFAS 2007 meeting the assessments were based on the following classification:

STOCK	CLASSIFICATION
Cod in Kattegat	Observation list
Cod in SD 22-24	Benchmark
Cod in SD 25-32	Observation list
Sole in Division IIIA	Observation list
Flounder in SD 24-25	Exploratory
Herring in SD 25-27, 28.2, 29 &32 (excl. GOR)	Update
Herring in GOR (SD 28.1)	Update
Herring in SD 30 (Bothnian Sea)	Update
Herring in SD 31 (Bothnian Bay)	Update
Sprat in SD 22-32	Update

The principle model for the running the assessments was the XSA.

WGBFAS carried out a benchmark assessment on Cod in SD 22-24. In this assessment the WGBFAS analysed the model assumptions and input data, by evaluating:

- Age groups and years used for commercial and scientific tuning fleets
- Inconsistencies (outliers and time trends) in stock indices from commercial tuning series
- Weight information in the stock, catches and discard
- Catch data quality against information from the industry on misreporting
- Sensitivity of assessment to different levels of shrinkage
- Impact of changes in Fbar to 2-4
- Impact of changing the first age at constant catchability
- Performance of simpler models (VPA and SURBA)
- Retrospective performance of the XSA model with different settings

The least consistent of the commercial tuning series (Danish Seine) was removed and the span of ages used for the trawler and gillnet tuning fleets were shortened to age 2-6. Furthermore, 2 new Danish surveys were implemented from 1994 and 1995, respectively (age 1-3) and the 1st quarter German survey was excluded. The German 4th quarter survey (name of survey) was extended to age 3.

The revised settings increased the retrospective bias (underestimating stock size and overestimating fishing mortality) as expected due to more scientific surveys being included in the revised tuning fleets which, therefore, are less dependant on the catch matrix.

The changes in the assessment did not have any major influence on the estimates of the historical stock development and on the perception of the current stock status.

The WGBFAS recognises the importance of the above listed changes in the ecosystem for the development of the Kattegat and Baltic Sea fish stocks, and has therefore when possible accounted for these in the stock assessments. Ecosystem changes have been considered in the following stock assessments:

- The changes in cod predation pressure on clupeids are accounted for in the assessments of herring in SD 25-27, 28.1+32 (section 6.2) and sprat (section 7) by using MSVPA estimates of natural mortality (SGMAB 2005).
- In previous assessments the influence of climatic factors on sprat recruitment has been considered in the sprat predictions. However, because the NAO index for February was not available to the working group, this was not possible in the short-term predictions made in 2007.
- The increasing sea surface temperatures and the zooplankton abundance changes are accounted for in the assessment of the Gulf of Riga herring, when estimating herring recruitment for the short term predictions (section 6.3). The relationships with average water temperature in April when the spawning starts and the abundance of *Copepoda* in May when the hatching of larvae begins, has changed compared to previous years. An updated relationship has been used for the prediction of recruitment.

1 Introduction

1.1 List of participants

Aho, Teija	Sweden	(part time)
Berth, Ulrich	Germany	
Boje; Jesper	Denmark	(part time)
Casini, Micele	Sweden	
Christensen, Steen (Chair)	Denmark	
Degel, Henrik	Denmark	
Eero, Margit	Denmark	
Gårdmark, Anna	Sweden	(part time)
Gasyukov, Pavel	Russia	
Gröhsler, Tomas	Germany	
Horbowy, Jan	Poland	(part time)
Kaljuste, Olavi	Estonia	
Karpushevskiyi, Igor	Russia	
Kornilovs, Georgs	Latvia	
Köster, Fritz W.	Denmark	(part time)
MacKenzie, Brian R.	Denmark	
Oeberst, Oberst	Germany	(part time)
Plikshs, Maris	Latvia	(part time)
Pönni, Jukka	Finland	
Radtke, Krzysztof	Poland	
Raid, Tiit	Estonia	
Raitaniemi, Jari	Finland	
Shvetsov, Faust	Latvia	
Sics, Ivo	Latvia	(part time)
Statkus, Romas	Lithuania	
Storr-Paulsen, Marie	Denmark	
Svedäng, Henrik	Sweden	

Contact details for each participant are given in Annex 1.

1.2 Terms of reference

2006/2/ACFM07 The Baltic Fisheries Assessment Working Group [WGBFAS] (Chair: S. Christensen*, Denmark) will meet at ICES Headquarters from 17-26 April 2007 to:

a) assess the status and provide management options for year 2008, for cod, sole, herring and sprat stocks in the following areas and taking into account the biological interaction between species and agreed management plans:

Baltic Herring:

1. SD 22-24 (based on assessment made by HAWG)

2. SD 25-29, 32 excluding Gulf of Riga (25-27, 28.2, 29 and 32)

3. Gulf of Riga (28.1)

4. SD 30

5. SD 31

Sprat:

1. The Whole Baltic: SD 22-32

Sole:

1. Division IIIa.

Cod:

1. SD 22-24

2. SD 25-32

3. Kattegat

b) update the available information on flatfish stocks in the Baltic;

c) for the stocks mentioned in a) and b) perform the tasks described in **C.Res. 2006/2/ACFM01**

WGBFAS will report by 30 April 2007 to the attention of ACFM.

IN: C.Res. 2006/2/ACFM01: Generic ToRs for assessment working groups

The ACFM action plan highlights the need to develop advice based on long term considerations on a fisheries basis and within an ecosystem approach. It is recognized that the required integration of fisheries and ecosystem knowledge can best/only be achieved at the scientific level of the (regional) working groups. The following generic Terms of Reference specifies the tasks of assessment working groups in achieving the objectives of the action plan. The following Terms of Reference are generic, and each individual assessment group should prioritise them according to the detailed rolling planning developed by AMAWGC and to take account of regional developments.

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, AFWG, HAWG, NWWG, WGNPBW and WGPAND will, in addition to the tasks listed by individual group in 2007:

1) set appropriate deadlines for submission of data. Data submitted after the deadline can be disregarded at the discretion of the WG Chair.

2) compile all relevant fisheries data, including data on different catch components (landings, discards, bycatch) and data on fishing effort. Data should be disaggregated by fisheries/fleets.

3) assess the state of the stocks according to the schedule for benchmark and update assessments as shown below.

4) provide specific information on possible deficiencies in the 2007 assessments and forecasts,

- any major inadequacies in the data on landings, effort or discards;
- any major expertise that was lacking
- any major inadequacies in research vessel surveys data,
- any major difficulties in model formulation or available software.

The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.

5) consider knowledge on important environmental drivers for stock productivity (based on input from e.g. WGRED and for the North Sea NORSEPP). If such drivers are considered important for management advice, incorporate such knowledge into assessment and prediction and comment on the consequences for long term targets of high yield and low risk.

6) consider existing knowledge of important impacts of fisheries on the ecosystem;

7) Evaluate existing management plans and develop options for management strategies including target and limit reference points. If mixed fisheries are considered important consider the consistency of target reference points and management strategies;

8) assess the influence of individual fleet activities on the stocks. For mixed fisheries, assess the technical interactions;

9) provide an overview of major regulatory changes (technical measures, TACs, effort control and management plans) and evaluate or assess their (potential) effects.

10) where misreporting and/or discarding is considered significant provide qualitative and where possible quantitative information, by fisheries and the describe the methods used to obtain the information and its influence on the assessment and predictions.

11) present an overview of the sampling on a national basis of the basic assessment data for the stocks considered according to the template that is supplied by the Secretariat

12) implement the roadmap for medium and long term strategy of the group as developed in AMAWGC.

1.3 Working Groups response to ad hoc requests

There were no ad hoc requests to be answered in 2007.

1.4 Fisheries overview Krzysztof

At present the sampling for catch at age information required for assessment purposes is collected based on the size of landing for each stock. For the Member States of the EU this is specified in the Data Collection Regulation (EC No 1639/2001).

The general view today is a wish to develop advice towards mixed species and mulitfleet forecasts. The aim is to implement a sampling programme with emphasis on precision rather than average landings and focus on a fishery based approach to management. ICES advice will be changed in several aspects, as outlined in the new MoU between the European Community and ICES. The objectives of the new advice are:

- changing the advice from mainly short-term to long-term
- transformation of the traditional stock based advice to fisheries based advice
- fisheries advice be revised to include long-term considerations of management targets relating to *inter alia* yield by
- developing concepts for management targets
- identifying targets for individual stocks
- developing methods to evaluate Harvest Control Rules (HCR) and recovery plans
- developing an advisory framework based upon long-term advice with short-term implications.

A basic requirement when adopting a fishery based approach to sampling in the Baltic area is to make national compatible definitions for the fisheries. In many cases a less aggregated sampling scheme is required. This work started in the first Regional Co-ordination Meeting for the Baltic Sea Area in 2003 and the problem has been addressed by providing templates for overviews during the Regional Co-ordination meeting in 2004 and will be filled out for every country. The result will be implemented in the database FishFrame and an analysis of the applicability will be performed. The overviews will also create a background for the calculation of precision in the sampling.

The method of how to identify more management operational units by identifying the concepts of fleet, fisheries and metiers is not obvious and need a general agreement on the course of action. It was therefore agreed in the RCM to adopt the guidelines described in the SGDFF report (ICES 2004, CM /ACFM:11). To achieve a description of fleet segmentation that is in line with the new approach the fleet description underpinning the sampling strategy will be a joint issue of economists and biologists.

It has been recognized that in some areas of the present data collection regulation the data does not give sufficient information for a fisheries based approach (e.g. lacking target stocks and geographical dimensions). In several cases the sampling of small scale fisheries (mainly vessels <10m) is not done on an adequate level.

As there is no available information of the fishery in the new format yet, WGBFAS gives an updated description of Baltic Sea commercial fisheries by countries, fleets and areas as in previous years. For the future WGBFAS adopted the following definitions for fleet, fishery, fishing unit and metier to be used in their work. WGBFAS is aware that definitions are always subjected to revisions and they tend to change.

The definitions at this stage are as follows:

Fleet: A physical group of vessels sharing similar characteristics in terms of technical features and/or major activity (regardless of which species or species groups they are targeting).

Fishery: Group of vessel fishing trips targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area.

Fishing unit: Common denomination for any grouping of voyages (i.e. fishery or métier) or vessels (i.e. fleet), and for any miscellaneous grouping of vessels and/or voyages that does not have the status of a fleet, fishery or métier.

Métier: Homogeneous Subdivision of a fishery by vessel type.

Some major approaches will be revised during the described process. Therefore the fisheries overview given by each country this year will be an updated version of last years entries in the WG Report with the aim to provide descriptions in line with the new objectives in the future.

1.4.1 General overview of the Baltic Sea fisheries

The main target species in commercial fishery are cod, herring and sprat. They constitute about 95 % of the total catch. Other target fish species having either local economical importance or ecosystem importance are salmon, plaice, flounder, dab, brill, turbot, pike-perch, pike, perch, vendace, whitefish, burbot, eel and sea-trout.

The main fisheries for cod in the Baltic use demersal trawls, pelagic trawls and gillnets. The importance of longlines has increased in later years probably due to the low stock size and the possibility to increase effort with maintained quality of the fish. In the cases where longlines are increasing it is in general at the expense of gillnet fishery. There was a substantial increase in gillnet fisheries in the 1990s and because of the change in stock age composition in late 1990's and early 2000. During 2005 the use of passive gears has increased in relation to trawls, which is probably a reflection of the rising fuel prices.

Pelagic trawlers catching a mixture of herring and sprat dominate pelagic fisheries in the Baltic. The proportion of the two species in the catches varies according to area and season. To a minor extent, a predominantly herring fishery is carried out with trap-nets/pound-nets and gill nets in coastal areas as well as with bottom trawls. Pelagic fishery targeting vendace takes place in the northern part of Bay of Bothnia during the spawning period October-November.

The catches of the pelagic species are used for human consumption, reduction to oil and meal and to animal fodder. The allocation of the catches into these categories differs not only by country, but also over time. The usage is to a large extent driven by the market conditions.

While feeding in the sea, salmon are caught by drift nets and long lines and during the spawning run they are caught along the coast, mainly in trap nets and fixed gillnets. Where fisheries are allowed in the river mouths, set gill nets and traps nets are used.

The coastal fishery targets a variety of species with a mixture of gears including fixed gears (e.g. gill, pound and trap nets, and weirs) and Danish seines. The main species exploited are herring, salmon, sea trout, flounder, turbot, cod and freshwater and migratory species (e.g. whitefish, perch, pikeperch, pike, smelt, vendace, eel and burbot. In addition, there are demersal trawling activities for herring, cod and flatfishes in some parts of the Baltic, although the trawling is forbidden in the coastal zone in most of the countries. Coastal fisheries are conducted along the entire Baltic coastline.

1.4.2 Detailed information on fisheries by countries

1.4.2.1 Denmark

The Danish fisheries in Kattegat

The Danish fisheries in Kattegat can be divided into trawling, gillnetting and Danish seine fleet categories by the gears and mesh sizes used as follows:

Trawl fisheries in Kattegat

The trawl fisheries can be divided into four groups:

a) Industrial fisheries targeting mixed clupeids, sandeel and Norway pout. This fishery is carried out using a mesh size of 32 mm in the cod end. Most vessels in this fishery are smaller trawlers (12-16 m).

b) A human consumption herring fishery using mesh sizes of 32 mm in the cod end. This fishery is mainly carried out by the larger trawlers (>20 m).

c) A trawl fishery targeting ***nephrops*** using a 90 mm mesh size. This fishery is mainly carried out by trawlers between 12-16 m. The major season for this fishery is the 2nd and 3rd quarter of the year but tent to be less seasonal in recent years.

d) A human consumption trawl fishery targeting mixed fishes but being mostly dependent on sole, cod and plaice. The mesh size in the cod end is at or above 90 mm. The size of vessel in this fishery is typically between 12 and 20 m.

2/3 of the yearly landings from the human consumption fishery are in the 1st quarter of the year.

Gillnet fisheries in Kattegat

Gillnets varying in mesh-sizes from 90 to about 200 mm are used in Kattegat. The species composition of the catches depends on the mesh size with the smaller mesh sizes (90 to 110 mm) being used when targeting sole and the larger mesh sizes (> 130 mm) for catching cod. Typically it is the smaller boats (<l4 m) which engage in the gillnet fishery.

Danish seines in Kattegat

The Danish seine fishery is of relatively limited importance in Kattegat accounting for a catch value of about a fifth of that taken by the human consumption trawling fleet. This fishery mainly target flatfish (plaice, flounder and dab) but also catches a fair amount of cod. The typical seine fishing vessel is about 12 to 16 m.

The Danish fishery in the Baltic

At present the Danish landings of cod, herring and sprat from the Baltic area can be divided into the following categories:

1) Cod landings from the trawl fishery where a minimum mesh size of 110 mm. and a BACOMA exit windows is mounted.
2) Cod landings from the gill net fishery using a minimum mesh size of 110 mm.
3) Herring landings from a directed fishery for human consumption carried out by trawlers using a minimum mesh size of 32 mm

Sprat landings from a directed fishery for industrial purposes using a mesh size of 16mm.

1.4.2.2 Estonia

Herring and sprat fishery

Estonian Baltic sea fishery is, in general, a trawl fishery and is directed mainly on herring and sprat. Pelagic trawls took, depending on region, from 40 to 99 % of total landings in 2004. The rest were taken as trap net catch of herring at the spawning grounds of herring. The Estonian fishing fleet in the Baltic consists of 233 vessels: 119 vessels of >=300 HP, 101 vessels of 90-150 HP and 13 cod gill-netters of 150 HP and has been rather stable in recent years. The vessel types are described in Table 1.

The total Estonian herring landings from the main fishing areas in the Baltic Sea in Sub-Divisions 28, 29S and 32 amounted to approximately 26,600 t in 2004 and 20,400 t in 2005. 12,500 t were taken from the Sub-division 28 (incl. Gulf of Riga), 2,300t in Sub-division 29 and 5,400 t in the Sub-division 32.

Altogether, 14,900 t were taken by pelagic trawl fishery and 5,400 t by the pound-net fishery on spawning grounds. Catch and sampling information is presented in the Tables 2-5.

Total catch of sprat (49,700) was 60% higher that in 2004 (30,200 t). Most of the catch was taken in the Sub-divisions 28 and 29 in the 1st and 4th quarters. All sprat fisheries are pelagic trawl fisheries.

The information on species composition of mixed sprat/herring catches is obtained from the logbooks, and from the observations of environmental inspectors, regularly visiting the landing sites. No discarding and sorting take place in herring and sprat fishery.

The protection measures enforced: closed season for trawl fishery from15 June to 15 September and ban for use of trawls in coastal areas (below 20 m).

Flounder fishery

Flounder fishery is generally coastal fishery where gillnets, trap nets and bottom seines are used. Altogether 62 t flounder were taken in 2005: (9 t in Sd. 28, 36 t in Sd. 29 and 17 t in Sd. 32. The catches are limited due the low market demand.

Cod fishery

At present the cod is missing in the Estonian EEZ. According to official statistics, the total catch of cod was 972 t in 2005 (1253 t in 2004), and was taken mostly by cod gill-netters in the Sd 25 (800 t). The total catch in Sub-divisions 28,29 and 32 was below 1 t.

Estonian Baltic Sea fishing fleet structure

Vessel category and type	Engine power, HP	Length, m	Quantity
Small vessels			
Wooden trawl boats MSTB STB MRS	54-90 90-150 150 150	12.6-17 17.6 18.5 16	84 14 2 1
	Total		101
Cod gillnetters	150	25.2	13
Medium size vessels			
MRTK-Baltica	300	25.5	45
TB (PTS)	150-300	27.3	59
RS	300	35.7	1
MKRTM	800	35.7	1
Big trawlers of various types	500-800	17-32	13
	Total		119

1.4.2.3 Finland

The Finnish fleet is mainly targeting Baltic herring, sprat, salmon and cod. For fisheries, flounder and coastal freshwater species have local importance. In coastal areas as well as in archipelagos, freshwater species such as European whitefish (*Coregonidae*), pikeperch, perch, pike, and burbot are targeted. Of these, whitefish, pikeperch, and perch have the highest local importance.

The gears used in the fishery statistics are as follows:

- herring trap nets
- salmon trap nets
- European whitefish trap nets
- big trap nets (for Baltic herring)
- pound nets (for Baltic herring)
- gill nets for herring and sprat
- drift net for salmon
- drift net for whitefish
- gill net traps
- less than 36 mm gill nets
- 36-45 mm gill nets
- 46-50 mm gill nets
- 51-60 mm gill nets
- more than 60 mm gill nets
- salmon long line
- other long line or hook
- pelagic trawls (single and pairs)
- demersal trawls (single and pairs)
- rod and line or trolling gear
- winter seine and beach seine.

Fishing information is recorded by statistical rectangles (roughly 55 km x 55 km) and fishing operations.

The number of vessels is given in the text table below. The data are from the Fishing Vessel Register held by EEDCs and Åland provincial government.

	Small scale coastal fishery	Pelagic trawlers	Demersal trawlers	Passive gear vessels	Total
Number	3198	142	2	51	3393
Average machine power	40	280	570	202	51
Average gross tonnage	2	58	224	31	5

The total number of fishing vessels has been round 3500 in commercial fisheries in the Baltic in recent years. Most of the vessels are shorter than 12 meters and used in coastal fisheries. During the last decade, the total commercial Finnish catches in the Baltic has fluctuated between 60 000 and 100 000 tonnes.

Trawling

In pelagic trawl and demersal trawl categories, fishing vessels overlap. Many of the vessels use both pelagic trawl and demersal trawl or the same gear is used in both fisheries. In Baltic herring fishery, pelagic trawl fishery exploits younger part of the Baltic herring stock and demersal trawling is directed to more adult part of the stock.

Pelagic Trawls

Pelagic trawling is used to exploit Baltic herring stocks in the Baltic Main Basin, the Archipelago Sea, the Gulf of Bothnia and the Gulf of Finland. Only few vessels are exploiting directly sprat stock, and sprat is the main by-catch in Baltic herring fishery. In recent years, there has not been any by-catch of cod in pelagic trawl fishery. Usually Baltic herring fishing is conducted as a single trawling. At certain times of the year, vessels may switch to demersal trawling. In autumn, early winter, and spring pelagic pair trawling is used for industrial purposes.

Common to pelagic trawlers, many vessels transfer between the Bothnian Bay (SD 31) and the Bothnian Sea (SD 30), the Bothnian Sea and the Åland Sea (SD 29), and between the Gulf of Finland (SD 32) and the Åland Sea depending on fishing possibilities and ice cover during the winter.

Demersal Trawls

Demersal trawls are used both for Baltic herring and cod. The main target is Baltic herring. Some demersal trawl vessels are targeting Baltic cod and they are mainly fishing in the Main Basin (SDs 24-25). There are some vessels using heavy ground gear but these have declined in numbers, and represent only a small part of the fleet.

Similarly to pelagic trawlers, the demersal trawlers shift between fishing grounds, depending on fishing possibilities and ice cover.

Trap-nets

Trap-net fishery include a variety of trap-net types for Baltic herring, Baltic salmon and European whitefish (*Coregonidae*). Fishery is conducted near the coast and inside archipelagos. Trap-net fishery for Baltic herring is conducted mainly during the spawning season in spring and early summer (May-June), targeting spawning component of Baltic herring stock.

Anchored gill nets

Anchored gill nets are used in Baltic herring, cod, flounder, and freshwater fish fishery along the Finnish coast. This gill net fishery is a predominantly mixed fishery located near the coast, conducted by small vessels except those few vessels targeting cod in the Baltic Main Basin.

1.4.2.4 Germany

Herring fleet

The German Baltic herring fishing fleet consists of two segments:

- coastal fleet with boats <12 m
- cutter fleet with vessels >= 12 m.

All landings account for the directed fishery.

In the years 2003 to 2006 the following types and numbers of vessels fished for herring in the Baltic Sea (i.e. total landings contain more than 20 % herring):

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2003	**Fixed gears (gill/trapnet)**	**<12**	333	1,665	13,432
		>=12	310	733	3,835
	Trawls	**<12**	13	643	52
		>=12	36	6,759	21,493
		Total	692	9,800	38,812
2004	**Fixed gears (gill/trapnet)**	**<12**	380	1,905	15,330
		>=12	10	733	3,835
	Trawls	**<12**	8	415	3,250
		>=12	47	8,851	27,910
		Total	445	11,904	50,325
2005	**Fixed gears (gill/trapnet)**	**<12**	505	1,812	15,534
		>=12	11	189	1,274
	Trawls	**<12**	12	214	1,859
		>=12	62	4,852	14,939
		Total	590	7,067	33,606
2006	**Fixed gears (gill/trapnet)**	**<12**	517	1,782	15,673
		>=12	16	545	2,482
	Trawls	**<12**	13	220	2,055
		>=12	62	4,404	14,227
		Total	608	6,951	34,437

Sprat fleet

The German sprat fishing fleet in the Baltic Sea mainly consists of a:

- cutter fleet with vessels >= 12 m.

All catches for sprat are taken in a directed trawl fishery:

In the years 2003 to 2006 the following fleet segments fished for sprat in the Baltic Sea (i.e. total landings contain more than 20 % sprat):

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2003	Trawls	>=12	6	1,531	3,716
2004	Trawls	>=12	26	2,750	7,682
2005	Trawls	>=12	38	3,479	10,289
2006	Trawls	>=12	33	3,134	8,685

Cod fleet

In the years 2003, 2004 and 2005 the following types and numbers of vessels fished for cod in the Baltic Sea (i.e. total landings with more then 20 % cod):

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2003	Gillnets	<12	453	1,962	17,097
		>=12	12	733	3,835
	Trawls	<12	13	643	52
		>=12	80	6,759	21,493
		Total	558	10,097	42,477
2004	Gillnets	<12	447	1,750	15,210
		>=12	15	916	4,780
	Trawls	<12	29	895	7,190
		>=12	82	6,959	22,110
		Total	573	10,520	49,290
2005	Gillnets	<12	601	2,041	18,719
		>=12	19	463	2,954
	Trawls	<12	30	465	4,165
		>=12	96	6,928	21,877
		Total	746	9,897	47,715
2006	Gillnets	<12	598	2,117	19,781
		>=12	22	948	4,197
	Trawls	<12	33	455	4,226
		>=12	95	6,432	20,603
		Total	748	9,952	48,807

In general, the German trawl fishery is a mixed fishery targeting cod, but with a by-catch of flounder (Sub-divisions 24 and 25) and dab (Sub-division 22).

The main fishing season according to peak landings were:

2004

- SD 22 and 24 in the 1st and 4th quarters,
- SD 25 in the 2nd quarter,

2005

- SD 22 and 24 in the 1st, 3rd and 4th quarters,
- SD 25 in the 1st, 2nd and 4th quarters,

2006

- SD 22 and 24 in the 1st, 3rd and 4th quarters,
- SD 25 in the 1st and 2nd quarter,

The Tables below show the temporal percentage distribution of cod landings in 2004, 2005 and 2006 by Subdivision:

2004

Quarter	Subdivision 22	Subdivision 24	Subdivision 25
1	57	28	21
2	11	26	68
3	12	8	2
4	19	38	9

2005

Quarter	Subdivision 22	Subdivision 24	Subdivision 25
1	27	17	20
2	17	27	19
3	31	33	8
4	25	23	53

2006

Quarter	Subdivision 22	Subdivision 24	Subdivision 25
1	52	23	46
2	8	11	52
3	20	19	0
4	20	47	1

The monthly distribution of cod fishery is as follows:

- January to May and September to December in Sub-division 22,
- January to May and September to December in Sub-division 24, and
- January to May/June in Sub-division 25, on pre-spawning concentrations in the Bornholm Basin.

In 2002 and 2003 the landings taken by gillnets amounted to 30 % and 40 %, respectively.

In contrast to previous years, when gill netting was mainly conducted in the western areas (Subdivision 22, Schleswig- Holstein), the share of gill netting increased substantially to about 30% in Subdivision 24 (Mecklenburg/Vorpommern) in 2004. In 2006 the share of gill netting has stabilized on last years' level.

The percentage distribution of cod landings taken by gillnets in 2004, 2005 and 2006 by Subdivision and quarter are shown in the tables below:

2004

Quarter	Sub-division 22	Sub-division 24
1	19	38
2	48	18
3	29	16
4	46	42
Average	28	33

2005

Quarter	Sub-division 22	Sub-division 24
1	23	31
2	30	24
3	28	18
4	53	28
Average	33	24

2006

Quarter	Sub-division 22	Sub-division 24
1	18	33
2	28	20
3	24	3
4	57	54
Average	27	36

Flatfish fleet

German flounder landings are mostly taken as by-catches in the directed cod fishery (see cod fleet structure above). In Subdivision 24 a trawl fishery directed to flounder is mainly conducted in the 3rd and in the 4th quarter. The share of that fishery is estimated to be about 35 % of the total flounder landings. Only a small amount of flounder is caught by passive gears. Since 1995 on average, about 85% of flounder has been caught by trawl in SD 24. Nearly all flounder in SD 25 is fished by trawls. In 2004 a trawl fishery started to target dab.

1.4.2.5 Latvia

Herring fishery

About 85% of the total Latvian herring catches are taken by trawls and 15% by trap-nets. Latvian herring fleets are operating in the Gulf of Riga (eastern part of Sub-division 28) and in the Sub-divisions 26 and 28 of the Baltic Main Proper.

In the Gulf of Riga there are two main kinds of fleets: trawl fleet and trap-net fleet. Trawl fleet is operating all year around except 30-day ban in May-June during the peak spawning of herring. Besides in cold winters fishery is stopped because of ice coverage of the Gulf of Riga. In the Gulf of Riga, herring is the dominating. The trawl fishery (mesh size 28 mm) is targeting herring. There is small amount by-catch of sprat in herring fishery. In Latvia the number of trawlers as well as the total engine power has not been allowed to increase since the end of 1990s. Each fishing company receives yearly catch quota. Recently the number of trawlers is gradually decreasing due to scrapping.

The trap-net fishery takes place during the spawning period from mid-April till July. The trap-net fishery is targeting on spawning fishes. The number of trap-nets has been limited and number of nets has been rather stable since the mid-1990s.

In the Baltic Main Proper herring fishery is trawl fishing. The number of trap-nets is minimal. Since 2002 herring targeted fishery has been forbidden and the by-catch of herring in the sprat-targeted fishery has been limited to 5%.

Sprat fishery

Latvian sprat fishing fleet is operating in Sub-divisions 26 and 28 of the Baltic Sea Main Proper. In the Gulf of Riga sprat targeted fishery (mesh size 16 mm) is forbidden. Sprat is caught with pelagic trawls all year around with lower intensity during the summer months. Sprat is mainly fished for human consumption. Each fishing firm receives yearly catch quota of sprat and the corresponding herring catch quota.

Vessel length	Data	Year	
		2005	2006
Less than 24 m	Catch, t	1865	3192
	Total duration, hour	18529	15402
	Catch per hour, kg	101	207
	Number of vessels	40	39
24-41m	Catch, t	62835	51339
	Total duration, hour	54134	39013
	Catch per hour, kg	1161	1316
	Number of vessels	74	65
More than 41m	Catch,t		108
	Total duration, hour		106
	Catch per hour, kg		1020
	Number of vessels		1

Cod fishery

In 2006 Latvian fishing fleet catching cod in direct fishery consisted of 63 vessels. The main reason of such decrease of ship number was ship cutting. Twenty – five trawlers larger than 24 m were catching cod using mainly bottom trawls (83.5 % of their catches). One trawler smaller than 24 m was catching cod using bottom trawl only. Other 37 ships were gill-netters. In 2006 two gill-netters worked with loglines too (approximately 0.5 % of catches in this fleet segment). This fleet segment took the 57.2 % from the Latvia cod catches.

It is not possible determine how much boats are involved in cod direct fishery (reason – coastal logbooks are not linked with boats register data).

Data about cod fishery fleet gross register tons (GT), main engines (KW) end effort are included in following table.

Segment	Year	Number	Total GT	Total KW	Trawling hours	Fishing days
Trawlers_>24 m	2005	27	3005	6102	11578	
	2006	25	2778	5827	18404	
Trawlers_<24 m	2006	1	204	353	368	
Gill-netter	2005	41	3447	6538		4103
	2006	37	3051	6055		3503

Flounder fishery

Number of vessels involved in direct flounder fishery was similar last two years (2004 – 25 vessels, 2005 – 27 vessels). Usually flounder was caught as by-catch in cod fishery. Specialised flounder fishery was active only in last quarter. Total landing as well as trawling hours was more than doubled in 2005. Landing increased in all segments, except gill-netter, were fishery realised only one vessel. Total landing in subdivision 28 was highest since 1976.

Landing increased due to better market price therefore fishermen started specialised flounder fishery, especially in the last quarter when 56 % of Latvian open sea landings were realised. Since 2005 Latvian fishermen haven't TAC for flounder fishery in Latvian waters.

SEGMENT	YEAR	NUMBER	TOTAL GT	TOTAL KW	TRAWLING HOURS	FISHING DAYS
Trawlers >24 m	2004	23	2534	5369	1721	
	2005	26	2856	5734	3775	
Gill-netter	2004	2	259	353		33
	2005	1	187	221		4

1.4.2.6 Lithuania

General information

Lithuanian Baltic Sea fishery by landings is, in general, a trawl fishery and in 2005 was directed mainly on cod and sprat. The all Lithuanian cod, herring, sprat, flounder catches was fished in subdivision 26 and landed in Lithuania ports. Species composition based on logbooks, landing declarations and sporadically checked by fishery inspectors in harbours and on ships. The protection measures enforced: closed season for cod trawl fishery from 15 June to 15 September and ban for use of trawls in coastal areas (below 20 m).

Fleet characteristics

The Lithuanian fishing fleet in the Baltic consists of 267 vessels: 192 vessels of < 12 m long, 15 vessels 12 – 24 m long, 15 vessels gill-netters and 45 vessels trawlers of 24 – 40 m long (2004 year data). The vessel types and landings by each are described in Table 1. In pelagic trawl and demersal trawl categories, fishing vessels overlap. Many of the vessels use both pelagic trawl and demersal trawl or the same gear is used in both fisheries. The main type of Lithuanian fishing fleet vessels is MRTK, with engine power up to 300 h.p. up to 27 m length, equipped with otter bottom or otter pelagic trawls, some of them use gill nets for specialised cod fishing and very occasionally drift nets and long-lines.

Parameter	Measure	Number
Coastal vessels <12 m		
Number of vessels	Units	192
Length	M	6
BT	1000 BT	0.431
kW	1000 kW	4.524
Landings	T	591
Gillnetters 12-24 m		
Number of vessels	Units	15
Length	M	17
BT	1000 BT	0.496
kW	1000 kW	1.583
Landings	T	254
Gillnetters 24-40 m		
Number of vessels	Units	15
Length	M	26
BT	1000 BT	1.145
kW	1000 kW	2.283
Landings	T	562
Baltic trawlers: 24-40 m		
Number of vessels	Units	45
Length	M	27
BT	1000 BT	5.727
kW	1000 kW	10.527
Landings	T	11172

Coastal fishery

For fisheries, coastal freshwater species have local importance. In coastal areas, cod and herring as well as freshwater and migratory species such as smelt, pikeperch, perch, vimba are targeted. Most of the vessels are shorter than 12 meters.

Demersal trawl fishery

In general, the Lithuanian demersal trawl fishery is a mixed fishery targeting cod but with big by-catch of flounder. These fishes are fished mainly by vessels type MRTK. Mainly demersal trawlers operates in autumn and wintertime.

Pelagic trawl fishery

Some of the withdrawn vessels were involved in herring exploitation. Therefore, Lithuanian herring landings decreased 2.4 times in 2005 as compared with 2004. Most of the herring catches in 2005 were taken in the first two quarters of the year (80%) as well as sprat catches (96 %). Total catch of sprat (8560,457 t) was 5,2 times higher than in 2004 (1645,3 t).

Gillnet fishery

This fishery is targeting for cod with a small landing of a flounder and turbot. In 2005 about 24 % of cod was taken.

Seasonality

As characterized by the following table, the main seasons according to peak landings are.

2004 year	2005 year
Cod in the I, IV quarters - 66 % of total catches	Cod in the I, IV quarters - 71 % of total catches
Flounder in the I, IV quarters - 88 % of total catches	Flounder in the III, IV quarters - 71 % of total catches
Herring in the I, IV quarters - 84 % of total catches	Herring in the I, II quarters - 80 % of total catches
Sprat in the I, IV quarters - 82 % of total catches	Sprat in the I, II quarters 96 % of total catches

1.4.2.7 Poland

General information

Since the end of 2004 Polish fisheries has undergone significant changes resulting from capacity reduction programme co-funded by EU. By the end of 2005, 300 fishing vessels (15,000 GT) from 1235 active vessels (including boats) have been withdrawn. The scrapping continued in 2006 but to much lesser extend. Fleet scrapping program reduced considerably the number of stern trawlers (25 m) specializing in pelagic fish catches. It resulted in remarkable decline of Polish sprat and herring landings by 44% and 26% respectively in 2006 as compared with 2004. In total Polish landings of sprat, herring, flounder and cod have fallen by 33% in comparison with 2004. High costs of fuel, low prices of fish, prolonged ban on cod fishing and many stormy days were the additional factors determining low catches in 2006.

Cod fishery

The main gears used in the cod fishery were bottom trawl and gillnets which have caught approximately 90% of the cod catches since many years. Since 1998 a rapid increase in application of long-lines has been observed resulting in a steady increase in the share of that

gear in total catches of cod (1.7% in 1998, 18.4% in 2006). Trawls are equipped with codends having 110 mm meshes in selection window. Minimum mesh size in gillnets is 110 mm. Cod fishing vessels are operating only in Polish fishery zone. The main fleet segments involved in cod catches are demersal trawlers of the length groups 12-<24 m and 24-<40 m. In the latter fleet segment, cod constituted in 2006 63% of all species taken. Two another fleet segments directed mainly at cod are gill-netters 12-<24 m and 24-<40 m. In 2006, in the segments gill-netters 12-<24 m and 24-<60 m cod accounted for 78% and 64% of volume of landings respectively.

Time and spatial distribution of cod catches was very uneven. Cod fishery in 2006 was mainly conducted during January-May (51%), while only in November-December it constituted 40% of the total catch in 2006. Similarly to 2005, the main volume of cod catches in 2006 was taken in Sub-division 25 (60%). Catches taken in Sub-divisions 26 and 24 amounted to 35% and 5% of the total catch, respectively.

Flatfish fishery

Of three flatfish species (flounder, plaice and turbot) inhabiting the southern Baltic, flounder is most abundant and its catches both dominate and are most important in Polish flatfish fishery.

Flounder is mainly fished with bottom trawl and gillnet: 61% and 35%, respectively in 2006. The main Polish flounder fishing area is Sub-division 25 which contributed 63% of the total flounder catch in 2006.

Share of turbot in flatfish catch till 1990s was in practice close to zero. In consequence the turbot and plaice species were not sorted out but sold together as flounder. For statistical purpose the flatfish catch splitting by species was carried out by the scientists of SFI in Gdynia on the basis of samples from landed catch. Estimated catch of turbot reached 98.7 t in 2006.

Plaice was more frequently fished on the fishing ground located within the boundaries of Subdivisions 24 and 25, where in some years it contributed up to 25% of the total flatfish catch. In Subdivision 26 plaice usually provides less than 3–5% to the total flatfish catch. Estimated catch of plaice reached 55 t in 2006.

Since the beginning of the 1990s turbot catches increased due to access to foreign markets and an increasing demand on domestic market, which in turn resulted in better prices paid to fishers. Nevertheless, a part of the fished plaice is still unsorted and sold together with flounder. A part of the volume of plaice taken and landed with flounder is estimated from the sampling data.

Herring fishery

Most of the withdrawn sprat vessels were also involved in herring exploitation. Therefore, Polish herring landings were by 10% lower in 2006 as compared with 2005. In addition, low prices for herring as compared with relatively high fuel prices also influenced on the decrease of herring catches. During 2005 more than 20 vessels specializing in herring fishery were scrapped. In Poland there are four fleets operating in Baltic herring fishery. The first fleet is exploiting herring stocks in the open sea area (pelagic trawlers 24-<40 m) and second fleet consists of small cutters with herring bottom single and/or pair trawls (bottom trawlers 12-24 m). Herring fishery by trawl is carried out during the whole year, however the highest catches are observed during May-November. The third and fourth fleets are fishing in the coastal area (small boats) either with gillnet or/and trap nets. This type of fishery is carried out mainly in April-May on the spring herring spawning grounds.

Sprat fishery

Similarly to herring fishery, sprat fishery was also affected by fleet reduction resulting in a decrease of sprat catches. The sprat fleet consists mainly of pelagic stern trawlers 24-40 m. In that fleet segment sprat was the most important species accounting for about 80% of total landings. About half of sprat catches is used for a reduction to fishmeal and landed primarily in Danish and Russian ports. Sprat vessels are operating in the open sea area. Most of the sprat catches in 2006 was taken in the first two quarters of the year (92%) and in Sub-division 26 (68%).

1.4.2.8 Russia

Pelagic fleets

Sprat is fished in Subdivisions 26 by two type of fleets:

1) vessels type SRTM with engine power of 1050 h.p.,
2) small vessels with engine power up to 300 h.p.

The first fleet (1 vessel), having the trawls with high vertical opening with mesh opening 18 mm, operate in the areas deeper than 50 m and according to national regulation they obliged to use the sorting machines, that can separate herring from sprat. This fleet, targeting sprat for the human consumption, during I-II quarters.

The species composition of the mixed catches is defined from logbooks and, partly, by observers of AtlantNIRO (Kaliningrad), on board of larger commercial vessels in compliance with the special agreement between institute and vessel owners.

The small vessels fleet (up to 24 vessels) operates mainly within 12-NM limit, targeting herring in the period from October to March. Mesh size in the trawl bag is 32 mm opening. The by-catches of sprat in quarter I can reach 82-92 %. In the period from March to September this fleet target on sprat with by-catches of herring up to 8-17 %. The species composition of this mixed fishery defined from logbooks and sporadically checked by fishery inspection in harbors.

Russian fishermen utilized their low herring quotas as much as possible and have not utilized the sprat quotas. This fact with increasing sprat TAC and decreasing herring TAC created a strong incentive to misreport herring as sprat. This situation took place in target herring pelagic fishery in SD 32 (Eastern part) where usually sprat by-catches is negligible, but in recent years fishermen reported the by-catch of sprat about 2.0 th. tones annually. The analogous situation may take place in SD 26 in the small fleet mixed sprat and herring fishery.

Demersal trawl fleet

The basic commercial fishes on a demersal trawl catches - a cod and a flounder. Cod and flounder are fished mainly by vessels type MRTK, MRTR (up to 16 vessels per fishing day), with engine power up to 300 h.p. up to 27 m length. These commercial vessels are fishing with bottom trawls using the BACOMA windows (120 mm mesh opening). Parameters of work of a demersal trawl fleet are shown in table.

Parameters of demersal trawl fleet	Quarter				Average for a year
	1	2	3	4	
Number of vessels in 1 day	5	6	2	3	4
Landings of 1 vessel for 1 day, t	1.51	1.54	1.22	1.60	1.5
Cod in catches, %	52.1	92.0	13.3	27.0	46.1
Flounder in catches, %	47.6	8.0	86.7	72.7	53.8

Gillnet fleet

This fishery is targeting for cod with a small landing of a flounder and a turbot (excepting catch in 3 quarter where the landing of a flounder 16.5 % and turbot 2.4% has made). Fishermen caught a cod and a flounder mainly by vessels type SCHS, TB, PTS, MRB, MSTB (up to 30 vessels per fishing day), with engine power up to 225 h.p. This vessels are using the anchored gillnets with mesh opening of 110-120 mm. According to statistics in 2006 more than 61 % of cod were taken by gillnetting. Parameters of work of a gillnet fleet are shown in table.

Parameters of gillnet fleet	Quarter				Average for a year
	1	2	3	4	
Average number of vessels in 1 day	15	18	4	8	11
Number of gillnets in 1 day	3977	4840	790	1753	2840
Landings of 1 net, kg	1.36	1.75	1.86	2.27	1.81
Cod in catches, %	98.2	94.9	80.6	86.9	90.1
Flounder in catches, %	1.8	4.6	16.5	12.3	8.8

Pound net fleet

This type of fishery exists in the Vistula Lagoon and Eastern part of Gulf of Finland. This fishery is targeting herring.

Methods used to determine species compositions for officially reported landings

Species composition based on logbooks, landing declarations and sporadically checked by fishery inspectors in harbours and on ships.

1.4.2.9 Sweden

The Swedish fishing fleet

An overview of the Swedish fishing fleet in 2004

	Total	Sum of Segment	Pelgic fleet *24 m	Pelagic fleet <24m	Shrimp trawlers	Dem. trawl fleet for cod *24m	Dem. trawl fleet for cod <24m	Nephrops fleet	Demersal vessels (passive gears) 12m	Small vessels for cod (passive gears) <12m
Landings (000) tons	268.4	263.3	222.1	17.5	3.3	4.2	9.0	1.4	1.9	4.0
Landings (mEUR)	91	89.2	37.1	8.2	10.1	5.4	14.0	5.5	2.8	6.1
Number of vessels	1672	522	55	55	53	13	74	67	37	168
GT total (000)	45.7	40.7	21.8	1.9	4.7	2.5	5.0	2.4	1.0	1.4
kW total (000)	220,8	160	64.4	13.2	17.8	7.8	22.7	14.6	5.9	13.6
GT (Mean)	27.4		396.4	31.9	89.2	195.1	68.1	35.5	27.8	8.4
kW (Mean)	133.4		1171	220	336	602	307	218	160	82
Swedish fishing fleet in 2004	Total	Sum of Segment	Pelgic fleet *24 m	Pelagic fleet <24m	Shrimp trawlers	Dem. trawl fleet for cod *24m	Dem. tarwl fleet for cod <24m	Nephrops fleet	Small vessels (passive gears) *12m	Small vessels for cod (passive gears) <12m
Target species (volume)			herring	herring	Nothern Prawn	cod	cod	Norway lobster	cod	cod
			sprat	sprat	Cod	saithe	Other species	cod	herring	
			Blue whiting	Other species	Norway lobster	Haddock	Norway lobster	Plaice	salmon	

The Kattegat fishery

The demersal fishery in the Kattegat targets nephrops, cod and flatfishes (plaice and sole). Back in the 1950s and 1960s there was also developed fishery on haddock and pollack, but due to the decline of these stocks the fishery on haddock and pollack is more or less non-existing at the present. The cod is mostly fished during the spawning period in the first quarter of the year by a trawl fishery directed on the spawning grounds. At present, such spawning grounds are found in the south-eastern part of the Kattegat, although several more spawning ground, located in other parts of the Kattegat, have been exploited in the past. The nephrops fishery takes place the whole year around in the deeper parts of the Kattegat. The by-catch of cod, in particular, in the nephrops fishery has declined profoundly in the last 25 years. The flatfish fishery is located to various fishing grounds in the Kattegat area. There also exists an artisanal fishery on eel and crab in shallow waters. The pelagic fishery is the dominating fishery in terms of biomass. This fishery targets herring and sprat. There are no signs of dramatic changes in abundance of herring and sprat in the Kattegat in recent years.

Baltic herring and sprat fishery

The Swedish fishery for herring and sprat in the Baltic is carried out by four fleet categories:

Trawlers catching herring with a minimum mesh size of 32 mm. This fishery is for human consumption and for meal/oil.

Trawlers catching sprat with a minimum mesh size of 16 mm. A part of the landings is used for human consumption. Most of the landings are used for industrial purposes. Herring is caught as by-catches in this fishery.

Coastal fishery for herring with gillnets. This fishery is for human consumption.

Purse seine fishery near the coast for spawning herring in the second quarter of the year. This fishery is also for human consumption.

Most of the Swedish landings of herring and sprat from the Baltic are from pelagic trawls and also with bottom trawls for herring. Fishing with gillnets for herring is of local importance in the coastal fisheries, especially in the northern Baltic.

Baltic cod and flatfish fishery

The Swedish fishery for cod and flatfishes in the Baltic is carried out by four fleet categories, all fisheries are for human consumption:

Trawlers catching cod with a minimum mesh size of 120 mm (diamond mesh) or 105 mm (selection window). Flatfishes are caught as by-catches in this fishery.

Baltic gillnetters/longliners fishing for cod with a minimum mesh size in the gillnets of 105 mm. Flatfishes are caught as by-catches in this fishery. Longlines are starting to increase on the behalf of gillnetters in this category.

Gillnetters fishing for flatfishes. Cod is caught as by-catch in this fishery.

Coastal fishery with trap nets for eel and other species. Cod and flatfishes are caught in this fishery.

In the 1980s the Swedish landings from the western cod stock increased to about 10 to 20% of the total landings from the area. The Swedish landings have since then remained at that level. The Swedish share of the total landings from the eastern cod stock has increased steadily since the early 1980s to about 20-25 % in recent years. The Swedish fishery for cod and flatfishes in the Baltic is carried out by four fleet categories, all fisheries are for human consumption:

Trawlers catching cod with a minimum mesh size of 120 mm (diamond mesh) or 105 mm (selection window). Flatfishes are caught as by-catches in this fishery.

Baltic gillnetters/longliners fishing for cod with a minimum mesh size in the gillnets of 105 mm. Flatfishes are caught as by-catches in this fishery. Longlines are starting to increase on the behalf of gillnetters in this category.

Gillnetters fishing for flatfishes. Cod is caught as by-catch in this fishery.

Coastal fishery with trap nets for eel and other species. Cod and flatfishes are caught in this fishery.

1.5 Reviews of groups or work important for WGBFAS

1.5.1 Baltic International fish survey Working Group (WGBIFS)

Reports of the WGBIFS meeting in 2007 was given by Rainer Oeberst:

1.5.1.1 Baltic international acoustic surveys (BIAS)

Results of the acoustic surveys in May and October 2006 were discussed, and it was concluded that the new design of the surveys where each rectangle is mandatory covered by one country improves the quality of indices. It was recommended that the indices which are based on the acoustic survey in October 2006 can be used for the assessment without any restrictions. the estimates of the acoustic survey in 2006 should be added to the time series of stock indices of herring and sprat which is used by WGBFAS in 2006 because the reworking of BAD1 database could not be finished yet.

Analyses were presented during the meeting of WGBIFS which have shown that the area corrected stock indices of sprat which are based on the acoustic surveys in May are correlated with the estimates of the VPA and can be used as additional tuning fleet for the stock assessment. The area corrected estimates of the acoustic surveys in May 2006 can be used for the stock assessment. Different studies were presented during the meeting which were related to different aspects of the combination of the data of acoustic surveys in the Baltic Sea (stratification, combination of the results of fishing stations). It was agreed that these studies should be continued based on extended time series and that proposals of new stratifications should be discussed during the next meeting.

1.5.1.2 Baltic international bottom trawl surveys (BITS)

Results of the trawl surveys in November 2006 and spring 2007 were discussed. It was recommended that the results of these surveys can be used for the stock assessment without any restrictions because the planned and realized hauls corresponded well. Changes of the position were only necessary for a small number of stations due to wrecks, rocky bottom, gill nets etc. The evaluation of the status of the planned reworking of cod and flounder data have shown that all cod data were checked by the countries that the reworked data are stored in the DATRAS system. Reworking of flounder data is not finalized by all countries until now. The feedback from the trawl surveys was used to improve the Tow Database. Furthermore, the next trawl surveys and special investigations during the trawl survey in November 2007 were planned. Acoustic measurements in combination with midwater trawls will be realized by Denmark in the Bornholm Basin during the trawl survey in November 2006 to estimate the cod density in the pelagic waters above the used standard gear of the trawl surveys in areas with oxygen deficiency close to the bottom. Sweden plans special experiments in the same area.

1.5.2 Working Group on Integrated Assessments in the Baltic (WGIAB)

A report from the WGIAB meeting in March 2007 was given by Anna Gardmark:

The ICES/HELCOM Working Group on Integrated Assessments (WGIAB), established by the Baltic committee (Resolution 2006/2/BCC04), met in Hamburg, Germany, March 2007 (co-chairs: Christian Möllman, Bärbel Müller-Karulis, Juha Flinkman) to

- update and further develop the Integrated Assessments (IA) for the Central Baltic Sea and the Gulf of Riga and starting IAs for other subsystems of the Baltic Sea
- cooperate with the HELCOM Biodiversity Assessments (BA), especially by integrating fish and fishing pressure in the HELCOM work

- develop an adaptive management framework (DPSIR) to support the HELCOM Baltic Sea Action Plan
- develop a common indicator database jointly with the HELCOM and ICES Secretariats and link the data to the HELCOM indicator fact sheets
- prepare ecosystem overview and assessment documents as the basis for ecosystem-based management, coordinating the work with HELCOM MONAS and HELCOM Projects (e.g. BIO and EUTRO-PRO) and ICES (e.g. WGRED) activities
- provide an inventory on survey and monitoring activities by the different countries for a sound planning of future IAs, taking into account the inventories developed by HELCOM EUTRO-PRO and HELCOM BIO
- review the various ecosystem modelling approaches available for the area, and their importance and utility towards future IAs.

The WGIAB compiled time series on ecosystem components including hydrography, nutrients, phyto- and zooplankton, benthos, fish, and fisheries, for four areas, the central Baltic sea (CBS; 1974-2005), the Bothnian Sea (BoS; 1979-2005), Gulf of Riga (GoR; 1973-2005), and Gulf of Finland (GoF; 1979-2005). The long term trends in each of the ecosystem components were described, as well as the general characteristics of the ecosystems in each sub-basin or gulf. Integrated assessments using principal component analysis (PCA), chronological clustering, and redundancy analysis (RDA) with forward selection was made on each area to identify possible trends in overall ecosystem composition, and corresponding driving forces. The PCAs in combination with chronological clustering identified a major shift in ecosystem composition in all areas (Text Table 1.5.2.1), which all can be described by moving from relatively saline ecosystems with abundant marine zooplankton and, for the CBS, high cod biomass, to warmer and more brackish ecosystems with high clupeid biomass (sprat in the CBS, herring in the other areas). The main explanatory variables identified in the RDA (Tables 1.x.x) were the same across all areas – salinity and temperature – suggesting that climate change with less frequent inflows, increasing run-off and elevated temperatures is the main driving force behind the ecosystem shift, although additional explanation is obtained by fishery related variables.

Table 1.x.x Ecosystem regime shifts identified in Integrated Assessment by WGIAB

Area	Regime 1	Regime 2 [1)]	Explanatory variables			
CBS	1974-1987	1994-2005	salinity	temperature		
BoS	1979-1989	1990-2005	salinity	temperature	max. ice cover	fishing effort
GoR	1973-1988	1994-2005	salinity	temperature	B. Sea Index	PO_4
GoF	1979-1995	2003-2005	salinity	temperature	PO_4	NO_3

[1)] years intermediate to Regime 1 and 2 were identified as transition periods.

The WGIAB asked for closer interaction with WGBFAS, and increased participation by fisheries scientists, to ensure that the approaches taken by WGIAB are useful in the fisheries assessments (ICES 2007c). During the presentation of WGIABs work to WGBFAS (by Anna Gårdmark), the following topics of interest to the WGBFAS were identified by the plenary:

- How well do the periods of the different ecosystem regimes correspond to the years identified by e.g. WKREF and to years for averaging recruitment used in predictions by WGBFAS?
- Can observed trends in fisheries data (e.g. growth changes) be explained by environmental data? [The WGBFAS pleanary also pointed out the importance of avoiding overlap with the XXXX on this issue]
- Why is the correlation between the temperature-zooplankton and herring recruitment in the Gulf of Riga (used for short term predictions) breaking down in recent years?
- Why does the current regime in the Central Baltic Sea show lower herring biomass compared to the previous regime, whereas the regime shift in all other areas correspond to

increases in herring biomass? In particular when the explanatory variables, salinity and temperature, are the same across all areas?

– Is there environmental factors that can explain why the 2002 year class is so strong in all herring stocks in the Baltic Sea?

1) Preparation by WGIAB of descriptions of both long term trends, and changes in the last years in the ecosystem, to identify environmental changes important to consider in the assessment work (and to be incorporated in the section on Ecosystem Considerations in the WGBFAS report.)

1.5.3 Study Group on multispecies assessment in the Baltic (SGMAB)

A presentation of the SGMAB was given by Fritz Köster.

The Study Group on Multispecies Assessment in the Baltic (SGMAB) has convened for the last time in November 2006 and focused on the following tasks:

i) update and correct the multispecies database (i.e. catch in numbers, maturity ogives, mean weight at age) for the Eastern and Western Baltic to enable bi-annual key-runs for both areas;

ii) conduct MSVPA key runs to supply WGBFAS with updated predation mortalities for herring and sprat singles-species assessments;

iii) develop, apply and validate enhanced multispecies models, e.g. the new Stochastic MultiSpecies model (SMS);

iv) explore the effect of heterogeneous distribution of predator and prey on species interactions in the Central Baltic and investigate the need and possibilities to integrate this heterogeneity into multispecies models;

v) implement and evaluate the suitable medium- to long-term projection methodology for simulation of stock and catch development under different fishery scenarios and management objectives.

A series of additional ToR were covered, such as to review the progress of the stomach sampling program, its sampling protocols and set-up of formats for inclusion of new information in the international stomach content database. The group dealt as well with possibilities to include coupled weight at age, proportion of maturity at age and consumption process models in multispecies prediction models.

The SGMAB recommend that a Study Group on Baltic Fish and Fisheries Dynamics (SGBFFD) will be established. This group should have a wider geographical and ecological remit than was the case for SGMAB and thus it will form an improved linkage between scientific activities within physical, chemical and biological oceanography, as well as fish stock assessment, which is a pre-requisite for the ICES Strategic Plan and BSRP goals of developing and implementing a holistic approach to ecosystem and fisheries management in the Baltic.

This new group is expected to provide an essential interface with the Study Group on Multispecies Model Development (WGMSAM) and will be responsible for performing multispecies assessments for the Baltic by utilizing the models developed in WGMSAM. One of the main goals of the Group is also to develop the methodology further to integrate environmental information in fish stock assessment and prediction tools and to implement these in the assessment of Baltic cod, sprat and herring stocks.

1.5.4 Workshop on Age Reading of Flounder

A report of the WKARFLO meeting in 2006 was presented by Georgs Kornilovs:

Knowledge of the biology and stock structure of the Baltic flounder were reviewed and discussed. Studies suggest that there are two different ecological and genetic types of flounder, a northern type with demersal eggs and a southern type with pelagic eggs.

Participants presented national sampling, processing and age determination methods. Regular sampling of flounder is done in Sub-divisions 23-29 and 32. Most institutes determine ages from whole otoliths but the sectioning and staining method is preferred by a few countries.

Results from an exchange experiment were presented. Altogether 6 samples of whole otoliths and 4 samples of sectioned and stained otoliths had been read by 4-10 persons. The overall agreement for whole otoliths were 62 % (CV=20%) while for sectioned and stained otoliths agreement was lower, 53 % (CV=22%).

Age determination by reading whole, burnt or sectioned otoliths was evaluated in a WS experiment. From each sampled fish one otolith was left whole and the other one either broken and burnt or sectioned. Participants were asked to state the number of winter rings and to mark the rings on a photo of the otoliths. The sectioned otolith technique had the highest percentage agreement (51%) and lowest CV (16%) while the burnt and whole otoliths had a lower level of agreement (40%) and higher CV (20 and 22% respectively). The markings on photos revealed large disagreements among readers where the actual rings were located.

After extensive discussions, a re-reading of two sectioned samples from the exchange program was done. The percentage agreement was significantly higher in the rereading compared to the original readings in both sets of otoliths (70% compared to 59% and 62% compared to 48%). Results indicate a higher consistency among readers than obtained prior to the workshop.

A first draft of an international manual for age determination of Baltic flounder was discussed during the meeting. It was agreed that the objective of the manual is to provide quality assurance among and within national laboratories.

It was recommended that sectioning and staining of otoliths should be used for the age determination of Baltic flounder. The second-best method is the broken and burnt method.

Training of age determination by sectioned otoliths will be achieved by an intercessional exchange program using sectioned otolith samples from Germany and Sweden.

Considering the fresh insights into the age determination of flounder a 2nd workshop is recommended to take place in 2008. The terms of reference should include:

a) evaluation of the 2007 exchange experiment
b) experiment on broken & burnt otoliths
c) experiment on influence of length information on age determination
d) updating of an international manual
e) measures to update national reference collections
f) protocol for updating historical data

1.5.5 Status of the FishFrame database

A presentation in plenary was given by Henrik Degel concerning the status of the data uploaded, the use and the future of FishFrame.

Landings -, effort and biological data for cod from Sweden, Latvia, and Denmark were by end of March uploaded to FishFrame. In addition landings - and biological data for cod were uploaded for Poland. Data was used for estimating of discard for cod in both western and eastern cod stocks.

Because the application concerning the open call for tenders FISH/2006/15-LOT 4 invited by the EU failed, we cannot initiate a funded International steering group as planed already this summer. This has to wait until the financial situation allows this. We have reasons to believe that the situation will improve in a not too distance future and we will then initiate the new management restructure of FishFrame.

This does not means that FishFrame development has stopped. Denmark has decided to rely 100% on FishFrame for data management and deliveries to ICES, STECF and others, as well as for national research and advice. This means that DIFRES in 2007 will allocate significant resources (approx. 4 x the activity level for 2006) on the development of version 5.0 of FishFrame. In this version we combine the need for regional use of streamlined international data and the national need for direct access to both dis-aggregated and aggregated national streamlined data in a flexible but still easy-accessible form.

It is the plan that version 5 will include new features such as:

Improved reporting and analysis module, data allocation module (hole filling), discard allocation module, more raising methods, implementation of COST functionality such as raising, uncertain estimates and reports, data download module, export to InterCatch and assessment input files, more detailed access-rights handling in the security module and a local copy of national data which allows national institutes to develop very individualized data consuming scripts that access FishFrame data directly using SQL from any platform.

In order to keep you informed, we will set up a FishFrame Wiki so that you can be updated on the progress on version 5 and follow the development.

Version 5 will be open source software as any other version of FishFrame and will be available for any institute which could see the advantage of using the software.

The present international version of FishFrame (version 4.3) will be in service unchanged until a new version can be developed and will be available for calculating discard estimates in the future.

1.5.6 WKREF

The Workshop on Limit and Target Reference Points (WKREF) was held in Gdynia in 29.01-2.02.2007 and was co-chaired by Martin Pastoors (ACFM chair) and Jan Horbowy (Poland). The ToR's for the meeting were the following:

a) a) review and update the biological basis of limit reference points for fish stocks in the ICES area, taking into account the possible effects of species interactions and regime shifts. As a minimum the limit reference points for North Sea herring, Norwegian spring spawning herring, North Sea cod, Baltic cod and Kattegat sole stocks;

b) b) review the scientific and management literature on the implementation of maximum sustainable yield reference points in line with the Johannesburg agreement 2002;

c) c) comment on potential target references points for fish stocks in the ICES area as suggested by SGMAS, taking into account the possible effects of species interactions and regime shifts and the framework on the evaluation of management strategies.

In this note some general results and results concerning stocks within the remit of WGBFAS (Baltic cod and sole) are presented. During the workshop it was demonstrated using simulations that stock-recruitment and recruitment – stock relationships may take similar form on the S-R plot. The recruitment and stock were generated from assumed initial values. The following options for recruitment were considered:

1) recruitment followed Beverton and Holt model with log-normal distribution at given SSB,
2) recruitment was externally driven with log-normal distribution and:showed declining trend; showed different levels in two different periods, fluctuating without trend within the periods.

The obtained in simulations S-R plots were similar irrespective if were generated with recruitment options 1. or 2. It was concluded that it may be difficult to distinguish if we have stock-recruitment relationship or recruitment -stock relationship basing only on plot of recruitment against SSB. General knowledge on stock biology and recruitment mechanism may be necessary to evaluate the relationship.

The number of methods was used to derive Blim for Baltic cod. It were: Myers et al. (1994), Segmented regression, Simmond's probabilistic method, Inclusion of environmental variables into S-R model. The estimates varied largely depending on time series used: whole time series, period of good environmental conditions or period of poor conditions for cod spawning. When the applied methods were constrained to recent period of low environmental conditions (period from 1987 onwards) than the realistic estimates of cod Blim were at considered at level of 90,000 – 100,000 tons.

In case of Kattegat sole no clear S-R relationship was observed. The Bloss (925 tons) may be considered as the proxy for Blim. The revised Fmed was estimated at 0.64. This was considered to be very high and not good for basis for revising reference points at this stage. It was suggested that the WGBFAS attempts to extent the time series of data for the assessment in order to have more observations from the earlier years when SSB was smaller.

1.6 Methods used by the Working Group

1.6.1 Data in the Assessment

As in the previous years, data for 2006 were prepared in advance of a WGBFAS meeting. All necessary revisions of the data are discussed in the corresponding stock sections. The discard data was included in assessment data (CANUM) for Western and Eastern Baltic cod stocks as in previous assessments. Discards were this year for the first time also included in the exploratory assessment for cod in the Kattegat. The available catch at age data also were updated for stocks which assessment were not performed e.g. Flounder stocks in Sub-division 28, Sub-division 26, Sub-division 29and 32, Sub-division 32.

1.6.2 Analysis of catch-at-age data

Full analytical assessment of fish stock with following short term assessment (and medium term projections for Herring in 25-29 and for sprat in SD 22-32) was done for following stocks in the Baltic, including medium term projection in some cases:

1) Cod in the Kattegat (exploratory)
2) Cod in the Sub-divisions 22-24
3) Cod in Sub-divisions 25-32
4) Sole in Division IIIA
5) Herring in the Subdivisions 25-29 and 32 excluding Gulf of Riga
6) Herring in the Gulf of Riga
7) Herring in the Bothnian Sea (Sub-division 30)
8) Herring in the Bothnian Bay (Sub-division 31) (Exploratory)
9) Sprat in the Sub-divisions 22-32.

Additionally, an experimental assessment of Flounder in Sub-divisions 24 and 25 was performed.

The main tool for the assessment of the state of stocks and catch-at-age was VPA tuned using the (Extended Survival Analysis) XSA method (Darby & Flatman, 1994). The version (FLXSA) incorporated in the FLR package (FLR Team 2007) was used in many cases to perform exploratory analyses. To date this implementation cannot produce standard output for tuning diagnostics, so version 3.1 of the Lowestoft VPA package was used for generating final runs.

The procedure used to screen the catch at age matrix was the same as in previous years. This follows the practice adopted at the previous Working Groups. In some cases where XSA revealed strong bias in the retrospective analyses input data quality if possible were checked and verified. The general approach of exploration of tuning data sets and XSA settings for the final assessment runs was following:

a) If tuning data traditionally consisted with several tuning series for all tuning data series, a single fleet runs were carried out using XSA with shrinkage given low weight. Results and diagnostics were used to explore survey or commercial fleet data consistency with catch at age data and to determine the fleet time span and age groups for the final assessment.

b) If tuning data consisted from one tuning series the first run (‘Same Procedure as last Year’(SPALY) run) was performed based on settings used in the previous runs. XSA settings for the final run were defined after exploratory runs with low or high shrinkage.

c) Additional tuning runs were carried out to investigate the influence of shrinkage on retrospective patterns in the estimates of terminal F. Appropriate level of shrinkage was adjusted to the best fit of retrospective pattern.

ICA (Integrated Catch at age Analysis, version 1.4w) software was used for Herring in SD 30 in order to explore the consistency with the XSA results. SURBA (Survey-Based Assessment, version 3.0) software that is recent development of RCRV1A (Cook, 1997) was used for Cod in the Kattegat, cod in Subdivisions 22-24 and cod in Subdivisions 25-32 in order to investigate the consistency of final XSA runs with assessment based on surveys and commercial fleets (WD Needle, C. L. 2003).

B-Adapt model was used for Cod in the Kattegat in order to investigate the inconsistencies in the information provided by surveys and catch at age analyses. B-Adapt is a modification to the Gavaris and Van Eeckhaute (1998) ADAPT model developed by Chris Darby (CEFAS, Lowestoft). The model allows estimating potential bias in the landings at age data in recent years. Detailed description of the model can be found in the reports of the WGNSSK (e.g. ICES-WGNSSK 2004, 2005).

The results of analyses are presented in corresponding sections of stocks.

1.6.3 Recruitment estimates

As in the previous years, recruitment estimates have been obtained with RCT3 programme from available hydro-acoustic survey data for pelagic fish stocks (Herring in SD 25-229&32 excl. Gulf of Riga and sprat SD 22-32). The environmental data (temperature and zooplankton abundance) was used for prediction of year-class strength for Herring in the Gulf of Riga. The effect of North Atlantic Oscillation on year class strength was explored for sprat in SD 22-32. Geometric mean recruitment abundance for the recent years from XSA analyses was used for sole in Division IIIa, herring stocks in SD 30 and 31, Cod in SD 22-24 and Cod

in SD 25-32. The year range used for geometric mean calculation of recruitments is given in corresponding stock section.

1.6.4 Short-term catch predictions

Short term forecasts were based on initial stock size as estimated by XSA (survivals at the end of the year) and supplemented with recruitment estimates as described below. Natural mortalities, maturity ogives, fishing pattern, mean weight at age in the stock and in the catch were set as average over recent years (normally 3). A detailed short-term projection for each stock was made using *status quo* F option. If predicted landings under the *status quo* option in the intermediate year was greater when agreed TAC for given stock, a short-term projection with TAC constraint in intermediate year also was presented.

The short-term predictions were run using MFDP (Multi fleet deterministic projection).

Yield per recruit were obtained from MFYPR (Multi fleet yield per recruit) software.

The standard MS Excel template was used to obtain yield per recruit and short term forecast plots. Both software and template were developed in the Lowestoft.

1.6.5 Medium-term projections

For calculation of medium-term projections of some stocks, the Working Group applied the model used by the Study Group on Management Strategies for Baltic Fish Stocks (ICES CM 1998/ACFM:11) and developed in DIFRES. In this model stochastic variation has been included for some parameters (e.g., stock-recruitment relationship, mean weight in catch, mean weight in stock and maturity ogive).

1.6.6 Assessment Software

Overview of used versions of software:

SOFTWARE	PURPOSE	VERSION
SVPA	Exploratory assessment	VPA95
ICA	Exploratory assessment	1.4w
XSA	Historical assessment	VPA95
RETVPA	Retrospective analysis	
RCT3	Recruitment estimates	
MFDP	Short-term prediction	
MFYPR	Long-term prediction	
SURBA	Survey-based assessment	3.0
B-ADAPT	Exploratory assessment	

1.6.7 Biological reference points

For some stocks (e.g., cod in Sub-divisions 22–24 and 25–32, herring in the Gulf of Riga) an estimation of MBAL, based on the Myers *et al.* (1994) and Study Group on Management Strategies for Baltic Fish Stocks (ICES CM 1998/ACFM:11) approach was applied. The approach recommended by the authors consists in fitting a stock-recruitment relationship and defining the MBAL value as the SSB producing 50% of maximum recruitment from the fitted relationship. To obtain Precautionary Approach Reference Points the Working Group applied the PA software developed by CEFAS, Lowestoft. The methods used for every particular stock are described in the respective sections below.

Existing Reference points

Presently defined reference points for Baltic stocks were taken from the ACFM Report, May 2002 and summarized in table below.

STOCK	LIMIT REFERENCE POINTS	PA REFERENCE POINTS
Cod in Katttegat	$\mathbf{B}_{lim}$ is 6 400 t Technical basis: lowest observed SSB $\mathbf{F}_{lim}$ is 1.0 Technical basis: The spawning stock has declined steadily since the early 1970s at fishing mortality rates averaging F = 1.0. $\mathbf{F}_{lim}$ is tentatively set equal to F = 1.0.	$\mathbf{B}_{pa}$ 10 500 t Technical basis: $\mathbf{B}_{lim}$*exp(1.645*0.3) $\mathbf{F}_{pa}$ be set at 0.6 Technical basis: $\mathbf{F}_{lim}$*exp(-1.645*0.3)
Cod in SD 22-24	$\mathbf{B}_{lim}$ not defined $\mathbf{F}_{lim}$ not defined	$\mathbf{B}_{pa}$ 23 000 t Technical basis: Previous MBAL $\mathbf{F}_{pa}$ not yet defined
Cod in SD 25-32	$\mathbf{B}_{lim}$ 160 000 t Technical basis: SSB below which recruitment is impaired $\mathbf{F}_{lim}$ 0.96 Technical basis: Fmed98	$\mathbf{B}_{pa}$ 240 000 t Technical basis: MBAL $\mathbf{F}_{pa}$ 0.6 Technical basis: 5 percentile of $\mathbf{F}_{med}$
Herring in SD 25-29&32 excluding Gulf of Riga	$\mathbf{B}_{lim}$ not defined $\mathbf{F}_{lim}$ not defined	$\mathbf{B}_{pa}$ not defined $\mathbf{F}_{pa}$ 0.19 Technical basis: $\mathbf{F}_{med}$
Herring in the Gulf of Riga	$\mathbf{B}_{lim}$ 36 500 t Technical basis: $\mathbf{B}_{pa}$/exp (1.65*0.2) $\mathbf{F}_{lim}$ not defined	$\mathbf{B}_{pa}$ 50 000 t Technical basis: = MBAL=50 000 t $\mathbf{F}_{pa}$ 0.4 Technical basis: from medium-term projections
Herring in SD 30	$\mathbf{B}_{lim}$ 145 000 t Technical basis: spawning stock biomass, where probability of lower recruitment increases $\mathbf{F}_{lim}$ 0.30 Technical basis: $\mathbf{F}_{loss}$	$\mathbf{B}_{pa}$ 200 000 t Technical basis: $\mathbf{B}_{lim}$ *exp(1.645*0.2) $\mathbf{F}_{pa}$ 0.21 Technical basis: $\mathbf{F}_{med}$
Herring in SD 31	Not defined	Not defined
Sprat in SD 22-32	$\mathbf{B}_{lim}$ is 200 000 t Technical basis: MBAL $\mathbf{F}_{lim}$ is not yet defined	$\mathbf{B}_{pa}$ 275 000 t Technical basis: $\mathbf{B}_{lim}$*1.38; some sources of uncertainty in assessment taken into account $\mathbf{F}_{pa}$ 0.40 Technical basis: ~ average $\mathbf{F}_{med}$ in recent years, allowing for variable natural mortality
Flounder SD 24-25	Not defined	Not defined
Sole in Division IIIA	$\mathbf{B}_{lim}$ 770 t Technical basis: $\mathbf{B}_{pa}$*exp(-1.645*0.2) $\mathbf{F}_{lim}$ is 0.47 Technical basis: $\mathbf{F}_{med}$ 98 excluding the abnormal years around 1990	$\mathbf{B}_{pa}$ 1 060 t Technical basis: MBAL $\mathbf{F}_{pa}$ 0.30 Technical basis: consistent with $\mathbf{F}_{lim}$

1.7 Quality handbook

1.7.1 Stock annex

The updated quality handbook annex is included in the annex for the following stocks:

ANNEX 3 – QUALITY HANDBOOK ANNEX – Cod in Kattegat
ANNEX 4 – QUALITY HANDBOOK ANNEX – Cod in SD 22-24
ANNEX 5 – QUALITY HANDBOOK ANNEX – Cod in SD 25-32
ANNEX 6 – QUALITY HANDBOOK ANNEX – Sole in Div. IIIa
ANNEX 7 – QUALITY HANDBOOK ANNEX – Flounder in SD 24-25
ANNEX 8 – QUALITY HANDBOOK ANNEX – Herring 25-29+32
ANNEX 9 – QUALITY HANDBOOK ANNEX – Herring in GOR
ANNEX 10 – QUALITY HANDBOOK ANNEX – Herring in SD 30
ANNEX 11 – QUALITY HANDBOOK ANNEX – Herring in SD 31
ANNEX 12 – QUALITY HANDBOOK ANNEX – Sprat in SD 22-32

1.7.2 Methods to be applied in subsequent assessments

During the WGBFAS 2007 meeting the assessments were classified as:

STOCK	CLASSIFICATION	ASSESSMENT IN 2006
Cod in Kattegat	Observation list	Observationlist
Cod in SD 22-24	Benchmark	Update
Cod in SD 25-32	Observation list	Observationlist
Sole in Division IIIA	Observation list	Observationlist
Flounder in SD 24-25	Exploratory	Exploratory
Herring in SD 25-27, 28.2, 29 &32	Update	Update
Herring in GOR (SD 28.1)	Update	Update
Herring in SD 30 (Bothnian Sea)	Update	Benchmark
Herring in SD 31 (Bothnian Bay)	Update	Update
Sprat in SD 22-32	Update	Update

There is not proposed any long term plan for the classification of assessments.

WGBFAS notes that several factors may be considered for choosing stocks for benchmark assessments.

- Some stocks are considered important for a high number of countries (e.g. Eastern and Western Cod, Sprat and Central Basin Herring). These stocks should be prime candidates for Benchmark assessments.
- There are recognized assessment problems for several stocks (e.g. Eastern Cod, Central Basin Herring). These stocks should be prior candidates for Benchmark assessments. In some cases the deficiencies are caused by factors outside the control of the scientific communities (e.g. unreported catches for Eastern Cod and insufficient separation between herring and sprat catches).
- When new approaches for assessments are made available from the scientific community these may allow more comprehensive assessments.
- If new types of data become available (e.g. stakeholder information) this may argue a benchmark assessment.

Suggestions for 2008

The WG await the comments and evaluation of the review group 2007

1.8 Ecosystem considerations

1.8.1 Introduction

The WGBFAS recognises the importance of considering ecosystem variability and trends in the stock assessments, and to assess the effects of fishing activities on the ecosystem as a whole. To this end, we have used the reports of the Working group for regional ecosystem descriptions (WGRED), the Study group on Baltic Sea fish and fisheries issues (SGBFFI), the Workshop on integrated assessments in the Baltic Sea (WKIAB), the Working group on introductions and transfers of marine organisms (WGITMO), the Workshop on the impact of zooplankton on cod abundance and production (WKIZC) as input to the sections below. The descriptions of the Kattegat and Baltic Sea ecosystems (section 1.9.2) and their changes (section 1.9.3) are to a large extent based on the WGRED report, but have been revised to include information on all of the basins hosting stocks assessed by the WGBFAS, as suggested by the SGBFFI (ICES 2006a, in prep.). In section 1.9.5 we list the details of how ecosystem variability has been accounted for and in which stock assessments. Finally, in section 1.9.6, we propose measures to further the development of methods to account for ecosystem variability and fisheries-induced ecosystem effects in stock assessments.

1.8.2 Ecosystem description

1.8.2.1 Kattegat

1.8.2.1.1 Topography and oceanographic conditions

The Kattegat forms part of the transitional area between the North Sea and the Baltic Sea. Its surface area is 22,000 km^2 and the mean depth is 23 m (Håkansson 2002). Hydrographic conditions are strongly influenced by the run-off of freshwater from the Baltic Sea and input of Atlantic water from the west/northwest. As a result the Kattegat has a strong latitudinal salinity gradient from 15-25 PSU. The Kattegat is also stratified vertically due to the run-off of Baltic water and a sharp pycnocline separates surface water from inflowing saline water from the Skagerrak and North Sea.

Thermal conditions in the Kattegat are typical for those of temperate-boreal ecosystems, and show strong seasonality. Winter surface temperatures can fall below freezing resulting in ice coverage in some years in some areas. Summer surface temperatures rise to 15-20 ^{o}C and a warm surface layer develops in spring. Thermal stratification is eroded in autumn and the water column becomes vertically homogeneous down to the permanent halocline. Oxygen deficiency may periodically occur after thermal stratification in late summer and in combination with long periods of low wind stress. The problem is exacerbated by large scale eutrophication of the coastal waters. Demersal fish will migrate out of low oxygen areas, and benthic organisms may experience mortality and reduced growth.

Circulation in the Kattegat is influenced by exchanges with neighbouring seas (Skagerrak, Belt Sea, Øresund and the Baltic Sea) and depends on meteorological forcing; tides are much weaker than in the southern North Sea. The horizontal exchanges can transport fish eggs and larvae among areas. For example 0-group plaice abundance along both the Danish and Swedish coasts of the Kattegat depends partly on wind-induced advection of water masses containing eggs and larvae to coastal nursery areas (Pihl, 1990; Nielsen *et al.*, 1998; Pihl *et al.*, 2000). The role of these processes on population abundance of this and other species is however unclear, partly due to large uncertainties in stock assessment – derived estimates of recruitment (ICES, 2005d).

1.8.2.1.2 The fish community

The Kattegat fish community includes many of the same species found in the North Sea and can be characterized as temperature-boreal (Muus and Nielsen, 1999). The community biomass is dominated by a relatively small number of species which include flatfishes (e. g., plaice, flounder, dab, turbot, sole), gadoids (primarily cod but historically also haddock, whiting and pollock), and pelagic fishes (e.g., herring, sprat; ICES, 2005d). The community is supplemented on a seasonal basis by migrant species, including mackerel, garfish, and occasionally horse mackerel (Muus and Nielsen, 1999).

The Skagerrak-Kattegat area is commonly described as a transition area between the North Sea and the Baltic also in terms of fish stock identity. Spawning aggregations that may supply recruits to the Skagerrak-Kattegat area have been located in the adjacent eastern North Sea, based on evidence of a major transport of eggs and larvae of cod, whiting, haddock, Norway pout and saithe in this direction (Munk et al. 1995; 1999). Considering the population structure of cod in the North Sea region, comprising the eastern English channel, the proper North Sea, the Skagerrak and Kattegat, genetic surveys suggest spatially, separated sub-populations units (Hutchinson et al., 2001; Knutsen et al., 2003; 2004). The observed level of differentiation is, however, on the whole, very small and the stability over time of putative sub-units remain to be shown (e.g. Nielsen et al., 2005). Notwithstanding the uncertainty of the genetic integrity of population sub-units, cod spawning aggregations are well known in the southern part of the Kattegat (Hagström et al., 1990; Svedäng and Bradon 2003; Svedäng et al., 2004).

1.8.2.2 Baltic Sea

1.8.2.2.1 Topography and oceanographic conditions

The Baltic Sea receives freshwater input from rivers and saltwater inflow from the North Sea in the narrow straits between Denmark and Sweden. This results in a salinity gradient from southwest to northeast that is one of the primary determinants and drivers of this brackish water ecosystem.

The topography is highly varied with large areas (ca 30%) that are less than 25 m deep interspersed by a number of deeper basins in the Baltic Proper, Bothnian Sea, and the Gulf of Finland that are separated by sills (the Gulf of Riga and the Bothnian Bay are internal fjords). Inflows of saline and oxygen rich water from the North Sea therefore needs to be strong to reach into all the main basins. As the water column in the open Baltic is permanently stratified, oxygen depletion in the deeper saline layers can occur due to the limited oxygen transport, with detrimental effects on benthos as well as cod and flounder recruitment. Inflows are necessary to renew oxygen depleted bottom water in the basins and thus influence fish recruitment. Major inflows occurred 1976, 1983, and 1993, and a medium-sized inflow occurred in 2003 (ICES 2005a).

The anoxic conditions also influence the nutrient levels in the Baltic Sea. The Baltic Sea became eutrophicated during the 20th century and nutrient levels in the Baltic Sea have remained persistently high since the mid-1990s (Helcom 2003). Anoxic conditions causes phosphorus leakage from sediments and prevents denitrification resulting in nutrient surplus in the deep water, which may increase primary production also in surface water layers (Helcom 2003). Eutrophication causes seasonal hypoxia also in shallow coastal waters with serious consequences for recruitment of coastal spawning species, as well as coastal biodiversity.

1.8.2.2.2 The plankton community

The composition of both the phytoplankton and zooplankton communities is determined mainly by the salinity gradient. In the southwest marine species such as diatoms and

Pseudocalanus sp. dominate, whereas brackish water species such as dinoflagellates, *Eurytemora affinis* and *Bosmina longispina maritima* are more common in the northeast. The marine species, e.g. *Pseudocalanus sp*., eggs and nauplii are sensitive to low salinity and oxygen levels (Schmidt et al. 2003, Renz and Hirche 2005). Other species are favoured by increasing temperature, such as *Acartia spp*. in which activation of resting eggs increases with temperature (Alheit et al. 2005).

Primary production decreases northwards, from about 170 g C m^{-2} $year^{-1}$ in the Baltic Proper (Johansson et al. 2004) to 20-30 g C m^{-2} $year^{-1}$ in the Bothnian Bay (Sandberg et al. 2004). There is no corresponding decrease in heterotrophic production (Samuelsson et al. 2006), which results in an increased relative importance of bacterioplankton in the ecosystems further north. In the Bothnian Bay the phytoplankton community is phosphorous limited, whereas it is nitrogen limited in the Bothnian Sea and Baltic Proper (Granéli et al. 1990, Andersson et al. 1996). Terrestrial derived dissolved organic carbon via run-off decreases from north to south, and supports bacterial and mesozooplanktonic secondary production in the Bothnian Bay (Zweifel et al. 1995, Rolff and Elmgren 2000).

1.8.2.2.3 The benthic community

The benthic community on hard bottom substrates is dominated by mussels while deposit feeders and burrowing forms dominate on soft bottoms. Community composition changes and species richness declines with decreasing salinity. Throughout the Baltic Sea, seaweed and seagrass habitats in shallow coastal areas form important nursery grounds for coastal spawning species, as well as important feeding habitats. The *Fucus vesiculosus* communities also have the most species rich fauna in the Baltic Sea, hosting mussels, snails, crustaceans, bryozoans and even insect larvae (Kautsky and Kautsky 2000).

Baltic Proper

The soft bottom communities are characterised by the bivalve *Macoma balthica*, with *Abra alba* and *Arctica islandica* being more common in deeper soft bottoms in the south-western Baltic Sea and polychaetes in deeper soft bottoms in the eastern parts. Hard bottom communities are dominated by *Fucus vesiculosus* and *Mytilus edulis* (Vopio 1981). The isopod *Idothea baltica* is one of the major grazers on *Fucus* (Kautsky and Kautsky 2000). Eelgrass (*Zostera marina*) occurs in sandy bottoms in the southern Baltic Proper. Much of the production in coastal soft bottom communities goes to larval food for fish (Nellbring 1988).

Bothnian Sea and Bothnian Bay

The Bothnian benthic communities are instead dominated by glacial relicts: the isopod *Saduria entomon* and the amphipod *Monoporeia affinis*, and by the mussel *Macoma baltica* (Kautsky and Kautsky 2000; Laine 2003). Decomposition is taken over by a variety of sediment-living meiofauna and insect larvae, mainly *Chironomidae*.

1.8.2.2.4 The fish community

The Baltic Sea fish community with about 100 species is unique in its combination of marine and limnic fish species. Its composition is predominantly determined by salinity, resulting in a transition from dominance by marine species (ca 70 sp.) to limnic species (ca 30 sp.) from south to north and in the gradient from the open sea to coastal waters.

The commercially most important species overall are cod (*Gadus morhua*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*), flounder (*Platichthys flesus*), turbot (*Psetta maxima*), and salmon (*Salmo salar*). Locally, high-valued species such as eel (*Anguillla anguilla*), vendace (*Coregonus albula*) and pikeperch (*Sander lucioperca*) are also commercially important.

Baltic Proper

The open sea fish community is dominated by cod, herring and sprat. Cod feeds as young on large copepods and mysids (Hüssy et al 1997, Köster and Möllman 2000a), and when older on herring and sprat and small cod (Köster and Möllman 2000a, Köster et al. 2003a). Small herring feeds prefereably on *Pseudocalanus sp*. (Möllman and Köster 2002, Casini et al. 2004), whereas larger herring eats mysids (Möllman and Köster 1999, Casini et al. 2004) and may predate on cod eggs (Köster and Möllman 2000a). Sprat feeds on *Pseudocalanus sp*., *Bosmina sp*. and other zooplankton (Möllman and Köster 1999, 2002, Viitasalo et al. 2001, Casini et al. 2004), and is especially successful in exploiting *Acartia spp*. and *Temora sp.* (Viitasalo et al. 2001).

The coastal fish community is dominated by limnic species such as perch (*Perca fluviatus*), roach (*Rutilus rutilus*), pike (*Esox lucius*), bream (*Abramis brama*), silver bream (*Blicca bjoerkna*), rudd (*Scardinius erythrophthalmus*), and tench (*Tinca tinca*) (Kautsky and Kautsky 2000). Due to the coastal spawning of some marine species, such as herring, they can also be subject to interactions with limnic species; for example, predation by pikeperch on young herring (Hansson et al. 1997).

Gulf of Riga

The Gulf of Riga is a separate semi-enclosed ecosystem of the Baltic Sea characterised by low salinity of about 5 PSU, which thus limits the residence of marine species like cod. Cod only found in the Gulf of Riga when the Eastern Baltic cod stock is on a very high level (last time in early 1980s). The dominant species in the Gulf of Riga is herring, but the fish fauna include several freshwater species like perch, pikeperch, diadromous species such as smelt, vimba and whitefish.

The year class strength of Gulf of Riga herring strongly depends on the severity of winter, with rich year classes appearing after mild winters (Rannak 1971). After mild winters the spawning starts earlier and the spawning activity is more evenly distributed over the spawning season. This results in a more even distribution and lower mortality of egg on the spawning grounds. Additionally, after mild winters the zooplankton is more abundant providing better feeding conditions for feeding of herring larvae.

Bothnian Sea and Bothnian Bay

Many marine species, such as cod and flounder, have their northernmost distribution limit in the Bothnian Sea, whereas other marine species such as herring and fourhorned sculpin (*Triglopsis quadricornis*) are common also in the northernmost Bothnian Bay. In southern Bothnian Sea herring and sprat are the most important species in the open sea, whereas vendace (*Coregonus albula*) and herring are the most important in the Bothnian Bay pelagic. Common coastal-dwelling species are sticklebacks (*Gasterosteus aculaetus* and *Pungitius pungitius*), perch, pike, roach (*Rutilus rutilus*), bleak (*Alburnus alburnus*), but pikeperch (*Sander lucioperca*) and burbot (*Lota lota*) are also imoprtant. Salmon (*Salmo salar*) and the benthic feeding whitefish (*Coregonus lavaraetus*) are together with herring and vendace the most important species for coastal fisheries.

1.8.2.2.5 Birds and mammals

The marine mammals in the Baltic consist of grey (*Halichoerus grypus*), ringed (*Phoca hispida*), and harbour seals (*Phoca vitulina*), and a small population of harbour porpoise (*Phocaena phocaena*). Seals have been recorded caught in fyke nets, set nets and salmon driftnets, but although the recorded data almost certainly underestimate the total number of by-caught seals, the added mortality does not appear to restrain the seal populations from increasing (Karlsson and Helander, 2004).

The seabirds in the Baltic Sea comprise pelagic species like divers, gulls and auks, as well as benthic feeding species like dabbling ducks, sea ducks, mergansers and coots (ICES 2003). Common eider, for example, predates on mussels. The Baltic Sea is more important for wintering (c.10 million) than for breeding (c.0.5 million) seabirds and sea ducks.

1.8.3 Ecosystem changes

1.8.3.1 Kattegat

1.8.3.2 Trends in abiotic factors

- **Sea surface summer temperatures in the Kattegat-Great Belt-Øresund region have increased** by 2 °C during 1984-2001 (Figure 1.9.1; MacKenzie and Schiedek, 2006). This increase is much faster than that expected as a result of global warming (ca. 3 °C over the next 70-100 years; Kerr, 2004), and is likely contributing to some of the ecological changes seen in the Kattegat. Temperatures are now as high or higher than at any time since the start of measurements by ICES in 1921 (Figure 1.9.1).
- Oxygen depletion events in the Kattegat and neighboring fjords and estuaries occur due to the interaction of eutrophication with specific hydrographic events (Håkansson, 2002; Ærtebjerg *et al.*, 2003). Such **oxygen-depleted bottom areas have increased** steadily in Kattegat since the 1970s. These situations reduce the size of habitat for benthic fish species and kill benthic prey for fish species (Pihl, 1994).

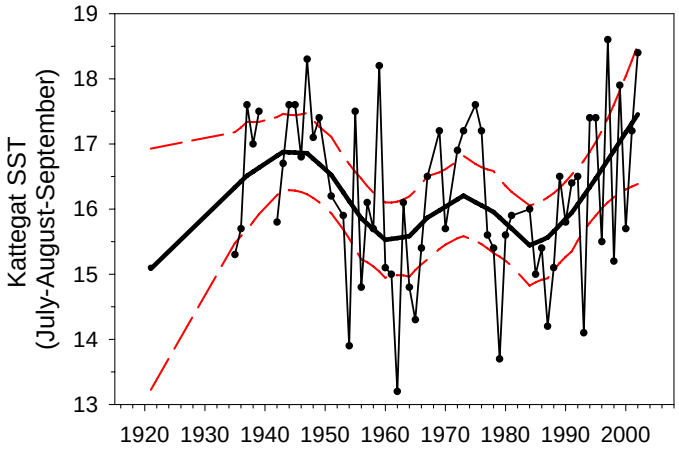
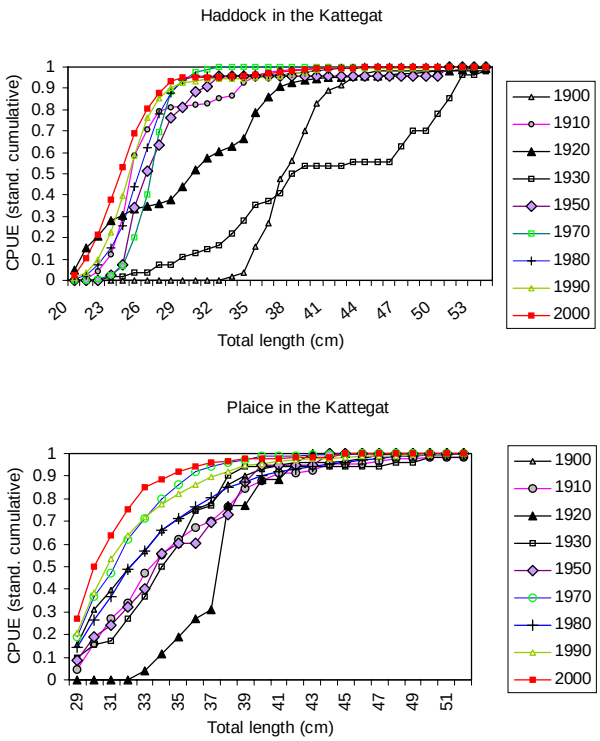


Figure 1.9.1 Interannual variability in sea surface temperature in the Kattegat-Great Belt-Øresund during summer (July-August-September) based on data from the ICES Hydrographic Database (MacKenzie and Schiedek 2006). Line with dots: raw data; thick solid line: statistical fit based on General Additive Modelling; red dashed line: 95% confidence limits of statistical fit as estimated from General Additive Model (GAM).

1.8.3.3 Trends in vegetation

- ***Fucus* spp., red algae, and eelgrass (*Z. marina*) have diminished** in the Kattegat due to eutrophication (Wallentinus 1996; Schramm 1996), whereas opportunistic filamentous algae have increased. Thus, important spawning and feeding grounds for coastal spawning species such as herring, flatfish and many limnic species are decreasing.
- The **non-native seaweed** *Sargassum muticum* has expanded rapidly in Kattegat since late 1980s (Wallentinus 1996), and *Graciliaria vermiculophylla*, first observed in eastern Skagerrak in 2003, was in 2005 found also in Kattegat (SBF

2006). *G. vermiculophylla* can have negative effects on eelgrass (and hence important fish habitats) through its competitive dominance for light.



1.8.3.4 Trends in fish community

- The fish community in the Kattegat has changed over time. Some species, e.g. haddock, are no longer present or are now extremely rare, and the size composition of species such as cod, haddock and plaice have all decreased during the 20th century (Figure 1.9.2).

Figure 1.9.2 The cumulative length distribution for haddock and plaice in the Kattegat observed in Swedish trawl surveys, estimated per decade between 1901 and 2004 (Hagberg 2005). The catch per unit effort (CPUE) values have been standardised within decade.

- The period of warm temperatures since the late 1980s-early 1990s (Figure 1.9.1) has caused the presence of some warm-adapted species (e.g., sole) to increase (ICES 2005d), as observed also in the North Sea and other areas of the northeast Atlantic (Brander et al., 2003; Genner et al., 2004; Perry et al., 2005).
- There is some evidence that the productivity of the benthic fish community has increased since the late 1950s due to eutrophication (Nielsen and Richardson, 1996).
- Regarding some of the ecologically and commercially most important species at the present time, the following trends have been documented:

vi) cod biomass has fallen nearly continuously for 20-30 years and is presently below safe biological limits. The decline of the cod stock in the Kattegat has shown associations with the disappearance of separate spawning aggregations/subpopulations in the Kattegat area (Svedäng and Bardon 2003, Cardinale and Svedäng 2004, Hagberg 2005).

vii) the biomass of plaice is uncertain but nevertheless continues to support important commercial fisheries

viii) sole biomass has increased in the late 1990s and early 2000s

ix) herring biomass has decreased in the 2000s

1.8.3.5 Baltic Sea

1.8.3.5.1 Trends in abiotic factors

Long-term hydrographic trends

- The recently low frequency of North Sea inflows have resulted in declining salinity and oxygen levels in deep-water layers in the Baltic Sea. The reproductive volume (i.e. the water volume with salinity and oxygen levels suitable for cod egg survival) has been very low or zero since mid-1980s in the Gotland and Gdansk deeps (MacKenzie et al. 2000).
- Hypoxia in shallow coastal waters seems to be increasing, especially in the archipelagos of the northern Baltic Sea (Helcom 2002, p. 166).

1.8.3.5.2 Trends in the plankton community

- Diatoms have decreased in spring and summer 1979-1999, whereas dinoflagellates and total phytoplankton biomass (measured as chlorophyll a) has increased in the Baltic Proper (Wasmund and Uhlig 2003). Phytoplankton production in the Bothnian Sea decreased drastically until 2000, but has increased since then (Andersson et al. 2004). Chlorophyll a, an indicator of total phytoplankton biomass, has increased significantly the last three decades (ICES 2007a). As in the Baltic Proper, diatoms in the Bothnian Sea have decreased and dinoflagellates increased. However, this change in phytoplankton composition can only be seen in Bothnian coastal and benthic areas (Andersson et al. 2004), no clear trends can be seen in the pelagic in the Gulf of Bothnia (Andersson et al. 2004; ICES 2007a).
- Summer blooms of nitrogen-fixing cyanobacteria have increased in the Baltic Proper since the 1960s, and toxin-producing species have become more abundant compared to non-toxin producing ones (Helcom 2002, 2003). In the Bothnian Sea the cyanobacteria Aphanizomenon sp. have increased during the last decade whereas other filamentous cyanobacteria, such as Nodularia sp.and Anabaena sp. have not (Andersson et al. 2004).
- Eutrophication has also affected the nutritional value of the phytoplankton community (decreasing amount of antioxidants), and as a result, also of the zooplankton community (Snoeijs 2005).
- The zooplankton community composition changed substantially in the Baltic Sea in the 1990s. Large nerictic copepods have decreased and cladocerans have increased in the northern Baltic Sea and in the Gulf of Finland, due to decreased salinity caused by increased river run-off (Viitasalo et al 1995, Ojaveer 1998, Vuorinen et al 1998). Pseudocalanus sp. have decreased in the Baltic Proper since the 1980s due to the decrease in deep water salinity (Möllman et al. 2000, 2003a). Acartia spp. and Temora longicornis has increased in the Baltic Proper due to the increased temperature (Möllmann et al. 2000, 2003a, Alheit et al. 2005). In the Bothnian Sea, Pseudocalanus sp. and Temora sp. have decreased whereas Bosmina has increased (ICES 2007a).

1.8.3.5.3 Trends in the benthic community

- Eutrophication has caused substantial changes in the coastal macroalgal communities. ***Fucus* spp. and some perennial red algae have diminished** and opportunistic filamentous algae such as *Pilayella littoralis* and *Ceramium tenuicorne* have increased, in the Baltic Sea (Kautsky et al. 1992; Schramm 1996) and in Kattegat (Wallentinus 1996). Similarly, the less abundant *Zostera marina* has also decreased (Schramm 1996). Although eutrophication has decreased since the 1990s in some areas, there is no corresponding recovery of *Fucus* spp. because the high abundance of filamentous algae inhibits recruitment of fucoid zygotes by outcompeting them for space (Kautsky and Kautsky 2000).

- Eutrophication has favoured the blue mussel, through increased phytoplankton production and limitation of the distribution of *Fucus* spp. (Kautsky et al. 1992; Figure 1.9.9).
- Due to the lower nutritional value of cyanobacteria, and the lower sedimentation rate of dinoflagellates compared to diatoms, the changes in phytoplankton composition seen in the Bothnian Sea (Andersson et al. 2004) have affected the benthic fauna. For example, ***Monoporeia affinis*, has decreased** substantially in the whole of Gulf of Bothnia since the late 1990s (Karlsson and Leonardsson 2004). The last three years a slight recovery of *M. affinis* has been reported from the Gulf of Bothnia pelagic and a few coastal areas (ICES 2007c), whereas it is continuing to decrease in most of the coastal areas (Karlsson and Leonardsson 2004). In spite of its low abundance, fecundity of *M. affinis* has decreased – an effect of the lower average nutritional value in the phytoplankton community.
- The zoobenthic community has also been affected by the poor oxygen conditions in the deeper bottom areas in the Baltic Sea. In the Gulf of Finland, the state of the habitats near the sea bottoms has been poor in most recent years, resulting in an almost total absence of zoobenthos both in the open Gulf and along the northern coast.
- The **non-native** polychaete *Marenzelleria viridis* first observed in the Baltic Sea in 1980s, has expanded in distribution and abundance during the latest years (Karlsson and Andersson 2004). In some areas in the southern Bothnian Sea it has become the dominating zoobenthic species, potentially increasing the bioturbation of the sediment (Kautsky and Kautsky 2000), and affecting native competitors such as *Macoma balthica* and *Monoporeia affinis* (Figure 1.9.9). Other non-native benthic species has changed the functional diversity in the Baltic Sea, such as *Dreissenia polymorpha* which filter-feeds in low salinity areas whetre *Mytilus edulis* is absent, the barnacle *Balanus improvisus* which suspension-feeds in the uppermost hydrolittoral zone, and the Chinese mitten crab *Eriocheir sinensis*, which is a predator and scavenger (Kautsky and Kausky 2000). *E. sinensis* has been suggested as so potentially harmful as to warrant Alien Species Alert Reports by the WGITMO (ICES 2005b).

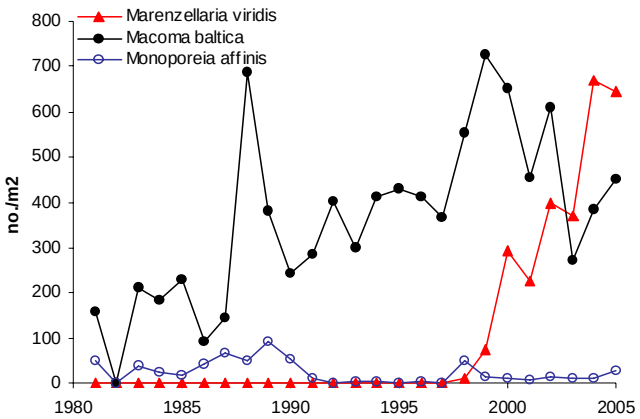


Figure 1.9.3 Increase of the non-native polychaete *Marenzellaria viridis* in southern Bothnian Sea. Data from zoobenthic sampling by Swedish Board of Fisheries (Kerstin Mo, Institute of Coastal Research, SBF, Öregrund, Sweden, pers. comm..).

1.8.3.5.4 Trends in the fish community

- In the late 1980s there was a **shift in the fish community in the open sea in the Baltic Proper**, from a cod-dominated system to a sprat-dominated, due to cod fishing (Jarre-Teichmann 1995), cod recruitment failure (Jarre-Teichmann et al. 2000) and hence predatory release of clupeids and subsequent good sprat recruitment (Köster and Möllmann 2000, Köster et al. 2003; MacKenzie and

Köster 2004). Sprat recruitment has also been favoured by the increase in *Acartia* (ICES 2005c). As a consequence clupeid predation on early life-stages of cod has increased (Köster and Möllmann 2000, Köster et al. 2003b, MacKenzie and Köster 2004). In consequence of the climate-related trends in dominating zooplankton species, the shift in peak spawning of cod, the differences in utilisation of copepods species, the carrying capacity of the ecosystem for larval survival switched from high for cod during the 1980s to high for sprat during the 1990s (ICES 2005c). Thus, given the low level of cod biomass and lack of major inflow events, there is no evidence to suggest that this ecosystem shift will reverse.

- Integrated assessments of the **Gulf of Riga, Gulf of Finland, and the Bothnian Sea** ecosystem show also show a **regime shift in ecosystem state** in the end of the 1980's and early 1990's (ICES 2007c; see also section 1.5.2.). The new regime (1994-2005) in the Gulf of Riga is characterized by high temperatures and nutrient levels (DIP) leading in spring to high zooplankton biomass and a large herring (Clupea harengus) recruitment and biomass (ICES 2007c). In the Bothnian Sea, the current regime (1990-2005) is characterized by low salinity, high biomass of Bosmina and Limnocalanus and very large herring stock with low mean weight at age (ICES 2007c) The main drivers behind the ecosystem shift in all sub-basins were the decreasing salinity and increasing temperature (ICES 2007c).
- **Cod recruitment has been drastically reduced**, as a consequence of the decadal trends in copepod abundance and hence the food supply for cod larvae. In addition, the shift in cod peak spawning time from spring to summer brings the larvae in an environment with low *nauplii* abundances, as *Pseudocalanus* sp. reproduces mainly in spring (ICES 2005c).
- **Sprat and herring growth have decreased**, due to the changes in zooplankton composition and abundance, in particular the decrease in *Pseudocalanus* sp., (Rönkkonen et al. 2004, Möllmann et al. 2005) and increased intra- and interspecific clupeid competition (Möllmann et al. 2005, Casini et al. 2006).
- **Recruitment failures in coastal spring-spawning fish species**, primarily perch (*Perca fluviatus*) and pike (*Esox lucius*), have occurred in open coastlines and outer archipelagos since the 1990s (Nilsson et al. 2004, Sandström and Karås 2002). The decrease in recruitment can be seen in all freshwater species that spawn in spring in the Baltic Proper, except in sticklebacks (Ljunggren et al. 2005), and seems to be due to starvation of the larvae, since it correlates with low densities of zooplankton, but not with any changes in vegetation or predation by sticklebacks or cormorants. In contrast, no recruitment failures have been observed in the Gulf of Bothnia (Ljunggren et al. 2005).
- Individual growth of coastal fish species favoured by temperature, such as perch, has increased, leading to high biomasses in areas without recruitment failures.
- Among **non-native fish species** in the Baltic Sea, the two most potent invaders are the black mouthed goby *Neogobius melanostomus* and the gibel carp *Carassius gibelio*. Since the first finding in 1990 *N. melanostomus* has spread rapidly along the south and east coast of the Baltic Proper. In 2005 it was observed in the Finnish coast, and had increased to being one of the most common species in Estonian waters. It is a highly competitive benthic feeder due to its high tolerance of oxygen-poor situations, but is sensitive to predation by e.g. cod and turbot. *C. gibelio* is found along the southern coast of the Baltic Proper, where it lately has increased greatly in abundance. During the last decennium it has become so common that it is now dominating biomass of commercial catches in some Estonian coastal waters (ICES 2005b).

1.8.3.5.5 Trends in birds and mammals

- **All Baltic seal populations are increasing** in all sub-basings, except for populations of ringed seal in the eastern Baltic Proper. The grey seal population has increased with about 7.5% annually during the period 1990-2004 along the Swedish Baltic Sea coast. The increase is greatest along the Finnish coast and

somewhat lower in the western parts of the Baltic Proper (Karlsson and Helander 2004).

- There is an **overall decrease for nine of the 19 breeding seabird species** in the Baltic Sea. Black-headed gulls are assessed as decreasing throughout the Baltic Sea, whereas the eight other species are considered decreasing in parts of the Baltic Sea. The status of other species, which predominantly breed in the archipelago areas, like common eider, arctic skua, Caspian tern and black guillemot, is uncertain, and populations of these species may be decreasing in parts of the archipelago areas (ICES 2003).). Cormorants have had a long period of fast increase, whereas the population growth has now levelled off the Baltic proper while it continues to increase in the northern Baltic Sea.
- Since 2000 a lethal decease with neurological symptoms is spreading among some seabird species, particularly gulls. The causes of the decease are unknown, and it is widely spread among areas, but at the same time quite local in the sense that one colony can be affected but the neighbouring colony is healthy. In many sites the populations of herring gull (*Largus argentatus*) have decreased by almost 50% (Tidlund and Mörner 2005).

1.8.4 Ecosystem considerations in the stock assessments

The WGBFAS recognises the importance of the above listed changes in the ecosystem for the development of the Kattegat and Baltic Sea fish stocks, and has therefore when possible accounted for these in the stock assessments. Ecosystem changes have been considered in the following stock assessments:

- The changes in cod predation pressure on clupeids are accounted for in the assessments of herring in SD 25-27, 28.1+32 (section 6.2.5) and sprat (section 7.4) by using MSVPA estimates of natural mortality (SGMAB 2005).
- In previous assessments the influence of climatic factors on sprat recruitment has been considered in the sprat predictions. However, because the NAO index for February was not available to the working group, this was not possible in the short-term predictions made in 2007.
- The increasing sea surface temperatures and the zooplankton abundance changes are accounted for in the assessment of the Gulf of Riga herring, when estimating herring recruitment for the short term predictions (section 6.3.7). The relationships with average water temperature in April when the spawning starts and the abundance of *Copepoda* in May when the hatching of larvae begins, has changed compared to previous years. An updated relationship has been used for the prediction of recruitment.

1.8.5 Conclusions and recommendations

As shown above, there are important ecosystem changes that need to be considered in the assessments. WGBFAS has accounted for the impact of climatic factors as well as of other species, from both lower and higher trophic levels, on the assessed stocks. However, WGBFAS wish to further advance this matter during future work. To this end, WGBFAS needs input from the following working groups:

(1) **WGRED**: the regional ecosystem description of the Baltic Sea should (i) be basin specific and include the points listed by the SGBFFI (ICES 2006c); and (ii) incorporate the results of WGIAB (ICES 2007c) identifying ecosystem changes important for stock assessments.

(2) **WGITMO**: WGBFAS recommends that WGITMO provide the WGIAB and the Baltic Committee with a summary of non-native species known to occur in the Baltic Sea, to support integrated assessments of the Baltic Sea ecosystem, as done for the North Sea to REGNS. This will ensure that the input from such integrated assessments to WGBFAS is based on best available information.

(3) **WGIAB**: Within the current stock assessment framework, ecosystem considerations necessarily are simplified to include interactions between two or at most three species, and/or one or at most two environmental variables. WGBFAS therefore highly appreciates the work done by the WGIAB to develop methods for integrated assessments of the ecosystem state and development. WGBFAS suggests that WGIAB addresses the following six topics, to further advance the usefulness of WGIAB results to the fisheries assessments:

- How well do the periods of the different ecosystem regimes correspond to the years identified by e.g. WKREF and to years for averaging recruitment used in predictions by WGBFAS?
- Can observed trends in fisheries data (e.g. growth changes) be explained by environmental data
- Why is the correlation between the temperature-zooplankton and herring recruitment in the Gulf of Riga (used for short term predictions) breaking down in recent years?
- Why does the current regime in the Central Baltic Sea show lower herring biomass compared to the previous regime, whereas the regime shift in all other areas correspond to increases in herring biomass? In particular when the explanatory variables, salinity and temperature, are the same across all areas?
- Are there environmental factors that can explain why the 2002 year class is so strong in all herring stocks in the Baltic Sea?
- Preparation of descriptions of both long term trends, and changes in the last years in the ecosystem, to identify environmental changes important to consider in the assessment.

1.9 Stock Overviews

In WGBFAS, a total of 3 cod stocks, 6 flounder stocks, 4 herring stocks, 1 sole stock and 1 sprat stock are considered. Analytical assessment could be carried out for all cod, herring, sole and sprat stocks and for one flounder stock. Results of the assessments are presented in the subsequent sections of the WG report.

Cod in Kattegat. The reported catches of cod in Kattegat have declined from more than 15.000 tonnes in the 1970'ties, 10.000 tonnes in the late 1990'ties to the present level about 1.000 tonnes. The SSB is considered to be below B_{lim} but the present level of fishing mortality is uncertain due to problematic catch data. The recruitment in the last decade is well below the long-term historical average.

Cod in Subdivisions 22-24 (Western Baltic cod) The cod stock in the Western Baltic has historically been much smaller than the neighbouring Eastern Baltic stock, from which it is biologically distinct. It appears to be highly productive stock, which has sustained a very high level of fishing mortality for many years. Recruitment is rather variable and the stock is highly dependent upon the strength of incoming year-classes. Spawner biomass has been at or below B_{PA} since 2002.

Cod in Subdivisions 25-32 (Eastern Baltic cod). The Eastern Baltic cod Stock is biologically distinct from the adjacent Western Baltic (Subdivisions 22-24) stock although there is some migration of fish between areas. Spawning is confined to the deep basins where egg survival depends on oxygen concentration in the deep saline water layer where fertilized eggs are neutrally buoyant. The total and spawning stock biomass increased by the end of the 1970s due to the extremely abundant year classes in 1976, 1977 and 1980 and favorable reproduction conditions in the southern and central Baltic Sea. The spawning stock declined from the historically highest level during 1982–1983 to the lowest level on record in 2004 and 2005. The decline of the stock was a result of an increase of the effort in the traditional bottom trawl fishery, introduction of gillnet fishery, and decreased egg and larval survival due to

unfavorable oceanographic conditions (i. e., low oxygen concentrations for eggs and low food supply for larvae). Since the mid-1980s cod reproduction has only been successful in the southern spawning areas - Bornholm Basin and Slupsk Furrow. Although the present estimates of stock are uncertain due to misreporting of landings, discarding and age reading problems, all available information indicates that the SSB is at a very low level and the stock is considered to be below the biological reference points.Recruitment since the late 1980s has continued to be at a low level, although the year classes 2000 and 2003 may be stronger than other recent year classes.

The landings of **Sole in Division IIIa** fluctuated between 200 and 500 t annually prior to the mid-1980s. Landings increased to a maximum of 1400 t in 1993 and since then have decreased to ca. 450 t until 2001. Landings since then have been 600-850 t and were 724 t in 2005. During 2002-2004 the fishery was increasingly limited by quota restrictions, increasing the incentive for misreporting. Spawning stock biomass increased from ca. 920 t in 1984 to ca. 4800 t in 1992–1994. From 1994 to 1998 the SSB decreased to 2300 t. Spawner biomass was stable at this level for several years before increasing nearly annually since 2001; spawner biomass is presently ca. 4600 t and therefore close to the maximum in the time series. Input data for the assessment was improved due mainly to a better understanding of the seasonality of the fishery, and identification and application of unbiased CPUE indices from the commercial fisheries from 2005 onwards.

Flounder in Subdivisions 24&25. The stock structure of the flounder in the Baltic Sea is uncertain. Stock identifications differ between studies relying on migration patterns (Aro 1989, Bagge and Stefflensen 1989), spawning behaviour (Nissling et al. 2000), or microsatellite analyses (Florin and Höglund, in prep.). Migration studies indicate that there are several rather distinct flounder stocks (populations). Flounder is regularly distributed in all parts of the Baltic Sea, except in the Bothnian Bay, the most eastern part of the Gulf of Finland and the deepest areas of the Gotland Deep. According to migration studies (Aro 1989), there are at least three stocks in the south-western and south-eastern Baltic (ICES Sub-divisions 22-26), three in the central and north eastern Baltic (ICES Sub-divisions 27-28), in the Åland Sea, one in the Archipelago Sea and the southern Bothnian Sea , and two in the Gulf of Finland.

The migrations between the mature flounder stocks are quite sparse (Aro 1989). The natural boundaries of the stock in the south-western and central southern Baltic (ICES Subdivisions 24 an 25) may be drawn from the southern part of the Öland Island to the Rozewie on the Polish coast in the east and the Darßer Schwelle in the west. Spawning takes place in the Arkona Deep, the Slupsk Furrow and the Bornholm Deep at a depth of 40-80 m in the period from the second half of February to May.After spawning feeding migrations are directed to the shallow coastal areas, southwards to the coasts of Germany (to the west up to the Island Rügen) and Poland (to the east up to the areas of Rozewie) and northwards to the south coast of Sweden. During the late autumn and early winter there is a spawning migration to the main spawning grounds, and some part of the mature stock feeding in the Arkona region migrates to the Bornholm Basin to spawn.

A preliminary genetic study (Florin and Höglund, in prep.) of flounder from 12 different places ranging from Åland in the norther Baltic Sea to the Danish west coast supports the notion of genetically differentiated flounder stocks, by showing that genetic distance is significantly correlated to geographic distance. However, the results indicate that rather than a high number of small stocks, three major different groups of flounder could be identified: (1) Skagerrakk/Kattegat (subdivisions 20-21), (2) Southwest Baltic Sea (subdivisions 22-25), and (3) Western Baltic Sea (subdivisions 26-32) (for more details, see Gårdmark and Florin, 2006).

Herring in Sub-divisions 25-29&32 excl. Gulf of Riga (Central Baltic herring) is the largest herring stock assessed by the WG and it comprises a number of spawning components. This stock complex experienced a high biomass level in the early 1970s but has declined since then. The proportion of the various spawning components has varied in both landings and in stock. The southern components growing to a relatively large size has declined and at present the more northerly components reaching a maximum size of only about 18-20 cm are dominating in the landings. The recruitment has been below the long-term average since the beginning of the 1990´s. The 2002 year-class is relatively large and the spawning stock has increased slightly in the most recent years. Amount of reported landings is uncertain as it is mostly caught in mixed fisheries together with sprat.

Gulf of Riga herring. The stock is classified to have a full reproduction capacity**.** The spawning stock biomass of the Gulf of Riga herring has been rather stable at the level of 40,000-60,000 t in the 1970s and 1980s. The SSB started to increase in the late 1980s, reaching the record high level of 120,000 t in 1994. Since then the SSB has been the range of 85,000-120,000 t. The year-class abundance of this stock is significantly influenced by hydro-meteorological conditions (by the severity of winter, in particular). Mild winters in the second half of 1990s have supported the formation of series of rich year-classes and increase of SSB. Due to low and only occasional presence of sprat in the Gulf, there is no mixed pelagic fishery in the Gulf of Riga.

Herring in Subdivision 30 The spawning stock of Bothnian Sea herring was at relatively low level of 100 000 – 150 000 t until the middle 1980s, after which the SSB more than tripled by 1994. In 1995–2001, the SSB declined from the highest value of 410,000 t in 1994. Since 2001, the SSB has been increasing, and it was 380,000 t in 2005. Although recruitment has been on average much higher during the high biomass period, favorable environmental conditions (i.e. warm summers in late 1980s, 1997, 2001 and 2002) have contributed to the production of the high year classes. The 2002 year class is estimated to exceed the second largest year class in time series by more than double.

Herring in Subdivision 31 is one of the smallest stocks assessed by the WG. The dynamics of the stock appears to be largely influenced by the environmental factors. The spawning stock biomass of the Bothnian Bay herring fluctuated between 26 000 t and 39 000 t during the 1980s. The SSB declined to a very low level in the late 1990s, but since year 2000 the SSB has doubled due to several good year classes in recent years, being more than 21 000 t in 2005.

Sprat in Subdivisions 22-32 is the largest stock assessed by this WG and is considered to be exploited sustainably and to have full reproductive capacity. The spawning stock biomass has been low in the first half of 1980s. In the beginning of 1990s the stock started to increase rapidly and in 1996-1997 it reached the maximum observed spawning stock biomass of 1.8 million tonnes. The stock size increased due to the combination of strong recruitments and declining natural mortality (effect of low cod biomass). In the following years a decreasing trend in stock size was observed as result of rather high fishing mortality (0.35-0.4). In 2005-2006 the stock is predicted to increase again due to strong year classes of 2002 and 2003. The year class 2004 is assessed as weak, and the 2005 is estimated above the average. The marked part of the sprat catches is taken in mixed sprat-herring fishery, and species composition of these catches is very imprecise in some fishing areas /periods.

The main **assessment tool** used by this WG is conventional VPA tuned in XSA. This model appears to behave well on the stocks considered by this WG. However, for some stocks additional methods need to be used, e.g. for herring in Sub-division 31 and for the Eastern Baltic cod.

Biological reference points have been defined for a most stocks for which analytical assessment is performed.

1.10 Recommendations

Please see Annex 2.

2 Cod Introduction

2.1 Introduction

2.1.1 Demersal stocks in the Baltic sea and Division IIIa: Cod and flatfish

In the Baltic Sea cod is the most important demersal target species, with some by-catch of flatfish, primarily flounder. A more diverse fish fauna is present in Division IIIa, leading to an associated greater diversity if fisheries. Stocks of Sole in Division IIIa and cod in the Kattegat are assessed by the current WG; the stock of Plaice in Division IIIa falls within the remit of WGNSSK, as do cod in the Skaggerak, which are treated as part of the main North Sea stock. There is also a population of *Nephrops norvegicus* in Division IIIa, which forms the basis of another fishery in the area, and which is now also assessed by WGNSSK.

2.1.2 Fishery Management

The primary management measure for demersal stocks in the Baltic and Division IIIa is annual TACs. These are accompanied by an extensive array of technical measures, including seasonal closed areas, an additional days of closure, to be allocated individually by the member states, minimum landings sizes and regulations concerning codend mesh configuration.

2.1.3 Catch Statistics in Baltic cod

Total landing of cod in the Baltic Sea (SD 22-32) is presented by country in Table 2.1.1 and by country and SD in Table 2.1.2.

In some previous years there have been problems of misreporting of catches for Baltic cod, and the WG has applied corrections to the official figures in order to obtain more realistic estimates of the catches. The purpose of this section is to provide as much information as possible on suspected misreporting during 2006.

For some nations unaccounted angling catches have been highlighted as a potential source of uncertainty in catch figures so this subject is also considered here.

2.1.3.1 Misreporting

Catch misreporting, mostly in the form of unreported landings, tends to result from a combination of restrictive quotas, the absence of other fishing opportunities and inadequate inspection. However, the precise circumstances can differ between countries, so information was obtained from representatives of each of the countries contributing data to the WG. The information supplied by each country is summarised below in order to illustrate the nature of the information available, and to allow the reliability of the estimates to be evaluated. However, there was a clear consensus amongst WG members that individual countries should not be identified. There were two main reasons for this :

- Information obtained on misreporting is regarded as for assessment purposes only, and the resultant catch estimates should not be made public in case of political problems if these estimates are seen to be different to the official figures.
- The estimates are often based on information which has been provided by fishers as a result of trust being established between fishers and scientists. If the information is then made public, there is a risk that this will lead to loss of trust,

which would then make it difficult to obtain information in the future or even to obtain access to fishing vessels for sampling purposes.

As a result of these potentially major problems, the individual countries concerned are not identified below, but are instead clustered into groups of one or more countries according to the information available.

The information supplied is summarised below, together with the raising factors (RFs) applied to the landings data that of that group of countries in order to account for suspected misreporting.

Group A: A rough estimate based on informal contacts with the industry. Assumed RF = 1.2 or RF = 1.5.

Group B: Information available from informal contacts with industry and enforcement sources indicates a reduction in non-reporting compared to 2004, largely due to a reduction in the cod fleet due to decommissioning , meaning that individual vessel quotas are less restrictive.

Group C: Information is available from at sea sampling, formal and informal contacts with the fishing industry and, and from inspection of import/export records. Taken together these sources of information indicate total catches about 100% greater than the reported figure. Assumed RF = 2.0.

Group D: Either no information available, or information indicates no or negligible misreporting. Assumed RF = 1.0

The above figures refer to non-reporting of landings. There is also suspected to be misreporting of catches by area, e.g. between the Western and Eastern cod stock areas, and also the Kattegat and Western Baltic. In the case of the misreporting between the two Baltic areas, this is believed to occur in both directions in response to different catching opportunities and closed seasons. No information is available to quantify this. In addition, there is also suspected to be some misreporting between national sectors in the Eastern Baltic as differences in nation conversion factors for gutted to live weight can make this practice worthwhile.

A recent empirical work on non-compliance behavior (Raakjær Nielsen and Mathiesen, 2003) notes that compliance is closely related to the expected profit from the allocated catch rations. Also, the potential gains in illegal fishing as opposed to the risk of detection are considered import. Fishermen are generally reluctant to discard fish already dead which concord with the finding that only few fishermen found it wrong to land catches exceeding their rations. The fishermen are opposed to the ration-period system as they may experience high landings when the rations is almost caught which provides strong incentives to misreport landings. Most fishermen found that a day at sea regulation would be a preferable measure to regulate the fisheries in order to protect the fish stocks.

The control activities includes paper control (logbooks, sale slips), harbor control (vessels, auctions and factories), at sea controls (bodings) as well as designated campaigns for tougher surveillance when that is deemed necessary. The control authorities have in the most recent years had focused attention on cod fisheries as a consequence of the implementation of the EU's cod recovery plan and the introduction of two management areas in the Baltic Sea.

2.1.3.2 Angling

Angling for cod is relatively well established in Germany, Denmark, and on the Øresund coast of Sweden. There is increasing interest in Poland, and also in Russia, although a restrictive recreational quota was implemented during 2004. There has been no development of sea angling off Latvia. Preliminary information on angling catches along the Swedish west coast

indicate insignificant proportion taken in the leisure fishery in the Kattegat-Skagerrak area (~1%), and about 10 %. in SD23 (Øresund).

2.1.4 Catch options by management areas

Baltic cod

The Eastern and Western cod stocks have historically been assessed separately but has been managed as a single stock under a common TAC. ICES has continuously advised that the two stock should be managed separately to allow stock specific regulation measures be implemented differently in the two areas. This measure was fully implemented for the first time in 2005.

A benchmark stock assessments of the Western and a update of the Eastern cod stocks are presented in section 2.3 and 2.4, respectively of this report.

Cod in Kattegat

The assessment and management areas are identical for the Kattegat cod stock. The key management tool is the annual TAC and effort. The updated stock assessment is found in section 2.2

Sole in Division IIIa

The assessment covers Division IIIa (the Kattegat and Skagerrak) whereas the management covers Division IIIa plus Sub-divisions 22-24 (the Western Baltic). Catches in the Western Baltic are low, approximately 10% of that in IIIa. The key management tool is the annual TAC. The updated stock assessment is found in section 3.

Baltic flounder

The flounder assessment only includes information from SD 24-25. The updated stock assessment is found in section 4.2. There are no TAC's set for flounder and hence no appropriate management areas. Management is restricted to technical measures. .

Table 2.1.1 Total landings (tons) of COD in the ICES Subdivisions 22-32 by country.

Year	Denmark	Estonia	Finland	German Dem.Rep.[2]	Germany, Fed. Rep.	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands[4]	Norway	Unallo-cated[3]	Total
1965	35,313		23	10,680	15,713			41,498		21,705	22,420				147,352
1966	37,070		26	10,589	12,831			56,007		22,525	38,270				177,318
1967	39,105		27	21,027	12,941			56,003		23,363	42,980				195,446
1968	44,109		70	24,478	16,833			63,245		24,008	43,610				216,353
1969	44,061		58	25,979	17,432			60,749		22,301	41,580				212,160
1970	42,392		70	18,099	19,444			68,440		17,756	32,250				198,451
1971	46,831		53	10,977	16,248			54,151		15,670	20,910				164,840
1972	59,717		76	13,720	15,516			57,093		16,471	30,140				192,733
1973	66,050		95	14,408	28,706			49,790		18,389	20,083				197,521
1974	57,810		160	10,976	22,224			48,650		16,435	38,131				194,386
1975	62,524		298	14,742	24,880			69,318		17,965	49,289				239,016
1976	77,570		287	8,552	26,626			70,466		20,188	49,047				252,736
1977	73,505		310	10,967	30,806			47,702		18,127	29,680				211,097
1978	50,611		1,437	9,345	15,122			64,113		16,793	37,200				194,621
1979	59,704		2,938	8,997	19,375			79,754		23,093	75,034	3,850			272,745
1980	75,529		5,962	7,406	18,407			123,486		33,201	124,350	1,250			389,591
1981	92,648		5,681	12,936	18,281			120,901		44,330	87,746	2,765			385,288
1982	91,927		8,126	11,368	21,860			92,541		46,548	86,906	4,300			363,576
1983	107,624		8,927	10,521	25,154			76,474		53,740	92,248	6,065			380,753
1984	113,701		9,358	9,886	42,031			93,429		65,927	100,761	6,354			441,447
1985	107,627		7,224	6,593	31,798			63,260		54,723	78,127	5,890			355,242
1986	98,464		5,633	3,179	22,422			43,236		49,572	52,148	4,596			279,250
1987	83,844		3,007	5,114	18,816			32,667		47,429	39,203	5,567			235,647
1988	74,742		2,904	4,634	18,295			33,351		54,968	28,137	6,915			223,946
1989	65,935		2,254	2,147	15,342			36,855		55,919	14,722	4,520			197,694
1990	56,700		1,731	1,629	7,745			32,028		54,474	13,461	3,558			171,326
1991	50,606	1,810	1,711		9,443	2,627	1,865	25,748	3,299	39,490		2,611			139,210
1992	30,420	1,368	485		6,449	1,250	1,266	13,314	1,793	15,940		593			72,878
1993	17,667	70	225		5,126	1,333	605	8,909	892	12,048		558		18,978	66,411
1994	24,805	952	594		7,079	2,831	1,887	14,335	1,257	25,530		779		44,000	124,049
1995	38,204	1,049	1,861		14,692	6,653	4,513	25,000	1,612	27,966		777	293	18,993	141,613
1996	48,494	1,388	3,139		19,358	8,741	5,524	34,855	3,306	36,119		706	289	10,815	172,734
1997	40,549	1,420	1,547		14,484	6,187	4,601	31,659	2,803	28,374		600			132,224
1998	29,477	1,196	1,039		10,992	7,778	4,176	25,778	4,599	16,609					101,644
1999	38,083	1,062	1,572		15,439	6,914	4,371	26,580	5,202	15,927					115,150
2000	32,042	609	1,819		13,080	6,280	5,165	22,120	4,231	19,172				23,118	127,636
2001	29,150	805	1,717		12,738	6,298	3,137	21,992	5,032	21,026				23,677	125,572
2002	21,543	37	1,717		8,767	4,867	3,137	15,888	3,793	14,588				17,562	91,898
2003	22,303	591	1,151		8,129	3,617	2,767	15,943	3,707	13,746				22,147	94,100
2004	20,707	1,192	859		7,310	5,056	2,041	15,120	3,410	14,163				19,563	89,421
2005	19,039	972	280		9,341	3,989	2,988	12,762	3,411	9,295					62,077
2006[1]	21,426	707	669		9,541	4,566	2,294	15,091	3,719	11,539				17,836	87,388

[1]Provisional data. [2]Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.
[3]Working group estimates. No information available for years prior to 1993.
[4] For 1997 landings not officially reported, estimated by the WG.

Table 2.1.2 Total landings (tons) of COD in the whole Baltic Sea (SDs 22-32) by Subdivision and country. 1/3

Year	Denmark				Faroe Island[6]	Finland						Federal Republic of Germany					
	22	23	24	25-29	25-28	24	25-28	29	30[2]	31	32	22	24	25	26	27	28
1972	17,717		7,928	34,072					76			10,531	1,782	3,193	10		
1973	21,400		9,195	35,455					95			12,833	900	9,100	5,200		673
1974	18,300		7,482	32,028					160			9,998	395	5,242	5,769		820
1975	15,981		7,500	39,043				270	8		20	12,415	497	8,809	1,975		1,184
1976	19,764	712	9,682	47,412				81	24		182	12,312	581	7,526	4,490		1,717
1977	17,726	1,166	10,213	44,400				85	26		199	10,807	879	3,649	13,803		1,668
1978	12,641	1,177	6,527	30,266				249	323	6	859	9,972	880	2,178	1,793		299
1979	16,093	2,029	7,232	34,350	3,850			707	518	16	1,697	8,910	688	7,616	2,149		12
1980	16,033	2,425	7,367	49,704	1,250			2,163	880	45	2,874	5,968	689	10,985	673		92
1981	15,502	1,473	7,152	68,521	2,765			3,036	684	11	1,950	9,095	2,165	7,021			
1982	11,669	1,638	7,469	71,151	4,300			4,557	1,368	42	2,159	7,394	666	13,069	662		69
1983	14,100	1,257	7,861	84,406	6,065			5,322	2,013	36	1,556	8,937	323	14,179	1,599		116
1984	13,867	1,703	8,042	90,089	6,354			5,433	2,741	7	1,177	11,340	208	21,948	7,926		609
1985	15,563	1,076	7,461	83,527	5,890			4,646	1,706	7	865	4,992	531	12,733	11,572		1,970
1986	8,914	748	7,281	81,521	4,596			3,571	1,306	2	754	2,236	666	10,545	8,399		576
1987	7,990	1,503	5,470	68,881	5,567			1,389	1,143	2	473	3,611	645	7,757	5,009		1,794
1988	5,680	1,121	7,505	60,436	6,915		614	998	1,257	1	34	3,670	547	11,321	2,577		180
1989	3,422	636	4,637	57,240	4,520		392	603	1,097	1	161	2,099	399	12,201	640		3
1990	3,235	722	5,349	47,394	3,558		833	187	685		26	1,997	1,057	3,232	1,427		32
1991	5,536	1,431	3,847	39,792	2,611		1,061	228	404		18	1,648	1,231	5,419	1,114	8	23
1992	7,567	2,449	2,379	18,025	593		253	48	174		10	2,320	1,336	2,187	586		20
1993	4,901	1,001	3,765	8,000	558		61	11	142	2	9	2,395	1,689	902	140		
1994	6,078	1,073	7,753	9,901	779		232	240	108		14	2,151	1,872	2,858	134		64
1995	11,851	2,547	6,911	16,895	777	132	1,704	3	18		4	5,085	4,111	4,960	225		311
1996	15,380	2,999	12,566	17,549	706	50	3,081		4		4	6,037	5,981	6,520	582		238
1997	15,196	1,886	13,691	9,776	600	11	1,512	4	9	1	10	6,770	2,499	4,632	393		190
1998	8,493	2,467	10,699	7,818		13	1,018	2	4		2	6,600	3,122	1,159	107		4
1999	11,244	2,839	11,830	12,170		116	1,453	1	2			9,165	4,059	2,171	44		
2000	11,473	2,451	8,403	9,715		171	1,646	1	1			7,461	4,111	1,405	79		24
2001	8,410	2,124	9,036	9,580		191	1,525	1				6,566	4,013	2,157	2		
2002	7,025	2,055	4,632	7,831		191	1,526					4,943	2,379	1,418	20		7
2003	5,184	1,373	8,091	7,655		59	1,092					4,389	2,386	1,343	11		1
2004	6,320	1,927	5,066	7,394			859					2,771	1,880	2,659			
2005	4314	1902	5553	7270		2	276		1		1	4342	2660	2339			
2006[1]	5299	1899	4462	9766		242	427					4673	2843	1999	26		

continued

Table 2.1.2 (continued) Total landings (tons) of COD in the whole Baltic Sea (SDs 22-32) by Subdivision and country. 2/3

Year	German Democratic Republic[5]							Poland				Sweden								
	22	24	25	26	27	28	29	24	25[4]	26	27	22	23	24	25	26	27[3]	28	29	30
1972	4,560	5,105	1,950	2,072		33			24,926	32,167				1,277	13,842		876	440		36
1973	4,004	4,370	4,065	1,912		57			29,010	20,780				1,655	15,224		971	485		54
1974	3,028	5,431	1,469	996		52			25,221	23,429				1,937	11,950		1,682	825		41
1975	3,471	2,571	3,320	5,250	50	60	20		35,373	33,945				1,932	12,511		2,052	1,367	103	
1976	1,292	3,290	800	3,150	10	10			26,082	44,384				1,800	14,109		1,979	2,180	115	5
1977	977	2,471	324	5,996	73	1,119	7		18,172	29,530			550	1,516	11,775		2,584	1,560	120	22
1978	1,619	5,466	414	1,714	1	131			31,161	32,952			600	1,730	9,017	26	3,207	1,740	417	55
1979	1,024	6,570	54	1,301	1	46	1		40,146	39,608			700	1,800	13,628	50	3,458	2,665	641	145
1980	880	4,700	5	1,818		3			50,832	72,654			1,300	2,610	18,694	88	6,014	3,185	790	516
1981	1,743	9,916	2	1,275					50,698	70,203			900	5,700	24,600	260	7,200	4,450	712	500
1982	1,908	8,707		728		25			41,830	50,711			140	7,933	20,429	2,279	4,109	9,264	687	1,669
1983	1,441	7,656		1,402		22			35,153	41,321			120	6,910	27,630	1,810	6,490	9,200	1,260	320
1984	1,851	6,242		1,793					35,261	58,168			228	6,014	33,493	4,413	8,223	11,947	1,338	271
1985	1,508	3,870		1,215					19,332	43,928			263	4,895	22,737	8,170	7,068	9,523	1,115	929
1986	825	2,173	1	180					18,297	24,939			227	3,622	19,214	7,764	7,554	9,606	1,233	298
1987	504	4,392	1	217					12,254	20,413			137	4,314	15,173	7,833	5,708	7,507	903	5,817
1988	330	4,302	1	1					14,910	18,441			155	5,849	20,893	7,453	6,674	7,946	535	5,456
1989	217	1,927	3						20,819	16,036			192	4,987	28,068	6,742	7,703	6,829	440	927
1990	129	1,500							14,528	17,500			120	3,671	23,311	13,512	6,702	6,525	252	353
1991									9,853	15,895			232	2,768	18,413	7,034	5,096	5,548	180	207
1992									5,449	7,865			290	1,655	7,169	2,133	2,145	2,153	93	301
1993									5,039	3,870			274	1,675	5,872	2,161	940	972	40	114
1994									9,659	4,676			555	3,711	16,675	846	2,845	842	17	39
1995									18,761	6,239			611	2,632	18,699	2,765	2,180	992	56	29
1996									22,806	12,049			1,032	4,418	22,645	2,871	3,622	1,512	17	2
1997								263	18,884	12,512			777	2,525	19,838	2,035	2,417	770	12	
1998								623	14,482	10,673			607	1,571	10,293	2,445	1,159	524	9	
1999								660	15,956	9,964			682	1,525	9,992	1,254	1,866	599	9	
2000								926	15,128	6,066			698	2,564	13,165	1,019	1,242	473	11	
2001								646	14,591	6,755			693	2,479	14,863	905	1,683	379	16	5
2002								782	11,093	4,014			354	1,727	12,507					
2003								568	10,952	4,422			551	1,899	10,840	250.022	204.233	1.7799		
2004								538	10,920	3,662			393	1,727	11,551	24	431	24	9	4
2005								1093	7,644	4,024	1	1	719	835	7629	42	6	63		
2006[1]								801	8,883	5,408				1,855	9,030	493	93	28		20

continued

Table 2.1.2 (continued) Total landings (tons) of COD in the whole Baltic Sea (SDs 22-32) by Subdivision and country. **3/3**

Year	USSR						Estonia								Latvia						Lithuania			Russia			Nor-way	Unallo-cated	Total
	25	26	27	28	29	32	22	24	25	26	27	28	29	32	24	25	26	27	28	29	25	26	28	26	28	32	26		
1972		23,951		6,189																									192,733
1973		8,768	1	11,250	50	14																							197,521
1974	811	18,633		17,677	1,010																								194,386
1975	946	17,884	3	28,677	1,735	44																							239,016
1976	8,855	25,302	126	14,645	106	13																							252,736
1977	390	17,880	4	11,304	91	11																							211,097
1978	12	18,010	78	18,623	166	311																							194,621
1979	13	30,776		39,875	1,575	2,795																							272,745
1980	7	45,734		59,892	4,575	14,142																							389,591
1981	2	44,254		32,195	3,733	7,562																							385,288
1982	5	33,221		40,876	3,308	9,496																							363,576
1983		33,600		39,464	6,095	13,089																							380,753
1984		39,871		43,802	6,185	10,903																							441,447
1985		32,096		27,137	8,822	10,072																							355,242
1986		22,818		21,840	3,289	4,201																							279,250
1987		22,652		11,457	1,654	3,440																							235,647
1988		15,928		10,868	172	1,169																							223,946
1989		8,440		6,058	121	103																							197,694
1990		10,020		3,420	3	18																							171,326
1991										1,537		273					1,190		1,432	5		1,854	11	3,034	264	1			139,210
1992										1,011		352	5				383		867			1,266		1,793					72,878
1993										61		8		1			761		572			605		892				18,978	66,411
1994									147	579		208	17	1		630	1,619		582			1,887		1,257				44,000	124,049
1995									338	246		465			15	1,124	3,649	1	1,864			4,513		1,612			293	18,993	141,613
1996								50	1,020	113		205			32	1,217	6,268		1,224			5,524		3,306			289	10,815	172,734
1997								6	1,189	138		87				1,354	4,052		781		1,871	2,730		2,803					132,224
1998								8	1,051	97		10	19	11	13	1,657	4,760		1,348		879	3,297		4,599					101,644
1999								10	966			86			25	1,298	4,384		1,207		1,149	3,222		5,202					115,150
2000								5	303	216		85			84	1,585	3,720		891		902	4,263		4,231				23118	127,636
2001								40	679	39		44	1	2	46	1,464	4,020		768			3,137		5,032				23677	125,572
2002										32			5		71	1,179	2,855	4	758			3,137		3,793				17562	91,898
2003									581	9					124	1,052	2,392	2	47			2,767		3,707				22147	94,100
2004									1,183	5		3	1		221	2,919	1,594	34	288			2,041		3,410				19563	89,421
2005							72	67	829	3	1				476	1075	2074	3	361			2988		3411					62,077
2006[1]								91	581	34					586	803	2,869		308			2,294		3,719				17,836	87,388

[1]Provisional. [2]Finland: 1972-1974 sub-divisions combined. [3]Sweden: 1972-1974 sub-divisions combined.
[4]Poland: Some catches from Sub-divisions 24 included. [5]Includes landinds from Oct.-Dec. 1990 of Fed. Rep. of Germany.
[6]Faroe Island: For 1997 landings not officially reported, landings estimated by WG

2.2 Cod in Kattegat (observation list assessment)

2.2.1 The Fishery

2.2.1.1 Catch trends

The TAC's and reported landings have been reduced significantly since 2000 to the present historic low levels. The official reported landings of cod in the Kattegat in 2006 were 876 tons corresponding to the agreed TAC at 850 t (Table 2.2.1). Since 2000, ICES has considered the stock to be outside safe biological limits and from 2002 has advised that there should be no fishing on this stock and that a rebuilding plan should be implemented in order to raise SSB above agreed B_{pa} (10,500 t).

2.2.1.2 Unallocated landings

The TAC was not restricting the fishery in 2000-2001 but has been restrictive for Denmark since 2002 and for Sweden since 2003, however in 2006 Sweden used up its quota just in the end of the year. Both Sweden and Denmark implemented the TAC regulation through a ration-period system until 2007. Reduction of Danish ration sizes in the Kattegat from more than 500 kg/day in 2000-2001 to less than 50 kg/day in 2004-2005 was illustrated for 14-16 m vessels in last year's WG report (ICES-WGBFAS 2006). The incentives for misreporting by areas were visualized by comparing rations between the Kattegat and the adjacent regulatory areas (ICES-WGBFAS 2006). The ration sizes in the Western Baltic were in the most recent years considerably higher than in the Kattegat implying that cod caught in the Kattegat might have been written down in the Western Baltic if possible. The consequences of implementing such a restrictive TAC were evaluated in further details in Work Document 6 in last year's WG report (Hovgård, 2006), where types of mis-reporting and fishermen non compliance were described.

Information from the annual pre-assessment meeting with Danish industry as well as other anecdotal information indicates that widespread discarding of marketable fish and catch misreporting occurs. The anecdotal information from the industry indicates that the amount of cod taken from Kattegat that does not appear in reported landings was in the order of 2000-2500 tons in 2004-2006, however this level of misreporting could not be validated with available data.

2.2.1.3 Discards

Background information

Danish and Swedish discard samplings have been conducted since 1995, but discard numbers have not been available until the last year due to low sampling coverage, and the lack of approved procedures for raising discard observations to the total. A first attempt to estimate discards for cod in the Kattegat for 2003 and 2004 was made by the STECF subgroup SGRST 05-02 in 2005 (Anon. 2005). Considering the fact that many different fisheries are taking place in the Kattegat, it has been difficult to allocate sufficient sampling effort in order to obtain reliable estimates of discard rates. The raising procedure for an area with a complex fishing structure and low sampling coverage is difficult to handle and will inevitably lead to uncertain estimates. In addition, bias in selection of fishing vessels may have occurred as large parts of the Swedish fishing fleet in the Kattegat from time to time have refused to admit sampling officers onboard. The sampling strategy during the first years of the sampling period was to get an overview of the discard rates in all fisheries and then in the later years, the sampling effort was concentrated on the fisheries where the highest discard rates were

demonstrated. The fisheries, which in the later years has been sampled most intensively is the Nephrops fishery, as it generally has demonstrated high discards rates.

Discard estimates were presented in last year's WG report, however these were not included in the assessment. The compilation of discard estimates was finalized shortly before the WG meeting, not allowing for sufficient quality checks prior to the meeting and ambiguities in the data were identified.

This year, time series of discard estimates were available from Sweden for 1997-2006 and from Denmark for 2000-2006. The Danish time series differed from the data presented in last year's report due to a different calculation procedure. The sampling procedure differs also somewhat between Denmark and Sweden which could not be handled in a common estimation process. The discard estimation was therefore conducted independently by the two countries.

Calculation procedures

Danish discard numbers were calculated separately for Danish seines and demersal trawls with mesh size >90 mm for 2004-2006. For 2000-2003 discards were calculated also separately for trawls with mesh size 70-89 mm, however the fishery using these mesh sizes has basically disappeared after 2003. No discard estimation was conducted for gill-net fishery, as discarding in this fishery is considered to be of relatively little importance.

Due to low sampling level and high variability in discard rates, samples from four years for a given quarter were pooled in order to stabilize the estimates of discard rates. Average discard rates based on samples from 2000-2003 were applied to estimate discards in these years. From 2004 and onwards, a running mean over four years was applied. The discards estimates were raised to the level of a fishery based on landings of all species in a given year:

$$\frac{cod_discarded(samples)}{all_species_landed(samples)} = \frac{cod_discarded(fishery)}{all_species_landed(fishery)}$$

For demersal trawls the sampling data from 3rd quarters in 2000 and 2002 were applied also for the 4th quarter and for Danish seines the data from 2003 3rd quarter were applied for the 4th quarter. This is because sampling level in the 4th quarter has been particularly low and even combining the data from 4 years did not give sufficient samples.

Swedish discard numbers were calculated separately for cod bottom trawl fishery and Nephrops fishery. No discards samples were available for passive gears. Hauls consisting of more than 5% Nephrops in landed weight according to the log books were depicted as Nephrops fishery, whereas the other demersal trawl fishery was depicted as cod fishery. The limit of 5% has been based on the landing structure observed during discard sampling tours, when fishermen defined it as a fishery after Nephrops or cod. The discards from samplings of Nephrops and cod bottom trawl fisheries were raised to the level of the total fishery using reported landings figures on Nephrops and cod, respectively:

$$\frac{Nephrops_landed(fishery)}{Nephrops_landed(samples)} = \frac{cod_discarded(fishery)}{cod_discarded(samples)}$$

$$\frac{cod_landed(fishery)}{cod_landed(samples)} = \frac{cod_discarded(fishery)}{cod_discarded(samples)}$$

Samples from 1997-1999 and 2000-2002 were pooled while estimating discard rates in these time periods, respectively. In calculation of annual discards for the years 2003-2005, data for some quarters of the year were missing. Data were therefore borrowed from those years when such data were available. In recent years, it has been prohibited to land cod during certain

periods of the year. Since this might have affected the discard pattern, the discard rising for these periods was conducted separately.

Estimated numbers of cod discarded by Sweden and Denmark were summed to obtain the total discard numbers by age-groups in 2000-2006. Discard data for 1997-1999 were available only from Sweden. The same proportion of discards per cod landings as estimated for Sweden was assumed also for Denmark. Therefore the discard estimation for 1997-1999 is inconsistent with the later years, as in 2000-2006 Danish cod discards were assumed to be proportional to the landings of all species, not to the cod landings. Therefore the discard estimates for 1997-1999 are not entirely comparable with the years 2000-2006.

Discard estimates

The estimated discards in tonnes and in numbers compared to the official landings are presented in Figure 2.2.1 and numbers by age-groups are shown in Figure 2.2.2. High level of discarding is estimated to take place especially on age-group 1, and the total amount of discarded cod in tons was in 2006 at the same level as the official landings (Figure 2.2.1).

Due to relatively low sampling levels and high variability in the data, our discard estimates are considered to be sensitive to the calculation procedures. For this reason and as data for several years were combined to produce discard estimates, these data cannot be used to analyse annual variability in discarding practice. Therefore, present discard estimates can only be used as an indication of the level of discarding and its impact on the stock. More detailed analyses of discard data from both countries and sensitivity analyses of discard estimates to calculation procedures is suggested for the future. A central estimation of all discard rates and raising to the level of fishery will be available next year and a revision of the estimates can be expected. However, the problems with data coverage would still remain.

The discard estimates for the eastern and western Baltic cod stocks where discard data are also available for relatively short time periods are extrapolated back in time assuming the numbers of cod discarded to be proportional to the numbers of cod landed by age-groups. Discarding of cod in the Kattegat is mainly taking place in Nephrops fishery. Therefore, extrapolating discard estimates retrospectively, assuming the numbers of cod discarded to be proportional to the numbers of cod landed is not appropriate for the Kattegat fishery, and would also be inconsistent with the raising procedures applied for the time period were discard data were available. Besides, the fishery has changed several times during the studied time period since 1971; in the beginning of the time period hardly any Nephrops fishery was going on, and cod and other gadoid species dominated in the fishery. Since then, the Nephrops fishery developed and cod is virtually the only gadoid species of any importance left. Therefore, retrospective extrapolation of discard estimates was not conducted. The estimated discard numbers by Sweden and Denmark and numbers of samples are presented in Table 2.2.2a and b, respectively.

2.2.1.4 Effort and CPUE data

The effort and CPUE from commercial fleets of Denmark and Sweden are presented in Table 2.2.3.

Survey CPUEs were available as in previous years from IBTS 1st and 3rd quarter surveys (Swedish R/V Argos) and from the Danish Kattegat bottom trawl surveys in the 1st and 4th quarter (Danish R/V Havfisken) (Table 2.2.11, Figure 2.2.3). Additionally, time series from the new Swedish coastal surveys (R/V Ancylus) in the 2nd and 4th quarter were available for the working group.

The historical part of the IBTS 1st quarter time series (years 1983-1995) has been subject to changes compared to the previously used indices. In last year's assessment the indices from

1995 onwards were obtained from DATRAS database in ICES, whereas the indices for 1983-1995 were used as calculated by Hovgård (1995). This was due to missing age information in ICES database for the Kattegat area for these years. Age information for calculating the indices for 1983-1995 had been derived from a combination of commercial age-length keys and modal separation for the fish below commercial sizes (Hovgård, 1995). This information was used in the assessments up to 2004. Last year it was noted that the total numbers of fish caught per hour differ for some years between the indices from Hovgård (1995) and the ones currently available in the ICES database for the time period before the 1996. The WG therefore recommended the inclusion of the age information from Hovgård (1995) into the ICES database to facilitate the revision of the time series used in assessment accordingly. Before the working group meeting in 2006, the Age-Length-Keys from Hovgård (1995) were recovered and submitted to DATRAS. Consequently, this year the full time series of IBTS 1st quarter indices were provided by ICES and the difference in the indices in 1983-1995 from the series used in assessments previously is presented in Figure 2.2.4. The differences can possibly be related to the calculation procedures or to the number of samples included depending on the definition of the Kattegat area.

The Havfisken surveys for the Kattegat area both in the 1st and 4th quarter were revised last year. This year, in connection to the scrutinization of the indices from these surveys for the western Baltic area, common procedure for filling in missing age information was implemented for the indices both for the Kattegat and the western Baltic. The details are described in the Working Paper no. 1 presented to the WG. This had a minor impact on the indices for the Kattegat cod for age-groups 1-3 that were included in the assessment last year. Larger impact was detected for age-groups 4 and 5 as these are caught relatively few in numbers and are often missing age information. This was considered as further support to the decision to exclude these age-groups from the assessment as was concluded last year based on the internal and external consistency analyses of the surveys.

The survey indices available for the assessment this year are presented in Table 2.2.11.

2.2.2 Biological composition of the landings

2.2.2.1 Age Composition

The estimated landings in numbers by age estimated for 2006 are given in Table 2.2.4. Historical landings in numbers by age and year are given in Table 2.2.5 and relative share of age-groups in landings is presented in Figure 2.2.5. Consistency analysis of landings at age data (numbers at age plotted against numbers at age+1 of the same cohort in the following year) is presented in Figure 2.2.6.

2.2.2.2 Quality of the catch and biological data

Both Danish and Swedish sampling data were available from the commercial fishery in 2006. Landings were allocated to age groups using the Danish and Swedish age information as indicated in Table 2.2.4. Danish and Swedish sample sizes are shown in Table 2.2.6a and b.

2.2.3 Mean weight at age

Mean weight at age in the landings from 2006, presented in Table 2.2.4, was provided by Sweden and Denmark. Historical weight at age in the landings is given in Table 2.2.7 for all years included in the assessment. Weight at age in catches (including the weight information in discards) is presented in Table 2.2.8.

Mean weight at age in the stock is based on the IBTS 1st quarter survey for age-groups 1-3 and the weight of ages 4-8+ were set equal to the mean weights in the catch. The historical time series of mean weight at age in the stock is given in Table 2.2.9.

2.2.4 Maturity at age

The historical time series of visual based maturity estimations used in the assessment are presented in Table 2.2.10.

2.2.5 Natural mortality

A constant natural mortality of 0.2 was assumed for all ages for the entire time series.

2.2.6 Catch at age analysis

2.2.6.1 Tuning fleets

Tuning data were available from six surveys listed in the table below.

Fleet	Details
Havfisken 4th quarter	Danish survey, 4th quarter, R/V Havfisken (age 0-5) (1994-2006)
Havfisken 1st quarter	Danish survey, 1st quarter, R/V Havfisken (age 0-5) (1996-2006)
IBTS 3rd quarter	International Bottom Trawl Survey, 3rd quarter, Kattegat (age 1-6) (1991-2006)
IBTS 1st quarter shifted	International Bottom Trawl Survey, 1st quarter, Kattegat; (Ages 2-6 treated as if survey took place in previous quarter) (1983-2007)
IBTS 1st quarter raw (not shifted)	International Bottom Trawl Survey, 1st quarter, Kattegat (age 1) (1983-2006)
Ancylus 2nd quarter	Swedish coastal survey, 2nd quarter, R/V Ancylus (age 1-4) (2002-2006)
Ancylus 4th quarter	Swedish coastal survey, 4th quarter, R/V Ancylus (age 1-4) (2002-2006)

WG doubted whether commercial catch rates based on official catch figures are at all useful as stock indicators as the CPUE may either be compromised due to discarding and misreportings or reflecting catch ceilings rather than stock size. The group therefore decided to only use fishery independent catch rate information from the scientific surveys as stock size indicators, similarly to last year.

Internal consistency analyses of all six surveys (numbers at age plotted against numbers at age+1 of the same cohort in the following year) are presented in Figures 2.2.7 a-f. The agreement of indices between surveys was examined by plotting survey time series by age-groups against each other (Figures 2.2.8 a-i). These analyses reveal that for younger age-groups all six surveys show similar patterns both in internal consistency analysis and between the surveys, i.e. all time series are relatively noisy but contain information that is to certain extent consistent between years within individual surveys and agree on the same level with estimates from other surveys. Accordingly, these analyses revealed no justification for excluding any of the time series from the assessment. The consistency plots are presented also for age-groups that were excluded from the assessment last year. However, the decision from last year in relation to selection of age-groups for the final assessment was unchanged. The new time series from Ancylus surveys showed similar consistency patterns for age-groups 1-3 as the other surveys, while age-group 4 was excluded from the further analyses due to lack of consistency with younger age-groups and/or other surveys.

2.2.6.2 Exploratory assessment

2.2.6.2.1 Exploratory runs with xsa

Change of the plus-group and first age at constant catchability

The working group decided to change the plus-group in catch at age data from 8 to 6, as there is no information available in the tuning fleets for age-classes older than 6, and these are also relatively few in the fishery. Catchability was set constant from age 4 instead of 5 as used in the previous settings. This is justified by similar catchability values estimated for the ages 4 and 5 from the IBTS 1st quarter survey. The impact of changing these settings is illustrated in Figure 2.2.9. Both of the runs presented in the figure were tuned with updated time series from the same fleets as used in last year's assessment.

The comparison reveals that changing the plus-group and the first age at constant catchability had minor influence on the estimates for the last year. However, the time series of fishing mortalities were generally estimated to be somewhat lower after setting the plus-group down to 6. This is likely related to the shrinkage to older age-groups in estimation procedure. Pronounced difference appears in SSB at the start of the time series in the 1970s, especially in the estimate for 1973. This could be the effect of relatively higher proportion of cod older than 6 being present in the catches in 1973, when pooling older ages into a plus-group may not be appropriate. However, as in the rest of the time series, ages older than 6 have generally contributed less than 5% to the landings, and as no tuning information for these age-groups is available, setting the plus-group down to 6 was considered justified.

Changing the plus-group down to 6 resulted in the last true age (age 5) being included in the currently set age range for Fbar (ages 3-5). Changing the Fbar should therefore be considered, however this matter was not looked into this year.

Selection of tuning fleets

XSA exploratory runs were made using one tuning fleet at a time setting min log SE value to which estimates are shrunk to 1.5. Log-catchability residuals from these runs are presented in Figure 2.2.10. Results from XSA runs with single tuning fleets are presented in Figure 2.2.11 and in the table below. The table shows also the result from the run including all available tuning fleets and from the run excluding the new Ancylus 2nd and 4th quarter surveys. The differences in the results from the runs including or excluding Ancylus surveys were minor. However, it was noted that Ancylus 2nd quarter survey was given relatively high weight in XSA run, compared to the other surveys that could be an effect of very short time series and should be treated with caution. Moreover, Ancylus time series are currently available only for 5 years that does not allow for retrospective analyses including these surveys. Therefore, it was concluded that Ancylus surveys potentially provide valuable fishery independent information for the assessment in the future, however they were not included in the final XSA run this year. The tuning fleets included in the final XSA run were therefore the same as last year:

1) IBTS 1st quarter shifted (ages 2-6) 1983-2007, excl. 1994
2) IBTS 3rd quarter (ages 1-4)
3) Havfisken 1st quarter (ages 1-3)
4) Havfisken 4th quarter (ages 1-3)
5) IBTS 1st quarter non-shifted 1983-2006, excl. 1994 (age 1)

Summary of the XSA runs, estimates for 2006:

Run	Tuning fleets	Recruits (age 1, thousands)	SSB (t)	F (3-5)
1	IBTS 1st quarter Shifted (ages 2-6)	2238	3575	0.21
2	IBTS 3rd quarter (ages 1-4)	2538	6214	0.12
3	Havfisken 1st quarter (ages 1-3)	4756	13091	0.06
4	Havfisken 4th quarter (ages 1-3)	3865	7586	0.11
5	IBTS 1st quarter(not shifted, age 1)	2618	1503	0.94
6	Ancylus 2nd quarter	1944	2564	0.53
7	Ancylus 4th quarter	1045	1279	1.00
8	All fleets	3735	5619	0.13
9	All fleets, excl. Ancylus 2nd, 4th quarter	4022	5710	0.13
10	tuned as run 9, but shrinkage 0.5	2261	2384	0.46

The results from single fleet runs showed high variability in the final estimates as illustrated in the Figure 2.2.11 and in the table above. This is likely a combined effect of relatively noisy survey indices and shrinkage, as runs with single tuning fleets are largely affected by shrinkage when tuned, e.g. only with one age-group (IBTS 1st quarter, age 1) despite of the high log SE value given to shrinkage.

Selection of log SE value for shrinkage

The WG noted last year the shift in the fishery from an unconstrained situation to the situation with very restrictive rations and presumed that significant changes in the fishing pattern may have occurred. As this implies changes in fishing mortalities the use of F shrinkage in XSA runs should be restricted. Therefore, low weight for shrinkage (log SE 1.5) was used also for the final run last year.

This year the WG analysed further the consequences applying different SE values to which estimates are shrunk. It was noted that the weight given for shrinkage has an impact on the XSA results. Differences in SSB and Fbar from XSA runs applying the log SE 1.5 and 0.5 are presented in Figure 2.2.12 and the estimates for 2006 are given in the table above. Catchability residuals from both runs are presented in Figures 2.2.13 and 2.2.14 and retrospective analyses are presented in Figures 2.2.15 and 2.2.16. The run with high weight given for shrinkage (log SE 0.5) resulted in blocks of positive catchability residuals in the last years for several fleets and higher standard errors on log catchability estimates compared to the run where log SE for shrinkage was set to 1.5. Diagnostics for both runs is presented in Tables 2.2.12 and 2.2.13. Furthermore, the retrospective pattern especially for fishing mortality indicated larger underestimation while applying heavier shrinkage (log SE 0.5) compared to the more consistent retrospective pattern when giving lower weight to shrinkage (log SE 1.5). Resulting from these analyses and additionally due to expected changes in fisheries under the more restrictive conditions in the last years, the working group decided not to change the weight given for shrinkage. The value for log SE was therefore kept at 1.5 as in last year.

The tuning diagnostics of the XSA run with final settings and tuning fleets are given in Table 2.2.13 and estimates of fishing mortality and stock numbers are given in Tables 2.2.14 and 2.2.15. A summary of the output is presented in Table 2.2.16. Log catchability residuals of the run with final settings and tuning fleets are shown in Figure 2.2.14. Relative weights of tuning indices in this run are shown in Figure 2.2.17.

The retrospective analyses indicate underestimation of fishing mortality while SSB and recruitment are slightly overestimated (Figure 2.2.16).

Including estimates of discard

Discard estimates were available for the years 1997-2006. The XSA run including discards was performed with truncated time series of all the input data starting from 1997 due to lack of basis for extrapolating discard estimates back in time. The estimates of SSB, Fbar and

recruitment compared to the results from the XSA run not including discards are presented in Figure 2.2.18. Diagnostics of the run including discards is shown in Table 2.2.17. Fishing mortalities and stock numbers are presented in Tables 2.2.18 and 2.2.19. Summary output is given in Table 2.2.20.

Including discards appeared to have relatively little impact on estimates of SSB and Fbar. Due to the high level of discarding of cod, especially at age 1, inclusion of discards to the model had a considerable impact on recruitment estimates. However, due to averaging discard rates over several years in calculation procedures of discard numbers, potential annual variability in recruitment can not be represented in XSA runs. The results not including discard estimates showed negligible fishing mortality at age 1 and relatively low fishing mortality also at age 2. However, the analyses including discards indicate relatively high level of fishing mortality at age 1 (0.3-0.5) and considerably higher fishing mortality also on age 2 in the years 2000-2006 (Figure 2.2.19). The discard calculation procedures for the years 1997-1999 are not comparable with the later years, therefore these years were not included in the time series of estimates presented in Figure 2.2.19.

XSA analyses both with and without discards indicate slight increase in SSB in the last year and drop of fishing mortality (Fbar) in recent years down to the level of 0.1-0.2 in 2006.

2.2.6.3 Exploratory runs with SURBA

SURBA is a tool for estimating relative stock trends and total mortality using only fisheries independent survey data (Needle 2002). As revealed from the consistency analysis of survey data, all survey time series available for Kattegat cod assessment are relatively noisy but do contain consistent information for age-groups kept in the final run. Since survey data are less affected by sources of bias that are characteristic to fisheries data, survey-based assessment using SURBA software was made in addition to the XSA to check for possible obvious contradictions between the results.

Based on the log cohort abundance (catch curve) analysis of the survey data (Figure 2.2.20), age-group 1, being not fully recruited into the IBTS 1st quarter survey, was excluded from the IBTS 1st quarter time series in the final SURBA run as in the last year.

The software version SURBA 3.0 was used for the analysis. The reference age was set to 2 and smoothing parameter lambda to 1, similar to the settings used in last year.

The final SURBA run was made including:

1) IBTS 1st quarter time series for ages 2-6 (not-shifted) 1983-2006 (excl. 1994 survey),
2) IBTS 3rd quarter (ages 1-4),
3) Havfisken 1st quarter (ages 1-3),
4) Havfisken 4th quarter (ages 1-3).

All catchabilities were set equal and age-groups were given equal weight.

Trial run (not shown in the report) was made including also the indices from the Ancylus 2nd and 4th quarter surveys that did not have an impact on the trends from SURBA.

A full output from the final SURBA run is shown in Figure 2.2.21 and the residuals in Figure 2.2.22.

The relative dynamics of SSB from the SURBA analyses were generally showing a decline in SSB over the time series reaching the historically lowest levels in 2002-2004. Somewhat higher level of SSB was indicated for the last two years. This development is similar to the results obtained from the XSA, however the increase in SSB in 2006 compared to the previous

year is not indicated by SURBA. In contrast to the drastic decline in fishing mortality F(3-5) in the recent years as indicated from XSA (Figure 2.2.18), the estimated total mortality Z (3-5) from the SURBA analysis is fluctuating at its historical level (Figure 2.2.21).

Contradicting results obtained from XSA and SURBA indicated the need for additional analyses. Due to problematic catch data in recent years, survey information can be considered as relatively more reliable. However, SURBA analyses based on survey information alone provide only information on relative developments over time not allowing for estimating absolute stock size. Therefore, alternative model (B-Adapt) was used, that allows estimating potential bias in catch at age data in recent years based on survey information.

2.2.6.4 Exploratory runs with B-Adapt

B-Adapt is a modification to the Gavaris and Van Eeckhaute (1998) ADAPT model developed by Chris Darby (CEFAS, Lowestoft). B-Adapt assumes that the time series of landings can be divided into two periods; a historic time series in which landings were relatively unbiased and a recent period during which landings at age were biased by a common factor across all ages.

Detailed description of the model can be found in the reports of the WGNSSK (e.g. ICES-WGNSSK 2004, 2005). The model was originally developed for analysing the cod stock development in the North Sea after observing inconsistencies in the information provided by surveys and catch at age analyses.

Mismatch between the levels of reported landings and actual removals were indicated also by the XSA and SURBA analyses for Kattegat cod that provided conflicting trends in mortality. This may be due to a number of causes (misreporting, nonreporting, unaccounted discards, natural mortality, changes in catchability of surveys, migration), and while these cannot be distinguished, an alternative model can be used to estimate a more realistic level of removals than indicated by the reported landings.

The same input data was used in B-Adapt as in final XSA run not including the discards.

Exploratory runs were performed with B-Adapt to analyse the behaviour of the model with different settings. Due to strong year effect in the surveys in 2003, F constraint weight of 0.5 was applied that penalises changes in F from year to year. All the surveys were given equal weight in the analyses.

The results from the B-Adapt run are presented in Figure 2.2.23. Fishing mortalities, stock number are summary output from B-Adapt are presented in Tables 2.2.21 and 2.2.22 and 2.2.23. The diagnostics is given in Table 2.2.24. The model suggested that unallocated mortality has increased in the last two years. The model was fitted assuming 6 years of uncertain catch levels but only the last two years clearly stand out estimating the factors of bias 3 and 4 in these years, respectively (Table 2.2.24).

The estimate of SSB from B-Adapt is similar to the XSA results, however the fishing mortality is indicated to be at a considerably higher level (0.7) in 2006 compared to very low values estimated by XSA (0.1-0.2 depending on whether discards are included).

2.2.7 Conclusions on recruitment estimates

Due to high level of discarding of especially age-group 1, recruitment estimates from the catch at age analyses not including discards are considered uncertain. The XSA run including discard estimates indicates relatively low level of recruitment in 1997-2006 compared to historical estimates even though historical data are not including discards. However, due to smoothing of discard estimates over several years, interannual variability in recruitment is not represented. Therefore, the best indication of the strength of recent year-classes can likely be obtained from survey indices. Slightly stronger 2003 year-class, recruiting as 1-year-olds in

2004 is visible in all survey indices. This year-class has sustained the main part of the fishery in 2005 when major part of the landings consisted of age-group 2 and also in 2006 when age-group 3 formed the largest part of the landings (Figure 2.2.5). The recruitment index (age 1) for 2006 appears to be somewhat higher compared to 2005, however not as high as the index for 2004. The most recent survey data from IBTS 1st quarter survey in 2007 and also preliminary data from Havfisken 1st quarter survey in 2007 indicate the abundance of age-group 1 at an average level of the past eight years (Figure 2.2.3).

2.2.8 Conclusions on historical stock trends

SSB of cod in the Kattegat has steadily declined from around 35 000 tons in the late 1970s to a level of 5000-6000 tons in the end of the 1990s. In recent years the values estimated for SSB from both XSA and B-Adapt analyses should be considered uncertain due to unreliable catch statistics and also relatively noisy survey data, but the analyses indicate that SSB is with high probability not above Blim.

2.2.9 Short-term forecast and management options

Due to uncertainty in the recent estimates of fishing mortality the WG considered short-term forecast as possibly mis-leading and is not included in the report.

2.2.10 Medium-term predictions

The present state fishery is to a large extent dependent on the strength of incoming year-classes. Therefore a medium-term prediction would be speculative and would not provide any relevant information for the management.

2.2.11 Reference points

The precautionary approach reference points have remained unchanged since 1999: Blim=6400 tons, Bpa=10500 tons, Fpa=0.6, Flim=1.0.

2.2.12 Quality of the assessment

The increasing uncertainty in collected landing statistics limits the value of present stock assessment work and lays stress on the need for improvement of fishery independent data. Time series with high quality from fishery independent surveys is most likely the best way of keeping track of the stock development.

Currently indices from six different surveys that provide information on cod in the Kattegat are available for the working group. All the available survey indices are noisy, however contain information that is to certain extent consistent between years in single surveys and agrees on the same level with estimates from other surveys. The consistency of fishery independent information on relative stock development could potentially be improved by pooling the information from different surveys. The working group therefore strongly recommends WGBIFS to look into the possibility for combining the indices from some of the surveys that could potentially result in fewer, but more consistent time series.

Discard estimates were for the first time included in the assessment in 2006. The annual discard numbers can be considered uncertain, however these can be used to represent the level of discarding and its impact on the stock as indicated by high mortality on young ages. Annual variability in year-class strength can be considered to be best represented in survey-based analyses.

Inconsistencies were observed in the information provided by surveys and catch at age analyses using XSA. Therefore, alternative model (B-Adapt) was applied that allows

estimating the potential bias in the catch at age data. The level and time trend of unallocated mortality derived by B-adapt were in line with the anecdotal information from the Danish fishing industry concerning the bias in reported landings. However, other factors (e.g. migration) could also influence the estimates.

The fishing mortality estimated from XSA showed a very deviant trend in last years compared to SURBA and B-Adapt estimates. Fishery independent survey information indicated increased unallocated mortality in the last years as demonstrated in B-Adapt analysis. The results from B-Adapt can be considered as providing likely more realistic level of the removals; however, the fishing mortality estimate suffers as well from the noise in survey indices.

The face value for SSB from both XSA and B-Adapt analyses should be treated with caution due to problematic catch data and also relatively noisy survey indices. However, the estimate for SSB in latest years showed to be relatively little sensitive to bias in landings data and XSA and B-Adapt estimates were relatively similar. Therefore, the current SSB is with high probability not exceeding Blim.

2.2.13 Comparison with previous assessment

The historical part of the IBTS 1st quarter survey for the years 1983-1995 was changed this year and minor revisions were made also in Havfisken time series both for the 1st and 4th quarter. The reasons for these revisions are described in detail in the section 2.2.1.4. The other input data were updated from the time series used in last year's assessment. Discard data were included in the assessment for the first time this year, though the XSA including discards was run with truncated time series.

The assessment on cod in the Kattegat was not accepted last year due to unreliable catch data. The different analyses conducted this year are considered exploratory and not resulting in final assessment. Estimates for 2005 compared to previous assessment are presented in the table below.

TUNING FLEETS	XSA (2006)	XSA(2007, WITHOUT DISCARD)	XSA(2007, WITH DISCARD)	B-ADAPT (2007), WITHOUT DISCARD
Tuning fleets:				
Havfisken 4th quarter	1-3 (1994-2005)	1-3 (1994-2006)	1-3 (1997-2006)	1-3 (1994-2006)
IBTS 3rd quarter	1-4 (1991-2005)	1-4 (1991-2006)	1-4 (1997-2006)	1-4 (1991-2006)
IBTS 1st quarter shifted	2-6(1983-2005, excl. 1994)	2-6(1983-2006, excl. 1994), revised for 1983-1995	2-6(1997-2006)	2-6(1983-2006, excl. 1994), revised for 1983-1995
IBTS 1st quarter, age1 raw	1-1(1983-2005, excl. 1994)	1-1(1983-2006, excl. 1994), revised for 1983-1995	1-1(1997-2006)	1-1(1983-2006, excl. 1994), revised for 1983-1995
Havfisken 1st quarter	1-3(1996-2005)	1-3(1996-2006)	1-3(1997-2006)	1-3(1996-2006)
XSA settings				
Tapered time weighting	Tricubic over 20 years	Tricubic over 20 years	Tricubic over 20 years	
First age of independent q	1	1	1	1
Catchability independent of age for ages>=	5	4	4	4
S.E. of the mean to which the estimates are shrunk	1.5	1.5	1.5	
Number of final years using shrinkage	5	5	5	
Number of oldest ages using shrinkage	3	3	3	
Plus-group	8	6	6	6
Results (2005)				
SSB (2005) (t)	3814	3807	3687	4782
F(3-5) (2005)	0.33	0.29	0.42	0.96
Recruitment (2005) (thousands)	1467	2213	5087	2912

2.2.14 Technical minutes

The Review Group in 2006 pointed out that the catch at age in 1971 (especially for age 1) should be checked. This task unfortunately appeared not to be trivial and was therefore not fulfilled.

2.2.15 Management considerations

It should be taken into consideration that:

– SSB has with high probability remained below B_{lim} since the end of the 1990s. This is indicated both from XSA and from B-Adapt analyses that takes into account the unallocated mortality.

- The fishery independent information indicates increased unallocated mortality in the last two years. The estimate of fishing mortality in 2006 is considered uncertain, however it is indicated to be at the same level as in the previous three years.
- At present the fishery is very dependent on incoming year-classes. The 2003 year-class formed a large part of the fishable stock in 2005 and 2006 as 2 and 3-year-olds, respectively. The following year-classes observed as 1-year-olds in the surveys in 2005 and in the first quarter of the year in 2007 were indicated to be among the weakest in the time series. The indices for 2006 age 1 indicated somewhat stronger year-class, however were lower than for the 2003 year-class.
- The available information indicated high level of discarding, leading to relatively high fishing mortality on young cod below the minimum landing size.
- The effect of the management plan is difficult to evaluate due to data quality problems. The quality of catch data may be seen as a direct effect of the present TAC regulation system.
- The restrictive catch ceilings implemented in the most recent years imply that large part of cod catches are presently taken as by-catch in fisheries targeting other species.

Table 2.2.1 Cod in Kattegat. Landings (in tonnes) 1971-2006.

Year	Kattegat			Total
	Denmark	Sweden	Germany[2]	
1971	11,748	3,962	22	15,732
1972	13,451	3,957	34	17,442
1973	14,913	3,850	74	18,837
1974	17,043	4,717	120	21,880
1975	11,749	3,642	94	15,485
1976	12,986	3,242	47	16,275
1977	16,668	3,400	51	20,119
1978	10,293	2,893	204	13,390
1979	11,045	3,763	22	14,830
1980	9,265	4,206	38	13,509
1981	10,693	4,380	284	15,337
1982	9,320	3,087	58	12,465
1983	9,149	3,625	54	12,828
1984	7,590	4,091	205	11,886
1985	9,052	3,640	14	12,706
1986	6,930	2,054	112	9,096
1987	9,396	2,006	89	11,491
1988	4,054	1,359	114	5,527
1989	7,056	1,483	51	8,590
1990	4,715	1,186	35	5,936
1991	4,664	2,006	104	6,834
1992	3,406	2,771	94	6,271
1993	4,464	2,549	157	7,170
1994	3,968	2,836	98	7,802 [3]
1995	3,789	2,704	71	8,164 [4]
1996	4,028	2,334	64	6,126 [5]
1997	6,099	3,303	58	9,460 [6]
1998	4,207	2,509	38	6,835
1999	4,029	2,540	39	6,608
2000	3,285	1,568	45	4,897
2001	2,752	1,191	16	3,960
2002	1,726	744 [1]	3	2,470
2003	1,441	603 [8]	1	2,045
2004	827	575	1	1,403
2005	608	336	10	1,070 [7]
2006	540	315	21	876

[1] The Swedish landings for 2002 were revised at the very end of the WG-meeting and the assessment results are calculated using an initial value of 610 tonnes.

[2] Landings statistics incompletely split on the Kattegat and Skagerrak.

[3] Including 900 t reported in Skagerrak.

[4] Including 1.600 t misreported by area.

[5] Excluding 300 t taken in Sub-divisions 22–24.

[6] Including 1.700t reported in Sub-division 23.

[7] Including 116 t reported as pollack

[8] the catch reported to the EU exceeds the catch reported to the WG by 40%

Table 2.2.2 a **Cod in Kattegat.** Estimates for numbers (in thousands) of discards by age-groups and countries

Denmark						
Year	a1	a2	a3	a4	a5	a6
1997						
1998						
1999						
2000	1378	921	121	4	0	0
2001	1155	831	109	3	0	0
2002	911	566	65	2	0	0
2003	1066	684	81	2	0	0
2004	1811	647	55	2	0	0
2005	1085	601	67	2	0	0
2006	1100	547	58	2	0	0
Sweden						
Year	a1	a2	a3	a4	a5	a6
1997	567	678	212	13	0	0
1998	684	641	157	8	0	0
1999	579	663	177	10	0	0
2000	922	876	153	19	2	0
2001	745	720	142	17	2	0
2002	667	419	93	12	1	0
2003	514	715	49	3	1	0
2004	982	583	533	2	2	0
2005	237	464	6	5	0	0
2006	784	448	182	7	3	0

Table 2.2.2.b Cod in Kattegat. Estimates of discards in tons by age-groups

year	a1	a2	a3	a4	a5	a6	sum
1997	186	523	159	12	1	0	881
1998	178	378	96	11	1	0	664
1999	142	506	106	9	1	0	764
2000	351	491	127	16	5	0	990
2001	273	418	112	14	4	0	822
2002	215	271	76	10	5	0	576
2003	248	408	81	7	3	1	748
2004	426	358	264	7	6	1	1063
2005	212	327	27	7	0	0	574
2006	285	339	200	13	11	1	848

Table 2.2.2.c. Cod in Kattegat. Percentage of discards of the total catch numbers by age-groups

year	a1	a2	a3	a4	a5	a6
1997	95.0	78.3	7.6	2.4	0.1	0.1
1998	91.3	40.5	17.8	1.2	0.1	0.0
1999	96.4	50.9	7.9	4.1	0.1	0.1
2000	99.3	55.6	11.2	2.2	1.5	0.0
2001	97.1	63.1	11.7	2.9	0.9	0.0
2002	99.1	65.6	18.9	3.6	1.6	0.0
2003	100.0	62.2	18.8	3.1	1.4	1.6
2004	99.9	89.6	49.3	1.6	3.3	1.3
2005	99.9	71.7	38.7	4.2	0.1	0.0
2006	99.6	90.4	36.9	24.3	8.1	4.8

Table 2.2.3. Cod in Kattegat. Effort, yield and CPUE of commercial Danish and Swedish fleets

	Danish Trawl 70-89mm			Danish Trawl 90-104mm			Danish Trawl 105-120mm			Danish Seine 100-120mm		
Year	stdefort (St. days)	Yield (tons)	CPUE (kg/day)	stdefort (St. days)	Yield (tons)	CPUE (kg/day)	stdefort (St. days)	Yield (tons)	CPUE (kg/day)	stdefort (St. days)	Yield (tons)	CPUE (kg/day)
1987				2993	1641	548	596	126	212	4405	1791	407
1988				2346	949	405	474	99	209	2136	533	250
1989				4677	1817	388	1003	305	304	3251	814	250
1990				4472	1314	294	1908	478	251	1852	371	200
1991	4166	700	168	5450	1099	202	2125	549	258	1993	406	204
1992	2926	337	115	7163	1106	154	1452	408	281	1632	313	192
1993	1877	197	105	7023	1056	150	3067	787	257	1146	288	251
1994	1715	200	117	6639	1003	151	2368	556	235	1147	252	220
1995	1780	246	138	5075	909	179	1814	847	467	1111	274	246
1996	1987	236	119	5670	887	156	2938	1331	453	1159	232	200
1997	1998	359	180	6306	1207	191	2290	987	431	981	261	266
1998	2273	434	191	5822	1442	248	2363	918	389	1006	303	301
1999	2670	338	127	7010	1322	189	2096	573	273	1050	336	320
2000	2903	208	72	8111	1020	126	2031	761	375	1241	342	275
2001	2805	163	58	9122	1038	114	1619	490	303	2193	362	165
2002	2509	101	40	7432	513	69	1099	181	164	2029	216	107
2003	2512	186	74	7481	549	73	587	37	63	1869	211	113
2004	262	28	109	11739	517	44	388	39	100	546	24	44
2005	75	4	47	10607	349	33	220	47	213	444	33	74
2006	9	1	163	12157	347	29	279	8	27	449	26	59

	Swedish Cod Bottom Trawl			Swedish Nephrops Trawl		
Year	Effort (hours)	Landings (tons)	CPUE (kg/h)	Effort (hours)	Landings (tons)	CPUE (kg/h)
1980	14866	1715	115	14137	972	69
1981	12454	1750	141	13875	884	64
1982	10443	1579	151	14270	603	42
1983	17321	2371	137	11739	485	41
1984	19168	1829	95	13718	398	29
1985	14112	1193	85	13090	558	43
1986	13157	933	71	16420	367	22
1987	14448	1082	75	19421	426	22
1988	13458	720	53	16802	291	17
1989	13508	874	65	15565	355	23
1990	13843	628	45	14211	309	22
1991	20271	1298	64	10209	261	26
1992	28170	1577	56	11667	292	25
1993	24051	1076	45	14929	251	17
1994	20143	1276	63	16243	279	17
1995	15001	1378	92	9795	268	27
1996	16934	1273	75	24460	344	14
1997	20486	1744	85	30434	409	13
1998	21719	1396	64	27919	546	20
1999	20172	1609	80	31406	461	15
2000	20419	994	49	35448	292	8
2001	16345	589	36	35759	382	11
2002	10804	309	29	26915	309	11
2003	11506	265	23	24779	377	15
2004	8104	217	27	23452	218	9
2005	8176	143	18	23506	165	7
2006	9415	121	13	28802	168	6

Table 2.2.4 Cod in Kattegat. Catch numbers and mean weight at age by quarter and country for 2006

Year: 2006 Gear: Trawl and gillnet combined
Sub-div. 21

Year:	**2006**	**Quarter:**	**1**							
Country	Denmark		Germany		Sweden		Tons with no age data	**Grand Total**	
Age	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Tons	Numbers *10^{-3}	Mean weight [g]
1	0.000	0	0.000	0	0.000	0.000		0.000	0
2	6.641	656	0.000	0	7.515	539.625		14.470	596
3	92.140	1328	0.000	0	128.168	1306.749		227.225	1322
4	10.815	3098	0.000	0	4.932	2410.714		17.171	2907
5	6.735	4341	0.000	0	10.050	3222.485		17.749	3708
6	0.430	5992	0.000	0	1.529	4092.333		2.021	4555
7	0.086	6825	0.000	0	1.007	5899.538		1.106	5982
8	0.000	0	0.000	0	0.465	5921.167		0.465	5921
9	0.000	0	0.000	0	0.077	8700.000		0.077	8700
10+	0.195	1969	0.000	0	0.000	0.000		0.215	1969
SOP [t]	193.002		0.000		231.437			444.396	
Landings (t)	183.285		3.673		198.975		19.053	385.933	

Year:	**2006**	**Quarter:**	**2**							
Country	Denmark		Germany		Sweden		Tons with no age data	**Grand Total**	
Age	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Tons	Numbers *10^{-3}	Mean weight [g]
1	0.000	0	0.000	0	0.000	0.000		0.000	0
2	22.901	822	0.000	0	1.237	676.000		24.895	815
3	52.669	1849	0.000	0	3.373	1569.417		58.227	1837
4	4.977	3494	0.000	0	0.145	2269.400		5.376	3462
5	2.265	5052	0.000	0	0.047	3332.200		2.428	5018
6	1.369	4604	0.000	0	0.008	4253.333		1.447	4602
7	0.237	7754	0.000	0	0.016	4358.833		0.264	7550
8	0.237	7528	0.000	0	0.008	7180.000		0.256	7517
9	0.000	0	0.000	0	0.000	0.000		0.000	0
10+	0.000	0	0.000	0	0.000	0.000		0.000	0
SOP [t]	154.930		0.000		6.775			168.599	
Landings (t)	146.063		5.956		6.061		6.547	158.080	

Year:	**2006**	**Quarter:**	**3**							
Country	Denmark		Germany		Sweden		Tons with no age data	**Grand Total**	
Age	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Tons	Numbers *10^{-3}	Mean weight [g]
1	0.000	0	0.000	0	0.000	0.000		0.000	0
2	9.836	782	0.000	0	1.547	785.583		11.454	782
3	38.948	1501	0.000	0	1.626	1590.724		40.854	1505
4	1.352	3069	0.000	0	0.039	2499.091		1.401	3053
5	3.812	4563	0.000	0	0.019	3684.000		3.859	4559
6	0.521	6217	0.000	0	0.003	3090.000		0.529	6198
7	0.000	0	0.000	0	0.000	0.000		0.000	0
8	0.000	0	0.000	0	0.000	0.000		0.000	0
9	0.000	0	0.000	0	0.000	0.000		0.000	0
10+	0.000	0	0.000	0	0.000	0.000		0.000	0
SOP [t]	90.955		0.000		3.978			95.611	
Landings (t)	87.106		0.646		3.422		0.646	91.174	

0

Sub-div. 21 Gear: Trawl and gillnet combined

Year:	**2006**	**Quarter:**	**4**							
Country	Denmark		Germany		Sweden		Tons with no age data	**Grand Total**	
Age	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Tons	Numbers *10^{-3}	Mean weight [g]
1	0.000	0	0.000	0	8.164	478.938		8.194	479
2	23.541	1179	0.000	0	28.747	865.079		54.036	1017
3	39.666	1875	0.000	0	39.939	1775.368		83.999	1845
4	2.007	4654	0.000	0	2.442	2661.378		4.753	3623
5	2.532	4400	0.000	0	3.000	3687.167		5.831	4054
6	1.234	2439	0.000	0	0.485	4017.509		1.855	2904
7	0.679	3308	0.000	0	0.309	5141.953		1.098	3826
8	0.000	0	0.000	0	0.000	0.000		0.000	0
9	0.000	0	0.000	0	0.000	0.000		0.000	0
10+	0.000	0	0.000	0	0.000	0.000		0.000	0
SOP [t]	127.859		0.000		120.783			264.306	
Landings (t)	123.193		10.275		106.862		15.108	240.330	

Year :	**2006**	**Quarter:**	**atl**							
Country	Denmark		Germany		Sweden		Tons with no age data	**Grand Total**	
Age	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Numbers *10^{-3}	Mean weight [g]	Tons	Numbers *10^{-3}	Mean weight [g]
1	0.000	0	0.000	0	8.164	479		8	480
2	62.918	932	0.000	0	39.046	793		105	880
3	223.423	1578	0.000	0	173.107	1423		411	1519
4	19.152	3362	0.000	0	7.558	2489		29	3130
5	15.344	4511	0.000	0	13.116	3330		30	3995
6	3.554	4257	0.000	0	2.025	4073		6	4222
7	1.002	4660	0.000	0	1.332	5706		2	5264
8	0.237	7528	0.000	0	0.473	5942		1	6507
9	0.000	0	0.000	0	0.077	8700		0	8682
10+	0.195	1969	0.000	0	0.000	0		0	1966
SOP [t]	566.746		0.000		362.974			973.102	
Landings (t)	539.646		20.550		315.320		41.354	875.516	

Table 2.2.5 **Cod in Kattegat**. Landings in numbers (in thousands) by year and age.

	Age							
Year	1	2	3	4	5	6	7	8+
1971	15049	7937	6936	1918	887	207	30	30
1972	38	3811	6422	2427	809	433	94	38
1973	5	623	2167	3954	2280	780	212	160
1974	591	4250	6943	4543	1538	349	68	31
1975	188	3610	2906	3251	661	429	47	19
1976	166	4431	6983	1835	1039	287	189	52
1977	1	2218	7078	4942	492	376	137	102
1978	88	6015	2551	2100	913	83	99	71
1979	213	3161	6116	991	1039	230	11	47
1980	552	1317	5434	3347	358	380	120	35
1981	328	3918	2378	4026	1388	146	93	78
1982	340	3196	3229	2143	677	435	113	36
1983	653	5194	4770	1221	204	200	56	25
1984	127	4328	4763	1749	281	84	27	19
1985	685	3132	6293	2182	387	75	8	15
1986	430	1764	2901	1414	360	118	12	10
1987	168	7635	2440	892	381	103	10	19
1988	179	1203	2434	610	155	39	15	3
1989	247	3122	1653	1159	169	48	22	10
1990	606	1135	1584	485	330	32	12	8
1991	275	4199	731	352	95	72	1	3
1992	263	2147	3115	147	50	7	11	2
1993	137	2752	1139	1200	31	8	3	8
1994	22	1136	3078	715	329	2	4	8
1995	37	1579	2163	1609	349	170	5	9
1996	7	1910	2237	759	301	62	31	1
1997	74	584	5857	1068	291	103	17	7
1998	130	2133	1311	1885	283	39	23	14
1999	43	1895	3658	437	408	42	23	12
2000	17	1432	2171	1005	124	88	8	7
2001	56	906	1889	685	186	27	15	3
2002	14	516	678	379	83	21	11	8
2003	0	850	561	180	64	12	4	0
2004	3	143	604	204	63	25	11	3
2005	1	420	115	162	21	8	3	1
2006	8	105	411	29	30	6	2	1

Table 2.2.6a **Cod in Kattegat. Sampling level of Danish landings, 2006**

Quarter	Landings in tons	n. of samples collected	n. of cod aged	n. of cod weighed	n. of cod measured
1		16	772	787	787
2		5	264	265	265
3		4	127	127	127
4		2	96	96	96
Total	0	27	1259	1275	1275

Table 2.2.6b **Cod in Kattegat. Sampling level of Swedish landings, 2006**

Quarter	Landings in tons	n. of samples collected	n. of cod aged	n. of cod weighed	n. of cod measured
1	199	21	340	340	340
2	6	17	288	288	288
3	3	16	284	284	284
4	107	27	572	572	572
Total	315	81	1484	1484	1484

Table 2.2.7 **Cod in Kattegat. Weight at age (kg) in the landings by year and age.**

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1971	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1972	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1973	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1974	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1975	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1976	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1977	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1978	0.699	0.880	1.170	1.690	2.860	4.120	5.180	6.900
1979	0.708	0.868	1.086	1.890	2.215	3.382	7.314	6.101
1980	0.691	0.893	0.951	1.440	2.478	3.157	3.526	6.903
1981	0.604	0.799	1.123	1.432	2.076	3.532	4.420	4.644
1982	0.600	0.784	1.233	1.391	2.078	2.911	3.698	6.480
1983	0.595	0.752	1.129	1.943	3.348	3.141	5.301	6.325
1984	0.711	0.745	1.133	1.687	2.798	3.022	5.273	7.442
1985	0.606	0.839	0.986	1.614	2.575	4.090	6.847	7.133
1986	0.671	0.705	1.253	1.955	2.956	4.038	7.100	7.290
1987	0.483	0.716	1.118	1.972	2.868	4.200	5.185	8.288
1988	0.541	0.784	1.099	1.792	2.880	4.283	5.852	7.073
1989	0.621	0.921	1.269	2.296	3.856	5.733	5.166	6.527
1990	0.618	0.973	1.584	2.323	3.288	5.383	6.412	10.337
1991	0.578	0.861	1.533	2.986	4.548	4.179	9.127	12.055
1992	0.610	0.707	1.291	2.662	4.048	5.888	7.067	7.895
1993	0.567	0.862	1.583	2.321	4.970	7.566	9.391	8.705
1994	0.549	0.783	1.276	2.652	3.526	7.279	9.793	10.130
1995	0.598	0.799	1.121	1.947	2.404	3.537	9.973	10.708
1996	0.469	0.669	1.088	1.771	2.638	3.773	4.677	7.871
1997	0.450	0.621	0.959	1.950	2.806	3.877	5.756	7.213
1998	0.623	0.697	0.853	1.680	2.497	4.317	6.669	8.948
1999	0.496	0.624	0.911	1.616	2.588	4.665	5.376	8.040
2000	0.487	0.611	0.868	1.332	2.779	3.944	5.069	9.020
2001	0.466	0.646	0.901	1.585	2.597	4.693	7.117	7.691
2002	0.546	0.711	1.120	2.052	3.539	4.814	6.915	7.833
2003	0.550	0.700	1.370	2.460	3.750	5.920	7.840	10.890
2004	0.570	0.700	1.010	1.630	2.700	3.920	6.180	9.420
2005	0.428	0.854	1.623	2.343	3.584	5.442	6.439	8.307
2006	0.480	0.880	1.519	3.130	3.995	4.222	5.264	6.713

Table 2.2.8 **Cod in Kattegat. Weight at age (kg) in the catch (landings and discard combined).**

Year	Age 1	2	3	4	5	6	7	8+
1997	0.149	0.330	0.912	1.914	2.806	3.877	5.756	7.213
1998	0.173	0.520	0.762	1.666	2.497	4.317	6.669	8.948
1999	0.136	0.437	0.866	1.570	2.588	4.665	5.376	8.040
2000	0.155	0.423	0.823	1.318	2.779	3.944	5.069	9.020
2001	0.153	0.408	0.847	1.559	2.597	4.693	7.117	7.691
2002	0.140	0.425	0.999	2.004	3.539	4.814	6.915	7.833
2003	0.157	0.446	1.229	2.423	3.750	5.920	7.840	10.890
2004	0.153	0.334	0.733	1.640	2.700	3.920	6.180	9.420
2005	0.161	0.462	1.140	2.286	3.584	5.442	6.439	8.307
2006	0.153	0.392	1.266	2.712	3.995	4.222	5.264	6.713

Table 2.2.9 **Cod in Kattegat**. Weight at age (kg) in the stock by year and age.

Year	Age 1	2	3	4	5	6	7	8+
1971	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1972	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1973	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1974	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1975	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1976	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1977	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1978	0.059	0.355	1.006	1.69	2.86	4.12	5.18	6.9
1979	0.059	0.35	0.934	1.89	2.215	3.382	7.314	6.101
1980	0.058	0.361	0.817	1.44	2.478	3.157	3.526	6.903
1981	0.051	0.323	0.965	1.432	2.076	3.532	4.42	4.644
1982	0.05	0.317	1.06	1.391	2.078	2.911	3.698	6.48
1983	0.05	0.304	0.971	1.943	3.348	3.141	5.301	6.325
1984	0.06	0.301	0.974	1.687	2.798	3.022	5.273	7.442
1985	0.051	0.339	0.848	1.614	2.575	4.09	6.847	7.133
1986	0.056	0.285	1.077	1.955	2.956	4.038	7.1	7.29
1987	0.041	0.289	0.961	1.972	2.868	4.2	5.185	8.288
1988	0.045	0.317	0.945	1.792	2.88	4.283	5.852	7.073
1989	0.052	0.372	1.091	2.296	3.856	5.733	5.166	6.527
1990	0.052	0.393	1.362	2.323	3.288	5.383	6.412	10.337
1991	0.06	0.415	1.799	2.986	4.548	4.179	9.127	12.055
1992	0.052	0.34	1.191	2.662	4.048	5.888	7.067	7.895
1993	0.056	0.353	1.086	2.321	4.97	7.566	9.391	8.705
1994	0.035	0.269	1.225	2.652	3.526	7.279	9.793	10.13
1995	0.032	0.148	1.31	1.947	2.404	3.537	9.973	10.708
1996	0.027	0.22	0.496	1.771	2.638	3.773	4.677	7.871
1997	0.034	0.179	0.743	1.95	2.806	3.877	5.756	7.213
1998	0.049	0.213	0.442	1.68	2.497	4.317	6.669	8.948
1999	0.046	0.207	0.625	1.616	2.588	4.665	5.376	8.04
2000	0.046	0.176	0.624	1.332	2.779	3.944	5.069	9.02
2001	0.065	0.269	0.72	1.585	2.597	4.693	7.117	7.691
2002	0.045	0.29	1.334	2.052	3.539	4.814	6.915	7.833
2003	0.066	0.224	1.054	2.46	3.75	5.923	7.835	10.891
2004	0.052	0.407	1.007	1.63	2.7	3.916	6.181	9.423
2005	0.058	0.349	1.187	2.343	3.584	5.442	6.439	8.307
2006	0.064	0.280	1.083	3.130	3.995	4.222	5.264	6.713

Table 2.2.10 **Cod in Kattegat. Proportion mature at age (combined sex).**

Year	Age 1	2	3	4	5	6	7	8+
1971	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1972	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1973	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1974	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1975	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1976	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1977	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1978	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1979	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1980	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1981	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1982	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1983	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1984	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1985	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1986	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1987	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1988	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1989	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1990	0.02	0.61	0.62	0.99	0.93	1.00	1.00	1.00
1991	0.02	0.62	0.64	0.88	1.00	1.00	1.00	1.00
1992	0.07	0.51	0.99	1.00	1.00	1.00	1.00	1.00
1993	0.03	0.49	0.73	0.95	0.87	1.00	1.00	1.00
1994	0.01	0.60	0.96	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.12	0.97	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.29	0.57	0.95	1.00	1.00	1.00	1.00
1997	0.00	0.19	0.90	1.00	1.00	1.00	1.00	1.00
1998	0.00	0.38	0.65	1.00	1.00	1.00	1.00	1.00
1999	0.02	0.58	0.87	1.00	1.00	1.00	1.00	1.00
2000	0.02	0.42	0.92	1.00	1.00	1.00	1.00	1.00
2001	0.02	0.44	0.91	1.00	1.00	1.00	1.00	1.00
2002	0.00	0.57	0.92	0.99	1.00	1.00	1.00	1.00
2003	0.00	0.54	1.00	1.00	1.00	1.00	1.00	1.00
2004	0.00	0.74	0.86	1.00	1.00	1.00	1.00	1.00
2005	0.01	0.53	0.83	0.92	1.00	1.00	1.00	1.00
2006	0.00	0.59	0.81	1.00	1.00	1.00	1.00	1.00

Table 2.2.11 Cod in Kattegat. Tuning data, trawl surveys

Havfisken_SD21_Q4

1994	2006		
1	1	0.83	0.92
1	3		
1	32.97	10.17	2.21
1	37.17	4.5	1.7
1	13.09	11.36	0.31
1	46.09	2.66	1.38
1	19.35	4.67	0
1	66.5	5.72	0.92
1	23.09	9.69	1.06
1	3.26	0.65	0.12
1	28.94	2.41	0.1
1	26.43	3.12	0.29
1	21.33	1.35	0.55
1	5.32	4.84	0.08
1	28.65	4.46	1.2

Havfisken_SD21_Q1

1996	2006		
1	1	0	0.25
1	3		
1	35.76	123.12	4.51
1	41.09	19.97	19.94
1	-9	-9	-9
1	403.24	17.85	5.11
1	55.38	24.26	2.09
1	14.27	14.07	5.15
1	53.22	6.94	1.31
1	5.44	29.65	2.86
1	118.93	6.04	2.69
1	52.08	52.15	1.24
1	82.7	22.07	5.35

IBTSQ1_2-6_Shifted

1982	2006				
1	1	0.99	1		
1	5				
1	283.38	34.455	10.205	3.296	3.752
1	147.894	45.229	16.632	6.817	12.071
1	97.496	56.693	16.858	3.346	1.357
1	56.209	21.111	7.468	3.52	1.297
1	353.202	29.121	5.585	1.678	0.552
1	25.461	59.682	12.077	3.051	0.884
1	51.168	20.144	23.043	4.817	3.061
1	14.158	14.29	6.56	5.644	0.503
1	229.828	19.022	5.405	3.294	1.297
1	21.245	28.303	1.749	1.242	0.442
1	41.598	12.971	13.414	0.81	0.179
1	11.768	8.843	2.887	3.27	0.196
1	34.074	16.051	12.82	2.457	0.76
1	264.205	48.031	15.928	3.979	2.112
1	54.179	108.874	6.336	1.379	1.052
1	470.649	47.071	24.617	2.672	1.321
1	167.799	62.984	2.257	3.114	0.583
1	233.688	47.39	14.025	1.313	1.16
1	46.059	24.373	5.276	1.692	0.748
1	20.843	15.715	14.689	3.273	1.066
1	52.554	3.58	2.626	1.713	0.375
1	14.122	32.847	6.007	2.051	2.649
1	86.948	5.061	10.697	1.2	0.388
1	21.883	27.47	2.661	2.247	0.987
1	41.937	7.399	7.523	0.766	0.828

IBTS Q1_raw_age1

1983	2006		
1	1	0	0.25
1	1		
1	106.48		
1	33.17		
1	8.61		
1	224.61		
1	7.49		
1	70.1		
1	5.66		
1	145.5		
1	22.47		
1	65.83		
1	26.28		
1	19.34		
1	378.69		
1	52.47		
1	174.47		
1	199.37		
1	237.68		
1	74.85		
1	47.05		
1	93.05		
1	2.34		
1	91.02		
1	19.99		
1	67.31		

IBTS_Q3

1991	2006			
1	1	0.75	0.83	
1	4			
1	14.38	23.56	11.07	0.84
1	65.81	5.27	2.62	0.56
1	15.95	5.69	1.54	1.07
1	154.05	2.52	1.67	0.29
1	259.74	11.65	0.75	0.51
1	30.41	11.06	1	0.58
1	141.86	32.69	14.63	0.78
1	141.92	38.42	1.57	0.92
1	85.73	6.18	1.64	0.2
1	-9	-9	-9	-9
1	6.03	2.11	0.46	0.12
1	46.53	1.51	0.26	0.19
1	1.7	4.5	0.13	0.05
1	67.12	2.28	2.43	0.08
1	12.17	10.94	0.08	0.26
1	25.69	4.2	2.94	0.17

Ancylus_Q2

2002	2006			
1	1	0.25	0.5	
1	4			
1	51.18	8.66	1.6	0.49
1	0.95	19.03	0.81	0.43
1	26	3.66	2.86	0.12
1	3.13	23.73	1.63	2.85
1	14.79	13.75	11.2	0

Ancylus_Q4

2002	2006			
1	1	0.75	1	
1	4			
1	57.64	9.5	0.75	0.68
1	2.12	7.29	0.62	0.31
1	40.79	3.46	3.7	0.25
1	9.33	7.92	0.07	0
1	14.26	4.18	1.93	0.4

Table 2.2.12 Cod in Kattegat. Tuning diagnostics of the XSA run with log SE on shrinkage 0.5

```
 Lowestoft VPA Version 3.1

   22/04/2007  11:42

 Extended Survivors Analysis

 Cod in   the Kattegat (part of Division IIIa) 2006WG COMBSEX PLUSGROUP

 CPUE data from file codkFL_final.txt

 Catch data for  36 years. 1971 to 2006. Ages  1 to   6.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                     ,    year, year,  age ,  age
 Havfisken_SD21_Q4   ,   1994, 2006,   1,     3,   .830,   .920
 Havfisken_SD21_Q1   ,   1996, 2006,   1,     3,   .000,   .250
 IBTSQ1_2-6_Shifted  ,   1982, 2006,   1,     5,   .990,  1.000
 IBTS_Q3             ,   1991, 2006,   1,     4,   .750,   .830
 IBTS Q1_raw_age1    ,   1983, 2006,   1,     1,   .000,   .250


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    4


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =    .500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   48 iterations

1


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

      1,  .007,  .018,  .008,  .006,  .028,  .006,  .000,  .001,  .001,  .004
      2,  .202,  .286,  .394,  .379,  .537,  .391,  .538,  .494,  .220,  .147
      3, 1.022,  .952, 1.178, 1.127, 1.359, 1.048, 1.009,  .965,  .989,  .348
      4, 1.061, 1.202, 1.043, 1.405, 1.627, 1.234,  .917, 1.488,  .760,  .734
      5,  .868,  .945,  .955, 1.012, 1.187,  .930,  .697, 1.026,  .563,  .298


1
```

Table 2.2.12 (Cont'd)

XSA population numbers (Thousands)

YEAR ,	AGE 1,	2,	3,	4,	5,
1997 ,	1.17E+04,	3.53E+03,	1.01E+04,	1.81E+03,	5.54E+02,
1998 ,	8.00E+03,	9.49E+03,	2.36E+03,	2.98E+03,	5.12E+02,
1999 ,	6.17E+03,	6.43E+03,	5.84E+03,	7.46E+02,	7.33E+02,
2000 ,	2.96E+03,	5.01E+03,	3.55E+03,	1.47E+03,	2.15E+02,
2001 ,	2.21E+03,	2.41E+03,	2.81E+03,	9.42E+02,	2.96E+02,
2002 ,	2.77E+03,	1.76E+03,	1.15E+03,	5.91E+02,	1.52E+02,
2003 ,	4.95E+02,	2.26E+03,	9.76E+02,	3.32E+02,	1.41E+02,
2004 ,	2.88E+03,	4.05E+02,	1.08E+03,	2.91E+02,	1.09E+02,
2005 ,	1.03E+03,	2.35E+03,	2.02E+02,	3.36E+02,	5.39E+01,
2006 ,	2.26E+03,	8.46E+02,	1.55E+03,	6.16E+01,	1.29E+02,

Estimated population abundance at 1st Jan 2007

,	0.00E+00,	1.84E+03,	5.98E+02,	8.93E+02,	2.42E+01,

Taper weighted geometric mean of the VPA populations:

,	3.52E+03,	3.17E+03,	2.13E+03,	6.92E+02,	2.34E+02,

Standard error of the weighted Log(VPA populations) :

,	.9928,	1.0210,	1.0371,	1.1011,	.8862,

1

Log catchability residuals.

Fleet : Havfisken_SD21_Q4

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.56,	-1.10,	-.74
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.13,	-.79,	-.62
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.23,	.50,	-1.37
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	-.47,	-.95,	.54,	.21,	-1.44,	.50,	2.13,	.16,	-.21,	.69
2 ,	-.62,	-.98,	-.29,	.47,	-1.36,	.14,	.28,	1.12,	.40,	1.27
3 ,	-.41,	99.99,	-.13,	.46,	-1.28,	-.84,	.35,	.86,	.62,	.74
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

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

Age ,	1,	2,	3
Mean Log q,	-4.8847,	-6.2153,	-7.4185,
S.E(Log q),	.9828,	.8278,	.7948,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	2.60,	-2.336,	-.22,	.19,	13,	2.13,	-4.88,
2,	2.28,	-2.852,	3.96,	.35,	13,	1.44,	-6.22,
3,	1.39,	-1.213,	7.34,	.55,	12,	1.07,	-7.42,

Table 2.2.12 (Cont'd)

Fleet : Havfisken_SD21_Q1

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.84
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.04
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.68
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	-1.70,	99.99,	1.23,	-.03,	-1.09,	.00,	-.56,	.77,	.96,	.65
2 ,	-.44,	99.99,	-1.13,	-.58,	-.37,	-.78,	.44,	.56,	.93,	1.08
3 ,	.07,	99.99,	-.72,	-1.13,	.04,	-.48,	.46,	.30,	1.20,	.55
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

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

Age ,	1,	2,	3
Mean Log q,	-3.9281,	-4.6820,	-6.1497,
S.E(Log q),	.9485,	.7707,	.7195,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	1.22,	-.440,	3.09,	.37,	10,	1.21,	-3.93,
2,	1.78,	-1.809,	2.29,	.43,	10,	1.21,	-4.68,
3,	1.84,	-2.735,	5.00,	.60,	10,	.99,	-6.15,

1

Fleet : IBTSQ1_2-6_Shifted

Age ,	1982,	1983,	1984,	1985,	1986
1 ,	99.99,	99.99,	99.99,	99.99,	99.99
2 ,	99.99,	99.99,	99.99,	99.99,	99.99
3 ,	99.99,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99,	99.99

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	-1.38,	-.99,	-1.39,	-.15,	-1.86,	-1.75,	99.99,	-1.56,	-.17,	-.34
2 ,	-.01,	-.47,	-.69,	.35,	-.97,	-1.09,	99.99,	-1.15,	-.15,	-.10
3 ,	.08,	.10,	-.18,	-.03,	-.48,	-.61,	99.99,	-.78,	-.02,	-1.12
4 ,	-.12,	.46,	.01,	.69,	.15,	-.03,	99.99,	-1.04,	-.57,	-1.42
5 ,	-.71,	.81,	-.59,	-.15,	-.06,	-.82,	99.99,	-1.58,	-.16,	-1.03

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	.83,	.19,	.77,	-.13,	-.60,	.07,	.48,	.54,	.18,	.05
2 ,	.52,	-.10,	.11,	-.32,	.13,	-1.18,	.94,	.74,	.40,	.04
3 ,	-.26,	-1.27,	-.12,	-.65,	.84,	-.31,	.65,	1.08,	1.39,	-.24
4 ,	-.68,	-.88,	-.52,	-.59,	.74,	.17,	.61,	.77,	.53,	1.13
5 ,	-.39,	-1.05,	-.72,	.13,	.34,	-.29,	1.50,	.17,	1.34,	.03

Table 2.2.12 (Cont'd)

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

Age ,	1,	2,	3,	4,	5
Mean Log q,	-3.8336,	-4.4340,	-4.5376,	-4.5847,	-4.5847,
S.E(Log q),	.6782,	.6474,	.8322,	.7932,	.8599,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	1.19,	-.750,	3.02,	.62,	19,	.82,	-3.83,
2,	1.30,	-1.219,	3.34,	.62,	19,	.83,	-4.43,
3,	2.03,	-2.608,	1.32,	.40,	19,	1.36,	-4.54,
4,	2.45,	-4.444,	1.80,	.49,	19,	1.17,	-4.58,
5,	3.53,	-3.358,	2.41,	.15,	19,	2.17,	-4.62,

1

Fleet : IBTS_Q3

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	99.99,	99.99,	99.99,	99.99,	-1.64,	-.67,	-1.54,	.58,	.44,	-.29
2 ,	99.99,	99.99,	99.99,	99.99,	.07,	-.77,	-1.37,	-1.72,	-.30,	-1.10
3 ,	99.99,	99.99,	99.99,	99.99,	3.33,	-.19,	-.30,	-.75,	-1.03,	-.90
4 ,	99.99,	99.99,	99.99,	99.99,	1.72,	1.65,	.03,	-1.07,	-.61,	-.20
5 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	.26,	.64,	.39,	99.99,	-1.22,	.58,	-1.01,	.90,	.22,	.19
2 ,	1.43,	.67,	-.68,	99.99,	-.66,	-.80,	.16,	1.16,	.76,	.77
3 ,	1.23,	.40,	-.29,	99.99,	-.69,	-.61,	-1.17,	1.63,	-.10,	.97
4 ,	.12,	-.10,	-.37,	99.99,	-.65,	-.04,	-1.04,	.01,	.47,	1.72
5 ,	No data for this fleet at this age									

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

Age ,	1,	2,	3,	4
Mean Log q,	-4.5021,	-5.7965,	-6.8013,	-6.8742,
S.E(Log q),	.7812,	.9541,	1.0363,	.8345,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.82,	.907,	5.16,	.74,	15,	.65,	-4.50,
2,	1.91,	-1.884,	3.77,	.32,	15,	1.63,	-5.80,
3,	1.06,	-.187,	6.75,	.49,	15,	1.16,	-6.80,
4,	1.76,	-2.174,	7.18,	.48,	15,	1.26,	-6.87,

1

Table 2.2.12 (Cont'd)

```
 Fleet : IBTS Q1_raw_age1

  Age  ,  1982,  1983,  1984,  1985,  1986
     1 , 99.99, 99.99, 99.99, 99.99, 99.99
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


  Age  ,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996
     1 , -2.64,  -.70, -2.39,  -.65, -1.85, -1.32, -1.69, 99.99,   .18,  -.38
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 ,  -.18,   .34,   .77,   .35,   .18,   .63, -1.33,   .57,   .08,   .51
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


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


    Age ,         1
 Mean Log q,   -4.0001,
 S.E(Log q),     .7702,


 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,     .92,     .369,      4.35,     .67,     19,     .74,   -4.00,
1


 Terminal year survivor and F summaries :

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2005

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      3694.,  1.026,       .000,    .00,   1,  .086,     .002
 Havfisken_SD21_Q1   ,      3515.,   .999,       .000,    .00,   1,  .091,     .002
 IBTSQ1_2-6_Shifted  ,      1937.,   .707,       .000,    .00,   1,  .182,     .004
 IBTS_Q3             ,      2220.,   .816,       .000,    .00,   1,  .136,     .003
 IBTS Q1_raw_age1    ,      3074.,   .803,       .000,    .00,   1,  .141,     .002

   F shrinkage mean  ,       995.,    .50,,,,                        .364,     .007

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1844.,       .30,      .28,    6,    .920,   .004
```

Table 2.2.12 (Cont'd)

```
 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2004

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      1155.,   .661,       .731,   1.11,   2,  .129,     .079
 Havfisken_SD21_Q1   ,      1680.,   .630,       .056,    .09,   2,  .142,     .055
 IBTSQ1_2-6_Shifted  ,       664.,   .488,       .068,    .14,   2,  .237,     .134
 IBTS_Q3             ,       926.,   .631,       .268,    .42,   2,  .142,     .098
 IBTS Q1_raw_age1    ,       647.,   .803,       .000,    .00,   1,  .088,     .137

   F shrinkage mean  ,       172.,    .50,,,,                        .262,     .439

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       598.,       .24,      .32,   10,   1.318,   .147


 Age  3   Catchability constant w.r.t. time and dependent on age

 Year class = 2003

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      1460.,   .521,       .167,    .32,   3,  .152,     .227
 Havfisken_SD21_Q1   ,      1833.,   .488,       .117,    .24,   3,  .175,     .185
 IBTSQ1_2-6_Shifted  ,      1164.,   .428,       .229,    .54,   3,  .218,     .277
 IBTS_Q3             ,      2158.,   .549,       .058,    .11,   3,  .133,     .159
 IBTS Q1_raw_age1    ,      1583.,   .804,       .000,    .00,   1,  .058,     .211

   F shrinkage mean  ,       189.,    .50,,,,                        .264,    1.087

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       893.,       .22,      .31,   14,   1.425,   .348

1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 2002

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,        71.,   .535,       .406,    .76,   3,  .066,     .316
 Havfisken_SD21_Q1   ,        48.,   .500,       .464,    .93,   3,  .076,     .433
 IBTSQ1_2-6_Shifted  ,        66.,   .470,       .171,    .36,   4,  .181,     .334
 IBTS_Q3             ,        65.,   .569,       .608,   1.07,   4,  .137,     .341
 IBTS Q1_raw_age1    ,         6.,   .807,       .000,    .00,   1,  .022,    1.628

   F shrinkage mean  ,        11.,    .50,,,,                        .519,    1.220

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        24.,       .29,      .34,   16,   1.176,   .734
```

Table 2.2.12 (Cont'd)

```
 Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)  4

 Year class = 2001

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,       146.,   .540,       .180,    .33,   3,  .048,     .170
 Havfisken_SD21_Q1   ,       104.,   .505,       .103,    .20,   3,  .055,     .232
 IBTSQ1_2-6_Shifted  ,       110.,   .495,       .189,    .38,   5,  .254,     .220
 IBTS_Q3             ,       146.,   .572,       .249,    .44,   4,  .100,     .170
 IBTS Q1_raw_age1    ,       147.,   .813,       .000,    .00,   1,  .015,     .169

   F shrinkage mean  ,        53.,    .50,,,,                        .527,     .413

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        78.,       .30,      .16,   17,    .542,   .298
```

Table 2.2.13 Cod in Kattegat. Tuning diagnostics of the final XSA run without discards

```
Lowestoft VPA Version 3.1

   22/04/2007  10:33

 Extended Survivors Analysis

 Cod in   the Kattegat (part of Division IIIa) 2006WG COMBSEX PLUSGROUP

 CPUE data from file codkFL_final.txt

 Catch data for  36 years. 1971 to 2006. Ages  1 to   6.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                     ,    year, year,  age ,  age
 Havfisken_SD21_Q4   ,   1994, 2006,   1,     3,   .830,   .920
 Havfisken_SD21_Q1   ,   1996, 2006,   1,     3,   .000,   .250
 IBTSQ1_2-6_Shifted  ,   1982, 2006,   1,     5,   .990,  1.000
 IBTS_Q3             ,   1991, 2006,   1,     4,   .750,   .830
 IBTS Q1_raw_age1    ,   1983, 2006,   1,     1,   .000,   .250


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    4


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   26 iterations


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000


 Fishing mortalities
    Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

      1,  .007,  .018,  .007,  .006,  .025,  .005,  .000,  .001,  .000,  .002
      2,  .195,  .279,  .391,  .324,  .516,  .333,  .458,  .249,  .106,  .066
      3, 1.029,  .892, 1.117, 1.108,  .960,  .961,  .742,  .701,  .325,  .144
      4, 1.160, 1.229,  .883, 1.172, 1.522,  .503,  .742,  .671,  .405,  .126
      5,  .834, 1.232, 1.019,  .676,  .701,  .756,  .145,  .635,  .128,  .120

1
```

Table 2.2.13 (Cont'd)

XSA population numbers (Thousands)

YEAR ,	AGE 1,	2,	3,	4,	5,
1997 ,	1.19E+04,	3.64E+03,	1.01E+04,	1.72E+03,	5.68E+02,
1998 ,	8.05E+03,	9.70E+03,	2.45E+03,	2.94E+03,	4.41E+02,
1999 ,	7.03E+03,	6.47E+03,	6.01E+03,	8.24E+02,	7.05E+02,
2000 ,	3.05E+03,	5.71E+03,	3.58E+03,	1.61E+03,	2.79E+02,
2001 ,	2.52E+03,	2.48E+03,	3.38E+03,	9.68E+02,	4.08E+02,
2002 ,	3.14E+03,	2.02E+03,	1.21E+03,	1.06E+03,	1.73E+02,
2003 ,	8.76E+02,	2.56E+03,	1.18E+03,	3.80E+02,	5.25E+02,
2004 ,	5.63E+03,	7.17E+02,	1.32E+03,	4.61E+02,	1.48E+02,
2005 ,	2.21E+03,	4.60E+03,	4.58E+02,	5.38E+02,	1.93E+02,
2006 ,	4.02E+03,	1.81E+03,	3.39E+03,	2.71E+02,	2.94E+02,

Estimated population abundance at 1st Jan 2007

,	0.00E+00,	3.29E+03,	1.39E+03,	2.40E+03,	1.95E+02,

Taper weighted geometric mean of the VPA populations:

,	4.51E+03,	3.88E+03,	2.57E+03,	9.07E+02,	3.32E+02,

Standard error of the weighted Log(VPA populations) :

,	.7953,	.8263,	.8481,	.7562,	.5998,

1

Log catchability residuals.

Fleet : Havfisken_SD21_Q4

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.27,	-.83,	-.50
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.40,	-.49,	-.34
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.66,	.87,	-.94
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	-.22,	-.68,	.68,	.45,	-1.30,	.65,	1.83,	-.24,	-.70,	.39
2 ,	-.39,	-.73,	-.02,	.57,	-1.13,	.23,	.36,	.61,	-.10,	.72
3 ,	-.02,	99.99,	.17,	.82,	-1.43,	-.59,	.31,	.80,	-.39,	.15
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

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

Age ,	1,	2,	3
Mean Log q,	-5.1567,	-6.4890,	-7.7995,
S.E(Log q),	.8737,	.5854,	.7441,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	2.06,	-1.577,	1.77,	.20,	13,	1.68,	-5.16,
2,	1.46,	-1.471,	5.71,	.53,	13,	.81,	-6.49,
3,	.93,	.251,	7.80,	.63,	12,	.73,	-7.80,

Table 2.2.13 (Cont'd)

Fleet : Havfisken_SD21_Q1

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.54
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.24
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.38
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	-1.39,	99.99,	1.42,	.27,	-.89,	.20,	-.80,	.42,	.53,	.40
2 ,	-.20,	99.99,	-.86,	-.44,	-.13,	-.65,	.58,	.24,	.51,	.58
3 ,	.34,	99.99,	-.49,	-.87,	.07,	-.27,	.51,	.33,	.57,	.01
4 ,	No data for this fleet at this age									
5 ,	No data for this fleet at this age									

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

Age ,	1,	2,	3
Mean Log q,	-4.2560,	-4.9570,	-6.4196,
S.E(Log q),	.8255,	.5339,	.4786,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.83,	.477,	4.92,	.52,	10,	.72,	-4.26,
2,	1.19,	-.668,	4.37,	.63,	10,	.66,	-4.96,
3,	1.35,	-1.543,	5.95,	.73,	10,	.60,	-6.42,

1

Fleet : IBTSQ1_2-6_Shifted

Age ,	1982,	1983,	1984,	1985,	1986
1 ,	99.99,	99.99,	99.99,	99.99,	99.99
2 ,	99.99,	99.99,	99.99,	99.99,	99.99
3 ,	99.99,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99,	99.99

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	-1.13,	-.73,	-1.17,	.15,	-1.63,	-1.48,	99.99,	-1.28,	.09,	-.12
2 ,	.24,	-.22,	-.42,	.55,	-.64,	-.85,	99.99,	-.88,	.14,	.17
3 ,	.44,	.42,	.13,	.34,	-.32,	-.12,	99.99,	-.37,	.32,	-.71
4 ,	.27,	1.00,	.46,	1.09,	.74,	.04,	99.99,	-.58,	.17,	-.90
5 ,	-.22,	1.05,	-.07,	.14,	.11,	-.17,	99.99,	-.25,	.20,	-.07

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	1.06,	.44,	.89,	.10,	-.48,	.20,	.16,	.12,	-.33,	-.27
2 ,	.74,	.14,	.37,	-.24,	.35,	-1.10,	1.00,	.19,	-.12,	-.54
3 ,	.11,	-1.01,	.15,	-.32,	.61,	-.08,	.55,	.97,	.27,	-.87
4 ,	.01,	-.30,	-.24,	-.36,	1.15,	-.60,	.84,	.04,	.25,	-.41
5 ,	.09,	-.08,	-.07,	.08,	.08,	-.05,	.18,	.02,	.18,	-.43

Table 2.2.13 (Cont'd)

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

Age ,	1,	2,	3,	4,	5
Mean Log q,	-4.0896,	-4.6991,	-4.8968,	-5.1288,	-5.1288,
S.E(Log q),	.6290,	.6098,	.6049,	.5964,	.1860,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.93,	.315,	4.40,	.66,	19,	.61,	-4.09,
2,	.99,	.028,	4.72,	.65,	19,	.64,	-4.70,
3,	1.28,	-1.009,	4.08,	.58,	19,	.77,	-4.90,
4,	1.29,	-.911,	4.66,	.51,	19,	.77,	-5.13,
5,	.97,	.280,	5.15,	.91,	19,	.19,	-5.13,

1

Fleet : IBTS_Q3

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	99.99,	99.99,	99.99,	99.99,	-1.38,	-.38,	-1.28,	.87,	.71,	-.06
2 ,	99.99,	99.99,	99.99,	99.99,	.38,	-.54,	-1.09,	-1.47,	-.02,	-.84
3 ,	99.99,	99.99,	99.99,	99.99,	3.50,	.28,	.00,	-.35,	-.69,	-.51
4 ,	99.99,	99.99,	99.99,	99.99,	2.25,	1.72,	.83,	-.66,	.04,	.27
5 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	.51,	.91,	.53,	99.99,	-1.09,	.72,	-1.31,	.50,	-.27,	-.12
2 ,	1.65,	.90,	-.44,	99.99,	-.45,	-.72,	.23,	.65,	.25,	.19
3 ,	1.58,	.65,	-.02,	99.99,	-.84,	-.38,	-1.23,	1.56,	-1.09,	.37
4 ,	.74,	.42,	-.11,	99.99,	-.27,	-.71,	-.83,	-.61,	.20,	.25
5 ,	No data for this fleet at this age									

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

Age ,	1,	2,	3,	4
Mean Log q,	-4.7730,	-6.0509,	-7.1472,	-7.3622,
S.E(Log q),	.8075,	.7913,	1.0597,	.6809,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.62,	2.376,	6.16,	.81,	15,	.41,	-4.77,
2,	1.32,	-.811,	5.36,	.42,	15,	1.06,	-6.05,
3,	.76,	.842,	7.31,	.57,	15,	.81,	-7.15,
4,	.88,	.450,	7.29,	.63,	15,	.63,	-7.36,

Table 2.2.13 (Cont'd)

```
 Fleet : IBTS Q1_raw_age1

  Age  ,  1982,  1983,  1984,  1985,  1986
     1 , 99.99, 99.99, 99.99, 99.99, 99.99
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


  Age  ,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996
     1 , -2.39,  -.44, -2.16,  -.36, -1.61, -1.04, -1.44, 99.99,   .44,  -.16
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 ,   .06,   .59,   .90,   .58,   .30,   .77, -1.64,   .16,  -.42,   .19
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


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


    Age ,         1
 Mean Log q,   -4.2585,
 S.E(Log q),     .8071,


 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,     .73,    1.216,      5.37,     .68,     19,     .58,   -4.26,
1


 Terminal year survivor and F summaries :

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2005

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      4849.,   .913,       .000,    .00,   1,  .148,     .001
 Havfisken_SD21_Q1   ,      4886.,   .870,       .000,    .00,   1,  .163,     .001
 IBTSQ1_2-6_Shifted  ,      2502.,   .655,       .000,    .00,   1,  .287,     .003
 IBTS_Q3             ,      2912.,   .844,       .000,    .00,   1,  .173,     .002
 IBTS Q1_raw_age1    ,      3987.,   .841,       .000,    .00,   1,  .174,     .002

   F shrinkage mean  ,      1167.,   1.50,,,,                        .055,     .006

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3286.,       .35,      .17,    6,    .478,   .002
```

Table 2.2.13 (Cont'd)

```
 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      1832.,   .508,       .654,   1.29,   2,  .216,     .051
 Havfisken_SD21_Q1   ,      2448.,   .472,       .023,    .05,   2,  .250,     .038
 IBTSQ1_2-6_Shifted  ,       898.,   .456,       .104,    .23,   2,  .268,     .101
 IBTS_Q3             ,      1342.,   .590,       .233,    .39,   2,  .160,     .068
 IBTS Q1_raw_age1    ,       909.,   .841,       .000,    .00,   1,  .079,     .099

   F shrinkage mean  ,       239.,   1.50,,,,                        .027,     .334

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1388.,       .24,      .20,   10,    .835,   .066


 Age  3   Catchability constant w.r.t. time and dependent on age

 Year class = 2003

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      2289.,   .426,       .106,    .25,   3,  .204,     .151
 Havfisken_SD21_Q1   ,      3093.,   .345,       .170,    .49,   3,  .317,     .114
 IBTSQ1_2-6_Shifted  ,      1739.,   .370,       .304,    .82,   3,  .272,     .194
 IBTS_Q3             ,      3489.,   .522,       .078,    .15,   3,  .135,     .101
 IBTS Q1_raw_age1    ,      2818.,   .842,       .000,    .00,   1,  .050,     .124

   F shrinkage mean  ,       336.,   1.50,,,,                        .020,     .745

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2404.,       .19,      .13,   14,    .679,   .144


1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,       321.,   .429,       .566,   1.32,   3,  .158,     .079
 Havfisken_SD21_Q1   ,       256.,   .348,       .322,    .93,   3,  .252,     .097
 IBTSQ1_2-6_Shifted  ,       193.,   .328,       .176,    .54,   4,  .334,     .128
 IBTS_Q3             ,       167.,   .436,       .440,   1.01,   4,  .196,     .146
 IBTS Q1_raw_age1    ,        38.,   .845,       .000,    .00,   1,  .037,     .527

   F shrinkage mean  ,        22.,   1.50,,,,                        .024,     .776

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       195.,       .18,      .20,   16,   1.065,   .126


 Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)  4
```

Table 2.2.13 (Cont'd)

```
 Year class = 2001

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,       385.,   .439,       .144,    .33,   3,  .063,     .068
 Havfisken_SD21_Q1   ,       315.,   .355,       .092,    .26,   3,  .105,     .083
 IBTSQ1_2-6_Shifted  ,       176.,   .244,       .222,    .91,   5,  .692,     .144
 IBTS_Q3             ,       333.,   .480,       .261,    .54,   4,  .103,     .078
 IBTS Q1_raw_age1    ,       459.,   .851,       .000,    .00,   1,  .014,     .057

   F shrinkage mean  ,       228.,   1.50,,,,                        .024,     .112

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       214.,       .19,      .13,   17,    .679,   .120



1
1
```

Table 2.2.14 Cod in Kattegat. Fishing mortalities from the final XSA run without discards

```
Run title : Cod in       the Kattegat (part of Division IIIa)

At 22/04/2007  10:33

                Terminal Fs derived using XSA (With F shrinkage)

   Table  8     Fishing mortality (F) at age
   YEAR,        1971,    1972,    1973,    1974,    1975,    1976,

   AGE
     1,         .5633,   .0017,   .0003,   .0202,   .0072,   .0160,
     2,         .3487,   .2665,   .0347,   .4221,   .1649,   .2345,
     3,         .3870,   .5315,   .2384,   .6541,   .5773,   .5509,
     4,         .4473,   .2256,   .7497,  1.1692,   .7509,   .9225,
     5,         .3970,   .3433,   .3430,   .7558,   .5016,   .5741,
   +gp,         .3970,   .3433,   .3430,   .7558,   .5016,   .5741,
FBAR  3- 5,     .4104,   .3668,   .4437,   .8597,   .6099,   .6825,


   YEAR,       1977,    1978,    1979,    1980,    1981,    1982,    1983,    1984,    1985,    1986,

   AGE
     1,        .0000,   .0040,   .0213,   .0417,   .0209,   .0179,   .0346,   .0119,   .0873,   .0261,
     2,        .3050,   .3030,   .1959,   .1779,   .4609,   .2889,   .4103,   .3354,   .4494,   .3384,
     3,        .7250,   .6950,   .5789,   .6060,   .5610,   .8899,   .9433,   .8398,  1.2297,  1.0269,
     4,       1.0084,   .4875,   .6467,   .7426,  1.4016,  1.7613,  1.0869,  1.2119,  1.3331,  1.0912,
     5,        .6858,   .4990,   .4775,   .5128,   .8161,   .9911,   .8219,   .8038,  1.0155,   .8273,
   +gp,        .6858,   .4990,   .4775,   .5128,   .8161,   .9911,   .8219,   .8038,  1.0155,   .8273,
FBAR  3- 5,    .8064,   .5605,   .5677,   .6205,   .9262,  1.2141,   .9507,   .9518,  1.1928,   .9818,


   YEAR,       1987,    1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,

   AGE
     1,        .0318,   .0252,   .0789,   .0452,   .0379,   .0216,   .0190,   .0027,   .0023,   .0017,
     2,        .8517,   .3325,   .7840,   .6181,   .4968,   .4599,   .3280,   .2160,   .2719,   .1584,
     3,       1.1402,   .7405,  1.0850,  1.3379,  1.1173,   .8748,   .4754,   .7556,   .8227,   .7780,
     4,       1.1183,  1.0488,  1.0162,  1.2114,  1.4397,   .7034,  1.0730,   .6286,  1.2755,   .7922,
     5,       1.0524,   .5747,   .9873,   .9494,   .8305,   .8177,   .3050,  1.0339,   .7375,   .8908,
   +gp,       1.0524,   .5747,   .9873,   .9494,   .8305,   .8177,   .3050,  1.0339,   .7375,   .8908,
FBAR  3- 5,   1.1037,   .7880,  1.0295,  1.1662,  1.1292,   .7987,   .6178,   .8060,   .9452,   .8203,


   YEAR,       1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

   AGE
     1,        .0069,   .0180,   .0068,   .0062,   .0248,   .0049,   .0000,   .0006,   .0005,   .0022,
     2,        .1950,   .2786,   .3912,   .3243,   .5162,   .3326,   .4578,   .2491,   .1063,   .0662,
     3,       1.0295,   .8921,  1.1175,  1.1081,   .9603,   .9613,   .7422,   .7010,   .3254,   .1439,
     4,       1.1597,  1.2290,   .8828,  1.1721,  1.5224,   .5028,   .7418,   .6711,   .4046,   .1261,
     5,        .8342,  1.2324,  1.0195,   .6760,   .7008,   .7556,   .1447,   .6352,   .1281,   .1197,
   +gp,        .8342,  1.2324,  1.0195,   .6760,   .7008,   .7556,   .1447,   .6352,   .1281,   .1197,
0  FBAR  3- 5,  1.0078,  1.1179,  1.0066,   .9854,  1.0612,   .7399,   .5429,   .6691,   .2860,   .1299,
1
```

Table 2.2.15 Cod in Kattegat. Stock numbers at age from the final XSA run without discards

Run title : Cod in the Kattegat (part of Division IIIa)

At 22/04/2007 10:33

Table 10 Stock number at age (start of year)
Numbers*10**-3

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,
AGE						
1,	38619,	24727,	16667,	32707,	28819,	11574,
2,	29799,	18002,	20211,	13641,	26243,	23425,
3,	23886,	17216,	11290,	15983,	7323,	18220,
4,	5878,	13280,	8284,	7283,	6804,	3366,
5,	2992,	3077,	8677,	3205,	1852,	2629,
+gp,	893,	2133,	4352,	920,	1373,	1321,
TOTAL,	102067,	78435,	69481,	73740,	72414,	60534,

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
1,	31064,	24079,	11145,	14933,	17556,	21207,	21226,	11819,	9052,	18452,
2,	9326,	25432,	19634,	8932,	11726,	14076,	17055,	16788,	9562,	6791,
3,	15169,	5628,	15379,	13215,	6121,	6055,	8633,	9264,	9829,	4995,
4,	8599,	6015,	2300,	7058,	5903,	2860,	2036,	2752,	3275,	2353,
5,	1096,	2568,	3025,	986,	2750,	1190,	402,	562,	671,	707,
+gp,	1352,	705,	830,	1459,	619,	1008,	546,	256,	167,	271,
TOTAL,	66605,	64427,	52313,	46582,	44674,	46397,	49899,	41442,	32555,	33569,

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	5926,	7953,	3596,	15146,	8165,	13576,	8045,	8977,	17642,	4458,
2,	14718,	4700,	6349,	2721,	11852,	6436,	10877,	6462,	7330,	14410,
3,	3964,	5142,	2759,	2373,	1201,	5904,	3327,	6415,	4263,	4573,
4,	1464,	1038,	2008,	763,	510,	322,	2015,	1693,	2467,	1533,
5,	647,	392,	298,	595,	186,	99,	130,	564,	739,	564,
+gp,	220,	143,	138,	92,	147,	39,	79,	24,	384,	173,
TOTAL,	26940,	19366,	15148,	21691,	22061,	26376,	24474,	24136,	32826,	25712,

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,
AGE										
1,	11924,	8045,	7026,	3052,	2524,	3139,	876,	5628,	2213,	4022,
2,	3644,	9696,	6469,	5714,	2483,	2016,	2557,	717,	4605,	1811,
3,	10070,	2455,	6008,	3582,	3382,	1213,	1183,	1325,	458,	3390,
4,	1720,	2945,	824,	1609,	968,	1060,	380,	461,	538,	271,
5,	568,	441,	705,	279,	408,	173,	525,	148,	193,	294,
+gp,	244,	116,	131,	229,	97,	82,	131,	91,	110,	88,
TOTAL,	28170,	23698,	21164,	14464,	9863,	7683,	5652,	8369,	8116,	9875,

Table 2.2.16 Cod in Kattegat. Summary output from the final XSA run without discards

Run title : Cod in the Kattegat (part of Division IIIa),

At 22/04/2007 10:33

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 5,
1971,	38619,	55837,	41815,	15732,	.3762,	.4104,
1972,	24727,	62292,	52689,	17442,	.3310,	.3668,
1973,	16667,	72999,	64817,	18837,	.2906,	.4437,
1974,	32707,	45432,	36893,	21880,	.5931,	.8597,
1975,	28819,	39067,	29709,	15485,	.5212,	.6099,
1976,	11574,	43933,	34172,	16275,	.4763,	.6825,
1977,	31064,	42260,	34880,	20119,	.5768,	.8064,
1978,	24079,	37367,	28737,	13390,	.4660,	.5605,
1979,	11145,	36242,	27977,	14830,	.5301,	.5677,
1980,	14933,	32578,	27018,	13509,	.5000,	.6205,
1981,	17556,	27266,	22450,	15337,	.6832,	.9262,
1982,	21207,	21702,	16320,	12465,	.7638,	1.2141,
1983,	21226,	22036,	15767,	12828,	.8136,	.9507,
1984,	11819,	22061,	16058,	11886,	.7402,	.9518,
1985,	9052,	19848,	15361,	12706,	.8272,	1.1928,
1986,	18452,	16265,	12712,	9096,	.7156,	.9818,
1987,	5926,	14119,	10276,	11491,	1.1182,	1.1037,
1988,	7953,	10385,	7971,	5527,	.6934,	.7880,
1989,	3596,	12102,	9630,	8590,	.8920,	1.0295,
1990,	15146,	9407,	6835,	5936,	.8685,	1.1662,
1991,	8165,	10605,	7296,	6834,	.9367,	1.1292,
1992,	13576,	11446,	9646,	6271,	.6501,	.7987,
1993,	8045,	13890,	10201,	7013,	.6875,	.6178,
1994,	8977,	16618,	15298,	7802,	.5100,	.8060,
1995,	17642,	15377,	13690,	8165,	.5964,	.9452,
1996,	4458,	10475,	6993,	6126,	.8760,	.8203,
1997,	11924,	14541,	12859,	9461,	.7357,	1.0078,
1998,	8045,	10277,	8222,	6835,	.8313,	1.1179,
1999,	7026,	9280,	7913,	6608,	.8351,	1.0066,
2000,	3052,	7300,	6401,	4897,	.7651,	.9854,
2001,	2524,	6417,	5663,	3960,	.6993,	1.0612,
2002,	3139,	5624,	5081,	2470,	.4862,	.7399,
2003,	876,	5617,	5296,	2045,	.3861,	.5429,
2004,	5628,	3521,	2966,	1402,	.4727,	.6691,
2005,	2213,	4882,	3807,	1070,	.2811,	.2860,
2006,	4022,	6872,	5710,	876,	.1534,	.1299,
Arith. Mean ,	13210,	22109,	17754,	9867,	.6300,	.8027,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						

Table 2.2.17 Tuning diagnostics of the final XSA run including discards

```
Lowestoft VPA Version 3.1

   22/04/2007  15:02

 Extended Survivors Analysis

 Cod in   the Kattegat (part of Division IIIa) 2006WG COMBSEX PLUSGROUP

 CPUE data from file codkFL_final.txt

 Catch data for  10 years. 1997 to 2006. Ages  1 to   6.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                     ,   year, year,  age ,  age
 Havfisken_SD21_Q4   ,   1997, 2006,   1,     3,   .830,   .920
 Havfisken_SD21_Q1   ,   1997, 2006,   1,     3,   .000,   .250
 IBTSQ1_2-6_Shifted  ,   1997, 2006,   1,     5,   .990,  1.000
 IBTS_Q3             ,   1997, 2006,   1,     4,   .750,   .830
 IBTS Q1_raw_age1    ,   1997, 2006,   1,     1,   .000,   .250


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    4


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   27 iterations

1


 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000



 Fishing mortalities
    Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

      1,  .108,  .140,  .129,  .390,  .437,  .265,  .516,  .351,  .339,  .297
      2,  .632,  .414,  .640,  .602,  .964,  .719,  .739, 1.261,  .318,  .526
      3, 1.087, 1.019, 1.182, 1.186, 1.105, 1.121,  .896, 1.233,  .550,  .224
      4, 1.198, 1.283,  .958, 1.254, 1.617,  .603,  .826,  .756,  .547,  .200
      5,  .903, 1.314, 1.148,  .784,  .819,  .884,  .183,  .795,  .151,  .184



1
 XSA population numbers (Thousands)

                                   AGE
```

Table 2.2.17 (Contd)

```
 YEAR ,           1,            2,            3,            4,            5,

 1997 ,    1.59E+04, 6.34E+03, 1.06E+04, 1.73E+03, 5.41E+02,
 1998 ,    1.27E+04, 1.17E+04, 2.76E+03, 2.92E+03, 4.28E+02,
 1999 ,    1.10E+04, 9.02E+03, 6.33E+03, 8.16E+02, 6.62E+02,
 2000 ,    7.92E+03, 7.89E+03, 3.89E+03, 1.59E+03, 2.56E+02,
 2001 ,    6.11E+03, 4.39E+03, 3.54E+03, 9.73E+02, 3.72E+02,
 2002 ,    7.57E+03, 3.24E+03, 1.37E+03, 9.59E+02, 1.58E+02,
 2003 ,    4.33E+03, 4.76E+03, 1.29E+03, 3.66E+02, 4.29E+02,
 2004 ,    1.04E+04, 2.12E+03, 1.86E+03, 4.31E+02, 1.31E+02,
 2005 ,    5.09E+03, 6.02E+03, 4.91E+02, 4.43E+02, 1.66E+02,
 2006 ,    8.15E+03, 2.97E+03, 3.58E+03, 2.32E+02, 2.10E+02,

 Estimated population abundance at 1st Jan 2007

    ,     0.00E+00, 4.96E+03, 1.44E+03, 2.35E+03, 1.55E+02,

 Taper weighted geometric mean of the VPA populations:

    ,     8.06E+03, 5.01E+03, 2.48E+03, 7.53E+02, 2.82E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .4015,    .5357,    .8699,    .7890,    .5640,
1

 Log catchability residuals.


 Fleet : Havfisken_SD21_Q4

  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 ,   .00,  -.61,   .76,   .26, -1.40,   .42,  1.11,  -.13,  -.81,   .36
     2 ,  -.44,  -.68,  -.02,   .61, -1.19,   .21,   .10,   .53,  -.07,   .74
     3 ,  -.04, 99.99,   .15,   .78, -1.38,  -.60,   .33,   .90,  -.29,   .14
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


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


    Age ,          1,          2,          3
 Mean Log q,   -5.5794,   -6.6052,   -7.7745,
 S.E(Log q),     .7719,     .6125,     .7091,


 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    1.01,    -.016,      5.54,     .21,     10,     .83,   -5.58,
  2,    1.87,   -1.202,      4.94,     .21,     10,    1.12,   -6.61,
  3,     .95,     .171,      7.78,     .65,      9,     .72,   -7.77,
1


 Fleet : Havfisken_SD21_Q1

  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 ,  -.93, 99.99,  1.73,   .10,  -.99,   .09, -1.60,   .59,   .48,   .46
     2 ,  -.21, 99.99,  -.67,  -.23,  -.15,  -.58,   .49,  -.23,   .77,   .64
     3 ,   .36, 99.99,  -.48,  -.89,   .10,  -.32,   .49,   .11,   .58,   .02
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
```

Table 2.2.17 (Contd)

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

Age ,	1,	2,	3
Mean Log q,	-4.9921,	-5.4524,	-6.4716,
S.E(Log q),	1.0051,	.5320,	.4814,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.50,	1.095,	6.98,	.42,	9,	.49,	-4.99,
2,	1.16,	-.314,	4.98,	.38,	9,	.66,	-5.45,
3,	1.30,	-1.245,	6.07,	.73,	9,	.60,	-6.47,

1

Fleet : IBTSQ1_2-6_Shifted

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	1.21,	.44,	.90,	-.14,	-.63,	-.09,	-.59,	.18,	-.49,	-.35
2 ,	.67,	.13,	.33,	-.24,	.27,	-1.15,	.70,	.16,	-.13,	-.53
3 ,	.00,	-1.12,	.04,	-.45,	.59,	-.16,	.50,	1.05,	.31,	-.97
4 ,	-.15,	-.43,	-.35,	-.46,	1.05,	-.59,	.77,	.00,	.39,	-.38
5 ,	.02,	-.16,	-.07,	.08,	.09,	-.03,	.23,	.10,	.16,	-.22

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

Age ,	1,	2,	3,	4,	5
Mean Log q,	-4.4221,	-4.7420,	-4.7795,	-4.9344,	-4.9344,
S.E(Log q),	.6123,	.5672,	.6894,	.5764,	.1454,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
1,	.42,	5.473,	7.06,	.92,	10,	.12,	-4.42,
2,	.74,	.922,	5.71,	.64,	10,	.43,	-4.74,
3,	1.30,	-.813,	3.88,	.51,	10,	.91,	-4.78,
4,	1.28,	-.834,	4.47,	.56,	10,	.75,	-4.93,
5,	1.03,	-.268,	4.89,	.94,	10,	.16,	-4.91,

Fleet : IBTS_Q3

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
1 ,	.83,	1.08,	.71,	99.99,	-1.12,	.58,	-1.97,	.69,	-.31,	-.06
2 ,	1.42,	.80,	-.59,	99.99,	-.69,	-.91,	-.19,	.35,	.13,	.05
3 ,	1.53,	.59,	-.07,	99.99,	-.82,	-.43,	-1.24,	1.59,	-1.03,	.32
4 ,	.76,	.47,	-.04,	99.99,	-.20,	-.53,	-.72,	-.47,	.51,	.46
5 ,	No data for this fleet at this age									

Table 2.2.17 (Contd)

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


    Age ,          1,          2,          3,          4
 Mean Log q,   -5.3038,   -6.0323,   -7.0949,   -7.3631,
 S.E(Log q),    1.0332,     .7172,    1.0475,     .5402,




 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,     .32,    4.369,      7.81,     .87,      9,     .18,   -5.30,
  2,     .76,     .622,      6.62,     .51,      9,     .57,   -6.03,
  3,     .62,    1.613,      7.35,     .74,      9,     .59,   -7.09,
  4,     .85,     .658,      7.24,     .76,      9,     .48,   -7.36,

 Fleet : IBTS Q1_raw_age1

  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 ,   .40,   .77,  1.09,   .29,   .09,   .54, -2.56,   .21,  -.59,   .15
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age

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


    Age ,          1
 Mean Log q,   -4.8799,
 S.E(Log q),    1.0364,


 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,     .34,    3.163,      7.61,     .76,     10,     .24,   -4.88,

 Terminal year survivor and F summaries :

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2005

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Havfisken_SD21_Q4   ,      7132.,   .812,       .000,    .00,   1,  .214,     .215
 Havfisken_SD21_Q1   ,      7880.,  1.063,       .000,    .00,   1,  .125,     .197
 IBTSQ1_2-6_Shifted  ,      3484.,   .644,       .000,    .00,   1,  .340,     .400
 IBTS_Q3             ,      4654.,  1.093,       .000,    .00,   1,  .118,     .313
 IBTS Q1_raw_age1    ,      5733.,  1.091,       .000,    .00,   1,  .119,     .261

   F shrinkage mean  ,      3658.,   1.50,,,,                        .084,     .384
Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4957.,       .38,      .15,    6,    .387,   .297
1
```

Table 2.2.17 (Contd)

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Havfisken_SD21_Q4	1861.	.511	.718	1.40	2	.225	.428
Havfisken_SD21_Q1	2651.	.501	.061	.12	2	.245	.319
IBTSQ1_2-6_Shifted	858.	.444	.019	.04	2	.292	.770
IBTS_Q3	1373.	.630	.153	.24	2	.151	.545
IBTS Q1_raw_age1	794.	1.091	.000	.00	1	.039	.812
F shrinkage mean	799.	1.50,,,,				.049	.809

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1436.	.25	.19	10	.782	.526

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Havfisken_SD21_Q4	2365.	.432	.082	.19	3	.220	.222
Havfisken_SD21_Q1	3220.	.363	.253	.70	3	.338	.168
IBTSQ1_2-6_Shifted	1631.	.388	.335	.87	3	.264	.308
IBTS_Q3	3134.	.558	.142	.26	3	.128	.172
IBTS Q1_raw_age1	2881.	1.092	.000	.00	1	.022	.186
F shrinkage mean	347.	1.50,,,,				.028	.992

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2346.	.20	.15	14	.739	.224

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Havfisken_SD21_Q4	162.	.523	.345	.66	3	.117	.192
Havfisken_SD21_Q1	225.	.415	.331	.80	3	.211	.142
IBTSQ1_2-6_Shifted	131.	.412	.185	.45	4	.336	.233
IBTS_Q3	194.	.473	.335	.71	4	.290	.163
IBTS Q1_raw_age1	12.	1.096	.000	.00	1	.006	1.348
F shrinkage mean	24.	1.50,,,,				.040	.879

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
155.	.23	.17	16	.746	.200

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Havfisken_SD21_Q4	251.	.459	.259	.56	3	.033	.109
Havfisken_SD21_Q1	176.	.382	.120	.31	3	.054	.152
IBTSQ1_2-6_Shifted	129.	.260	.144	.55	5	.760	.202
IBTS_Q3	245.	.492	.189	.38	4	.119	.112
IBTS Q1_raw_age1	245.	1.104	.000	.00	1	.003	.112
F shrinkage mean	77.	1.50,,,,				.030	.319

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
143.	.21	.10	17	.454	.184

Table 2.2.18 Cod in Kattegat. Fishing mortalities from the final XSA run including discards

```
Run title : Cod in       the Kattegat (part of Division IIIa)

At 22/04/2007  15:03

               Terminal Fs derived using XSA (With F shrinkage)

   Table  8    Fishing mortality (F) at age
   YEAR,       1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

   AGE
     1,        .1078,   .1401,   .1291,   .3905,   .4366,   .2646,   .5160,   .3509,   .3388,   .2967,
     2,        .6317,   .4138,   .6405,   .6023,   .9640,   .7190,   .7394,  1.2613,   .3183,   .5263,
     3,       1.0868,  1.0185,  1.1818,  1.1856,  1.1052,  1.1214,   .8959,  1.2332,   .5502,   .2240,
     4,       1.1984,  1.2830,   .9581,  1.2536,  1.6170,   .6034,   .8262,   .7558,   .5468,   .1998,
     5,        .9031,  1.3144,  1.1479,   .7842,   .8189,   .8838,   .1831,   .7949,   .1507,   .1843,
   +gp,        .9031,  1.3144,  1.1479,   .7842,   .8189,   .8838,   .1831,   .7949,   .1507,   .1843,
FBAR  3- 5,    1.0628,  1.2053,  1.0960,  1.0745,  1.1804,   .8695,   .6351,   .9280,   .4159,   .2027,
```

Table 2.2.19 Cod in Kattegat. Stock numbers from the final XSA run including discards

```
Run title : Cod in       the Kattegat (part of Division IIIa) 2006WG COMBSEX PLUSGROUP

At 22/04/2007  15:03
               Terminal Fs derived using XSA (With F shrinkage)

   Table 10    Stock number at age (start of year)               Numbers*10**-3
   YEAR,       1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

   AGE
     1,        15915,   12671,   10961,    7922,    6114,    7569,    4332,   10442,    5087,    8145,
     2,         6339,   11698,    9018,    7887,    4389,    3235,    4756,    2117,    6020,    2968,
     3,        10565,    2759,    6332,    3891,    3536,    1370,    1291,    1859,     491,    3585,
     4,         1731,    2917,     816,    1590,     973,     959,     366,     431,     443,     232,
     5,          541,     428,     662,     256,     372,     158,     429,     131,     166,     210,
   +gp,          232,     112,     122,     206,      88,      74,     105,      77,      94,      59,
    TOTAL,     35322,   30585,   27910,   21753,   15472,   13365,   11279,   15058,   12302,   15199,
```

Table 2.2.20 Cod in Kattegat. Summary output from the final XSA run including discards

```
    Run title : Cod in       the Kattegat (part of Division IIIa),

    At 22/04/2007  15:03

        Table 16    Summary     (without SOP correction)

                   Terminal Fs derived using XSA (With F shrinkage)

,            RECRUITS,    TOTALBIO,    TOTSPBIO,    LANDINGS,   YIELD/SSB,  FBAR  3- 5,
 ,             Age 1
    1997,        15915,       15358,       13113,        9461,       .7215,      1.0628,
    1998,        12671,       10920,        8328,        6835,       .8207,      1.2053,
    1999,        10961,        9982,        8190,        6608,       .8068,      1.0960,
    2000,         7922,        7892,        6535,        4897,       .7493,      1.0745,
    2001,         6114,        7106,        5826,        3960,       .6797,      1.1804,
    2002,         7569,        6032,        5123,        2470,       .4821,       .8695,
    2003,         4332,        5880,        5104,        2045,       .4007,       .6351,
    2004,        10442,        4724,        3694,        1402,       .3795,       .9280,
    2005,         5087,        5147,        3687,        1070,       .2902,       .4159,
    2006,         8145,        6981,        5382,         876,       .1628,       .2027,

 Arith.
   Mean   ,       8916,        8002,        6498,        3962,       .5493,       .8670,
0 Units,   (Thousands),    (Tonnes),    (Tonnes),    (Tonnes),
1
```

Table 2.2.21 Cod in Kattegat. Fishing mortalities from B-Adapt run (not including discards)

```
Run title : Cod in       the Kattegat (part of Division IIIa)

At 23/04/2007  12:22


   Table  8    Fishing mortality (F) at age
   YEAR,       1971,    1972,    1973,    1974,    1975,    1976,

   AGE
     1,       0.5864,  0.0018,  0.0003,  0.0212,  0.0078,  0.0169,
     2,       0.3662,  0.2849,  0.0371,  0.4409,  0.1734,  0.2524,
     3,       0.4929,  0.5718,  0.2601,  0.7105,  0.6189,  0.5876,
     4,       0.5287,  0.3189,  0.8616,  1.3750,  0.8922,  1.0675,
     5,       0.5108,  0.4454,  0.5608,  1.0428,  0.7555,  0.8276,
   +gp,       0.5108,  0.4454,  0.5608,  1.0428,  0.7555,  0.8276,
FBAR  3- 5,   0.5108,  0.4454,  0.5608,  1.0428,  0.7555,  0.8276,


   YEAR,       1977,    1978,    1979,    1980,    1981,    1982,    1983,    1984,    1985,    1986,

   AGE
     1,       0.0000,  0.0042,  0.0220,  0.0429,  0.0214,  0.0183,  0.0353,  0.0124,  0.0890,  0.0268,
     2,       0.3233,  0.3157,  0.2027,  0.1832,  0.4731,  0.2964,  0.4204,  0.3420,  0.4658,  0.3447,
     3,       0.8100,  0.7603,  0.6138,  0.6318,  0.5808,  0.9276,  0.9732,  0.8702,  1.2507,  1.0920,
     4,       1.1555,  0.6046,  0.7770,  0.8312,  1.5421,  1.8948,  1.2132,  1.3219,  1.4660,  1.1554,
     5,       0.9827,  0.6824,  0.6954,  0.7315,  1.0615,  1.4112,  1.0932,  1.0960,  1.3583,  1.1237,
   +gp,       0.9827,  0.6824,  0.6954,  0.7315,  1.0615,  1.4112,  1.0932,  1.0960,  1.3583,  1.1237,
FBAR  3- 5,   0.9827,  0.6824,  0.6954,  0.7315,  1.0615,  1.4112,  1.0932,  1.0960,  1.3583,  1.1237,


   YEAR,       1987,    1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,
```

Table 2.2.21 (Cont'd)

```
      AGE
        1,       0.0329,  0.0257,  0.0835,  0.0449,  0.0399,  0.0218,  0.0197,  0.0027,  0.0024,  0.0018,
        2,       0.8713,  0.3440,  0.7922,  0.6615,  0.4868,  0.4870,  0.3289,  0.2239,  0.2725,  0.1613,
        3,       1.1594,  0.7809,  1.1407,  1.3557,  1.3101,  0.8324,  0.5213,  0.7515,  0.8619,  0.7716,
        4,       1.3502,  1.1045,  1.1530,  1.4256,  1.5130,  1.0995,  0.9418,  0.7398,  1.2373,  0.8819,
        5,       1.2548,  0.9427,  1.1468,  1.3907,  1.4116,  0.9660,  0.7316,  0.7457,  1.0496,  0.8268,
      +gp,       1.2548,  0.9427,  1.1468,  1.3907,  1.4116,  0.9660,  0.7316,  0.7457,  1.0496,  0.8268,
  FBAR  3- 5,    1.2548,  0.9427,  1.1468,  1.3907,  1.4116,  0.9660,  0.7316,  0.7457,  1.0496,  0.8268,


      YEAR,       1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

      AGE
        1,       0.0070,  0.0171,  0.0062,  0.0046,  0.0301,  0.0052,  0.0000,  0.0006,  0.0013,  0.0049,
        2,       0.2055,  0.2849,  0.3632,  0.2918,  0.5408,  0.4420,  0.3221,  0.2404,  0.2575,  0.2239,
        3,       1.0398,  0.9624,  1.1425,  0.9344,  1.3915,  1.1396,  0.7390,  0.6270,  0.9060,  0.5668,
        4,       1.1225,  1.2603,  1.0719,  1.2556,  1.7385,  1.4870,  0.6808,  1.1552,  1.0236,  0.8286,
        5,       1.0812,  1.1114,  1.1072,  1.0950,  1.5650,  1.3133,  0.7099,  0.8911,  0.9648,  0.6977,
      +gp,       1.0812,  1.1114,  1.1072,  1.0950,  1.5650,  1.3133,  0.7099,  0.8911,  0.9648,  0.6977,
  FBAR  3- 5,    1.0812,  1.1114,  1.1072,  1.0950,  1.5650,  1.3133,  0.7099,  0.8911,  0.9648,  0.6977,
```

Table 2.2.22 Cod in Kattegat. Stock numbers from B-Adapt run (not including discards)

```
Run title : Cod in       the Kattegat (part of Division IIIa)

At 23/04/2007  12:22


   Table 10    Stock number at age (start of year)               Numbers*10**-3
   YEAR,       1971,    1972,    1973,    1974,    1975,    1976,

   AGE
     1,        37064,   23088,   15951,   31119,   26863,   10944,
     2,        28389,   16882,   18869,   13055,   24944,   21824,
     3,        19506,   16116,   10396,   14886,    6878,   17171,
     4,         5109,    9756,    7448,    6562,    5989,    3033,
     5,         2426,    2465,    5806,    2577,    1358,    2009,
   +gp,           730,    1722,    2934,     751,    1017,    1021,
    TOTAL,     93224,   70030,   61405,   68949,   67049,   56001,


   YEAR,       1977,    1978,    1979,    1980,    1981,    1982,    1983,    1984,    1985,    1986,

   AGE
     1,        29789,   23241,   10804,   14507,   17069,   20626,   20743,   11388,    8861,   17915,
     2,         8810,   24389,   18949,    8653,   11379,   13679,   16580,   16393,    9209,    6637,
     3,        13882,    5220,   14563,   12668,    5899,    5805,    8326,    8915,    9534,    4732,
     4,         7811,    5056,    1998,    6454,    5514,    2702,    1880,    2576,    3058,    2235,
     5,          854,    2014,    2262,     752,    2301,     966,     333,     457,     562,     578,
   +gp,         1067,     558,     627,    1124,     526,     833,     458,     212,     142,     225,
    TOTAL,     62214,   60478,   49202,   44159,   42688,   44610,   48320,   39942,   31367,   32322,


   YEAR,       1987,    1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,
```

Table 2.2.22 (Cont'd)

```
AGE
  1,        5723,    7787,    3398,   15233,    7748,   13450,    7753,    8904,   17270,    4229,
  2,       14279,    4534,    6214,    2560,   11925,    6096,   10774,    6224,    7270,   14106,
  3,        3850,    4891,    2631,    2304,    1081,    6000,    3067,    6349,    4073,    4532,
  4,        1300,     989,    1834,     689,     486,     239,    2137,    1491,    2452,    1409,
  5,         576,     276,     268,     474,     136,      88,      65,     682,     582,     582,
+gp,         200,     101,     127,      75,     108,      35,      40,      29,     307,     182,
 TOTAL,    25927,   18578,   14473,   21334,   21485,   25907,   23836,   23678,   31954,   25040,


YEAR,      1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

AGE
  1,       11622,    8478,    7636,    4076,    2920,    4337,    1330,    8298,    2912,    7411,
  2,        3456,    9448,    6824,    6213,    3321,    2320,    3532,    1089,    6790,    2381,
  3,        9828,    2304,    5818,    3885,    3799,    1583,    1221,    2096,     701,    4297,
  4,        1715,    2845,     721,    1520,    1250,     774,     415,     477,     917,     232,
  5,         477,     457,     660,     202,     354,     180,     143,     172,     123,     270,                                +gp,
208,     123,     125,     168,      86,      87,      36,     106,      70,      81,
 TOTAL,    27307,   23654,   21783,   16063,   11730,    9280,    6676,   12238,   11513,   14672,
```

Table 2.2.23 Cod in Kattegat. Summary output from the B-Adapt run (not including discards)

Run title : Cod in the Kattegat (part of Division IIIa)

At 23/04/2007 12:22

Table 16 Summary (without SOP correction)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 5,
1971,	37064,	47841,	35149,	15732,	0.4476,	0.5108,
1972,	23088,	51682,	42823,	17442,	0.4073,	0.4454,
1973,	15951,	56919,	49301,	18837,	0.3821,	0.5608,
1974,	31119,	40648,	32590,	21880,	0.6714,	1.0428,
1975,	26863,	34108,	25285,	15485,	0.6124,	0.7555,
1976,	10944,	38896,	29758,	16275,	0.5469,	0.8276,
1977,	29789,	37623,	30731,	20119,	0.6547,	0.9827,
1978,	23241,	32552,	24342,	13390,	0.5501,	0.6824,
1979,	10804,	32150,	24241,	14830,	0.6118,	0.6954,
1980,	14507,	29390,	24042,	13509,	0.5619,	0.7315,
1981,	17069,	25049,	20391,	15337,	0.7521,	1.0615,
1982,	20626,	20021,	14812,	12465,	0.8416,	1.4112,
1983,	20743,	20694,	14614,	12828,	0.8778,	1.0932,
1984,	11388,	20802,	14983,	11886,	0.7933,	1.0960,
1985,	8861,	18723,	14386,	12706,	0.8832,	1.3583,
1986,	17915,	15088,	11661,	9096,	0.7801,	1.1237,
1987,	5723,	13248,	9527,	11491,	1.2061,	1.2548,
1988,	7787,	9468,	7149,	5527,	0.7731,	0.9427,
1989,	3398,	11325,	8938,	8590,	0.9611,	1.1468,
1990,	15233,	8571,	6085,	5936,	0.9755,	1.3907,
1991,	7748,	9921,	6710,	6834,	1.0184,	1.4116,
1992,	13450,	11145,	9408,	6271,	0.6666,	0.9660,
1993,	7753,	13184,	9634,	7013,	0.7279,	0.7316,
1994,	8904,	16401,	15112,	7802,	0.5163,	0.7457,
1995,	17270,	14386,	12726,	8165,	0.6416,	1.0496,
1996,	4229,	10245,	6836,	6126,	0.8961,	0.8268,
1997,	11622,	13899,	12273,	9461,	0.7709,	1.0812,
1998,	8478,	10088,	8069,	6835,	0.8471,	1.1114,
1999,	7636,	8947,	7537,	6608,	0.8768,	1.1072,
2000,	4076,	7025,	6013,	4897,	0.8144,	1.0950,
2001,	2920,	7209,	6276,	3960,	0.6310,	1.5650,
2002,	4337,	5724,	5054,	2470,	0.4887,	1.3133,
2003,	1330,	3952,	3500,	2045,	0.5843,	0.7099,
2004,	8298,	4757,	3915,	1402,	0.3581,	0.8911,
2005,	2912,	6376,	4782,	1070,	0.2238,	0.9648,
2006,	7411,	7980,	6348,	876,	0.1380,	0.6977,
Arith. Mean ,	13069,	19890,	15694,	9867,	0.6803,	0.9828,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						

Table 2.2.24. Cod in Kattegat. Diagnostics from B-Adapt run

```
 Lowestoft VPA Program

   23/04/2007  12:21

 Adapt Analysis
 Cod in the Kattegat (part of Division IIIa)
 CPUE data from file codkFL_final.txt

 Catch data for  36 years : 1971 to 2006. Ages   1 to   6+

 Fleet                , First, Last, First, Last, Alpha,  Beta,
                       , year, year,  age ,  age,
 Havfisken_SD21_Q4   ,   1994, 2006,2007,     1,  0.000,  0.830
 Havfisken_SD21_Q1   ,   1996, 2006,2007,     1,  0.000,  0.000
 IBTSQ1_2-6_Shifted  ,   1982, 2006,2007,     1,  0.000,  0.990
 IBTS_Q3             ,   1991, 2006,2007,     1,  0.000,  0.750
 IBTS Q1_raw_age1    ,   1983, 2006,2007,     1,  0.000,  0.000

 Time series weights :
      Tapered time weighting not applied
 Catchability analysis :

 Fleet                     , PowerQ, QPlateau
                                                          , ages<x,  ages>x
      Havfisken_SD21_Q4   ,           1,           4
      Havfisken_SD21_Q1   ,           1,           4
      IBTSQ1_2-6_Shifted  ,           1,           4
      IBTS_Q3             ,           1,           4
      IBTS Q1_raw_age1    ,           1,           4
      Catchability independent of stock size for all ages

 Bias estimation :

 Bias estimated for the final   6 years.

 Oldest age F estimates in 1971 to 2007 calculated as 1.000 * the mean F of
ages  3-  4

 Total F penalty applied, lambda =   0.500

 Individual fleet weighting not applied

  INITIAL  SSQ = , 415.8966389764
 PARAMETERS = , 10
 OBSERVATIONS = ,304

       SSQ  =  , 155.69905
       QSSQ =  , 149.50425
       CSSQ =  ,   6.19480
       IFAIL = ,  3
      IFAILCV = 0

 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Fishing mortalities
    Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

      1, 0.007, 0.017, 0.006, 0.005, 0.030, 0.005, 0.000, 0.001, 0.001, 0.005
      2, 0.206, 0.285, 0.363, 0.292, 0.541, 0.442, 0.322, 0.240, 0.258, 0.224
      3, 1.040, 0.962, 1.143, 0.934, 1.391, 1.140, 0.739, 0.627, 0.906, 0.567
      4, 1.123, 1.260, 1.072, 1.256, 1.738, 1.487, 0.681, 1.155, 1.024, 0.829
      5, 1.081, 1.111, 1.107, 1.095, 1.565, 1.313, 0.710, 0.891, 0.965, 0.698
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
 Population numbers (Thousands)
                                AGE
 YEAR ,           1,        2,        3,        4,        5,

 1997 ,    1.16E+04, 3.46E+03, 9.83E+03, 1.72E+03, 4.77E+02,
 1998 ,    8.48E+03, 9.45E+03, 2.30E+03, 2.84E+03, 4.57E+02,
 1999 ,    7.64E+03, 6.82E+03, 5.82E+03, 7.21E+02, 6.60E+02,
 2000 ,    4.08E+03, 6.21E+03, 3.89E+03, 1.52E+03, 2.02E+02,
 2001 ,    2.92E+03, 3.32E+03, 3.80E+03, 1.25E+03, 3.54E+02,
 2002 ,    4.34E+03, 2.32E+03, 1.58E+03, 7.74E+02, 1.80E+02,
 2003 ,    1.33E+03, 3.53E+03, 1.22E+03, 4.15E+02, 1.43E+02,
 2004 ,    8.30E+03, 1.09E+03, 2.10E+03, 4.77E+02, 1.72E+02,
 2005 ,    2.91E+03, 6.79E+03, 7.01E+02, 9.17E+02, 1.23E+02,
 2006 ,    7.41E+03, 2.38E+03, 4.30E+03, 2.32E+02, 2.70E+02,

 Estimated population abundance at 1st Jan 2007

    ,     0.00E+00, 6.04E+03, 1.56E+03, 2.00E+03, 8.29E+01,
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
 Taper weighted geometric mean of the VPA populations:

    ,     1.02E+04, 8.41E+03, 5.19E+03, 1.86E+03, 5.49E+02,

 Standard error of the weighted Log(VPA populations) :

    ,       0.7653,   0.7721,   0.8214,   0.9849,   1.0813,

 Log population residuals (unweighted).

 Fleet : Havfisken_SD21_Q4

 Log index residuals

  Age  ,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997
     1 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, -0.02, -0.56, -0.20,  0.05
     2 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  0.59, -0.34, -0.17, -0.18
     3 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  0.66,  0.93, -0.95,  0.00
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age


  Age  ,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007
     1 , -0.49,  0.84,  0.41, -1.19,  0.57,  1.66, -0.38, -0.73,  0.03, 99.99
     2 , -0.55,  0.05,  0.60, -1.25,  0.33,  0.06,  0.33, -0.21,  0.73, 99.99
     3 , 99.99,  0.21,  0.57, -1.18, -0.71,  0.26,  0.26, -0.32,  0.27, 99.99
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age

 Log population resi

  Age  ,  1971,  1972,  1973,  1974,  1975,  1976,  1977,  1978,  1979,  1980,
1981,  1982,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,
1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,
2003,  2004,  2005,  2006
     1 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, -
0.0175, -0.5604, -0.1976,  0.0549, -0.4889,  0.8408,  0.4094, -1.1925,  0.5736,
1.6606, -0.3844, -0.7254,  0.0275
     2 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
0.5920, -0.3362, -0.1702, -0.1769, -0.5504,  0.0464,  0.6048, -1.2530,  0.3300,
0.0627,  0.3305, -0.2081,  0.7284
     3 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
0.6561,  0.9340, -0.9536,  0.0002, 99.9900,  0.2088,  0.5723, -1.1844, -0.7116,
0.2631,  0.2647, -0.3239,  0.2742
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

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

   Age ,          1,          2,          3
Mean Log q,   -5.4037,   -6.6379,   -7.7868,
S.E(Log q),    0.7446,    0.5447,    0.6614,

Regression statistics :

 Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 1,    1.56,   -1.168,      3.59,    0.28,     13,   1.14536,   -5.40,
 2,    1.26,   -0.901,      6.17,    0.52,     13,   0.69245,   -6.64,
 3,    0.85,    0.633,      7.83,    0.65,     12,   0.58073,   -7.79,

Fleet : Havfisken_SD21_Q1

Log index residuals

 Age  ,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997
    1 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, -0.21, -1.08
    2 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  0.46,  0.05
    3 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, -0.22,  0.53
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age


 Age  ,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007
    1 , 99.99,  1.62,  0.27, -0.75,  0.16, -0.94,  0.32,  0.54,  0.07, 99.99
    2 , 99.99, -0.72, -0.33, -0.22, -0.58,  0.44,  0.02,  0.34,  0.53, 99.99
    3 , 99.99, -0.30, -0.81,  0.16, -0.36,  0.63,  0.02,  0.37, -0.02, 99.99
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age


Log population resi

 Age  ,  1971,  1972,  1973,  1974,  1975,  1976,  1977,  1978,  1979,  1980,  1981,
1982,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,
1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
    1 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, -0.2092, -1.0805, 99.9900,  1.6232,
0.2655, -0.7538,  0.1636, -0.9354,  0.3183,  0.5397,  0.0686
    2 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,  0.4600,  0.0529, 99.9900, -0.7202,
-0.3284, -0.2166, -0.5763,  0.4406,  0.0166,  0.3439,  0.5276
    3 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, -0.2190,  0.5254, 99.9900, -0.2997,
-0.8147,  0.1634, -0.3599,  0.6334,  0.0182,  0.3725, -0.0196
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age


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

   Age ,          1,          2,          3
Mean Log q,   -4.5386,   -5.1563,   -6.5746,
S.E(Log q),    0.8017,    0.4486,    0.4440,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 1,    0.74,    0.814,      5.54,    0.56,     10,   0.60657,   -4.54,
 2,    0.95,    0.223,      5.30,    0.74,     10,   0.45219,   -5.16,
 3,    1.15,   -0.668,      6.37,    0.72,     10,   0.52561,   -6.57,
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
Fleet : IBTSQ1_2-6_Shifted

Log index residuals

 Age  ,  1982,  1983,  1984,  1985,  1986,  1987
    1 ,  0.40, -0.24, -0.08, -0.31,  0.77, -0.72
    2 , -0.58, -0.38, -0.22, -0.50,  0.02,  0.50
    3 , -0.28, -0.11, -0.27, -0.77, -0.52,  0.53
    4 ,  0.15,  0.56, -0.36, -0.34, -1.07,  0.26
    5 ,  0.82,  2.74,  0.24,  0.25, -0.86, -0.26

 Age  ,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997
    1 , -0.33, -0.73,  0.52, -1.19, -1.09, 99.99, -0.90,  0.49,  0.31,  1.47
    2 ,  0.04, -0.18,  0.87, -0.45, -0.56, 99.99, -0.63,  0.36,  0.41,  1.02
    3 ,  0.56,  0.28,  0.43,  0.02, -0.14, 99.99, -0.32,  0.45, -0.67,  0.18
    4 ,  0.75,  0.33,  1.05,  0.51,  0.38, 99.99, -0.70, -0.22, -1.08, -0.38
    5 ,  1.41, -0.17,  0.45,  0.65, -0.26, 99.99, -1.09,  0.40, -0.52,  0.16

 Age  ,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007
    1 ,  0.76,  1.19,  0.19, -0.25,  0.26,  0.12,  0.11, -0.22, -0.50, 99.99
    2 ,  0.38,  0.50, -0.14,  0.30, -0.92,  0.75, -0.02, -0.14, -0.44, 99.99
    3 , -0.83,  0.25, -0.53,  0.97, -0.13,  0.56,  0.49,  0.47, -0.64, 99.99
    4 , -0.59, -0.27, -0.58,  0.76,  0.34,  0.34,  0.13, -0.02,  0.08, 99.99
    5 , -0.59, -0.27,  0.46,  0.72,  0.10,  1.69, -0.24,  1.10, -0.12, 99.99

Log population resi

 Age  ,  1971,  1972,  1973,  1974,  1975,  1976,  1977,  1978,  1979,  1980,  1981,
1982,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,
1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
    1 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900,  0.3968, -0.2423, -0.0822, -0.3058,  0.7664, -0.7163, -0.3336, -0.7317,
0.5168, -1.1934, -1.0909, 99.9900, -0.8970,  0.4884,  0.3104,  1.4665,  0.7606,  1.1856,
0.1878, -0.2462,  0.2581,  0.1211,  0.1082, -0.2237, -0.5036
    2 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, -0.5783, -0.3752, -0.2160, -0.5040,  0.0247,  0.5001,  0.0366, -0.1761,
0.8669, -0.4484, -0.5574, 99.9900, -0.6269,  0.3622,  0.4071,  1.0189,  0.3834,  0.5023, -
0.1399,  0.2953, -0.9233,  0.7533, -0.0213, -0.1432, -0.4407
    3 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, -0.2808, -0.1077, -0.2650, -0.7678, -0.5156,  0.5290,  0.5590,  0.2806,
0.4338,  0.0164, -0.1352, 99.9900, -0.3174,  0.4533, -0.6651,  0.1849, -0.8309,  0.2488, -
0.5321,  0.9689, -0.1281,  0.5609,  0.4861,  0.4678, -0.6438
    4 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900,  0.1468,  0.5581, -0.3605, -0.3378, -1.0743,  0.2592,  0.7452,  0.3339,
1.0464,  0.5060,  0.3778, 99.9900, -0.7015, -0.2219, -1.0810, -0.3772, -0.5928, -0.2707, -
0.5805,  0.7554,  0.3371,  0.3384,  0.1340, -0.0221,  0.0820

 5 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900,  0.8239,  2.7421,  0.2406,  0.2499, -0.8650, -0.2609,  1.4073, -0.1675,
0.4528,  0.6495, -0.2624, 99.9900, -1.0874,  0.3952, -0.5234,  0.1562, -0.5882, -0.2723,
0.4615,  0.7209,  0.1043,  1.6868, -0.2366,  1.1044, -0.1211

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

    Age ,          1,          2,          3,          4,          5
 Mean Log q,   -4.4670,   -4.9117,   -4.9409,   -4.7714,   -4.7714,
 S.E(Log q),    0.6824,    0.5188,    0.5044,    0.5671,    0.9035,

 Regression statistics :

  Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    0.85,    0.875,      5.14,    0.60,     24,   0.58200,   -4.47,
  2,    1.11,   -0.633,      4.50,    0.61,     24,   0.58279,   -4.91,
  3,    1.31,   -1.665,      3.92,    0.56,     24,   0.63792,   -4.94,
  4,    1.49,   -2.308,      3.66,    0.50,     24,   0.77581,   -4.77,
  5,    1.62,   -1.405,      3.67,    0.19,     24,   1.35370,   -4.49,

 Fleet : IBTS_Q3
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
Log index residuals
 Age  ,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997
    1 , 99.99, 99.99, 99.99, -1.11, -0.16, -1.03,  1.09,  0.95,  0.21,  0.75
    2 , 99.99, 99.99, 99.99,  0.55, -0.28, -0.89, -1.24,  0.17, -0.63,  1.89
    3 , 99.99, 99.99, 99.99,  3.55,  0.02, -0.09, -0.55, -0.82, -0.71,  1.41
    4 , 99.99, 99.99, 99.99,  1.91,  1.89,  0.22, -0.88, -0.42, -0.02,  0.27
    5 , No data for this fleet at this age

 Age  ,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007
    1 ,  1.07,  0.66, 99.99, -1.01,  0.61, -1.52,  0.33, -0.33, -0.52, 99.99
    2 ,  1.11, -0.33, 99.99, -0.54, -0.60, -0.02,  0.41,  0.16,  0.23, 99.99
    3 ,  0.57, -0.18, 99.99, -0.82, -0.72, -1.47,  0.83, -1.27,  0.26, 99.99
    4 ,  0.04, -0.26, 99.99, -0.80, -0.06, -1.41, -0.70, -0.28,  0.51, 99.99
    5 , No data for this fleet at this age

Log population resi

 Age  ,  1971,  1972,  1973,  1974,  1975,  1976,  1977,  1978,  1979,  1980,  1981,
1982,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,
1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, -1.1124, -0.1573, -1.0254,  1.0907,  0.9503,  0.2119,  0.7452,  1.0690,  0.6610,
99.9900, -1.0133,  0.6147, -1.5166,  0.3286, -0.3313, -0.5153
     2 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900,  0.5495, -0.2768, -0.8945, -1.2431,  0.1710, -0.6317,  1.8934,  1.1119, -0.3280,
99.9900, -0.5424, -0.5960, -0.0193,  0.4133,  0.1645,  0.2283
     3 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900,  3.5491,  0.0174, -0.0883, -0.5532, -0.8228, -0.7132,  1.4077,  0.5652, -0.1754,
99.9900, -0.8240, -0.7180, -1.4673,  0.8320, -1.2661,  0.2569
     4 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900,  1.9116,  1.8905,  0.2222, -0.8826, -0.4228, -0.0205,  0.2686,  0.0367, -0.2650,
99.9900, -0.8003, -0.0598, -1.4077, -0.7037, -0.2813,  0.5142
     5 , No data for this fleet at this age

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

   Age ,          1,          2,          3,          4
Mean Log q,   -4.9875,   -6.2339,   -6.9385,   -6.9201,
S.E(Log q),    0.8773,    0.8009,    1.2574,    0.9198,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 1,    0.57,    2.552,      6.61,    0.73,     15,   0.42326,   -4.99,
 2,    1.22,   -0.587,      5.72,    0.35,     15,   1.00108,   -6.23,
 3,    0.99,    0.014,      6.95,    0.27,     15,   1.29639,   -6.94,
 4,    1.63,   -1.297,      7.00,    0.25,     15,   1.46284,   -6.92,


Fleet : IBTS Q1_raw_age1

Log index residuals

 Age  ,  1982,  1983,  1984,  1985,  1986,  1987
    1 , 99.99, -0.32, -0.89, -1.98,  0.57, -1.69
    2 , No data for this fleet at this age
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age

 Age  ,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996,  1997
    1 ,  0.24, -1.44,  0.30, -0.89, -0.37, -0.74, 99.99,  1.13,  0.56,  0.75
    2 , No data for this fleet at this age
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
  Age  ,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007
     1 ,  1.20,  1.48,  0.95,  0.82,  1.10, -1.40,  0.43, -0.04,  0.24, 99.99
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age

 Log population resi

  Age  ,  1971,  1972,  1973,  1974,  1975,  1976,  1977,  1978,  1979,  1980,  1981,
1982,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,
1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     1 , 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900, 99.9900,
99.9900, 99.9900, 99.9900, -0.3223, -0.8918, -1.9801,  0.5697, -1.6892,  0.2382, -1.4420,
0.2999, -0.8927, -0.3716, -0.7392, 99.9900,  1.1257,  0.5561,  0.7474,  1.1974,  1.4765,
0.9487,  0.8211,  1.1042, -1.3972,  0.4328, -0.0360,  0.2446
     2 , No data for this fleet at this age
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age

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

    Age ,         1
 Mean Log q,   -4.9205,
 S.E(Log q),    1.0101,

 Regression statistics :

 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,    0.79,    0.822,      5.74,    0.43,     23,   0.80635,   -4.92,
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
 Estimated catch numbers (Thousands)

  YEAR                              AGE
       , 0       , 1       , 2       , 3       , 4       , 5       , 6       , 7       , 8
, 9       ,10       ,11       ,12       ,13       ,14       ,15       ,16       ,17
,18       ,19       ,20       ,21       ,22       ,23       ,24       ,25

 1971 ,          0.000,     15049.000,      7937.000,      6936.000,      1918.000,
887.000,       267.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       267.000,
 1972 ,          0.000,        38.000,      3811.000,      6422.000,      2427.000,
809.000,       565.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       565.000,
 1973 ,          0.000,         5.000,       623.000,      2167.000,      3954.000,
2280.000,      1152.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,      1152.000,
 1974 ,          0.000,       591.000,      4250.000,      6943.000,      4543.000,
1538.000,       448.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       448.000,
 1975 ,          0.000,       188.000,      3610.000,      2906.000,      3251.000,
661.000,       495.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       495.000,

 1976 ,          0.000,       166.000,      4431.000,      6983.000,      1835.000,
1039.000,       528.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       528.000,
 1977 ,          0.000,         1.000,      2218.000,      7078.000,      4942.000,
492.000,       615.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       615.000,
 1978 ,          0.000,        88.000,      6015.000,      2551.000,      2100.000,
913.000,       253.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       253.000,
 1979 ,          0.000,       213.000,      3161.000,      6116.000,       991.000,
1039.000,       288.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       288.000,
 1980 ,          0.000,       552.000,      1317.000,      5434.000,      3347.000,
358.000,       535.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       535.000,
 1981 ,          0.000,       328.000,      3918.000,      2378.000,      4026.000,
1388.000,       317.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       317.000,
 1982 ,          0.000,       340.000,      3196.000,      3229.000,      2143.000,
677.000,       584.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       584.000,
 1983 ,          0.000,       653.000,      5194.000,      4770.000,      1221.000,
204.000,       281.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       281.000,
 1984 ,          0.000,       127.000,      4328.000,      4763.000,      1749.000,
281.000,       130.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       130.000,
 1985 ,          0.000,       685.000,      3132.000,      6293.000,      2182.000,
387.000,        98.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        98.000,
```

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 1986 ,          0.000,       430.000,      1764.000,      2901.000,      1414.000,
360.000,       140.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       140.000,
 1987 ,          0.000,       168.000,      7635.000,      2440.000,       892.000,
381.000,       132.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       132.000,
 1988 ,          0.000,       179.000,      1203.000,      2434.000,       610.000,
155.000,        57.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        57.000,
 1989 ,          0.000,       247.000,      3122.000,      1653.000,      1159.000,
169.000,        80.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        80.000,
 1990 ,          0.000,       606.000,      1135.000,      1584.000,       485.000,
330.000,        52.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        52.000,
 1991 ,          0.000,       275.000,      4199.000,       731.000,       352.000,
95.000,        76.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        76.000,
 1992 ,          0.000,       263.000,      2147.000,      3115.000,       147.000,
50.000,        20.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        20.000,
 1993 ,          0.000,       137.000,      2752.000,      1139.000,      1200.000,
31.000,        19.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        19.000,
 1994 ,          0.000,        22.000,      1136.000,      3078.000,       715.000,
329.000,        14.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        14.000,
 1995 ,          0.000,        37.000,      1579.000,      2163.000,      1609.000,
349.000,       184.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       184.000,
1996 ,           0.000,         7.000,      1910.000,      2237.000,       759.000,
301.000,        94.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        94.000,
 1997 ,          0.000,        74.000,       584.000,      5857.000,      1068.000,
291.000,       127.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       127.000,
 1998 ,          0.000,       130.000,      2133.000,      1311.000,      1885.000,
283.000,        76.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        76.000,
 1999 ,          0.000,        43.000,      1895.000,      3658.000,       437.000,
408.000,        77.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        77.000,
 2000 ,          0.000,        17.000,      1432.000,      2171.000,      1005.000,
124.000,       103.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,       103.000,
 2001 ,          0.000,        78.425,      1268.810,      2645.456,       959.310,
260.484,        45.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        63.020,
 2002 ,          0.000,        20.528,       756.606,       994.144,       555.724,
121.702,        40.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        58.652,
 2003 ,          0.000,         0.000,       886.381,       585.012,       187.704,
66.739,        16.000,         0.000,         0.000,         0.000,         0.000,
```

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        16.685,
 2004 ,           0.000,         4.440,       211.644,       893.936,       301.925,
93.242,        39.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        57.721,
 2005 ,           0.000,         3.341,      1403.051,       384.169,       541.177,
70.153,        12.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        40.087,
 2006 ,           0.000,        33.109,       434.555,      1700.971,       120.020,
124.158,         9.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,         0.000,         0.000,         0.000,         0.000,
0.000,         0.000,        37.248,
```

Year ,	Est.Landings,	Landings ,	Bias
1971 ,	31455. ,	15732. ,	
1972 ,	18636. ,	17442. ,	
1973 ,	20189. ,	18837. ,	
1974 ,	24857. ,	21880. ,	
1975 ,	15419. ,	15485. ,	
1976 ,	19540. ,	16275. ,	
1977 ,	21770. ,	20119. ,	
1978 ,	15844. ,	13390. ,	
1979 ,	14856. ,	14830. ,	
1980 ,	14297. ,	13509. ,	
1981 ,	15935. ,	15337. ,	
1982 ,	12996. ,	12465. ,	
1983 ,	13818. ,	12828. ,	
1984 ,	12986. ,	11886. ,	
1985 ,	14235. ,	12706. ,	
1986 ,	9630. ,	9096. ,	
1987 ,	11769. ,	11491. ,	
1988 ,	5531. ,	5527. ,	
1989 ,	8893. ,	8590. ,	
1990 ,	6532. ,	5936. ,	
1991 ,	6724. ,	6834. ,	
1992 ,	6428. ,	6271. ,	
1993 ,	7351. ,	7013. ,	
1994 ,	8020. ,	7802. ,	
1995 ,	8428. ,	8165. ,	
1996 ,	6240. ,	6126. ,	
1997 ,	9460. ,	9461. ,	
1998 ,	7006. ,	6835. ,	
1999 ,	6714. ,	6608. ,	
2000 ,	4902. ,	4897. ,	
2001 ,	5796. ,	3960. ,	1.400
2002 ,	3585. ,	2470. ,	1.466
2003 ,	2241. ,	2045. ,	1.043
2004 ,	2085. ,	1402. ,	1.480
2005 ,	3580. ,	1070. ,	3.341
2006 ,	4030. ,	876. ,	4.139

Parameters

Age,	Survivors,	s.e log est
1 ,	6037.65025 ,	0.32823
2 ,	1558.70720 ,	0.27715
3 ,	1995.83900 ,	0.32263
4 ,	82.90412 ,	0.44153

Table 2.2.24. continued Cod in Kattegat. Diagnostics from B-Adapt run

```
 Year,   Multiplier,    s.e log est

   31 ,        1.40045 ,   0.22036
   32 ,        1.46629 ,   0.23801
   33 ,        1.04280 ,   0.28498
   34 ,        1.48003 ,   0.24739
   35 ,        3.34060 ,   0.23915
   36 ,        4.13862 ,   0.32088

 Variance covariance matrix

    0.10773,   0.01014,   0.00123,  -0.00232,   0.00585,   0.00514,   0.00520,   0.00332,
0.00127,   0.01511,
    0.01014,   0.07681,   0.01217,   0.00408,   0.00572,   0.00532,   0.00512,   0.00203,
0.00718,  -0.00582,
    0.00123,   0.01217,   0.10409,   0.01462,   0.00511,   0.00513,   0.00627,   0.00463,
-0.00475,  -0.03027,
   -0.00232,   0.00408,   0.01462,   0.19495,   0.00328,   0.00406,   0.00309,  -0.00320,
-0.02355,  -0.04201,
    0.00585,   0.00572,   0.00511,   0.00328,   0.04856,   0.00485,   0.00284,   0.00378,
0.00505,   0.00565,
    0.00514,   0.00532,   0.00513,   0.00406,   0.00485,   0.05665,   0.00343,  -0.00148,
0.00348,   0.00501,
    0.00520,   0.00512,   0.00627,   0.00309,   0.00284,   0.00343,   0.08121,   0.00048,
-0.00379,   0.00067,
    0.00332,   0.00203,   0.00463,  -0.00320,   0.00378,  -0.00148,   0.00048,   0.06120,
0.00425,  -0.00194,
    0.00127,   0.00718,  -0.00475,  -0.02355,   0.00505,   0.00348,  -0.00379,   0.00425,
0.05719,   0.01195,
    0.01511,  -0.00582,  -0.03027,  -0.04201,   0.00565,   0.00501,   0.00067,  -0.00194,
0.01195,   0.10297,
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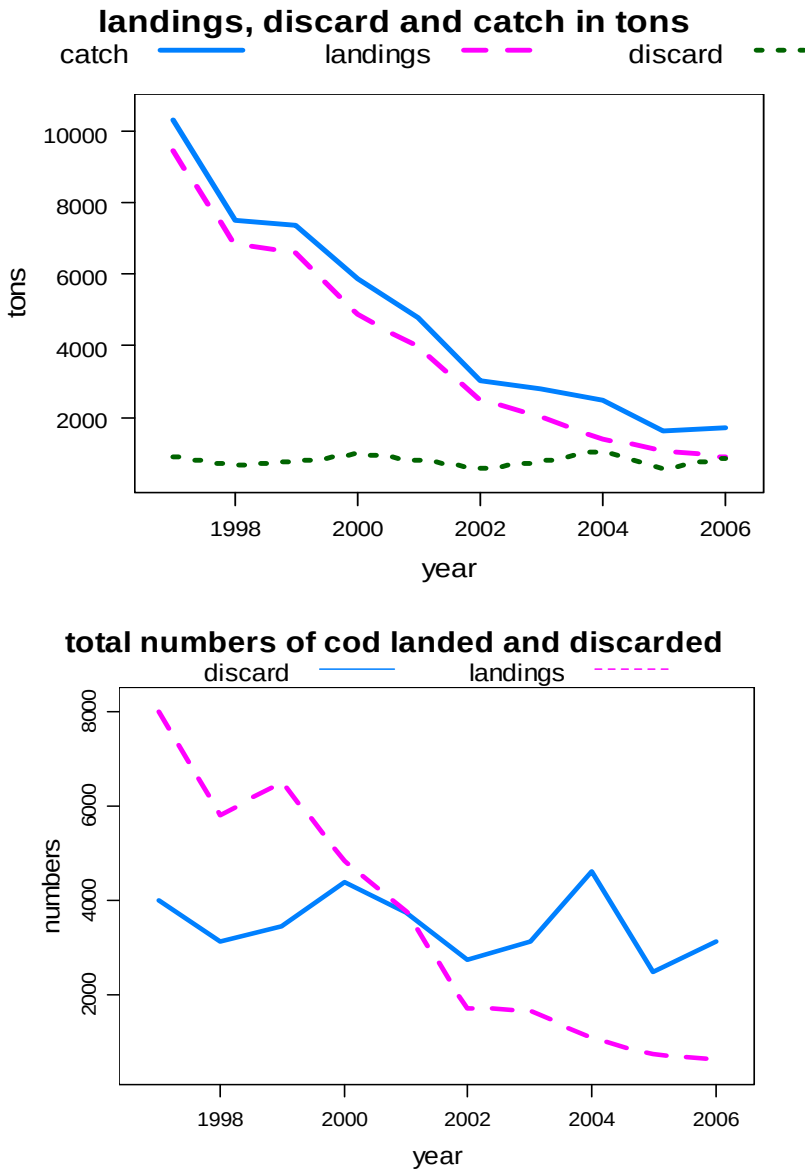


Figure 2.2.1. Cod in Kattegat. Discards and landings in tons and in total numbers (thousands) of cod.

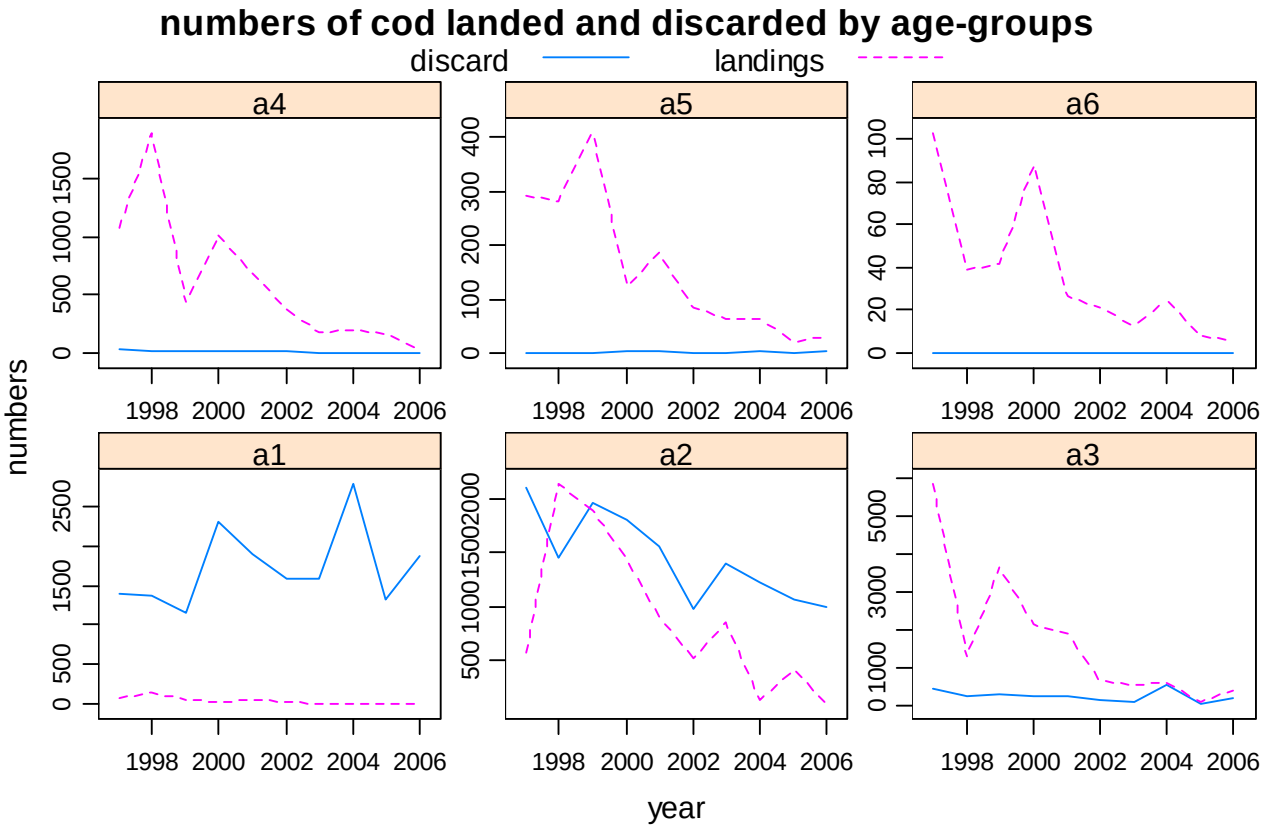


Figure 2.2.2. Cod in Kattegat. Numbers (in thousands) of cod in landings and in discards by age-groups.

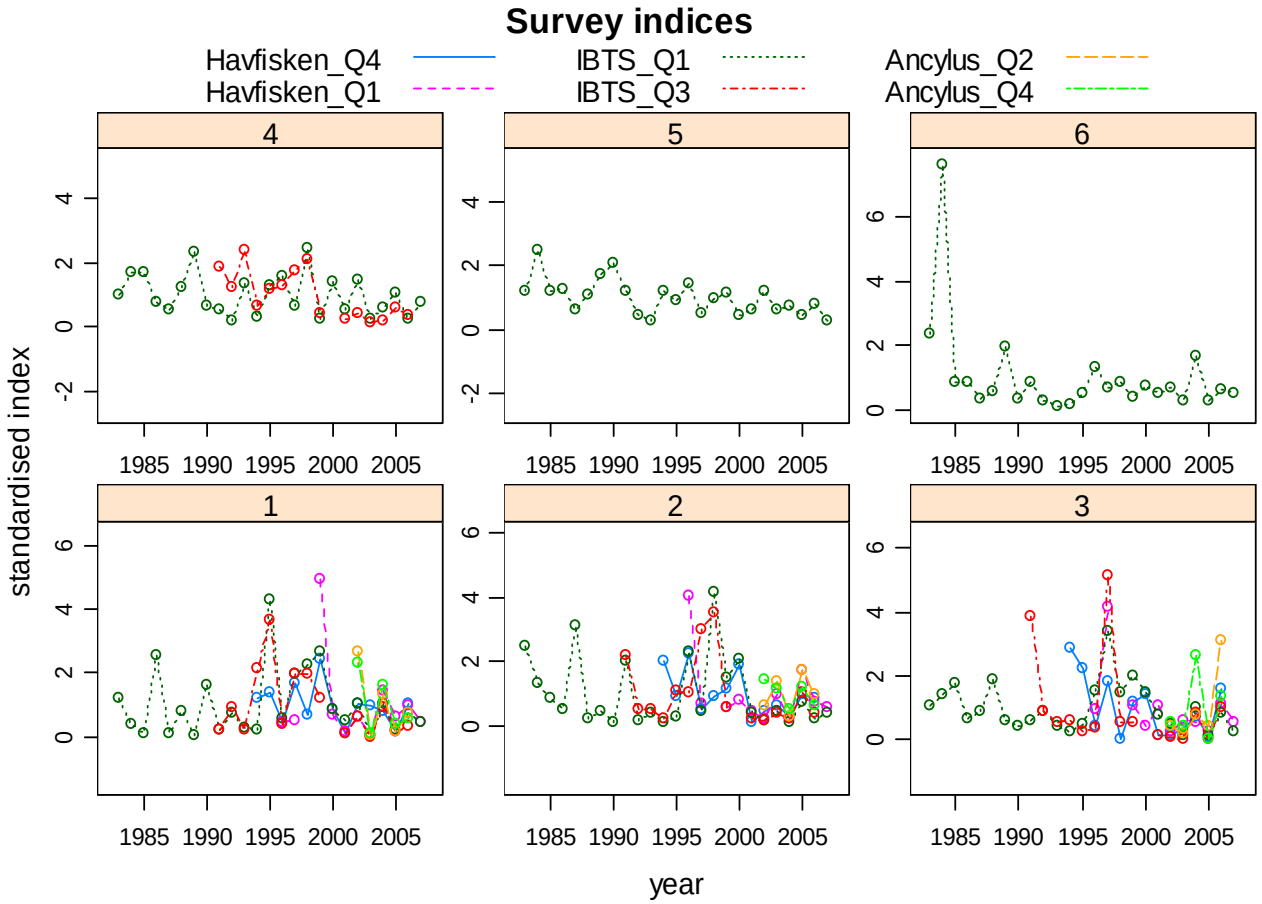


Figure 2.2.3. Cod in Kattegat. Indices from IBTS 1st and 3rd quarter, Havfisken 1st and 4th quarter and Ancylus 2nd and 4th quarter surveys by age-groups.

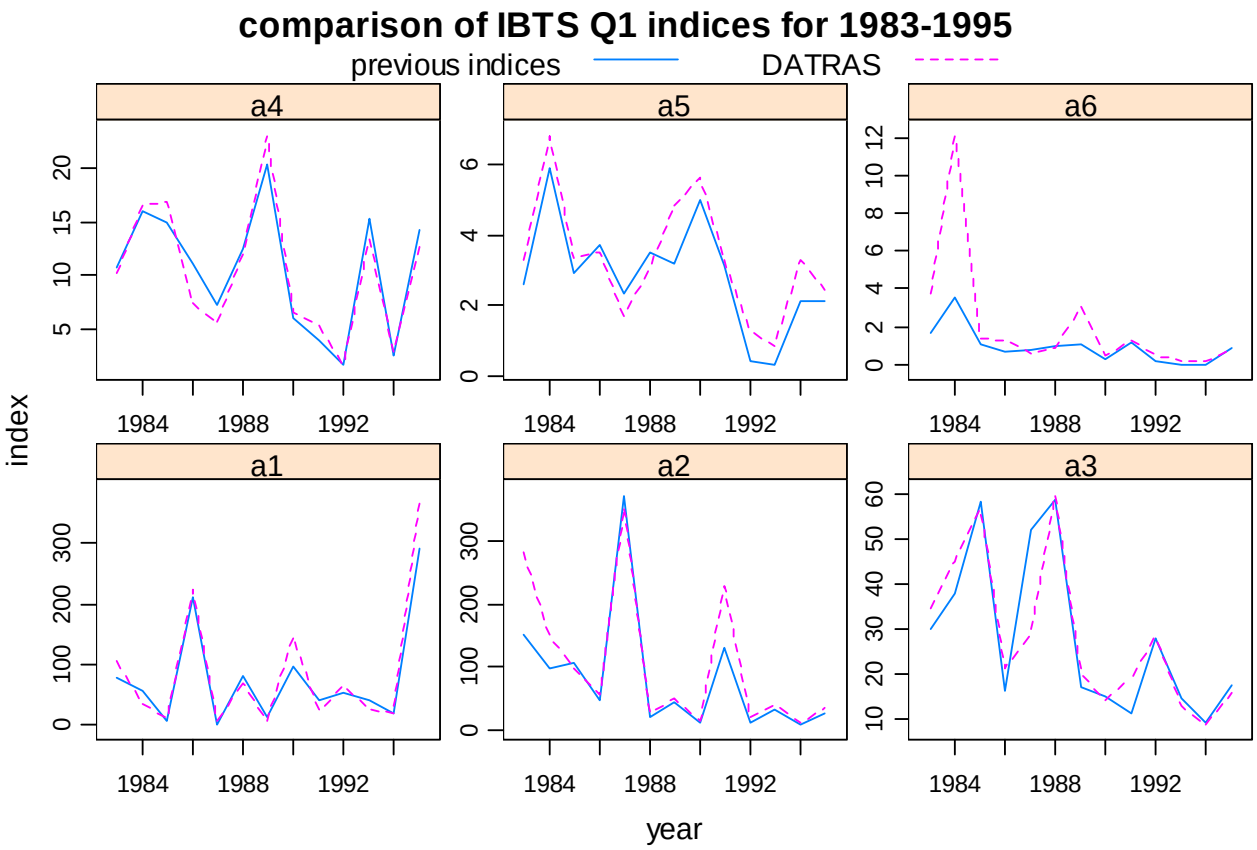


Figure 2.2.4. Cod in Kattegat. Comparison of IBTS 1st quarter indices for 1983-1995 from DATRAS with the indices used in assessment in previous years.

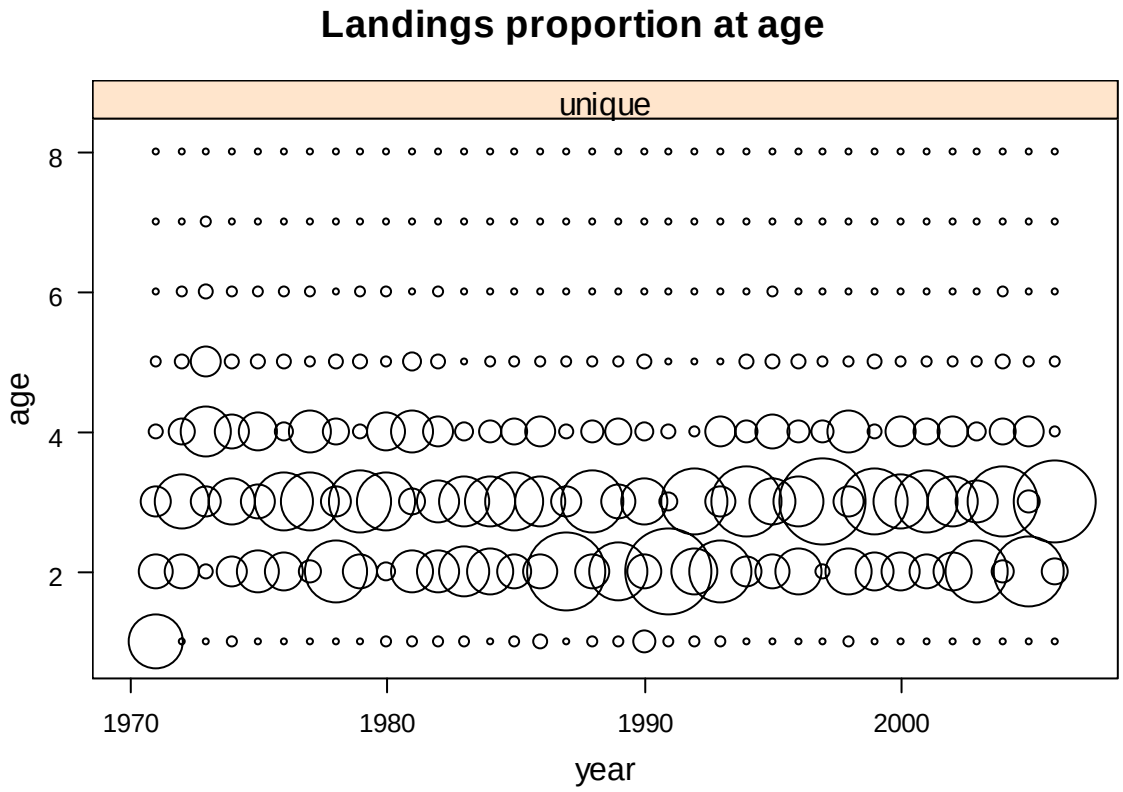


Figure 2.2.5. Cod in Kattegat. Relative proportion of age-groups in landings by years.

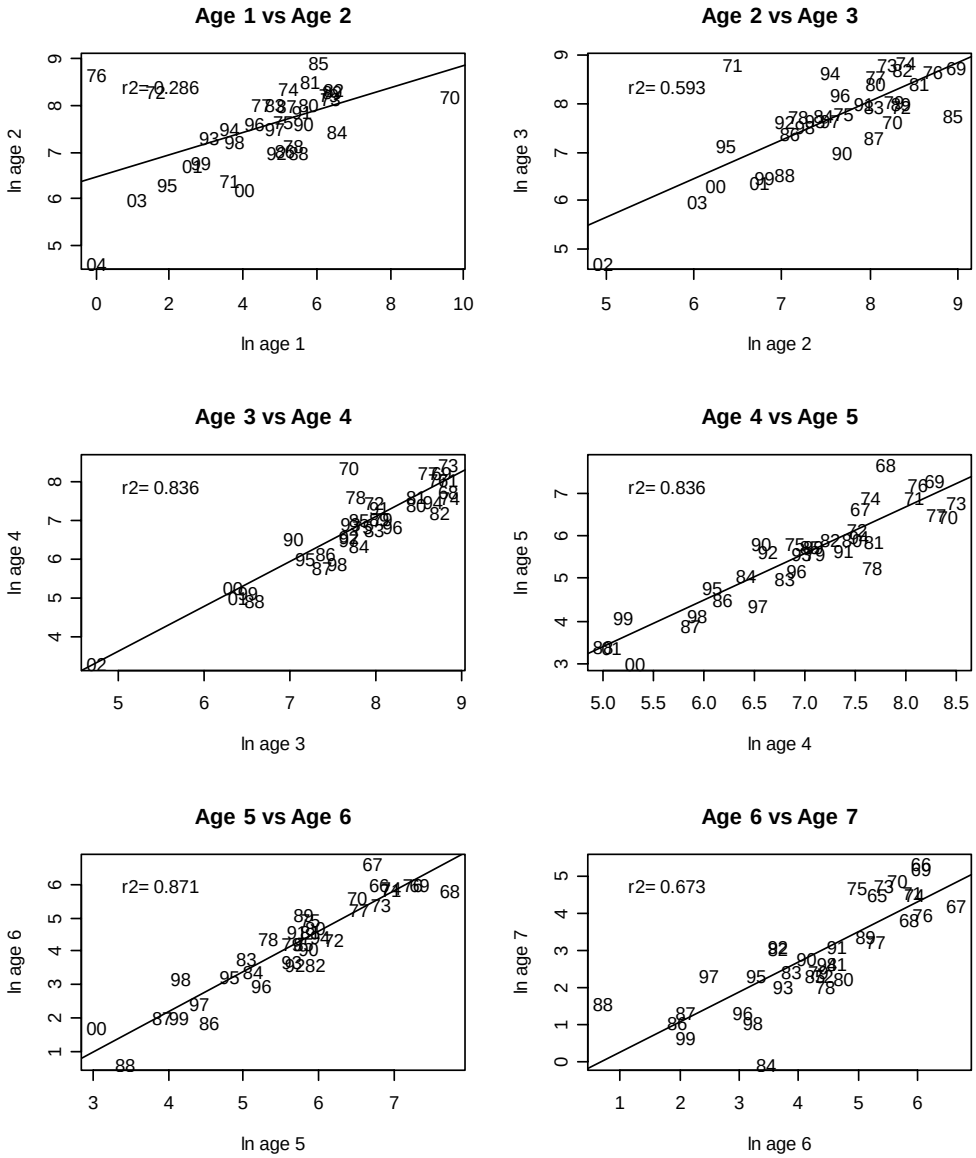


Figure 2.2.6. Cod in Kattegat. Numbers at age in landings vs numbers at age+1 of the same cohort in the following year (on logarithmic scale). Individual points are given by year-class.

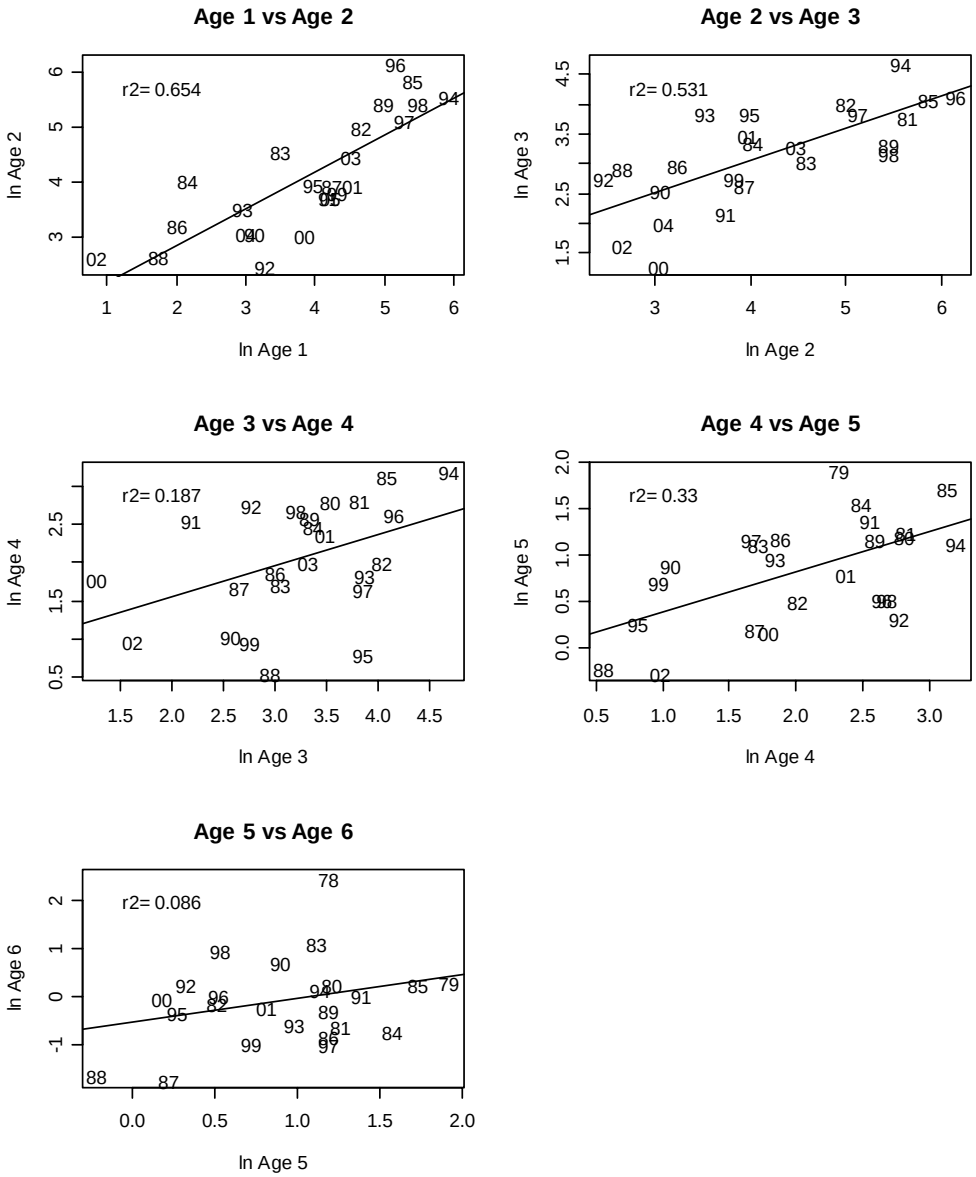


Figure 2.2.7a Cod in Kattegat. IBTS 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 1983-2007 (on logarithmic scale). Individual points are given by year-class.

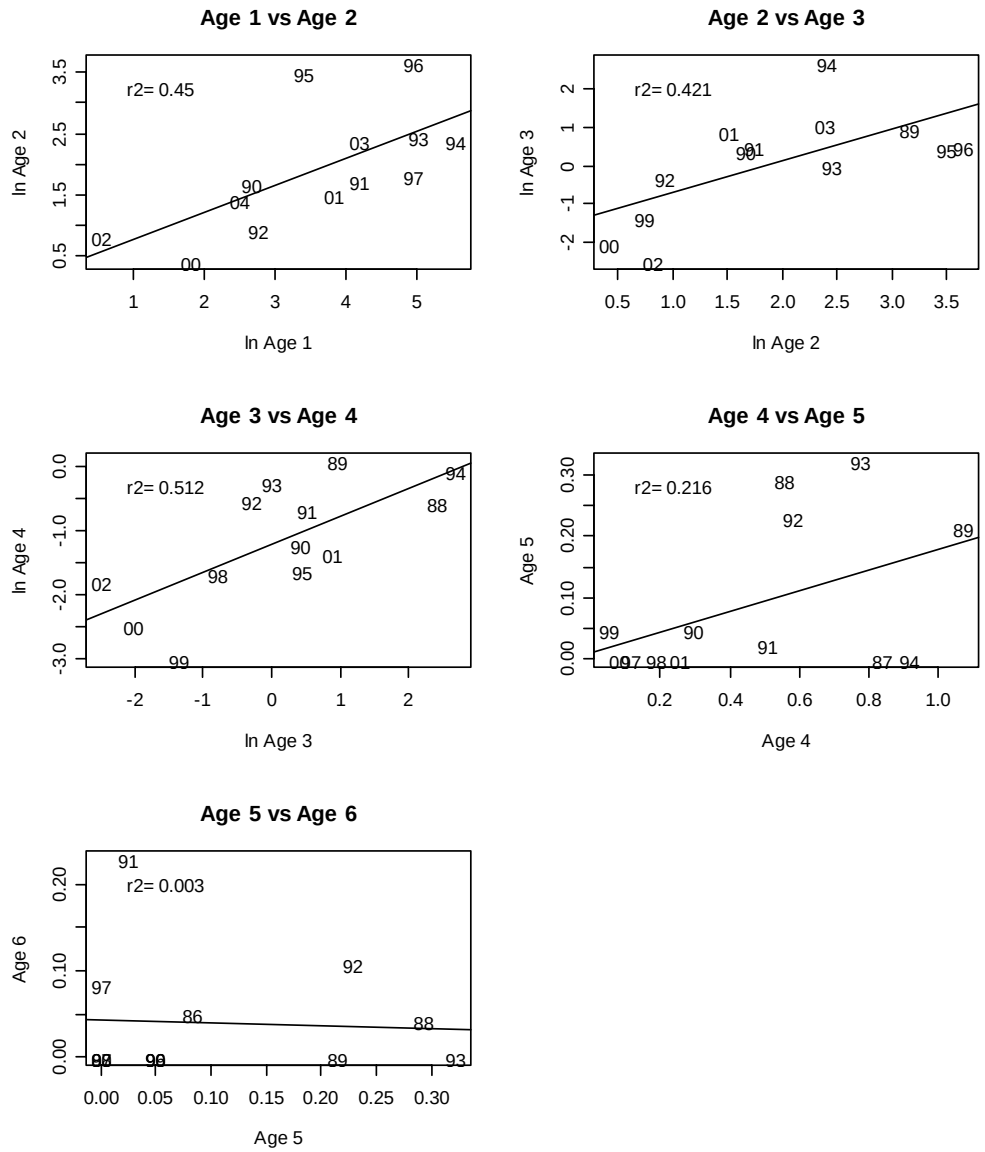


Figure 2.2.7b Cod in Kattegat. IBTS 3rd quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 1991-2006 (two plots on the figure referring to the oldest age-groups with large number of 0 values are shown on arimetric scale, the plots referring to younger age-groups are on logarithmic scale). Individual points are given by year-class.

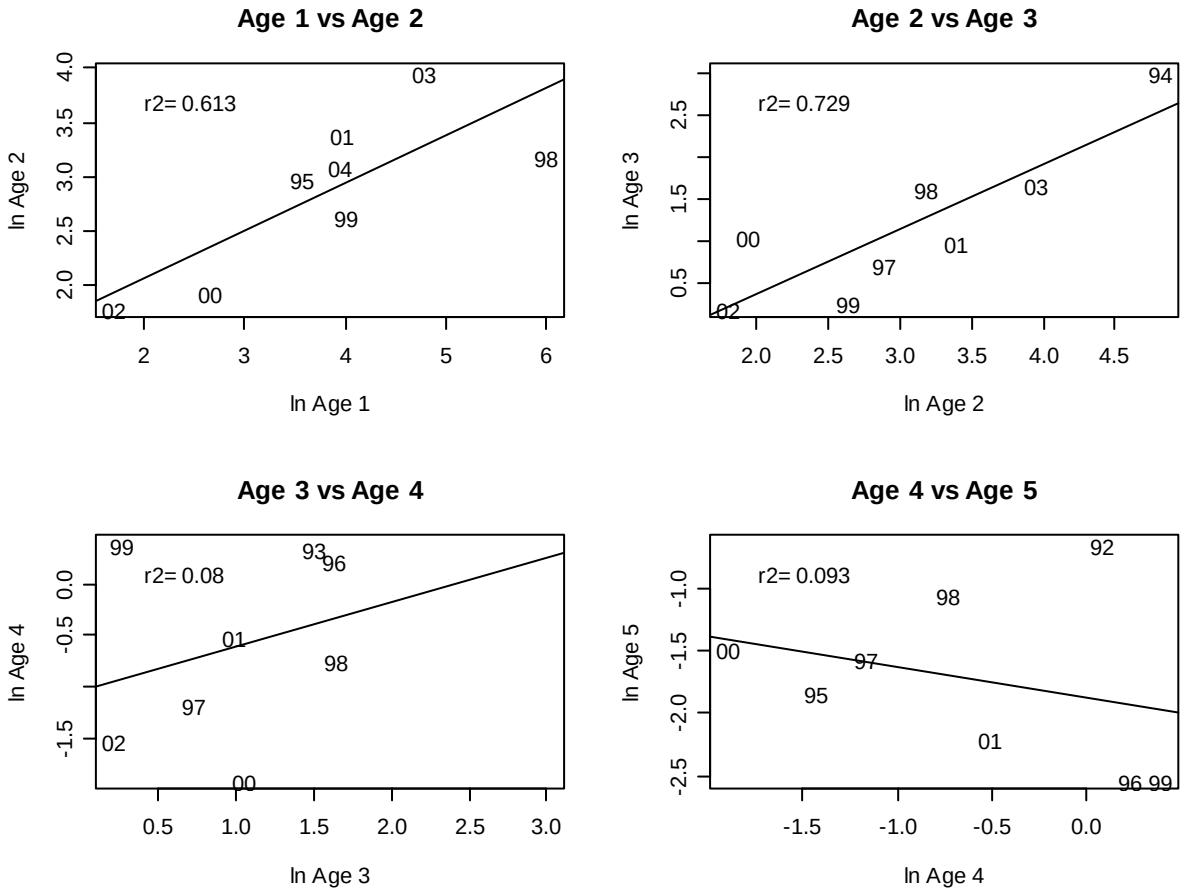


Figure 2.2.7c Cod in Kattegat. Havfisken 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 1996-2006 (logarithmic scale). Individual points are given by year-class.

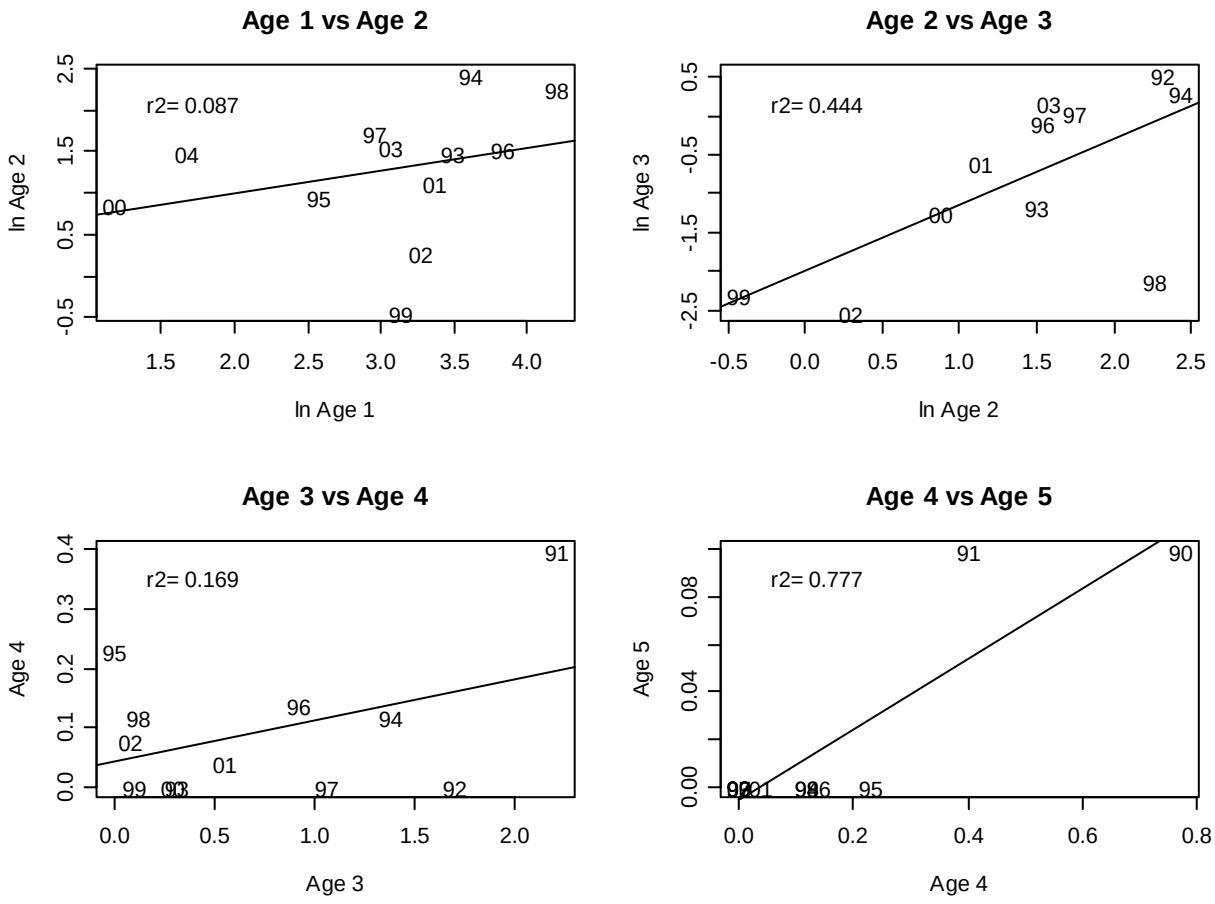


Figure 2.2.7d Cod in Kattegat. Havfisken 4th quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 1994-2006 (two plots on the figure referring to the oldest age-groups with large number of 0 values are shown on arimetric scale, the plots referring to younger age-groups are on logarithmic scale). Individual points are given by year-class.

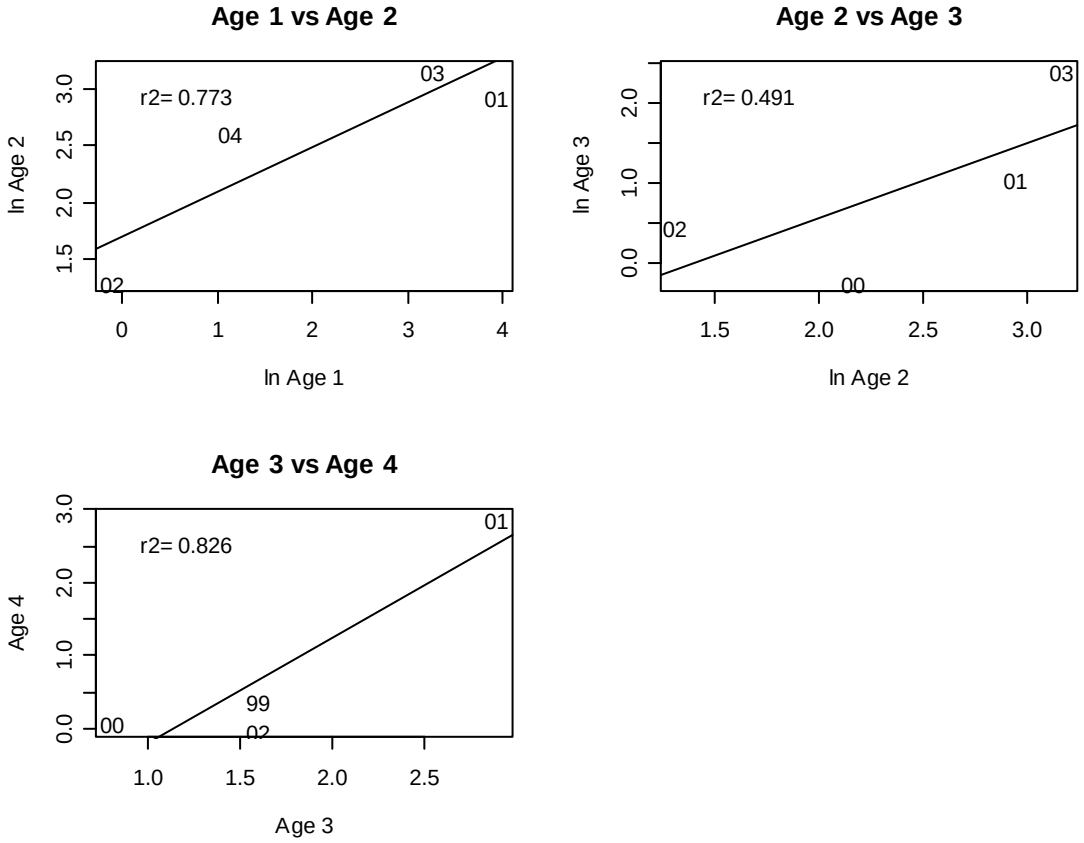


Figure 2.2.7e Cod in Kattegat. Ancylus 2nd quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2002-2006 (last plot on the figure referring to the oldest age-groups with 0 values are shown on arimetric scale, the plots referring to younger age-groups are on logarithmic scale). Individual points are given by year-class.

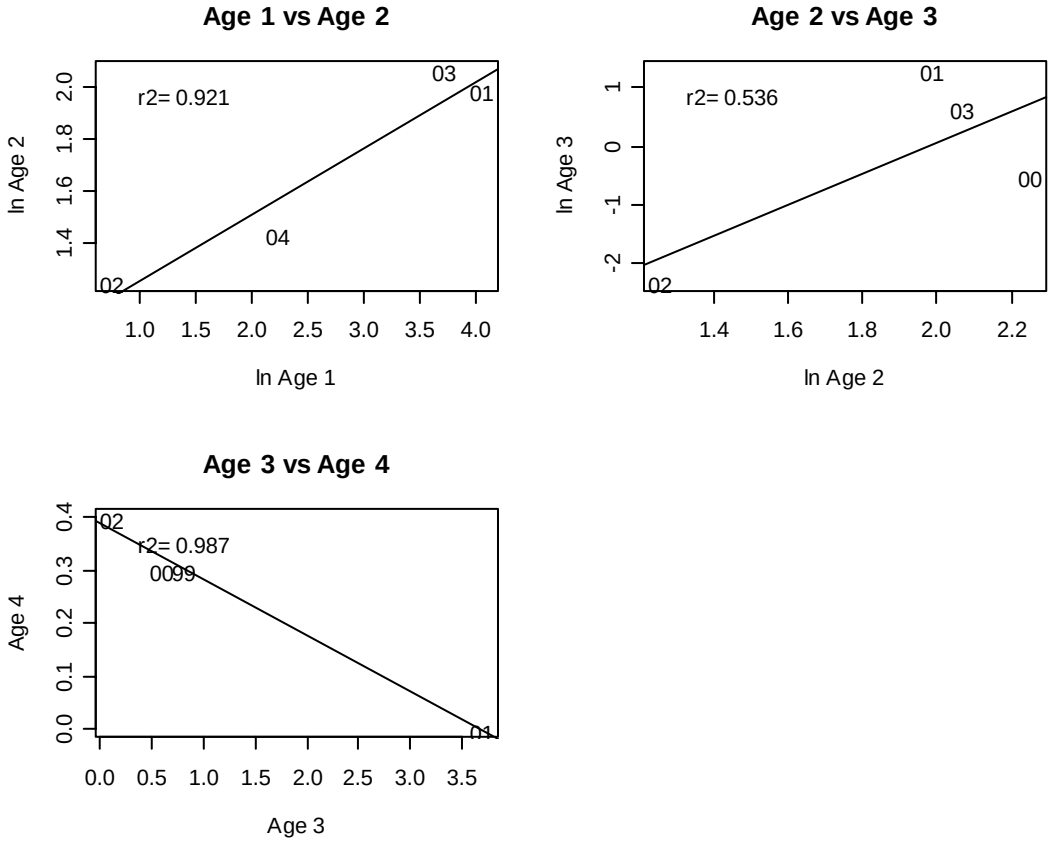


Figure 2.2.7f Cod in Kattegat. Ancylus 4th quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2002-2006 (last plot on the figure referring to the oldest age-groups with 0 values are shown on arimetric scale, the plots referring to younger age-groups are on logarithmic scale). Individual points are given by year-class.

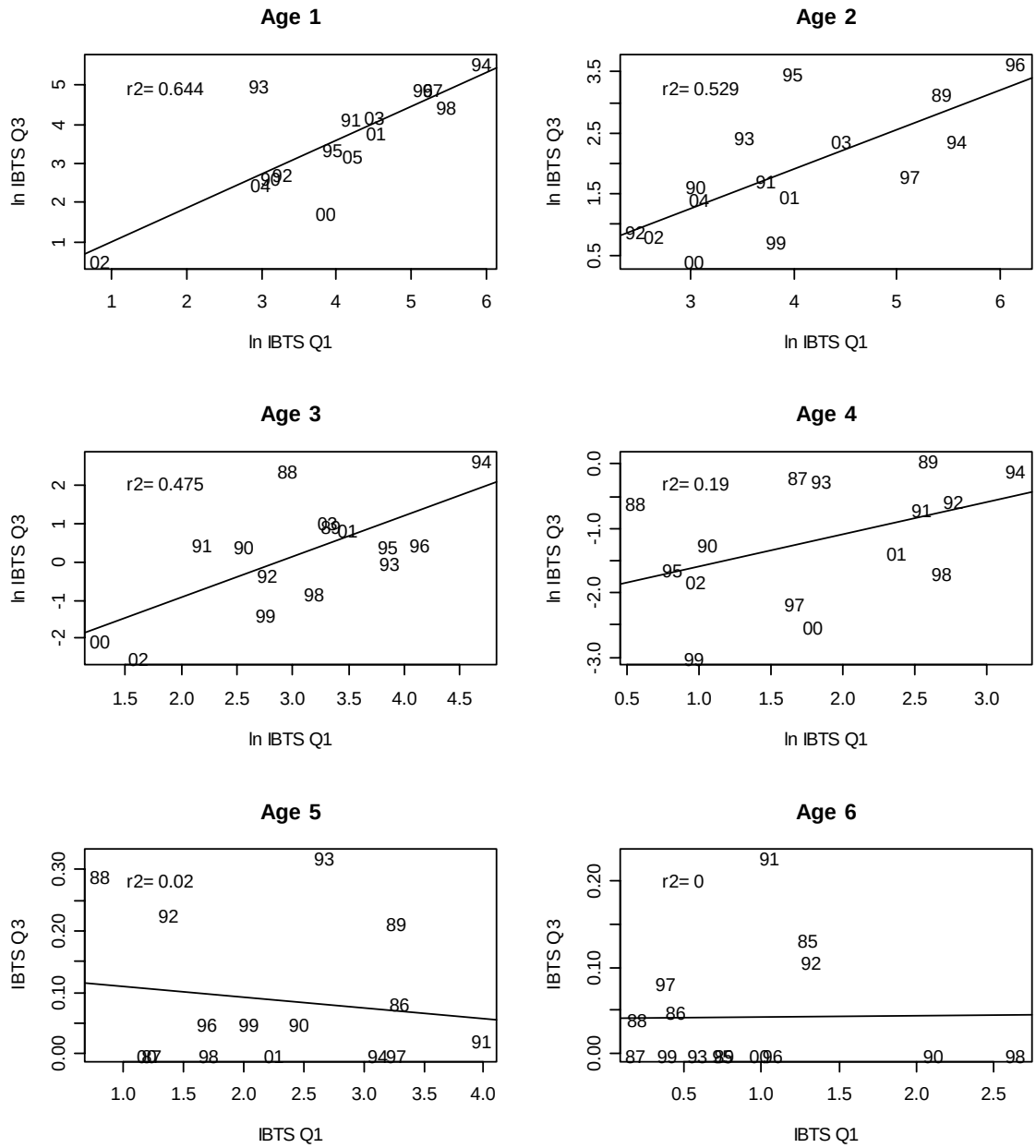


Figure 2.2.8a Cod in Kattegat. Numbers at age in IBTS 1st quarter survey vs numbers at age in IBTS 3rd quarter survey in the period 1991-2006 (age-groups 5 and 6 that have large number of 0 values are shown on arimetric scale, the age-groups 1-4 are on logarithmic scale). Individual points are given by year-class.

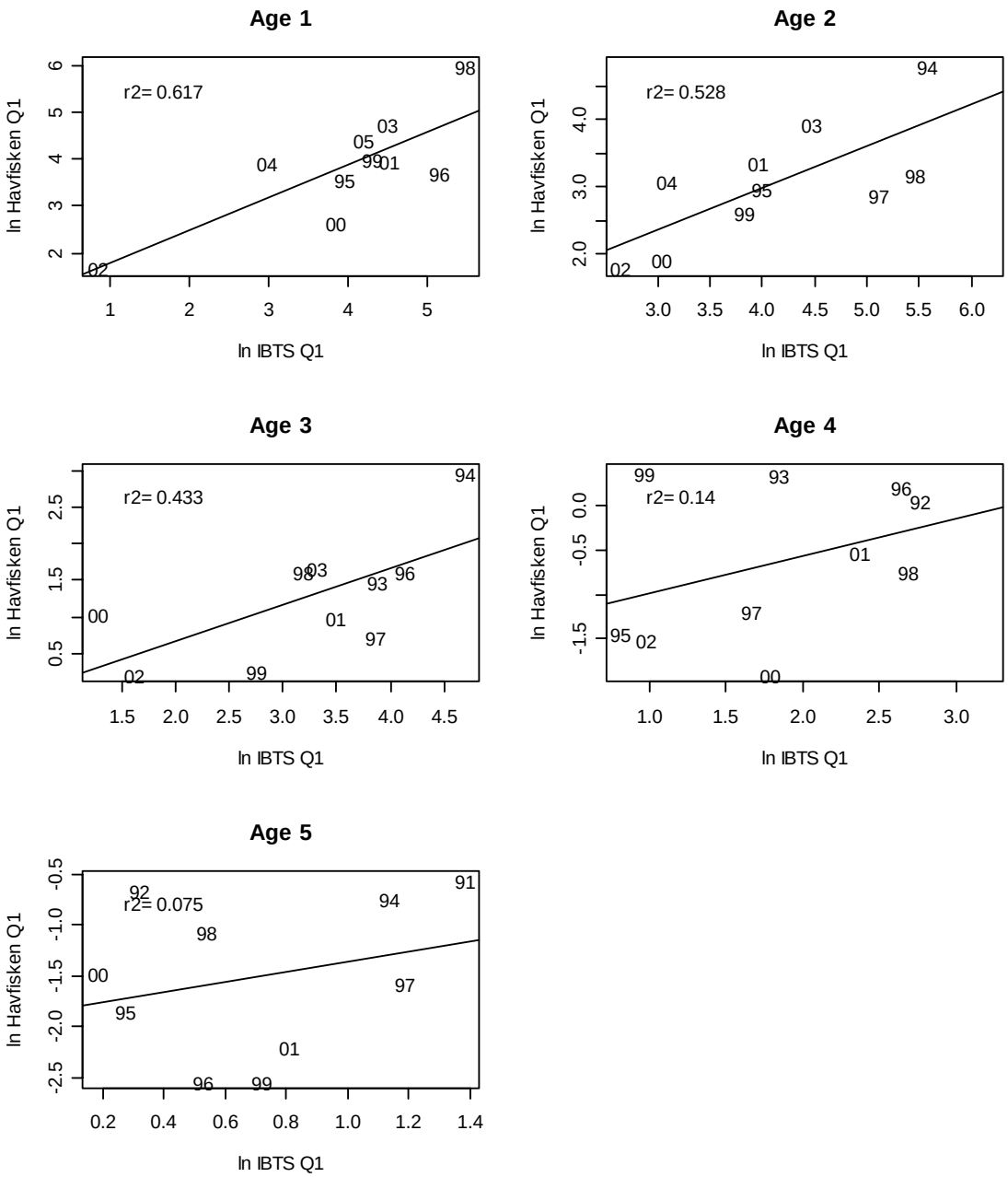


Figure 2.2.8b Cod in Kattegat. Numbers at age in IBTS 1st quarter survey vs numbers at age in Havfisken 1st quarter survey in the period 1996-2006 (logarithmic scale). Individual points are given by year-class.

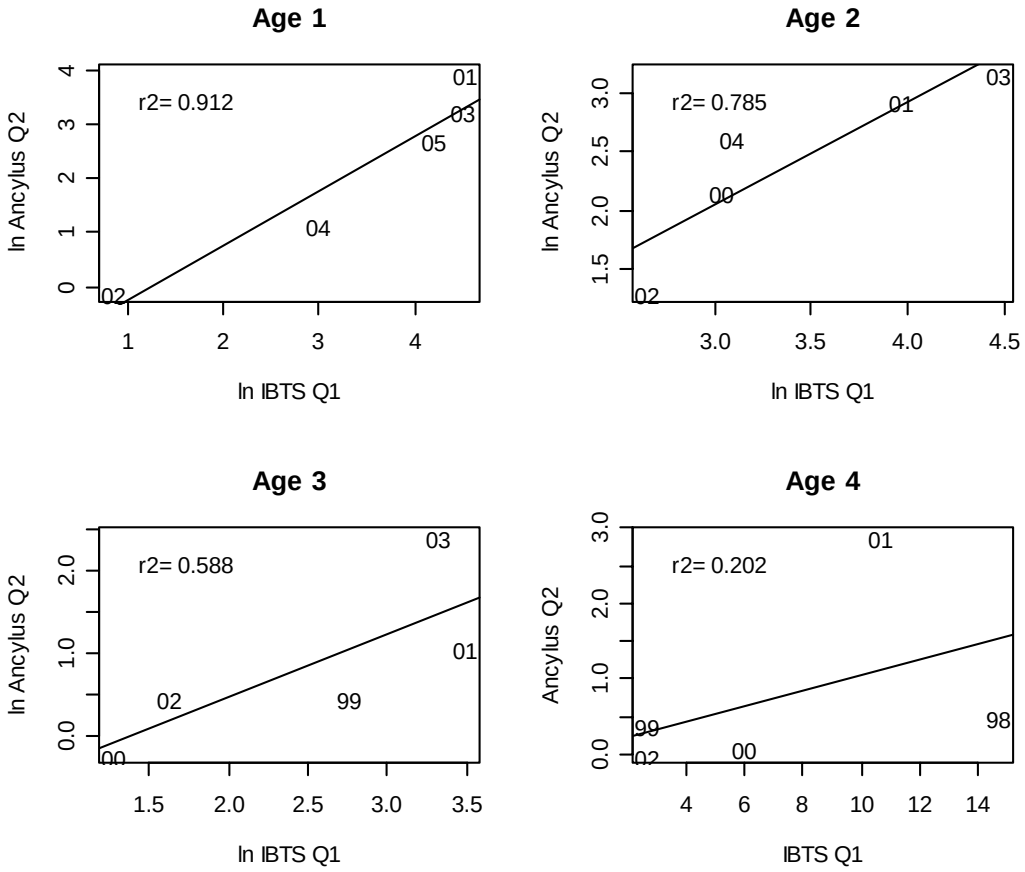


Figure 2.2.8c Cod in Kattegat. Numbers at age in IBTS 1st quarter survey vs numbers at age in Ancylus 2nd quarter survey in the period 2002-2006 (age-groups 4 that have number of 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

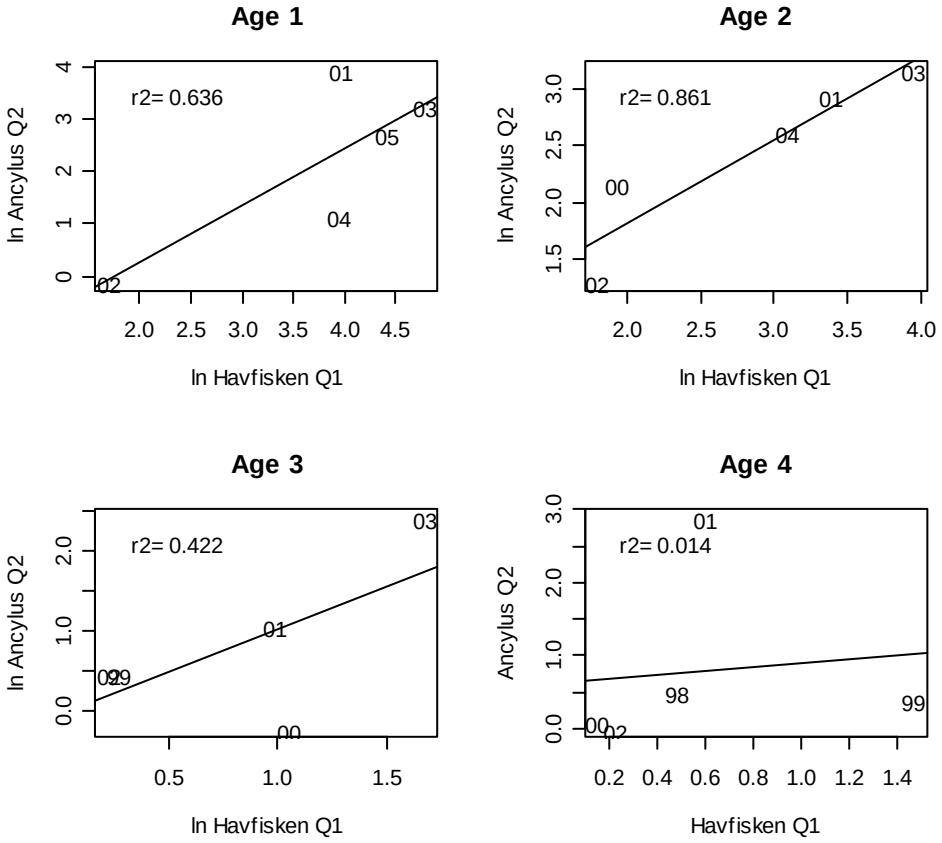


Figure 2.2.8d Cod in Kattegat. Numbers at age in Havfisken 1st quarter survey vs numbers at age in Ancylus 2nd quarter survey in the period 2002-2006 (age-groups 4 that has 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

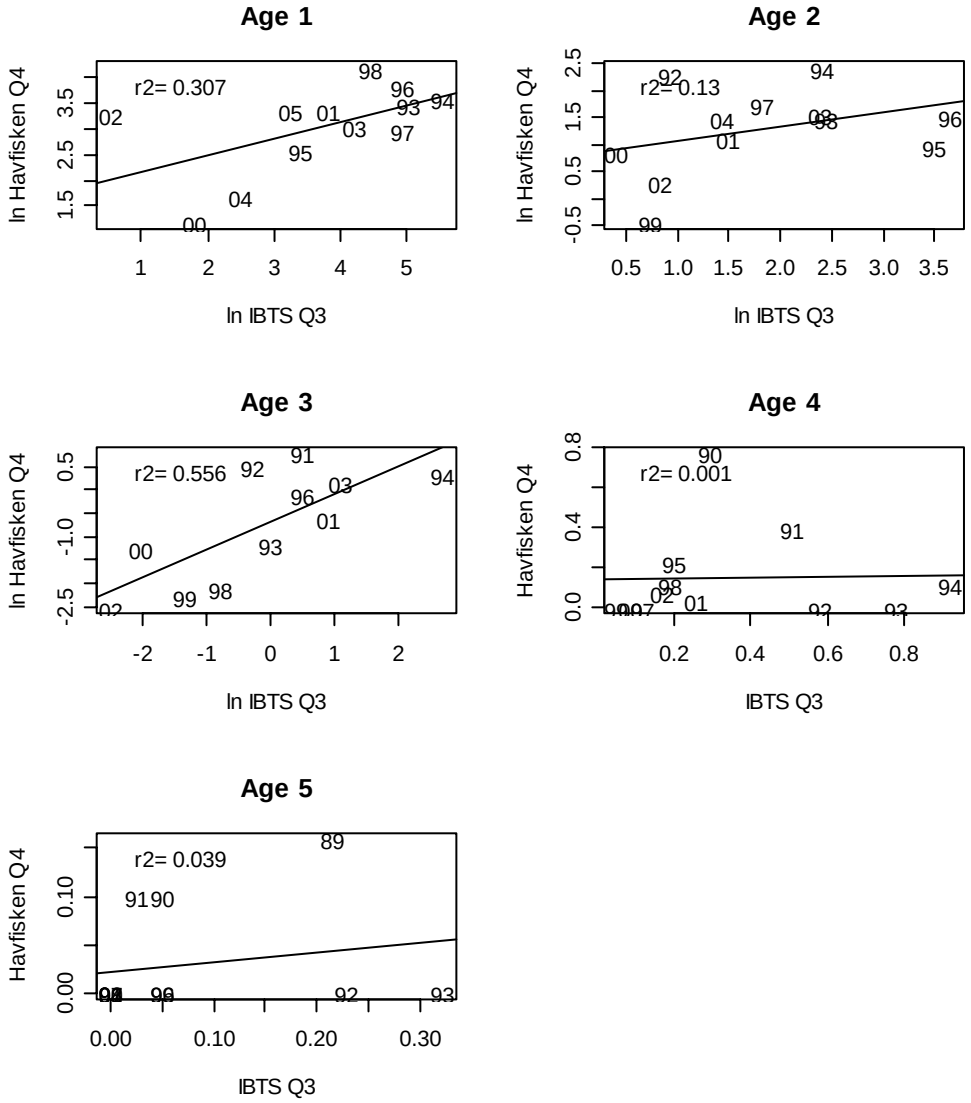


Figure 2.2.8e Cod in Kattegat. Numbers at age in IBTS 3rd quarter survey vs numbers at age in Havfisken 4th quarter survey in the period 1994-2006 (age-groups 4 and 5 that have large number of 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

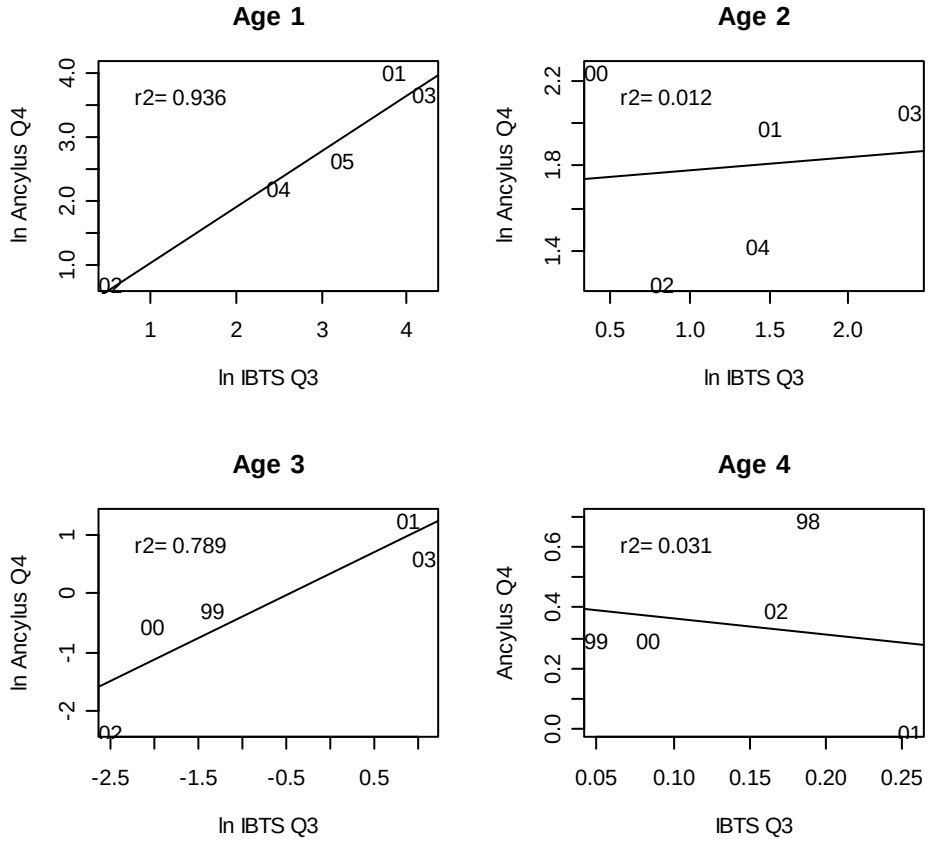


Figure 2.2.8f Cod in Kattegat. Numbers at age in IBTS 3rd quarter survey vs numbers at age in Ancylus 4th quarter survey in the period 2002-2006 (age-group 4 that have 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

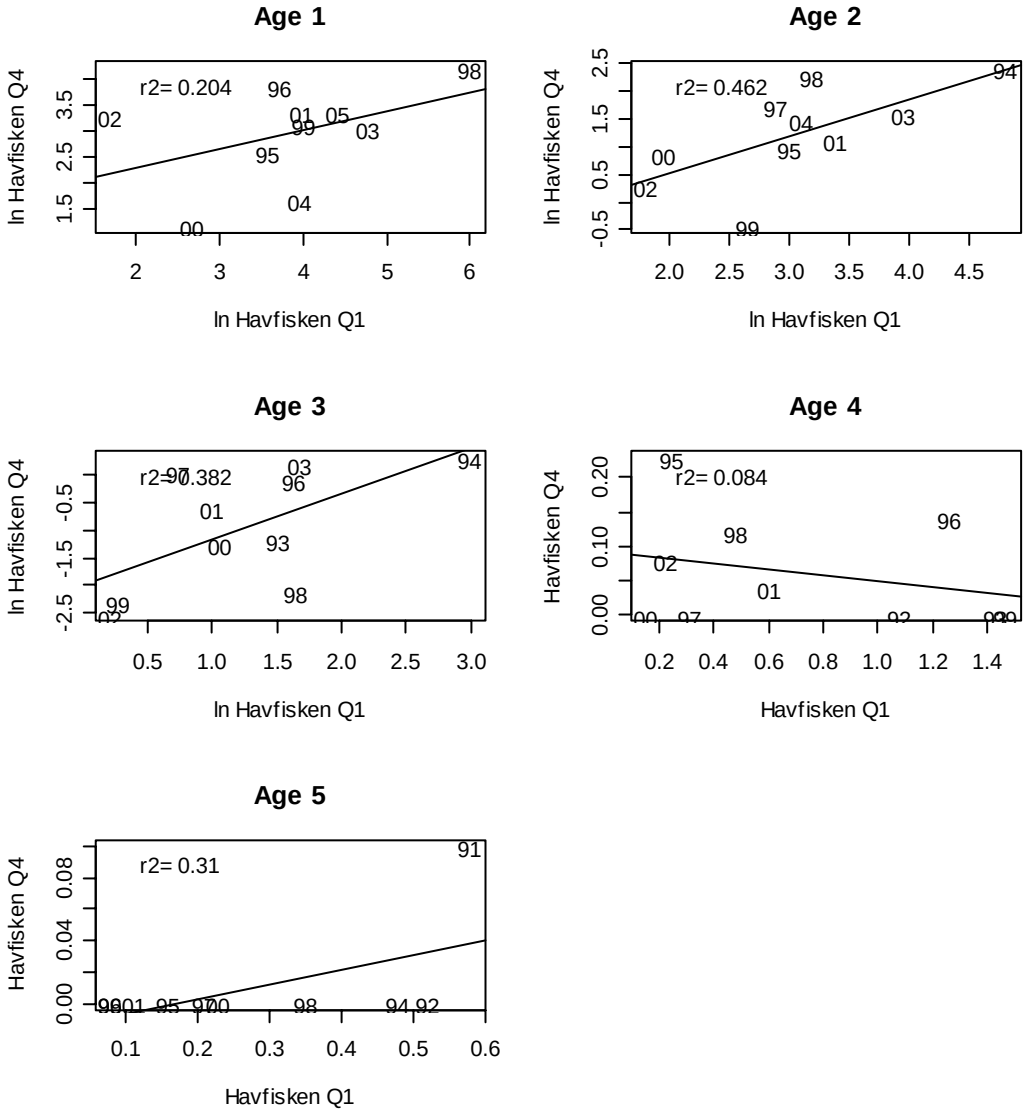


Figure 2.2.8g Cod in Kattegat. Numbers at age in Havfisken 1st quarter survey vs numbers at age in Havfisken 4th quarter survey in the period 1996-2006 (age-groups 4 and 5 that have large number of 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

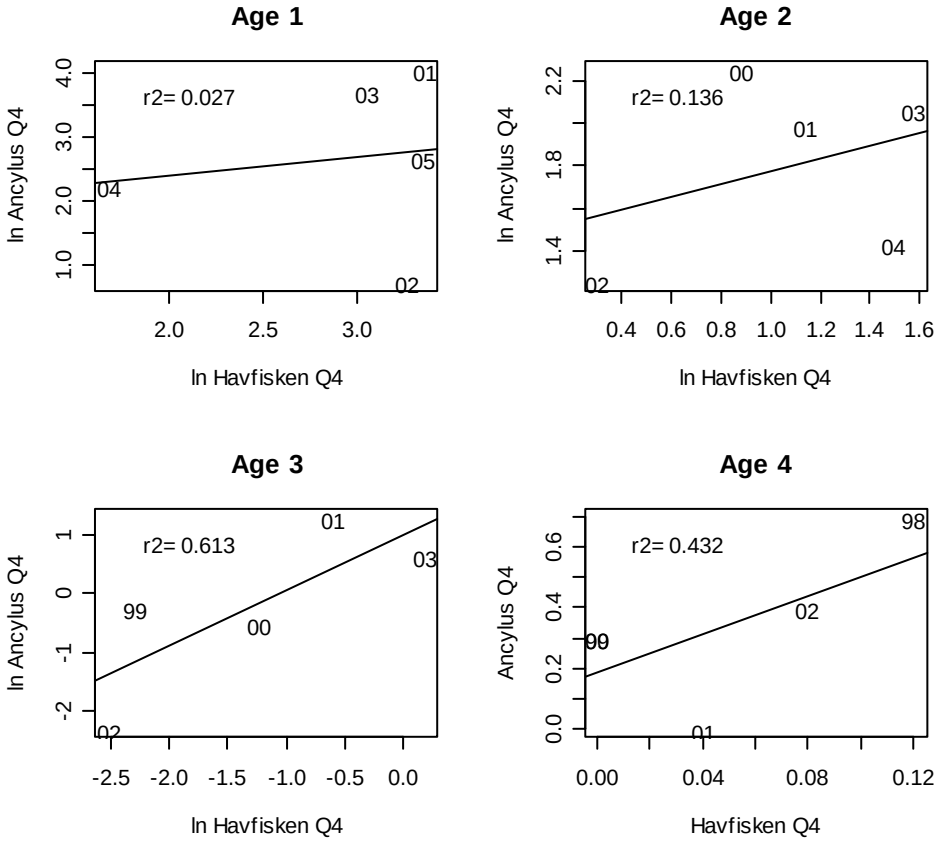


Figure 2.2.8h Cod in Kattegat. Numbers at age in Havfisken 4th quarter survey vs numbers at age in Ancylus 4th quarter survey in the period 2002-2006 (age-group 4 that has 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

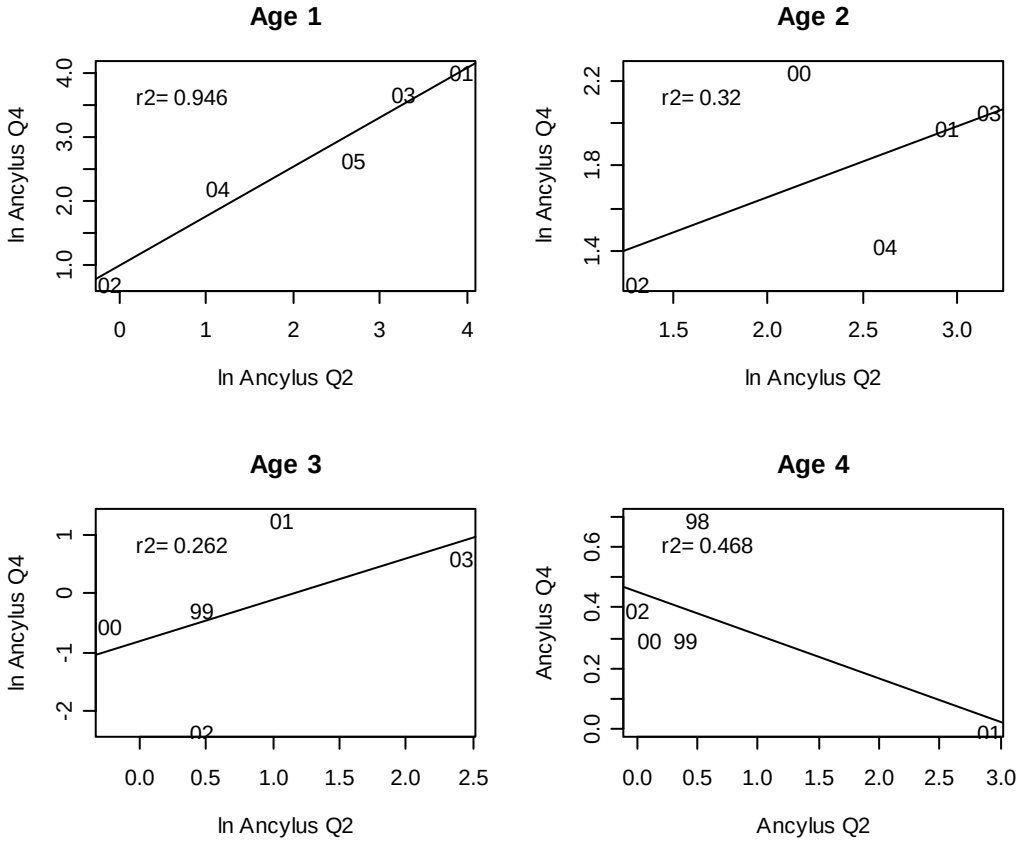


Figure 2.2.8i Cod in Kattegat. Numbers at age in Ancylus 2nd quarter survey vs numbers at age in Ancylus 4th quarter survey in the period 2002-2006 (age-group 4 that has 0 values are shown on arimetric scale, the age-groups 1-3 are on logarithmic scale). Individual points are given by year-class.

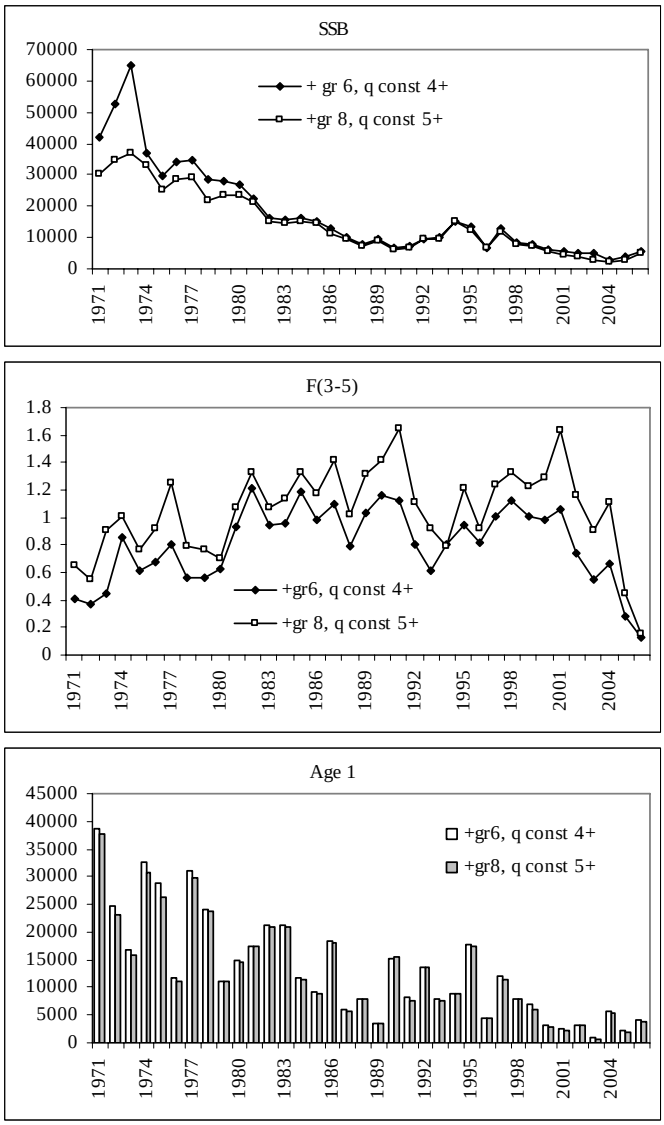


Figure 2.2.9 Cod in Kattegat. SSB, Fbar and recruitment estimates from XSA with changed plus-group (set to 6+) and first age at constant catchability (set to 4) compared to the run with plus-group 8 and catchability constant from age 5 as used in previous assessments

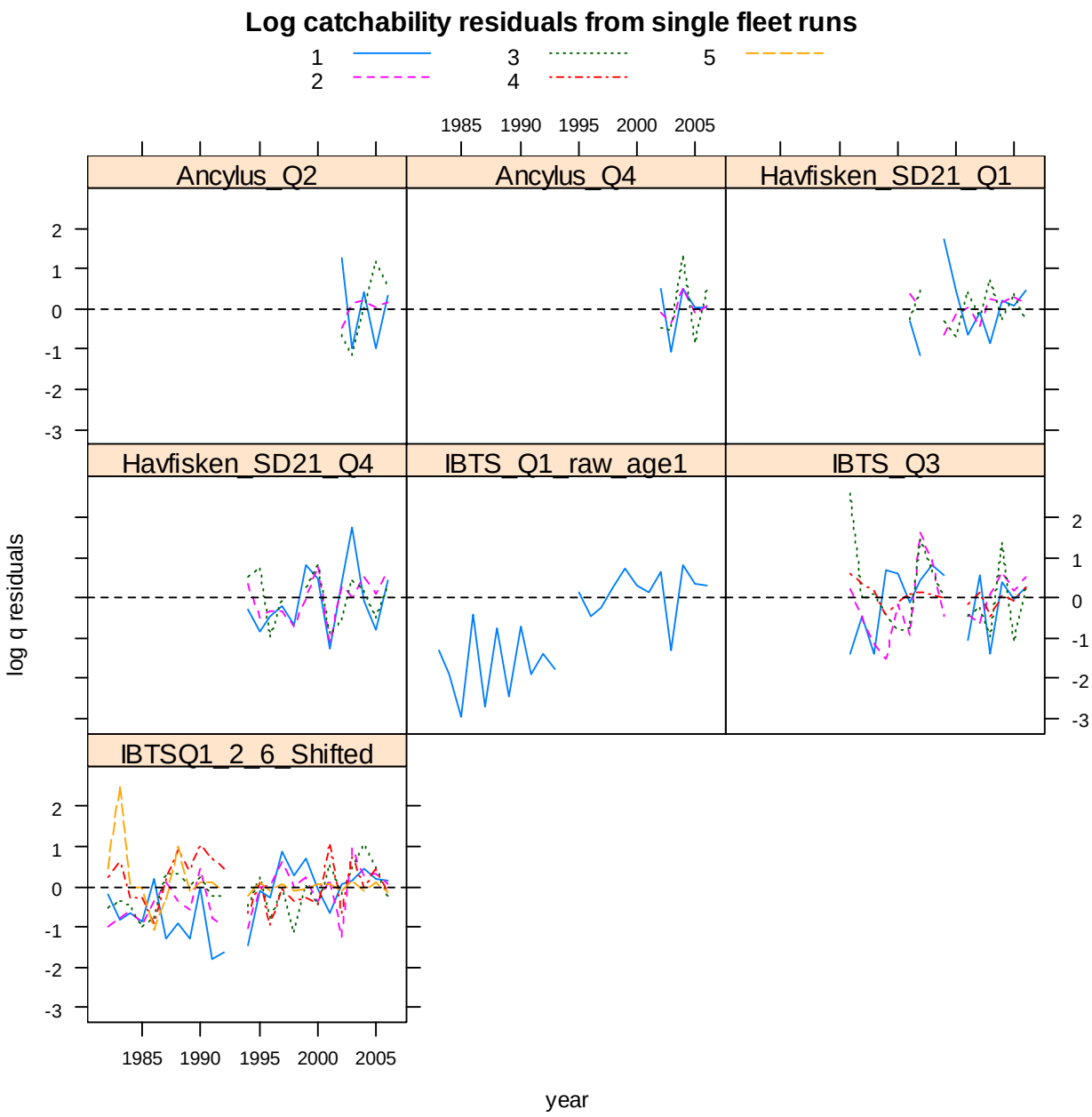


Figure 2.2.10. Cod in Kattegat. Catchability residuals from XSA single fleet runs

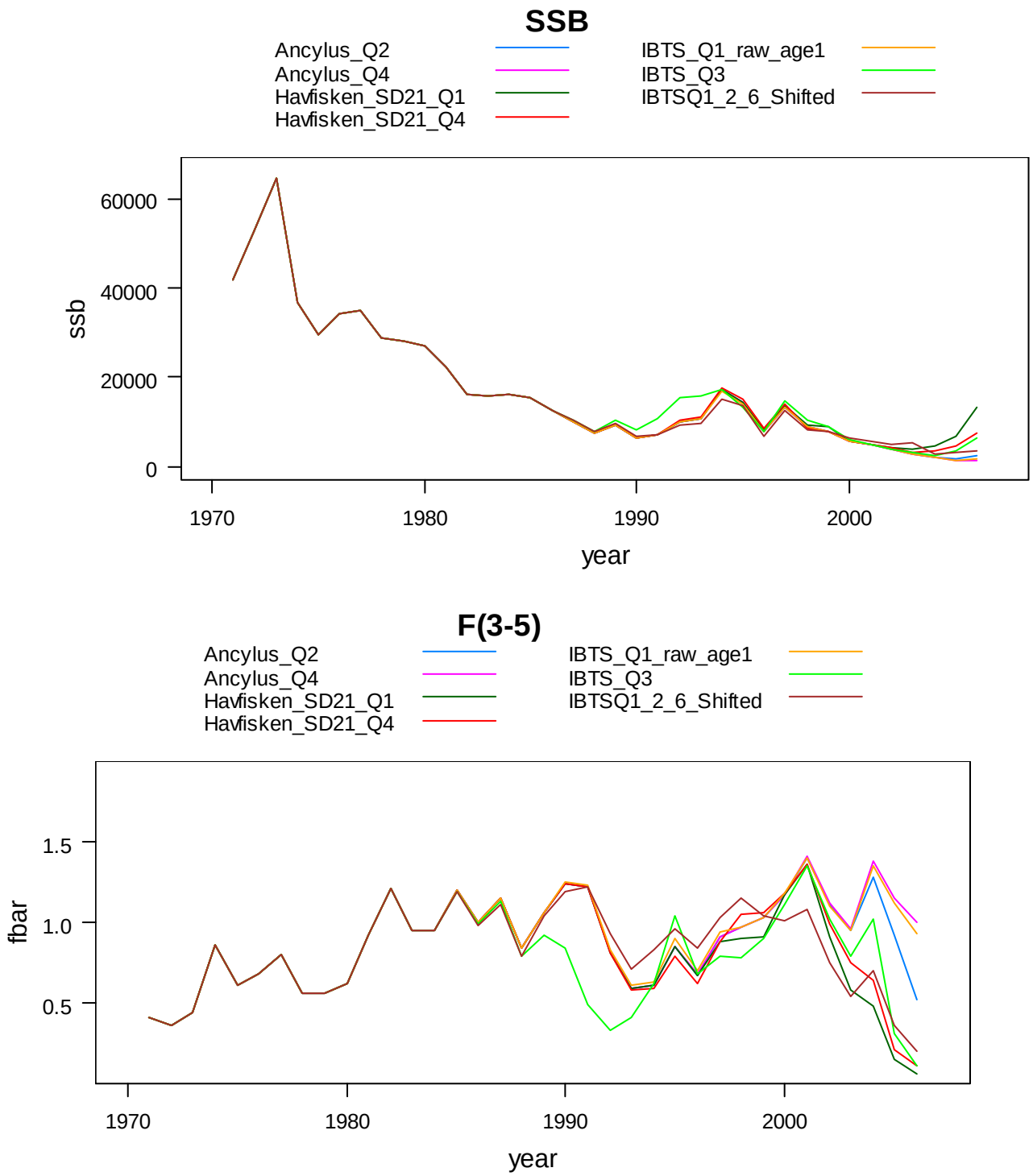


Figure 2.2.11. Cod in Kattegat. SSB and F(3-5) estimates from XSA runs tuned with single fleets

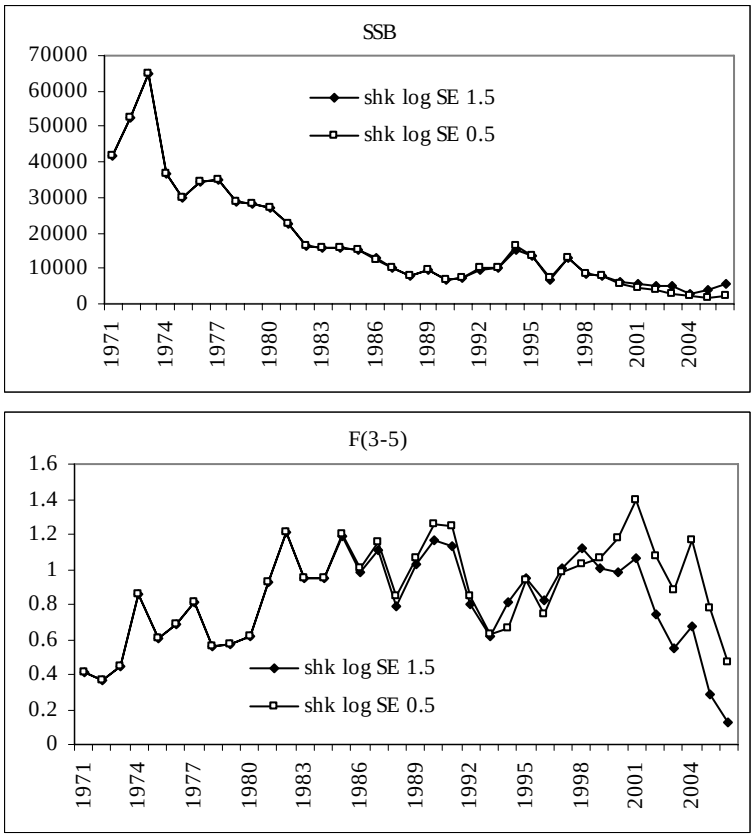


Figure 2.2.12 Cod in Kattegat. Comparison of SSB and Fbar estimates with log SE value for F shrinkage set to 0.5 and to 1.5

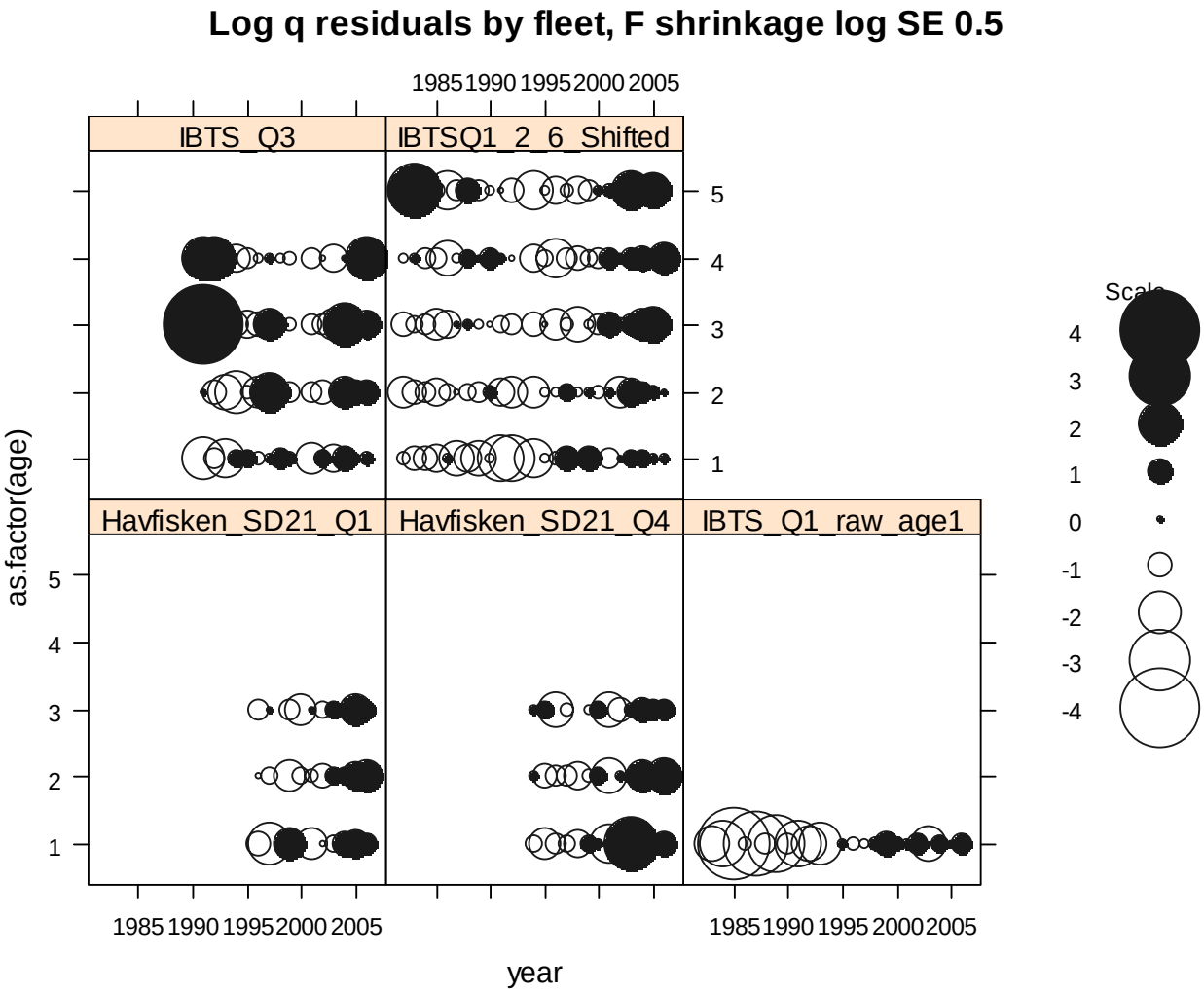
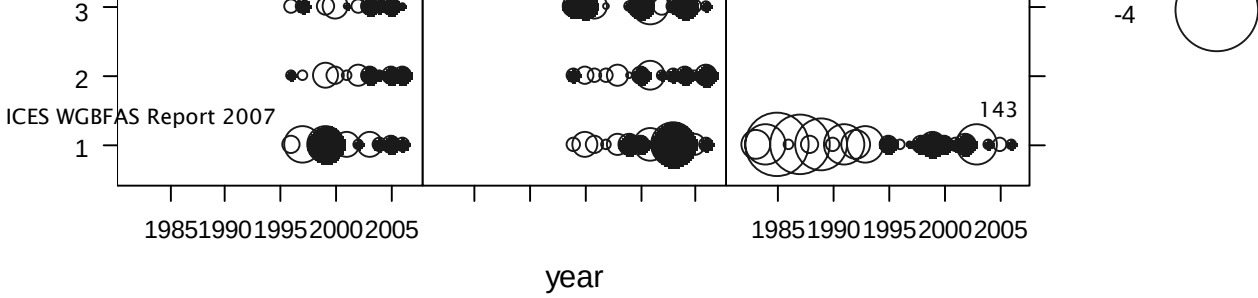


Figure 2.2.13. Cod in Kattegat. Catchability residuals from XSA with log SE for F shrinkage set to 0.5



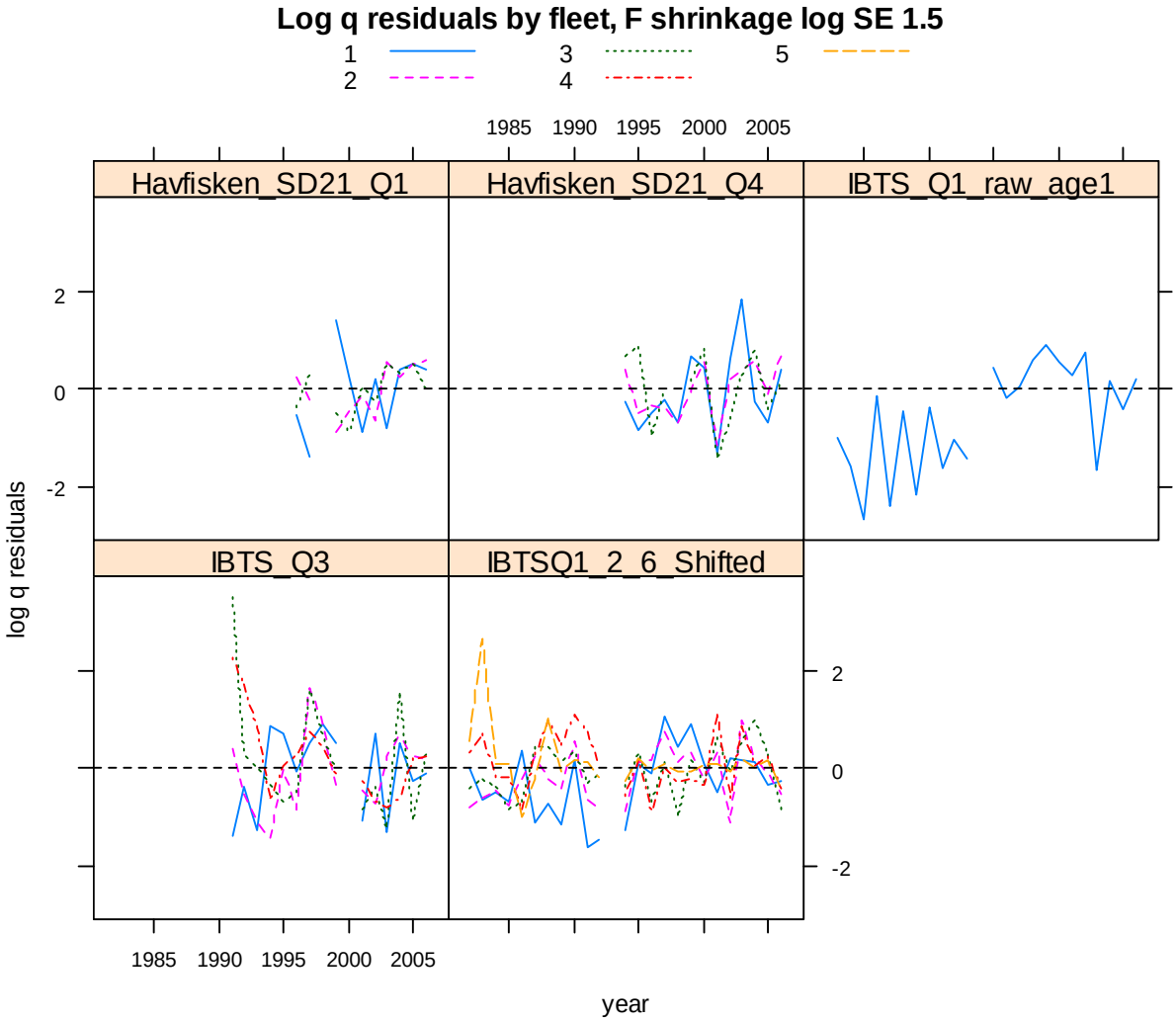


Figure 2.2.14 Cod in Kattegat. Log catchability residuals from the final XSA run (not including discards, log SE on F shrinkage 1.5)

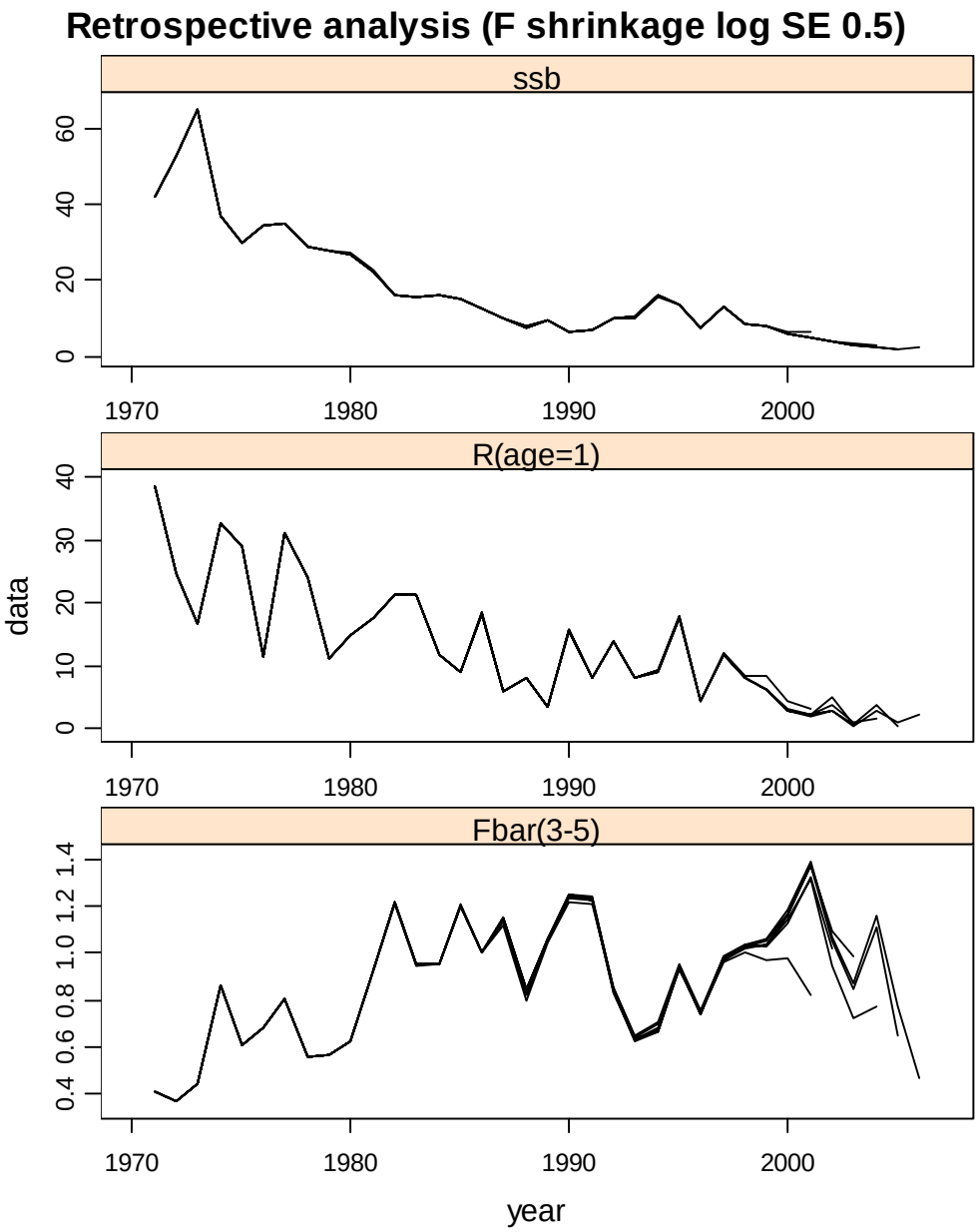


Figure 2.2.15 Cod in Kattegat. Retrospective analyses with log SE for F shrinkage set to 0.5

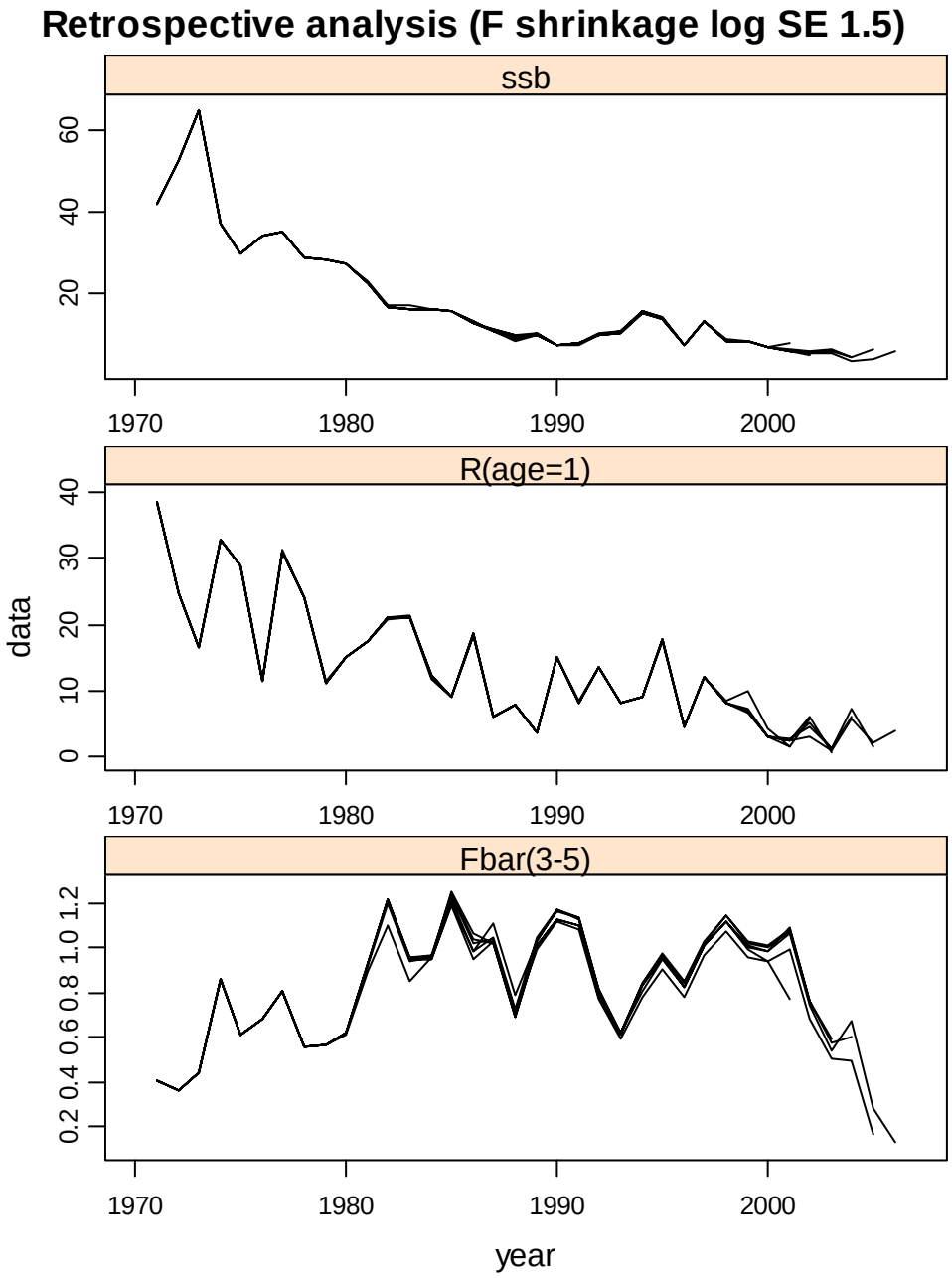


Figure 2.2.16 Cod in Kattegat. Retrospective analyses of the final XSA (not including discards)

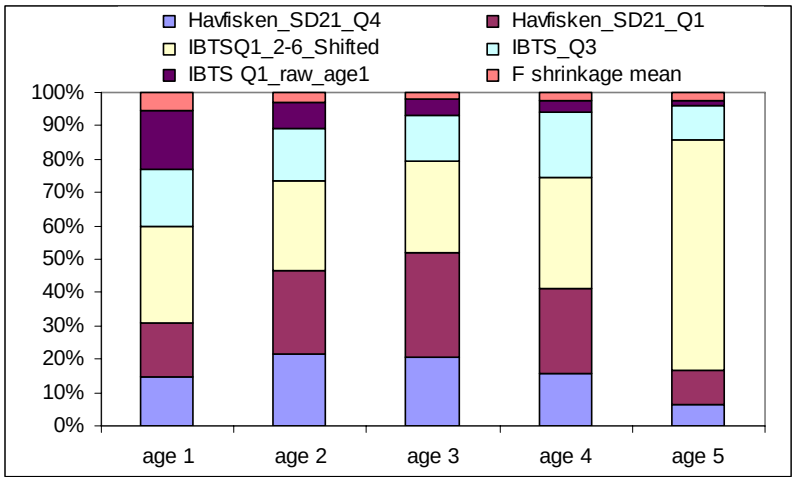


Figure 2.2.17 Cod in Kattegat. Relative weights of tuning indices in the final XSA run (not including discards)

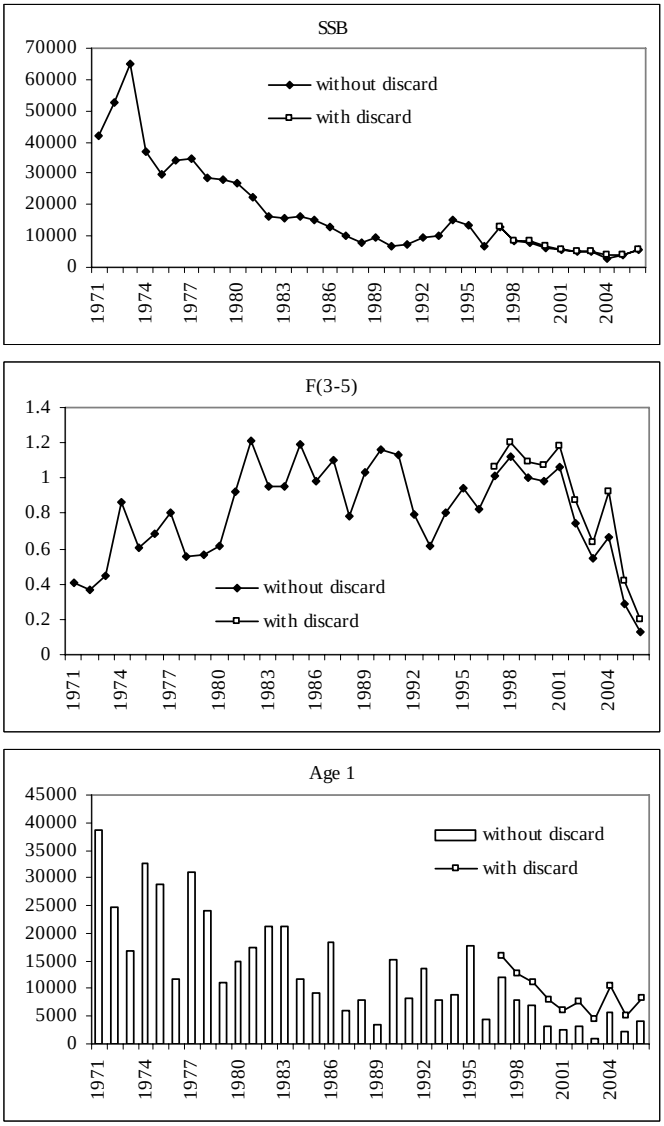


Figure 2.2.18 Cod in Kattegat. SSB (t), F(3-5) and recruitment (age 1, thousands) from final XSA runs without discards and including discards

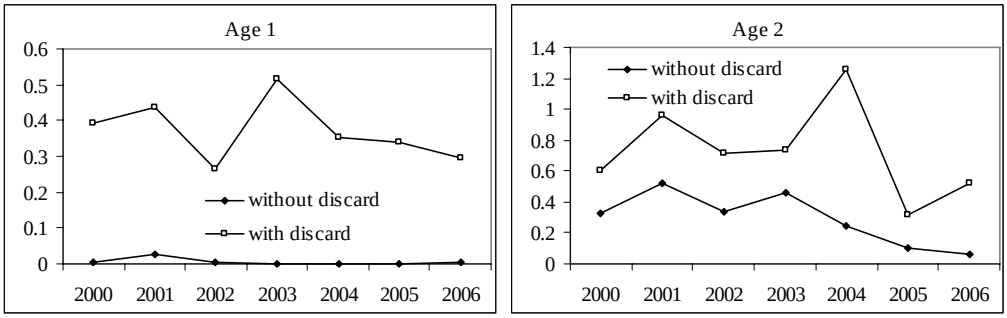


Figure 2.2.19. Cod in Kattegat. Fishing mortalities at ages 1 and 2 from the final XSA runs without discards and including discards

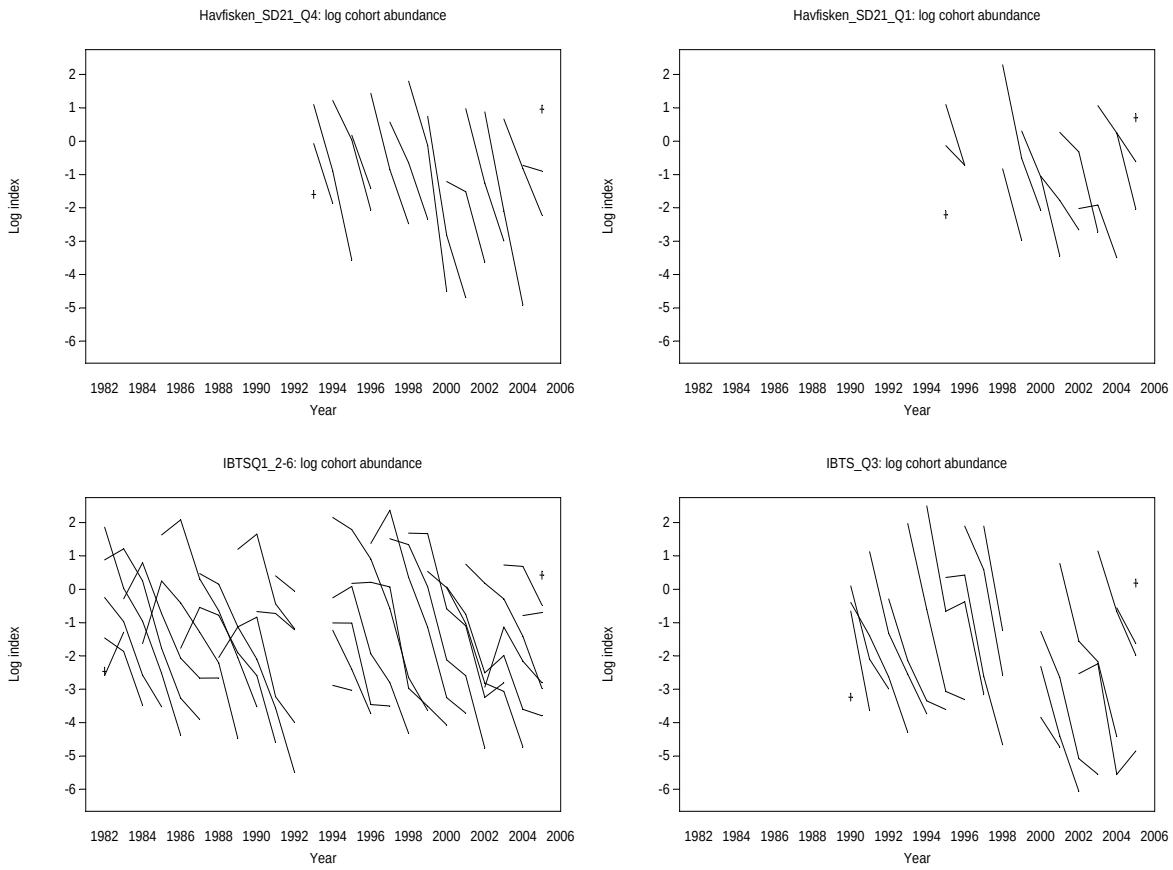


Figure 2.2.20 Cod in Kattegat. Log cohort abundances (catch curves) from IBTS 1st and 3rd quarter and Havfisken 1st and 4th quarter survey indices

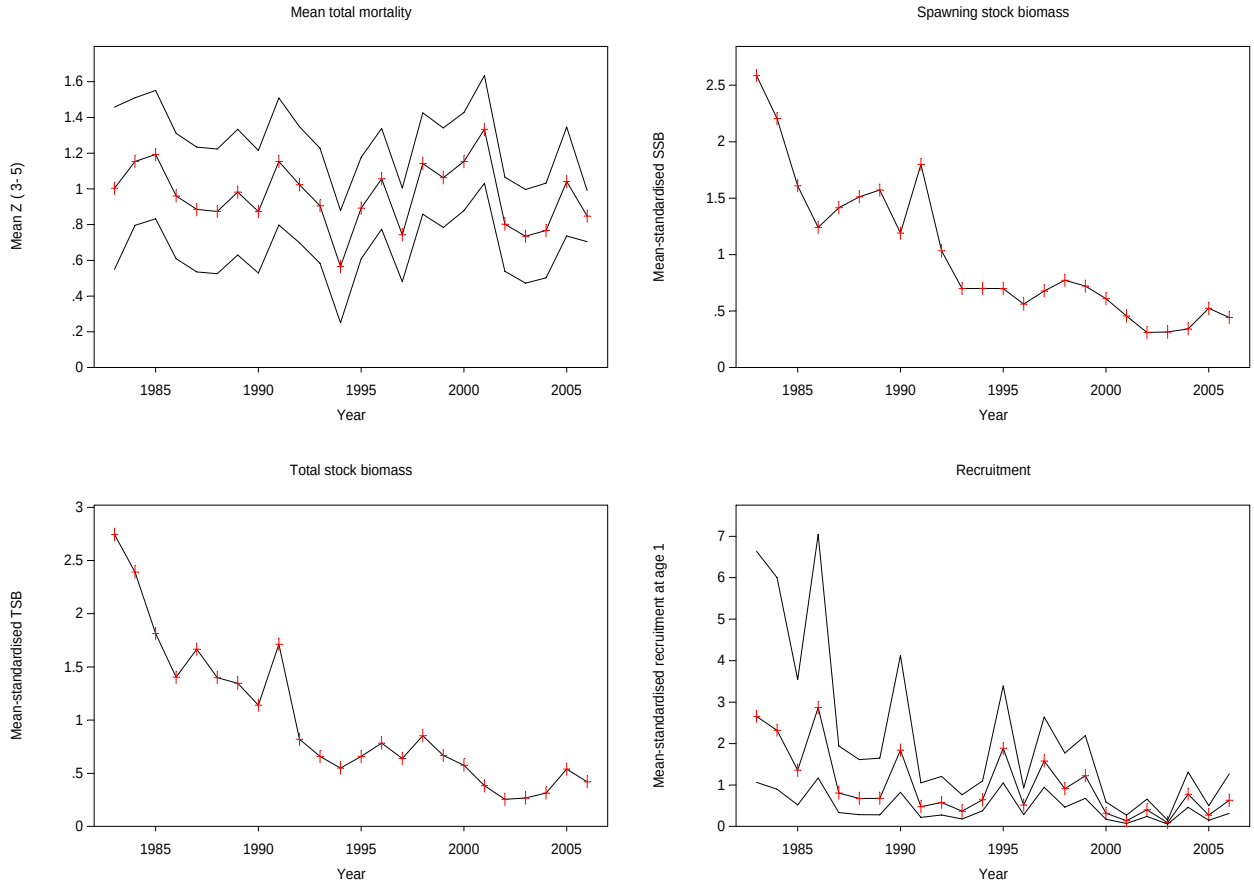


Figure 2.2.21 Cod in Kattegat. Output of the final SURBA run

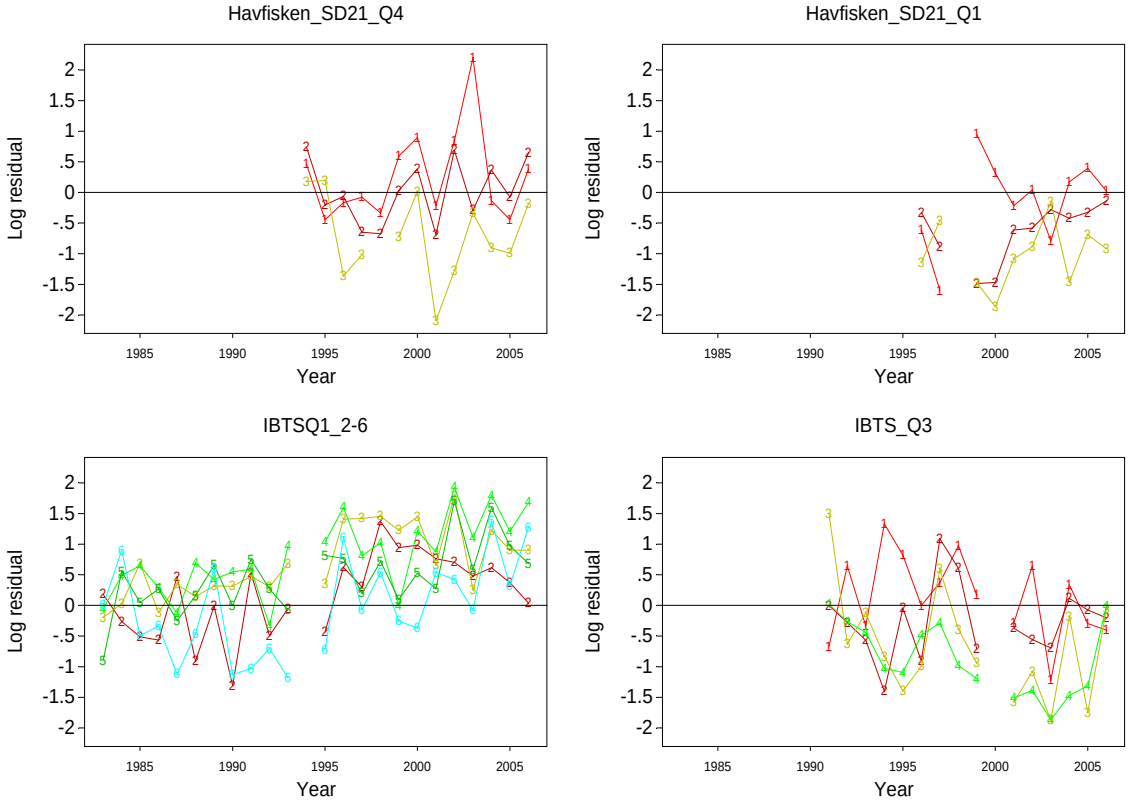


Figure 2.2.22 Cod in Kattegat. Log residuals from the final SURBA run.

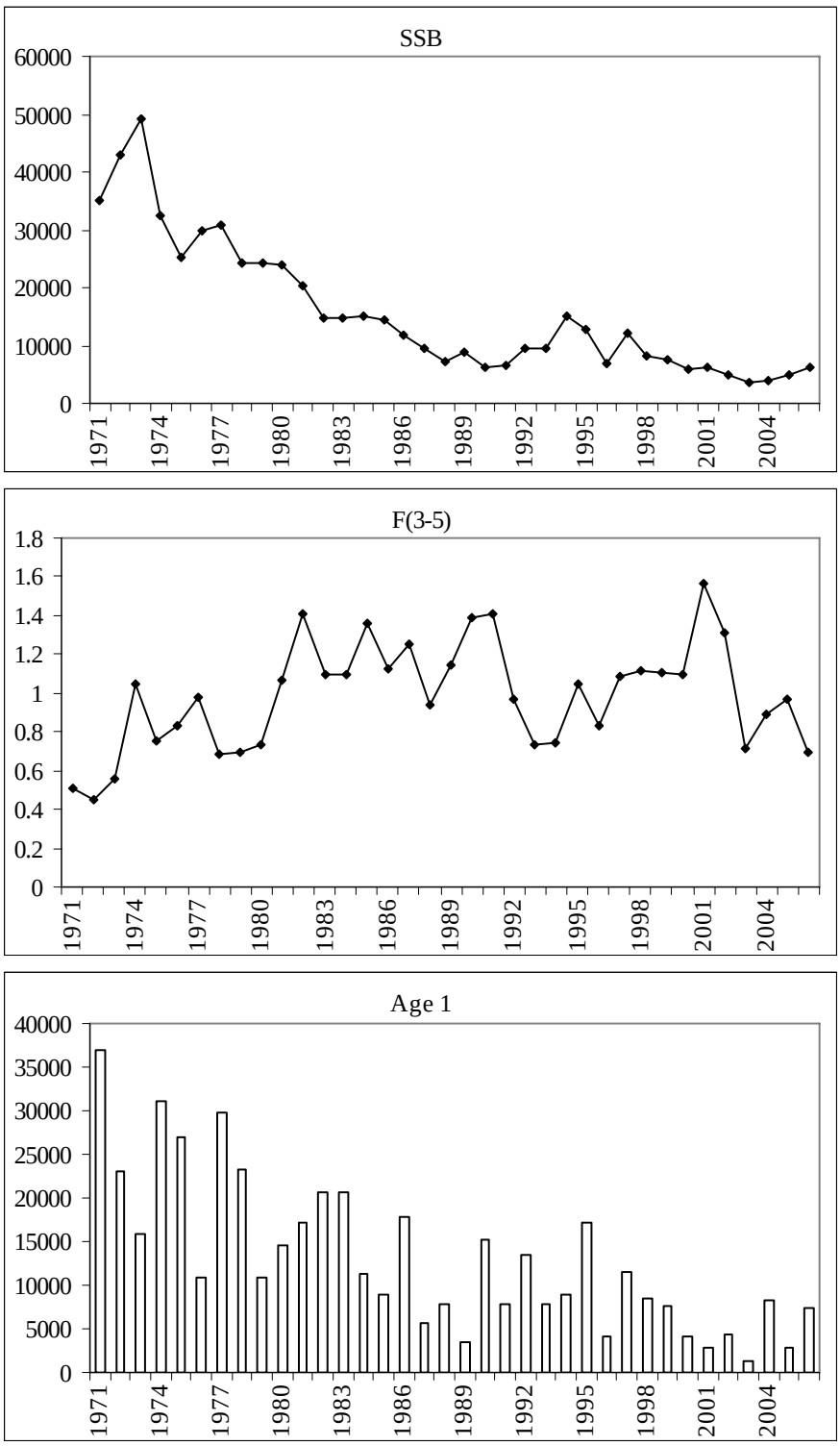


Figure 2.2.23. Cod in Kattegat. SSB (t), F(3-5) and recruitment (age 1, thousands) from B-Adapt run (not including discards)

2.3 Cod in Subdivisions 22-24 (benchmark assessment)

2.3.1 The Fishery

Catches are taken by both trawlers and gillnetters in Subdivisions 22-24. There is a trawling ban in place in Subdivision (SD) 23 (Øresund) except for a minor area adjacent to Kattegat (SD 21), with the result that gillnetters are responsible for the major part of the commercial catches in this SD. In SD 22 and 24 the main part of the catches are taken by trawlers. Catches are predominantly Danish, Swedish and German, with smaller amounts occasionally reported by other Baltic coastal states.

2.3.1.1 Catch trends

Estimated landings in 2006 were 22.8 thousand tonnes. The landings are almost similar to the average of the last 5 years and slightly higher than the catches in 2005 (22,000 t, Table 2.3.1 and Figure 2.3.1). A relative catch proportion plot indicates a shift towards targeting older age groups compared to the period before the mid 1980s (Figure 2.3.2). The proportion of age group 1 cod in the landings have become rather low after 2000. This could be due to the introduction of BACOMA window in 2003. An alternative explanation could be the significantly weaker year classes since the late 1980s (Figure 2.3.3).

2.3.1.2 Unallocated landings

Only little information concerning misreporting of landings were available. Information supplied to the WG members by the Danish industry indicated that landings in the order of 2000 to 2500 t in the last three years are not appearing in the Kattegat statistics. These include misreporting of Kattegat cod into the Western Baltic, indicating an over-reporting of landings in this area. Another issue is the possibility of significant misreporting between the western and eastern cod stock. As misreporting in both directions can be expected due to different closed area procedures in the two areas, it is difficult to estimate the net misreporting. In view of this information, no correction has been applied to the catch data although an exploratory run taking into account possible area misreporting from Kattegat was made see section 2.3.6.3.

2.3.1.3 Discards

Discard data for 2006 were available from Germany, Sweden and Denmark. No discard information was available from Finland, Latvia and Estonia. However, these countries only land small quantities of the western cod stock. Table 2.3.2 indicates when information used in the raising procedure was borrowed from other sources (subdivision/ years) as discard data were not available.

The most abundant age group in the discard is age 2 (56%) but relatively more age 3 has been discarded in 2006 compared to 2005. This is probably an effect of the strong 2003 year class but also high-grading of the catches induced by the restrictive quota policy. Table 2.3.3 -2.3.7 gives the estimated discarded numbers by age and sampling strata and gear in 2006. Close to 25 % of discards are from passive gears; the rest is from the active gears.

The total discard of cod in 2006 is 5.6 mill individuals or 2009 t (9 % of the total landings), which is somewhat below the level of the overall mean (Table 2.3.5 and 2.3.9). Any interpretations of differences between years should only be done with great caution because of the large uncertainties in the estimates.

For the current assessment the discard estimates were included in the catch-at-age data in order to give a better estimate of the true exploitation pattern of the fishery.

The discards from Denmark were in 2006 estimated by quarters as a 4 year mean. Furthermore, the Danish discards were this year raised by landings of all spices and not just by the landings of cod (as most other countries do).

In the period 1996-2005 all discards estimates were calculated by year and raised by landings of cod.

As last year, the estimated discard numbers for years prior to 1996 (when sampling commenced) are based on average proportions discarded at age over 1996 to 2003. The discard weights were included in the catch-at-age weights see section 2.3.3 Table 2.3.8.

The working group recommends that all countries upload discard data to FishFrame prior to the working group and that all discard data are revised back in time as soon as the data extrapolation module is available in FishFrame.

2.3.1.4 Effort and CPUE Data

Indices of abundance are available from German surveys conducted with 'Solea' in SD 22-24 in 1st (1979-2006) and 4th quarter (1978-2006); and from the Danish surveys conducted with 'Havfisken' in SD 22-23 in 1st and 4th quarter (from 1995 and 1994, respectively). Commercial LPUE data are available from the Danish trawlers 105-120mm (1987-2006), seiners 100-130mm (1987-2006) and gillnetters 120-160mm (1987-2006). The major part of the fleet in Subdivisions 22–24 is the trawlers followed by the gillnetters.

In 2007 a major revision of the commercial CPUE time series was conducted. Previously the Danish commercial tuning fleets included almost all Danish cod landings in the area, covering themselves a very large part of the total landings of the stock. This creates de facto a high correlation between the tuning fleets and the catch-at-age matrix. Furthermore, the previous time-series appeared difficult to reproduce due to a large change in the DIFRES database and data extraction programs. The calculations of the new indices are more transparent and allows modifications of the entire time-series in order to test alternative options. The new commercial time series were calculated based on a more reduced part of the total fishery compared to previous indices e.g. the vessel had to be fishing for minimum three years in the Western Baltic, it had to have home port in the Western Baltic area (in order to exclude the opportunistic vessels) and only vessels for which complete information was available were included. Thereby the tuning indices were made more independent from the catch-at-age matrix.

2.3.2 Biological composition of the catch

2.3.2.1 Age compositions

Denmark, Germany, Poland and Sweden provided quarterly landings, CANUM and WECA by gear type and Subdivisions (Tables 2.3.10– 2.3.12). The CANUM and WECA for other countries were estimated using gear specific mean age distributions and mean weights based on the fleets for which age composition data were available and including discards. The consistency of the catch at age data was analysed by plotting the number at age versus the numbers at age+1 of the same cohort (Figure 2.3.4). These analyses and also a cohort plot (Figure 2.3.5) indicated a rather good consistency between ages.

2.3.2.2 Quality of catch and biological data

The sampling levels for the catch (landings) at age data are shown in Table 2.3.14.

2.3.3 Mean weight at age

- The historical record of weight-at-age in the catches is shown in Table 2.3.13 and illustrated in Figure 2.3.6 and is a weighted average of the weights sampled from the landings and the discard. Before 1982 weights at age in the catch were set constant.

- Weights-at-age in the stock are indicated in Table 2.3.15 and illustrated in Figure 2.3.7. As in previous assessment the weights for ages 1-3 have been kept constant from 1995-2006. The data for these age-groups were based on surveys information from the stock area. In the previous assessments the weight in the stock were set constant for ages 4-11 between 1990 - 2005. In 2007, weights at ages 4-11 in the stock were set equal to the annual weights in catches from 1982 to 2006.

  Updated weight at age information was presented from the Danish Havfisken surveys in the years 2001-2006. However, due to low sampling level and incomplete coverage of the stock area, these data were not used in the final assessment. Updated weight at age information from other relevant surveys was not available in time for the WG to include them in the assessment. Availability of these data would improve this stock assessment.

- Mean weights at age in discard was in former year's assessment set constant based on the estimates from 2002. Do to the large variance in discard weights between years it was decided to use a weighted average of the weight-at-age in discards from 2001-2006. Weight data from discard for earlier time were not available. The time series is presented in Table 2.3.8.

2.3.4 Maturity Ogives

The maturity ogive was assumed equal to the values used last year (Table 2.3.16 and Figure 2.3.8). In 2007 a revision of the maturity ogive for years 1996-2006 was presented but as the sampling level was low and did not cover the total stock area the updated ogives was not used in the final assessment. The analysis indicates though a shift towards younger maturation since the latest maturity ogive was conducted in 1997. The working group therefore recommends that an updating of maturity ogive data should be conducted with input data from all relevant 1st quarter surveys in the Western Baltic area.

Spawning stock biomass is calculated at the start of the year, i.e. the proportion of fishing and natural mortality before spawning is assumed to be zero for all years and ages.

2.3.5 Natural mortality

The natural mortality values for cod at age 1 incorporate predation mortalities derived from an earlier MSVPA key run. Discards estimates are not included in calculation of this estimate. These predation mortalities have not been updated since 1997, so in recent years an average value at 0.042 has been assumed. Natural mortality due to other causes than predation is set to 0.2. A constant value of 0.2 was used for ages 2 and older (Table 2.3.17).

2.3.6 Catch-at-age Analysis

2.3.6.1 Tuning fleets

The available tuning fleets are listed in Section 2.3.1.4. Last year the two "Solea" surveys (1th and 4th quarter) as well as the three Danish commercial fleets were used in the final

assessment. All the available tuning fleets were carefully scrutinised in this years benchmark assessment and 2 new Danish surveys with "Havfisken" were introduced in exploratory runs.

Internal consistency was checked for all fleets by regressing. The numbers at age vs. the numbers at age +1 by cohorts (Figure 2.3.9 to 2.3.14b). Due to poor fitting it was decided to exclude ages 1 and 2 from Solea 1st quarter survey, age 5 from the Havfisken 4th quarter survey and age 1 from all the commercial tuning fleets.

2.3.6.2 Exploratory runs with SURBA

The same tuning fleets as used in the final XSA run were used in SURBA analyses. Reference age was set to 4 and smoothing parameter lambda to 1. Year-class consistency showed to be reasonably good for all final tuning fleets (Figure 2.3.15).

A increase in the relative SSB estimate is evident between 2005 and 2006 in SURBA (Figure 2.3.17). This trend are consistent with the results from the final XSA run.

Total mortality was indicated to be stable from 1997 to present (Figure 2.3.18). Residuals from SURBA are shown in Figure 2.3.16

2.3.6.3 XSA runs

The XSA settings and input data used in the assessment were investigated thoroughly and revised when needed.

Selection of tuning fleets

As an overall comment a shift in catchability is observed in the mid 1990s for all fleets.

- "Solea" 1st quarter survey (age 3-6; years 1979-present); Due to a negative trend in the catchability residuals with time the first 18 years were excluded from the time series keeping the years 1996 to present. However, the S.E of log q was relatively high (above 0.8) for all age groups (age 3-6). Therefore, this survey was excluded from the final run (Figure 2.3.19 and 2.3.20).
- "Solea" 4th quarter (age 1-5; 1978- present). Due to a negative trend in the catchability residuals with time the years 1978-1993 were excluded keeping the years 1994 to present. S.E of log q was relatively high (above 0.8) for age groups (age 4-5) (Figure 2.3.19 and 2.3.20). Therefore, ages 1-3 were included in the final run
- "Havfisken" 1st quarter (age 1-5, 1995-present). S.E of log q was relatively high (above 0.8) for older age groups (age 4-5) (Figure 2.3.19 and 2.3.20) Ages 1-3 were included in the final run
- "Havfisken" 4th quarter (age 1-4, 1994-present). S.E of log q was relatively high (above 0.8) for age group 4 (Figure 2.3.19 and 2.3.20). Therefore, ages 1-3 were included in the final run
- Danish trawlers (age 2-6, 1987-present). Due to a negative trend in the catchability residuals with time (Figure 2.3.20) the years 1987-1991 was excluded keeping the years 1992 to present. Furthermore, due to the impact of the Bacoma windows selectivity on age 1 and age 2 (Suuronen et al. 2005), age 2 was excluded in the final run.
- Danish gillnetters (age 2-6, 1987-present). Due to a negative trend in the catchability residuals with time (Figure 2.3.20) the years 1987-1993 were excluded, keeping the years 1994 to present in the final run.
- Danish Seiners (age 2-6, 1987-present). Due to trends in catchability residuals and their large values (Figure 2.3.20), the whole time series was excluded from the final run
- The final tuning input file is given in Table 2.3.18 and in Figure 2.3.21

The final settings were;

FLEET	YEAR RANGE	AGE RANGE
”Solea”, Q4, SD22-24	1994- present	age 1-3
Danish Gillnetters	1994- present	age 2-6
Danish Trawlers	1992- present	age 3-6
“Havfisken”, 1Q SD22-23	1995- present	age 1-3
“Havfisken”, 4Q SD22-23	1994- present	age 1-3

XSA settings:

- Different log SE values for F shrinkage (between 0.5 and 2) were explored. As a consistent overestimation of the Fbar is evident in the retrospective runs and the overestimation increased with lower weight given for shrinkage it was decided to keep the log SE to which the estimates are shrunk at 0.5. (Table 2.3.18b) Changing the shrinkage did not affect the catchability residuals in the final years. (Furthermore an analysis of the catch matrix (Figures 2.3.4 and 2.3.5) did not indicate obvious inconsistencies or bias in the final years.).
- A change in Fbar was investigated. The stock is first fully recruited at age 3 and the catch curves are very stable from age 3-6. It was therefore decided to keep the Fbar at 3-6 (Figure 2.3.5).
- The first age at constant catchability was explored in separable VPA and the output indicated that this value was very stable to different selection pattern (S) and F for final years. (Figure 2.3.22). Therefore, the catchability was kept constant for ages 4 and older as in previous assessments.

The final settings were;

- Shrinkage SE 0.5
- Fbar 3-6
- First age for q independent of age; 2
- First age for q independent of N; 4

Exploratory XSA runs:

- The outputs from exploratory single fleet XSA runs are presented in Figures 2.3.23 and 2.3.24. The results show minor differences in SSB and Fbar.
- As all tuning fleets have been revised in 2007, XSA run was also preformed with the updated SPALY tuning fleets. The estimates for 2006 are presented in Figure 2.3.25 (former fleets). In addition, estimates from the XSA run with previous settings and tuning fleets are presented (Figure 2.3.25, SPALY). The differences in SSB and Fbar from the final run compared to the SPALY run were minor. However, SPALY run indicated somewhat lower recruitment (age 1) in 2006.
- Exploratory run was performed withdrawing 2000, 2000 and 2500 tons from the landings in 2004-2006, respectively. Anecdotal information from the Danish industry indicates that an amount in this order of magnitude could have been taken in Kattegat, but reported to the western Baltic area. The result indicated a reduction in SSB in 2006 by 2000 tons and approx. 10% lower fishing mortality Figure 2.3.25 (-Kat.). The retrospective pattern showed to be more consistent (not shown in the report) with the reduced catches. However, as the information from the industry could not be confirmed based on available data, the final XSA run is based on officially reported landings and discard estimates

The output from the tuning fleet indices in the final run is presented in Figure 2.3.26 and the estimates for 2006 compared to exploratory runs are shown in Figure 2.3.25. Log catchability residuals from the final run are presented in Figure 2.3.21 and 2.3.27. Fishing mortalities, stock numbers and summary output are presented in Tables 2.3.20, 2.3.21, 2.3.24. Diagnostics of the final run is shown in Table 2.3.19 and in Figure 2.3.28. An increase in SSB and reduction in Fbar in 2006 compared to 2005 was estimated in the final XSA. Recruitment in 2006 (age 1) is estimated to be among the lowest historically observed, similarly to 2005 (Figure 2.3.29).

The retrospective analysis is shown in Figure 2.3.30. With the revised tuning fleets an overestimation of the F in the last years is more evident in the retrospective pattern than was the case in the previous assessments. This overestimation of F is likely due to the revision of commercial tuning fleet that are more independent of the catch matrix and, inclusion of more information from scientific surveys. The overestimation of F are getting more pronounced with log SE values for F shrinkage at 1.5 or 2 (not included in the report). Overestimation of F could also be related to misreporting from other areas into the Western Baltic or to migration pattern. Mean F for the entire time frame is 1.15 which must be considered relatively high for a cod stock.

All exploratory XSA runs were conducted in the FLR. The difference in the results from FLR compared to the output from the standard Lowestoft program were less than 0.1% in the final year for SSB, F and recruits.

2.3.7 Historical stock trends

The western Baltic cod stock have since the beginning of the 1970s fluctuated with a record high SSB in 1980 at 56 000 t. and in 10 years decreasing with more than 80% to a record low SSB in 1992 at 10 000 t. After this dramatic drop the F was reduced from 1.97 in 1991 to 0.56 in 1994 and the stock started to recover. The last 14 years the average SSB has been at 25 800 t, and the SSB in 2006 (23 700 t) is indicated to be just below this average level (Figure 2.3.29).

2.3.8 Recruitment estimation

In the beginning of the 1970s the highest recruitment estimates (age 1) in the time series were recorded (280 millions). In the last 10 years, relatively high recruitment has been estimated in several years in the late 1990s. Since 2000, the highest recruitment at age 1 (75 millions) has been estimated for 2004. The recruitment estimate for 2006 is among the lowest in the time series (28 millions, figure 2.3.29).

In last year's assessment, 6 time series of recruitment indices were used in the recruitment estimation in RCT3. As the indices from the "Solea" 1st quarter were excluded in the final XSA run due to low internal consistency between the first age groups it was decided to exclude this survey also from the RCT3 estimation. Also the German "Sonderborg" survey was excluded as it has not been updated since 1998 and do not contribute to the forecast. Therefore, the RCT3 was performed including "Solea" 4th quarter age 0 and 1, Havfisken 1st quarter age 1, Havfisken 4th quarter age 0. A SPALY RCT3 run was performed for comparison. The differences in recruitment estimates from these analyses were minor.

All recruitment indices used in RCT3 to estimate recent year-class strength are presented in Table 2.3.22. The recruitment estimates applied from XSA included the year classes 1977-2004 and excluding the latest age 1 estimated by XSA, as this estimate is considered uncertain. The results from RCT3 are given in Table 2.3.23. Following recent practice, RCT3 estimates were used to estimate the two most recent year-classes, i.e. 2005 and 2006 as age 1.

E.g. numbers of age 2 in 2007 were estimated by applying Z (in 2006) (= M + F-yield + F-discard) to year class 2005 (40677 individuals) estimated by RCT3 analysis. For subsequent year-classes (age 1 in 2008 and 2009), a geometric mean over 1986 to 2004 was used. This reflects the apparently reduced level of recruitment over this period. It should be noted that the 2006 year-class estimated by XSA is estimated to be 50% lower (29 millions) than the average in the last 10 years.

2.3.9 Short-term forecast and management options

For prediction purposes, mean weights at age in the catch and in the stock and the proportion mature were taken as the averages of the last three years. Stock numbers for ages 3+ in year 2007 were taken from the VPA survivors; numbers of age 1 and 2 in 2007 were estimated by RCT3 analysis The exploitation pattern was taken as an average over the last three years. Two exploratory runs were conducted using the exploitation pattern scaled and unscaled to the point estimate of F in 2006. The input data are summarised in Table 2.3.25.

According to standard procedure an average F is applied over the latest 3 years if there is no trend in F. Adopting this procedure and assuming status quo F (landing + discard), the forecast indicates that SSB will decrease from 22,400 t in 2007 to 19,000 t in 2008 and further down to 16,500 t in 2009. The corresponding estimates of landings are 22,900 t in 2007 (corresponding to 85% of the TAC in 2007) and 19,200 t in 2008 (Figure 2.3.31).

However, the WG recognise a drop in F of all age-groups in 2006 compared to the level in 2004 and 2005 (despite a shrinkage to S.E. of 0.5). Furthermore, retrospective analysis shows that F tends to be overestimated (Figure 2.3.30) which indicates that scaling to the final year might be appropriate.

When F is scaled to final year exploitation pattern, and at the present exploitation level of Fbar (3–6) of 0.92 (landing + discard) the forecast indicates that SSB will decrease from 22,400 t in 2007 to 22,300 t in 2008 and further down to 21,200 t in 2009 (Figure 2.3.31). The corresponding estimates of landings are 20,000 t in 2007 (corresponding to 75% of the TAC in 2007) and 19,000 t in 2008 (Figure 2.3.31). The results from the short-term predictions are shown in Table 2.3.26.

year	SSB	Yield	Scaling
2007	22388	22894	no scaling
2008	18981	19172	no scaling
2009	16486		no scaling
2007	22388	20044	with scaling
2008	22268	19018	with scaling
2009	21242		with scaling

SSB is estimated to be below Bpa (23,000 t) in 2007. In both exploitation scenarios (F scaled and unscaled to 2006 exploitation pattern), SSB declines further below Bpa in 2009. This is partly due to several recent years of low recruitment.

The contributions of the various age groups to the yield in the forecast period are shown in Figure 2.3.32. In both scenarios the 2003 year class contributes considerably both to the 2007 landings and the 2008 SSB.

2.3.10 Medium-term projections

Were not estimated in 2007

2.3.11 Reference points

ICES has proposed Bpa at 23,000 t equal to the former established MBAL. IBSFC have established a SSB reference point of 23,000 t for the stock and a fishing mortality reference point of 1.0. (ICES, CM 1998/ACFM:11).

2.3.12 Quality of assessment

The retrospective analyses indicate an overestimation of F in the terminal year. The SSB and recruitment estimates show consistent retrospective patterns. The results from XSA were confirmed by additional analyses with SURBA.

Preliminary investigations indicate that a change in maturity and weight at age in the stock might have occurred and would have a significant impact on SSB estimates. More thorough investigations on these issues are recommended.

Landings data in this area can be compromised by misreporting's from Kattegat and also between the western and eastern cod stocks. These amounts cannot be quantified. According to the anecdotal information from the Danish industry, in most recent years in the order of 10% of cod landings reported in the western Baltic might have been taken in Kattegat. However, the assessment of this stock appears to be relatively robust to different settings (e.g.shrinkage levels and the major revision of tuning fleets in 2007).

The WGBFAS considerer the quality of the assessment of cod in SD 22-24 to be reasonable good.

2.3.13 Technical minutes

- A change in Fbar was investigated. The stock is first fully recruited at age 3 and the catch curve are very stable from age3-6. It was therefore decided to keep the Fbar at 3-6 (Figure 2.3.5)
- Weight at age in the stock and discard have revised and are explained in section 2.3.3
- M values used from the MSVPA were not revised in this years assessment se section 2.3.5
- Residual trend were apparent in the Sole 1st quarter survey last year, but this year the survey is excluded in the final run se section 2.3.6.3
- Reduction of the exploitation pattern at age 1 has been incorporated in this years assessment (as an effect of the BACOMA window) and age 1 and 2 are therefore excluded from the trawler fleet in the tuning series see section 2.3.6.3.

2.3.14 Comparison with previous assessment

This years assessment has resulted in an estimated Fbar of 0.92 and a SSB of 23 700 t in 2006.

A comparison of last years short-term predictions for yield and SSB in 2007 with this years estimate shows that the yield estimates are rather different whereas the SSB estimates were almost similar (2% higher in 2006 assessment) There is a considerable difference in yields estimates (14-25% less in the 2007 assessment depending on whether F was scaled to final year exploitation pattern in the predictions). The significant difference in the yield predictions is particularly due to the higher estimates of incoming recruitment and of the 2005 year class (age 2) used in last year's predictions. The 2005 year class is in this years assessment

estimated lower than last year. Furthermore, the recruitment index (age 1) estimated by RCT3 for the 2006 year class is much lower than the geometric mean index used in last years forecast. In addition, the exploitation pattern of age 2 used in last year's predictions was higher than in this year's prediction (indicating that they will appear in the yield but not in SSB estimates). A portion of the difference is also due to lower weights-at-ages in catches and discards for age groups 1 and 2 in this year's assessment.

The text table below summarises differences between the current & previous assessments of this stock.

	ASSESSMENT 2006	ASSESSMENT 2007	DIFFERENCES
Catch data	Including discards	Including discards	No
Method	XSA	XSA (FLR)	No
Tuning fleets			
Solea, Q1, SD22-24	1994-2005, age 1	Excluded	yes
Solea, Q4, SD22-24	1981-2005, age 1	1994-2006, age 1-3	yes
Danish Gillnetters	1994-2005, ages 1-6	1994-2006, age 2-6	yes
Danish Trawlers	1993-2005, ages 1-6	1992-2006, age 3-6	yes
Danish Seiners	1987-2005, ages 2-6	Excluded	yes
Havfisken Q1, SD22-23	Not used	1995-2006, age 1-3	yes
Havfisken Q4, SD22-23	Not used	1994-2006, age 1-3	yes
XSA settings			
Taper	Tricubic, 20 years	Tricubic, 20 years	No
First age for q independent of N	2	2	No
First age for q independent of age	4	4	No
Shrinkage SE	0.5	0.5	No
XSA results			
$SSB_{(2005)}$ (t)	17,916	17,758	-1%
Recruits Age $1_{(2005)}$ (thousands)	42,093	30,495	-28%
Fbar $(3\text{-}6)_{(2005)}$	1.06	1.29	+22%
Short term forcast for 2007			
SSB in 2007	22872	22388	-2.1%
Yield in 2007	26715	22894 (F not scaled)	-14.3%
		20044 (F scaled)	-25.0%

2.3.15 Management considerations

The stock is indicated to be just above IBSFC biomass reference point in 2006, with current exploitation below the IBSFC fishing mortality reference point. This stock is very dependent upon the strength of incoming year-classes. The recruitment (as age 1) the last 3 years (the 2005, 2006 and 2007 year class) is estimated to be 50% below the average the last 10 years, and the recruitment in 2006 is estimated to be not far from the historical minimum.

The present of separate TACs for the eastern and western Baltic cod stocks makes it possible to restrict fishing activity by TAC although the separation surely has induce misreporting of landings between Eastern and Western stock.

Table 2.3.1 Cod in SD 22-24. Total landings (tons) of COD in the ICES Sub-divisions 22, 23, 24.

Year	Denmark		Finland	German Dem.Rep.[2]	Germany, FRG	Estonia		Latvia	Poland	Sweden			Total						
	23	22+24	24	22+24	22+24	22	24	24	24	22	23	24	22	23	24	Unalloc.	22+24	22+24 + Unalloc.	22-24+ Unalloc.
1965		19,457		9,705	13,350							2,182	27,867		17,007		44,874	44,874	44,874
1966		20,500		8,393	11,448							2,110	27,864		14,587		42,451	42,451	42,451
1967		19,181		10,007	12,884							1,996	28,875		15,193		44,068	44,068	44,068
1968		22,593		12,360	14,815							2,113	32,911		18,970		51,881	51,881	51,881
1969		20,602		7,519	12,717							1,413	29,082		13,169		42,251	42,251	42,251
1970		20,085		7,996	14,589							1,289	31,363		12,596		43,959	43,959	43,959
1971		23,715		8,007	13,482							1,419	32,119		14,504		46,623	46,623	46,623
1972		25,645		9,665	12,313							1,277	32,808		16,092		48,900	48,900	48,900
1973		30,595		8,374	13,733							1,655	38,237		16,120		54,357	54,357	54,357
1974		25,782		8,459	10,393							1,937	31,326		15,245		46,571	46,571	46,571
1975		23,481		6,042	12,912							1,932	31,867		12,500		44,367	44,367	44,367
1976	712	29,446		4,582	12,893							1,800	33,368	712	15,353		48,721	48,721	49,433
1977	1,166	27,939		3,448	11,686						550	1,516	29,510	1,716	15,079		44,589	44,589	46,305
1978	1,177	19,168		7,085	10,852						600	1,730	24,232	1,777	14,603		38,835	38,835	40,612
1979	2,029	23,325		7,594	9,598						700	1,800	26,027	2,729	16,290		42,317	42,317	45,046
1980	2,425	23,400		5,580	6,657						1,300	2,610	22,881	3,725	15,366		38,247	38,247	41,972
1981	1,473	22,654		11,659	11,260						900	5,700	26,340	2,373	24,933		51,273	51,273	53,646
1982	1,638	19,138		10,615	8,060						140	7,933	20,971	1,778	24,775		45,746	45,746	47,524
1983	1,257	21,961		9,097	9,260						120	6,910	24,478	1,377	22,750		47,228	47,228	48,605
1984	1,703	21,909		8,093	11,548						228	6,014	27,058	1,931	20,506		47,564	47,564	49,495
1985	1,076	23,024		5,378	5,523						263	4,895	22,063	1,339	16,757		38,820	38,820	40,159
1986	748	16,195		2,998	2,902						227	3,622	11,975	975	13,742		25,717	25,717	26,692
1987	1,503	13,460		4,896	4,256						137	4,314	12,105	1,640	14,821		26,926	26,926	28,566
1988	1,121	13,185		4,632	4,217						155	5,849	9,680	1,276	18,203		27,883	27,883	29,159
1989	636	8,059		2,144	2,498						192	4,987	5,738	828	11,950		17,688	17,688	18,516
1990	722	8,584		1,629	3,054						120	3,671	5,361	842	11,577		16,938	16,938	17,780
1991	1,431	9,383			2,879						232	2,768	7,184	1,663	7,846		15,030	15,030	16,693
1992	2,449	9,946			3,656						290	1,655	9,887	2,739	5,370		15,257	15,257	17,996
1993	1,001	8,666			4,084						274	1,675	7,296	1,275	7,129	5,528	14,425	19,953	21,228
1994	1,073	13,831			4,023						555	3,711	8,229	1,628	13,336	7,502	21,565	29,067	30,695
1995	2,547	18,762	132		9,196			15			611	2,632	16,936	3,158	13,801		30,737	30,737	33,895
1996	2,999	27,946	50		12,018		50	32			1,032	4,418	21,417	4,031	23,097	2,300	44,514	46,814	50,845
1997	1,886	28,887	11		9,269		6		263		777	2,525	21,966	2,663	18,995		40,961	40,961	43,624
1998	2,467	19,192	13		9,722		8	13	623		607	1,571	15,093	3,074	16,049		31,142	31,142	34,216
1999	2,839	23,074	116		13,224		10	25	660		682	1,525	20,409	3,521	18,225		38,634	38,634	42,155
2000	2,451	19,876	171		11,572		5	84	926		698	2,564	18,934	3,149	16,264		35,198	35,198	38,347
2001	2,124	17,446	191		10,579		40	46	646		693	2,479	14,976	2,817	16,451		31,427	31,427	34,244
2002	2,055	11,657	191		7,322			71	782		354	1,727	11,968	2,409	9,781		21,749	21,749	24,158
2003	1,373	13,275	59		6,775			124	568		551	1,899	9,573	1,925	13,127		22,700	22,700	24,624
2004	1,927	11,386			4,651			221	538		393	1,727	9,091	2,320	9,430	13	18,521	18,534	20,854
2005	1,902	9,867	2		7,002	72	67	476	1,093	1	719	835	8,729	2,621	10,686	9	19,415	19,424	22,045
2006	1,899	9761	242		7,516		91	586	801			1,855	9,979	1,914	10,858		20,837	20,837	22,751

[1]Provisional data. [2]Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.

Table 2.3.2 . Cod in 22-24. The procentage of discard (numbers) for which no discard data have been available. Data are extrapolated from other areas according to the rules given in the text. Stratification 1=Mobil gears, stationary gears. Stratification 2=gillnets, several trawl fisheries (se text for further explanation).

Sub-division 22-24			
Year	Stratification	Gillnet	Trawl
1996	2	7.9	15.8
1997	2	6.6	22.5
1998	2	21.5	1.4
1999	2	43.6	0.7
2000	2	35.2	8.5
2001	2	0.2	23.4
2002	2	72.5	14.1
2003	1	70.9	6.4
2004	1	73.8	23.0
2005	1	6.8	14.2
2006	1	100.0	2.0

Table 2.3.3 Cod 22-24. 2006. Discard ('000) by quarter and gear type.

Year	2006
Stock	22-24

Sum of DISCARD	Quarter				
Metier	1	2	3	4	Grand Tota
Passive gears	200	250	619	304	1374
Active gears	2120	785	774	560	4240
Grand Total	2321	1036	1393	864	5614

2.3.4 Discard ('000) by gear type and year.

Stock	22-24

Gear type	Year										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Passive	592	691	189	220	349	2114	474	2865	119	458	1374
Active	25919	15723	20476	14252	14750	9256	5712	8791	6122	11389	4240
Grand Tota	26511	16414	20665	14472	15098	11370	6186	11656	6241	11847	5614

Table2.3.5 Cod in 22-24. Landings ('000) and discard ('000) by age group in the period 1996-2006.

Stock	22-24

Age group	Year									
	1996		1997		1998		1999		2000	
	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard
Age0	0	15	0	39	0	85	0	250	0	325
Age1	395	21025	3658	16264	3968	16309	1387	4317	3096	7798
Age2	28610	5162	3762	97	23553	4154	27903	9606	12439	5201
Age3	20584	308	28004	15	3238	116	14002	299	19897	1774
Age4	3647	1	5174	0	4634	0	1832	0	3942	0
Age5	2217	0	1030	0	701	0	1146	0	306	0

Age group	Year											
	2001		2002		2003		2004		2005		2006	
	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard	Landing	Discard
Age0	0	44	0	0	0	16	0	149	0	47	0	28
Age1	2398.534	4033	1624	2000	2178	1565	368	2666	667	3148	346	1271
Age2	13708.7	6612	8612	3437	12795	8737	3500	1171	11601	8197	4294	3148
Age3	10969.34	640	8801	1615	6527	489	10009	2252	3233	362	14185	1109
Age4	5167.869	41	2155	19	1898	11	3489	3	3582	65	1302	53
Age5	855.6014	0	912	40	333	0	633	0	826	28	639	4

Table 2.3.6 Cod 2224. Discard in tonnes by age. Average weights in the period 2001-2006 has been applied.

Age group	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age0	2.4	6.0	13.2	38.6	50.2	6.9	0.0	2.5	23.0	7.3	4.3
Age1	5570.7	4309.2	4321.1	1143.9	2066.1	1068.5	529.9	414.6	706.4	834.1	336.8
Age2	1929.7	36.2	1553.0	3591.1	1944.4	2471.7	1285.0	3266.3	437.8	3064.5	1176.8
Age3	127.8	6.0	48.2	123.9	736.0	265.6	669.8	202.7	934.0	150.2	460.1
Age4	0.6	0.0	0.2	0.0	0.0	22.2	10.4	5.7	1.6	34.7	28.6
Age5	0.0	0.0	0.0	0.0	0.0	0.0	19.3	0.0	0.0	13.1	1.9
total	7631	4357	5936	4898	4797	3835	2514	3892	2103	4104	2009

Table 2.3.7 Discard percentage of cod (of landing+discard) in SD22-24 by age group in the period 1996-2006.

Age group	Year										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Age1	98.2	81.6	80.4	75.7	71.6	62.7	55.2	41.8	87.9	82.5	78.6
Age2	15.3	2.5	15.0	25.6	29.5	32.5	28.5	40.6	25.1	41.4	42.3
Age3	1.5	0.1	3.5	2.1	8.2	5.5	15.5	7.0	18.4	10.1	7.3
Age4	0.0	0.0	0.0	0.0	0.0	0.8	0.9	0.6	0.1	1.8	3.9
Age5	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	3.2	0.6

Table 2.3.8 Cod in 22-24. Mean weight (g) of discard in western cod stock by age.

Country	(All)
Year	2006
stock	22-24
Catch category	discard

Average of wgt	
age	Grand Total
0	46
1	131
2	373
3	417
4	455
5	474
6	474
7	474

Table 2.3.9 Cod in 22-24. Discard of cod in numbers ('000) by age, quarter sub division and gear type.

Stock	22-24
Year	2006

		Sub-div. Metier									
		22		22 Total	24		24 Total	23		23 Total	Grand Total
Quarter	Data	Active gea	Passive gears		Active gea	Passive gears		Active gea	Passive gears		
1	Age 0	0.115	0.000	0.115	0.012	0.000	0.012	0.055	0.000	0.055	0.182
	Age 1	159.840	0.000	159.840	37.066	0.000	37.066	1.664	0.000	1.664	198.569
	Age 2	1208.285	64.228	1272.513	195.253	7.819	203.072	4.063	32.339	36.402	1511.987
	Age 3	464.292	51.382	515.674	33.533	7.677	41.210	0.872	25.871	26.743	583.627
	Age 4	14.262	6.423	20.684	0.119	1.145	1.264	0.096	3.234	3.329	25.278
	Age 5	0.876	0.000	0.876	0.001	0.056	0.057	0.015	0.000	0.015	0.948
	Age 6	0.022	0.000	0.022	0.000	0.001	0.001	0.000	0.000	0.000	0.022
	Age 7	0.005	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.005
	Age 8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Age 0	18.478	0.000	18.478	0.065	0.000	0.065	0.013	0.000	0.013	18.557
	Age 1	99.123	59.563	158.686	54.584	17.824	72.408	16.603	18.170	34.773	265.867
	Age 2	129.159	64.011	193.170	135.116	19.321	154.437	128.354	19.342	147.696	495.303
	Age 3	20.721	23.040	43.760	135.467	7.719	143.187	43.196	5.568	48.764	235.711
	Age 4	1.121	7.165	8.287	1.561	5.711	7.272	1.602	0.586	2.188	17.747
	Age 5	0.000	0.753	0.753	0.018	1.509	1.526	0.098	0.000	0.098	2.378
	Age 6	0.000	0.007	0.007	0.000	0.087	0.087	0.002	0.000	0.002	0.097
	Age 7	0.000	0.002	0.002	0.000	0.015	0.015	0.001	0.000	0.001	0.018
	Age 8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	Age 0	0.208	0.000	0.208	0.105	0.000	0.105	6.769	0.000	6.769	7.082
	Age 1	84.926	144.911	229.837	105.946	19.122	125.068	36.309	82.219	118.528	473.434
	Age 2	141.548	207.334	348.883	151.505	28.999	180.504	27.641	117.637	145.278	674.665
	Age 3	28.807	6.688	35.495	181.847	5.575	187.422	5.750	3.795	9.545	232.462
	Age 4	2.032	0.000	2.032	0.211	2.929	3.140	0.411	0.000	0.411	5.583
	Age 5	0.011	0.000	0.011	0.030	0.177	0.208	0.000	0.000	0.000	0.218
	Age 6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Age 7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Age 8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Age 0	1.574	0.000	1.574	0.469	0.000	0.469	0.054	0.000	0.054	2.098
	Age 1	47.871	13.298	61.169	197.848	19.355	217.203	19.041	35.987	55.028	333.400
	Age 2	116.922	64.293	181.215	95.540	38.330	133.869	34.926	116.044	150.970	466.054
	Age 3	25.103	4.153	29.255	9.560	10.608	20.168	7.357	0.672	8.029	57.453
	Age 4	2.751	0.519	3.270	0.054	0.759	0.813	0.533	0.000	0.533	4.615
	Age 5	0.429	0.000	0.429	0.004	0.003	0.007	0.003	0.000	0.003	0.440
	Age 6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Age 7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Age 8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Age 0		20.376	0.000	20.376	0.652	0.000	0.652	6.891	0.000	6.891	27.918
Total Age 1		391.760	217.772	609.532	395.444	56.301	451.745	73.617	136.375	209.992	1271.269
Total Age 2		1595.914	399.866	1995.780	577.415	94.468	671.883	194.984	285.362	480.345	3148.008
Total Age 3		538.922	85.263	624.185	360.406	31.580	391.986	57.175	35.906	93.081	1109.253
Total Age 4		20.165	14.107	34.272	1.945	10.544	12.489	2.641	3.820	6.461	53.222
Total Age 5		1.317	0.753	2.070	0.053	1.745	1.798	0.116	0.000	0.116	3.984
Total Age 6		0.022	0.007	0.029	0.000	0.088	0.088	0.002	0.000	0.002	0.119
Total Age 7		0.005	0.002	0.007	0.000	0.016	0.016	0.001	0.000	0.001	0.023
Total Age 8		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 2.3.10: Total landings (t) of the western Baltic cod stock (Sub-div. 22-24) by Sub-division and quarter.

Year: 2006 Gear: Trawl and gillnet combined

Sub-div.	22	23	24	22-24
Country:				
Denmark	5299	1899	4462	11660
Germany	4673	0	2843	7516
Poland	0	15	786	801
Finland	0	0	242	242
Latvia	7	0	579	586
Estonia	0	0	91	91
Russia	0	0	0	0
Sweden	0	0	1855	1855
Lithuania	0	0	0	0
Total	9979	1914	10858	22750

Year: 2006 Gear: Trawl

Sub-div.	22	23	24	22-24
Country:				
Denmark	3735	577	3668	7980
Germany	3394	0	1831	5226
Poland	0	15	204	219
Finland	0	0	242	242
Latvia	0	0	1	1
Estonia	0	0	0	0
Russia	0	0	0	0
Sweden	0	0	1217	1217
Lithuania	0	0	0	0
Total	7129	592	7163	14884

Year: 2006 Gear: Gillnet

Sub-div.	22	23	24	22-24
Country:				
Denmark	1564	1322	794	3679
Germany	1279	0	1012	2291
Poland	0	0	582	582
Finland	0	0	0	0
Latvia	7	0	578	585
Estonia	0	0	91	91
Russia	0	0	0	0
Sweden	0	0	638	638
Lithuania	0	0	0	0
Total	2850	1322	3694	7866

Table 2.3.11: Numbers at age (CANUM) and mean weight at age (WECA) in commercial landings of western Baltic cod (Sub-div. 22-24) by Sub-division, quarter and gear

BFAS WG

Year: 2006 **Gear: Trawl and gillnet combined**

Year:	**2006**	**Quarter:**	**1**					
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 24		Sub-div. 22-24	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	0.000	0	0.000	0	4.113	619	4.113	619
2	83.826	652	113.174	654	600.717	627	797.718	633
3	5287.329	979	662.009	1111	2327.612	918	8276.950	972
4	223.638	2435	28.963	2725	291.518	1241	544.119	1811
5	256.213	3609	21.134	4259	85.938	1657	363.285	3185
6	27.026	5532	1.918	5182	10.416	3969	39.360	5102
7	5.848	7805	0.349	6778	2.332	6301	8.529	7352
8	0.000	0	0.013	5870	0.215	5870	0.228	5870
9	0.000	0	0.007	6688	0.773	8963	0.781	8941
10+	0.000	0	0.000	0	0.000	0	0.000	0
SOP [t]	6896		991		3083		10970	
Landings (t)	6622		942		3137		10701	

Year:	**2006**	**Quarter:**	**2**					
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 24		Sub-div. 22-24	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	0.000	0	0.000	0	1.545	605	1.545	605
2	43.457	642	11.537	741	290.934	723	345.927	713
3	477.486	1194	42.503	1523	1007.149	976	1527.138	1060
4	8.194	1530	2.321	869	101.311	1265	111.826	1276
5	29.808	3752	0.456	1325	19.882	2334	50.146	3168
6	3.085	3854	0.085	2155	2.637	3983	5.807	3888
7	0.000	0	0.037	6713	2.027	2920	2.063	2987
8	3.085	3186	0.029	10346	1.242	5089	4.356	3777
9	0.000	0	0.037	14783	0.209	11602	0.246	12076
10+	0.000	0	0.007	16333	0.055	10921	0.062	11557
SOP [t]	744		77		1395		2216	
Landings (t)	737		76		1391		2204	

Year:	**2006**	**Quarter:**	**3**					
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 24		Sub-div. 22-24	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	2.934	617	0.000	0	84.225	626	87.159	626
2	238.874	745	50.328	678	1175.363	761	1464.566	756
3	568.175	1411	186.086	1217	1024.847	1080	1779.108	1200
4	53.875	2791	12.677	2044	209.423	1110	275.975	1481
5	58.652	3597	12.631	5246	52.655	1643	123.938	2935
6	14.329	3109	2.474	6188	5.450	3718	22.253	3601
7	0.000	0	0.000	0	1.249	5009	1.249	5009
8	0.000	0	0.000	0	0.276	11247	0.276	11247
9	0.000	0	0.000	0	0.126	17336	0.126	17336
10+	0.000	0	0.000	0	1.432	9539	1.432	9539
SOP [t]	1387		368		2419		4175	
Landings (t)	1380		347		2417		4144	

Table 2.3.11 (Cont'd)

Year:	**2006**	**Quarter:**	**4**					
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 24		Sub-div. 22-24	
Age	Numbers *10-3	Mean w eight [g]	Numbers *10-3	Mean w eight [g]	Numbers *10-3	Mean w eight [g]	Numbers *10-3	Mean w eights [g]
1	31.765	784	0.000	0	223.537	691	255.302	702
2	212.128	1030	65.963	861	1437.701	883	1715.791	900
3	448.107	1877	315.697	1370	1896.356	1016	2660.159	1203
4	24.117	3660	26.224	2336	273.186	1286	323.527	1548
5	28.739	3865	11.054	1404	54.714	1974	94.507	2482
6	0.000	0	9.416	950	9.587	5348	19.003	3169
7	0.000	0	1.628	3308	3.732	5515	5.360	4845
8	0.000	0	0.000	0	2.077	5878	2.077	5878
9	0.000	0	0.000	0	1.250	6713	1.250	6713
10+	0.000	0	0.000	0	0.000	0	0.000	0
SOP [t]	1284		580		3901		5766	
Landings (t)	1239		548		3914		5701	

Year:	**2006**	**Quarter:**	**All**					
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 24		Sub-div. 22-24	
Age	Numbers *10-3	Mean w eight [g]	Numbers *10-3	Mean w eight [g]	Numbers *10-3	Mean w eight [g]	Numbers *10-3	Mean w eights [g]
1	22.456	755	0.000	0	312.295	668	334.751	674
2	510.857	798	241.002	720	3472.036	789	4223.894	787
3	6853.997	1073	1206.295	1210	6213.155	987	14273.448	1047
4	319.729	2550	70.185	2395	925.280	1195	1315.194	1589
5	392.887	3658	45.275	3808	224.084	1747	662.247	3021
6	46.880	4775	13.893	2474	28.085	4295	88.859	4264
7	6.683	7800	2.013	3971	9.612	4967	18.309	5891
8	3.451	3186	0.042	8977	3.831	5966	7.324	4674
9	0.000	0	0.044	13426	2.408	8543	2.452	8631
10+	0.000	0	0.007	16333	1.682	9827	1.690	9855
SOP [t]	10316		2017		10807		23140	
Landings (t)	9979		1914		10858		22750	

Table 2.3.12 Cod in SD22-24. Catch in numbers 1970-2006 ('000) at age
Catch at age ('000); Cod in the Western Baltic (22-24), **age**

Year	1	2	3	4	5	6	7	8	9	10	11+
1970	90062	64382	11550	3648	903	248	53	39	12	5	3
1971	68894	68256	17774	2642	1157	461	121	56	27	8	4
1972	97150	48268	18898	4673	1030	487	120	53	19	10	5
1973	17850	67045	16525	4558	974	142	93	32	10	5	3
1974	63436	29315	23722	5334	1302	472	52	46	13	7	4
1975	13854	61511	8726	4981	786	318	131	31	11	4	1
1976	17938	42008	30203	2493	1383	289	69	37	7	3	1
1977	35324	37491	13617	5551	561	253	66	30	9	3	1
1978	16040	59723	10023	2250	731	109	30	12	7	1	1
1979	3175	35946	20551	2447	580	264	37	16	9	4	2
1980	20635	12062	20725	5585	794	250	193	28	22	6	2
1981	4196	53889	12713	5735	2083	393	92	86	5	3	1
1982	44050	36274	17927	1659	824	406	124	31	19	3	2
1983	57161	38675	14836	4681	771	330	116	39	10	5	2
1984	15492	45154	10246	3727	1192	318	97	47	10	11	1
1985	5723	10364	16354	4313	1496	680	102	40	20	22	3
1986	11227	7949	8178	4030	1241	492	118	20	14	8	3
1987	11663	31791	5561	1308	505	105	50	23	5	5	1
1988	3105	16929	14408	1989	250	137	41	21	10	2	3
1989	3105	3017	8704	3949	570	127	46	8	5	2	2
1990	3555	8314	3280	2318	1032	206	41	24	4	1	0
1991	5110	6065	4996	1621	436	226	34	8	8	4	2
1992	13938	9968	4378	540	96	68	48	11	0	4	0
1993	622	20891	6754	1201	141	15	28	3	3	3	3
1994	3769	15674	15514	1842	84	12	8	7	4	0	0
1995	10248	17446	7568	6550	1379	119	6	2	1	0	1
1996	21420	33772	20892	3648	2217	306	13	7	0	4	18
1997	19922	3859	28019	5174	1030	681	124	34	0	7	0
1998	20277	27707	3354	4634	701	123	66	15	0	0	0
1999	5704	37509	14301	1832	1146	234	54	38	3	0	0
2000	10893	17640	21672	3942	306	217	39	8	10	7	0
2001	6377	20720	11873	5397	906	76	60	15	3	1	0
2002	4483	11497	9128	2178	951	255	24	9	1	1	0
2003	3743	21532	7016	1909	333	175	49	5	2	0	0
2004	3034	4671	12261	3492	633	165	66	21	3	4	0
2005	3815	19798	3595	3647	854	203	52	18	1	19	0
2006	1606	7372	15383	1368	666	89	18	7	2	2	0

Table 2.3.13 Cod in SD 22-24. Mean weight (kg) in catch (landings and discard)

	Age										
Year	1	2	3	4	5	6	7	8	9	10	11+
1970	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1971	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1972	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1973	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1974	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1975	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1976	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1977	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1978	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1979	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1980	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1981	0.27	0.52	0.94	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1982	0.27	0.51	1.20	1.71	2.95	3.60	4.66	7.20	9.04	11.19	13.00
1983	0.29	0.56	1.01	1.68	2.45	3.47	4.59	5.78	6.96	11.00	12.62
1984	0.28	0.64	1.23	1.74	2.29	2.54	4.35	6.58	6.98	11.12	12.00
1985	0.30	0.71	1.20	1.88	2.24	3.12	4.26	5.89	7.91	8.21	10.50
1986	0.30	0.61	1.12	1.84	1.92	2.65	3.87	5.54	8.90	9.73	11.03
1987	0.28	0.65	1.11	1.90	3.20	4.10	5.27	6.45	8.83	4.82	11.16
1988	0.32	0.66	1.05	1.46	3.09	4.76	5.29	6.75	9.13	9.00	11.45
1989	0.30	0.63	1.00	1.49	2.13	3.36	5.43	7.13	6.25	6.58	9.18
1990	0.33	0.79	1.01	1.99	2.58	3.15	5.33	7.02	8.12	9.83	10.00
1991	0.33	0.83	1.29	1.54	2.97	4.50	7.71	7.95	8.91	8.90	10.00
1992	0.33	0.82	1.57	2.33	3.09	6.06	6.77	8.66	8.51	10.00	10.00
1993	0.31	0.67	1.26	2.45	3.92	3.49	8.21	13.68	6.12	15.43	14.30
1994	0.29	0.86	1.23	2.19	4.20	6.36	7.23	7.03	7.94	9.37	10.00
1995	0.31	0.71	1.04	1.17	2.70	5.43	6.12	9.03	11.45	9.40	12.68
1996	0.27	0.63	1.02	1.35	2.49	3.10	2.86	5.87	8.24	8.71	10.00
1997	0.31	0.75	1.02	1.41	1.76	2.74	4.29	2.80	7.00	4.98	10.00
1998	0.32	0.72	1.13	1.88	2.71	3.43	5.63	5.78	3.86	7.34	7.02
1999	0.33	0.61	1.10	1.40	2.92	3.87	5.12	4.81	6.70	10.91	0.00
2000	0.35	0.62	0.92	1.57	2.48	5.06	6.24	7.75	8.08	10.87	0.00
2001	0.39	0.60	0.94	1.58	2.80	4.25	6.40	7.56	6.56	6.62	0.00
2002	0.39	0.64	1.07	1.48	2.86	4.12	5.72	6.96	7.54	7.80	0.00
2003	0.56	0.66	0.99	1.65	3.11	4.89	6.83	7.88	8.04	10.47	0.00
2004	0.31	0.71	0.89	1.26	2.33	3.62	5.81	6.93	8.28	11.70	0.00
2005	0.34	0.61	1.04	1.69	1.93	3.37	4.15	6.24	15.20	9.75	0.00
2006	0.35	0.61	1.00	1.55	3.01	4.26	5.89	4.67	8.63	9.86	10.00

Table 2.3.14 Cod in SD 22-24. Number of sampled discard of COD in the ICES Sub-divisions 22, 23, 24.
Cod in Sd 22-24. Number of samples Discard

				Length measuements	Age readings
		Landings (t)	Number of samples		
Country	Quarter		Sea sampling	Number	Number
DEN	1	6719	18	3085	275
	2	895	23	4179	108
	3	1548	14	2406	
	4	2498	5	1049	
	Total	11660	60	10719	383
POL	1	113	1	63	48
	2	128	2	112	97
	3	161	2	155	105
	4	399	1	46	46
	Total	801	6	376	296
SWE	1	442	1	287	494
	2	218	6	2079	489
	3	731	13	2472	158
	4	464	2	717	346
	Total	1855	22	5555	1487
GER	1	3090	20	1401	259
	2	700	3	139	139
	3	1469	18	1067	377
	4	2256	32	2806	255
	Total	7516	73	5413	1030
LAT	1	305			
	2	155			
	3	64			
	4	62			
	Total	586	0	0	0
FIN	1	24			
	2	53			
	3	144			
	4	21			
	Total	242	0	0	0
EST	1	8			
	2	55			
	3	27			
	4	1			
	Total	91	0	0	0
Total	1	10701	40	4836	1076
	2	2204	34	6509	833
	3	4144	47	6100	640
	4	5701	40	4618	647
Grand Total		22750	161	22063	3196

Table 2.3.15 Cod in SD 22-24. Mean weights (kg). 1970-2006 at age in the stock

	Age										
year	1	2	3	4	5	6	7	8	9	10	11+
1970	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1971	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1972	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1973	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1974	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1975	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1976	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1977	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1978	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1979	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1980	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1981	0.09	0.42	1.06	1.62	2.41	3.36	5.57	6.82	9.53	10.50	11.00
1982	0.09	0.42	1.06	1.71	2.95	3.60	4.66	7.20	9.04	11.19	13.00
1983	0.09	0.42	1.06	1.68	2.45	3.47	4.59	5.78	6.96	11.00	12.62
1984	0.09	0.42	1.06	1.74	2.29	2.54	4.35	6.58	6.98	11.12	12.00
1985	0.15	0.59	1.16	1.88	2.24	3.12	4.26	5.89	7.91	8.21	10.50
1986	0.05	0.60	1.12	1.84	1.92	2.65	3.87	5.54	8.90	9.73	11.03
1987	0.09	0.52	0.92	1.90	3.20	4.10	5.27	6.45	8.83	4.82	11.16
1988	0.09	0.45	0.94	1.46	3.09	4.76	5.29	6.75	9.13	9.00	11.45
1989	0.16	0.60	1.00	1.49	2.13	3.36	5.43	7.13	6.25	6.58	9.18
1990	0.19	0.54	0.85	1.99	2.58	3.15	5.33	7.02	8.12	9.83	10.00
1991	0.19	0.54	0.85	1.54	2.97	4.50	7.71	7.95	8.91	8.90	10.00
1992	0.19	0.54	0.85	2.33	3.09	6.06	6.77	8.66	8.51	10.00	10.00
1993	0.19	0.54	0.85	2.45	3.92	3.49	8.21	13.68	6.12	15.43	14.30
1994	0.19	0.54	0.85	2.19	4.20	6.36	7.23	7.03	7.94	9.37	10.00
1995	0.08	0.36	0.83	1.17	2.70	5.43	6.12	9.03	11.45	9.40	12.68
1996	0.08	0.36	0.83	1.35	2.49	3.10	2.86	5.87	8.24	8.71	10.00
1997	0.08	0.36	0.83	1.41	1.76	2.74	4.29	2.80	7.00	4.98	10.00
1998	0.08	0.36	0.83	1.88	2.71	3.43	5.63	5.78	3.86	7.34	7.02
1999	0.08	0.36	0.83	1.40	2.92	3.87	5.12	4.81	6.70	10.91	0.00
2000	0.08	0.36	0.83	1.57	2.48	5.06	6.24	7.75	8.08	10.87	0.00
2001	0.08	0.36	0.83	1.58	2.80	4.25	6.40	7.56	6.56	6.62	0.00
2002	0.08	0.36	0.83	1.48	2.86	4.12	5.72	6.96	7.54	7.80	0.00
2003	0.08	0.36	0.83	1.65	3.11	4.89	6.83	7.88	8.04	10.47	0.00
2004	0.08	0.36	0.83	1.26	2.33	3.62	5.81	6.93	8.28	11.70	0.00
2005	0.08	0.36	0.83	1.69	1.93	3.37	4.15	6.24	15.20	9.75	0.00
2006	0.08	0.36	0.83	1.55	3.01	4.26	5.89	4.67	8.63	9.86	10.00

Table 2.3.16 Cod in SD 22-24. Proportion mature at age in the start of the year.

	Age										
year	1	2	3	4	5	6	7	8	9	10	11+
1970	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1971	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1972	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1973	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1974	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1975	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1976	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1977	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1978	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1979	0.05	0.20	0.55	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1980	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.25	0.82	0.95	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.01	0.16	0.69	0.87	0.94	0.95	0.99	0.91	0.91	0.91	0.91
1991	0.01	0.16	0.69	0.87	0.94	0.95	0.99	0.91	0.91	0.91	0.91
1992	0.01	0.16	0.69	0.87	0.94	0.95	0.99	0.91	0.91	0.91	0.91
1993	0.01	0.16	0.69	0.87	0.94	0.95	0.99	0.91	0.91	0.91	0.91
1994	0.01	0.16	0.69	0.87	0.94	0.95	0.99	0.91	0.91	0.91	0.91
1995	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
1996	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
1997	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
1998	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
1999	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2000	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2001	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2002	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2003	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2004	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2005	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88
2006	0.01	0.10	0.64	0.87	0.93	0.91	0.99	0.88	0.88	0.88	0.88

Table 2.3.17 Cod in SD 22-24. Natural mortallity at age

	age										
Year	1	2	3	4	5	6	7	8	9	10	11+
1970	0.332	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1971	0.359	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1972	0.365	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1973	0.361	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1974	0.374	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1975	0.327	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1976	0.368	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1977	0.319	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1978	0.343	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1979	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1980	0.352	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1981	0.362	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1982	0.344	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1983	0.315	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1984	0.324	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1985	0.32	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1986	0.261	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1987	0.259	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1988	0.274	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1989	0.263	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1990	0.25	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1991	0.235	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1992	0.228	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1993	0.245	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1994	0.266	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1995	0.286	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.286	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1998	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2000	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2001	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2002	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2004	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2005	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2006	0.242	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 2.3.18. Cod 22-24. Tuning input file

```
      105
Solea_4Q
     1994      2006
        1         1      0.83      0.92
        1         3
        1  137.4356   72.6217  24.75857
        1  489.8913  168.2148   18.9399
        1  32.49045  88.92539  5.527027
        1  330.7776  9.506709  7.848319
        1  524.3097  48.74475  1.103162
        1  110.7635  53.15834  2.120646
        1  135.7774  12.35657  2.819629
        1  252.0115  13.75094  1.466023
        1  248.0003  15.72564  4.165402
        1  37.26496  23.68049  1.490537
        1  377.3533  10.32587  3.458151
        1  111.7035  42.11209  1.288823
        1  74.41897  49.30959  8.705801
Den_Gillnet_120_159mm
     1994      2006
        1         1         0         1
        2         6
 782.0866  11193.53    132927  23766.53  2076.975         0
 2336.719  86678.69  73431.08  135341.4  24142.85  2975.695
 1819.549  128822.3  170321.8  18775.03  53492.09   3152.83
 1985.165     18296  256094.9  38765.45   6126.46  8899.922
 2199.804  101825.8  25249.25  157914.1  17199.28  2034.103
 2195.285  170427.3  139009.7  17375.67  35375.64  5814.721
 1972.428  24597.94  156920.6  63163.27  4313.516  10938.13
 1726.078  46974.64  47656.78  63349.67  16928.19  971.4874
  1274.32  31046.99  74877.63   17643.3   17914.8  1960.812
  1490.75  32593.77  37578.09   24335.2   5146.04  4959.947
 1459.806  8092.272  81639.82  20524.27  6079.081  1351.096
 2136.431   56051.3  19149.51  78470.92  8592.536  2035.557
 1547.876  6352.721  101076.1  10512.73  16069.45  2210.915
Den_Trawl_105-120mm
     1992      2006
        1         1         0         1
        3         6
 2626.933  80784.26  33866.04  294.6976   19810.3
    895.87  95286.67  8246.677  3195.567         0
 2936.254   1089172  125985.5  10836.94         0
  5982.96  777829.8  822426.8  141366.1  18170.56
  7304.07   3603747    116379    378388  18731.74
 7326.444   6286728  557491.5  42122.11  59735.52
 7355.122  285141.8  987268.7  101746.4  13010.35
 8955.651   2078938  215598.8  244176.7  40306.55
 7825.451   2921574  528438.2  27993.46  59434.29
 7483.511  808171.1  664026.8  150765.8  7860.644
 4092.142  994726.5  140238.4  142576.7   21378.7
 2003.556  157090.3  68630.25  13272.91  12532.93
 3566.938   1654523  150824.2  32257.43  5485.515
  3023.14  112093.4  298409.8  33693.44  8440.822
 2602.308   1389350  72227.99   84642.7  8216.293
Havfisken_Q1
     1995      2006
        1         1         0      0.25
        1         3
        1  481.9653  127.4865  17.01449
        1  113.4456  491.0229  68.66388
        1  95.46666  14.48413  102.6947
        1  526.8766  86.17906  17.01092
        1  58.53511  90.80675  29.27911
        1  122.9988  41.31217  87.30199
        1  26.60726  52.11848  19.09167
        1  439.2088  11.47292  7.385417
        1         6  59.94048  6.178571
        1  393.4432  28.14409  55.19883
        1  10.83333  194.9552  16.71145
        1  60.81212  38.29772  44.32349
Havfisken_Q4
     1994      2006
        1         1      0.75         1
        1         3
        1  269.6686  51.92685  10.19934
        1  135.5982  19.03003  7.171305
        1   6.39617   33.5143  4.057971
        1  147.6179  11.18536  7.070598
        1  147.3706  27.49444  3.626256
        1    58.535  36.17984   14.6551
        1  44.49798  12.42886  3.568831
        1  24.51268  4.869048      1.65
        1  31.24118  2.471619    2.0992
        1  12.32917  23.53464    1.7375
        1  48.33206   7.53443  3.133333
        1  26.88889  9.511111  0.666667
        1  15.04231  7.944872  9.666667
```

Table 2.3.18b. Cod 22-24. S.E of log Q by fleets at different shrinkage levels and age groups

	age 2		age 3		age 4		age 5		age 6		
	S.E(Log q)	RSquare	S.E(Log q)	RSquare	S.E(Log q)	RSquare	S.E(Log q)	RSquare	S.E(Log q)	RSquare	
Solea-1Q			0.82	0.24	1.17	0.08	1.29	0.2	1.32	0.1	shr.2
			0.82	0.24	1.17	0.08	1.28	0.2	1.31	0.1	shr1.5
			0.82	0.25	1.17	0.08	1.28	0.21	1.29	0.12	shr.1.0
			0.81	0.25	1.17	0.08	1.25	0.25	1.20	0.21	shr0.5
Solea-4Q	0.70	0.4	0.68	0.52	0.91	0.1	1.08	0.6			shr.2
	0.69	0.41	0.68	0.52	0.89	0.11	1.07	0.6			shr1.5
	0.67	0.44	0.68	0.53	0.86	0.14	1.06	0.6			shr.1.0
	0.63	0.49	0.69	0.53	0.82	0.19	1.06	0.56			shr0.5
Den_Gillnet_120_160m	0.47	0.78	0.44	0.86	0.38	0.70	0.34	0.88	0.17	0.94	shr.2
	0.48	0.78	0.45	0.86	0.38	0.70	0.34	0.88	0.17	0.94	shr1.5
	0.49	0.77	0.45	0.86	0.39	0.70	0.35	0.88	0.19	0.92	shr.1.0
	0.52	0.74	0.46	0.86	0.42	0.68	0.39	0.87	0.28	0.82	shr0.5
Den_Trawl_105-120mm	0.54	0.77	0.60	0.88	0.41	0.67	0.52	0.86	0.22	0.92	shr.2
	0.55	0.77	0.60	0.88	0.41	0.67	0.53	0.85	0.24	0.91	shr1.5
	0.56	0.76	0.60	0.87	0.41	0.67	0.54	0.84	0.27	0.87	shr.1.0
	0.59	0.73	0.62	0.87	0.43	0.66	0.58	0.81	0.43	0.63	shr0.5
Havfisken_SD22_Q1	0.65	0.63	0.65	0.55	0.85	0.61	1.07	0.22	1.06	0.03	shr.2
	0.65	0.63	0.65	0.55	0.85	0.61	1.07	0.22	1.05	0.03	shr1.5
	0.65	0.63	0.65	0.55	0.86	0.61	1.07	0.22	1.03	0.02	shr.1.0
	0.65	0.64	0.65	0.55	0.86	0.63	1.08	0.22	0.97	0.02	shr0.5
Havfisken_SD22_Q4	0.77	0.28	0.64	0.56	1.07	0.00					shr.2
	0.76	0.28	0.64	0.56	1.06	0.00					shr1.5
	0.76	0.29	0.65	0.55	1.04	0.00					shr.1.0
	0.75	0.31	0.66	0.55	1.00	0.01					shr0.5

Table 2.3.19 XSA Diagnostics

Lowestoft VPA Version 3.1

11/05/2007 11:23

Extended Survivors Analysis

#Index File; Cod in the Western Baltic (22-24)

CPUE data from file tuningXSA5.tun

Catch data for 37 years. 1970 to 2006. Ages 1 to 7.

Fleet	Fi year	Last year	First age	Last age	Alpha	Beta
Solea_4Q	1994	2006	1	3	0.83	0.92
Den_Gillnet_120_159m	1994	2006	2	6	0	1
Den_Trawl_105-120mm	1992	2006	3	6	0	1
Havfisken_Q1	1995	2006	1	3	0	0.25
Havfisken_Q4	1994	2006	1	3	0.75	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 4

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 20 iterations

Table 2.3.19 XSA Diagnostics (Cont'd)

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.261	0.197	0.118	0.215	0.172	0.078	0.226	0.046	0.152	0.064
2	0.41	0.729	0.697	0.66	0.84	0.549	0.666	0.503	0.486	0.505
3	1.478	0.771	1.129	1.243	1.466	1.231	0.787	1.075	0.953	0.902
4	1.544	1.15	1.494	1.218	1.388	1.371	0.965	1.3	1.207	1.349
5	1.708	0.94	1.055	1.221	1.104	1.042	0.797	1.073	1.598	0.739
6	1.494	1.077	1.01	0.567	1.29	1.183	0.531	1.337	1.403	0.697

1

XSA population numbers (Thousands)

	AGE					
YEAR	1	2	3	4	5	6
1997	9.78E+04	1.27E+04	4.01E+04	7.27E+03	1.39E+03	9.70E+02
1998	1.28E+05	5.92E+04	6.90E+03	7.49E+03	1.27E+03	2.06E+02
1999	5.78E+04	8.26E+04	2.34E+04	2.61E+03	1.94E+03	4.07E+02
2000	6.36E+04	4.03E+04	3.37E+04	6.19E+03	4.80E+02	5.54E+02
2001	4.55E+04	4.03E+04	1.71E+04	7.95E+03	1.50E+03	1.16E+02
2002	6.74E+04	3.01E+04	1.43E+04	3.23E+03	1.62E+03	4.06E+02
2003	2.09E+04	4.89E+04	1.42E+04	3.41E+03	6.70E+02	4.69E+02
2004	7.58E+04	1.31E+04	2.06E+04	5.30E+03	1.06E+03	2.47E+02
2005	3.05E+04	5.68E+04	6.47E+03	5.75E+03	1.18E+03	2.98E+02
2006	2.91E+04	2.06E+04	2.86E+04	2.04E+03	1.41E+03	1.96E+02

Estimated population abundance at 1st Jan 2007

0.00E+00	2.14E+04	1.02E+04	9.50E+03	4.34E+02	5.51E+02

Taper weighted geometric mean of the VPA populations:

5.41E+04	3.67E+04	1.73E+04	4.45E+03	1.08E+03	2.61E+02

Standard error of the weighted Log(VPA populations) :

0.5613	0.6294	0.6049	0.5861	0.7251	0.8616

1

Log catchability residuals.

Fleet : Solea_4Q

Table 2.3.19 XSA Diagnostics (Cont'd)

Age	1992	1993	1994	1995	1996
1	99.99	99.99	-0.56	0.02	-0.44
2	99.99	99.99	1.02	1.16	0.27
3	99.99	99.99	1.2	1.65	0.11
4	No data for this fleet at this age				
5	No data for this fleet at this age				
6	No data for this fleet at this age				

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.05	0.1	-0.37	-0.24	0.54	0.07	-0.13	0.26	0.3	-0.03
2	-0.18	0.19	-0.08	-0.86	-0.6	-0.42	-0.4	-0.05	-0.13	1.06
3	0.41	-0.41	-0.66	-0.64	-0.42	0.6	-0.82	-0.09	-0.03	0.35
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									

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

Age	2	3
Mean Log q	-6.4783	-7.4822
S.E(Log q)	0.6223	0.6789

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.78	1.235	6.67	0.78	13	0.32	-5.48

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.04	-0.124	6.31	0.48	13	0.68	-6.48
3	0.87	0.394	7.79	0.5	13	0.62	-7.48
1							

Table 2.3.19 XSA Diagnostics (Cont'd)
Fleet : Den_Gillnet_120_159m

Age	1992	1993	1994	1995	1996
1	No data for this fleet at this age				
2	99.99	99.99	-0.26	0.1	0.43
3	99.99	99.99	0.71	-0.26	0.3
4	99.99	99.99	0.19	0.06	-0.85
5	99.99	99.99	0.18	0.2	0.61
6	99.99	99.99	99.99	0.22	-0.06

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	No data for this fleet at this age									
2	0.24	0.45	0.62	-0.51	0.35	0.41	-0.14	-0.26	-0.18	-1.01
3	0.46	-0.47	0.16	0.07	-0.23	0.62	-0.4	0.14	-0.58	-0.1
4	-0.33	0.79	-0.23	0.21	0.16	0.08	0.03	-0.43	0.41	-0.19
5	-0.46	0.27	0.61	0.08	0.4	0.65	0.03	-0.13	-0.07	0.36
6	0.2	0.01	0.35	0.6	0.17	-0.12	0.24	-0.07	-0.2	0.34

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

Age	2	3	4	5	6
Mean Log q	-7.1761	-5.4789	-4.8425	-4.8425	-4.8425
S.E(Log q)	0.4861	0.408	0.4007	0.395	0.2813

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.75	1.473	8.03	0.79	13	0.34	-7.18
3	0.68	2.661	6.85	0.89	13	0.22	-5.48
4	0.83	0.801	5.47	0.7	13	0.34	-4.84
5	0.79	1.577	5.16	0.86	13	0.24	-4.63
6	0.93	0.533	4.78	0.87	12	0.23	-4.71
1							

Fleet : Den_Trawl_105-120mm

Age	1992	1993	1994	1995	1996
1	No data for this fleet at this age				
2	No data for this fleet at this age				
3	-0.82	-0.34	0.01	-0.33	0.47
4	0.41	-0.63	-0.37	0.02	-1.32
5	-2.39	0.72	-0.4	0.12	0.27
6	1.89	99.99	99.99	0.18	-0.58

Table 2.3.19 XSA Diagnostics (Cont'd)

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	0.87	-0.74	-0.03	0.13	-0.35	0.55	-0.76	0.77	-0.65	0.51
4	0.12	0.51	-0.02	0.05	0.13	0.08	-0.14	-0.24	0.49	0.31
5	-0.75	-0.07	0.23	-0.34	0.21	0.65	-0.22	-0.26	0.04	0.6
6	-0.11	-0.25	-0.02	0.01	-0.11	0.2	-0.04	-0.47	-0.04	0.22

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

Age	3	4	5	6
Mean Log q	-3.9927	-3.9361	-3.9361	-3.9361
S.E(Log q)	0.5916	0.4438	0.5686	0.4096

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.58	3.317	6.44	0.86	15	0.25	-3.99
4	0.99	0.027	3.97	0.64	15	0.46	-3.94
5	0.72	1.815	4.8	0.81	15	0.37	-3.94
6	1.22	-0.81	3.57	0.6	13	0.51	-3.96
1							

Fleet : Havfisken_Q1

Age	1992	1993	1994	1995	1996
1	99.99	99.99	99.99	-0.08	0.43
2	99.99	99.99	99.99	0.35	1.33
3	99.99	99.99	99.99	-0.32	0.4
4	No data for this fleet at this age				
5	No data for this fleet at this age				
6	No data for this fleet at this age				

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.54	-0.05	-0.24	0	-0.34	0.51	-0.22	0.34	-0.35	0.47
2	-0.29	-0.01	-0.3	-0.37	-0.12	-1.37	-0.19	0.35	0.82	0.21
3	0.6	0.48	-0.16	0.58	-0.23	-1.03	-1.26	0.6	0.54	0.03
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Table 2.3.19 XSA Diagnostics (Cont'd)
Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3
Mean Log q	-6.4066	-6.3613
S.E(Log q)	0.6679	0.6685

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.45	2.569	8.9	0.72	12	0.38	-6.41

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.81	0.672	7.19	0.6	12	0.56	-6.41
3	0.86	0.427	6.85	0.52	12	0.6	-6.36
1							

Fleet : Havfisken_Q4

Age	1992	1993	1994	1995	1996
1	99.99	99.99	0.86	-0.03	-0.52
2	99.99	99.99	1.52	-0.19	0.13
3	99.99	99.99	0.27	0.63	-0.25
4	No data for this fleet at this age				
5	No data for this fleet at this age				
6	No data for this fleet at this age				

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.36	0.05	0.17	-0.06	-0.15	-0.44	0.19	-0.27	0.3	-0.1
2	0.81	0.45	0.36	-0.02	-0.8	-1.44	0.43	0.47	-0.78	0.07
3	0.25	0.73	1.22	-0.46	-0.36	-0.14	-0.71	-0.24	-0.74	0.4
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Table 2.3.19 XSA Diagnostics (Cont'd)
Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3
Mean Log q	-7.3137	-7.4356
S.E(Log q)	0.7458	0.608

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.68	1.637	8.14	0.75	13	0.35	-6.86

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.23	-0.48	6.57	0.32	13	0.96	-7.31
3	0.84	0.545	7.81	0.57	13	0.53	-7.44
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2005

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Solea_4Q	20712	0.351	0	0	1	0.289	0.066
Den_Gillnet_120_159m	1	0	0	0	0	0	0
Den_Trawl_105-120mm	1	0	0	0	0	0	0
Havfisken_Q1	34103	0.403	0	0	1	0.22	0.041
Havfisken_Q4	19293	0.383	0	0	1	0.243	0.071
P shrinkage mean	36743	0.63				0.096	0.038
F shrinkage mean	9797	0.5				0.152	0.136

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	21417	0.19	0.21	5	1.113	0.064

Table 2.3.19 XSA Diagnostics (Cont'd)

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Solea_4Q	16418	0.301	0.327	1.09	2	0.282	0.341
Den_Gillnet_120_159m	3697	0.508	0	0	1	0.111	1.031
Den_Trawl_105-120mm	1	0	0	0	0	0	0
Havfisken_Q1	8545	0.37	0.256	0.69	2	0.188	0.577
Havfisken_Q4	13071	0.332	0.092	0.28	2	0.23	0.412
F shrinkage mean	7866	0.5				0.189	0.614

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10163	0.17	0.19	8	1.111	0.505

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Solea_4Q	11777	0.289	0.115	0.4	3	0.192	0.78
Den_Gillnet_120_159m	8376	0.335	0.036	0.11	2	0.183	0.979
Den_Trawl_105-120mm	15863	0.616	0	0	1	0.061	0.63
Havfisken_Q1	13255	0.33	0.192	0.58	3	0.153	0.718
Havfisken_Q4	8368	0.301	0.278	0.92	3	0.184	0.98
F shrinkage mean	6788	0.5				0.228	1.115

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9504	0.16	0.1	13	0.631	0.902

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Solea_4Q	399	0.312	0.033	0.1	3	0.07	1.411
Den_Gillnet_120_159m	325	0.297	0.117	0.4	3	0.235	1.571
Den_Trawl_105-120mm	501	0.396	0.368	0.93	2	0.153	1.245
Havfisken_Q1	522	0.354	0.248	0.7	3	0.058	1.216
Havfisken_Q4	387	0.322	0.346	1.08	3	0.069	1.434
F shrinkage mean	489	0.5				0.414	1.262

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
434	0.23	0.08	15	0.349	1.349

Table 2.3.19 XSA Diagnostics (Cont'd)

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2001

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Solea_4Q	524	0.294	0.121	0.41	3	0.032	0.765
Den_Gillnet_120_159m	780	0.304	0.056	0.18	4	0.359	0.573
Den_Trawl_105-120mm	982	0.402	0.049	0.12	3	0.194	0.479
Havfisken_Q1	831	0.344	0.204	0.59	3	0.025	0.546
Havfisken_Q4	425	0.314	0.193	0.62	3	0.03	0.883
F shrinkage mean	285	0.5				0.36	1.136

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
551	0.23	0.16	17	0.718	0.739

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Solea_4Q	80	0.296	0.433	1.46	3	0.007	0.696
Den_Gillnet_120_159m	105	0.263	0.089	0.34	5	0.462	0.57
Den_Trawl_105-120mm	95	0.372	0.08	0.22	4	0.23	0.612
Havfisken_Q1	34	0.339	0.338	1	3	0.005	1.218
Havfisken_Q4	47	0.317	0.313	0.99	3	0.006	0.998
F shrinkage mean	46	0.5				0.29	1.008

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
80	0.21	0.11	19	0.517	0.697

Table 2.3.20 Cod in SD 22-24. Estimated fishing mortality (F) at age

Run title : Cod in the Western Baltic (22-24)
Terminal Fs

AGE	1970	1971	1972	1973	1974	1975	1976
1	0.519	0.508	0.523	0.262	0.362	0.154	0.216
2	1.105	1.115	0.951	0.990	1.050	0.831	1.070
3	1.174	1.143	1.181	1.090	1.311	1.125	1.500
4	0.923	0.978	1.158	1.094	1.504	1.188	1.292
5	0.704	0.885	1.563	0.811	1.180	0.994	1.483
6	0.944	1.014	1.317	1.010	1.349	1.115	1.444
7+	0.944	1.014	1.317	1.010	1.349	1.115	1.444
FBAR 3-6	0.936	1.005	1.305	1.001	1.336	1.105	1.430

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.244	0.156	0.069	0.165	0.048	0.443	0.476	0.415	0.205	0.144
2	1.107	0.932	0.684	0.460	0.965	0.836	1.027	0.974	0.593	0.528
3	1.420	1.083	1.041	1.178	1.391	1.078	1.060	0.868	1.306	1.513
4	1.521	1.003	0.872	0.937	1.424	0.656	0.964	0.864	1.240	1.661
5	1.295	0.856	0.784	0.803	1.228	0.807	0.747	0.702	1.117	1.990
6	1.430	0.991	0.909	0.983	1.365	0.856	0.934	0.820	1.236	1.745
7+	1.430	0.991	0.909	0.983	1.365	0.856	0.934	0.820	1.236	1.745
FBAR 3-6	1.416	0.983	0.901	0.975	1.352	0.849	0.926	0.813	1.225	1.728

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.254	0.226	0.147	0.187	0.156	0.184	0.015	0.055	0.098	0.902
2	0.800	0.752	0.374	0.766	0.579	0.525	0.471	0.654	0.401	0.566
3	0.902	1.134	1.218	0.924	1.860	1.177	0.848	0.789	0.786	1.281
4	1.177	1.022	1.221	1.486	2.483	1.258	1.395	0.588	0.967	1.216
5	1.058	0.743	0.974	1.441	1.539	1.578	1.626	0.300	1.314	1.121
6	1.058	0.977	1.151	1.300	1.988	1.195	1.325	0.552	0.930	1.336
7+	1.058	0.977	1.151	1.300	1.988	1.195	1.325	0.552	0.930	1.336
FBAR 3-6	1.049	0.969	1.141	1.288	1.967	1.302	1.298	0.557	0.999	1.239

AGE	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Fbar
1	0.2611	0.1969	0.1181	0.2147	0.1721	0.0781	0.2263	0.0462	0.1522	0.0643	0.096
2	0.4097	0.7291	0.6973	0.6604	0.8397	0.5487	0.6662	0.5029	0.4862	0.5046	0.537
3	1.4777	0.7713	1.1288	1.2433	1.4657	1.2307	0.787	1.0746	0.9528	0.902	0.9795
4	1.5437	1.1499	1.4941	1.2184	1.388	1.3714	0.9651	1.3003	1.2065	1.3487	1.2885
5	1.7084	0.9397	1.0551	1.2205	1.1044	1.0417	0.7967	1.0733	1.5979	0.7389	1.137
6	1.4942	1.0767	1.0098	0.5674	1.2899	1.1828	0.5314	1.3368	1.4026	0.6968	1.1469
7+	1.4942	1.0767	1.0098	0.5674	1.2899	1.1828	0.5314	1.3368	1.4026	0.6968	
FBAR 3-6	1.556	0.9844	1.172	1.0624	1.312	1.2066	0.7701	1.1963	1.29	0.9216	

Table 2.3.21. Cod in SD 22-24. Estimated stock numbers at age in ('000)

AGE	1970	1971	1972	1973	1974	1975	1976
1	262766	206955	286485	92894	251576	114316	110990
2	106379	112245	86958	117933	49843	120462	70667
3	18479	28841	30138	27521	35890	14283	42968
4	6690	4679	7530	7575	7580	7920	3798
5	1975	2177	1440	1937	2078	1379	1977
6	449	800	735	247	705	523	418
7+	199	368	305	244	178	287	165
Total	396937	356064	413591	248351	347849	259170	230984

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	191230	131992	57848	161437	106624	146232	176779	53626	36208	95640
2	61895	108884	80155	36177	96231	70739	66579	80180	25610	21415
3	19847	16752	35107	33100	18705	30026	25094	19515	24789	11590
4	7851	3928	4646	10148	8347	3811	8363	7121	6707	5498
5	854	1405	1180	1590	3255	1645	1619	2611	2458	1589
6	368	192	489	441	583	780	601	628	1059	659
7+	155	88	124	435	271	339	308	323	285	212
Total	282198	263241	179549	243329	234016	253572	279343	164005	97116	136602

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	59139	17605	25884	23603	39860	92811	46807	80410	126731	41600
2	63816	35398	10678	17176	15245	26968	61453	36086	58330	86326
3	10341	23483	13664	6012	6540	6994	13060	31411	15362	31970
4	2089	3435	6189	3311	1955	834	1765	4582	11679	5730
5	855	527	1012	1494	613	134	194	358	2084	3635
6	178	243	205	313	289	108	23	31	217	459
7+	140	134	100	104	69	98	59	49	18	62
Total	136557	80824	57732	52014	64571	127946	123361	152926	214422	169782

AGE	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	97834	128056	57815	63634	45526	67383	20862	75805	30495	29093	0
2	12687	59153	82565	40334	40305	30090	48928	13061	56823	20560	21417
3	40120	6895	23360	33659	17061	14251	14233	20576	6467	28609	10163
4	7271	7495	2611	6186	7948	3226	3408	5304	5752	2042	9504
5	1390	1272	1943	480	1498	1624	670	1063	1183	1409	434
6	970	206	407	554	116	406	469	247	298	196	551
7+	229	133	162	159	119	56	149	138	129	65	107
Total	160501	203211	168863	145006	112573	117036	88718	116194	101146	81974	42175

Table 2.3.22 Cod in SD22-24. Input to RCT3

Age 1 and 0

'Yclass'	'VPA1'	SoleaQ4_1'	SoleaQ4_0'	HavQ1_1'	HavQ4_0'
1977	131992	208	-9	-9	-9
1978	57848	143	139	-9	-9
1979	161437	-9	81	-9	-9
1980	106624	327	-9	-9	-9
1981	146232	120	51	-9	-9
1982	176779	201	215	-9	-9
1983	53626	56	32	-9	-9
1984	36208	52	23	-9	-9
1985	95640	235	47	-9	-9
1986	59139	-9	36	-9	-9
1987	17605	-9	-9	-9	-9
1988	25884	63	-9	-9	-9
1989	23603	-9	5	-9	-9
1990	39860	50	-9	-9	-9
1991	92811	266	-9	-9	-9
1992	46807	151	79	-9	-9
1993	80410	137	106	-9	-9
1994	126731	490	696	482	976
1995	41600	32	9	113	53
1996	97834	331	396	95	100
1997	128056	524	2259	527	2196
1998	57815	111	172	59	420
1999	63634	136	319	123	109
2000	45526	252	80	27	25
2001	67383	248	346	439	325
2002	20862	37	95	6	8
2003	75805	377	807	393	67
2004	30495	112	159	11	27
2005	-9	74	50	61	35
2006	-9	-9	173	8	1

Table 2.3.23

```
Analysis by RCT3 ver3.1 of data from file :

 F2007e.txt

 Cod in SD22-24 RCT3  input age 1 run123-04-2007

 Data for    4 surveys over   30 years :  1977 - 2006

 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2000

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 GerQ4_     .61   8.05    .26   .800     19   5.53   11.43     .308     .436
 GerQ4_     .33   9.51    .31   .755     17   4.40   10.96     .373     .298
 DenQ1_     .67   7.84    .44   .574      6   3.32   10.07     .765     .071
 DenQ4_     .42   8.88    .46   .554      6   3.25   10.26     .745     .075

                                         VPA Mean =   11.01     .586     .121


 Yearclass =   2001

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 GerQ4_     .67   7.69    .36   .667     20   5.52   11.38     .417     .231
 GerQ4_     .33   9.46    .29   .764     18   5.85   11.40     .351     .327
 DenQ1_     .54   8.57    .37   .652      7   6.09   11.87     .524     .146
 DenQ4_     .36   9.28    .38   .641      7   5.79   11.37     .492     .166

                                         VPA Mean =   11.01     .556     .130

 Yearclass =   2002

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 GerQ4_     .66   7.70    .34   .651     21   3.64   10.11     .453     .216
 GerQ4_     .32   9.46    .28   .760     19   4.56   10.93     .325     .419
 DenQ1_     .56   8.38    .47   .501      8   1.95    9.47     .823     .065
 DenQ4_     .37   9.23    .37   .617      8   2.18   10.02     .573     .135

                                         VPA Mean =   11.04     .519     .164

 Yearclass =   2003

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 GerQ4_     .70   7.50    .35   .726     22   5.94   11.64     .420     .270
 GerQ4_     .49   8.51    .54   .552     20   6.69   11.78     .653     .112
 DenQ1_     .47   8.88    .37   .738      9   5.98   11.66     .471     .215
 DenQ4_     .38   9.16    .35   .759      9   4.22   10.75     .430     .259
                                         VPA Mean =   10.97     .576     .144
```

Table 2.3.23 (Cont'd)

Yearclass = 2004

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
GerQ4_	.68	7.55	.35	.714	23	4.72	10.76	.403	.295
GerQ4_	.48	8.48	.52	.545	21	5.08	10.92	.601	.132
DenQ1_	.45	8.92	.36	.724	10	2.47	10.02	.487	.202
DenQ4_	.39	9.15	.38	.702	10	3.34	10.45	.475	.212
					VPA Mean =		11.00	.550	.158

Yearclass = 2005

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
GerQ4_	.74	7.17	.39	.682	24	4.32	10.39	.458	.220
GerQ4_	.56	7.98	.60	.488	22	3.92	10.18	.715	.090
DenQ1_	.42	9.09	.33	.771	11	4.12	10.81	.386	.309
DenQ4_	.40	9.08	.37	.723	11	3.57	10.52	.447	.231
					VPA Mean =		10.95	.554	.150

Yearclass = 2006

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
GerQ4_									
GerQ4_	.58	7.85	.61	.482	22	5.16	10.84	.705	.143
DenQ1_	.41	9.11	.32	.776	11	2.20	10.02	.425	.394
DenQ4_	.40	9.08	.37	.722	11	.75	9.38	.559	.228
					VPA Mean =		10.95	.552	.234

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	63403	11.06	.20	.21	1.09	45527	10.73
2001	89983	11.41	.20	.11	.33	67384	11.12
2002	38320	10.55	.21	.25	1.45	20862	9.95
2003	83475	11.33	.22	.21	.94	75805	11.24
2004	40321	10.60	.22	.17	.62	30495	10.33
2005	40677	10.61	.21	.12	.32		
2006	27134	10.21	.27	.35	1.68		

Table 2.3.24 Cod in SD 22-24. Stock Summary

Run title : Index File; Cod in the Western Baltic (22-24)

At 24/04/2007 22:47

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

Year	Recruits Age 1	Total Bio tonnes	SSB tonnes	Landings tonnes	Yield/SSB	Fbar Ages 3-6
1970	262766	107139	38045	43959	1.1554	0.9361
1971	206955	114961	44205	46623	1.0547	1.0051
1972	286485	115194	44885	48900	1.0895	1.3048
1973	92894	106851	44221	54357	1.2292	1.001
1974	251576	103139	45626	46571	1.0207	1.3358
1975	114316	96210	37127	44367	1.195	1.1052
1976	110990	98967	44077	49433	1.1215	1.4296
1977	191230	81791	33143	46305	1.3971	1.4164
1978	131992	86839	29719	40612	1.3665	0.983
1979	57848	89240	39415	45046	1.1429	0.9014
1980	161437	89711	56154	41972	0.7474	0.9752
1981	106624	95326	50577	53646	1.0607	1.3522
1982	146232	91273	49230	47524	0.9653	0.8492
1983	176779	92659	49715	48605	0.9777	0.926
1984	53626	81197	46366	49495	1.0675	0.8134
1985	36208	72141	49462	40159	0.8119	1.2248
1986	95640	46113	29185	26692	0.9146	1.7276
1987	59139	56383	24086	28566	1.186	1.049
1988	17605	48195	30384	29159	0.9597	0.9687
1989	25884	36819	24938	18516	0.7425	1.1409
1990	23603	31036	15990	17780	1.1119	1.2877
1991	39860	28235	11374	16693	1.4677	1.9674
1992	92811	42239	10034	17996	1.7934	1.3022
1993	46807	59085	18196	21228	1.1667	1.2984
1994	80410	73956	32452	30695	0.9459	0.5573
1995	126731	64351	28667	33895	1.1824	0.9993
1996	41600	79584	36904	50845	1.3778	1.2385
1997	97834	61603	36237	43624	1.2039	1.556
1998	128056	56125	22722	34216	1.5058	0.9844
1999	57815	65482	26082	42155	1.6163	1.172
2000	63634	62224	32526	38347	1.179	1.0624
2001	45526	50319	26587	34244	1.288	1.312
2002	67383	39368	19002	24158	1.2713	1.2066
2003	20862	42155	19241	24624	1.2798	0.7701
2004	75805	38571	21207	20854	0.9834	1.1963
2005	30495	42121	17758	22045	1.2414	1.29
2006	29093	41961	23714	22750	0.9593	0.9216
2007	27134*					
Average	98772	69918	32678	36396	1.1564	1.1506

* output from RCT3 analysis

Table 2.3.25 Input short-term

MFDP version 1a
Run: WestBalticCod_notScaled
Time and date: 14:28 11-05-2007
Fbar age range (Total) : 3-6 F is not scaled to final year
Fbar age range Fleet 1 : 3-6

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	27134	0.242	0.01	0	0	0.08	0.02	0.68	0.07	0.27
2	29945	0.2	0.1	0	0	0.36	0.32	0.79	0.18	0.37
3	10163	0.2	0.64	0	0	0.83	0.86	1.05	0.12	0.42
4	9504	0.2	0.87	0	0	1.50	1.26	1.52	0.02	0.54
5	434	0.2	0.93	0	0	2.42	1.12	2.44	0.02	0.48
6	551	0.2	0.91	0	0	3.75	1.15	3.75	0.00	0.00
7	107	0.2	0.99	0	0	6.10	1.15	6.10	0.00	0.00

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	51367	0.242	0.01	0	0	0.08	0.02	0.68	0.07	0.27
2 .		0.2	0.1	0	0	0.36	0.32	0.79	0.18	0.37
3 .		0.2	0.64	0	0	0.83	0.86	1.05	0.12	0.42
4 .		0.2	0.87	0	0	1.50	1.26	1.52	0.02	0.54
5 .		0.2	0.93	0	0	2.42	1.12	2.44	0.02	0.48
6 .		0.2	0.91	0	0	3.75	1.15	3.75	0.00	0.00
7 .		0.2	0.99	0	0	6.10	1.15	6.10	0.00	0.00

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	51367	0.242	0.01	0	0	0.08	0.02	0.68	0.07	0.27
2 .		0.2	0.1	0	0	0.36	0.32	0.79	0.18	0.37
3 .		0.2	0.64	0	0	0.83	0.86	1.05	0.12	0.42
4 .		0.2	0.87	0	0	1.50	1.26	1.52	0.02	0.54
5 .		0.2	0.93	0	0	2.42	1.12	2.44	0.02	0.48
6 .		0.2	0.91	0	0	3.75	1.15	3.75	0.00	0.00
7 .		0.2	0.99	0	0	6.10	1.15	6.10	0.00	0.00

Input units are thousands and kg - output in tonnes

N_{2007} Age 1:	Based on RCT3 analysis using 4 surveys, but excluding final year age 1 estimate from XSA
N_{2007} Age 2:	Based on RCT3 analysis using YC 2005 (40677) as age 1 in 2006, and with Z (M+Fland+Fdiscard) in 2006.
N_{2007} Age 3-7+:	Output from VPA 10.05.07
N_{2008} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
N_{2009} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
Natural mortality (M):	Average for 2004-2006
Weight in the catch & stock	Average for 2004-2006
Exploitation pattern (Sel.):	Average for 2004-2006,not scaled to final year
Maturity ogive	Average for 2004-2006

MFDP version 1a
Run: WestBalticCod F is scaled to final year
Time and date: 14:17 11-05-2007
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	27134	0.242	0.01	0	0	0.08	0.01	0.68	0.06	0.27
2	29945	0.2	0.1	0	0	0.36	0.26	0.79	0.15	0.37
3	10163	0.2	0.64	0	0	0.83	0.70	1.05	0.10	0.42
4	9504	0.2	0.87	0	0	1.50	1.02	1.52	0.02	0.54
5	434	0.2	0.93	0	0	2.42	0.91	2.44	0.02	0.48
6	551	0.2	0.91	0	0	3.75	0.93	3.75	0.00	0.00
7	107	0.2	0.99	0	0	6.10	0.93	6.10	0.00	0.00

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	51367	0.242	0.01	0	0	0.08	0.01	0.68	0.06	0.27
2 .		0.2	0.1	0	0	0.36	0.26	0.79	0.15	0.37
3 .		0.2	0.64	0	0	0.83	0.70	1.05	0.10	0.42
4 .		0.2	0.87	0	0	1.50	1.02	1.52	0.02	0.54
5 .		0.2	0.93	0	0	2.42	0.91	2.44	0.02	0.48
6 .		0.2	0.91	0	0	3.75	0.93	3.75	0.00	0.00
7 .		0.2	0.99	0	0	6.10	0.93	6.10	0.00	0.00

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
1	51367	0.242	0.01	0	0	0.08	0.01	0.68	0.06	0.27
2 .		0.2	0.1	0	0	0.36	0.26	0.79	0.15	0.37
3 .		0.2	0.64	0	0	0.83	0.70	1.05	0.10	0.42
4 .		0.2	0.87	0	0	1.50	1.02	1.52	0.02	0.54
5 .		0.2	0.93	0	0	2.42	0.91	2.44	0.02	0.48
6 .		0.2	0.91	0	0	3.75	0.93	3.75	0.00	0.00
7 .		0.2	0.99	0	0	6.10	0.93	6.10	0.00	0.00

Input units are thousands and kg - output in tonnes

N_{2007} Age 1:	Based on RCT3 analysis using 4 surveys, but excluding final year age 1 estimate from XSA
N_{2007} Age 2:	Based on RCT3 analysis using YC 2005 (40677) as age 1 in 2006, and with Z (M+Fland+Fdiscard) in 2006.
N_{2007} Age 3-7+:	Output from VPA 10.05.07
N_{2008} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
N_{2009} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
Natural mortality (M):	Average for 2004-2006
Weight in the catch & stock	Average for 2004-2006
Exploitation pattern (Sel.):	Average for 2004-2006,is scaled to final year
Maturity ogive	Average for 2004-2006

Table 2.3.26 output short-term

MFDP version 1a
Run: WestBalticCod
Time and date: 14:17 11-05-2007
Fbar age range (Total) : 3-6 F is scaled to final year
Fbar age range Fleet 1 : 3-6

2007								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
39406	22388	1	0.8885	20044	0.0331	1917		0.9216
	22.388	26.7						
2008							2009	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
38839	22268	0	0	0	0	0	69820	43941
.	22268	0.1	0.0888	2621	0.0033	230	66015	40740
.	22268	0.2	0.1777	5045	0.0066	452	62502	37795
.	22268	0.3	0.2665	7289	0.0099	665	59255	35086
.	22268	0.4	0.3554	9366	0.0133	870	56253	32591
.	22268	0.5	0.4442	11291	0.0166	1067	53477	30294
.	22268	0.6	0.5331	13075	0.0199	1258	50907	28178
.	22268	0.7	0.6219	14730	0.0232	1442	48526	26228
	22268	0.75	0.66635	15498	0.02485	1530.5	47423.5	25329
.	22268	0.8	0.7108	16266	0.0265	1619	46321	24430
.	22268	0.9	0.7996	17692	0.0298	1791	44275	22772
.	22268	1	0.8885	19018	0.0331	1957	42378	21242
.	22268	1.1	0.9773	20251	0.0364	2117	40615	19830
.	22268	1.2	1.0662	21398	0.0398	2273	38978	18526
.	22268	1.3	1.155	22467	0.0431	2424	37456	17321
.	22268	1.4	1.2439	23462	0.0464	2570	36039	16207
.	22268	1.5	1.3327	24390	0.0497	2712	34720	15178
.	22268	1.6	1.4215	25257	0.053	2849	33491	14225
.	22268	1.7	1.5104	26066	0.0563	2983	32344	13344
.	22268	1.8	1.5992	26822	0.0596	3113	31274	12527
.	22268	1.9	1.6881	27529	0.063	3240	30275	11771
.	22268	2	1.7769	28192	0.0663	3363	29340	11070

Input units are thousands and kg - output in tonnes

N_{2007} Age 1:	Based on RCT3 analysis using 4 surveys, but excluding final year age 1 estimate from XSA
N_{2007} Age 2:	Based on RCT3 analysis using YC 2005 (40677) as age 1 in 2006, and with Z (M+Fland+Fdiscard) in 2006.
N_{2007} Age 3-7+:	Output from VPA 10.05.07
N_{2008} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
N_{2009} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
Natural mortality (M):	Average for 2004-2006
Weight in the catch & stock	Average for 2004-2006
Exploitation pattern (Sel.):	Average for 2004-2006, scaled to final year
Maturity ogive	Average for 2004-2006

MFDP version 1a
Run: WestBalticCod_notScaled
Time and date: 14:28 11-05-2007
Fbar age range (Total) : 3-6
Fbar age range Fleet 1 : 3-6 F is not scaled to final year

2007								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
39406	22388	1	1.0951	22894	0.0408	2267		1.1359
	22.388	26.7						
2008							2009	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
34774	18981	0	0	0	0	0	64384	39073
.	18981	0.1	0.1095	2803	0.0041	273	60299	35673
.	18981	0.2	0.219	5354	0.0082	534	56589	32601
.	18981	0.3	0.3285	7677	0.0123	783	53215	29823
.	18981	0.4	0.438	9795	0.0163	1021	50144	27311
.	18981	0.5	0.5475	11727	0.0204	1248	47347	25036
.	18981	0.6	0.6571	13491	0.0245	1467	44797	22976
.	18981	0.7	0.7666	15105	0.0286	1676	42470	21110
	18981	0.75	0.82135	15843	0.03065	1776.5	41407	20263.5
.	18981	0.8	0.8761	16581	0.0327	1877	40344	19417
.	18981	0.9	0.9856	17933	0.0368	2071	38399	17881
.	18981	1	1.0951	19172	0.0408	2257	36619	16486
.	18981	1.1	1.2046	20310	0.0449	2436	34987	15218
.	18981	1.2	1.3141	21356	0.049	2609	33490	14065
.	18981	1.3	1.4236	22318	0.0531	2775	32114	13017
.	18981	1.4	1.5331	23204	0.0572	2937	30848	12061
.	18981	1.5	1.6426	24022	0.0613	3092	29683	11191
.	18981	1.6	1.7521	24776	0.0653	3243	28608	10396
.	18981	1.7	1.8617	25473	0.0694	3389	27616	9671
.	18981	1.8	1.9712	26119	0.0735	3530	26698	9009
.	18981	1.9	2.0807	26717	0.0776	3668	25848	8404
.	18981	2	2.1902	27271	0.0817	3801	25061	7849

Input units are thousands and kg - output in tonnes

N_{2007} Age 1:	Based on RCT3 analysis using 4 surveys, but excluding final year age 1 estimate from XSA
N_{2007} Age 2:	Based on RCT3 analysis using YC 2005 (40677) as age 1 in 2006, and with Z (M+Fland+Fdiscard) in 2006.
N_{2007} Age 3-7+:	Output from VPA 10.05.07
N_{2008} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
N_{2009} Age 1:	Geom. mean from VPA output of age 1 for the YCs 1986-2004 (XSA from 10.05.07)
Natural mortality (M):	Average for 2004-2006
Weight in the catch & stock	Average for 2004-2006
Exploitation pattern (Sel.):	Average for 2004-2006,not scaled to final year
Maturity ogive	Average for 2004-2006

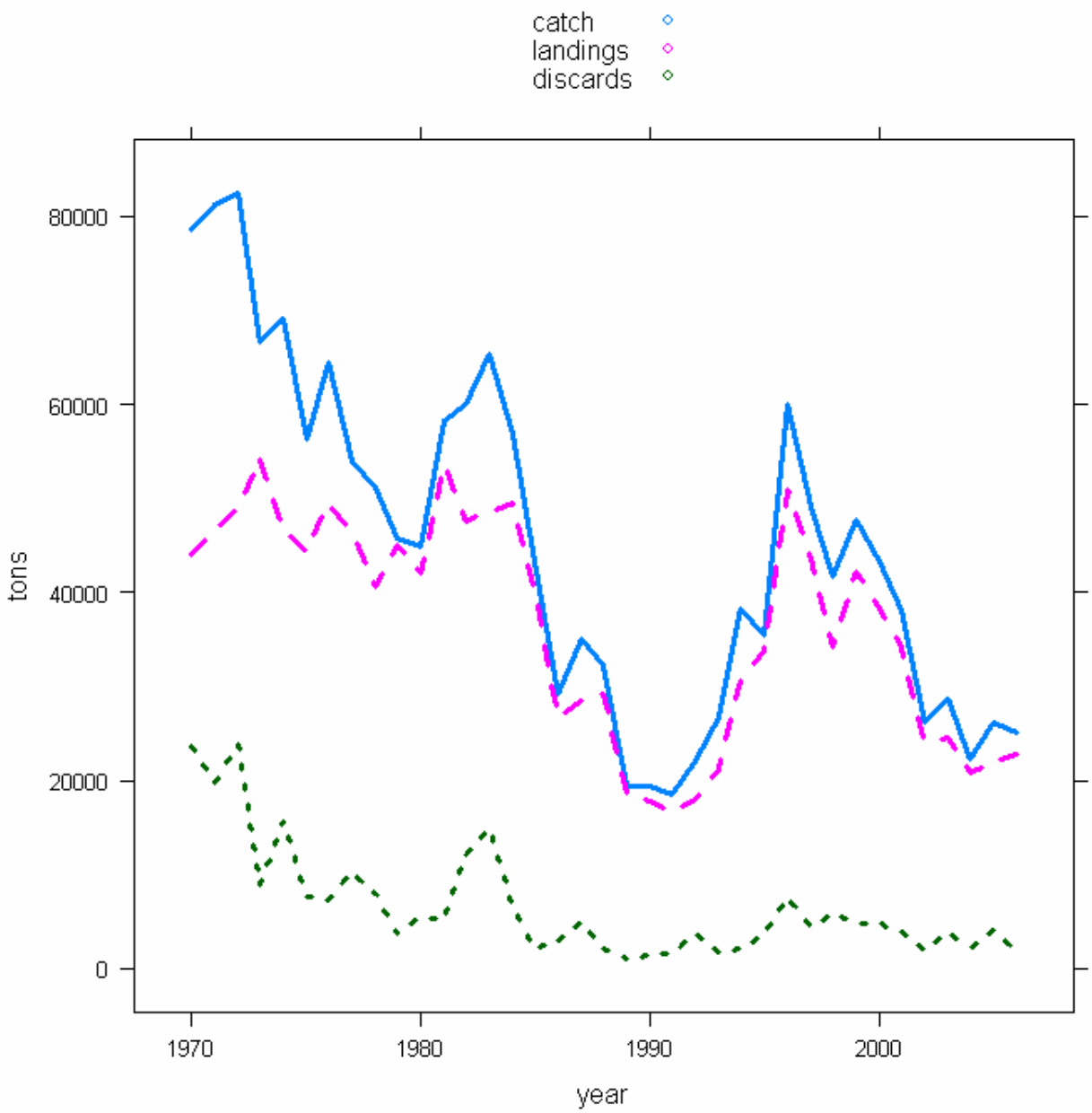


Figure 2.3.1 Cod 22-24. Landings, discards and catches in the Western Baltic area in the period 1970-2006.

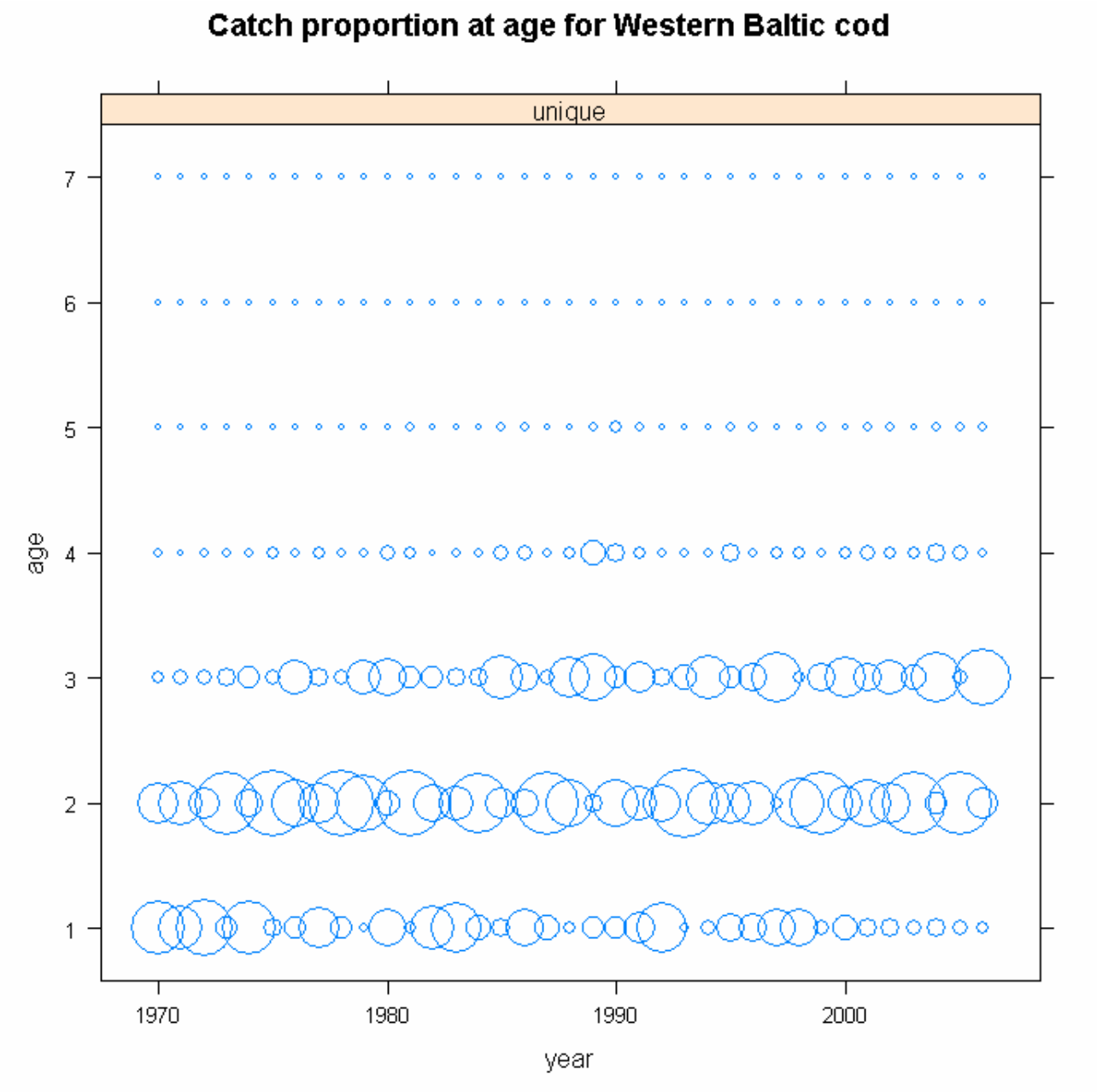


Figure 2.3.2 Cod 22-24. Relative catch composition.

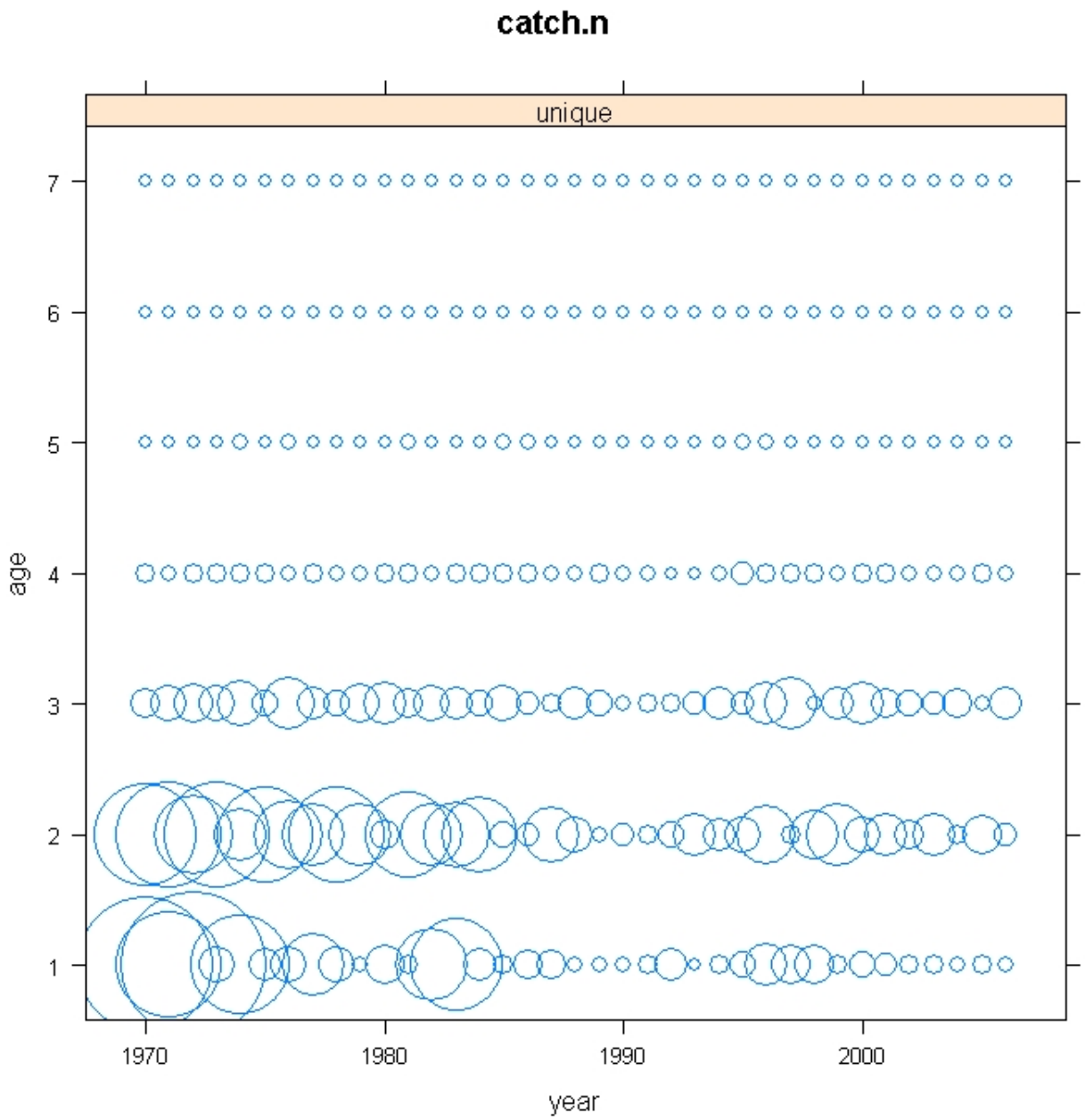


Figure 2.3.3 Cod 22-24. The proportion of age groups in the catches between 1970 – 2006.

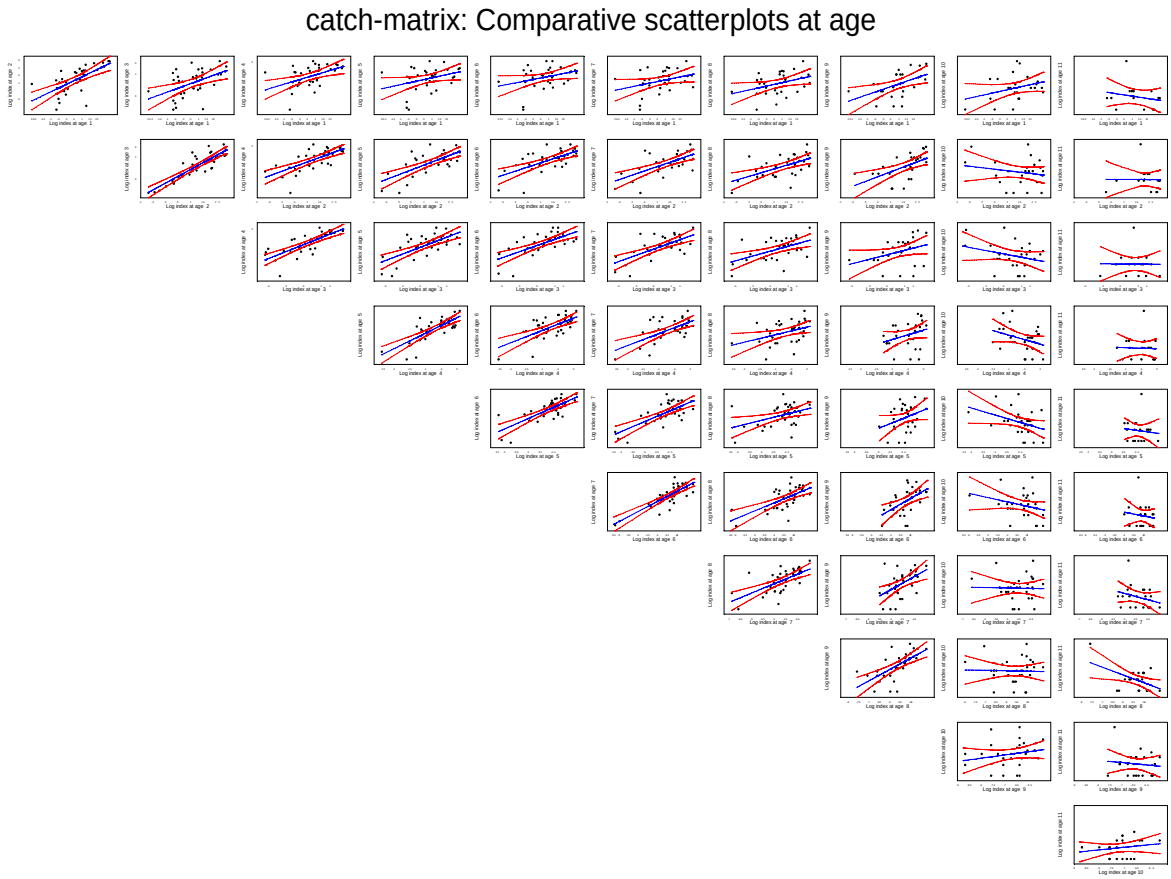


Figure 2.3.4 Cod 22-24. Internal consistency plot in the catch at age matrix from age 1-11.

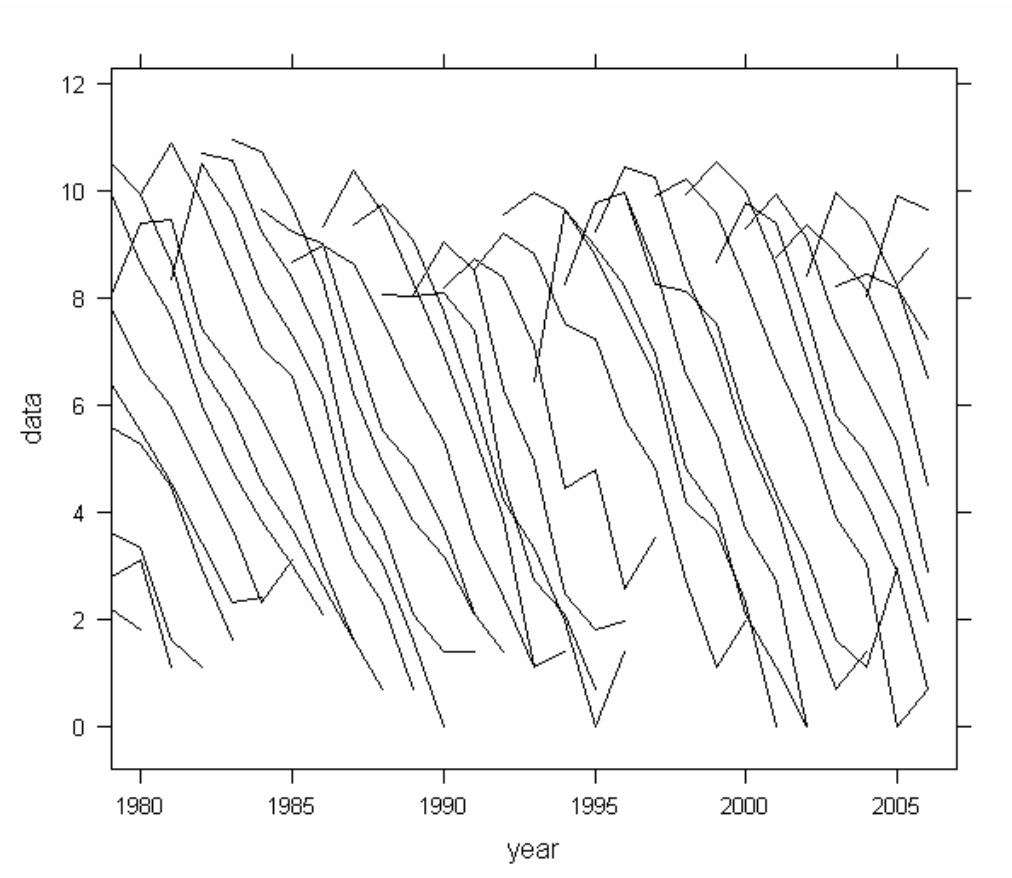


Figure 2.3.5. Cod 22-24. Cohort plot from the catch at age matrix.

Figure 2.3.6 Cod 22-24. Weight at age in catches.

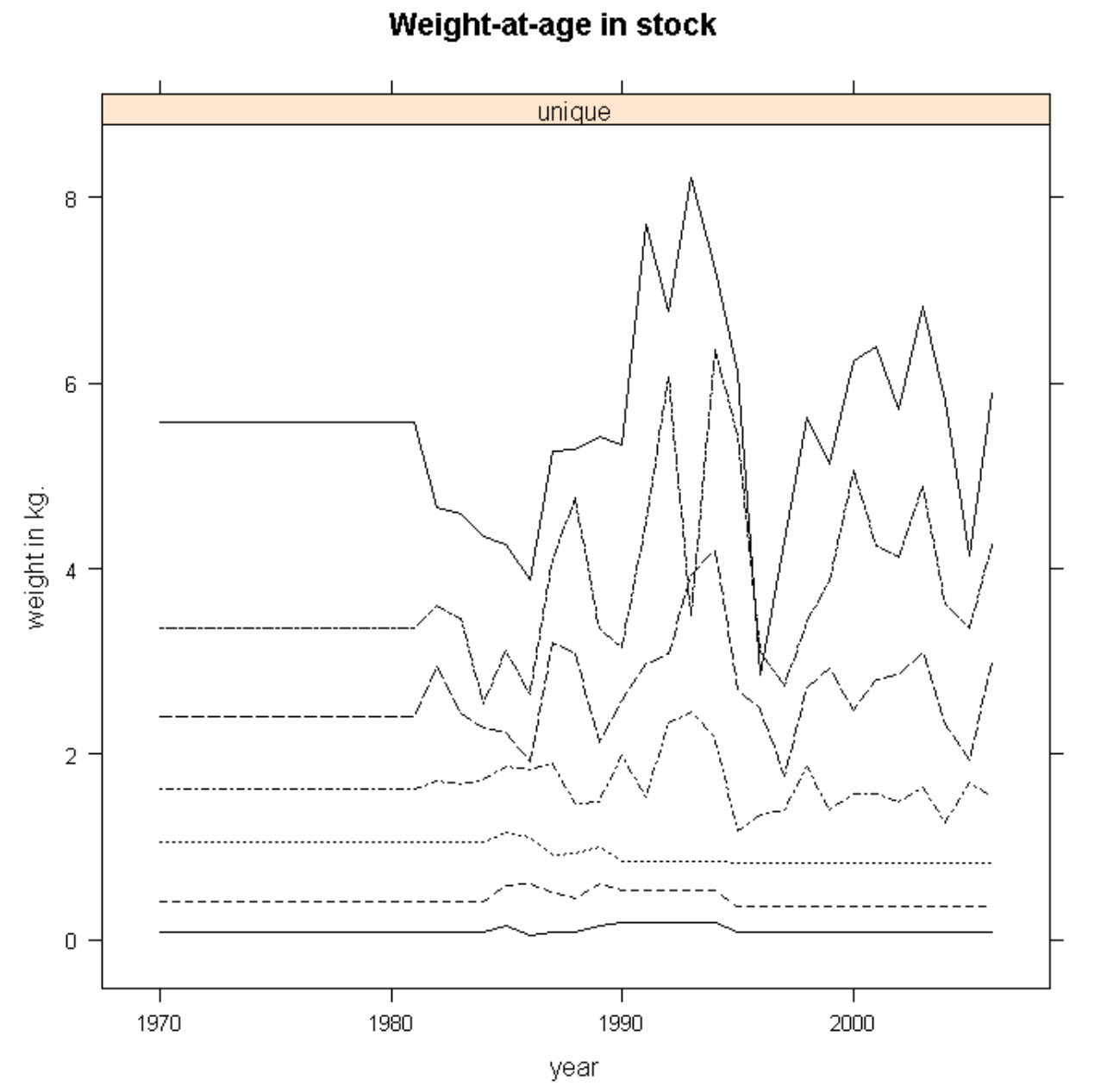


Figure 2.3.7 Cod 22-24. Weight at age in stock.

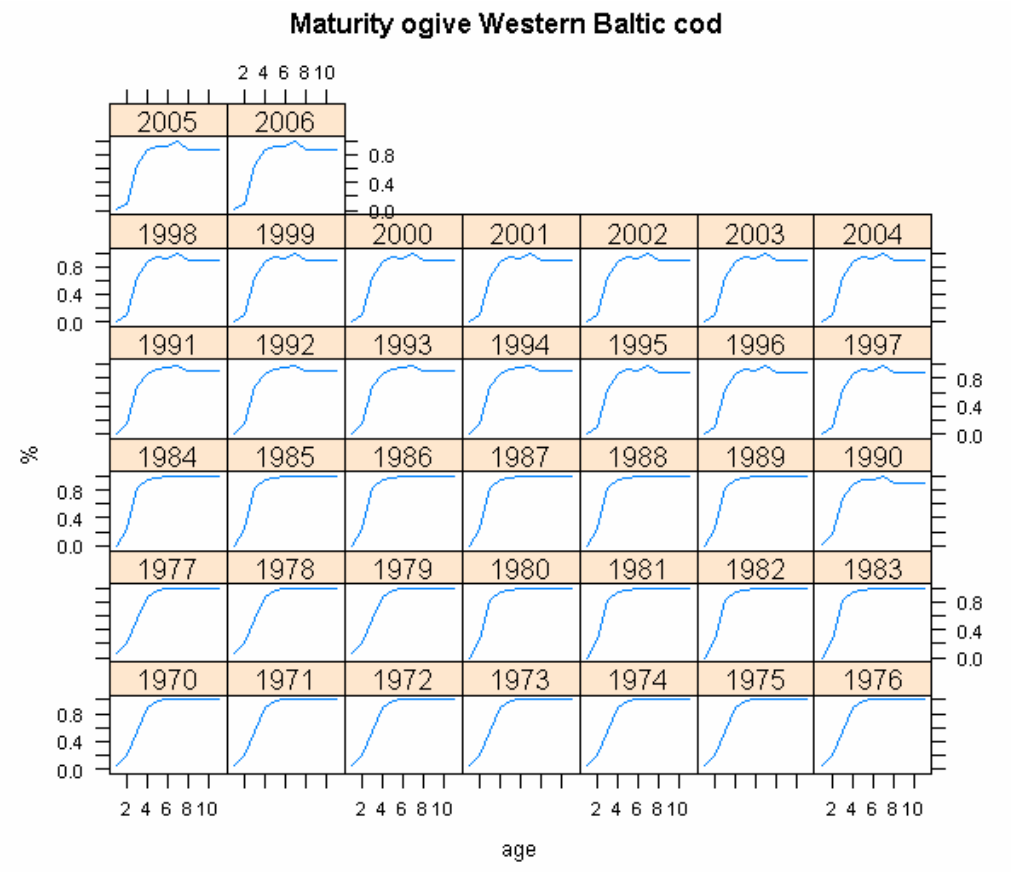


Figure 2.3.8. Cod 22-24. Maturity ogive for Western Baltic cod

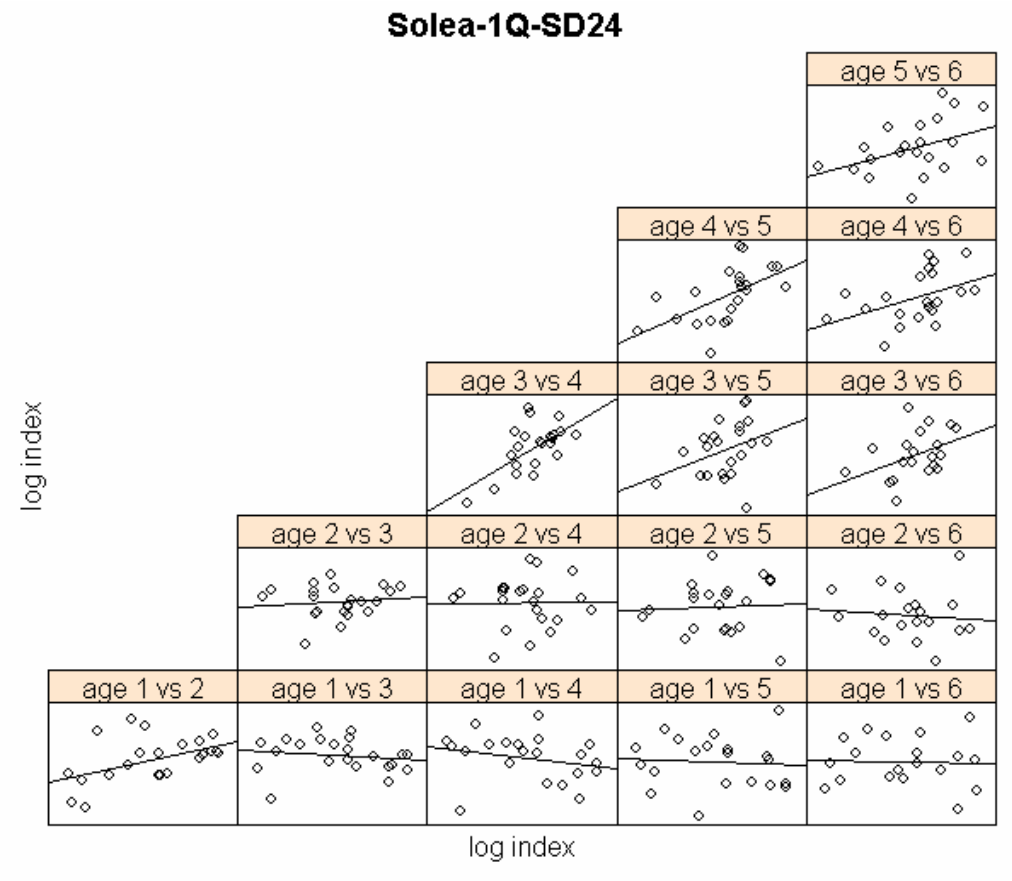


Figure 2.3.9 Cod 22-24. Internal consistency plot between one age group and the the age group+1 the year after. From the German survey in the 1st quarter.

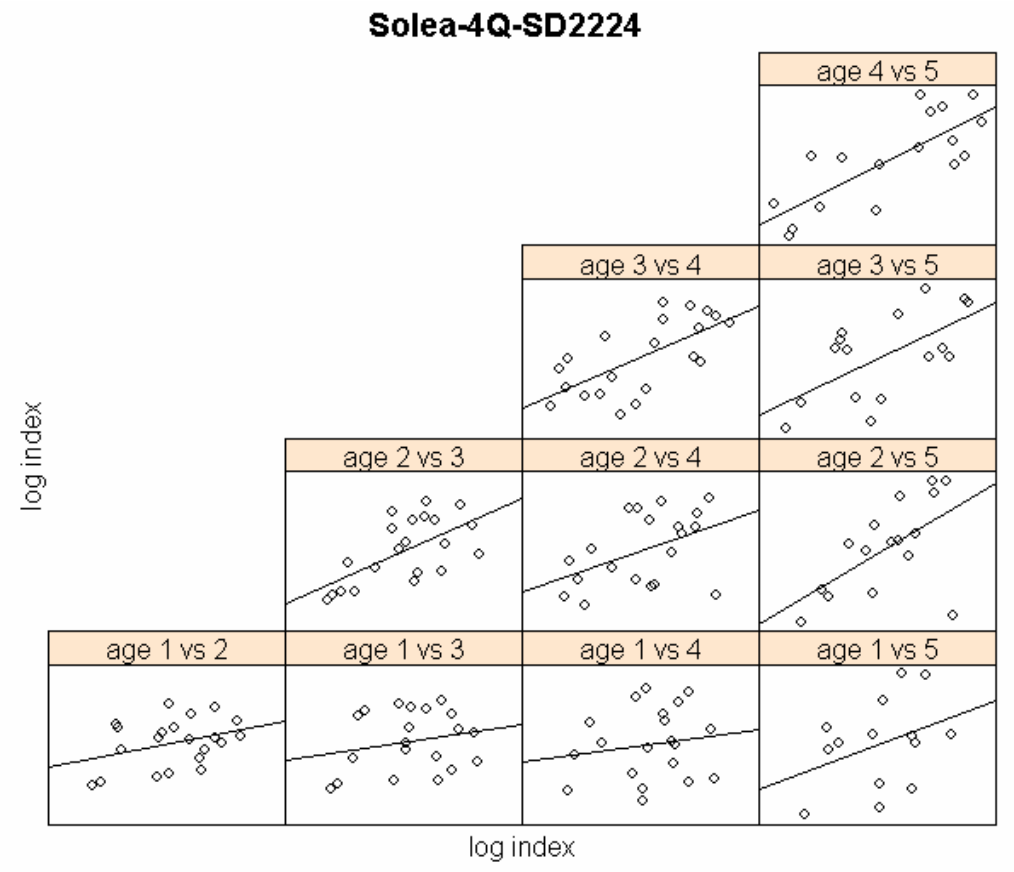


Figure 2.3.10 Cod 22-24. Internal consistency plot between one age group and the age group+1 the year after. From the Solea 4th quarter survey.

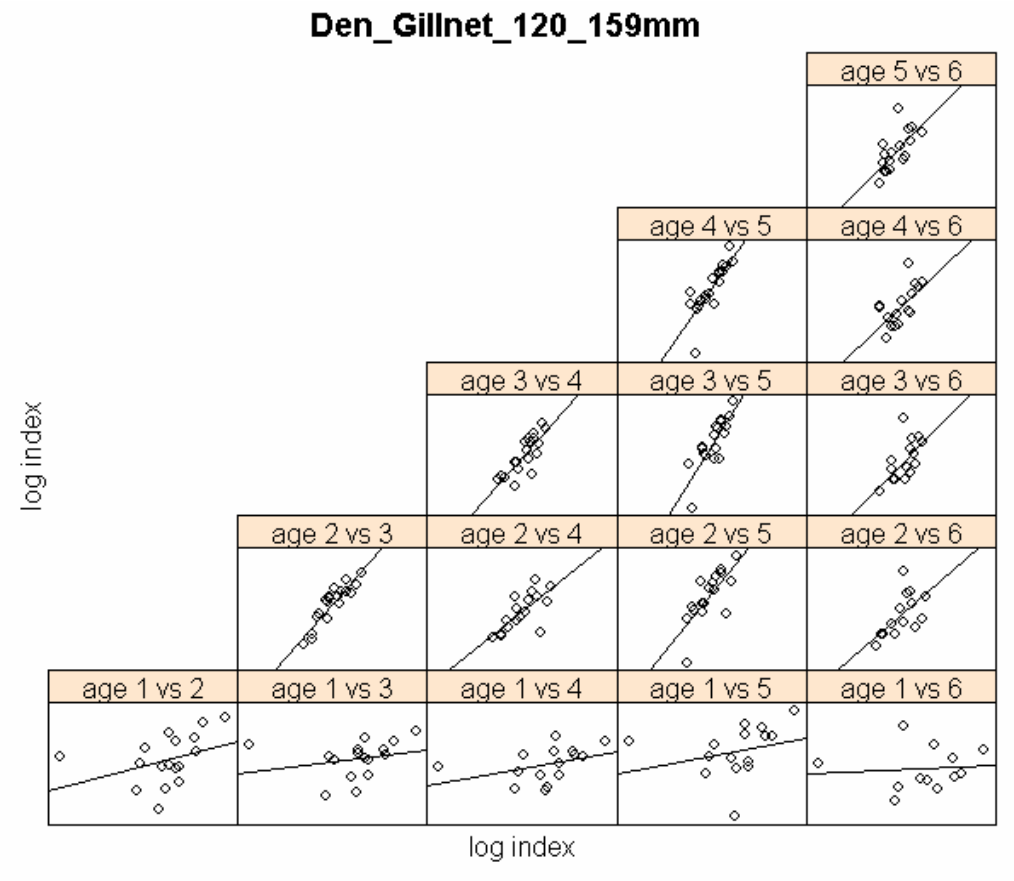


Figure 2.3.11 Cod 22-24. Internal consistency plot between one age group and the age group+1 the year after. From the Danish commercial gilnetter fleet.

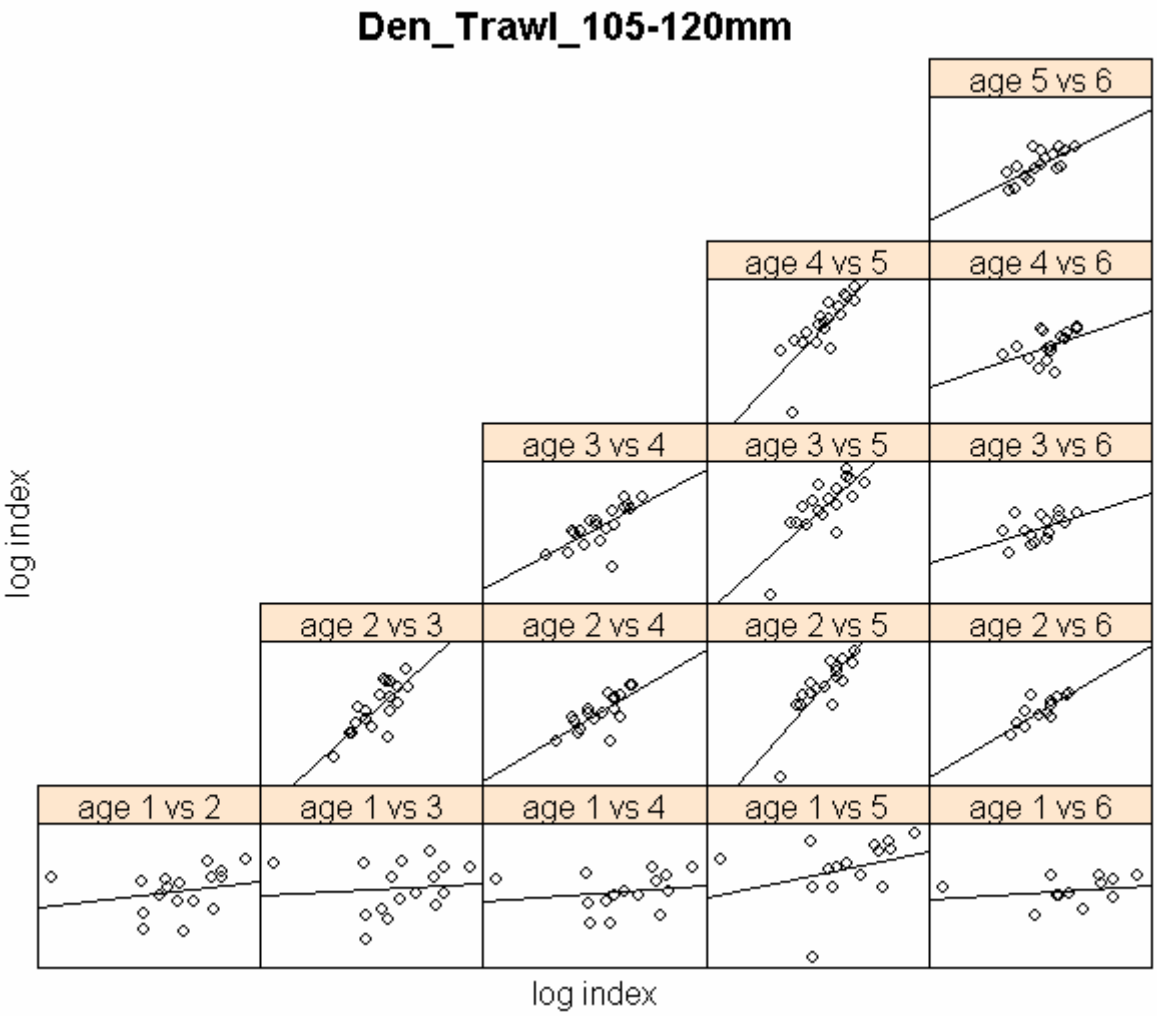


Figure 2.3.12 Cod 22-24. Internal consistency plot between one age group and the age group+1 the year after. From the Danish commercial trawler fleet

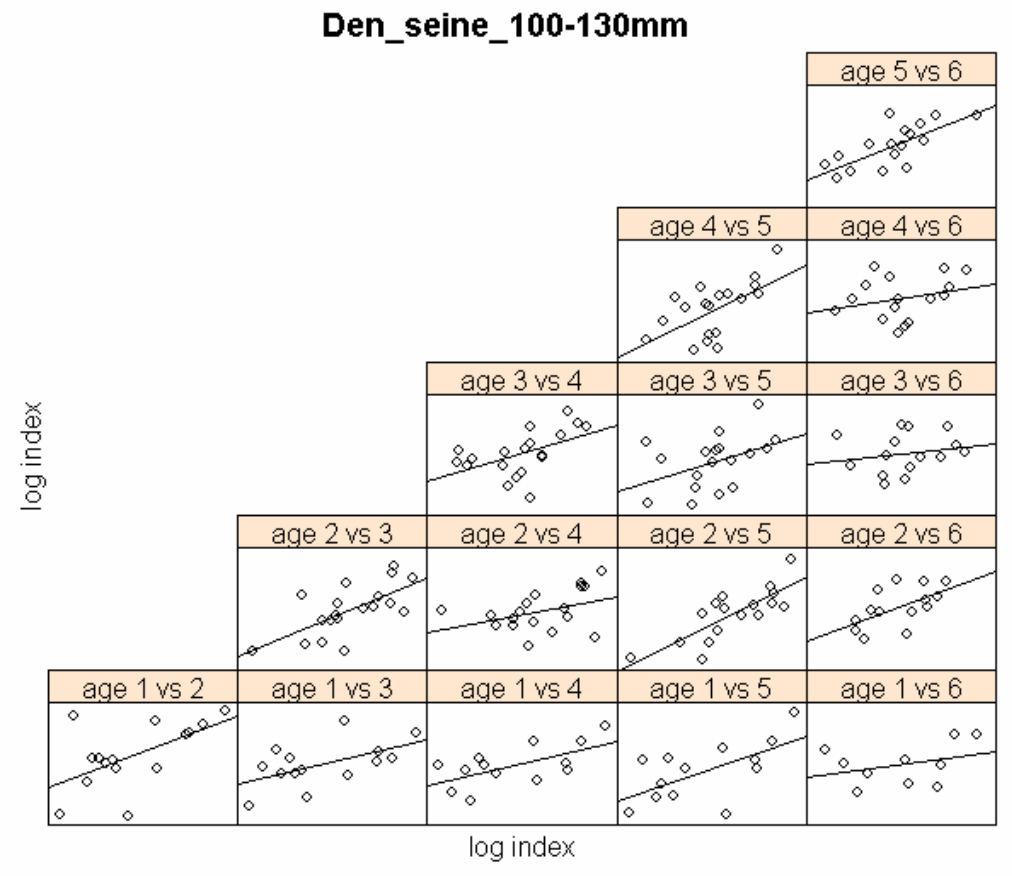


Figure 2.3.13 Cod 22-24. Internal consistency plot between one age group and the age group+1 the year after. From the Danish commercial Seiner fleet.

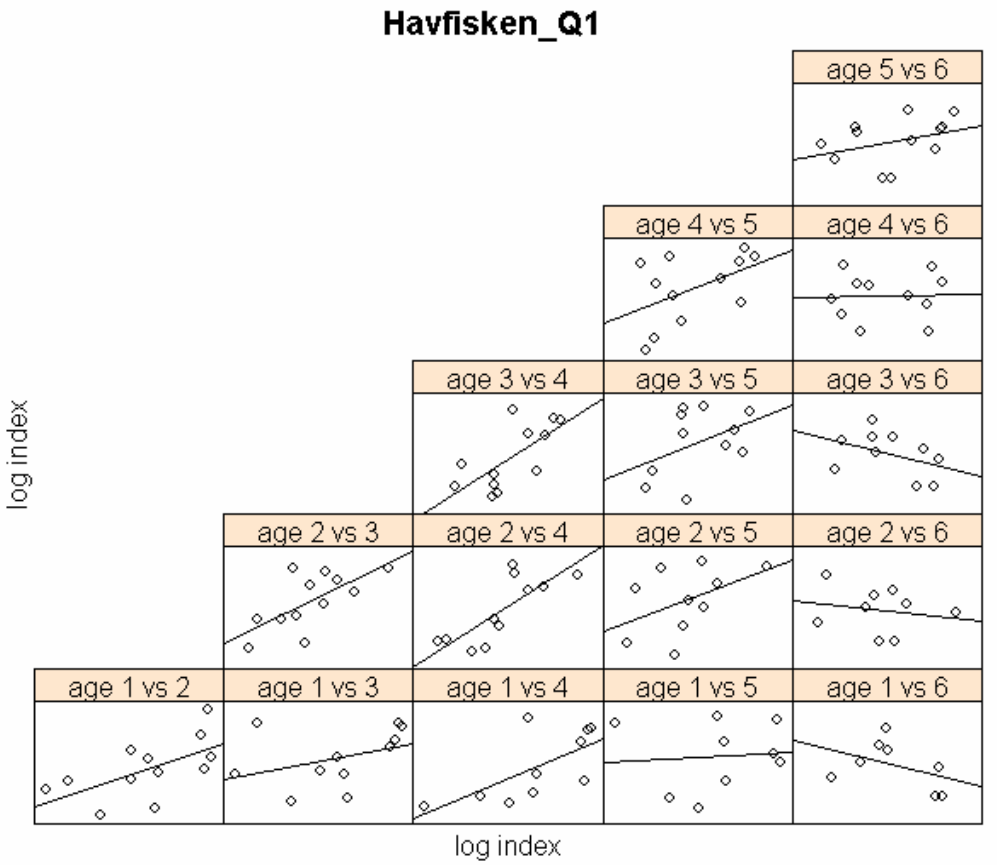


Figure 2.3.14 Cod 22-24. Internal consistency plot between one age group and the age group+1 the year after. From the Danish "Havfisken" survey.

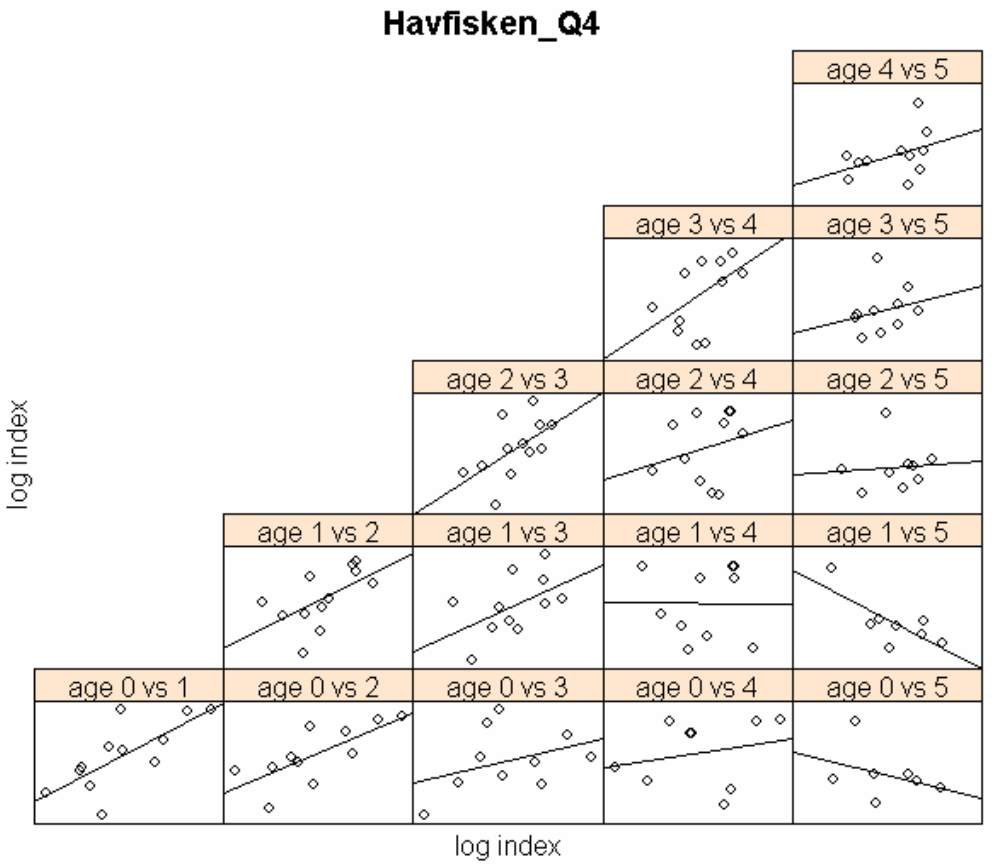


Figure 2.3.14b Cod 22-24. Internal consistency plot between one age group and the age group+1 the year after. From the Danish "Havfisken" survey.

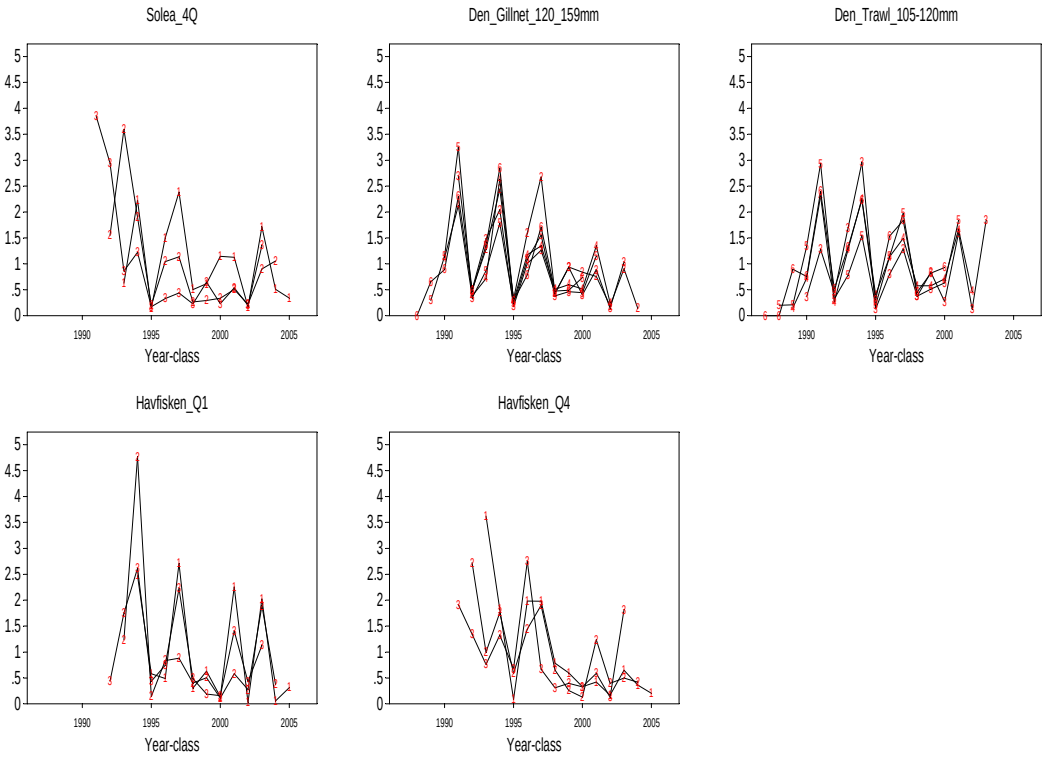


Figure 2.3.15. Cod 22-24. Consistency plot between year classes in the final tuning fleets from SURBA.

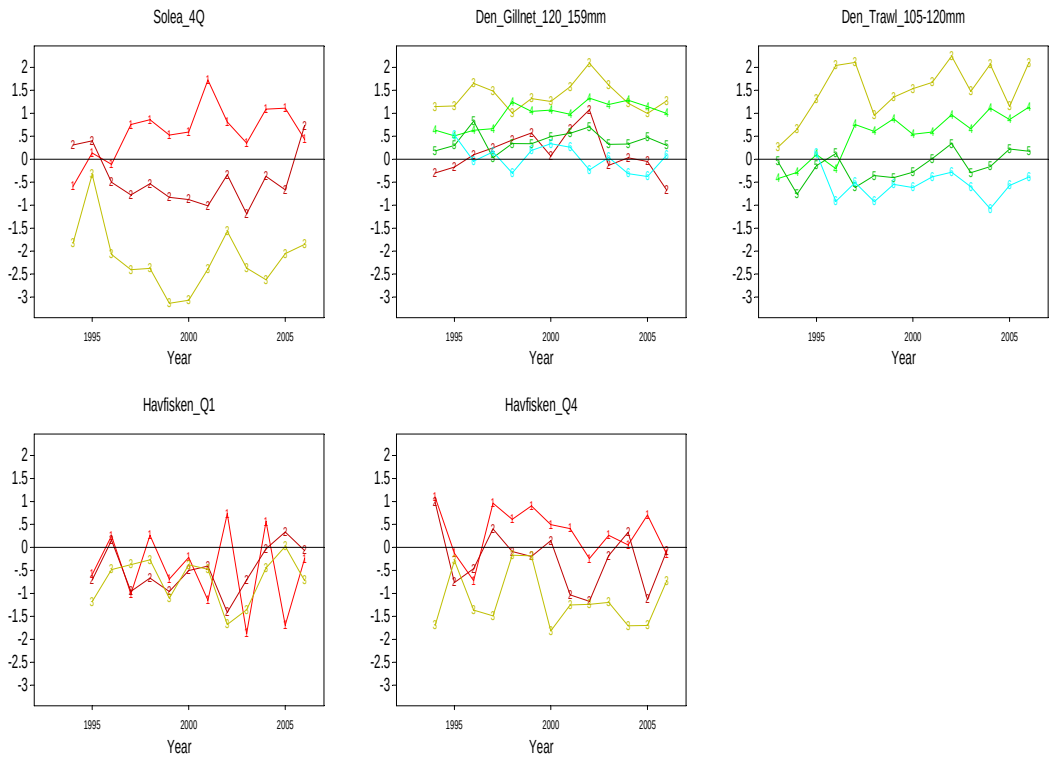


Figure 2.3.16. Cod 22-24. Residuals by age group for the final tuning fleets from SURBA.

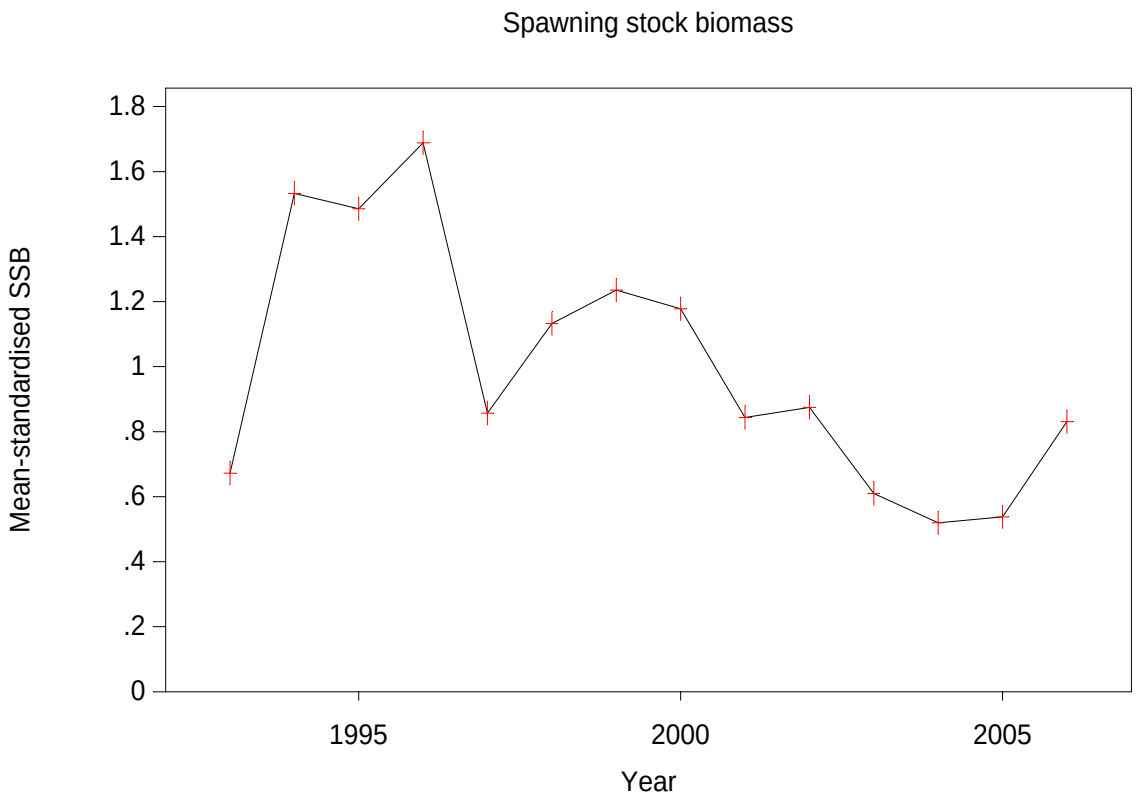


Figure 2.3.17. Cod 22-24. Relative SSB estimate from SURBA.

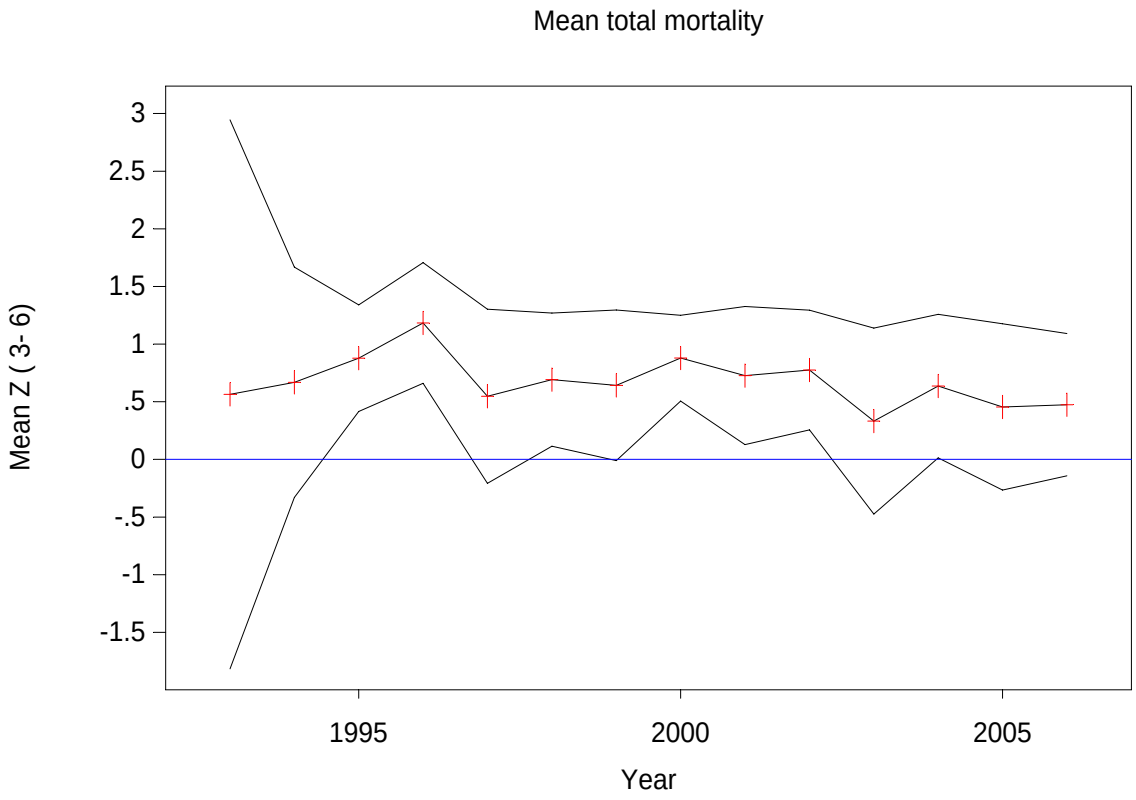


Figure 2.3.18. Cod 22-24. Relative total mortality estimate from SURBA.

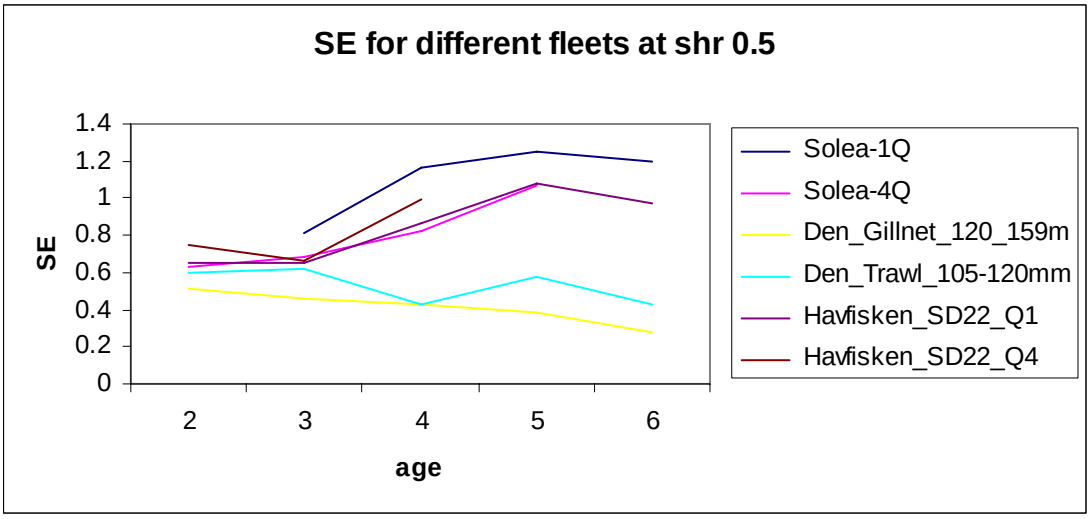


Figure 2.3.19. Cod 22-24. S.E of log q by age from two German surveys, the two Danish survey and the two Danish commercial tuning fleet.

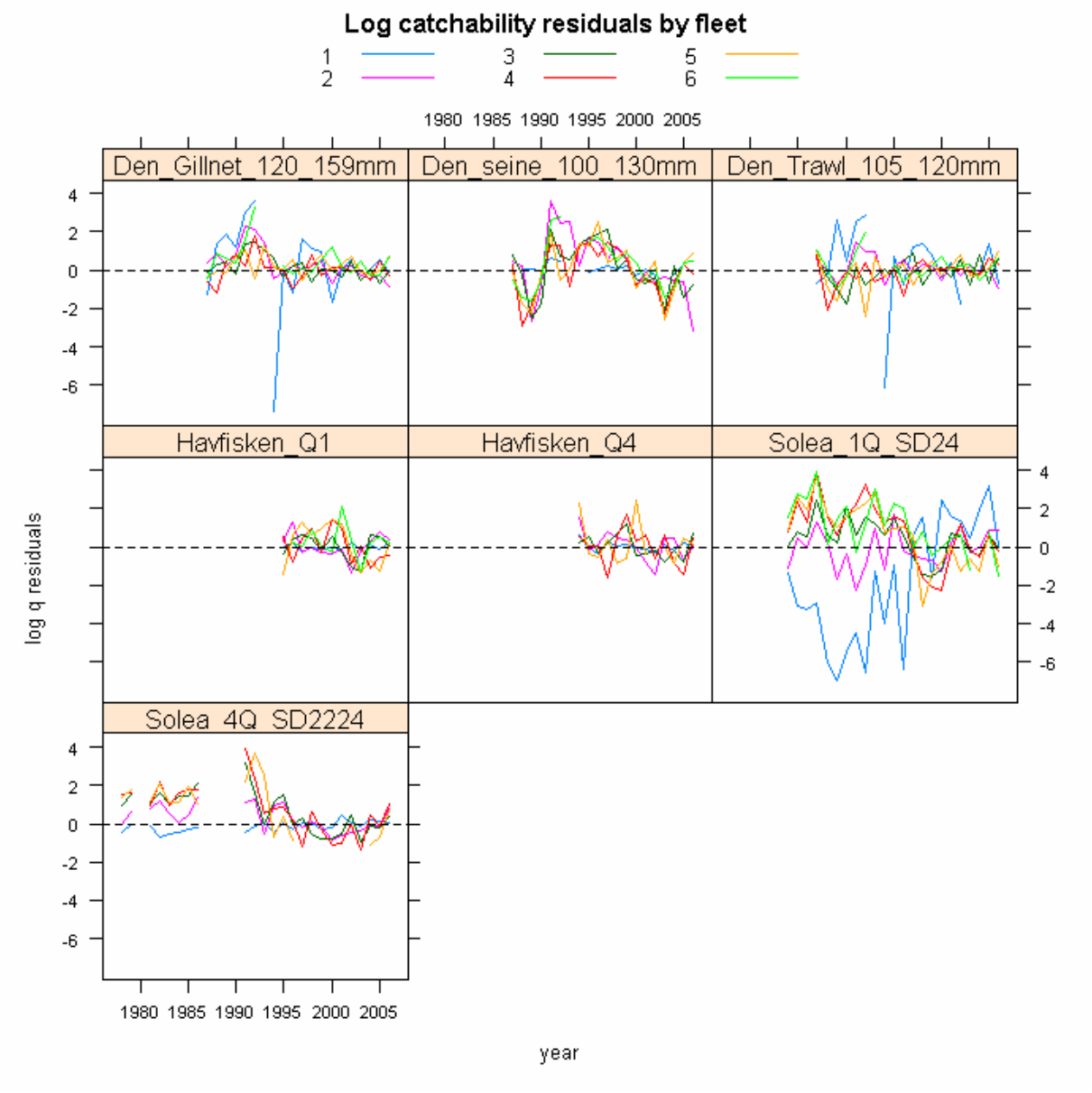


Figure 2.3.20. Cod 22-24. Log catchability by all fleets and for all available years used in the preliminary runs.

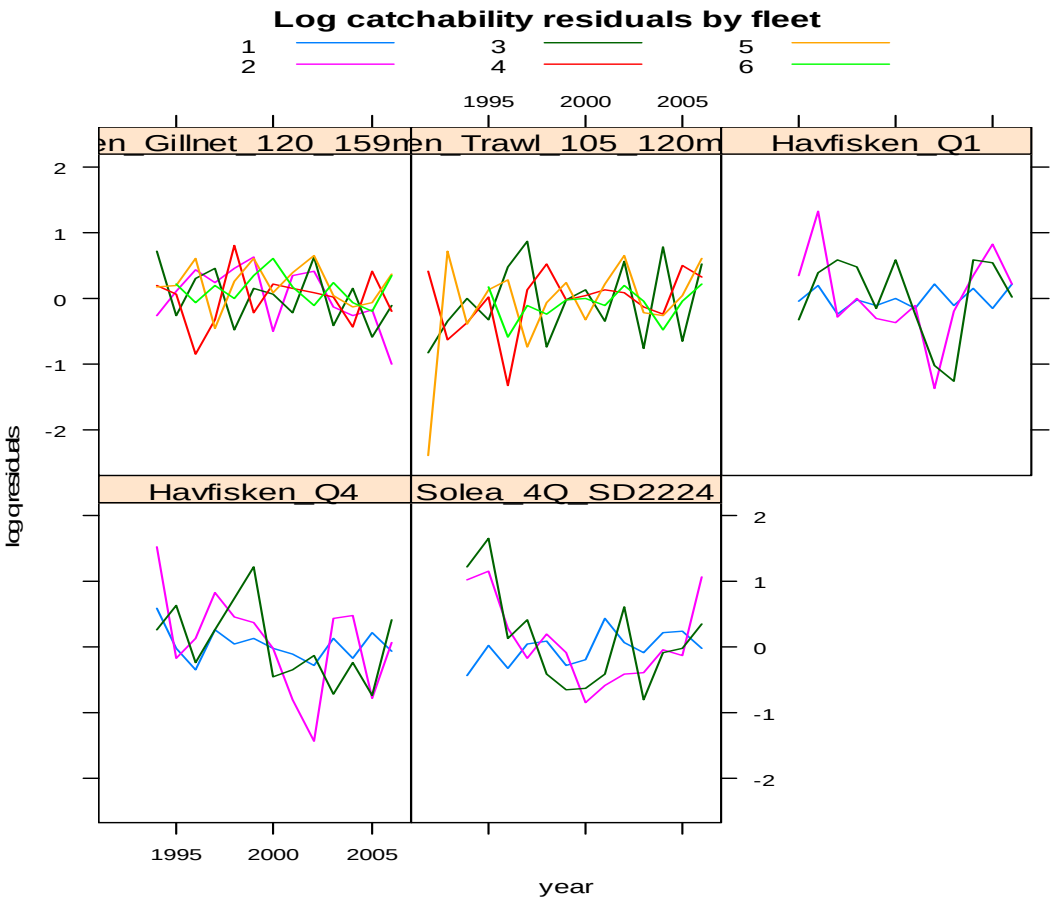


Figure 2.3.21. Cod 22-24. Log catchability for years, age groups and fleets used in the final assessment.

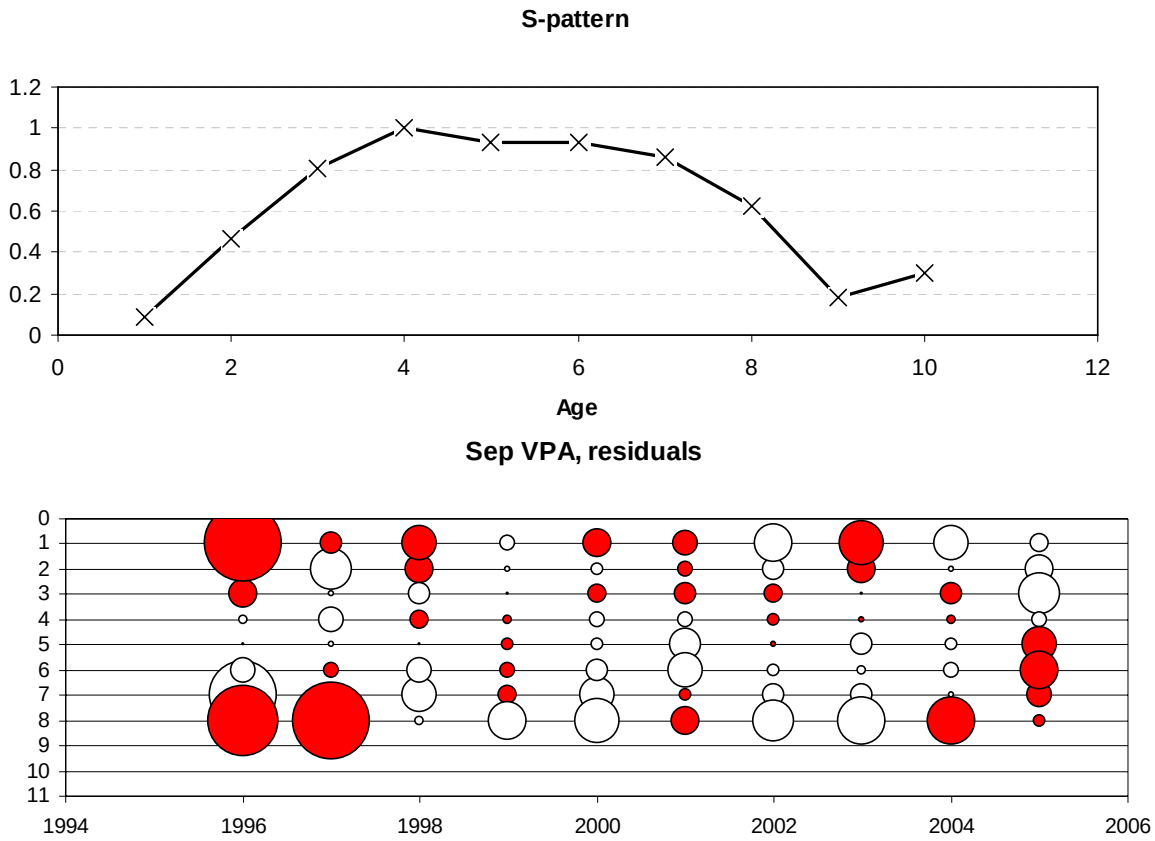


Figure 2.3.22. Cod 22-24. Selection patterns in the catch at age matrix

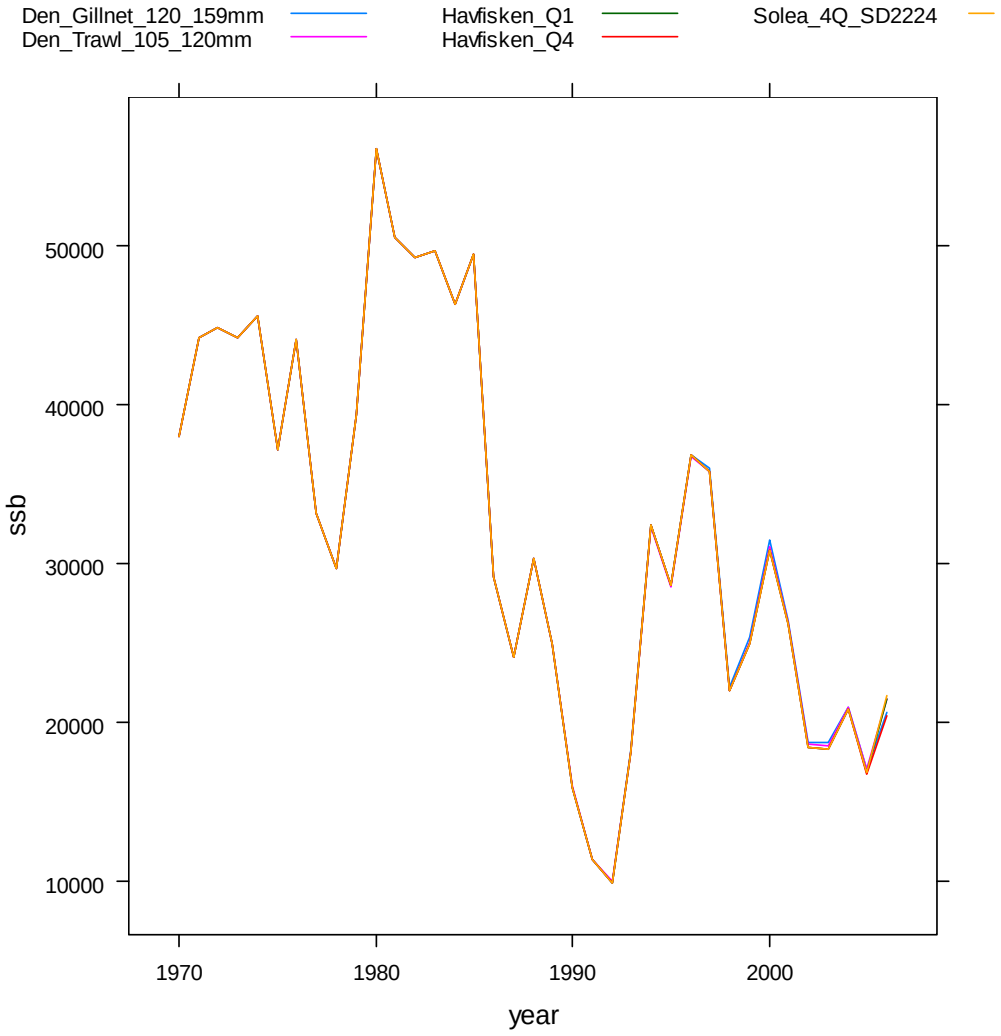


Figure 2.3.23. Cod 22-24. SSB in the single fleet run for the final tuning fleets.

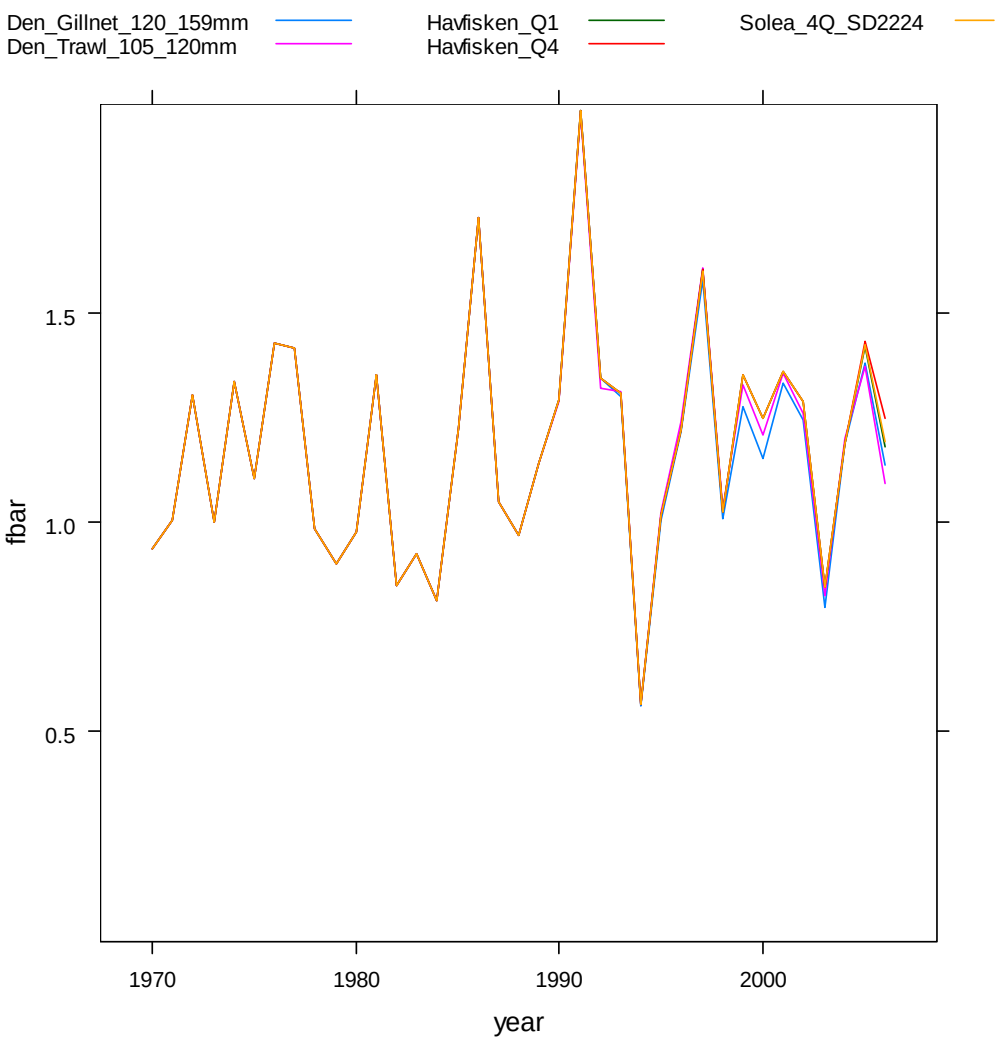


Figure 2.3.24. Cod 22-24. Fbar in the single fleet run for the final tuning fleets.

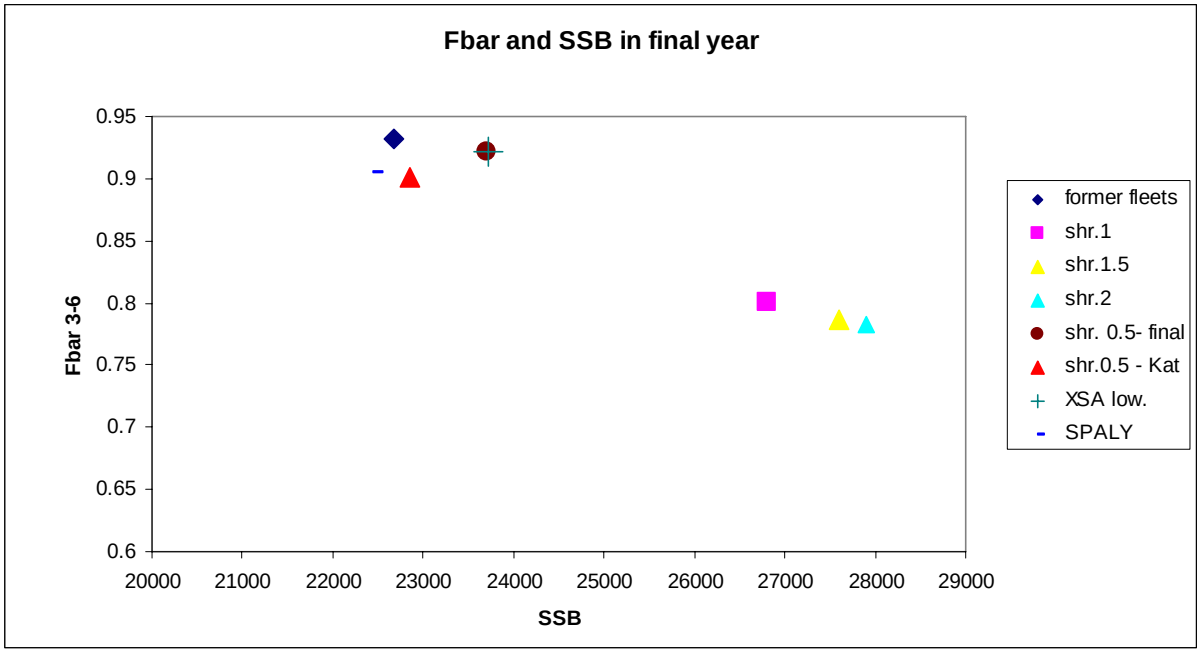


Figure 2.3.25 Comparison between exploratory runs and final run. Former fleets (last years updated tuning fleet), shr 0.5-2 different shrinking settings, XSA low (Lowestoft version of XSA), SPALY last years settings and updated tuning fleets, -Kat (taking into account the possibly over reported landings taken in Kattegat).

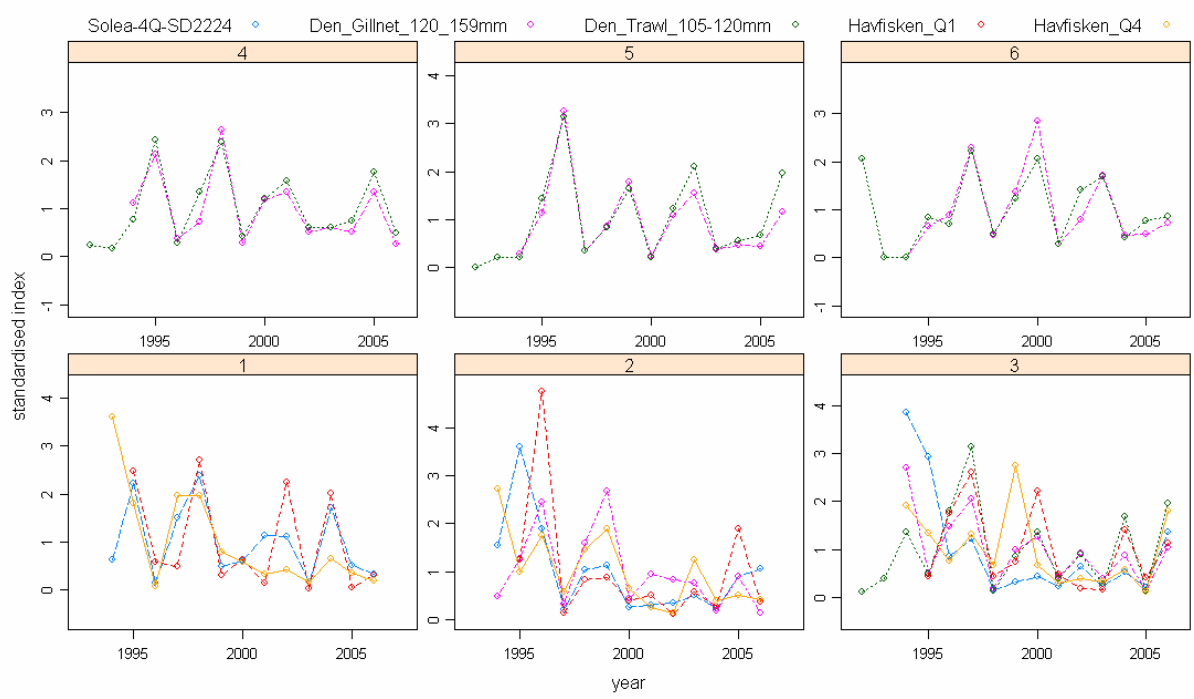


Figure 2.3.26. Cod 22-24. Age 1-6 With all the final tuning fleets by year.

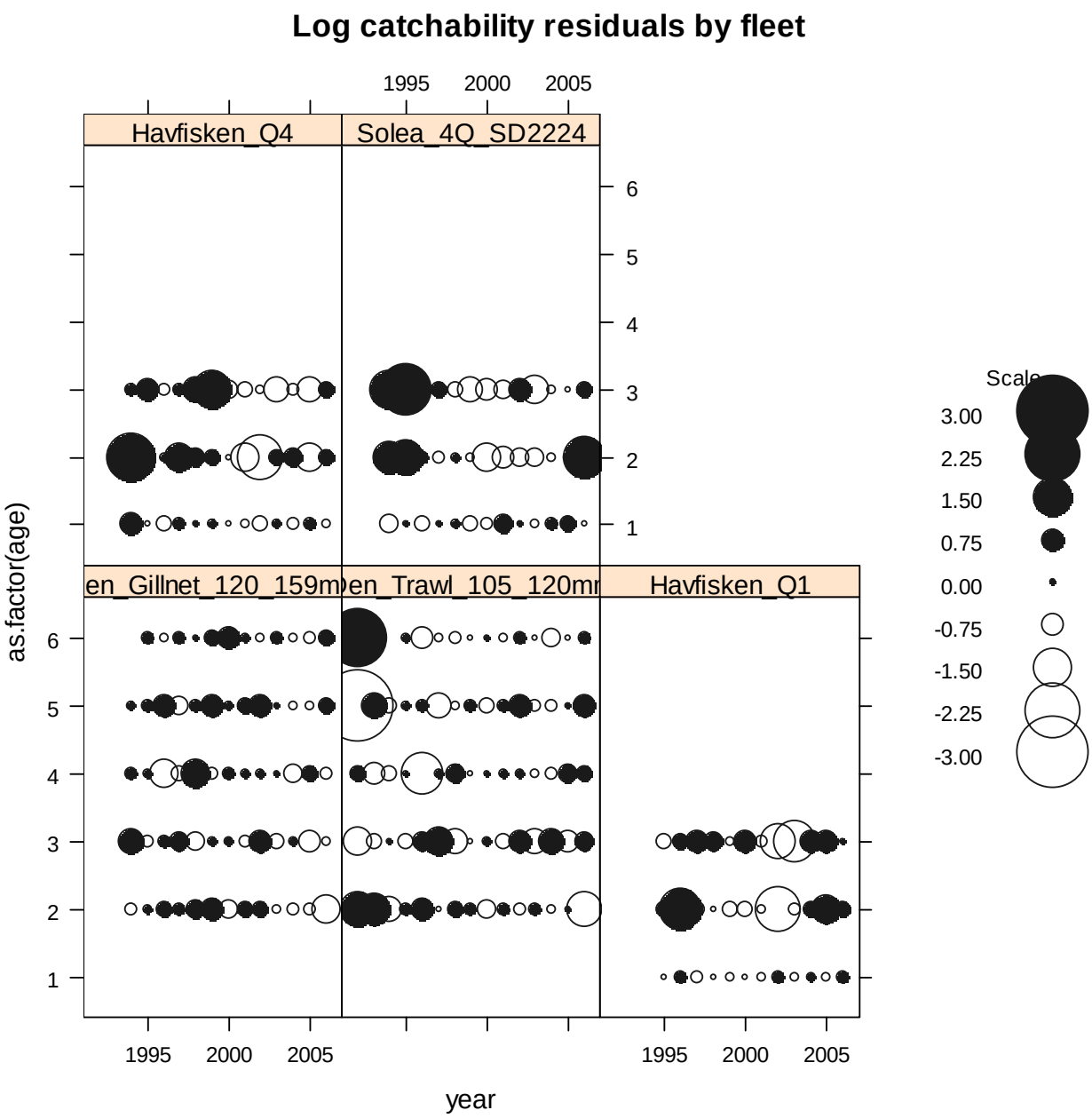


Figure 2.3.27. Cod 22-24. Log catchability residuals as bobble plot.

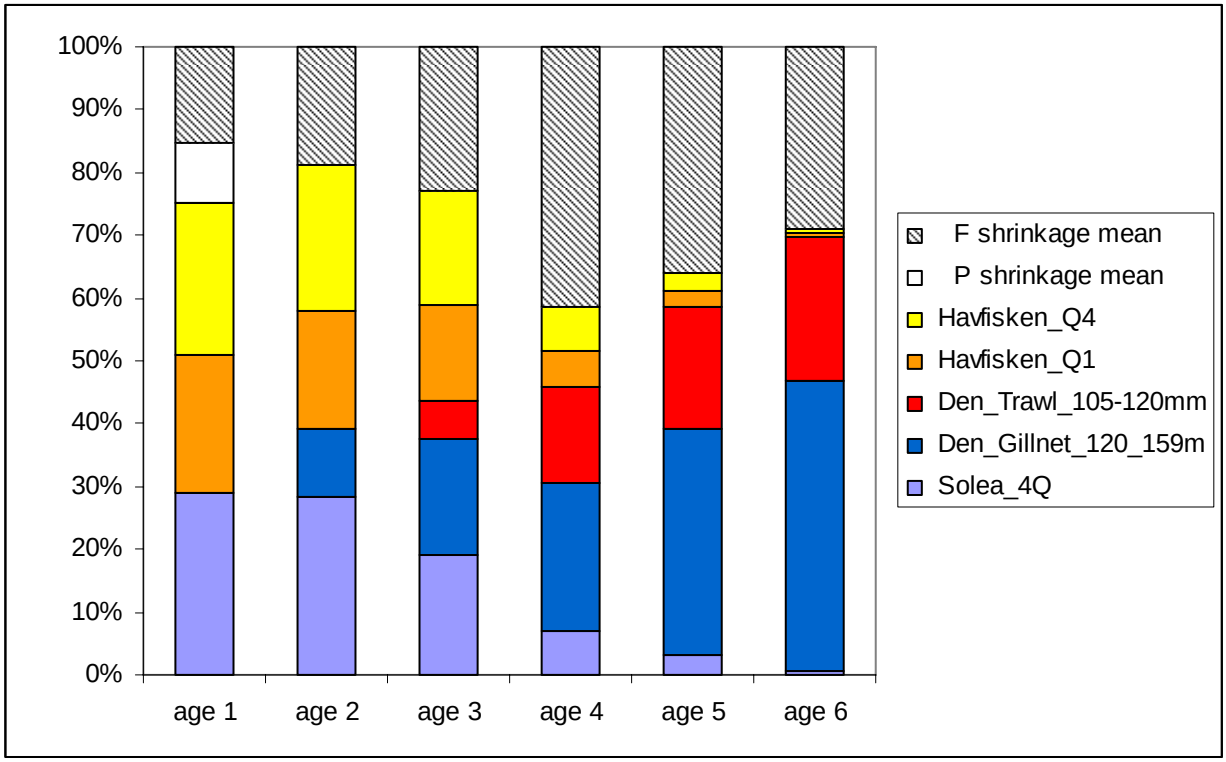


Figure 2.3.28. Weighting of different tuning fleets in the final XSA run

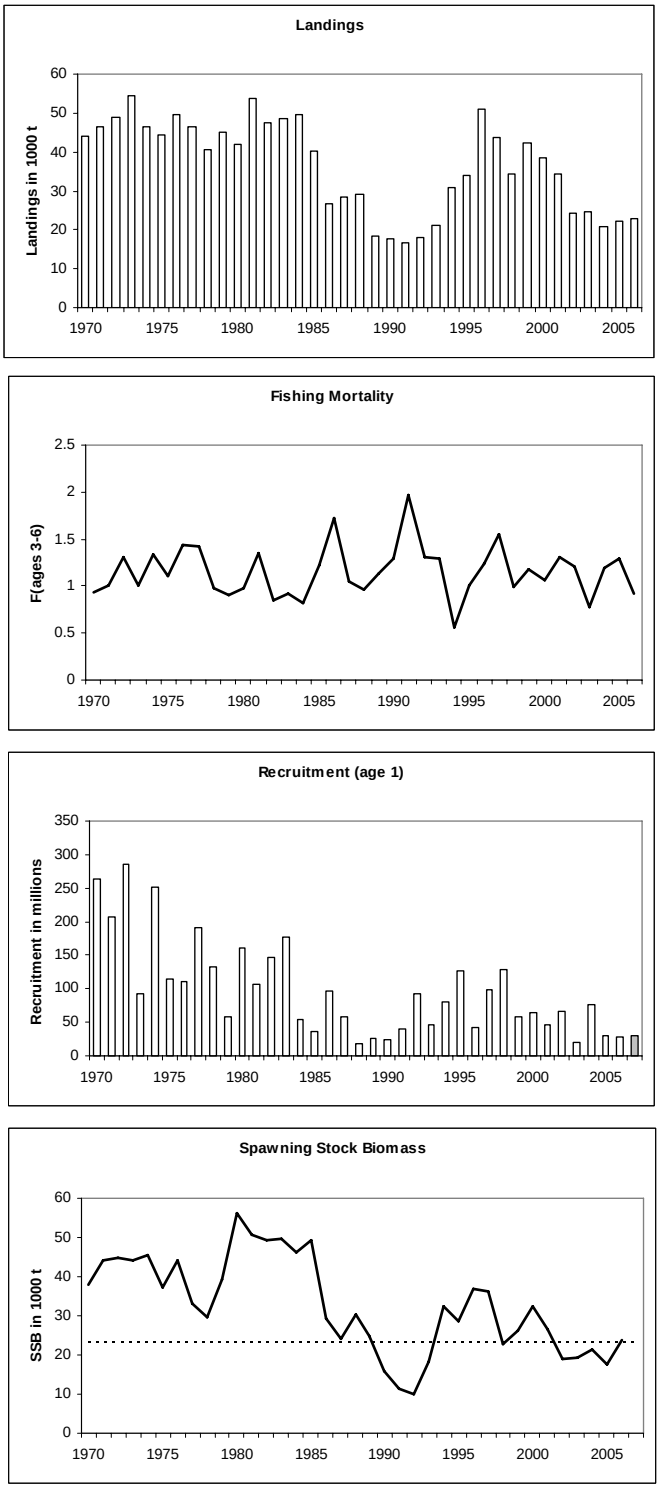


Figure 2.3.29. Cod 22-24. Summary plot for SSB, landings, Fbar and recruits.

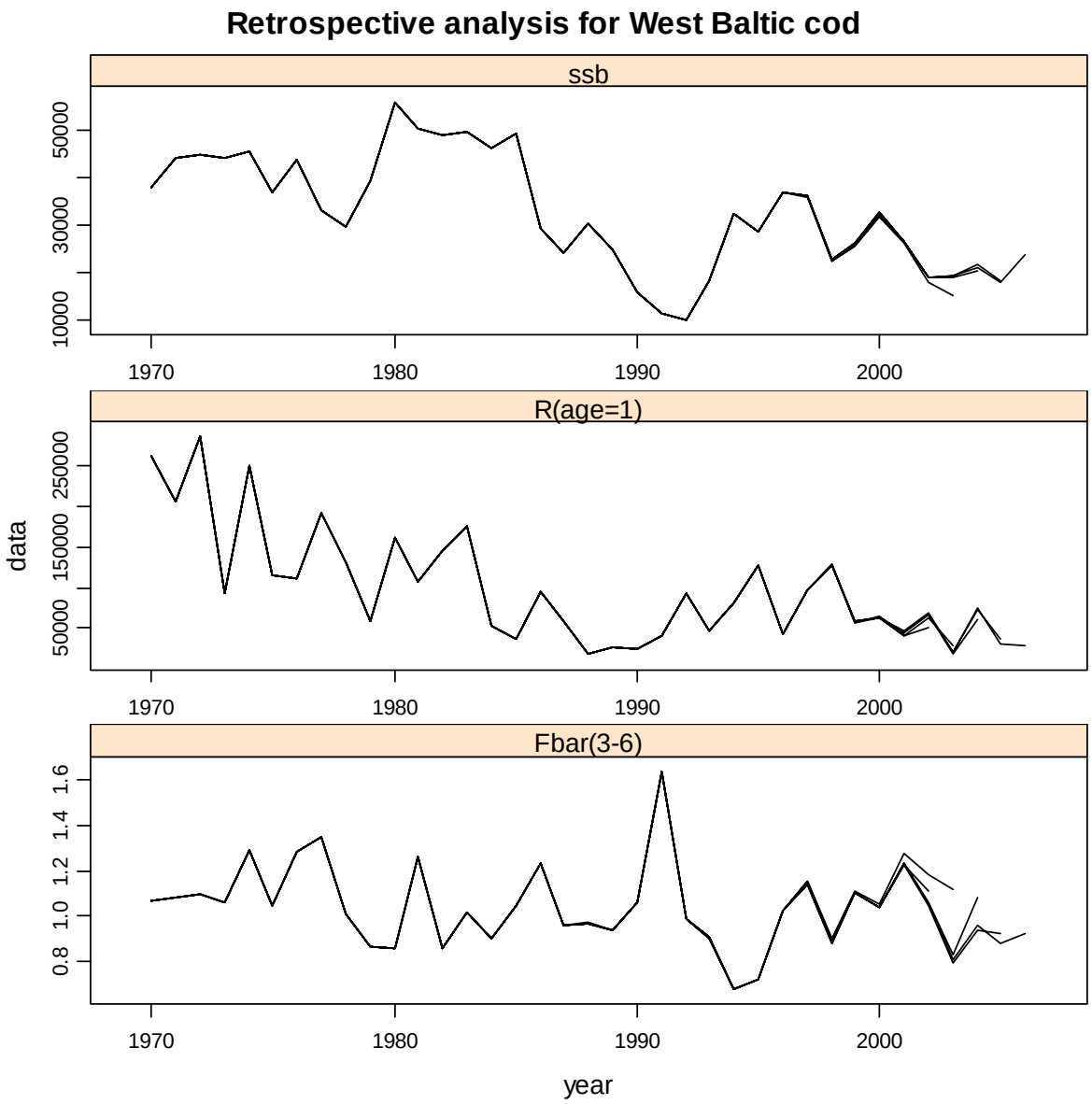
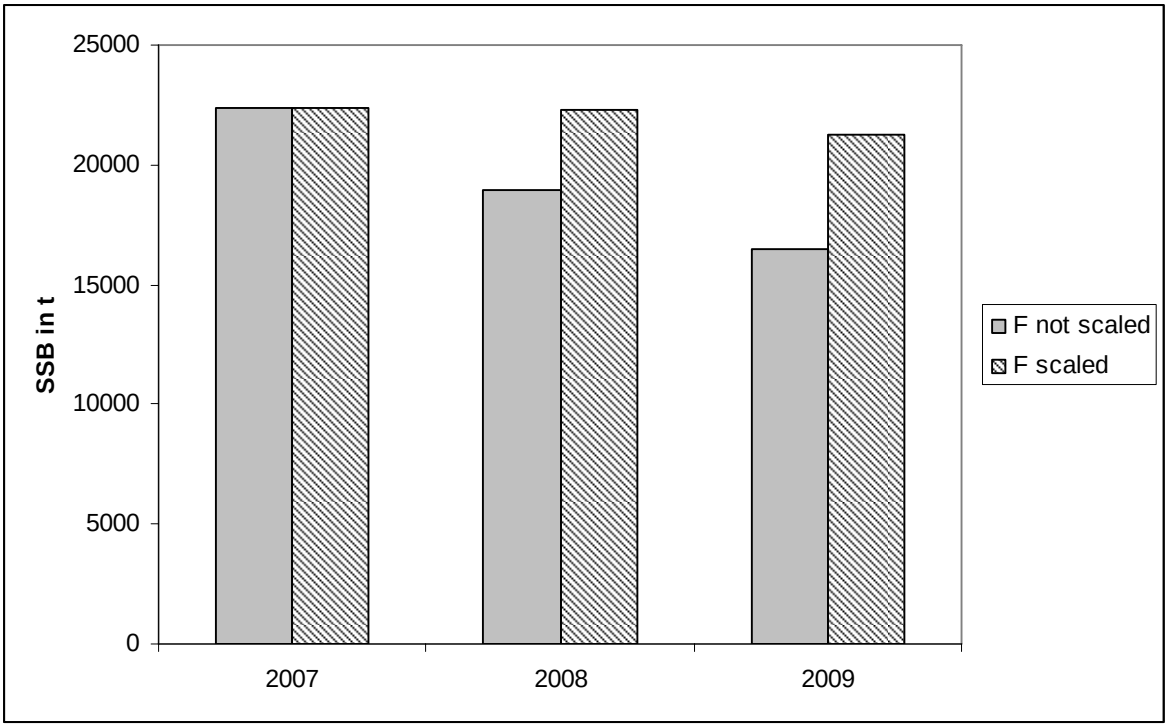


Figure 2.3.30. Cod 22-24. Retrospective run for SSB, recruits and Fbar the last 6 years.



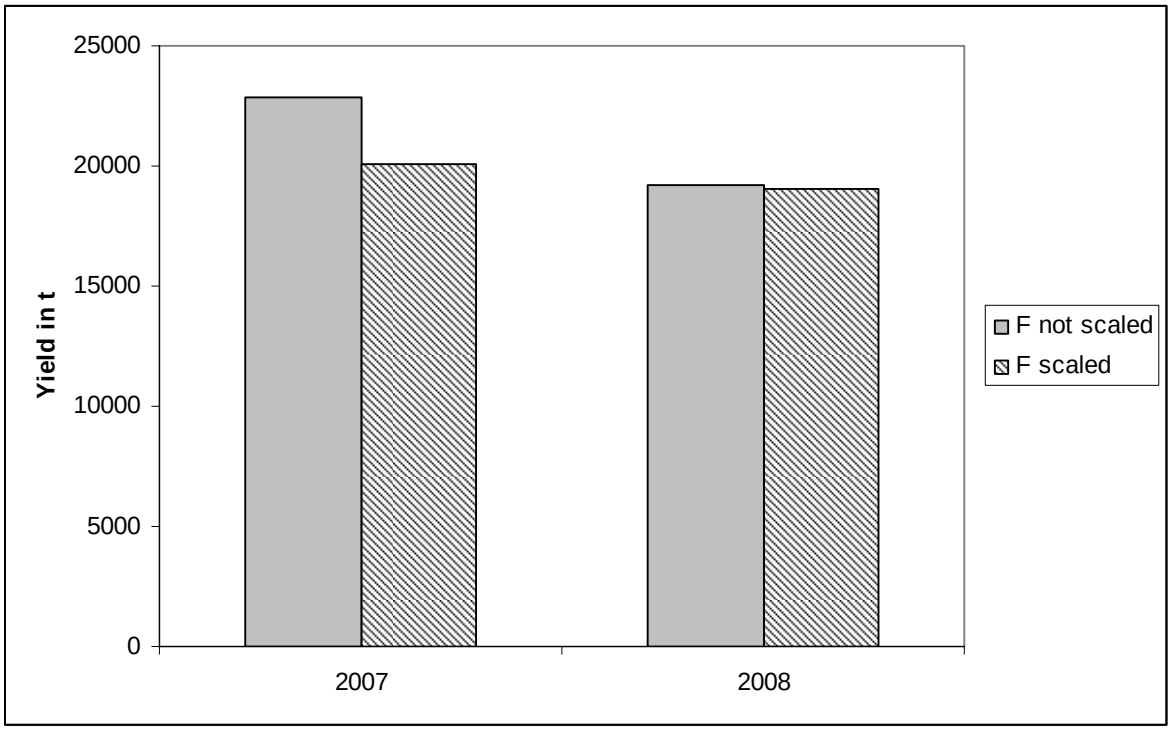
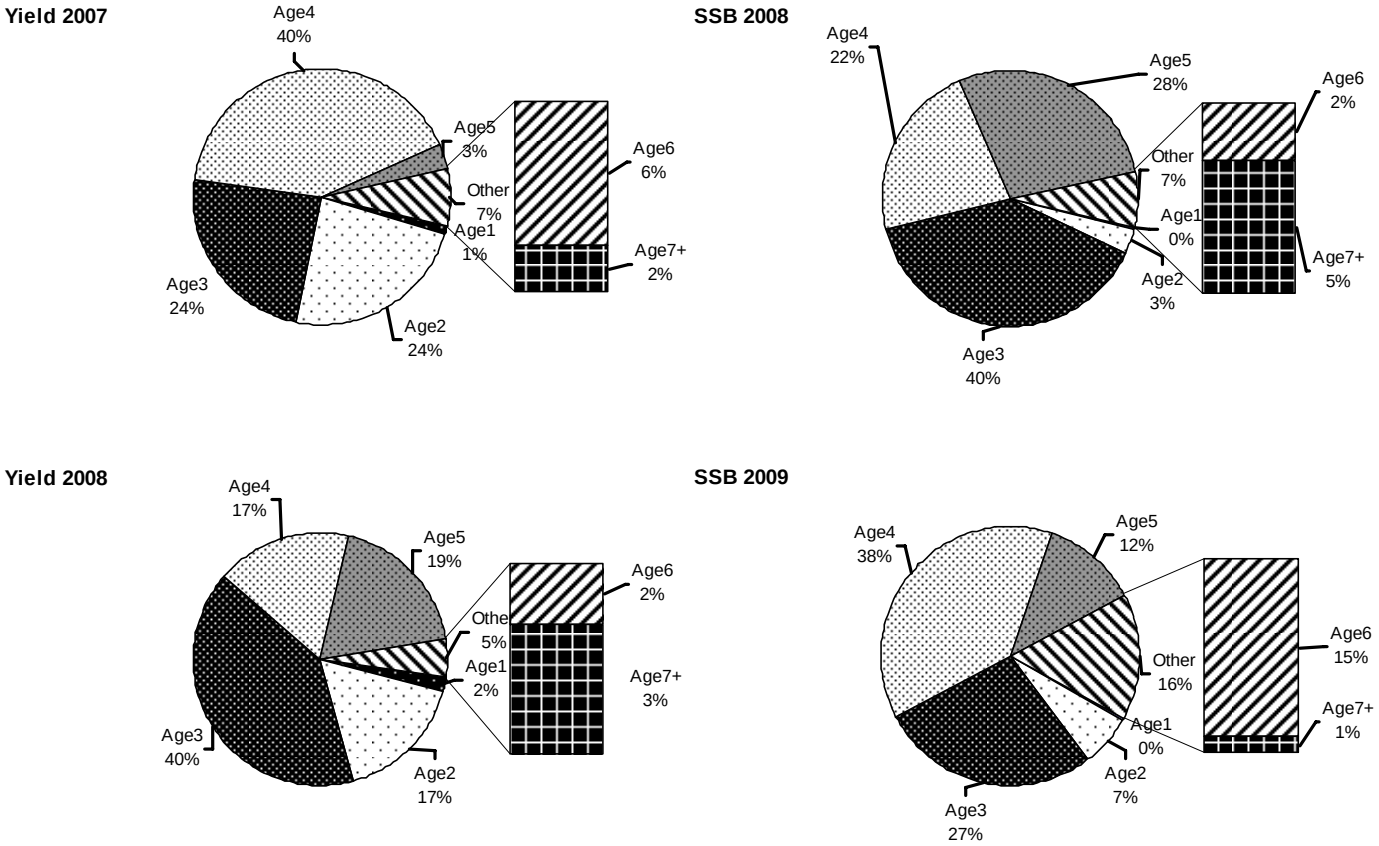


Figure 2.3.31. Cod in 22-24. Comparison between 2 different short term predictions in yield and SSB, when F is scaled to final year exploitation pattern and when F is not scaled.

Figure 2.3.32 Cod in SD 22-24. Short-term forecast for 2007-2009. Yield and SBB at age 1-7+ for status quo fishing mortality.



2.4 Cod in Subdivisions 25-32 (observation list assessment)

2.4.1 The fishery

Cod in the eastern Baltic have traditionally been taken in a directed fishery while catches of cod as by-catch in pelagic fisheries targeting herring and sprat have been very limited. The main fisheries for cod in the Eastern Baltic use demersal trawls, pelagic trawls and gillnets. The cod fishery was intensified during the early 1980s when the stock biomass substantially increased due to favourable reproduction conditions leading to particularly abundant year classes in 1976, 1977 and 1980. As a result, landings increased to 350-400 thousand tonnes in the mid 1980s. During this time, a considerable share of the catches was taken in Sub-divisions 28-32. However, the spawning stock declined from its highest recorded level during 1982–1983 to the lowest historical level in the early 1990s as a result of the increased effort of the traditional bottom trawl fishery, introduction of a gillnet fishery, and advers environmental conditions hampering recruitment success, first of all decreased egg survival due to oxygen depletion of deep water layers. During the 1990s when the proportion of older cod in the stock was large, the gillnet fisheries expanded. However, with the change in stock age composition towards younger ages since late 1990s, the share of the total catch of cod taken by gillnets has decreased while that of demersal trawl increased. During most recent years, the cod catches are largely taken in Sub-divisions 25 and 26 with approximately 40% being taken by gillnets.

2.4.1.1 Catch trends

National landings of cod from the eastern Baltic stock (Subdivisions 25–32) are given in Table 2.4.1 as provided by the Working Group members.

2.4.1.2 Unallocated landings

The information available on unallocated landings of Baltic cod during 2006 is summarised in Section 2.1.3. Details of the corrections applied by year are given in the text table below.

Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
RF	1.42	1.61	1.21	1.08	1	1	1	1.35	1.35
Year	**2002**	**2003**	**2004**	**2005**	**2006**				
RF	1.35	1.45	1.41	1.38	1.37				

Average RF = Raising Factor, i.e. an RF of 1.37 implies that the WG estimate of landings is 37 higher than the officially reported figure. No corrections have been applied for other years. Up to last years assessment the RF was applied to the overall CANUM. In this years assessment country specific RF's were applied to the national CANUM data for 2006..

2.4.1.3 Discards

For the current assessment discard estimates were included in the catch-at-age data in order to give a better estimate of the true exploitation pattern of the fishery and enhanced recruitment estimates. Table 2.4.2 gives the estimated discards by age and sampling strata. The most abundant age group in the discard has changed from age group 2 in 2005 to age group 3 in 2006. This is probably caused by a combination of the relatively strong 2003 year class which is now fully recruited to the fishery and high-grading induced by the restrictive quota policy in Sweden and Denmark. By these reasons the total estimated discard in tons in the 2006 is approximately 3 times higher then in the previous two years.

Discard data for 2006 were available from Latvia, Poland, Russia, Germany, Sweden and Denmark. No discard information was available from Finland, Lithuania and Estonia. Estimates from Denmark were based on an estimation procedure which differ from the

procedure used in FishFrame by most other countries. The Danish procedure includes averaging the discard information over previous 4 years and uses a raising procedure based on the landing of all species and not just on cod landings as done by the other countries. This implies that fisheries taking cod as by-catch contribute also to discarding. This procedure is of importance for the Kattegat, but the impact for the Eastern Baltic cod stock is very limited.

The discard data were nationally aggregated into passive gears (traps and nets) and active gears (trawl and seines) even though the sampling in most countries was stratified to a more detailed level. The overall sampling coverage for active gears is around 56% (meaning that 56% of the estimated discard of cod is from strata covered by the sampling programme). In contrast only 25% of the estimated discard from passive gears are actually covered by the sampling programme as the passive gears are sampled alone by Russia and Latvia in Sd 26 The discard rates and the age distribution in passive gears estimated from the Russian and Latvian data are applied to the catches from Poland, Latvia and Lithuania in strata where these are missing in Sd 26, 27, 28 and 30 due to the incomplete sampling programme. For other countries and Sds discard rates and age distributions are picked up from Swedish data in sd 24 and 25 from 2005, assuming that the discarding behaviour in fleets from Germany, Sweden, Finland and Denmark are different from other countries. Finland is included in the latter group because most Finish fishery directed toward cod is done in Sd 25 by Danish crews.

The amount of discard estimated is sensitive to extrapolation of discard data into strata where no data exist. Particularly, taking into account the low number of discard samples and the large fractions of strata where it has been necessary to borrow data from other strata, the discard estimates for both passive and active gears have to be taken with a great caution.

The circumstances that not all countries upload discard data to FishFrame made the discard estimate procedure also very complex because data had to be compiled from several data sources with different formats and involved combination of extractions from both FishFrame and EXCEL files. Because neither the InterCatch database nor FishFrame include facilities to exchange discard rates from one stratum to another this was done in EXCEL. Considering the large extent of data extrapolations involved, this procedure is very complex, error prone and difficult to check.

In consequences, the WG recommends that all countries upload discard data to FishFrame in the future and that all discard data are revised back in time as soon as the data extrapolation module is available in FishFrame. While uploading into FishFrame care needs to be taken to avoid formatting errors. During the WG meeting such problems were identified for Polish data. Due to time constraints it was not possible to correct the data, but the irregularities do not change the general impression of the discard in 2006, even though it most probably is a moderate over-estimate.

The estimated discard of age group 0, 1 and 2 have been raised with the official landings plus the estimated tons of unreported landings. Older age groups have only been raised by the official landings because it is assumed that the fishery representing the unreported landings have a different discard pattern where only under-sized fish is discarded because quota restrictions do not prevent the fisherman to land valuable fish over minimum size (i.e. fish older than 2 years).

As previously, the estimated discard numbers for years prior to 1996 (when sampling commenced) are based on average proportions discarded at age over 1996 to 2003.

2.4.1.4 Effort and CPUE data

Landing per unit effort were supplied from Danish and Swedish fisheries. The Swedish data are presented in Table 2.4.6 and the Danish data are given in Table 2.4.7. These data are also plotted in standardised form in Figure 2.4.1, showing a rather stable development since 1998.

2.4.2 Biological composition of catch

2.4.2.1 Age composition

Estimated age distributions in the landings by Subdivision, Quarter and gear (trawl and gillnet) were provided by all countries. Tables 2.4.8a-b show the age composition in the national and total landings by Subdivision and Quarter. The age composition data were applied to the national landings. The age compositions of the unreported landings were assumed similar to the ones of the reported landings (by country, sub-division and gear). Sampling levels are indicated in Table 2.4.9. The annual catch-at-age data used in the assessment include estimated discards (see Section 2.4.1.3). The estimated catch at age data are given in Table 2.4.10 (official landings only) and in Table 2.4.11 (official landings with corrections for misreporting and discards).

There are long-standing problems with ageing inconsistencies in this stock. These were illustrated by analysis of survey age-length keys in Section 2.4.6.1 in the 2004 WG Report (ICES CM 2004/ACFM:22) concluding that there are substantial differences in age-determination for fish from the same SD and year. The analysis indicated that there is variation between nations within year, and they these differ between years. It was concluded that the age-reading inconsistencies are highly complex, and that their classification into two 'schools' of age-reading approaches (e.g. Reeves, 2003) represents a substantial oversimplification of the actual situation.

The age composition of the landings in 2006 showed pronounced differences between Denmark, Germany, Sweden and Lithuania on one side and Poland and Latvia on the other side. While age-group 2 was almost absent in the landings of latter countries, it constituted a substantial share in landings of the former (Fig. 2.4.2 a-d). These differences are apparent also within specific Sub-divisions and quarters, which makes it unlikely that variation in distribution of different age groups and different allocation of fishing effort can explain these deviating catch compositions. Likewise, a pronounced difference in gear selectivity is unlikely as the country difference is apparent in both landings of trawlers and gill-netters. This indicates severe inconsistencies in age determination between countries, affecting the quality of the assessment.

2.4.2.2 Quality of catch and biological information

As noted above, there are problems with catch misreporting for this stock. This leads to substantial uncertainty associated with the estimates of total landings. In recent years the WG has attempted to correct for such misreporting by applying raising factors to national catches based on the available information on misreporting by each national fleet. By nature this information is highly uncertain, and also incomplete, with no information available for some nations where nonetheless misreporting is suspected to occur. This means that the corrected landings values derived by the WG can at best be considered to be approximate minimum values. For reasons of discretion the WG can not identify the sources of information. Consequently the estimates cannot be considered transparent or repeatable. In comparison, the way in which the estimated reported landings have been derived is completely transparent and repeatable, but the results are considered to be substantial under-estimates of the true catches (recent misreporting estimates imply that true catches have been at least 30-40% greater than reported catches).

2.4.3 Mean weight-at-age

Weights-at-age in the catch were estimated from national data using the same procedure as for catch numbers-at-age. The mean weights at age in the catch matrix were corrected taking into account the mean weights in the discards by weighting to the number in landing and discards

(previously used mean weight at age in landings alone caused SOP deviations). The annual catch weights-at-age are shown in Table 2.4.12a. Additionally in Table 2.4.12b-c are shown mean weight at age in the discards and mean weight at age in landings.

Estimates of the mean weight-at-age in the stock are given in Table 2.4.13. Apart from 2005 and 2006, the stock weights since 1995 are based on data from the first quarter BITS survey data. The values are calculated from the mean weight-at-age in each Subdivision weighted by survey estimates of the relative abundance of cod in each Subdivision.

Mean weight in stock for 2005 and 2006 were not available at the WG meeting, as the survey database DATRAS was not operationable. Therefore these values were estimated by applying the ratio between stock weight at age and catch weights at age as average over 2002-2004 to the 2005 and 2006 catch weights at age.

2.4.4 Maturity at age

The existing database on sex-specific maturity ogives, sex ratios, and number sampled at age per Subdivision (ICES, 1997/ACFM:12; Tomkiewicz et al. 1997) was updated in 1998 and 1999, but not subsequently. For this reason, the mean maturity-at-age over 1997 to 1999 was used as maturity at age in more recent years. The proportions mature used in the assessment are given in Table 2.4.14. Updating of the database is in progress and is discussed in more detail in the Report of the 2005 meeting of WGBIFS (ICES 2006).

Spawning biomass totals were calculated at the start of the year, as previously.

2.4.5 Natural mortality

A constant natural mortality of 0.2 was assumed for all years and ages, as previously.

2.4.6 Catch-at-age analysis

2.4.6.1 Tuning fleets

The indices from the BITS first quarter survey are used back-shifted', i.e. survey data from 2006 are treated as if the survey took-place at the end of 2005 and so on, to get around the inability of XSA to use data from after the last year with catch data. The backshifting means that the age 2 data are excluded as age 1 is not included in the assessment. To nevertheless use the survey results of age 2 these are included in the exploratory analysis (in an unshifted form) as a separate fleet. The full, untransformed dataset is given in Table 2.4.15a and the backshifted version, as used in the final tuning, are given in Table 2.4.16. The design of the survey, and the gears used, were completely revised in 2001 in order to provide a fully co-ordinated international survey. Corrections have been applied to the data for earlier years correcting for the changes in survey design (Levy et al, 2004).

A second, internationally co-ordinated BITS survey has taken place in the fourth quarter of every year since 2000. This has used a consistent gear and survey design so there are no complications with conversion factors. However the coverage in 2000 and 2001 was more limited than in later years. The available indices are given in Table 2.4.15b. The indices are calculated using the same area weighting and depth stratification as the indices for the first quarter. It is not clear if this is appropriate as the stock shows a different distribution in the fourth quarter compared to the pre-spawning aggregations encountered during the first quarter survey. With the main spawning season being since early 1990's relatively late, i.e. from mid May to mid August, the impact is assumed to be limited. However, there is a need to check that zero-hauls are properly accounted for in the existing database. The latter concern also applies to the first quarter data. The inclusion of quarter 4 surveys in the assessment was

investigated for the first time in 2005 assessment, however due to poor diagnostics it was not used in the final XSA analyses previously.

Additionally the BITS quarter 4 survey showed high negative residuals in the 2000 and 2001. In these years the area coverage by surveys was not sufficient, especially in the SD 26. It can be stated that the autumn BITS survey was fully implemented with new survey design and new survey gear only since 2002 and therefore 2000 and 2001 were excluded.

In the 2005 assessment three commercial CPUE series were introduced into the assessment. These used aggregate CPUE series from Danish and Swedish commercial fisheries allocated to age using WG data on the age compositions for the relevant nation, gear, SD and quarter. The series are Danish Trawlers and Gillnetters and Swedish trawlers. The data from these fleets are given in Table 2.4.16. The Danish vessels take the majority of their catch in SD 25, with a smaller proportion taken in SD 26. The Swedish vessels take a higher proportion of their catch in SD 26 as well as smaller amounts in SDs 27-29. One possible concern with using these CPUE data as indices of stock size is that the distribution of the stock can change with stock size and environmental conditions, in which case CPUE from only one part of the distribution may not be representative for the whole stock. However, in recent years the majority of the stock has been concentrated in SDs 25 and 26 so this problem is not also anticipated in the current assessment.

2.4.6.2 XSA runs

For the assessment the following fleets were available:

Name	First year	Last year	Youngest age	Oldest age
BITS Q1	1991	2007	2	8
BITS Q4	2000	2006	2	5
Danish Gillnetters < 160mm	1994	2006	2	7
Danish trawlers >90mm mesh	1994	2006	2	7
Swedish trawlers	1994	2006	2	7

To investigate internal consistency of the available tuning fleets, indices at each age were plotted against indices from the same cohort at the next age (Figure 2.4.3a-f). In general the relationships are quite noisy with the Danish commercial CPUE behaving somewhat better than the 1st quarter BITS survey and the Swedish trawler fleet.

As the single fleet tuning data were only updated by one year and age cohort analyses were similar to last years assessment, single fleet runs with low shrinkage were not investigated. This was done during WGBFAS 2006.

The following combination of tuning series were investigated in exploratory runs:

- SPALY run with fleet selection as in WGBFAS 2006;
- BITS quarter 1 (backshifted)
- BITS quarter 4
- BITS quarter 1 (backshifted) and commercial CPUE;
- BITS quarter 1 (backshifted) and quarter 4 and commercial CPUE.

All runs including research survey and commercial CPUE tuning series produced very similar results (estimated SSB in 2006 between 81.0 and 86.0 thousand tonnes; Fbar over ages 4-7 between 0.91 and 0.97) which did not differ greatly from a run using the same fleet

configuration as in the 2006 assessment (SSB = 84.0 kt; Fbar = 0.95). The results from the single survey fleet runs were however considerably different (Figure 2.4.4).

There was no clear basis for choosing any one of these alternative configurations over the configuration used in 2006. XSA diagnostics analyses (high residuals, low R^2 values and high SE) revealed the necessity to exclude some age groups from further analyses.

BITS 1st quarter survey residuals shifted from negative residuals to positive around 2000 (Figure 2.4.5a). It was considered to be related to change in survey gear and design that took place in 2001. Obviously the used conversion factors between old and new survey gears are not satisfactory. Therefore the fleets used in the final XSA were as follows:

Name	First year	Last year	Youngest age	Oldest age
BITS Q1 Backshifted	1990	2000	2	5
BITS Q1 Backshifted	2001	2006	2	5
BITS Q2 age 2 unshifted	1991	2000	2	2
BITS Q2 age 2 unshifted	2001	2006	2	2
BITS Q4	2002	2006	2	5
Danish Gillnetters < 160mm	1994	2006	3	7
Danish trawlers >90mm mesh	1994	2006	3	7
Swedish trawlers	1994	2006	3	7

The final XSA settings were as follows:

- Time weighting: tricubic over 20 years
- Catchability: independent of stock sizes for all ages; independent of age for ages >= 6
- Survivor estimates shrunk toward the mean F of the final five years and three oldest ages with an assumed SE of 0.5.
- Other settings used were default values.

The XSA settings used are the same as those used during the three previous years for this stock.

XSA diagnostics from the final XSA configuration are given in Table 2.4.17, with estimates of fishing mortality and stock number at age from this run given in Tables 2.4.18 and 2.4.19. Table 2.4.20 contains the stock summary information. The log catchability residuals from this run are given in Figure 2.4.5b, with retrospective analysis in Figure 2.4.6.

2.4.6.3 SURBA analysis

In view of the problems with misreporting the WG investigated the use of the survey-based approach SURBA, using the BITS first and fourth quarter and commercial fleet cpue indices. The complete available age and year range of these tuning fleets have been explored for research vessel surveys and for commercial tuning fleets separately.

The log q residuals of tuning fleets are shown in Figures 2.4.7a and 2.4.8a revealing that some age classes or time periods have high values. Specifically age group 2 from commercial tuning series and years 2000 and 2001 fourth quarter BITS survey behaved unsatisfactory. These data were excluded from final XSA run.

Age structured data sufficiently follow the cohorts with minor exception in oldest ages (Figures 2.4.7b and 2.4.8b).

BITS as well as the commercial CPUE time series do not reveal contrasts in year-class strength for recent period. The fully recruited age in surveys is 2 and for commercial surveys 3-4. Correlation matrices showed relatively low R^2 values that can be explained by: age reading differences in BITS surveys (1), short time series - BITS quarter 4 survey (2) and the fact that were is not much variation in the year-class strength since 1990-ies (3) (Table 2.4.21 and Figures 2.4.7c-e and 2.4.8c-f).

Values of relative SSB, recruitment and F from the model were scaled to absolute values based on the XSA estimate of corresponding parameters in 1994. Comparisons between trends in key parameters estimated by SURBA and by XSA are shown in Figure 2.4.9. The principle difference between the XSA and the SURBA trends from research surveys comes in the period around 2000 when SURBA indicates a significant increase in SSB while XSA indicates that these quantities remained rather constant over this period. The WG considers that this difference is determined by changes in catchability in the survey rather than as evidence of additional problems in the catch data. Since 2001 the new standard survey gear and survey design was introduced. However, uncertainty over the true level of catches in recent years may also have influenced this discrepancy. Additional difference appear in 1995-1996 and also in 2005 when commercial fleets indicate high recruitment of the 1993 and 1994 as well as the 2003 year-classes while the XSA does not. It should be mentioned that these year-classes were formed in years when major salt water inflows occurred in the Baltic enhancing reproductive success. F trends are more consistent, although the relative F based on commercial fleet data are on lower level than XSA and BITS survey results.

2.4.7 Recruitment estimates

Indices of recent recruitment to this stock are available from the BITS in the 1st and 4th quarters, presented by year-class in Table 2.4.15. Only the age group 2 indices have been included in the XSA runs in the recruitment estimation.

Year-class 2003 is the highest on record since 1990 as ages 1-2 in the 1st quarter surveys 2004 and 2005, being still abundant as ages 3 and 4 in the 2006 and 2007 surveys. In the 4th quarter surveys 2003 the year-class was as well very abundant at age 0, on a similar high level as year-class 2000 as age 1 in the 2004 survey, but below the year-class 2000 level as age 2 in the 2005 survey.

An attempt was made to use survey indices of age 1 and 2 from the 1. quarter and age 0-2 from the 1, quarter surveys in an RCT3 run. Input is given in Table 2.4.22 and results in Table 2.4.23. It can be seen that the regression diagnostics from this run are unsatisfactory with some negative slopes, and large changes in regression slopes with the addition of single points. These problems occur over the period for which recruitment indices are available. The XSA estimates of recruitment appear rather low with relatively little contrast. Over the same period, the indices show relatively high variability in the surveys. A further complication is the change in gear and survey design in the BITS survey in 2001. This appears to have resulted in an increase in catchability in the survey, which may be further complicated by a ‘year-effect’ in the survey in 2002 when catches of all age-classes appear high.

The group considers the signal of a relatively strong year-class 2003 detected in successive surveys to be real, being likely also due to enhanced environmental conditions after the 2003 major Baltic inflow. The group furthermore considers the age composition of the international catches to be uncertain. Besides age determination problems, it is unclear whether discarding as well as unaccounted or unallocated landings have affected the age composition. Thus, the group decided to utilise the abundance estimates from the RCT3 in the short-term forecast for year-class 2005. For year-class 2006 and onwards a geometric mean of year-classes 1987 to 2003 has been used.

2.4.8 Historical stock trends

Long-term stock trends are given in Figure 2.4.10a, Figure 2.4.10b and Table 2.4.20.

The total and spawning stock biomass increased by the end of the 1970s due to the extremely abundant year-classes formed in 1976, 1977 and 1980 and favourable reproduction conditions in the southern and central Baltic Sea. The spawning stock declined from the historically highest level around 650,000 t during 1982–1983 to the extremely low level in 1992 (92,000 t). The decline of the stock was a result of an increase of the effort in the traditional fishery (i.e., the bottom trawl fishery), introduction of gillnet fishery, and decreasing reproductive success due to limited inflow of oxygenated, saline water from the North Sea. Since the mid-1980s successful cod reproduction has only been observed in the southern spawning areas. Since 1987 all year classes have been below the long-term average. After 1992, the SSB increased and in 1995 was close to 240,000 tonnes. Subsequently however, SSB has decreased due to the poor recruitment and high fishing mortality. Recently, the stock has exhibited something close to equilibrium dynamics, with almost constant recruitment meaning that the stock size fluctuates largely in response to variations in fishing mortality.

2.4.9 Short-term forecast and management options

Short-term forecasts have been prepared for this stock based on the final XSA run which included correction for discards and misreporting. Stock numbers at age at the start of 20067 were taken from the XSA estimates of survivors. Overall fishing mortality was estimated using the mean over the last three years, without scaling to the point estimate of mean F in 2006. This was then partitioned between landings and discards on the basis of the mean discarding pattern at age over the last three years. Weights at age in the catches were estimated using means over 2004-2006.

Input data to the short-term forecast are given in Table 2.4.24, with the management option table from this forecast given in Table 2.4.25. The contribution of recent year classes to the forecast yield and SSB are given in Figure 2.4.11. As it is seen the yield in 2007-2008 and SSB in 2008 will be largely dependent on the year classes 2003 and 2004.

As an exploratory exercises, short term prediction were conducted with scaling the F in 2007 to the to final year of XSA output and with TAC constraint in 2007. The SSB and yield comparison from these runs are presented in Figure 2.4.13. The run with TAC constraint was done to investigate whether the stock could have exceeded present B_{lim} if in 2007 total catches (official and unreported landings + discards) corresponds to the TAC. The EU adopted TAC for Eastern Baltic cod in 2007 is 40,805 tons plus 3,500 tons quota for Russian. Hence, the exploratory forecast was run using a catch constraint in 2006 of 44,305 tons with other inputs unchanged from the standard run. The output of the exploratory run showed that the stock would not have exceeded present B_{lim} in 2008, but in 2009, at levels of $F_{BAR} \leq 0.55$ in 2008.

2.4.10 Reference points and Management Plans

Limit reference points

In 2006 WGBFAS asked ACFM for clarifications:

> *which limit reference points are needed in future, in which framework will they be used and what does that imply for their precision, stability against structural uncertainties (e.g. single vs. multispecies, environmental changes) ?*

WGBFAS notes that ACFM passed on the questions to WKREF with the following ToR:

> *review and update the biological basis of limit reference points for fish stocks in the ICES area, taking into account the possible effects of species interactions and regime*

shifts. As a minimum the limit reference points for North Sea herring, Norwegian spring spawning herring, North Sea cod, Baltic cod and Kattegat sole stocks;

While WKREF was able to review and update the biological basis for the determination of limit reference points, it had no mandate to revise them and was additionally unable to give clear guidelines on methodology how to determine limit reference points under shifting environmental conditions. Instead *WGBFAS is invited to further develop this methodology and to come with recommendations for a possible revision of Blim.*

In response WGBFAS conducted a review of the WKREF results, given in Annex 13 and agreed on a number of conclusions. However, due to time constraints, these conclusions could not be discussed in plenum and in subsequent discussion no agreement on the conclusions could be reached.

Yield (in terms of landings) and SSB per recruit are presented in Figure 2.4.12. Fmax for this stock is indicated to be around 0.26.

Target reference points and management plan

AGLTA (2005) conducted medium-term simulations for both the eastern and the western Baltic cod stock using the STPR3 software, which is a stochastic medium term (10 years) projection program, taking into account uncertainty in initial stock numbers at age, future recruitments, individual weights and maturities, as well as uncertainty and bias in future assessments and implementation. It does not perform annual assessments in each of the simulation years, however, but just draws random assessment errors. The harvest rules which can be evaluated includes fixed F and fixed TAC rules for 3 intervals of SSB, with the option to let F decline linearily with SSB within the intermediate SSB interval. It also allows constraints on year-to-year variation in TAC, F and SSB.

The Harvest control rule tested by AGLTA (2005) has three parameters – a target F (Ft), a limit spawning stock biomass (Blim) and a trigger spawning stock biomass (Btrig), below which fishing mortality is reduced linear to reach zero (or more precisely a residual mortality of 0.05) at Blim. The model settings for the eastern cod were Blim: 160 kt, Btrig: 240 kt, assessment bias: 1.0 (none), alternative 1.2, but random variation of assessment with SD: 0.35, alternatively: 0.55 from SURBA, implementation bias: 1.2 (20% overshoot in catch), alternatively 1.0 and 1.4 and an initial stock size from 2005 assessment with CV of 0.6 for ages 2 & 8+, 0.5 for ages 3-7. The stock recruitment model applied was a segmented regression covering the year-classes 1987-2001, resulting in a breakpoint of 90.000 tons being very similar to the result of WGBFAS (2005) and WKREF (2007). However the recruitment of the plateau was 130 mill recruits, which is somewhat higher than determined by WGBFAS (2005), but very similar to the value determined by WKREF (2007).

The simulations included Fsq forecasts, without a HCR to develop a base case against which comparisons can be made. Secondly consequences of alternative human consumption and discard Fs on the probability of being below Blim in 2015 were explored with and without 15% TAC constraints. Finally the sensitivity of the 2015 situation to the assumptions on the underlying population dynamics (e.g. stock recruitment relationship) and the perception status (e.g. standard deviation on stock status) were explored.

Results showed that the risk to Blim in 2015 at an F of 0.3 is very low (<5%). This result is independent of discard mortality, as this is relatively low in the stock. The scenario with a 15% cap on TAC variation was found as a useful method to dampen the noise in the assessment process. However, this benefit is on the cost of significant lower average catches in all years except the earliest and the recovery process was lower.

AGLTA (2005) concluded that if the objective is to obtain a high long term yield in combination with a low risk to Blim, the preferred level of human consumption fishing

mortality could be in the area of 0.3 - 0.4. At this fishing mortality, the expected landings in the final years of the simulation are around 110 000 t, while the short term landings are expected to be around 45 000 t. No major improvement to the stock development and to the landings is expected by the additional reduction of the already low discard mortality. The cap on annual TAC variations is expected to improve the performance in terms of minimising short term landings variation and in terms of making the system less sensitive to the noise in annual assessments, but at the cost of reduced medium term catches. At a target F in the range of 0.3 to 0.4 the likelihood of meeting objectives and performance criteria is furthermore insensitive to assumption regarding stock productivity and assessment error and bias.

The sensitivity to the underlying assumptions was explored by applying different stock recruitment relationships, and as to be expected if the recruitment scenario is lower (i.e. lower recruitment at given stock size, e.g. due to less favourable environmental situations), the risk to Blim is higher. These simulations were conducted with segmented regressions having breakpoints at 90.000 tons, but a plateau of 93 mio recruits, which is not the stock recruitment relationship used in the simulations and it is origin is unclear. For the sensitivity test this means that the risk against Blim is overestimated compared to the stock recruitment relationships used in the simulations.

The sensitivity test uses additionally segmented regressions with 160.000 tons and 356.000 tons breakpoints. While the latter origins from the entire stock assessment time series, the origin of the former is unclear. It should be pointed out that the slopes of all three segmented regressions (the 90.000 tons breakpoint relationship used in the simulations and the 160.000 tons and the 356.000 tons breakpoint relationships) are very similar. The only difference between the stock recruitment relationships is a higher breakpoint and thus allowing a higher recruitment at increasing SSB, implying that recovery rates at low stock sizes are similar, but recruitment at higher SSB is truncated at 90.000 tons to account for unfavourable environmental scenarios. This justification corresponds to the explanation of WGBFAS that in periods of low occurrence of Baltic inflows only one out of three spawning areas is operational, meaning that SSB distributed in eastern spawning areas will not contribute to reproductive success.

Apart of this agreement, WGBFAS finds it inconsistent to use a segmented regression with a breakpoint of 90.000 tons considering a truncated time series with low recruitment and than testing the risk against a Blim of 160.000 tons determined from a period with higher recruitment. If accepting the segmented regression for the simulation, Blim should be revised as well to 90.000 tons as suggested by WGFAS (2005 and 2006) or alternatively a segmented regression with a breakpoint at 160.000 tons should be used in the simulations testing for performance at enhanced environmental conditions. In practice it means that when applying the 90.000 tons segmented regression the risk against a Blim of 90.000 tons will be very small, as it is already small (<5%) against a Blim of 160.000 tons. Thus, a target fishing mortality of 0.3 is with very high probability sustainable and precautionary. WGBFAS concludes that accepting the segmented regression with 90.000 tons breakpoint for the simulations to advice on precautionary target fishing mortalities and not accepting it as Blim is inconsistent.

Advice of ACFM (2005) on long-term management of Baltic cod

Based on results of the simulations by AGLTA (2005) for the Eastern Baltic cod stock, ACFM (2005) advised to the EU commission in response to a special request on a harvest control rules for a Baltic cod management plan that: "*Evaluations demonstrated that under the current exploitation pattern target fishing mortalities (all catches) close to 0.3 (ages 4-7) result in a low risk to reproduction and high long-term yields*."

Multi-annual plan for the Baltic cod stocks

Based on the advice by ACFM (2005), covering as well based on similar simulations the western Baltic cod stock, the EU commission proposed a management for Baltic cod stocks "Establishing a multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting those stocks" COM(2006) 411. It outlines the following harvest control rule for the Eastern Baltic cod:

Reduce F by 10% compared to the year before, until F (4-7) is 0.3. Interannual changes in TAC are restricted to +/-15%, except if F > 0.6 (ages 4-7), than TAC may be reduced by > 15%.

Although the target F in the harvest control is based on the ACFM (2005) advice and is considered as precautionary, the management plan has not been evaluated by ICES. WGBFAS sees the central element of the harvest control rule, a cumulative 10% reduction of F every year compared to the F value in 2005, as a procedure which will bring eventually the fishing mortality down to the target F. However once the target F is reached, it is less clear whether a 15% TAC constraint is ensuring to keep F at this level. The harvest control rule enables TAC changes of more than 15% only if F > 0.6, which is questionable to give the necessary possibilities to adjust TAC's to return to F target levels. WGBFAS suggests simulations to be conducted to explore the behaviour of the harvest control rule with respect to the included TAC constraints and will prepare these until the ACFM meeting.

2.4.11 Quality of assessment

The WG has previously noted the following problems in relation to the input data for the assessment of this stock.

- There is substantial uncertainty associated with the total catches due to extensive misreporting.
- The age composition data in both the catches and the survey suffer from severe inconsistencies which appear to differ between countries and between years.
- There have been changes in management regions, closed seasons and areas and gear regulations in recent years which may have led to changes in exploitation pattern including discard practise,
- Recent recruitment appears to have been relatively constant, leading to data which would naturally have little contrast.

These have previously led to rather poor assessment performance, but introduction of three age-disaggregated commercial CPUE series in 2005 has resulted in a considerably more stable assessment, which does not demonstrate the obvious problems of assessments during preceding years. The addition of further years of BITS 1st quarter survey data with the new design has enabled to utilise separate time series of surveys for tuning up to and after 2001. Furthermore, the 4th quarter survey has for the first time been used in the assessment. This does not mean that all the problems have been solved, but the assessment performance has certainly improved by these changes.

2.4.12 Comparison with previous assessment

The present assessment utilises three age-disaggregated commercial CPUE series in combination with 1st quarter and for the first time 4th quarter BITS survey results, which resulted in a more stable assessment compared to preceding years. However, deviations in output exists between the 2006 and the 2007 assessments. The SSB in 2005 year as estimated by the present assessment is higher, while F is lower. Such change in trends is not usual for this stock. Changes are related especially to an underestimation of year-class 2002 at age 3 and an overestimation of F in the same and the preceding year-class.

Especially in relation to the short term prediction some differences are important. Although WGBFAS in 2006 quite satisfactory determined the 2003 year class strength at age 2 (difference 7%), the strength of 2004 year class was estimated to be substantially lower (Figure 2.4.26). These differences results in a more optimistic short-term prediction for 2007. The higher 2004 year class abundance can be related to age reading inconsistencies, i.e. ageing errors on individuals from the abundant 2003 year-class, as survey results do not indicate a relatively high abundance of this year-class at age 0 and 1, which corresponds to the expectation from environmental conditions being largely unfavourable for reproduction in eastern spawning areas in 2004.

The Table below is showing the comparison of settings and model outputs for final runs of XSA in WGBFAS 2006 and 2007.

	XSA (2006)	XSA (2007)	DIFF. IN OUTPUT
Tuning fleets			
BITS Q1 Backshifted	2-5 (1990-2005)		Yes
BITS Q1 Backshifted		2-5 (1990-2000)	Yes
BITS Q1 Backshifted		2-5 (2001-2006)	Yes
BITS Q1 age 2 unshifted	2 (1991-2005)		Yes
BITS Q1 age 2 unshifted		2 (1991-2000)	Yes
BITS Q1 age 2 unshifted		2 (2000-2006)	Yes
BITS Q4		2-5 (2002-2006)	Yes
BITS Q1 age 2 unshifted			Yes
Danish Gillnetters < 160mm	3-7 (1996-2005)	3-7 (1996-2006)	No
Danish trawlers >90mm mesh	3-7 (1996-2005)	3-7 (1996-2006)	No
Swedish trawlers	3-7 (1996-2005)	3-7 (1996-2006)	No
XSA settings			
Fishing effort	Hours & hp hours fishing	Same as last year	
Tapered time weighting	Tricubic over 20 years	Same as last year	
First age of independent q	2	Same as last year	
Catchability independ. of age for ages>=	6	Same as last year	
S.E. of the mean to which the estimates are shrunk	0.5	Same as last year	
Number of final years using shrinkage	5	Same as last year	
Number of oldest ages using shrinkage	3	Same as last year	
XSA results			
SSB (2005) (t)	65.4	81.2	19%
F(4-7) (2005)	1.03	0.91	-13%
Recruitment Age 2 (2005) (thousands)	162.3	172	6%

2.4.13 Management considerations

The spawning stock of cod in the Eastern Baltic remains at a low level, with the final and all exploratory XSA runs indicating a spawning stock size well below Blim (160,000 t). Fishing mortality is still high, and although more uncertain than the stock estimate, clearly above Fpa.

The assessment output shows recent recruitment to have been in general low and relatively constant, although the year-class 2003 is relatively abundant, being well above average for the last 15 years and it expected that the year-class together with the year-class 2004 will form the backbone of the fishery in catches in 2007.

The available information indicates that large changes in the stock status are unlikely in the short-term. Recovery to stock levels observed in the 1970's and 1980's likely requires both an increased reproductive success dependent on environmental conditions and a significant

reduction in fishing mortality. To realise the latter, requires a substantial reduction in landings relative to recent level is required.

Table 2.4.1 Cod in SD 25-32. Total landings (tons) by country.

Year	Denmark	Estonia	Finland	German Dem.Rep.[2]	Germany, Fed. Rep.	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands[4]	Norway	Unallo-cated[3]	Total
1965	15,856		23	975	2,183			41,498		19,523	22,420				102,478
1966	16,570		26	2,196	1,383			56,007		20,415	38,270				134,867
1967	19,924		27	11,020	1,057			56,003		21,367	42,980				152,378
1968	21,516		70	12,118	2,018			63,245		21,895	43,610				164,472
1969	23,459		58	18,460	4,715			60,749		20,888	41,580				169,909
1970	22,307		70	10,103	4,855			68,440		16,467	32,250				154,492
1971	23,116		53	2,970	2,766			54,151		14,251	20,910				118,217
1972	34,072		76	4,055	3,203			57,093		15,194	30,140				143,833
1973	35,455		95	6,034	14,973			49,790		16,734	20,083				143,164
1974	32,028		160	2,517	11,831			48,650		14,498	38,131				147,815
1975	39,043		298	8,700	11,968			69,318		16,033	49,289				194,649
1976	47,412		287	3,970	13,733			70,466		18,388	49,047				203,303
1977	44,400		310	7,519	19,120			47,702		16,061	29,680				164,792
1978	30,266		1,437	2,260	4,270			64,113		14,463	37,200				154,009
1979	34,350		2,938	1,403	9,777			79,754		20,593	75,034	3,850			227,699
1980	49,704		5,962	1,826	11,750			123,486		29,291	124,350	1,250			347,619
1981	68,521		5,681	1,277	7,021			120,001		37,730	87,746	2,765			330,742
1982	71,151		8,126	753	13,800			92,541		38,475	86,906	4,300			316,052
1983	84,406		8,927	1,424	15,894			76,474		46,710	92,248	6,065			332,148
1984	90,089		9,358	1,793	30,483			93,429		59,685	100,761	6,354			391,952
1985	83,527		7,224	1,215	26,275			63,260		49,565	78,127	5,890			315,083
1986	81,521		5,633	181	19,520			43,236		45,723	52,148	4,596			252,558
1987	68,881		3,007	218	14,560			32,667		42,978	39,203	5,567			207,081
1988	60,436		2,904	2	14,078			33,351		48,964	28,137	6,915			194,787
1989	57,240		2,254	3	12,844			36,855		50,740	14,722	4,520			179,178
1990	47,394		1,731		4,691			32,028		50,683	13,461	3,558			153,546
1991	39,792	1,810	1,711		6,564	2,627	1,865	25,748	3,299	36,490		2,611			122,517
1992	18,025	1,368	485		2,793	1,250	1,266	13,314	1,793	13,995		593			54,882
1993	8,000	70	225		1,042	1,333	605	8,909	892	10,099		558		13,450	45,183
1994	9,901	952	594		3,056	2,831	1,887	14,335	1,257	21,264		779		36,498	93,354
1995	16,895	1,049	1,729		5,496	6,638	4,513	25,000	1,612	24,723		777	293	18,993	107,718
1996	17,549	1,338	3,089		7,340	8,709	5,524	34,855	3,306	30,669		706	289	8,515	121,889
1997	9,776	1,414	1,536		5,215	6,187	4,601	31,396	2,803	25,072		600			88,600
1998	7,818	1,188	1,026		1,270	7,765	4,176	25,155	4,599	14,431					67,428
1999	12,170	1,052	1,456		2,215	6,889	4,371	25,920	5,202	13,720					72,995
2000	9,715	604	1,648		1,508	6,196	5,165	21,194	4,231	15,910				23,118	89,289
2001	9,580	765	1,526		2,159	6,252	3,137	21,346	5,032	17,854				23,677	91,328
2002	7,831	37	1,526		1,445	4,796	3,137	15,106	3,793	12,507				17,562	67,740
2003	7,655	591	1,092		1,354	3,493	2,767	15,374	3,707	11,297				22,147	69,476
2004	7,394	1,192	859		2,659	4,835	2,041	14,582	3,410	12,043				19,563	68,578
2005	7,270	833	278		2,339	3,513	2,988	11,669	3,411	7,740				14,991	55,032
2006[1]	9,766	616	427		2,025	3,980	3,200	14,290	3,719	9,672				17,836	65,532

[1]Provisional data. [2]Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.

[3]Working group estimates. No information available for years prior to 1993.

[4] For 1997 landings not officially reported, estimated by the WG.

Table 2.4.2 Cod in SD 25-32. Estimated numbers (10^3) discarded by age, gear and subdivision.

Stock	25-32
Year	2006

		Sub-div.	Gear																		
		25		25 Total	26		26 Total	28		28 Total	27		27 Total	29		29 Total	30		30 Total	32	32 Total	Grand Total
Quarter	Data	Active gears	Passive gears		Active gears	Passive gears		Active gears	Passive gears		Active gears	Passive gears		Active gears	Passive gears		Active gear	Passive gears		Passive gears		
1	Age 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 1	50	0	50	81	0	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	131
	Age 2	1477	53	1531	377	10	387	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1918
	Age 3	3891	73	3964	195	43	238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4202
	Age 4	10	15	25	12	30	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66
	Age 5	0	2	2	2	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	Age 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Age 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 1	26	3	29	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
	Age 2	2862	57	2918	343	7	350	0	0	0	0	4	4	0	0	0	0	0	0	0	0	3272
	Age 3	3954	38	3992	256	29	286	0	0	0	0	2	2	0	0	0	0	0	0	0	0	4280
	Age 4	39	45	84	11	62	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	158
	Age 5	1	20	20	0	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
	Age 6	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	Age 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Age 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 1	6	15	21	2	1	3	0	1	1	0	1	1	0	0	0	0	0	0	0	0	26
	Age 2	246	30	276	42	7	49	0	2	2	0	1	1	0	0	0	0	0	0	0	0	328
	Age 3	51	11	63	54	7	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124
	Age 4	0	1	1	4	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	Age 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Age 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 1	93	49	142	123	3	126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	268
	Age 2	1262	102	1364	307	32	339	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1704
	Age 3	194	40	234	135	64	200	0	0	0	0	0	1	0	0	0	0	0	0	0	0	434
	Age 4	1	7	7	4	34	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47
	Age 5	0	1	1	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	Age 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Age 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Age 0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Age 1		175	66	241	208	3	211	0	1	1	0	1	1	0	0	0	0	0	0	0	0	454
Total Age 2		5848	242	6089	1069	55	1125	0	2	2	0	5	5	0	0	0	0	0	0	0	0	7221
Total Age 3		8091	161	8252	641	143	784	0	1	1	0	2	2	0	0	0	0	0	0	0	0	9040
Total Age 4		50	67	117	31	127	159	0	0	0	0	1	1	0	0	0	0	0	0	0	0	277
Total Age 5		1	22	23	2	23	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48
Total Age 6		0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Total Age 7		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Age 8		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		28327	1120	29447	3902	707	4610	0	9	9	1	16	18	1	1	2	0	0	0	0	0	34085

Table 2.4.3 Cod 25-32. The percentage of discard (numbers) in 2006 for which no discard data have been available.

Sub-division 25-32			
Year	Stratification*	Gillnet	Trawl
1996	2	22.8	43.2
1997	2	76.5	53.3
1998	2	87.2	31.7
1999	2	38.3	70.7
2000	2	71.0	62.7
2001	2	11.7	13.5
2002	2	92.8	94.8
2003	1	87.8	25.7
2004	1	62.6	40.2
2005	1	60.7	26.4
2006	1	75.5	43.8

Stratification 1=Mobile gears, passive gears
Stratification 2=gillnets, several trawl fisheries.

Table 2.4.4 Cod in SD 25-32. Discard percentage (of landing+discard in numbers) by age group in the period 1996-2006.

Age group	Year										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age0	15.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Age1	85.5	99.2	97.9	99.6	93.0	56.5	98.1	96.0	67.9	77.7	92.8
Age2	26.2	22.8	39.4	13.6	70.2	26.8	37.5	56.2	25.0	26.2	49.8
Age3	2.7	24.7	9.8	10.4	4.9	5.9	1.5	3.8	7.2	8.7	19.8
Age4	0.9	0.2	0.8	0.2	0.1	0.3	0.1	0.3	0.9	2.3	1.4
Age5	0.6	0.5	0.2	0.2	0.1	0.0	0.6	0.1	1.3	0.3	0.6
Age6									0.7	0.3	0.1
Age7									0.2	0.7	0.1

Table 2.4.5a Cod in SD 25-32. Discard (in numbers) by metier and year.

Stock	25-32

Gear	Year										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Passive gear	2037	2255	12772	865	14471	1920	1283	3933	1349	4396	927
Active gear	5318	15325	9565	21314	8822	9008	5841	4315	2324	799	16116
Grand Total	7355	17580	22337	22179	23293	10929	7125	8248	3673	5195	17042

Table 2.4.5b **Cod in SD 25-32. Discard in weight (tons) by age group in 2006.**

Species	Cod
Year	2006
Stock	25-32
Catch category	Discard
Quarter	(All)
wgt (tons)	
age	Grand Total
0	0
1	79
2	2510
3	3520
4	130
5	32
6	3
7	1
Total	6276

Table 2.4.6 **Cod in SD 25-32. Swedish effort data in sub-divisions 25-29.**

Year	Catch sampled (tonnes)	Effort (hours)	CPUE	Relative CPUE
1982	12,027	25.587	0.470	1.000
1983	18,360	38.923	0.472	1.004
1984	30,064	66.837	0.450	0.957
1985	29,184	59.309	0.492	1.047
1986	27,912	82.869	0.337	0.717
1987	24,020	77.068	0.312	0.663
1988	28,788	99.460	0.289	0.616
1989	30,273	107.247	0.282	0.601
1990	23,983	99.157	0.242	0.515
1991	14,557	70.981	0.205	0.436
1992	2,916	29.115	0.100	0.213
1993	3,678	24.424	0.151	0.320
1994	6,952	25.658	0.271	0.576
1995	11,796	34.966	0.337	0.718
1996	14,562	52.842	0.276	0.586
1997	11,295	60.893	0.185	0.395
1998	6,879	40.769	0.169	0.359
1999	5,995	41.791	0.143	0.305
2000	7,411	53.256	0.139	0.296
2001	6,961	57.233	0.122	0.259
2002	7,057	51.575	0.137	0.291
2003	6,085	45.187	0.135	0.286
2004	7,036	44.960	0.156	0.332
2005	4,373	41.913	0.104	0.221
2006	5,307	41.077	0.129	0.274

Table. 2.4.7 **Cod in SD 25-32. Aggregate catch per unit effort data from Danish commercial fleets.**

Year	Danish Gillnetters < 160mm mesh			Danish Trawlers >= 90 mm mesh		
	Fleet landing (tonnes)	Effort (HP-hours)	LPUE (kg/Hp-hour)	Fleet landing (tonnes)	Effort (HP-hours)	LPUE (kg/Hp-hour)
1991	1594.4	421100	3.79	8853.6	3327700	2.66
1992	1486.8	426200	3.49	5412.2	2872300	1.88
1993	431.3	125050	3.45	493.7	160500	3.08
1994	1834.8	295600	6.21	2502.9	382100	6.55
1995	2587.1	489850	5.28	4222.4	804300	5.25
1996	2761.8	619650	4.46	7936.0	1586200	5.00
1997	530.4	166150	3.19	5872.5	1544950	3.80
1998	288.8	107550	2.69	4477.7	1775450	2.52
1999	528.8	192800	2.74	6587.7	2038050	3.23
2000	392.1	157200	2.49	3204.4	1026700	3.12
2001	672.0	246500	2.73	3010.3	1254950	2.40
2002	507.0	194500	2.61	2232.3	962400	2.32
2003	440.1	205500	2.1	3318.8	1299200	2.55
2004	573.3	236150	2.43	2699.1	849600	3.18
2005	925.8	330500	2.80	2772.9	1225050	2.26
2006	555.1	209400	2.65	4311.4	1148500	3.75

Table 2.4.8a Cod in SD 25-32. Numbers at age (CANUM) and mean weight at age (WECA) in commercial Landings by Subdivision, quarter and gear in 2006.

Year: 2006 Gear: Trawl and gillnet combined

Year: 2006	Quarter: 1													
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	4.735	617	4.170	168									9	407
2	1635.586	617	112.520	237									1732	592
3	8276.910	810	1941.368	616	0.064	513	0.130	513	0.000	543	0.000	558	10126	773
4	5125.205	916	3483.117	790	1.323	725	2.687	725	0.012	755	0.023	757	8537	865
5	921.559	1491	1752.315	1127	3.624	979	7.333	980	0.047	954	0.092	953	2662	1251
6	113.089	3073	469.089	1541	1.472	1403	2.984	1403	0.017	1377	0.032	1376	581	1835
7	69.784	4443	72.060	2309	0.340	2118	0.689	2120	0.004	1970	0.008	1960	142	3350
8	15.439	6992	27.467	4023	0.063	3133	0.127	3139	0.001	2719	0.002	2699	43	5082
9	7.110	7497	6.080	4028	0.016	3025	0.032	3027	0.000	2647	0.000	2573	13	5887
10+	1.221	10733	2.400	7358	0.004	9300	0.007	9300	0.000	9300	0.000	9300	4	8499
SOP [t]	14614		6993		8		15		0		0		21437	
Landings (t)	14421		6993		8		15		0		0		21437	

Year: 2006	Quarter: 2													
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1			3.367	135									3	135
2	1251.428	601	187.656	450									1431	581
3	12185.815	722	2821.573	725	0.186	528	1.256	622	0.000	540	0.004	598	14924	723
4	4041.759	937	2764.534	894	10.394	749	21.170	772	0.011	754	0.859	760	6800	919
5	1061.663	1392	1660.258	1077	38.628	957	28.224	1021	0.041	954	3.562	951	2776	1195
6	211.953	2506	505.634	1531	14.049	1381	8.523	1509	0.015	1378	1.251	1374	737	1807
7	39.023	6522	112.494	2399	3.252	1993	1.829	2037	0.003	1973	0.290	1950	156	3411
8	31.419	7552	35.360	3347	0.759	2769	0.203	3163	0.001	2725	0.072	2679	67	5289
9	17.935	14373	9.706	5018	0.070	2771	0.150	5278	0.000	2667	0.004	2473	28	11036
10+	3.501	15624	6.404	8354	0.073	9300	0.042	5183	0.000	9300	0.008	9300	10	10887
SOP [t]	16154		7654		74		64		0		7		23817	
Landings (t)	16019		7653		74		64		0		7		23817	

Year: 2006	Quarter: 3													
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1			3.841	128									4	128
2	483.857	675	100.539	629			0.284	400					576	667
3	1660.783	775	745.578	686	0.005	600	24.152	585	0.000	600	0.002	600	2395	746
4	322.555	1032	494.441	860	1.150	760	84.766	754	0.015	760	0.384	760	890	911
5	63.935	1956	293.519	1197	4.774	951	50.211	1249	0.064	951	1.595	951	408	1317
6	7.663	4601	53.371	1702	1.677	1374	10.897	1558	0.022	1374	0.560	1374	73	1970
7	1.377	9385	10.394	2208	0.388	1950	1.529	2254	0.005	1950	0.130	1950	14	2918
8	2.091	13973	4.474	4252	0.097	2678	0.757	6036	0.001	2678	0.032	2678	7	7132
9	1.114	13644	1.063	3981	0.005	2470			0.000	2470	0.002	2470	2	8903
10+	0.459	14950	0.730	4400	0.010	9300			0.000	9300	0.003	9300	1	8481
SOP [t]	2171		1492		9		166		0		3		3784	
Landings (t)	2114		1492		9		166		0		3		3784	

Year: 2006	Quarter: 4													
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1			19.779	135									20	135
2	2688.714	687	865.342	523			0.389	400					3526	647
3	5936.605	830	3382.403	645	0.026	527	11.876	616	0.000	600	0.021	510	9249	763
4	1267.387	1143	2344.301	851	1.388	749	55.118	816	0.016	760	0.327	712	3635	952
5	313.002	1834	1646.939	1155	5.125	958	50.062	1099	0.066	951	0.721	999	2003	1259
6	57.948	5127	339.556	1616	1.868	1382	18.457	1590	0.023	1374	0.321	1419	415	2101
7	2.647	5201	64.739	2292	0.432	1995	1.693	1997	0.005	1950	0.074	2213	69	2394
8	2.333	5520	21.095	3857	0.100	2775	0.091	1655	0.001	2678	0.011	3570	23	4006
9	0.802	10406	5.508	3444	0.009	2781	0.128	2280	0.000	2470	0.005	3089	6	4281
10+	0.202	9936	2.167	6312	0.010	9300			0.000	9300	0.000	9300	2	6634
SOP [t]	9130		7348		10		141		0		2		16494	
Landings (t)	8994		7348		10		141		0		2		16494	

Year: 2006	Quarter: All													
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	5.028		31.925	113									35	202
2	6180.952	639	1269.970	493			0.660	400					7265	622
3	27957.813	777	8930.744	665	0.281	526	31.869	698	0.000	562	0.027	529	36694	748
4	10704.294	957	9087.856	841	14.254	748	154.292	823	0.054	758	1.614	750	19863	901
5	2347.689	1511	5346.112	1126	52.147	958	140.906	1089	0.219	952	6.059	957	7848	1237
6	388.667	3116	1365.632	1565	19.064	1382	43.704	1459	0.077	1375	2.196	1381	1806	1890
7	113.747	5188	258.659	2350	4.412	1999	6.082	1998	0.018	1959	0.508	1989	380	3186
8	50.917	7608	88.380	3727	1.019	2783	1.012	5666	0.004	2696	0.119	2760	141	5109
9	26.145	12807	22.242	4336	0.100	2796	0.358	3322	0.000	2559	0.011	2753	49	8701
10+	5.190	14787	11.564	7616	0.096	9300	0.061	4886	0.000	9300	0.012	9300	17	9634
SOP [t]	42066		23486		100		386		0		12		65532	
Landings (t)	41548		23486		100		386		0		12		65532	

Table 2.4.8a continued 2/3

Year: 2006 **Gear:** Trawl

Year: 2006	Quarter: 1												Sub-div. 25-32			Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction	Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3 weight [g]	*10-3	weights [g]
1	4.735	617.300	4.170	168									9	407		8.819	407
2	1519.983	614.313	110.593	237									1631	589		1614.943	589
3	5650.561	817.590	1876.201	617	0.062	510	0.126	510	0.000	510	0.000	510	7527	768		7454.786	768
4	2628.175	934.126	2607.770	775	0.906	709	1.854	709	0.001	709	0.001	709	5239	855		5188.483	855
5	646.387	1413.467	894.916	1162	1.895	1005	3.876	1005	0.003	1005	0.003	1005	1547	1266		1532.247	1266
6	95.417	2903.009	355.582	1594	0.865	1423	1.770	1423	0.001	1423	0.001	1423	454	1868		449.287	1868
7	50.297	4603.386	50.436	2395	0.199	2237	0.407	2237	0.000	2237	0.000	2237	101	3490		100.369	3490
8	13.901	6867.005	16.642	4747	0.027	3715	0.056	3715	0.000	3715	0.000	3715	31	5707		30.333	5707
9	6.335	7300.991	4.036	3873	0.014	3100	0.028	3100	0.000	3100	0.000	3100	10	5955		10.314	5955
10+	0.655	10796.000	1.515	7112									2	8224		2.150	8224
SOP [t]	9583		5040		4		9		0		0		14636			14495	
Landings (t)	9443		5039		4		9		0		0		14495.188		0.990	14495	

Year: 2006	Quarter: 2												Sub-div. 25-32			Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction	Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3 weight [g]	*10-3	weights [g]
1			3.367	135									3	135		3.350	135
2	1117.504	601.805	166.219	432									1284	580		1277.129	580
3	8771.385	701.038	2023.870	716	0.150	510	1.106	617	0.000	510	0.000	510	10797	704		10741.051	704
4	3098.649	913.133	1980.777	911	2.194	709	11.954	729	0.001	709	0.001	709	5094	912		5067.411	912
5	801.570	1310.854	855.999	1130	4.587	1005	14.365	1033	0.003	1005	0.003	1005	1677	1215		1667.914	1215
6	125.830	2276.472	261.391	1611	2.094	1423	5.517	1599	0.001	1423	0.001	1423	395	1822		392.806	1822
7	27.586	6922.842	65.483	2553	0.482	2237	1.211	2053	0.000	2237	0.000	2237	95	3817		94.276	3817
8	17.715	9611.431	19.503	3535	0.066	3715	0.187	3197	0.000	3715	0.000	3715	37	6406		37.279	6406
9	17.248	14509.383	7.008	5159	0.033	3100	0.150	5278	0.000	3100	0.000	3100	24	11756		24.314	11756
10+	3.404	15856.575	5.248	8515			0.042	5183					9	11373		8.649	11373
SOP [t]	11654		5032		11		37		0		0		16733			16647	
Landings (t)	11569		5030		11		37		0		0		16647.320		0.995	16647	

Year: 2006	Quarter: 3												Sub-div. 25-32			Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction	Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3 weight [g]	*10-3	weights [g]
1			3.527	129									4	129		3.483	129
2	176.728	630.847	55.496	611									232	626		229.329	626
3	595.048	785.539	562.289	679			21.742	577					1179	731		1164.381	731
4	133.122	1124.074	268.877	884			60.714	695					463	928		456.946	928
5	32.580	1784.553	79.163	1240			16.614	1145					128	1366		126.757	1366
6	5.273	3984.562	24.409	1394			7.589	1213					37	1724		36.807	1724
7	0.603	8691.325	3.682	1936			0.820	1515					5	2667		5.043	2667
8	0.785	13862.716	2.309	4868			0.615	6160					4	6986		3.663	6986
9	0.396	13665.870	0.583	3981									1	7900		0.967	7900
10+	0.169	14950.000	0.167	4400									0	9704		0.331	9704
SOP [t]	832		807				88						1727			1705	
Landings (t)	810		807				88						1705		0.988	1705	

Year: 2006	Quarter: 4												Sub-div. 25-32			Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction	Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3 weight [g]	*10-3	weights [g]
1			18.928	133									19	133		18.668	133
2	1387.688	676	266.104	548									1654	656		1631.061	656
3	2625.064	803	2456.828	666	0.021	510	8.405	600			0.021	510	5090	737		5020.374	737
4	553.504	1117	1503.104	836	0.309	709	35.195	789			0.309	709	2092	910		2063.661	910
5	127.995	1893	533.958	1139	0.646	1005	22.588	1051			0.646	1005	686	1276		676.406	1276
6	25.986	4099	143.150	1408	0.295	1423	12.082	1565			0.295	1423	182	1803		179.309	1803
7	1.752	5381	33.553	2151	0.068	2237	0.525	1220			0.068	2237	36	2295		35.473	2295
8	1.634	6290	14.932	4060	0.009	3715					0.009	3715	17	4279		16.356	4279
9	0.580	10105	3.660	4032	0.005	3100					0.005	3100	4	4859		4.191	4859
10+	0.098	9936	2.167	6312									2	6468		2.234	6468
SOP [t]	4041		4012		2		76				2		8132			8020	
Landings (t)	3929		4012		2		76				2		8020		0.986	8020	

Year: 2006	Quarter: All												Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1	5.028		30.769	111									34	203
2	4302.733	617	604.454	460									4752	611
3	17527.444	761	6960.913	664	0.232	510	25.916	707	0.000	510	0.021	510	24381	731
4	6386.182	948	6360.562	836	3.408	709	100.322	797	0.002	709	0.311	709	12777	889
5	1598.430	1417	2356.167	1152	7.127	1005	62.145	990	0.005	1005	0.651	1005	4003	1250
6	250.890	2754	781.977	1565	3.253	1423	29.346	1344	0.002	1423	0.297	1423	1058	1835
7	81.446	5368	152.027	2416	0.749	2238	3.214	1644	0.001	2237	0.068	2237	235	3423
8	33.724	8507	53.308	4123	0.103	3716	0.690	6664	0.000	3715	0.009	3715	88	5791
9	23.732	12969	15.165	4541	0.052	3101	0.222	3952	0.000	3100	0.005	3100	40	9432
10+	4.129	15628	8.961	7798			0.052	4172					13	10005
SOP [t]	26106		14890		17		210		0		2		40868	
Landings (t)	25751		14888		17		210		0		2		40868	

Table 2.4.8a continued 3/3

Year: 2006 Gear: Gillnet

Year: 2006	Quarter: 1												Sub-div. 25-32				Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction		Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1																		
2	115.603	646	1.927	235									118	639			116.642	639
3	2626.349	793	65.167	588	0.002	600	0.004	600	0.000	600	0.000	600	2692	788			2671.203	788
4	2497.030	896	875.347	836	0.417	760	0.833	760	0.011	760	0.021	760	3374	881			3348.189	881
5	275.172	1674	857.400	1090	1.729	951	3.457	951	0.045	951	0.089	951	1138	1230			1129.301	1230
6	17.671	3992	113.507	1375	0.607	1374	1.214	1374	0.016	1374	0.031	1374	133	1723			132.042	1723
7	19.487	4030	21.624	2108	0.141	1950	0.281	1950	0.004	1950	0.007	1950	42	3008			41.230	3008
8	1.537	8123	10.825	2910	0.035	2678	0.070	2678	0.001	2678	0.002	2678	12	3551			12.376	3551
9	0.775	9096	2.044	4336	0.002	2470	0.004	2470	0.000	2470	0.000	2470	3	5638			2.803	5638
10+	0.566	10660	0.884	7780	0.004	9300	0.007	9300	0.000	9300	0.000	9300	1	8907			1.451	8907
SOP [t]	5031		1954		3		6		0		0		6995				6942	
Landings (t)	4978		1954		3		6		0		0		6942		0.992		6942	

Year: 2006	Quarter: 2												Sub-div. 25-32				Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction		Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1																		
2	133.924	591	21.437	588									155	590			154.280	590
3	3414.430	776	797.703	746	0.036	600	0.151	655	0.000	600	0.004	600	4212	771			4183.043	771
4	943.110	1017	783.757	851	8.200	760	9.216	828	0.009	760	0.857	760	1745	940			1733.019	940
5	260.094	1643	804.259	1021	34.041	951	13.858	1009	0.039	951	3.559	951	1116	1164			1108.093	1164
6	86.124	2841	244.243	1446	11.954	1374	3.007	1344	0.014	1374	1.250	1374	347	1789			344.182	1789
7	11.437	5553	47.011	2185	2.770	1950	0.618	2007	0.003	1950	0.290	1950	62	2792			61.696	2792
8	13.705	4891	15.857	3116	0.692	2678	0.016	2750	0.001	2678	0.072	2678	30	3906			30.132	3906
9	0.688	10944	2.698	4652	0.036	2470			0.000	2470	0.004	2470	3	5890			3.402	5890
10+	0.097	7497	1.156	7623	0.073	9300			0.000	9300	0.008	9300	1	7715			1.324	7715
SOP [t]	4500		2623		63		27		0		7		7220				7169	
Landings (t)	4450		2623		63		27		0		7		7169		0.993		7169	

Year: 2006	Quarter: 3												Sub-div. 25-32				Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction		Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1			0.314	107									0	107			0.308	107
2	307.128	701	45.043	652			0.284	400					352	694			346.541	694
3	1065.735	769	183.290	708	0.005	600	2.410	657	0.000	600	0.002	600	1251	760			1230.444	760
4	189.433	968	225.564	831	1.150	760	24.052	903	0.015	760	0.384	760	441	893			433.206	893
5	31.355	2133	214.356	1182	4.774	951	33.597	1301	0.064	951	1.595	951	286	1295			280.946	1295
6	2.390	5961	28.961	1961	1.677	1374	3.308	2349	0.022	1374	0.560	1374	37	2219			36.298	2219
7	0.774	9925	6.712	2358	0.388	1950	0.709	3110	0.005	1950	0.130	1950	9	3066			8.572	3066
8	1.306	14039	2.165	3594	0.097	2678	0.142	5497	0.001	2678	0.032	2678	4	7277			3.680	7277
9	0.717	13632	0.480	3981	0.005	2470			0.000	2470	0.002	2470	1	9723			1.184	9723
10+	0.290	14950	0.563	4400	0.010	9300			0.000	9300	0.003	9300	1	8007			0.853	8007
SOP [t]	1339		685		9		78		0		3		2114				2078	
Landings (t)	1304		685		9		78		0		3		2078		0.983		2078	

Year: 2006	Quarter: 4												Sub-div. 25-32				Sub-div. 25-32	
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Totals without SOP corr		SOP correction		Totals with SOP corr	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1			0.850	200									1	200			0.848	200
2	1301.026	697	599.238	511			0.389	400					1901	639			1895.331	639
3	3311.541	851	925.575	591	0.005	600	3.472	655	0.000	600	0.000	600	4241	794			4228.719	794
4	713.882	1163	841.197	879	1.079	760	19.923	864	0.016	760	0.018	760	1576	1007			1571.702	1007
5	185.006	1793	1112.981	1163	4.479	951	27.475	1138	0.066	951	0.075	951	1330	1250			1326.358	1250
6	31.962	5963	196.406	1767	1.573	1374	6.375	1637	0.023	1374	0.026	1374	236	2328			235.703	2328
7	0.895	4850	31.185	2444	0.364	1950	1.168	2347	0.005	1950	0.006	1950	34	2499			33.530	2499
8	0.700	3725	6.163	3366	0.091	2678	0.091	1655	0.001	2678	0.002	2678	7	3370			7.028	3370
9	0.221	11194	1.848	2280	0.005	2470	0.128	2280	0.000	2470	0.000	2470	2	3176			2.196	3176
10+	0.105	9936			0.010	9300			0.000	9300	0.000	9300	0	9881			0.114	9881
SOP [t]	5089		3336		8		65		0		0		8498				8474	
Landings (t)	5065		3336		8		65		0		0		8474		0.997		8474	

Year: 2006	Quarter: All													
Sub-div.	Sub-div. 25		Sub-div. 26		Sub-div. 27		Sub-div. 28		Sub-div. 29		Sub-div. 30		Sub-div. 25-32	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1			1.157	175									1	175
2	1878.219	687	665.516	522			0.660	400					2513	643
3	10430.369	804	1969.831	665	0.048	600	5.952	656	0.000	600	0.006	600	12313	781
4	4318.113	970	2727.294	853	10.845	760	53.970	871	0.051	760	1.303	760	7086	924
5	749.259	1713	2989.944	1105	45.021	951	78.761	1167	0.213	951	5.408	951	3845	1222
6	137.776	3774	583.655	1565	15.810	1374	14.358	1694	0.075	1374	1.899	1374	748	1968
7	32.300	4735	106.632	2256	3.663	1950	2.869	2394	0.017	1950	0.440	1950	145	2802
8	17.194	5846	35.072	3125	0.916	2678	0.323	3532	0.004	2678	0.110	2678	53	3986
9	2.413	11207	7.077	3898	0.048	2470	0.135	2286	0.000	2470	0.006	2470	10	5668
10+	1.061	11513	2.603	6990	0.096	9300	0.008	9300	0.000	9300	0.012	9300	4	8310
SOP [t]	15960		8597		83		176		0		10		24664	
Landings (t)	15797		8597		83		176		0		10		24654	

Table 2.4.8b Cod in SD 25-32. Total landings (t) by Subdivision, gear and country in 2006.

Year: 2006 Gear: Trawl and gillnet combined

Sub-div.	25	26	27	28	29	30	31	32	25-32
Country:									
Denmark	9626	140							9766
Germany	1999	26							2025
Poland	8883	5408							14290
Finland	287	133	1	5	0	0		0	427
Latvia	803	2869		308					3980
Estonia	581	34		0	0			0	616
Russia		3719							3719
Sweden	9029	504	99	28		12			9672
Lithuania	872	2294		35					3200
Sum	32082	15127	100	376	0	12		0	47696
Unallocated	9466	8359		10		0			17836
Total	41548	23486	100	386	0	12		0	65532

Year: 2006 Gear: Trawl

Sub-div.	25	26	27	28	29	30	31	32	25-32
Country:									
Denmark	7874	139							8013
Germany	1935	26							1961
Poland	3578	4085							7663
Finland	241	121	1	0	0	0			363
Latvia	446	1344		164					1954
Estonia	304	6		0					310
Russia		1443							1443
Sweden	6483	502	16	1		2			7005
Lithuania	872	1667		35					2574
Sum	21733	9333	17	200	0	2			31287
Unallocated	4018	5555		10		0			9582
Total	25751	14888	17	210	0	2			40868

Year: 2006 Gear: Gillnet

Sub-div.	25	26	27	28	29	30	31	32	25-32
Country:									
Denmark	1752	1							1753
Germany	64								64
Poland	5305	1323							6627
Finland	47	12	0	4	0	0		0	64
Latvia	357	1525		144					2026
Estonia	277	28		0	0			0	306
Russia		2276							2276
Sweden	2547	2	83	27		10			2670
Lithuania		626							626
Sum	10349	5794	83	176	0	10		0	16413
Unallocated	5447	2804							8251
Total	15797	8597	83	176	0	10		0	24664

Table. 2.4.9. Cod in Sub-divisions 25-32. Number of samples for discards by quarter and Sub-division for 2006 available to the Working Group.

				HARBOUR AND MARKET SAMPLING		SEA SAMPLING		
Total	Country	Quarter	Total landings in tonnes	Number of samples	Number of fish measured	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	4054	59	2637	8	3219	2922
		2	4176	24	922	19	5897	922
		3	458	4	267	0	0	267
		4	1078	23	1117	2	464	1117
		Total	9766	110	4943	29	9580	5228
	Estonia	1	82	0	0	0	0	0
		2	360	0	0	0	0	0
		3	16	0	0	0	0	0
		4	158	0	0	0	0	0
		Total	616	0	0	0	0	0
	Russia	1	845	0	0	11	2689	306
		2	1476	0	0	28	6863	549
		3	145	0	0	5	454	454
		4	1252	0	0	57	10229	696
		Total	3719	0	0	101	20235	2005
	Finland	1	202	0	0	0	0	0
		2	21	0	0	0	0	0
		3	27	0	0	0	0	0
		4	177	0	0	0	0	0
		Total	427	0	0	0	0	0
	Germany	1	936	0	0	6	1656	0
		2	1062	0	0	10	2136	1223
		3	8	0	0	0	0	0
		4	19	0	0	0	0	0
		Total	2025	0	0	16	3792	1223
	Latvia	1	923	0	0	11	2792	524
		2	1256	0	0	33	6166	875
		3	481	0	0	4	1501	284
		4	1320	0	0	11	4079	332
		Total	3980	0	0	59	14538	2015
	Lithuania	1	982	3	1179	1	118	363
		2	1375	1	1074	2	235	309
		3	67	1	56	1	73	104
		4	776	1	644	6	535	624
		Total	3200	6	2953	10	961	1400
	Poland	1	4515	5	350	25	2968	695
		2	4369	9	648	19	3577	668
		3	985	1	62	0	0	52
		4	4422	17	6124	8	3499	517
		Total	14290	32	7184	52	10044	1932
	Sweden	1	3471	40	4576	28	9888	737
		2	4018	29	3077	13	4797	680
		3	395	19	1277	4	1384	477
		4	1788	20	1513	22	7543	598
		Total	9672	108	10443	67	23612	2492
	Total	1	16010	107	8742	90	23330	5547
		2	18114	63	5721	124	29671	5226
		3	2582	25	1662	14	3412	1638
		4	10990	61	9398	106	26349	3884
		Total	47696	256	25523	334	82762	16295

Table 2.4.10 Cod in SD 25-32.
XSA Input: Catch in numbers (thousands)-
(Official landings only)

Year	Age2	Age3	Age4	Age5	Age6	Age7	Age8+
1966	29009	91231	34141	11946	2658	922	103
1967	36345	132299	50122	14395	5014	1330	580
1968	30047	107518	70398	23022	4787	653	85
1969	37488	102497	49728	23944	5570	1190	213
1970	24764	80159	51571	22735	5248	1439	512
1971	20026	47606	38631	21669	4606	948	405
1972	32990	69783	42759	18437	6003	1841	636
1973	28190	64705	42779	18295	5637	1138	1387
1974	23242	93448	49776	16163	4663	1510	1325
1975	21923	135537	70356	18751	5327	1256	1096
1976	8541	62790	86375	38326	13043	1936	1339
1977	6102	42363	46109	35583	13214	3250	1409
1978	40773	72169	46560	22749	7982	2467	867
1979	50464	143205	76948	26478	8697	3857	2006
1980	20285	111509	160282	62205	18267	4990	2206
1981	21825	52669	101889	83499	25397	7393	3364
1982	37718	119568	81157	53499	25122	7759	4465
1983	36901	108259	122532	46146	19729	8458	2399
1984	22161	103672	144308	83822	21340	7373	5553
1985	32236	62632	74177	57154	23214	5643	3696
1986	11798	40119	58468	43020	34113	9802	4180
1987	41863	55696	44253	23504	11387	5836	3102
1988	21428	84337	52156	17299	6741	3166	2158
1989	4526	59026	69293	23041	8703	2414	1677
1990	16974	30322	39775	20868	6850	2095	1642
1991	5902	39296	31400	13406	3854	1732	1586
1992	7619	14556	13343	6103	1906	982	525
1993	6257	12181	5833	2390	574	152	97
1994	5803	22546	14797	6479	1398	299	196
1995	6222	18146	25506	13956	3144	937	595
1996	9930	28409	24416	20047	5522	1323	357
1997	2641	25209	22022	12396	4674	1983	1092
1998	7619	16483	17527	10067	2547	1241	907
1999	8353	31660	18495	8945	1983	671	778
2000	7478	29041	25353	7568	1455	447	506
2001	9172	33592	26686	8681	1638	514	312
2002	4808	22034	19816	6925	1461	495	391
2003	4055	22577	19460	5849	1150	363	248
2004	4942	17430	17909	6413	2248	620	352
2005	7128	13128	13424	4930	1069	276	163
2006	5766	26076	12962	5364	1246	262	142

Table 2.4.11 Cod in SD 25-32
XSA Input: Catch in numbers (thousand)
(incl. Misreporting correction and discards)

Year	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1966	44274	101532	34295	11980	2658	922	103
1967	55470	147237	50347	14436	5014	1330	580
1968	45858	119658	70715	23088	4787	653	85
1969	57214	114070	49952	24013	5570	1190	213
1970	37795	89210	51803	22800	5248	1439	512
1971	30564	52981	38805	21731	4606	948	405
1972	50349	77662	42951	18490	6003	1841	636
1973	43024	72011	42971	18348	5637	1138	1387
1974	35472	103999	50000	16209	4663	1510	1325
1975	33459	150841	70672	18805	5327	1256	1096
1976	13035	69880	86763	38436	13043	1936	1339
1977	9313	47146	46316	35685	13214	3250	1409
1978	62228	80318	46769	22814	7982	2467	867
1979	77018	159375	77294	26554	8697	3857	2006
1980	30959	124100	161003	62384	18267	4990	2206
1981	33309	58616	102347	83739	25397	7393	3364
1982	57565	133069	81522	53653	25122	7759	4465
1983	56318	120483	123083	46279	19729	8458	2399
1984	33822	115378	144957	84063	21340	7373	5553
1985	49199	69704	74511	57318	23214	5643	3696
1986	18006	44649	58731	43144	34113	9802	4180
1987	63892	61985	44452	23572	11387	5836	3102
1988	32704	93860	52391	17349	6741	3166	2158
1989	6908	65691	69605	23107	8703	2414	1677
1990	25906	33746	39954	20928	6850	2095	1642
1991	9008	43733	31541	13445	3854	1732	1586
1992	11628	16200	13403	6121	1906	982	525
1993	13598	19304	8344	3413	818	217	138
1994	14294	40499	23990	10487	2257	483	317
1995	11528	24516	31104	16992	3817	1138	722
1996	13917	31426	26502	21692	5936	1422	384
1997	3423	33498	22072	12454	4674	1983	1092
1998	12582	18277	17673	10089	2547	1241	907
1999	9665	35341	18531	8966	1983	671	778
2000	33820	41234	34254	10229	1964	603	683
2001	19828	49376	36170	11722	2211	694	421
2002	11131	31927	26777	9404	1972	668	527
2003	16350	34471	28345	8489	1668	526	359
2004	9286	26475	25477	9162	3192	877	497
2005	13321	19850	18964	6825	1481	383	225
2006	12987	35115	13239	5412	1248	262	142

Table 2.4.12a **COD in SD 25-32. Mean weight in Catch (Kilograms).**

WECA: Mean Weight in Catch (Total International Catch) (Total) (Kilograms)

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1966	0.210	0.391	0.874	1.413	2.206	3.696	5.484
1967	0.210	0.391	0.874	1.413	2.206	3.696	5.576
1968	0.210	0.391	0.874	1.413	2.206	3.696	5.809
1969	0.210	0.391	0.874	1.413	2.206	3.696	5.552
1970	0.210	0.391	0.874	1.413	2.206	3.696	5.523
1971	0.210	0.391	0.874	1.413	2.206	3.696	5.524
1972	0.210	0.391	0.874	1.413	2.206	3.696	5.917
1973	0.210	0.391	0.874	1.413	2.206	3.696	5.719
1974	0.210	0.391	0.874	1.413	2.206	3.696	5.656
1975	0.210	0.391	0.874	1.413	2.206	3.696	5.953
1976	0.210	0.391	0.874	1.413	2.206	3.696	5.926
1977	0.210	0.391	0.874	1.413	2.206	3.696	5.655
1978	0.210	0.391	0.874	1.413	2.206	3.696	5.750
1979	0.210	0.391	0.874	1.413	2.206	3.696	5.753
1980	0.210	0.391	0.874	1.413	2.206	3.696	5.556
1981	0.395	0.716	0.902	1.201	2.011	2.460	4.920
1982	0.356	0.622	0.937	1.327	1.859	2.664	4.064
1983	0.452	0.658	0.916	1.361	1.799	2.410	4.709
1984	0.351	0.574	0.888	1.357	1.921	2.558	4.450
1985	0.465	0.729	1.080	1.575	2.104	2.426	4.453
1986	0.508	0.682	0.994	1.458	1.967	2.325	4.229
1987	0.567	0.806	1.175	1.750	2.508	2.972	4.100
1988	0.616	0.734	1.147	1.766	2.536	3.371	4.449
1989	0.498	0.696	1.002	1.526	2.104	2.941	4.202
1990	0.639	0.753	1.214	1.753	2.390	3.219	4.709
1991	0.578	0.912	1.166	1.697	2.525	3.815	4.719
1992	0.765	0.849	1.111	1.682	2.797	3.662	5.282
1993	0.533	0.848	1.139	1.703	2.345	3.482	4.873
1994	0.641	0.851	1.161	1.591	2.195	3.926	6.067
1995	0.748	0.960	1.201	1.525	2.433	3.459	5.659
1996	0.812	0.980	1.205	1.504	2.191	3.026	4.781
1997	0.594	0.832	1.086	1.500	2.375	3.431	5.117
1998	0.662	0.773	1.127	1.448	2.337	3.485	5.403
1999	0.606	0.784	1.046	1.363	2.194	3.810	5.984
2000	0.616	0.662	0.943	1.365	2.266	3.455	6.245
2001	0.487	0.629	0.893	1.276	2.098	3.371	5.983
2002	0.498	0.610	0.907	1.351	2.130	3.301	5.774
2003	0.475	0.723	0.891	1.323	2.198	3.697	5.873
2004	0.366	0.681	0.984	1.374	1.834	3.137	5.246
2005	0.849	0.804	0.962	1.299	2.106	3.079	4.721
2006	0.630	0.764	0.908	1.238	1.898	3.174	5.984

Table 2.4.12b **COD in SD 25-32. Mean weight in Discards (Kilograms).**

Mean Weight in Discards (Total International Catch) (Total) (Kilograms)

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1966-2001	0.309	0.381	0.453	0.677	0.983	2.023
2002	0.270	0.303	0.365	0.940	1.234	1.543
2003	0.224	0.307	0.394	0.394	0.601	
2004	0.381	0.331	0.404	0.588	0.762	1.074
2005	0.382	0.429	0.464	0.609	1.349	2.501
2006	0.348	0.389	0.470	0.669	1.573	2.601

Table 2.4.12c COD in SD 25-32. Mean weight in Catch (landings + discards) (Kilograms).

Mean Weight in Catch (landings + discards) (Total International Catch) (Total) (Kilograms)

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1966	0.244	0.390	0.872	1.411	2.206	3.696	5.484
1967	0.244	0.390	0.872	1.411	2.206	3.696	5.576
1968	0.244	0.390	0.872	1.411	2.206	3.696	5.809
1969	0.244	0.390	0.872	1.411	2.206	3.696	5.552
1970	0.244	0.390	0.872	1.411	2.206	3.696	5.523
1971	0.244	0.390	0.872	1.411	2.206	3.696	5.524
1972	0.244	0.390	0.872	1.411	2.206	3.696	5.917
1973	0.244	0.390	0.872	1.411	2.206	3.696	5.719
1974	0.244	0.390	0.872	1.411	2.206	3.696	5.656
1975	0.244	0.390	0.872	1.411	2.206	3.696	5.953
1976	0.244	0.390	0.872	1.411	2.206	3.696	5.926
1977	0.244	0.390	0.872	1.411	2.206	3.696	5.655
1978	0.244	0.390	0.872	1.411	2.206	3.696	5.750
1979	0.244	0.390	0.872	1.411	2.206	3.696	5.753
1980	0.244	0.390	0.872	1.411	2.206	3.696	5.556
1981	0.365	0.682	0.900	1.199	2.011	2.460	4.920
1982	0.340	0.598	0.935	1.325	1.859	2.664	4.064
1983	0.403	0.630	0.914	1.359	1.799	2.410	4.709
1984	0.337	0.554	0.886	1.355	1.921	2.558	4.450
1985	0.411	0.694	1.077	1.572	2.104	2.426	4.453
1986	0.439	0.651	0.992	1.456	1.967	2.325	4.229
1987	0.478	0.763	1.172	1.747	2.508	2.972	4.100
1988	0.510	0.698	1.144	1.763	2.536	3.371	4.449
1989	0.433	0.664	1.000	1.524	2.104	2.941	4.202
1990	0.525	0.715	1.211	1.750	2.390	3.219	4.709
1991	0.485	0.858	1.163	1.694	2.525	3.815	4.719
1992	0.608	0.802	1.108	1.679	2.797	3.662	5.282
1993	0.456	0.801	1.136	1.700	2.345	3.482	4.873
1994	0.527	0.803	1.158	1.588	2.195	3.926	6.067
1995	0.597	0.901	1.198	1.523	2.433	3.459	5.659
1996	0.695	0.963	1.198	1.499	2.191	3.026	4.781
1997	0.529	0.720	1.085	1.496	2.375	3.431	5.117
1998	0.523	0.735	1.121	1.446	2.337	3.485	5.403
1999	0.566	0.742	1.045	1.361	2.194	3.810	5.984
2000	0.401	0.648	0.943	1.365	2.266	3.455	6.245
2001	0.420	0.609	0.891	1.276	2.098	3.371	5.983
2002	0.403	0.589	0.906	1.349	2.130	3.301	5.774
2003	0.315	0.702	0.888	1.322	2.198	3.697	5.873
2004	0.370	0.656	0.979	1.364	1.827	3.132	5.246
2005	0.727	0.771	0.951	1.296	2.103	3.075	4.721
2006	0.473	0.668	0.899	1.233	1.897	3.173	5.984

Table 2.4.13 COD in SD 25-32. Mean weight in Stock (Kilograms).

WEST: Mean Weight in Stock (Total International Catch) (Total) (Kilograms)

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1966	0.203	0.671	0.874	1.413	2.206	3.696	5.484
1967	0.203	0.671	0.874	1.413	2.206	3.696	5.576
1968	0.203	0.671	0.874	1.413	2.206	3.696	5.809
1969	0.203	0.671	0.874	1.413	2.206	3.696	5.552
1970	0.203	0.671	0.874	1.413	2.206	3.696	5.523
1971	0.203	0.671	0.874	1.413	2.206	3.696	5.524
1972	0.203	0.671	0.874	1.413	2.206	3.696	5.917
1973	0.203	0.671	0.874	1.413	2.206	3.696	5.719
1974	0.203	0.671	0.874	1.413	2.206	3.696	5.656
1975	0.203	0.671	0.874	1.413	2.206	3.696	5.953
1976	0.203	0.671	0.874	1.413	2.206	3.696	5.926
1977	0.203	0.671	0.874	1.413	2.206	3.696	5.655
1978	0.203	0.671	0.874	1.413	2.206	3.696	5.75
1979	0.203	0.671	0.874	1.413	2.206	3.696	5.753
1980	0.203	0.671	0.874	1.413	2.206	3.696	5.556
1981	0.203	0.671	0.874	1.413	2.206	3.696	5.92
1982	0.203	0.671	0.874	1.413	2.206	3.696	5.67
1983	0.203	0.671	0.917	1.36	1.794	2.4	4.709
1984	0.203	0.671	0.888	1.357	1.921	2.558	4.45
1985	0.203	0.671	1.08	1.575	2.104	2.426	4.453
1986	0.203	0.671	0.994	1.458	1.967	2.325	4.229
1987	0.203	0.671	1.175	1.75	2.508	2.972	4.1
1988	0.203	0.671	1.147	1.766	2.536	3.371	4.449
1989	0.203	0.671	1.002	1.526	2.104	2.941	4.202
1990	0.203	0.671	1.214	1.753	2.39	3.219	4.709
1991	0.203	0.671	1.164	1.696	2.521	3.828	4.784
1992	0.203	0.671	1.164	1.696	2.521	3.828	4.987
1993	0.203	0.671	1.164	1.696	2.521	3.828	4.689
1994	0.293	0.67	1.166	1.908	2.69	3.427	5.653
1995	0.354	0.692	1.284	2.224	3.016	3.347	6.386
1996	0.241	0.7	0.932	1.511	2.326	2.955	5.594
1997	0.242	0.563	1.199	1.528	2.912	4.214	5.737
1998	0.244	0.548	1.23	1.595	2.963	4.624	5.7
1999	0.292	0.603	0.866	1.271	1.915	2.625	4.724
2000	0.277	0.606	0.986	1.272	2.068	3.462	6.093
2001	0.17	0.487	1.004	1.349	1.928	2.594	3.407
2002	0.164	0.527	0.889	1.185	1.774	2.238	4.142
2003	0.188	0.495	0.874	1.262	1.803	2.266	2.861
2004	0.179	0.536	0.881	1.295	1.996	3.075	4.038
2005	0.344	0.626	0.916	1.201	1.924	2.331	3.107
2006	0.255	0.595	0.865	1.145	1.734	2.403	3.938

Table 2.4.14 COD in SD 25-32. Proportion Mature at Year Start.

MATPROP: Proportion of Mature at Year Start (Total International Catch) (Total)

Year	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1966	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1967	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1968	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1969	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1970	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1971	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1972	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1973	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1974	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1975	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1976	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1977	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1978	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1979	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1980	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1981	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1982	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1983	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1984	0.08	0.45	0.78	0.92	0.95	0.98	0.99
1985	0.12	0.5	0.72	0.91	0.95	0.98	1
1986	0.12	0.5	0.72	0.91	0.95	0.98	1
1987	0.12	0.5	0.72	0.91	0.95	0.98	1
1988	0.12	0.5	0.72	0.91	0.95	0.98	1
1989	0.12	0.5	0.72	0.91	0.95	0.98	1
1990	0.27	0.6	0.88	0.97	1	1	1
1991	0.27	0.6	0.88	0.97	1	1	1
1992	0.27	0.6	0.88	0.97	1	1	1
1993	0.27	0.6	0.88	0.97	1	1	1
1994	0.27	0.6	0.88	0.97	1	1	1
1995	0.15	0.53	0.93	0.98	0.98	1	1
1996	0.12	0.53	0.91	0.97	0.96	0.97	0.97
1997	0.12	0.42	0.79	0.94	0.97	0.96	0.95
1998	0.14	0.32	0.84	0.94	0.98	0.96	1
1999	0.14	0.33	0.85	0.93	0.94	0.96	1
2000	0.13	0.36	0.83	0.94	0.96	0.96	0.98
2001	0.13	0.36	0.83	0.94	0.96	0.96	0.98
2002	0.13	0.36	0.83	0.94	0.96	0.96	0.98
2003	0.13	0.36	0.83	0.94	0.96	0.96	0.98
2004	0.13	0.36	0.83	0.94	0.96	0.96	0.98
2005	0.13	0.36	0.83	0.94	0.96	0.96	0.98
2006	0.13	0.36	0.83	0.94	0.96	0.96	0.98

Table 2.4.15a Cod in SD 25-32. Full year and age range of indices from Baltic International Trawl.
Surveys in the first quarters.

BITS Q1 Datras 19/4/07

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1991	0	8.73	7.648	15.161	13.838	8.216	1.743	1.203	0.294	0.044	0.116
1992	0	8	10.329	14.119	4.766	1.719	0.574	0.985	0.148	0.012	0.046
1993	0	20.262	113.654	85.067	9.414	2.73	0.528	0.162	0.029	0.036	0.022
1994	0	41.201	143.148	100.959	24.992	4.784	0.58	0.158	0.067	0.17	0.088
1995	0	54.601	113.644	61.224	26.536	8.453	1.26	0.36	0.073	0.038	0.066
1996	0	8.754	83.692	74.542	36.589	14.926	3.274	0.717	0.275	0.079	0.09
1997	0	6.148	41.002	39.078	13.814	7.673	1.37	0.528	0.171	0.072	0.032
1998	0	25.763	66.261	32.505	8.875	4.368	0.675	0.385	0.203	0.091	0.09
1999	0	37.913	63.827	40.566	12.682	5.324	0.953	0.236	0.144	0.047	0.071
2000	0	31.95	130.972	51.21	10.467	2.554	0.385	0.114	0.106	0.058	0.022
2001	0	39.552	68.868	39.4	25.661	8.181	1.065	0.144	0.148	0.061	0.03
2002	0	41.518	219.099	76.806	26.68	16.183	5.844	3.335	0.661	0.331	0.447
2003	0	10.267	61.747	85.108	46.739	10.33	1.593	0.653	0.355	0.189	0.09
2004	0	83.266	74.005	51.782	25.046	8.276	2.455	0.674	0.278	0.099	0.049
2005	0	57.2	226.714	60.793	23.477	7.302	1.426	0.761	0.444	0.145	0.169
2006	0	6.559	110.839	133.245	30.046	10.132	1.944	0.43	0.162	0.064	0.056
2007	0	64.406	201.919	138.245	51.905	14.945	3.14	0.796	0.403	0.115	0.122

Table 2.4.15b Cod in SD 25-32. Full year and age range of indices from Baltic International Trawl.
Surveys in the fourth quarters.

BITS Q4 Datras 19/4/07

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2000	13.782	60.403	54.95	31.026	9.498	2.669	0.457	0.147	0.141	0.081	0.054
2001	7.755	395.476	125.498	24.764	2.058	0.499	0.391	0.347	0.024	0.028	0
2002	2.481	98.657	333.863	135.9	46.676	4.495	0.861	0.026	0.1	0.009	0.023
2003	57.669	64.866	66.704	58.016	26.994	6.992	1.772	0.848	0.417	0.096	0.214
2004	10.838	353.053	103.962	61.255	25.251	4.048	1.727	0.602	0.134	0.059	0.13
2005	9.509	133.157	200.171	107.561	34.878	8.82	2.653	0.655	0.348	0.12	0.124
2006	23.194	172.63	208.251	91.297	21.742	4.971	1.528	0.447	0.04	0.012	0

Table 2.4.16 Cod in SD 25-32 Tuning Fleets

```
Cod 25 32
108
BITSQ1_3-9_Backshifted
1990  2000
1  1  0.99  1
2  5
1  15.161  13.838  8.216  1.743
1  14.119   4.766  1.719  0.574
1  85.067   9.414  2.73   0.528
1  100.959 24.992  4.784  0.58
1  61.224  26.536  8.453  1.26
1  74.542  36.589  14.926 3.274
1  39.078  13.814  7.673  1.37
1  32.505   8.875  4.368  0.675
1  40.566  12.682  5.324  0.953
1  51.21   10.467  2.554  0.385
1  39.4    25.661  8.181  1.065
BITSQ1_2_raw
1991  2000
1  1  0  0.25
2  2
1    7.648
1   10.329
1  113.654
1  143.148
1  113.644
1   83.692
1   41.002
1   66.261
1   63.827
1  130.972
BITSQ1_3-9_Backshifted
2001  2006
1  1  0.99  1
2  5
1  76.806  26.68  16.183  5.844
1  85.108  46.739  10.33  1.593
1  51.782  25.046  8.276  2.455
1  60.793  23.477  7.302  1.426
1  133.245  30.046  10.132  1.944
1  138.245 51.905 14.945 3.14
BITSQ1_2_raw
2001  2006
1  1  0  0.25
2  2
1   68.868
1  219.099
1   61.747
1   74.005
1  226.714
1  110.839
BITS_Q4_raw
2002  2006
1  1  0.75  1
2  5
1  333.863  135.9    46.676  4.495
1   66.704   58.016  26.994  6.992
1  103.962   61.255  25.251  4.048
1  200.171  107.561  34.878  8.82
1  208.251   91.297  21.742  4.971
Den_Gillnet_<160mm
```

Table 2.4.16 Cod in SD 25-32 Tuning Fleets (Cont'd)

```
1994  2006
1  1  0  1
3  7
475200   1603.43  694.13   89.89   15.45   1.69
846800   1006.12 1420.40  550.34   50.11  13.07
1067850  1430.57  779.04  621.09  295.14  40.92
371000    476.59  300.20   75.47   39.45  23.69
253050     29.91  152.01   37.18   17.27  16.64
341750    301.19  101.87   50.57    7.62   1.01
270550    155.09  181.05   42.82    5.45   1.41
430400    361.25  504.92   88.51    6.37   0.76
338100    251.66  365.53   86.00   20.78   4.38
360350    442.49  230.70   70.92   17.14   5.97
314850    236.24  268.75   57.75   13.85   5.18
418200    193.39  214.96   76.33   13.83   3.94
259750    509.04  186.22  40.80     7.56   1.40
Den_Trawl_>90mm
1994  2006
1  1  0  1
3  7
858450    2976.41  1288.49  166.86    28.68    3.13
1577600   1952.93  2757.05  1068.23   97.27   25.36
2594400   4007.19  2182.18  1739.73  826.72  114.62
2890300   4638.20  2921.54   734.50  383.96  230.58
2634100   2181.97  1575.73   297.56   73.41   45.64
3354550   6156.14  1927.24   333.79   62.59   37.11
1751500   2352.28  2609.97   161.35   18.08    6.96
2170500   2849.24  2275.98   325.01   48.23   10.76
1696500   1763.06  1944.69   353.56   69.34   12.30
2297900   3559.83  1356.96   408.41   72.87   21.45
1808875   2246.00  1729.58   229.06   45.52   17.16
1928300   1018.64   845.81   181.74   34.08   12.80
1950750   4012.08  1467.29   433.64  122.04   36.20
Swe_Trawl
1994  2006
1  1  0  1
3  7
25658    3896.23   836.05   48.81   23.68   7.58
34966    4385.22  2523.50  235.71   72.54  39.14
52842    6122.60  2105.81  744.83  120.13   8.20
60893    6941.05  2289.61  723.64  236.44  105.50
40769    3554.61  1095.68  120.47   56.40   36.31
41791    4245.27   997.36  144.17   21.61    8.42
53256    6278.80  1184.89  102.09   50.36   28.42
57233    5994.99  1043.94   91.13   13.09    7.18
42563    4647.99  1085.95  104.78   15.34    3.17
45187    5057.08  1454.11  255.36   41.19   13.67
44960    3783.19  3244.28  345.12    63.70  15.81
41913    2264.34   931.74  115.15   12.80    4.51
41077    4017.33   667.36  273.01   40.42    4.75
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics

```
Lowestoft VPA Version 3.1

  22/05/2007  19:32

Extended Survivors Analysis

Index File; Cod in the Eastern Baltic (25-32)

CPUE data from file Tu8ind1.txt

Catch data for  41 years. 1966 to 2006. Ages  2 to   8.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
BITSQ1_3-9_Backshift,   1990, 2006,   2,     5,   .990,  1.000
BITSQ1_2_raw        ,   1991, 2006,   2,     2,   .000,   .250
BITSQ1_3-9_Backshift,   2001, 2006,   2,     5,   .990,  1.000
BITSQ1_2_raw        ,   2001, 2006,   2,     2,   .000,   .250
BITS_Q4_raw         ,   2002, 2006,   2,     5,   .750,  1.000
Den_Gillnet_<160mm  ,   1994, 2006,   3,     7,   .000,  1.000
Den_Trawl_>90mm     ,   1994, 2006,   3,     7,   .000,  1.000
Swe_Trawl           ,   1994, 2006,   3,     7,   .000,  1.000


Time series weights :

     Tapered time weighting applied
     Power =    3 over  20 years


Catchability analysis :

     Catchability independent of stock size for all ages

     Catchability independent of age for ages >=    6

Terminal population estimation :

     Survivor estimates shrunk towards the mean F
     of the final   5 years or the   3 oldest ages.

     S.E. of the mean to which the estimates  are shrunk =    .500

     Minimum standard error for population
     estimates derived from each fleet =    .300

     Prior weighting not applied

Tuning converged after   29 iterations

Regression weights
      ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000

Fishing mortalities
   Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

     2,  .044,  .098,  .073,  .240,  .176,  .106,  .183,  .121,  .089,  .101
     3,  .602,  .348,  .434,  .498,  .662,  .476,  .550,  .506,  .410,  .497
     4,  .837,  .760,  .723, 1.033, 1.175,  .973, 1.080, 1.084,  .859,  .991
     5, 1.302, 1.313, 1.223, 1.258, 1.410, 1.242, 1.014, 1.459, 1.021, 1.179
     6, 1.006, 1.105, 1.056, 1.026, 1.093, 1.012,  .762, 1.646, 1.056,  .855
     7,  .693,  .826, 1.049, 1.191, 1.483, 1.319,  .845, 1.324,  .951,  .887
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

```
 XSA population numbers (Thousands)

                                AGE
 YEAR ,           2,            3,            4,            5,            6,
7,

 1997 ,    8.78E+04, 8.18E+04, 4.30E+04, 1.89E+04, 8.14E+03, 4.38E+03,
 1998 ,    1.49E+05, 6.88E+04, 3.67E+04, 1.53E+04, 4.21E+03, 2.44E+03,
 1999 ,    1.53E+05, 1.11E+05, 3.98E+04, 1.40E+04, 3.36E+03, 1.14E+03,
 2000 ,    1.75E+05, 1.16E+05, 5.88E+04, 1.58E+04, 3.38E+03, 9.58E+02,
 2001 ,    1.36E+05, 1.13E+05, 5.78E+04, 1.71E+04, 3.68E+03, 9.93E+02,
 2002 ,    1.22E+05, 9.32E+04, 4.76E+04, 1.46E+04, 3.42E+03, 1.01E+03,
 2003 ,    1.08E+05, 9.01E+04, 4.74E+04, 1.47E+04, 3.46E+03, 1.02E+03,
 2004 ,    8.99E+04, 7.37E+04, 4.26E+04, 1.32E+04, 4.37E+03, 1.32E+03,
 2005 ,    1.72E+05, 6.52E+04, 3.64E+04, 1.18E+04, 2.51E+03, 6.90E+02,
 2006 ,    1.66E+05, 1.29E+05, 3.54E+04, 1.26E+04, 3.48E+03, 7.15E+02,

 Estimated population abundance at 1st Jan 2007

    ,     0.00E+00, 1.23E+05, 6.42E+04, 1.08E+04, 3.18E+03, 1.21E+03,

 Taper weighted geometric mean of the VPA populations:

    ,     1.31E+05, 9.29E+04, 4.59E+04, 1.60E+04, 4.18E+03, 1.28E+03,

 Standard error of the weighted Log(VPA populations) :

    ,        .2437,    .2438,    .2546,    .3346,    .4451,    .5587,
1

 Log catchability residuals.



 Fleet : BITSQ1_3-9_Backshift

  Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996
     2 ,  -.94,  -.70,   .55,   .43,   .34,   .58,   .00
     3 ,  -.06,  -.60,  -.14,   .16,   .10,   .79,   .01
     4 ,   .36,  -.53,  -.14,  -.28,  -.20,   .35,   .27
     5 ,   .36,   .01,   .25,  -.55,  -.11,   .34,  -.15
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age



  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     2 ,  -.01,  -.26,  -.08,  -.31, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     3 ,  -.27,   .00,  -.58,   .33, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     4 ,  -.08,   .20,  -.65,   .43, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     5 ,  -.20,   .37,  -.54,   .40, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age



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


    Age ,          2,          3,          4,          5
 Mean Log q,   -7.6498,   -8.0565,   -8.0814,   -8.5492,
 S.E(Log q),     .3868,     .4215,     .4025,     .3923,
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

```
 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  2,    1.09,    -.109,      7.28,     .27,     11,     .47,   -7.65,
  3,     .85,     .204,      8.56,     .32,     11,     .40,   -8.06,
  4,     .61,    1.128,      9.14,     .67,     11,     .24,   -8.08,
  5,     .84,     .406,      8.75,     .62,     11,     .36,   -8.55,


 Fleet : BITSQ1_2_raw

  Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996
     2 , 99.99, -1.74, -1.96,   .16,   .76,   .59,   .33
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age


  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     2 ,  -.13,  -.17,  -.23,   .37, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     3 , No data for this fleet at this age
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age

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


    Age ,         2
 Mean Log q,   -7.5116,
 S.E(Log q),     .7029,


 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  2,     .68,     .352,      8.89,     .23,     10,     .53,   -7.51,
1

 Fleet : BITSQ1_3-9_Backshift

  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
     2 , 99.99, 99.99, 99.99, 99.99,  -.11,   .03,  -.27,   .02,   .12,   .20
     3 , 99.99, 99.99, 99.99, 99.99,  -.26,   .31,  -.21,  -.12,   .16,   .11
     4 , 99.99, 99.99, 99.99, 99.99,   .28,  -.17,  -.28,  -.30,  -.04,   .51
     5 , 99.99, 99.99, 99.99, 99.99,   .87,  -.44,  -.24,  -.23,  -.25,   .32
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

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


   Age ,         2,         3,         4,         5
Mean Log q,   -6.9956,   -7.2331,   -7.0959,   -7.2483,
S.E(Log q),     .1673,     .2248,     .3301,     .4908,


Regression statistics :


Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 2,     .72,    1.393,      8.31,     .87,      6,     .11,   -7.00,
 3,    1.12,    -.237,      6.75,     .51,      6,     .28,   -7.23,
 4,    1.49,    -.369,      5.35,     .13,      6,     .54,   -7.10,
 5,     .35,    1.131,      8.73,     .44,      6,     .17,   -7.25,



Fleet : BITSQ1_2_raw

 Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
    2 , 99.99, 99.99, 99.99, 99.99,  -.51,   .74,  -.39,  -.03,   .43,  -.25
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age

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


   Age ,         2
Mean Log q,   -7.0287,
S.E(Log q),     .4913,


Regression statistics :


Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 2,     .80,     .257,      7.98,     .30,      6,     .44,   -7.03,


Fleet : BITS_Q4_raw

 Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
    2 , 99.99, 99.99, 99.99, 99.99, 99.99,   .79,  -.63,  -.06,  -.08,   .00
    3 , 99.99, 99.99, 99.99, 99.99, 99.99,   .39,  -.37,  -.15,   .45,  -.32
    4 , 99.99, 99.99, 99.99, 99.99, 99.99,   .29,  -.16,  -.12,   .17,  -.17
    5 , 99.99, 99.99, 99.99, 99.99, 99.99,  -.26,  -.03,  -.08,   .43,  -.07
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

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


   Age ,         2,         3,         4,         5
Mean Log q,   -6.4219,   -6.3265,   -6.1915,   -6.5663,
S.E(Log q),     .5049,     .3912,     .2111,     .2597,


Regression statistics :


Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 2,     .82,     .211,      7.38,     .32,      5,     .48,   -6.42,
 3,    5.05,   -1.095,    -14.13,     .02,      5,    1.93,   -6.33,
 4,     .82,     .263,      7.01,     .41,      5,     .20,   -6.19,
 5,    -.94,   -2.007,     12.26,     .26,      5,     .18,   -6.57,

Fleet : Den_Gillnet_<160mm

 Age  ,  1990,  1991,  1992,  1993,  1994,  1995,  1996
    2 , No data for this fleet at this age
    3 , 99.99, 99.99, 99.99, 99.99,   .97,   .31,   .55
    4 , 99.99, 99.99, 99.99, 99.99,   .12,   .18,  -.19
    5 , 99.99, 99.99, 99.99, 99.99,  -.47,   .27,   .30
    6 , 99.99, 99.99, 99.99, 99.99,  -.62,  -.27,   .74
    7 , 99.99, 99.99, 99.99, 99.99, -1.12,  -.43,   .42



 Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
    2 , No data for this fleet at this age
    3 ,   .61, -1.72,  -.15,  -.59,  -.11,  -.12,   .45,   .13,  -.27,   .53
    4 ,   .12,  -.05,  -.85,  -.30,   .33,   .36,  -.11,   .28,  -.16,   .26
    5 ,  -.14,  -.24,  -.19,  -.23,   .01,   .32,  -.03,   .18,   .12,  -.04
    6 ,   .25,   .51,  -.40,  -.52,  -.89,   .57,   .21,   .24,   .28,  -.25
    7 ,   .23,   .91, -1.35,  -.55, -1.56,   .36,   .41,   .33,   .28,  -.34

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


   Age ,         3,         4,         5,         6,         7
Mean Log q,  -18.2046,  -17.4340,  -17.5512,  -17.8648,  -17.8648,
S.E(Log q),     .6580,     .3456,     .2232,     .5067,     .7945,

Regression statistics :


Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 3,     .49,    1.204,     14.76,     .38,     13,     .32,  -18.20,
 4,     .80,     .500,     16.11,     .41,     13,     .29,  -17.43,
 5,     .87,     .622,     16.55,     .73,     13,     .20,  -17.55,
 6,     .76,     .812,     15.57,     .56,     13,     .39,  -17.86,
 7,     .68,    1.043,     14.55,     .54,     13,     .53,  -18.02,
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

Fleet : Den_Trawl_>90mm

Age ,	1990,	1991,	1992,	1993,	1994,	1995,	1996
2 ,	No data for this fleet at this age						
3 ,	99.99,	99.99,	99.99,	99.99,	.54,	-.10,	.23
4 ,	99.99,	99.99,	99.99,	99.99,	.01,	.09,	-.18
5 ,	99.99,	99.99,	99.99,	99.99,	-.26,	.50,	.63
6 ,	99.99,	99.99,	99.99,	99.99,	-.41,	-.04,	1.07
7 ,	99.99,	99.99,	99.99,	99.99,	-.91,	-.21,	.75

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2 ,	No data for this fleet at this age									
3 ,	.38,	-.22,	.14,	-.20,	-.12,	-.24,	.22,	.19,	-.59,	.13
4 ,	.21,	-.19,	-.33,	.36,	.08,	.29,	-.33,	.26,	-.45,	.17
5 ,	.27,	-.32,	-.40,	-.58,	-.12,	.31,	.05,	-.01,	-.36,	.49
6 ,	.66,	-.20,	-.40,	-1.01,	-.30,	.35,	-.01,	-.14,	-.16,	.70
7 ,	.64,	-.24,	.16,	-.63,	-.34,	-.04,	.02,	-.03,	.11,	1.08

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

Age ,	3,	4,	5,	6,	7
Mean Log q,	-17.7517,	-17.2995,	-17.7367,	-18.0497,	-18.0497,
S.E(Log q),	.2996,	.2824,	.3884,	.5492,	.5326,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
3,	.67,	1.238,	15.70,	.62,	13,	.20,	-17.75,
4,	.70,	1.084,	15.37,	.60,	13,	.20,	-17.30,
5,	.64,	1.536,	14.81,	.66,	13,	.23,	-17.74,
6,	.59,	1.878,	14.06,	.70,	13,	.29,	-18.05,
7,	.88,	.418,	16.71,	.58,	13,	.49,	-18.00,

Fleet : Swe_Trawl

Age ,	1990,	1991,	1992,	1993,	1994,	1995,	1996
2 ,	No data for this fleet at this age						
3 ,	99.99,	99.99,	99.99,	99.99,	-.01,	.19,	.22
4 ,	99.99,	99.99,	99.99,	99.99,	-.44,	.28,	.15
5 ,	99.99,	99.99,	99.99,	99.99,	-1.15,	-.37,	.51
6 ,	99.99,	99.99,	99.99,	99.99,	-.28,	.29,	-.15
7 ,	99.99,	99.99,	99.99,	99.99,	.30,	.85,	-1.17

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2 ,	No data for this fleet at this age									
3 ,	.31,	.11,	-.18,	-.05,	-.07,	.08,	.18,	.07,	-.29,	-.34
4 ,	.30,	.09,	-.13,	-.46,	-.58,	-.13,	.14,	1.06,	-.05,	-.28
5 ,	.95,	-.22,	-.02,	-.71,	-.92,	-.39,	.34,	.93,	-.15,	.73
6 ,	.85,	.52,	-.26,	.33,	-1.15,	-.65,	.16,	.71,	-.49,	.27
7 ,	.54,	.51,	-.12,	1.08,	-.29,	-.89,	.31,	.40,	-.29,	-.28

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

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

    Age ,          3,          4,          5,          6,          7
 Mean Log q,  -13.4219,  -13.7743,  -14.5695,  -14.8674,  -14.8674,
 S.E(Log q),     .2037,     .4473,     .6748,     .5949,     .6460,


 Regression statistics :


 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  3,    1.37,    -.985,     14.15,     .44,     13,     .28,  -13.42,
  4,    1.76,    -.682,     16.09,     .08,     13,     .81,  -13.77,
  5,    1.37,    -.376,     16.38,     .10,     13,     .97,  -14.57,
  6,     .67,    1.091,     12.73,     .55,     13,     .40,  -14.87,
  7,     .79,     .673,     13.24,     .54,     13,     .53,  -14.82,

 Terminal year survivor and F summaries :

 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 BITSQ1_3-9_Backshift,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_2_raw        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_3-9_Backshift,    150710.,   .300,       .000,    .00,   1,  .497,     .083
 BITSQ1_2_raw        ,     96092.,   .531,       .000,    .00,   1,  .159,     .128
 BITS_Q4_raw         ,    123344.,   .553,       .000,    .00,   1,  .146,     .101
 Den_Gillnet_<160mm  ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 Den_Trawl_>90mm     ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 Swe_Trawl           ,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,     90243.,    .50,,,,                        .198,     .136

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    123116.,       .21,      .14,    4,    .634,   .101

 Age  3   Catchability constant w.r.t. time and dependent on age

 Year class = 2003

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 BITSQ1_3-9_Backshift,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_2_raw        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_3-9_Backshift,     71953.,   .212,       .005,    .02,   2,  .338,     .454
 BITSQ1_2_raw        ,     98881.,   .531,       .000,    .00,   1,  .051,     .350
 BITS_Q4_raw         ,     50793.,   .339,       .112,    .33,   2,  .134,     .596
 Den_Gillnet_<160mm  ,    109179.,   .687,       .000,    .00,   1,  .034,     .321
 Den_Trawl_>90mm     ,     72849.,   .313,       .000,    .00,   1,  .162,     .450
 Swe_Trawl           ,     45624.,   .300,       .000,    .00,   1,  .177,     .646

   F shrinkage mean  ,     59928.,    .50,,,,                        .104,     .525
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     64218.,       .13,      .08,    9,    .651,   .497

1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 BITSQ1_3-9_Backshift,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_2_raw        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_3-9_Backshift,     13723.,   .187,       .148,    .79,   3,  .241,     .845
 BITSQ1_2_raw        ,     10407.,   .532,       .000,    .00,   1,  .023,    1.012
 BITS_Q4_raw         ,     10557.,   .230,       .177,    .77,   3,  .185,    1.003
 Den_Gillnet_<160mm  ,     12814.,   .323,       .190,    .59,   2,  .101,     .885
 Den_Trawl_>90mm     ,      9564.,   .221,       .368,   1.67,   2,  .198,    1.067
 Swe_Trawl           ,      8065.,   .258,       .004,    .02,   2,  .133,    1.182

   F shrinkage mean  ,      9867.,    .50,,,,                        .120,    1.046

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     10760.,       .11,      .08,   14,    .747,   .991

 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 2001

5

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3175.,       .12,      .06,   19,    .503,  1.179

1
 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 BITSQ1_3-9_Backshift,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_2_raw        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_3-9_Backshift,       990.,   .222,       .066,    .30,   4,  .093,     .976
 BITSQ1_2_raw        ,      2541.,   .538,       .000,    .00,   1,  .005,     .497
 BITS_Q4_raw         ,      1582.,   .216,       .171,    .79,   4,  .149,     .710
 Den_Gillnet_<160mm  ,      1196.,   .262,       .122,    .46,   4,  .217,     .862
 Den_Trawl_>90mm     ,      1560.,   .276,       .255,    .92,   4,  .183,     .717
 Swe_Trawl           ,      1607.,   .371,       .186,    .50,   4,  .117,     .702

   F shrinkage mean  ,       784.,    .50,,,,                        .236,    1.127
```

Table 2.4.17 Cod in SD 25-32/ With misreporting: XSA diagnostics (Cont'd)

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1210.,       .15,      .09,   22,    .597,   .855



 Age  7   Catchability constant w.r.t. time and age (fixed at the value for
age)  6

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 BITSQ1_3-9_Backshift,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_2_raw        ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 BITSQ1_3-9_Backshift,       217.,   .222,       .131,    .59,   4,  .034,     .950
 BITSQ1_2_raw        ,       145.,   .544,       .000,    .00,   1,  .002,    1.219
 BITS_Q4_raw         ,       226.,   .223,       .091,    .41,   3,  .052,     .926
 Den_Gillnet_<160mm  ,       240.,   .365,       .140,    .38,   5,  .156,     .890
 Den_Trawl_>90mm     ,       441.,   .364,       .301,    .83,   5,  .214,     .577
 Swe_Trawl           ,       189.,   .446,       .150,    .34,   5,  .145,    1.037

   F shrinkage mean  ,       194.,    .50,,,,                        .396,    1.020

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       241.,       .23,      .10,   24,    .436,   .887



1
1
```

Table 2.4.18 Cod in SD 25-32/ With misreporting: Fish mortality (F) at age

Run title

At 22/05/2007 19:33

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE											
2	0.1207	0.1807	0.1545	0.2309	0.1912	0.1365	0.1895	0.1166	0.0805	0.1298	0.0503
3	0.6504	0.7365	0.7375	0.7083	0.6823	0.4475	0.6048	0.4534	0.4542	0.5716	0.4365
4	0.7994	0.8096	1.0176	0.8122	0.8478	0.7336	0.8183	0.8244	0.6666	0.6484	0.7802
5	0.9499	0.9926	1.1988	1.3194	1.1987	1.1515	0.9944	1.0813	0.8915	0.5715	0.9318
6	0.7552	1.6633	1.1643	1.1473	1.3157	0.8473	1.3084	1.0056	0.9286	0.8617	1.0586
7	0.8436	1.1692	1.1404	1.1059	1.1342	0.9207	1.0524	0.9814	0.8375	0.7004	0.9337
+gp	0.8436	1.1692	1.1404	1.1059	1.1342	0.9207	1.0524	0.9814	0.8375	0.7004	0.9337
0 FBAR 4	0.837	1.1587	1.1303	1.0962	1.1241	0.9133	1.0434	0.9732	0.8311	0.6955	0.9261

Table 8 Fishing mortality (F) at age

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE											
2	0.0217	0.0866	0.1489	0.0837	0.0548	0.0962	0.1413	0.1317	0.2419	0.0796	0.213
3	0.2589	0.2631	0.3325	0.3797	0.2257	0.3217	0.2986	0.4776	0.4375	0.3614	0.428
4	0.5852	0.4433	0.4365	0.6667	0.6259	0.5622	0.5598	0.7162	0.6595	0.8319	0.7538
5	0.9008	0.651	0.4891	0.7754	0.9217	0.8142	0.7405	0.9833	0.7042	1.0802	1.011
6	1.0393	0.5097	0.5572	0.7551	0.8736	0.8088	0.8317	0.962	0.831	1.359	0.9865
7	0.8506	0.539	0.4981	0.7396	0.8153	0.7355	0.7175	0.8967	0.7387	1.1033	0.9272
+gp	0.8506	0.539	0.4981	0.7396	0.8153	0.7355	0.7175	0.8967	0.7387	1.1033	0.9272
0 FBAR 4	0.844	0.5358	0.4952	0.7342	0.8091	0.7301	0.7124	0.8896	0.7334	1.0936	0.9196

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE											
2	0.1758	0.0645	0.2528	0.1281	0.0969	0.0858	0.1328	0.1129	0.1431	0.044	0.0978
3	0.5551	0.6375	0.5068	0.8991	0.3568	0.231	0.3943	0.3531	0.5073	0.6023	0.3477
4	0.8018	1.1152	1.0862	1.4002	0.7887	0.3144	0.5015	0.6041	0.8191	0.8369	0.7603
5	0.7686	1.0859	1.3979	1.6437	1.2886	0.4675	0.8373	0.8287	1.2267	1.3022	1.3126
6	0.9434	1.2335	1.2395	1.1562	1.2831	0.5603	0.6563	0.8731	0.7999	1.0058	1.1049
7	0.8467	1.1587	1.2567	1.4183	1.1325	0.4504	0.7807	0.8472	1.0064	0.693	0.8263
+gp	0.8467	1.1587	1.2567	1.4183	1.1325	0.4504	0.7807	0.8472	1.0064	0.693	0.8263
0 FBAR 4	0.8401	1.1483	1.2451	1.4046	1.1232	0.4482	0.6939	0.7883	0.963	0.9595	1.001

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	FBAR **-**
AGE									
2	0.0726	0.2403	0.176	0.106	0.183	0.1213	0.0893	0.1012	0.1039
3	0.4343	0.4979	0.6623	0.4756	0.5498	0.5062	0.4104	0.4974	0.4713
4	0.7235	1.0327	1.1754	0.9731	1.0799	1.0836	0.8592	0.9909	0.9779
5	1.2232	1.258	1.4104	1.242	1.0143	1.4593	1.0211	1.1787	1.2197
6	1.0556	1.0263	1.0934	1.0121	0.7622	1.6462	1.0557	0.8555	1.1858
7	1.0488	1.1913	1.4835	1.3186	0.8446	1.3242	0.951	0.8874	1.0542
+gp	1.0488	1.1913	1.4835	1.3186	0.8446	1.3242	0.951	0.8874	
0 FBAR 4	1.0128	1.1271	1.2907	1.1364	0.9253	1.3784	0.9717	0.9781	
1									

Table 2.4.19 Cod in SD 25-32/With Misreporting: Stock numbers (thousands) at age

Run title

At 22/05/2007 19:33

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
	AGE											
	2	430264	370921	354062	306727	240010	264787	322278	432140	506893	303683	293397
	3	234672	312210	253494	248388	199357	162306	189134	218301	314877	382912	218359
	4	68862	100264	122390	99272	100148	82499	84945	84578	113571	163697	177016
	5	21591	25349	36533	36220	36079	35121	32433	30683	30364	47743	70077
	6	5542	6837	7691	9019	7926	8908	9091	9823	8520	10193	22073
	7	1788	2132	1061	1966	2345	1741	3126	2012	2942	2756	3526
	+gp	197	911	135	345	818	731	1060	2409	2542	2374	2397
0	TOT/	762917	818624	775366	701936	586683	556093	642067	779946	979710	913358	786845

	YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE											
	2	479002	829398	615355	425886	689813	693588	472372	302918	253071	260194	368042
	3	228418	383747	622748	434121	320673	534631	515775	335787	217405	162680	196736
	4	115548	144353	241511	365655	243138	209507	317314	313263	170521	114925	92791
	5	66421	52694	75868	127794	153691	106457	97766	148424	125316	72191	40951
	6	22596	22092	22499	38088	48182	50062	38613	38169	45456	50736	20067
	7	6270	6543	10865	10551	14655	16468	18256	13762	11941	16212	10673
	+gp	2676	2275	5595	4600	6569	9347	5109	10197	7714	6779	5578
0	TOT/	920932	1441103	1594440	1406695	1476721	1620060	1465204	1162520	831423	683717	734838

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE											
	2	224249	122204	128168	82818	139196	182787	127033	119350	115321	87785	149311
	3	243516	154008	93802	81495	59655	103443	137349	91072	87284	81824	68775
	4	104988	114447	66652	46264	27151	34183	67224	75807	52381	43027	36682
	5	35749	38552	30720	18418	9338	10102	20437	33332	33922	18905	15256
	6	12199	13571	10655	6215	2914	2108	5182	7243	11915	8145	4209
	7	6126	3888	3236	2526	1601	661	985	2201	2477	4384	2439
	+gp	4111	2647	2482	2257	839	417	637	1375	657	2383	1756
0	TOT/	630938	449317	335715	239993	240695	333700	358848	330380	303956	246452	278427

	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 66-**	AMST 66-**
	AGE											
	2	152603	174997	135778	122318	108040	89868	172258	166385	0	241611	294273
	3	110861	116195	112674	93224	90074	73661	65175	128979	123116	179298	217581
	4	39770	58788	57822	47572	47437	42555	36353	35400	64218	92182	115090
	5	14041	15794	17137	14613	14720	13191	11789	12605	10760	34890	46769
	6	3361	3383	3675	3424	3456	4371	2510	3477	3175	10421	15595
	7	1141	958	993	1008	1019	1320	690	715	1210	3214	5091
	+gp	1299	1062	586	777	685	731	398	383	370		
0	TOT/	323077	371176	328665	282937	265430	225697	289173	347943	202849		
	1											

Table 2.4.20 Cod in SD 25-32/ With Misreporting: Stock Summary

Run title

At 22/05/2007 19:33

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RE	TOTALE	TOTSPE	LANDIN	YIELD/S	FBAR 4- 7
	Age 2					
1966	430264	355416	172018	134867	0.784	0.837
1967	370921	436280	228679	152378	0.6663	1.1587
1968	354062	422232	233958	164472	0.703	1.1303
1969	306727	395953	222659	169909	0.7631	1.0962
1970	240010	351666	208842	154492	0.7398	1.1241
1971	264787	314516	184181	118217	0.6419	0.9133
1972	322278	350280	198995	143833	0.7228	1.0434
1973	432140	394362	211991	143164	0.6753	0.9732
1974	506893	500395	262952	147815	0.5621	0.8311
1975	303683	575916	339545	194649	0.5733	0.6955
1976	293397	535740	355564	203303	0.5718	0.9261
1977	479002	533503	326914	164792	0.5041	0.844
1978	829398	712485	379201	154009	0.4061	0.5358
1979	615355	983040	579671	227699	0.3928	0.4952
1980	425886	1026484	696743	347619	0.4989	0.7342
1981	689813	984216	666132	330742	0.4965	0.8091
1982	693588	1057368	670941	316052	0.4711	0.7301
1983	472372	1003056	645257	332148	0.5148	0.7124
1984	302918	920296	657665	391952	0.596	0.8896
1985	253071	737745	544907	315083	0.5782	0.7334
1986	260194	547627	399365	252558	0.6324	1.0936
1987	368042	492334	320453	207081	0.6462	0.9196
1988	224249	462354	299235	194787	0.6509	0.8401
1989	122204	352763	240203	179178	0.7459	1.1483
1990	128168	271296	215801	153546	0.7115	1.2451
1991	82818	192718	151173	122517	0.8104	1.4046
1992	139196	133388	92481	54882	0.5934	1.1232
1993	182787	173237	113097	45188	0.3996	0.4482
1994	127033	267542	192985	93380	0.4839	0.6939
1995	119350	314730	240465	107712	0.4479	0.7883
1996	115321	227673	167129	121877	0.7292	0.963
1997	87785	203646	143532	88600	0.6173	0.9595
1998	149311	177329	110990	67429	0.6075	1.001
1999	152603	179266	89234	72989	0.818	1.0128
2000	174997	213726	114887	89168	0.7761	1.1271
2001	135778	170784	103901	91325	0.879	1.2907
2002	122318	140349	82827	67740	0.8178	1.1364
2003	108040	135434	80684	71386	0.8848	0.9253
2004	89868	125876	78643	67768	0.8617	1.3784
2005	172258	155187	70729	55254	0.7812	0.9717
2006	166385	173480	81040	65532	0.8086	0.9781
Arith. Mean	288177	431749	272577	160417	0.6479	0.943
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 2.4.21 Linear regressions between log mean-std indices at age for tuning fleets

BITSQ1_3-9_Backshifted

Y age	X age	I'cept	Slope	R2 (%)
3	2	-0.7705	0.8559	64.2092
4	3	-0.9214	0.7152	43.344
5	4	-1.8964	0.6376	27.2375
6	5	-1.8289	0.6721	30.9294
7	6	-4.0456	0.0972	1.1989
8	7	-5.3634	-0.0359	0.1272

BITS_Q4_raw

Y age	X age	I'cept	Slope	R2 (%)
3	2	0.1196	0.3508	15.3896
4	3	-0.9542	0.4678	7.6802
5	4	-2.1611	0.298	11.2156
6	5	-2.7312	0.3127	22.2347
7	6	-0.9796	1.0426	40.5613

Den_Gillnet_<160mm

Y age	X age	I'cept	Slope	R2 (%)
3	2	0.9207	0.3064	32.3162
4	3	0.2794	0.4046	54.65
5	4	-1.1602	0.8124	59.3714
6	5	-1.3028	1.4262	77.3575
7	6	-1.4608	0.9433	43.1055

Den_Trawl_>90mm

Y age	X age	I'cept	Slope	R2 (%)
3	2	0.9923	0.1825	32.9852
4	3	-0.0398	0.5697	39.0281
5	4	-1.5328	0.8932	32.2174
6	5	-1.4498	1.1046	63.9894
7	6	-1.737	0.7491	64.8778

Swe_Trawl

Y age	X age	I'cept	Slope	R2 (%)
3	2	1.0858	0.2549	61.059
4	3	-1.5352	1.2609	44.9961
5	4	-1.9652	0.7003	18.9213
6	5	-2.3102	0.5967	25.9034
7	6	-2.7119	0.5613	22.4793

Table 2.4.22 Cod in 25-32. RCT3 input data

Cod 25-32 in 2007 WGBFAS
5 18 2

'Yclass'	'XSA'	'BTS1_1'	'BTS1_2'	'BTS4_0'	'BTS4_1'	'BTS4_2'
1989	82818	-9	7.648	-9	-9	-9
1990	139196	8.73	10.329	-9	-9	-9
1991	182787	8	113.654	-9	-9	-9
1992	127033	20.262	143.148	-9	-9	-9
1993	119350	41.201	113.644	-9	-9	-9
1994	115321	54.601	83.692	-9	-9	-9
1995	87785	8.754	41.002	-9	-9	-9
1996	149311	6.148	66.261	-9	-9	-9
1997	152603	25.763	63.827	-9	-9	-9
1998	174997	37.913	130.972	-9	-9	54.95
1999	135778	31.95	68.868	-9	60.403	125.498
2000	122318	39.552	219.099	13.782	395.476	333.863
2001	108040	41.518	61.747	7.755	98.657	66.704
2002	89868	10.267	74.005	2.481	64.866	103.962
2003	172258	83.266	226.714	57.669	353.053	200.171
2004	166385	57.2	110.839	10.838	133.157	208.251
2005	-9	6.559	210.412	9.509	172.63	-9
2006	-9	64.406	-9	23.194	-9	-9

Table 2.4.23 Cod in SD 25-32. Output from RCT3

```
Analysis by RCT3 ver3.1 of data from file :

InRCT31.txt

Cod 25-32 in 2007 WGBFAS

Data for    5 surveys over   18 years :  1989 - 2006

Regression type = C
Tapered time weighting applied
power =    3 over  20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   2002

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

BTS1_1   -2.24  18.88   1.71   .016     12   2.42   13.46    2.091     .010
BTS1_2     .69   8.80    .55   .158     13   4.32   11.78     .633     .106
BTS4_0
BTS4_1    -.59  14.59    .79   .040      3   4.19   12.13    1.736     .014
BTS4_2    -.72  15.22    .67   .123      4   4.65   11.85    1.063     .037

                                       VPA Mean =   11.76     .225     .833

Yearclass =   2003

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

BTS1_1    4.72  -2.97   3.61   .004     13   4.43   17.95    4.754     .001
BTS1_2     .92   7.76    .68   .118     14   5.43   12.76     .858     .030
BTS4_0     .21  11.14    .01   .998      3   4.07   12.00     .040     .558
BTS4_1     .80   7.85    .82   .065      4   5.87   12.55    1.580     .009
BTS4_2   -1.67  19.59   1.32   .046      5   5.30   10.73    2.009     .006

                                       VPA Mean =   11.73     .237     .396

Yearclass =   2004

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

BTS1_1    1.12   8.12    .90   .071     14   4.06   12.69    1.083     .018
BTS1_2     .74   8.49    .52   .194     15   4.72   11.97     .601     .057
BTS4_0     .23  11.10    .02   .997      4   2.47   11.67     .030     .516
BTS4_1     .47   9.39    .40   .330      5   4.90   11.69     .573     .063
BTS4_2   13.79 -54.60  10.35   .001      6   5.34   19.09   14.485     .000

                                       VPA Mean =   11.76     .244     .347
```

Table 2.4.23 Cod in SD 25-32. Output from RCT3 (Cont'd)

Yearclass = 2005

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
BTS1_1	.83	9.03	.64	.133	15	2.02	10.70	.814	.045
BTS1_2	.79	8.23	.51	.203	16	5.35	12.47	.618	.078
BTS4_0	.33	10.93	.22	.689	5	2.35	11.70	.310	.311
BTS4_1	.64	8.62	.51	.239	6	5.16	11.90	.677	.065
BTS4_2									
					VPA Mean =		11.78	.244	.501

Yearclass = 2006

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
BTS1_1	.76	9.25	.57	.164	15	4.18	12.41	.696	.073
BTS1_2									
BTS4_0	.33	10.93	.22	.689	5	3.19	11.97	.325	.335
BTS4_1									
BTS4_2									
					VPA Mean =		11.79	.245	.592

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	132039	11.79	.21	.09	.17	89868	11.41
2003	150623	11.92	.15	.13	.77	172258	12.06
2004	125655	11.74	.14	.07	.26	166386	12.02
2005	129435	11.77	.17	.15	.77		
2006	146666	11.90	.19	.12	.40		

Table 2.4.24 Cod in SD 25-32. Input to short term forecast.
Inputs based on XSA with correction for misreporting and discards

MFDP version 1a
Run: R09
Time and date: 21:54 22.05.2007
Fbar age range (Total) : 4-7
Fbar age range Fleet 1 : 4-7

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
2	129435	0.2	0.13	0	0	0.259	0.074	0.615	0.030	0.370
3	123116	0.2	0.36	0	0	0.586	0.421	0.750	0.050	0.383
4	64218	0.2	0.83	0	0	0.887	0.966	0.951	0.012	0.446
5	10760	0.2	0.94	0	0	1.214	1.212	1.304	0.008	0.622
6	3175	0.2	0.96	0	0	1.885	1.182	1.946	0.004	1.228
7	1210	0.2	0.96	0	0	2.603	1.052	3.130	0.002	2.059
8	370	0.2	0.98	0	0	3.694	1.054	5.317	0.000	0.000

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
2	126731	0.2	0.13	0	0	0.259	0.074	0.615	0.030	0.370
3	.	0.2	0.36	0	0	0.586	0.421	0.750	0.050	0.383
4	.	0.2	0.83	0	0	0.887	0.966	0.951	0.012	0.446
5	.	0.2	0.94	0	0	1.214	1.212	1.304	0.008	0.622
6	.	0.2	0.96	0	0	1.885	1.182	1.946	0.004	1.228
7	.	0.2	0.96	0	0	2.603	1.052	3.130	0.002	2.059
8	.	0.2	0.98	0	0	3.694	1.054	5.317	0.000	0.000

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
2	126731	0.2	0.13	0	0	0.259	0.074	0.615	0.030	0.370
3	.	0.2	0.36	0	0	0.586	0.421	0.750	0.050	0.383
4	.	0.2	0.83	0	0	0.887	0.966	0.951	0.012	0.446
5	.	0.2	0.94	0	0	1.214	1.212	1.304	0.008	0.622
6	.	0.2	0.96	0	0	1.885	1.182	1.946	0.004	1.228
7	.	0.2	0.96	0	0	2.603	1.052	3.130	0.002	2.059
8	.	0.2	0.98	0	0	3.694	1.054	5.317	0.000	0.000

Input units are thousands and kg - output in tonnes

Input units are thousands and kg - output in tonnes

M =	Natural mortality
Mat =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWt =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWt =	Weight in catch (kg)
Dsel=	Discard - Exploitation pattern
DCWt=	Discard - Weight in catch (kg)

N2007 age group2	From RCT3
N2008, N_{2009} Age 2:	Geometric mean of age 2 for the yearclasses 1987-2003 from VPA output
N_{2006} Age 3 - 8+:	Output from VPA (Table 2.4.19)
Natural mortality (M):	Constant = 0.2
Weight in the catch (CWt)	Average for 2004-2006
Weight in the stock (SWt)	Average for 2004-2006
Exploitation pattern (Sel.):	Average for 2004-2006, partioned in landings and discards

Table 2.4.25 Cod in 25-32. Results of status quo catch forecast.
Inputs based on XSA with correction for misreporting and discards

MFDP version 1a
Run: R09
Time and date: 21:54 22.05.2007
Fbar age range (Total) : 4-7
Fbar age range Fleet 1 : 4-7

2007						
		Catch	Landings		Discards	
Biomass	SSB	FMult	FBar	Yield	FBar	Yield
186214	100000	1	1.103	84593	0.0064	3176

2008							2009	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
177265	101630	0	0	0	0	0	265361	180812
.	101630	0.1	0.1103	11824	0.0006	325	251213	168131
.	101630	0.2	0.2206	22678	0.0013	638	238271	156575
.	101630	0.3	0.3309	32654	0.0019	940	226420	146035
.	101630	0.4	0.4412	41832	0.0026	1231	215555	136412
.	101630	0.5	0.5515	50286	0.0032	1512	205584	127619
.	101630	0.6	0.6618	58083	0.0039	1783	196423	119577
.	101630	0.7	0.7721	65281	0.0045	2045	187996	112215
.	101630	0.8	0.8824	71936	0.0051	2299	180235	105470
.	101630	0.9	0.9927	78095	0.0058	2544	173080	99282
.	101630	1	1.103	83803	0.0064	2782	166474	93601
.	101630	1.1	1.2133	89100	0.0071	3013	160368	88379
.	101630	1.2	1.3236	94021	0.0077	3236	154717	83575
.	101630	1.3	1.4339	98600	0.0084	3453	149480	79150
.	101630	1.4	1.5442	102865	0.009	3663	144620	75070
.	101630	1.5	1.6544	106844	0.0096	3868	140105	71304
.	101630	1.6	1.7647	110560	0.0103	4067	135904	67824
.	101630	1.7	1.875	114036	0.0109	4260	131991	64604
.	101630	1.8	1.9853	117291	0.0116	4448	128340	61623
.	101630	1.9	2.0956	120343	0.0122	4631	124930	58858
.	101630	2	2.2059	123209	0.0129	4809	121740	56292

Input units are thousands and kg - output in tonnes

Table 2.4.26. Cod Sd 25-32. Comparison of year class estimates in WGBFAS 2006 and WGBFAS 2007

Predictions 2006 WG

Year class	Year Age	**2006** Stock num
2004	Age 2	126638
2003	Age3	120826
2002	Age4	23903
2001	Age5	9363
2000	Age6	3328
1999	Age7	690
1998	Age8	338

XSA 2007

Year class	Year Age	**2006** Stock num
2004	Age 2	168071
2003	Age3	129506
2002	Age4	35353
2001	Age5	12617
2000	Age6	3480
1999	Age7	715
1998	Age8	383

Difference (%)

Year class	
2004	**25**
2003	**7**
2002	32
2001	26

Year class	Year Age	**2007** Stock num
2005	Age 2	126638
2004	Age3	89482
2003	Age4	56771
2002	Age5	6697
2001	Age6	2361
2000	Age7	852
1999	Age8	202

Predictions 2007 WG

Year class	Year Age	**2007** Stock num
2005	Age 2	129685
2004	Age3	124497
2003	Age4	64649
2002	Age5	10722
2001	Age6	3185
2000	Age7	1212
1999	Age8	371

Difference (%)

Year class	
2004	**28**
2003	**12**
2002	38

Year class	Year Age	**2008** Stock num
2006	Age 2	126638
2005	Age3	89482
2004	Age4	42043
2003	Age5	15906
2002	Age6	1689
2001	Age7	605
2000	Age8	250

Year class	Year Age	**2008** Stock num
2006	Age 2	126755
2005	Age3	95737
2004	Age4	63672
2003	Age5	19897
2002	Age6	2595
2001	Age7	797
2000	Age8	346

Difference (%)

Year class	
2004	**34**
2003	**20**
2002	35

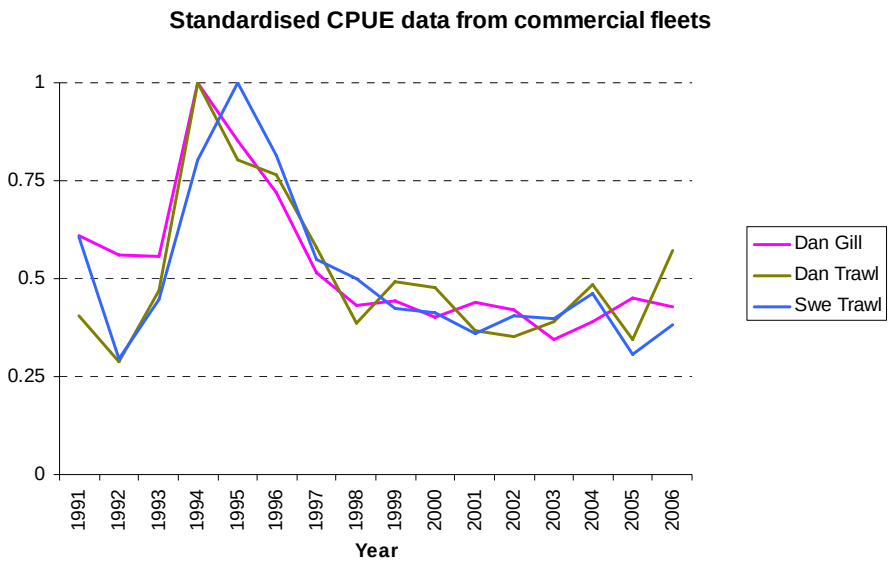


Figure 2.4.1 Cod in SD 25-32. Standardised aggregate CPUE data from Swedish trawlers and Danish Gillnetters and Trawlers.

Data are presented as values standardised to the series maxima.

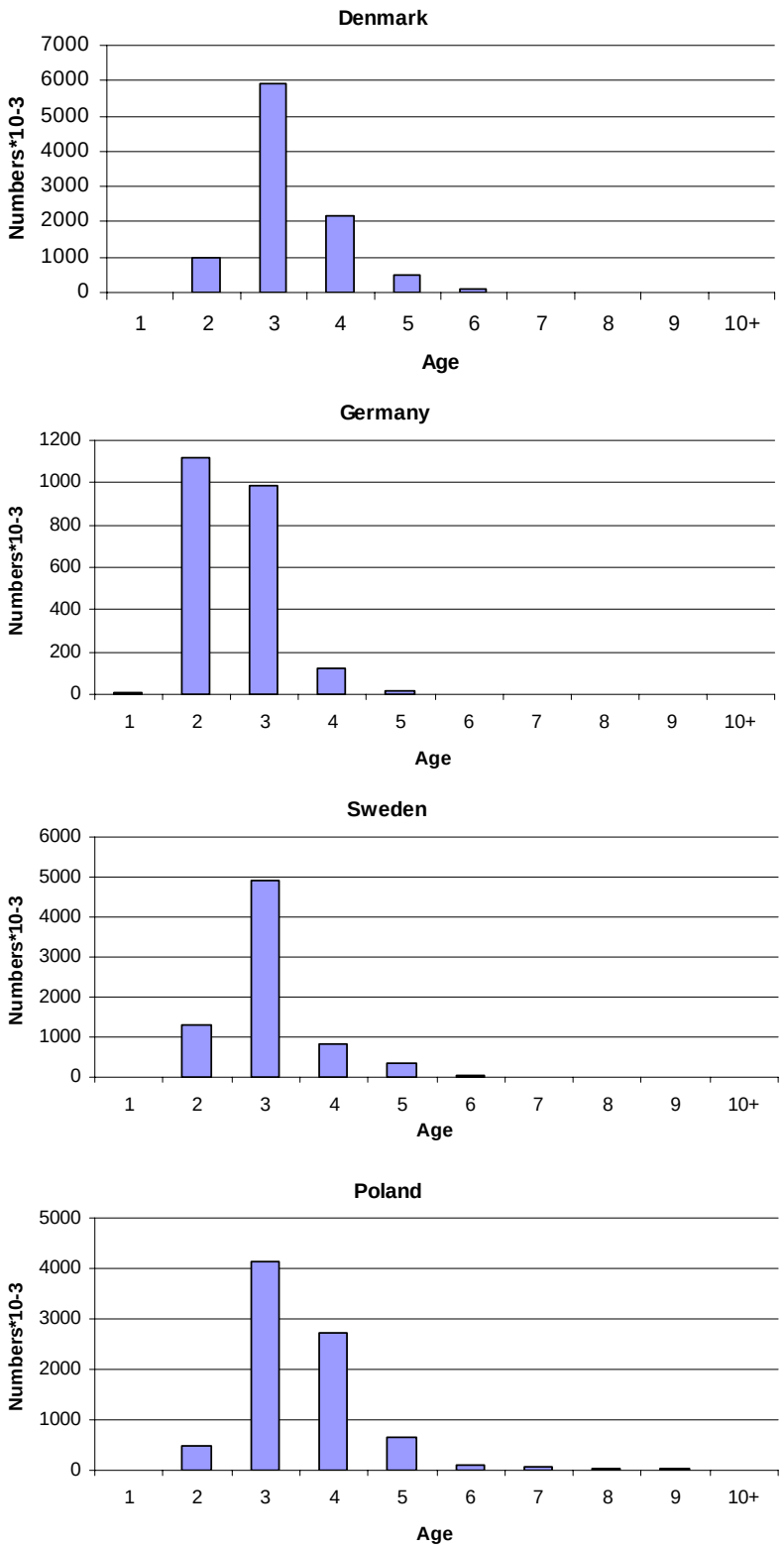


Figure 2.4.2a **Cod in SD 25-32. The trawl age composition of the landings by Countries in SD-25.**

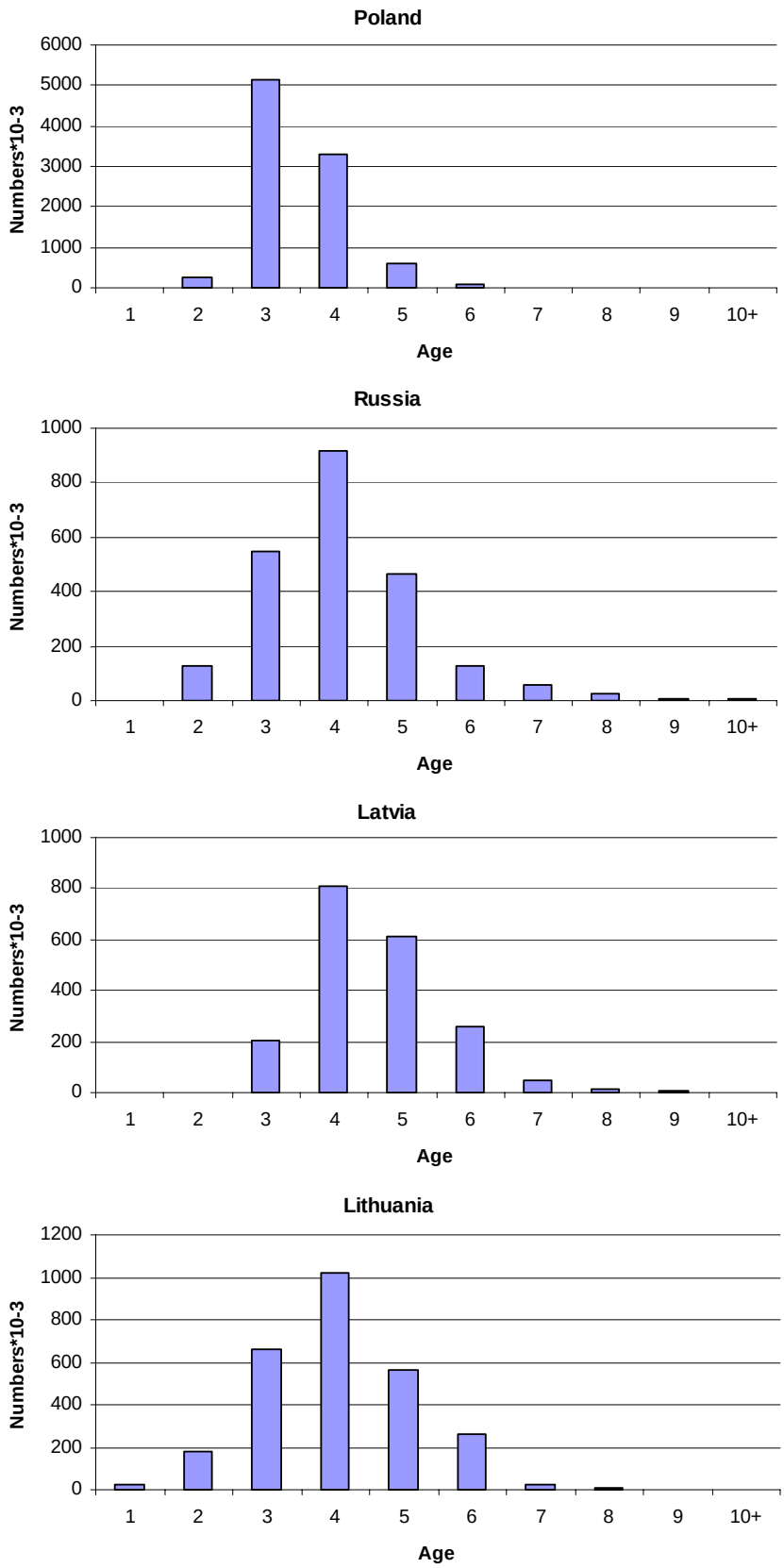


Figure 2.4.2b **Cod in SD 25-32. The trawl age composition of the landings by Countries in SD-26.**

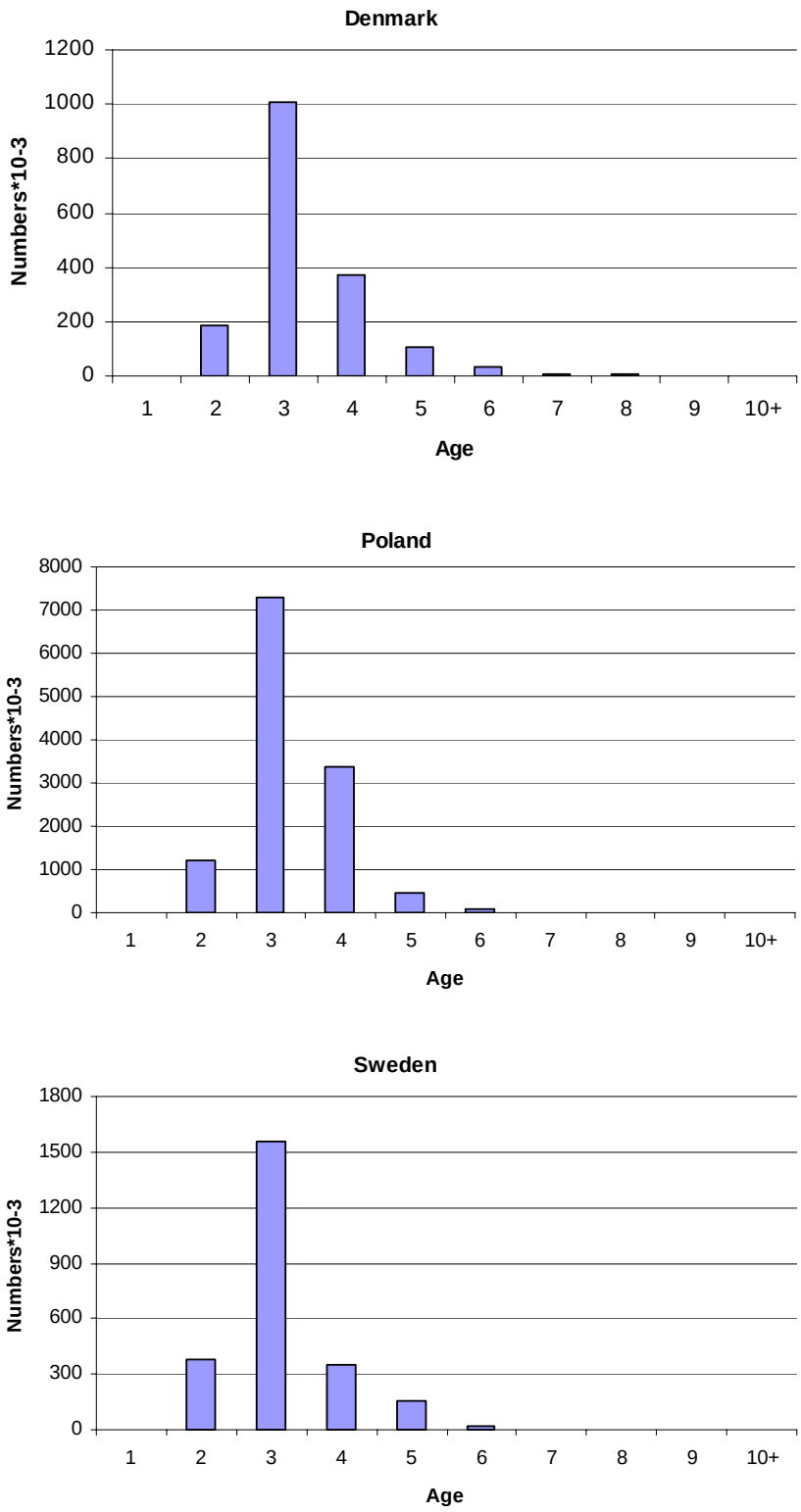


Figure 2.4.2c **Cod in SD 25-32. The gillnet age composition of the landings by Countries in SD-25.**

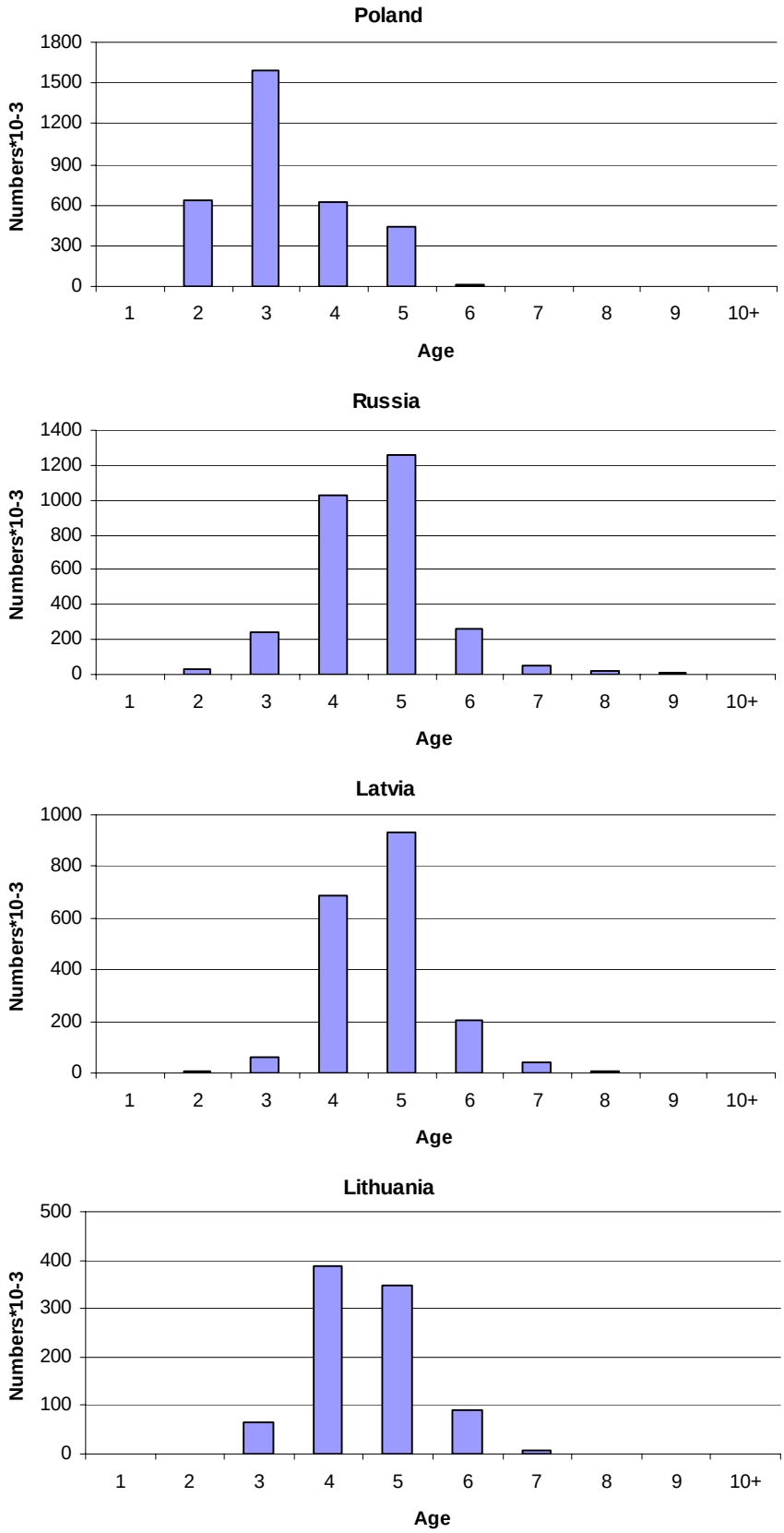


Figure 2.4.2d **Cod in SD 25-32. The gillnet age composition of the landings by Countries in SD-26.**

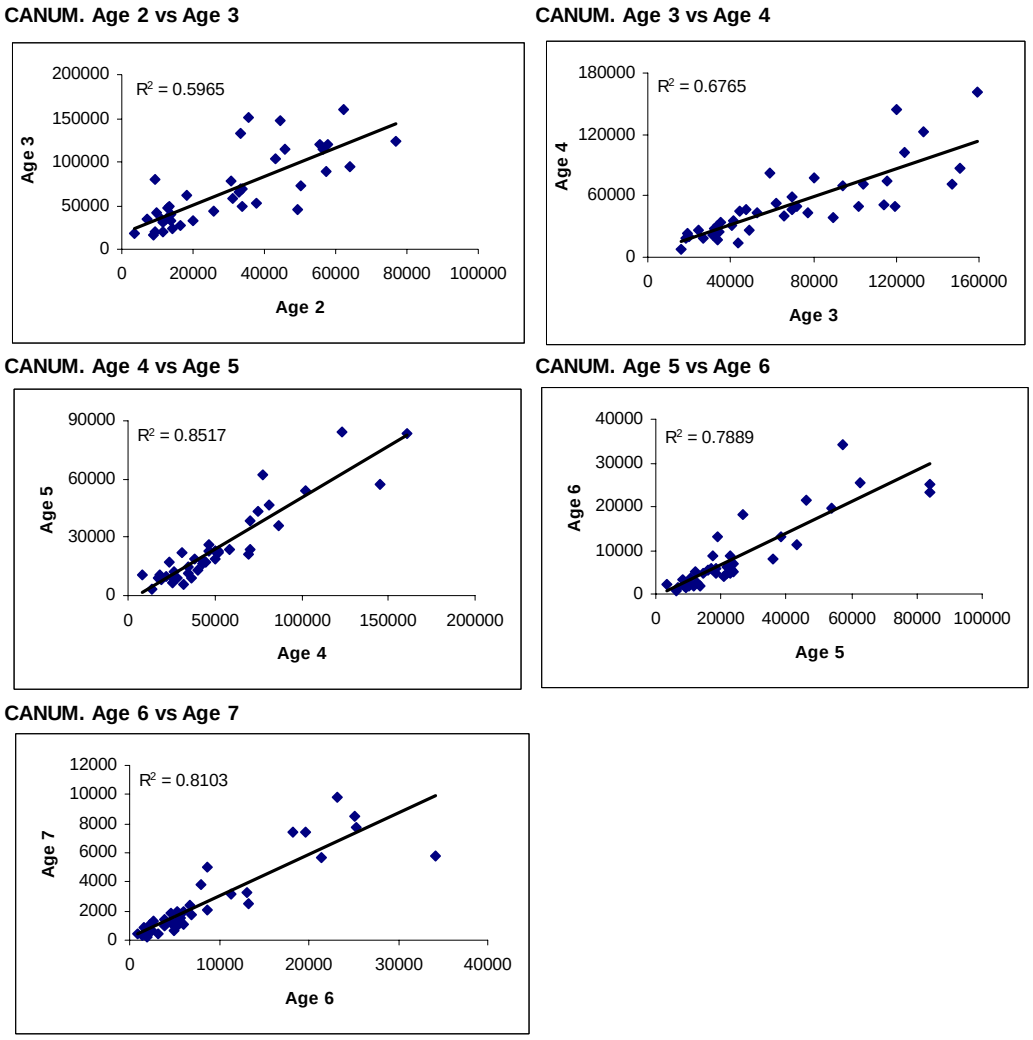


Figure 2.4.3 a **Cod in SD 25-32. Comparision of catch at age data (CANUM incl. misreporting and dis by plotting Age vs Age+1.**

BITS Q1

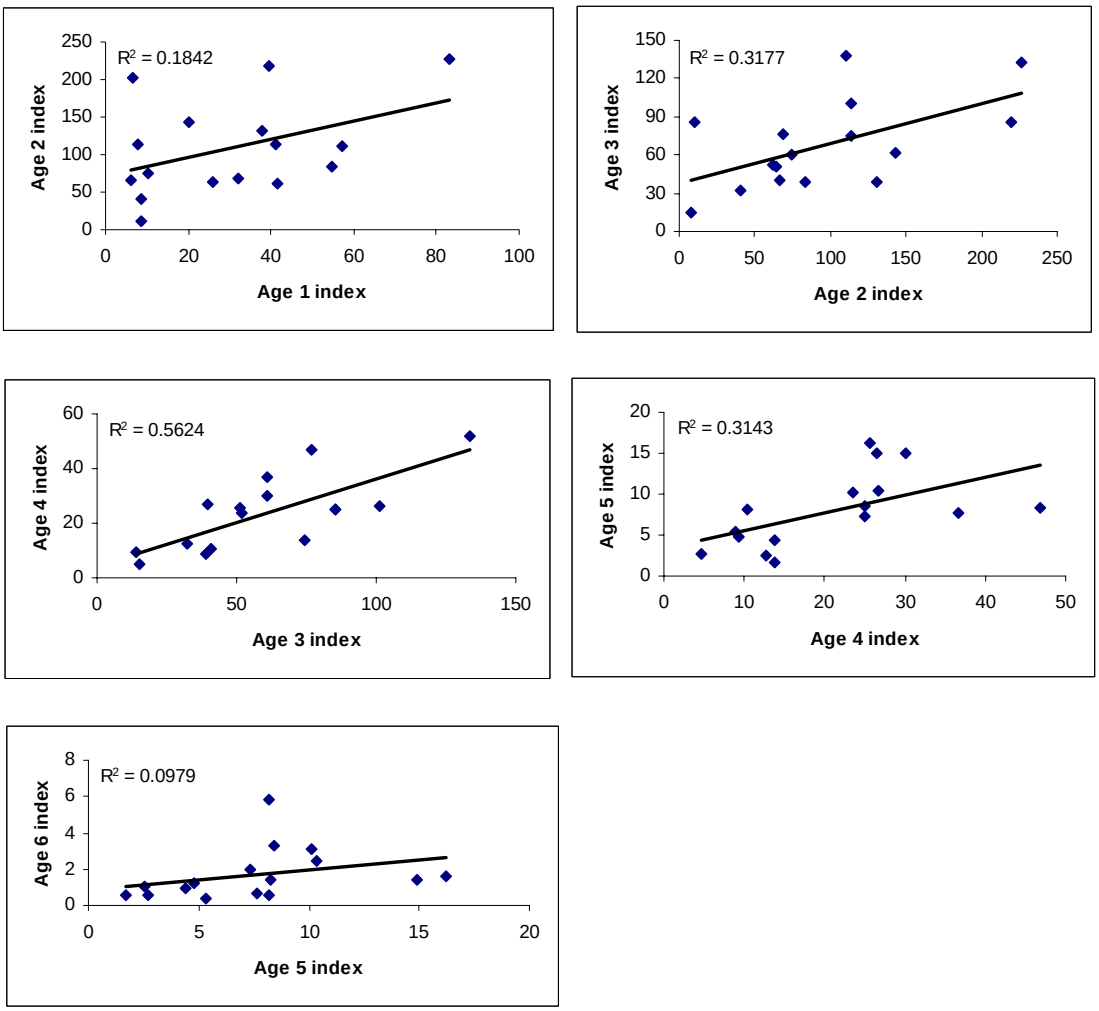


Figure 2.4.3 b **Cod in SD 25-32. Comparision of input data of BITS Q1 survey by age group**

BITS Q4

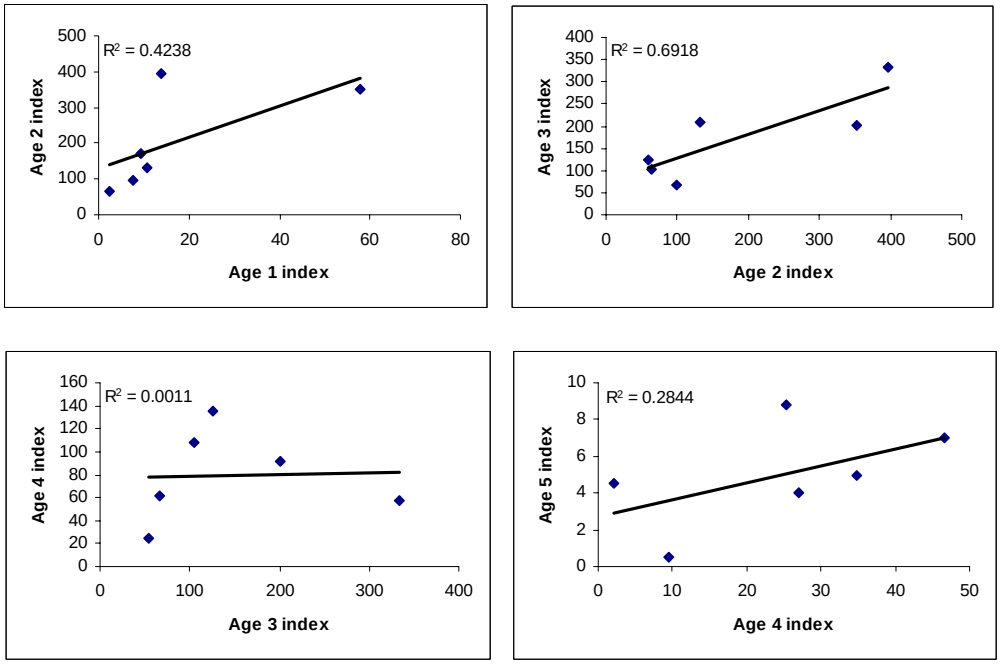


Fig 2.4.3 c **Cod in SD 25-32. Comparision of input data of BITS Q4 survey by age group.**

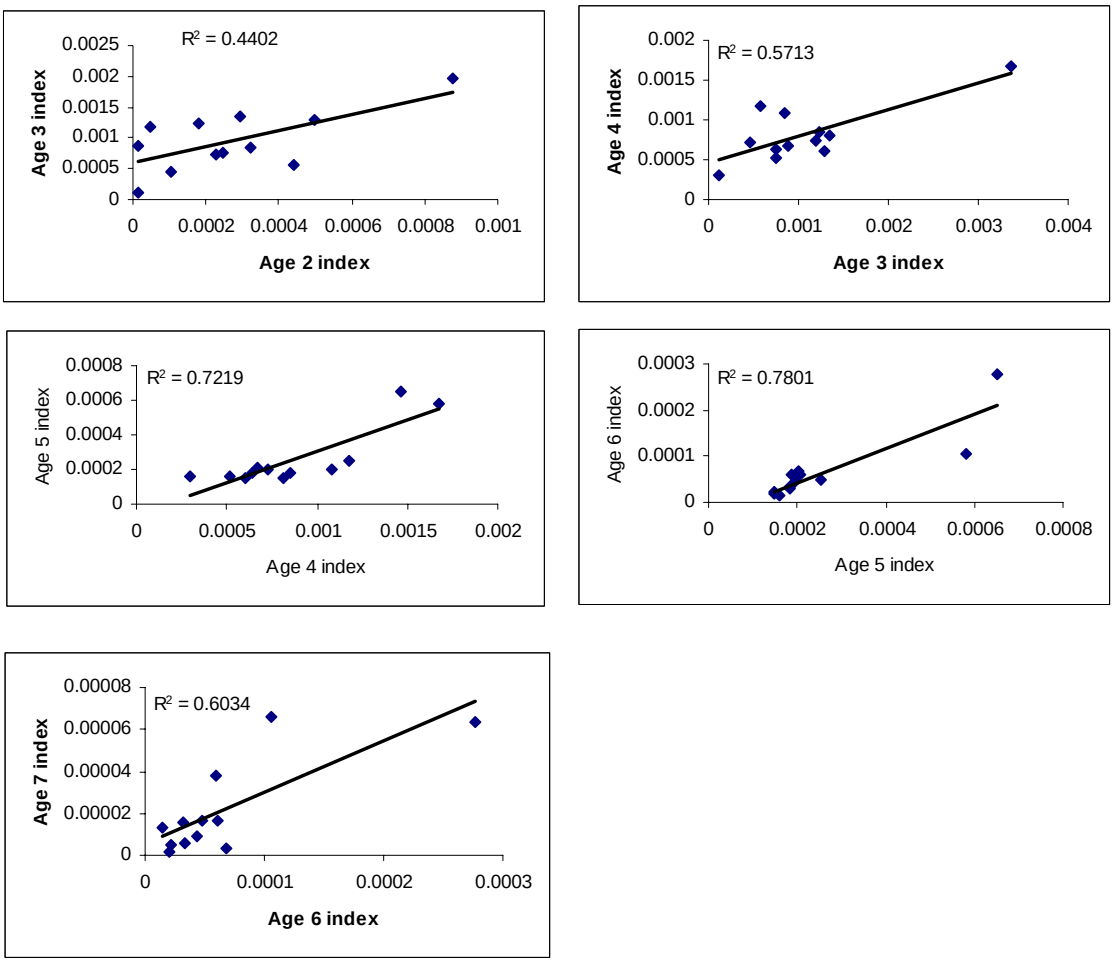


Figure 2.4.3 d Cod in SD 25-32. Comparision of input data of Danish Gillnets by age group

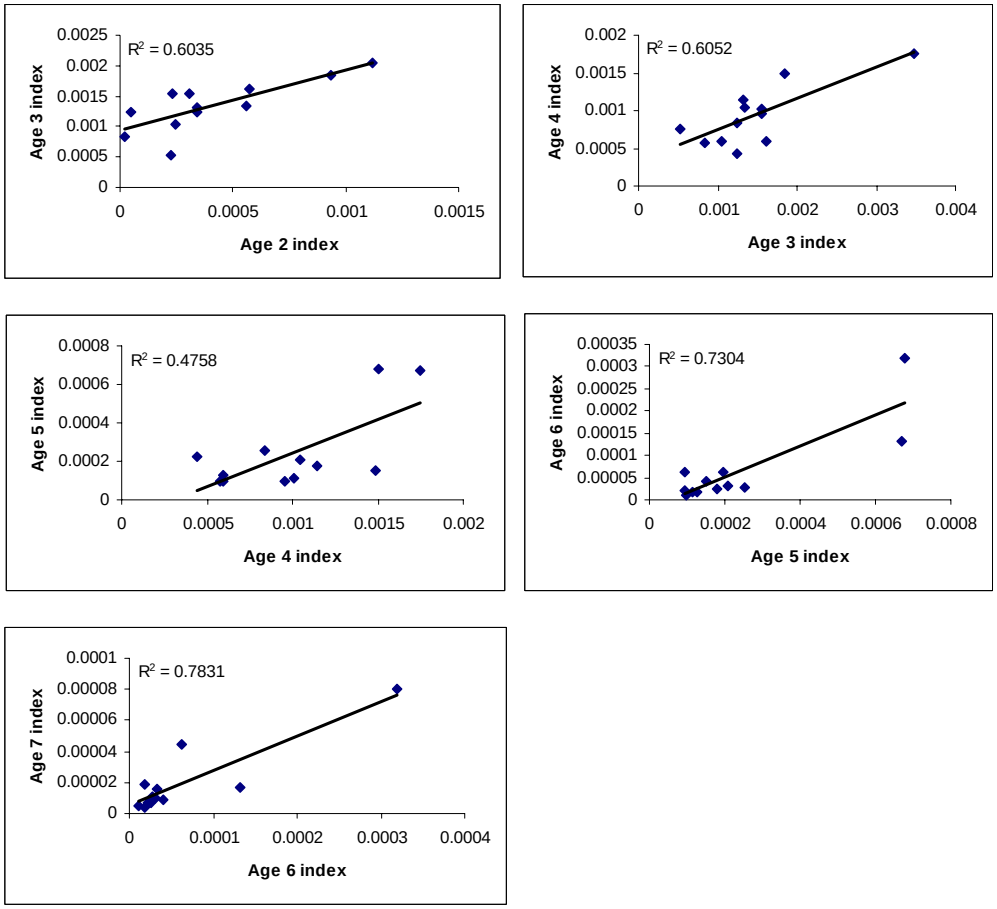


Figure 2.4.3 e Cod in SD 25-32. Comparision of input data of Danish Trawlers by age grou

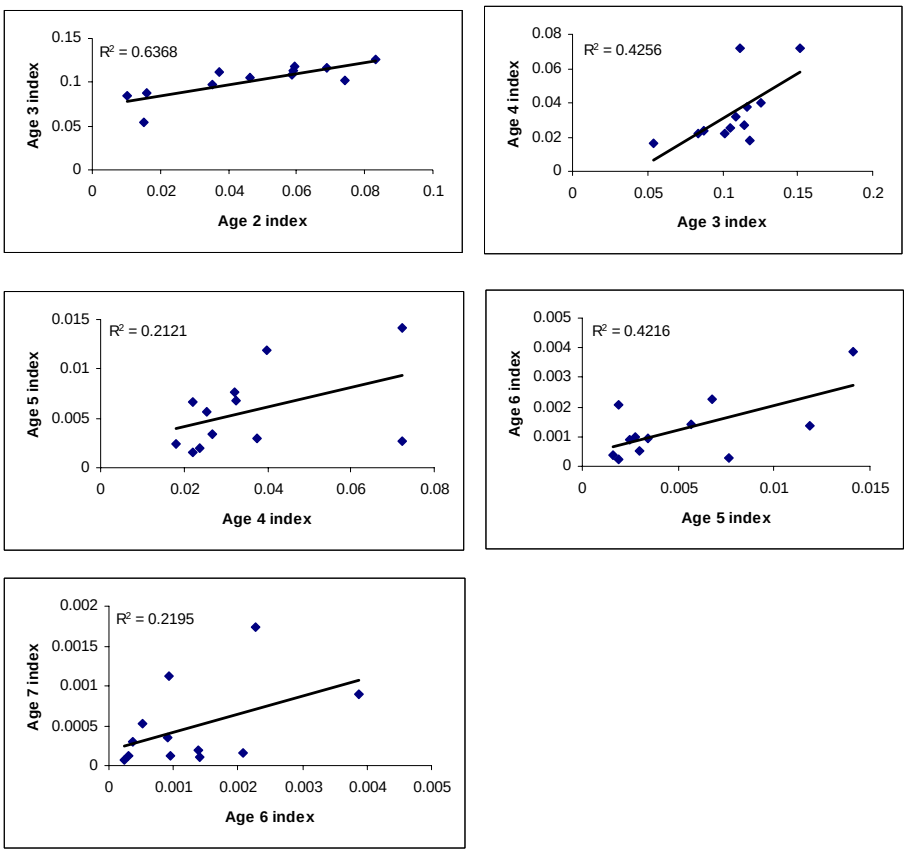


Figure 2.4.3 f **Cod in SD 25-32. Comparision of input data of Swedish Trawlers by age group.**

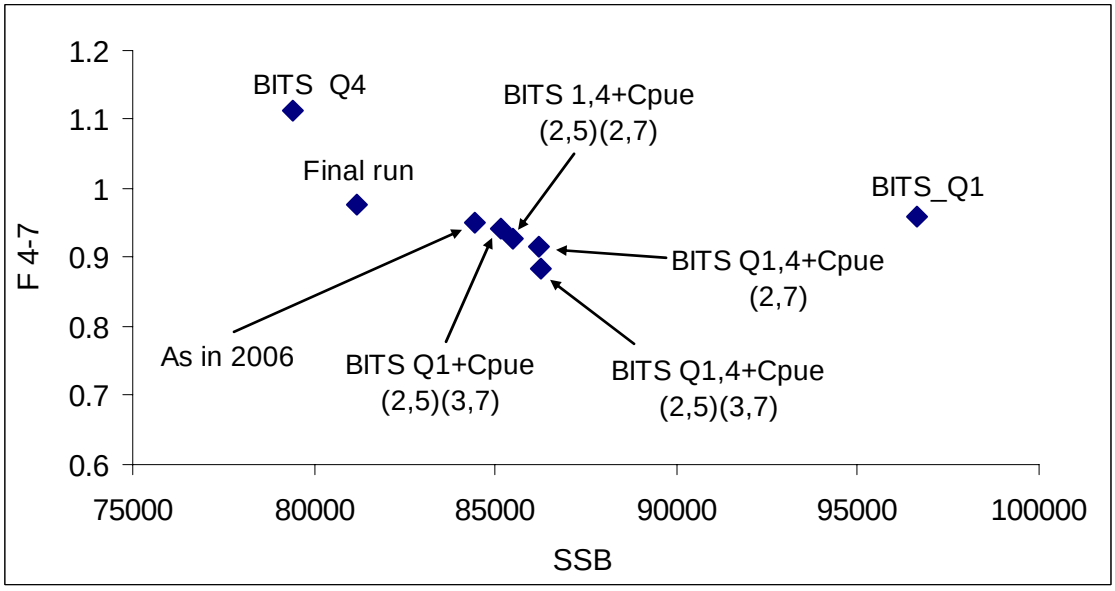


Figure 2.4.4 Cod SD 25-32 SSB and F relation in the trial XSA runs (in brackets indicated youngest and eldest age groups)

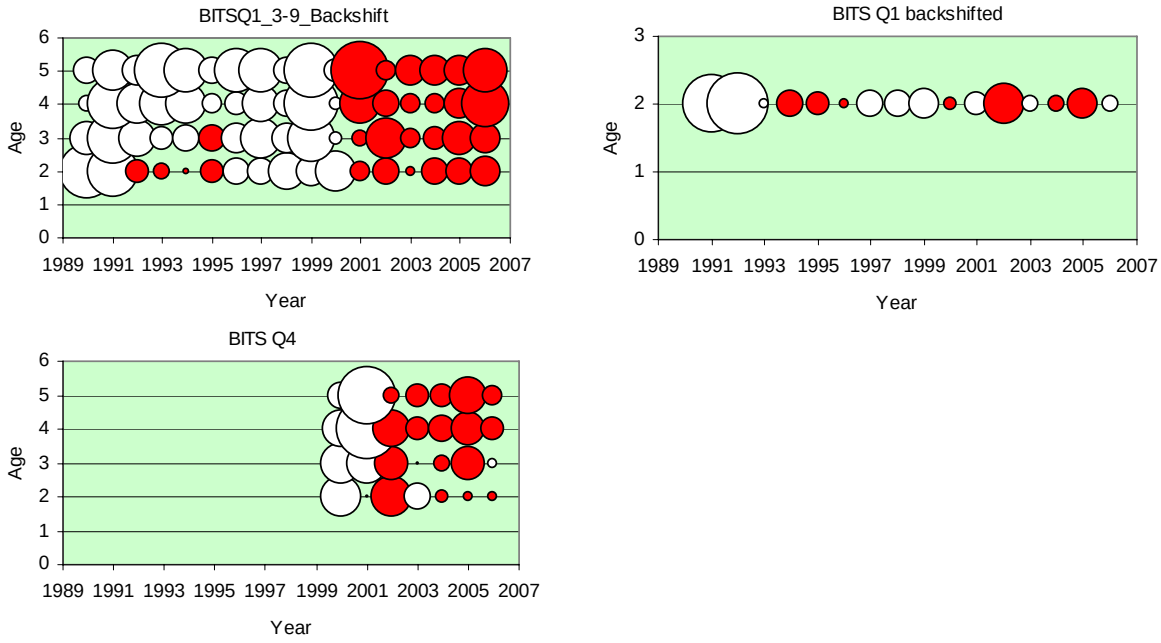


Figure 2.4.5a Cod in SD 25-32. Log cachability residuals (BITS full time series)

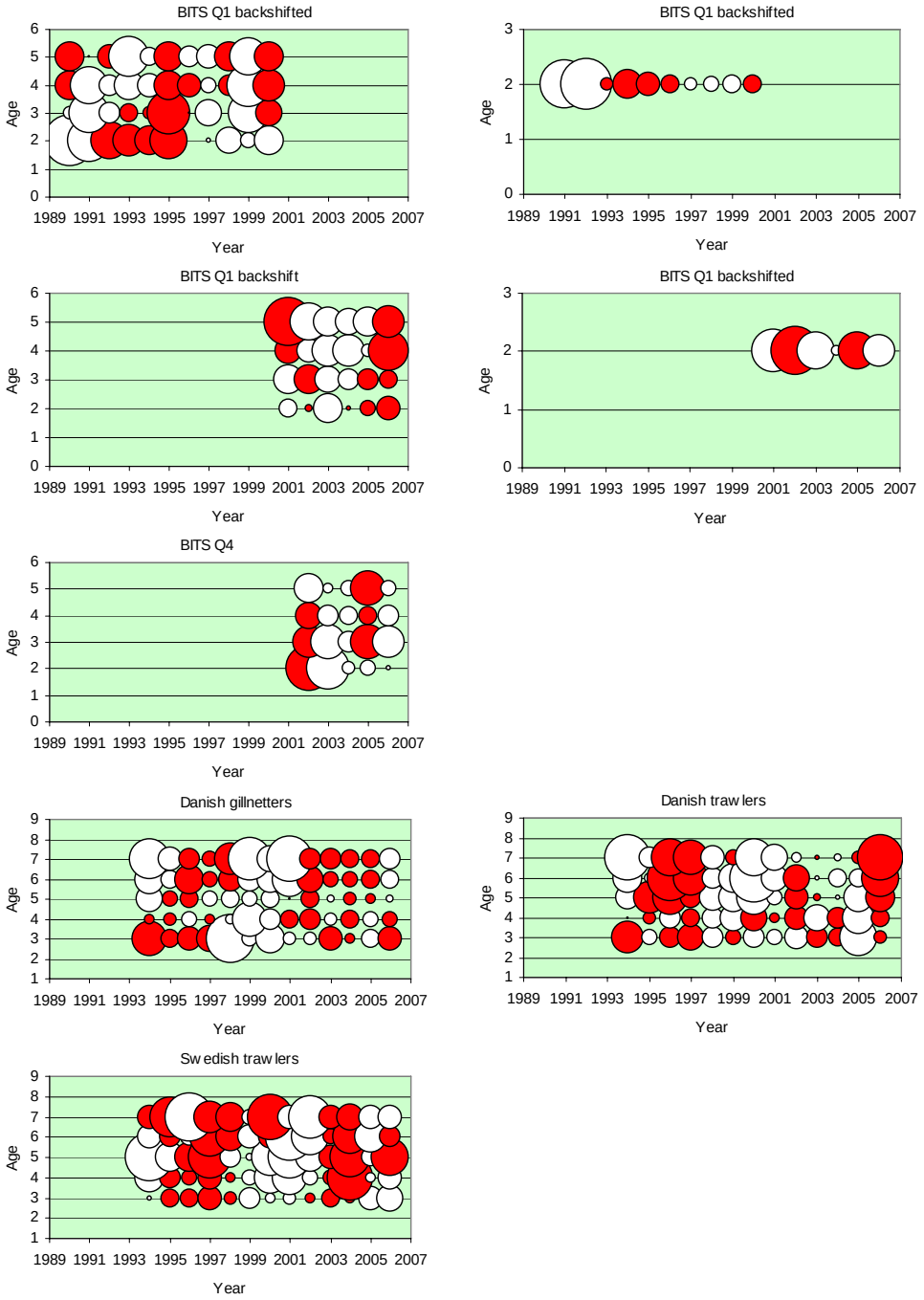


Figure 2.4.5b Cod in SD 25-32. Log cachability residuals (final XSA)

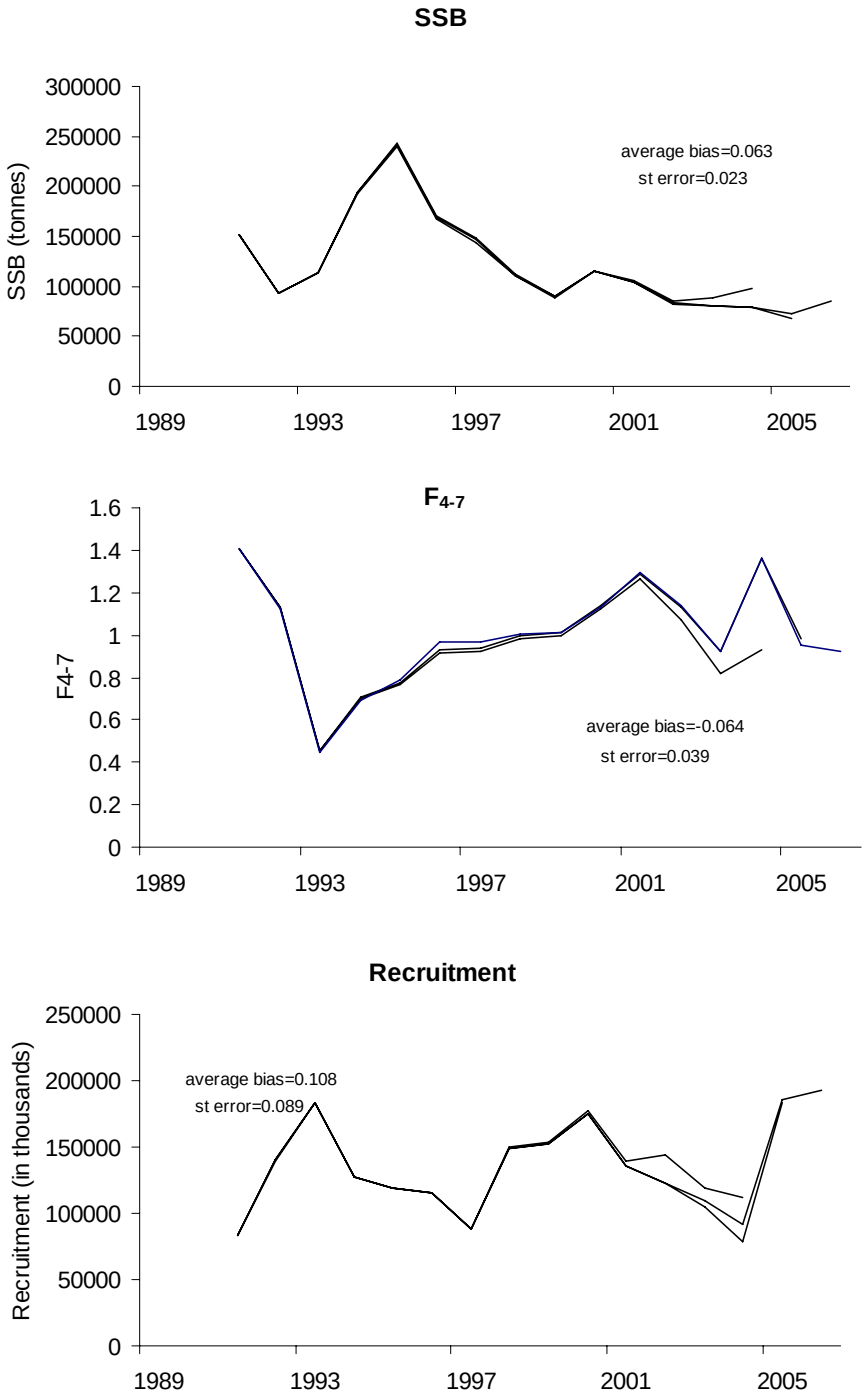


Figure 2.4.6 Cod in SD 25-32. Retrospective analysis.

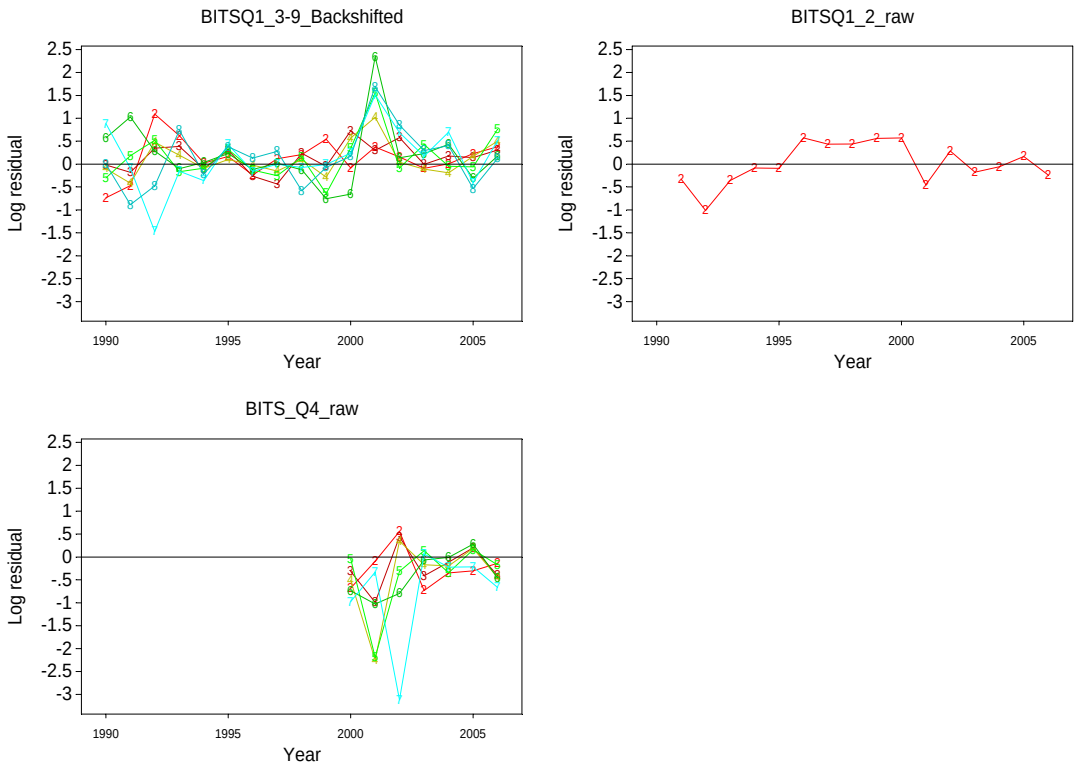


Figure 2.4.7a Log catchability residuals of survey fleets

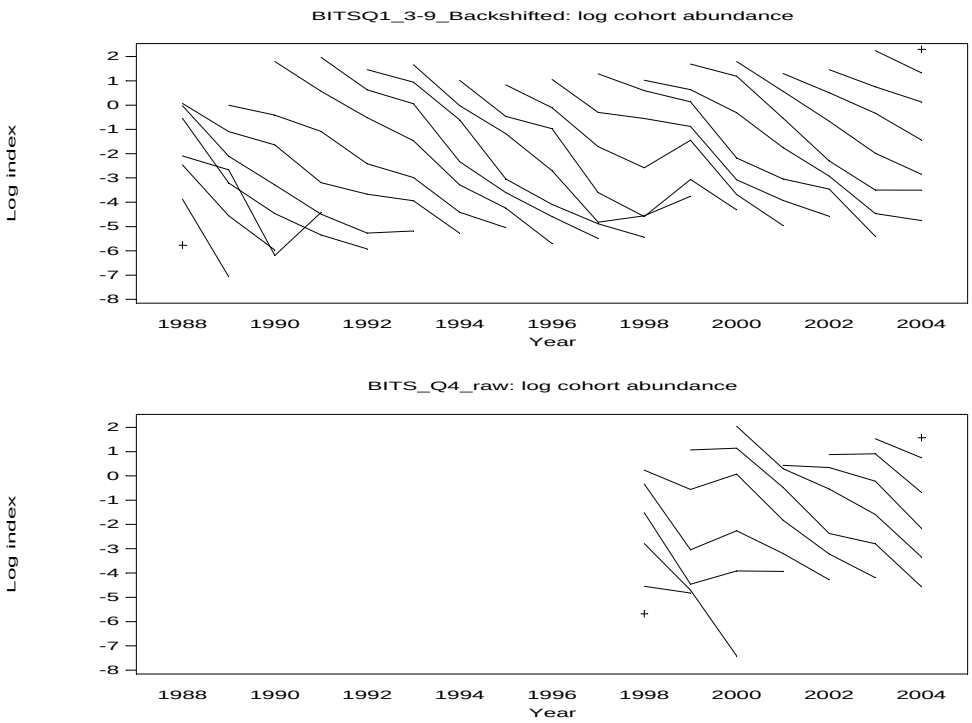


Figure 2.4.7b

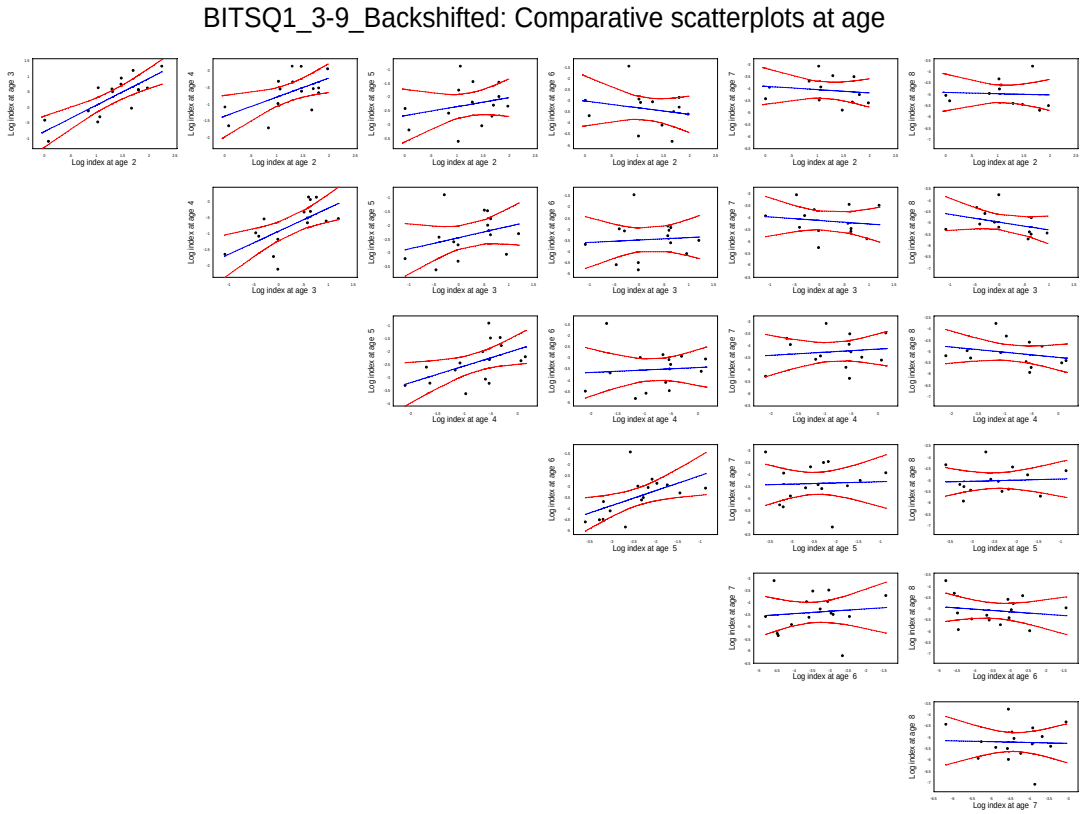


Figure 2.4.7c

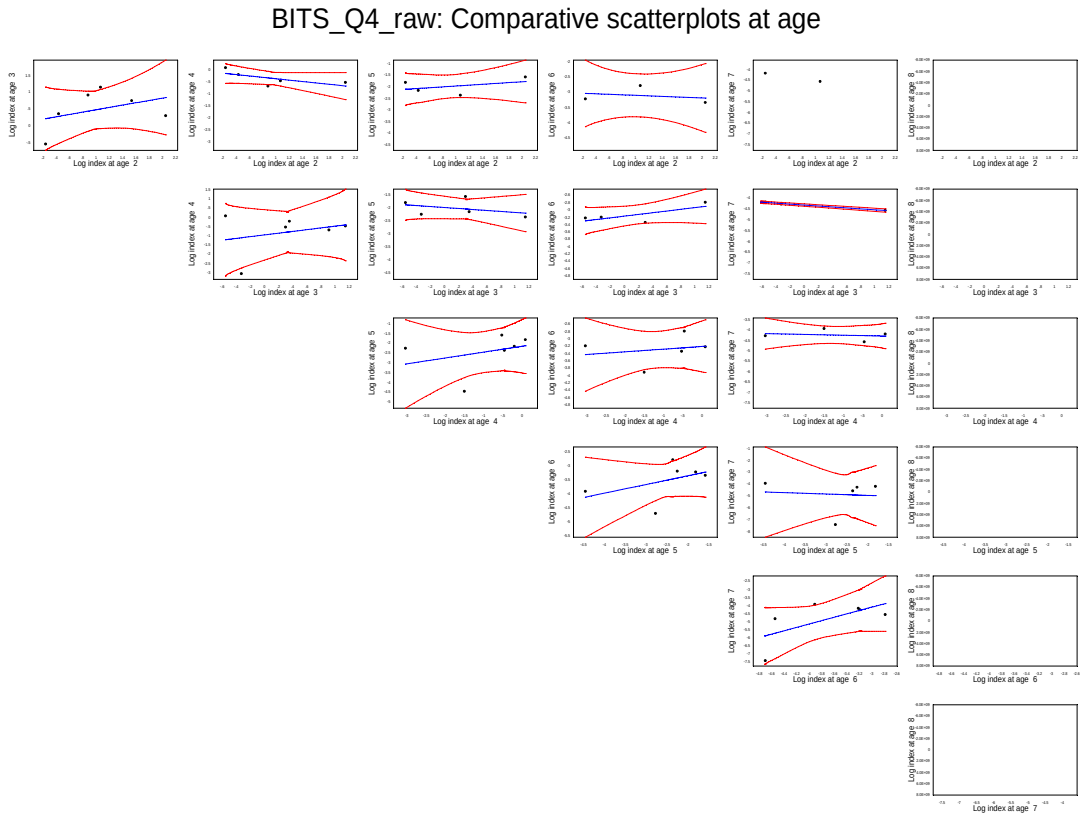


Figure 2.4.7d

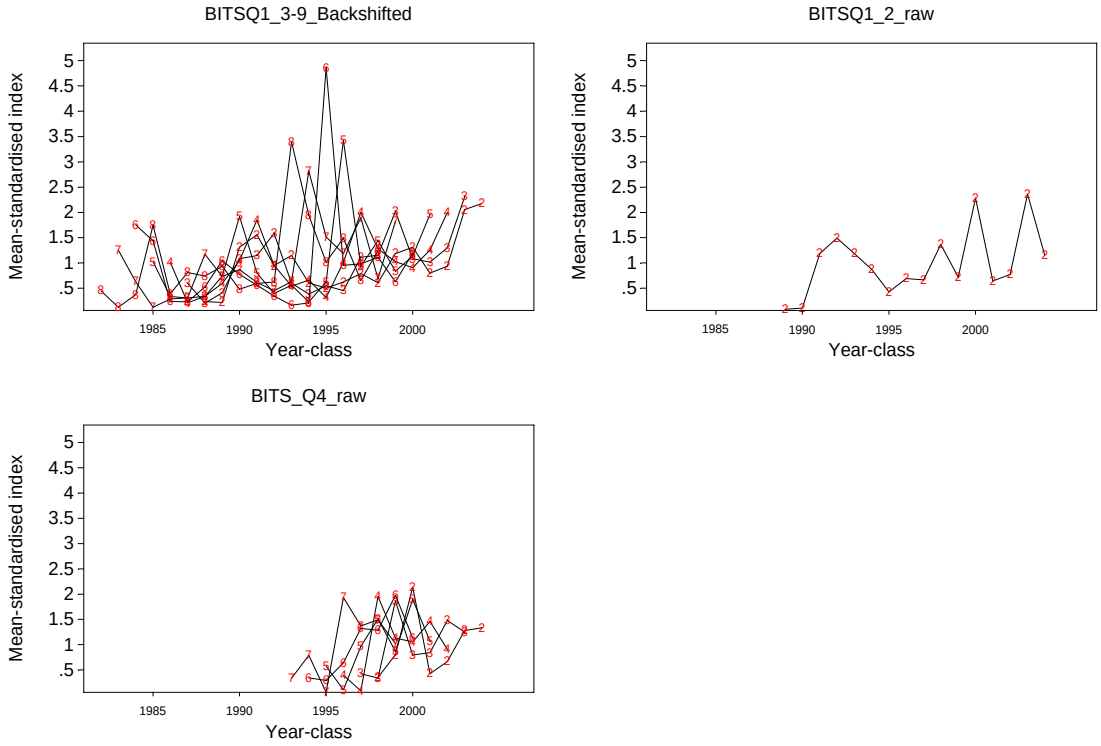


Figure 2.4.7e

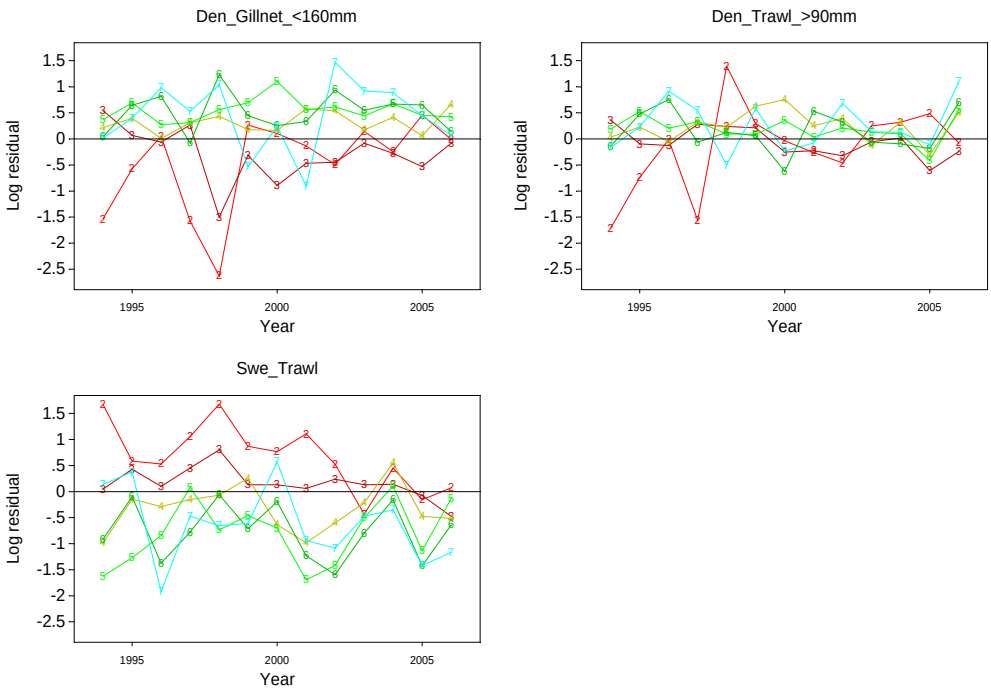


Figure 2.4.8a Log catchability residuals of commercial fleets

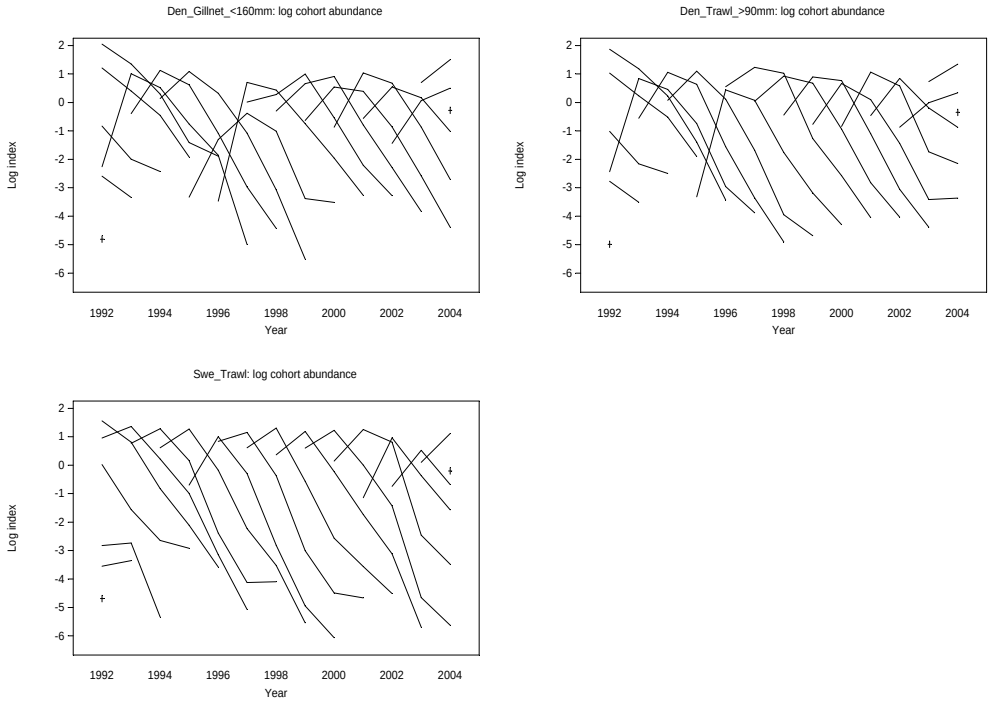

Den_Gillnet_<160mm: log cohort abundance
Den_Trawl_>90mm: log cohort abundance
Swe_Trawl: log cohort abundance
Log index
Year
2
1
0
-1
-2
-3
-4
-5
-6
1992
1994
1996
1998
2000
2002
2004

Figure 2.4.8b

Den_Gillnet_<160mm: Comparative scatterplots at age

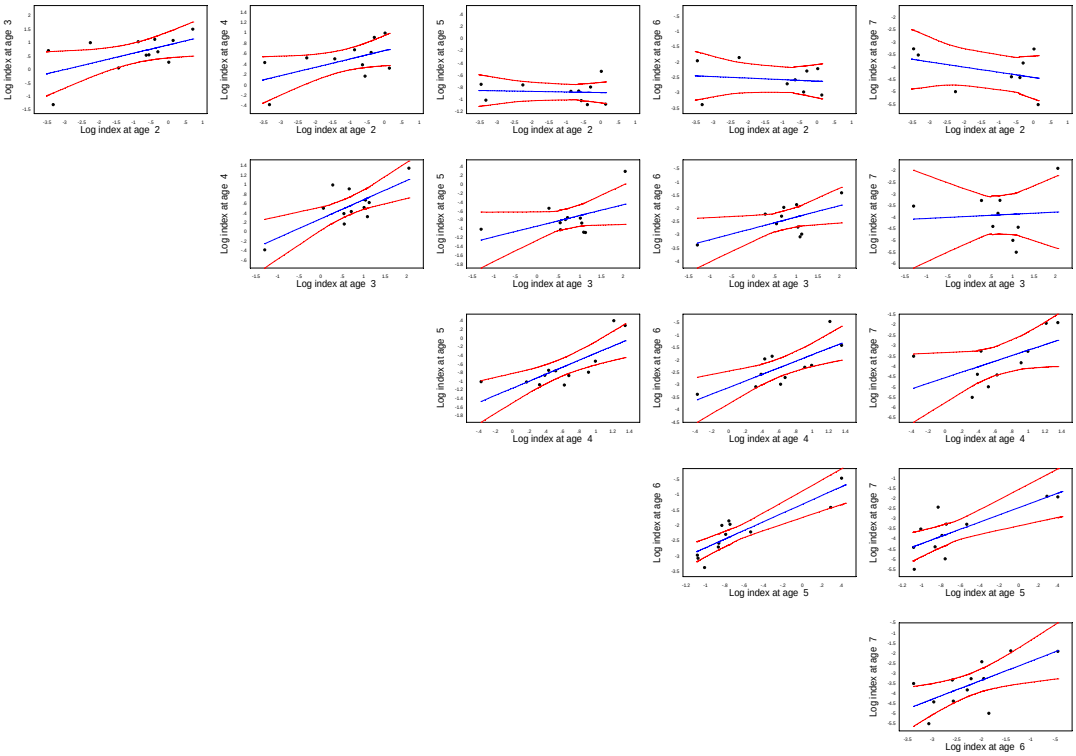


Figure 2.4.8c

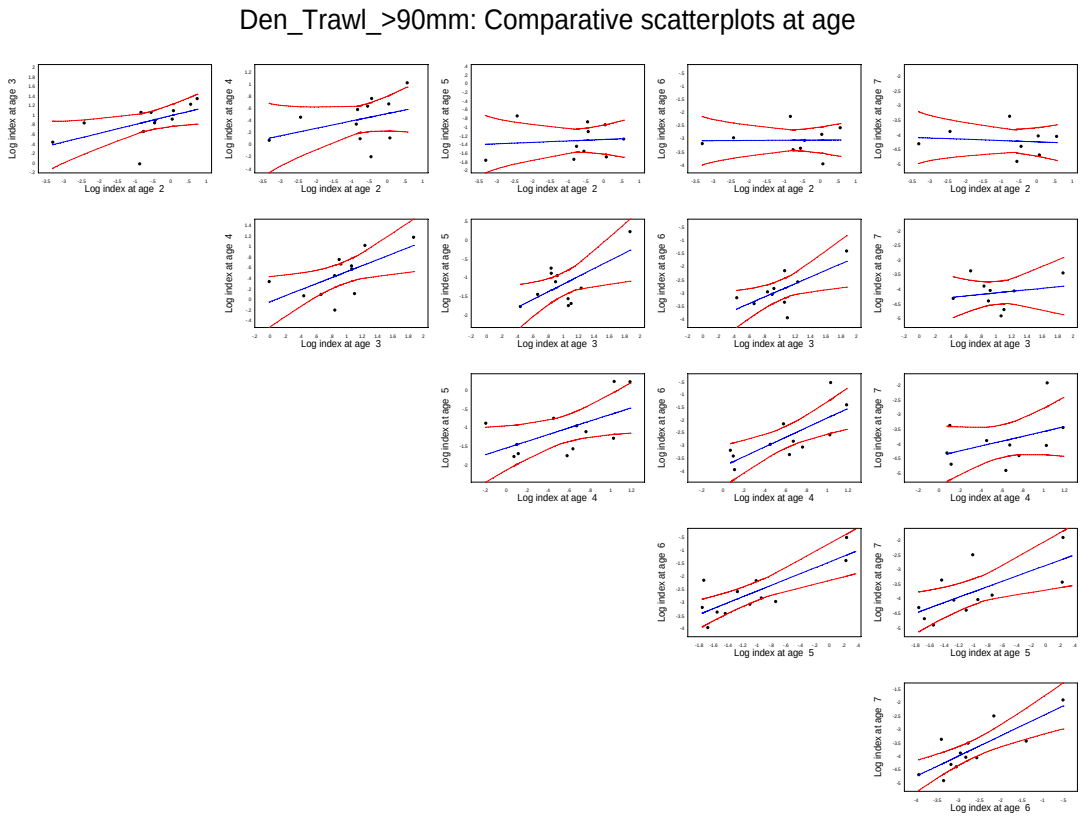


Figure 2.4.8d

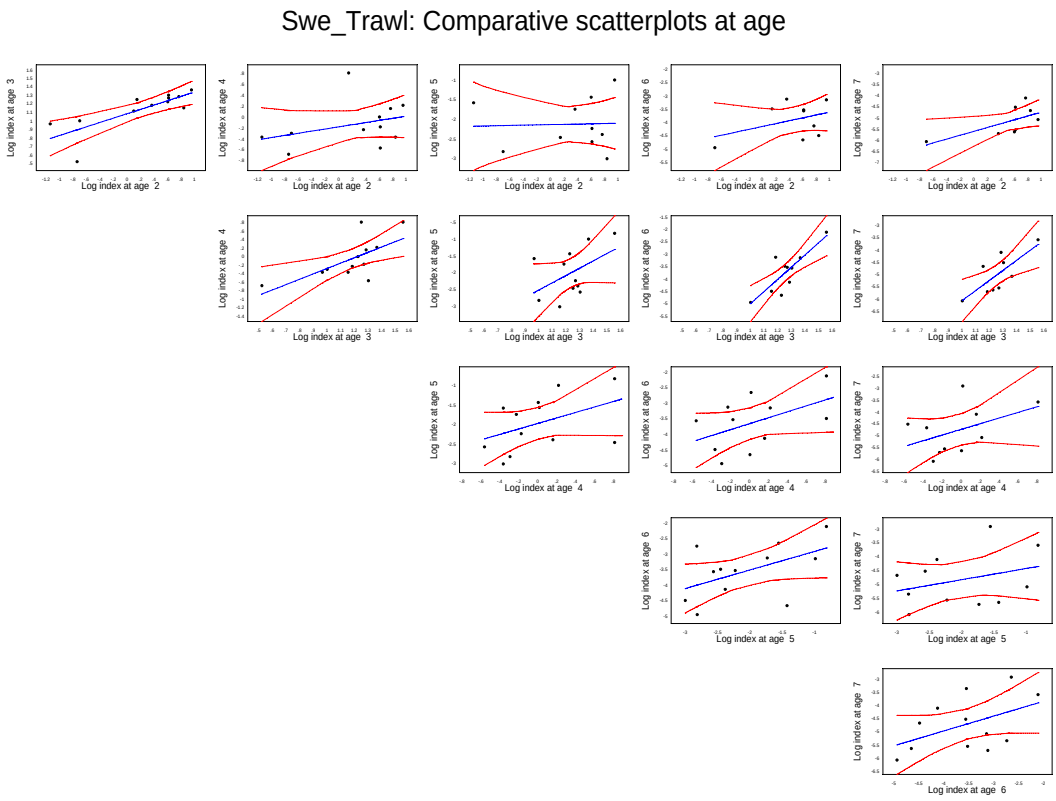


Figure 2.4.8e

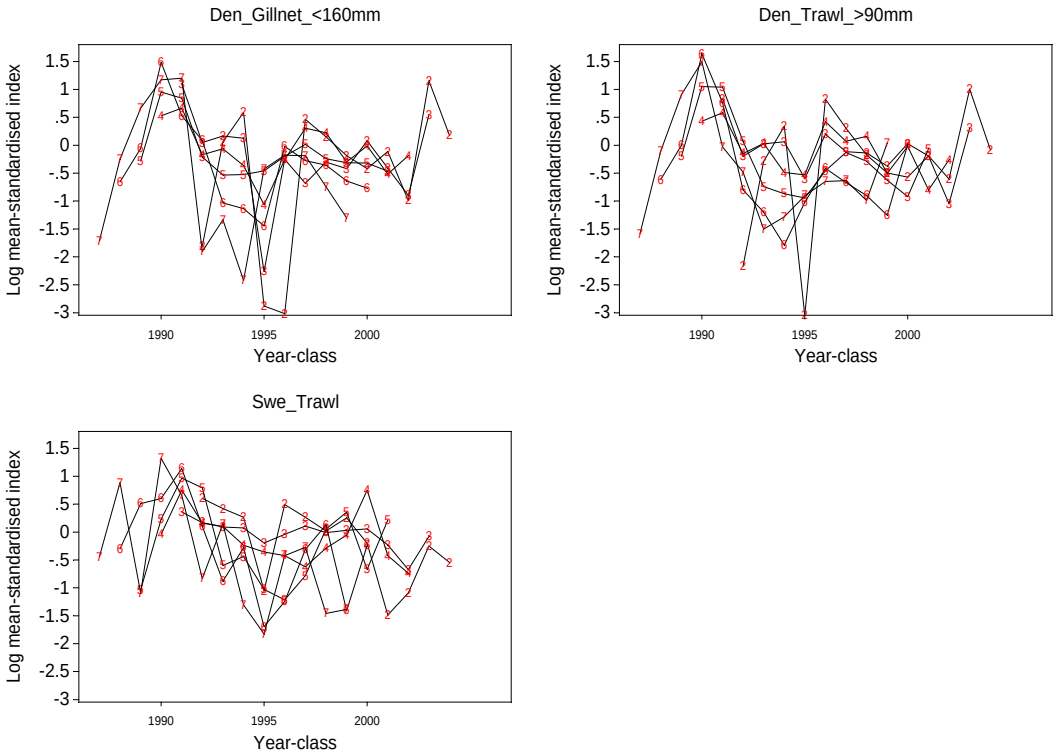
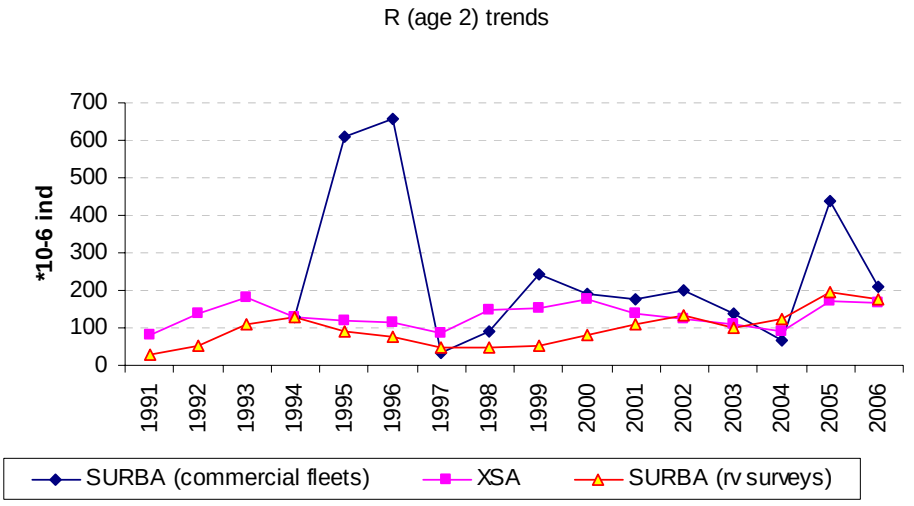
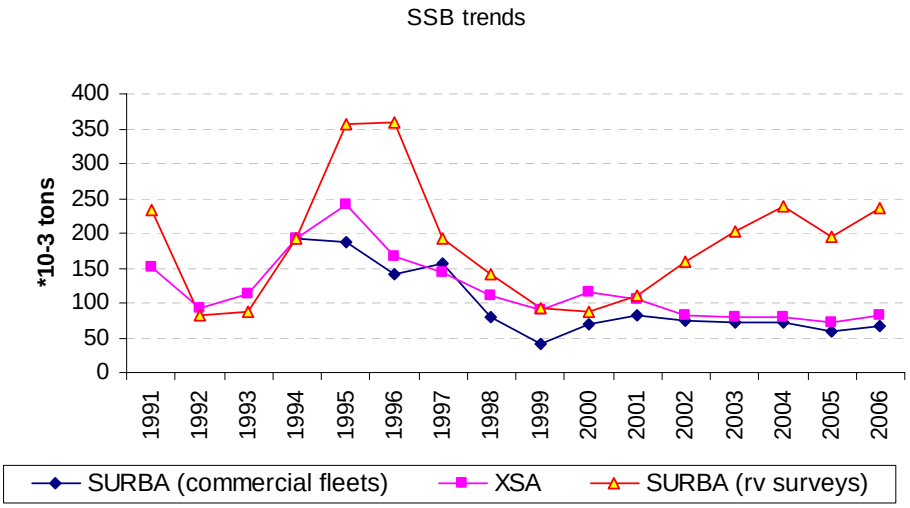

Den_Gillnet_<160mm
Den_Trawl_>90mm
Swe_Trawl
Log mean-standardised index
Year-class
1.5
1
.5
0
-.5
-1
-1.5
-2
-2.5
-3
1990
1995
2000

Figure 2.4.4f





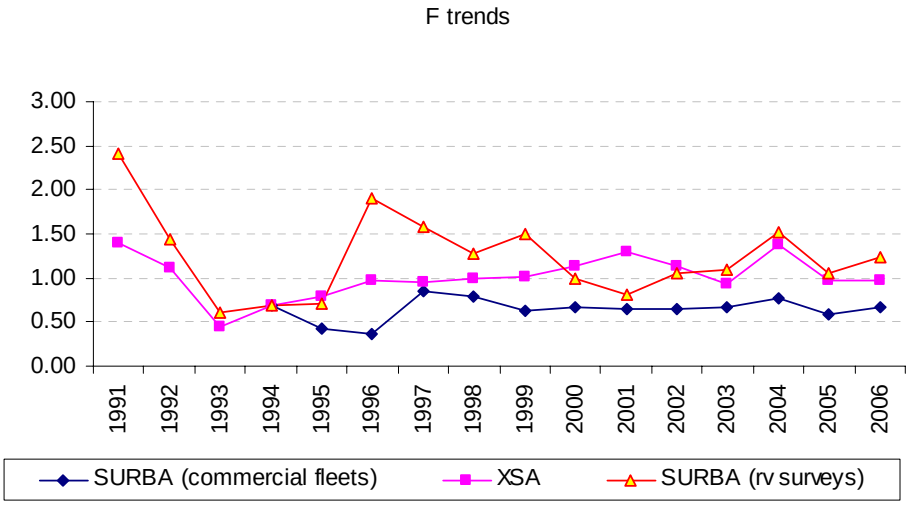


Figure 2.4.9 Cod in SD 25-32. Comparison of XSA and SURBA run results

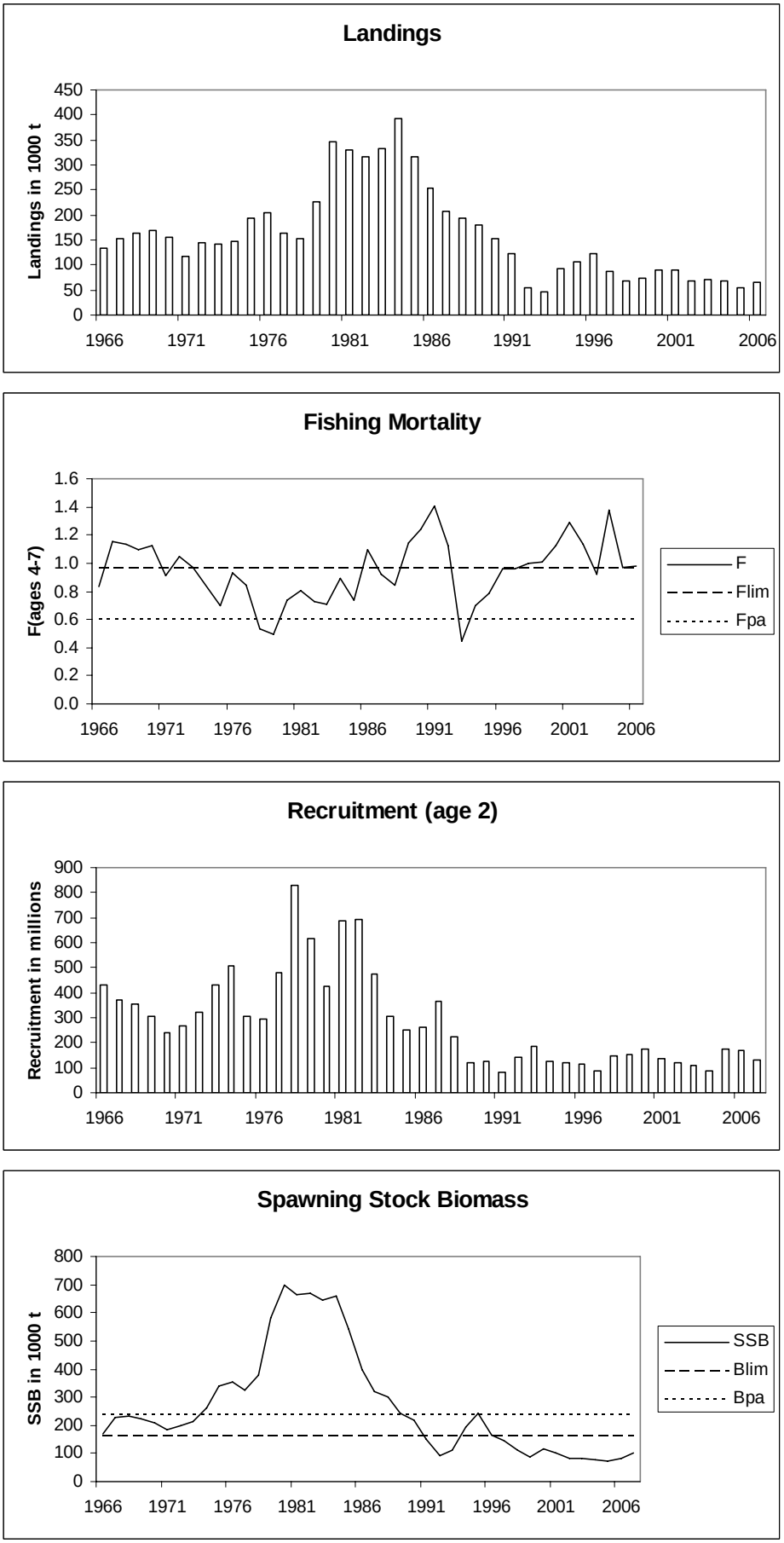


Figure 2.4.10a Cod in SD 25-32. Stock summary

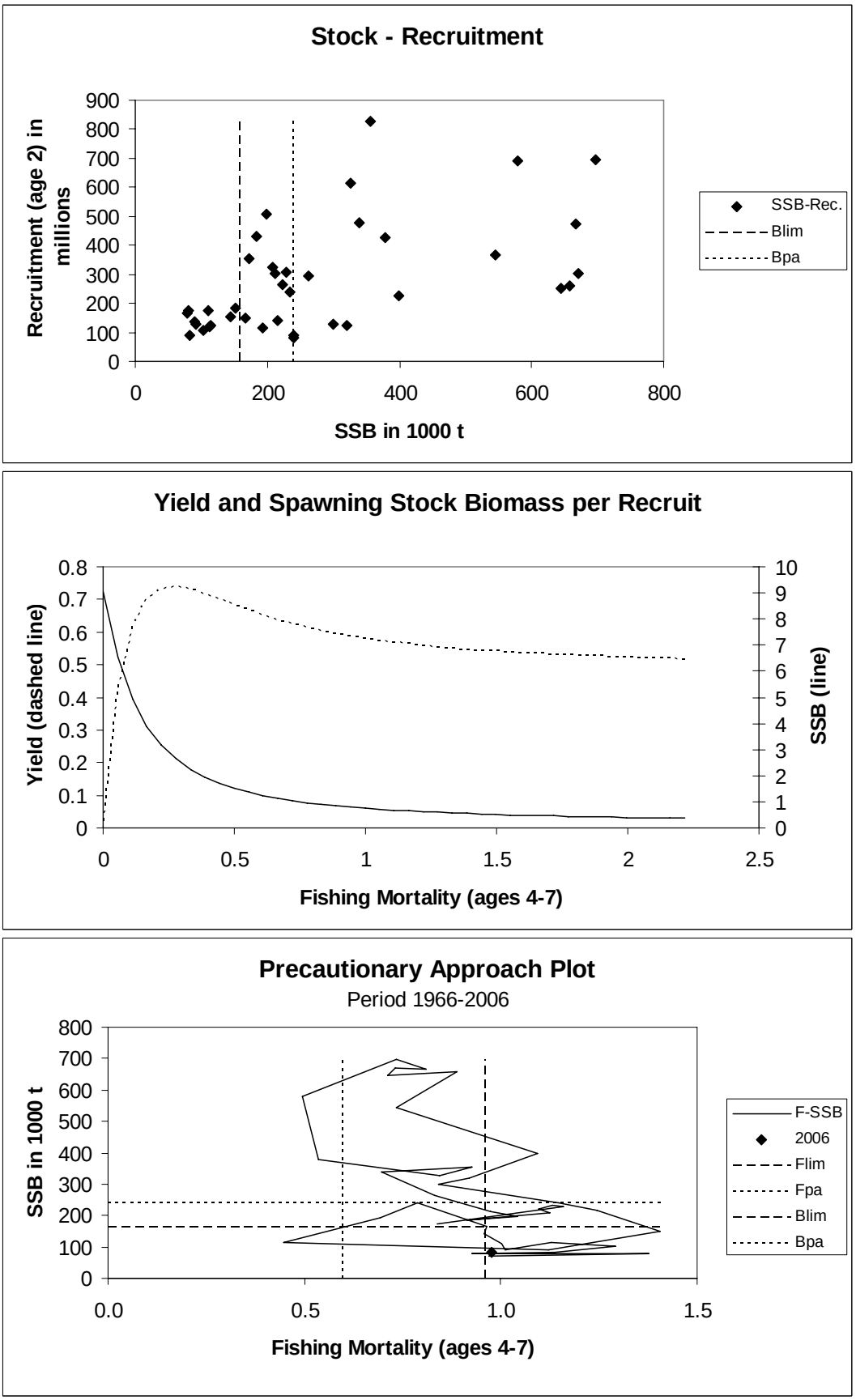


Figure 2.4.10b Cod in SD 25-32. Stock summary

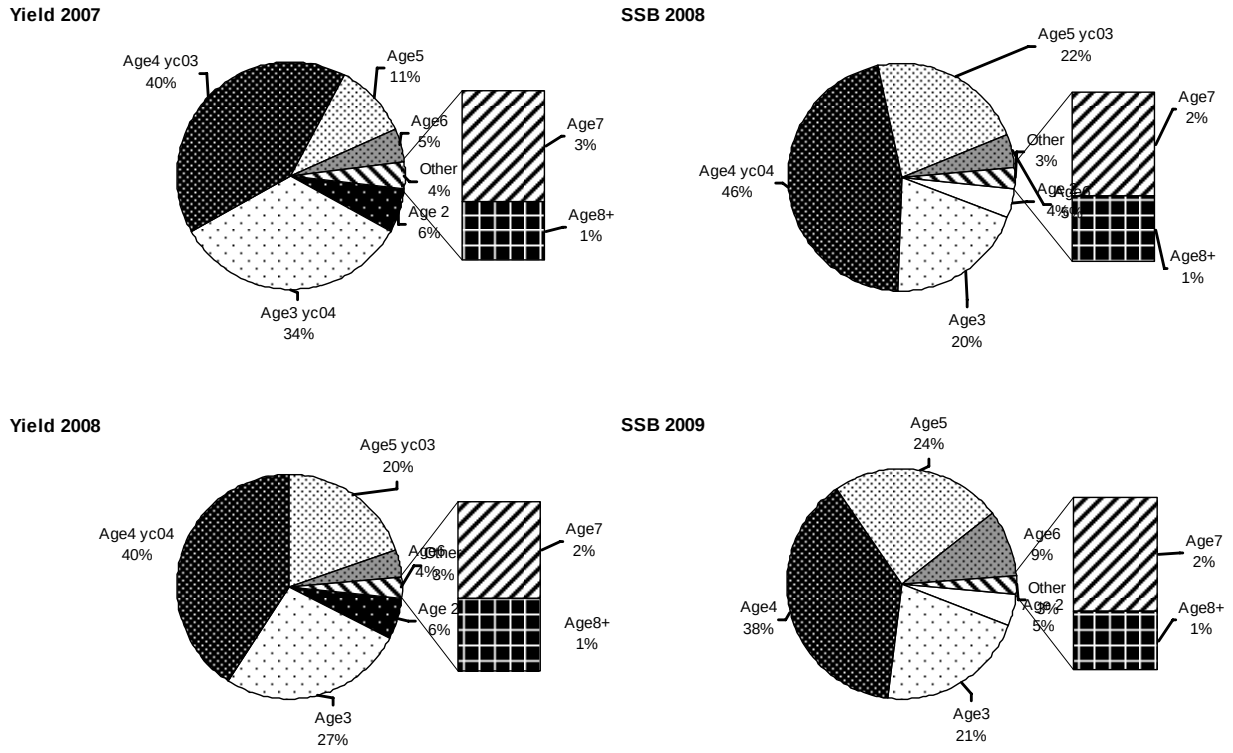
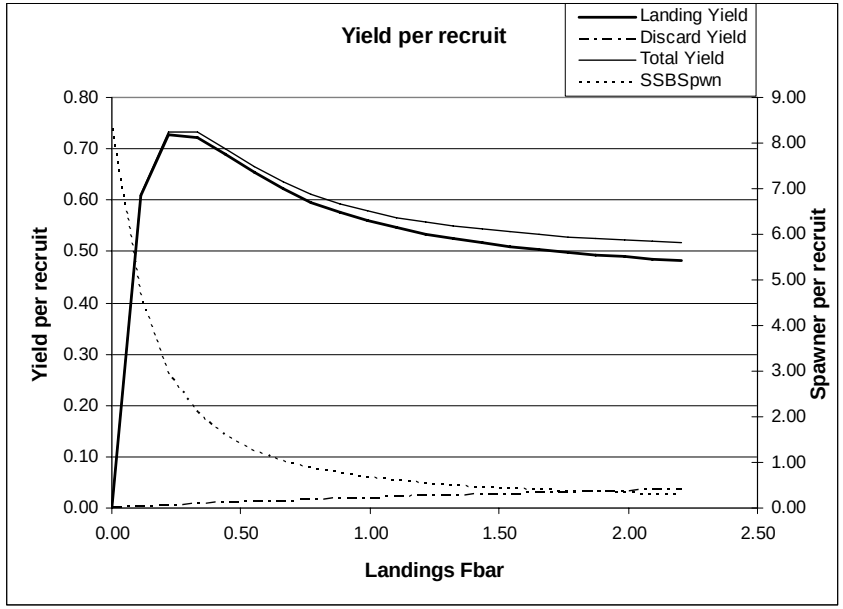
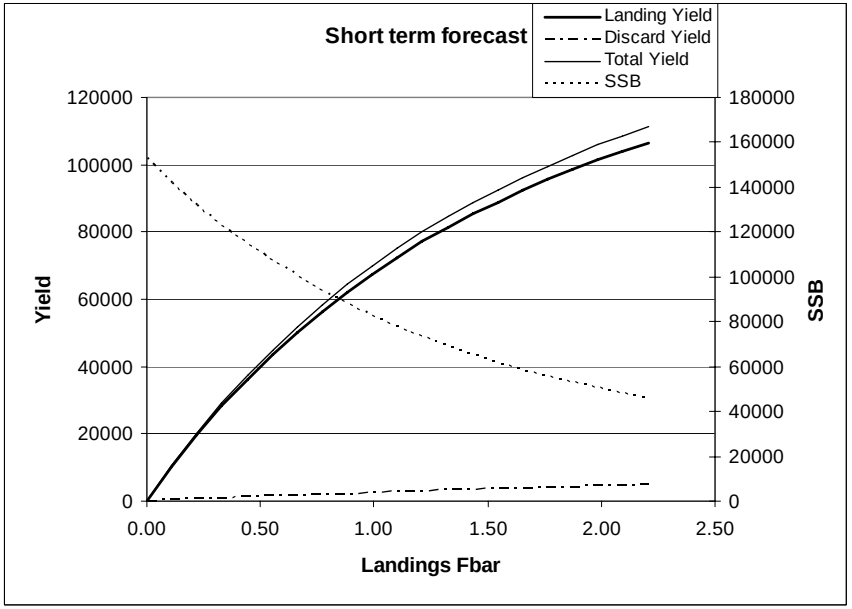


Figure2. 4.11. Cod in SD 25-32. Short-term forecast for 2007-2009. Yield and SBB at age 1-8+ for status quo fishing mortality.





MFYPR version 2a
Run: Cod_2532
Time and date: 19:36 26/04/2006

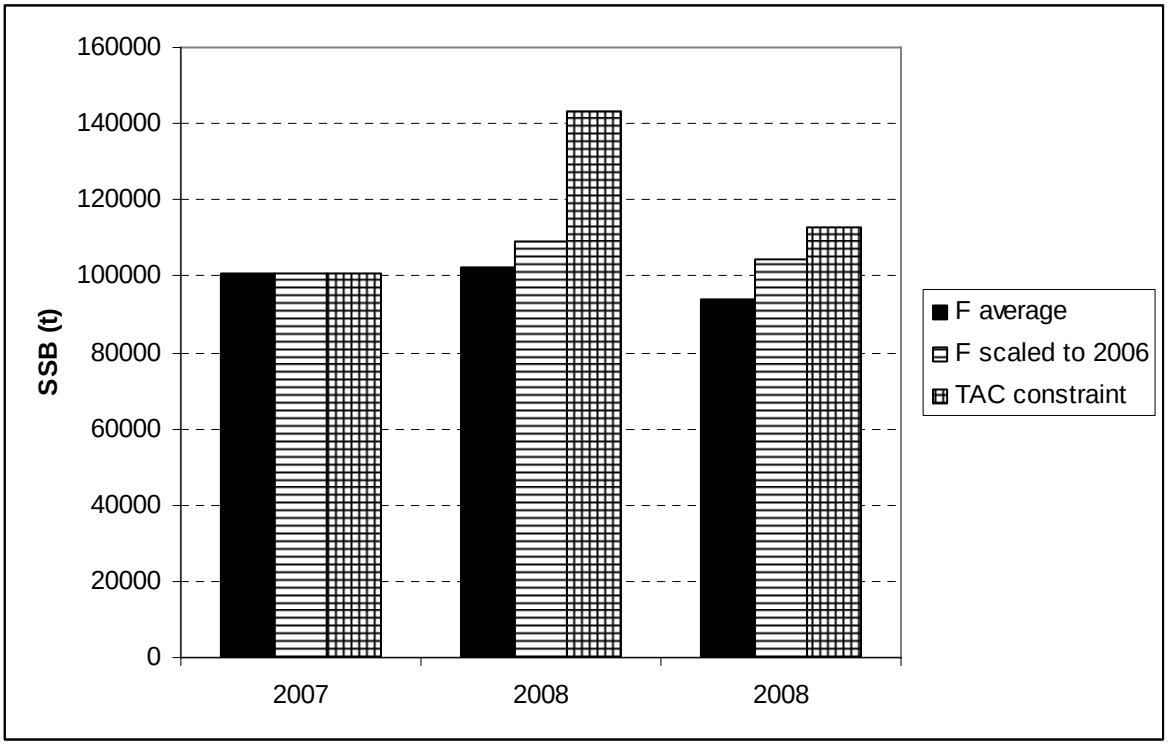
Reference point	F multiplier	Absolute F
Fleet1 Landings Fbar(4-7)	1.0000	1.1028
FMax	0.2376	0.2621
F0.1	0.1439	0.1587
F35%SPR	0.2031	0.2240

Weights in kilograms

MFDP version 1a
Run: Cod2532
Time and date: 17:44 26/04/2006
Fbar age range (Total) : 4-7
Fbar age range Fleet 1 : 4-7

Input units are thousands and kg - output in tonnes

Figure 2.4.12.



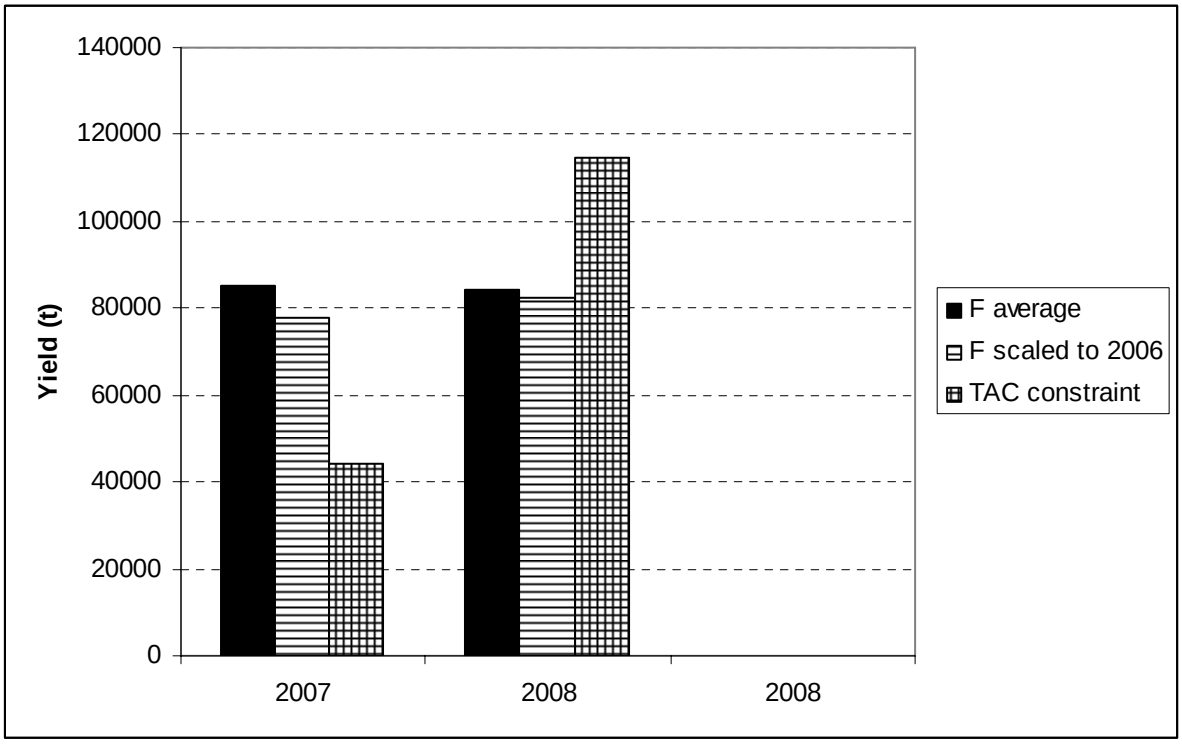


Figure 2.4.13. Cod in 25-32. Comparison between 3 different short term prediction runs: with and without scaling to the last years exploitation pattern and with TAC constraint in 2007 (44 305 tons).

3 Sole in Division IIIa (Kattegat and Skagerrak) (Observation list assessment)

3.1 The Fishery

Sole has economically been one of the most important species in recent years in the Danish Kattegat fisheries. The importance of sole is more limited in Skagerrak where it accounts for less than 5% of the total value of the Danish human consumption fisheries. For both Kattegat and Skagerrak the major part of the sole catches is taken in the mixed species trawl fishery using mesh sizes 70–105 mm and with gillnets using mesh sizes of 90–120 mm. Minimum legal landing size is 24.5 cm.

Analysis of private logbook data (Christensen, 2005) indicated strong seasonality in sole fishery with both gill net and trawl. The peak season for trawl is from October to January. In average more than 75% of the annual sole catches with trawl are caught in this 4 month season. However, September and February are important months for the sole fishery also, but the percentage of sole in the catches is significantly less indicating that there might be other target species also in these periods. The season for sole gill net fishery is from April to September. During the entire season about 80 % of the gill net catches are sole. Additional general details of the sole fishery can be found in the Stock Annex.

During the beginning of the 2000s, the fishery became increasingly limited by quota restrictions and weekly or semi-monthly catch rations, increasing the incentive for misreporting (ICES 2004; Hovgård 2005) and discarding. Based on information from the industry mis- or non-reporting and discarding is believed to have been about 50-100% in 2002 and 100-200% in both 2003 and 2004. In June 2005 a new regulation was put in force with total quotas and weekly rations not limiting the fishery, and therefore it is assumed that since June 2005 there is no incentive to mis- or nonreport the catches. The total misreporting for 2005 was due to those circumstances assumed to be approximately 20% for the entire year.

The stock assessment by WGBFAS in 2005, did for the first time include tuning fleets based on information from private logbooks as well as from official logbooks outside the sole fishing season, which consequently revised the perception of the stock in the most recent years. This new perspective indicates an increasing trend in SSB and decreasing F since the late 1990's accompanied by a TAC increase to 900 t since 2005.

Catch trends

The officially reported landings by area, gear and country for 2006 are given in Table 3.1. Denmark takes more than 90% of the total Kattegat-Skagerrak catch. Kattegat is traditionally the most important area accounting for 70–80% of the annual catches.

Historical catches including the working group corrections are given in Table 3.2 and Fig. 3.1. The fishery fluctuated between 200 and 500 t annually prior to the mid-1980s. Reported catches increased to a maximum of 1400 t in 1993 and decreased during the subsequent years to a level about 455 t in 2001. Including working group estimates of misreporting and discard ratios at 50% in 2002, 100% in both 2003 and 2004 and 20% in 2005, catches in recent years have fluctuated between 600 and 800 t and were 729 t in 2006.

The gillnet fishery traditionally takes place in late spring early summer, while the trawler fishery is conducted in autumn. Fig. 3.2 provides the Danish catches by month since 1998, and the two main periods of fishery is evident.

3.1.1 Unallocated landings

For the period 1991–1993 the official catch statistics are disputable with a significant amount of sole assumed landed without being properly recorded. For Kattegat where most of the sole catches in 1994–2000 were taken under an effort regime, the official statistics are assumed fairly accurate as there were no catch constraints.

Considerable misreporting by areas in 2000 and 2001 was corrected at the WGBFAS 2003 meeting (North Sea sole reported as caught in Div. IIIa).

In 2002 to June 2005 quotas were very restrictive and the Danish sole fishery was entirely closed late in the year in 2002-2004 (on Nov. 22, 2002, Nov. 2, 2003 and Dec. 20, 2004). Analyses of private logbooks (Christensen, 2005), survey data (Jørgensen, 2005) and observer data Hovgård (2005) indicated that there was considerable economic incentive to misreport landings in 2002-2004 as the entire two week ration in many cases could be taken in just a few hauls. However, it is not known to what extend the catches were discarded, landed as black landings (i.e. excluding both catch and effort data from the official statistics), or distributed to and landed by vessels not having caught their rations, i.e. the catch data would be correct but the corresponding effort would (most likely) be overestimated.

Based on information from the industry mis- or non-reporting and discarding (see section 3.1.3), is believed to be in the order of magnitude of 50-100% in 2002 and between 100 and 200% in 2003 and 2004. In 2005 misreporting is only assumed to have taken place until June when quotas were raised and therefore did not limit the fishery. The assumption is 20% misreporting in 2005.

3.1.2 Discards

Danish discard sampling at sea is carried out within EU programmes that began in 1995 in both Kattegat and Skagerrak. Results indicate that the amount of sole discarded was very limited in years when the fishery was not restricted by quotas (i.e., discard levels are believed to be only a few percent when measured relative to the sole landings).

However, in 2002-2004, discarding rates of sole (e. g., caught as by-catch in fisheries for other species) were probably higher due to the reduction in TAC, particularly in periods when the fishery was closed for the remaining of the year due to quota restrictions (Nov. 22, 2002, Nov. 2, 2003 and Dec. 20, 2004).

Discard data from the Danish discard programme were made available to the working group (Table 3.3). The available discard data are incomplete as discards from 1999 have not yet been raised to total discarded numbers and data from 2001 and 2004 are missing. Furthermore the age distributions of discards appear to be doubtful specifically in 2005. Due to the scattered sampling discard data are not included in the present assessment.

3.1.3 Effort and CPUE Data

In former assessments (until the WGBFAS 2005 assessment) the WG used overall CPUE averages from two trawl fisheries (using 70-90mm and 90-104mm mesh size respectively) to calibrate the XSA. However, both ACFM and STECF expressed doubts on the extent to which these CPUE indices were compromised due to lack of knowledge of fishers' targeting behavior and the effect of misreporting.

Similar to the WGBFAS 2005 assessment, the present assessment is calibrated with CPUE series based on 1) private logbook data from gill net and trawl fishery in the main sole seasons; 2) official logbook data outside the main sole season; and 3) scientific survey data (Havfisken 1st quarter).

The available time series of catch and effort data for the present assessment are as follows:

Official logbooks from trawlers, 12-20 m, 90-104 mm mesh, April-August
Official logbooks from small gilnetters, 9-12 m, 120-159 mm mesh, January-April
Private logbooks ,6 trawlers, October-January
Private logbooks, 3 gillnetters, April-oktober
Havfisken Survey (KASU) 4th quarter

Private logbook data

In order to establish consistent time series of CPUE data from the commercial fishery to be used for calibrating the XSA sole assessment, collaboration between the Danish Fishermen Organisation and DIFRES was initiated in 2004 to establish a database with data from private logbooks. Until now data from 6 trawlers and 3 gill netters covering the time period 1987 to 2006 have been included in the data base. For all trawlers, each logbook covers the entire fishery in one year and provides haul by haul information about the fishing location and catches measured by major commercial species. With regard to the gill netters, until now only catch and effort data have been encoded for the trips using sole gear (90mm).

Details about the status of the private logbook programme are given by Christensen (2006).

The compilation of the 2 private logbook cpue tuning fleets, namely gillnetters and trawlers, was made similar to last year (ICES CM 2006 / ACFM:24).

The overall CPUE trend over time for the two fleets is shown in Fig. 3.3. The gillnetters show a rather stable increase in CPUE since the beginning of about 2000, while the trawlers fluctuate more between years, but also increase CPUE's since 1999. For both series the 2006 catch rates are among the highest on record.

Fig. 3.6-7. presents data on the internal consistency within the two fleets. The log cohorte curves for both fleets indicate that a shift took place in the late 1990's after a period of low recruitment to conditions with higher recruitment. The cohorts do not show a uniform decline in abundance, and especially for the older ages are some noise. The fleets ability to track the cohorts (as shown on the lower part of the figures), varies considerably: for the gillnetters, being good for ages 3 to 5 and relative poor for the remaining ages (R2 < 0.4). For the trawlers cohorts are tracked well by all ages (2-6) (R^2 >0.4-5).

The CPUE indices from the two fleets are shown by age in Fig. 3.8.

Official logbook data

Based on analysis of data from the official logbooks outside the peak sole seasons (i.e. when the incentive to misreport is limited) two tuning fleets are identified and used in tuning of the XSA..

Both fleets, official logbooks from trawlers, covering April-August and official logbooks from small gillnetters, covering January-April, were compiled as last year (see Stock Annex).

Their aggregated CPUE catch rates differ to some extent, the gillnetters have a pronounced increase from 2003 to 2005 in the order of magnitude of three to four times. The high catch rates are kept from 2005 to 2006. For the trawlers there is a moderate increase from the period 1996-2003 to the period 2004-2006.

Figures 3.4 and 3.5 provide information on the internal consistency of the two official logbook cpue data. The log cohorte curves for both fleets indicate that a shift took place in the late 1990's after a period of low recruitment to conditions with higher recruitment and also with older fish in the catches. Age of full recruitment to gear seem to variate from age 2 to older

ages in recent period for gillnetters. The relative abundance of year classes within the official logbook data show consistency across years. Abundant year classes of particular age-groups generally appear as abundant in the following year (Fig.3.4-5). This is particularly true for the gillnet data and for younger age-groups (3 and 4) in the trawl data.

The CPUE indices from the two fleets are shown by age in Fig. 3.8.

Scientific survey data

Danish scientific survey targeting sole

Results from the Danish trawl survey targeting sole were made available (Jørgensen , 2007, WD # 2). The survey was initiated in 2004 thus data is available only for 3 years and still too short a time series to be included in the assessment. The survey comprises of a scientific part and a fishermens part. Fig. 3.11a gives an overview of the surveyed area and the distribution of the catch rates. The indices are stable throughout the three years (Fig. 3.11b) with catch rates of approx. 50 kg/hour for the fisherman survey and approx. 20 kg/hour for the scientific survey. The age dis-aggregated index is considered for use in the analytical assessment next year when a time series of 4 years is available.

RV Havfisken survey(KASU)

The RV Havfisken usually conducts 30-40 stations annually in the Kattegat and Belt Sea. The surveys started in October 1994, and since 1996 surveys are also conducted in March. Average catch rates for the Kattegat have been calculated. All soles captured by the survey are length-measured. The Havfisken survey is a general survey of juvenile demersal fish abundances in the region, and is not designed specifically to estimate sole abundance.

In the early years of the survey, only a small non-representative part of the sole catches were aged using otoliths. It is therefore not possible to produce annual age-length keys for the spring or fall surveys. Age information from all years has been combined by quarter to increase sample size. Age-specific abundance indices from the surveys were then derived from length measurements converted into ages indices using the combined quarter specific age-length key

The age-specific catch rates for the Kattegat (Subdivision 21) have been averaged across stations to produce annual abundance indices. Abundances in the Kattegat are higher in fall surveys than spring surveys, particularly among the younger age-groups (ICES 2005; MacKenzie et al. 2005).

In 2006 sole abundances was unchanged compared to 2005 (Fig. 3.3) All age-groups seem to follow the same trend between years (Fig. 3.10), making the survey performing very poor with regard to internal consistency (Fig. 3.9). Year-classes are poorly tracked. The year 2004 is outstanding as all ages had a dramatic increase in abundance. A distribution map of the CPUE in the surveyed area for all the years from 1994 and onwards shows the variability in the area (Fig. 3.11b). The recent three years shows a pattern of widely distributed good cpue's in the Kattegat.

The age-specific index is used as tuning fleet and is the only fishery independent stock index.

3.2 Biological composition of the catch

3.2.1 Age composition

The age structure of the Danish catch was assumed to apply to the total international catch (Table 3.6).

The age composition of the catch is mainly composed of 3-5-year-olds since the beginning of the 1990's(Fig. 3.12). Recruits (i. e. age 2) enter the fishery in the 4th quarter. However in 2003, when the fishery was closed in November and December, the catch of age 2 was the lowest in the time period.

The relative abundance of year classes within the catch data show good consistency across years. Abundant year classes of particular age-groups generally appear as abundant in the following year (Figure 3.13). The noise for the older age groups in the log cohorts is presumably due to ageing problems.

A separable VPA was conducted in order to explore the catch matrix. The residuals from the analysis did not show any particular trends indicating consistency and that no shift in catchability has taken place (Fig. 3.14).

3.2.2 Quality of catch and biological data

Denmark provided statistics on catch age sampling for the Kattegat and Skagerrak (Table 3.4). Samples were collected during all four quarters in the area (Kattegat) where most of the sole are captured. The number of samples and fish aged in 2006 is similar to the previous year.

3.3 Mean weight-at-age

Data for mean weight-at-age were derived by using the same sample allocation as used in the computation of catch-at-age. The mean weight-at-age in the catch is shown in Table 3.7 and Fig. 3.15. Weight-at-age for age groups 2-6 were relatively stable in recent years (Fig. 3.15, upper panel), while the older age groups exhibits high variability between years as well between ages. The difficulties in ageing is considered to be the main contributor to this variability.

In the sole assessment mean weight-at-age of the stock is assumed to be equal to the mean weight-at-age in the catch.

3.4 Maturity at age

The present assessment uses the same maturity ogive as in assessments since 1996 (knife-edge maturity-at-age 3). This maturity ogive is similar to that used for the North Sea sole stock (ICES CM 2006/ACFM: 35).

3.5 Natural mortality

The natural mortality was assumed to be 0.1 per year for all ages as in previous assessments.

3.6 Catch-at-age analysis

3.6.1 Tuning fleets

The tuning fleets are described with effort and CPUE data in section 3.1.3.

3.6.2 Examination of input data and exploratory runs

Weight at age in the catch

Weight at age in the catch for especially the older age groups (ages 8 and older) is very noisy, i.e. show high variability between years and also between ages. The variability might reflect biological dynamics, but ageing problems cannot be excluded as a main contributor to the noisy pattern. Therefore, effects of smoothing of the weight at age data were explored; scenarios with both three years running averages as well as using 8+ mean values for 8+ ages

were conducted. Neither of the approaches changed the SSB estimates to any significant degree and it was therefore decided to keep the observed catch mean weight at age in the final assessment runs.

Stock weight at age

Stock weight at age has previously been assumed equal to catch weight at age, due to missing information of stock weight. Since 2004 a sole survey/exploratory fishery has been conducted by the Danish Institute for Fisheries Research and Danish fishermen. From the survey part of the fishery data has been made available to generate stock weight at age. An approach was used where survey weights at ages were taken face value from the three years of survey (2004-2006), whereas an average of the three years was used constantly for the remaining period (1984-2003). Apart from age 2, for which weight was considerably lower than in the catch, most weights from the survey was higher than in the catch in 2006. This resulted in a significant change in perception of development of SSB from 2005 (increasing), but also in the 2006 estimate (from about 4300 t to 5000 t). Given this marked change, it was decided as too premature to establish as stock weight at age based on this short period of survey.

Examination of the official logbook gillnetter tuning series

The official logbook gillnetter tuning series show a pronounced increase in cpue since 2004 (almost five fold). This trend is rather unique compared to the remaining tunning indices, although they mainly support an increase but at a lesser order of magnitude. The contribution of the index to F and biomass estimation is relatively high, and as this gillnetter series shows the most positive signal in recent years, it also contributes to the increasing SSB in recent years. The internal consistency was therefore carefully examined for the official logbook gillnetter tuning series. Regressions of years class strength one year to the next was good for ages up to 7 (R^2>0.6-7), while for ages 8 and 9 R^2 was about 0.3. In the XSA tuning the official logbook gillnetter tuning series was performing well as measured from the regression statistics, performing with high R^2 (0.7-0.9) for all age groups in contradiction to the remaining indices. Also the retrospective pattern behaves poorer without the gillnetters. However, the dramatic increase in CPUE since 2004 might be an effect of a change in fishing pattern due to a change in regulation implemented in 2005 resulting in less restriction in catches in the peak season. Presently is selected a time window from January to April, considered outside the main season, to calculate CPUE for the fleet. However, part of this season might since 2005 be part of the main season and explain the pronounced increase in CPUE.

Therefore it was decided to leave out the tuning series in the final assessment until a further examination of the selected time window for the gillnet fleet is conducted.

Age range in the assessment

Due to insignificant catches of older fish (e.g. ages 9-11+) and also to the uncertainty in age reading of especially older ages, ACFM in its 2006 review suggested to omit the older age groups from the assessment. A decision was made to reduce the plus group from 11+ to 9+ as those age groups in particular are caught in small numbers (Table 3.6 and Fig. 3.12-13). The reduction in age groups leads to in an improved retrospective behaviour, now being less biased in the underestimation of F and overestimation of SSB for especially the recent years. The use of a shorter age range has the effect that SSB in the terminal year is reduced by about 5% from 4300 t to 4100 t, while Fbar is unchanged (Fig 3.20).

With this insignificant change in perception of stock and the improved retrospective behaviour, it was decided to adopt the reduced age matrix for the assessment.

Single fleet runs

In order to examine the effect of the single indices on the terminal estimates, XSA runs were conducted with the single fleets applying low shrinkage (1.5).

Figure 3.16 provide the log q residuals from the single runs and Fig. 3.17 gives the SSB, F and recruitment estimates per single run. Residuals for Havfisken survey have marked shifts between years but no overall trend. Also the fleet official logbooks from trawlers do have a marked reduction in catchability in recent two years, but do otherwise not reveal any trends. Most fleets, however, behaves relatively well with residuals being within +/- 1.5.

Calibrating with gillnet data from the official logbooks (OL_Gillnet) gave significant higher estimates of SSB (about 3 times) than is estimated for the remaining series. An examination of the XSA diagnostics showed that the estimation of higher stock numbers from calibration with OL_Gillnet was evident for all ages. OL_gillnet fleet is mainly an estimator of older age groups in the XSA but affect the final estimation of SSB. The remaining tuning series do estimate the SSB consistently at about 4000 t, while estimates of fishing mortality ranges from 0.15 to 0.3 (Fig. 3.17).

Based on the single fleet runs and the analyses of the internal consistency, it was decided to reject the official logbook gillnetter series from the final XSA run.

Final XSA setting

Based on evaluation of the output from the single fleet exploratory XSA runs and the analyses of the indices, i.e. internal consistency, it was decided to include the following tuning fleets in the final XSA run:

Official logbooks from trawlers, 12-20 m, 90-104 mm mesh, April-August
Private logbooks ,6 trawlers, October-January Private logbooks, 3 gillnetters, April-October
Havfisken Survey (KASU) 4th quarter

The XSA settings is unchanged from last year and provided in Table 3.8 as well as in the text table in Section 3.12.

XSA diagnostics is provided in Table 3.8 and log catchability residuals are further shown in Fig.3.18. Fleets behave well and no evident trend appears. The fleet weights applied for the F and survivor estimation and the resulting terminal survivor estimates by age is given in Fig. 3.19. Younger ages 2 and 3 are mainly estimated by Havfisken survey and the private trawler logbooks, while older ages are estimated by private logbook gillnetters and official trawler logbooks. F shrinkage only estimates about 5% of age 2 fish and insignificant proportions of older fish.

Retrospective analyses were conducted also examining the effect of F shrinkage (1.5 vs 0.5) (Fig. 3.22). Using a low F shrinkage as have been applied for this assessment gave less biased estimates in recent years in contrast to previous assessments with an overestimation of SSB and underestimation of F.

3.7 Recruitment estimates

Recruitment of the 2004 year-class (age 2) was estimated by XSA to be 3.9 million soles. This estimate is close to the geometric mean (3.5 million) recruitment for the period 1994-2004 when recruitment was relatively low and stable (Table 3.11).

3.8 Historical stock trends

Estimated fishing mortalities and stock numbers at age are provided in Tables 3.9 and 3.10, and the stock summary is given in Table 3.11. and Fig. 3.21. SSB in 2006 was estimated at 3947 t and the corresponding Fbar is 0.22 .

The spawning stock biomass increased from about 900 t in 1984 to approx. 5,000 t in 1992–1994. From 1994 to 1998 the SSB decreased to 2400 t. There has been an increase in SSB since 2001 to about 4000 t in recent years with a slight decrease in 2006. (Figures 3.21 and Table 3.11). Fishing mortality is near a record low in 2006 at 0.22.

3.9 Short-term forecast and management options

The input to the standard short term forecast is given in Table 3.13. Weight-at-age estimates were applied as averages over the recent three years 2004–2006. Natural mortality was assumed to be constant at 0.1 as was also used in the catch-at-age analysis. The exploitation pattern is assumed an average of the age-specific fishing mortality for recent three years 2004–2006 rescaled to the last year due to the declining trend in F in the period.

Age 2 (recruits) abundance in 2007–2009 is assumed constant as the geometric mean for 1994–2004 (3.54 million). This period for averaging was chosen because it represents a period during which recruitment was relatively stable and low compared to earlier years.

No survey data were attempted for estimating recruitment at age 2 as only low correlation were found between the estimated series of recruits from XSA and the survey abundances.

Analysis of stock – recruitment relationship for sole in IIIa indicated that this it is too weak to be used for recruitment predictions ($R = 8.5; Se^{-0.0005S}$; $R^2 = 22\%$, $P = 0.02$).

The forecast predicts that a fishing mortality at Fsq ($F_{4–8} = 0.22$) will lead to yields of 742 t in 2007 and 728 t in 2008 (Table 3.14). At this level of exploitation, spawning stock biomass is estimated to be 4059 t in 2008 and 4000 t in 2009, considerably higher than the B_{pa} (1060 t). Catch and stock composition in 2008 and 2009, respectively, is estimated to be comprised of mainly ages 3-6 as indicated in Fig. 3.16 under the assumed average recruitment.

A yield-per-recruit analysis was made with long term averages (15 years) with the exploitation pattern rescaled to 2006 (Table 3.13). The results are presented in Table 3.15 and Fig. 3.18. The yield-per-recruit curve (Figure 3.18) indicates that maximal yield per recruit is poorly estimated at $F_{4–8}$ about 0.55 and that $F_{0.1}$ is estimated to 0.18.

3.10 Reference points

Reference points as suggested by ICES in 1999:

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is 770 t	$\mathbf{B}_{pa}$ be set at 1060 t
$\mathbf{F}_{lim}$ is 0.47	$\mathbf{F}_{pa}$ be set at 0.30

The reference points estimates are uncertain. Additional details are found in the stock annex.

3.11 Quality of assessment

The major weakness of the present assessment is that

- the amount of misreporting for the period 2002-2005 is uncertain
- the Danish discard data are too scattered to be applied in the assessment.

- there is still no CPUE time series from a scientific survey specifically targeting sole to be used for calibrating F as the time series of the survey implemented by DIFRES in 2004 is too short. Havfisken survey is not directed towards sole.
- the stock-recruitment relationship continues to be uncertain.
- Ageing have been and continues to be difficult for sole. According to age readers, fish determined older than 8 years are subject to high uncertainty in the estimates of age. Examination of the ALK also supports this view. The variable weight at age for the catch might be due to the uncertain estimation of ages. The reduction in age groups used the present analytical assessment is in line with this.
- Maturity at age have not been available for this stock. Maturity is difficult to assess for this species and the problem is similar for the neighbouring sole stocks in the North Sea and the Channel. However, work is ongoing at the Danish Institute to solve the issue since 2004, which hopefully might contribute to a more accurate maturity at age. The assumption on a constant maturity at age for the stock should be considered in the case of any deviation from that with respect to calculation of SSB reference points .

The information obtained from the logbook time series was supported by the scientific survey and the monitoring fishery implemented by DIFRES in November and December 2004 and 2005.

3.12 Comparison with previous assessment

The comparison between main input parameters for assessment and the results of the XSA and predictions from 2006 and 2007 are presented in the text table below. The main changes in settings of this years analytical assessment is a reduction in the number of ages used (from 2-11+ to 2-9+) and the rejection of a tuning fleet (OL_gillnetters) in the calibration.

Comparison of the final assessments since 2005:

Category	Parameter	Assessment 2005	Assessment 2006	Assessment 2007	Diff. in recent assess (+/-)%
XSA Input	Age range	2-11+	2-11+	2-9+	yes
	Q dep. on stock	All ages	All ages	All ages	No
	Fbar	4-8	4-8	4-8	
	Q indep.of age	>=7	>=7	>=7	No
	F shrinkage	Shrinkage =1.5 5 oldest ages Final 5 years	Shrinkage =1.5 5 oldest ages Final 5 years	Shrinkage =1.5 5 oldest ages Final 5 years	No
	Tuning data	8 commercial fleets 1996-04 ages 3-10	Combined and season selected to fleets below: OL_G_small Gill net in K Years: 1998-2005 Ages: 3-10 Havfisken Q4 Years: 1998-2005 Ages: 2-6 OL_T_comb Trawlers in K Years: 1994-2005 Age: 3-10 PL_T_comb 6 trawlers in K Years: 1987-2005 Ages: 2-6 PL_G_comb 3 gillnet in K Years: 1994-2005 Ages: 2-10	excluded Havfisken Q4 Years: 1998-2006 Ages: 2-6 OL_T_comb Trawlers in K Years: 1994-2006 Age: 3-10 PL_T_comb 6 trawlers in K Years: 1987-2006 Ages: 2-6 PL_G_comb 3 gillnet in K Years: 1994-2006 Ages: 2-10	
XSA results	SSB 2005 F 4-8 2005 Rec age 2 2005		4620 0.180 4310	4289 0.250 3334	-7% +28% -30%
Prediction results	SSB 2007 sq(F) Yield 2007		4864 750	4848 742	-0.3% -1.1%

3.13 Management considerations

Management of the sole fishery should take into account that in particular the trawl fishery is a mixed fishery with cod by catch ratios about 10-15% of total catches.

Age at maturity is not determined for the sole in Division IIIa. It is assumed that maturity is constant over time and a knife edge maturity ogive is applied with age group 3 being fully mature. Therefore SSB for the stock is artificial and future application of an observed maturity ogive might therefore change the perception of the stock history and stock-recruitment relationship with a potential impact on estimation of biomass reference points.

3.14 Communication to ACFM review group

In its 2006 review, the ACFM review group, RGBFAS, commented on a number of issues for the sole in IIIa stock. The WG has addressed the issues as follows:

- **"More information on the sampling program should be presented, including the number of fish for measured for lengths and ages.":** The sampling from the fishery has always been presented in report and will be so in the future (see Table 3.4 this report).
- **"Should re-think the age for the plus group. The selectivity and weights at older ages are quite variable".** The matter have been examined in section 3.6.2, and the WG concludes to reduce the age for the plus group.
- **"Should clarify in the text what is the difference in the age-compositions used for the official and private logbooks".** Figure 3.3b provides the relative age distributions from the two categories of commercial fleets. The age compositions are quite equal.

Table 3.1. Sole IIIa. Landings of sole in 2006 by area, nation, quarter and gear.

Skagerrak	Quarter					Gear			Total
Nation	1	2	3	4	Unkn qrt	Trawl	Gillnet	other	
DK	35	38	12	29		72	42		114
Sweden	3	1	0	2				7	7
Germany	0	32	7	4				43	43
Norway					9			9	9
Netherlands					4			4	4
Total	37	70	20	35	13	72	42	63	177

Kattegat	Quarter					Gear			Total
Nation	1	2	3	4	Unkn qrt	Trawl	Gillnet	other	
DK	132	101	93	195		359	162		521
Sweden	10	7	6	7		17	14		31
Total	142	108	100	202	0	377	176	0	552

Table 3.2 Sole in Division IIIa. Catches (tons) in the Kattegat and Skagerrak 1952–2005. Official statistics and Working Group corrections. For Sweden there is no information 1962–1974.

Year	Denmark		Sweden	Germany	Belgium	Netherlands	WG	Total
	Kattegat	Skagerrak	Skag+Kat	Kat+Skag	Skagerrak	Skagerrak	Corrections	
1952	156		51	59				266
1953	159		48	42				249
1954	177		43	34				254
1955	152		36	35				223
1956	168		30	57				255
1957	265		29	53				347
1958	226		35	56				317
1959	222		30	44				296
1960	294		24	83				401
1961	339		30	61				430
1962	356			58				414
1963	338			27				365
1964	376			45				421
1965	324			50				374
1966	312			20				332
1967	429			26				455
1968	290			16				306
1969	261			7				268
1970	158	25						183
1971	242	32		9				283
1972	327	31		12				370
1973	260	52		13				325
1974	388	39		9				436
1975	381	55	16	16		9	-9	468
1976	367	34	11	21	2	155	-155	435
1977	400	91	13	8	1	276	-276	513
1978	336	141	9	9		141	-141	495
1979	301	57	8	6	1	84	-84	373
1980	228	73	9	12	2	5	-5	324
1981	199	59	7	16	1			282
1982	147	52	4	8	1	1	-1	212
1983	180	70	11	15		31	-31	276
1984	235	76	13	13		54	-54	337
1985	275	102	19	1	+	132	-132	397
1986	456	158	26	1	2	109	-109	643
1987	564	137	19		2	70	-70	722
1988	540	138	24		4			706
1989	578	217	21	7	1			824
1990	464	128	29	-	2		427	1050
1991	746	216	38	+			11	1011[1]
1992	856	372	54				12	1294[1]
1993	1016	355	68	9			-9	1439[1]
1994	890	296	12	4			-4	1198
1995	850	382	65	6			-6	1297
1996	784	203	57	612			-597	1059
1997	560	200	52	2				814
1998	367	145	90	3				605
1999	431	158	45	3				637
2000	399	320	34	11			-132[2]	633[2]
2001	249	286	25				-103[2]	455[2]
2002	360	177	15	11			281[3]	844
2003	195	77	11	17			301[3]	602
2004	249	109	16	18			392[3]	784
2005	531	132	30	34	Norway		145[3]	872
2006	521	114	38	43	9	4		729

[1]Considerable non-reporting assumed for the period 1991–1993. [2]Catches from Skagerrak were reduced by these amounts because of misreporting from the North Sea. The subtracted amount has been added to the North Sea sole catches. Total landings for these years in IIIA has been reduced by the amount of misreporting. [3]Assuming misreporting rates at 50, 100, 100 and 20% in 2002-2005, respectively.

Table 3.3 Sole in IIIa. Discard from active gear as obtained from observers.

Number (thousands)									
	Year								
Age	1999	2000	2001	2002	2003	2004	2005	2006	Total
1		148							148
2		293		44	254				591
3		1114			64		53		1231
4		56		43	71				170
5				18	6				24
6					6				6
7					1				1
8					1				1
9									
10					1				1
Total		1611		105	404		53		2173

Mean weight (gram)									
	Year								
Age	1999	2000	2001	2002	2003	2004	2005	2006	
1		54							
2	82	126		98	96				
3	88	107			110				
4		82		97	146				
5	116			109					
6	124				98				
7					158				
8	183				123				
9									
10					158				

Table 3.4 Sole in Division IIIa. Number of sole samples and individual measured and aged by Denmark in 2006 in Kattegat and Skagerrak.

	Kattegat			Skagerrak		
Quarter	**Samples**	**Measured**	**Aged**	**Samples**	**Measured**	**Aged**
1	2	373	372			
2	1	163	163			
3	1	227	221			
4	2	274	272			
Total	6	1037	1028	0	0	0

Table 3.5. Sole IIIa. Tuning fleets (OL Gillnetter Small rejected in final assessment).

Havfisken KASU

1999	2006				
1	1	0.75	0.92		
2	6				
1	1.189	0.784	0.540	0.225	0.108
1	0.760	0.554	0.539	0.203	0.112
1	0.574	0.263	0.168	0.119	0.144
1	0.833	0.497	0.295	0.168	0.099
1	1.249	1.012	0.597	0.302	0.153
1	3.360	2.209	1.247	0.750	0.347
1	1.376	1.139	0.627	0.366	0.181
1	1.636	1.308	0.829	0.548	0.144

OL Gillnetter Small

1998	2006							
1	1	0	0.33					
3	10							
220	45	199	386	174	246	233	131	35
236	222	87	205	164	128	130	72	45
98	128	339	34	62	83	47	50	56
201	116	312	397	75	65	38	41	53
108	31	43	58	218	20	46	16	28
55	33	50	62	53	69	12	10	8
62	154	231	176	78	56	41	15	8
81	308	719	543	352	92	65	53	4
83	194	763	672	513	191	76	16	34

Official logbooks TR All combined

1994	2006							
1	1	0.25	0.66					
3	10							
3606	11209	14945	7858	3763	914	750	218	248
3602	6392	20029	15745	5873	2973	828	531	307
4407	7581	4369	6931	4501	2428	1210	761	147
3499	1232	3443	3552	4573	2422	1386	616	412
4189	2465	3649	4915	3154	3157	3401	2172	543
5169	14718	2639	5083	3416	2729	1875	1524	860
6987	10623	19562	2079	3310	3955	2961	3126	2717
6270	8422	9988	6213	1952	2957	1005	1521	2154
6422	11188	5292	4442	8893	2290	2455	3185	2645
6092	15599	17715	6983	8115	3535	1299	1456	1508
5268	12371	16285	7511	6010	3722	1743	1250	1932
3732	5946	14773	8052	1594	447	886	146	49
4162	3968	12025	11457	7179	1172	753	139	341

Private logbooks Gillnet KC + KS combined

1994	2006								
1	1	0.25	0.87						
2	10								
7246	1071	8794	7892	2547	1254	268	187	60	83
5900	682	3284	6795	4942	1673	936	203	153	69
24238	4914	19748	8589	10880	6350	2872	1578	948	231
19939	1303	5568	8787	7036	9251	6658	4775	3280	1512
18984	2685	3309	3816	4869	2632	3033	3443	2270	733
19917	10704	33215	3187	3507	2700	2176	1978	1633	979
23645	2336	12192	11953	1815	2285	2461	2222	2315	1574
17755	5721	11108	9181	3953	1463	2717	812	1260	2123
19930	17094	20860	6010	6043	6757	2384	2155	2801	1804
13812	2029	17166	16000	4387	7051	2468	395	691	845
5518	547	3854	4483	2289	1391	864	523	226	393
9067	2827	11590	13754	5559	1832	485	455	170	148
9742	1495	5999	10446	8760	5434	1443	991	287	209

Private logbook TR KC+KS combined

1987	2006				
1	1	0.75	1		
2	6				
712	2756	5140	5562	2667	954
876	5667	7735	5361	3432	1025
933	5097	2253	3761	2825	2126
1174	16408	10277	2753	3874	1545
1809	16085	35139	14745	4452	3878
3136	56849	46507	16304	7177	1545
4035	41739	44475	19945	11105	6685
5276	9498	55455	64125	19324	12725
4969	42026	35885	41231	29359	14705
4294	24861	38831	23489	26033	16360
4027	3927	13138	14220	10668	13279
2464	12543	3357	1117	1041	1736
2142	13031	24798	3690	4268	3927
3342	9566	16153	20370	3215	2692
2268	6292	11562	6052	6953	635
1498	29987	20538	4835	5483	3963
2093	7473	21584	14949	7199	3760
3985	20101	39842	47586	18353	8392
2463	7956	34026	29590	16011	6975
2096	8862	10973	17968	14284	9556

Table 3.6. Sole IIIa. Catch in numbers (thousands) by year and age.

```
Table  1    Catch numbers at age            Numbers*10**-3
       YEAR,       1984,    1985,    1986,

       AGE
         2,          64,     786,     258,
         3,         638,     594,    1255,
         4,         240,     190,     671,
         5,         117,      55,     210,
         6,          31,      60,      33,
         7,          33,      16,      36,
         8,          40,       8,      33,
       +gp,         175,      69,      63,
0    TOTALNUM,      1338,    1778,    2559,
     TONSLAND,       337,     397,     643,
     SOPCOF %,        99,     100,     100,

         Numbers*10**-3
       YEAR,       1987,    1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,

       AGE
         2,         391,     516,     863,    1209,     530,     506,     523,     127,     272,     316,
         3,         857,    1035,     613,    1300,    1301,    1178,    1804,    1037,     622,    1015,
         4,        1018,     897,     847,     651,     928,     939,    1251,    1451,    1359,     537,
         5,         434,     484,     592,     564,     334,     493,     826,     752,    1226,     691,
         6,         174,     129,     404,     310,     345,     320,     418,     444,     600,     440,
         7,          64,      37,      83,     167,     302,     178,     117,     152,     385,     232,
         8,          31,      23,      30,      27,     180,     166,     137,      45,     142,     148,
       +gp,          87,      60,      52,      31,      76,     239,     157,      59,     104,     203,
0    TOTALNUM,      3056,    3181,    3484,    4259,    3996,    4019,    5233,    4067,    4710,    3582,
     TONSLAND,       722,     706,     824,    1050,    1011,    1294,    1439,    1198,    1297,    1059,
     SOPCOF %,       100,     100,     100,     100,      95,      93,     100,      99,      98,      98,

         Numbers*10**-3
       YEAR,       1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

       AGE
         2,          54,     303,     249,     141,     165,     642,      48,     184,     201,     110,
         3,         251,     146,     826,     476,     354,     746,     424,     572,     912,     353,
         4,         440,     212,     150,     756,     346,     279,     470,     774,     957,     745,
         5,         365,     299,     228,     112,     338,     413,     272,     452,     509,     641,
         6,         505,     267,     177,     127,      65,     462,     334,     244,     242,     439,
         7,         360,     250,     165,     120,      81,      93,     192,     178,     102,     145,
         8,         262,     218,     167,     132,      35,      84,      24,      82,      88,      58,
       +gp,         263,     292,     233,     302,     200,     458,     204,     162,      78,     100,
0    TOTALNUM,      2500,    1987,    2195,    2166,    1584,    3177,    1968,    2648,    3089,    2591,
     TONSLAND,       814,     605,     638,     633,     455,     845,     600,     782,     878,     729,
     SOPCOF %,       100,     100,     100,     100,     100,     100,      99,      99,     100,      98,
1
```

Table 3.7 Sole IIIa. Weight at age (kg) in the catch and in the stock. .

```
       Table  2    Catch weights at age (kg)
       YEAR,       1984,    1985,    1986,

       AGE
         2,        .1830,   .1740,   .1650,
         3,        .2130,   .2340,   .2310,
         4,        .2570,   .2830,   .2870,
         5,        .2940,   .2910,   .2970,
         6,        .2970,   .3350,   .4090,
         7,        .2800,   .2920,   .2670,
         8,        .3210,   .2790,   .2620,
       +gp,        .3677,   .3640,   .3830,
0    SOPCOFAC,     .9932,   .9984,   .9995,
```

```
       Table  2    Catch weights at age (kg)
       YEAR,       1987,    1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,

       AGE
         2,        .1600,   .1590,   .1760,   .1800,   .1740,   .2130,   .1780,   .1740,   .1870,   .1760,
         3,        .1940,   .1970,   .2210,   .2280,   .2290,   .2520,   .2240,   .2290,   .2000,   .2180,
         4,        .2450,   .2350,   .2550,   .2510,   .2750,   .3360,   .2740,   .2800,   .2480,   .2670,
         5,        .2740,   .2510,   .2660,   .3080,   .2920,   .4120,   .3280,   .3420,   .2910,   .3070,
         6,        .3190,   .3350,   .2710,   .3330,   .3460,   .4300,   .3740,   .3880,   .3510,   .3390,
         7,        .3600,   .3480,   .3520,   .4000,   .3090,   .4910,   .4030,   .4450,   .3820,   .4040,
         8,        .4170,   .3630,   .3000,   .5470,   .3860,   .5660,   .3880,   .4480,   .4320,   .4570,
       +gp,        .3610,   .3517,   .3547,   .5550,   .5027,   .6220,   .4737,   .3937,   .3830,   .6637,
0    SOPCOFAC,    1.0027,  1.0032,   .9964,   .9970,   .9509,   .9304,   .9980,   .9931,   .9767,   .9827,
1
```

```
       Table  2    Catch weights at age (kg)
       YEAR,       1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006,

       AGE
         2,        .1980,   .1610,   .1620,   .1690,   .1840,   .1730,   .1750,   .2050,   .1890,   .2010,
         3,        .2720,   .2190,   .2320,   .2360,   .2410,   .2050,   .2090,   .2380,   .2210,   .2140,
         4,        .2960,   .3160,   .3040,   .3030,   .2880,   .2930,   .2450,   .2920,   .2960,   .2620,
         5,        .3080,   .3220,   .3680,   .3430,   .3770,   .3720,   .3580,   .3290,   .3190,   .3160,
         6,        .3450,   .3500,   .3600,   .3180,   .3430,   .3850,   .3800,   .3720,   .3620,   .3380,
         7,        .3590,   .3580,   .3780,   .3620,   .3030,   .2120,   .4290,   .4010,   .3680,   .3180,
         8,        .3640,   .3770,   .3970,   .3500,   .3580,   .2920,   .2590,   .3710,   .4170,   .2870,
       +gp,        .3610,   .3267,   .3497,   .3267,   .2757,   .2737,   .3823,   .3147,   .3583,   .3677,
0    SOPCOFAC,     .9983,  1.0007,  1.0042,  1.0011,   .9951,   .9978,   .9950,   .9872,  1.0035,   .9808,
1
```

Table 3.8. Sole IIIa. XSA diagnostics.

```
Extended Survivors Analysis

 Sole in IIIa

 CPUE data from file FL_Final.txt

 Catch data for  23 years. 1984 to 2006. Ages  2 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                      ,    year, year,  age ,  age
 Havfisken KASU       ,   1999, 2006,   2,     6,   .750,   .920
 Official logbooks TR,    1994, 2006,   3,     8,   .250,   .660
 Private logbooks Gil,    1994, 2006,   2,     8,   .250,   .870
 Private logbook TR K,    1987, 2006,   2,     6,   .750,  1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7

 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning had not converged after   70 iterations


 Total absolute residual between iterations
 69 and  70 =     .00011

 Final year F values
 Age          ,      2,      3,      4,      5,      6,      7,      8
 Iteration 69,  .0298,  .1408,  .2283,  .2345,  .2505,  .1862,  .1873
 Iteration 70,  .0298,  .1408,  .2283,  .2344,  .2504,  .1861,  .1873

 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000


 Fishing mortalities
    Age,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006

      2,  .051,  .072,  .083,  .061,  .043,  .120,  .008,  .033,  .065,  .030
      3,  .166,  .169,  .254,  .202,  .191,  .246,  .097,  .112,  .204,  .141
      4,  .344,  .185,  .235,  .346,  .198,  .203,  .216,  .231,  .249,  .228
      5,  .298,  .368,  .276,  .247,  .228,  .341,  .277,  .296,  .209,  .234
      6,  .428,  .330,  .344,  .218,  .198,  .490,  .450,  .380,  .228,  .250
      7,  .309,  .346,  .310,  .368,  .189,  .425,  .343,  .408,  .240,  .186
      8,  .462,  .278,  .364,  .388,  .155,  .271,  .164,  .215,  .322,  .187

 XSA population numbers (Thousands)

                                  AGE
 YEAR ,           2,            3,            4,            5,            6,            7,
8,

 1997 ,    1.15E+03, 1.72E+03, 1.59E+03, 1.49E+03, 1.52E+03, 1.42E+03, 7.44E+02,
 1998 ,    4.60E+03, 9.85E+02, 1.32E+03, 1.02E+03, 1.00E+03, 8.99E+02, 9.44E+02,
 1999 ,    3.29E+03, 3.87E+03, 7.52E+02, 9.93E+02, 6.39E+02, 6.51E+02, 5.75E+02,
 2000 ,    2.51E+03, 2.74E+03, 2.72E+03, 5.38E+02, 6.81E+02, 4.10E+02, 4.32E+02,
 2001 ,    4.14E+03, 2.14E+03, 2.03E+03, 1.74E+03, 3.80E+02, 4.96E+02, 2.56E+02,
 2002 ,    5.99E+03, 3.59E+03, 1.60E+03, 1.50E+03, 1.25E+03, 2.82E+02, 3.71E+02,
 2003 ,    6.30E+03, 4.81E+03, 2.54E+03, 1.18E+03, 9.68E+02, 6.95E+02, 1.67E+02,
 2004 ,    5.94E+03, 5.65E+03, 3.95E+03, 1.85E+03, 8.11E+02, 5.58E+02, 4.46E+02,
 2005 ,    3.33E+03, 5.20E+03, 4.57E+03, 2.84E+03, 1.25E+03, 5.02E+02, 3.36E+02,
 2006 ,    3.94E+03, 2.83E+03, 3.84E+03, 3.22E+03, 2.08E+03, 8.97E+02, 3.57E+02,

 Estimated population abundance at 1st Jan 2007

    ,     0.00E+00, 3.46E+03, 2.22E+03, 2.76E+03, 2.31E+03, 1.47E+03, 6.74E+02,

 Taper weighted geometric mean of the VPA populations:

    ,     3.92E+03, 3.33E+03, 2.48E+03, 1.66E+03, 1.04E+03, 6.17E+02, 3.77E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .4886,    .5229,    .5515,    .5303,    .4912,    .4514,    .5037,
```

Table 3.8 (Cont'd)

Log catchability residuals.

Fleet : Havfisken KASU

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2 ,	99.99,	99.99,	.27,	.07,	-.72,	-.66,	-.39,	.67,	.39,	.36
3 ,	99.99,	99.99,	-.04,	-.08,	-.59,	-.42,	-.13,	.50,	.00,	.70
4 ,	99.99,	99.99,	1.21,	.02,	-.98,	-.18,	.08,	.39,	-.43,	.00
5 ,	99.99,	99.99,	.21,	.69,	-1.03,	-.45,	.33,	.80,	-.41,	-.12
6 ,	99.99,	99.99,	.04,	-.09,	.73,	-.60,	.07,	1.00,	-.20,	-.93
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									

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

Age ,	2,	3,	4,	5,	6
Mean Log q,	-8.0409,	-8.1745,	-8.1697,	-8.2857,	-8.3584,
S.E(Log q),	.5289,	.4343,	.6188,	.6251,	.6425,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.85,	-.728,	7.77,	.11,	8,	1.01,	-8.04,
3,	.71,	.830,	8.19,	.59,	8,	.32,	-8.17,
4,	1.92,	-1.201,	8.50,	.23,	8,	1.15,	-8.17,
5,	2.04,	-1.274,	9.27,	.21,	8,	1.22,	-8.29,
6,	20.58,	-2.884,	38.62,	.00,	8,	9.15,	-8.36,

Fleet : Official logbooks TR

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
2 ,	No data for this fleet at this age									
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.17,	.21,	.38
4 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.03,	.65,	-.52
5 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.05,	.56,	-.12
6 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.07,	.12,	-.54
7 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.23,	.46,	-.36
8 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	.47,	.35,	.05

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2 ,	No data for this fleet at this age									
3 ,	-.85,	.22,	.47,	.16,	.28,	.05,	.08,	-.17,	-.43,	-.36
4 ,	-.18,	-.18,	-.13,	.33,	.00,	-.42,	.38,	.01,	.12,	-.03
5 ,	-.11,	.45,	.26,	-.34,	-.32,	-.48,	.24,	.01,	-.04,	.09
6 ,	.07,	-.10,	.22,	-.23,	-.08,	.35,	.55,	.54,	-.94,	-.04
7 ,	-.40,	.16,	.11,	.67,	.22,	.61,	.16,	.60,	-1.14,	-.89
8 ,	-.24,	.16,	-.11,	.34,	-.22,	.33,	.50,	-.02,	-.02,	-.41

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

Age ,	3,	4,	5,	6,	7,	8
Mean Log q,	-7.5239,	-7.0106,	-7.0052,	-6.8940,	-7.0456,	-7.0456,
S.E(Log q),	.3689,	.3043,	.3024,	.4373,	.6074,	.3052,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
3,	1.03,	-.137,	7.51,	.64,	13,	.40,	-7.52,
4,	.80,	1.610,	7.17,	.87,	13,	.23,	-7.01,
5,	.91,	.520,	7.04,	.80,	13,	.29,	-7.01,
6,	1.20,	-.590,	6.88,	.49,	13,	.54,	-6.89,
7,	2.36,	-1.377,	7.86,	.10,	13,	1.37,	-7.05,
8,	1.30,	-1.224,	7.28,	.65,	13,	.37,	-6.97,

Fleet : Private logbooks Gil

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.25,	-.43,	.60
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.04,	-.21,	.39
4 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.13,	.26,	-.37
5 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.45,	.25,	-.05
6 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.52,	-.28,	-.57
7 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.88,	.11,	-.64
8 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	-.36,	-.24,	-.11

Table 3.8 (Cont'd)

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2 ,	.07,	-.53,	1.14,	-.29,	.38,	1.03,	-.85,	-1.17,	.58,	-.32
3 ,	-.35,	-.26,	.67,	-.18,	.25,	.28,	.07,	-.65,	.08,	-.07
4 ,	.20,	-.49,	-.13,	-.20,	.04,	-.26,	.63,	-.16,	.33,	.14
5 ,	.16,	.26,	-.14,	-.37,	-.49,	.02,	.28,	.10,	.02,	.29
6 ,	.39,	-.45,	-.02,	-.49,	-.08,	.30,	.95,	.38,	-.35,	.16
7 ,	.14,	-.12,	-.20,	.25,	.34,	.79,	.25,	.37,	-.69,	-.28
8 ,	.53,	-.08,	-.14,	.10,	-.22,	.33,	-.26,	-.02,	-.31,	.26

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

Age ,	2,	3,	4,	5,	6,	7,	8
Mean Log q,	-9.7600,	-8.2258,	-8.1445,	-8.2889,	-8.1921,	-8.2665,	-8.2665,
S.E(Log q),	.7415,	.3583,	.3204,	.2751,	.4659,	.4738,	.2711,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	1.72,	-.811,	10.87,	.12,	13,	1.29,	-9.76,
3,	.94,	.272,	8.22,	.69,	13,	.35,	-8.23,
4,	.83,	1.184,	8.08,	.84,	13,	.26,	-8.14,
5,	.88,	.855,	8.18,	.85,	13,	.25,	-8.29,
6,	1.03,	-.093,	8.23,	.53,	13,	.51,	-8.19,
7,	1.70,	-1.237,	9.53,	.26,	13,	.78,	-8.27,
8,	.79,	1.695,	7.79,	.87,	13,	.19,	-8.29,

Fleet : Private logbook TR K

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
2 ,	-.44,	.50,	-.12,	.60,	.04,	.50,	.27,	-.87,	.76,	.87
3 ,	-.28,	.01,	-.88,	.05,	.56,	.11,	-.40,	-.16,	.08,	.60
4 ,	.34,	.08,	-.23,	-.30,	.60,	-.26,	-.46,	.21,	.20,	.28
5 ,	1.30,	.08,	-.14,	.08,	.25,	-.14,	-.34,	-.30,	.04,	.37
6 ,	1.19,	.80,	.05,	-.53,	.19,	-.58,	.27,	.08,	.04,	.03
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									

Age ,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2 ,	-.34,	-.06,	.46,	-.04,	-.59,	1.08,	-.79,	-.36,	-.20,	-.13
3 ,	-.19,	-.50,	.34,	-.23,	.06,	.58,	-.13,	-.30,	.18,	-.23
4 ,	.21,	-1.79,	.15,	.22,	-.44,	-.01,	.34,	.42,	.30,	.12
5 ,	-.03,	-1.43,	.07,	-.07,	-.10,	.32,	.44,	.30,	.14,	.09
6 ,	.32,	-.89,	.53,	-.47,	-.96,	.35,	.19,	.46,	.19,	.18
7 ,	No data for this fleet at this age									
8 ,	No data for this fleet at this age									

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

Age ,	2,	3,	4,	5,	6
Mean Log q,	-6.5933,	-5.8468,	-5.9350,	-5.9532,	-5.9946,
S.E(Log q),	.5943,	.3485,	.5693,	.4567,	.4907,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	.98,	.061,	6.63,	.41,	20,	.61,	-6.59,
3,	.87,	.729,	6.14,	.76,	20,	.31,	-5.85,
4,	.73,	1.221,	6.44,	.67,	20,	.41,	-5.94,
5,	.85,	.680,	6.18,	.66,	20,	.40,	-5.95,
6,	.70,	1.524,	6.28,	.72,	20,	.32,	-5.99,

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Havfisken KASU ,	4972.,	.562,	.000,	.00,	1,	.400,	.021
Official logbooks TR,	1.,	.000,	.000,	.00,	0,	.000,	.000
Private logbooks Gil,	2511.,	.774,	.000,	.00,	1,	.211,	.041
Private logbook TR K,	3037.,	.618,	.000,	.00,	1,	.331,	.034
F shrinkage mean ,	1892.,	1.50,,,,				.058,	.054

Weighted prediction :

Table 3.8 (Cont'd)

```
Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3458.,       .36,      .18,    4,    .519,   .030


Age  3   Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Havfisken KASU      ,      3955.,   .357,       .152,    .42,   2,  .227,     .081
Official logbooks TR,      1548.,   .385,       .000,    .00,   1,  .200,     .196
Private logbooks Gil,      2322.,   .337,       .248,    .74,   2,  .259,     .135
Private logbook TR K,      1772.,   .313,       .014,    .04,   2,  .299,     .174

  F shrinkage mean  ,      1807.,   1.50,,,,                        .015,     .170

Weighted prediction :


Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2221.,       .17,      .14,    8,    .823,   .141

Age  4   Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Havfisken KASU      ,      3363.,   .315,       .215,    .68,   3,  .167,     .191
Official logbooks TR,      2322.,   .246,       .190,    .77,   2,  .297,     .266
Private logbooks Gil,      2805.,   .239,       .250,   1.05,   3,  .310,     .225
Private logbook TR K,      2948.,   .278,       .145,    .52,   3,  .215,     .215

  F shrinkage mean  ,      2885.,   1.50,,,,                        .011,     .220

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2764.,       .13,      .09,   12,    .686,   .228


Age  5   Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Havfisken KASU      ,      2248.,   .287,       .232,    .81,   4,  .135,     .240
Official logbooks TR,      2417.,   .196,       .077,    .40,   3,  .319,     .225
Private logbooks Gil,      2434.,   .189,       .250,   1.33,   4,  .344,     .224
Private logbook TR K,      1999.,   .243,       .194,    .80,   4,  .195,     .266

  F shrinkage mean  ,      1960.,   1.50,,,,                        .008,     .271

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2308.,       .11,      .09,   16,    .811,   .234


Age  6   Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Havfisken KASU      ,      1018.,   .271,       .215,    .79,   5,  .135,     .344
Official logbooks TR,      1457.,   .182,       .024,    .13,   4,  .320,     .252
Private logbooks Gil,      1537.,   .178,       .109,    .61,   5,  .330,     .240
Private logbook TR K,      1775.,   .223,       .164,    .73,   5,  .207,     .211

  F shrinkage mean  ,       995.,   1.50,,,,                        .008,     .350

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1467.,       .10,      .07,   20,    .677,   .250


Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
```

Havfisken KASU ,	610.,	.278,	.251,	.90,	5,	.118,	.204
Official logbooks TR,	554.,	.180,	.261,	1.45,	5,	.329,	.222
Private logbooks Gil,	737.,	.174,	.155,	.89,	6,	.363,	.172
Private logbook TR K,	886.,	.229,	.149,	.65,	5,	.181,	.145
F shrinkage mean ,	363.,	1.50,,,,				.009,	.322

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
674.,	.10,	.10,	22,	.984,	.186

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1998

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Havfisken KASU ,	307.,	.278,	.290,	1.05,	5,	.077,	.165
Official logbooks TR,	218.,	.171,	.205,	1.20,	6,	.375,	.225
Private logbooks Gil,	293.,	.163,	.140,	.86,	7,	.421,	.172
Private logbook TR K,	343.,	.229,	.108,	.47,	5,	.118,	.149
F shrinkage mean ,	238.,	1.50,,,,				.009,	.208

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
268.,	.10,	.09,	24,	.898,	.187

Table 3.9. Sole IIIa. Fishing mortality at age.

At 21/04/2007 15:15

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986
AGE			
2	0.0247	0.1415	0.0541
3	0.532	0.2961	0.3123
4	0.5818	0.2628	0.5624
5	0.4431	0.223	0.4576
6	0.1925	0.3797	0.1811
7	0.6157	0.1291	0.3657
8	0.4747	0.2587	0.3769
+gp	0.4747	0.2587	0.3769
0 FBAR 4	0.4616	0.2507	0.3888

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
2	0.0832	0.1635	0.1724	0.1931	0.0794	0.0591	0.0849	0.0383	0.0877	0.1608
3	0.2283	0.2929	0.2655	0.3757	0.292	0.2269	0.2744	0.2159	0.2373	0.4745
4	0.3983	0.352	0.3679	0.4414	0.4459	0.3154	0.3552	0.3295	0.4294	0.295
5	0.7757	0.2972	0.3677	0.3964	0.3778	0.4003	0.4471	0.3332	0.4532	0.3586
6	0.758	0.4862	0.3846	0.2973	0.3987	0.6657	0.6185	0.4078	0.4287	0.258
7	0.5545	0.31	0.5892	0.2412	0.4665	0.3276	0.4816	0.4217	0.6589	0.2597
8	0.5451	0.3486	0.3939	0.3404	0.3929	0.448	0.4001	0.3051	0.78	0.5045
+gp	0.5451	0.3486	0.3939	0.3404	0.3929	0.448	0.4001	0.3051	0.78	0.5045
0 FBAR 4	0.6063	0.3588	0.4207	0.3433	0.4164	0.4314	0.4605	0.3595	0.55	0.3352

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR **-**
AGE											
2	0.0508	0.0718	0.0829	0.0608	0.0428	0.1195	0.008	0.0331	0.0655	0.0298	0.0428
3	0.1663	0.1694	0.2538	0.2017	0.191	0.2463	0.0972	0.1125	0.2038	0.1408	0.1524
4	0.3438	0.185	0.2352	0.3457	0.1979	0.2025	0.2162	0.2307	0.2487	0.2283	0.2359
5	0.2981	0.3683	0.2764	0.247	0.2283	0.3406	0.2769	0.2964	0.209	0.2344	0.2466
6	0.4283	0.3296	0.3444	0.2181	0.1981	0.4899	0.4505	0.3802	0.2283	0.2504	0.2863
7	0.3094	0.346	0.3101	0.3682	0.1885	0.4252	0.343	0.4082	0.2404	0.1861	0.2783
8	0.4623	0.278	0.3642	0.3878	0.1549	0.2715	0.1639	0.2146	0.3222	0.1873	0.2414
+gp	0.4623	0.278	0.3642	0.3878	0.1549	0.2715	0.1639	0.2146	0.3222	0.1873	
0 FBAR 4	0.3684	0.3014	0.3061	0.3134	0.1935	0.346	0.2901	0.306	0.2497	0.2173	

Table 3.10. Sole IIIa. Stock number at age.

Stock number at age (start of year) Numbers*10**-3

YEAR	1984	1985	1986
AGE			
2	2760	6263	5149
3	1626	2437	4919
4	572	864	1640
5	344	289	601
6	186	200	209
7	75	139	124
8	111	37	110
+gp	485	317	210
TOTAL	6159	10546	12963

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
2	5147	3597	5730	7240	7298	9266	6754	3555	3407	2236
3	4414	4285	2764	4364	5401	6099	7902	5613	3096	2824
4	3257	3178	2893	1918	2712	3649	4399	5434	4093	2210
5	845	1979	2023	1812	1116	1571	2409	2790	3537	2411
6	344	352	1330	1267	1103	692	953	1394	1809	2034
7	158	146	196	819	852	670	322	464	839	1066
8	78	82	97	98	582	483	437	180	276	393
+gp	217	214	167	113	245	693	499	235	201	536
TOTAL	14460	13833	15200	17630	19309	23123	23673	19666	17257	13710

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 84-**	AMST 84-**
AGE													
2	1145	4599	3289	2514	4144	5991	6296	5940	3334	3937	0	4410	4872
3	1723	985	3873	2740	2140	3593	4810	5652	5200	2825	3458	3464	3870
4	1590	1320	752	2719	2026	1600	2541	3949	4570	3837	2221	2189	2539
5	1488	1020	993	538	1741	1504	1182	1853	2837	3224	2764	1277	1526
6	1524	1000	639	681	380	1254	968	811	1246	2083	2308	733	911
7	1422	899	651	410	496	282	695	558	502	897	1467	408	537
8	744	944	575	432	256	371	167	446	336	357	674	238	329
+gp	744	1261	800	984	1463	2020	1416	880	297	614	729		
0 TOTAL	10380	12028	11572	11017	12647	16616	18077	20089	18321	17776	13621		

Table 3.11. Sole IIIa. Stock summary from XSA.

Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1984	2760	1390	885	337	0.381	0.462
1985	6263	2222	1132	397	0.351	0.251
1986	5149	2863	2014	643	0.319	0.389
1987	5147	2987	2163	722	0.334	0.606
1988	3597	2933	2361	706	0.299	0.359
1989	5730	3413	2404	824	0.343	0.421
1990	7240	4203	2900	1050	0.362	0.343
1991	7298	4571	3301	1011	0.306	0.416
1992	9266	6715	4742	1294	0.273	0.431
1993	6754	5859	4657	1439	0.309	0.461
1994	3555	5300	4682	1198	0.256	0.360
1995	3407	4452	3815	1297	0.340	0.550
1996	2236	3995	3601	1059	0.294	0.335
1997	1145	3200	2973	814	0.274	0.368
1998	4599	3141	2401	605	0.252	0.301
1999	3289	3009	2476	638	0.258	0.306
2000	2514	2917	2492	633	0.254	0.313
2001	4144	3294	2531	455	0.180	0.194
2002	5991	4005	2969	845	0.285	0.346
2003	6296	4404	3302	600	0.182	0.290
2004	5940	5294	4076	782	0.192	0.306
2005	3334	4919	4289	878	0.205	0.250
2006	3937	4738	3947	729	0.185	0.217
Arith. Mean	4765	3905	3048	824	0.2796	0.3598
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.12. Sole IIIa. Input to Yield per recruit

age	Fbar(4-8)	M	Catch weight	Maturity
2	0.051	0.1	0.180	0
3	0.141	0.1	0.224	1
4	0.187	0.1	0.278	1
5	0.212	0.1	0.324	1
6	0.243	0.1	0.352	1
7	0.225	0.1	0.369	1
8	0.220	0.1	0.389	1
9	0.220	0.1	0.400	1

F and catch weight averaged over 20 yrs

Fbar scaled to the last yr

Stock weight equal to catch weight

Table 3.13. Sole IIIa. Input to short term prediction.

MFDP version 1a
Run: run2
Time and date: 10:25 23-04-2007
Fbar age range: 4-8

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3540	0.1	0	0	0	0.198	0.036	0.198
3	3458	0.1	1	0	0	0.224	0.128	0.224
4	2221	0.1	1	0	0	0.283	0.199	0.283
5	2764	0.1	1	0	0	0.321	0.208	0.321
6	2308	0.1	1	0	0	0.357	0.241	0.357
7	1468	0.1	1	0	0	0.362	0.235	0.362
8	674	0.1	1	0	0	0.358	0.204	0.358
9	734	0.1	1	0	0	0.347	0.204	0.347

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3540	0.1	0	0	0	0.198	0.036	0.198
3	.	0.1	1	0	0	0.224	0.128	0.224
4	.	0.1	1	0	0	0.283	0.199	0.283
5	.	0.1	1	0	0	0.321	0.208	0.321
6	.	0.1	1	0	0	0.357	0.241	0.357
7	.	0.1	1	0	0	0.362	0.235	0.362
8	.	0.1	1	0	0	0.358	0.204	0.358
9	.	0.1	1	0	0	0.347	0.204	0.347

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3540	0.1	0	0	0	0.198	0.036	0.198
3	.	0.1	1	0	0	0.224	0.128	0.224
4	.	0.1	1	0	0	0.283	0.199	0.283
5	.	0.1	1	0	0	0.321	0.208	0.321
6	.	0.1	1	0	0	0.357	0.241	0.357
7	.	0.1	1	0	0	0.362	0.235	0.362
8	.	0.1	1	0	0	0.358	0.204	0.358
9	.	0.1	1	0	0	0.347	0.204	0.347

Input units are thousands and kg - output in tonnes

Table 3.14. Sole IIIa. Management options table for short term prediction.

MFDP version 1a
Run: run2
Sole in IIIa Prediction
Time and date: 10:25 23-04-2007
Fbar age range: 4-8

2007 Biomass	SSB	FMult	FBar	Landings
4848	4146	1	0.2173	742

2008 Biomass	SSB	FMult	FBar	Landings	2009 Biomass	SSB
4761	4059	0	0	0	5399	4697
.	4059	0.1	0.0217	80	5318	4616
.	4059	0.2	0.0435	158	5239	4537
.	4059	0.3	0.0652	234	5161	4459
.	4059	0.4	0.0869	309	5085	4383
.	4059	0.5	0.1087	382	5011	4309
.	4059	0.6	0.1304	454	4937	4235
.	4059	0.7	0.1521	525	4866	4164
.	4059	0.8	0.1738	594	4795	4093
.	4059	0.9	0.1956	662	4727	4024
.	4059	1	0.2173	728	4659	3957
.	4059	1.1	0.239	794	4593	3891
.	4059	1.2	0.2608	858	4528	3826
.	4059	1.3	0.2825	920	4464	3762
.	4059	1.4	0.3042	982	4402	3700
.	4059	1.5	0.326	1042	4341	3639
.	4059	1.6	0.3477	1101	4281	3579
.	4059	1.7	0.3694	1159	4222	3520
.	4059	1.8	0.3911	1216	4164	3462
.	4059	1.9	0.4129	1272	4108	3406
.	4059	2	0.4346	1326	4052	3350

Input units are thousands and kg - output in tonnes

Table 3.15. Sole IIIa. Yield per recruit output.

MFYPR version 2a
Run: run1
Time and date: 11:23 23-04-2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwr	SSBSpwn
0	0	0	0	10.5083	3.6099	9.5083	3.4302	9.5083	3.4302
0.1	0.0217	0.1605	0.057	8.9046	2.9774	7.9046	2.7977	7.9046	2.7977
0.2	0.0435	0.2721	0.095	7.7901	2.5401	6.7901	2.3604	6.7901	2.3604
0.3	0.0652	0.3543	0.1215	6.9701	2.2201	5.9701	2.0404	5.9701	2.0404
0.4	0.0869	0.4173	0.1408	6.3412	1.9763	5.3412	1.7966	5.3412	1.7966
0.5	0.1087	0.4673	0.1551	5.8433	1.7845	4.8433	1.6048	4.8433	1.6048
0.6	0.1304	0.5078	0.1661	5.4391	1.6298	4.4391	1.4501	4.4391	1.4501
0.7	0.1521	0.5415	0.1746	5.1041	1.5025	4.1041	1.3228	4.1041	1.3228
0.8	0.1738	0.5698	0.1812	4.8219	1.396	3.8219	1.2163	3.8219	1.2163
0.9	0.1956	0.5941	0.1864	4.5807	1.3057	3.5807	1.126	3.5807	1.126
1	0.2173	0.6151	0.1906	4.372	1.2281	3.372	1.0484	3.372	1.0484
1.1	0.239	0.6335	0.1939	4.1896	1.1608	3.1896	0.9811	3.1896	0.9811
1.2	0.2608	0.6497	0.1966	4.0286	1.1019	3.0286	0.9222	3.0286	0.9222
1.3	0.2825	0.6642	0.1987	3.8855	1.0499	2.8855	0.8702	2.8855	0.8702
1.4	0.3042	0.6771	0.2004	3.7573	1.0037	2.7573	0.824	2.7573	0.824
1.5	0.326	0.6888	0.2018	3.6417	0.9623	2.6417	0.7826	2.6417	0.7826
1.6	0.3477	0.6994	0.2029	3.537	0.9251	2.537	0.7454	2.537	0.7454
1.7	0.3694	0.709	0.2037	3.4415	0.8914	2.4415	0.7117	2.4415	0.7117
1.8	0.3911	0.7179	0.2044	3.3541	0.8608	2.3541	0.6811	2.3541	0.6811
1.9	0.4129	0.7261	0.2049	3.2737	0.8328	2.2737	0.6531	2.2737	0.6531
2	0.4346	0.7336	0.2053	3.1995	0.8072	2.1995	0.6275	2.1995	0.6275

Reference	F multiplier	Absolute F
Fbar(4-8)	1	0.2173
FMax	2.3896	0.5193
F0.1	0.7207	0.1566
F35%SPR	0.8163	0.1774

Weights in kilograms

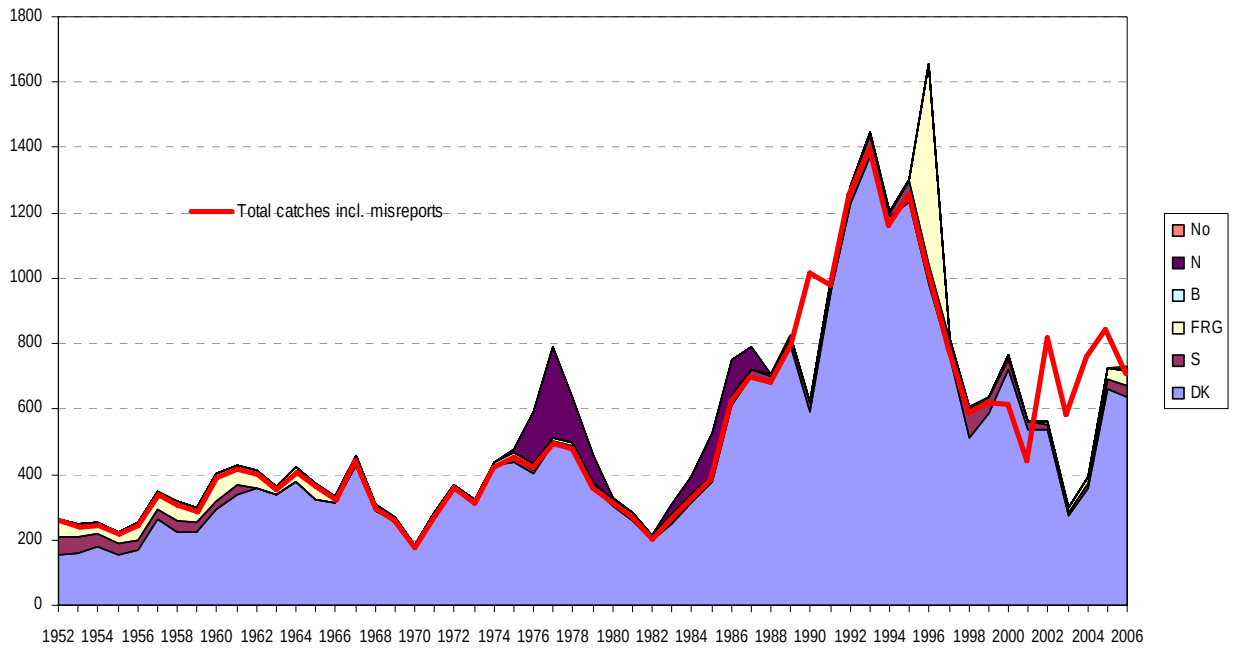


Figure 3.1. Sole IIIa. Landings of sole in Skagerrak and Kattegat (IIIa) by nation since 1952. Bold red line indicate estimated total landings including misreportings as restimated by the WG.

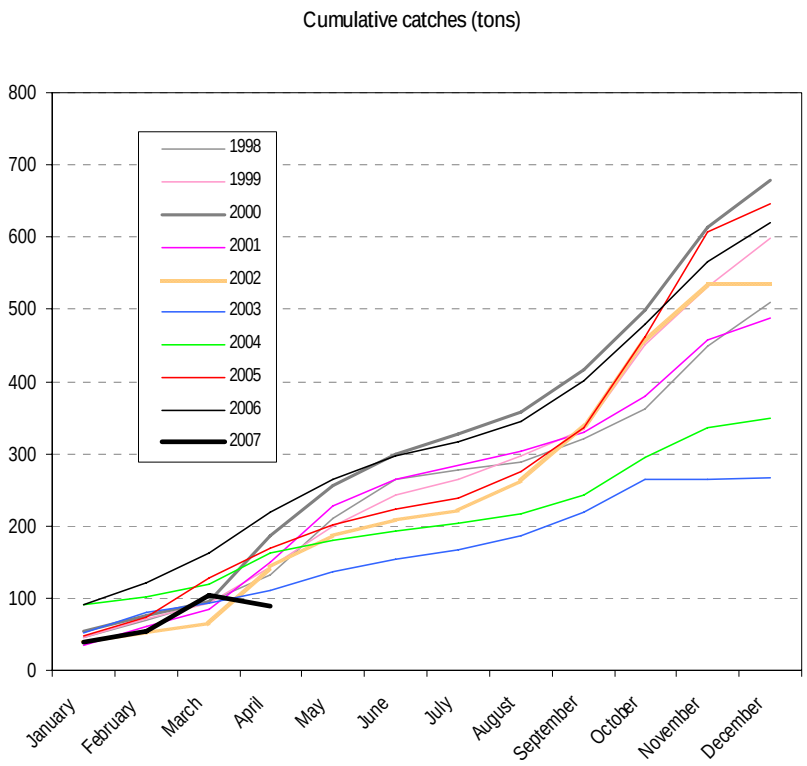


Figure 3.2. Sole IIIa. Cumulative Danish landings of sole by month. April 2007 landings not complete.

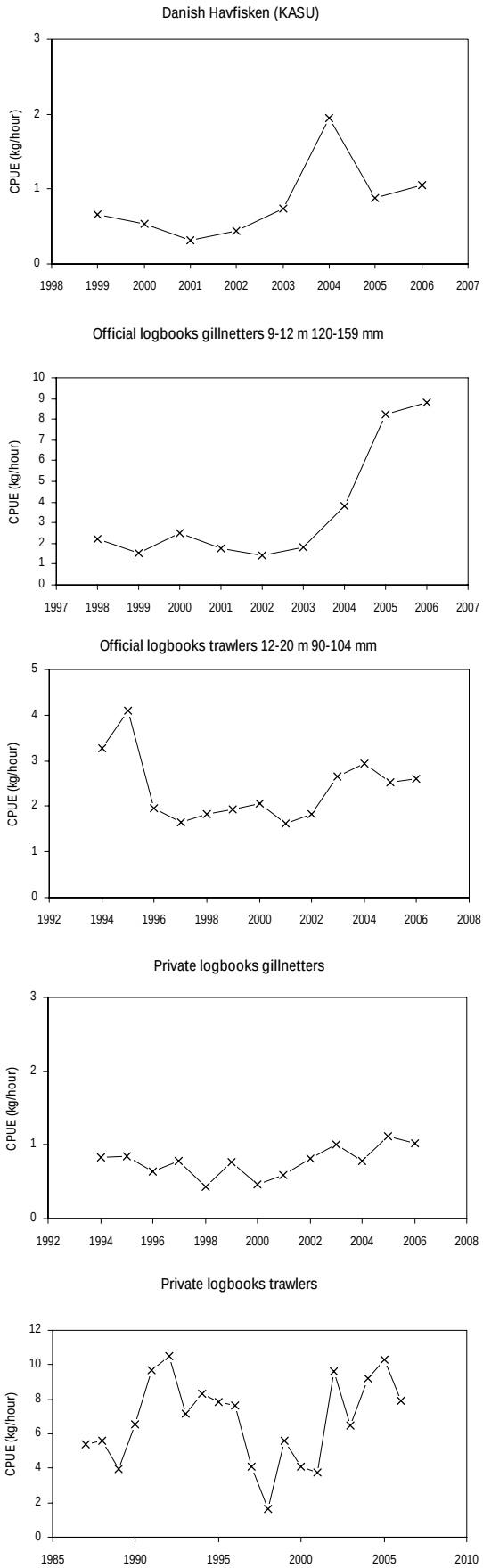


Figure 3.3 . Sole IIIa. Indices of sole abundance; uppermost danish survey KASU, and below 4 kommercial fishery index. The official logbook gillnetters were not used as tuning fleet in final XSA run.

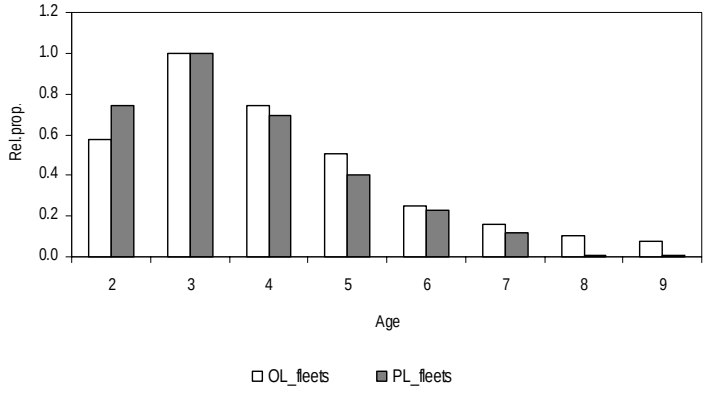
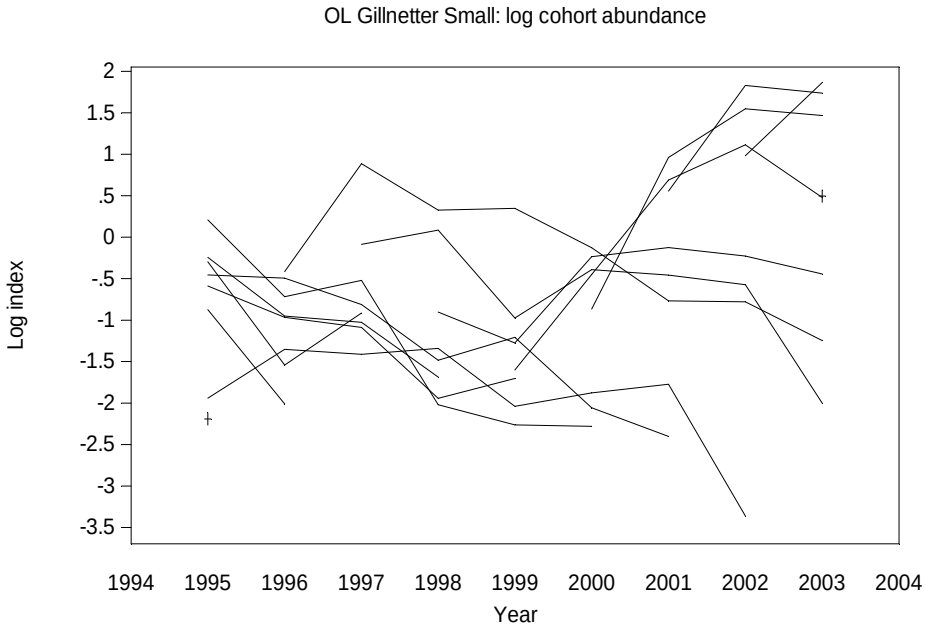
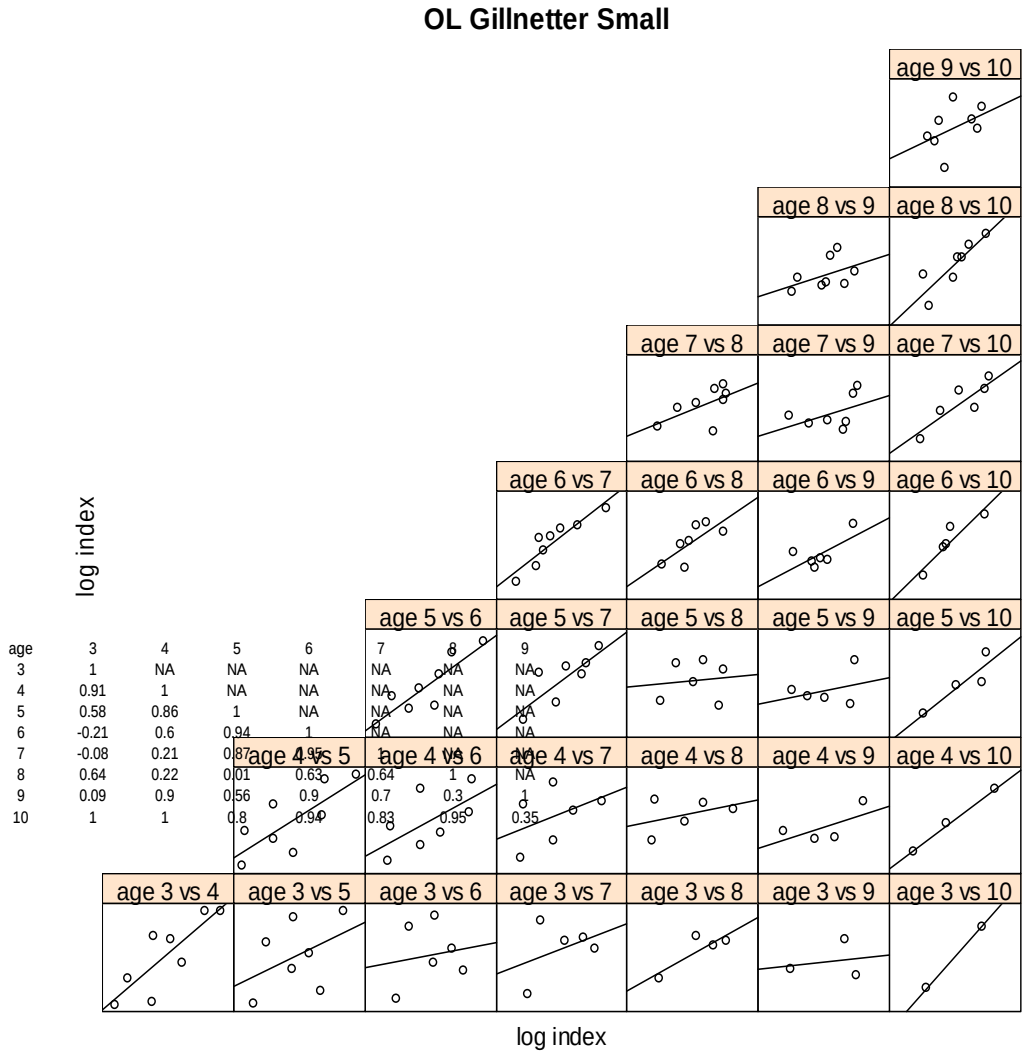


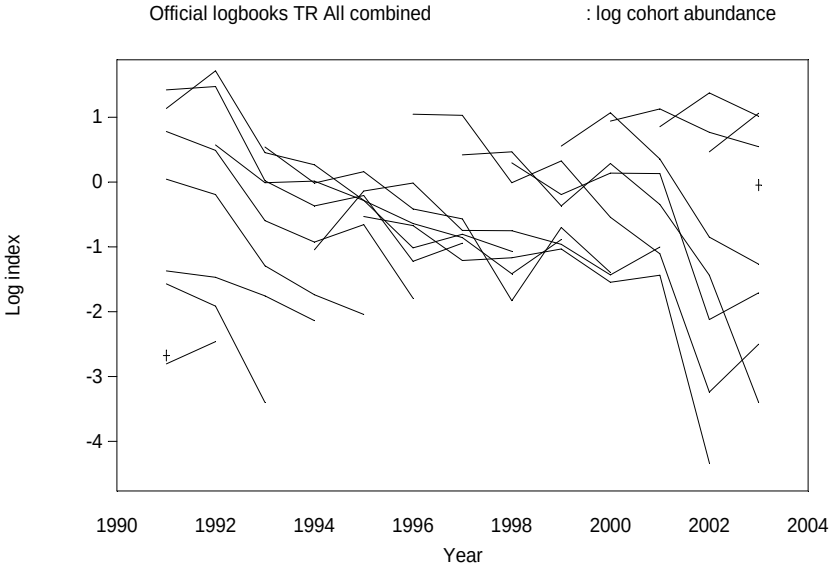
Figure3.3b. Sole IIIa. Age distribution by fleets from official logbooks versus the private logbooks. Distribution are averaged over the entire time period available for each fleet.

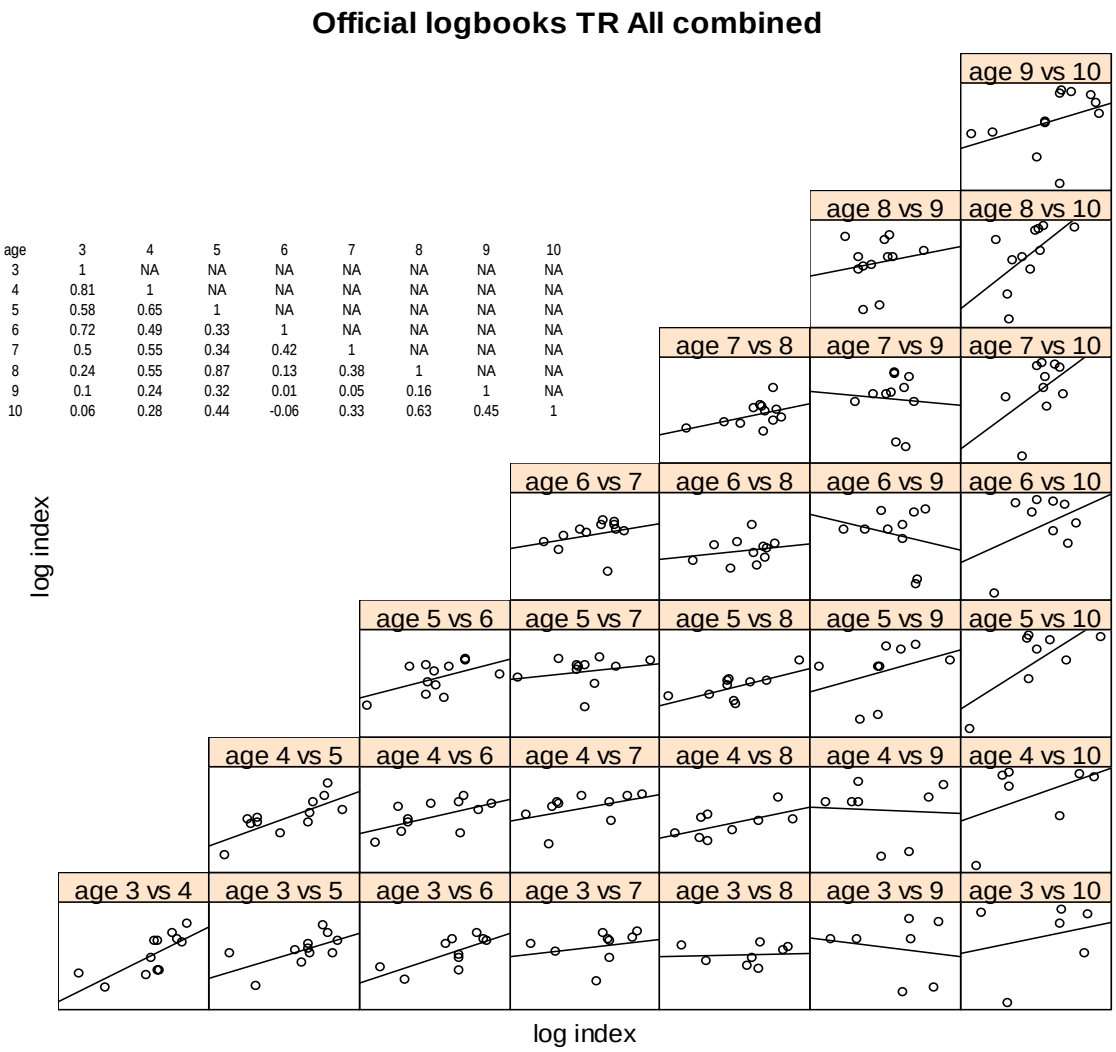




age	3	4	5	6	7	8	9
3	1	NA	NA	NA	NA	NA	NA
4	0.91	1	NA	NA	NA	NA	NA
5	0.58	0.86	1	NA	NA	NA	NA
6	-0.21	0.6	0.94	1	NA	NA	NA
7	-0.08	0.21	0.87	0.95	1	NA	NA
8	0.64	0.22	0.01	0.63	0.64	1	NA
9	0.09	0.9	0.56	0.9	0.7	0.3	1
10	1	1	0.8	0.94	0.83	0.95	0.35

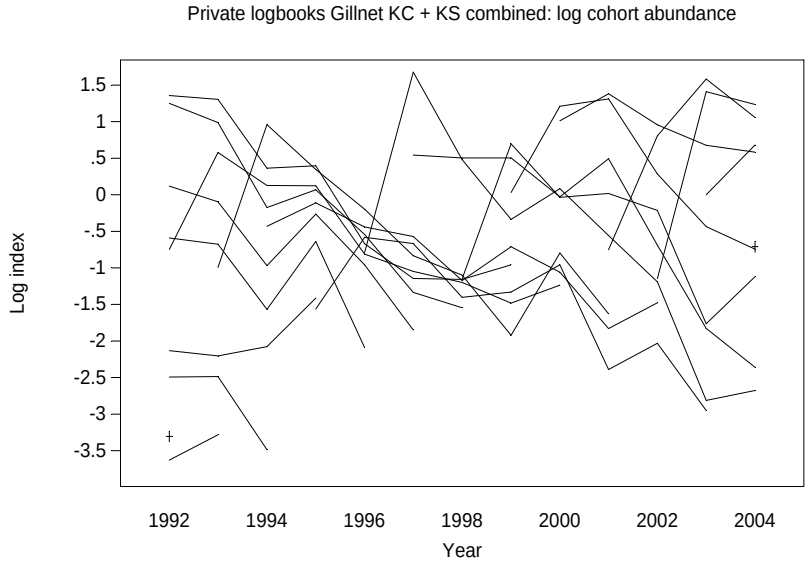
Figure 3.4. Sole IIIa. Internal consistency plots within the fleet Official logbooks from small Gillnetters. Upper left: cpue by age, upper right (2 plots): Year-class index and log cohorte curves. Lower: Age-age matrix plot and corresponding correlation matrix.





age	3	4	5	6	7	8	9	10
3	1	NA	NA	NA	NA	NA	NA	NA
4	0.81	1	NA	NA	NA	NA	NA	NA
5	0.58	0.65	1	NA	NA	NA	NA	NA
6	0.72	0.49	0.33	1	NA	NA	NA	NA
7	0.5	0.55	0.34	0.42	1	NA	NA	NA
8	0.24	0.55	0.87	0.13	0.38	1	NA	NA
9	0.1	0.24	0.32	0.01	0.05	0.16	1	NA
10	0.06	0.28	0.44	-0.06	0.33	0.63	0.45	1

Figure 3.5. Sole IIIa. Internal consistency plots within the fleet Official logbooks from trawlers. Upper log cohorte curves. Lower: Age-age matrix plot and corresponding correlation matrix.



Private logbooks Gillnet KC + KS combined

age	2	3	4	5	6	7	8	9	10
2	1	NA	NA	NA	NA	NA	NA	NA	NA
3	0.2	1	NA	NA	NA	NA	NA	NA	NA
4	0.17	0.49	1	NA	NA	NA	NA	NA	NA
5	0.34	0.28	0.84	1	NA	NA	NA	NA	NA
6	0.84	0.55	0.48	0.44	1	NA	NA	NA	NA
7	0.48	0.44	0.57	0.73	0.21	1	NA	NA	NA
8	-0.14	0.35	0.57	0.57	0.14	0.42	1	NA	NA
9	-0.34	0.04	0.35	0.31	-0.22	0.03	0.31	1	NA
10	0.61	0.05	0.54	0.44	0.38	-0.04	0.24	0.38	1

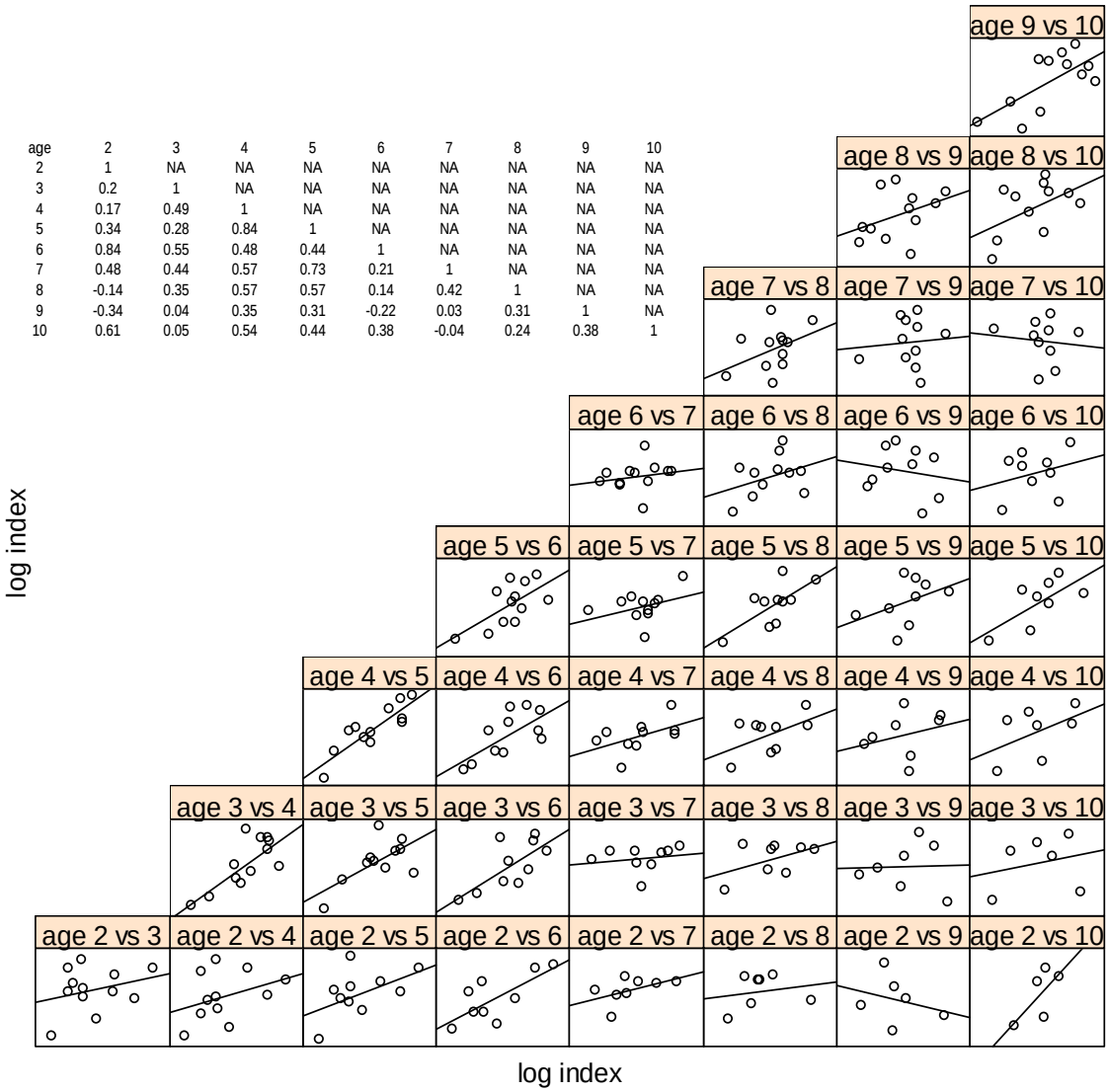
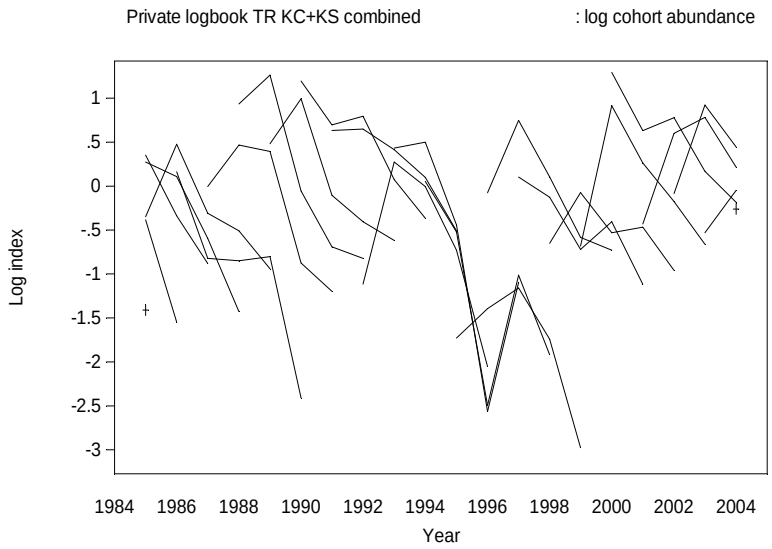
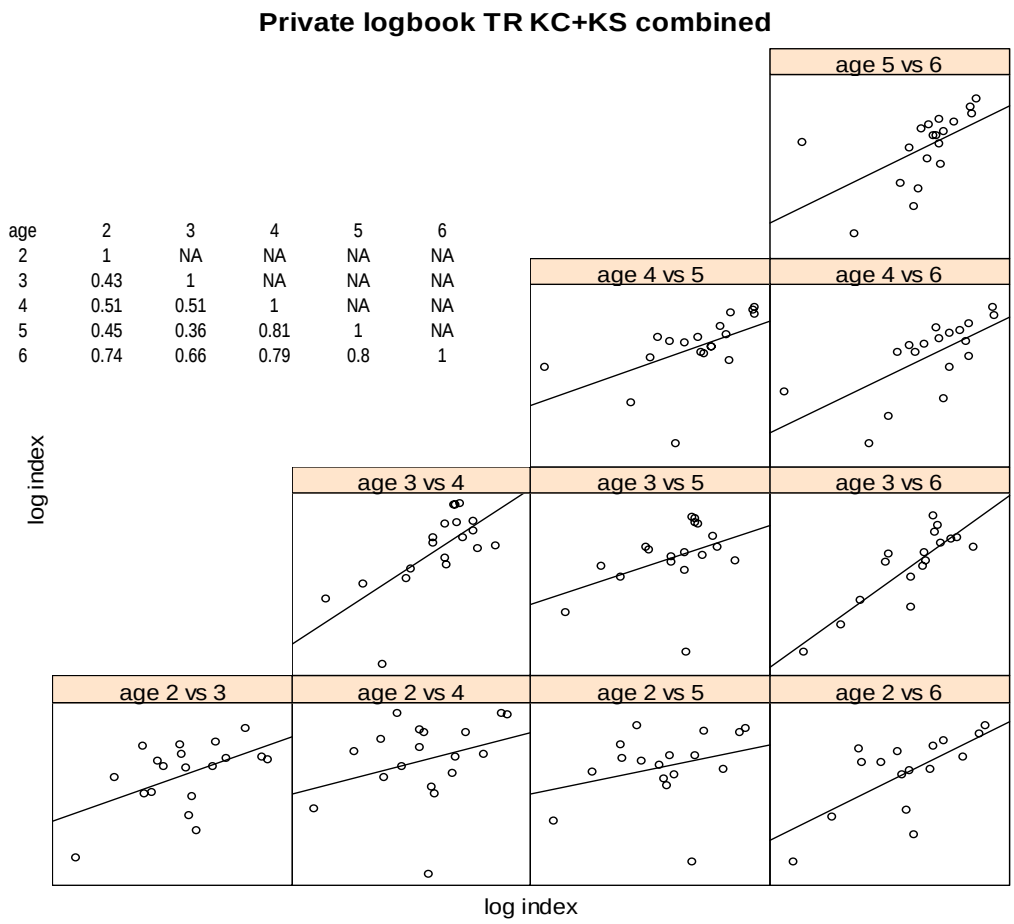


Figure 3.6. Sole IIIa. Internal consistency plots within the fleet Private logbooks from gillnetters. Upper log cohorte curves. Lower: Age-age matrix plot and corresponding correlation matrix.





age	2	3	4	5	6
2	1	NA	NA	NA	NA
3	0.43	1	NA	NA	NA
4	0.51	0.51	1	NA	NA
5	0.45	0.36	0.81	1	NA
6	0.74	0.66	0.79	0.8	1

Figure 3.7. Sole IIIa. Internal consistency plots within the fleet Private logbooks from trawlers. Upper log cohorte curves. Lower: Age-age matrix plot and corresponding correlation matrix.

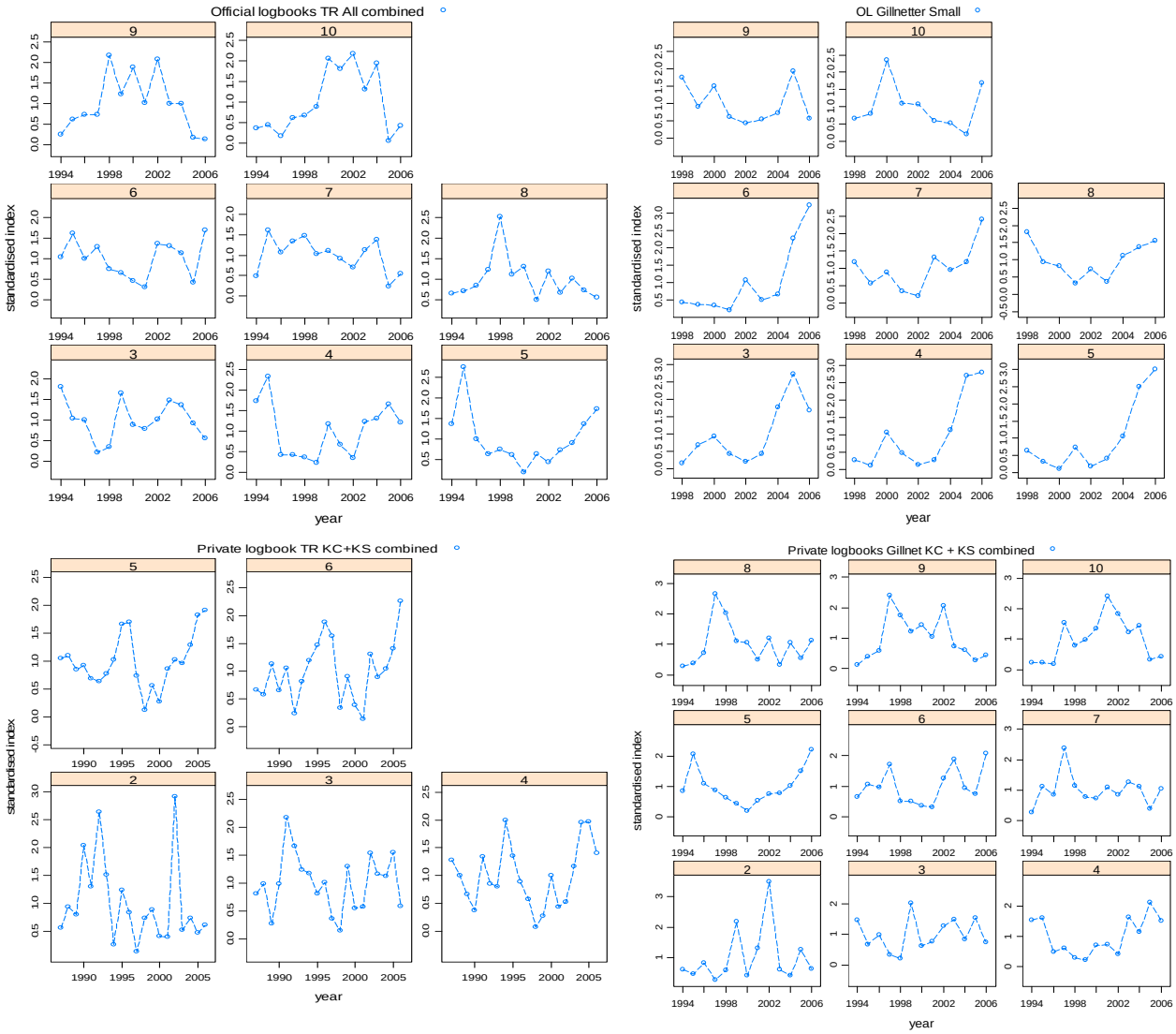
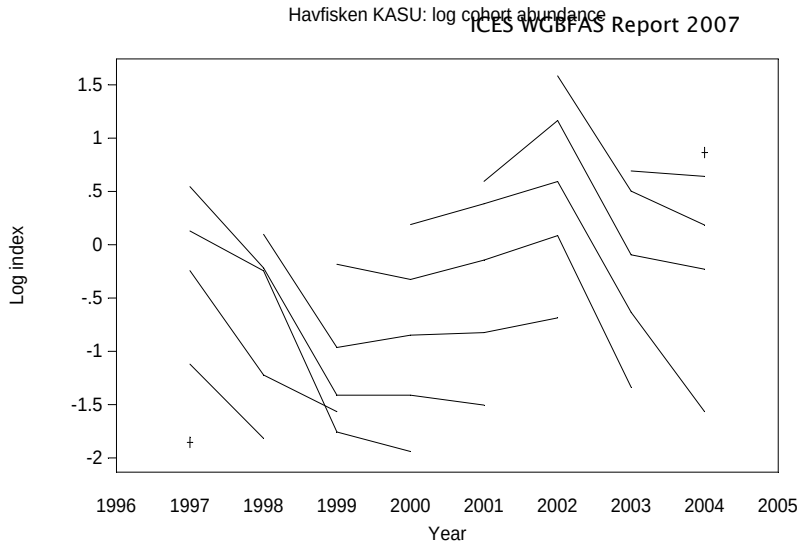
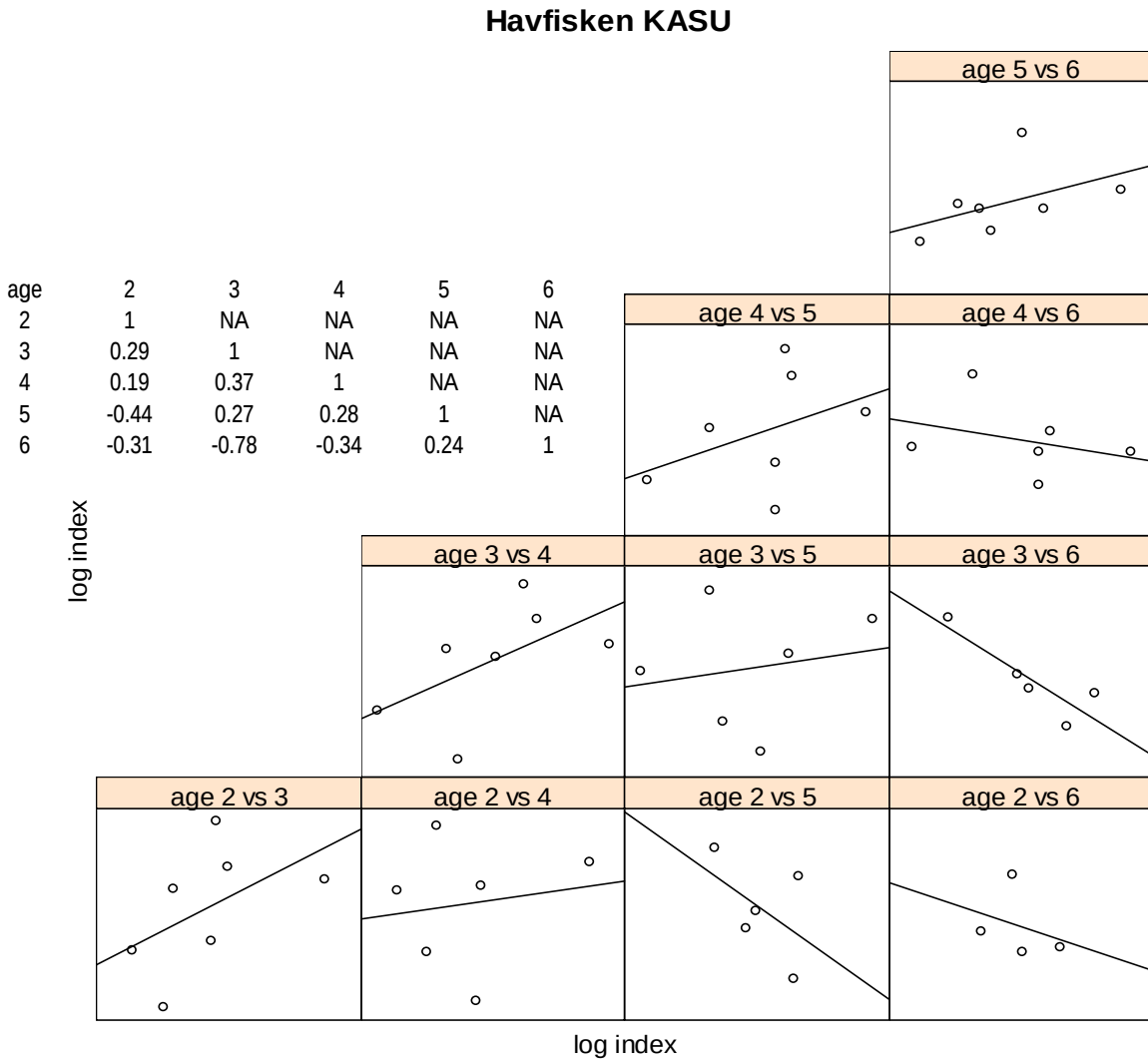


Figure 3.8. Sole IIIa. Indices (CPUE kg/hrs) by age from all commercial fleets.





age	2	3	4	5	6
2	1	NA	NA	NA	NA
3	0.29	1	NA	NA	NA
4	0.19	0.37	1	NA	NA
5	-0.44	0.27	0.28	1	NA
6	-0.31	-0.78	-0.34	0.24	1

Figure 3.9. Sole IIIa. Internal consistency plots within Havfisken KASU survey. Upper log cohorte curves. Lower: Age-age matrix plot and corresponding correlation matrix.

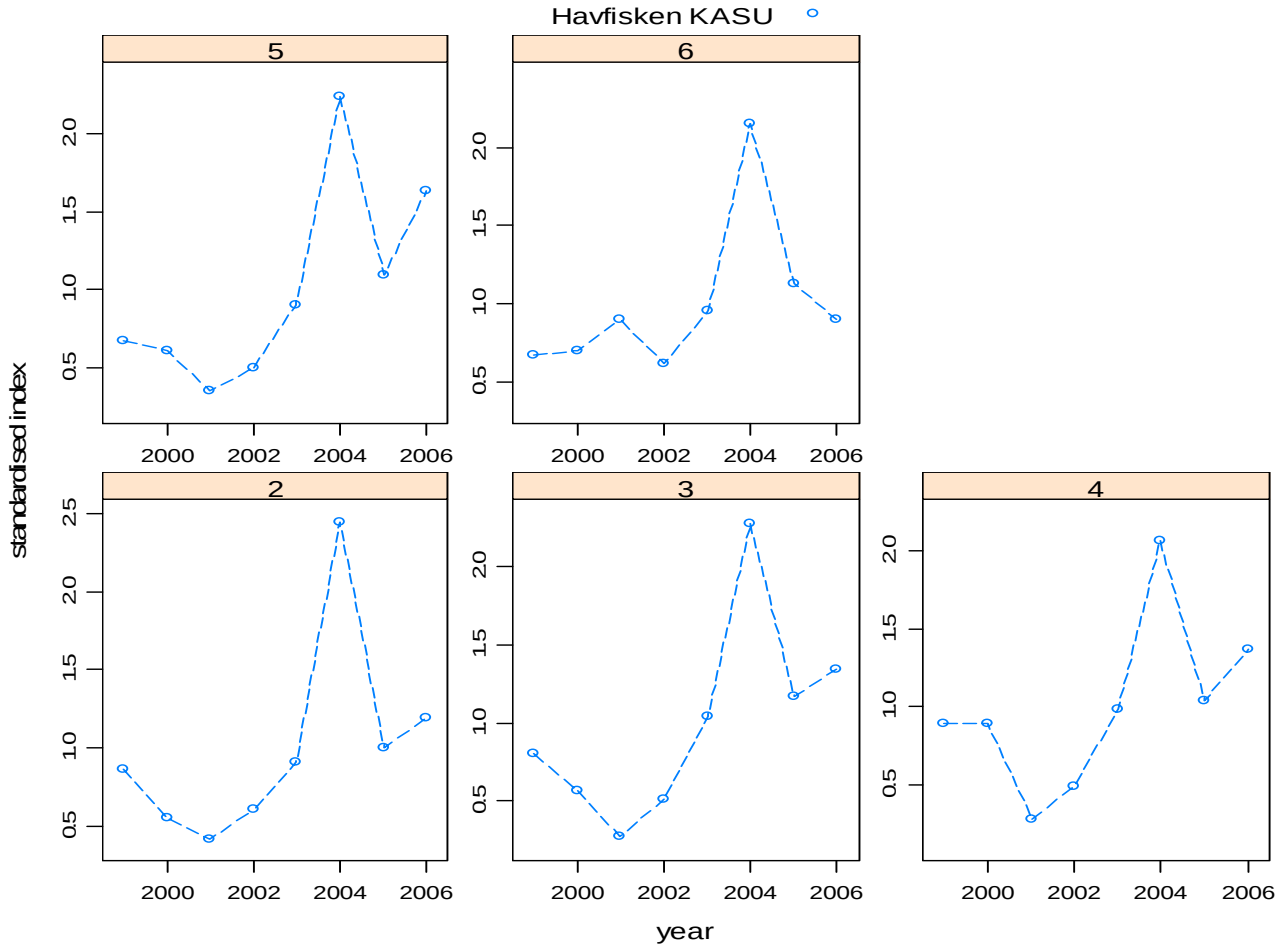


Figure 3.10 Sole IIIa. Index (CPUE kg/hrs) by age from Havfisken survey (KASU).

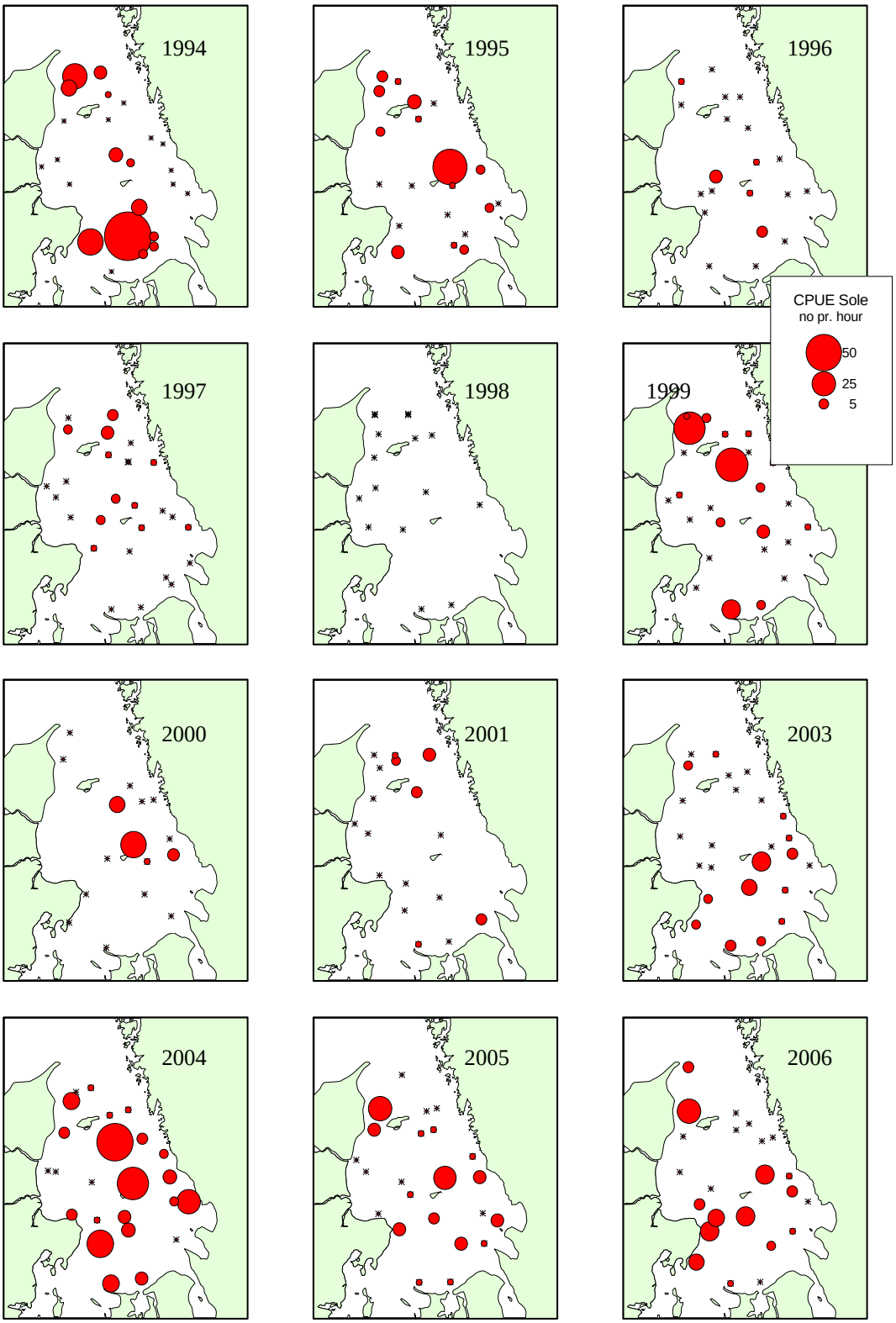


Figure 3.11. Sole IIIa. Catch rates from the Danish Havfisken survey (KASU) since 1994.

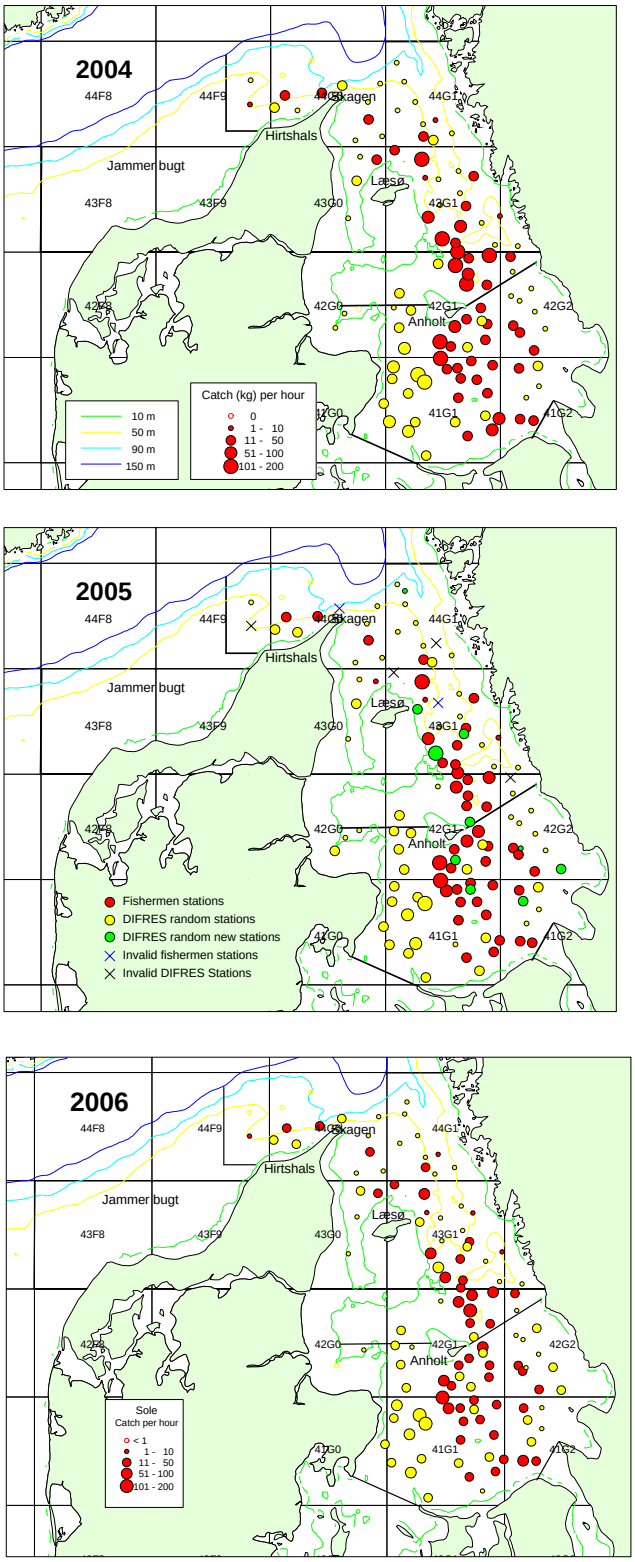


Figure 3.11a. Sole IIIa. Catch rates from the Danish scientific and fisherman survey 2004-2006. Yellow and green dots represent the scientific survey while red dots are fishermens survey.

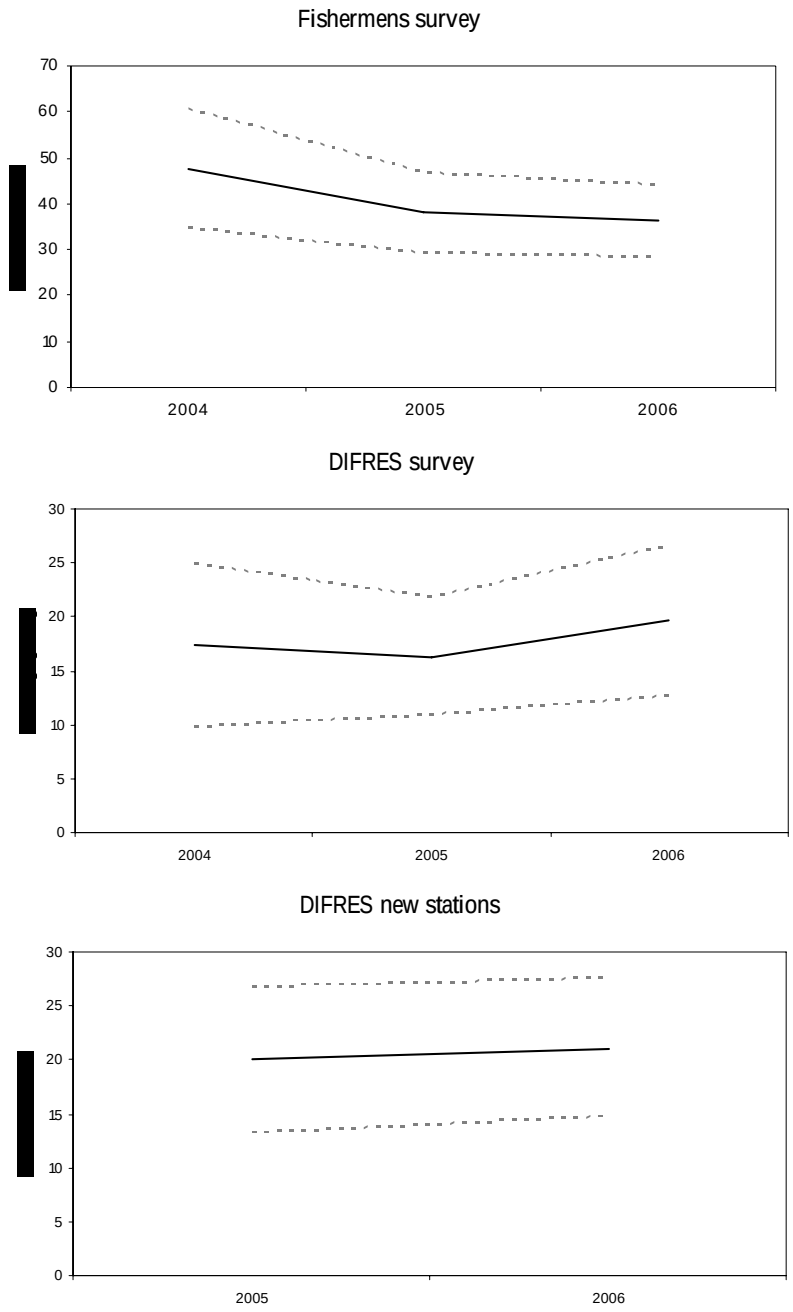


Figure 3.11b. Sole IIIa. Catch rates from the Danish Sole Survey conducted by DIFRES and Danish Fishermen (for locations of stations, see Fig. 3.11a). (95% conf intervals are given as dashed lines).

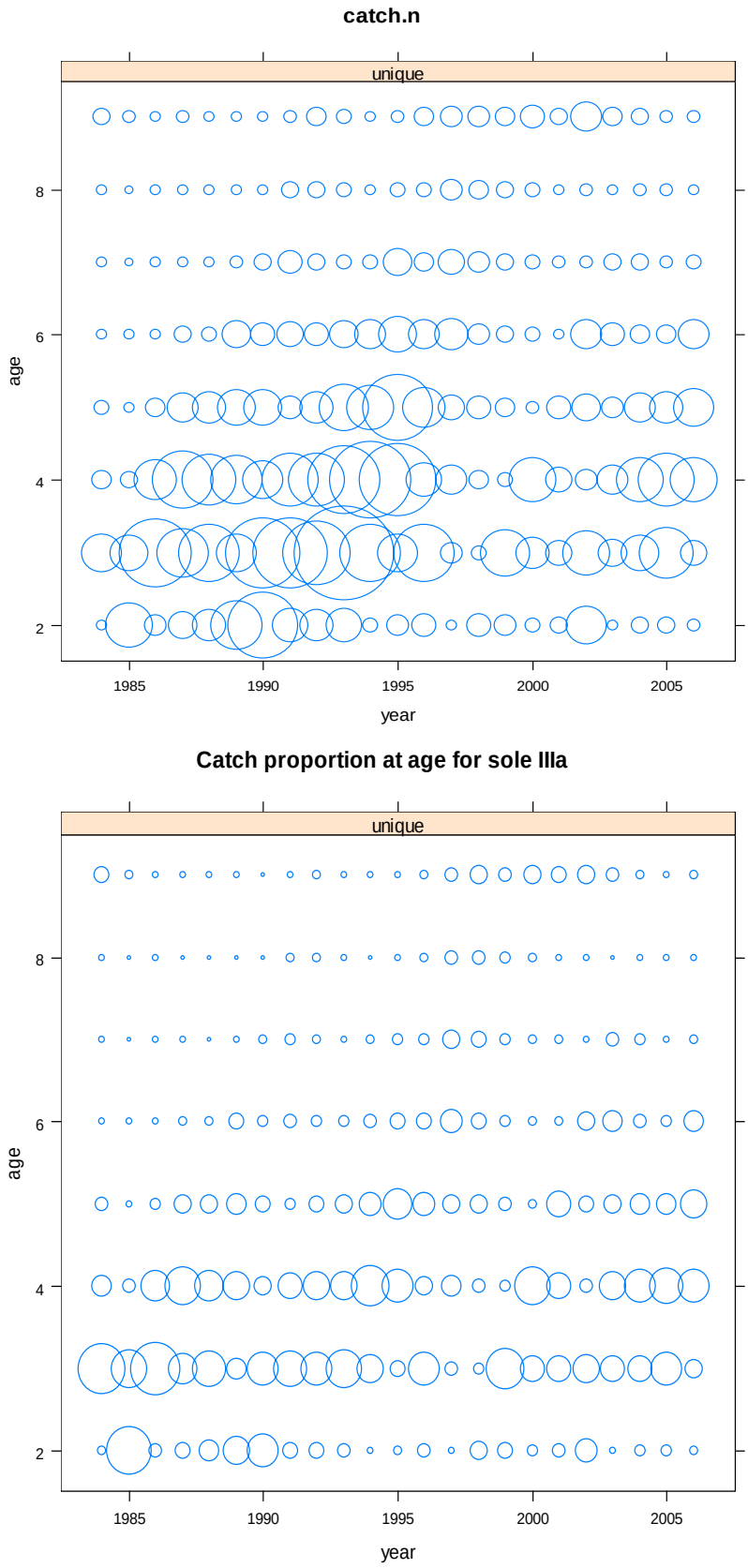
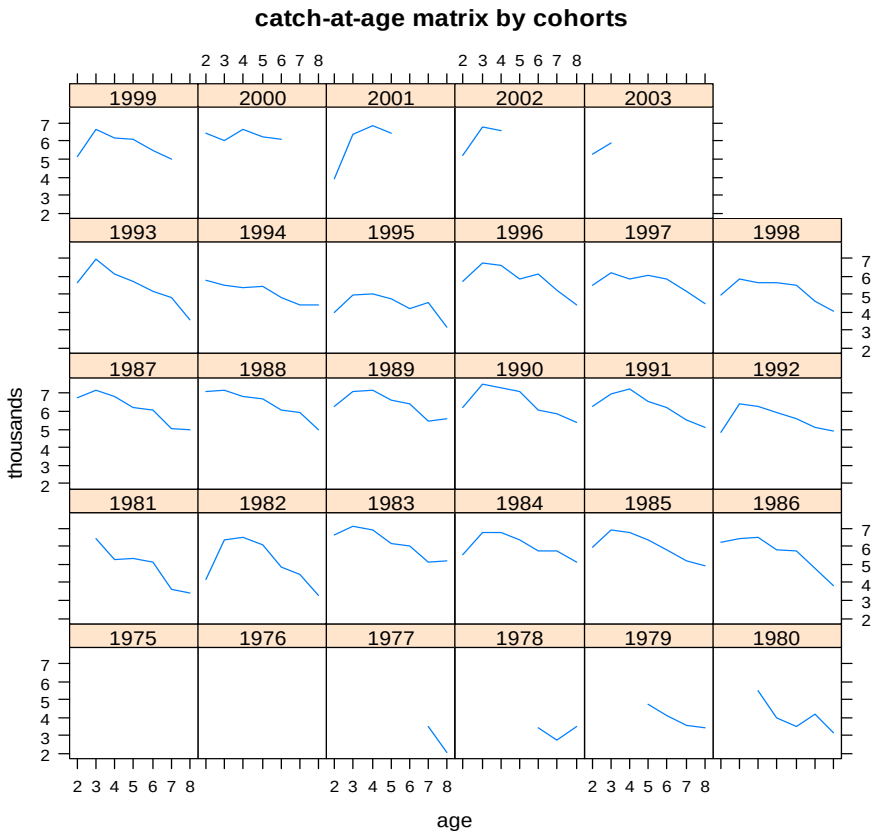


Figure 3.12. Sole IIIa. Catch numbers at age. Upper: CANUM, Lower: Proportion at age.



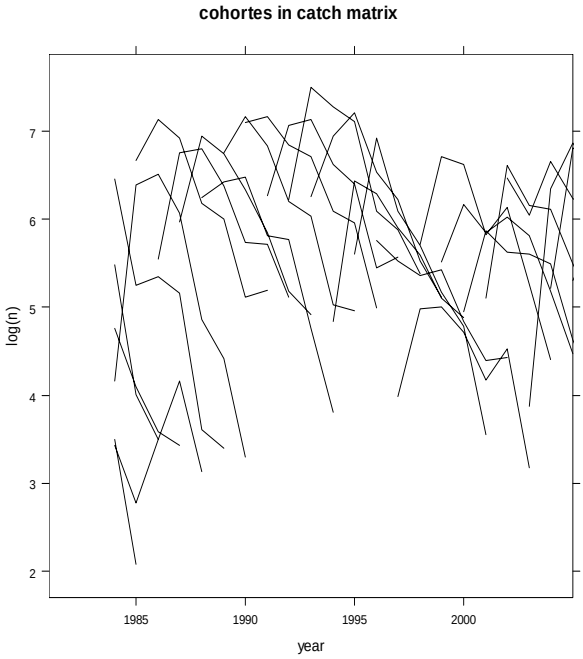


Figure 3.13. Sole IIIa. Log catch curves of cohortes.

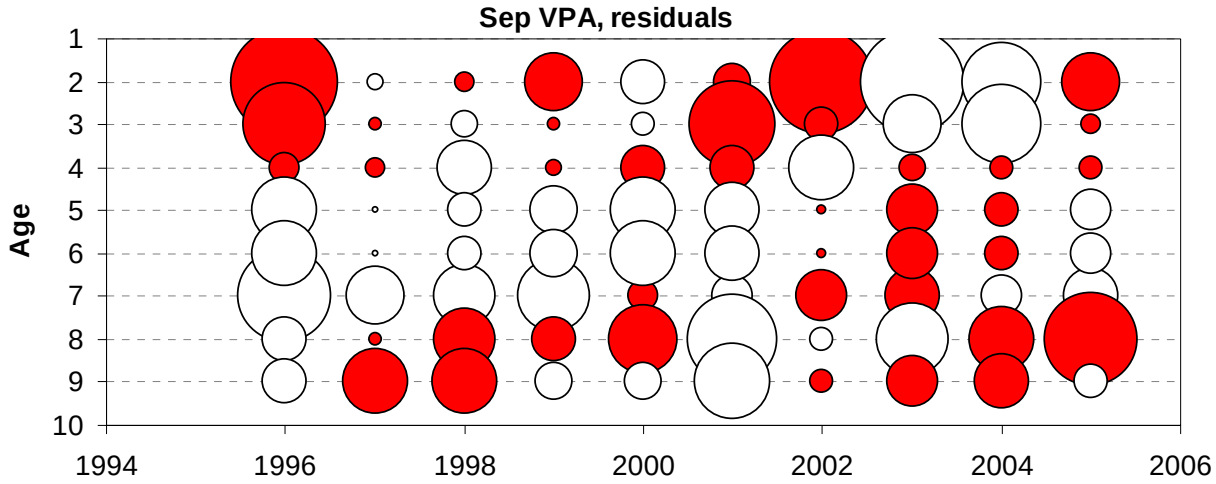


Figure 3.14. Sole IIIa. Residuals from a separable VPA on ages 2 to 10 with terminal F of 0.2 at age 5 (ref. age) and terminal S of 0.5.

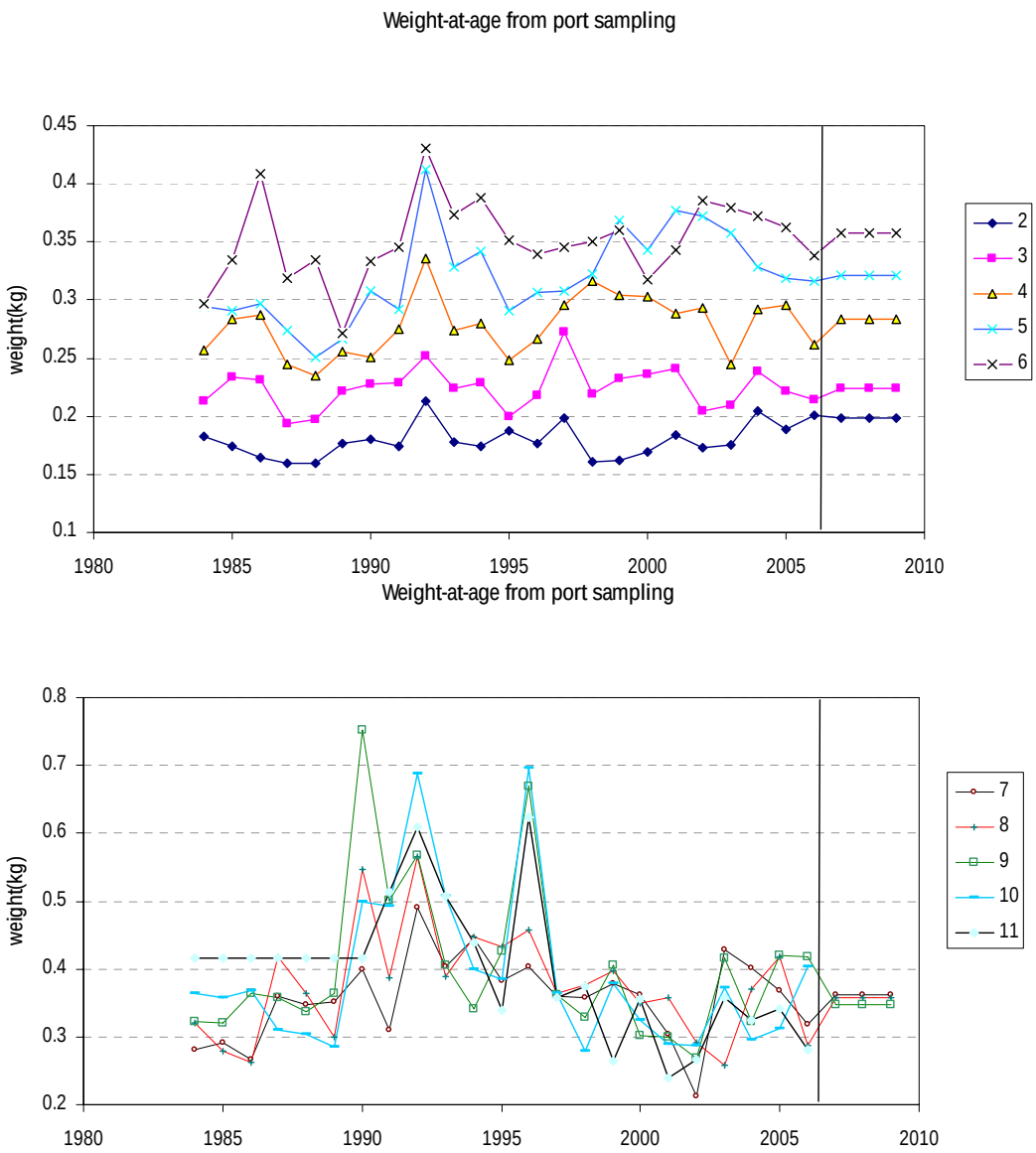


Figure 3.15. Sole IIIa. Landings weight-at-age. Weights right to the line in 2007-2009 are avg. weights used for short term prediction (Sec. 3.9).

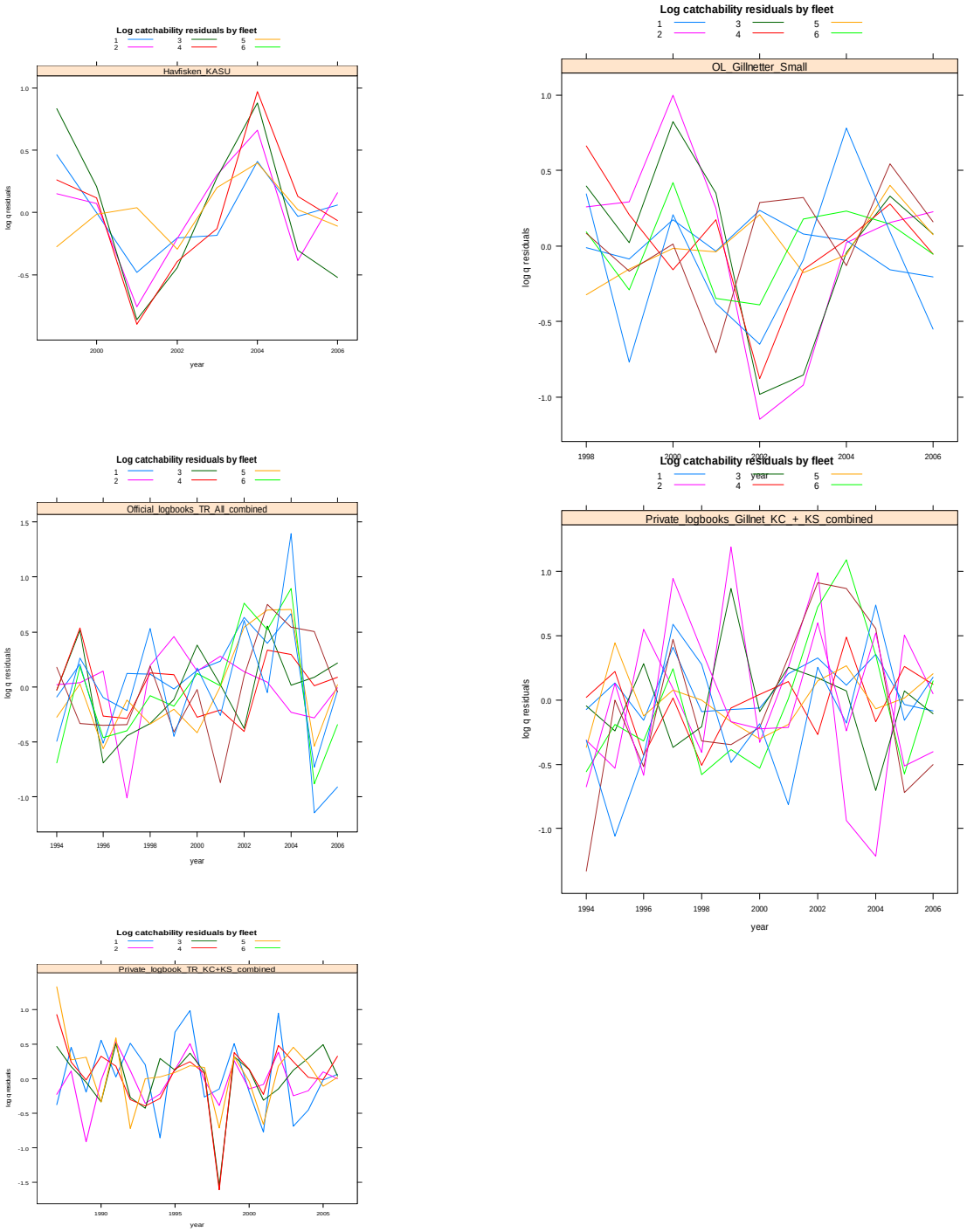


Figure 3.16. Sole IIIa. Log catchability residuals from single fleet runs using F shrinkage equal to 1.5.

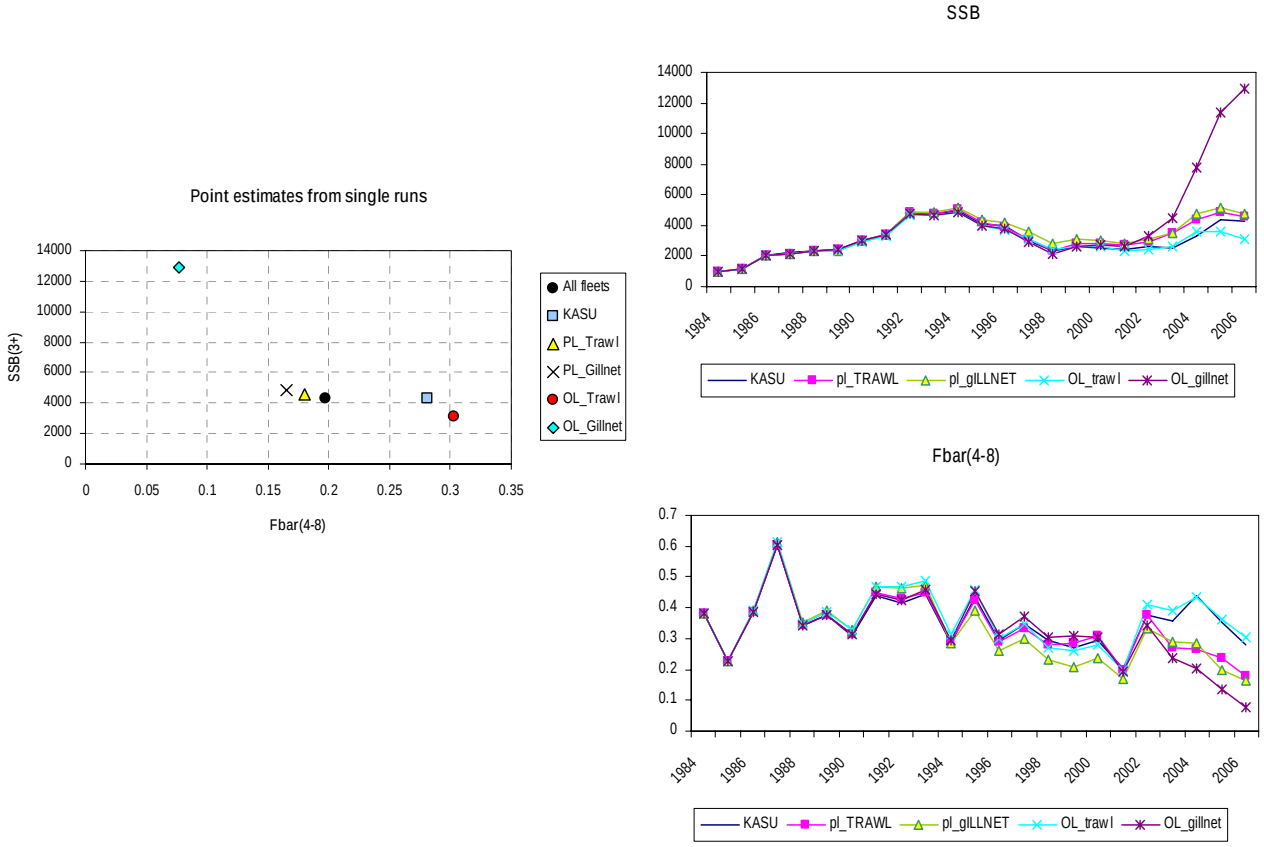


Figure 3.17. Sole IIIa. Estimated SSB and fishing mortality from single fleet runs.

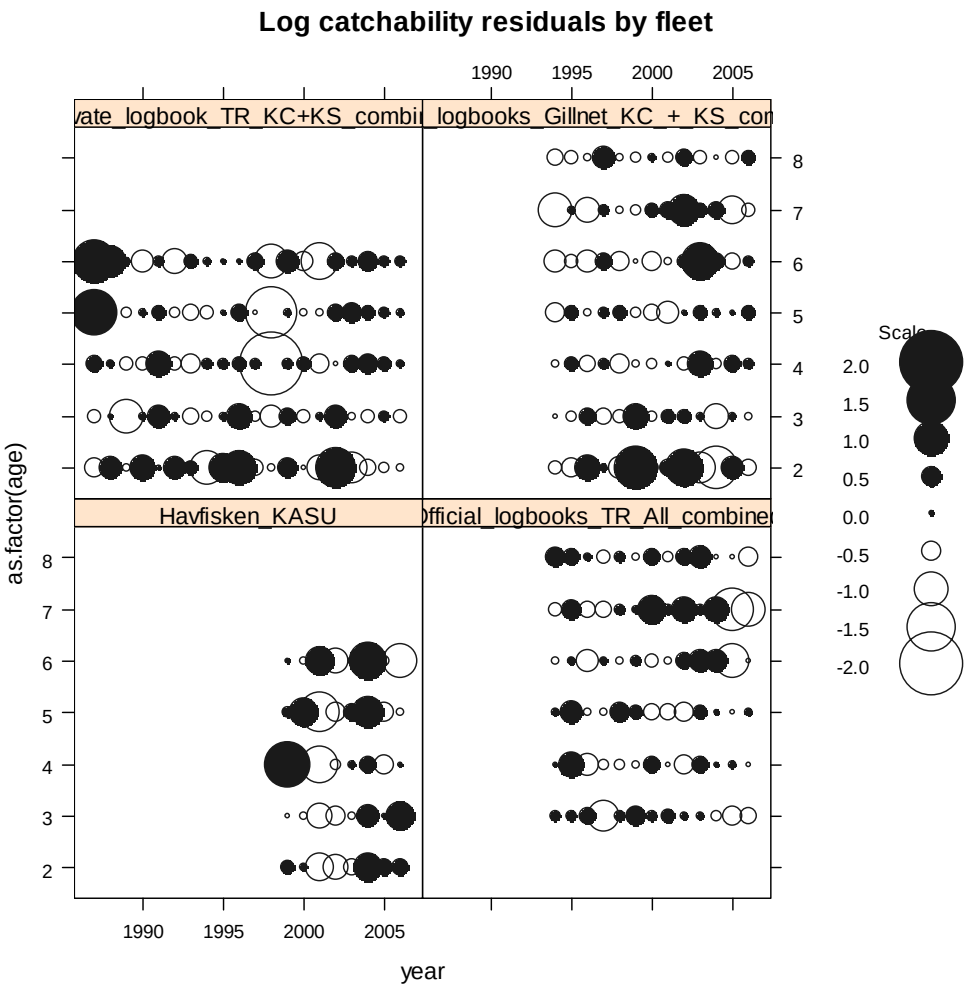


Figure 3.18. Sole IIIa. Log catchability residuals from final XSA run.

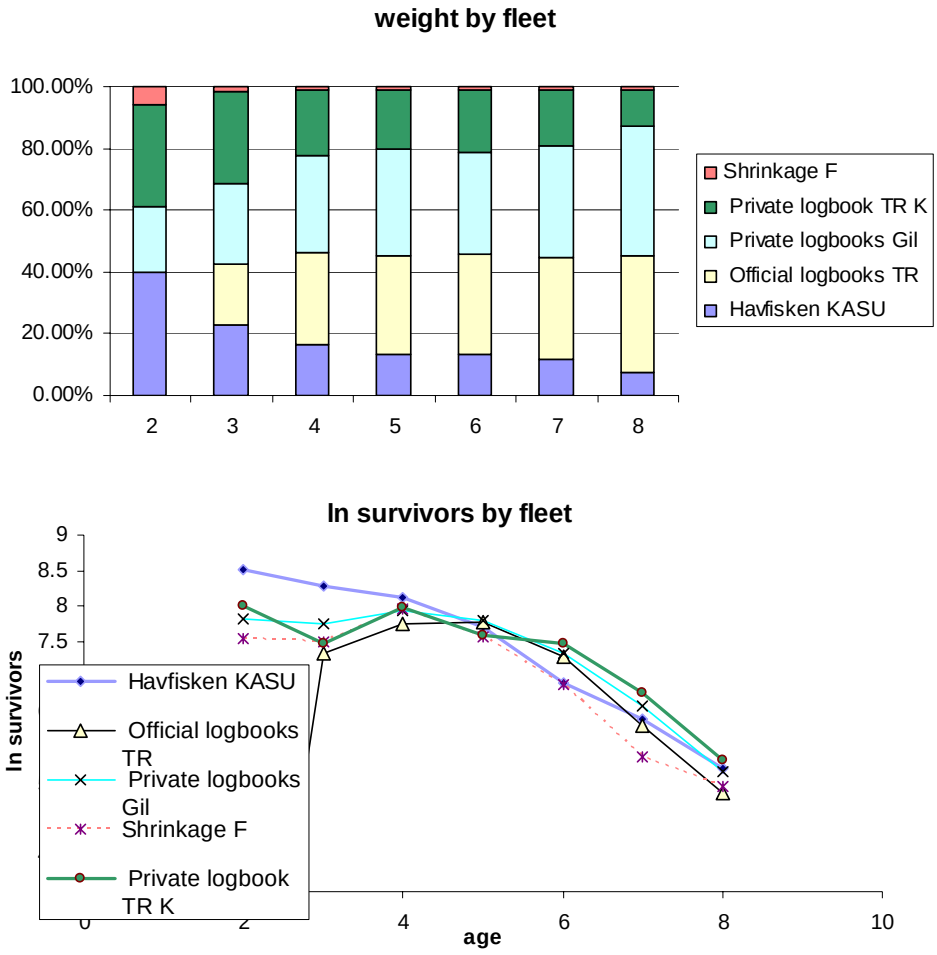


Figure 3.19. Sole IIIa. Diagnostics from final XSA run; upper: fleet weight in estimation of terminal year F and survirvors by age, lower: terminal year ln(survirvors) estimates by fleet and age

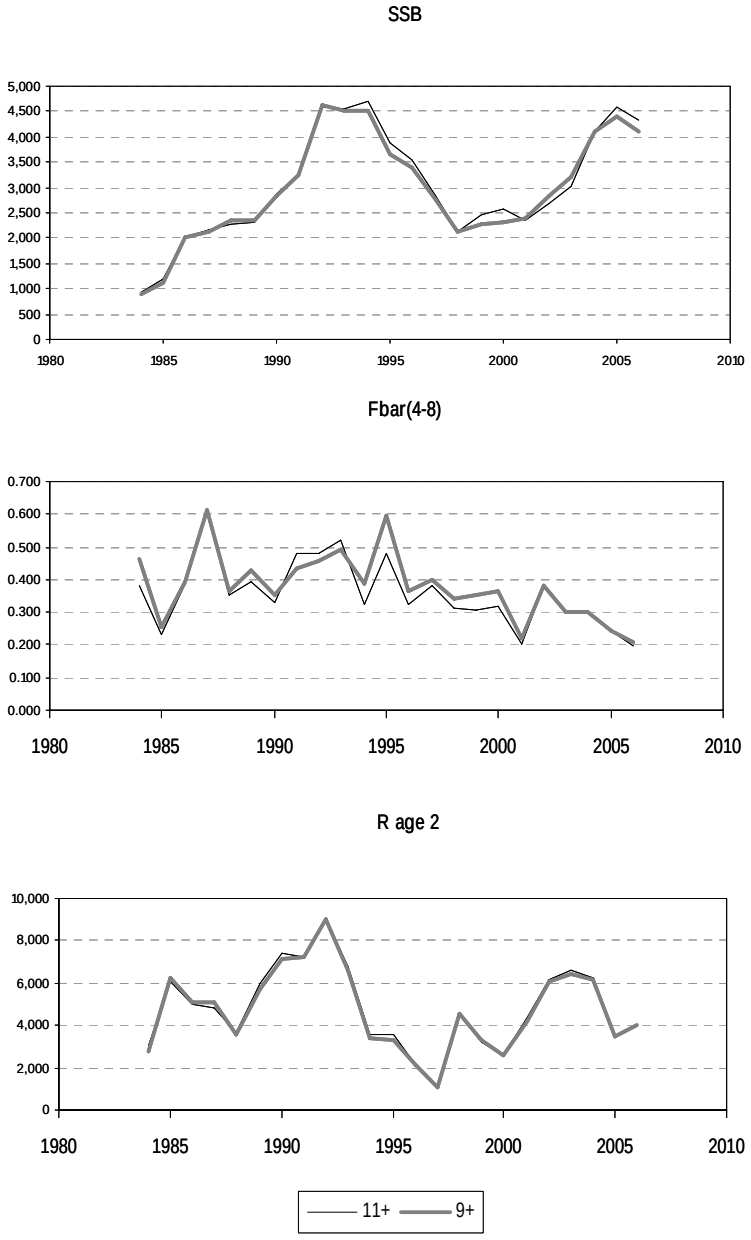


Figure 3.20. Sole IIIa. Estimates of SSB, F and R from XSA with ages 2-9+ versus XSA with ages 2-11+.

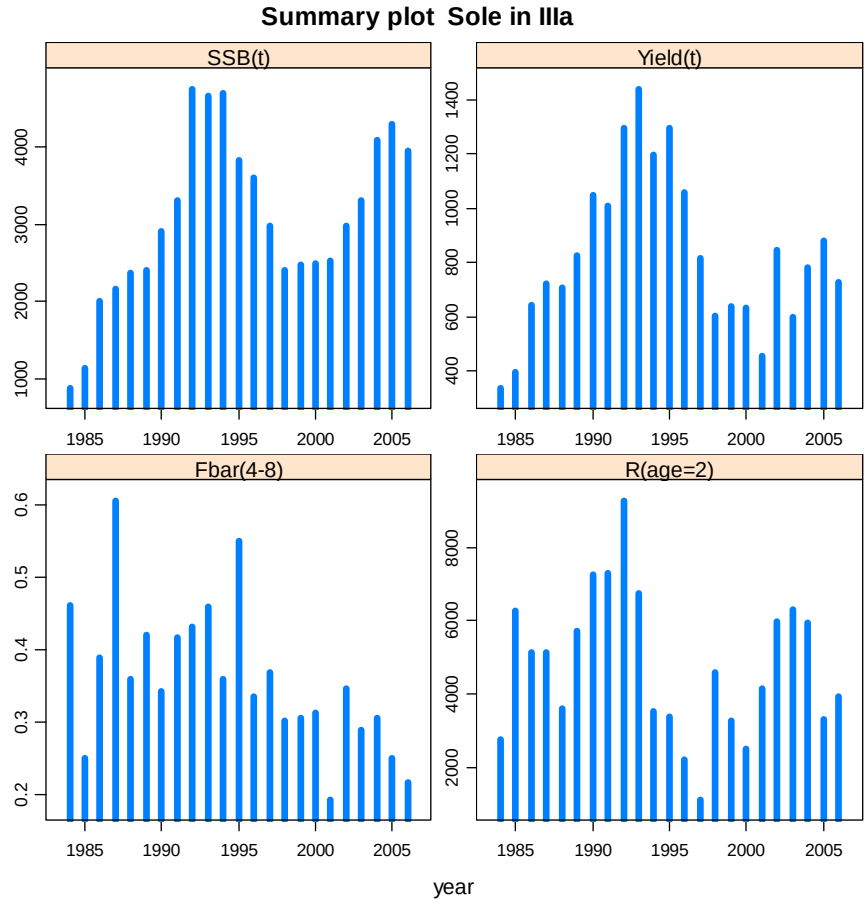


Figure 3.21. Sole IIIa. Stock summary from final XSA.

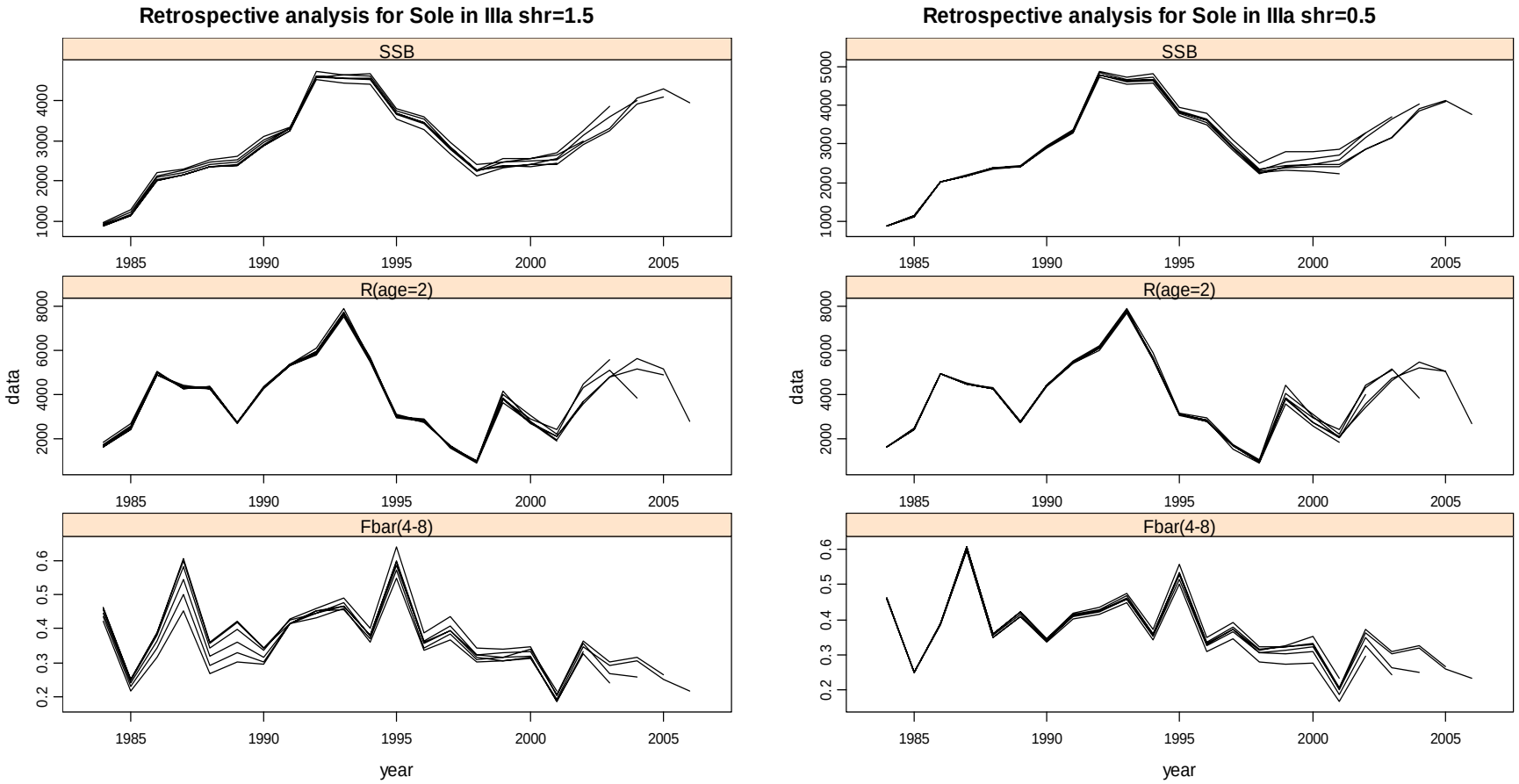


Figure 3.22. Sole IIIa. Retrospective analyses of R, SSB and F for F shrinkage of 0.5 and 1.5. Shrinkage = 1.5 is used for final run.

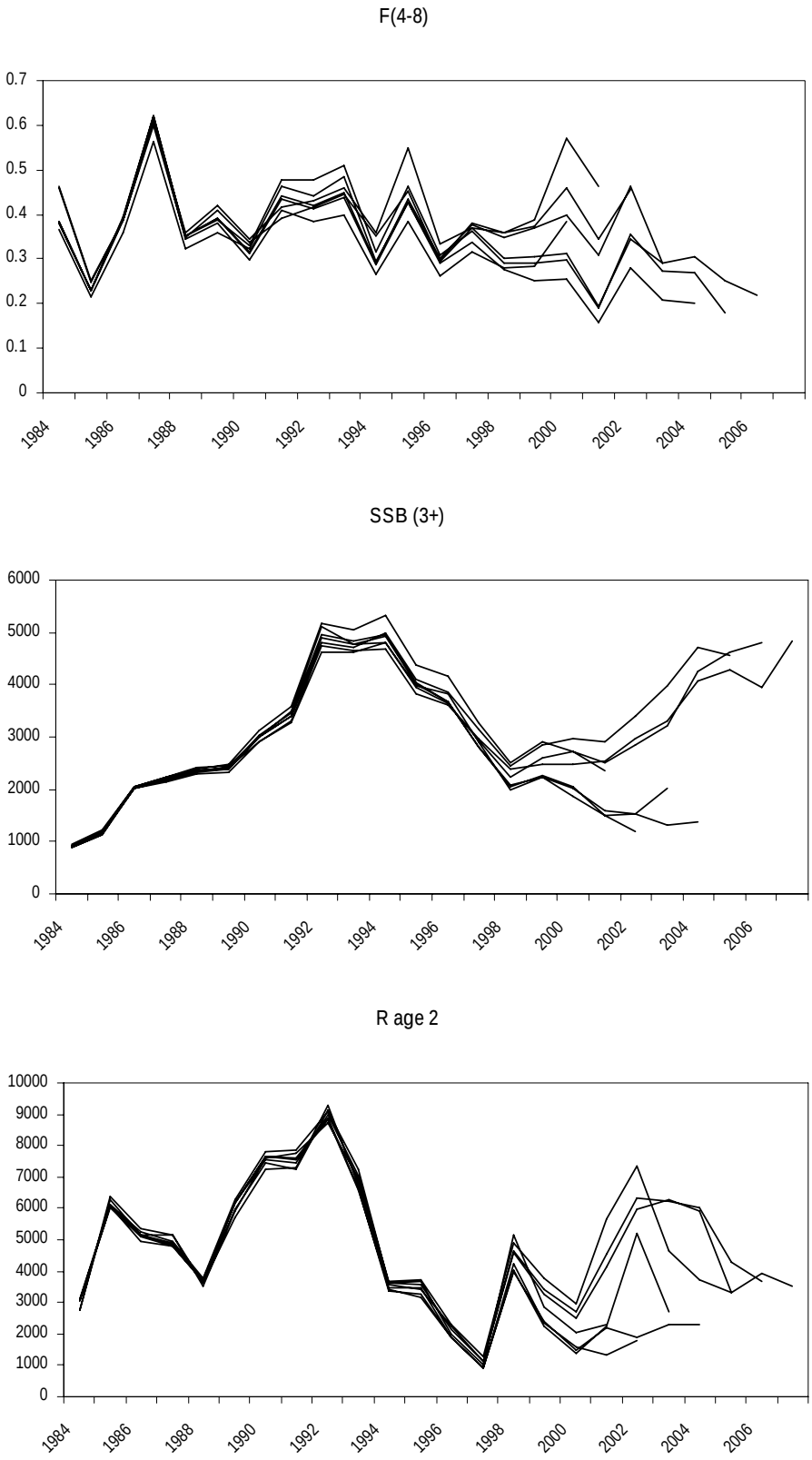


Figure 3.23 Sole IIIa. Historical retrospective plot of F, SSB and recruitment.

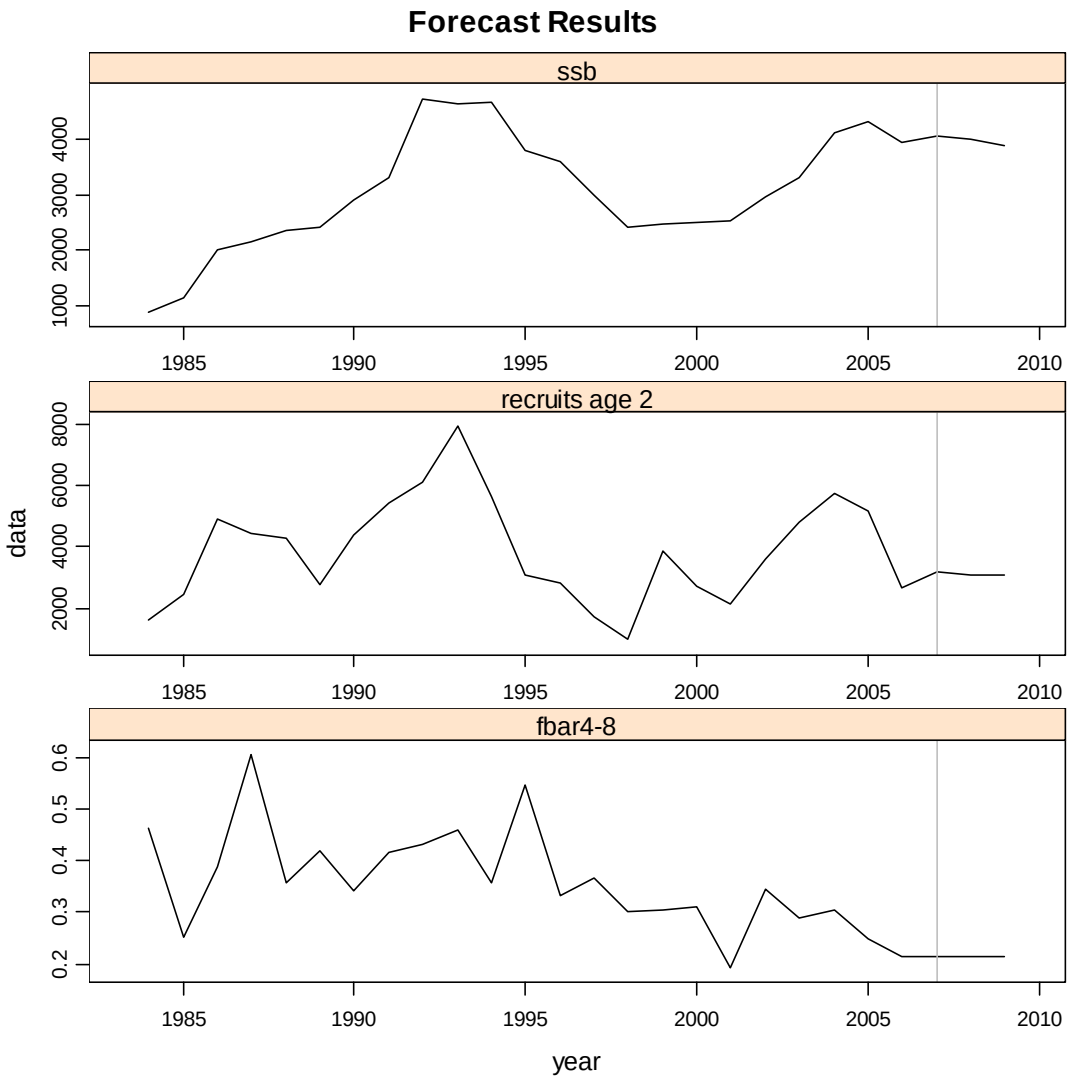


Figure 3.24. Sole IIIa. Forecasts of SSB and recruitment assuming status quo F and R as gm(1994-2004).

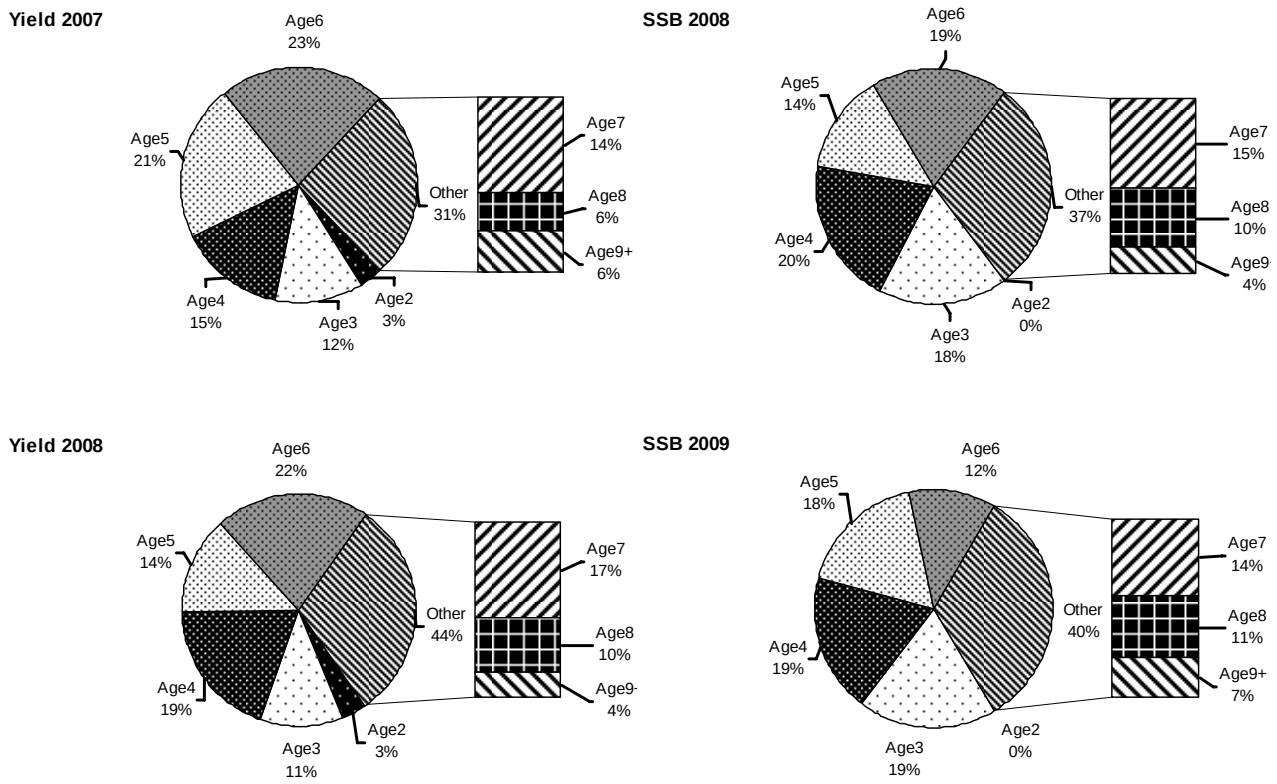
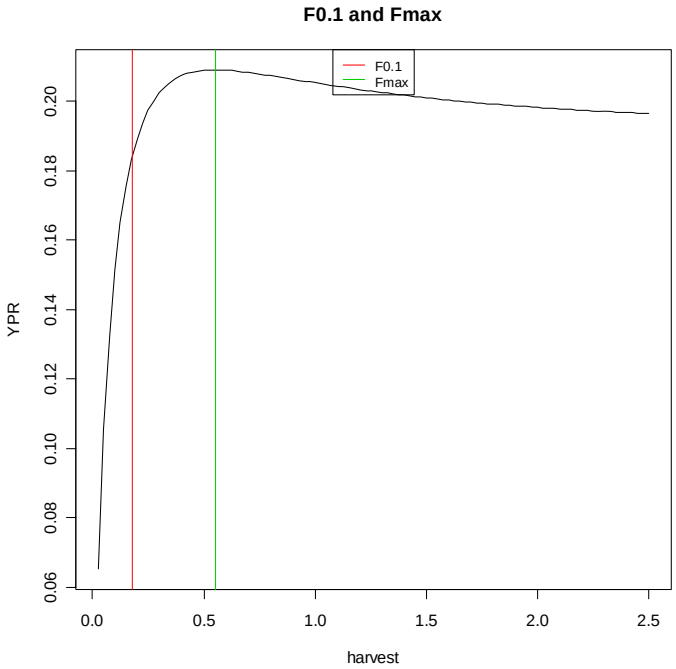


Figure 3.25. Sole IIIa. Short-term forecast for 2007-2009. Yield and SBB at age 2-9+ for status quo fishing mortality.



Reference point estimates from Y/R

	Fbar(4-8)	Yield	R	SSB
f0.1	0.178	0.184	1.000	1.062
fmax	0.551	0.209	1.000	0.477
spr.30	0.213	0.192	1.000	0.942
msy	0.551	0.209	1.000	0.477

Figure 3.26. Sole IIIa. Yield per recruit curve and reference point estimates.

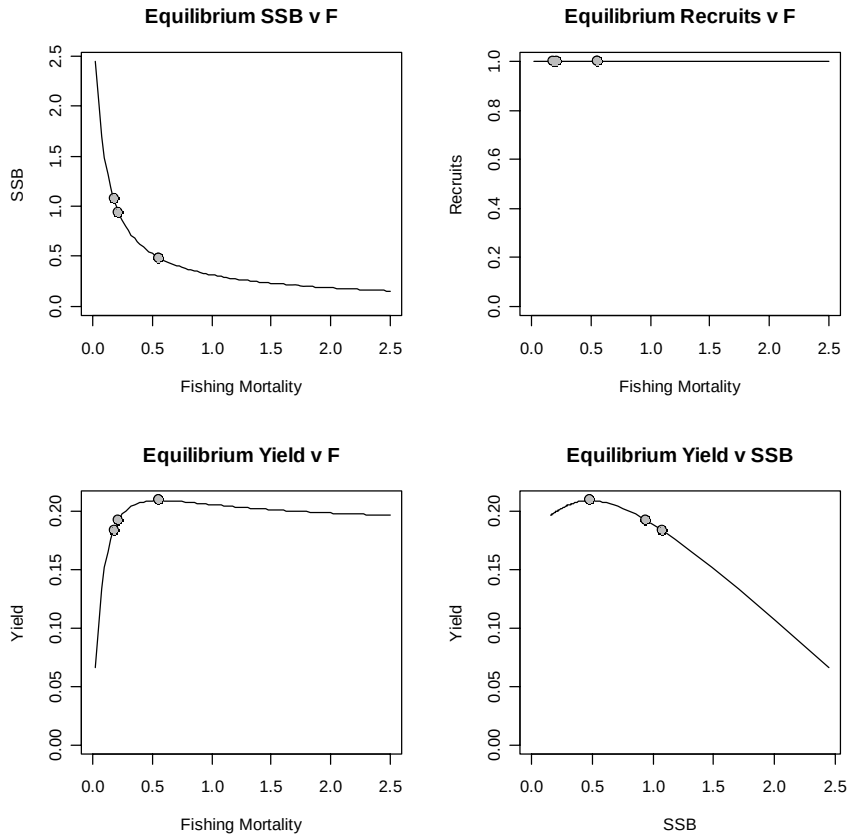


Figure 3.27. Sole IIIa. Equilibrium plots of SSB, F, recruitment and yield from Y/R analysis. The reference points $F_{0.1}$, 30%SPR and F_{max} are shown. Fsq is 0.22.

4 Flounder

In the Baltic Sea there are several distinct flounder stocks (populations). The migrations between the mature flounder stocks are limited. Details can be found in Appendix 7.

On average about 50%, 20% and 15% of the flounder landings are reported respectively from Subdivisions 24 + 25, 26 and 22. Total landings fluctuated between 8 400 t and 19600 t (Table 4.1, Figure 4.2.1). The highest landings were recorded in 2002 and 2005. During the mid-1990s flounder landings were misreported, mainly for Subdivisions 24 and 25. The landings in 2006 were about 16570 tonnes in total. This means a decrease of about 3000 tonnes from 2005. The decrease in 2003 was mainly due to the prolonged summer ban for cod trawl fishery which usually has flounder as by-catch.

An experimental length based SURBA stock assessment was tried for flounder in Subdivisions 24.

For the stocks in Subdivisions 24, 25, 26, 28, 29, and 32 landing numbers and weight at age data were submitted.

4.1 Flounder in Subdivision 22

4.1.1 Landings

The total landing amounted to about 650 t in 2006, a further decrease compared to the previous years.

4.1.2 Age composition

Landing number and weight at age data were not available.

4.2 Flounder in Subdivisions 24 and 25

4.2.1 The fishery

4.2.1.1 Catch trends

The landings decreased from about 12100 t in 2005 to about 10800 t in 2006.

Total landings of the stock fluctuated between about 4 300 t and 12100 t (Table 4.1, Table 4.2.1 and Figure 4.2.1). Some landings in the mid-1990s are misreported (over-reported) from the cod fishery. Peaks of the total landings occurred in 2002 and 2005. In 2003 the landing dropped to 8 500 t. This decrease compared to 2002 is partly due to the longer summer ban for cod trawl fishery and partly due to German trawlers did not target flounder in 2003. In 2004 the flounder landings increased again and reached about 10700 t. The Danish landings are mainly by-catch in the cod fishery. Germany in Sub-division 24 (by trawl) and Poland in Sub-division 25 (mainly by gillnet) have flounder directed fisheries.

Further information is given in the Appendix 7.

4.2.1.2 Unallocated landings

Unallocated landings were not reported.

4.2.1.3 Discards

Discard data were not available for all fleets, but preliminary analyses of Swedish by-catch and discard data (Gårdmark and Florin 2006) shows that the amount discarded in the demersal trawling for cod is very high and variable. Estimated discarded amounts of flounder are five to ten times greater than the amounts of landed by-catches of flounder in the cod trawl fishery.

German investigations on discard rates using a 130 mm bottom trawl compared with that of the BACOMA-net (escape window with 110 mm square meshes in the cod end) showed an increase in discard rates by 25-60 %, depending on trawling time (U. Berth, Institute for Baltic Sea Fisheries, Rostock, pers. Comm.). This means that with the implementation of the Fishery Rule to use exclusively the BACOMA-net in the cod fishery from 2004 onwards the flounder discard rates had increased.

As identified by the Workshop on alternative assessment strategies for flounder in the Baltic, WKAFAB (Gårdmark et al. 2007), discard estimates must be provided from all countries and included into any assessment based on catch data.

4.2.1.4 Effort and CPUE data

No data were available.

4.2.2 Biological composition of the commercial catch derived from age data

4.2.2.1 Age composition from otolith age determination

For 2006 commercial landing numbers at age data are available from Germany for Sub-division 24 (quarters 1, 3 and 4), from Poland for Subdivisions 24 and 25 and from Sweden in SD 25.

The catches in numbers at age from the Polish and German BITS surveys are given in tables 4.2.1.1 to 4.2.1.3.

4.2.2.2 Quality of catch data

The sampling effort is given in Table 4.2.2.

Because of the major age determination problems in flounder, especially from whole otoliths (see ICES 2007a), WGBFAS decided in 2006 that age data from whole otoliths shall not be used for assessment (ICES 2006a; see also Gårdmark et al. 2007).

Furthermore, due to the possible large importance of discards (see section 4.2.1.3) there can not be any assessment based on catch data before discards have been estimated.

To avoid both discard and age reading problems and following the recommendations of WKAFAB (Gårdmark et al. 2007) the assessment is based on length data from surveys (using SURBA). Moreover, large differences in growth for female and male flounder (Gårdmark and Florin 2007) suggest a separate assessment (see recommendations in Gårdmark et al. 2007)**.**

As a first approach the SURBA was done for female flounder from German BITS surveys in SD 24 quarter 1 where the longest time series was available.

How this data is compiled is presented and discussed in section in section 4.2.3 below.

4.2.3 Biological composition of survey catch derived from length data

Survey indices by sex and length class are only available for a longer time period from the German BITS in sub-division 24 in quarter 1. Catches of females per unit effort (in numbers

per hour) per length class were compiled as average catch per unit effort across 10 m depth strata from 10m depth on, weighted by the area of each depth stratum. Catch per unit effort (cpue) indices obtained from HG 20 trawl was converted to TVS equivalent indices by using the conversion factor (0.90) for flounder based on the mean horizontal net opening during haul, as derived by the WGBIFS (ICES 2007b). The total cpue of females from the German q1 BITS in sub-division 24 has been fluctuating substantially between years since 2000 (Figure 4.2.3.1). This can either indicate poor spatial and/or temporal coverage of the survey, or be related to the introduction of TVS gear, for which calibration hauls (omitted from the analysis) started in 2000 and which was used regularly from 2001.

4.2.3.1 Age composition from survey length distributions

Gårdmark and Florin (2007) estimated von Bertanlanffy growth parameters from ages determined using sliced otoliths for samples from sub-divisions 23, 24, 25, 27, and 28. The parameters for sub-division 24 (Linf=372, k=0.4, t0=-0.33; non-linear regression: N=16, r2=0.76) were used to derive predicted length class intervals that are equivalent to different ages (age 0: 50-140 mm, age 1: 150-210 mm, age 2: 220-260 mm, age 3: 270-300 mm, age 4: 310-320 mm, age 5: 330 mm, age 6: 340 mm, age 7: 350 mm, age 8+: > 360 mm). Since individuals older than seven years grow less than a centimetre per year, these older ages cannot be distinguished from each other in the BITS since length measurements are done down to centimetre only, and these were therefore pooled to a plus-group. We denote the ages derived using a growth model “age equivalents”.

Resulting catch per unit effort indices per age equivalent are presented in Table 4.2.3.2 and catch curves for cohorts derived from the age equivalents are presented in Figure 4.2.3.1. Age equivalent 3 is fully recruited to the survey, and for many cohorts also age equivalent 2. For older ages, however, the cpue increase with age (Figure 4.2.3.2). This could be either due to erroneous “slicing” of length classes into age equivalents, or inadequate survey coverage for areas with younger (smaller) flounder, leading to underestimation of these ages (sizes). Indeed, consistency plots of the correlation between consecutive age equivalents show poor correlation between age equivalents 2 vs.3, and 3 vs. 4 (Figure 4.2.3.3). For older ages the consistency is better, with the exception of the plus group (Figure 4.2.3.3). Thus, the inability to follow cohorts at older ages (Figure 4.2.3.2) does not vary much between years. Based on the catch curves (Figure 4.2.3.2) age equivalents 2 to 5 are chosen for the assessment.

4.2.3.2 Mean weight at age from survey length distributions

Mean weight for an age equivalent was derived from German BITS SD 24 quarter 1 data as a weighted average over all length classes in the interval corresponding to that age (Table 4.2.3.3). The mean weights per age equivalent (and hence mean weight at length) are remarkably stable between years (Figure 4.2.3.4), indicating no drastic changes in the condition of females in the stock. Weights were not available for 1992. Because of the low variation between years, they were readily assumed to be identical to weights in 1993.

4.2.3.3 Maturity at age from survey length distributions

Proportion mature was determined from the German BITS SD 24 quarter 1 data where individuals had been assigned to an age equivalent according to their length (see section 4.2.3.1). The proportion mature used in the assessment is presented in Table 4.2.3.4.

4.2.3.4 Natural mortality

Natural mortality was assumed to be 0.2 for all age equivalents and years.

4.2.3.5 Quality of biological data from survey length distributions

The small sample size to which the growth model is fitted, and the sharp "slicing" of length distributions into age equivalents assuming no overlap in length distributions between ages, makes the catch per unit effort per age equivalents sensitive to variation in growth. Age determination of more individuals from sub-division 24 using sliced/stained otoliths is necessary to ensure a better growth model. Future improvements should also include converting length based cpue data into age equivalents by separating length distributions into Gaussian components, to replace the "slicing" method.

The assignment of females to gonad status 2 on the BITS scale from the national 8-graded scale is not unequivocal (U. Berth, Institute for Baltic Sea Fisheries, Rostock, pers. comm.), since status 2 may include individuals that are maturing but will not reach maturity within the sampled year. Hence, the proportions mature derived (assuming all individuals with gonadal status >1 are mature) is an overestimation. In future assessments maturity ogives should be derived directly from fine-scaled national data used in the respective sub-divisions.

4.2.3.6 Catch at age analysis (SURBA) for SD 24 flounder

A survey based statistical catch at age analysis using SURBA versions 2.1 and 3.0 (Needle 2004) was made to estimate relative stock trends, and total mortality trends. The survey indices (Table 4.2.3.2) were smoothed, using smoothing parameter rho=2, before model fitting (Figure 4.2.3.5). This is known as index smoothing, and is less arbitrary than "SSQ-smoothing" based on the parameter lambda (Needle 2004). Based on the catch curves (Figure 4.2.3.2) catchability was set to 0.8 for age equivalent 2, and to 1 for age equivalents 3-5. Because of the high variability in indices for some age equivalents (see Figure 4.2.3.3), they were weighted according to their inverse variance. Since no negative age effects were found (Figure 4.2.3.6b), the estimation was set to be unconstrained to enable derivation of S.E. of the parameter estimates (see Needle 2004 for details).

The estimated temporal trend, age and cohort effects are presented in Figure 4.2.3.6, and the mean mortality and SSB in Figure 4.2.3.7. The residuals for the log survey indices show a good fit until 2000 (Figure 4.2.3.8), without any clear year or age effects. From 2000 onwards the residuals are considerably larger (Figure 4.2.3.8). In particular for age equivalent three there is a clear increasing trend (Figure 4.2.3.8). The relative average total mortality for age equivalents 3-5 is stable until 2000, whereafter it starts to fluctuate highly (Figure 4.2.3.7b). The trend in relative SSB (Figure 4.2.3.7a) based on the age equivalents 2-5 closely follows the total cpue in the survey for all ages (Figure 4.2.3.1b), with very small relative stock sizes in 2001 and 2004 (Figure 4.2.3.7a). However, the high variability in the survey indices from 2000 (Figure 4.2.3.1b, Figure 4.2.3.5), and the large residuals for the same time period (Figure 4.2.3.8) show that the survey is not a reliable estimate of flounder stock size after 2000.

The retrospective temporal trends, effects, mean mortality, relative SSB, and relative recruitment (at age equivalent two) show no large retrospective bias (Figure 4.2.3.9). The trend in relative recruitment closely follows that of relative SSB (Figure 4.2.3.9e-f), which is to be expected given that all individuals of age equivalent 2 are assumed to be mature and catchability of them are set to 0.8.

4.2.4 Historical stock trends

Only an exploratory SURBA for SD 24 female flounder was presented in 2007.

4.2.5 Quality of assessment

Only an exploratory SURBA for SD 24 female flounder was presented in 2007.

4.2.6 Comparison with previous assessment

The exploratory assessment in 2007 is not compared with the assessment in the previous year since in 2006 there was no analytical assessment, and in 2005 it was based on age determinations using whole otoliths (see ICES 2006a, and 2007a for comments on this). Furthermore, the SURBA assessment could be made for SD 24 flounder, only.

4.3 Flounder in Subdivision 26

4.3.1 Landings

In 2006 the total landing of about 3.600 t means an 800 t decrease compared to 4400 t in 2005. The main fishing countries in this area are Poland, Russia and Lithuania. As in the previous years the Polish fishery was mainly a gillnet fishery along the coast whereas the Russian and Lithuanian landings were by-catches mainly in a bottom trawl mix-fishery. Total landings in Subdivision 26 increased since 1999.

4.3.2 Catch at age in number and mean weight at age

Poland and Russia supplied number at age and weight at age data in the catch.

4.4 Flounder in Subdivision 28

4.4.1 Landings

The total landings amounted to 940 t in 2006, a 600 t decrease compared to 2005, the year with the highest landings since 1976. Landings in Latvia have decreased by 800 t. Latvian landings were mainly taken as by-catches in the bottom trawl mix-fishery

4.4.2 Catch at age in number and mean weight at age

Estonia and Latvia supplied landing number and weight at age data by quarter..

4.5 Flounder in Subdivisions 29 and 30

4.5.1 Landings

In Subdivision 29 the flounder fishery is carried out by Estonia, Finland and Sweden. In 2006 180 t were landed in SD 29. Landings in Subdivision 29 have been steadily decreasing since 1999.

For Subdivision 30, 4 tonnes were reported.

The procedure for estimating the proportion of recreational landings relative to commercial landings has been revised in 2002. This revision is based on the results of an angler survey in Finland in 2002. This survey showed that approximately 80 % of the Finnish landings from Subdivisions 29 and 30 are from non-commercial (i.e. recreational angling) catches. This proportion has been applied since 2002.

4.5.2 Catch at age in numbers and mean weight at age

Estonia supplied landing number and weight at age data by quarter for Subdivision 29.

4.6 Flounder in Subdivision 32

4.6.1 Landings

The flounder fishery in this area is carried out by Finland and Estonia.

The total landings of about 130 t remained unchanged compared to 2005. This is a steep decrease (about 75 %) compared to 2001 and the years before. The reason is the reduced proportion of non-commercial landings to the total Finish landing as estimated by the enquiry in 2002 (see also Section 4.5).

4.6.2 Catch at age in numbers and mean weight at age

Landing number and mean weight at age data by quarter were provided by Estonia.

Table 4.1a **Flounder in the Baltic Sea.**
Total landings (tons) 1973-1980 by Subdivision and country.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1973	Denmark	1.983		386									2.369
	Finland												0
	Gem. Dem. Rep.	181		1.624	1.516								3.321
	Gem. Fed. Rep.	349		4									353
	Poland				1.580	2.070							3.650
	Sweden				502								502
	USSR							2.610					2.610
	Total	2.513	0	2.014	3.598	2.070	0	2.610	0	0	0	0	12.805
1974	Denmark	2.097		2.578									4.675
	Finland												0
	Gem. Dem. Rep.	165		1.482	654								2.301
	Gem. Fed. Rep.	304		3									307
	Poland				1.635	2.473							4.108
	Sweden				470								470
	USSR							2.510					2.510
	Total	2.566	0	4.063	2.759	2.473	0	2.510	0	0	0	0	14.371
1975	Denmark	1.992		1.678									3.670
	Finland								113	22		47	182
	Gem. Dem. Rep.	163		1.469	406								2.038
	Gem. Fed. Rep.	469		1									470
	Poland				1.871	2.585							4.456
	Sweden				400								400
	USSR							6.455					6.455
	Total	2.624	0	3.148	2.677	2.585	0	6.455	113	22	0	47	17.671
1976	Denmark	2.038		482									2.520
	Finland								118	23		59	200
	Gem. Dem. Rep.	174		1.556	901								2.631
	Gem. Fed. Rep.	392		2									394
	Poland				1.549	2.289							3.838
	Sweden				400								400
	USSR					471		1.779	409			359	3.018
	Total	2.604	0	2.040	2.850	2.760	0	1.779	527	23	0	418	13.001
1977	Denmark	1.974		389									2.363
	Finland								115	32		56	203
	Gem. Dem. Rep.	555		2.708	1.096								4.359
	Gem. Fed. Rep.	393		4									397
	Poland				2.071	2.089							4.160
	Sweden				416								416
	USSR					210		1.081	321			414	2.026
	Total	2.922	0	3.101	3.583	2.299	0	1.081	436	32	0	470	13.924
1978	Denmark	2.965		415									3.380
	Finland								174	61		155	390
	Gem. Dem. Rep.	348		2.572									2.920
	Gem. Fed. Rep.	477		1									478
	Poland				996	2.106							3.102
	Sweden				346								346
	USSR					288		1.290	334			395	2.307
	Total	3.790	0	2.988	1.342	2.394	0	1.290	508	61	0	550	12.923
1979	Denmark	2.451		405									2.856
	Finland								192	54		153	399
	Gem. Dem. Rep.	189		2.509									2.698
	Gem. Fed. Rep.	259		3									262
	Poland				1.230	1.860							3.090
	Sweden				315								315
	USSR					158		1.170	330			1.012	2.670
	Total	2.899	0	2.917	1.545	2.018	0	1.170	522	54	0	1.165	12.290
1980	Denmark	2.185		286									2.471
	Finland								194	69		165	428
	Gem. Dem. Rep.	138		2.775									2.913
	Gem. Fed. Rep.	212		1									213
	Poland				1.613	1.380							2.993
	Sweden			16	46		20	181	32				295
	USSR					93		798	334			1.080	2.305
	Total	2.535	0	3.078	1.659	1.473	20	979	560	69	0	1.245	11.618

* Denmark: Catches of SD 23 are included in SD 22 & catches of SDs 28&29 are included in SD 27
Sweden: Catches of SDs 24-29 of the years 1973-1979 are included in SD 25
Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Gem. Dem. Rep. Catches of SD 26 are included in SD 25
Gem. Fed. Rep. Catches of SD 25 are included in SD 24
Poland Catches of SD 24 are included in SD 25

Table 4.1b **Flounder in the Baltic Sea.**
Total landings (tons) 1981-1988 by Subdivision and country.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1981	Denmark	1.964		548									2.512
	Finland								227	56		135	418
	Gem. Dem. Rep.	271		2.595									2.866
	Gem. Fed. Rep.	351		1									352
	Poland				1.151	1.541							2.692
	Sweden			21	30		21	194	34				300
	USSR					58		742	445			1.078	2.323
	Total	2.586	0	3.165	1.181	1.599	21	936	706	56	0	1.213	11.463
1982	Denmark	1.563	104	257									1.924
	Finland								219	58		144	421
	Gem. Dem. Rep.	263		3.202									3.465
	Gem. Fed. Rep.	248		1									249
	Poland				2.484	1.623							4.107
	Sweden			22	33		65	16	3				139
	USSR					195		665	615			1.121	2.596
	Total	2.074	104	3.482	2.517	1.818	65	681	837	58	0	1.265	12.901
1983	Denmark	1.714	115	450									2.279
	Finland								181	67		120	368
	Gem. Dem. Rep.	280		3.572									3.852
	Gem. Fed. Rep.	418		1									419
	Poland				1.828	905							2.733
	Sweden			72	108		212	52	9				453
	USSR					209		551	497			1.114	2.371
	Total	2.412	115	4.095	1.936	1.114	212	603	687	67	0	1.234	12.475
1984	Denmark	1.733	85	306									2.124
	Finland								174	108		135	417
	Gem. Dem. Rep.	349		2.719									3.068
	Gem. Fed. Rep.	371		1									372
	Poland				2.471	1.288							3.759
	Sweden			18	27		53	13	2				113
	USSR					145		202	286			1.226	1.859
	Total	2.453	85	3.044	2.498	1.433	53	215	462	108	0	1.361	11.712
1985	Denmark	1.561	130	649									2.340
	Finland								157	97		137	391
	Gem. Dem. Rep.	236		3.253									3.489
	Gem. Fed. Rep.	199		4									203
	Poland				2.063	1.302							3.365
	Sweden			16	24		47	12	2				101
	USSR					268		189	265			806	1.528
	Total	1.996	130	3.922	2.087	1.570	47	201	424	97	0	943	11.417
1986	Denmark	1.525	65	1.558									3.148
	Finland								199	128		181	508
	Gem. Dem. Rep.	127		2.838									2.965
	Gem. Fed. Rep.	125		10									135
	Poland				3.030	1.784							4.814
	Sweden			20	31		60	15	3				129
	USSR					442		159	281			556	1.438
	Total	1.777	65	4.426	3.061	2.226	60	174	483	128	0	737	13.137
1987	Denmark	1.208	122	1.007									2.337
	Finland								159	106		143	408
	Gem. Dem. Rep.	71		2.096									2.167
	Gem. Fed. Rep.	114		11									125
	Poland				2.530	1.745							4.275
	Sweden			17	26		51	13	2				109
	USSR					1.315		203	279			397	2.194
	Total	1.393	122	3.131	2.556	3.060	51	216	440	106	0	540	11.615
1988	Denmark	1.162	125	990									2.277
	Finland								177	118		159	454
	Gem. Dem. Rep.	92		2.981									3.073
	Gem. Fed. Rep.	133		5									138
	Poland				1.728	1.292							3.020
	Sweden			23	35		68	17	3				146
	USSR					578		439	257			331	1.605
	Total	1.387	125	3.999	1.763	1.870	68	456	437	118	0	490	10.713

* Denmark: Catches 1981 of SD 23 are included in SD 22 & catches of SDs 28&29 are included in SD 27
Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Gem. Dem. Rep. Catches of SD 26 are included in SD 25
Gem. Fed. Rep. Catches of SD 25 are included in SD 24
Poland Catches of SD 24 are included in SD 25

Table 4.1c **Flounder in the Baltic Sea.**
Total landings (tons) 1989-1995 by Subdivision and country.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1989	Denmark	1.321	83	1.062									2.466
	Finland								175	122		163	460
	Gem. Dem. Rep.	126		3.616									3.742
	Gem. Fed. Rep.	122		2									124
	Poland				1.896	1.089							2.985
	Sweden			22	34		66	16	3				141
	USSR					783		512	214			214	1.723
	Total	1.569	83	4.702	1.930	1.872	66	528	392	122	0	377	11.641
1990	Denmark	941		1.389									2.330
	Finland								219	81		161	461
	Gem. Dem. Rep.	52		1.622									1.674
	Gem. Fed. Rep.	183		10									193
	Poland				1.617	599							2.216
	Sweden				120								120
	USSR					752		390	144			141	1.427
	Total	1.176	0	3.021	1.737	1.351	0	390	363	81	0	302	8.421
1991	Denmark	925		1.497									2.422
	Finland								236	81		167	484
	Germany	246		1.814									2.060
	Poland				2.008	1.905							3.913
	Sweden			24	31		88	20					163
	Estonia					49		1	135			51	236
	Latvia					123		323					446
	Lithuania					125							125
	Russia					216		10					226
	Total	1.171	0	3.335	2.039	2.418	88	354	371	81	0	218	10.075
1992	Denmark	713	185	975									1.873
	Finland								405	40		627	1.072
	Germany	227		1.972									2.199
	Poland				1.877	1.869							3.746
	Sweden			41	88	3	86	11	3				232
	Estonia							47	47			46	140
	Latvia					26		664					690
	Lithuania					399							399
	Russia					146							146
	Total	940	185	2.988	1.965	2.443	86	722	455	40	0	673	10.497
1993	Denmark	649	194	635									1.478
	Finland								438	57		683	1.178
	Germany	235		1.230									1.465
	Poland				3.276	1.229							4.505
	Sweden		26	27	63	1	83	10					210
	Estonia							52	86			55	193
	Latvia					99		389					488
	Lithuania					155							155
	Russia					225							225
	Total	884	220	1.892	3.339	1.709	83	451	524	57	0	738	9.897
1994	Denmark	882	181	1.016									2.079
	Finland								445	33		87	565
	Germany	44		4.262		2		3					4.311
	Poland				3.177	1.266							4.443
	Sweden		84	20	18	37	33	55	10				257
	Estonia								3			4	7
	Latvia					31		276					307
	Lithuania					218							218
	Russia					167							167
	Total	926	265	5.298	3.195	1.721	33	334	458	33	0	91	12.354
1995	Denmark	859	231	2.110									3.200
	Finland								398	28		131	557
	Germany	286		2.825		4		40					3.155
	Poland				7.437	1.482							8.919
	Sweden		58	28	186	7	81	18					378
	Estonia				8			16	52			35	111
	Latvia					39		322					361
	Lithuania				8	187							195
	Russia					271							271
	Total	1.145	289	4.963	7.639	1.990	81	396	450	28	0	166	17.147

* Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Denmark: Catches of SDs 28&29 are included in SD 27
Gem. Dem. Rep. Catches of SD 26 are included in SD 25
Gem. Fed. Rep. Catches of SD 25 are included in SD 24
Germany Catches of SD 25 are included in SD 24
Poland/Latvia Catches of SD 24 are included in SD 25

Table 4.1d **Flounder in the Baltic Sea.**
Total landings (tons) 1996-2001 by Subdivision and country.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1996	Denmark	1.041	227	2.306									3.574
	Finland				1				365	78		271	715
	Germany	189		1.322		10		9					1.530
	Poland				6.069	2.556							8.625
	Sweden	2	58	101	718	48	114	31					1.072
	Estonia							44	99			145	288
	Latvia					74		215					289
	Lithuania					316							316
	Russia					740							740
	Total	1.232	285	3.729	6.788	3.744	114	299	464	78	0	416	17.149
1997	Denmark	1.356		2.421	31	10							3.818
	Finland				1				283	69		299	652
	Germany	655		1.982		12		4					2.653
	Poland				3.877	1.730							5.607
	Sweden		42	62	308	31	105	370					918
	Estonia				15			101	96			125	337
	Latvia					78		284					362
	Lithuania					554							554
	Russia					1.001							1.001
	Total	2.011	42	4.465	4.232	3.416	105	759	379	69	0	424	15.902
1998	Denmark	1.372		2.393									3.765
	Finland				4				284	59		297	644
	Germany	411		1.729		2							2.142
	Poland				4.215	1.370							5.585
	Sweden		61	49	187	18	70	117					502
	Estonia				10			146	79			87	322
	Latvia				2	88		274					364
	Lithuania					737							737
	Russia					1.188							1.188
	Total	1.783	61	4.171	4.418	3.403	70	537	363	59	0	384	15.249
1999	Denmark	1.473		1.206									2.679
	Finland				1				286	57		276	620
	Germany	510		1.825									2.335
	Poland				4.015	1.435							5.450
	Sweden		37	24	87	47	15						210
	Estonia				8			92	150			164	414
	Latvia					140		365					505
	Lithuania					547							547
	Russia					964							964
	Total	1.983	37	3.055	4.111	3.133	15	457	436	57	0	440	13.724
2000	Denmark	1.896		1.757									3.653
	Finland			15	6				276	43		275	615
	Germany	660		2.089									2.749
	Poland				3.423	1.668							5.091
	Sweden		41	49	122	0	73	28					313
	Estonia				2	1		65	150			126	344
	Latvia				3	113		302					418
	Lithuania					575							575
	Russia					1.236							1.236
	Total	2.556	41	3.910	3.556	3.593	73	395	426	43	0	401	14.994
2001	Denmark	2.030		3.048									5.078
	Finland			9	69				224	28		267	597
	Germany	458		1.886									2.344
	Poland				4.608	1.433							6.041
	Sweden		52	31	96	3	90	178			3		453
	Estonia							100	161			221	482
	Latvia					201		412					613
	Lithuania					1.127							1.127
	Russia					1.355							1.355
	Total	2.488	52	4.974	4.773	4.119	90	690	385	28	3	488	18.090

* Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Poland/Latvia Catches of SD 24 are included in SD 25
Germany Catches of SD 25 are included in SD 24

Table 4.1e **Flounder in the Baltic Sea.**
Total landings (tons) 2002-2006 by Subdivision and country.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
2002	Denmark	1.490		2.883	2								4.375
	Finland			9	69				109	77		21	285
	Germany	317		2.066									2.383
	Poland				6.979	1.512							8.491
	Sweden		42	30	111	4	90	48		5			330
	Estonia							91	199			226	516
	Latvia					221		375					596
	Lithuania					1.077							1.077
	Russia					1.314							1.314
	Total	1.807	42	4.988	7.161	4.128	90	514	308	82	0	247	19.367
2003	Denmark	1.063		1.786	1	1							2.851
	Finland			2	7				103	69		22	203
	Germany	241		1.490									1.731
	Poland				5.068	1.425							6.493
	Sweden		33	45	105		57	17					257
	Estonia							122	192			128	442
	Latvia					281		392					673
	Lithuania					1.066							1.066
	Russia					1.402							1.402
	Total	1.304	33	3.323	5.181	4.175	57	531	295	69	0	150	15.118
2004	Denmark	952		2.615									3.567
	Finland				1				85	65		24	175
	Germany	315		1.591									1.906
	Poland				6.364	1.900							8.264
	Sweden		31	19	86		45	18					199
	Estonia							89	144			167	400
	Latvia				7	169		600					776
	Lithuania					834							834
	Russia					1.277							1.277
	Total	1.267	31	4.225	6.458	4.180	45	707	229	65	0	191	17.398
2005	Denmark	725	184	2.159	144								3.212
	Finland								59	40	0	13	112
	Germany	94		883	43								1.020
	Poland			2.072	6.762	1.714							10.548
	Sweden	+	38	26	58	+	47	124	2	+			296
	Estonia							133	144			114	391
	Latvia			2		383		1.333					1.718
	Lithuania					949							949
	Russia					1.393							1.393
	Total	819	223	5.142	7.007	4.439	47	1.590	206	40	0	127	19.639
2006**	Denmark	620	182	517	1.517	4							2.840
	Finland			2	2				12	4	1	2	23
	Germany	34		974	7								1.015
	Poland			1.779	5.950	1.681							9.410
	Sweden		30	23	61	1	33	20					168
	Estonia							83	165			129	377
	Latvia					317		838					1.155
	Lithuania					355							355
	Russia					1.231							1.231
	Total	654	212	3.295	7.537	3.589	33	941	177	4	1	131	16.574

* Finland: Where not given separately,catches of SDs 27&28 are included in SD 29 and catches of SD 31 are included in SD 30
Poland/Latvia Where not given separately,catches of SD 24 are included in SD 25
Germany Where not given separately,catches of SD 25 are included in SD 24
** provisional

Table 4.2.1 Flounder in SD 24-25 Landings by Subdivision

Year	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total	Except 24-25
1975	2624	0	3148	2677	2585	0	6455	113	22	0	47	**17671**	**11846**
1976	2604	0	2040	2850	2760	0	1779	527	23	0	418	**13001**	**8111**
1977	2922	0	3101	3583	2299	0	1081	436	32	0	470	**13924**	**7240**
1978	3790	0	2988	1342	2394	0	1290	508	61	0	550	**12923**	**8593**
1979	2899	0	2917	1545	2018	0	1170	522	54	0	1165	**12290**	**7828**
1980	2535	0	3078	1659	1473	20	979	560	69	0	1245	**11618**	**6881**
1981	2586	0	3165	1181	1599	21	936	706	56	0	1213	**11463**	**7117**
1982	2074	104	3482	2517	1818	65	681	837	58	0	1265	**12901**	**6902**
1983	2412	115	4095	1936	1114	212	603	687	67	0	1234	**12475**	**6444**
1984	2453	85	3044	2498	1433	53	215	462	108	0	1361	**11712**	**6170**
1985	1996	130	3922	2087	1570	47	201	424	97	0	943	**11417**	**5408**
1986	1777	65	4426	3061	2226	60	174	483	128	0	737	**13137**	**5650**
1987	1393	122	3131	2556	3060	51	216	440	106	0	540	**11615**	**5928**
1988	1387	125	3999	1763	1870	68	456	437	118	0	490	**10713**	**4951**
1989	1569	83	4702	1930	1872	66	528	392	122	0	377	**11641**	**5009**
1990	1176	0	3021	1737	1351	0	390	363	81	0	302	**8421**	**3663**
1991	1171	0	3335	2039	2418	88	354	371	81	0	218	**10075**	**4701**
1992	940	185	2988	1965	2443	86	722	455	40	0	673	**10497**	**5544**
1993	884	220	1892	3339	1709	83	451	524	57	0	738	**9897**	**4666**
1994	926	265	5298	3195	1721	33	334	458	33	0	91	**12354**	**3861**
1995	1145	289	4963	7639	1990	81	396	450	28	0	166	**17147**	**4545**
1996	1232	285	3729	6788	3744	114	299	464	78	0	416	**17149**	**6632**
1997	2011	42	4465	4232	3416	105	759	379	69	0	424	**15902**	**7205**
1998	1783	61	4171	4418	3403	70	537	363	59	0	384	**15249**	**6660**
1999	1983	37	3055	4111	3133	15	457	436	57	0	440	**13724**	**6558**
2000	2556	41	3910	3556	3593	73	395	426	43	0	401	**14994**	**7528**
2001	2488	52	4974	4773	4119	90	690	385	28	3	488	**18090**	**8343**
2002	1807	42	4988	7161	4128	90	514	308	82	0	247	**19367**	**7218**
2003	1304	33	3323	5181	4175	57	531	295	69	0	150	**15118**	**6614**
2004	1267	31	4225	6458	4180	45	707	229	65	0	191	**17398**	**6715**
2005	819	223	5142	7007	4439	47	1590	206	40	0	127	**19640**	**7491**
2006	654	212	3.295	7537	3589	33	941	177	4	1	131	**16574**	**5741**
Total	**59167**	**2847**	**118012**	**114321**	**83641**	**1773**	**26831**	**13823**	**2035**	**4**	**17642**	**440096**	**207763**

Table 4.2.1.1 Flounder in SD 24 and 25: catches per hour at age (weighted mean by areas of the depth strata,40-, 60-,80-) of the Polish bottom trawl survey in SD 25 in the 1st quarter. Gear: P20/25, in 2001 TV3 930 meshes.

Year	Catch in number							
	Total	AG 2	AG 3	AG 4	AG 5	AG 6	AG 7	AG 8+
1993	99,1	0,0	15,4	25,4	53,1	4,5	0,5	0,2
1994	105,4	3,5	26,9	35,6	20,7	17,2	1,1	0,6
1995	166,5	0,0	4,1	69,3	44,6	29,1	13,4	6,0
1996	21,5	0,0	5,0	5,4	6,3	3,0	1,3	0,4
1997	102,5	8,2	35,2	43,0	9,1	3,7	2,2	1,1
1998	125,3	0,0	21,5	38,5	40,6	15,0	6,7	3,1
1999	204,4	1,0	74,9	77,8	27,9	14,4	2,5	5,9
2000	77,3	0,1	14,5	34,0	16,4	8,2	2,4	1,7
2001	199,3	0,5	46,7	81,0	51,1	13,5	5,3	1,2
2002	217,4	0,2	38,1	81,6	67,6	11,2	14,4	4,4
2003	80,4	0,0	17,3	33,8	17,8	5,8	3,1	2,6
2004	453,9	0,0	28,7	237,7	135,8	41,2	6,9	3,6
2005	851,3	1,5	178,3	298,7	251,9	100,8	9,2	10,8
2006	1405,0	0,0	4,7	555,6	590,5	200,8	52,7	0,6

Table 4.2.1.2. Flounder in SD 24 and 25: catches per half an hour (mean of the strata means 30-39m and 40-49m weighted by stratum areas) of the German bottom trawl surveys in ICES SD 24 in November/December. Gear: HG20/25, in 2001 TV3 520 meshes

Year	Catch in number							
	Total	AG 2	AG 3	AG 4	AG 5	AG 6	AG 7	AG 8+
1983	16,7	0,3	1,1	6,3	4,6	2,5	1,5	0,4
1984	20,1	1,1	3,1	8,8	4,2	1,9	0,5	0,5
1985	42,1	0,4	13,4	14,2	8,7	3,0	0,2	2,1
1986	16,5	0,0	1,2	8,7	3,7	1,3	0,9	0,7
1987	30,7	4,7	12,4	8,3	3,4	0,7	0,7	0,5
1988	12,0	0,2	8,0	2,7	0,5	0,2	0,2	0,2
1989	21,1	1,0	6,4	8,8	3,3	0,9	0,5	0,0
1990	213,0	28,3	78,8	52,2	37,5	10,4	4,3	1,5
1991	44,0	2,2	11,1	19,4	7,1	2,7	0,7	0,8
1992	34,5	3,4	20,1	7,9	2,0	0,7	0,3	0,0
1993	59,4	5,3	33,0	12,8	6,7	0,9	0,4	0,3
1994	37,3	1,3	17,3	11,5	5,0	1,4	0,7	0,2
1995	21,0	1,4	7,0	5,5	3,4	1,8	1,0	0,9
1996	19,6	0,6	4,4	5,3	3,6	1,9	1,4	1,9
1997	22,9	3,3	10,9	4,9	2,0	1,0	0,5	0,3
1998	23,1	1,1	11,9	6,6	2,5	0,4	0,3	0,3
1999	57,1	1,4	29,5	19,0	4,8	1,1	0,7	0,6
2000	23,7	0,8	10,6	7,9	2,8	0,6	0,4	0,6
2001	42,4	1,4	25,2	10,1	3,2	1,4	0,5	0,6
2002	77,4	1,4	47,5	19,9	3,8	1,8	1,2	1,2
2003	20,6	1,4	8,2	7,7	1,8	0,5	0,2	0,2
2004	46,6	3,1	28,1	8,8	3,3	1,3	0,4	0,2
2005	21,8	3,5	10,1	4,9	2,4	0,6	0,3	0,2
2006	85,9	5,0	24,8	43,9	9,6	1,7	0,6	0,3

Table 4.2.1.3 Flounder in SD 24 and 25: catches per half an hour (mean of the strata means 30-39m and 40-49m weighted by stratum areas) of the German bottom trawl surveys in ICES SD 24 in February. Gear: HG20/25, in 2001 TV3 520 meshes.

Year	Catch in number							
	Total	AG 2	AG 3	AG 4	AG 5	AG 6	AG 7	AG 8+
1992	90,9	0,2	14,2	37,4	24,1	9,4	3,4	2,2
1993	80,4	4,3	38,9	24,9	10,4	1,3	0,5	0,1
1994	58,1	1,6	28,9	17,2	7,0	2,2	0,7	0,5
1995	89,0	5,0	36,5	27,8	13,2	3,8	2,2	0,5
1996	35,0	3,9	13,1	8,3	5,9	2,1	1,0	0,7
1997	36,5	4,1	16,0	10,4	4,0	1,1	0,5	0,4
1998	50,9	3,9	31,0	11,3	3,0	0,7	0,5	0,6
1999	36,4	3,1	25,8	6,1	1,2	0,1	0,1	
2000	124,6	10,7	69,7	31,9	9,6	1,8	0,5	0,3
2001	36,0	10,4	15,8	7,1	1,2	0,4	0,3	0,3
2002	92,2	10,3	67,8	9,6	2,1	0,7	0,5	1,2
2003	57,9	10,1	31,9	12,7	1,7	0,6	0,4	0,4
2004	37,9	10,5	22,4	3,3	0,6	0,1	0,1	0,2
2005	44,9	3,6	16,6	19,6	3,7	1,0	0,3	0,1
2006	59,0	3,1	22,8	23,7	7,8	1,4	0,2	0,0

Table. 4.2.2. Flounder in SD 24- 25 Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.

Sub-division	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
24	Denmark	1	154,3			
		2	34,0			
		3	87,7			
		4	241,3			
		Total	**517,3**	**0**	**0**	**0**
	Germany	1	57,4	10	1149	220
		2	137,5			
		3	421,9	24	4464	1199
		4	357,4	55	4242	323
		Total	**974,2**	**89**	**9855**	**1742**
	Poland	1	389,0	2	250	104
		2	372,6	2	237	101
		3	541,8	2	176	108
		4	475,9	1	131	30
		Total	**1779,3**	**7**	**794**	**343**
	Sweden	1	11,2			
		2	0,5			
		3	6,0			
		4	5,4			
		Total	**23,1**	**0**	**0**	**0**
	Total	1	611,9	12	1399	324
		2	544,6	57	237	101
		3	1057,4	91	4640	1307
		4	1079,9	90	4373	353
		Total	**3293,8**	**96**	**10649**	**2085**
25	Denmark	1	1302,0			
		2	158,3			
		3	10,2			
		4	46,3			
		Total	**1516,8**	**0**	**0**	**0**
	Estonia	1				
		2				
		3				
		4				
		Total	**0,0**	**0**	**0**	**0**
	Germany	1	5,8	6	625	
		2	0,7			
		3	0,0			
		4	0,0			
		Total	**6,5**	**6**	**625**	**0**
	Poland	1	2920,6	4	549	201
		2	1227,5	4	471	209
		3	734,1	5	526	264
		4	1068,1	1	40	25
		Total	**5950,3**	**14**	**1586**	**699**
	Sweden ++	1	38,4		432	85
		2	7,5			
		3	7,1			
		4	7,9			
		Total	**61,0**	**0**	**432**	**85**
	Total	1	4266,8	10	1606	286
		2	1394,0	4	471	209
		3	751,3	5	526	264
		4	1122,4	1	40	25
		Total	**7534,6**	**20**	**2643**	**784**

** **Sweden** **Samples allocated to the 1st quarter arbitrarily**

Table 4.2.3.1 Flounder in SD 24 Average catch per unit effort (numbers/hour) for females from German BITS quarter 1.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
cpue (no./h)	33,1	40,5	37,9	17,2	19,4	14,3	33,7	27,1	54,8	13,5	57,9	21,7	11,7	19,2	55,3	53,4

Table 4.2.3.2 Flounder in SD 24. Survey catch of females per unit effort (numbers per hour).

Year	Age eq. 1	Age eq. 2	Age eq. 3	Age eq. 4	Age eq. 5	Age eq. 6	Age eq. 7	Age eq. 8+	Total
1992	n.a.	9,27	13,31	5,03	1,35	1,40	0,80	1,97	33,12
1993	0,67	15,28	13,16	4,92	2,05	2,07	0,75	1,62	40,52
1994	0,08	9,16	15,82	4,10	2,37	2,86	0,97	2,51	37,87
1995	0,96	4,26	4,47	2,00	0,58	0,78	1,07	3,12	17,25
1996	0,84	4,48	6,67	2,86	1,20	0,61	0,81	1,73	19,40
1997	0,30	5,40	4,79	1,35	0,51	0,39	0,39	1,18	14,31
1998	5,42	16,24	7,77	1,54	0,50	0,62	0,48	0,98	33,69
1999	3,13	17,37	4,57	1,14	0,31	0,25	0,12	0,25	27,14
2000	2,15	28,63	16,17	4,08	0,80	0,59	0,45	1,69	54,84
2001	2,86	2,06	3,56	1,75	0,65	0,74	0,33	1,05	13,46
2002	2,72	34,25	14,45	2,69	0,69	0,70	0,76	1,67	57,95
2003	0,90	7,96	8,35	1,91	0,36	0,40	0,50	1,26	21,72
2004	1,10	4,68	3,94	0,94	0,17	0,07	0,08	0,60	11,74
2005	1,86	5,24	7,93	1,38	0,81	0,80	0,24	0,79	19,25
2006	13,25	26,10	10,27	2,13	0,89	0,51	0,53	1,53	55,27
2007	3,06	23,21	20,17	2,86	1,08	0,62	0,78	1,55	53,42

Table 4.2.3.3 Flounder in SD 24. Mean weight (kg) for length class intervals equivalent to ages

Year	Age eq. 1	Age eq. 2	Age eq. 3	Age eq. 4	Age eq. 5	Age eq. 6	Age eq. 7	Age eq. 8+
1992	0,11	0,19	0,30	0,37	0,49	0,50	0,57	0,75
1993	0,11	0,19	0,30	0,37	0,49	0,50	0,57	0,75
1994	0,12	0,20	0,31	0,38	0,49	0,50	0,58	0,71
1995	0,10	0,19	0,32	0,38	0,49	0,55	0,55	0,76
1996	0,08	0,19	0,31	0,38	0,46	0,55	0,60	0,79
1997	0,10	0,20	0,30	0,36	0,51	0,52	0,61	0,78
1998	0,08	0,18	0,28	0,37	0,47	0,53	0,61	0,77
1999	0,09	0,18	0,28	0,38	0,49	0,54	0,53	0,69
2000	0,10	0,19	0,29	0,38	0,49	0,55	0,61	0,78
2001	0,06	0,19	0,31	0,39	0,51	0,53	0,58	0,79
2002	0,10	0,18	0,28	0,36	0,53	0,57	0,58	0,86
2003	0,06	0,19	0,29	0,36	0,49	0,51	0,58	0,86
2004	0,06	0,19	0,29	0,39	0,45	0,51	0,60	0,79
2005	0,06	0,19	0,30	0,37	0,47	0,52	0,54	0,80
2006	0,09	0,17	0,29	0,37	0,49	0,51	0,58	0,78
2007	0,11	0,19	0,29	0,37	0,46	0,51	0,57	0,75

Table 4.2.3.4 Flounder in SD 24. Proportions mature.

Year	Age eq. 2	Age eq. 3	Age eq. 4	Age eq. 5
1992-2007	1,00	1,00	1,00	1,00

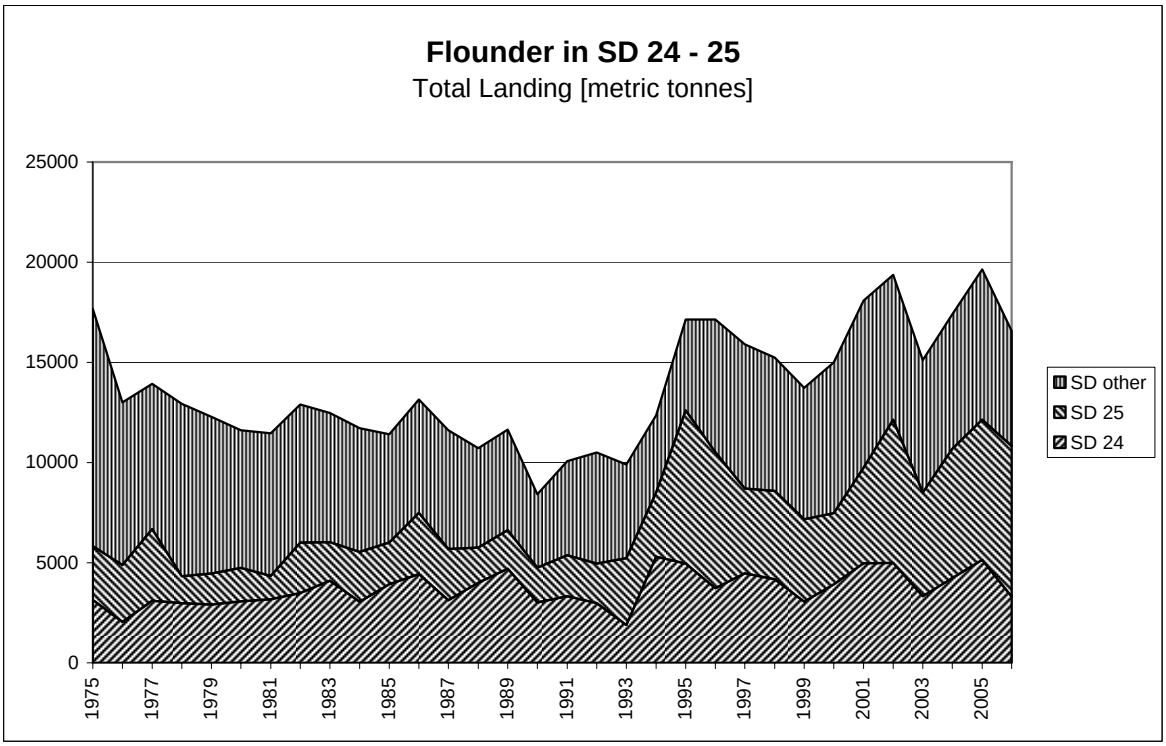


Figure 4.2.1 Flounder SD 24-25 Landing in Assessment Area compared to other Baltic Landings

Figure 4.2.3.1 Flounder in SD 24 Average catch per unit effort (numbers/hour) for females from German BITS quarter 1.

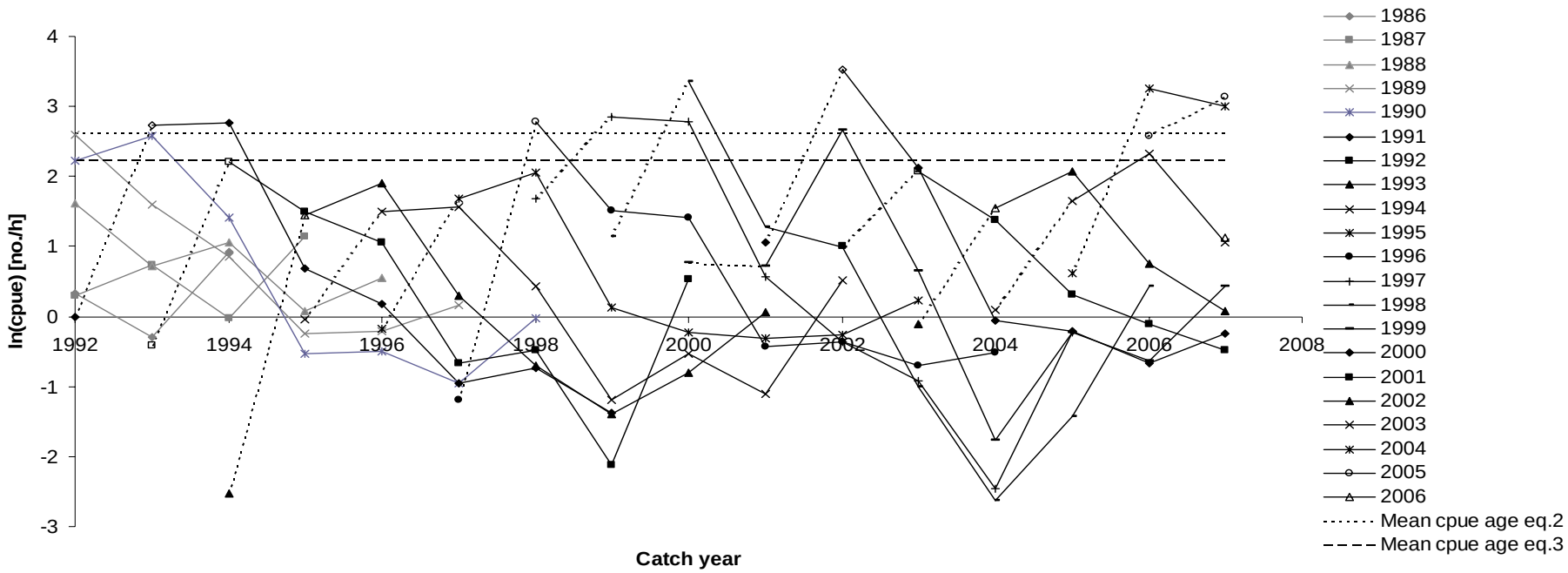


Figure 4.2.3.2 **Flounder in SD 24 Catch curve (ln(cpue)) for each cohort, derived from age equivalents and catch years. Each cohort is plotted for age equivalent 1 (open symbols, dotted line) to age equivalent 8+. Average ln(cpue) for age equivalent 2 is indicated by dashed lines, and for age equivalent 3 by long dashed lines.**

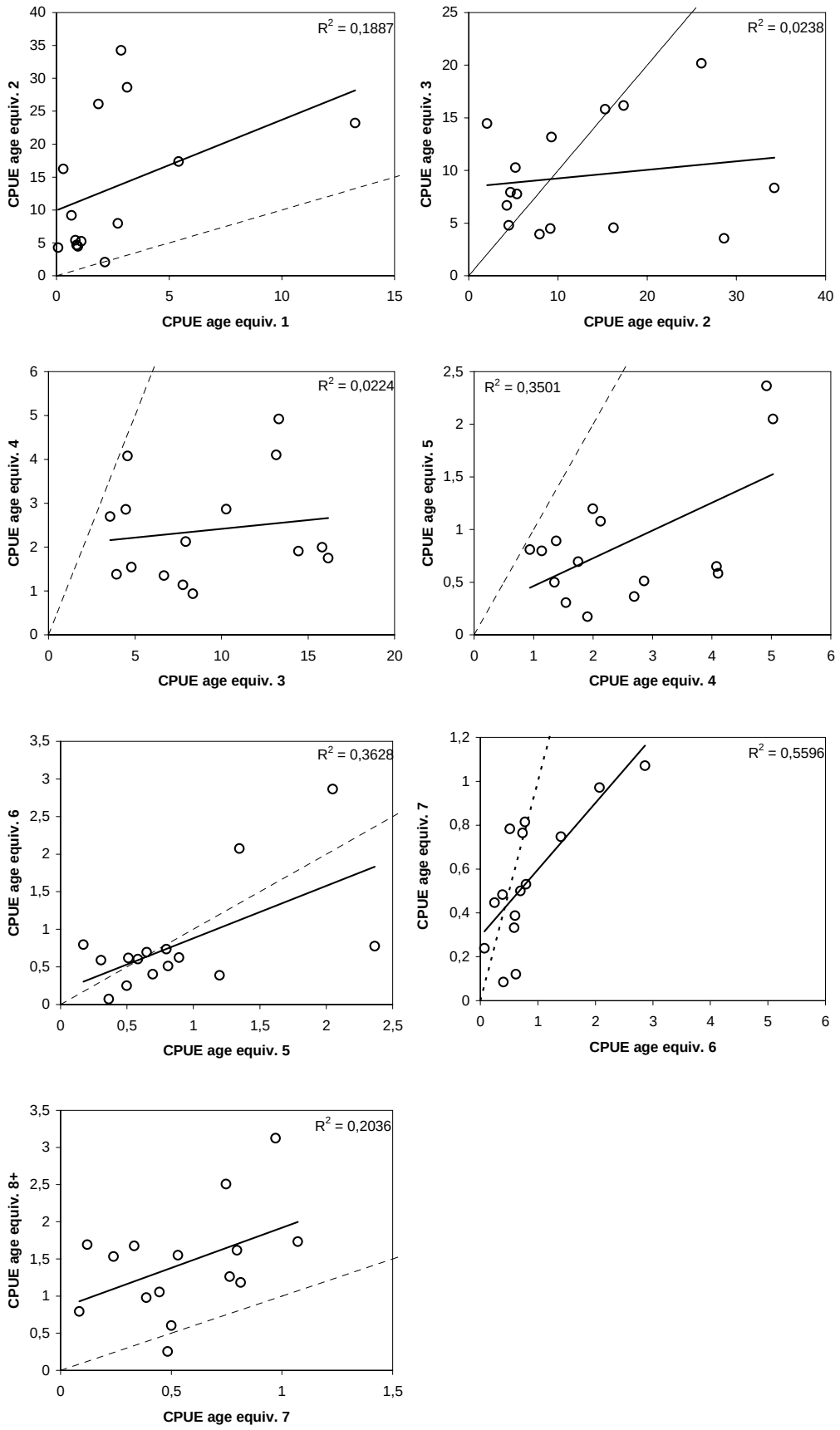


Figure 4.2.3.3 **Flounder in SD 24 Correlations between BITS catch per unit effort (numbers per hour) of length groups corresponding to consequitive ages. Full line indicate relationship between cpue in consequtive years and dashed lines are reference lines of slope 1.**

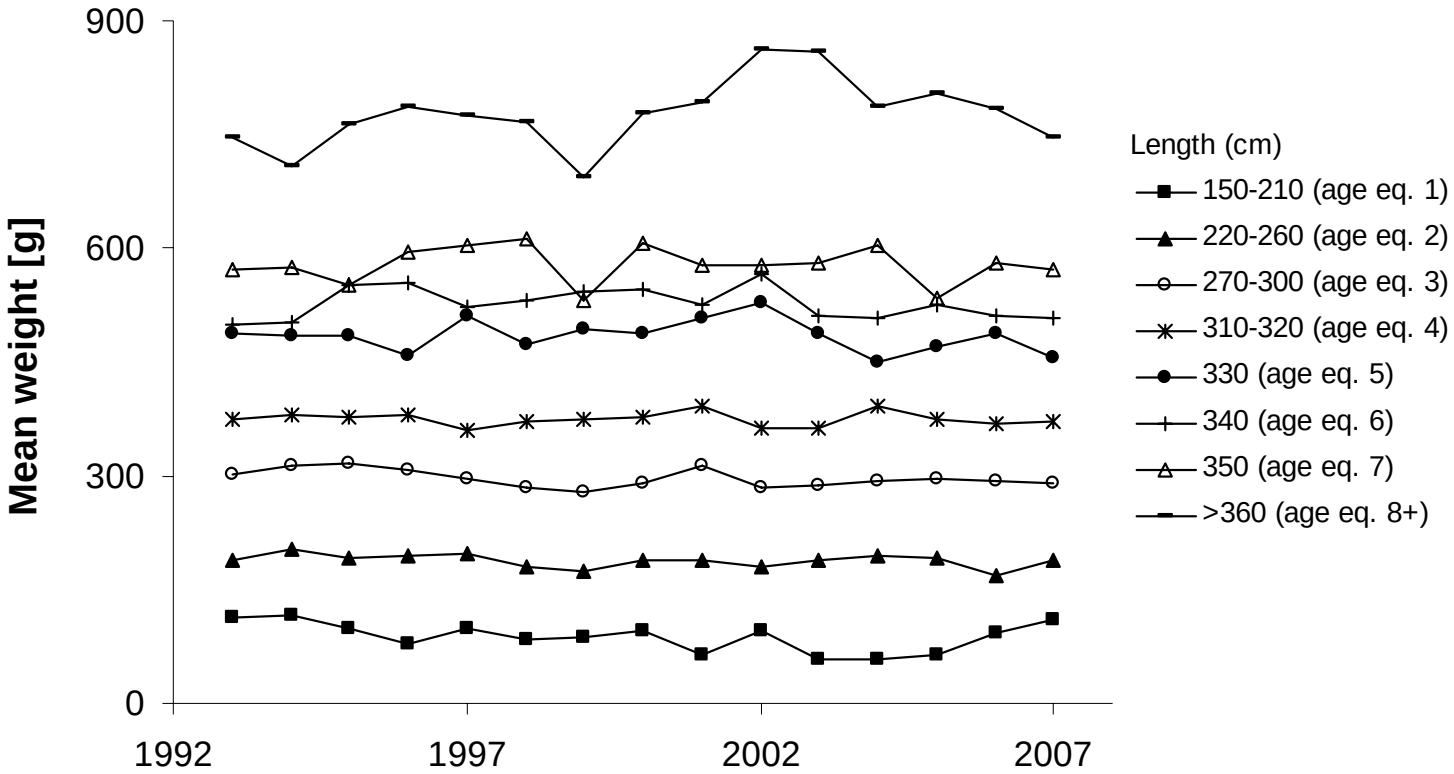


Figure 4.2.3.4 Flounder in SD 24 Mean weight (g) per age equivalent length class intervalls.

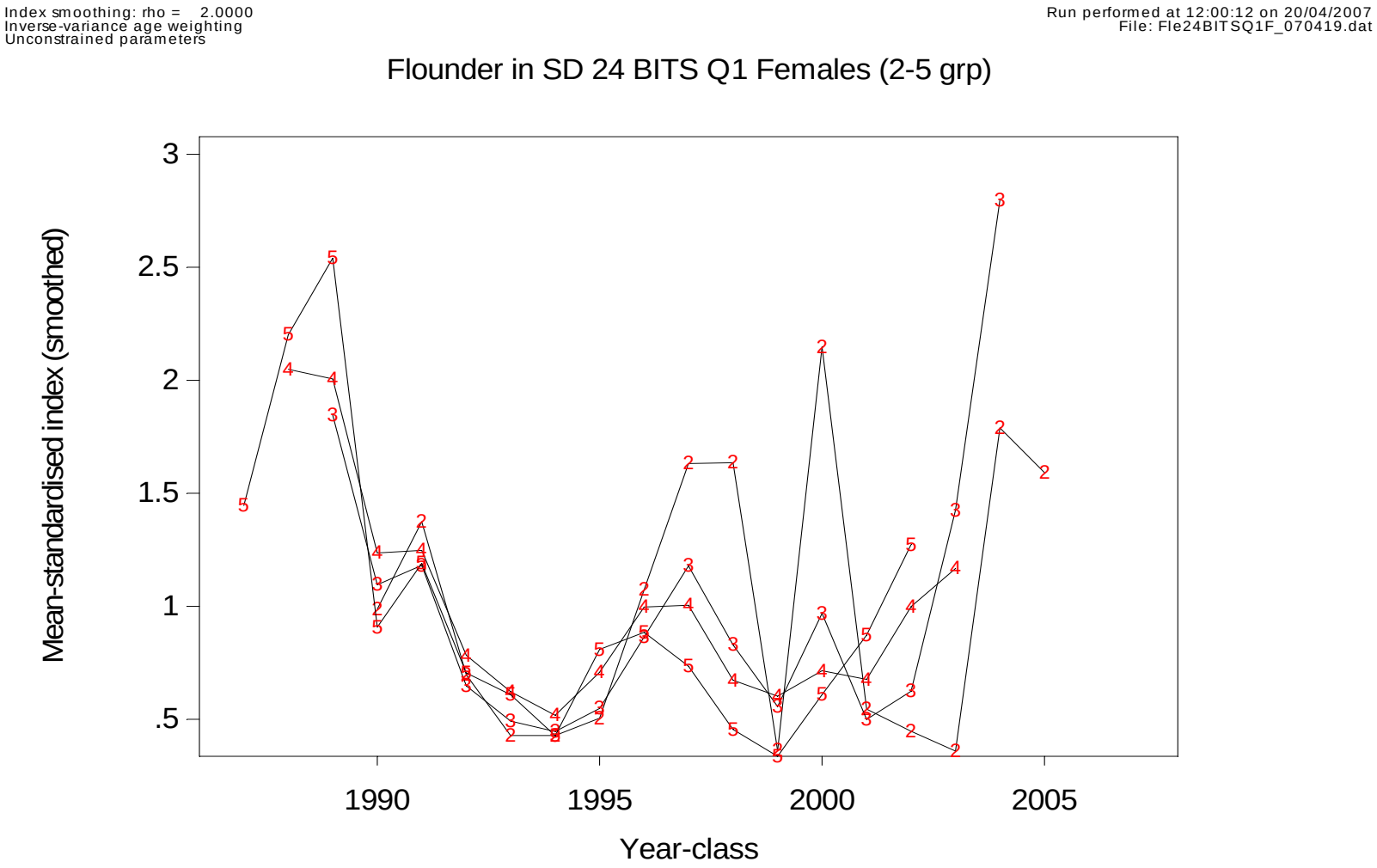


Figure 4.2.3.5 **Flounder in SD 24 Smoothed survey indices for females, per age equivalent, from German q1 BITS used as input in the SURBA.**

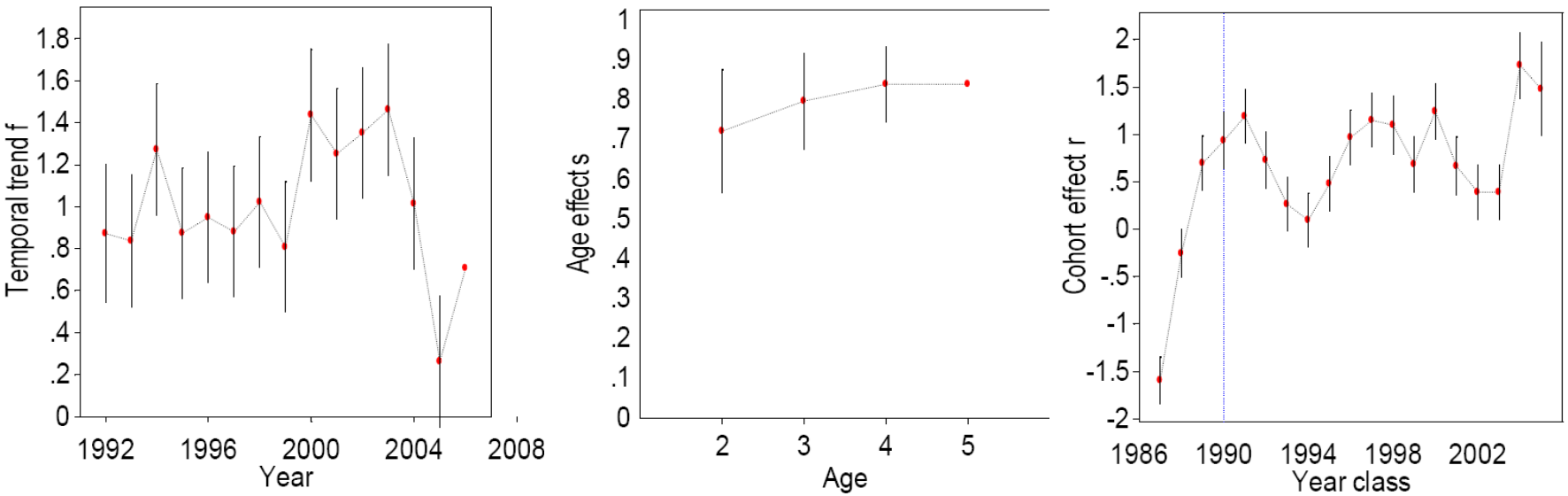


Figure 4.2.3.6 **Flounder in SD 24 Estimated (a) temporal trend, (b) age effects, and (c) cohort effects from final SURBA run on German q1 BITS indices for females. Vertical black lines indicate the S.E. of the estimates, vertical dashed line in panel (c) correspond to the cohort to which the model fit is standardised. Notice that "age" indicates age equivalents.**

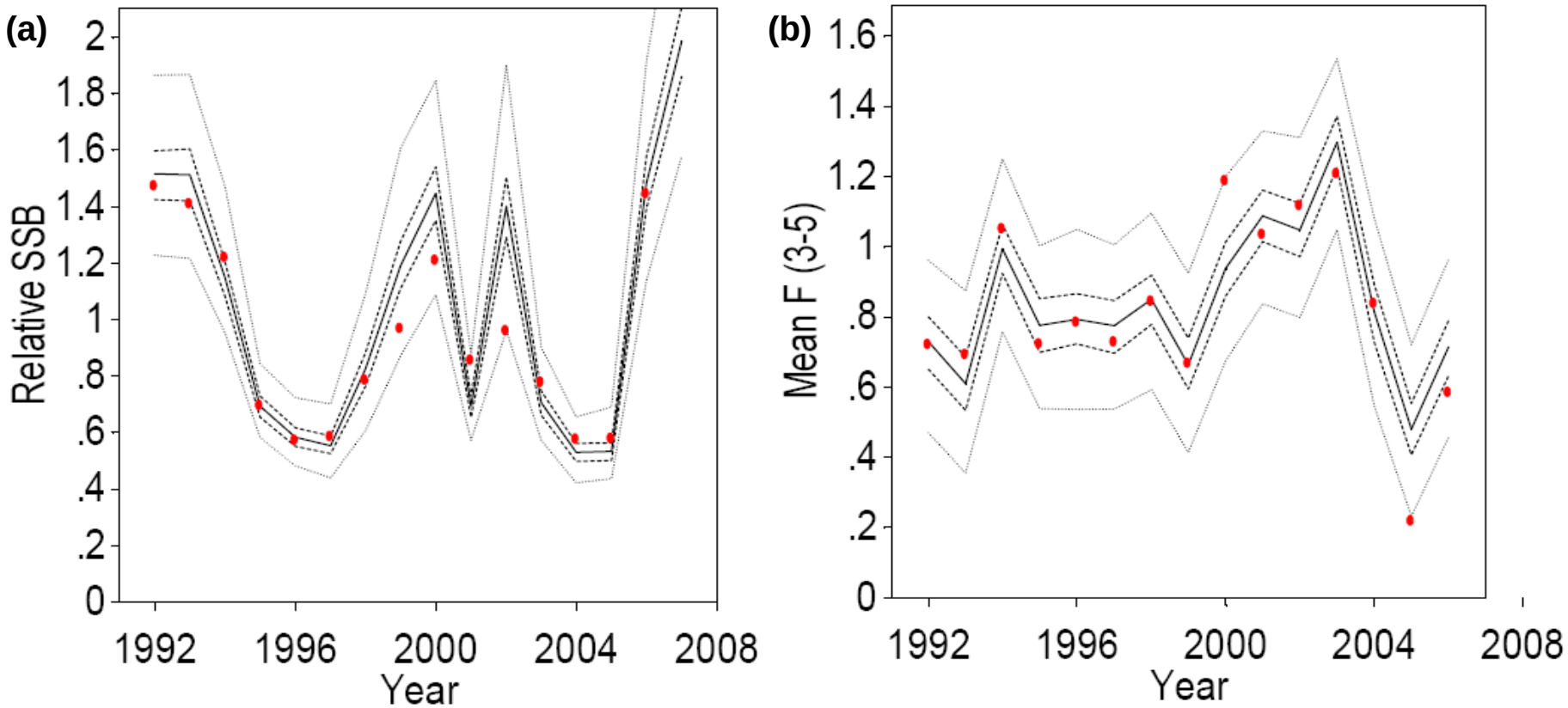


Figure 4.2.3.7 **Flounder in SD 24 Estimated (a) relative spawning stock biomass, and (b) relative mean mortality for age equivalents 3 to 5, from final SURBA run on German q1 BITS indices for females. Full line indicate estimated mean, dashed and grey lines the 75% and 95% confidence intervals, respectively.**

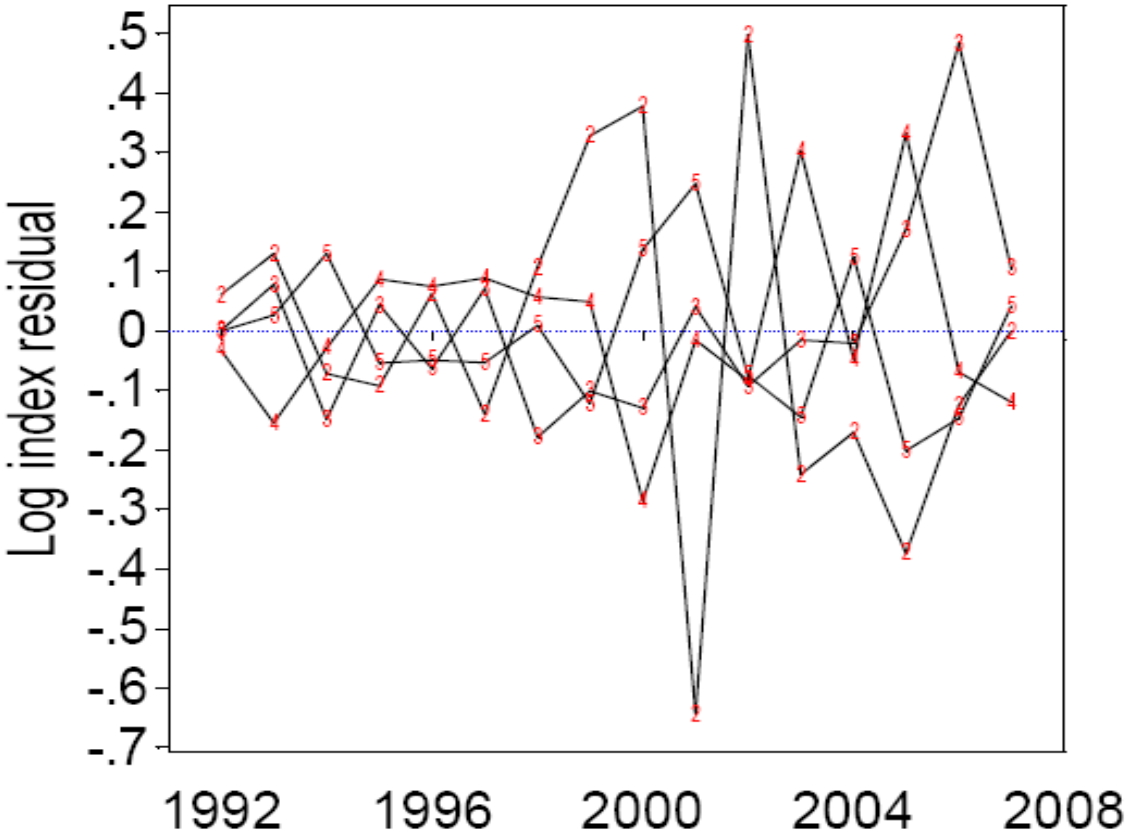


Figure 4.2.3.8 **Flounder in SD 24 Log index residuals from final SURBA run run on German q1 BITS indices for females. Number on lines refer to the index for each age equivalent.**

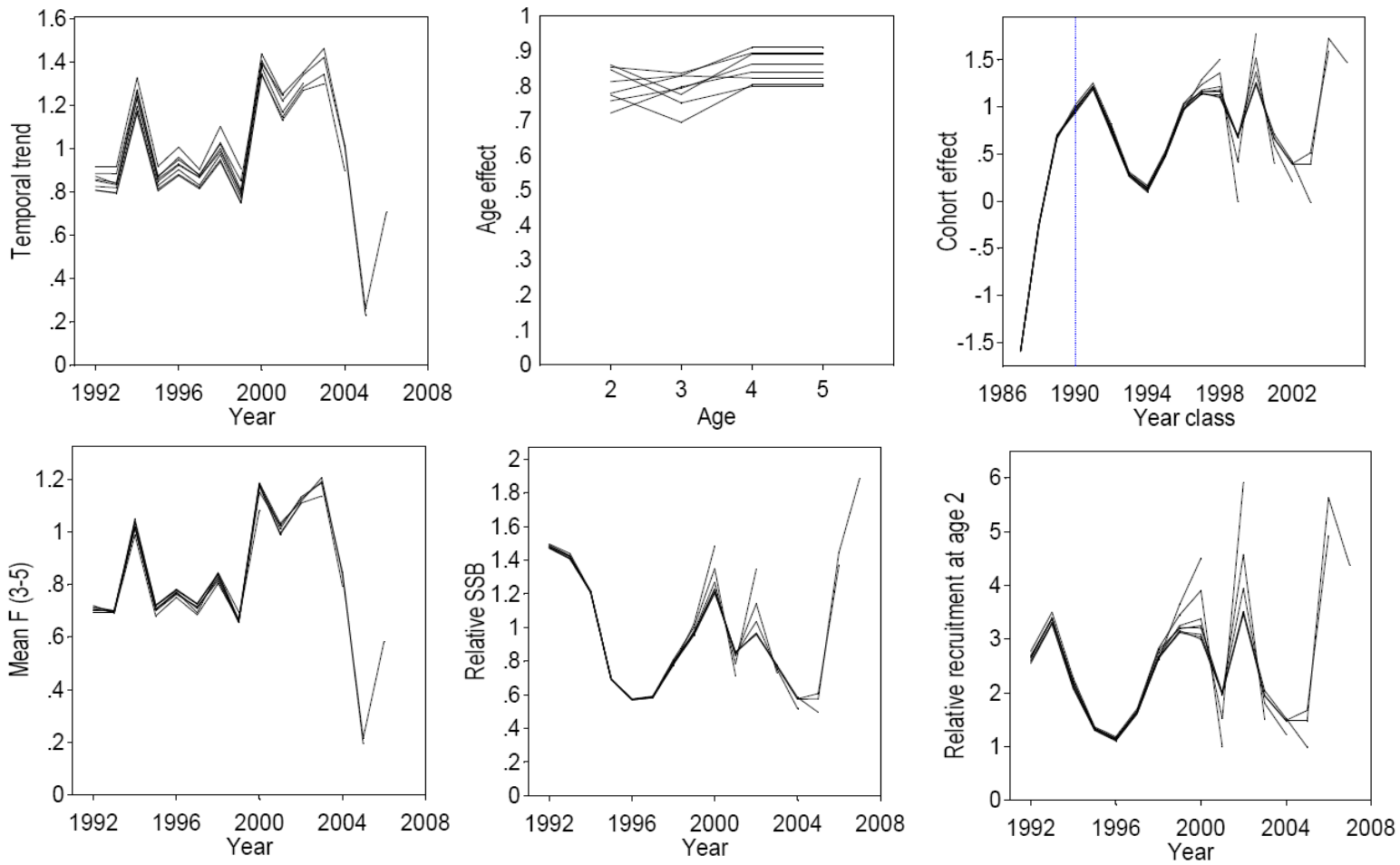


Figure 4.2.3.9 **Flounder in SD 24 Retrospective patterns from final SURBA run on German q1 BITS indices for females. Vertical dahsed line in panel (c) correspond to the cohort to which the model fit is standardised. Notice that "age" indicates age equivalents.**

5 Plaice, Turbot, Dab, and Brill in the Baltic

The landing data of plaice, turbot, dab, and brill according to ICES Subdivisions and countries are presented in Tables 5.1–5.4. The trend and the amount of the landings of these flatfishes are demonstrated in Figure 5.1. Plaice and dab have the greatest proportions of the total landings of flatfish when excluding flounder from the consideration.

The highest total landings of **plaice** were observed at the end of the seventies (8 289 t in 1979) and the lowest around the year 1990 (1989 380 t). Since 1995 the landings increased again and reached a moderate temporal maximum in 2002 (2 760 t). After then the landings decreased to 1860 t in 2006. The fluctuations are supposed to be caused mainly by immigration of plaice from the Kattegat into the western Baltic Sea. ICES Subdivision 22 is the main fishing area, and Denmark is the main fishing country. Subdivision 25 is on the second place. Poland and Denmark are the main fishing countries there. The plaice stock is on a low level and better recruitment could not be observed.

Turbot occurs mainly in the southern and western parts of the Baltic Proper. Therefore, most of the landings are reported for ICES Subdivisions 22-26. The total reported landings of turbot increased from 40 t to 1 210 t between 1965 and 1996. From that high level the landings decreased to about 500 t in the 2000s. The total landings in 2006 of 310 t were only about 25% of the highest reported turbot landings (1996).

A successful turbot gillnet fishery started at the beginning of the 1990s in Subdivisions 26 and 28. This development was caused by fishermen having more interest in turbot. In this context is it important to mention that in all eastern Baltic countries after 1990 turbot was sorted out from the flatfish catches due to the better price. For example, the Polish landings of turbot increased from 33 t to 360 t in 1999-2003. Swedish landings are taken mainly from a gillnet fishery. Denmark and Germany landed turbot from Subdivisions 22 and 24. Since 2000 these landings have been noticeably decreased. German landings in last five years are around 50 t. This indicates that the turbot stock in the western part of the Baltic Sea had decreased.

Due to the low stock level, fishery targeted on turbot is totally banned in the EEZ of Latvia and Lithuania.

In the 2000s, the total landing of **dab** increased to 1890 t in 2004. Then it decreased to 1230 t in 2006. During the years 1994 to 1996 the total landing of dab was over-reported due to by-catch misreporting in cod fishery. The highest landing was observed in Subdivision 22 where the majority of the dab landings were taken. The main dab landings are reported by Denmark (Subdivision 22 and 24) and Germany (mainly in Subdivision 22). The German landings of dab are by-catch of the directed cod fishery and in 2003 a trawl fishery targeted to dab was started in Subdivision 22. The recent years' increase in landings is due to an increase in the stock as derivable from the German BITS surveys data.

The **brill** fishery is carried out mainly by Denmark (about 90-100% in the period 1985-2006) and in Subdivision 22. In the period from 1970 to 2005 the total reported landings varied between 1 and 160 t. It can be assumed that the total landings of brill reported for 1994-1996 are over-reported due to species-misreporting in the landings of the cod-directed fishery. Excluding these years the landing averaged to about 25 t. A moderate increase of total landings was observed in the last five years (from 19 t in 2001 to 56 t in 2006).

Table 5.1. Plaice in the Baltic Sea: total landings (tons) by ICES Sub-division and country.
(There are some gaps in the information, therefore "Total" is preliminary)

	Denmark					Germ. Dem. Rep.[1]		Germany, FRG			Poland		Sweden[2]							
Year/SD	22	23	24(+25)	25	26+27	22	24	22	24(+25)	28	25(+24)	26	22	23	24	25	26	27	28	29
1970	3.757		494					202	16						149					
1971	3.435		314					160	2						107					
1972	2.726		290					154	2						78					
1973	2.399		203			2	44	163	1		174	30			75					
1974	3.440		126			36	10	166	2		114	86			60					
1975	2.814		184			11	67	302	1		158	142			45					
1976	3.328		178			11	82	302	3		164	76			44					
1977	3.452		221			5	36	348	2		265	26			41					
1978	3.848		681			33	1.198	346	3		633	290			32					
1979	3.554		2.027			10	1.604	195	7		555	224			113					
1980	2.216		1.652			5	303	84	5		383	53			113					
1981	1.193		937			6	52	74	31		239	27			118					
1982	716		393			6	25	39	6		43	64			40	6		7	1	
1983	901		297			5	12	37	14		64	12			133	20		24	2	
1984	803		166			7	2	23	8		106				23	3		4	1	
1985	648		771			68	593	26	40		119	49			25	4		5	1	
1986	570		1.019			34	372	25	7		171	59			48	7		9	1	
1987	414		794			4	142	14	16		188	5			68	10		12	1	
1988	234		323			3	16	7	1		9	1			49	7		9	1	
1989	167		149				5	7			10				34	5		6	1	
1990	236		100				1	9	1		6				50					
1991	328		112					15	9		2	1			5	2		2		
1992	316		74					11	4		6				3	1		1		
1993	171		66					16	6		4			2	4					
1994	355		159					1			43	4		6	4	7				
1995	601	64	343					75	91	1	233	2		12	13	10	1			
1996	859	81	263					43	77		183	5	1	13	28	23	10	1		
1997	902		201					51	56		308	3		13	7	8		1		
1998	642		278					213	41		101	14		13	6	17		1		
1999	1.456		183					244	46		145	1	1	13	5	10				
2000	1.932		161					140	37		408	3		26	9	12				
2001	1.627		173					58	43		549	3		39	9	13				
2002	1.759		153	159	0			46	146		429	3		42	10	15				
2003	1024		326	299	2			35	96		480	10	0	26	16	51		0	0	
2004	911		167	239				60	65		292	8		35	6	37				
2005	908	145	164	241				51	108		511	11		35	16	28		0	0	
2006[4]	600	166	82	632				46	185		52	3		39	17	41			0	

continued

Table 5.1 continued

Year	Total by SD								Total
	22	23	24[3]	25	26	27	28	29	SD 22-29
1970	3.959		659						4.618
1971	3.595		423						4.018
1972	2.880		370						3.250
1973	2.564		323	174	30				3.091
1974	3.642		198	114	86				4.040
1975	3.127		297	158	142				3.724
1976	3.641		307	164	76				4.188
1977	3.805		300	265	26				4.396
1978	4.227		1.914	633	290				7.064
1979	3.759		3.751	555	224				8.289
1980	2.305		2.073	383	53				4.814
1981	1.273		1.138	239	27				2.677
1982	761		464	49	64	7	1		1.346
1983	943		456	84	12	24	2		1.521
1984	833		199	109		4	1		1.146
1985	742		1.429	123	49	5	1		2.349
1986	629		1.446	178	59	9	1		2.322
1987	432		1.020	198	5	12	1		1.668
1988	244		389	16	1	9	1		660
1989	174		188	15		6	1		384
1990	245		152	6					403
1991	343		126	4	1	2			476
1992	327		81	7		1			416
1993	187	2	76	4					269
1994	356	6	163	50	4				579
1995	676	76	447	243	3		1		1.446
1996	903	94	368	206	15	1			1.587
1997	953	13	264	316	3	1			1.550
1998	855	13	325	118	14	1			1.326
1999	1.701	13	234	155	1				2.104
2000	2.072	26	207	420	3				2.728
2001	1.685	39	225	562	3				2.514
2002	1.805	42	309	603	3				2.763
2003	1.059	26	438	830	13	0	0		2.366
2004	971	35	289	781	11	0	0		2.087
2005	959	179,52	289	781	11	0	0		2.220
2006[4]	646	205	284	725	3				1.863

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.
[2] For the years 1970-1981 and 1990 the catches of Sub-divisions 25-28 are included in Sub-division 24.
[3] For the years 1970-1981 and 1990 the Swedish catches of Sub-divisions 25-28 are included in Sub-division 24.
[4] Preliminary data
[5] Danish catches in 2002 in SW Baltic were separated according to Sub-divisions 24 and 25

Table 5.2. Turbot in the Baltic Sea: total landings (tons) by ICES Sub-division and country.
(There are some gaps in the information, therefore "Total" is preliminary)

	Denmark					Germ. Dem. Rep.[1]		Germany, FRG				Poland		Sweden[2]							Latvia		Lithuania	Russia
Year/SD	22	23	24(+25)	25	26+27	22	24	22	24	25	27	25(+24)	26	22	23	24	25	26	27	28(+29)	26	28	26	26
1965						3	39																	
1966	16		21			5	53																	
1967	14		20			7	10																	
1968	14		18			3	67																	
1969	13		13			4	57																	
1970	11		13			5	40									2								
1971	11		26			4	86									2								
1972	10		26			3	100									3								
1973	11		30			3	33					58	13			5								
1974	14		40			2	23					34	36			6								
1975	27		48			3	38	15				23	6			7								
1976	29		24				52	11				14	12			7								
1977	32		37				55	9				12	55			8								
1978	33		37			2	27	9				7	3			10								
1979	23		38			3	39	6				29	34			12								
1980	28		38				30	9				12	20			15								
1981	28		62			1	46	8				10	19			7								
1982	31		51			1	27	7				2	17			3	4		4	3				
1983	33		40			3	9	8				5	4			31	41		35	24				
1984	41		45			4	8	12				13	2			3	4		3	2				
1985	56		34			5	22	15				67	15			4	5		4	3				
1986	99		81			6	32	25				32	37			6	8		7	5				
1987	134		93			4	34	30				155	21			8	11		9	6				
1988	117		117			3	28	34				7	10			12	16		14	9				
1989	135		109			7	22	20					11			11	15		13	9				
1990	178		181			4	2	26				24	25			14								
1991	228		137					44	39			73	20			2	12		16					
1992	267		127					55	68			80	55			12	12		21	36				30
1993	159	29	152					74	56			520	72		2	4	14		13	38				34
1994	211	18	166					52	57	10		380	30		2	3	18	1	17	44				15
1995	257	11	94					65	53	4		30	15		2	3	54	9	31	83	34	27	15	20
1996	207	12	95					36	47	4	1	288	92	1	3	15	100	5	54	104	42	3	72	25
1997	151		68					60	52	3		290	70		2	6	70	1	53	86	33	14	59	25
1998	138		80					44	55	1		66	68		2	4	58	1	18	69	12	24	62	96
1999	106		59					23	48			18	15		2	4	41	3	17	60	20	34	58	48
2000	97		58					23	54			90	12		2	3	39		16	39	7	9	23	53
2001	76		53					19	31			121	10		2	5	16		9	29	5	1	18	69
2002	73		22	4	0			20	32	2		245	65		5	2	15		7	21	2	8	18	50
2003	48		28	5	0			10	39	1		184	178		1	2	18		3	14	7	2	13	28
2004	61		27	7				12	27	1		225	96		1	1	8		3	14	3	8	7	15
2005	57	5	36	12				14	35	1		123	57		1	3	6		5	21	1	6	18	28
2006[4]	30	5	16	33				19	45	1		87	11								3	3	9	18

continued

Table 5.2 continued

Year	Total by SD							Total
	22	23	24[3]	25	26	27	28(+29)	SD 22-28(+29)
1965	3		39					42
1966	21		74					95
1967	21		30					51
1968	17		85					102
1969	17		70					87
1970	16		55					71
1971	15		114					129
1972	13		129					142
1973	14		68	58	13			153
1974	16		69	34	36			155
1975	45		93	23	6			167
1976	40		83	14	12			149
1977	41		100	12	55			208
1978	44		74	7	3			128
1979	32		89	29	34			184
1980	37		83	12	20			152
1981	37		115	10	19			181
1982	39		81	6	17	4	3	150
1983	44		80	46	4	35	24	233
1984	57		56	17	2	3	2	137
1985	76		60	72	15	4	3	230
1986	130		119	40	37	7	5	338
1987	168		135	166	21	9	6	505
1988	154		157	23	10	14	9	367
1989	162		142	15	11	13	9	352
1990	208		197	24	25			454
1991	272		178	85	20	16		571
1992	322		207	92	85	21	36	763
1993	233	31	212	534	106	13	38	1.167
1994	263	20	226	408	46	17	44	1.024
1995	322	13	150	88	93	31	110	807
1996	244	15	157	392	236	55	107	1.206
1997	211	2	126	363	188	53	100	1.043
1998	182	2	139	125	239	18	93	798
1999	129	2	111	59	144	17	94	556
2000	120	2	115	129	95	16	48	525
2001	95	2	89	137	102	9	30	464
2002	93	5	56	266	135	7	29	591
2003	58	1	69	208	225	3	16	579
2004	73	1	55	241	121	3	22	516
2005	72	5	74	143	104	5	27	429
2006[4]	49	6	61	126	41	4	25	312

[1] From October-December 1990 landings of Germany, Fed. Rep. are included
[2] For the years 1970-1981 and 1990 the catches of Sub-divisions 25-28 are included in Sub-division 24
[3] For the years 1970-1981 and 1990 the Swedish catches of Sub-divisions 25-28 are included in Sub-division 24
[4] Preliminary data
Danish catches in 2002-2004 in SW Baltic were separated according to Sub-divisions 24 and 25
In 2005 Lithuanian landings are reported for 1995 onwards

Table 5.3. Dab in the Baltic Sea: total landings (tons) of by Sub-division and country.
(There are some gaps in the information, therefore "Total" is preliminary)

	Denmark				Ger. Dem. Rep.[1]		Germany, FRG				Sweden[2]								Total									Total
Year/SD	22	23	24(+25)	25-28	22	24	22	24	25	26	22	23	24	25	27	28	29	30	22	23	24[3]	25[5]	26	27	28	29	30	SD 22-30
1970	845		20		11		74												930		20							950
1971	911		26		10		64												985		26							1.011
1972	1110		30		9		63						23						1.182		53							1.235
1973	1087		58		18		118						30						1.223		88							1.311
1974	1178		51		18		118						34						1.314		85							1.399
1975	1273		74		20		131						32						1.424		106							1.530
1976	1238		60		17		114						27						1.369		87							1.456
1977	889		32		13		89						25						991		57							1.048
1978	928		51		19	14	128	4											1.075		69							1.144
1979	1413		50		18	25	123	1					9						1.554		85							1.639
1980	1593		21		15	25	101						3						1.709		49							1.758
1981	1601		32		24	39	164						5						1.789		76							1.865
1982	1863		50		46	38	182	4					6	5	8	6		1	2.091		98	5		8	6		1	2.209
1983	1920		42		46	28	198						24	20	32	22		2	2.164		94	20		32	22		2	2.334
1984	1796		65		30	47	175	2					4	3	5	4		1	2.001		118	3		5	4		1	2.132
1985	1593		58		52	51	187	2					3	3	5	3		1	1.832		114	3		5	3		1	1.958
1986	1655		85		36	35	185	1					1	1	1	1			1.876		122	1		1	1			2.001
1987	1706		93		14	87	276	4					1	1	1	1			1.996		185	1		1	1			2.184
1988	1846		75		22	91	281	1					1	1	1	1			2.149		168	1		1	1			2.320
1989	1722		48		26	19	218	1					1	1	2	1			1.966		69	1		2	1			2.039
1990	1743		146		14	11	252	1					8						2.009		166							2.175
1991	1731		95				340	5					1						2.071		101							2.172
1992	1406		81				409	6						1	1		4		1.815		87	1		1		4		1.908
1993	996		155				556	10				7	1	1			1		1.552	7	166	1				1		1.727
1994	1.621		163				1.190	80	45			5	1	1					2.811	5	244	46						3.106
1995	1.510	47	127	10			1.185	49	3			5	1	5		1			2.695	52	177	18			1			2.943
1996	913	37	128				991	134	13	2	3		3	4	1				1.907	37	265	17	2	1				2.229
1997	728		60				413	21	2			5	5	10	3	1			1.141	5	86	12		3	1			1.248
1998	569		89				280	6	2			7	3	3	1				849	7	98	5		1				960
1999	664		59				339	4				3	1	1					1.003	3	64	1						1.071
2000	612		46				212	3				2		1					824	2	49	1						876
2001	586		72				191	5				4	1	2					777	4	78	2						861
2002	502		31				173	5				4							675	4	36							715
2003	559		171				494	7	0			1	0						1053	1	179	0						1.233
2004	953		185				745	10	0			1	1	0					1698	1	196	0						1.894
2005	752	34	163	16			474	45	9			1	1	0					1226	35	209	25						1.495
2006[4]	400	23	112	161			494	24	11			1	2						894	24	138	172						1.228

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.
[2] For the years 1970-1981 and 1990 the catches of Sub-divisions 25-28 are included in Sub-division 24.
[3] For the years 1970-1981 and 1990 the Swedish catches of Sub-divisions 25-28 are included in Sub-division 24.
[4] Preliminary data.
[5] In 1995 Danish landings of Sub-divisions 25-28 are included.

Table 5.4. Brill in the Baltic Sea: total landings (tons) by Sub-division and country
(There are some gaps in the information, therefore "Total" is preliminary)

	Denmark			Germany, FRG	Sweden		Total			Total
Year	22	23	24-28	22	23	24-28	22	23	24-28	SD 22-28
1970	4						4			4
1971	3						3			3
1972	7						7			7
1973	11		2				11		2	13
1974	25		1				25		1	26
1975	38		1	1			39		1	40
1976	45		1	2			47		1	48
1977	60		2	5			65		2	67
1978	37			3			40			40
1979	30						30			30
1980	26						26			26
1981	22			1			23			23
1982	19					17	19		17	36
1983	13					42	13		42	55
1984	12					3	12		3	15
1985	16					1	16		1	17
1986	15					3	15		3	18
1987	12					3	12		3	15
1988	5					1	5		1	6
1989	9					1	9		1	10
1990						1			1	1
1991	15						15			15
1992	28						28			28
1993	29	5	1				29	5	1	35
1994	57	4	1			1	57	4	2	63
1995	134	12	1		5	8	134	17	9	160
1996	56	6					56	6		62
1997	25				1		25	1		26
1998	21				1		21	1		22
1999	24				1		24	1		25
2000	27				1		27	1		28
2001	19						19			19
2002	25		0		1		25	1	0	27
2003	35		1		0		35	0	1	36
2004	39		1		1	0	39	1	1	41
2005	50	9	3		0	0	50	9	3	62
2006[1]	42	9	2	3			45	9	2	56

[1] Preliminary data

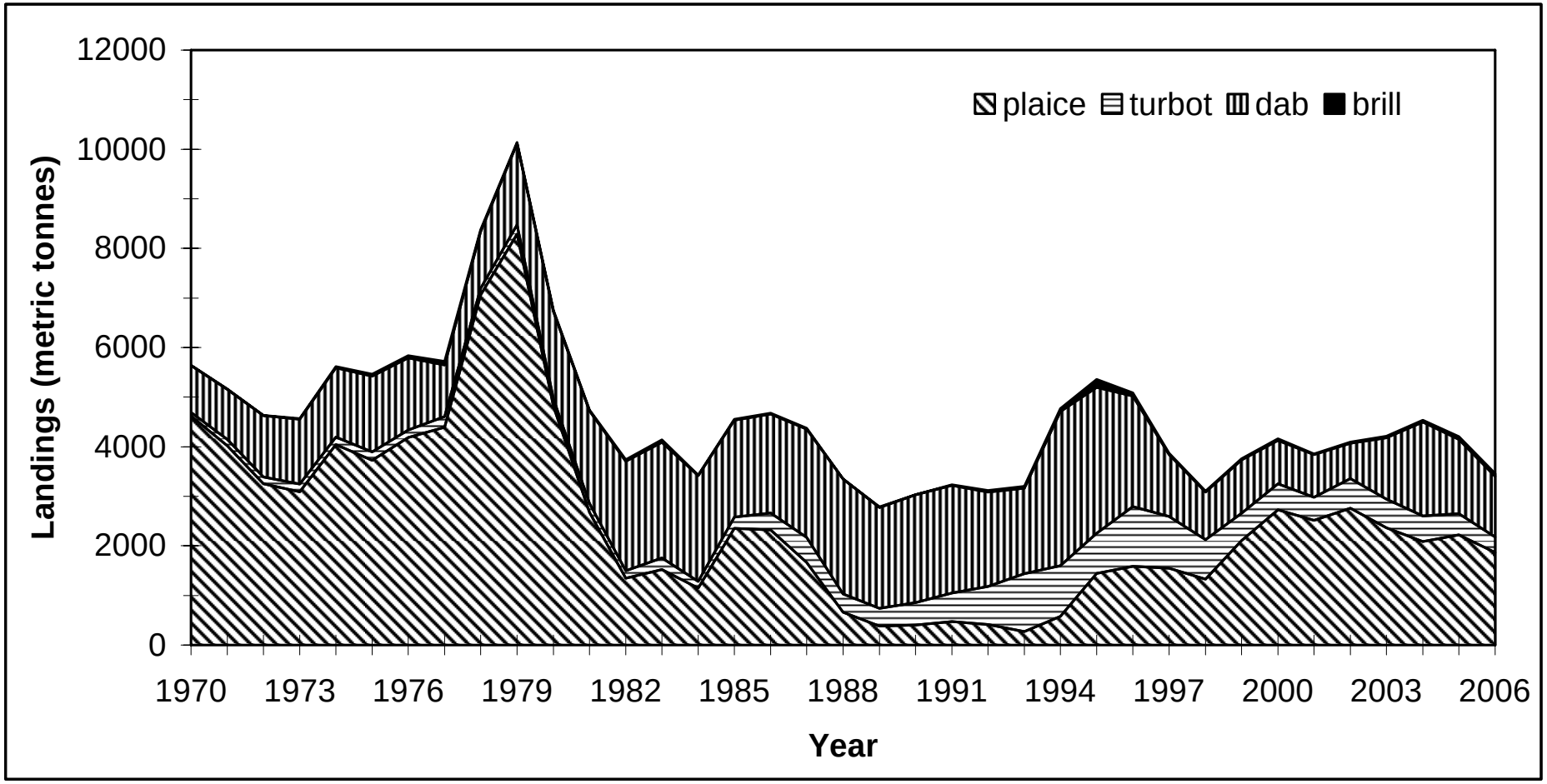


Figure 5.1. Landings of brill, dab, turbot, and plaice in ICES Sub-divisions 22-32 (1970-2006)

6 Herring

6.1 Introduction

6.1.1 Pelagic Stocks in the Baltic: Herring and Sprat

Descriptions of the fisheries for pelagic species and the species are found in Section 1.4 Fisheries Overview.

The distribution by Subdivision of reported landings of herring and sprat in 2006 is given in Table 6.1.1. Sprat is the dominating species in the reported landings in all areas, except in Subdivisions 30 and 31 where sprat seldom occurs. In Subdivision 25 the proportion of herring and sprat in the reported landings is almost equal.

In Table 6.1.2 the proportion of herring in landings is given by country, Subdivision and quarter for 2006 together with the proportion of herring in the acoustic survey in the fourth quarter. It is tacitly assumed that the acoustic survey would yield a reasonably good picture of the spatial distribution of the pelagic stocks. Consequently some resemblance with the distribution of landings of the two species could be expected.

The table indicates, however, some discrepancies in the proportion of herring, especially in Subdivision 26. This could mean that commercial fleets are fishing more discriminatory than do the Research Vessels or that the reported proportions are not reflecting the species composition particularly well.

Table 6.1.3 shows the total reported landings of herring by quarter, along with the number of samples, the number of fish measured and the number of fish aged.

6.1.2 Fisheries Management

Management units

The IBSFC has managed sprat by one TAC agreed for the whole Baltic.

Herring has in recent years been managed by three TAC:s

- SD 22–29S and 32 (excl. Gulf of Riga),
- Gulf of Riga (SD 28.1),
- SD 29N, 30, 31.

The units were changed in 2005 to be

- SD 22-24,
- SD 25-29, 32 (excl. Gulf of Riga),
- Gulf of Riga (SD 28.1),
- SD 30, 31.

The historical development of agreed TAC:s and reported landings for these management units are illustrated in Figure 6.1.1.

Management 2006 and 2007 herring – sprat

The stock status, recommendations from ICES and the TAC decided are presented for the pelagic stocks. The stock status is expressed in relation to the precautionary reference levels.

STOCK	STOCK STATUS 2006		ICES ADVICE 2007	TAC 2007
	in relation to SSB	in relation to F		
SPRAT				
SD 22-32	Full reproductive capacity	Harvested sustainably	< 477 000 t (< F_{pa})	* 454 492 t
HERRING				
SD 25-29&32 (excl. GOR)	Pa points not defined	Harvested sustainably	< 164 000 t (< F_{pa})	* 132 718 t
SD 28.1 (Gulf of Riga)	Full reproductive capacity	Harvested sustainably	33 900 t (= F_{pa})	37 500 t
SD 30 (Bothnian Sea)	Full reproductive capacity	Harvested sustainably	83 400 t (< Fpa)	91 600 t
SD 31 (Bothnian Bay)	Unknown	Unknown	< 4 700 t (< average catches 02-05)	

* EC quotas

6.1.3 Catch options by management unit for herring

The herring assessed in SD 25-29 and 32 is also caught in the Gulf of Riga; likewise the Gulf herring assessed in the Gulf of Riga is caught in SD 28 outside the Gulf. These allocations may be based on proportions of landed amounts in the areas.

Proportion caught in SD 22-24 of the stock in SD 22-24, Div. IIIa and IVa (spring spawners)

YEAR	IN SD 22–24 (1000 TONS)	TOTAL STOCK (SPRING SPAWN.) SD 22-24, DIV. IIIA AND IVA (1000 TONS)	% IN SD 22-24
2000	53.9	109.9	49.0%
2001	63.7	105.8	60.2%
2002	52.7	106.2	49.6%
2003	40.3	78.3	51.5%
2004	41.7	76.8	54.3%
2005	43.7	88.4	49.4%
2006	41.9	88.9	47.1%
Mean	**48.3**	**93.5**	**51.6%**

Proportion caught in the Gulf of Riga (SD 28.1) of the stock in SD 25-29 and 32

YEAR	IN GULF OF RIGA (SD 28.1) (1000 TONS)	TOTAL STOCK SD 25-29, 32 (1000 TONS)	% IN GULF OF RIGA
2000	4.5	175.6	2.6%
2001	2.9	148.4	2.0%
2002	3.5	129.2	2.7%
2003	4.3	113.6	3.8%
2004	3.3	93.0	3.6%
2005	2.3	91.6	2.5%
2006	3.2	110.4	2.9%
Mean	**3.4**	**123.1**	**2.9%**

Proportion caught outside the Gulf of Riga (SD 28.2) of the stock in Gulf of Riga (only Latvian catches)

YEAR	OUTSIDE GULF OF RIGA (SD 28.2) (1000 TONS)	TOTAL STOCK GULF HERRING (1000 TONS)	% OUTSIDE GULF OF RIGA
2000	1.9	34.1	5.6%
2001	1.2	38.8	3.1%
2002	0.4	40.1	1.0%
2003	0.4	40.8	1.0%
2004	0.2	39.1	0.5%
2005	0.5	31.6	1.6%
2006	0.4	31.1	1.3%
Mean	**0.7**	**36.5**	**2.0%**

The two tables above are used for the calculation of the fishing quotas in SD 25-29, 32 (excl. GOR) and in the Gulf of Riga (SD 28.1).

6.1.4 Assessment units for herring stocks

The herring in the Central Baltic, is assessed as two units:

- Herring in SD 25-29, 32 excluding Gulf of Riga herring and
- Gulf of Riga herring (SD 28.1).

The herring in the Gulf of Bothnia are assessed as two stocks:

- Herring in SD 30,
- Herring in SD 31.

The herring in SW Baltic (SD 22-24) is assessed together with the spring spawners in Kattegatt and Skagerrak (Division IIIa).

Table 6.1.1 **Pelagic landings ('1000 t) and species composition (%) in 2006 by Subdivision and quarter.**

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
SD 25	Landings ('000 t)	23.3	20.0	8.1	6.2	**57.6**
	Herring (%)	26	36	96	82	**46**
	Sprat (%)	74	64	4	18	**54**
SD 26	Landings ('000 t)	68.5	54.6	8.8	11.0	**142.9**
	Herring (%)	11	16	20	22	**14**
	Sprat (%)	89	84	80	78	**86**
SD 27	Landings ('000 t)	26.8	8.3	0.2	2.6	**37.9**
	Herring (%)	23	23	72	54	**25**
	Sprat (%)	77	77	28	46	**75**
SD 28*	Landings ('000 t)	48.9	22.2	9.7	23.8	**104.7**
	Herring (%)	25	29	9	27	**25**
	Sprat (%)	75	71	91	73	**75**
SD 29	Landings ('000 t)	27.4	6.6	1.2	21.7	**56.9**
	Herring (%)	23	50	49	39	**33**
	Sprat (%)	77	50	51	61	**67**
SD 30	Landings ('000 t)	21.9	26.9	10.6	12.5	**71.9**
	Herring (%)	96	12	96	91	**95**
	Sprat (%)	4	4	4	9	**5**
SD 31	Landings ('000 t)	0.00	1.7	0.9	0.3	**3.0**
	Herring (%)	100	100	99	100	**100**
	Sprat (%)	0	0	1	0	**0**
SD 32	Landings ('000 t)	10.6	6.4	1.5	16.7	**35.1**
	Herring (%)	21	42	40	27	**28**
	Sprat (%)	79	58	60	73	**72**
Total	Landings ('000 t)	**205.5**	**118.1**	**29.4**	**82.0**	**435.0**
	Herring (%)	**19**	**26**	**40**	**35**	**25**
	Sprat (%)	**81**	**74**	**60**	**65**	**75**

*** Herring landings from the Gulf of Riga excluded**

Table 6.1.2 Proportion of herring in landings 2006.

COUNTRY	QUARTER	SUB-DIVISION								
		25	26	27	28	29	30	31	32	Total
DEN	1	0.00	0.00	0.00	0.00					0.00
	2	0.00								0.00
	3	0.94								0.94
	4	**0.01**			**0.00**	**0.00**				**0.00**
EST	1				0.15	0.13			0.14	0.14
	2	0.00		0.00	0.14	0.18			0.21	0.18
	3				0.24	0.11			0.27	0.24
	4				**0.26**	**0.17**			**0.23**	**0.22**
FIN	1	0.29	0.22	0.26	0.21	0.25	0.96	1.00	0.08	0.76
	2	0.22	0.21	0.20	0.24	0.98	0.94	1.00	1.00	0.84
	3					0.60	0.94	1.00	0.64	0.91
	4			**0.33**	**0.50**	**0.53**	**0.89**	**1.00**	**0.19**	**0.68**
GER	1	0.06	0.04	0.15	0.05	0.08				0.10
	2	0.24	0.09							0.11
	3									
	4									
LAT	1	0.00	0.06		0.02	1.00				0.03
	2	0.00	0.02		0.02					0.02
	3		0.01		0.06					0.05
	4	**0.33**	**0.14**		**0.06**					**0.07**
LIT	1		0.13							0.13
	2	1.00	0.11	1.00	1.00					0.14
	3		0.14							0.14
	4		**0.16**							**0.16**
POL	1	0.17	0.02							0.08
	2	0.25	0.08		0.00					0.14
	3	0.99	0.48							0.87
	4	**0.92**	**0.29**							**0.59**
RUS	1		0.07						0.00	0.07
	2		0.23						0.89	0.25
	3		0.15							0.15
	4		**0.16**						**0.73**	**0.26**
SWE	1	0.57	0.26	0.33	0.68	0.58	1.00			0.51
	2	0.86	0.24	0.25	0.38	0.44	1.00	1.00		0.49
	3	0.88		0.72	0.34	1.00	1.00	1.00		0.76
	4	**0.85**	**0.38**	**0.54**	**0.43**	**0.51**	**1.00**	**1.00**	**0.00**	**0.52**
Total	1	0.26	0.11	0.23	0.26	0.23	0.96	1.00	0.14	0.27
	2	0.36	0.16	0.23	0.18	0.50	0.95	1.00	0.29	0.35
	3	0.96	0.20	0.72	0.10	0.49	0.94	1.00	0.31	0.53
	4	**0.82**	**0.22**	**0.54**	**0.28**	**0.39**	**0.90**	**1.00**	**0.25**	**0.40**
Acoust. Stock	4	**0.89**	**0.51**	**0.57**	**0.22**	**0.50**			**0.15**	**0.43**

Table 6.1.3 **Herring in Sub-divisions 25-32. Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 25	1	6144	27	2357	1255
	2	7254	17	2294	773
	3	7782	14	1972	745
	4	5115	8	1459	665
	Total	26294	66	8,082	3,438
Sub-division 26	1	7192	17	3048	890
	2	8732	35	5418	2014
	3	1786	32	6198	1029
	4	2426	24	3636	1353
	Total	20137	108	18,300	5,286
Sub-division 27	1	6157	10	506	503
	2	1924	1	10	10
	3	123	1	41	41
	4	1377	0	0	0
	Total	9581	12	557	554
Sub-division 28	1	15007	22	2180	1740
	2	21301	57	5470	5248
	3	5157	18	2197	1593
	4	15388	28	3512	2530
	Total	56853	125	13,359	11,111
Sub-division 29	1	6226	9	1932	523
	2	3269	13	3376	675
	3	584	6	1456	385
	4	8557	10	2220	612
	Total	18636	38	8,984	2,195
Sub-division 30	1	20971	13	4415	452
	2	25843	20	8134	589
	3	10147	15	5318	640
	4	11404	12	4401	362
	Total	68365	60	22,268	2,043
Sub-division 31	1	0	0	0	0
	2	1695	11	4396	481
	3	917	6	2705	198
	4	341	1	491	158
	Total	2953	18	7,592	837
Sub-division 32	1	2171	13	1415	714
	2	2676	53	9854	1996
	3	587	5	618	466
	4	4546	40	7166	1661
	Total	9981	111	19,053	4,837
Sub-divisions 25-32	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish meas.**	**Number of fish aged**
	1	**63867**	**111**	**15853**	**6077**
	2	**72694**	**207**	**38952**	**11786**
	3	**27085**	**97**	**20505**	**5097**
	4	**49154**	**123**	**22885**	**7341**
	Total	**212800**	**538**	**98195**	**30301**

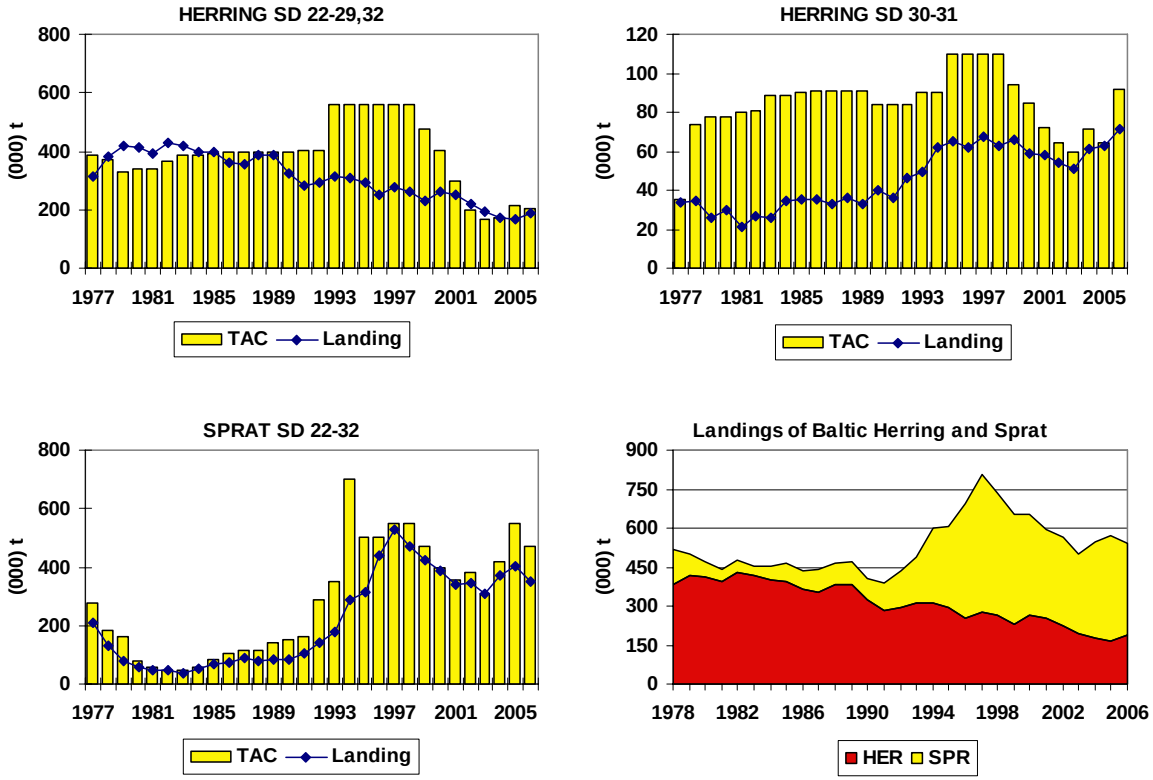


Figure 6.1.1 **Reported landings of herring and sprat and agreed TACs in the Baltic Sea**

6.2 Herring in Subdivisions 25–27, 28.2, 29 and 32 (update assessment)

6.2.1 The Fishery

6.2.1.1 Catch trends

The total reported landings by country are given in Table 6.2.1. Landings in 2006 amounted to 110 400 t, which is an increase compared to last years record low level of 21 %. In most countries landings increased compared to previous year. However, the increase resulted mainly from higher landings of Sweden (+40 %) and of Finland (+50 %). Danish, German and Polish landings were lower then in 2005. Almost all German landings were landed in foreign ports (93 %).

The spatial distribution (by Subdivision) of herring landings changed compared to last year. Landings in 2006 mainly originated from Subdivision 25 and 28.2 (24 % and 23 %, respectively), whereas in 2005 the main part of the landings was coming from Subdivisions 25 and 26 (27 % and 20 %, respectively). Landings by country and Subdivision are presented in Tables 6.2.1-6.2.3.

6.2.1.2 Unallocated landings

No information on unallocated landings was presented. It is, however, expected that misreporting of catches occurs, as the species composition of clupeoids is imprecise in mixed pelagic fishery. It is also expected that the EG regulation 1434/98 that limits the possibilities of landing herring taken west of 16˚ East with small meshed trawls, would be an incentive to report a higher proportion of herring from SD 24 and a higher proportion of sprat from SD 25.

6.2.1.3 Discards

Discarding at sea is not regarded to be a problem for this stock.

6.2.1.4 Effort and CPUE data

Data on commercial effort and CPUE were not used in the assessment.

6.2.2 Biological composition of the catch

6.2.2.1 Age composition

Most countries provided age distributions of their major landings (landed in their waters by quarter and Subdivision). The landings for which age composition was missing represented about 24 % of the total landings in 2006. Almost all German landings were landed in foreign ports and the age distribution of these catches was not provided.

The compiling of national data was done by Subdivision and quarter, but not by fishery. The non-sampled landings were assumed to have the same age distribution as the total for the Subdivision and quarter in which they were caught.

Herring of age groups 1-4 constitute about 76% of the catches in numbers (Figure 6.2.1a). The strong year-class 2002 is in 2006 contributing to the overall catch in numbers by 27 %. The catches in the NE Baltic (Subdivisions 28.2, 29 and 32) dominates with 67% of the total number of herring caught. The internal consistency of the catch at in numbers was checked by plotting catch at age against the catch of the same generation at age 1 year younger (Figure 6.2.1b). Table 6.2.3 gives landings, catch numbers at age and mean weight at age by Subdivision and in Table 6.2.4 by Subdivision and by quarter.

6.2.2.2 Quality of catch and biological data

The level and frequency of sampling of herring in Subdivisions 25-29 and 32 (excl. GOR) in the Baltic is compiled in Table 6.2.2. The overall frequency was 3.5 samples, 537 fishes measured and 175 fishes aged per 1000 tonnes landed. Sampling was most frequent in SD 26 and 32 in 2006. The sampling for age composition is mostly adequate, but could be improved for landings in foreign ports. Furthermore catches in non-national fishing zones are not sampled either.

Mixed fisheries are generally not considered a problem in the Baltic Sea. However the catch data (in tonnes) is regarded as uncertain for this fishery, particularly from 1992 and onwards due to the mixing of sprat and herring in the catches. It has not been possible to estimate the amount of misreporting by species and therefore not to evaluate its effect on the assessment. Some countries have however started to collect additional information on the species catch composition to make adjustments for total catches.

Information on maturity at age is lacking from some areas and countries and a revision of the maturity ogives was therefore not attempted.

6.2.3 Mean weight-at-age

The mean weights-at-age were compiled by Subdivision and quarter for 2006 in Table 6.2.4 and then combined to give the mean weight-at-age for the whole catch. The marked decrease in mean weights that started in the early 1980's stopped and was reversed after 1998. Overall, the mean weights have been rather stable or even slightly increased for most age groups since 1998, although after 2003 younger ages showed a decrease reversed during the last two years. The weight at age 4 in 2006 (year-class 2002) shows a slight decrease which could be the result of density dependent effects as this year-class is very strong (Figure 6.2.2). The marked geographical differences in growth patterns are shown in Table 6.2.4: the mean weight is considerably higher in Subdivisions 25 and 26 and decreases in the more northern Subdivisions. As consequence, the observed variation in average weight (total landings in ton/total numbers) could be due not only to a real decrease in growth, but also to an increase in the proportion of herring caught in Subdivisions 25 and 26 (Figure 6.2.3).

6.2.4 Maturity at age

The Study Group on Baltic Herring and Sprat Stock Maturity gave in its 2002 report an overview of available maturity data for the period 1996-2000. The weighted mean ogives by year over Subdivisions were presented for 1996-1998, 2000. The average for these years is given in the text-table below together with the maturity ogives used by the Working Group.

SOURCE	AGE 1	2	3	4	5+
Mean	0.016	0.67	0.90	0.94	0.97
WG ogive	0	0.70	0.90	1.00	1.00

Based on these findings and considering the uneven distribution of the available information, the Working Group decided to use the same proportions mature at age as during previous years and await further efforts to compile a longer historical series.

6.2.5 Natural mortality

The natural mortalities applied (Table 6.2.7) are based on the latest Multispecies Virtual Population Analysis (Study Group on Multispecies Assessment in the Baltic, ICES CM 2006/BCC:07). The whole time series were updated with the values provided and the differences between the two time series supplied in 2006 (WGBFAS 2006: 1976-2005) and 2007 (updated MSVPA from 2006: 1976-2005) are shown in Figure 6.2.4. The differences are largest in age 1 and towards the beginning of the time series and in the most recent years. Due

to lack of new information the natural mortality for latest year was taken as the average of 2001-2005 of the updated MSAVPA from 2006 (WGBFAS 2006: average for 2005 for the years 2000-2004). Running the XSA with the SPALY settings (see 6.2.6.2) using the new and last years natural mortalities resulted in differences in SBB in the order of -4 % to 1 %.

6.2.6 Catch at age analysis

6.2.6.1 Tuning fleets

As previous years the stock estimates from the International Hydroacoustics Survey was used for tuning the XSA (1982-latest year, ages 1-8+)

The correction factors for area covered i.e. calculated in relation to a standard area, was done by WGBIFS and provided to WGBFAS in a ready format (WGBIFS 2007/LRC:06). The 2005 value was corrected during this meeting since no area corrected value was used in last year assessment. The revision resulted in -4% to + 8% differences in SSB when running the XSA with the tuning data with the area corrected and not area corrected 2005 value (as in last years assessment).

The consistency of the survey data at age was checked by plotting survey numbers at age at given age against the numbers of the same generation at age 1 year younger (Figure 6.2.5).

6.2.6.2 XSA run

The assessment performed this year is an update assessment.

The input data for catch at age analysis are found in Tables 6.2.5-6.2.11, containing catches in numbers at age, mean weights at age in the catch and in the stock, tuning fleet and natural mortality by age and year, proportion of F and M before spawning time and proportion mature fish by age.

The catch at age analysis was performed with an XSA using the same settings as last year. The settings were established in the benchmark assessment performed in 2004 and were decided to be as the settings from previous years i.e. catchability dependent on stock size <3 and independent of age <=6, but with the application of a weak shrinkage (1.5) instead of the previously used 0.5. Increasing the importance of the tuning acoustic fleet improved the outcome of the statistics (lower standard errors and higher correlation coefficients).

In contrast to last years assessment the calculation process has to be stopped after 50 iterations before the tuning has converged (51 iterations) in order to get any output of the regression statistics. The differences of SSB and F, when comparing the results of 50 and 51 iterations were in the order of less than 1 %.

The diagnostics of the final run are shown in Table 6.2.12. Fishing mortalities and stock number are given in Table 6.2.13 and Table 6.2.14, respectively. The summary is presented in Table 6.2.15. The overall perception of the stock is the same as last year with continuing decreasing fishing mortality, which is now on record low level. The SSB shows an increasing tendency. The development of herring biomass as estimated by the Hydroacoustic Surveys and by XSA is illustrated in Figure 6.2.6. The strong year effect in 2003 is still quite evident.

A retrospective analysis for the period 2006 back to 2001 (Figure 6.2.7) showed a tendency to slightly overestimate fishing mortality and underestimate spawning stock biomass in the last years.

As in previous assessments the residual catchability standard errors were, with a few exceptions acceptable (<0.5) and showed no significant time trends (Figure 6.2.8). There are however some year effects showing consistent positive residuals in 2003 and negative

residuals in 2004. However, as this year is an update assessment and the values of the positive and negative figures are within the normal range of the model for both 2003 and 2004, it was therefore decided that the option to exclude certain years from the tuning will be explored at a future benchmark assessment.

The CPUE by age group for the tuning fleet, adjusted to the start of the year was plotted against the estimated stock numbers (Figure 6.2.9). The regression analyses gave R (squared) values around 0.4-0.8.

6.2.7 Recruitment estimates

The number of 0 group herring from the acoustic surveys in 1991-2006 (representing the time span of the area corrected values), was used in a RCT3 analysis to estimate the year class 2006 at age 1. Input and result are presented in Table 6.2.16 and 6.2.17. The estimate of the year class (14 706 mill.) is at the level of the geometrical mean value for the period 1988-2005 (14 801 mill.).

6.2.8 Historical stock trend

The positive development of SSB observed in the recent three years is continuing in this years catch at age analysis (Figure 6.2.10). The stock biomass in 2006 is estimated to be 94 % of the long-term mean. In numbers the metrics shows a stock that varies around 25 billion fish from 1982–1996, but decreases in 1997 (Figure 6.2.11). In 2003 an increasing trend started and now is the stock estimated to be in level with the values from the beginning of the time series in the mid 1970s around 35 billion fish.

A major cause for these deviating trends in stock development is the drastic changes in mean weight (size) during the period of assessment, however slightly increasing in recent years (Figure 6.2.2). Reasons are slow-growing herring, emanating from the north eastern parts of the Baltic, dominating the catches over the recent years. These fish are also caught—outside the spawning time—in other parts of the Baltic, thereby decreasing the overall mean weights. Simultaneously a decrease in condition (indicating slower growth) for herring was observed, which was attributed to shortening in the availability of the main food components, the copepod *Pseudocalanus* sp. This is most probably caused by decreasing salinity, affecting stock development of this copepod (Möllmann et al., 2003; Rönkkönen et al., 2004), and increased competition with large sprat stock (Cardinale and Arrhenius, 2000; Casini et al., 2006).

Fishing mortality more than doubled over the assessment period, but is now following the declining trend that started in recent years and reached now record low level (Fig. 6.2.10). The large proportion of slow-growing herring may have contributed to the increase in fishing mortality, as a given catch in tonnes of these small and slow-growing herring will contain many more individuals and thus cause a higher fishing mortality.

Recruitment-at-age 1 was high in the beginning of the 1980s, but being on a low level afterwards (Fig. 6.2.10). The recent assessments and the hydroacoustic survey results indicate that the 2002 year-class is abundant.

6.2.9 Short-term forecast and management options

The input data of the short-term prediction are presented in Table 6.2.18. The mean weights at age in the prediction, for both catch and stock, were the average of 2004-2006. The estimate of recruitment for 2007 was taken from the RCT3 analysis whereas recruits in 2008 and 2009 were the GM for 1988-2005 (14 801 mill). Natural mortality was the average for 2001-2005, and the exploitation pattern was the average over 2004-2006 scaled to 2006.

The result for the forecast in Table 6.2.19 applying status quo fishing mortality predicts landings of 118 800 t and 127 600 t in 2007 and 2008. The SSB is expected to increase to 980 700 t in 2007.

The share of the different age groups to the yield in 2007 and 2008 and to the SSB in 2008 and 2009 is presented in Figure 6.2.12. The sensitivity of the projection to the assumed strength (GM for 1988-2005) of the 2007 year-classes (age 1 in 2008) is small to the predicted yield in 2008 (4 %). This year class constitute 12 % of the SSB predicted for 2008 (as age 2). The year-class 2006 from the RCT3 model constitutes 4 % of yield in 2007 (as age 1), 8 % of the yield in 2008 (as age 2) and 16 % of SSB in 2009 (as age 3). The strong year-class 2002 is still contributing to a larger extend to the yield in 2007 and 2008 and to the SSB in 2008 and 2009 (Yield 2007: 29 % as age 5; yield 2008: 27 % as age 6; SSB 2008: 24 % as age 6; SSB 2009: 18 % as age 7).

6.2.9.1 Yield and Spawning Stock per Recruit

The input used for the calculation of the yield and spawning stock per recruit is presented in (Table 6.2.18). The output is in Table 6.2.20 and yield and SSB for long- and short-term is shown in Figure 6.2.10.

The reference points were estimated as in last year to F_{max} 0.6, $F_{0.1}$ 0.2.

6.2.10 Medium-term projections

Medium-term projections based on the double-linear stock recruitment relation that was estimated by SGPA in 2003 has been performed. It has the breaking point at 1 130 000 tons of SSB. It is illustrated in Figure 6.2.13 together with a Ricker function for comparison.

The same model as applied in the SGBFS, 1998 was used. It is a prediction model in which stochastic variation has been included for some of the input parameters. The stock size as estimated per 1 January 2006 was taken as basis. Stock size, recruitment and yield were then projected nine years ahead through 200 iterations per year.

Stochasticity was introduced in the calculation of the initial stock size, for which the largest of the Internal and External SE for the survivors from the XSA was applied – recruits from a stock-recruitment relation (double linear), SE of log recruitment values = 0.37. Recruitment was truncated upwards at +2 * SE corresponding to the highest value observed in the time-series.

Mean weights-at-age, both in stock and in catches, where taken as the 2004-2006 average and assumed to be normally distributed with the observed standard deviation from the same period.

A projection was run under the assumption that the fishing mortality is kept at $\mathbf{F}_{sq}$ (0.12), which is lower than Fpa (0.19), for all years. It predicts the SSB to increase and reach about 1 700 000 t in end of the projection period. A second projection was using F_{sq} in 2006 and F_{pa} (0.19) in the following prediction years which predicts the SBB to end just below 1 200 000 t.

Catches are expected to rise to about 220 000 t and 260 000 t for the two projections, respectively.

Results are presented in Table 6.2.21 and Table 6.2.22 and given in Figures 6.2.14 and 6.2.15.

The results are to a large extent dependent on the assumptions about future mean weights.

6.2.11 Reference points

The biological reference points were estimated in 2005 by the PA–programme supplied by CEFAS (Table 6.2.23, Figure 6.2.16). The standard BRF:s estimates for $\mathbf{F}_{0.1}$ = 0.19 and $\mathbf{F}_{med}$ = 0.22.

The PA-reference points

The values proposed for the stock in 25-29, 32 (including. Gulf of Riga) by ACFM 1999 were $\mathbf{B}_{lim}$ = approx. $\mathbf{B}_{loss}$ = 750 000 tonnes; $\mathbf{B}_{pa} = \mathbf{B}_{lim}$ *1.33 = 1 million tonnes; $\mathbf{F}_{pa} = \mathbf{F}_{med}$ = 0.17 and $\mathbf{F}_{lim} = \mathbf{F}_{loss}$ = 0.33.

For the stock herring in 25-29, 32 (excl. Gulf of Riga) a $\mathbf{F}_{pa}$ of 0.19 (based on $\mathbf{F}_{med}$) was adopted in 2002.

The Study Group on Precautionary Reference Points for Advice on Fishery Management (ICES CM 2003/ACFM:15) estimated $\mathbf{B}_{lim}$ as 1 130 000 tonnes and a corresponding $\mathbf{F}_{lim}$ as 0.19. These values were commented as follows:

"There were no defined biomass reference points for this stock. Segmented regression is highly significant however results reveals similar patterns as for previous stocks: 1) time-series effect in S-R relationship, 2) breaking point is placed close to maximal observed recruitment. For estimation of $\mathbf{B}_{lim}$ a stock-specific approach may be appropriate."

The recent development in attitudes towards the PA-reference points both among management bodies and within ICES, with a stronger emphasis on definitions of safe biological limits and long-term development and sustainability has contributed to an apparent halt in producing guide-lines for calculation of these points. The WG could not find an alternative way to reach an estimate for B_{lim}.

The complex structure of this stock with a number of spawning components varying in size at age, in maximal length and in size at maturity contribute to make the traditionally calculated spawning stock size a less suitable indicator for stock productivity.

The fishing mortality of 0.19, earlier adopted as F_{pa} for this stock, is below F_{med} and now at the level of $F_{0.1}$ and would be a safe basis for advice and serve as a candidate for target level in management.

6.2.12 Quality of assessment

The inputs to the assessment are catch-at-age data and age-structured stock estimates from the International Acoustic Survey. There is uncertainty associated with the total catches due to misreporting between herring and sprat catches. It has not been possible for the Working Group to quantify these uncertainties.

The procedure in which area based factors are used for raising indices from the acoustic survey is a matter in need of quality assurance to secure comparability between assessments.

These uncertainties could influence the estimates of absolute stock size and fishing mortality. The trends in stock development are probably more robust, as the comparison with the acoustic stock estimates indicates.

The fishing mortality (F_{3-6}) shows in recent years a decreasing trend and is on a record low level in 2006. An exploratory run with SURBA based on the international acoustic survey is also showing an overall decreasing trend in total mortality (Z_{3-6}) after 2000. However, the decreasing trend observed in the SURBA analysis is less pronounced than the results from the final XSA runs.

6.2.13 Comparison with previous assessment

Settings and results of the final XSA-runs of the last 2 years assessments are compared in the text table below. XSA-settings are equal. This resulted in different figures for the SSB in 2005, being 18 % higher in this year's assessment. $F_{(3-6)}$ in 2005 was estimated to be 12 % lower compared to last year's assessment and recruitment-at-age 1 in 2004 was estimated to be 23 % higher in the final run this year. Short-term predictions produced a SBB-figure for 2007, which was 7 % higher compared to the 2006 assessment, while the yield decreased by a value of 11 %. The outcome of this year's assessment shows the same pattern as encountered last year with an increase in stock size and declining fishing mortality.

CATEGORY	VARIABLE /PARAMETER	2006 ASSESSMENT	2007 ASSESSMENT	DIFF. (%)
XSA Input	Catch data	1974–latest year/Ages 1-8+	1974–latest year/Ages 1-8+	No
	Natural mortality	MSVPA 2005	**MSVPA 2006**	**Yes**
	Maturity ogive	Age1=0%, Age2=70%, Age3= 90%	Age1=0%, Age2=70%, Age3= 90%	No
	TUNING DATA	Intern. Acoustic Survey 1982–latest year/Ages 1–8+	Intern. Acoustic Survey 1982–latest year/Ages 1–8+ **2005 corrected**	**Yes**
XSA settings	Time weighting	Tricubic, 20 years	Tricubic, 20 years	No
	Catchability dep. on stock size	ages < 3	ages < 3	No
	Catchability indep. of age	ages >= 6	ages >= 6	No
	Shrinkage towards mean F	5 years 3 oldest ages	5 years 3 oldest ages	No
	S.E of mean	1.5	1.5	No
XSA results	SSB_{2005}(1000 t) $F\ (3\text{-}6)_{2005}$ Recruitment Age 1_{2004} (billions)	640.5 0.151 14.7	755.8 0.133 18.1	+18.0 -11.9 +23.1
Short-term Prediction	SSB_{2007} at Fsq (1000 t) $Yield_{2007}$(1000 t)	896.3 132.9	960.7 118.8	+7.2 -10.6

6.2.14 Management considerations

There are no explicit management objectives for this stock. However, for any management objective to meet the precautionary criteria, F should be less than the proposed F_{pa}.

The increase in SSB in 2006 is mainly driven by the strong year-class 2002 and will still have some impact on the development of the stock in the next years.

Table 6.2.1 Herring in SD 25-29, 32 (excl. GOR). Catches by country (1000 t).

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia**	Sweden	Total
1977	11.9		33.7	0.0			57.2	112.8	48.7	264.3
1978	13.9		38.3	0.1			61.3	113.9	55.4	282.9
1979	19.4		40.4	0.0			70.4	101.0	71.3	302.5
1980	10.6		44.0	0.0			58.3	103.0	72.5	288.4
1981	14.1		42.5	1.0			51.2	93.4	72.9	275.1
1982	15.3		47.5	1.3			63.0	86.4	83.8	297.3
1983	10.5		59.1	1.0			67.1	69.1	78.6	285.4
1984	6.5		54.1	0.0			65.8	89.8	56.9	273.1
1985	7.6		54.2	0.0			72.8	95.2	42.5	272.3
1986	3.9		49.4	0.0			67.8	98.8	29.7	249.6
1987	4.2		50.4	0.0			55.5	100.9	25.4	236.4
1988	10.8		58.1	0.0			57.2	106.0	33.4	265.5
1989	7.3		50.0	0.0			51.8	105.0	55.4	269.5
1990	4.6		26.9	0.0			52.3	101.3	44.2	229.3
1991	6.8	27.0	18.1	0.0	20.7	6.5	47.1	31.9	36.5	194.6
1992	8.1	22.3	30.0	0.0	12.5	4.6	39.2	29.5	43.0	189.2
1993	8.9	25.4	32.3	0.0	9.6	3.0	41.1	21.6	66.4	208.3
1994	11.3	26.3	38.2	3.7	9.8	4.9	46.1	16.7	61.6	218.6
1995	11.4	30.7	31.4	0.0	9.3	3.6	38.7	17.0	47.2	189.3
1996	12.1	35.9	31.5	0.0	11.6	4.2	30.7	14.6	25.9	166.7
1997	9.4	42.6	23.7	0.0	10.1	3.3	26.2	12.5	44.1	172.0
1998	13.9	34.0	24.8	0.0	10.0	2.4	19.3	10.5	71.0	185.9
1999	6.2	35.4	17.9	0.0	8.3	1.3	18.1	12.7	48.9	148.7
2000	15.8	30.1	23.3	0.0	6.7	1.1	23.1	14.8	60.2	175.1
2001	15.8	27.4	26.1	0.0	5.2	1.6	28.4	15.8	29.8	150.2
2002	4.6	21.0	25.7	0.3	3.9	1.5	28.5	14.2	29.4	129.1
2003	5.3	13.3	14.7	3.9	3.1	2.1	26.3	13.4	31.8	113.8
2004	0.2	10.9	14.5	4.3	2.7	1.8	22.8	6.5	29.3	93.0
2005	3.1	10.8	6.4	3.7	2.0	0.7	18.5	7.0	39.4	91.6
2006*	0.1	13.4	9.6	3.2	3.0	1.2	16.8	7.6	55.3	110.4

* Preliminary

** in 1977-1990 sum of catches for Latvia, Lithuania and Russia

Table 6.2.2 **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

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	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 25	Denmark	1	3	9	148	148
		2				
		3	130	5	98	98
		4	4			
		Total	137	14	246	246
	Finland	1	20			
		2	134			
		3				
		4				
		Total	154	0	0	0
	Germany	1	60			
		2	100			
		3				
		4				
		Total	160	0	0	0
	Latvia	1				
		2				
		3				
		4	83			
		Total	83	0	0	0
	Lithuania	1				
		2	5			
		3				
		4				
		Total	5	0	0	0
	Poland	1	1,766	9	1,759	661
		2	2,581	10	2,094	573
		3	5,489	5	1,674	452
		4	3,246	4	1,059	268
		Total	13,082	28	6,586	1,954
	Sweden	1	4,294	9	450	446
		2	4,435	7	200	200
		3	2,163	4	200	195
		4	1,782	4	400	397
		Total	12,674	24	1,250	1,238
	Total	1	6,144	27	2,357	1,255
		2	7,254	17	2,294	773
		3	7,782	14	1,972	745
		4	5,115	8	1,459	665
		Total	26,294	66	8,082	3,438

continued

continued **2/6**

Table 6.2.2 **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 26	Denmark	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Finland	1	16			
		2	281			
		3				
		4				
		Total	297	0	0	0
	Germany	1	228			
		2	190			
		3				
		4				
		Total	418	0	0	0
	Latvia	1	187	1	266	141
		2	29	0	0	0
		3	6	0	0	0
		4	143	1	209	132
		Total	365	2	475	273
	Lithuania	1	409	7	1,066	300
		2	501	11	1,171	300
		3	2	6	732	200
		4	127	8	666	199
		Total	1,039	32	3,635	999
	Poland	1	293	5	922	239
		2	1,483	8	1,100	336
		3	847	3	1,236	269
		4	1,106	6	909	328
		Total	3,729	22	4,167	1,172
	Russia	1	636	4	794	210
		2	3,307	16	3,147	1,378
		3	932	23	4,230	560
		4	682	9	1,852	694
		Total	5,557	52	10,023	2,842
	Sweden	1	5,423			
		2	2,940			
		3				
		4	367			
		Total	8,731	0	0	0
	Total	1	7,192	17	3,048	890
		2	8,732	35	5,418	2,014
		3	1,786	32	6,198	1,029
		4	2,426	24	3,636	1,353
		Total	20,137	108	18,300	5,286

continued

continued **3/6**

Table 6.2.2 **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 27	Denmark	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Finland	1	204			
		2	319			
		3				
		4	20			
		Total	543	0	0	0
	Germany	1	2,133			
		2				
		3				
		4				
		Total	2,133	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Lithuania	1				
		2	20			
		3				
		4				
		Total	20	0	0	0
	Sweden	1	3,820	10	506	503
		2	1,585	1	10	10
		3	123	1	41	41
		4	1,357			
		Total	6,885	12	557	554
	Total	1	6,157	10	506	503
		2	1,924	1	10	10
		3	123	1	41	41
		4	1,377	0	0	0
		Total	9,581	12	557	554

continued

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Table 6.2.2 **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 28.2	Estonia	1	612	2	204	204
		2	2,522	2	203	203
		3	118	2	204	204
		4	366	3	306	306
		Total	3,617	9	917	917
	Finland	1	336			
		2	218			
		3				
		4	88			
		Total	643	0	0	0
	Germany	1	233			
		2				
		3				
		4				
		Total	233	0	0	0
	Latvia	1	469	6	516	392
		2	916	7	350	350
		3	487	4	200	200
		4	711	4	250	250
		Total	2,582	21	1,316	1,192
	Lithuania	1				
		2	145			
		3				
		4				
		Total	145	0	0	0
	Poland	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Russia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Sweden	1	10,476	5	223	223
		2	2,564	2	105	103
		3	303			
		4	5,181			
		Total	18,524	7	328	326
	Total	1	12,126	13	943	819
		2	6,365	11	658	656
		3	907	6	404	404
		4	6,345	7	556	556
		Total	25,744	37	2,561	2,435

continued

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Table 6.2.2 **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 29	Denmark	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Estonia	1	1,719	2	204	204
		2	638	4	408	408
		3	32	2	204	204
		4	927	4	410	410
		Total	3,316	12	1,226	1,226
	Finland	1	1,486	6	1,671	262
		2	2,365	9	2,968	267
		3	542	4	1,252	181
		4	2,150	6	1,810	202
		Total	6,542	25	7,701	912
	Germany	1	290			
		2				
		3				
		4				
		Total	290	0	0	0
	Latvia	1	2			
		2				
		3				
		4				
		Total	2	0	0	0
	Sweden	1	2,729	1	57	57
		2	266			
		3	10			
		4	5,480			
		Total	8,486	1	57	57
	Total	1	6,226	9	1,932	523
		2	3,269	13	3,376	675
		3	584	6	1,456	385
		4	8,557	10	2,220	612
		Total	18,636	38	8,984	2,195

continued

continued **6/6**

Table 6.2.2 **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches by quarter and Sub-division for 2006 available to the Working Group.**

	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 32	Estonia	1	1,980	7	630	630
		2	1,505	16	1,584	1,584
		3	563	4	404	404
		4	2,413	12	1,180	1,180
		Total	6,461	39	3,798	3,798
	Finland	1	39	1	35	19
		2	5	8	2,530	192
		3	24	1	214	62
		4	1,348	8	2,086	221
		Total	1,417	18	4,865	494
	Russia	1	152	5	750	65
		2	1,166	29	5,740	220
		3				
		4	745	20	3,900	260
		Total	2,063	54	10,390	545
	Sweden	1				
		2				
		3				
		4	40			
		Total	40	0	0	0
	Total	1	2,171	13	1,415	714
		2	2,676	53	9,854	1,996
		3	587	5	618	466
		4	4,546	40	7,166	1,661
		Total	9,981	111	19,053	4,837
Sub-divisions 25-32 (excl. 28.1 & 30-31)	**Total**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish meas.**	**Number of fish aged**
		1	**40,015**	**89**	**10,201**	**4,704**
		2	**30,219**	**130**	**21,610**	**6,124**
		3	**11,770**	**64**	**10,689**	**3,070**
		4	**28,367**	**89**	**15,037**	**4,847**
		Total	**110,372**	**372**	**57,537**	**18,745**

Table 6.2.3 Herring in SD 25-29, 32 (excl. GOR). Catch by country and SD and mean weight by SD in 2006.

Catch (1000 t) by country and SD

Country	Total	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
Denmark	0.137	0.137					
Estonia	13.394				3.617	3.316	6.461
Finland	9.596	0.154	0.297	0.543	0.643	6.542	1.417
Germany	3.234	0.160	0.418	2.133	0.233	0.290	
Latvia	3.032	0.083	0.365		2.582	0.002	
Lithuania	1.209	0.005	1.039	0.020	0.145		
Poland	16.811	13.082	3.729				
Russia	7.621		5.557				2.063
Sweden	55.339	12.674	8.731	6.885	18.524	8.486	0.040
Total	110.4	26.3	20.1	9.6	25.7	18.6	10.0

Catch in numbers (millions)

AGE	Total	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	**172.4**	2.1	10.0	0.5	2.2	130.9	26.8
1	**808.4**	91.7	131.6	30.4	72.6	327.3	154.7
2	**505.6**	77.5	96.0	37.5	80.7	101.8	112.2
3	**754.0**	92.3	75.6	112.7	119.9	172.8	180.8
4	**1105.0**	124.6	70.7	117.0	300.3	297.4	195.0
5	**409.1**	54.1	52.9	34.3	116.1	76.0	75.8
6	**264.9**	53.3	33.0	28.7	89.6	38.5	21.7
7	**154.5**	25.5	23.5	10.6	65.0	18.9	11.0
8	**62.7**	14.5	10.5	1.4	21.7	11.7	2.9
9	**41.6**	7.4	7.0	2.1	17.9	4.9	2.1
10+	**43.4**	4.1	7.5	1.4	19.6	9.4	1.3
Total N	4321.5	547.1	518.3	376.5	905.6	1189.5	784.4
CATON	**110372.2**	**26293.7**	**20136.7**	**9581.0**	**25743.8**	**18635.6**	**9981.3**

Mean weight (g)

AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	**4.8**	26.5	10.7	3.6	3.6	4.3	3.5
1	**12.0**	27.7	13.8	8.2	10.4	9.3	8.4
2	**23.4**	44.3	32.8	20.2	19.3	15.5	12.1
3	**23.7**	46.4	42.8	20.2	23.7	17.0	12.9
4	**26.3**	47.2	45.9	28.5	26.7	19.5	14.3
5	**33.9**	53.2	60.3	32.0	30.2	25.5	16.5
6	**43.5**	64.1	61.1	38.8	37.7	30.1	19.9
7	**48.6**	69.1	65.9	45.6	43.5	33.9	21.7
8	**54.1**	75.0	67.7	51.3	45.9	39.1	24.2
9	**55.6**	81.5	69.1	60.0	48.4	33.4	27.1
10+	**56.8**	85.2	84.1	52.9	49.9	39.7	44.4
N*w	110372.2	26293.7	20136.7	9581.0	25743.8	18635.6	9981.3

Table 6.2.4 **Herring in SD 25-29, 32 (excl. GOR).** **1/2**
Catch in number at age per SD and quarter in 2006.

Catch in numbers (millions)

Quarter:	1						
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	164.7	8.9	54.6	19.4	13.1	49.8	18.9
2	109.5	23.2	25.8	21.3	15.5	15.0	8.7
3	289.4	21.9	25.9	76.0	37.6	100.0	27.9
4	437.4	21.4	23.2	78.9	112.7	132.4	68.8
5	172.1	11.9	20.1	21.8	58.0	24.0	36.3
6	118.9	13.3	15.9	16.5	45.7	18.8	8.8
7	83.0	9.3	11.3	7.3	41.3	6.8	6.9
8	30.8	3.8	5.8	1.0	12.7	5.2	2.3
9	24.9	3.4	3.7	0.5	13.7	1.9	1.8
10+	23.8	1.2	3.5	1.0	13.6	3.7	0.8
Total N	1454.4	118.2	189.7	243.5	364.0	357.6	181.4
CATON	30884.1	6063.7	1338.3	3820.2	11556.5	5934.3	2171.1
NoAgeTON	9131.4	79.9	5853.8	2336.7	569.6	291.5	0.0
Quarter:	**2**						
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	156.2	48.7	61.8	1.4	13.4	23.7	7.2
2	133.4	26.3	64.2	5.6	13.4	7.1	16.8
3	228.6	26.2	36.4	28.0	40.3	23.9	73.7
4	269.3	22.0	23.4	19.6	98.2	53.1	53.1
5	114.8	10.7	20.9	7.0	30.9	22.1	23.1
6	68.2	13.3	8.5	7.0	18.4	12.1	8.9
7	37.5	5.6	7.0	1.4	14.3	6.7	2.5
8	20.9	6.3	2.2	0.0	7.0	4.9	0.5
9	10.9	1.5	2.3	1.4	3.1	2.3	0.3
10+	11.6	1.6	1.6	0.0	4.0	4.1	0.3
Total N	1051.2	162.1	228.3	71.5	243.0	159.9	186.5
CATON	25571.9	7015.2	5290.8	1585.1	6001.7	3002.6	2676.5
NoAgeTON	4647.5	238.4	3440.8	339.0	363.2	266.1	0.0
Quarter:	**3**						
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	31.5	0.0	0.2	0.0	0.0	30.0	1.3
1	69.5	15.8	7.2	0.6	4.7	29.7	11.4
2	46.4	20.2	1.2	1.1	8.2	7.6	8.0
3	50.4	24.8	7.1	0.8	6.0	0.9	10.9
4	83.2	46.6	12.4	1.5	11.1	1.5	10.1
5	34.2	19.9	5.0	0.6	4.6	0.3	3.7
6	27.7	18.5	4.2	0.5	3.6	0.3	0.4
7	10.3	6.2	2.4	0.2	1.4	0.0	0.1
8	4.4	2.7	1.2	0.0	0.3	0.1	0.0
9	2.3	1.5	0.6	0.0	0.2	0.0	0.0
10+	2.8	1.1	1.3	0.0	0.3	0.1	0.0
Total N	362.7	157.4	42.8	5.5	40.5	70.6	46.0
CATON	11327.9	7781.7	1780.8	0.0	604.3	573.7	587.4
NoAgeTON	442.4	0.0	5.6	123.3	303.1	10.4	0.0
Quarter:	**4**						
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	140.9	2.1	9.8	0.5	2.2	100.9	25.5
1	418.1	18.4	8.0	9.0	41.5	224.0	117.1
2	216.3	7.9	4.8	9.4	43.5	72.1	78.6
3	185.6	19.4	6.3	7.8	36.0	47.9	68.3
4	315.1	34.6	11.7	17.0	78.3	110.4	63.0
5	88.0	11.5	6.8	4.9	22.6	29.6	12.6
6	50.2	8.2	4.4	4.8	21.9	7.3	3.5
7	23.7	4.4	2.9	1.7	7.9	5.3	1.5
8	6.6	1.7	1.3	0.4	1.6	1.6	0.1
9	3.4	1.1	0.5	0.2	0.9	0.7	0.0
10+	5.2	0.2	1.0	0.4	1.7	1.6	0.2
Total N	1453.1	109.4	57.6	56.0	258.1	601.4	370.5
CATON	15607.8	5032.0	1915.6	0.0	1076.8	3077.0	4506.3
NoAgeTON	12759.2	82.9	510.9	1376.8	5268.6	5480.1	40.0

continued

Table 6.2.4 **Herring in SD 25-29, 32 (excl. GOR).** **2/2**

Mean weight at age per SD and quarter in 2006.

Mean weight (g)

Quarter:	1						
AGE	**Mean**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O							
1	7.6	18.4	11.4	5.9	5.8	4.0	4.1
2	25.6	39.1	29.3	18.9	25.6	17.7	9.2
3	22.5	49.8	39.8	20.3	24.8	16.1	10.9
4	25.3	52.9	43.4	29.1	29.8	18.5	11.8
5	31.7	54.5	57.7	32.9	31.3	24.6	14.4
6	41.0	68.4	60.7	38.9	37.3	27.7	16.1
7	46.6	69.1	64.6	43.9	44.4	32.1	17.9
8	50.3	69.2	67.4	54.5	48.6	34.9	19.3
9	52.7	82.1	65.0	39.0	50.5	25.3	22.9
10+	56.0	94.5	84.4	57.0	52.0	38.1	21.8
N*w	40015.5	6143.5	7192.1	6156.8	12126.1	6225.8	2171.1

Quarter:	2						
AGE	**Mean**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O							
1	13.4	22.3	12.1	8.0	6.6	5.1	4.1
2	29.0	40.5	32.9	30.0	19.2	10.9	11.1
3	24.5	43.9	45.4	18.7	22.4	17.1	13.1
4	25.6	50.1	53.3	28.0	23.7	17.4	14.2
5	37.5	63.9	67.7	31.6	29.1	30.2	17.9
6	44.7	71.7	66.4	38.6	37.3	31.9	21.4
7	50.7	77.4	72.5	58.0	41.8	30.4	31.5
8	56.6	78.6	72.1	0.0	41.8	43.6	46.4
9	60.8	103.3	74.7	70.0	41.5	42.0	51.3
10+	57.0	82.0	94.0	0.0	46.4	42.9	51.0
N*w	30219.4	7253.6	8731.6	1924.1	6364.9	3268.7	2676.5

Quarter:	3						
AGE	**Mean**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	3.7		17.6	4.6	4.6	3.6	3.2
1	17.7	35.9	29.0	12.0	12.0	9.8	8.9
2	32.0	53.1	36.8	17.1	17.1	15.1	11.4
3	33.5	45.7	35.2	21.6	21.6	18.0	13.3
4	36.9	45.5	37.9	23.1	23.1	18.1	15.8
5	42.5	50.2	44.9	27.9	27.9	24.4	19.7
6	53.9	59.8	54.5	32.2	32.2	27.1	21.5
7	57.0	62.4	58.4	36.0	36.0	24.6	33.8
8	68.0	75.6	63.1	35.6	35.6	30.5	
9	63.6	64.5	73.6	31.3	31.3	19.4	
10+	72.7	82.8	74.1	38.0	38.0	59.9	
N*w	11770.3	7781.7	1786.4	123.3	907.4	584.1	587.4

Quarter:	4						
AGE	**Mean**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	5.0	26.5	10.6	3.6	3.6	4.4	3.5
1	12.3	39.2	29.9	12.9	12.9	10.8	9.3
2	17.0	50.0	48.6	17.6	17.6	15.6	12.6
3	22.1	47.1	48.6	24.5	24.5	18.7	13.3
4	25.5	44.0	44.5	26.7	26.7	21.7	16.9
5	30.1	47.2	56.1	29.3	29.3	22.8	19.2
6	42.0	54.9	58.6	39.8	39.8	33.7	25.3
7	48.3	68.0	61.6	43.8	43.8	40.6	22.0
8	54.4	73.5	66.5	44.6	44.6	39.0	23.0
9	54.0	73.8	67.4	44.1	44.1	27.6	
10+	52.0	65.1	79.9	43.8	43.8	34.1	126.1
N*w	28367.0	5114.9	2426.5	1376.8	6345.4	8557.1	4546.3

Table 6.2.5 **Herring in SD 25-29, 32 (excl. GOR).**
XSA input: Catch in Numbers (Thousands)

CANUM: Catch in numbers (Total International Catch) (Total) (Thousands)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	SOPCOF %
1974	2436300	1553800	1090600	1347900	483100	343500	619000	285100	99.5
1975	1861800	1229200	1405600	829900	870700	364000	274800	546800	100.2
1976	2093100	1114800	1034000	907300	476800	558500	246500	494400	100.0
1977	1258500	1825900	773600	608300	621700	365300	284000	545400	99.9
1978	1044000	1298700	1575100	436800	355100	370700	186800	478300	100.0
1979	405300	1195500	873200	1159500	338900	278700	281200	478500	100.0
1980	1037000	907100	977400	524600	654900	182500	204400	550500	100.0
1981	1325500	1523500	680000	615000	343600	436300	146600	527500	100.2
1982	867000	2277000	810100	334200	312000	188100	250500	420700	99.6
1983	744300	1698700	1875700	625300	233100	245700	162500	433400	100.3
1984	822000	1177900	1282900	1145700	374300	165500	166300	421100	100.0
1985	1237800	2124100	1076100	867300	707200	240300	131000	346900	99.9
1986	552824	1733617	1601914	838843	614707	320221	114772	208901	100.4
1987	920000	726000	1445000	1237000	607000	461000	238000	194000	100.1
1988	474000	2091300	746300	1009600	849400	354300	254200	210100	100.1
1989	792900	540600	1988300	580000	840700	695100	266500	336600	99.9
1990	643300	1194800	585500	1245900	419400	541100	370500	306000	100.4
1991	372900	1571700	1286100	512700	807700	278400	265900	238200	100.1
1992	1112600	1139400	1696900	702900	324100	422300	157700	218600	100.7
1993	826300	1852600	1503000	1473400	615700	274000	197500	140100	99.8
1994	486870	1138560	1559930	1068900	1057400	495520	213790	282450	100.5
1995	820500	960200	1742700	1555400	645700	440400	205200	212100	100.5
1996	985800	1441300	1095900	1216600	798100	492000	301100	223800	99.3
1997	549200	1350300	1738700	1173900	904800	492600	244200	186100	99.9
1998	1873286	947360	1810804	1781642	813071	481770	211361	186102	100.1
1999	628815	1660328	949293	1307772	950155	340256	185943	119952	102.9
2000	1842170	940000	1682170	818970	864530	567220	191280	185030	99.9
2001	1052466	1930067	605055	1010660	375834	391122	303247	199646	99.4
2002	1034640	1012975	1339851	456838	522442	179710	169851	230139	98.6
2003	1347364	782607	687478	686673	261252	226812	89925	202367	101.1
2004	656630	1242941	673629	568055	384598	162350	119700	129883	100.0
2005	326272	753498	1187077	557148	378447	219723	82530	159318	101.2
2006	808387	505592	754016	1104978	409059	264865	154493	147666	100.8

Table 6.2.6 **Herring in SD 25-29, 32 (excl. GOR).**
XSA input: Mean weight in the Catch and in the Stock (Kilograms)

WECA (= WEST): Mean weight in Catch (Total International Catch) (Total) (Kilograms)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.0300	0.0350	0.0430	0.0460	0.0710	0.0790	0.0830	0.0750
1975	0.0300	0.0340	0.0520	0.0520	0.0540	0.0790	0.0780	0.0790
1976	0.0230	0.0380	0.0400	0.0600	0.0580	0.0570	0.0800	0.0810
1977	0.0290	0.0310	0.0500	0.0580	0.0690	0.0610	0.0720	0.0910
1978	0.0270	0.0440	0.0430	0.0560	0.0620	0.0730	0.0730	0.0810
1979	0.0240	0.0420	0.0590	0.0530	0.0660	0.0720	0.0770	0.0860
1980	0.0240	0.0370	0.0540	0.0680	0.0630	0.0770	0.0800	0.0940
1981	0.0260	0.0350	0.0530	0.0700	0.0790	0.0770	0.0860	0.1000
1982	0.0220	0.0390	0.0530	0.0650	0.0750	0.0840	0.0800	0.1010
1983	0.0180	0.0310	0.0560	0.0590	0.0770	0.0870	0.0910	0.1030
1984	0.0160	0.0300	0.0460	0.0650	0.0670	0.0820	0.0890	0.1010
1985	0.0160	0.0230	0.0420	0.0580	0.0670	0.0750	0.0850	0.1020
1986	0.0180	0.0250	0.0330	0.0510	0.0630	0.0690	0.0790	0.0990
1987	0.0150	0.0330	0.0380	0.0450	0.0590	0.0640	0.0710	0.0920
1988	0.0200	0.0260	0.0470	0.0510	0.0530	0.0650	0.0710	0.0900
1989	0.0230	0.0360	0.0370	0.0520	0.0570	0.0590	0.0670	0.0820
1990	0.0180	0.0310	0.0420	0.0390	0.0600	0.0620	0.0640	0.0770
1991	0.0230	0.0240	0.0350	0.0490	0.0410	0.0600	0.0560	0.0690
1992	0.0130	0.0230	0.0310	0.0420	0.0570	0.0500	0.0670	0.0710
1993	0.0130	0.0210	0.0320	0.0350	0.0440	0.0510	0.0500	0.0660
1994	0.0160	0.0210	0.0280	0.0380	0.0420	0.0520	0.0610	0.0640
1995	0.0110	0.0210	0.0240	0.0320	0.0410	0.0420	0.0490	0.0540
1996	0.0110	0.0170	0.0240	0.0280	0.0330	0.0370	0.0400	0.0510
1997	0.0110	0.0170	0.0220	0.0260	0.0300	0.0350	0.0400	0.0440
1998	0.0100	0.0180	0.0210	0.0280	0.0330	0.0370	0.0410	0.0460
1999	0.0130	0.0160	0.0220	0.0250	0.0290	0.0360	0.0390	0.0540
2000	0.0130	0.0230	0.0260	0.0280	0.0310	0.0360	0.0410	0.0460
2001	0.0140	0.0190	0.0290	0.0300	0.0340	0.0370	0.0440	0.0470
2002	0.0133	0.0216	0.0271	0.0330	0.0366	0.0392	0.0438	0.0454
2003	0.0094	0.0242	0.0298	0.0355	0.0388	0.0446	0.0501	0.0549
2004	0.0086	0.0143	0.0265	0.0304	0.0389	0.0418	0.0474	0.0540
2005	0.0122	0.0152	0.0193	0.0292	0.0356	0.0434	0.0481	0.0561
2006	0.0120	0.0234	0.0237	0.0263	0.0339	0.0435	0.0486	0.0553

Table 6.2.7 Herring in SD 25-29, 32 (excl. GOR). XSA input: Natural Mortality

NATMOR: Natural Mortality (Total International Catch) (Total)
(based on new MSVPA-data produced in 2006)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.5728	0.3111	0.2724	0.2461	0.2452	0.2306	0.2255	0.2077
1975	0.7335	0.3334	0.2882	0.2579	0.2568	0.2374	0.2316	0.2096
1976	0.5499	0.3068	0.2742	0.2488	0.2468	0.2316	0.2262	0.2079
1977	0.4932	0.2878	0.2654	0.2443	0.2430	0.2300	0.2239	0.2072
1978	0.6464	0.3315	0.2938	0.2621	0.2610	0.2422	0.2341	0.2103
1979	0.7737	0.3726	0.3307	0.2875	0.2838	0.2585	0.2462	0.2137
1980	0.8003	0.3652	0.3268	0.2857	0.2805	0.2558	0.2439	0.2129
1981	0.6974	0.3486	0.3169	0.2817	0.2790	0.2539	0.2423	0.2126
1982	0.8120	0.3842	0.3447	0.3006	0.2974	0.2686	0.2536	0.2160
1983	0.7794	0.3866	0.3444	0.3004	0.2981	0.2678	0.2545	0.2163
1984	0.6472	0.3326	0.3078	0.2756	0.2715	0.2494	0.2379	0.2111
1985	0.5491	0.3053	0.2854	0.2601	0.2572	0.2398	0.2308	0.2091
1986	0.4499	0.2741	0.2574	0.2397	0.2385	0.2270	0.2214	0.2064
1987	0.3966	0.2617	0.2463	0.2316	0.2309	0.2214	0.2171	0.2051
1988	0.4335	0.2664	0.2503	0.2349	0.2337	0.2228	0.2181	0.2054
1989	0.3682	0.2507	0.2409	0.2286	0.2273	0.2191	0.2148	0.2044
1990	0.3106	0.2335	0.2265	0.2188	0.2183	0.2127	0.2101	0.2030
1991	0.2661	0.2188	0.2142	0.2099	0.2094	0.2065	0.2051	0.2015
1992	0.2638	0.2177	0.2124	0.2080	0.2076	0.2053	0.2043	0.2013
1993	0.2848	0.2252	0.2172	0.2115	0.2119	0.2078	0.2067	0.2021
1994	0.2870	0.2271	0.2200	0.2136	0.2135	0.2091	0.2075	0.2023
1995	0.2868	0.2319	0.2254	0.2179	0.2177	0.2122	0.2100	0.2030
1996	0.2787	0.2294	0.2237	0.2164	0.2160	0.2114	0.2091	0.2027
1997	0.2973	0.2337	0.2272	0.2191	0.2183	0.2134	0.2105	0.2031
1998	0.3086	0.2329	0.2246	0.2171	0.2167	0.2116	0.2093	0.2028
1999	0.3198	0.2357	0.2252	0.2164	0.2157	0.2110	0.2089	0.2027
2000	0.3238	0.2359	0.2254	0.2171	0.2168	0.2113	0.2094	0.2028
2001	0.3080	0.2301	0.2209	0.2139	0.2133	0.2090	0.2074	0.2022
2002	0.3217	0.2349	0.2249	0.2169	0.2164	0.2111	0.2092	0.2028
2003	0.2591	0.2149	0.2105	0.2074	0.2075	0.2048	0.2040	0.2012
2004	0.2565	0.2170	0.2125	0.2086	0.2084	0.2056	0.2046	0.2014
2005	0.2659	0.2174	0.2119	0.2079	0.2078	0.2052	0.2043	0.2013
2006*	0.2822	0.2229	0.2161	0.2109	0.2107	0.2071	0.2059	0.2018

* average 2001-2005

Table 6.2.8 **Herring in SD 25-29, 32 (excl. GOR).**
XSA input: Proportion Mature at Year Start

MATPROP: Proportion of Mature at Year Start (Total international Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2006	0.0	0.7	0.9	1.0	1.0	1.0	1.0	1.0

Table 6.2.9 **Herring in SD 25-29, 32 (excl. GOR).**
XSA input: Proportion of M before Spawning

MPROP: Proportion of M before Spawning (Total International Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2006	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Table 6.2.10 **Herring in SD 25-29, 32 (excl. GOR)**
XSA input: Proportion of F before Spawning

FPROP: Proportion of F before Spawning (Total international Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2006	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35

Table 6.2.11 **Herring in SD 25-29, 32 (excl. GOR).**
XSA input: Tuning Fleet/International Acoustic Survey

Fleet: International Acoustic Survey corrected by area covered (Catch: Millions)

Year	Fish. Effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1982	1	7398	10609	3863	2219	2178	1690	983	1582
1983	1	3583	5854	5939	2605	1682	1829	1275	2063
1984	1	7522	6769	6841	5413	1871	1150	769	1148
1985	1	3649	8240	4466	3764	1289	593	454	603
1986	1	4065	9199	10088	4589	3206	1020	420	587
1987	1	6945	2677	5692	5914	2237	1305	407	210
1988	1	1537	5210	2531	5638	4725	1912	965	498
1989	1	6046	2840	7835	3202	4812	2815	1147	544
1990	1	11954	10075	6016	5433	3176	2611	1341	1136
1991	1	6217	16515	10197	3782	8184	2119	2006	2156
1992	1	6794	7762	11774	6565	3728	2158	1471	1132
1993	1	-11	-11	-11	-11	-11	-11	-11	-11
1994	1	3336	9577	18196	11337	5505	2027	906	802
1995	1	4608	3132	6067	7382	6276	3631	1710	902
1996	1	3288	12263	8962	6621	4363	2280	1121	756
1997	1	-11	-11	-11	-11	-11	-11	-11	-11
1998	1	3645	1748	5600	5984	2530	1522	791	429
1999	1	1663	4218	2521	3794	3593	1417	824	601
2000	1	2744	1475	5089	1837	2722	2181	940	611
2001	1	2870	6600	2901	4504	1555	1260	900	465
2002	1	2275	3509	5545	2511	2267	860	733	450
2003	1	13112	7552	9601	6238	2213	1734	745	1142
2004	1	5544	14730	7101	4934	2599	1169	638	706
2005*	1	2125	8700	16639	8275	5101	2999	1314	1427
2006	1	7317	8061	12702	21123	7337	3069	1701	1212

*Updated with area corrected values (no area corrected values were used at WGBFAS 2006)

Table 6.2.12 Herring in SD 25-29, 32 (excl. GOR). Output from XSA Final Run: Diagnostics

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Lowestoft VPA Version 3.1
18/04/2007 16:57
Extended Survivors Analysis
Herring in Sub-div. 25 to 29 and 32 (excl. Gulf of Riga)
CPUE data from file acoustic.tun

Catch data for 33 years. 1974 to 2006. Ages 1 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
International Acoust	1982	2006	1	7	0.8	0.9

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability dependent on stock size for ages < 3
Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3
Catchability independent of age for ages >= 6
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.500
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied
Tuning had not converged after 50 iterations
Total absolute residual between iterations
49 and 50 = .00012
Final year F values

Age	1	2	3	4	5	6	7
Iteration 49	0.0534	0.0607	0.0867	0.1136	0.1264	0.1552	0.1676
Iteration 50	0.0534	0.0607	0.0867	0.1136	0.1264	0.1552	0.1675

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.072	0.156	0.092	0.147	0.098	0.085	0.056	0.042	0.029	0.053
2	0.149	0.184	0.219	0.211	0.246	0.14	0.091	0.07	0.065	0.061
3	0.236	0.316	0.293	0.374	0.211	0.279	0.136	0.108	0.089	0.087
4	0.365	0.416	0.408	0.456	0.415	0.249	0.229	0.161	0.123	0.114
5	0.474	0.477	0.419	0.533	0.398	0.4	0.223	0.195	0.154	0.126
6	0.465	0.511	0.381	0.485	0.501	0.342	0.305	0.212	0.164	0.155
7	0.229	0.377	0.383	0.389	0.53	0.428	0.289	0.263	0.159	0.168

XSA population numbers (Thousands)

	AGE						
YEAR	1	2	3	4	5	6	7
1997	9.18E+06	1.10E+07	9.27E+06	4.28E+06	2.67E+06	1.47E+06	1.32E+06
1998	1.51E+07	6.35E+06	7.47E+06	5.83E+06	2.39E+06	1.34E+06	7.48E+05
1999	8.39E+06	9.51E+06	4.19E+06	4.35E+06	3.09E+06	1.19E+06	6.49E+05
2000	1.59E+07	5.56E+06	6.03E+06	2.49E+06	2.33E+06	1.64E+06	6.59E+05
2001	1.31E+07	9.92E+06	3.56E+06	3.31E+06	1.27E+06	1.10E+06	8.18E+05
2002	1.50E+07	8.74E+06	6.16E+06	2.31E+06	1.77E+06	6.90E+05	5.42E+05
2003	2.82E+07	9.97E+06	6.01E+06	3.72E+06	1.45E+06	9.55E+05	3.97E+05
2004	1.81E+07	2.06E+07	7.34E+06	4.25E+06	2.41E+06	9.42E+05	5.73E+05
2005	1.29E+07	1.34E+07	1.55E+07	5.33E+06	2.94E+06	1.61E+06	6.20E+05
2006	1.79E+07	9.60E+06	1.01E+07	1.14E+07	3.83E+06	2.04E+06	1.11E+06

Estimated population abundance at 1st Jan 2007

0.00E+00	1.28E+07	7.23E+06	7.47E+06	8.27E+06	2.73E+06	1.42E+06

Taper weighted geometric mean of the VPA populations:

1.51E+07	1.03E+07	7.09E+06	4.41E+06	2.42E+06	1.35E+06	7.60E+05

Standard error of the weighted Log(VPA populations) :

0.3057	0.3333	0.3853	0.4186	0.3394	0.3478	0.3578

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Table 6.2.12 Herring in SD 25-29, 32 (excl. GOR). Output from XSA Final Run: Diagnostics

Log catchability residuals.

Fleet : International Acoustic

Age	1982	1983	1984	1985	1986
1	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.01	-0.02	0.27	0.41	0.21	0.2	99.99	0.08	-0.1	-0.1
2	-0.13	-0.34	0.11	0.32	0.31	0.01	99.99	0.2	-0.25	0.16
3	-0.47	-0.76	-0.08	0.28	0.37	0.22	99.99	0.81	-0.2	0.29
4	-0.32	-0.31	-0.38	-0.2	-0.05	0.05	99.99	0.46	0.24	0.16
5	-0.56	-0.17	-0.09	-0.06	0.62	0.23	99.99	0.16	0.19	0.2
6	-0.65	-0.17	-0.04	-0.12	0.02	-0.17	99.99	-0.21	0.31	-0.29
7	-1.22	-0.42	-0.12	-0.17	0.09	0.08	99.99	-0.12	0.08	-0.32

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	99.99	0.04	0.17	-0.16	0.03	-0.23	0.05	0.02	-0.17	0.2
2	99.99	-0.15	-0.05	-0.1	0.16	-0.11	0.15	-0.22	-0.08	0.21
3	99.99	-0.21	-0.45	-0.05	-0.22	-0.06	0.38	-0.15	-0.06	0.1
4	99.99	-0.1	-0.27	-0.4	0.17	-0.19	0.22	-0.2	0.05	0.22
5	99.99	-0.15	-0.11	0	-0.08	-0.02	-0.01	-0.38	0.06	0.14
6	99.99	-0.01	-0.08	0.12	-0.02	-0.07	0.28	-0.18	0.18	-0.04
7	99.99	-0.2	-0.01	0.11	-0.03	0.09	0.29	-0.25	0.3	-0.01

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

Age	3	4	5	6	7
Mean Log q	-6.5226	-6.241	-6.1119	-6.1525	-6.1525
S.E(Log q)	0.3019	0.2444	0.1875	0.1775	0.1974

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.55	2.525	11.84	0.78	18	0.16	-7.99
2	0.55	2.735	11.2	0.81	18	0.18	-7.18

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.83	0.823	8.07	0.73	18	0.26	-6.52
4	0.78	1.718	8.21	0.87	18	0.17	-6.24
5	0.85	1.018	7.36	0.85	18	0.16	-6.11
6	1.02	-0.111	6.01	0.8	18	0.19	-6.15
7	1.37	-1.539	3.41	0.66	18	0.25	-6.14

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	15575370	0.3	0	0	1	0.527	0.044
P shrinkage mean	10253280	0.33				0.451	0.066
F shrinkage mean	10910570	1.5				0.022	0.062

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12799370	0.22	0.2	3	0.915	0.053

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Table 6.2.12 Herring in SD 25-29, 32 (excl. GOR). Output from XSA Final Run: Diagnostics

Age 2 Catchability dependent on age and year class strength

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	7387740	0.212	0.194	0.91	2	0.742	0.059
P shrinkage mean	7094321	0.39				0.242	0.062
F shrinkage mean	3459552	1.5				0.016	0.123

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7227280	0.18	0.11	4	0.606	0.061

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	7554977	0.176	0.052	0.3	3	0.984	0.086
F shrinkage mean	3765945	1.5				0.016	0.165

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7472926	0.18	0.07	4	0.376	0.087

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	8351256	0.153	0.095	0.62	4	0.987	0.112
F shrinkage mean	3725091	1.5				0.013	0.237

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8265895	0.15	0.09	5	0.616	0.114

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	2759481	0.137	0.075	0.55	5	0.989	0.125
F shrinkage mean	1159430	1.5				0.011	0.276

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2732544	0.14	0.08	6	0.573	0.126

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	1435010	0.128	0.077	0.6	6	0.989	0.154
F shrinkage mean	665193	1.5				0.011	0.307

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1422850	0.13	0.08	7	0.605	0.155

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
International Acoust	762202	0.125	0.084	0.67	7	0.988	0.168
F shrinkage mean	985958	1.5				0.012	0.132

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
764477	0.13	0.08	8	0.621	0.168

Table 6.2.13 Herring in SD 25-29, 32 (excl. GOR). Fishing Mortality (F) at age.

Run title : Herring SD 25-29, 32 (excl. GOR)
Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Age 1	0.1447	0.1428	0.0873	0.0954	0.0711	0.0380	0.0717	0.0545	0.0399	0.0435	0.0365
Age 2	0.1223	0.1319	0.1679	0.1289	0.1696	0.1514	0.1662	0.2155	0.1807	0.1571	0.1310
Age 3	0.1633	0.1729	0.1751	0.1850	0.1729	0.1901	0.2103	0.2115	0.1995	0.2677	0.2006
Age 4	0.2167	0.1935	0.1735	0.1578	0.1618	0.2056	0.1877	0.2227	0.1715	0.2682	0.2952
Age 5	0.1636	0.2244	0.1718	0.1816	0.1375	0.1973	0.1878	0.1977	0.1851	0.1936	0.2811
Age 6	0.1673	0.1870	0.2307	0.2013	0.1641	0.1625	0.1670	0.1982	0.1712	0.2389	0.2224
Age 7	0.1835	0.2027	0.1930	0.1811	0.1552	0.1896	0.1819	0.2074	0.1770	0.2352	0.2681
Age 8+	0.1835	0.2027	0.1930	0.1811	0.1552	0.1896	0.1819	0.2074	0.1770	0.2352	0.2681
FBAR 3-6	**0.1777**	**0.1944**	**0.1878**	**0.1814**	**0.1591**	**0.1888**	**0.1882**	**0.2075**	**0.1818**	**0.2421**	**0.2498**

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age 1	0.0655	0.0556	0.0519	0.0600	0.0627	0.0403	0.0274	0.0767	0.0627	0.0440	0.0522
Age 2	0.1678	0.1544	0.1135	0.1847	0.1046	0.1413	0.1404	0.1143	0.1856	0.1224	0.1222
Age 3	0.1913	0.2016	0.1991	0.1738	0.2858	0.1644	0.2287	0.2255	0.2214	0.2416	0.2875
Age 4	0.2225	0.2404	0.2488	0.2180	0.2076	0.3023	0.2165	0.1905	0.3168	0.2467	0.4142
Age 5	0.3239	0.2570	0.2861	0.2807	0.2951	0.2339	0.3333	0.2085	0.2572	0.4017	0.2353
Age 6	0.3135	0.2493	0.3238	0.2778	0.4043	0.3219	0.2438	0.2937	0.2761	0.3443	0.2940
Age 7	0.2886	0.2504	0.3048	0.3047	0.3563	0.3992	0.2614	0.2133	0.2184	0.3644	0.2356
Age 8+	0.2886	0.2504	0.3048	0.3047	0.3563	0.3992	0.2614	0.2133	0.2184	0.3644	0.2356
FBAR 3-6	**0.2628**	**0.2371**	**0.2644**	**0.2376**	**0.2982**	**0.2556**	**0.2556**	**0.2296**	**0.2679**	**0.3086**	**0.3077**

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Age 1	0.0753	0.0719	0.1561	0.0920	0.1467	0.0983	0.0846	0.0559	0.0422	0.0293
Age 2	0.1299	0.1491	0.1835	0.2188	0.2111	0.2463	0.1397	0.0914	0.0697	0.0647
Age 3	0.2061	0.2360	0.3162	0.2927	0.3740	0.2108	0.2789	0.1360	0.1076	0.0893
Age 4	0.3425	0.3651	0.4164	0.4077	0.4558	0.4147	0.2491	0.2290	0.1607	0.1233
Age 5	0.3962	0.4740	0.4773	0.4186	0.5331	0.3984	0.3996	0.2232	0.1953	0.1544
Age 6	0.2884	0.4650	0.5113	0.3814	0.4848	0.5011	0.3416	0.3055	0.2120	0.1643
Age 7	0.3404	0.2292	0.3766	0.3826	0.3887	0.5296	0.4281	0.2886	0.2632	0.1594
Age 8+	0.3404	0.2292	0.3766	0.3826	0.3887	0.5296	0.4281	0.2886	0.2632	0.1594
FBAR 3-6	**0.3083**	**0.3850**	**0.4303**	**0.3751**	**0.4619**	**0.3812**	**0.3173**	**0.2234**	**0.1689**	**0.1328**

YEAR	2006	FBAR 04-06
Age 1	0.0534	0.0416
Age 2	0.0607	0.0650
Age 3	0.0867	0.0945
Age 4	0.1136	0.1325
Age 5	0.1264	0.1587
Age 6	0.1552	0.1772
Age 7	0.1675	0.1967
Age 8+	0.1675	
FBAR 3-6	**0.1205**	

Table 6.2.14 Herring in SD 25-29, 32 (excl. GOR). Stock number at age (Number*10-4)**

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Age 1	2408748	2019181	3296378	1769699	2100488	1601358	2237638	3540377	3323750	2580622	3173202
Age 2	1577443	1175442	840642	1743041	982355	1024938	711184	935632	1669148	1417874	1133274
Age 3	829610	1022702	738139	522917	1149008	595146	606892	418032	532272	948778	823238
Age 4	782431	536616	644932	470966	333278	720509	353553	354702	246460	308894	514449
Age 5	361768	492555	341678	422760	315050	218121	440055	220214	214202	153717	174933
Age 6	250284	240365	304425	224808	276501	211511	134820	275500	136715	132209	94010
Age 7	413373	168130	157244	191746	146056	184184	138840	88332	175296	88065	79657
Age 8+	187771	329118	310907	363383	367870	306741	366303	311420	287441	229015	197720
TOTAL	**6811427**	**5984110**	**6634345**	**5709319**	**5670605**	**4862508**	**4989286**	**6144210**	**6585285**	**5859174**	**6190485**

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age 1	2568900	1278962	2218162	1010732	1567445	1901205	1576910	1720066	1567491	1305560	1862661
Age 2	1601727	1389399	771438	1416491	617030	1018681	1338520	1175840	1223718	1107349	937660
Age 3	712878	997977	905140	530112	902171	432516	700234	934595	843618	811432	780746
Age 4	495141	442581	630649	579780	346877	532767	292573	449672	603159	544085	511445
Age 5	290705	305587	273841	390097	368631	224256	316390	191016	301880	355624	343379
Age 6	100662	162591	186184	163299	233227	218643	142673	183874	125992	188854	192222
Age 7	58650	57884	100986	107938	98989	125040	128100	90945	111637	77656	108587
Age 8+	152588	103938	81258	88033	123414	102042	113856	125217	78587	101533	111211
TOTAL	**5981249**	**4738920**	**5167658**	**4286482**	**4257784**	**4555151**	**4609255**	**4871225**	**4856082**	**4492093**	**4847913**

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age 1	1561568	918366	1512839	839159	1587761	1311383	1497259	2820588	1808063	1289282	1790468
Age 2	1327140	1095986	634848	950598	555887	991897	873530	997295	2058412	1341238	959690
Age 3	658080	926579	747443	418625	603414	355531	615985	600584	734153	1545364	1011582
Age 4	467493	428178	583064	435239	249392	331355	230885	372189	424701	533034	1143496
Age 5	271823	267342	238721	309441	233181	127250	176731	144876	240573	293559	382763
Age 6	218292	147378	133788	119254	164101	110161	69026	95455	94178	160663	204368
Age 7	115863	132432	74782	64933	65950	81810	54152	39719	57304	62027	111027
Age 8+	85207	99991	65105	41420	63062	53157	72491	88679	61703	119039	105428
TOTAL	**4705467**	**4016251**	**3990589**	**3178668**	**3522749**	**3362543**	**3590061**	**5159386**	**5479086**	**5344205**	**5708823**

YEAR	2007	MST 74-04	AMST 74-04
Age 1	0	1829313	1951178
Age 2	1279937	1086131	1138530
Age 3	722728	694279	722534
Age 4	747293	437718	458646
Age 5	826590	267135	281497
Age 6	273254	161167	171968
Age 7	142285	102447	115622
Age 8+	149320		
TOTAL	**4141407**		

Table 6.2.15 **Herring in SD 25-29, 32 (excl. GOR). Output from XSA: Stock Summary.**

Run title : Herring SD 25-29, 32 (excl. GOR)
At 24/04/2006 14:26
Table 16 Summary (without SOP correction)
Terminal Fs derived using XSA (With F shrinkage)

Year	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1974	24087476	2929887	1750785	368652	0.2106	0.1777
1975	20191814	2663263	1630957	354851	0.2176	0.1944
1976	32963774	2509151	1414088	305420	0.2160	0.1878
1977	17696994	2485747	1562142	301952	0.1933	0.1814
1978	21004874	2481849	1512855	278966	0.1844	0.1591
1979	16013583	2249672	1460631	278182	0.1905	0.1888
1980	22376380	2204753	1340115	270282	0.2017	0.1882
1981	35403764	2491308	1241031	293615	0.2366	0.2075
1982	33237500	2530541	1347972	273134	0.2026	0.1818
1983	25806216	2167025	1274383	307601	0.2414	0.2421
1984	31732018	2025662	1167907	277926	0.2380	0.2498
1985	25688996	1841772	1097069	275760	0.2514	0.2628
1986	12789622	1585947	1048615	240516	0.2294	0.2371
1987	22181622	1642225	1028665	248653	0.2417	0.2644
1988	10107320	1584036	1070448	255734	0.2389	0.2376
1989	15674447	1612068	976307	275501	0.2822	0.2982
1990	19012054	1476155	874777	228572	0.2613	0.2556
1991	15769096	1437997	827545	197676	0.2389	0.2556
1992	17200660	1323292	866431	189781	0.2190	0.2296
1993	15674913	1246587	808107	209094	0.2587	0.2679
1994	13055601	1235304	795960	218260	0.2742	0.3086
1995	18626612	1087624	686180	188181	0.2742	0.3077
1996	15615680	946494	590011	162578	0.2756	0.3083
1997	9183660	831265	553789	160002	0.2889	0.3850
1998	15128388	774666	471643	185780	0.3939	0.4303
1999	8391585	642453	397353	145922	0.3672	0.3751
2000	15877609	748391	397988	175646	0.4413	0.4619
2001	13113827	719569	389316	148404	0.3812	0.3812
2002	14972593	779313	431098	129222	0.2998	0.3173
2003	28205880	984951	555364	113584	0.2045	0.2234
2004	18080628	966937	629631	93006	0.1477	0.1689
2005	12892819	1085912	755833	91592	0.1212	0.1328
2006	17904680	1310826	906673	110372	0.1217	0.1205
Arith. Mean	19262509	1594019	965505	222861	0.2468	0.2542
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.2.16 Herring in SD 25-29, 32 (excl. GOR). Input for RCT3 analysis.

Yearclass	VPA Age 1	International Acoustic Age 0
1991	17201	11234
1992	15675	1445
1993	13056	-11
1994	18627	6081
1995	15616	1281
1996	9184	322
1997	15128	-11
1998	8392	518
1999	15878	1885
2000	13114	1139
2001	14973	1788
2002	28206	11187
2003	18081	7387
2004	12893	1736
2005	-11	5815*
2006	-11	1991

*updated with area corrected value (no area corrected value was used at WGBFAS2006?)

Table 6.2.17 Herring in SD 25-29, 32 (excl. GOR). Output from RCT3 analysis.

Analysis by RCT3 ver3.1 of data from file : rect3in.txt
Herring 25-29, 32 (excl. GOR). RCT3 input data.
Data for 1 surveys over 16 years : 1991 - 2006
Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Yearclass		**2000**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.30	7.28	0.22	0.727	7	7.04	9.42	0.282	0.499
					VPA	Mean =	9.53	0.281	0.501
Yearclass		**2001**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.31	7.28	0.2	0.73	8	7.49	9.57	0.248	0.536
					VPA	Mean =	9.52	0.266	0.464
Yearclass =		**2002**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.31	7.24	0.18	0.733	9	9.32	10.15	0.269	0.472
					VPA	Mean =	9.53	0.255	0.528
Yearclass =		**2003**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.34	7.08	0.18	0.822	10	8.91	10.06	0.232	0.667
					VPA	Mean =	9.59	0.329	0.333
Yearclass =		**2004**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.32	7.15	0.18	0.813	11	7.46	9.56	0.212	0.699
					VPA	Mean =	9.61	0.323	0.301
Yearclass =		**2005**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.33	7.09	0.17	0.817	12	8.67	9.95	0.208	0.698
					VPA	Mean =	9.60	0.315	0.302
Yearclass =		**2006**							
Survey/ Series	Slope cept	Inter- Error	Std Pts	Rsquare Value	No. Value	Index Error	Predicted Weights	Std	WAP
Int Acoust	0.33	7.07	0.17	0.827	12	7.6	9.59	0.198	0.719
					VPA	Mean =	9.60	0.32	0.281

Year Class	**Weighted Average Prediction**	**Log WAP**	**Int Std Error**	**Ext Std Error**	**Var Ratio**	**VPA**	**Log VPA**
2000	13026	9.47	0.20	0.06	0.08	13115	9.48
2001	13988	9.55	0.18	0.02	0.02	14974	9.61
2002	18397	9.82	0.18	0.31	2.79	28207	10.25
2003	20074	9.91	0.19	0.22	1.37	18082	9.80
2004	14375	9.57	0.18	0.03	0.02	12894	9.46
2005	18793	9.84	0.17	0.16	0.84		
2006	14706	9.60	0.17	0.00	0.00		

Table 6.2.18 Herring in SD 25-29, 32 (excl. GOR). Input data for short-term predictions.

MFDP version 1a
Run: CB Herring_1
Time and date: 10:16 21/04/2007
Fbar age range: 3-6

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	14706000	0.2822	0	0.35	0.3	0.0109	0.0356	0.0109
2	12799370	0.2229	0.7	0.35	0.3	0.0176	0.0557	0.0176
3	7227280	0.2161	0.9	0.35	0.3	0.0232	0.0809	0.0232
4	7472930	0.2109	1	0.35	0.3	0.0286	0.1135	0.0286
5	8265900	0.2107	1	0.35	0.3	0.0361	0.1359	0.0361
6	2732540	0.2071	1	0.35	0.3	0.0429	0.1517	0.0429
7	1422850	0.2059	1	0.35	0.3	0.0480	0.1684	0.0480
8	1493200	0.2018	1	0.35	0.3	0.0551	0.1684	0.0551

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	14801061	0.2822	0	0.35	0.3	0.0109	0.0356	0.0109
2		0.2229	0.7	0.35	0.3	0.0176	0.0557	0.0176
3		0.2161	0.9	0.35	0.3	0.0232	0.0809	0.0232
4		0.2109	1	0.35	0.3	0.0286	0.1135	0.0286
5		0.2107	1	0.35	0.3	0.0361	0.1359	0.0361
6		0.2071	1	0.35	0.3	0.0429	0.1517	0.0429
7		0.2059	1	0.35	0.3	0.0480	0.1684	0.0480
8		0.2018	1	0.35	0.3	0.0551	0.1684	0.0551

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	14801061	0.2822	0	0.35	0.3	0.0109	0.0356	0.0109
2		0.2229	0.7	0.35	0.3	0.0176	0.0557	0.0176
3		0.2161	0.9	0.35	0.3	0.0232	0.0809	0.0232
4		0.2109	1	0.35	0.3	0.0286	0.1135	0.0286
5		0.2107	1	0.35	0.3	0.0361	0.1359	0.0361
6		0.2071	1	0.35	0.3	0.0429	0.1517	0.0429
7		0.2059	1	0.35	0.3	0.0480	0.1684	0.0480
8		0.2018	1	0.35	0.3	0.0551	0.1684	0.0551

Input units are thousands and kg - output in tonnes

M =	Natural mortality
MAT =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWT =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWT =	Weight in catch (kg)

N_{2007} Age 1:	Output form RCT3 Analysis (Table 6.2.17)
N_{2007} Age 2-8+:	Output from VPA (Table 6.2.14)
$N_{2008/2009}$ Age 1:	Geometric Mean from VPA-Output of age 1 (Table 6.2.15) for the years 1988-2005
Natural Mortality (M):	Year 2006 (= average 2001-2005)
Weight in the Catch/Stock (CWt/SW	Average for 2004-2006
Expoitation pattern (Sel):	Average for 2004-2006 rescaled to the last year

Table 6.2.19 **Herring in SD 25-29, 32 (excl. GOR). Output from short-term predictions with management option table for status quo fishery in 2007.**

MFDP version 1a
Run: CB Herring_1
Herring in Sd 25-29, 32 (excl. GOR).
Time and date: 10:16 21/04/2007
Fbar age range: 3-6

2007				
Biomass	SSB	FMult	FBar	Landings
1334458	980695	1	0.1205	118748

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1377188	1066593	0	0	0	1529848	1210359
	1062009	0.1	0.0120	13478	1515562	1191878
	1057446	0.2	0.0241	26790	1501453	1173719
	1052905	0.3	0.0361	39937	1487520	1155876
	1048385	0.4	0.0482	52923	1473760	1138343
	1043886	0.5	0.0602	65750	1460172	1121115
	1039409	0.6	0.0723	78419	1446752	1104185
	1034952	0.7	0.0843	90933	1433498	1087548
	1030517	0.8	0.0964	103293	1420408	1071199
	1026102	0.9	0.1084	115503	1407480	1055132
	1021708	**1**	**0.1205**	**127564**	**1394711**	**1039342**
	1017335	1.1	0.1325	139478	1382100	1023823
	1012982	1.2	0.1446	151247	1369644	1008571
	1008649	1.3	0.1566	162873	1357341	993581
	1004337	1.4	0.1687	174358	1345190	978848
	1000045	1.5	0.1807	185704	1333187	964366
	995773	1.6	0.1928	196913	1321331	950132
	991521	1.7	0.2048	207987	1309620	936140
	987289	1.8	0.2169	218927	1298052	922387
	983077	1.9	0.2289	229735	1286625	908868
	978885	2	0.2410	240413	1275337	895578

Input units are thousands and kg - output in tonnes

Table 6.2.20 Herring in SD 25-29, 32 (excl. GOR). Yield per recruit: Summary table.

MFYPR version 2a
Run: CB Herring_2
Time and date: 10:23 21/04/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	4.9704	0.1562	3.6838	0.1398	3.4591	0.1314
0.1	0.0120	0.0436	0.002	4.7582	0.1454	3.4730	0.1291	3.2465	0.1207
0.2	0.0241	0.0815	0.003	4.5743	0.1362	3.2904	0.1200	3.0625	0.1116
0.3	0.0361	0.1148	0.004	4.4132	0.1283	3.1306	0.1120	2.9015	0.1037
0.4	0.0482	0.1444	0.005	4.2705	0.1213	2.9893	0.1051	2.7592	0.0969
0.5	0.0602	0.1708	0.006	4.1432	0.1152	2.8633	0.0990	2.6323	0.0908
0.6	0.0723	0.1947	0.007	4.0286	0.1097	2.7501	0.0936	2.5184	0.0854
0.7	0.0843	0.2163	0.008	3.9249	0.1048	2.6476	0.0887	2.4154	0.0807
0.8	0.0964	0.2361	0.008	3.8303	0.1004	2.5543	0.0843	2.3217	0.0764
0.9	0.1084	0.2542	0.009	3.7437	0.0965	2.4690	0.0804	2.2360	0.0725
1	0.1205	0.2710	0.009	3.6639	0.0928	2.3905	0.0768	2.1572	0.0690
1.1	0.1325	0.2865	0.009	3.5901	0.0895	2.3180	0.0735	2.0845	0.0658
1.2	0.1446	0.3010	0.010	3.5217	0.0865	2.2508	0.0705	2.0172	0.0628
1.3	0.1566	0.3145	0.010	3.4579	0.0837	2.1883	0.0677	1.9546	0.0601
1.4	0.1687	0.3271	0.010	3.3982	0.0811	2.1299	0.0652	1.8961	0.0576
1.5	0.1807	0.3390	0.010	3.3422	0.0788	2.0752	0.0628	1.8414	0.0554
1.6	0.1928	0.3502	0.011	3.2896	0.0765	2.0238	0.0606	1.7901	0.0532
1.7	0.2048	0.3608	0.011	3.2400	0.0745	1.9754	0.0586	1.7418	0.0512
1.8	0.2169	0.3709	0.011	3.1931	0.0726	1.9297	0.0567	1.6963	0.0494
1.9	0.2289	0.3804	0.011	3.1486	0.0707	1.8865	0.0549	1.6532	0.0477
2	0.2410	0.3895	0.011	3.1064	0.0690	1.8455	0.0532	1.6124	0.0461

Reference point	F multiplier	Absolute F
Fbar(3-6)	1	0.1205
FMax	4.8669	0.5863
F0.1	1.5622	0.1882
F35%SPR	2.0054	0.2416

Weights in kilograms

Table 6.2.21 **Herring in SD 25-29, 32 (excl. GoR). Medium-term prediction.**
Fsq at 0.12 for all years (corresponding factor*F(06)=0.856)

Start. Year:	2006									
Age	Stock (millions)	SD ln	Nat. mort.	Fish. pattern	mW stock (Kg)	SD	mW catch (Kg)	SD	Mature (%)	SD
1	17905	0.30	0.28	0.042	0.011	0.002	0.011	0.002	0.00	0.00
2	9597	0.21	0.22	0.065	0.018	0.005	0.018	0.005	0.70	0.00
3	10116	0.18	0.22	0.095	0.023	0.004	0.023	0.004	0.90	0.00
4	11435	0.15	0.21	0.133	0.029	0.002	0.029	0.002	1.00	0.00
5	3828	0.14	0.21	0.159	0.036	0.003	0.036	0.003	1.00	0.00
6	2044	0.13	0.21	0.177	0.043	0.001	0.043	0.001	1.00	0.00
7	1110	0.13	0.21	0.197	0.048	0.001	0.048	0.001	1.00	0.00
8+	1054	0.13	0.20	0.197	0.055	0.001	0.055	0.001	1.00	0.00
SSB	907									
factor*F(06)	0.856	0.856	0.856	0.856	0.856	0.856	0.856	0.856	0.856	0.856
Catch level	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	SSB									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	816	829	934	991	1077	1180	1230	1299	1382	1452
25%	854	910	1006	1094	1187	1285	1362	1444	1501	1561
50%	914	982	1092	1188	1291	1411	1509	1609	1674	1697
75%	968	1056	1188	1296	1432	1567	1638	1734	1790	1851
90%	1024	1120	1286	1410	1540	1703	1762	1855	1921	2014

	F%									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
25%	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
50%	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
75%	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
90%	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3

	Recruitment									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	11970	13047	13579	15209	16744	15115	16148	15511	15637	16330
25%	14253	16800	17219	18710	19944	19015	20606	19475	19619	20382
50%	17625	21469	22837	24125	24271	23393	25885	25099	26622	26155
75%	21291	27459	29079	31705	30241	30546	32421	31564	32714	33114
90%	24348	32321	34668	38111	38943	38894	41627	39128	39872	41971

	Catch									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	96	110	121	128	139	150	159	167	176	186
25%	100	115	128	139	152	161	173	184	193	200
50%	108	123	137	150	161	176	190	202	211	218
75%	113	131	146	162	176	191	203	215	226	231
90%	118	137	156	175	187	204	218	229	237	251

	Y/SSB									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
25%	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
50%	0.12	0.12	0.13	0.13	0.12	0.12	0.13	0.13	0.13	0.13
75%	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
90%	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Table 6.2.22 **Herring in SD 25-29, 32 (excl. GOR). Medium-term prediction.**
Fsq=0.12 for the first year and Fpa=0.19 for the following prediction years
(corresponding factor*F(06)=0.856 and factor*Fpa=1.58)

Start. Year:	2006									
Age	Stock (millions)	SD ln	Nat. mort.	Fish. pattern	mW stock (Kg)	SD	mW catch (Kg)	SD	mature (%)	SD
1	17905	0.30	0.28	0.042	0.011	0.002	0.011	0.002	0.00	0.00
2	9597	0.21	0.22	0.065	0.018	0.005	0.018	0.005	0.70	0.00
3	10116	0.18	0.22	0.095	0.023	0.004	0.023	0.004	0.90	0.00
4	11435	0.15	0.21	0.133	0.029	0.002	0.029	0.002	1.00	0.00
5	3828	0.14	0.21	0.159	0.036	0.003	0.036	0.003	1.00	0.00
6	2044	0.13	0.21	0.177	0.043	0.001	0.043	0.001	1.00	0.00
7	1110	0.13	0.21	0.197	0.048	0.001	0.048	0.001	1.00	0.00
8+	1054	0.13	0.20	0.197	0.055	0.001	0.055	0.001	1.00	0.00
SSB	907									
factor*F(06)	0.856	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58
Catch level	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	SSB									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	814	828	836	833	827	834	841	833	861	879
25%	870	902	914	914	915	941	955	981	993	985
50%	921	968	995	1015	1031	1065	1083	1116	1128	1166
75%	979	1042	1076	1092	1173	1182	1220	1265	1275	1293
90%	1028	1116	1155	1190	1286	1301	1389	1429	1382	1415

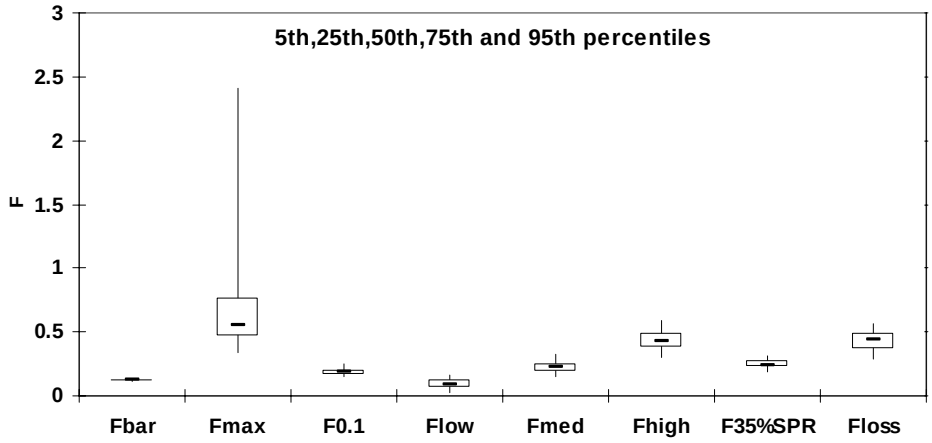
	F%									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	11.3	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
25%	11.3	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
50%	11.3	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
75%	11.3	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
90%	11.3	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9

	Recruitment									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	12290	12568	12916	13976	13451	14019	13204	13866	14368	14473
25%	14890	16471	15859	18475	16853	18084	17428	17323	17237	18928
50%	18892	21559	21371	22562	21614	23481	22725	22372	22839	24037
75%	22450	26462	26098	28516	28395	29902	29593	29091	29220	30074
90%	27376	32473	33388	34849	34206	37894	34481	36257	38339	36114

	Catch									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	97	194	196	193	192	185	191	193	194	200
25%	102	203	208	208	209	213	215	222	225	228
50%	109	219	224	231	231	236	246	247	252	262
75%	114	233	240	242	258	260	266	275	283	287
90%	120	246	254	267	280	283	297	311	308	314

	Y/SSB									
Percentiles	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
10%	0.11	0.21	0.21	0.22	0.21	0.21	0.21	0.21	0.21	0.21
25%	0.12	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
50%	0.12	0.22	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
75%	0.12	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
90%	0.12	0.24	0.24	0.24	0.24	0.24	0.23	0.24	0.24	0.24

Table 6.2.23 Herring in SD 25-29, 32 (excl. GOR). PA Reference points



Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	17696990	17696990	17904680	19012050	
MBAL	0				0.00
Bloss	391760				
SSB90%R90%Surv	960644	892175	970114	1112363	51.52
SPR%ofVirgin	52.79	52.37	55.40	58.61	
VirginSPR	0.13	0.13	0.14	0.18	
SPRloss	0.03	0.03	0.03	0.04	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.12	0.12	0.12	0.12	96.97
Fmax	0.58	0.56	0.46	0.34	0.00
F0.1	0.19	0.19	0.17	0.15	69.70
Flow	0.07	0.09	0.07	0.03	100.00
Fmed	0.22	0.23	0.19	0.16	63.64
Fhigh	0.42	0.43	0.38	0.30	6.06
F35%SPR	0.24	0.24	0.22	0.19	48.48
Floss	0.42	0.43	0.36	0.29	6.06

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

Steady state selection averaged over 3 years.
FBar averaged from age 3 to 6
Number of iterations = 100
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit
Data source: C:\XSA\CEBHE\CBHE_pa.txt
FishLab DLL used FLVB32.DLL built on Jun 14 1999 at 11:53:37 PASoft 4 October 1999
21/04/2007 18:39:23

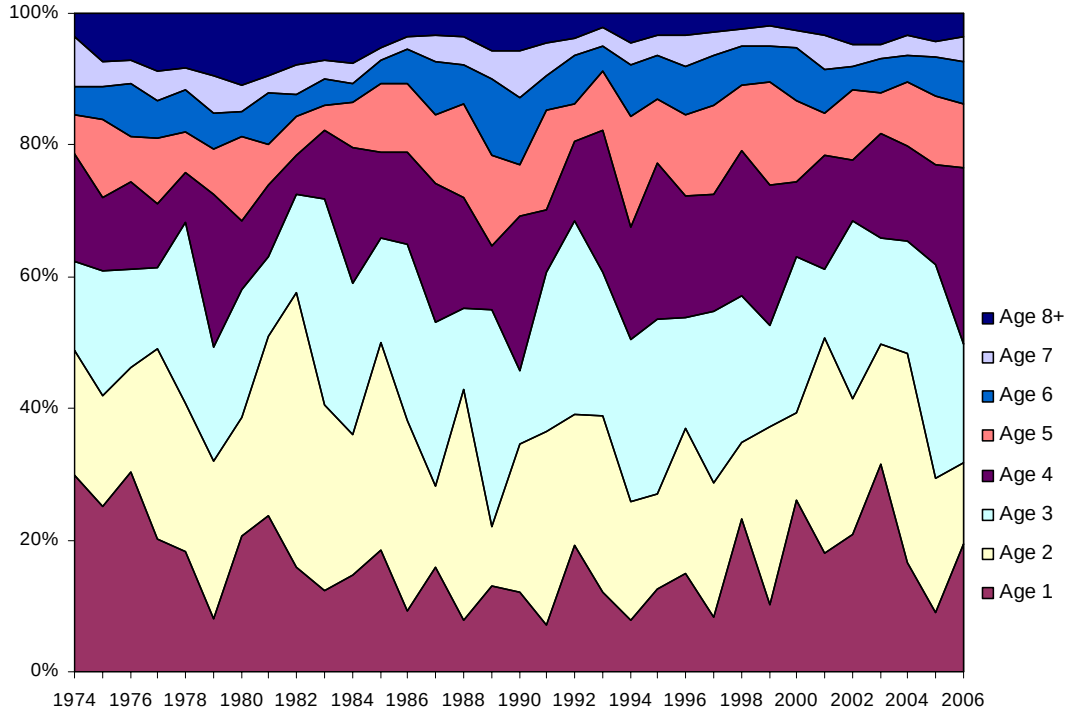


Figure 6.2.1a **Herring in SD 25-29, 32 (excl. GOR).**
Proportions of age groups (numbers) in the total catch (CANUM).

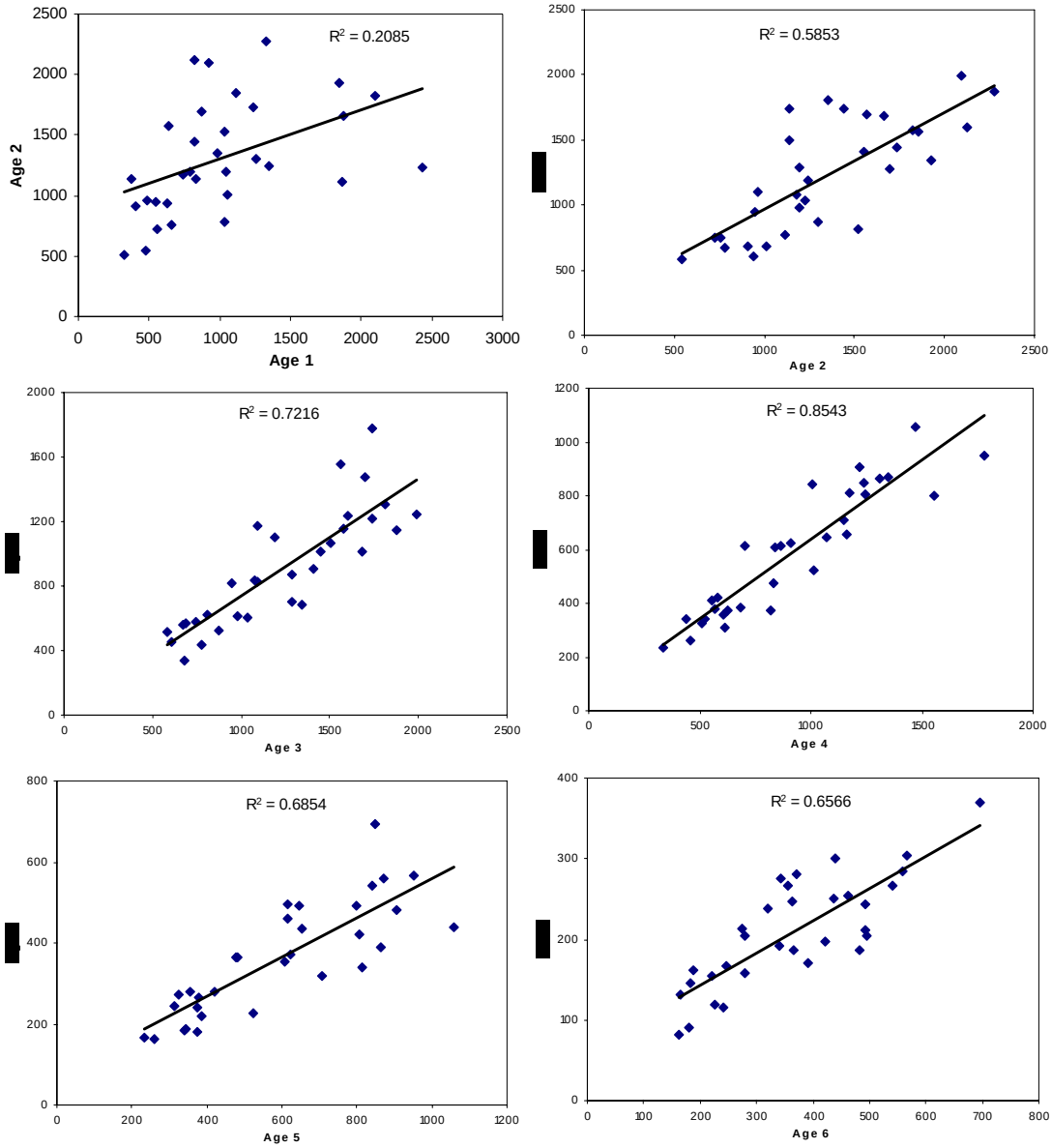


Figure 6.2.1b **Herring in SD 25-29, 32 (excl. GOR). Catch in numbers (1000 t) at age vs numbers at age +1 of the same cohort in the following year in the period 1974-2006.**

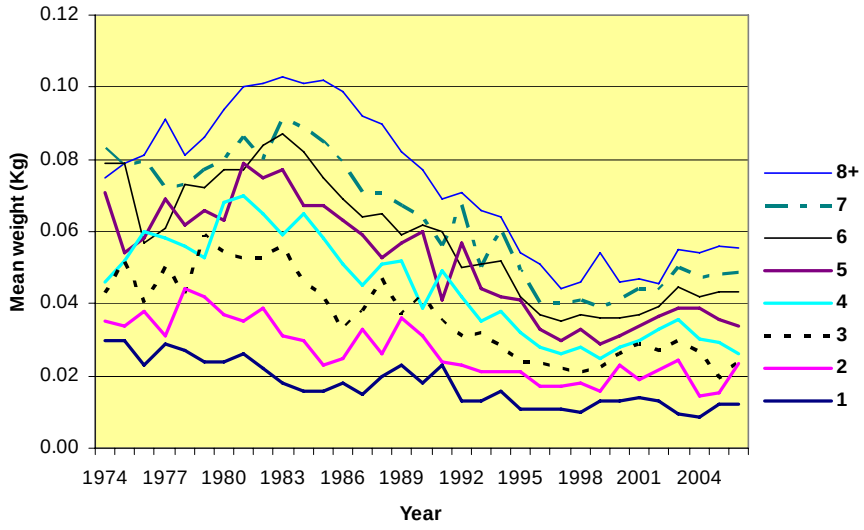


Figure 6.2.2 **Herring in SD 25-29, 32 (excl. GOR). Trends in the mean weights at age (kg) in the catch (WECA).**

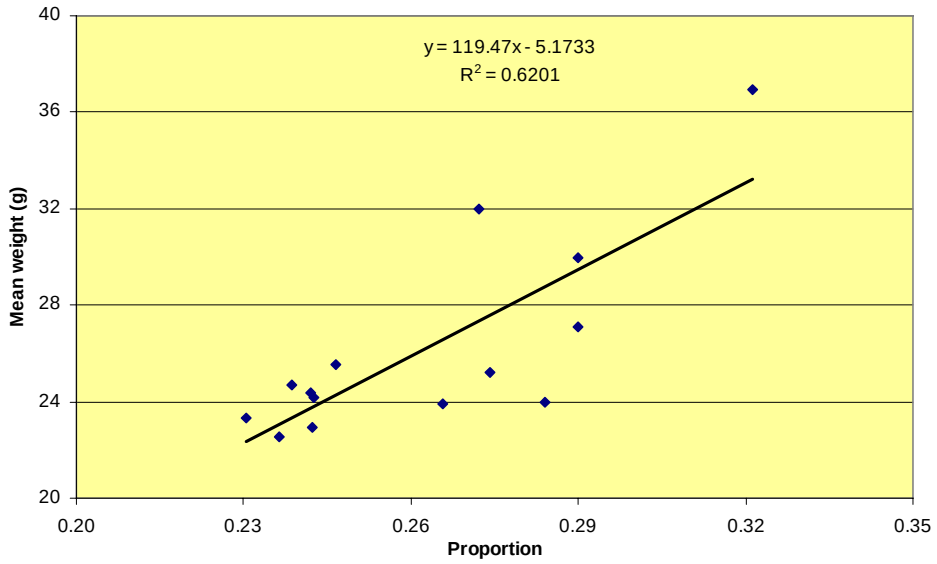


Figure 6.2.3 **Herring in SD 25-29, 32 (excl. GOR). Average individual weight in catches versus the proportion of catches taken in SD 25 plus SD 26 (1993-2006).**

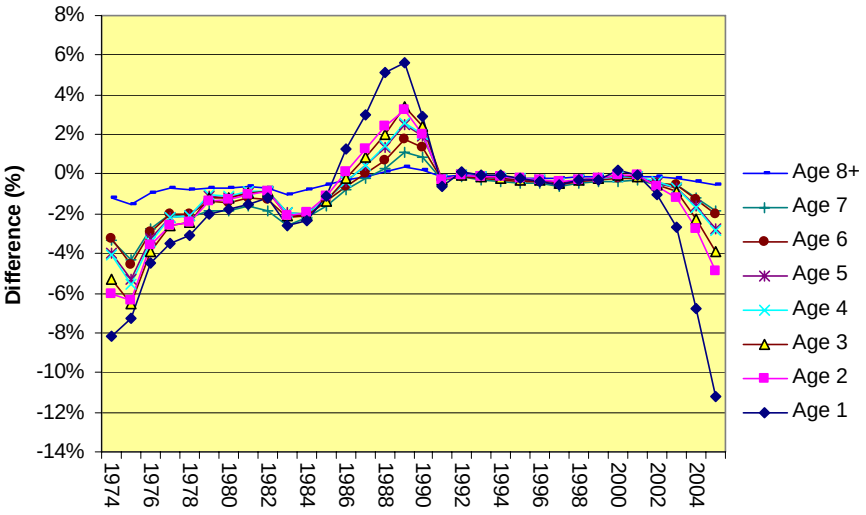


Figure 6.2.4 **Herring in SD 25-29, 32 (excl. GOR). Difference between M estimated from new MSVPA 2006 compared to time series from WGBFAS 2006.**

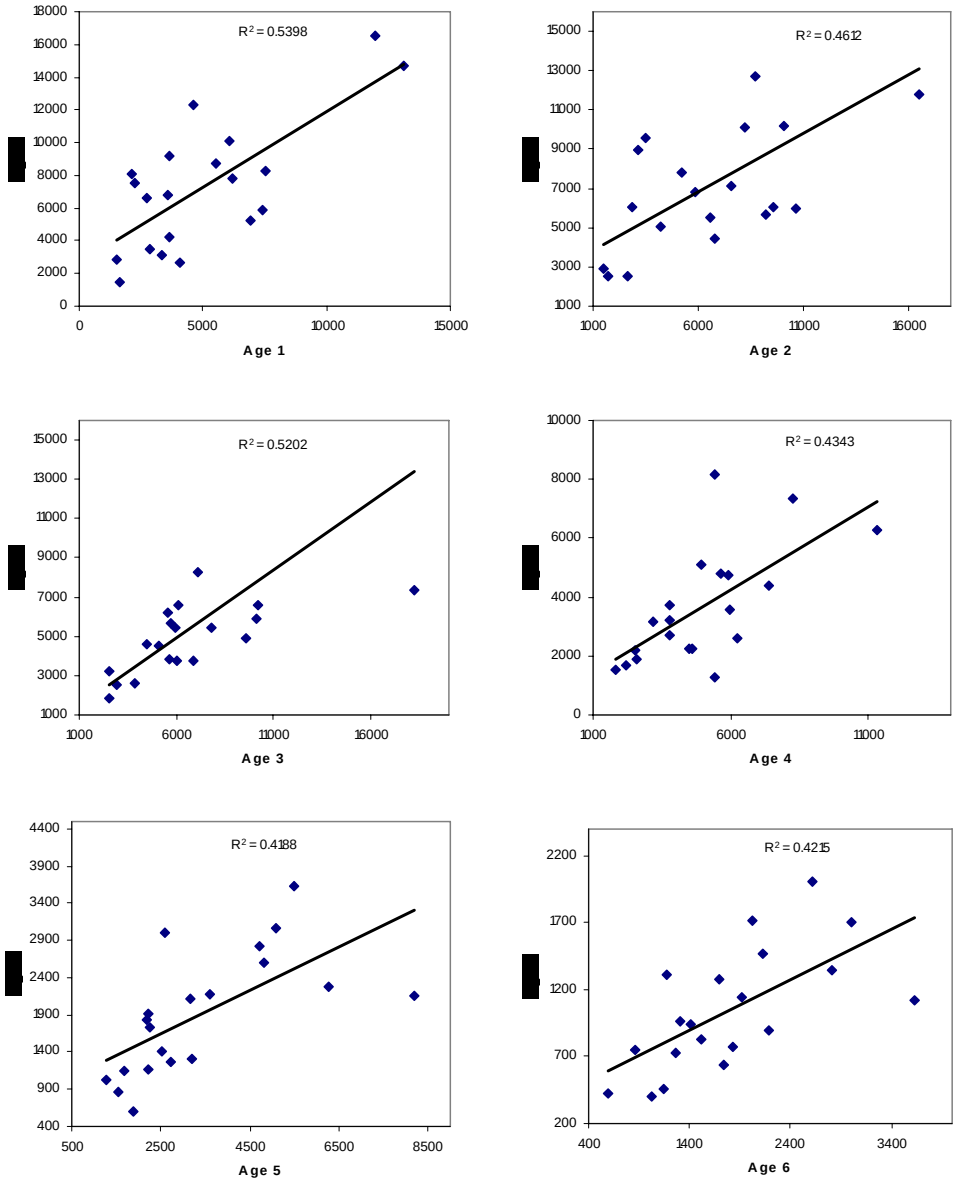


Figure 6.2.5 **Herring in SD 25-29, 32 (excl. GOR). Acoustic survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 1982-2006.**

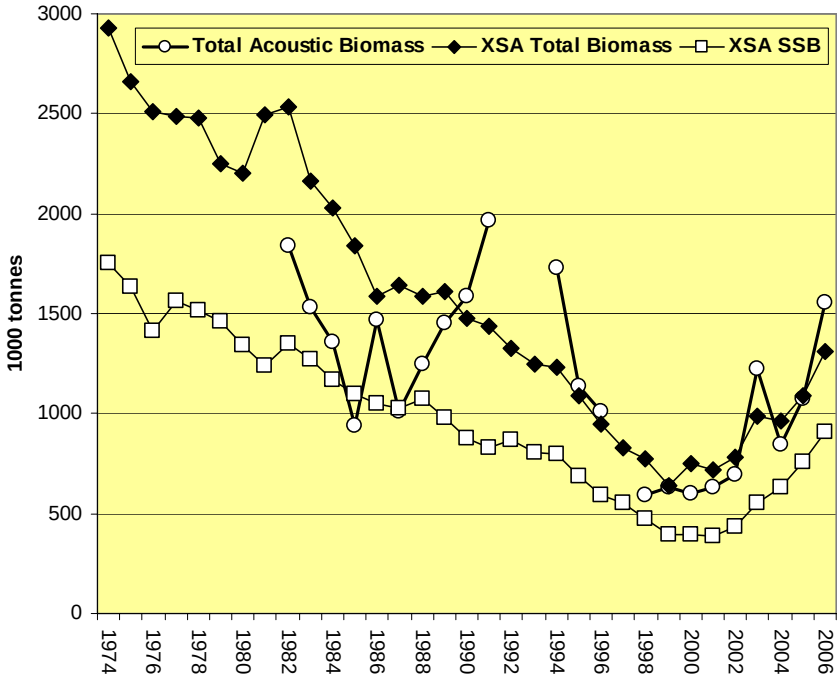


Figure 6.2.6 **Herring in SD 25-29, 32 (excl. GOR)**
Estimates of biomass from acoustic surveys and from XSA.

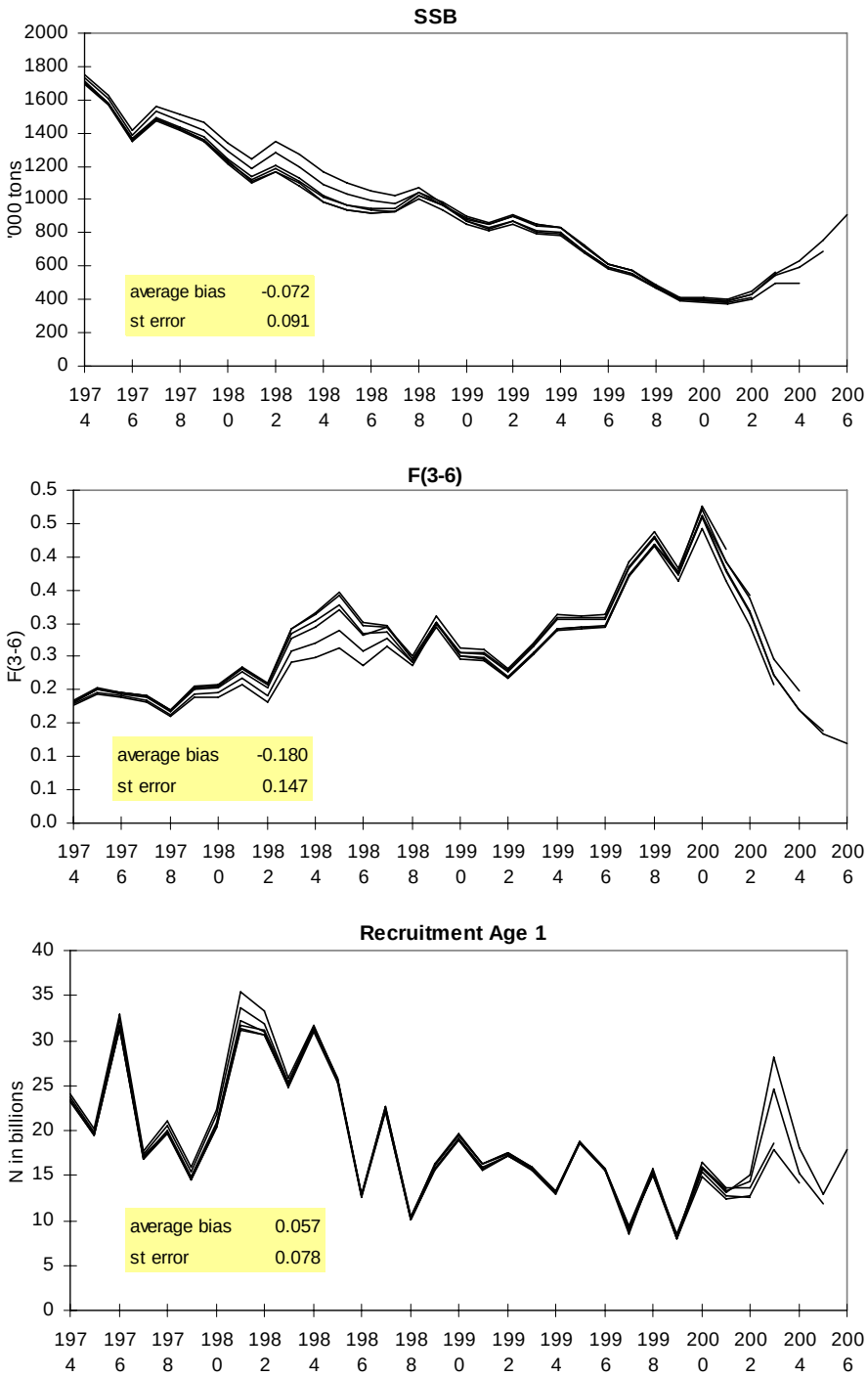


Figure 6.2.7 Herring in SD 25-29, 32 (excl. GOR). Retrospective analysis.

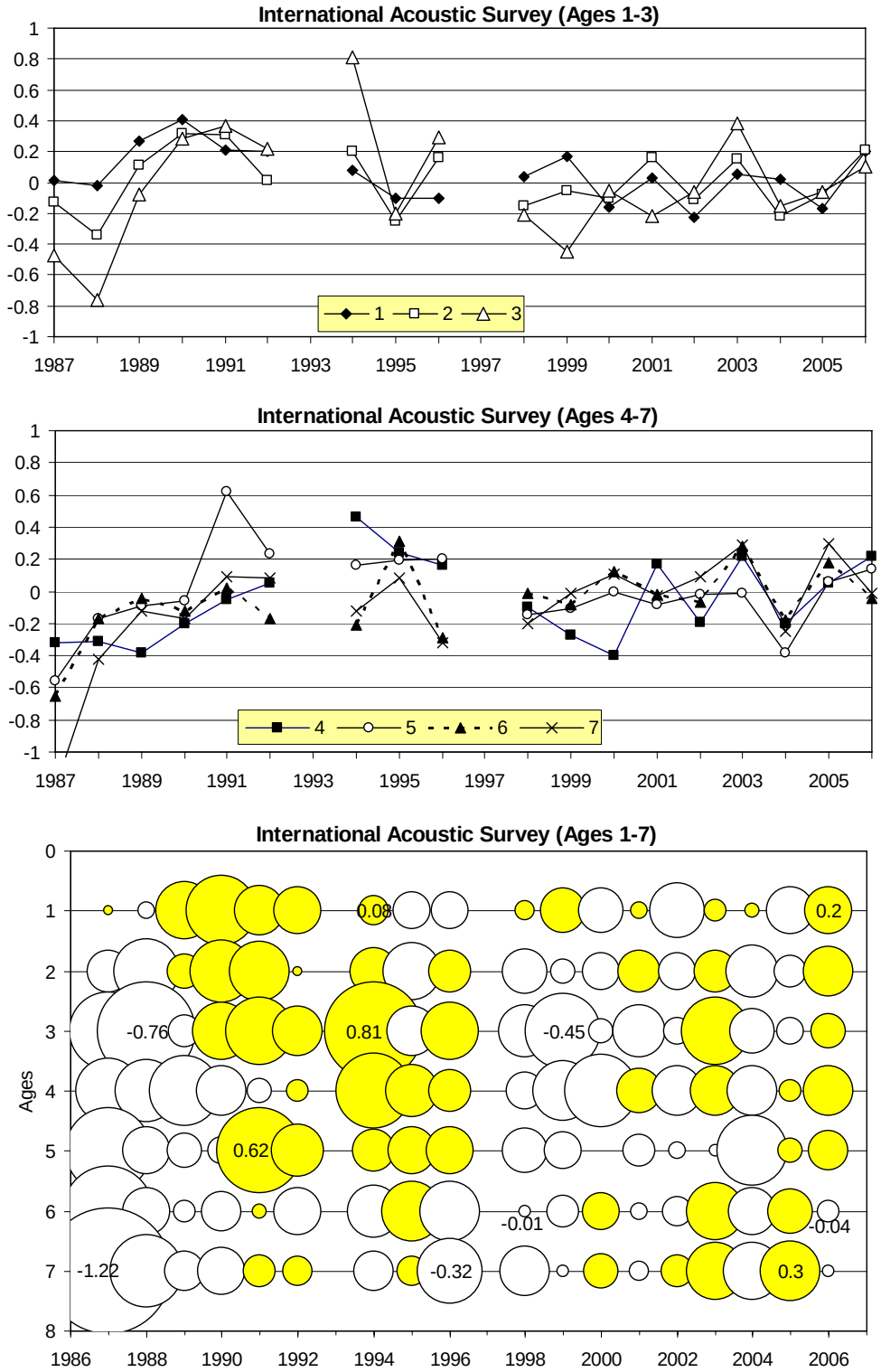


Figure 6.2.8 Herring in SD 25-29, 32 (excl. GOR).
International Acoustic Survey (Ages 1-7): Log Catchability residuals.

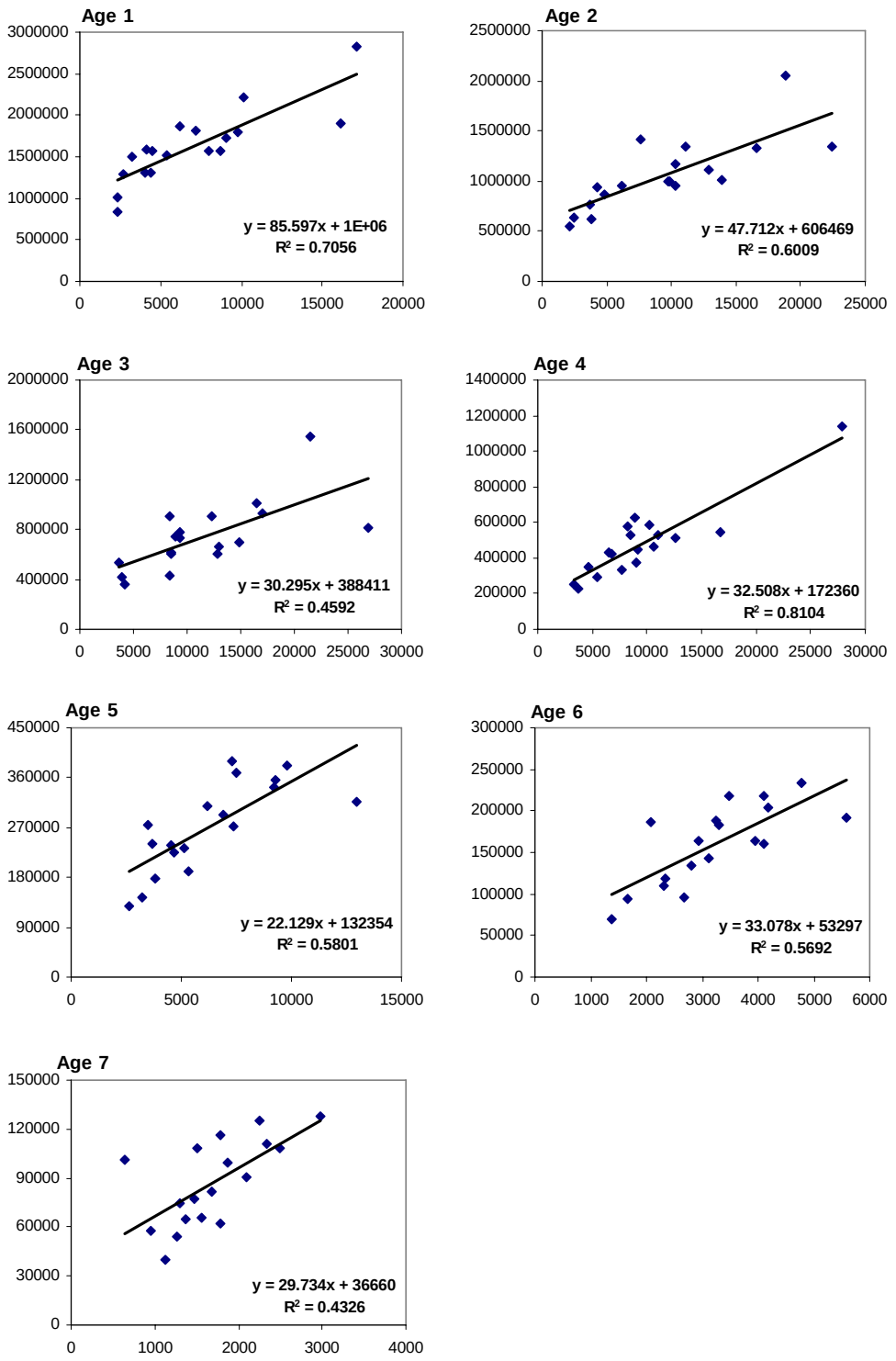
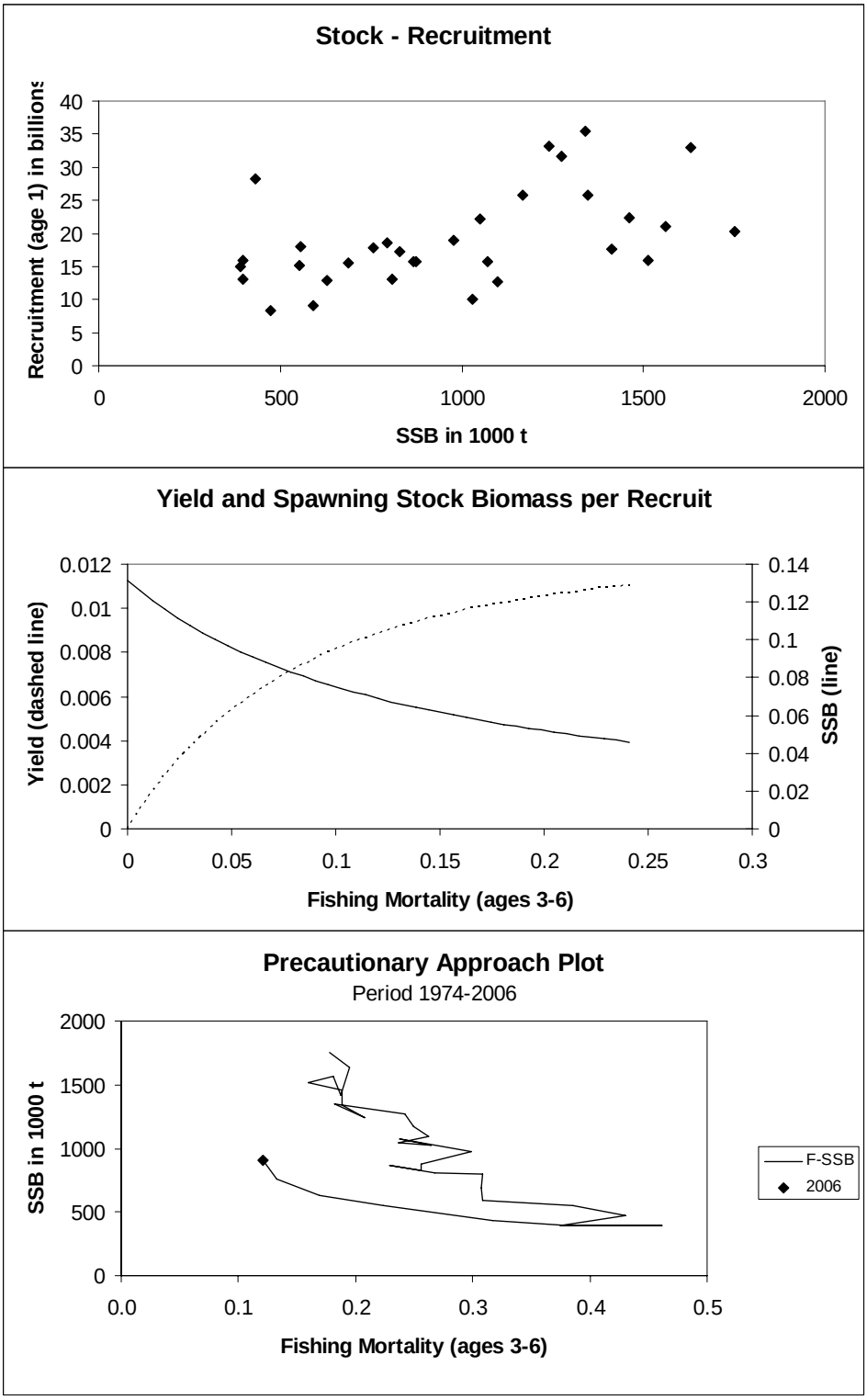


Figure 6.2.9 **Herring in SD 25-29, 32 (excl. GOR). Regression of XSA population Vs acoustic survey population numbers. CPUE adjusted to start of year.**
x-axis: Acoustic estimates
y-axis: XSA

Figure 6.2.10 **Herring in SD 25-29, 32 (excl. GOR). Summary sheet plots: Landings, fishing mortality, recruitment (age 1) and SSB.** **1/2**



continued

Figure 6.2.10 **Herring in SD 25-29, 32 (excl. GOR). Summary sheet plots: Stock-recruitment, Yield per recruit and PA-plot.** **2/2**

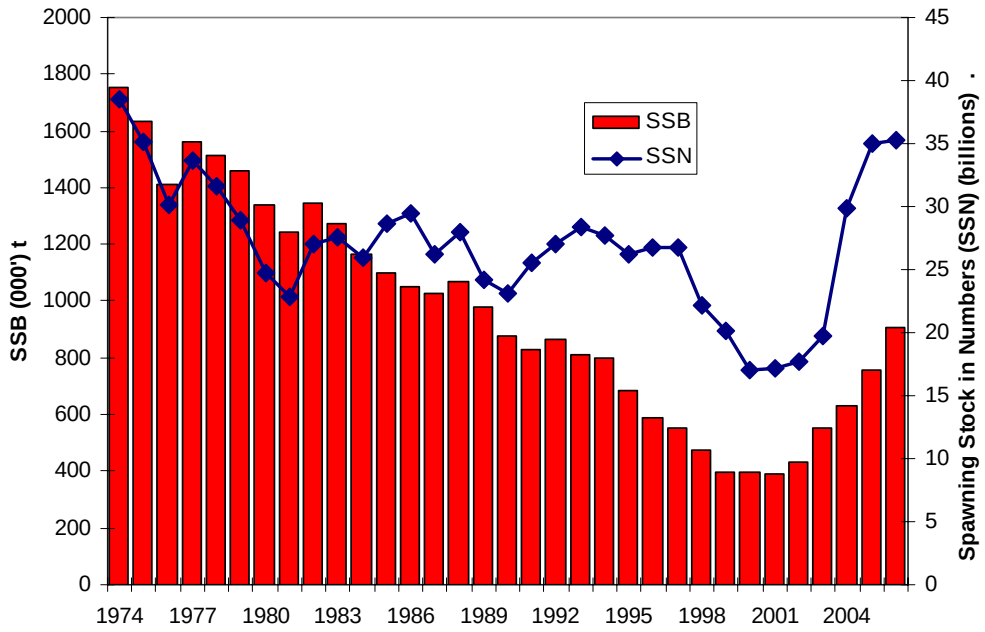


Figure 6.2.11 Herring in SD 25-29, 32 (excl. GOR).
SSB (000' t) and Spawning Stock in Numbers (SSN) (billions).

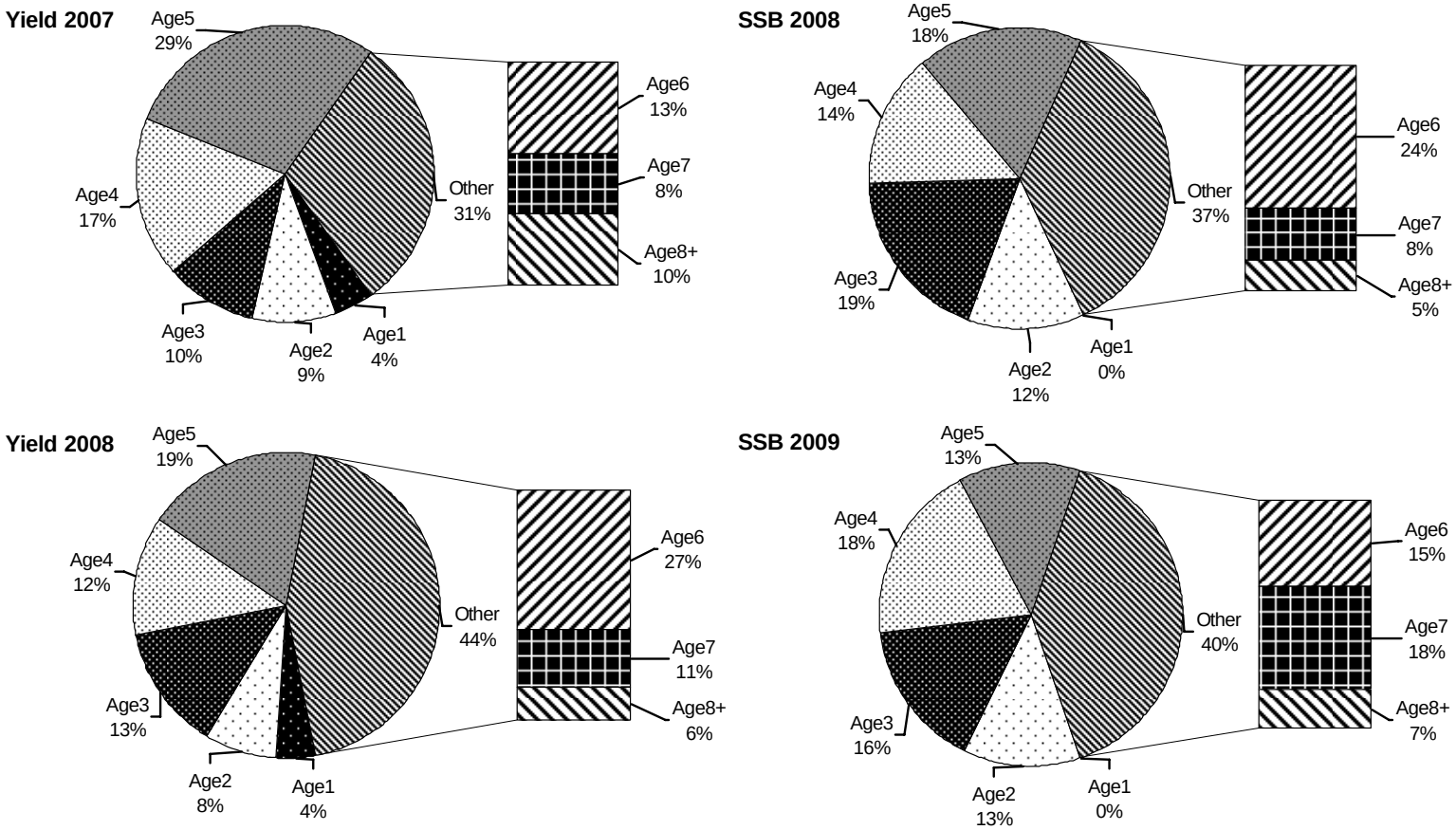


Figure 6.2.12 **Herring in SD 25-29, 32 (excl. GOR). Short-term forecast for 2007-2009. Yield and SBB at age 1-8+ for status quo fishing mortality.**

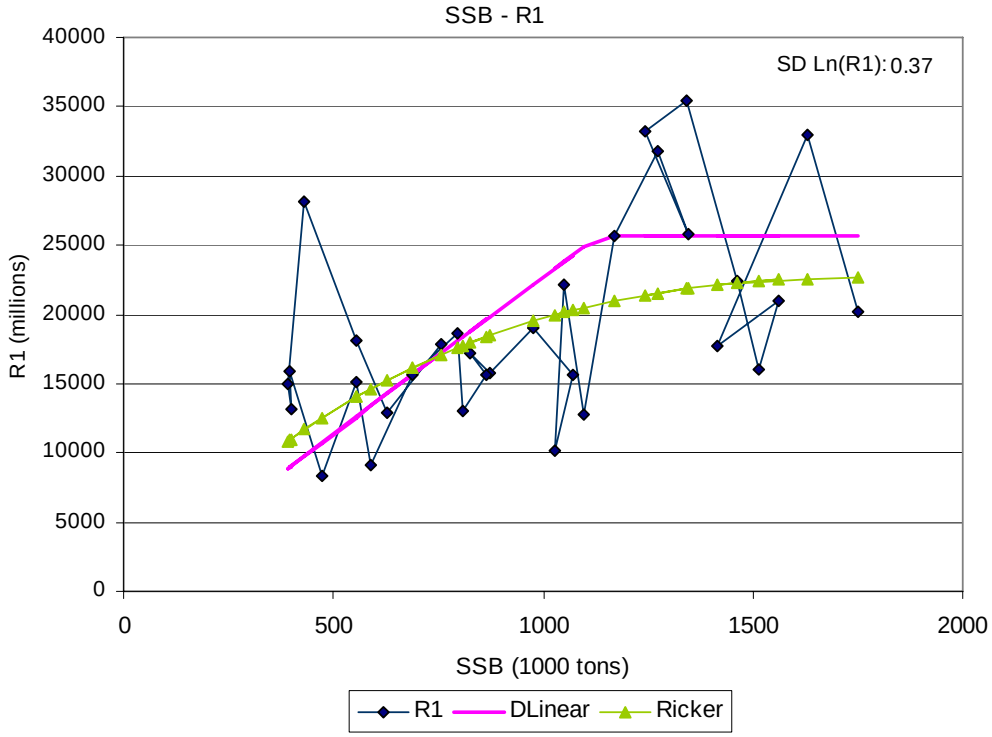


Figure 6.2.13 **Herring in SD 25-29, 32 (excl. GOR). Stock-recruitment relation. Double Linear with a breaking point at 1 130 000 t and a Ricker curve.**

PREDICTION. Herring in SD 25-29, 32 (excl. GOR)

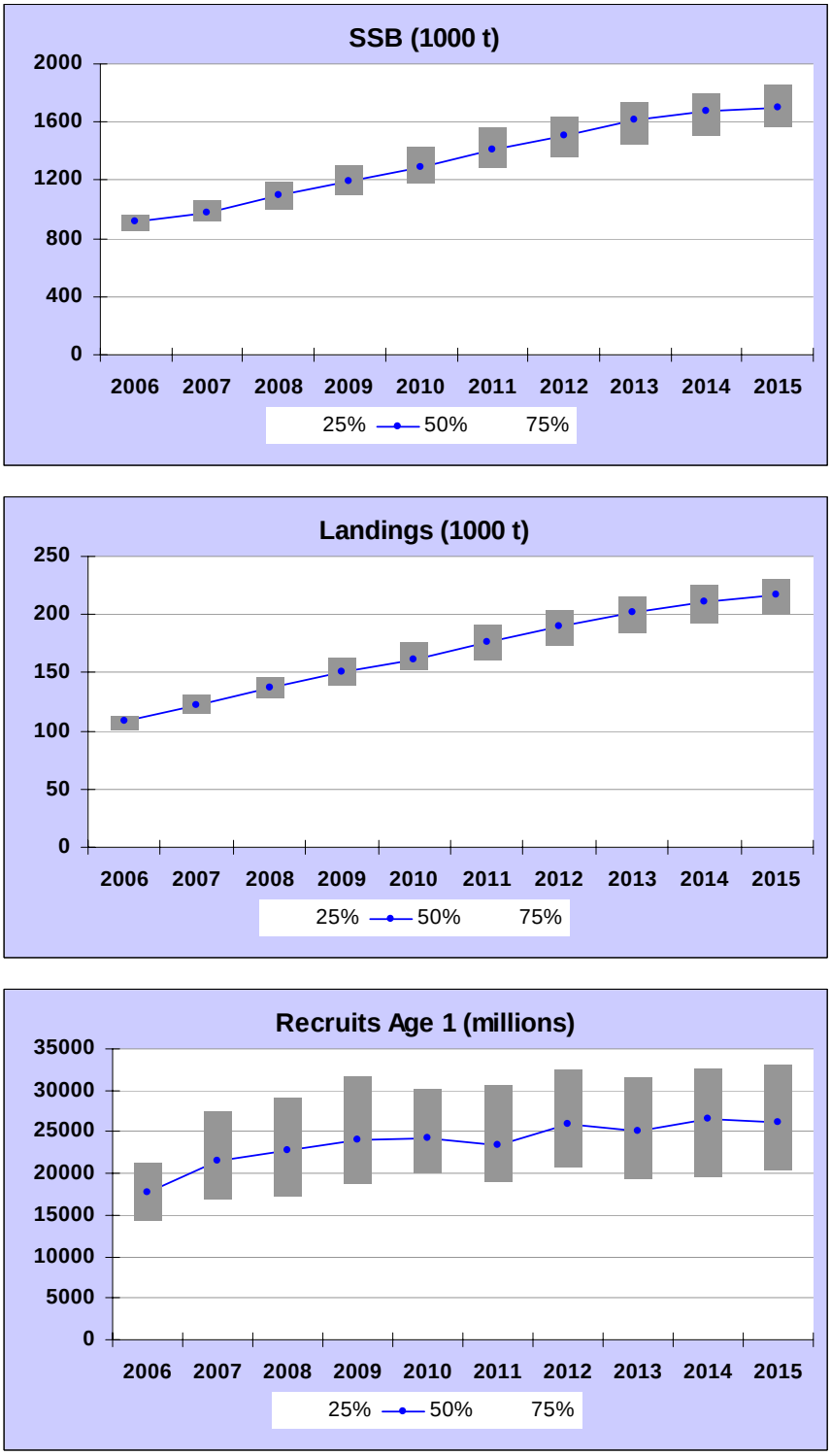


Figure 6.2.14 **Herrring in SD 25-29, 32 (excl. GOR).**
Output from medium-term predictions.
Fsq=0.12 for all years (corresponding factor*F(06)=0.856)

PREDICTION. Herring in SD 25-29, 32 (excl. GOR)

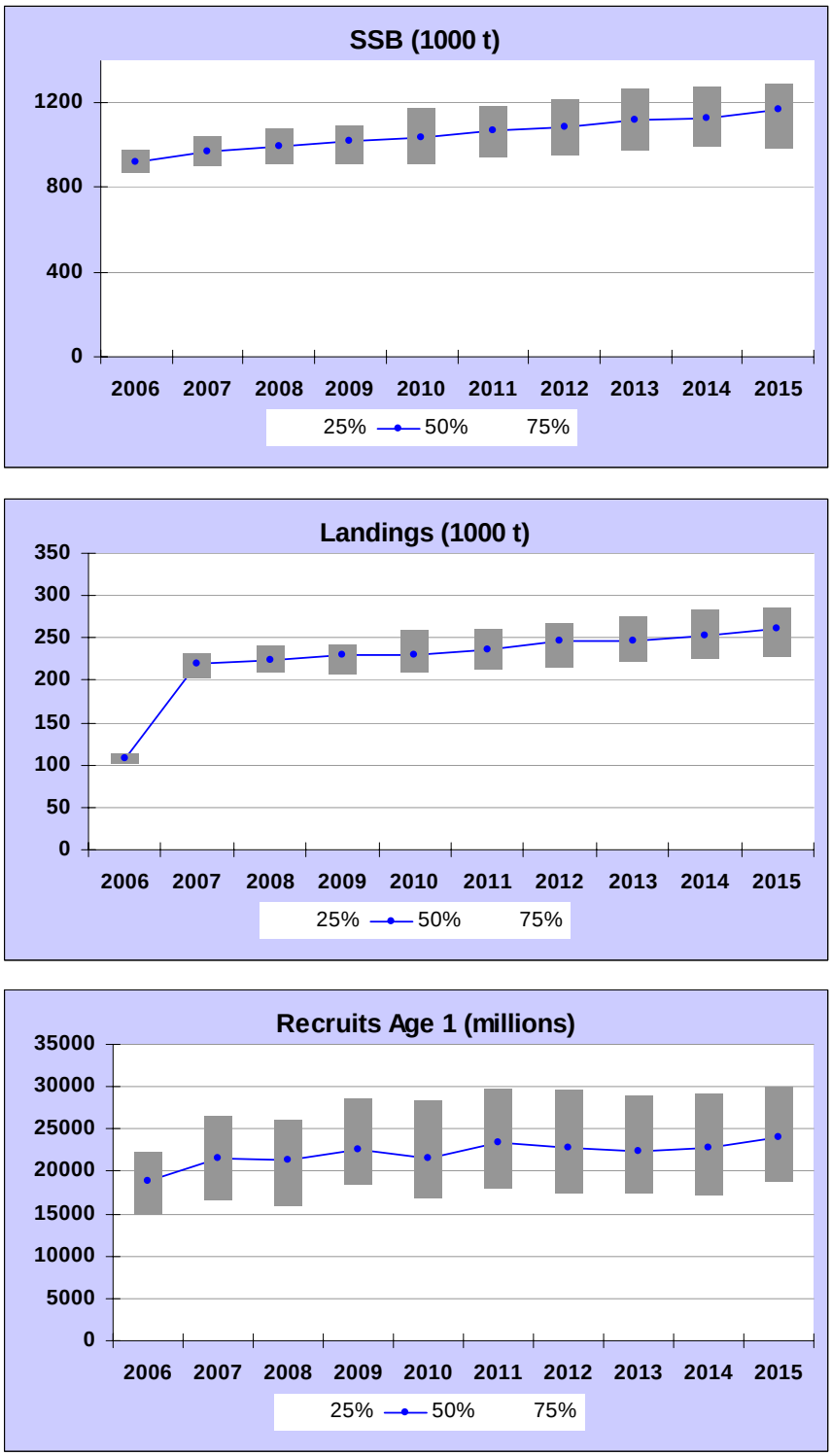


Figure 6.2.15 **Herrring in SD 25-29, 32 (excl. GOR).**
Output from medium-term predictions.
Fsq at 0.12 and Fpa=0.19 for the following prediction years
(corresponding factor*F(06)=1.58)

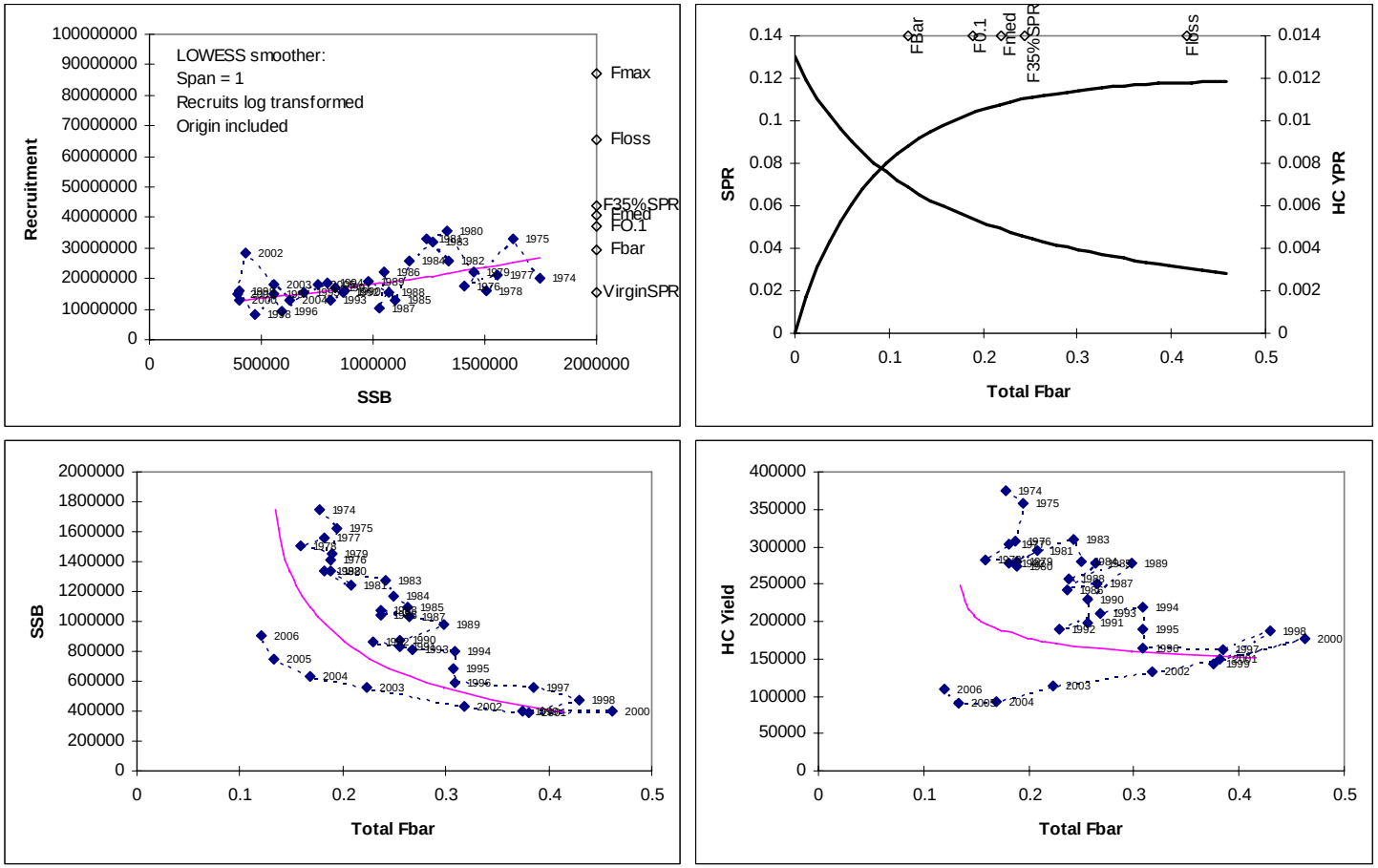


Figure 6.2.16 Herring in SD 25-29, 32 (excl. GOR). Pa plots.

6.3 Gulf of Riga herring (Subdivision 28.1) (update assessment)

Gulf of Riga herring is a separate population of Baltic herring (*Clupea harengus membras*) that is met in the Gulf of Riga (Sub-division 28.1 - the eastern part of ICES Sub-division 28). It is a slow-growing herring with one of the smallest length and weight at age in the Baltic and thus considerably differs from the neighbouring herring stock in the Baltic Proper (Subdivisions 25-29). The differences in otolith structure serve as a basis for discrimination of Baltic herring populations. The stock does not perform migrations into the Baltic Proper; only minor part of the older herring leaves the gulf after spawning season in summer –autumn period but afterwards returns to the gulf. There is evidence, that the migrating fishes mainly stay close to the Irbe Strait region in Sub-division 28 and do not perform longer trips. The extent of this migration depends on the stock size and the feeding conditions in the Gulf of Riga. In 1970s and 1980s when the stock was on a low level the amount of migrating fishes was considered negligible. In the beginning of 1990s when the stock size increased also the number of migrating fishes increased and the catches of Gulf of Riga herring outside the Gulf of Riga in Sub-division 28 were taken into account in the assessments.

6.3.1 The Fishery

Herring fishery in the Gulf of Riga was performed by Estonia and Latvia, using both trawls and trap-nets. Herring catches in the Gulf of Riga include the local Gulf herring and the open-sea herring, entering the Gulf of Riga for spawning. Discrimination between the two stocks is based on the different otolith structure. The Latvian fleet also takes gulf herring outside the Gulf of Riga in Subdivision 28 (193 t in 2004, 510 t in 2005 and 398 t in 2006). These catches are included in the total Gulf herring landings (Table 6.3.1.).

6.3.1.1 Catch trendS

After the considerable decrease of catches in 1998 as a result of the worsened market conditions, the catches have gradually increased till 40,803 t in 2003. In 2005 the total Gulf herring landings decreased to 32,225 t. In 2006 the landings slightly increased to 33,988 t (Tables 6.3.1 & 6.3.4).

The catches have shown a sharp increase in the 1990s after being at a record low level during the 1980s. In 1997 and in 2001-2004 they were the highest in the 1970–2006 period. The landings of open-sea herring in the Gulf of Riga were 3,155 t in 2006, which are 901 t more than in 2005 (Table 6.3.1). The average catch of open-sea herring in the last three years was 2,914 t.

The trap-net catches of Gulf herring were 8,337 t in 2006 and were 971 t higher than in 2005. The fishing effort was almost the same as in 2005. The trap-net catches comprised 17.2% of the total catches of Gulf herring in 2006.

6.3.1.2 Unallocated landings

According to the information (interviews) about the level of misreporting in the commercial fishery, it was stated that the level of misreporting has decreased in comparison with 1990s. However, in 2000-2006 the Latvian catch data presented to the Working Group were 15% higher compared than the official landing data (a 20% increase was used in 1995-1999) (Table 6.3.1). The level of misreporting in Estonian herring fishery has been low in 1995–2006 and therefore the official catch figures were used in the assessment.

6.3.1.3 Discards

The discards of herring in the Gulf of Riga are assumed very rare and have not been recorded by observers working on the fishing vessels.

6.3.1.4 Effort and CPUE data

The number of trap-nets used in herring fishery increased up to 2001 and slightly decreased since then, however in 2005 the decrease was more substantial especially in the Estonian coastal fishery. In 2006 the number of trap-nets was only slightly smaller than in 2005. The trawl fishery has been permanently performed by 70 Latvian and 5–10 Estonian vessels with 150-300 HP engines. A considerable increase (more than 270%) in trawl catches of gulf herring was observed in Estonia in 2002-2003 and remained the same in 2004 but was substantially reduced in 2005-2006. In Latvian trawl fleet the number of vessels has slightly decreased due to scrapping. A number of protection measures have been implemented by the authorities in management of the Gulf of Riga herring fishery. The maximum number and engine power of trawl vessels operating in the Gulf of Riga are limited. Additionally, the summer ban (from mid- June to September) in Estonian part of the gulf and the 30-day ban for trawl fishery during the main spawning migrations of herring (April-May) in both Latvia and Estonia are implemented in the Gulf of Riga. No historical time-series of CPUE data are available.

6.3.2 Biological composition of the catch

6.3.2.1 Age composition

The quarterly catches of Gulf herring from Estonian and Latvian trawl and trap-net fishery were compiled to get the annual catch in numbers (Table 6.3.3, Figure 6.3.1).

6.3.2.2 Quality of catch and biological data

The sampling of biological data from commercial trawl and trap-net catches was performed by Estonia and Latvia on monthly basis (from trap-nets on weekly basis). The sampling intensity of both countries is described in Table 6.3.2. The check of consistency of catch-at-age data is shown in Figure 6.3.2. The sample number per 1000 t is as follows: in Estonia 2.18 samples and in Latvia 3.23 samples.

6.3.3 Mean weight-at-age

The annual mean weights by age groups used for assessment were compiled from quarterly data on the trap-net and trawl fishery of Estonia and Latvia (Table 6.3.6, Figure 6.3.3.). The mean weights-at-age in the stock were assumed to be equal to the mean weights in catches because it was not possible to obtain the historical mean weight-at-age at the spawning time.

A decreasing trend in mean weight-at-age of Gulf of Riga herring was observed since the mid–1980s. Since 1998 the mean weight-at-age has started to increase and in 2000 was at the level of the beginning of the 1990s, but was still considerably lower than in the 1980s. Since 2000 the mean weight-at-age was fluctuating without clear trend and seemingly depended on feeding conditions in the specific year. Thus the most unfavourable feeding conditions in 2003 resulted in a decrease of mean weight-at-age for the most of the age groups. Particularly low weight was recorded for 1-year-old herring (abundant year-class of 2002), that was the lowest on record. The bad growth conditions in 2003 resulted in the lowest weight at age of 2-year-old herring in 2004, also in other age groups it was in general lower than in the previous 3 years.

6.3.4 Maturity at age

As no special surveys on herring maturity are performed in the Gulf of Riga it was decided to use the same maturity ogives as in previous years (Table 6.3.5).

6.3.5 Natural mortality

Since the cod stock has remained at a low level in the Eastern Baltic and is currently absent in the Gulf of Riga, the natural mortality was taken to be the same as that used in the previous years - 0.2 (Table 6.3.7). Constant natural mortality M=0.20 is used for all the years except for the period 1979-1983 when a value of M=0.25 is used.

6.3.6 Catch-at-age analysis

6.3.6.1 Tuning fleets

Two tuning fleets were available: from trap-net fishery (1986-2006) and from joint Estonian-Latvian hydro-acoustic survey in the Gulf of Riga which is carried out in the end of July-beginning of August since 1999. The tuning data are given in Tables 6.3.8-6.3.9. The check of consistency of tuning data is shown in Figures 6.3.4 and 6.3.5.

6.3.6.2 XSA runs

The input data for analytical assessment of the Gulf of Riga herring is available for the period 1970-2006. However, since the 2003 WGBFAS meeting the catch-at-age analysis is performed for the period starting with 1977. The years 1970-1976 were excluded because the fishing mortality for that period was considered to be too high for pelagic fish stock.

The update assessment was performed with the same settings of the XSA like in the final assessment of the previous year, where the VPA was tuned in XSA using data on the effort (number of trap-nets) directed at the Gulf herring in the Estonian and Latvian trap-net fishery and the corresponding abundance of Gulf herring in trap-net catches and the data from the hydro-acoustic survey (Table 6.3.9). The catchability was assumed to be independent of stock size for all ages, and the catchability independent of age >=5 was selected. The default level of shrinkage (SE=0.5) was used in terminal population estimation. The assessment produced two problems connected with the log catchability residuals in both tuning fleets: positive trend in trap-net fleet and all negative residuals in acoustic fleet in 2006 (Figure 6.3.6).

In the Technical Minutes of 2006 the attention was paid to possible positive trend in the log catchability residuals in trap-net fleet of Gulf of Riga herring assessment. In the current assessment this trend was even more obvious (Figure 6.3.6.). Therefore it was decided to shorten the time series of the trap-net fleet excluding the period 1986-1995 where mainly negative residuals were observed. The retention or exclusion of 2006 data from acoustic fleet was decided from two XSA runs with trap-net fleet with years 1996-2006 and acoustic fleet with and without data for 2006 survey. The results of these assessments as well as of the SPALY assessment are shown in Figure 6.3.7. and in the text table below.

Assessment, tuning fleets	SSB, t	F BAR 3-7
SPALY, trap-nets 1986-2006, acoustics 1999-2006	77532	0.3626
Trap-nets 1996-2006, acoustics 1999-2006	73007	0.4008
Trap-nets 1996-2006, acoustics 1999-2005	88747	0.3322

The inclusion of 2006 acoustic data produced the lowest SSB estimate and the highest fishing mortality. In general the difference between 3 runs was not large: the SSB was in the range of

73 to 88 thousand t and the fishing mortality was in the range of 0.33 to 0.4. The XSA diagnostics were also rather similar between the three runs. Although the exclusion of 2006 acoustic data gave slight improvement in S.E. of log catchabilities and R squared it was decided that this improvement was too small. It was argued that acoustic data of 2006 could contain important information on the state of the stock especially for age group 1. Therefore the final assessment included trap-net fleet of 1996-2006 and acoustic fleet of 1999-2006. The XSA diagnostics were similar with the results of the previous years. The standard errors of log q were in the range from 0.23 to 0.49 and the regression analyses gave R^2 values on average 0.66 and 0.73 respectively for trap-net and hydro-acoustic fleets.

The retrospective analysis was performed only for four years since acoustic data series are too short (Figure 6.3.8.) There is a tendency to slightly overestimate SSB and underestimate fishing mortality.

The fishing mortality, stock numbers, and biomasses obtained from the final VPA are presented in the Tables 6.3.11-6.3.13. The stock summary is plotted in the Figure 6.3.9.

6.3.7 Recruitment estimates

The historical dynamics of the recruitment (age 1) reveal a trend rather similar to the spawning stock biomass trend. The recruitment fluctuated at the level of 500-3,000 millions in the 1970s and 1980s mainly having the values at the lower end. In the 1990s the reproduction of Gulf of herring improved and recruitment had values around 3,000 millions in the most of the years (Table 6.3.13). In 2000s three record high year classes appeared reaching values over 6,000 millions at age 1 in the beginning of the year.

The values of mean water temperature in April and abundance of zooplankton in May (factors which significantly influence the year class strength of Gulf herring, ICES 1995/J:10) were regressed to the 1-group from the XSA using the RCT3 program (Tables 6.3.14-6.3.15). It was considered that year-class strength of the Gulf of Riga herring was strongly influenced by the severity of winter, which determines the water temperature, and abundance of zooplankton in spring. The higher water temperature in spring favours a longer spawning period and more even distribution of herring spawning activity. The zooplankton abundance was characterised as abundance of two most abundant species of Copepoda in spring, particularly *Eurytemora affinis* and *Acartia bifilosa.* A series of mild winters since 1989 has been favourable for the reproduction of Gulf herring and resulted in a row of rich year classes for the period 1989-2006, only in 1996 and 2003 after cold winters the year classes were below the average level.

However, in the recent RCT3 predictions the weight of zooplankton abundance in the prediction of recruitment has considerably decreased due to appearance of two very rich year classes. Zooplankton abundance in May in those years was only slightly above the average and thus these years stand out of line in the relationship between zooplankton abundance and year-class strength. Therefore during the ICES Workshop of Recruitment processes of herring in the Baltic Sea (ICES 2007, not finalised yet) other factors explaining the year-class strength were analysed. It was stated that the average water temperature of 0-20 m layer in May and the biomass of *Eurytemora affinis* have significant relationship with year-class strength of Gulf of Riga herring (Figure 6.3.10). Therefore for prediction of 2006 year-class at age 1 in 2007 we used new data mentioned above (Tables 6.3.14, 6.3.15). The resulting estimate for the 2006 year class would be 2,482 millions that is slightly below the average. The estimates for the 2007 and 2008 year classes for the 1-group prediction were taken to be equal to the geometrical mean of year classes over the period 1987-2004 (2,720 millions) a period when a shift from low recruitment to high recruitment is observed (Table 6.3.15).

6.3.8 Historical stock trends

The resulting estimates of the main stock parameters (Table 6.3.13, Figure 6.3.3) show that the spawning stock biomass of the Gulf of Riga herring has been rather stable at the level of 40,000-50,000 t in the 1970s and 1980s. The SSB started to increase in the late 1980s, reaching the record high level of 118,000 t in 1994. In 1998-2001 SSB decreased to the level around 80,000 t and increased somewhat in 2002-2004. In 2005-2006 SSB has decreased again to the level of 73,000 t that is close to the long-term mean. The mean fishing mortality in age groups 3-7 has been rather high in 1970s and 1980s fluctuating between 0.35 and 0.71. It has decreased below 0.4 in 1989 and stayed on this level till 1996. Since then it increased to level above 0.4 the fishing mortality that is regarded as F_{pa}. The estimate of 2006 was 0.4008.

6.3.9 Short-term forecast and management options

The input data and summary of short-time forecast with management options are presented in the Tables 6.3.16 and 6.3.17. For prediction the mean weights-at-age were taken to be equal to the average of the last three years 2004–2006. The exploitation pattern has been taken equal to the average of 2004-2006 and is not scaled to the last year. Since the cod abundance is still at a very low level in the eastern Baltic and absent in the Gulf of Riga, the natural mortality was assumed to remain at the level of 0.2. The abundance of 1 year age group in 2007 was obtained from RCT3 (Table 6.3.15). The estimates for the 2007 and 2008 year classes for the 1-group prediction were taken to be equal to the geometrical mean of year classes over the period 1987-2004. At *status quo* fishing mortality (F=0.4741) the catches of the Gulf of Riga herring in 2007 are predicted to be 37.7 thousand t that is close to the TAC of 2006 – 37.5 thousand t. The predicted catch in 2008 at *status quo* fishing mortality is 34.7 thousand t and at Fpa (0.4) is 30.1 thousand t. The SSB in 2007 would be approximately 96.8 thousand t (according to the 2006 assessment 98.7 thousand t). If the year class of 2007 is at the level of the long-term average and F at the Fpa exploitation level, SSB will decrease to the levels of 86.8 thousand t and 80.8 thousand t in 2008 and 2009, respectively. Catch corresponding to exploitation at $\mathbf{F}_{0.1}$ (0.26) would be approximately 20 thousand t in 2008 (Table 6.3.17). In 2007 and 2008 the catches will be dominated by the rich year-class of 2005. The SSB will be dominated by the 2005 year-class in 2007 while in 2008 the year-classes of 2006 and 2007 will also be important (Figure 6.3.11). The share of younger age groups (1-2) in yield of 2007-2008 will decrease in comparison with the previous year. The yield-per-recruit summary is presented in Table 6.3.18 and in Figure 6.3.13.

6.3.10 Medium-term predictions

The medium term prediction was not requested by ICES.

6.3.11 Reference points

The biological reference points were estimated using the PA software (CEFAS, Lowestoft, UK). The results are presented in the Figures 6.3.9.-6.3.10. The following values of reference points were obtained, being close to those found in the 2006 analysis – the values in brackets:

$\mathbf{F}_{0.1}$=0.25 (0.264)

$\mathbf{F}_{low}$=0.08 (0.09)

$\mathbf{F}_{med}$=0.29 (0.30)

$\mathbf{F}_{high}$=0.64 (0.66)

$\mathbf{F}_{loss}$ =0.26 (0.28)

The F_{PA} = 0.4 has been obtained earlier from the medium-term simulations.

MBAL estimate of 50,000 t was obtained from stock-recruitment plot, and correspondingly B_{lim} was calculated at the level of 36,500 t. B_{loss} value obtained from PA analysis in 2007 was 37,766 t.

6.3.12 Quality of assessment

The catches are estimated on the basis of the national official landing statistics of Latvia and Estonia. The stock is well sampled and the number of measured and aged fish has been historically high (Table 6.3.2.). Since 1993 the total landings of Latvia increased according to information on misreporting. The number of trap-nets directed at the Gulf herring in the Estonian and Latvian trap-net fishery and the corresponding abundance of Gulf herring in trap-net catches are used for tuning VPA. These data could be very sensitive to changes in market demand, and as described in section 6.3.9 also could be affected by fishery regulation. Therefore, the joint Estonian-Latvian hydro-acoustic surveys were started in 1999 to obtain the additional tuning data, which were implemented for the first time in 2004 assessment. There are indications that hydro-acoustic survey underestimates the older age groups especially in the years when stock is dominated by an abundant age group 1. This was especially evident in 2006.

6.3.13 Comparison with the previous assessment

The comparison between main input parameters for assessment and the results of XSA and predictions from 2006 and 2007 are presented in the text table below.

Comparison of XSA settings from assessments performed in 2006 and 2007

Category	Parameter	Assessment 2006	Assessment 2007	Diff.
XSA Setting	Catchability dependent on stock	Independent for all ages	Independent for all ages	No
	Catchability independent of age	>=5	>=5	No
	Survivor estimates shrinkage towards mean F of	Final 5 years, 3 oldest ages	Final 5 years, 3 oldest ages	No
	S.E. of the mean for shrinkage	0.5	0.5	No
Tuning fleet	Trap-nets	1986-2005	1996-2006	Yes
	Acoustic surv ey	1999-2005	1999-2006	No

Comparison of SSB and F estimates from assessments performed in 2006 and 2007

Assessment year	Tuning fleet	SSB (2005) (t)	FBAR3-7 (2005)	Diff.(+/-)%
2006 (update)	Trap-nets+acoustics	88,973	0.4156	
2007 (update)	Trap-nets+acoustics	72,634	0.4814	-18.4; +15.8

Comparison of prediction results performed in 2006 and 2007

Parameter	Prediction 2006	Prediction 2007	Actual yield 2006 (t)	Diff. (+/-)%
Yield 2006 (t)	39,473		31,232	-20.9
SSB 2007 (t)	98,658	96,760		-1.9
Yield 2007 (t)	35,360	37,723		+6.7

6.3.14 Management considerations

There are no explicit management objectives for this stock. The International Baltic Sea Fisheries Commission (IBSFC) has started to treat Gulf of Riga herring as a separate management unit since 2004 and a separate TAC for the Gulf of Riga was established. Since then the TAC is divided into catch quotas of Estonia and Latvia. Thus the danger of overshooting the ICES advice for the Gulf of Riga herring, that was present when this stock was managed together with herring stock in the Central Baltic, has been reduced.

Table 6.3.1 Herring catches ('000 t) in the Gulf of Riga.

Category	Catch in ' 000 t									
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Total catch	31.9	26.6	23.0	21.8	20.7	22.7	17.5	20.3	19.6	20.2
Gulf of Riga herring	27.4	24.2	16.7	17.1	15.0	16.8	12.8	15.5	15.8	15.6
Open sea herring	4.5	2.4	6.3	4.7	5.7	5.9	4.7	4.8	3.8	4.6

Category	Catch in ' 000 t									
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total catch	18.2	17.7	19.8	22.7	20.8	20.8	25.2	26.5	29.3	38.8
Gulf of Riga herring	16.9	12.9	16.8	16.8	14.8	14.7	20.4	21.5	22.2	30.3
Open sea herring	1.3	4.8	3.0	5.9	6.0	6.1	3.5	4.3	5.0	6.1
Gulf of Riga herring taken outside gulf*							1.3	0.7	2.1	2.4

Category	Catch in ' 000 t										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total catch	37.0	44.1	33.5	35.7	38.6	41.7	43.6	45.1	42.4	35	34.4
Gulf of Riga herring	28.3	36.9	26.6	29.5	32.2	37.6	39.7	40.4	38.9	32.2	30.8
Open sea herring	4.4	4.3	4.1	4.3	4.5	2.9	3.5	4.3	3.3	2.3	3.2
Gulf of Riga herring taken outside gulf	4.3	2.9	2.8	1.9	1.9	1.2	0.4	0.4	0.2	0.5	0.4

* negligible and not estimated before 1992

Total catches of herring in the Gulf of Riga by nation (official landings), t

Year	Estonia	Latvia	Unallocated landings	Total
1991	7420	13481	-	20901
1992	9742	14204	-	23946
1993	9537	13554	3446	26537
1994	9636	14050	3512	27198
1995	16008	17016	3401	36425
1996	11788	17362	3473	32623
1997	15819	21116	4223	41158
1998	11313	16125	3225	30663
1999	10245	20511	3077	33833
2000	12514	21624	3244	37382
2001	14311	22775	3416	40502
2002	16962	22441	3366	42769
2003	19647	21780	3267	44694
2004	18218	20903	3136	42257
2005	11213	19741	2961	33915
2006	11924	19186	2878	33988

Table 6.3.2. Sampling of herring landings in the Gulf of Riga in 2006

Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Estonia	I	503	2	204	204
	II	9208	14	1428	1428
	III	717	2	204	204
	IV	1496	8	816	816
	Total	11924	26	2652	2652
Latvia	I	2378	7	1033	717
	II	5728	32	3384	3164
	III	3533	10	1589	985
	IV	7547	13	2140	1158
	Total	19186	62	8146	6024
Total	1	2881	9	1237	921
	2	14936	46	4812	4592
	3	4250	12	1793	1189
	4	9043	21	2956	1974
	Total	31110	88	10798	8676

Table 6.3.3 Gulf of Riga herring. Catch in numbers 1970-2006 in thousands.

Year	1	2	3	4	5	6	7	8	9+
1970	545600	383400	409700	148600	48800	44500	2300	500	1500
1971	795400	627700	130500	114300	36000	13200	15200	300	200
1972	105400	770100	154300	53600	35100	13100	7000	5300	900
1973	86700	294100	577800	60000	17000	17400	2400	1300	600
1974	302700	303200	299400	326100	37900	8500	13000	3000	900
1975	112200	562800	288400	157100	161300	15000	2200	2300	1900
1976	425900	237200	364000	159700	59200	80500	3500	3500	2100
1977	69500	885100	141400	109700	35300	15700	16000	500	100
1978	112000	97300	403900	39200	35900	9300	3200	5300	400
1979	76700	176500	103800	342500	22100	19300	6800	3100	2400
1980	101000	125900	99600	55400	133100	10500	8600	1500	1000
1981	62500	172500	112000	83000	51400	71700	7400	3000	500
1982	80000	96000	116900	68800	43000	29900	24500	1700	1600
1983	49700	225300	138300	77700	38900	23300	15500	9000	600
1984	44000	152100	255100	96300	56700	32500	14700	9700	2200
1985	23200	283900	203900	121700	31800	23700	8000	3800	2300
1986	9200	106700	246900	110600	66500	19600	8000	3500	2300
1987	70000	49000	110000	205000	75000	32000	5000	1000	1000
1988	6000	197700	112700	112400	144600	38700	27800	3800	2100
1989	61100	47400	492700	143000	76300	53900	6500	4900	500
1990	88100	83100	67100	263500	66800	27600	14600	2600	1500
1991	119500	234000	94500	40800	180500	40500	35400	31200	9600
1992	150300	339100	369300	91300	33200	157400	19000	17400	30200
1993	192200	381400	298100	224400	66800	19000	78800	9600	17300
1994	164230	288440	368870	263500	192700	46080	9410	48660	7490
1995	232400	316900	363000	426900	277200	170900	39300	6900	44600
1996	428800	450100	281400	247600	291000	183800	105600	28000	29000
1997	204200	930700	559700	345400	242800	186700	90600	46300	14800
1998	239360	282060	505410	274890	172470	114020	90230	41350	26300
1999	361890	446500	157050	316480	157200	83650	60670	51440	29610
2000	259030	552300	359430	123730	258070	83980	35120	26350	27020
2001	819480	461570	378160	261040	81170	120980	56040	31880	38830
2002	304160	1182680	360540	202120	118950	36310	48060	22660	22280
2003	596730	396180	922840	231180	107440	70510	19990	34380	24260
2004	166760	1342020	306210	505770	129160	64390	33200	6810	55460
2005	383307	197546	873585	171434	186054	50952	27898	14427	14399
2006	787870	600120	113610	467380	100900	70420	16470	9250	10760

Table 6.3.4 Gulf of Riga herring. Catch in tons.

Year	Catch
1970	33,196
1971	32,178
1972	27,145
1973	27,895
1974	30,850
1975	28,523
1976	27,422
1977	24,186
1978	16,728
1979	17,142
1980	14,998
1981	16,769
1982	12,777
1983	15,541
1984	15,843
1985	15,575
1986	16,927
1987	12,884
1988	16,791
1989	16,783
1990	14,931
1991	14,791
1992	20,000
1993	22,200
1994	24,300
1995	32,656
1996	32,584
1997	39,843
1998	29,443
1999	31,403
2000	34,069
2001	38,785
2002	39,701
2003	40,803
2004	39,115
2005	32,225
2006	31,232

Table 6.3.5 Gulf of Riga herring. Proportion of mature at year start in 1970-2005

Period	1	2	3	4	5	6	7	8	9+
1970-2006	0	0.93	0.98	0.98	1	1	1	1	1

Table 6.3.6 Gulf of Riga herring. Weights in catch and stock in 1970-2006, kg.

Year	Age 1	2	3	4	5	6	7	8	9+
1970	0.0127	0.0192	0.0243	0.0292	0.0330	0.0460	0.0450	0.0500	0.0550
1971	0.0122	0.0192	0.0265	0.0348	0.0429	0.0646	0.0450	0.0500	0.0550
1972	0.0154	0.0210	0.0314	0.0409	0.0462	0.0400	0.0682	0.0544	0.0603
1973	0.0163	0.0213	0.0280	0.0349	0.0424	0.0458	0.0450	0.0500	0.0550
1974	0.0138	0.0183	0.0260	0.0323	0.0377	0.0413	0.0543	0.0666	0.0505
1975	0.0142	0.0173	0.0225	0.0322	0.0338	0.0391	0.0473	0.0432	0.0550
1976	0.0122	0.0185	0.0241	0.0292	0.0305	0.0393	0.0383	0.0397	0.0658
1977	0.0132	0.0160	0.0227	0.0269	0.0295	0.0312	0.0294	0.0500	0.0550
1978	0.0098	0.0177	0.0219	0.0273	0.0311	0.0304	0.0381	0.0500	0.0550
1979	0.0122	0.0162	0.0234	0.0276	0.0298	0.0340	0.0368	0.0363	0.0356
1980	0.0145	0.0201	0.0241	0.0321	0.0393	0.0456	0.0533	0.0703	0.0723
1981	0.0121	0.0216	0.0288	0.0334	0.0390	0.0439	0.0499	0.0553	0.0847
1982	0.0141	0.0214	0.0287	0.0357	0.0372	0.0451	0.0503	0.0624	0.1064
1983	0.0138	0.0193	0.0276	0.0379	0.0416	0.0509	0.0610	0.0936	0.0573
1984	0.0100	0.0150	0.0215	0.0281	0.0343	0.0391	0.0491	0.0512	0.0765
1985	0.0129	0.0172	0.0208	0.0278	0.0358	0.0487	0.0531	0.0591	0.0786
1986	0.0126	0.0198	0.0256	0.0314	0.0402	0.0462	0.0639	0.0653	0.0793
1987	0.0101	0.0154	0.0197	0.0263	0.0303	0.0379	0.0431	0.0406	0.1403
1988	0.0117	0.0186	0.0210	0.0273	0.0368	0.0434	0.0586	0.0611	0.1001
1989	0.0120	0.0148	0.0166	0.0196	0.0230	0.0315	0.0382	0.0340	0.0599
1990	0.0146	0.0178	0.0198	0.0269	0.0306	0.0331	0.0522	0.0596	0.0482
1991	0.0119	0.0154	0.0178	0.0199	0.0214	0.0225	0.0269	0.0314	0.0406
1992	0.0112	0.0136	0.0177	0.0215	0.0236	0.0250	0.0264	0.0304	0.0391
1993	0.0125	0.0136	0.0161	0.0201	0.0247	0.0263	0.0275	0.0316	0.0372
1994	0.0112	0.0146	0.0162	0.0188	0.0215	0.0252	0.0263	0.0296	0.0317
1995	0.0104	0.0136	0.0164	0.0179	0.0209	0.0229	0.0263	0.0274	0.0294
1996	0.0105	0.0125	0.0157	0.0177	0.0189	0.0215	0.0235	0.0268	0.0292
1997	0.0097	0.0124	0.0149	0.0178	0.0191	0.0196	0.0212	0.0226	0.0290
1998	0.0101	0.0133	0.0169	0.0182	0.0203	0.0213	0.0225	0.0234	0.0250
1999	0.0131	0.0155	0.0189	0.0221	0.0231	0.0245	0.0265	0.0277	0.0311
2000	0.0125	0.0165	0.0201	0.0229	0.0254	0.0264	0.0282	0.0278	0.0313
2001	0.0102	0.0160	0.0205	0.0230	0.0245	0.0277	0.0283	0.0285	0.0325
2002	0.0100	0.0153	0.0193	0.0236	0.0250	0.0271	0.0280	0.0310	0.0323
2003	0.0075	0.0153	0.0199	0.0223	0.0248	0.0263	0.0268	0.0276	0.0277
2004	0.0086	0.0101	0.0165	0.0210	0.0242	0.0268	0.0271	0.0253	0.0339
2005	0.0120	0.0142	0.0159	0.0204	0.0244	0.0260	0.0298	0.0333	0.0308
2006	0.0086	0.0132	0.0178	0.0191	0.0228	0.0266	0.0275	0.0275	0.0313

Table 6.3.7 Gulf of Riga herring. Natural mortality.

Year	Age 1	2	3	4	5	6	7	8	9+
1977-1978	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
1979	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1980	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1981	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1982	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1983	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1984-2006	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 6.3.8 Gulf of Riga herring. Tuning fleet: trap-nets.

Year	Effort	Age2	Age3	Age4	Age5	Age6	Age7	Age8*
1982	83.00	28.50	38.90	14.50	10.00	3.60	11.00	0.50
1983	44.00	26.90	16.50	9.30	4.60	2.80	1.90	1.10
1984	122.00	34.50	57.90	21.90	12.90	7.40	3.40	2.20
1985	78.00	16.00	14.70	42.90	6.10	10.50	2.00	1.50
1986	145.00	30.70	70.50	31.60	26.90	3.90	2.00	0.50
1987	65.00	4.60	5.40	38.40	14.40	9.00	1.60	0.70
1988	106.00	24.60	26.40	29.90	82.90	13.90	16.20	1.60
1989	67.00	5.30	48.60	13.90	12.70	28.60	2.60	4.80
1990	41.00	8.10	0.70	25.60	7.20	6.70	8.20	1.90
1991	87.00	42.90	22.80	10.00	54.00	10.00	9.10	10.50
1992	102.00	99.00	95.10	21.80	7.90	56.60	4.20	5.90
1993	78.00	67.80	74.60	70.40	24.80	7.70	32.10	2.10
1994	54.00	17.70	43.60	62.70	40.70	13.10	2.00	17.80
1995	64.00	37.30	53.40	68.70	59.20	33.60	11.40	0.80
1996	94.00	84.40	87.40	88.80	95.60	67.90	33.40	8.70
1997	101.00	115.50	115.70	85.10	68.20	46.70	18.80	12.40
1998	70.00	65.38	122.80	65.70	36.40	20.80	20.20	6.60
1999	78.00	34.56	21.36	101.42	51.14	25.81	18.47	18.49
2000	84.00	91.12	89.00	27.79	114.19	31.05	5.96	5.12
2001	100.00	124.13	149.34	118.20	37.23	59.59	27.53	10.40
2002	90.00	207.06	107.78	61.26	39.47	8.93	12.12	6.11
2003	86.00	77.79	265.91	72.98	23.36	25.15	3.17	6.07
2004	68.00	109.49	79.51	114.20	29.77	15.85	7.43	1.68
2005	51.00	23.01	162.65	31.30	51.30	13.68	6.04	4.31
2006	49.00	81.76	27.33	101.11	34.88	23.22	6.76	3.77

Table 6.3.9 Gulf of Riga herring. Tuning fleet: Hydroacoustic survey.

Year	Effort	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8*
1999	1	5292	4363	1343	1165	457	319	208	61
2000	1	4486	4012	1791	609	682	336	151	147
2001	1	7567	2004	1447	767	206	296	58	66
2002	1	3998	5994	1068	526	221	87	165	34
2003	1	12441	1621	2251	411	263	269	46	137
2004	1	3177	10694	675	1352	218	195	84	25
2005	1	8190	1564	4532	337	691	92	75	62
2006	1	12082	1986	213	937	112	223	36	33

* Age 8 is true age group

Table 6.3.10

```
Tuning Fleets: Trapnets from 1996, Acoustics till 2006
Lowestoft        VPA      Version  3.1
18/04/2007       16:39
Extended Survivors Analysis
Herring Gulf of Riga,2004,ANON,COMBSEX,PLUSGROUP
CPUE     data     from     file     c:\VPA\Herg\Fleet1.txt
Catch    data for 30 years. 1977 to 2006 Ages 1 to 8
Fleet,   First, Last,  First,  Last,       Alpha,  Beta
                 year,     year,  age          age
Trap-nets        1996,     2006,   2,          7,   .330,       0.58
Acoustics        1999,     2006,   1,          7,   .550,       0.6

Time series      weights :
         Tapered time weighting applied
         Power    = 3 over 20      years

Catchability analysis :
         Catchability independent of stock size for all ages
         Catchability independent of age for ages >= 5

Terminal population estimation :
         Survivor estimates shrunk towards the mean F
         of the final 5 years or the 3 oldest ages.
         S.E. of the mean to which the estimates are shrunk = 0.5
         Minimum standard error for population
         estimates derived from each fleet = 0.3
         Prior weighting not applied
         Tuning converged after 36 iterations

Regression       weights
.751,    .820,    .877,    .921,    .954,    .976,    .990,    .997,    1.000,   1

         Fishing mortalities
         Age,     1997,    1998,    1999,    2000,    2001,    2002,    2003,    2004,    2005,    2006
         1,       .154,    .099,    .148,    .115,    .155,    .160,    .106,    .174,    .130,    0.145
         2,       .350,    .329,    .271,    .353,    .307,    .351,    .323,    .367,    .321,    0.307
         3,       .443,    .325,    .308,    .365,    .437,    .420,    .512,    .445,    .435,    0.31
         4,       .518,    .407,    .348,    .426,    .495,    .444,    .525,    .592,    .484,    0.441
         5,       .518,    .534,    .433,    .535,    .554,    .441,    .450,    .638,    .451,    0.594
         6,       .574,    .492,    .541,    .436,    .520,    .519,    .513,    .538,    .562,    0.306
         7,       .618,    .611,    .534,    .458,    .590,    .402,    .611,    .487,    .474,    0.354

XSA      population       numbers  (Thousands)
AGE
YEAR     1,           2,     3,         4,         5,    6,              7,
1997     1.58E+06  3.49E+06  1.73E+06  9.45E+05  6.64E+05  4.73E+05  2.17E+05,
1998     2.81E+06  1.11E+06  2.01E+06      9.08E+05  4.61E+05  3.24E+05,      2.18E+05,
1999     2.91E+06  2.08E+06  6.55E+05  1.19E+06  4.94E+05  2.21E+05  1.62E+05,
2000     2.64E+06  2.05E+06  1.30E+06  3.94E+05  6.88E+05  2.63E+05  1.06E+05,
2001     6.30E+06  1.93E+06  1.18E+06      7.39E+05  2.11E+05  3.30E+05      1.39E+05,
2002     2.28E+06  4.42E+06  1.16E+06      6.24E+05  3.69E+05  9.91E+04      1.61E+05,
2003     6.55E+06  1.59E+06  2.55E+06      6.25E+05  3.28E+05  1.94E+05      4.83E+04,
2004     1.15E+06  4.82E+06  9.41E+05      1.25E+06  3.03E+05  1.71E+05      9.52E+04,
2005     3.48E+06  7.94E+05  2.74E+06      4.94E+05  5.66E+05  1.31E+05      8.17E+04,
2006     6.44E+06  2.51E+06  4.72E+05      1.45E+06  2.49E+05  2.95E+05      6.11E+04,

Estimated population abundance at 1st Jan  2007
0.00E+00  4.56E+06  1.51E+06      2.83E+05  7.63E+05  1.13E+05      1.78E+05,

Taper    weighted geometric mean of the VPA populations:
3.24E+06  2.20E+06  1.34E+06      8.41E+05  4.34E+05  2.36E+05      1.17E+05,
Standard error of the weighted Log(VPA populations):
.5432,  .5336,  .5574,  .4816,  .5180,  .5587,  .6051,

Log catchability residuals.

Fleet: Trap-nets


Age                  1996       1997       1998       1999       2000        2001       2002        2003       2004       2005
         2006
         1           No         No         data       for        this        fleet      at          this       age
         2           -0.39      -0.37       0.56      -0.84       0.11  0.28  0.15       0.17       -0.35      0.16       0.32
         3           -0.46      -0.32      -0.1       -0.85      -0.15       0.32  0.16  0.31       0.31       0.24       0.2
         4           -0.37      -0.24      -0.14      -0.11      -0.34       0.33       -0.01       0.18       0.2        0.08
         0.19
         5           -0.27      -0.35      -0.24      -0.12       0.33       0.22       -0.17      -0.58       0.06       0.18
         0.72
         6           0.09       -0.36      -0.46       0.05      -0.06       0.23       -0.3        0.04      -0.04       0.37
         0.02
         7           -0.23      -0.47      -0.04       0.02      -0.79       0.35       -0.53      -0.59      -0.2 -0.01  0.38

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

Table 6.3.10 (Cont'd)

```
Age                2,              3,              4,            5,      6,       7
Mean Log q,      -14.3090,  -13.6119,  -13.3645,  -13.1275,  -13.1275,   -13.1275,
S.E(Log q),        .4039,     .3789,     .2348,    .3753,     .2518,      .4358,

Regression       statistics       :

Ages with q independent of year class strength and constant w.r.t. time.

Age,     Slope     t-value Intercept RSquare No Pts, Regs.e,  Mean    Q
2,       1.42,     -1.275,   14.19,   .54,  11,      .55,       -14.31,
3,        .87,       .620,   13.67,   .75,  11,      .34,       -13.61,
4,        .91,       .533,   13.39,   .80,  11,      .22,    -13.36,
5,       1.35,      -.926,   13.19,   .46,  11,      .51,       -13.13,
6,       1.08,      -.410,   13.22,   .77,  11,      .28,    -13.16,
7,       1.02,      -.090,   13.35,   .67,  11,      .42,       -13.31,
Fleet    :        Acoustics
Age      1999,    2000,  2001,  2002,  2003,  2004,  2005,   2006
1    -0.03 -0.12 -0.44     -0.06  -0.01   0.4    0.22      0
2        0.34     0.32     -0.34     -0.05  -0.35   0.45   0.3         -0.61
3        0.62     0.26      0.18     -0.11  -0.1   -0.35   0.48        -0.89
4        0.02     0.53      0.17     -0.07  -0.27   0.26  -0.26        -0.34
5        0.1      0.23      0.23     -0.33  -0.03  -0.03   0.39        -0.53
6        0.61     0.43      0.12      0.1       0.55   0.37  -0.1       -0.17
7        0.49     0.55     -0.6       0.19   0.23   0.2    0.12        -0.39

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

Age,             1,            2,     3,              4,            5,     6,              7
Mean Log q,      -6.0806,  -6.2348,  -6.5216,  -6.6387,  -6.7237,  -6.7237,  -6.7237,
S.E(Log q),        .2464,          .4048,    .4885,    .3012,         .3093,    .3848,    .4110,

Regression       statistics       :

Ages with q independent of year class strength and constant w.r.t. time.
Age,     Slope,  t-value, Intercept,  RSquare, No Pts, Reg s.e, Mean Q
1,       1.33,     -1.885,    3.17,       .85,            8,      .28,    -6.08,
2,        .98,       .071,    6.40,       .68,            8,      .43,    -6.23,
3,        .73,      1.248,    8.54,       .79,            8,      .34,    -6.52,
4,       1.17,      -.570, 5.44,    .65,         8,      .37,    -6.64,
5,        .73,      1.363,    8.39,         .81,          8,      .21,    -6.72,
6,        .94,       .212,    6.83,       .69,            8,      .30,    -6.49,
7,        .90,       .289,    7.10,         .61,          8,      .39,    -6.63,

Terminal year     survivor and      F        summaries         :

Age 1 Catchability constant w.r.t. time and dependent on age
Year     class    =2005
Fleet,           Estimated,         Int,    Ext,  Var,   N,     Scaled,         Estimated
                 Survivors,         s.e,       s.e,  Ratio,     Weights,        F
Trap-nets                1.,          .000,  .000,  .00,   0,    .000,  0
Acoustics                4562376.,    .300,  .000,  .00,   1,   .706,     0.145
F shrinkage mean, 4552648.,   .50,,,,                           .294,  0.145

Weighted prediction        :
Survivors,             Int,          Ext,     N,      Var,       F
At end of year,  s.e,      s.e,       ,      Ratio,
4559514.,              .26,          .00,     2,      .004,      0.145

Age 2 Catchability constant w.r.t. time and dependent on age
Year class = 2004
Fleet,           Estimated,        Int,      Ext,     Var,       N,  Scaled,   Estimated
                    Survivors,     s.e,      s.e,     Ratio,   Weights,        F
Trap-nets         2071474.,        .424,     .000,  .00,   1,  .213,     0.233
Acoustics         1394130.,        .247,     .398, 1.61,   2,  .579,     0.329
F shrinkage mean, 1360284.,        .50,,,,                .208,       0.336

Weighted prediction:
Survivors,             Int,         Ext,      N,      Var,       F
at end of year,  s.e,     s.e,              Ratio,
1508991.,              .20,         .20,      4,      1.007,  0.307

Age 3 Catchability constant        w.r.t.   time and dependent on age
Year     class    =        2003
Fleet,        Estimated,  Int,   Ext,        Var,      N,     Scaled,   Estimated
Survivors,       s.e,      s.e,     Ratio,  Weights,  F
Trap-nets         340374.,    .293,        .015,     .05,      2,     .343,        0.264
Acoustics              295361.,   .227,    .389,     1.71,  3,        .476,        0.299
F shrinkage mean, 179263.,         .50,,,,                   .181,        0.453
```

Table 6.3.10 (Cont'd)

```
Weighted prediction       :
Survivors,                Int,     Ext,     N,       Var,        F
at end of year,  s.e,     s.e,     ,        Ratio,
283370.,         .17,     .20,     6,       1.167,   0.31

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2002
Fleet,           Estimated,       Int,   Ext,       Var,      N,     Scaled,  Estimated
Survivors,       s.e,      s.e,     Ratio,  Weights, F
Trap-nets         867280.,    .218,         .136, .62,         3,      .412,   0.397
Acoustics              721156.,   .198,     .192, .97,         4,      .443,   0.461
F shrinkage mean, 632190.,        .50,,,,                     .145,   0.512

Weighted prediction       :
Survivors,                Int,     Ext,     N,       Var,       F
at end of year,  s.e,     s.e,     ,        Ratio,
763460.,         .14,     .11,     8,       .730,      0.441

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2001
Fleet,   Estimated,        Int,   Ext,  Var,   N,    Scaled,    Estimated                Survivors,
s.e,   s.e,  Ratio,        Weights,   F
Trap-nets             161012.,      .200,  .167, .84,   4,   .382,   0.449
Acoustics              78206.,     .183,  .082, .45,   5,  .459,    0.774
F shrinkage mean, 136884.,     .50,,,,                       .159,   0.511
Weighted prediction:
Survivors,       Int,     Ext,     N,       Var,        F
at end of year,  s.e,     s.e,     ,        Ratio,
112619.,       .14,       .13,     10,      .966,       0.594

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 2000
Fleet,       Estimated,   Int,     Ext,      Var,      N,      Scaled, Estimated
Survivors,   s.e,s.e,     Ratio,   Weights,         F
Trap-nets        197699.,   .185, .050,     .27,      5,      .473,   0.279
Acoustics             192703.,   .185,     .127,     .69,      6,      .406,      0.286
F shrinkage mean 90115.,   .50,,,,                              .121,   0.535

Weighted prediction:
Survivors,                Int,     Ext,     N,       Var,       F

at end of year,  s.e,     s.e,     ,        Ratio,
177908.,         .13,     .10,     12,      .767,      0.306

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 1999
Fleet,        Estimated,   Int,      Ext,  Var,  N, Scaled,  Estimated
                     Survivors,     s.e,      s.e,  Ratio,   Weights, F
Trap-nets                47523.,   .190,     .052,  .27,  6, .441,            0.273
Acoustics                 28186., .197,     .061,  .31,  7, .403,            0.424
F shrinkage mean, 26211., .50,,,,                    .155,            0.45

Weighted prediction:
Survivors,                Int,     Ext,     N,       Var,        F
at end of year,  s.e,     s.e,     ,        Ratio,
35095.,          .14,     .08,     14,      .602,      0.354
```

Table 6.3.11 Gulf of Riga herring. XSA output: Fishing mortality at age.

Run title: Gulf of Riga herring
At 18/04/2007 16:39
Table 8. Fishing mortality (F) at age
Terminal Fs derived using XSA (with F shrinkage)

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0.0849	0.1222	0.0932	0.1088	0.0812	0.0552	0.046	0.0243	0.0188	0.0092
2	0.4228	0.1644	0.2963	0.2305	0.2904	0.1825	0.2298	0.199	0.2159	0.113
3	0.6604	0.3472	0.2728	0.2875	0.3511	0.3471	0.4625	0.4563	0.447	0.2957
4	0.6181	0.381	0.5812	0.242	0.4407	0.4031	0.4372	0.7192	0.4108	0.4675
5	0.6456	0.4184	0.3966	0.4998	0.3947	0.4596	0.4469	0.6953	0.5527	0.4142
6	0.8246	0.3452	0.4304	0.3523	0.595	0.4486	0.5207	0.8906	0.719	0.8108
7	0.7027	0.3841	0.474	0.3678	0.4816	0.4412	0.4729	0.7761	0.5655	0.5689
+gp	0.7027	0.3841	0.474	0.3678	0.4816	0.4412	0.4729	0.7761	0.5655	0.5689
F_{BAR3-7}	0.6903	0.3752	0.431	0.3499	0.4526	0.4199	0.468	0.7075	0.539	0.5114

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.0202	0.0121	0.0551	0.0284	0.0377	0.0409	0.0692	0.0671	0.0776	0.1055
2	0.062	0.0731	0.1249	0.0989	0.0981	0.143	0.1384	0.1408	0.1788	0.2117
3	0.1632	0.1981	0.2625	0.2615	0.156	0.2214	0.1804	0.1928	0.2645	0.2386
4	0.4292	0.2501	0.4147	0.2182	0.251	0.2221	0.2033	0.2401	0.3575	0.2907
5	0.6804	0.6195	0.2687	0.347	0.2282	0.3335	0.2514	0.2697	0.4288	0.4428
6	0.3589	0.9526	0.4954	0.1464	0.367	0.3188	0.3239	0.2755	0.4085	0.5684
7	0.4933	0.6128	0.3956	0.2384	0.2836	0.2931	0.2609	0.2632	0.401	0.4794
+gp	0.4933	0.6128	0.3956	0.2384	0.2836	0.2931	0.2609	0.2632	0.401	0.4794
F_{BAR3-7}	0.425	0.5266	0.3673	0.2423	0.2572	0.2778	0.244	0.2482	0.3721	0.404

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR
AGE											
1	0.1537	0.099	0.1481	0.1147	0.1551	0.1599	0.1061	0.1739	0.1296	0.1453	0.1496
2	0.3496	0.329	0.2707	0.3533	0.3071	0.3508	0.3227	0.3674	0.3213	0.3074	0.332
3	0.4433	0.3252	0.3078	0.3648	0.4375	0.4199	0.5115	0.4455	0.4354	0.3095	0.3968
4	0.5176	0.4075	0.348	0.426	0.4952	0.4436	0.5255	0.5925	0.4842	0.4408	0.5058
5	0.5176	0.5335	0.4329	0.5354	0.5544	0.4411	0.4501	0.6381	0.4514	0.5937	0.5611
6	0.5736	0.4924	0.5406	0.4361	0.5199	0.5188	0.5131	0.5381	0.5624	0.3061	0.4689
7	0.6178	0.6111	0.5336	0.4584	0.5897	0.4017	0.6112	0.487	0.4736	0.3539	0.4382
+gp	0.6178	0.6111	0.5336	0.4584	0.5897	0.4017	0.6112	0.487	0.4736	0.3539	
F_{BAR3-7}	0.534	0.4739	0.4326	0.4441	0.5193	0.445	0.5223	0.5402	0.4814	0.4008	

Table 6.3.12 Gulf of Riga Herring. XSA output: Stock numbers at age (start of year) (10^4).

Run title: Gulf of Riga herring
At 18/04/2007 16:39
Table 10. Stock numbers at age (start of year) (10^4)
Terminal Fs derived using XSA (with F shrinkage)

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE											
1	94316	107642	97683	111016	90821	168721	125260	202189	137393	111046	386318
2	283689	70931	77995	69307	77546	65216	124340	93167	161557	110389	90084
3	32330	152178	49269	45167	42866	45170	42318	76953	62516	106584	80724
4	26298	13675	88046	29211	26386	23500	24862	20753	39922	32734	64923
5	8202	11605	7649	38345	17860	13225	12230	12506	8277	21673	16793
6	3090	3521	6253	4007	18117	9373	6505	6092	5108	3899	11727
7	3503	1109	2041	3167	2194	7782	4661	3010	2047	2038	1419
+gp	130	1960	1631	911	1025	1036	2852	2402	1544	1461	562
TOTAL	451557	362620	330568	301130	276815	334023	343029	417071	418365	389824	652550

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE											
1	55137	125861	347877	356718	414949	317695	279472	344126	473203	158363	280587
2	309956	44599	97518	276846	281243	326132	242716	213952	260718	348626	111180
3	69321	235882	32226	72322	205489	199579	232504	172620	146495	172731	201218
4	56138	46558	148543	20313	50661	134825	136429	156981	108484	94478	90776
5	34605	35792	25179	97774	12939	33217	90080	87856	89898	66415	46099
6	6963	15248	22400	14570	63718	7590	21151	56315	46848	47271	32407
7	6706	2199	7607	15842	8265	37926	4495	13148	30644	21725	21809
+gp	1407	1812	2124	18143	20570	12869	26658	17087	16382	14479	16160
TOTAL	540233	507951	683474	872528	1057835	1069833	1033505	1062084	1172671	924088	800236

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 77-**	AMST 77-**
AGE											
1	290505	264279	630193	227529	655157	115460	348482	643967	0	204217	248911
2	208067	205100	192935	441808	158764	482403	79441	250629	455951	159924	193814
3	65505	129950	117948	116197	254709	94137	273527	47166	150899	96136	116247
4	119012	39420	73871	62350	62511	125036	49366	144899	28337	54675	68453
5	49448	68802	21079	36861	32759	30262	56607	24906	76346	27625	36694
6	22137	26261	32979	9914	19416	17100	13090	29511	11262	13432	19285
7	16215	10555	13902	16055	4831	9516	8174	6107	17791	6349	9800
+gp	21436	15892	17342	14888	14006	20841	8366	7363	7741		
TOTAL	792325	760260	1100249	925602	1202154	894755	837052	1154549	748327		

Table 6.3.13 Gulf of Riga Herring. XSA output: Summary.

Run title: Gulf of Riga herring
At 18/04/2007 16:39
Table 16. Summary (with SOP correction)
Terminal Fs derived using XSA (with F shrinkage)

Year	Recruits age 1	Total biomass	Spawning stock biomass	Landings	Yield/SSB	Fishing mortality $F_{BAR\ 3\text{-}7}$
1977	943160	76732	54521	24186	0.4436	0.6903
1978	1076416	66254	49354	16728	0.3389	0.3752
1979	976830	66126	46736	17142	0.3668	0.431
1980	1110164	69522	46707	14998	0.3211	0.3499
1981	908212	65521	47214	16769	0.3552	0.4526
1982	1687206	72869	42747	12777	0.2989	0.4199
1983	1252604	76232	50824	15541	0.3058	0.468
1984	2021895	66062	39874	15843	0.3973	0.7075
1985	1373933	77178	51827	15575	0.3005	0.539
1986	1110457	86265	63947	16927	0.2647	0.5114
1987	3863177	96522	51131	12884	0.252	0.425
1988	551371	114727	95368	16791	0.1761	0.5266
1989	1258615	84521	62201	16783	0.2698	0.3673
1990	3478769	134754	75496	14931	0.1978	0.2423
1991	3567179	136559	84030	14791	0.176	0.2572
1992	4149488	160537	101752	20000	0.1966	0.2778
1993	3176952	168458	115027	22200	0.193	0.244
1994	2794718	163929	118870	24300	0.2044	0.2482
1995	3441255	160984	111355	32656	0.2933	0.3721
1996	4732029	163329	100738	32584	0.3235	0.404
1997	1583635	131205	100786	39843	0.3953	0.534
1998	2805868	118700	79879	29443	0.3686	0.4739
1999	2905052	136327	83474	31403	0.3762	0.4326
2000	2642789	134113	85050	34069	0.4006	0.4441
2001	6301926	159877	79931	38785	0.4852	0.5193
2002	2275293	148279	104688	39701	0.3792	0.445
2003	6551573	156446	89392	40803	0.4564	0.5223
2004	1154595	121826	92333	39115	0.4236	0.5402
2005	3484816	127819	72634	32225	0.4437	0.4814
2006	6439673	141923	73007	31232	0.4278	0.4008
Arith. Mean	2653988	116120	75696	24368	0.3277	0.4368
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.3.14 Gulf of Riga Herring. Input data for RCT3.

Herring recruitment in the Gulf of Riga
2 30 2

'Year'	'VPA'	'Temp.'	'Zoopl.'
1977	1076416	28	7.2
1978	976830	34	33.1
1979	1110164	26	44.6
1980	908212	29	16.6
1981	1687206	32	8.2
1982	1252604	34	15.7
1983	2021895	48	32.6
1984	1373933	46	22.9
1985	1110457	26	7.4
1986	3863177	41	44.4
1987	551371	19	7.8
1988	1258615	33	36.4
1989	3478769	65	87.6
1990	3567179	81	73.1
1991	4149488	52	35.9
1992	3176952	49	56.5
1993	2794718	59	75.3
1994	3441255	40	100.5
1995	4732029	46	137.2
1996	1583635	25	29.8
1997	2805868	34	139.8
1998	2905052	52	123.8
1999	2642789	45	74.2
2000	6301926	50	114.0
2001	2275293	51	98.6
2002	6551573	64	97.0
2003	1154595	23	6.6
2004	3484816	44	125.0
2005	-11	50	100.9
2006	-11	44	26.0

VPA - recruitment values (age 1) from 2007 VPA
Temp.- mean water temperature in May, all values multiplied by 10
Zoopl. – the biomass of *Eurytemora affinis* in May (mg/m^3)

Table 6.3.15 Gulf of Riga Herring. RCT3 results.

Analysis by RCT3 ver3.1 of data from file :
c:\RCT3\DOC\recrdata.txt
Herring recruitment in the Gulf of Riga
Data for 2 surveys over 30 years : 1977 - 2006
Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Yearclass = 2002

	I----------Regression----------				I----------Prediction----------				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Temp.	2.47	5.44	0.61	0.411	25	4.17	15.75	0.731	0.213
Zoopl.	1.08	10.21	0.53	0.475	25	4.58	15.18	0.614	0.303
				VPA	Mean	=	14.88	0.485	0.484

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Temp.	2.49	5.39	0.58	0.444	26	3.18	13.29	0.793	0.247
Zoopl.	1.35	9.05	0.64	0.397	26	2.03	11.79	1.121	0.124
				VPA	Mean	=	14.97	0.497	0.629

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Temp.	2.12	6.84	0.49	0.573	27	3.81	14.91	0.562	0.347
Zoopl.	0.87	11.24	0.53	0.534	27	4.84	15.44	0.621	0.284
				VPA	Mean	=	14.9	0.545	0.369

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Temp.	2.14	6.8	0.47	0.573	28	3.93	15.21	0.539	0.344
Zoopl.	0.84	11.31	0.52	0.528	28	4.62	15.21	0.591	0.286
				VPA	Mean	=	14.92	0.52	0.37

Yearclass = 2006

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Temp.	2.14	6.8	0.46	0.585	28	3.81	14.95	0.535	0.362
Zoopl.	0.83	11.37	0.52	0.53	28	3.3	14.1	0.633	0.259
				VPA	Mean	=	14.93	0.523	0.379

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	3826120	15.16	0.34	0.24	0.49	******	15.7
2003	1410854	14.16	0.39	0.8	4.16	******	13.96
2004	3465748	15.06	0.33	0.17	0.26	******	15.06
2005	3625391	15.1	0.32	0.1	0.09		
2006	2481575	14.72	0.32	0.26	0.65		

Table 6.3.16. Gulf of Riga herring. Input to the short term forecast.

MFDP version 1a
Run: Her_Riga06_01
Time and date: 15:25 21.04.2007
Fbar age range: 3-7

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	2481575	0.2	0	0.2	0.3	0.0097	0.1496	0.0097
2	4559510	0.2	0.93	0.2	0.3	0.0124	0.3320	0.0124
3	1508990	0.2	0.98	0.2	0.3	0.0167	0.3968	0.0167
4	283370	0.2	0.98	0.2	0.3	0.0200	0.5058	0.0200
5	763460	0.2	1	0.2	0.3	0.0237	0.5611	0.0237
6	112620	0.2	1	0.2	0.3	0.0263	0.4689	0.0263
7	177910	0.2	1	0.2	0.3	0.0277	0.4382	0.0277
8	77410	0.2	1	0.2	0.3	0.0312	0.4382	0.0312

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	2720473	0.2	0	0.2	0.3	0.0097	0.1496	0.0097
2	,	0.2	0.93	0.2	0.3	0.0124	0.3320	0.0124
3	,	0.2	0.98	0.2	0.3	0.0167	0.3968	0.0167
4	,	0.2	0.98	0.2	0.3	0.0200	0.5058	0.0200
5	,	0.2	1	0.2	0.3	0.0237	0.5611	0.0237
6	,	0.2	1	0.2	0.3	0.0263	0.4689	0.0263
7	,	0.2	1	0.2	0.3	0.0277	0.4382	0.0277
8	,	0.2	1	0.2	0.3	0.0312	0.4382	0.0312

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	2720473	0.2	0	0.2	0.3	0.00973	0.1496	0.00973
2	,	0.2	0.93	0.2	0.3	0.01243	0.332033	0.01243
3	,	0.2	0.98	0.2	0.3	0.01670	0.3968	0.01670
4	,	0.2	0.98	0.2	0.3	0.02000	0.505833	0.02000
5	,	0.2	1	0.2	0.3	0.02367	0.561067	0.02367
6	,	0.2	1	0.2	0.3	0.02630	0.468867	0.02630
7	,	0.2	1	0.2	0.3	0.02773	0.438167	0.02773
8	,	0.2	1	0.2	0.3	0.03117	0.438167	0.03117

Input units are thousands and kg - output in tonnes

Table 6.3.17. Gulf of Riga herring. Short- term forecast.

MFDP version 1a
Run: Her_Riga06_01
Herring Gulf of Riga,2004,ANON,COMBSEX,PLUSGROUP
Time and date: 15:25 21.04.2007
Fbar age range: 3-7

2007				
Biomass	SSB	FMult	FBar	Landings
140089	96760	1	0.4741	37723

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
128069	93084	0	0	0	154071	117059
.	92313	0.1	0.0474	4101	149633	111947
.	91548	0.2	0.0948	8047	145366	107077
.	90789	0.3	0.1422	11844	141265	102438
.	90037	0.4	0.1897	15498	137322	98018
.	89291	0.5	0.2371	19015	133531	93806
.	88551	0.6	0.2845	22399	129885	89792
.	87818	0.7	0.3319	25658	126379	85966
.	87091	0.8	0.3793	28795	123006	82319
.	86370	0.9	0.4267	31816	119763	78842
.	85655	1	0.4741	34725	116642	75526
.	84946	1.1	0.5216	37527	113639	72364
.	84244	1.2	0.569	40227	110750	69347
.	83547	1.3	0.6164	42827	107970	66470
.	82856	1.4	0.6638	45333	105294	63725
.	82171	1.5	0.7112	47748	102718	61105
.	81491	1.6	0.7586	50075	100239	58605
.	80818	1.7	0.806	52319	97851	56218
.	80150	1.8	0.8535	54482	95553	53940
.	79488	1.9	0.9009	56567	93339	51764
.	78831	2	0.9483	58578	91207	49686

Input units are thousands and kg - output in tonnes

Table 6.3.18. Gulf of Riga herring. Yield per recruit. Input.

MFYPR version 2a
Run: YPR_Riga06_01
Herring Gulf of Riga,2004,ANON,COMBSEX,PLUSGROUP
Time and date: 15:56 21.04.2007
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
1	0.2	0	0.2	0.3	9.73E-03	0.1496	9.73E-03
2	0.2	0.93	0.2	0.3	1.24E-02	0.332033	1.24E-02
3	0.2	0.98	0.2	0.3	0.0167	0.3968	0.0167
4	0.2	0.98	0.2	0.3	0.02	0.505833	0.02
5	0.2	1	0.2	0.3	2.37E-02	0.561067	2.37E-02
6	0.2	1	0.2	0.3	0.0263	0.468867	0.0263
7	0.2	1	0.2	0.3	2.77E-02	0.438167	2.77E-02
8	0.2	1	0.2	0.3	3.12E-02	0.438167	3.12E-02

Weights in kilograms

Table 6.3.19. Gulf of Riga herring. Yield per recruit

MFYPR version 2a
Run: YPR_Riga06_01
Time and date: 15:56 21.04.2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJ	SSBJan	SpwnNosS	SSBSpwn
0	0	0	0	5.5167	0.1131	4.435	0.1023	4.1767	0.0963
0.1	0.0474	0.1568	0.0033	4.7356	0.091	3.6563	0.0801	3.4136	0.0748
0.2	0.0948	0.2651	0.0054	4.1972	0.0761	3.1202	0.0653	2.8883	0.0604
0.3	0.1422	0.3444	0.0067	3.8039	0.0656	2.7291	0.0549	2.5052	0.0503
0.4	0.1897	0.405	0.0075	3.504	0.0579	2.4312	0.0471	2.2134	0.0428
0.5	0.2371	0.4528	0.0081	3.2674	0.0519	2.1966	0.0412	1.9838	0.0372
0.6	0.2845	0.4917	0.0085	3.0758	0.0473	2.0069	0.0366	1.7981	0.0327
0.7	0.3319	0.5239	0.0088	2.9171	0.0435	1.85	0.0329	1.6447	0.0291
0.8	0.3793	0.5512	0.009	2.7833	0.0404	1.7179	0.0298	1.5157	0.0262
0.9	0.4267	0.5746	0.0092	2.6687	0.0379	1.605	0.0273	1.4055	0.0238
1	0.4741	0.5949	0.0093	2.5693	0.0357	1.5071	0.0251	1.3101	0.0218
1.1	0.5216	0.6128	0.0093	2.4821	0.0339	1.4214	0.0233	1.2266	0.02
1.2	0.569	0.6287	0.0094	2.4047	0.0322	1.3455	0.0217	1.1528	0.0185
1.3	0.6164	0.643	0.0094	2.3356	0.0308	1.2777	0.0203	1.087	0.0172
1.4	0.6638	0.6559	0.0095	2.2733	0.0296	1.2168	0.0191	1.0279	0.0161
1.5	0.7112	0.6675	0.0095	2.2168	0.0285	1.1616	0.018	0.9745	0.0151
1.6	0.7586	0.6782	0.0095	2.1653	0.0275	1.1113	0.0171	0.9259	0.0142
1.7	0.806	0.6881	0.0095	2.1181	0.0266	1.0652	0.0162	0.8815	0.0133
1.8	0.8535	0.6971	0.0095	2.0746	0.0258	1.0229	0.0154	0.8408	0.0126
1.9	0.9009	0.7056	0.0095	2.0343	0.0251	0.9837	0.0147	0.8032	0.0119
2	0.9483	0.7134	0.0095	1.9969	0.0244	0.9474	0.014	0.7684	0.0113

Reference	F multiplie	Absolute F
Fbar(3-7)	1	0.4741
FMax	1.7815	0.8447
F0.1	0.5327	0.2526
F35%SPR	0.5753	0.2728

Weights in kilograms

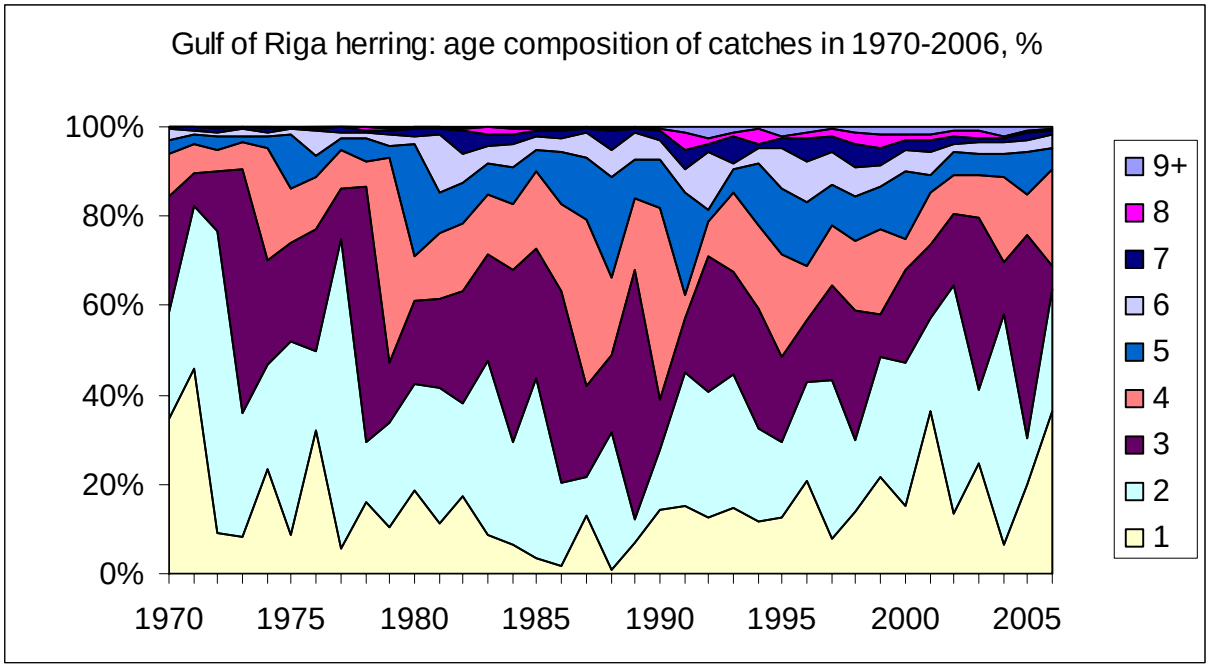


Figure 6.3.1. Gulf of Riga herring. Relative catch at age in numbers.

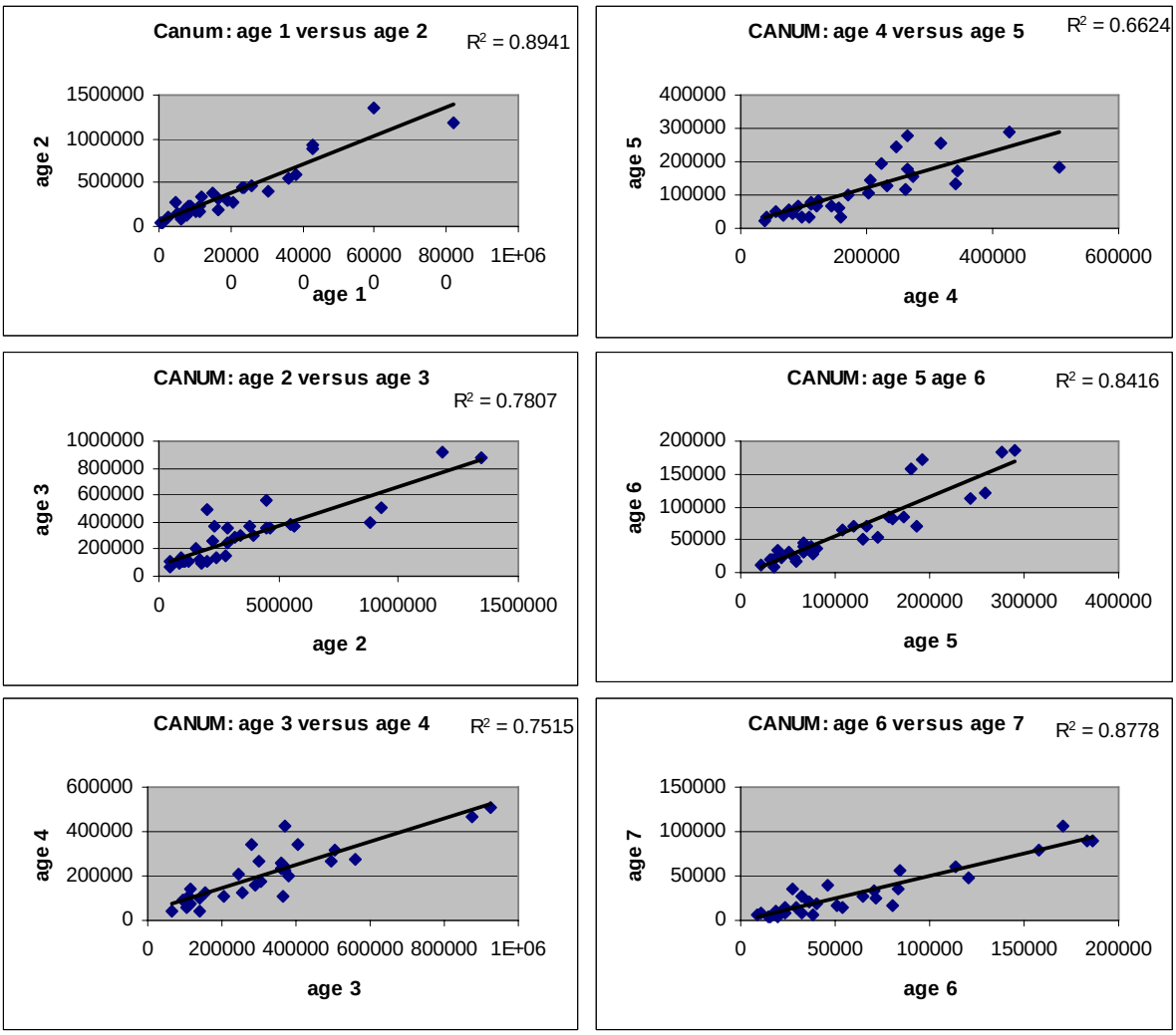


Figure 6.3.2. Gulf of Riga herring. Check for consistency in catch-at-age data.

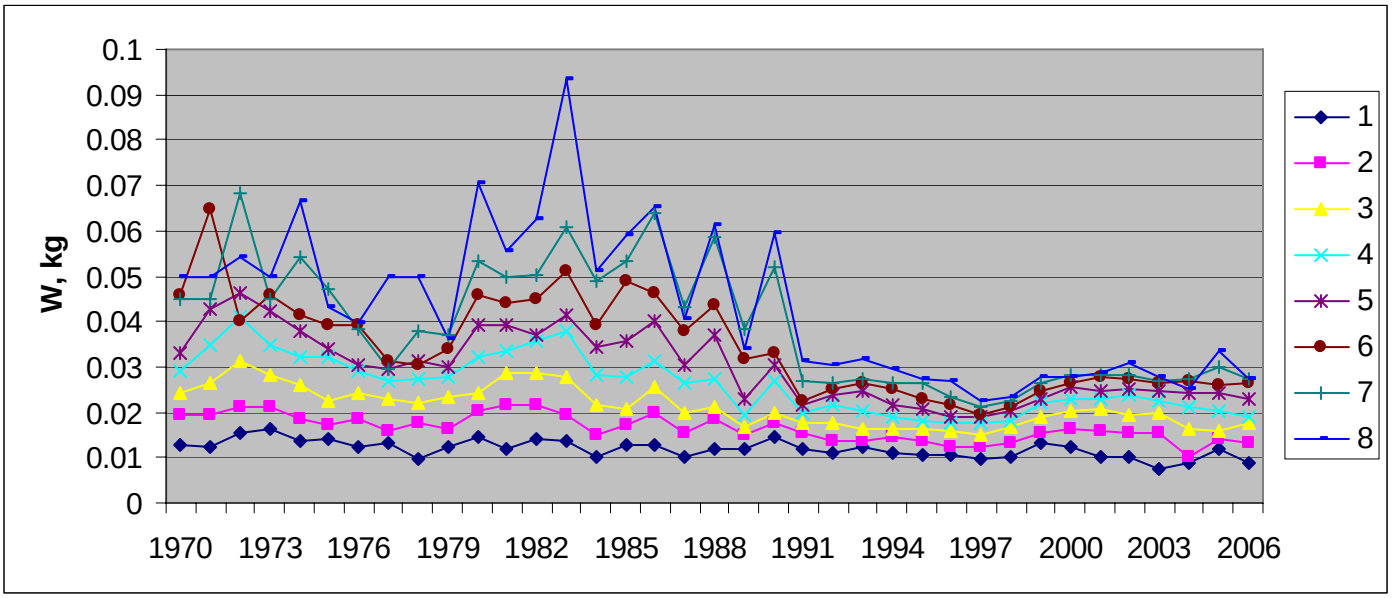


Figure 6.3.3. Gulf of Riga herring. Mean weight at age in catches.

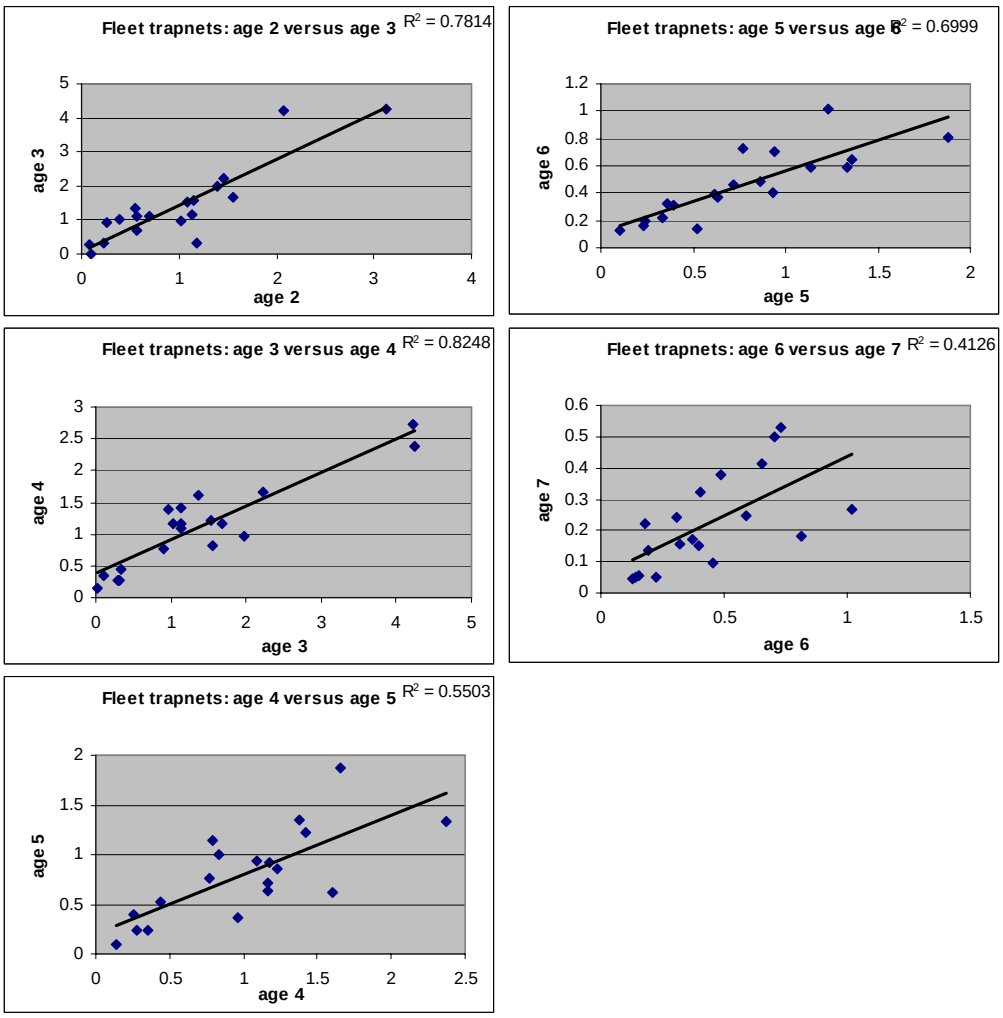


Figure 6.3.4. Gulf of Riga herring. Check for consistency of trap-net fleet (log indices) data.

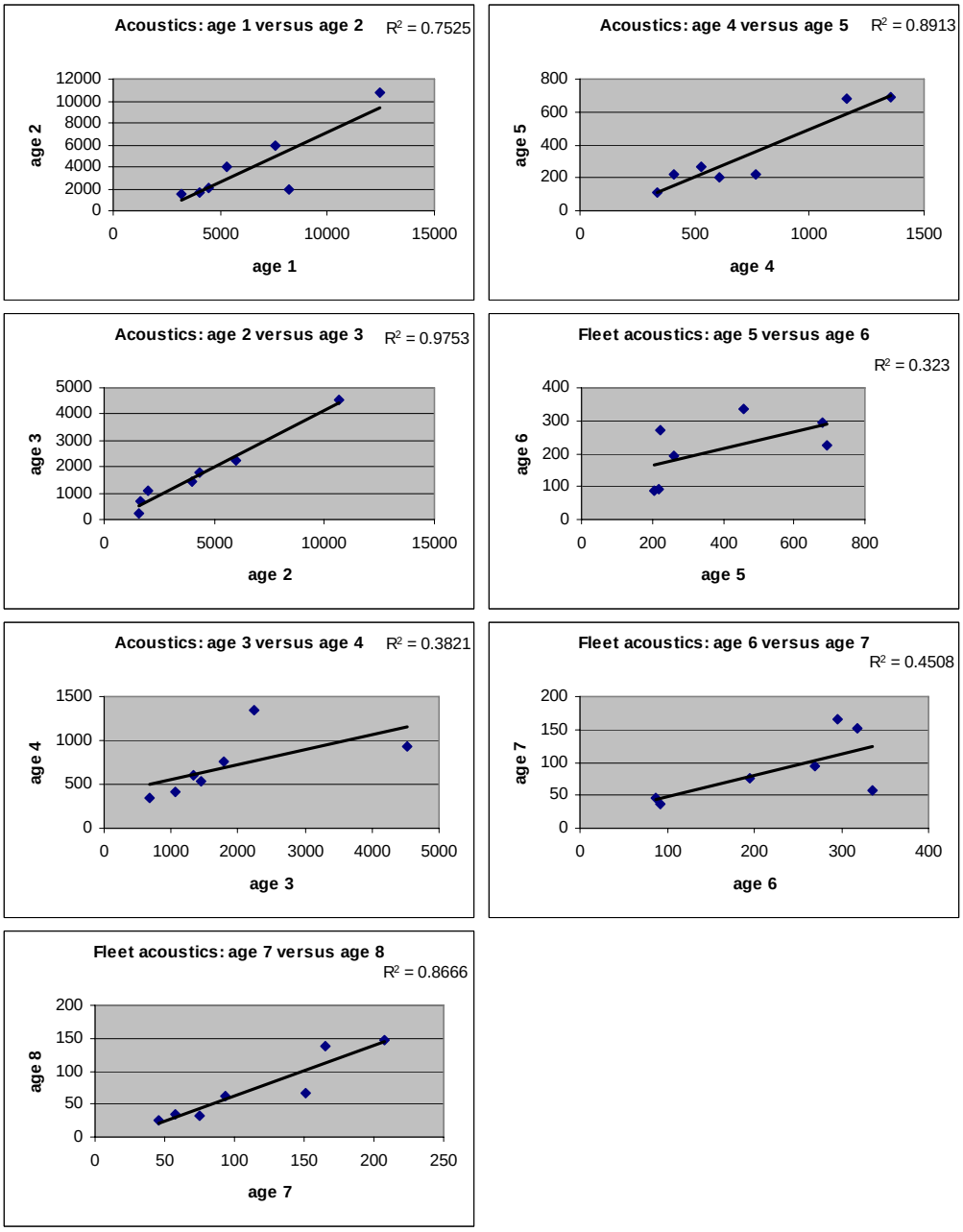
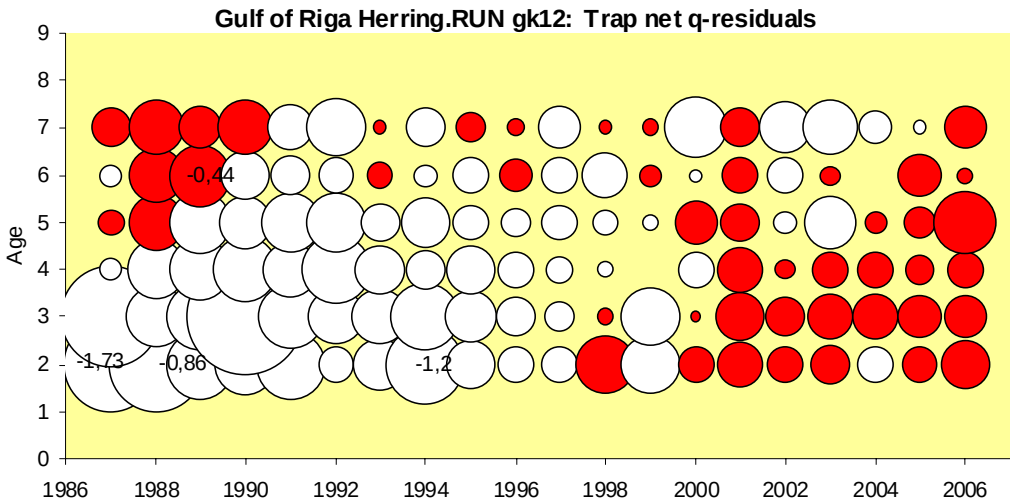
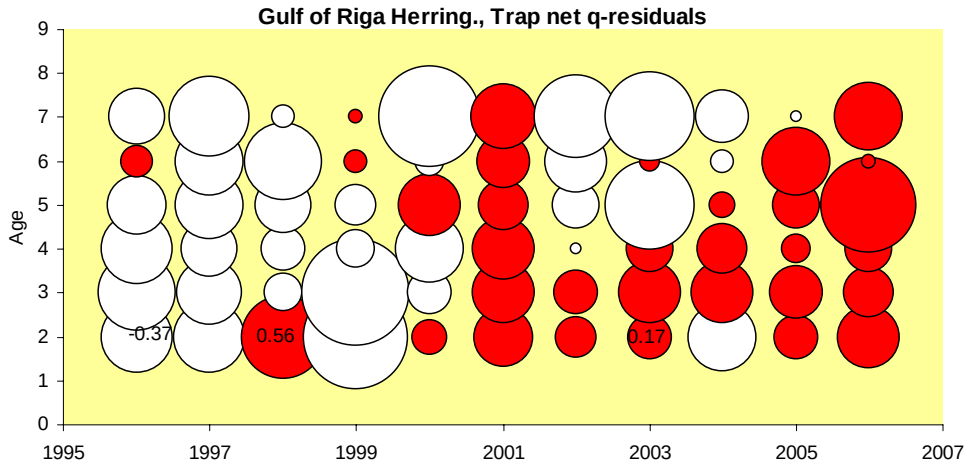


Figure 6.3.5. Gulf of Riga herring. Check for consistency of acoustic fleet data.





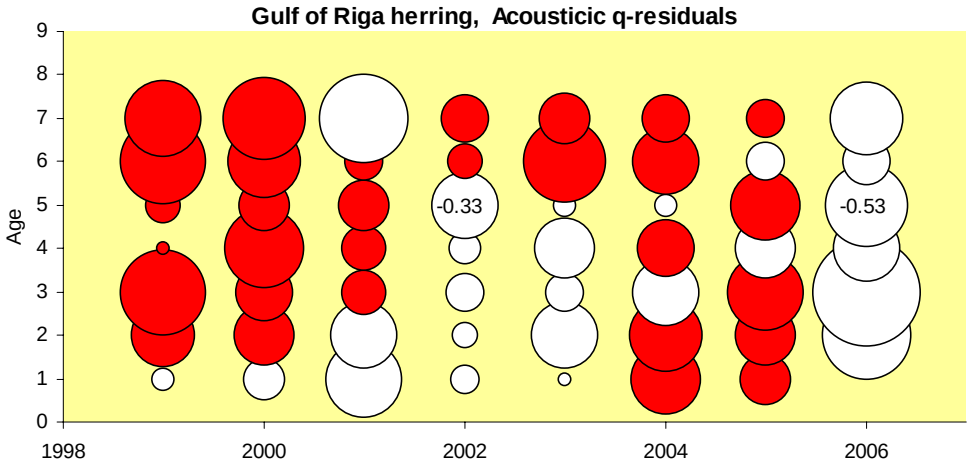


Figure. 6.3.6.Gulf of Riga herring. Plots of catchability residuals for trapnet (1987-2006;1996-2006) and acoustic (1999-2006) fleets.

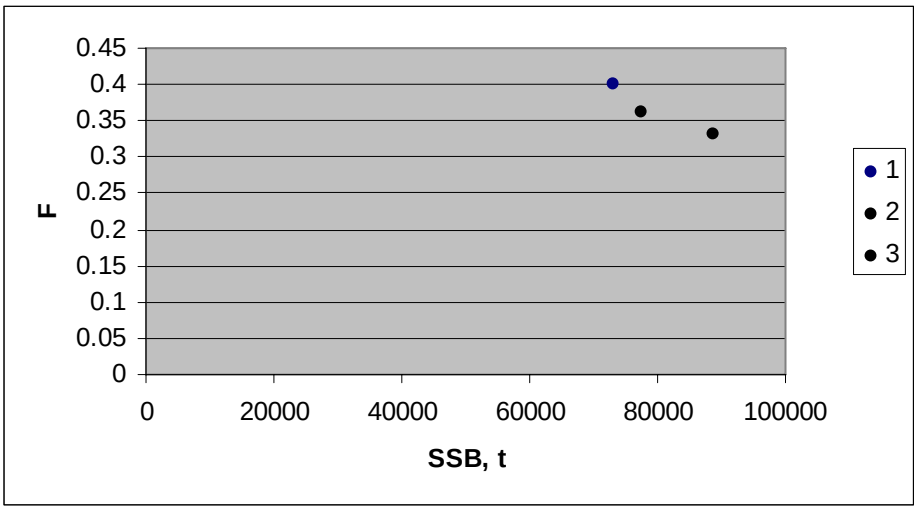
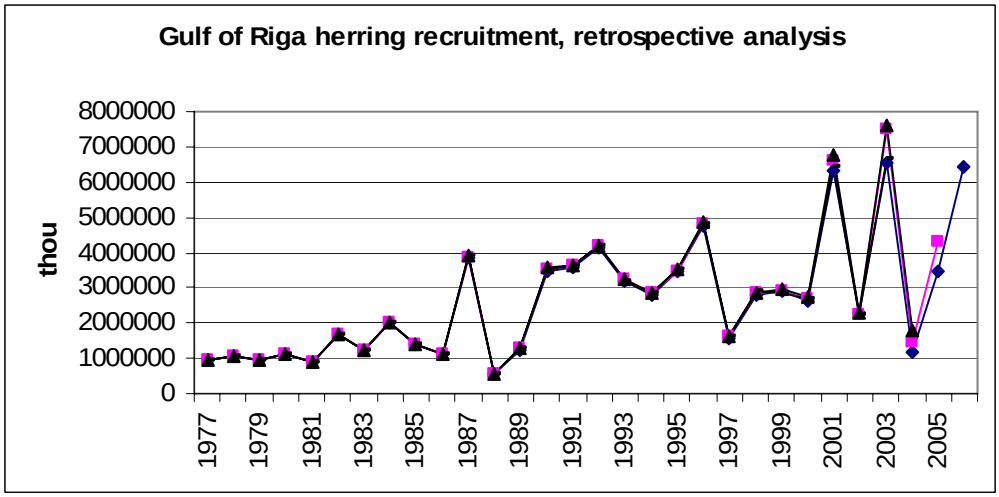
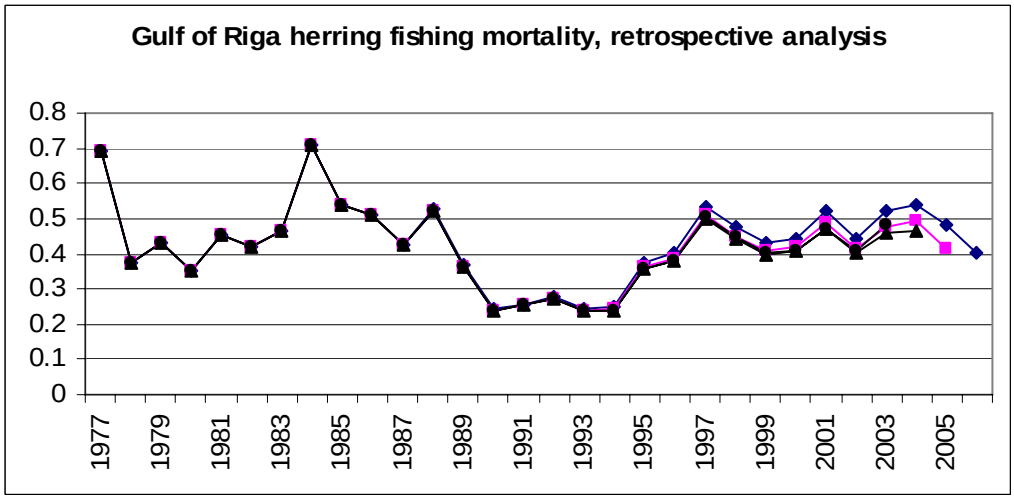


Figure 6.3.7. Estimates of SSB and F (3-7) for 2006 in different XSA runs. 1- trap-nets 1996-2006, acoustics 1999-2006; 2 – trap-nets 1986-2006, acoustics 1999-2006; 3- trap-nets 1996-2006, acoustics 1999-2005.





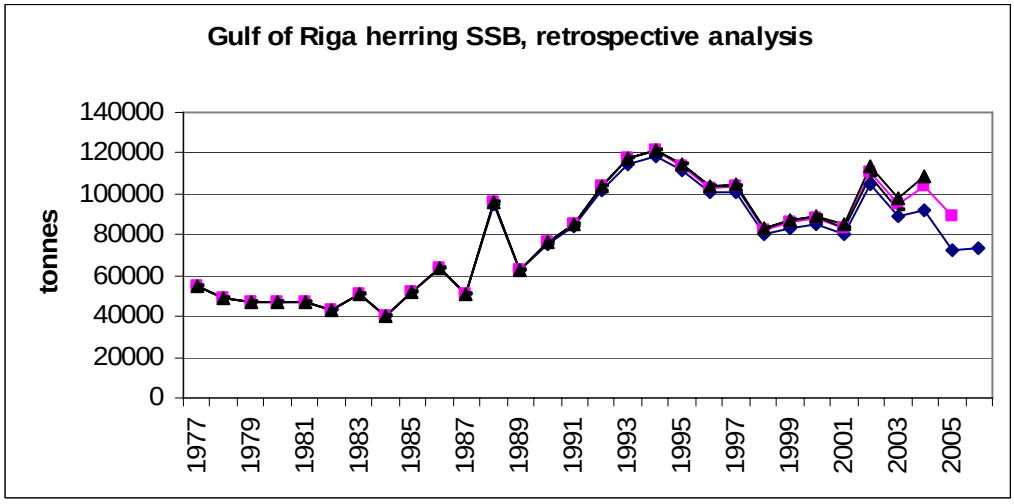


Figure 6.3.8. Gulf of Riga herring. Retrospective analysis for 2003-2006.

Figure 6.3.9. Herring in the Gulf of Riga. Standard plots of stock trends.

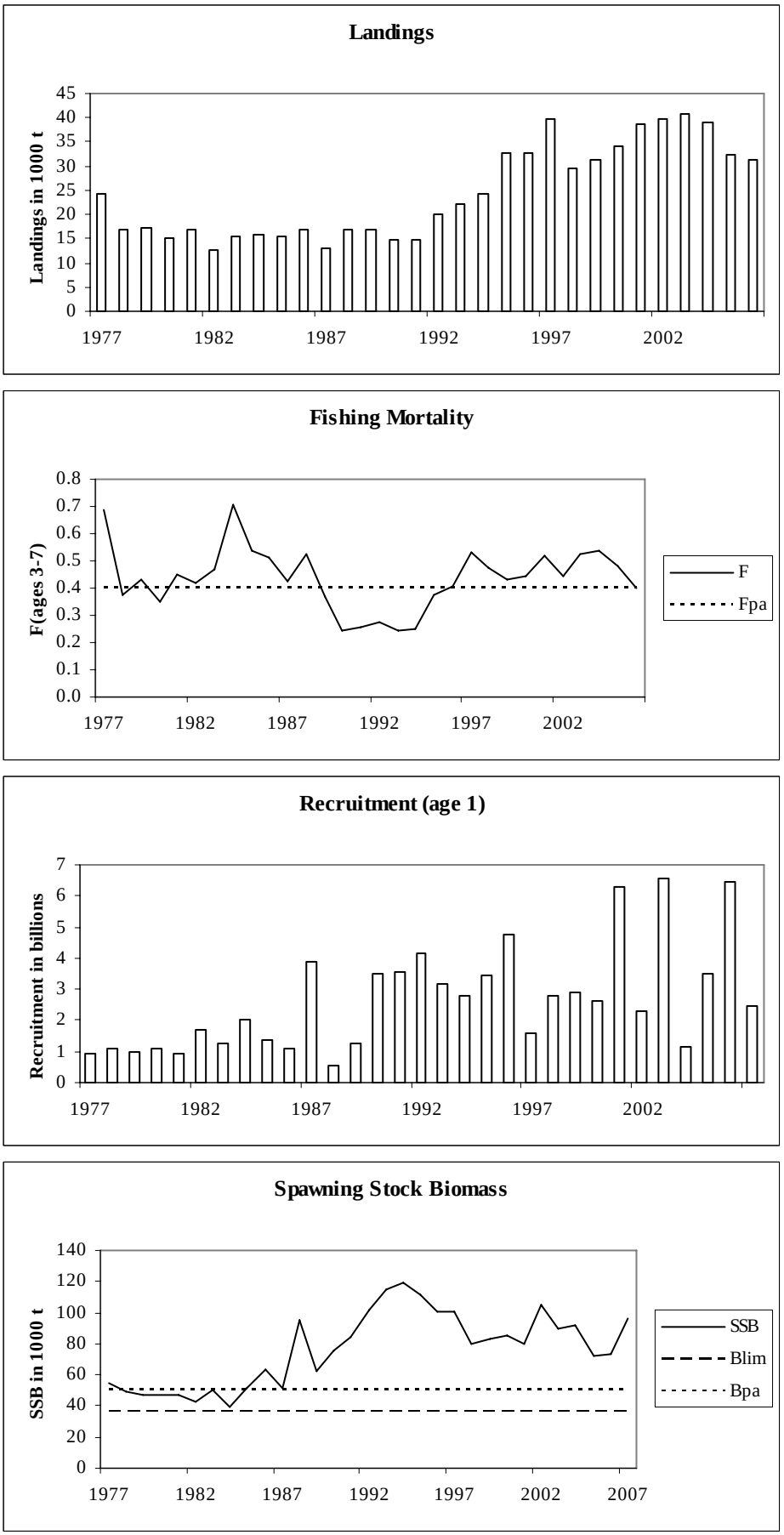
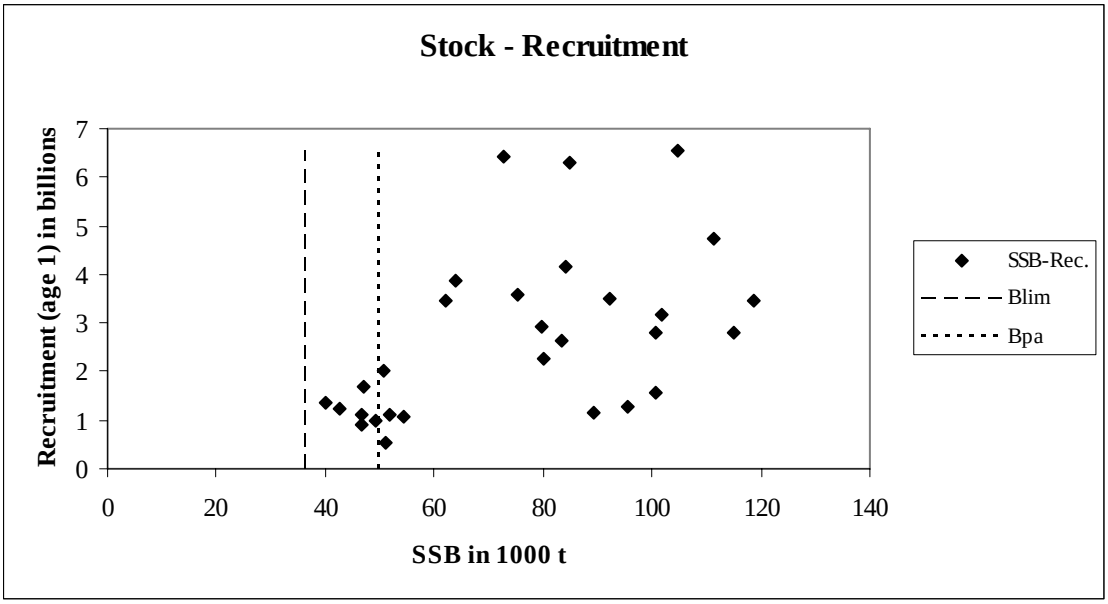
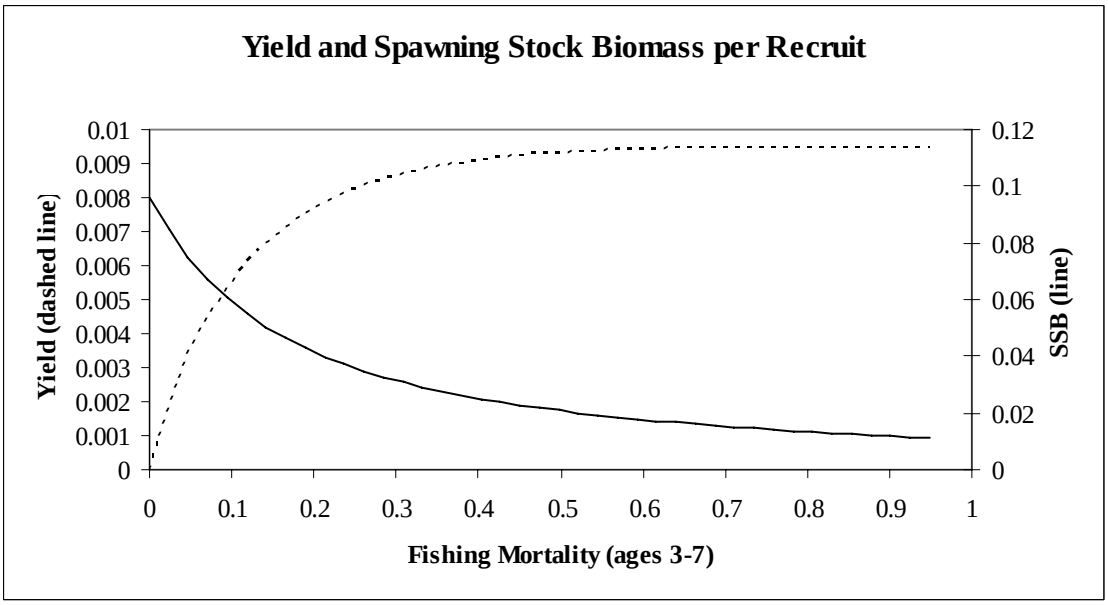
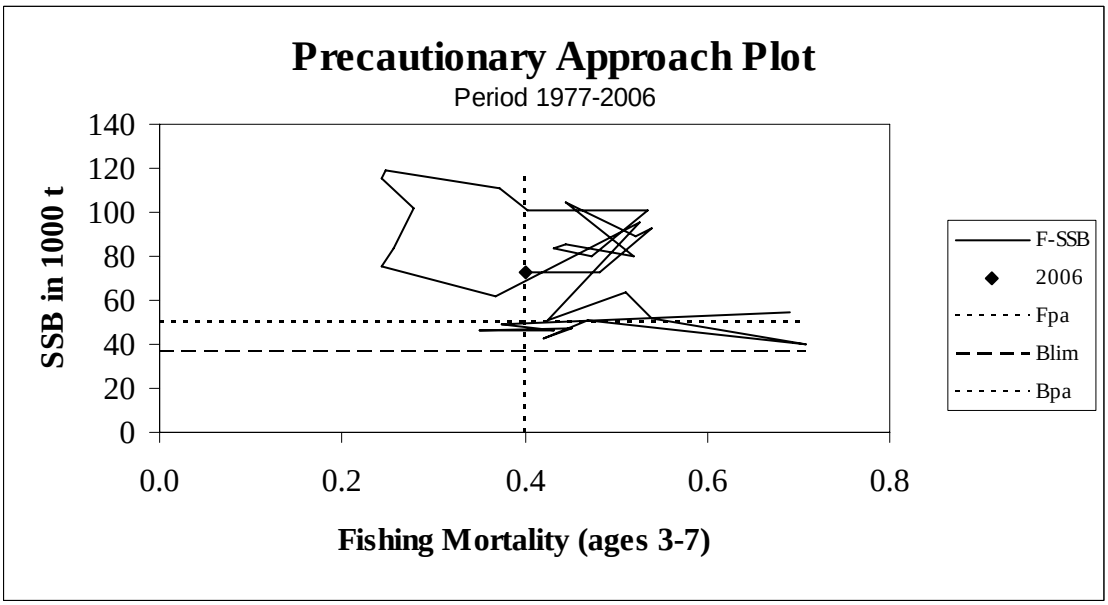
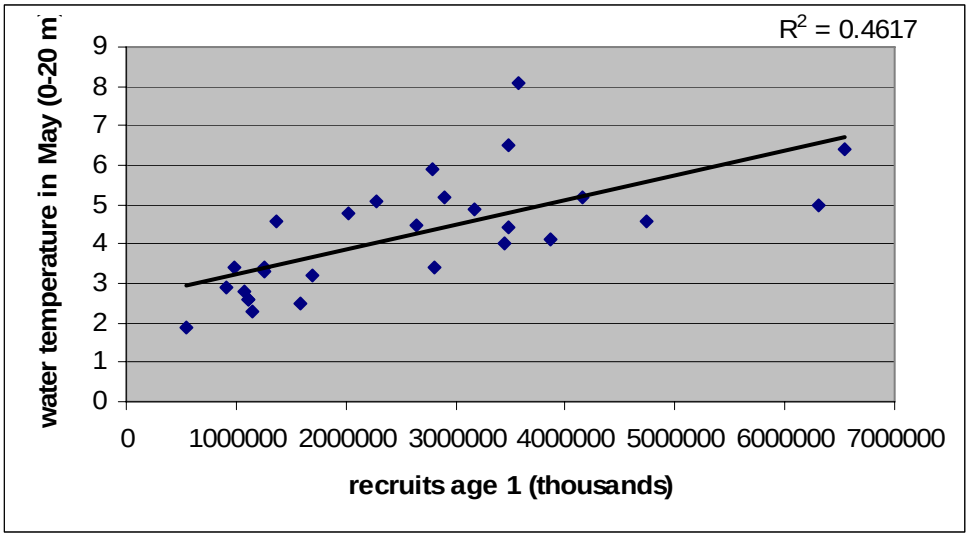


Figure 6.3.9 (cont). Herring in the Gulf of Riga. Standard plots of stock trends.









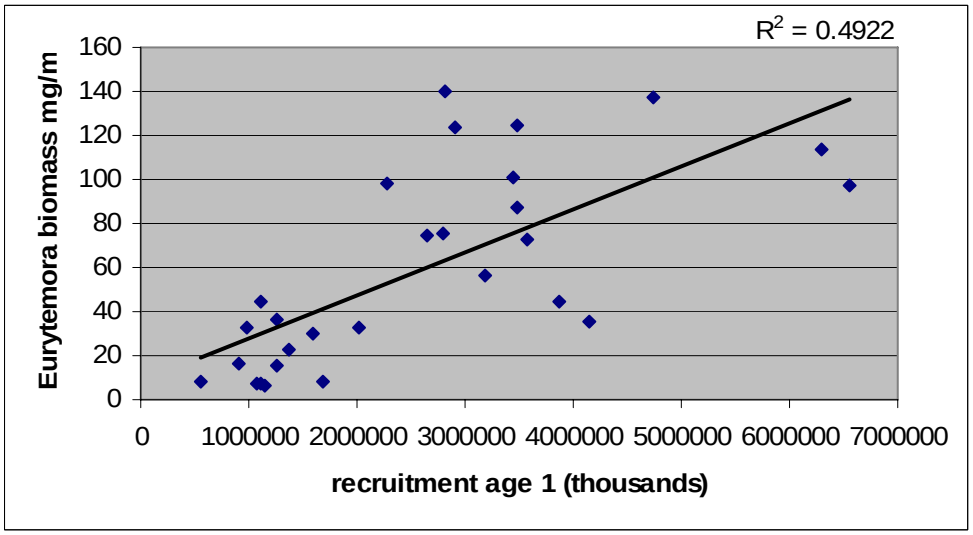


Figure 6.3.10. Gulf of Riga herring. Relationships between herring year-class strength and environmental conditions in spring.

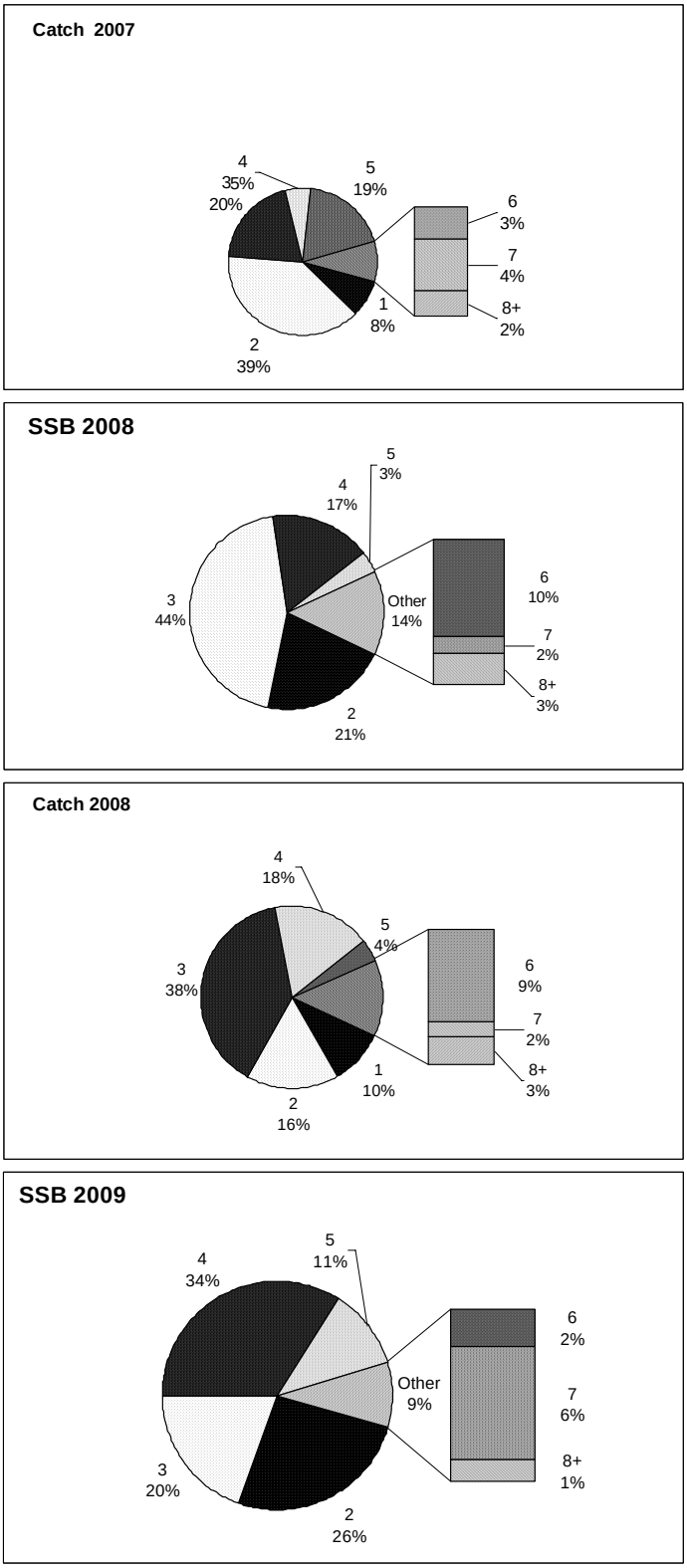
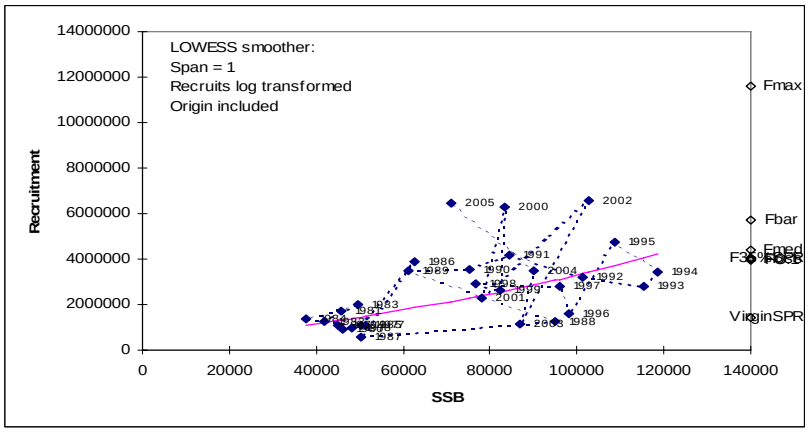
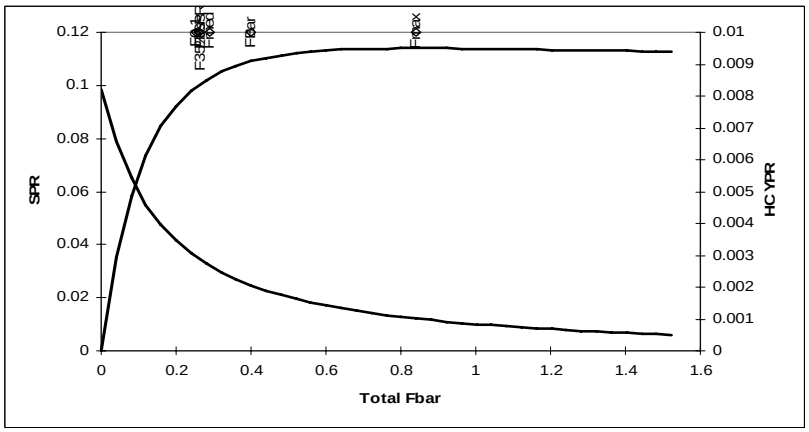
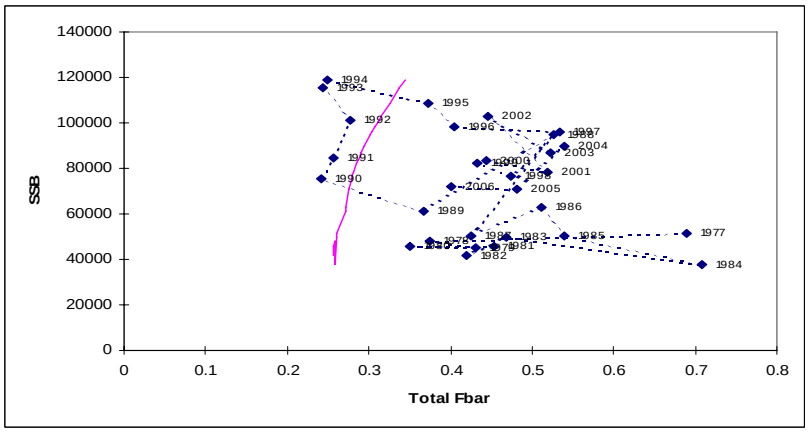
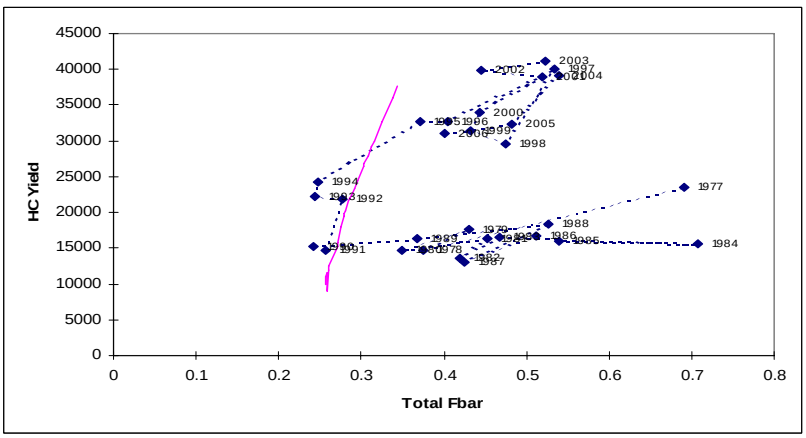


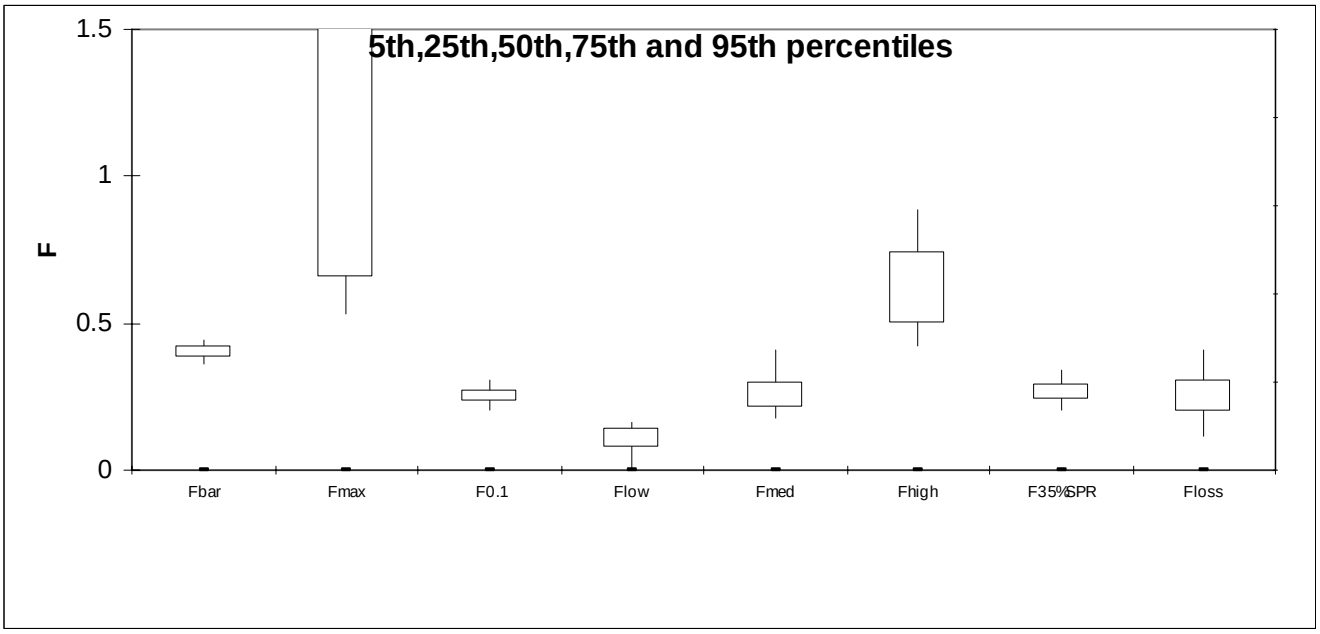
Figure 6.3.11. Gulf of Riga herring. Short-term perspectives of catch and SSB year-class composition.


LOWESS smoother:
Span = 1
Recruits log transformed
Origin included
Recruitment
SSB
Fmax
Fbar
Fmed
VirginSPR


SPR
HC YPR
Total Fbar


SSB
Total Fbar


HC Yield
Total Fbar



Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	2459041	2332342	2794718	3045130	
MBAL	50000				23.33
Bloss	37766				
SSB90%R90%Surv	81329	80864	89169	100765	56.67
SPR%ofVirgin	25.06	25.05	26.96	30.26	
VirginSPR	0.10	0.10	0.11	0.13	
SPRloss	0.03	0.04	0.04	0.05	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.40	0.40	0.38	0.36	66.67
Fmax	0.84	0.93	0.65	0.53	0.00
F0.1	0.25	0.25	0.23	0.20	90.00
Flow	0.08	0.12	0.07	0.00	100.00
Fmed	0.29	0.26	0.21	0.18	83.33
Fhigh	0.64	0.59	0.50	0.42	6.67
F35%SPR	0.26	0.26	0.24	0.20	86.67
Floss	0.26	0.25	0.20	0.11	86.67

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

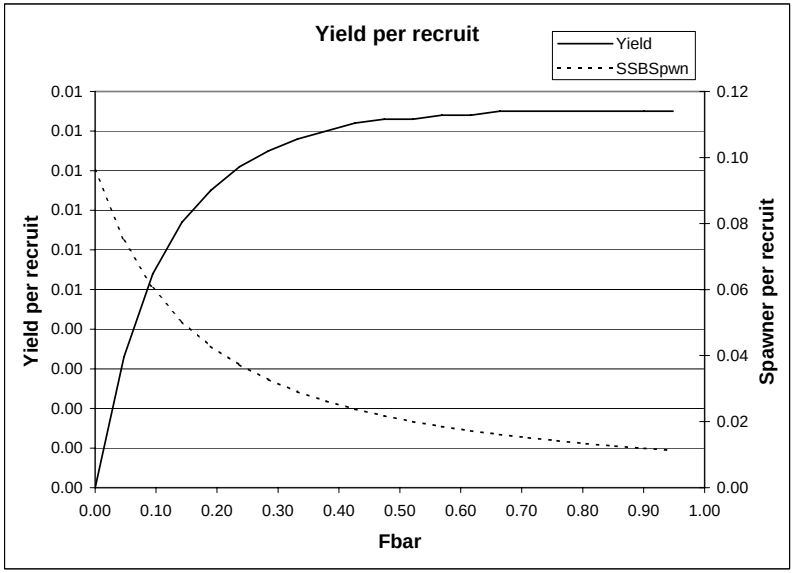
Herring Gulf of Riga,2004,ANON,COMBSEX,PLUSGROUP

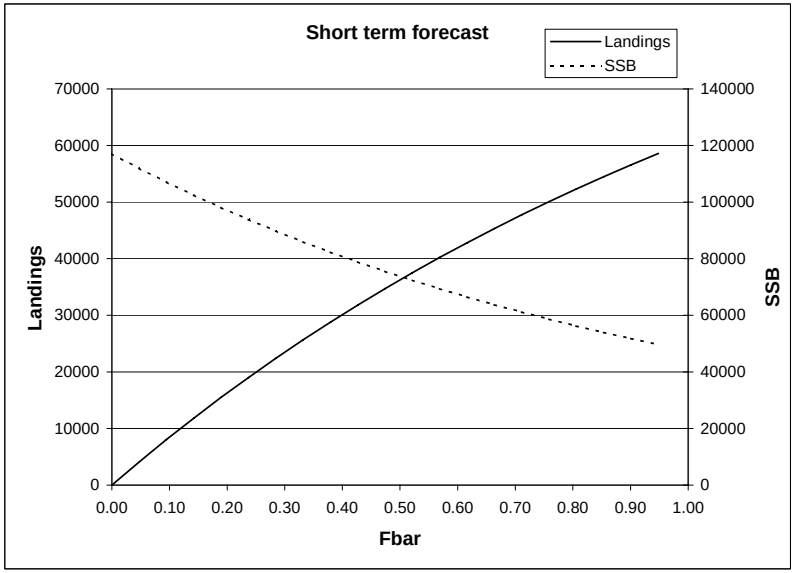
Steady state selection averaged over 3 years.
FBar averaged from age 3 to 7

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

Data source:
C:\Documents and Settings\Tiit\My Documents\WGBFAS\Wg2007\Riga\Standardplots\pa07.

Figure 6.3.12. Gulf of Riga herring. PA plots and reference points.





MFYPR version 2a
Run: YPR_Riga06_01
Time and date: 15:56 21.04.2007

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.4741
FMax	1.7815	0.8447
F0.1	0.5327	0.2526
F35%SPR	0.5753	0.2728

Weights in kilograms

MFDP version 1a
Run: Her_Riga06_01
Herring Gulf of Riga,2004,ANON,COMBSEX,PLUSGROUP
Time and date: 15:25 21.04.2007
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 6.3.13. Gulf of Riga herring. Yield per Recruit and short term perspectives.

6.4 Herring in Subdivision 30 (update assessment)

6.4.1 The Fishery

The three main fleets operating in Baltic herring fisheries in the Bothnian Sea are:

- Pelagic trawling (single and pair trawling)
- Demersal trawling
- Trapnet fisheries (spawning fishery)

In the Finnish trawl fishery, the same trawls are often used in the pelagic and demersal trawling, and the trawl is classified as pelagic or demersal depending only on its vertical position in the water column. In 2006, 61 % of the Finnish landings came from pelagic trawls, 35 % from demersal trawls, 4 % with trapnets, and 0.2 % with gillnets. The Swedish part of the fishery is much smaller and of a different composition. In 2006, 56% of the Swedish landings came from demersal trawls, 1 % from pelagic trawls, and 43% from gill-nets.

6.4.1.1 Catch trends

The total landings in SD30 (Bothnian Sea) in 2006 increased for the third year in a row to a record high catch of 68,635 tonnes (Figure 6.4.1), of which 98% (66,962 tonnes) was Finnish landings and 2% (1,403 tonnes) was Swedish landings (Table 6.4.1). In total landings increased by 18% compared to the landings in 2005. The Finnish landings increased by 21% (+11,540 tonnes) whereas the Swedish landings, in contrast, decreased by 44% (-1,117 tonnes) compared to 2005 (Table 6.4.1).

6.4.1.2 Unallocated landings

No unallocated landings were reported in 2006. In the year 2006, the non-response fraction of fishing activities in Finnish fisheries was 0 % in the group with an EU fishing logbook and about 10 % among those completing coastal fishery forms (= fisheries with trap-nets, coastal gill-nets and vessels less than 10 meters). Of the total catch, almost 90% was reported with the EU fishing logbook. In final catch estimates, the landings data are corrected accordingly.

6.4.1.3 Discards

Discarding rate has been regularly negligible (only few tonnes annually) and discards were not taken into account in assessments.

6.4.1.4 Effort and CPUE data

There has been an increase in trawl gear size and changes in gear properties since the early 1980s in the Finnish Baltic herring fishery. Reported fishing effort data (trawling hours) therefore needs to be corrected for gear development in order to not underestimate fishing mortality. Thus, we have multiplied the pelagic and demersal trawl fishing effort data in 1980-2005 with a correction factor to quantify the relative change in fishing power of the trawl fleets. The correction coefficient is derived using yearly data of trawls sold, their size and an estimated annual abolition rate (Rahikainen and Kuikka 2002). As the same gear is used for both demersal trawling and pelagic trawling, the same coefficient has been used for both fleets. In assessments, correction factors of CPUE data have been used since the 1997 assessment.

The total fishing effort for stock assessment is reported as trawling hours (multiplied by the correction factor for fishing power) and as number of trap nets set for the trawl and trap net fisheries, respectively. Throughout the 1980s the number of trap nets decreased dramatically,

in 1991 the number of trap nets was only a fifth of the number in 1980, and it has since then remained more or less stable (Figure 6.4.2). In 2006 the number of trap nets decreased by 15% (from 233 in 2005 to 197). The trawl fishing effort quadrupled during the 1990s but has thereafter halved (Figure 6.4.2). In 2006 however, the number of trawling hours increased in the pelagic fleet by 20% (from 16,965 hours in 2005 to 20,281).

Total catch number per unit effort has increased in all fleets (Figure 6.4.3). Catch number per unit effort in trap nets has increased by on average ten percent annually since the late 1990s. Trawl catch number per unit effort increased drastically the last two years when the strong 2002 year class was recruited to the trawl fisheries. In pelagic trawl fishery the CPUE decreased slightly in 2006 compared to 2005.

6.4.2 Biological composition of the catch

6.4.2.1 Age composition

The data of Finnish catches at age were used for years 1973–2006 and these have been used to the Swedish landings as well except in 1987, 1989–1991, 1993 and 2000–2006 when the Swedish landings were allocated according to Swedish catch sampling. In 2006 there was no sampling of the Swedish pelagic trawl fishery, and pelagic trawl catches at age were therefore derived using Finnish samples.

The Finnish cut otolith samples from the third quarter in 2006 were destroyed in a fire, and these have been replaced by aging corresponding whole otoliths. However, catches in the third quarter constitute only 15% of the total Finnish catches and the agreement between the two aging methods has improved in the recent years. Therefore the effect of the method change in the 3rd quarter is not considered to be significant for the assessment.

From the beginning of 1998, the Finnish sampling procedure was changed from random sampling into length based stratified random sampling, whereas Sweden apply random sampling within strata based on gear and quarter. The catch in number by gear type for herring in SD 30 for 2006 (Swedish and Finnish data quarterly combined) are given in Table 6.4.2. The catch-at-age time series for Finnish trap nets and trawl fleets are provided in Table 6.4.3. The input for catch in numbers is shown in Table 6.4.4.

The most common age class in the catches is four-year-olds, both in numbers and in biomass (Figure 6.4.4a), on average making up 39% of the catch in numbers and 33% of the catch biomass. There are many age classes in the catches, however, and ages two to seven each constitute between 5-15% each of the catch in biomass (Figure 6.4.4b). One-year-olds on average only corresponds to 2% of the catch in biomass, but can reach above 7% when there are strong year classes (Figure 6.4.4b).

6.4.2.2 Mean weight at age and condition

Mean weight at age in the catches (Table 6.4.5) was also used as the mean weight in the stock, due to the lack of survey data. The average weight at age has decreased for all ages since about 1990 (Figure 6.4.5), concurrent with the increase in herring stock biomass, suggesting that body growth is density-dependent. Indeed, the slope of the growth curve (mass increase) of Bothnian Sea herring is negatively correlated to stock size in numbers (Figure 6.4.6), indicating density-dependent body growth, as shown for herring stocks in the Baltic Proper (Cardinale et al. 2002, Cardinale & Arrhenius 2000, Casini et al. 2006). The average condition (Fulton's k) in the stock has also declined, since the mid 1990's, decreasing by about 15% ($p<0.01$; Figure 6.4.7). The changes in growth and condition could also be related to changes in the quality rather than the amount of food, since biomass of *Pseudocalanus*, the preferred food by herring, has decreased substantially during the same period whereas other zooplankton species have increased (ICES 2007).

6.4.2.3 Maturity at age

Constant maturity ogives have been used for period 1973 – 1982. Since 1983 the proportions mature at age have been annually updated, and since 1998 they have been determined from specimens that are sub-sampled for age determinations within the Finnish sampling programme. Before spawning time, the number of sampled specimens from length classes that are not expected to be fully mature, is increased in order to assure adequate age representation for age groups 2–5. Updated maturity ogives for 1973–2006 are shown in Table 6.4.6. There is high variability in maturity ogives among years which causes noise in assessments.

6.4.2.4 Natural mortality

Natural mortality rate 0.20 was used for all the age groups in all years in the final stock assessment run. The proportion of natural mortality before spawning was assumed to be 0.33 and fishing mortality before spawning 0.15 for all the years and ages.

The rapid increase in grey seal population in the Bothnian Sea (section 1.9.3.5.5) could potentially result in significant predation on herring. We therefore estimated total herring consumption by seals from minimum and maximum estimates of fish consumption rate per seal (5-7 kg fish per seal and day, Mohn & Bowen, 1996), proportion of herring in the diet (55-80%; Lundström et al. 2007), and seal population size (6000-8000 inds; Sven-Gunnar Lunneryd, Swedish Board of Fisheries, pers. comm.) in the Bothnian Sea. According to these estimates, grey seals consume 6000-16000 tonnes herring annually. Since this corresponds to 2-5% of the spawning stock biomass, or 1-4 % of the total stock biomass, and 9-23 % of the annual landings, we found that there is no need to account for seal predation in this year's assessment. However, given the very high rate (7%) of increase of the grey seal population (section 1.9.3.5.5) this conclusion should be re-evaluated in future assessments. In particular because grey seals selectively feeds on larger herring (20-30 cm; Lundström et al. 2007), which thus could influence estimates of e.g. spawning stock biomass.

6.4.3 Quality of catch and biological data

Due to the lack of survey data, tuning in the catch at age analyses are made using commercial catch per unit effort indices, which is not independent of the catch data used to derive catch numbers at age. Because of these problems, the WGBFAS strongly recommended in 2006 (ICES CM 2006/ACFM:24) that an acoustic survey is initiated in sub-division 30. A pilot acoustic survey will be initiated by Sweden in SD 30 in 2007.

As for the biological data on catch composition, sampling levels for catch at age data, mean weight at age in the catch in relation to landings are shown in Table 6.4.2 (see section 6.4.2). In total, 60 samples were taken in 2006, of which 51 samples from four year quarters of Finnish fisheries and 9 from Swedish fisheries.

The total catch numbers at age data show high consistency (Figure 6.4.8), as does most of the data on catch numbers at age in the tuning fleets (Figures 6.4.9-10). The exception is a low correspondence between numbers of four- versus five-year-olds in the trap net catches. This is probably due to an effect of a typical age reading error related to exceptionally abundant year classes.

As long as survey data on maturity is not available, maturity ogives should be estimated from catch samples of all the fleets, i.e. also from Swedish samples (which routinely involves estimation of individual maturation status), to improve the accuracy of the maturation estimates. Since the Swedish catches amount to only 2% of the total catches, however, the current procedure of estimating maturity ogives does not affect the quality of the assessment in any significant way.

6.4.4 Catch at age analysis

6.4.4.1 Final assessment run (XSA)

This year's assessment is an update from the last year with the following settings:

- input data based on age determination from whole otoliths for 1973-2001 and from cut otoliths for 2002-2006,
- two tuning fleets: catch per unit effort in commercial trapnets in 1994-2006 covering age groups 2 to 9+, and catch per unit effort in commercial pelagic trawls in 1999-2006, covering age groups 2 to 9+, without prior weight to the fleets.
- tricubic time weighting over 20 years
- catchability dependent on year class strength at age one
- catchability independent of age for ages seven and older
- the S.E. of the fishing mortality shrinkage mean for the last five years or three oldest ages was set to 1.0

The preliminary run did not converge until after 379 iterations resulting in an estimate of the spawning stock biomass at least twice as high as the previous year's level. This large number of iterations indicates that XSA had problems in finding the solution. This could be due to the fact that fishing mortality is lower than the natural mortality. Stopping the XSA-run after 30 iterations gave a solution that is in line with the previous year's results and therefore 30 iterations was decided to be the final setting. The diagnostics, detailed below, of the final run revealed that this run behaved similarly as previous year's run.

The diagnostics of this run is presented in Table 6.4.7, and the residuals are shown in Figure 6.4.11. The residuals of catchabilities in the pelagic trawl series are small and do not show any trends (Figure 6.4.11). The trapnet tuning series is noisier than the pelagic trawl series (average S.E. of log catchabilities range 0.2-0.6 and 0.1-0.4, respectively). This noise comes primarily from the cpue of two-year-olds (average S.E. 0.6 for age group 2, for all other ages it is 0.2-0.4), since these have not been fully recruited to the trapnet fishery (a spawning fishery) throughout the whole assessment period. The diagnostics show that the final estimate of two-year-olds is mainly determined by the pelagic tuning series, and the influence of the trapnet series is less than 20% (Table 6.4.7).

The retrospective analyses (Figure 6.4.12) show the same retrospective bias as found in the analyses made in previous years. Spawning stock biomass is consistently underestimated and fishing mortality, correspondingly, overestimated. Although that leads to conservative estimates, it points to a problem with the assessment. We have been unable to find a satisfactory explanation to the retrospective bias, although the consistent underestimation of cpue in the commercial tuning series combined with the lack of a scientific survey are candidate explanations.

Final estimates of spawning stock numbers and fishing mortalities at age, and the stock summary table are presented in Tables 6.4.8-11, and fish stock summary plots are presented in Figures 6.4.13-14.

6.4.5 Recruitment estimates

In the end of the 1980s there was a drastic shift in recruitment, from a period with low recruitment to a period with an average two and a half times higher than before (Figure 6.4.15). The geometric mean recruitment in 1989-2004 is more than twice as high as in 1973-1988 as estimated from the XSA. The two different recruitment regimes correspond to the regime shift in the Bothnian Sea ecosystem as a whole identified by WGIAB (ICES CM 2007/ACFM:in prep).

The estimated 2002 year class is more than twice as high as any other year class previously observed. This was an exceptionally abundant year class in the Baltic Sea area also for other fish species. Previously strong year classes have also been produced in warm years, such as in 1988-1989, 1997, and 2001 (Figure 6.4.15).

Since there are no fishery-independent data, we have estimated the number of recruitments for projections as the geometric mean of recruits (1-yr-olds) during the current high recruitment regime, that is from the 1988 year class to 2004 year class (i.e., from catch year 1989-2005; Figure 6.4.15), leaving out the exceptionally abundant year class 2002.

6.4.6 Historical stock trends

The herring spawning stock biomass at the beginning of the assessment period (1973) was 140 thousand tonnes. It remained rather stable until the mid 1980s when it started increasing rapidly. It peaked in 1994 at 420 thousand tonnes, decreased until 1999, but has thereafter increased again. However, the estimate of the spawning stock biomass decreased from 370 thousand tonnes in 2005 to 320 thousand tonnes in 2006. During the current period of high recruitment, the spawning stock biomass is more than two times higher than it was in the low recruitment period before the late 1980s.

6.4.7 Short-term forecast and management options

For the short-term prediction, the mean weights at age were assumed to be equal to the averages of 2004-2006. A natural mortality rate value of 0.20 was used and since there is no strong trend in fishing mortality (Table 6.4.10), we used the average of fishing mortality rates in 2004–2006. A geometric mean of the number of recruits (age 1) in 1989-2005 was used as an approximation for recruitment, leaving out the exceptionally large year class in 2002. As in the XSA, proportion of total annual natural mortality before spawning was assumed to be 33% and proportion of F before spawning 15% of the annual fishing mortality. The input data and summary of the short-term forecast with management options are presented in the Tables 6.4.12 and 6.4.13, respectively.

At status quo fishing mortality (F=0.16), the herring catches in the Bothnian Sea would decrease by about 18% in 2007 and additionally 5% in 2008, mostly because of the decreasing contribution of the year class 2002 in the catches. In 2007 and 2008 predicted landings are 56,000 tonnes and 53,000 tonnes, respectively. Spawning stock biomass is also predicted to decrease slightly in 2007 and 2008 compared to 2006. The predicted SSBs for the years 2008 and 2009 are 285,000 t and 279,000 t (at spawning time), respectively. The proportions of year classes in short-term yields and spawning-stock biomasses are presented in Figure 6.4.16. The summary table and the Y/R reference values are presented in Table 6.4.14. Long and short term yields and SSB are shown in Figure 6.4.17.

6.4.8 Medium-term projections

Medium-term projections were not calculated.

6.4.9 Reference points

Biological reference points were estimated using the PA software (CEFAS, Lowestoft). The estimated reference fishing mortalities are presented in Figure 6.4.18. The equilibrium spawning stock biomass and yield for different fishing mortalities are presented in Figure 6.4.19, together with the trajectories of SSB, recruitment, and yields. As in common ICES practice, the stock-recruitment relationship was estimated based on the XSA estimates of SSB and recruits from the whole time series, that is, 1973-2005. Thus, the fitted stock-recruitment relationship underestimates the current productivity of the stock found since 1989, in the high recruitment period (Figure 6.4.19). The reference points are strongly dependent on this assumption, and the

estimates become very conservative in relation to the current stock production. Estimated $\mathbf{F}_{med}$ (which is used by the ACFM as a basis for $\mathbf{F}_{pa}$) is 0.07, and $\mathbf{F}_{loss}$ (which is used by the ACFM as a basis for $\mathbf{F}_{lim}$) is 0.13. As explained above, these estimates are highly conservative given current stock production, and both end up being below the current estimate of fishing mortality in 2006 (0.17). This shows the need for a revision of the procedures for estimating biological reference points, to include methods that can account for drastic changes in stock productivity. This is particularly important in systems known to have undergone ecosystem regime shifts, as in the Baltic Sea (see section 1.9.3.5 for more details) (ICES CM 2007/ACFM: Report from WGIAB, in prep; ICES CM 2007/ACFM: Report from WKREF, in prep).

6.4.10 Comparison with previous assessment

The assessment is an update assessment. The present estimate of the 2005 spawning stock biomass is higher than in last year's assessment, whereas the estimate for fishing mortality in 2005 is lower in the current assessment. The data, assumptions and estimates from the final 2006 year's benchmark assessment and the update assessment in 2007 are shown in the text table below.

CATEGORY	PARAMETER	ASSESSMENT 2006	ASSESSMENT 2007	DIFF.(+/-) %
DATA INPUT	Age composition	From whole (1973-2001) and cut otoliths (2002-2005)	From whole (1973-2001) and cut otoliths (2002-2006)	No
	Maturity ogives	1973-2001 age determination from whole otoliths; 2002-05 from cut otoliths	1973-2001 age determination from whole otoliths; 2002-06 from cut otoliths	No
	Natural mortality	0.2 for all ages	0.2 for all ages	No
XSA INPUT	Catchability independent on age	Age >=7	Age >=7	No
	SE of the F shrinkage mean	1.0 (5 yrs, 3 oldest ages)	1.0 (5 yrs, 3 oldest ages)	No
	Time weighting	Tricubic, 20 yrs	Tricubic, 20 yrs	No
	Tuning data	Commercial trapnet cpue (1994-2005), pelagic trawl cpue (1999-2005)	Commercial trapnet cpue (1994-2006), pelagic trawl cpue (1999-2006)	No
XSA RESULTS	SSB in 2005 (in '000 t)	339	367	+8.3 %
	TSB in 2005 (in '000 t)	510	470	-7.8 %
	F(3-7) in 2005	0.16	0.15	-6.3 %
	Recruitment (age 1) in 2004	3624 millions	2195 millions	-39,4 %

6.4.11 Quality of the assessment

In the absence of survey indices, the assessment becomes highly dependent on commercial catch per unit data, which are not independent of the catch data. Reducing the number of the

commercial tuning fleets and the length of these time series since 2006 year's benchmark assessment has resulted in less uncertain estimates, but the retrospective bias in assessment remains. The lack of a satisfactory explanation for the bias is a problem, but at least the bias is conservative, in the sense that the stock is consistently underestimated and the fishing mortality is overestimated.

The combination of data from two different age determination methods within the same time series is not preferable. Given the few years (six) of determination from cut otoliths, it does not affect the estimates of the stock or fishing mortalities in the most recent years to any larger extent. With a longer time series of age determined from cut otoliths the estimated historical stock sizes may change. To obtain such a longer time series more rapidly, Finnish samples determined from cut otoliths will include both historical and upcoming data.

When a time series of the initiated acoustic survey data of at least five years, and when a longer time series with ages determined from cut otoliths have been obtained, the WGBFAS suggests that the assessment of the herring stock in sub-division 30 is re-evaluated.

6.4.12 Management considerations

This stock is the dominating part of the resource basis for the herring TAC set for Management Unit III including Subdivisions 30 and 31. The abundant year class 2002 is decreasing in the catches which leads to decreasing landings in the short term.

Table 6.4.1 Herring in SD 30. Catches in Subdivision 30 (tonnes).

Year	Finland	Sweden	Total
1971	24284	5100	29384
1972	24027	5700	29727
1973	20027	6944	26971
1974	17597	6321	23918
1975	13567	6000	19567
1976	19315	4455	23770
1977	22694	3610	26304
1978	22215	2890	25105
1979	17459	1590	19049
1980	18758	1392	20150
1981	12410	1290	13700
1982	16117	1730	17847
1983	16104	2397	18501
1984	23228	2401	25629
1985	24235	1885	26120
1986	23988	2501	26489
1987	22615	1905	24520
1988	24478	3172	27650
1989	25453	3205	28658
1990	28815	2467	31282
1991	23219	3000	26219
1992	35610	3700	39310
1993	36600	3579	40179
1994	53860	2520	56380
1995	58806	2280	61086
1996	54372	1737	56109
1997	63532	1995	65527
1998	54115	2777	56892
1999	60483	1862	62345
2000	54886	1374	56261
2001	52987	1997	54984
2002	46315	3903	50218
2003	45932	3707	49638
2004	50236	5214	55450
2005	55422	2 520	57 942
2006	66962*	1403	68365

* preliminary.

Table 6.4.2 Herring catch-at-age (millions) by country and fishery in SD 30 year 2006

Q	AGE	Finnish Fisheries					Swedish fisheries			TOTAL CN
		TRAPNET	BOTTOM TRAWL	PELAGIC TRAWL	GILLNET	WINTER SEINE	BOTTOM TRAWL	PELAGIC TRAWL	GILLNET	
1	0									
	1		37.2	31.4	0.0002					69
	2		64.4	54.3	0.0003					119
	3		27.5	23.2	0.0001		0.1			51
	4		203.4	171.6	0.0011		0.4			375
	5		65.6	55.3	0.0003		0.7		0.0001	122
	6		14.5	12.2	0.0001		0.4		0.0001	27
	7		14.7	12.4	0.0001		1.0		0.0001	28
	8		16.4	13.8	0.0001		0.7		0.0001	31
	9		47.7	40.2	0.0002		0.4		0.0002	88
	TOTAL		400.7	643.4	0.008		3.7		0.0006	1048
	CATCH (t)		***11286.6***	***9518.9***	***0.1***		***165.0***		***0.034***	***20971***
2	0									0
	1	5.9	13.9	32.2	0.165					52
	2	12.0	28.3	65.8	0.336			0.1		107
	3	5.2	12.3	28.7	0.147			0.0	0.093	47
	4	46.1	108.5	252.1	1.290		0.1	0.2	0.093	408
	5	15.8	37.2	86.5	0.442		0.2	0.1	0.748	141
	6	8.4	19.8	46.1	0.236		0.3	0.0	0.841	76
	7	3.6	8.5	19.8	0.101		0.6	0.0	2.057	35
	8	6.1	14.2	33.1	0.169		1.0	0.0	2.057	57
	9	11.8	27.8	64.6	0.330		1.2	0.1	3.179	109
	TOTAL	139.1	213.8	447.5	6.191		3.3	0.6	9.069	820
	CATCH (t)	***2842.2***	***6684.6***	***15530.2***	***79.4***		***192.6***	***14.0***	***499.9***	***25843***
3	0	0.01	0.03	0.5	0.002					1
	1	0.11	0.32	6.1	0.028					7
	2	0.19	0.56	10.7	0.049		0.1	0.002		12
	3	0.17	0.51	9.6	0.044		0.1	0.002		10
	4	1.76	5.14	97.3	0.448		0.7	0.015	0.249	106
	5	0.84	2.43	46.1	0.212		0.6	0.007	0.321	50
	6	0.40	1.17	22.1	0.102		0.4	0.003	0.352	25
	7	0.18	0.53	10.0	0.046		0.5	0.002	0.498	12
	8	0.38	1.10	20.9	0.096		0.3	0.003	0.342	23
	9	1.03	3.01	56.9	0.262		0.1	0.009	0.238	62
	TOTAL	11.2	10.4	200.3	1.400		2.8	0.044	2.001	228
	CATCH (t)	***167.7***	***488.6***	***9249.5***	***42.6***		***109.4***	***1.5***	***87.9***	***10147***
4	0	0.0000	6.2	8.5	0.007	0.0002	0.0		0.000	15
	1	0.0001	12.5	17.2	0.014	0.0004	0.0		0.000	30
	2	0.0001	13.3	18.2	0.015	0.0005	0.0		0.000	32
	3	0.0000	5.2	7.2	0.006	0.0002	0.1		0.000	13
	4	0.0003	56.5	77.5	0.064	0.0020	0.9		0.048	135
	5	0.0001	22.6	31.0	0.026	0.0008	1.9		0.062	56
	6	0.0001	10.8	14.9	0.012	0.0004	1.0		0.068	27
	7	0.0000	3.6	5.0	0.004	0.0001	1.5		0.095	10
	8	0.0000	6.4	8.8	0.007	0.0002	0.7		0.066	16
	9	0.0001	24.1	33.0	0.027	0.0008	1.0		0.046	58
	TOTAL		154.9	166.6	0.105	0.0056	7.3		0.383	329
	CATCH (t)	***0.02***	***4667.6***	***6398.9***	***5.3***	***0.16***	***315.3***		***16.8***	***11404***
Grand Total	0	0.0	6.2	9.1	0.010	0.0002	0.0	0.0	0.000	15
	1	6.0	63.9	86.9	0.207	0.0004	0.0	0.0	0.000	157
	2	12.2	106.6	149.0	0.401	0.0005	0.1	0.1	0.000	268
	3	5.4	45.6	68.6	0.197	0.0002	0.4	0.0	0.093	120
	4	47.9	373.6	598.5	1.803	0.0020	2.1	0.2	0.390	1024
	5	16.7	127.8	218.8	0.680	0.0008	3.3	0.1	1.131	369
	6	8.8	46.3	95.2	0.350	0.0004	2.2	0.0	1.261	154
	7	3.8	27.3	47.1	0.152	0.0001	3.5	0.0	2.650	85
	8	6.4	38.2	76.6	0.273	0.0002	2.7	0.0	2.465	127
	9	12.8	102.5	194.7	0.620	0.0008	2.9	0.1	3.463	317
	TOTAL	120.1	938.1	1544.6	4.692	0.0	17.1	0.6	11.454	2637
	CATCH (t)	***3009.9***	***23127.4***	***40697.5***	***127.4***	***0.16***	***782.3***	***15.5***	***604.7***	***68365***

Table 6.4.3 Herring in SD 30. Time series of catch at age (millions) in finnish fleets

Finnish trapnet-fleet	2	3	4	5	6	7	8	9+
1980	11.9	26.2	29.6	102.9	49	50.5	24.9	32.6
1981	27.5	19.2	30.1	25.9	53.7	21.6	14.6	22.7
1982	33.6	77.9	22.5	27.2	31	45.4	16	24.2
1983	23.4	30.7	53.8	10.6	10.9	16.5	26	19.9
1984	14.8	66.7	23.5	34	7.4	8.2	13.9	31.4
1985	26.6	44.2	60	12.1	23.8	4.1	5.9	30.3
1986	30	80.6	39.7	32.6	8.2	9.4	2	9
1987	7.4	48.6	79.4	35.1	26.7	11.8	4.4	11.6
1988	17.8	11.3	39.7	57.6	27.2	18	6	13.3
1989	4.2	36.5	10	25.7	25.2	12.4	6.6	7.9
1990	39.4	15.6	38.3	8.5	20.8	25.4	8.8	11.1
1991	18.1	50.6	9.2	14.9	5.6	9.6	8.4	8.6
1992	13.1	49.5	36.4	12.2	11.7	7.4	7.7	6.6
1993	21.3	30.5	48	37.7	10	10.4	7.4	4.8
1994	22.7	28.7	21.7	40.1	32.4	6.6	9.8	7.3
1995	7.5	29.4	19.6	17.9	22.8	14.1	2.1	8.1
1996	7.1	21.4	29.9	18.4	19.9	21.8	10.3	7.5
1997	19	22.9	13.4	16	11.3	9.6	7.9	6.6
1998	19.9	23.7	23.3	19.7	13.7	12.4	4.5	22.6
1999	30.3	11.3	14.2	8.7	5.4	7.2	2.5	5.8
2000	9	15.7	14.2	7.6	9	4.6	3.6	13.5
2001	27.4	13.5	26.3	8.3	5.2	8.1	3.9	15.7
2002	15.4	19.2	7.4	11.2	5	2.8	6.2	16.3
2003	43.4	29.5	21	15.8	15.9	6.5	4.7	24.5
2004	85.8	45.2	26.2	18.7	8	9.5	5.1	17.5
2005	17.7	65.8	22	13.2	6.3	5.2	4.3	9.5
2006	12.2	5.4	47.9	16.7	8.8	3.8	6.4	12.8

Finnish bottom trawl fleet	2	3	4	5	6	7	8	9+
1980	28.9	15	10.6	28.7	7.3	8.4	3.2	0.6
1981	5.8	4.5	3.8	5	13.8	5.1	3.9	4.8
1982	15	28.6	4.4	4.5	6.3	8.5	2.6	4.6
1983	24.7	9.9	15.5	1	1	3.5	16.1	7
1984	7.7	12.1	6.3	5.1	2.8	3.5	2.7	7.3
1985	3.8	5.9	3.1	2.7	1.5	1.1	1	3.5
1986	14	16.7	14.7	9.1	3.3	2.8	0.5	4.6
1987	7.3	19.4	18.5	7.1	3.1	2.7	1.1	2.3
1988	24.5	7.4	20.5	13.9	6.7	2.7	0.9	2.4
1989	16.4	13.1	23.1	5	17.9	12.9	4.8	5.3
1990	75.5	11.3	26.2	6.3	18.6	17.8	6.8	6
1991	69.4	68.1	12.4	26.5	15.5	23.9	11.8	13.9
1992	64.3	142.3	86.6	19.7	19.4	24.1	15.8	13.2
1993	78.5	55.1	97.5	76.6	14.9	19.5	12.8	17.5
1994	121.2	96.4	59.3	88.9	81.6	17.4	24.4	23.9
1995	55.2	110.5	78.5	56.7	60	40.8	7.6	23.9
1996	135.8	90.7	115.4	82.1	56.2	68.4	50.9	30.9
1997	105	110.5	75.8	77.2	62.3	48.7	37.6	33.8
1998	74.7	105.8	127.4	84.9	68.9	60.9	24.3	74.8
1999	260.1	101	129.9	108.9	62.3	79.9	33.4	64.4
2000	76.6	176.5	111.3	70.9	62.5	46.3	24.3	109.6
2001	130.1	64.5	156.4	56.5	48.2	46.1	34.9	100.9
2002	124.3	150.6	72.4	103	41.2	24.4	38.6	122.8
2003	133.6	91.9	68.6	48.4	61.7	19.1	20.5	101.3
2004	417.9	170.2	78.2	62.8	53.6	52.6	24.7	95.6
2005	64.4	368.2	88.3	51.9	43.1	22.6	28.8	68.3
2006	106.6	45.6	373.6	127.8	46.3	27.3	38.2	102.5

Finnish pelagic trawl fleet	2	3	4	5	6	7	8	9+
1980	4.4	6.8	6.3	18.7	11.4	6.6	6.3	6.6
1981	5.4	5.4	3	7.1	5.4	4.6	2.6	3.4
1982	28.7	22.6	6.5	6.4	11.3	17.6	3.7	8.8
1983	106.3	33.1	21.8	1.4	4.4	8.2	7.3	1.8
1984	101.3	84.3	54.2	27.5	5.3	5	12.7	34.4
1985	227	127.8	54.1	19	26.4	6.7	4.4	29.3
1986	299.6	172.3	75.7	36.8	17.6	11.6	1.8	19.7
1987	24.3	114.4	93	43.1	23.1	13.2	5.1	15.9
1988	117.7	31.3	94.3	79.8	36.2	17.8	8.2	13.6
1989	44.9	100.3	23.4	64.7	52.2	25	10.9	15.9
1990	250.9	25.9	39.8	14.5	39.4	39.8	20.1	20.2
1991	118.2	131.4	23.3	33	19.7	23.3	17.7	19.1
1992	122.1	188.5	116.2	23.7	24.2	20.8	18.8	26.1
1993	194.7	78.7	110.1	78.4	14.1	16.9	8.8	14.5
1994	201	182.8	114.6	169.9	139.6	19.1	29.1	31.3
1995	154.5	312.9	191.2	133.1	170.6	123.1	27.2	71.6
1996	256.5	116.6	157.4	133.6	74.7	94.7	51.8	21
1997	224.2	272	162.1	188.8	137.2	113.1	93.3	78.8
1998	109.3	124.9	129.2	104.2	79	71.7	31.3	123.9
1999	406.1	187.7	195.5	136.1	94.3	138.1	45.5	142.5
2000	114.8	219	178.9	102.3	116.6	60.1	45.7	183.3
2001	229.5	115.1	247.3	86	65.2	73.4	47	160.9
2002	141.7	172.9	83.8	119.2	52.2	34.2	52.8	139.1
2003	185.5	127.3	91.9	68.3	74.2	27.6	24.2	127.9
2004	371.6	159.1	82.7	62.5	53.3	50.9	25.6	97.5
2005	116.7	668.5	171.5	94.9	85.8	48	54.3	145.2
2006	149	68.6	598.5	218.8	95.2	47.1	76.6	194.7

Table 6.4.4 Herring in SD 30. Catch in Numbers (thousands).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1973	15070	45210	232100	140670	181860	78370	25120	7030	4020
1974	6680	71540	115410	174550	76310	59140	57230	23850	32430
1975	33680	111320	124410	61740	69220	38350	33680	29930	36480
1976	87880	98750	180710	126400	57270	80970	33570	35550	58260
1977	18650	173700	130520	192340	99120	58880	84400	48090	59860
1978	27850	69120	235210	128950	136180	69120	45390	53650	54680
1979	3980	25890	60750	220100	62740	81660	51790	17930	48800
1980	63030	55020	56020	53020	174070	77030	74030	39020	44020
1981	13970	48900	33930	42910	44910	86820	36920	23950	34930
1982	23110	92440	150720	38180	44210	57280	86410	26130	45220
1983	94020	185040	90020	109020	16000	20000	34010	60010	35010
1984	101710	146580	189460	98720	77780	17950	18950	33900	84760
1985	87350	282140	195790	129520	39160	57230	13050	13050	70280
1986	13900	388080	302720	146890	88340	32750	26800	4960	37720
1987	38970	42960	203830	212820	94920	58950	30970	11990	32970
1988	9980	184690	56910	177700	174710	81860	44930	17970	33940
1989	88180	69140	156320	59120	116240	116240	56110	25050	34070
1990	182990	363080	54900	104980	34670	85710	93420	38520	40450
1991	42090	190770	242710	43890	73440	50150	62690	37620	41200
1992	73340	210970	412890	268230	61280	70320	63290	45210	49230
1993	203310	333510	186290	291450	220340	44070	53080	33050	42070
1994	77500	366360	327110	208340	318050	270750	46300	68440	66430
1995	62360	230330	478760	305760	219260	267540	188080	39230	108630
1996	86390	412090	236330	311800	241300	154910	190660	116180	60570
1997	114510	366900	426700	264940	296890	222180	180440	146040	138390
1998	286340	216730	270210	297000	221900	171710	154060	63820	235510
1999	146210	678470	282410	326560	244240	153980	211850	77980	195730
2000	239010	201460	425100	310440	187870	193500	115700	76220	310190
2001	208120	392140	196730	440550	159320	129760	135840	90320	283240
2002	275862	258589	312651	149840	210191	95402	53337	85338	278442
2003	241202	369505	256915	195934	161628	180499	62910	52476	257680
2004	87669	921471	407703	210834	166427	134821	131383	63028	222886
2005	148723	206674	1134904	293866	167029	140499	81473	92785	235926
2006	157060	268432	120334	1024498	368522	154222	84624	126683	317097

Table 6.4.5. Herring in SD 30. Weight in Catch and in the Stock (kg).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1973	0.011	0.019	0.025	0.031	0.035	0.043	0.042	0.047	0.055
1974	0.011	0.019	0.025	0.031	0.035	0.043	0.042	0.047	0.055
1975	0.011	0.020	0.025	0.030	0.034	0.039	0.042	0.045	0.056
1976	0.011	0.019	0.025	0.029	0.033	0.037	0.041	0.045	0.054
1977	0.015	0.019	0.025	0.028	0.032	0.037	0.041	0.044	0.052
1978	0.010	0.019	0.024	0.029	0.032	0.035	0.042	0.045	0.055
1979	0.012	0.018	0.025	0.030	0.033	0.035	0.040	0.046	0.053
1980	0.005	0.015	0.023	0.032	0.034	0.037	0.040	0.045	0.058
1981	0.008	0.015	0.025	0.033	0.040	0.042	0.045	0.049	0.066
1982	0.003	0.013	0.023	0.033	0.038	0.043	0.042	0.051	0.061
1983	0.004	0.015	0.027	0.035	0.044	0.049	0.049	0.055	0.070
1984	0.007	0.017	0.030	0.039	0.045	0.055	0.058	0.061	0.062
1985	0.006	0.015	0.028	0.039	0.046	0.048	0.063	0.062	0.066
1986	0.006	0.015	0.024	0.032	0.039	0.044	0.046	0.052	0.059
1987	0.008	0.019	0.027	0.033	0.039	0.046	0.050	0.059	0.067
1988	0.012	0.017	0.029	0.034	0.040	0.046	0.053	0.061	0.073
1989	0.010	0.021	0.032	0.041	0.047	0.053	0.058	0.062	0.072
1990	0.008	0.020	0.032	0.039	0.047	0.051	0.057	0.061	0.074
1991	0.009	0.020	0.027	0.037	0.042	0.049	0.054	0.055	0.062
1992	0.012	0.020	0.027	0.031	0.041	0.047	0.052	0.055	0.064
1993	0.013	0.020	0.027	0.031	0.034	0.047	0.050	0.056	0.065
1994	0.009	0.020	0.027	0.032	0.035	0.040	0.052	0.058	0.068
1995	0.007	0.018	0.026	0.029	0.034	0.038	0.044	0.053	0.066
1996	0.008	0.018	0.025	0.031	0.035	0.039	0.043	0.050	0.065
1997	0.009	0.015	0.023	0.029	0.034	0.037	0.043	0.048	0.061
1998	0.008	0.013	0.019	0.025	0.032	0.039	0.044	0.055	0.064
1999	0.007	0.012	0.020	0.026	0.031	0.040	0.045	0.051	0.060
2000	0.008	0.013	0.019	0.023	0.028	0.032	0.036	0.041	0.057
2001	0.008	0.014	0.021	0.025	0.029	0.032	0.039	0.042	0.052
2002	0.008	0.016	0.024	0.028	0.030	0.034	0.037	0.039	0.053
2003	0.006	0.015	0.023	0.027	0.030	0.036	0.040	0.040	0.060
2004	0.005	0.012	0.020	0.025	0.031	0.035	0.040	0.041	0.058
2005	0.006	0.011	0.018	0.023	0.029	0.029	0.039	0.039	0.050
2006	0.007	0.013	0.018	0.022	0.027	0.032	0.037	0.040	0.050

Table 6.4.6. Herring in SD 30. Proportion Mature at Year Start.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1973	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1974	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1975	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1976	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1977	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1978	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1979	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1980	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.21	0.92	0.98	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.17	0.93	0.98	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.20	0.91	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.28	0.90	0.98	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.32	0.88	0.97	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.04	0.79	0.96	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.22	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.00	0.63	0.99	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.53	0.92	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.00	0.45	0.81	0.97	1.00	1.00	1.00	1.00	1.00
1994	0.00	0.65	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.37	0.92	0.95	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.32	0.82	0.97	1.00	1.00	1.00	1.00	1.00
1998	0.03	0.31	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1999	0.01	0.38	0.87	0.99	1.00	1.00	1.00	1.00	1.00
2000	0.13	0.65	0.93	0.98	1.00	1.00	1.00	1.00	1.00
2001	0.01	0.61	0.97	0.97	1.00	1.00	1.00	1.00	1.00
2002	0.03	0.59	0.96	0.97	0.99	0.96	1.00	1.00	1.00
2003	0.00	0.55	0.94	0.97	0.96	1.00	1.00	0.88	0.89
2004	0.00	0.34	0.90	0.96	1.00	1.00	1.00	1.00	0.96
2005	0.02	0.25	0.86	0.95	0.94	0.97	1.00	1.00	0.96
2006	0.02	0.35	0.93	0.91	1.00	0.94	1.00	1.00	1.00

Table 6.4.7 Final XSA run diagnostics

Lowestoft VPA Version 3.1

22/04/2007 16:25

Extended Survivors Analysis

Herring in Bothnian Sea SD 30

CPUE data from file c:\XSA\FLEET.TXT

Catch data for 34 years. 1973 to 2006. Ages 1 to 9.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT 0: Finnish Trapn	1994	2006	2	8	0.4	0.6
FLT 2: Finnish Pelag	1999	2006	2	8	0	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .02349

Final year F values

Age	1	2	3	4	5	6	7	8
Iteration 29	0.0375	0.1168	0.1166	0.1757	0.2072	0.1823	0.1761	0.4356
Iteration 30	0.0372	0.1158	0.1155	0.1738	0.2046	0.1796	0.1727	0.4251

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.033	0.049	0.043	0.061	0.051	0.045	0.016	0.045	0.048	0.037
2	0.135	0.082	0.157	0.078	0.134	0.082	0.078	0.081	0.143	0.116
3	0.153	0.139	0.146	0.139	0.101	0.15	0.11	0.115	0.135	0.115
4	0.171	0.152	0.249	0.237	0.21	0.104	0.132	0.124	0.114	0.174
5	0.213	0.211	0.18	0.221	0.183	0.146	0.157	0.159	0.136	0.205
6	0.291	0.184	0.222	0.211	0.235	0.159	0.18	0.19	0.195	0.18
7	0.355	0.337	0.363	0.26	0.225	0.142	0.149	0.193	0.167	0.173
8	0.228	0.204	0.285	0.213	0.332	0.215	0.203	0.219	0.203	0.425

Table 6.4.7 Final XSA run diagnostics (continued)

1
XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8
1997	3.85E+06	3.21E+06	3.32E+06	1.87E+06	1.71E+06	9.72E+05	6.67E+05	7.91E+05
1998	6.62E+06	3.05E+06	2.30E+06	2.33E+06	1.29E+06	1.13E+06	5.95E+05	3.83E+05
1999	3.80E+06	5.16E+06	2.30E+06	1.64E+06	1.64E+06	8.53E+05	7.70E+05	3.48E+05
2000	4.49E+06	2.98E+06	3.61E+06	1.63E+06	1.05E+06	1.12E+06	5.59E+05	4.39E+05
2001	4.66E+06	3.46E+06	2.26E+06	2.57E+06	1.05E+06	6.86E+05	7.45E+05	3.53E+05
2002	6.97E+06	3.62E+06	2.48E+06	1.67E+06	1.71E+06	7.18E+05	4.44E+05	4.87E+05
2003	1.63E+07	5.45E+06	2.73E+06	1.75E+06	1.23E+06	1.21E+06	5.01E+05	3.15E+05
2004	2.20E+06	1.31E+07	4.13E+06	2.00E+06	1.25E+06	8.62E+05	8.26E+05	3.53E+05
2005	3.48E+06	1.72E+06	9.92E+06	3.01E+06	1.45E+06	8.76E+05	5.84E+05	5.58E+05
2006	4.75E+06	2.71E+06	1.22E+06	7.10E+06	2.20E+06	1.04E+06	5.90E+05	4.04E+05

Estimated population abundance at 1st Jan 2007

0.00E+00	3.78E+06	2.00E+06	8.99E+05	4.94E+06	1.49E+06	7.21E+05	4.15E+05

Taper weighted geometric mean of the VPA populations:

4.91E+06	3.88E+06	2.96E+06	2.29E+06	1.45E+06	9.67E+05	6.53E+05	4.37E+05

Standard error of the weighted Log(VPA populations) :

0.4854	0.4999	0.5077	0.4361	0.2879	0.2862	0.3063	0.3271

Log catchability residuals.

Fleet : FLT 0: Finnish Trapn

Age	1994	1995	1996
2	-0.15	-1	-1.55
3	0.23	0.03	-0.2
4	0.11	-0.09	-0.03
5	0.43	0.11	-0.07
6	0.54	0.15	0.37
7	0.4	-0.09	0.17
8	0.15	-0.44	-0.24

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	-0.24	-0.07	0.16	-0.25	0.67	-0.01	0.39	0.14	0.76	0.09
3	-0.41	0.08	-0.36	-0.19	0.04	0.28	0.38	0.33	-0.02	-0.26
4	-0.59	-0.17	0.04	0.33	0.41	-0.52	0.27	0.29	-0.15	-0.03
5	-0.4	0.19	-0.59	0.04	0.04	-0.21	0.25	0.34	-0.02	0
6	-0.16	-0.08	-0.41	0.12	0.01	-0.16	0.27	-0.13	-0.24	0.08
7	-0.04	0.42	-0.07	0.05	0.24	-0.39	0.12	-0.04	-0.17	-0.32
8	-0.47	-0.22	-0.37	0.02	0.31	0.35	0.28	0.2	-0.29	0.71

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

Age	2	3	4	5	6	7	8
Mean Log q	-17.5278	-17.1908	-16.968	-16.8689	-16.8524	-16.7301	-16.7301
S.E(Log q)	0.5919	0.271	0.3161	0.2788	0.2472	0.2445	0.3738

Table 6.4.7 Final XSA run diagnostics (continued)

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.16	-0.363	17.9	0.36	13	0.72	-17.53
3	0.91	0.548	16.99	0.82	13	0.26	-17.19
4	1.01	-0.042	16.99	0.64	13	0.34	-16.97
5	1.37	-0.755	17.87	0.31	13	0.39	-16.87
6	0.63	2.461	15.72	0.83	13	0.13	-16.85
7	0.94	0.228	16.54	0.65	13	0.24	-16.73
8	1.41	-0.812	18.21	0.3	13	0.53	-16.7
1							

Fleet : FLT 2: Finnish Pelag

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	99.99	99.99	0.18	-0.39	0.23	-0.08	-0.14	-0.17	0.38	-0.02
3	99.99	99.99	0.03	-0.1	-0.24	0.34	0	-0.03	0.18	-0.19
4	99.99	99.99	0.23	0.32	0.22	-0.24	-0.09	-0.19	-0.22	0.02
5	99.99	99.99	-0.21	0.16	0.01	0.07	-0.07	-0.02	-0.11	0.16
6	99.99	99.99	-0.06	0.05	0.02	-0.04	-0.11	0.05	0.16	-0.09
7	99.99	99.99	0.47	0.09	0.03	-0.01	-0.25	0.03	-0.05	-0.25
8	99.99	99.99	0.12	0.04	0.38	0.37	0.1	0.2	0.14	0.73

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

Age	2	3	4	5	6	7	8
Mean Log q	-20.7096	-20.5197	-20.295	-20.2547	-20.0972	-20.0769	-20.0769
S.E(Log q)	0.2499	0.191	0.2228	0.127	0.0915	0.2231	0.3635

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.21	-1.111	21.85	0.83	8	0.3	-20.71
3	0.88	1.195	19.84	0.94	8	0.16	-20.52
4	1.03	-0.184	20.49	0.83	8	0.25	-20.29
5	0.96	0.219	19.99	0.82	8	0.13	-20.25
6	1.15	-0.718	21.05	0.8	8	0.11	-20.1
7	0.66	1.411	17.78	0.75	8	0.14	-20.08
8	0.95	0.104	19.48	0.45	8	0.24	-19.81
1							

Table 6.4.7 Final XSA run diagnostics (continued)

Fleet disaggregated estimates of survivors :

Age 1 Catchability dependent on age and year class strength

Year class = 2005

FLT 0: Finnish Trapn

Age	1
Survivors	0
Raw Weights	0

FLT 2: Finnish Pelag

Age	1
Survivors	0
Raw Weights	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	1	0	0	0	0	0	0
FLT 2: Finnish Pelag	1	0	0	0	0	0	0
P shrinkage mean	3884421	0.5				0.8	0.036
F shrinkage mean	3380380	1				0.2	0.041

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	3777950	0.45	15.14	2	33.868	0.037

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2004

FLT 0: Finnish Trapn

Age	2	1
Survivors	2165010	0
Raw Weights	2.33	0

FLT 2: Finnish Pelag

Age	2	1
Survivors	1938083	0
Raw Weights	9.896	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	2165010	0.618	0	0	1	0.176	0.106
FLT 2: Finnish Pelag	1938085	0.3	0	0	1	0.748	0.118
F shrinkage mean	2221816	1				0.076	0.104

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	1996782	0.26	0.04	3	0.142	0.116

Table 6.4.7 Final XSA run diagnostics (continued)

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2003

FLT 0: Finnish Trapn

Age	3	2	1
Survivors	684297	1911296	0
Raw Weights	9.899	2.02	0

FLT 2: Finnish Pelag

Age	3	2	1
Survivors	738063	1305060	0
Raw Weights	9.899	8.58	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	814437	0.27	0.385	1.43	2	0.38	0.125
FLT 2: Finnish Pelag	961668	0.213	0.284	1.34	2	0.589	0.107
F shrinkage mean	833582	1				0.032	0.123

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
898776	0.16	0.17	5	1.008	0.115

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2002

FLT 0: Finnish Trapn

Age	4	3	2	1
Survivors	4717564	4803463	5605966	0
Raw Weights	7.713	8.155	1.767	0

FLT 2: Finnish Pelag

Age	4	3	2	1
Survivors	4986996	5855341	4124637	0
Raw Weights	9.338	8.155	7.503	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	4840048	0.21	0.035	0.17	3	0.404	0.175
FLT 2: Finnish Pelag	4964016	0.174	0.098	0.56	3	0.573	0.171
F shrinkage mean	6298118	1				0.023	0.137

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4940403	0.13	0.05	7	0.358	0.174

Table 6.4.7 Final XSA run diagnostics (continued)

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2001

FLT 0: Finnish Trapn

Age	5	4	3	2	1
Survivors	1466728	1259550	2052196	2173113	0
Raw Weights	9.055	6.671	7.177	1.552	0

FLT 2: Finnish Pelag

Age	5	4	3	2	1
Survivors	1722656	1176488	1420257	1280428	0
Raw Weights	9.055	8.076	7.177	6.592	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	1592038	0.173	0.119	0.69	4	0.434	0.19
FLT 2: Finnish Pelag	1399447	0.151	0.086	0.57	4	0.548	0.214
F shrinkage mean	1964829	1				0.018	0.157

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	1488921	0.11	0.07	9	0.594	0.205

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2000

FLT 0: Finnish Trapn

Age	6	5	4	3	2	1
Survivors	769784	693986	950853	1032553	699912	0
Raw Weights	9.284	8.1	5.897	6.352	1.359	0

FLT 2: Finnish Pelag

Age	6	5	4	3	2	1
Survivors	648895	633674	588865	710954	653461	0
Raw Weights	9.284	8.1	7.14	6.352	5.77	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	824879	0.151	0.078	0.52	5	0.452	0.156
FLT 2: Finnish Pelag	644225	0.136	0.029	0.21	5	0.534	0.196
F shrinkage mean	656907	1				0.015	0.193

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	720500	0.1	0.05	11	0.525	0.18

Table 6.4.7 Final XSA run diagnostics (continued)

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1999

FLT 0: Finnish Trapn

Age	7	6	5	4	3	2	1
Survivors	295185	318483	573181	532959	539491	797510	0
Raw Weights	9.349	7.688	6.542	4.701	4.83	0.972	0

FLT 2: Finnish Pelag

Age	7	6	5	4	3	2	1
Survivors	315746	477640	398247	371221	570019	510200	0
Raw Weights	9.349	7.688	6.542	5.691	4.83	4.129	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	414645	0.138	0.14	1.02	6	0.465	0.169
FLT 2: Finnish Pelag	415076	0.127	0.091	0.72	6	0.521	0.169
F shrinkage mean	397264	1				0.014	0.176

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	414627	0.09	0.07	13	0.804	0.173

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1998

FLT 0: Finnish Trapn

Age	8	7	6	5	4	3	2	1
Survivors	438023	183263	189682	277791	128656	225543	168931	0
Raw Weights	4.289	6.141	5.066	4.301	3.156	3.373	0.71	0

FLT 2: Finnish Pelag

Age	8	7	6	5	4	3	2	1
Survivors	447916	206449	227970	202569	170821	170267	146734	0
Raw Weights	4.38	6.141	5.066	4.301	3.82	3.373	3.014	0

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT 0: Finnish Trapn	222347	0.131	0.148	1.13	7	0.465	0.416
FLT 2: Finnish Pelag	216352	0.122	0.134	1.09	7	0.518	0.425
F shrinkage mean	559267	1				0.017	0.186

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	222729	0.09	0.1	15	1.082	0.425

Table 6.4.8 Herring in SD 30. XSA output F -table

Run title : Herring in Bothnian Sea SD 30

At 22/04/2007 16:26

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1973	1974	1975	1976
AGE				
1	0.0081	0.0029	0.0205	0.0243
2	0.0464	0.0484	0.0609	0.0769
3	0.1582	0.1601	0.1112	0.1329
4	0.171	0.1714	0.1204	0.1578
5	0.2573	0.1319	0.0949	0.1566
6	0.1296	0.1239	0.0905	0.1534
7	0.0998	0.1317	0.0963	0.1068
8	0.163	0.1297	0.0943	0.1396
+gp	0.163	0.1297	0.0943	0.1396
0 FBAR 3- 7	0.1632	0.1438	0.1027	0.1415

Table 8 Fishing mortality (F) at age

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0.0143	0.0407	0.0088	0.0479	0.0109	0.0106	0.0308	0.0241	0.0236	0.0064
2	0.0612	0.0674	0.0483	0.1618	0.0476	0.0925	0.1096	0.0614	0.0864	0.1389
3	0.1382	0.1102	0.0778	0.1401	0.1419	0.2028	0.1224	0.1565	0.109	0.1259
4	0.2042	0.1971	0.1428	0.0902	0.1517	0.2351	0.2214	0.1917	0.1525	0.1116
5	0.1787	0.2181	0.1386	0.1605	0.1028	0.2308	0.1458	0.2433	0.108	0.1476
6	0.2394	0.1823	0.1966	0.2523	0.1122	0.1847	0.1548	0.2421	0.2844	0.1238
7	0.2371	0.294	0.2022	0.2752	0.1839	0.1558	0.1591	0.2154	0.2787	0.2084
8	0.2197	0.2329	0.1802	0.2309	0.1337	0.1918	0.1543	0.2357	0.2259	0.1616
+gp	0.2197	0.2329	0.1802	0.2309	0.1337	0.1918	0.1543	0.2357	0.2259	0.1616
0 FBAR 3- 7	0.1995	0.2003	0.1516	0.1837	0.1385	0.2018	0.1607	0.2098	0.1865	0.1435

Table 8 Fishing mortality (F) at age

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.0105	0.0062	0.0142	0.0284	0.0109	0.0166	0.0386	0.0207	0.0124	0.024
2	0.0246	0.0632	0.0544	0.0747	0.0374	0.0697	0.0976	0.0905	0.0789	0.1064
3	0.1005	0.0412	0.0698	0.0558	0.0654	0.1061	0.081	0.131	0.164	0.1085
4	0.1223	0.1194	0.0548	0.0612	0.0576	0.0957	0.1015	0.1225	0.1741	0.1529
5	0.0978	0.1398	0.1068	0.0412	0.0554	0.1067	0.1062	0.1536	0.1833	0.2025
6	0.1389	0.1145	0.1301	0.1071	0.0772	0.0689	0.1041	0.1842	0.187	0.1907
7	0.1652	0.1493	0.1071	0.1466	0.1064	0.132	0.0681	0.1518	0.1882	0.1972
8	0.1354	0.1362	0.1161	0.0996	0.0808	0.1042	0.0943	0.1176	0.1859	0.1699
+gp	0.1354	0.1362	0.1161	0.0996	0.0808	0.1042	0.0943	0.1176	0.1859	0.1699
0 FBAR 3- 7	0.1249	0.1128	0.0937	0.0824	0.0724	0.1019	0.0922	0.1486	0.1793	0.1704

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR **-**
AGE											
1	0.0334	0.049	0.0434	0.0606	0.0507	0.0447	0.0165	0.0451	0.0484	0.0372	0.0436
2	0.1349	0.0818	0.1569	0.0777	0.1337	0.0822	0.0778	0.0807	0.1427	0.1158	0.113
3	0.1531	0.1392	0.1457	0.1393	0.1013	0.1501	0.1097	0.1155	0.1352	0.1155	0.122
4	0.1707	0.1515	0.249	0.2365	0.2097	0.1044	0.1323	0.1235	0.114	0.1738	0.1371
5	0.2133	0.2113	0.1795	0.2215	0.183	0.1461	0.1567	0.1587	0.1361	0.2046	0.1665
6	0.291	0.1838	0.2224	0.2111	0.2346	0.1589	0.1804	0.1897	0.1952	0.1796	0.1882
7	0.3551	0.337	0.3626	0.2595	0.2251	0.1424	0.1493	0.1933	0.1675	0.1727	0.1778
8	0.2281	0.2036	0.2847	0.2133	0.332	0.2153	0.2033	0.2195	0.2032	0.4251	0.2826
+gp	0.2281	0.2036	0.2847	0.2133	0.332	0.2153	0.2033	0.2195	0.2032	0.4251	
0 FBAR 3- 7	0.2366	0.2046	0.2319	0.2136	0.1907	0.1404	0.1457	0.1562	0.1496	0.1692	

Table 6.4.9 Herring in SD 30. XSA output Stock numbers

Run title : Herring in Bothnian Sea SD 30

At 22/04/2007 16:26

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1973	1974	1975	1976	1977	1978
AGE						
1	206249	255228	183760	404921	145178	77209
2	110309	167499	208359	147402	323569	117174
3	175267	86223	130663	160517	111747	249199
4	98905	122495	60150	95721	115069	79681
5	88588	68248	84497	43660	66933	76807
6	71248	56075	48972	62917	30564	45831
7	29235	51241	40559	36625	44185	19696
8	5166	21663	36775	30159	26948	28539
+gp	2941	29343	44678	49229	33366	28926
TOTAL	787908	858015	838412	1031151	897561	723063

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
1	50163	148958	142847	243171	342649	471383	413619	240012	411317	177267
2	60694	40710	116254	115689	197001	272030	376732	330739	195247	333232
3	89680	47349	28352	90756	86354	144547	209456	282913	235671	155968
4	182744	67927	33697	20142	60667	62555	101202	153772	204238	174508
5	53569	129703	50816	23706	13037	39805	42283	71138	112607	147960
6	50562	38182	90441	37541	15409	9226	25552	31075	50250	83606
7	31269	34008	24291	66191	25553	10806	5929	15742	22479	35807
8	12019	20915	21145	16547	46374	17844	7133	3674	10463	15602
+gp	32559	23465	30719	28497	26940	44367	38204	27816	28659	29352
TOTAL	563260	551217	538562	642241	813984	1072562	1220111	1156880	1270932	1153301

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	690515	722204	427751	492324	593836	418546	558203	401987	385266	662259
2	144231	557367	574733	346405	396444	467795	335664	451376	321302	305068
3	256116	111830	423480	453290	264523	294404	349849	253978	332268	229862
4	122546	195546	86591	324755	333763	199717	211440	243112	186555	233428
5	126796	94983	150600	66924	241617	246890	144663	145446	170830	128766
6	105331	93294	74628	116656	49248	177882	173358	98600	97247	113000
7	61044	75720	68627	56563	89147	36333	121139	117726	66710	59516
8	25251	44901	53541	50515	40583	68184	25558	82162	79134	38291
+gp	34220	46995	58460	54820	51492	65943	70434	42643	74581	140590
TOTAL	1566048	1942840	1918413	1962251	2060652	1975694	1990308	1837029	1713894	1910779

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 73-**	AMST 73-**
AGE											
1	380064	449276	465574	696665	1631198	219523	347872	475213	0	330095	409660
2	516302	297940	346209	362348	545420	1313687	171797	271357	377795	259963	324842
3	230158	361322	225704	247970	273268	413118	992178	121955	199678	185706	218931
4	163745	162884	257361	166990	174731	200486	301342	709636	89878	130137	153035
5	164241	104515	105268	170847	123162	125329	145067	220128	494040	90421	107007
6	85346	112370	68570	71771	120859	86212	87551	103657	148892	62957	74744
7	76980	55943	74492	44399	50128	82618	58385	58968	72050	42550	50959
8	34787	43857	35333	48698	31525	35349	55754	40430	41463	26744	33082
+gp	86760	177555	110011	158060	154022	124343	141054	100321	75965		
TOTAL	1738384	1765662	1688523	1967747	3104312	2600665	2301001	2101665	1499761		

Table 6.4.10 Herring in SD 30 XSA output summary table

Run title : Herring in Bothnian Sea SD 30

At 22/04/2007 16:26

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1973	2062493	196090	140712	22531	0.1601	0.1632
1974	2552283	215270	148305	20294	0.1368	0.1438
1975	1837596	219027	153207	16264	0.1062	0.1027
1976	4049208	233295	151128	22012	0.1457	0.1415
1977	1451782	223462	141034	26304	0.1865	0.1995
1978	772094	190543	147300	25105	0.1704	0.2003
1979	501629	164855	135170	19049	0.1409	0.1516
1980	1489584	141032	116346	20150	0.1732	0.1837
1981	1428466	146952	112313	13700	0.122	0.1385
1982	2431712	128629	99048	17847	0.1802	0.2018
1983	3426490	157977	108457	18501	0.1706	0.1607
1984	4713825	214649	127037	25629	0.2017	0.2098
1985	4136190	244531	154798	26120	0.1687	0.1865
1986	2400115	248098	174544	26489	0.1518	0.1435
1987	4113174	304678	218042	24520	0.1125	0.1249
1988	1772673	330049	223118	27650	0.1239	0.1128
1989	6905145	422659	301559	28658	0.095	0.0937
1990	7222044	478846	358416	31282	0.0873	0.0824
1991	4277512	502394	389537	26219	0.0673	0.0724
1992	4923237	525970	391670	39310	0.1004	0.1019
1993	5938359	537441	369141	40179	0.1088	0.0922
1994	4185464	535472	424424	56380	0.1328	0.1486
1995	5582034	480167	358160	61086	0.1706	0.1793
1996	4019870	461047	367587	56109	0.1526	0.1704
1997	3852663	419620	305248	65527	0.2147	0.2366
1998	6622587	417170	291232	56892	0.1953	0.2046
1999	3800636	366658	267089	62345	0.2334	0.2319
2000	4492758	385338	304641	56261	0.1847	0.2136
2001	4655740	351021	264575	54984	0.2078	0.1907
2002	6966648	414826	303355	50218	0.1655	0.1404
2003	16311979	495246	313226	49638	0.1585	0.1457
2004	2195229	490049	331068	55450	0.1675	0.1562
2005	3478722	470171	366874	57941	0.1579	0.1496
2006	4752133	427368	320866	68635	0.2139	0.1692
Arith. Mean	4097708	339429	246448	37332	0.1549	0.1572
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.4.11 Standard fish stock summary tables. Herring in Sub-division 30, Bothnian Sea

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1973	2062493	140712	22531	0.1632
1974	2552283	148305	20294	0.1438
1975	1837596	153207	16264	0.1027
1976	4049208	151128	22012	0.1415
1977	1451782	141034	26304	0.1995
1978	772094	147300	25105	0.2003
1979	501629	135170	19049	0.1516
1980	1489584	116346	20150	0.1837
1981	1428466	112313	13700	0.1385
1982	2431712	99048	17847	0.2018
1983	3426490	108457	18501	0.1607
1984	4713825	127037	25629	0.2098
1985	4136190	154798	26120	0.1865
1986	2400115	174544	26489	0.1435
1987	4113174	218042	24520	0.1249
1988	1772673	223118	27650	0.1128
1989	6905145	301559	28658	0.0937
1990	7222044	358416	31282	0.0824
1991	4277512	389537	26219	0.0724
1992	4923237	391670	39310	0.1019
1993	5938359	369141	40179	0.0922
1994	4185464	424424	56380	0.1486
1995	5582034	358160	61086	0.1793
1996	4019870	367587	56109	0.1704
1997	3852663	305248	65527	0.2366
1998	6622587	291232	56892	0.2046
1999	3800636	267089	62345	0.2319
2000	4492758	304641	56261	0.2136
2001	4655740	264575	54984	0.1907
2002	6966648	303355	50218	0.1404
2003	16311979	313226	49638	0.1457
2004	2195229	331068	55450	0.1562
2005	3478722	366874	57941	0.1496
2006	4752133	320866	68635	0.1692
2007	4732030			
Average	4115832	246448	37332	0.1572

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 3-7	Yield/R	SSB/R
Average last 3 years	0.158	0.009	0.049
Fmax	0.370	0.010	0.026
F0.1	0.141	0.009	0.053
Fmed	0.067	0.007	0.076

Table 6.4.12 Herring in SD 30. Input data for short-term predictions.

MFDP version 1a
Run: SD 30 herring
Herring in SD 30
Time and date: 17:05 23.4.2007
Fbar age range: 3-7

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4732030	0.2	0.02	0.15	0.33	0.0060	0.0436	0.0060
2	3777950	0.2	0.35	0.15	0.33	0.0120	0.1131	0.0120
3	1996780	0.2	0.93	0.15	0.33	0.0187	0.1221	0.0187
4	898780	0.2	0.91	0.15	0.33	0.0233	0.1371	0.0233
5	4940400	0.2	1.00	0.15	0.33	0.0290	0.1665	0.0290
6	1488920	0.2	0.94	0.15	0.33	0.0320	0.1882	0.0320
7	720500	0.2	1.00	0.15	0.33	0.0387	0.1778	0.0387
8	414630	0.2	1.00	0.15	0.33	0.0400	0.2826	0.0400
9	759650	0.2	1.00	0.15	0.33	0.0527	0.2826	0.0527

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4732030	0.2	0.02	0.15	0.33	0.0060	0.0436	0.0060
2		0.2	0.35	0.15	0.33	0.0120	0.1131	0.0120
3		0.2	0.93	0.15	0.33	0.0187	0.1221	0.0187
4		0.2	0.91	0.15	0.33	0.0233	0.1371	0.0233
5		0.2	1.00	0.15	0.33	0.0290	0.1665	0.0290
6		0.2	0.94	0.15	0.33	0.0320	0.1882	0.0320
7		0.2	1.00	0.15	0.33	0.0387	0.1778	0.0387
8		0.2	1.00	0.15	0.33	0.0400	0.2826	0.0400
9		0.2	1.00	0.15	0.33	0.0527	0.2826	0.0527

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4732030	0.2	0.02	0.15	0.33	0.0060	0.0436	0.0060
2		0.2	0.35	0.15	0.33	0.0120	0.1131	0.0120
3		0.2	0.93	0.15	0.33	0.0187	0.1221	0.0187
4		0.2	0.91	0.15	0.33	0.0233	0.1371	0.0233
5		0.2	1.00	0.15	0.33	0.0290	0.1665	0.0290
6		0.2	0.94	0.15	0.33	0.0320	0.1882	0.0320
7		0.2	1.00	0.15	0.33	0.0387	0.1778	0.0387
8		0.2	1.00	0.15	0.33	0.0400	0.2826	0.0400
9		0.2	1.00	0.15	0.33	0.0527	0.2826	0.0527

Input units are thousands and kg - output in tonnes

Input units are thousands and kg - output in tonnes

M =	Natural mortality
MAT =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWT =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWT =	Weight in catch (kg)

N2007 Age 1:	Geometric Mean from VPA-Output of age 1 for the years 1989-2005
N2007 Age 2-9+:	Output from VPA
N2008/2009 Age 1:	Geometric Mean from VPA-Output of age 1 for the years 1989-2005, leaving out the exceptionally large 2002 year-class
Natural Mortality (M):	Average for 2004-2006
Weight in the Catch/Stock (CWt/SWt):	Average for 2004-2006
Expoitation pattern (Sel):	Average for 2004-2006

Table 6.4.13 Herring in SD 30 Short term prediction with management options

MFDP version 1a
Run: SD 30
Herring in SD 30
Time and date: 12:31 24.4.2007
Fbar age range: 3-7

2007				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
407342	312242	1.0000	0.1583	56040

2008					2009	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
383394	293398	0.0000	0.0000	0	429538	338663
.	292589	0.1000	0.0158	5767	423245	332083
.	291784	0.2000	0.0317	11429	417068	325646
.	290980	0.3000	0.0475	16988	411003	319348
.	290179	0.4000	0.0633	22446	405050	313186
.	289381	0.5000	0.0792	27804	399205	307157
.	288584	0.6000	0.0950	33066	393467	301258
.	287790	0.7000	0.1108	38232	387832	295485
.	286999	0.8000	0.1267	43306	382300	289835
.	286210	0.9000	0.1425	48288	376868	284306
.	285423	1.0000	0.1583	53180	371534	278896
.	284639	1.1000	0.1742	57985	366296	273600
.	283857	1.2000	0.1900	62704	361152	268416
.	283077	1.3000	0.2058	67339	356100	263343
.	282299	1.4000	0.2217	71891	351138	258377
.	281524	1.5000	0.2375	76363	346266	253515
.	280751	1.6000	0.2533	80755	341480	248756
.	279981	1.7000	0.2692	85070	336779	244097
.	279213	1.8000	0.2850	89309	332161	239535
.	278447	1.9000	0.3008	93473	327625	235069
.	277683	2.0000	0.3167	97564	323169	230696

Input units are thousands and kg - output in tonnes

Table 6.4.14 Herring in SD 30. Y/R reference values.

MFYPR version 2a
Run: sd 30
Time and date: 12:32 24.4.2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	0.1461	3.8861	0.1311	3.6379	0.1227
0.1000	0.0158	0.0706	0.0024	5.1648	0.1300	3.5399	0.1151	3.3044	0.1074
0.2000	0.0317	0.1276	0.0041	4.8810	0.1173	3.2616	0.1026	3.0365	0.0954
0.3000	0.0475	0.1749	0.0054	4.6457	0.1071	3.0317	0.0925	2.8153	0.0858
0.4000	0.0633	0.2151	0.0063	4.4462	0.0987	2.8375	0.0841	2.6285	0.0778
0.5000	0.0792	0.2497	0.0071	4.2740	0.0916	2.6704	0.0772	2.4679	0.0712
0.6000	0.0950	0.2801	0.0077	4.1232	0.0856	2.5247	0.0712	2.3279	0.0655
0.7000	0.1108	0.3070	0.0082	3.9895	0.0804	2.3959	0.0661	2.2043	0.0607
0.8000	0.1267	0.3312	0.0085	3.8698	0.0759	2.2810	0.0617	2.0941	0.0565
0.9000	0.1425	0.3530	0.0088	3.7616	0.0719	2.1776	0.0578	1.9949	0.0528
1.0000	0.1583	0.3729	0.0091	3.6632	0.0683	2.0839	0.0543	1.9051	0.0495
1.1000	0.1742	0.3911	0.0093	3.5731	0.0651	1.9984	0.0512	1.8232	0.0465
1.2000	0.1900	0.4078	0.0094	3.4902	0.0622	1.9199	0.0484	1.7481	0.0439
1.3000	0.2058	0.4234	0.0096	3.4134	0.0596	1.8475	0.0459	1.6789	0.0415
1.4000	0.2217	0.4378	0.0097	3.3421	0.0573	1.7805	0.0436	1.6149	0.0394
1.5000	0.2375	0.4513	0.0098	3.2756	0.0551	1.7182	0.0415	1.5554	0.0374
1.6000	0.2533	0.4639	0.0098	3.2133	0.0531	1.6601	0.0396	1.4999	0.0356
1.7000	0.2692	0.4757	0.0099	3.1549	0.0513	1.6058	0.0378	1.4481	0.0339
1.8000	0.2850	0.4869	0.0099	3.0999	0.0496	1.5548	0.0362	1.3995	0.0324
1.9000	0.3008	0.4974	0.0099	3.0480	0.0480	1.5069	0.0347	1.3539	0.0310
2.0000	0.3167	0.5074	0.0100	2.9989	0.0465	1.4617	0.0332	1.3109	0.0297

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.1583
FMax	2.3390	0.3703
F0.1	0.8896	0.1408
F35%SPR	1.2386	0.1961

Weights in kilograms

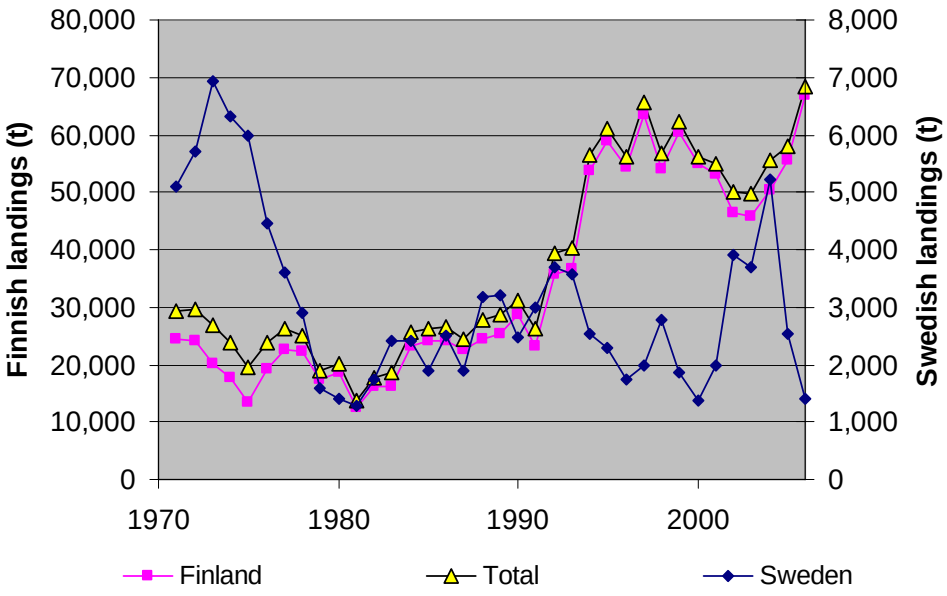


Figure 6.4.1 Herring in SD 30. Landings in tonnes by country.

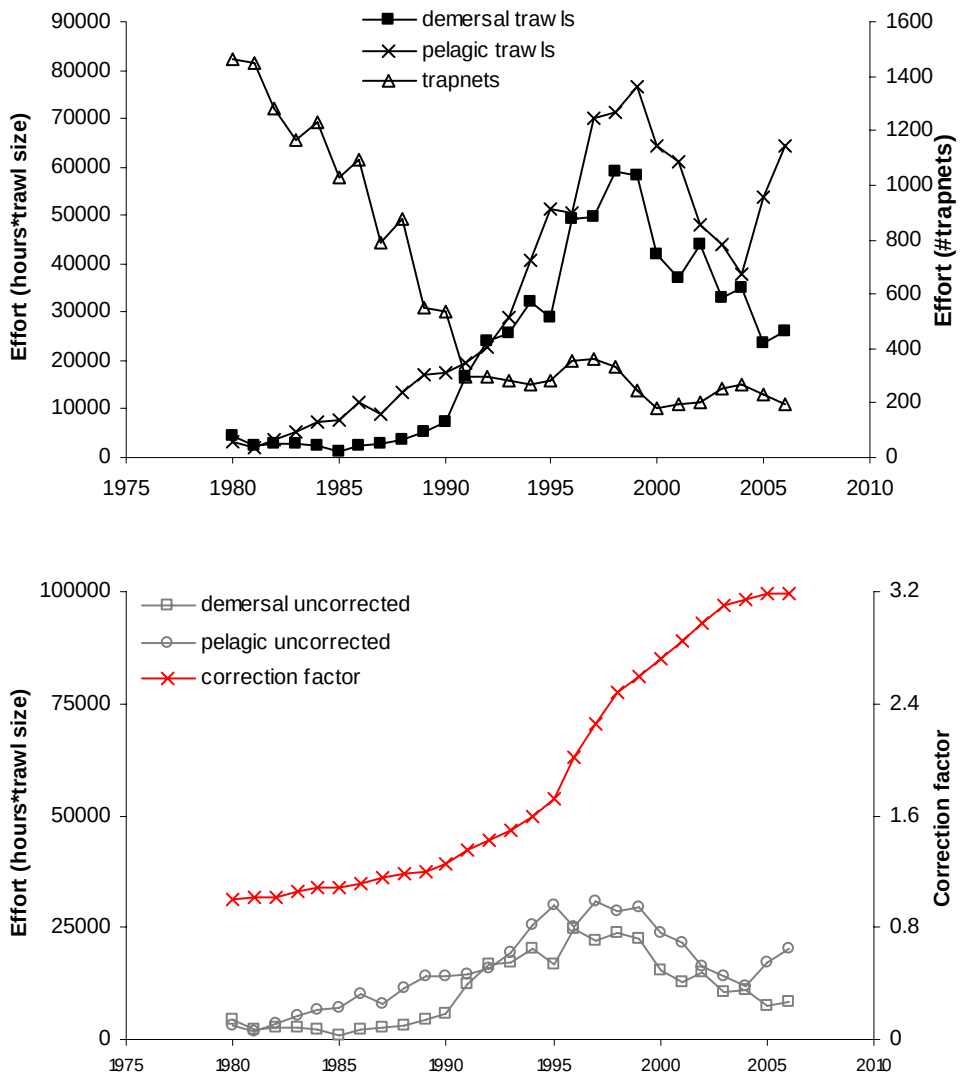


Figure 6.4.2 Herring in SD 30. Effort in Finnish commecial fleets.

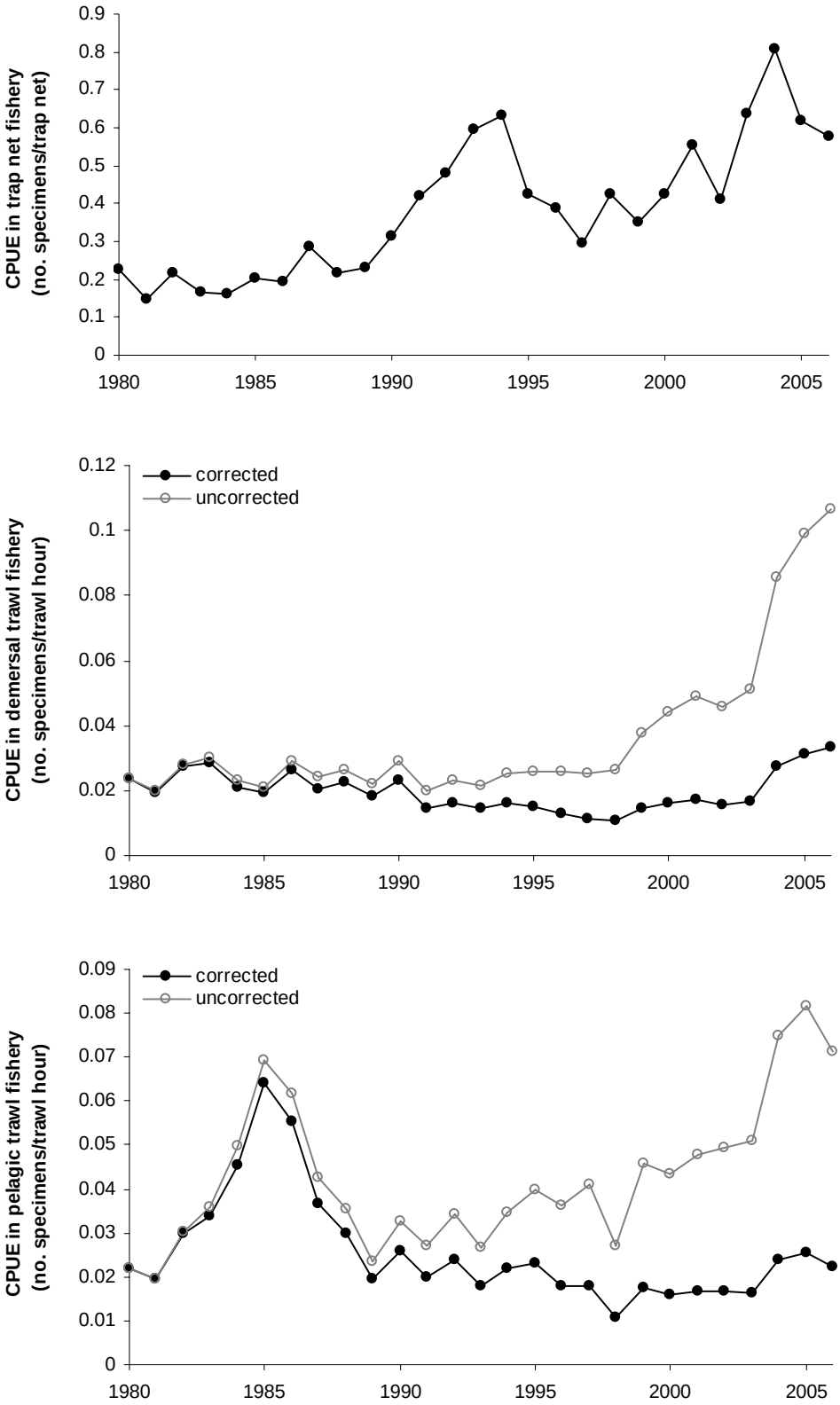


Figure 6.4.3 Herring in SD 30. CPUE in trawl fleets.

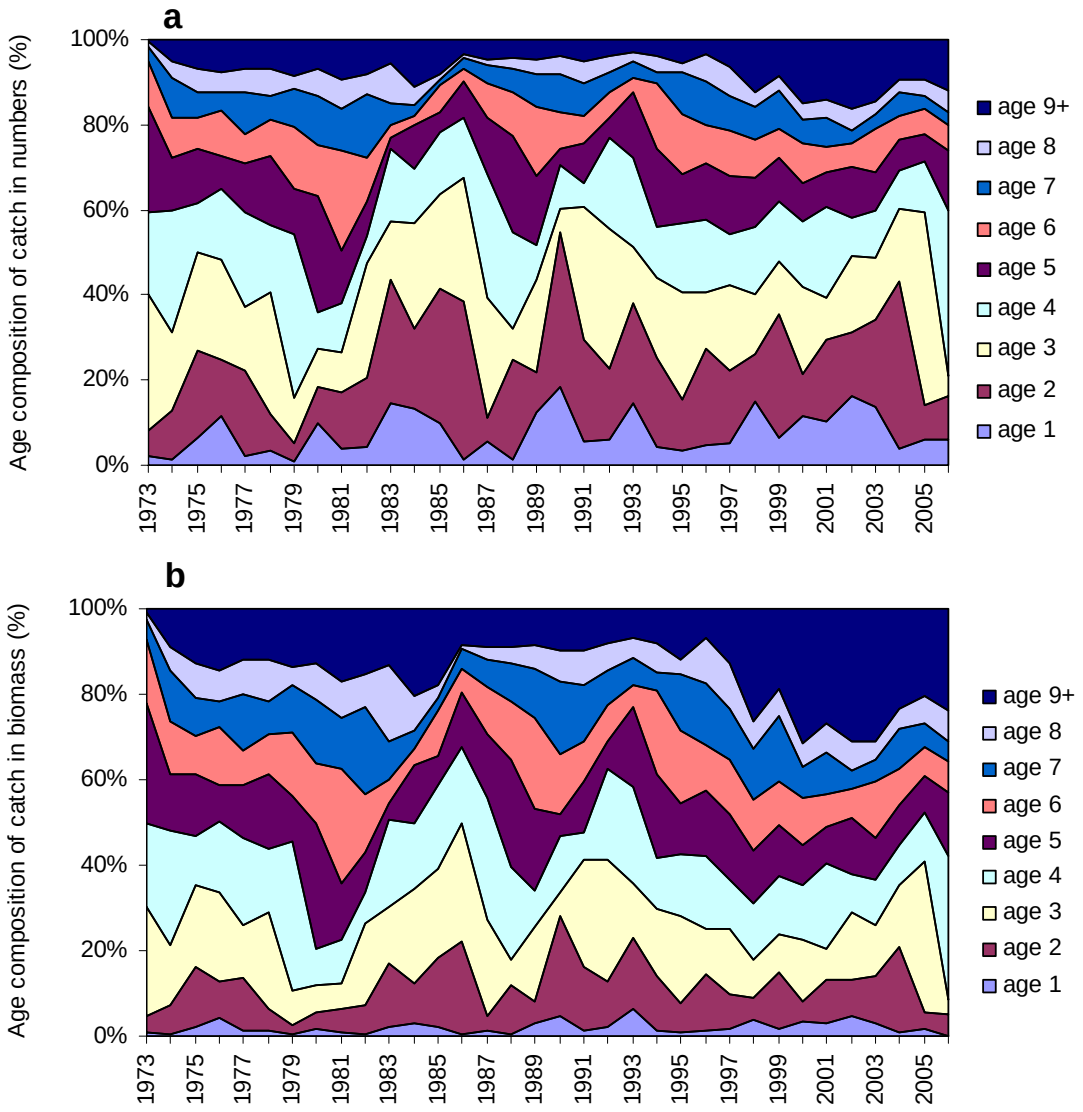


Figure 6.4.4 **Herring in SD 30. Age composition of the catches in (a) numbers and (b) biomass.**

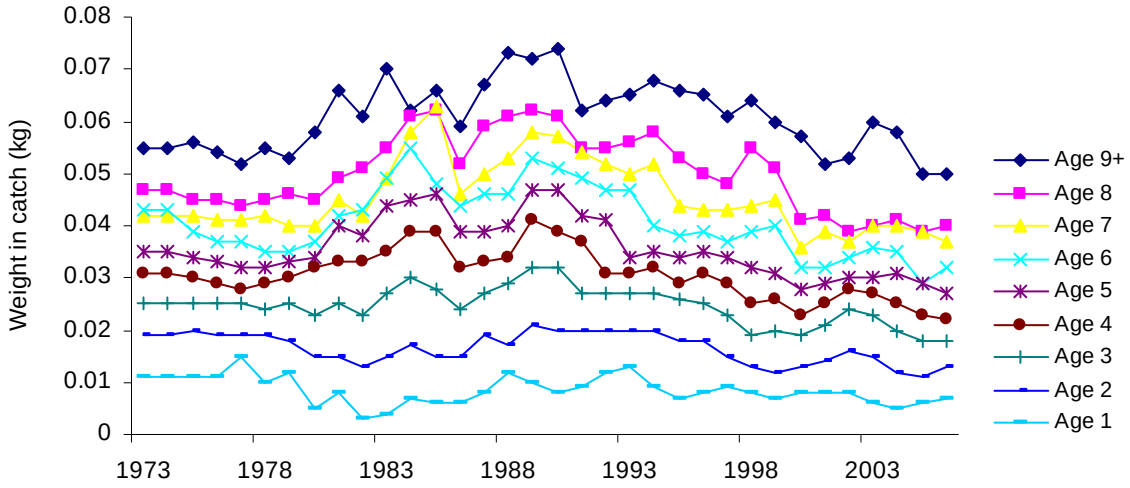


Figure 6.4.5 Herring in SD 30. Weight at age in the catches (kg).

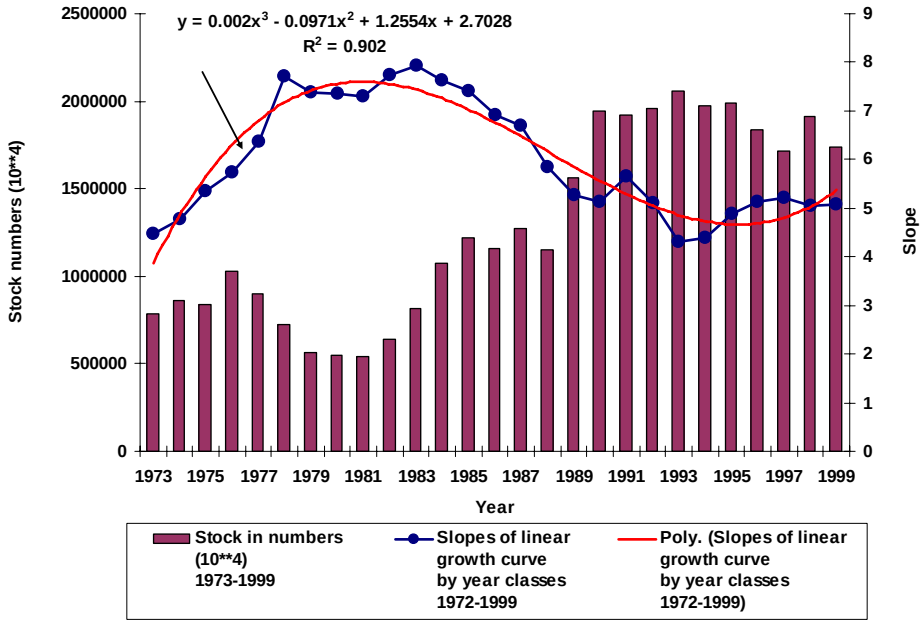


Figure 6.4.6 Herring in SD 30. Stock in numbers and slope of the linear growth curve (weight) by year class

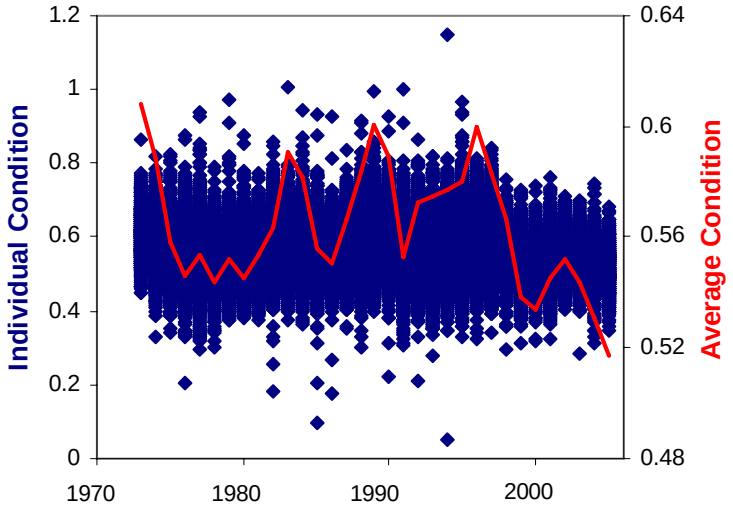


Figure 6.4.7 **Herring in SD 30 Fulton's condition. Full line indicate the average condition (right axis) in the stock, points show individual condition (left axis).**

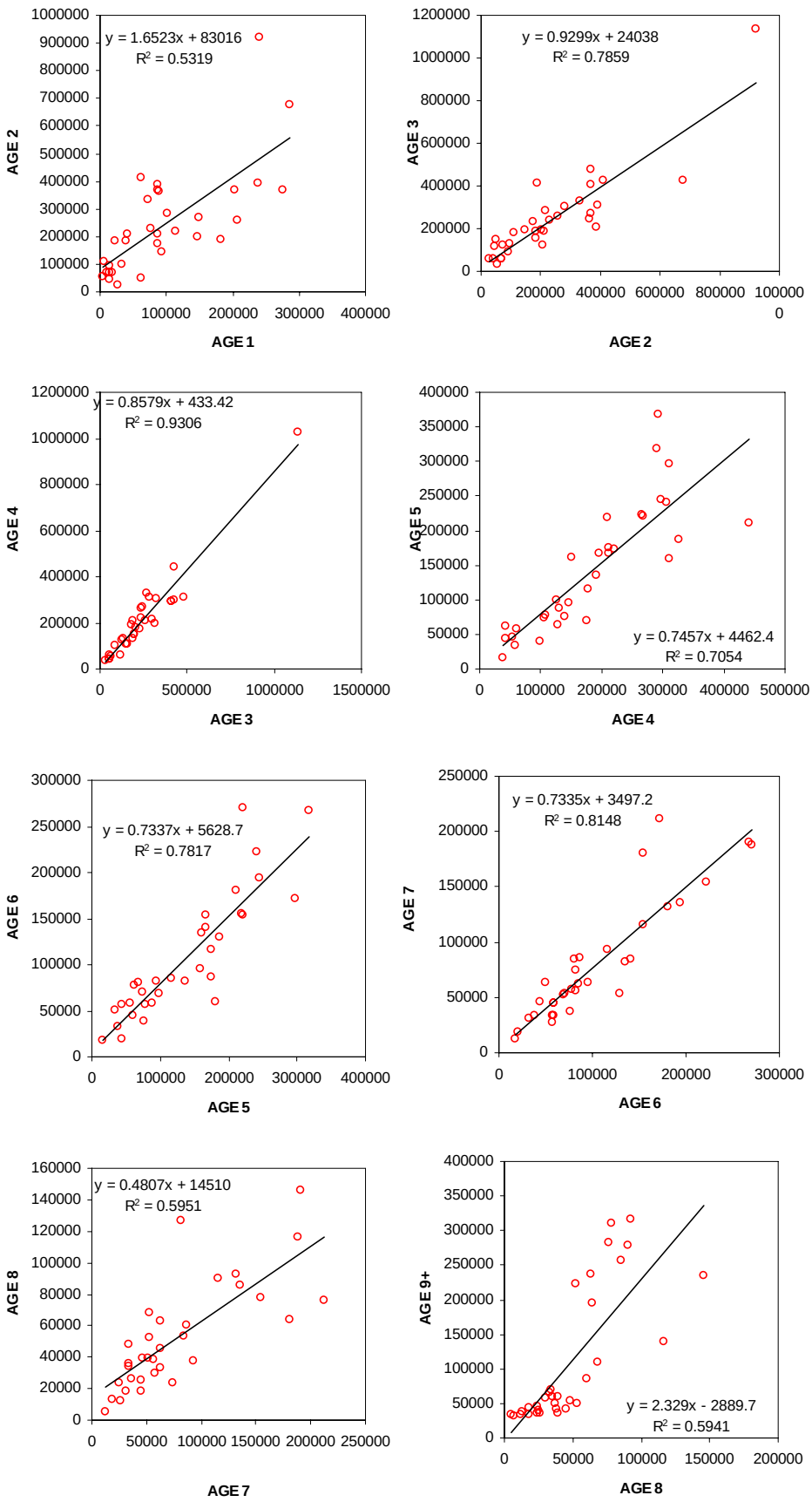


Figure 6.4.8 **Herring in SD 30 The R^2 values of correlation between catch in numbers in consecutive ages**

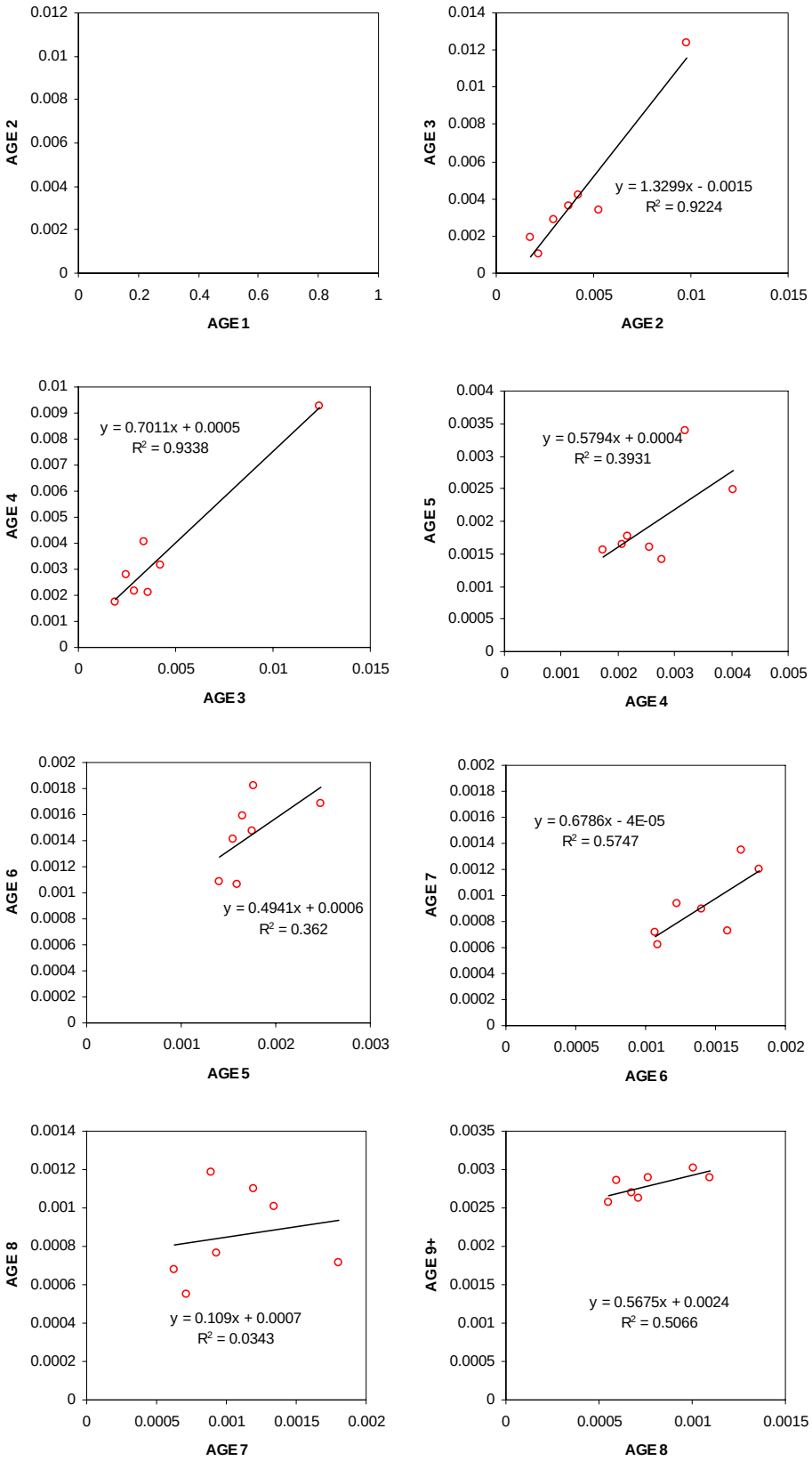


Figure 6.4.9 **Herring in SD 30 The R^2 values of correlation between catch numbers at age per effort between consecutive ages in Pelagic trawl CPUE data.**

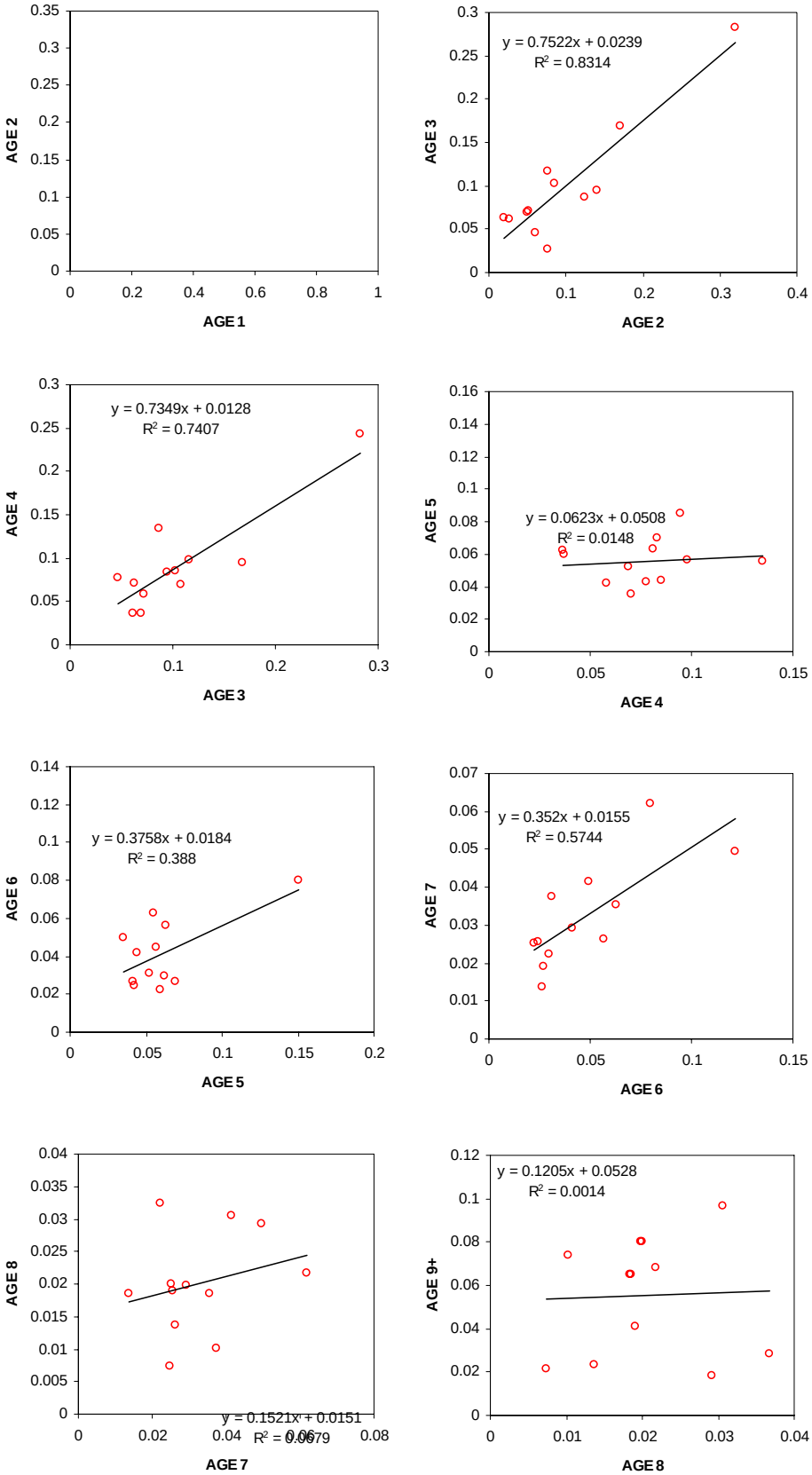


Figure 6.4.10 **Herring in SD 30. The R^2 values of correlation between catch numbers at age per effort between consecutive ages in Trapnet CPUE data.**

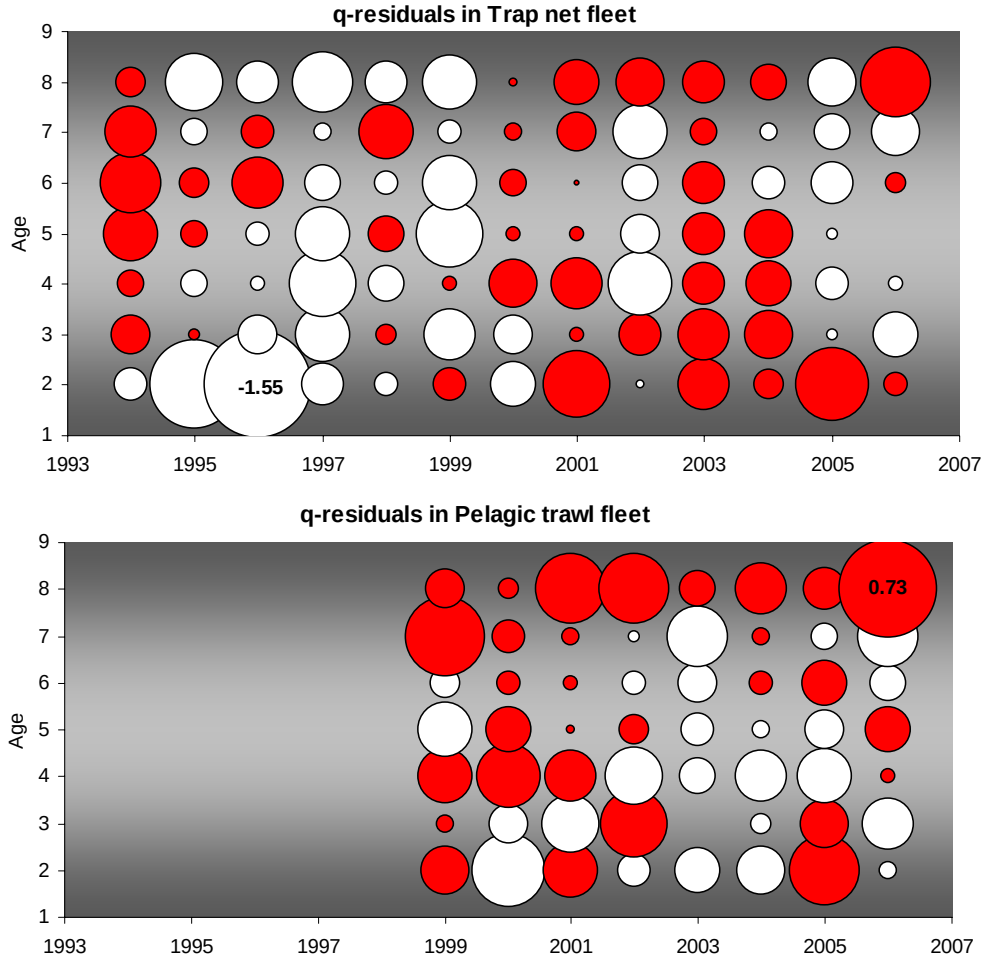


Figure 6.4.11 **Herring in SD 30. Catchability residuals from SPALY Trapnet- and Pelagic trawl fleets.**

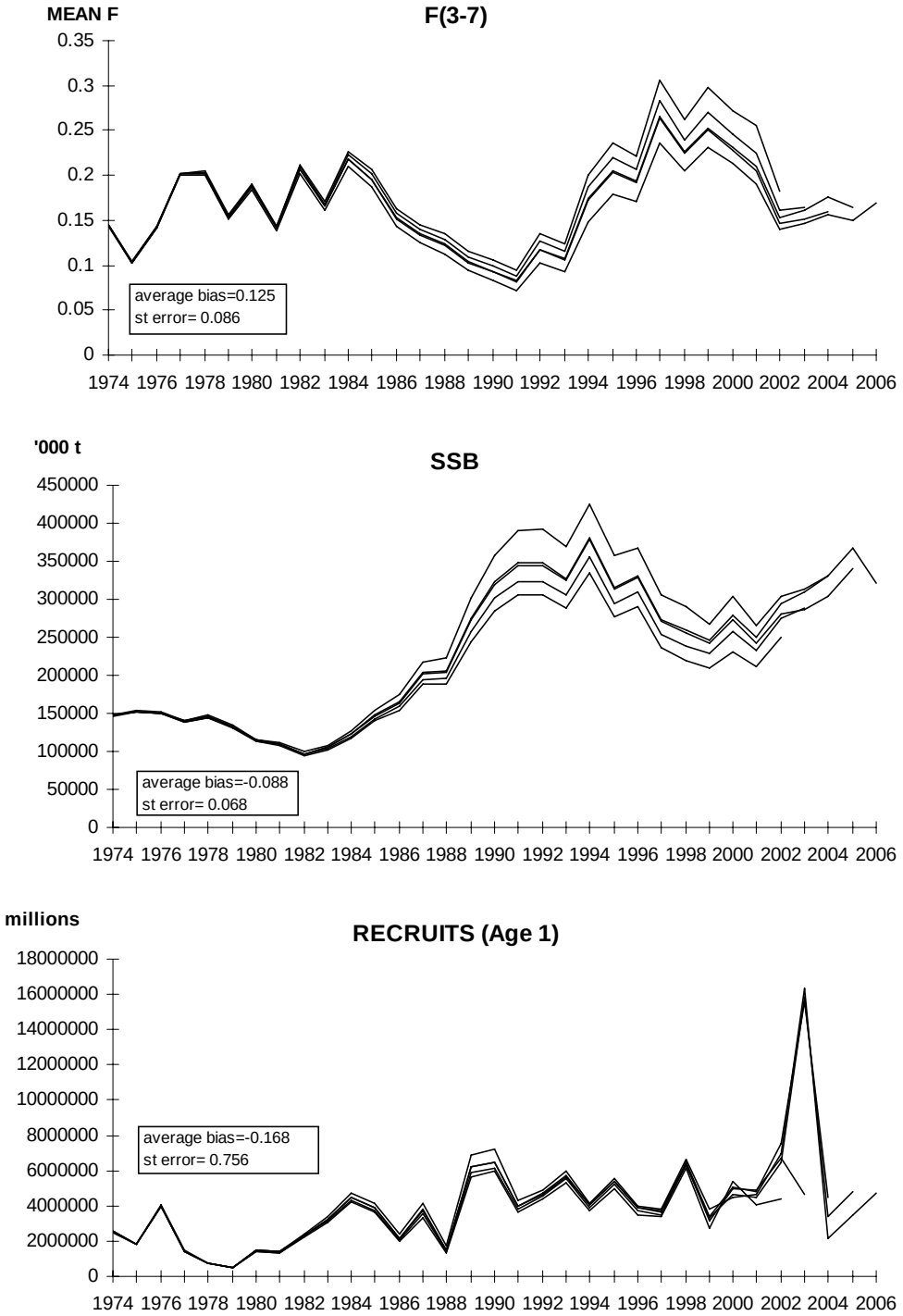
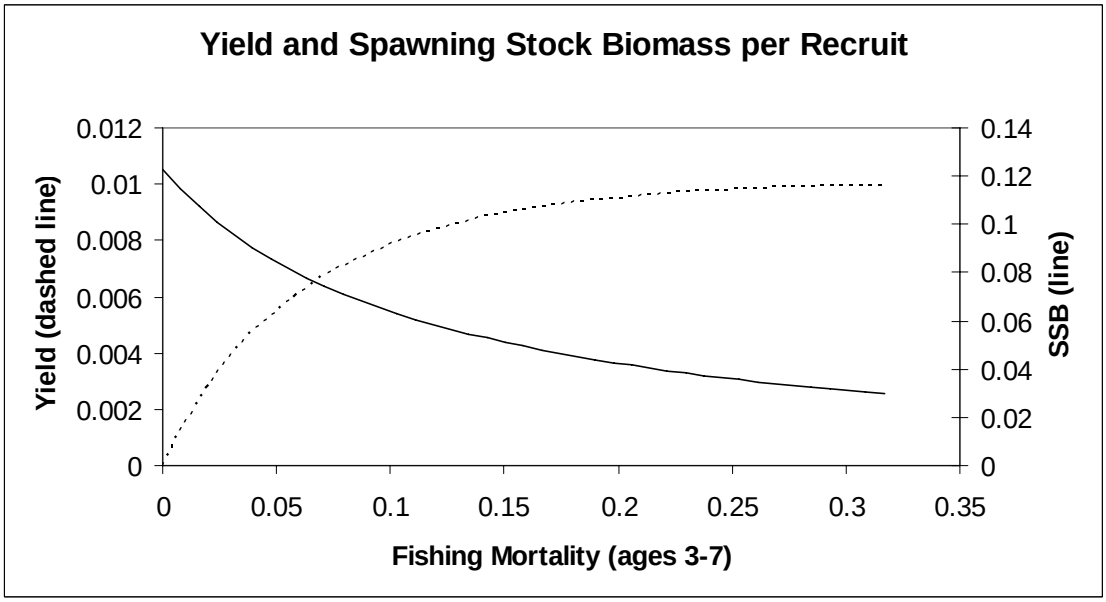


Figure 6.4.12 HERRING IN SD 30: Restrospective Analysis (XSA)

Figure 6.4.13 Fish stock summary plots for Herring in Sub-division 30, Bothnian Sea



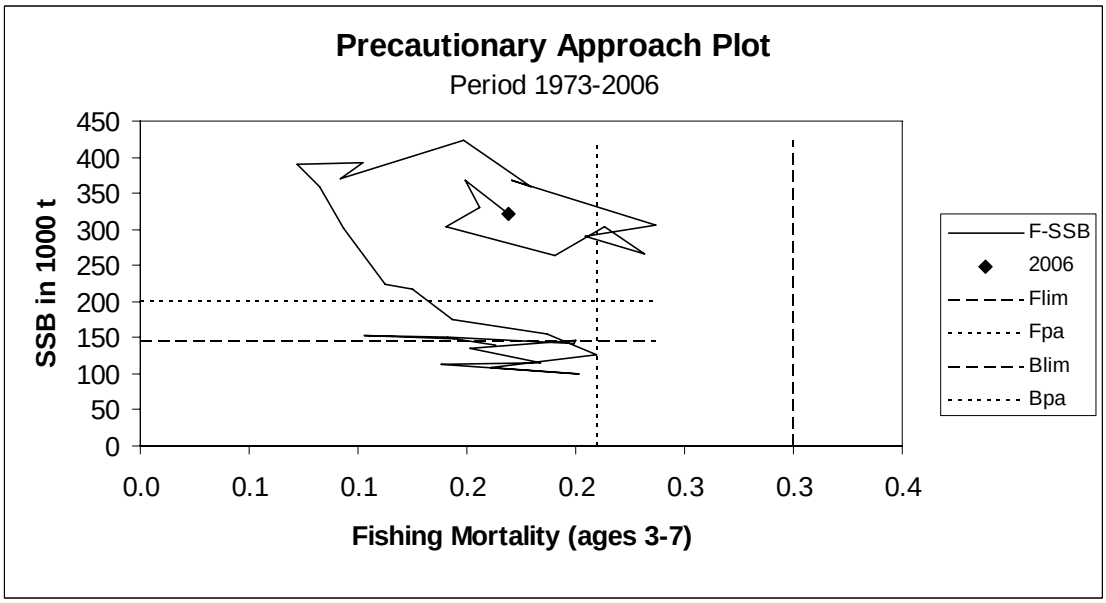


Figure 6.4.14 Fish stock summary plots for Herring in Sub-division 30, Bothnian Sea

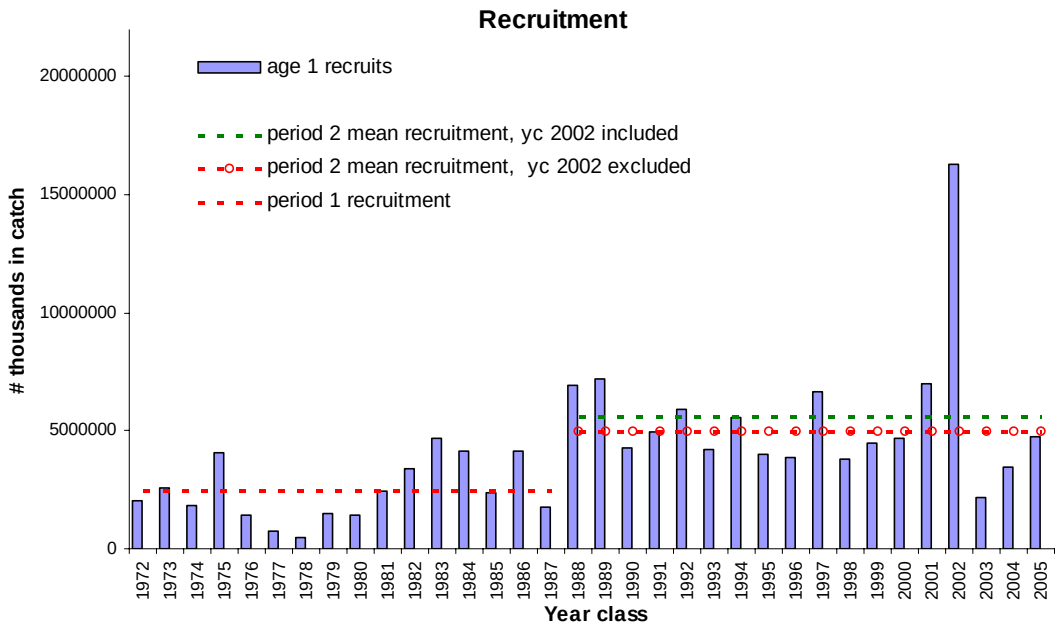


Figure 6.4.15 Herring in SD 30. Recruitment in 2 different regimes.

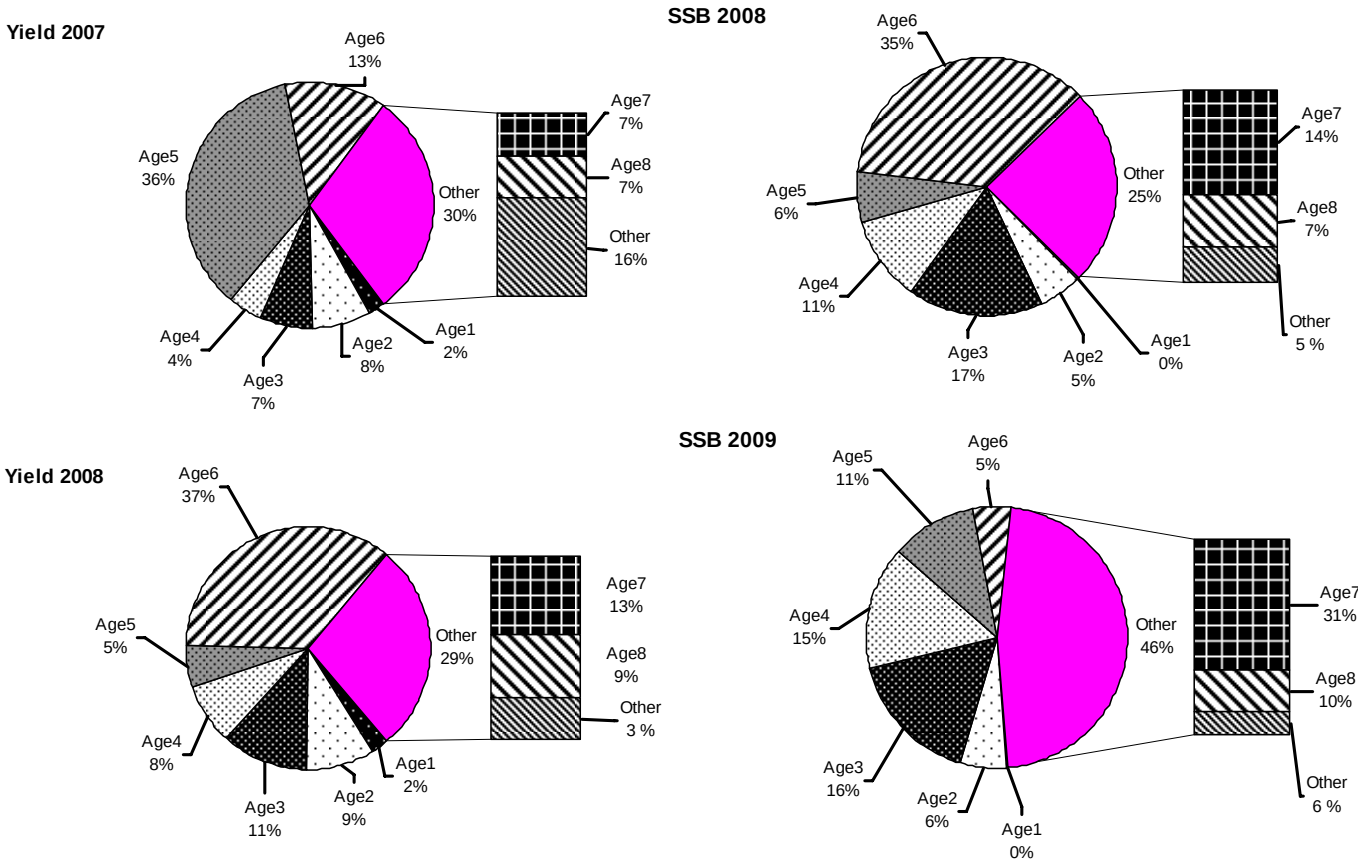
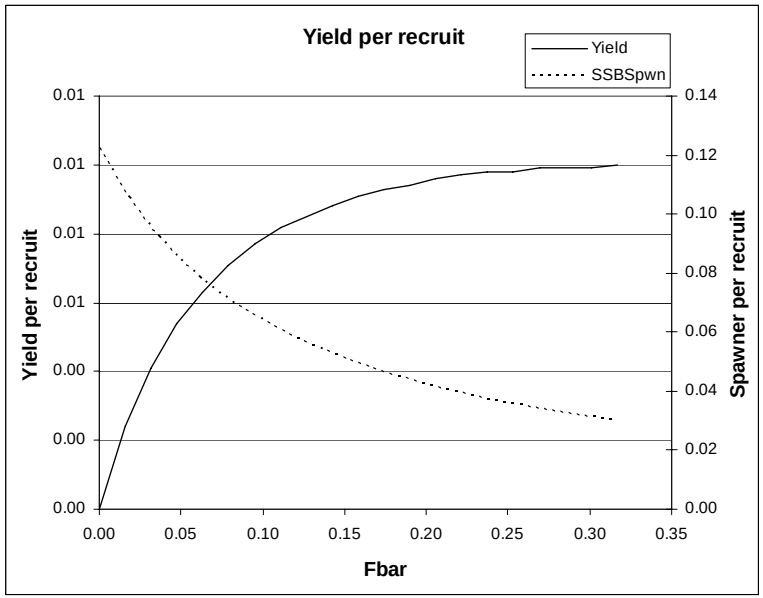
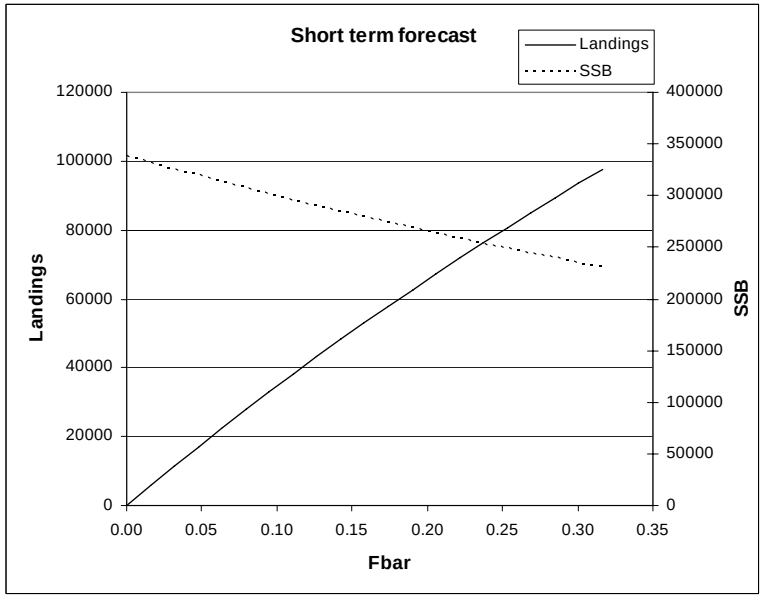


Figure 6.4.16 Herring in SD 30. Short-term forecast for 2007-2009. Yield and SSB at age 1-9+ under the status quo fishing mortality.





MFYPR version 2a
Run: sd 30
Time and date: 12:32 24.4.2007

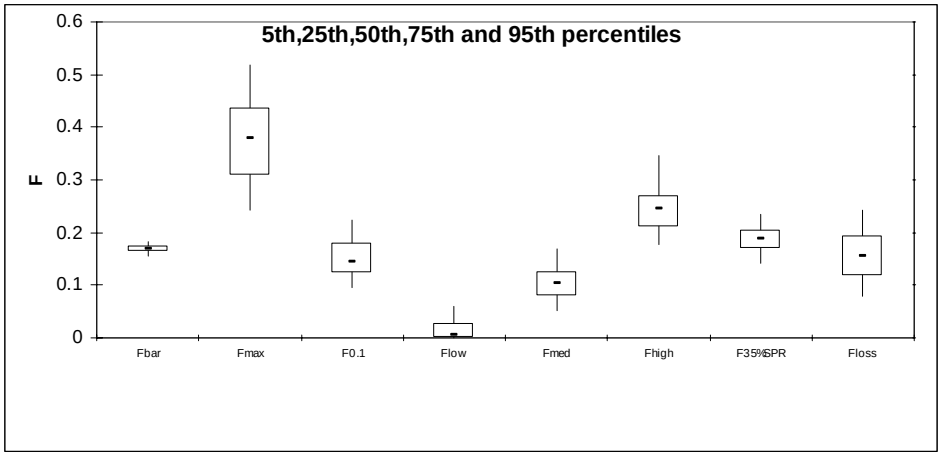
Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.1583
FMax	2.3390	0.3703
F0.1	0.8896	0.1408
F35%SPR	1.2386	0.1961

Weights in kilograms

MFDP version 1a
Run: SD 30
Herring in SD 30
Time and date: 12:31 24.4.2007
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 6.4.17 Herring in SD 30 Yield per recruit and Short term forecast.



Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	4034533	4034533	4113141	4385118	
MBAL	0				0.00
Bloss	99315				
SSB90%R90%Surv	213354	282141	303736	340196	41.18
SPR%ofVirgin	37.38	38.04	40.12	44.06	
VirginSPR	0.13	0.13	0.15	0.19	
SPRloss	0.06	0.05	0.06	0.07	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.17	0.17	0.16	0.15	38.24
Fmax	0.37	0.38	0.31	0.24	0.00
F0.1	0.14	0.14	0.12	0.10	67.65
Flow	0.01	0.00	0.00	0.00	100.00
Fmed	0.07	0.10	0.08	0.05	100.00
Fhigh	0.29	0.25	0.21	0.18	0.00
F35%SPR	0.19	0.19	0.17	0.14	29.41
Floss	0.13	0.16	0.12	0.08	76.47

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

Herring in Bothnian Sea SD 30

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

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

Data source:
W:\acfm\wgbfas\2007\Sharepoint files\Personal Folders\Jukka\pahersd30.txt

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

24.4.2007 15:19:18

Figure 6.4.18 Herring in SD 30. Reference F estimates

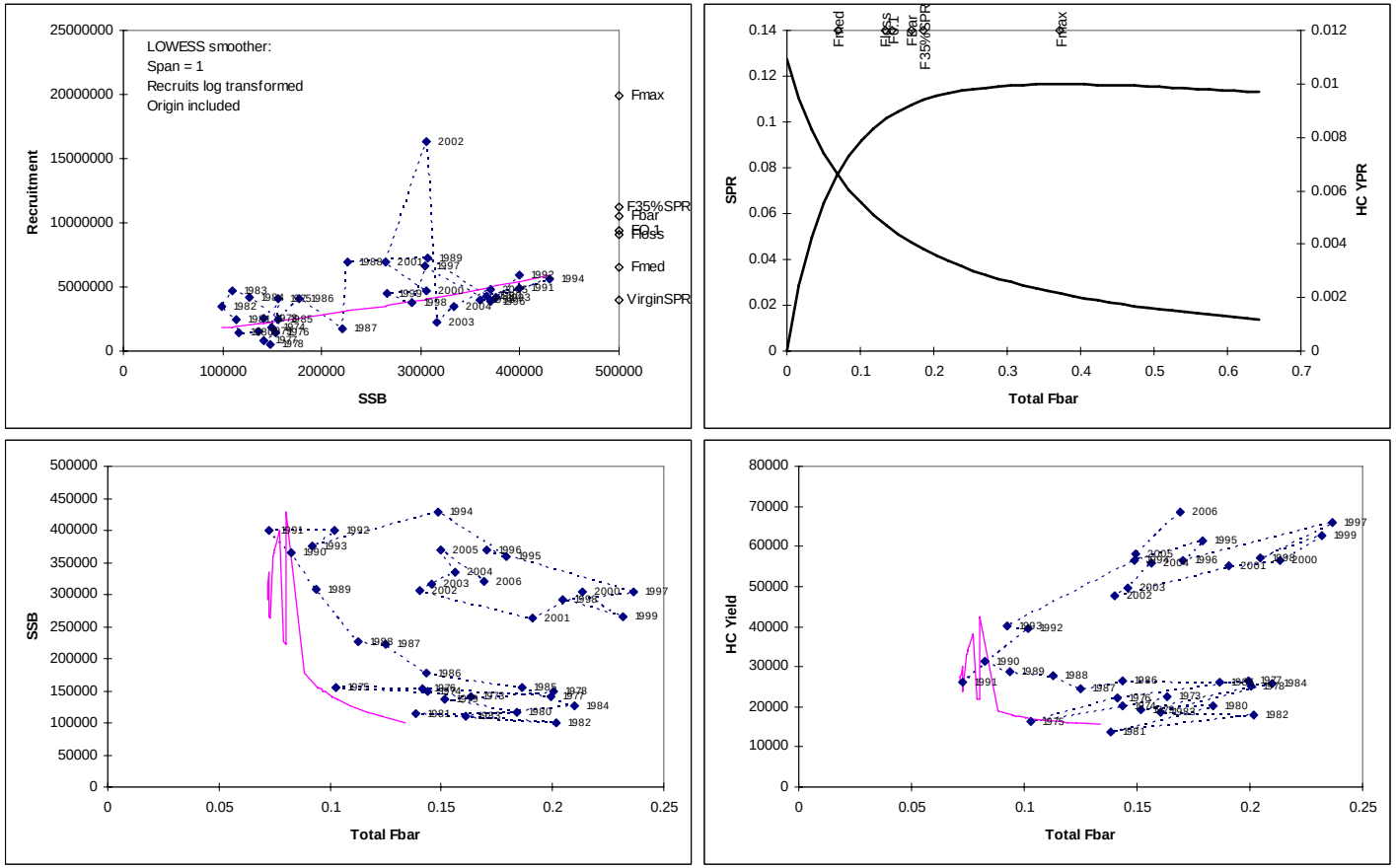


Figure 6.4.19 Herring in SD 30. PA-plots.

6.5 Herring in Subdivision 31 (update assessment)

6.5.1 The fishery

6.5.1.1 Catch Trends

The total landings in the Bothnian Bay in 2006 (2,954 t) are comprised of Finnish (2,684 t) and Swedish (269 t) landings (91% and 9%, respectively). The catches decreased in 2006 by 41% from the year 2005 (Table 6.5.1). Demersal trawling is the most important fishery in SD 31 with the proportion of 55% of the Finnish herring catch. Pelagic trawling takes 37% and trapnet fisheries 8% of the Finnish catches, whereas vendace trawls take 63% and gillnets 36% of the Swedish catch.

6.5.1.2 Unallocated Landings

No unallocated landings were reported. In the year 2006 non-response fraction of fishing activities in Finnish fisheries was 0 % in the group with a EU fishing logbook and about 10 % among those completing coastal fishery forms (= fisheries with trap-nets, coastal gill-nets and vessels less than 10 meters). Of the total catch, almost 90% was reported with the EU fishing logbook. In final catch estimates, the landings data is corrected accordingly.

6.5.1.3 Discards

Discarding rate has been regularly negligible, and discards were not taken into account in assessments.

6.5.1.4 Effort and CPUE Data

According to the updated 2006 Finnish data, the number of total trawling hours decreased in 2006 by 22% from the year 2005. The number of trapnets decreased from 98 in 2005 to 81 in 2006 (Figure 6.5.1, Table 6.5.2). The trapnet CPUE decreased in 2006 by 52% from the year 2005. In trapnet catch, the CPUE has been slightly higher in the 1990's and the 2000's than in the 1980's, and especially in trawl fisheries the CPUE seems to have had an increasing trend (Figures 6.5.2). This may be an indication of an increase in the efficiency of the trawl fishery. The large variation in the CPUE:s of trawl fisheries in the 2000's may be related to regulations on fisheries that have varied from year to year; some trawlers may have occasionally come to the Bothnian Bay from the Bothnian Sea area.

6.5.2 Biological composition of the catch

6.5.2.1 Age Composition

Abundant year classes appear irregularly. Three fairly abundant year classes have appeared since 1999. Of them, the one hatched in 1999, comprised 33% of the catch in 2003 and 18% in 2004. The year classes 2001 and 2002 were abundant in the catches of 2004 (52% of the catch) and 2005 (48% of the catch) and formed 40% of the catch still in 2006. The age composition in the assessment of Bothnian Bay herring is based mainly on Finnish sampling with the addition of Swedish sampling in the II–IV year-quarter. The combined catch in numbers and the summary of sampling for 2006 are given in Tables 6.5.3a and 6.5.3b and the catch-at-age input in Table 6.5.4. One-year-olds corresponded to 7% of the catch in biomass, which is slightly above the yearly average (5%) from 1980–2005, but at highest, their proportion was 18% in 2000. In the regression plots showing the numbers at age versus number at age +1, the best correlations were found in the catch input data gathered from all fleets (Figures 6.5.3, 6.5.4, 6.5.5, and 6.5.6).

6.5.2.2 Quality of catch and biological data

The Finnish and Swedish catch statistics are assumed to be reliable. Of the total catch, almost 90% was reported with the EU fishing logbook without any non-responders. Among the remaining 10% completing coastal fishery forms, the amount of non-responders was about 10%. Therefore this error is regarded negligible. The coverage of the biological sampling in the Bothnian Bay is 2.4 length measurements and 0.1 aged fish per 1000 kg landed herring in Finnish sampling, and 1.4 length measurements and aged fish per 1000 kg landed herring in Swedish sampling.

6.5.3 Mean weight at age

Mean weight-at-age in catches (Table 6.5.5) in 1980–2005 was also used as mean weight in the stock. The growth rate of young herring decreased throughout the 1990s, and since then, it has remained lower than in the 1980s or the first half of the 1990s.

6.5.4 Maturity at age

The maturity data are derived from the Finnish sampling. Constant maturity ogives have been used for period 1980–1982. Since 1983 maturities at age have been annually checked, and since 1998 they have been checked from specimens that are sub-sampled for age determinations. Before spawning time, the number of sampled specimens from length classes that are not expected to be fully mature, is increased in order to assure adequate age representation for age groups 2–5. Updated maturity ogive for 1980–2005 is shown in Table 6.5.6.

6.5.5 Natural Mortality

The natural mortality value of 0.15 is assumed for all years and ages. There is no significant fish predation on herring in the Bothnian Bay.

6.5.6 Catch-at-age Analysis

6.5.6.1 Tuning fleets

Three fleets were available for tuning the XSA: the effort (trawling hours) and CPUE data from two Finnish trawl fleets, pelagic and demersal trawls, and effort (number of trap nets) and CPUE information from Finnish trap net fishery (Table 6.5.2).

6.5.6.2 XSA runs

The official status of this year's assessment is an update assessment. However, as the last year's assessment was not accepted, WGBFAS suggests that in the future the status of the assessment of herring in SD 31 should be changed to an exploratory assessment. The same settings as last year were applied (text table in section 6.5.13). Age group one was included in the final assessment, although not being represented in the tuning series. This was because on average, age group one represents 5% of the catches in biomass, and the share of the age group in catch biomass can be above 10% in strong year classes.

The assessment revealed that there are still problems with internal consistencies and residuals of log catchabilities. Therefore, several alternatives were explored with shortened time series settings to solve the problem (Figures 6.5.7–6.5.11). Last year, the tuning data was restricted to 1994 and onwards, because earlier than 1994 there are inconsistencies in catch at age matrix caused by improper random sampling design and classification of fleets into pelagic and demersal trawl fleets. In this year, the tuning data was restricted even more to start from 1998

with trapnet and demersal trawl and from 2000 with pelagic trawl. This was conducted in order to improve the quality of residual plots (Figures 6.5.7–6.5.11) and retrospective analysis.

In the analysis with the tuning data since 1998 and 2000, the log catchability residual plots (Figure 6.5.11) and the overall diagnostics (Table 6.5.7, Figure 6.5.12) improved somewhat from the last year. The results of the final run are given in Tables 6.5.8-6.5.10. The results of the retrospective analysis (Figure 6.5.13) show a tendency of underestimation of F and overestimation of SSB. Trends in CPUE indices (all values standardised to the mean) compared to final XSA are given in Figure 6.5.14.

Taking into consideration the poor diagnostics, the working group decided that this assessment should be regarded as indicative for the present stock status and exploitation rate.

6.5.7 Recruitment Estimates

There are no fishery independent recruitment data from this stock. Recruitment has varied independently of SSB during the last 20 years (Figure 6.5.15). The recruitment estimates obtained from XSA show only a few strong year classes since 1980. In this area, which is extreme for herring distribution due to low salinity, low temperatures, and ice-coverage, environmental conditions seem to determine the recruitment each year. For example, the strong year classes of 1988, 1999, and 2002 hatched during very warm summers. Because of a possible age determination error, the year class of 2001 may be somewhat smaller than in the XSA results, where it is nearly as strong as the year class of 2002. This is supported by age determination results from cut otoliths, which were not yet used in XSA because of the time series with this method. According to Swedish data, the year classes 1999, 2001, and 2002 of vendace (*Coregonus albula* L.), a planktivorous freshwater fish, were similarly very abundant in Bothnian Bay, which suggests that environmental factors play a major role in the appearance of strong year classes.

6.5.8 Historical stock trends

In the 1980s, the spawning stock biomass fluctuated between 26 000 t and 40 000 t. In the first half of the 1990s, the SSB declined to a level of about 10 000 t, where it has since remained.

6.5.9 Short-term forecast and management options

As WGBFAS did not accept the assessment, no short-term forecast was conducted.

6.5.10 Medium-term projections

No medium-term projections were conducted.

6.5.11 Reference points

No biological reference points have been estimated and proposed.

6.5.12 Quality of assessment

Fishery independent data are not available to be used in the assessment. Due to this, only commercial data have been utilized, which probably causes the problems found in the internal consistencies and residuals of log catchabilities in the XSA.

6.5.13 Comparison with previous assessment

In recent years, the assessments of the Bothnian Bay herring have shown a decreasing trend of SSB and increasing trend of F-value. The assessment results have been consistent with the external information on environmental factors and observed stock dynamics of other species

in the area. In the final run, the SSB estimate for 2005 differed by 31% and the F estimate by 48% between the assessments of the years 2006 and 2007. The difference in recruitment was 52%. A comparison between the assessments of 2006 and 2007 is presented in the text table below.

COMPARISONS OF ASSESSMENT IN 2006 AND 2007: HERRING SD 31				
Category	Parameter	Assessment 2006	Assesment 2007	Difference 2006/2007
XSA-input	Catchability dependent on stock size	<2	<2	No
	Catchability independent of age	>=7	>=7	No
	Tapered time weighting	20 years	20 years	No
	Shrinkage	0.8	0.8	No
	Use of plus group	9+	9+	No
	Tuning data and Tuning period	Three fleets: Trapnet from 1994 on Demersal trawl from 1994 on Pelagic trawl from 1994 on	Three fleets: Trapnet from 1998 on Demersal trawl from 1998 on Pelagic trawl from 2000 on	Yes
	CPUE:			
	Pelagic trawl	Hours	Hours	No change
	Demersal trawl	Hours	Hours	No change
	Trap net	No. nets	No. nets	No change
	Fbar	3-7	3-7	No
XSA-results	SSB 2005 (‘000 t)	21.1	13.0	- 31.0 %
	F3-7 in 2005	0.30	0.44	+48.2 %
	Recruitment Age 1 in 2004 (billions)	0.33	0.16	- 52 %

6.5.14 Management considerations

This stock is a minor part of the resource basis for the herring TAC set for Management Unit III. From the beginning of the year 2005 on, this management unit has included Subdivisions 30 and 31 (to the end of 2004, SD 29N was also included). The actual level of the stock size is unknown.

Table 6.5.1 **Herring in Subdivision 31. Catches (tonnes) by country.**

Year	Finland	Sweden	Total
1971	6,143	820	6,963
1972	3,550	770	4,320
1973	3,152	727	3,976
1974	5,737	665	6,482
1975	4,802	800	5,547
1976	7,763	750	8,508
1977	6,580	750	7,330
1978	9,068	700	9,768
1979	6,275	785	7,060
1980	8,899	760	9,659
1981	7,206	620	7,826
1982	7,982	670	8,652
1983	7,011	696	7,707
1984	8,322	594	8,916
1985	8,595	717	9,312
1986	8,754	336	9,090
1987	7,788	320	8,108
1988	8,501	267	8,768
1989	4,005	423	4,428
1990	7,603	295	7,898
1991	6,800	400	7,200
1992	6,900	400	7,300
1993	8,752	383	9,135
1994	5,195	411	5,606
1995	3,898	563	4,461
1996	5,080	114	5,194
1997	4,195	86	4,281
1998	5,358	224	5,582
1999	3,909	248	4,157
2000	2,479	113	2,592
2001	2,755	67	2,822
2002	3,532	219	3,750
2003	3,855	150	4,004
2004	5,831	142	5,973
2005	4,800	169	4,970
2006*	2,684	269	2,954

* Preliminary

Table 6.5.2 Herring in SD 31. TUNING FLEETS.

TRAPNET. Effort: number of trapnets; Catch: millions.

Year	effort	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1980	424	0.55	0.69	13.99	1.65	2.51	1.82
1981	370	3.27	0.55	1.17	10.07	1.87	1.78
1982	272	16.69	3.61	0.77	3.4	4.35	0.88
1983	233	1.78	6.72	0.54	0.3	1.04	1.82
1984	232	2.76	1.91	8.42	1.25	1.26	0.46
1985	203	14.09	3.48	1.53	4.81	0.52	0.81
1986	292	4.87	7.81	1.2	1.01	2.56	0.63
1987	263	2.61	4.23	7.31	1.14	1.06	1.1
1988	182	2.23	1.43	2.4	3.24	0.58	0.66
1989	78	2.3	1.04	0.69	1.14	0.81	0.18
1990	158	1.03	2.31	1.14	1.07	1.86	1.01
1991	126	9.3	0.36	0.75	0.1	0.69	0.34
1992	95	2.17	2.44	0.23	0.41	0.11	0.13
1993	79	2.31	4.5	5.53	0.85	0.62	0.33
1994	120	3	1.25	2.6	1.92	0	0.26
1995	150	3.43	1.47	1.01	1.15	0.94	0.17
1996	149	0.84	2.9	1.44	0.89	1.26	0.45
1997	174	12.54	2.19	4.51	1.5	0.9	0.74
1998	197	6.5	6.79	1.71	0.91	0.69	0.35
1999	158	2.46	3.82	3.01	0.78	0.41	0.09
2000	138	1.31	2.61	2.1	2.95	0.46	0.07
2001	129	1.07	3.57	1.53	1.86	0.63	0.41
2002	120	10.9	1.15	0.64	0.95	0.62	0.12
2003	111	1.91	9.93	2.97	0.97	0.8	0.99
2004	106	6.21	2.39	2.64	0.7	0.39	0.23
2005	98	5.07	4.22	1.66	2.59	0.73	0.23
2006	81	0.74	2.91	0.81	0.37	0.84	0.11

DEMERSAL TRAWL. Effort:total annual trawling hours * estimated trawlsize coefficient; Catch: millions

Year	effort	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1980	23969	39.1	5	9.7	56.8	13.5	21.9	11.8
1981	12983	41.1	11.8	2.8	9.5	29.9	10.7	9.7
1982	9830	4.6	71.3	13	4.6	11.9	27.4	6.1
1983	13836	10	16.7	50.7	8.7	8	6.7	8.7
1984	18421	62.6	15.2	6.9	25.7	3.3	2.6	1.2
1985	10080	28.3	55.7	10.5	11.2	19.2	4.2	1.8
1986	16230	10	31.4	39.8	6.1	8.5	17.5	1.8
1987	9223	26.4	19.6	25.7	25.6	5.2	6.9	4.9
1988	11936	28.3	18.3	12.9	23.6	22.1	4.7	4.6
1989	8445	4.9	14.4	7.2	7.2	10.8	9.3	2.7
1990	8910	82.2	3.8	16.2	7.1	6.7	11.8	9.4
1991	6746	17.7	55.4	3.5	14.5	7	6.4	6.2
1992	8069	10.7	33.4	61.3	4.4	6.7	7.7	7.4
1993	7994	45	16.1	37.2	57.7	5.2	5.1	4.9
1994	6892	26.7	25.9	9.8	15.5	22.4	1.5	1.4
1995	4839	11.3	27.9	16.1	5	11.1	11.8	1.7
1996	7566	89.9	6.6	17.7	13.4	7.5	9.3	7.9
1997	5198	26.63	40.67	6.26	13.8	5.55	5.23	2.88
1998	9436	34.22	52.41	52.76	13.45	6.78	5.31	2.68
1999	4154	10.75	20.43	31.73	22.14	6.13	2.87	0.71
2000	2532	5.61	4.85	8.89	7.02	9	1.58	0.27
2001	1628	35.94	4.46	12.49	5.29	6.34	2.17	1.34
2002	3546	8.65	66.26	6.7	4.59	4.6	3.73	4.41
2003	3838	33.07	6.6	29.35	8.73	2.85	2.41	2.92
2004	2989	57.45	47.08	19.24	19.47	5.27	2.79	1.59
2005	3378	24.8	42.1	33.3	10.8	15.2	4.6	1.8
2006	2301	12.4	5.5	19	5.5	4.4	5.2	0.9

PELAGIC TRAWL. Effort:total annual trawling hours * estimated trawlsize coefficient; Catch: millions

Year	effort	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1980	3589	5.4	1.4	2.4	2.4	1	0.3	0.3
1981	3242	31.4	4.4	0.1	0.4	1.7	0.6	0.4
1982	1803	7.3	6.5	1.7	0.3	0.3	0.1	0
1983	3014	1.8	1.9	5.7	0.9	0.8	1.6	2.3
1984	3940	34.4	2.3	1.5	10.1	2.6	1	0
1985	6393	28.9	27.1	3.3	2.3	5.6	0.7	0.9
1986	4864	9.2	18.1	23.8	4.4	4.1	7.2	1.3
1987	4898	5.3	6.8	10.4	11.9	3	2.9	1.9
1988	7447	4.5	4.9	6.4	7.5	8.7	1.1	2.3
1989	2639	3.4	5.8	2.1	2.6	3.7	4.2	0.9
1990	3620	31.1	3	7	3.8	5.2	6.9	3.2
1991	4738	11.2	32.5	1.6	4.6	1.8	2.4	3.3
1992	4197	7.7	12.1	21.3	1.5	3.9	3.1	2.4
1993	3880	9	5.7	13.1	30.4	3.5	2.9	1.7
1994	1192	3.4	3.4	1.3	3.9	10.8	1	2.4
1995	886	1.9	4	2.3	1	2	2	1.9
1996	1659	9.3	3.9	4.9	2	1.6	1.8	4.4
1997	697	6.26	6.01	0.49	0.7	0.87	0.56	0.16
1998	628	2.29	5.07	4.16	0.94	0.55	0.23	0.13
1999	612	3.13	6.2	9.64	7.59	1.96	1.03	0.24
2000	740	2.53	2.33	3.7	2.91	3.15	0.68	0.15
2001	406	11.5	1.45	3.73	1.58	1.93	0.64	0.4
2002	554	1.24	9.73	0.95	0.67	0.66	0.55	0.64
2003	681	10.87	2	9.97	2.9	0.94	0.81	1.02
2004	1647	33.23	26.89	10.55	11.33	3.02	1.67	0.95
2005	676	3.8	6.3	5	1.7	2.4	0.7	0.3
2006	871	9.3	3.7	13.3	3.5	2	3.5	0.5

Table 6.5.3a **Herring in SD 31 in 2006. Catch in numbers (millions) and mean weights (g).**
Quarterly combined Finnish and Swedish data.
There were no samples from the first quarter of 2006 in SD 31, thus weighs from SD 30 were used (yellow).

SD30

2006	Q1		Q2		Q3		Q4		ANNUAL	
FI 31	CN	WC	CN	WC	CN	WC	CN	WC	CN	WC
0					0.94	6.17	0.00	0.00	0.94	6.17
1	0.0005	4.78	4.93	5.72	13.22	11.86	0.04	12.00	18.19	10.19
2	0.0008	12.40	12.14	14.67	11.2934	18.59	0.09	17.60	23.53	16.56
3	0.0003	17.86	5.35	20.29	3.7354	21.70	0.71	21.63	9.80	20.93
4	0.0025	21.43	23.16	23.78	10.3655	25.28	1.57	23.18	35.10	24.19
5	0.0008	25.06	6.95	26.64	1.7795	29.56	1.06	28.00	9.79	27.32
6	0.0002	32.25	3.12	31.57	0.8239	32.33	2.71	29.56	6.65	30.85
7	0.0002	33.88	7.51	36.48	1.3285	30.92	0.68	35.29	9.52	35.62
8	0.0002	36.27	0.91	35.75	0.2627	38.50	0.34	42.00	1.51	37.63
9	0.0006	47.37	3.21	47.39	0.6638	42.79	0.00	0.00	3.88	46.60
CATCH	0.14		1608		874.4		202		2684.44	90.88583 %
SOP	0.14		1608		874.4		202		2684.44	
SOP%					100%				100%	

2006	Q1		Q2		Q3		Q4		ANNUAL	
SWE 31	CN	WC	CN	WC	CN	WC	CN	WC	CN	WC
0			0		0.03045581	12	0.12723814	12	0.157694	12
1			0		0.25887442	14.29412	1.08152419	14.29412	1.340399	14.29412
2			0		0.18273488	18.91667	0.76342884	18.91667	0.946164	18.91667
3			0		0.38069767	23.48	1.59047674	23.48	1.971174	23.48
4			0.04953535	30.6	0.32231687	24.30689	1.3366086	24.24208	1.708461	24.43865
5			0.18823432	42.05263	0.24107273	25.74555	0.9573267	25.10775	1.386634	27.51888
6			0.44581812	42.75556	0.0836461	33.2646	0.19997918	28.52913	0.729443	37.767
7			0.5845171	44.77966	0.10384975	36.06401	0.14487394	26.90574	0.833241	40.58569
8			0.33684036	46.05882	0.07601067	35.58802	0.1381845	26.39947	0.551036	39.68444
9+			0.33684036	49.17647	0.07845558	43.74194	0.01885206	43.74194	0.434148	47.9584
CATCH	0		86.7463		43.167		139.2865		269.1998	9.114172 %
SOP	0		87		43		139		269	
SOP%	100%		100%		100%		100%		100%	

2006	Q1		Q2		Q3		Q4		ANNUAL	
FIN + SWE	CN	WC	CN	WC	CN	WC	CN	WC	CN	WC
0					0.97	6.3	0.13	12.0	1.1	7.0
1	0.0005	4.8	4.93	5.7	13.48	11.9	1.12	14.2	19.53	10.47
2	0.0008	12.4	12.14	14.7	11.48	18.6	0.86	18.8	24.48	16.65
3	0.0003	17.9	5.35	20.3	4.12	21.9	2.30	22.9	11.77	21.35
4	0.0025	21.4	23.21	23.8	10.69	25.3	2.91	23.7	36.81	24.20
5	0.0008	25.1	7.14	27.0	2.02	29.1	2.02	26.6	11.18	27.34
6	0.0002	32.3	3.57	33.0	0.91	32.4	2.91	29.5	7.38	31.53
7	0.0002	33.9	8.10	37.1	1.43	31.3	0.82	33.8	10.35	36.02
8	0.0002	36.3	1.24	38.5	0.34	37.8	0.48	37.5	2.06	38.18
9+	0.0006	47.4	3.55	47.6	0.74	42.9	0.02	43.7	4.31	46.74
CATCH	0.14		1695		918		341		2954	100 %
SOP	0		1695		918		341		2954	
SOP%	100%		100%		100%		100%		100%	

Table 6.5.3b Herring in SD 31, Bothnian Bay. Samples of commercial catches by quarter for 2006 available to the Working Group.

Sub-division 31	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
	Finland	1	0			
		2	1608	9	4196	281
		3	874	6	2705	198
		4	202		391	58
		Total	2684	15	7292	537
	Sweden	1	0			
		2	87	2	200	200
		3	43			
		4	139	1	100	100
		Total	269	3	300	300
	Total	1	0	0	0	0
		2	1695	11	4396	481
		3	917	6	2705	198
		4	341	1	491	158
		Total	2953	18	7592	837

Table 6.5.4 Herring in SD 31. Catch in Numbers (thousands).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1980	61900	57900	5900	13600	88200	13200	22800	18100	18700
1981	13600	75100	25200	5100	12200	50100	17300	16700	18200
1982	3700	15400	119300	22200	5200	15800	28500	6600	16100
1983	8100	6300	14300	69500	7900	12000	14600	26800	21000
1984	40500	144600	20100	10800	54800	7500	6400	1100	19500
1985	7800	91500	124000	15100	11000	31200	4700	2800	13400
1986	5200	18300	52200	70900	12400	14600	29700	4200	24700
1987	10200	34300	28300	42100	48600	10300	12400	9600	12800
1988	6500	41800	29400	25300	39200	40900	8000	8300	14500
1989	11200	10600	24800	11400	11600	17100	15800	3900	4600
1990	16900	148500	8800	26400	12600	13500	20900	9300	10700
1991	2100	34100	99200	5100	19100	8700	9200	9300	15600
1992	16200	21500	50500	89800	6500	11500	11500	10500	13000
1993	19500	58200	25100	57100	97600	9900	9000	7300	11100
1994	7000	37700	34600	12800	29200	40300	2100	9700	4200
1995	47300	19400	37200	19700	10900	19700	17800	2000	1800
1996	23100	107700	11600	26100	17200	10300	12700	13000	1100
1997	26800	40700	63500	9600	20400	8500	7100	4100	2500
1998	10200	42500	66900	66200	16700	8500	6400	3300	3000
1999	1500	15800	30300	47100	33900	9200	4500	1100	1800
2000	50766	10213	8868	15987	12685	16071	2862	508	1839
2001	58123	58162	7164	20261	8603	10374	3521	2198	862
2002	32620	11985	91421	9460	6330	6515	5146	5287	859
2003	64194	55794	10973	50333	15517	5274	4236	5001	3089
2004	16724	100494	82613	33062	34092	9150	4940	2820	2617
2005	23442	32224	54707	43693	15087	21037	6265	2570	3584
2006	19532	24477	11771	36809	11182	7384	10350	2059	4039

Table 6.5.5 Herring in SD 31. Weight in Catch and in the Stock (g).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1980	11.3	22.8	30.4	37.8	40.0	41.6	43.3	46.6	50.4
1981	14.4	20.7	28.8	33.6	39.2	42.0	44.6	46.6	52.0
1982	16.9	25.8	30.7	37.5	42.9	47.2	49.4	52.9	55.1
1983	15.5	27.2	34.4	38.3	39.5	47.6	47.9	53.0	55.9
1984	15.9	20.9	33.5	39.1	42.1	44.8	51.8	54.1	55.4
1985	12.3	19.8	29.7	37.3	43.7	45.3	53.0	53.4	58.3
1986	13.4	20.2	29.3	36.6	41.6	46.3	49.6	48.8	65.5
1987	14.2	22.6	31.5	38.2	43.6	48.6	54.1	57.2	63.3
1988	8.3	22.1	34.7	40.8	45.3	50.2	54.9	60.1	64.8
1989	11.4	21.7	32.6	41.7	46.4	49.8	53.2	58.1	64.6
1990	13.5	18.4	33.4	37.7	44.6	50.1	54.1	55.9	67.2
1991	14.9	20.3	27.3	35.4	41.5	46.5	48.9	53.8	66.3
1992	12.6	19.4	26.5	29.9	40.8	42.1	48.2	51.2	62.2
1993	14.2	20.3	27.6	31.5	33.4	43.2	48.5	52.6	60.1
1994	15.4	20.1	28.5	33.2	35.0	36.5	43.8	50.3	60.7
1995	6.6	17.5	28.7	33.1	35.8	38.7	41.0	48.1	60.8
1996	10.9	14.9	25.8	31.3	34.7	39.8	41.3	48.4	51.9
1997	9.5	16.5	22.7	30.1	35.0	37.3	41.3	43.0	43.2
1998	9.6	13.5	21.4	28.4	36.8	41.1	44.6	52.7	56.4
1999	9.2	14.0	20.7	27.5	35.4	44.1	49.3	54.1	55.7
2000	9.3	16.5	22.8	28.6	32.4	38.5	43.5	44.7	58.3
2001	7.0	15.8	24.4	24.4	25.9	32.3	35.8	35.8	41.2
2002	9.2	17.5	22.5	28.3	32.5	34.5	37.9	41.7	43.9
2003	7.4	14.9	22.2	26.5	28.8	34.6	38.0	37.5	44.4
2004	7.3	13.6	20.9	27.1	30.8	38.0	40.2	42.1	48.5
2005	10.9	16.2	21.2	27.2	33.0	35.3	39.7	45.5	51.4
2006	10.5	16.7	21.4	24.2	27.3	31.5	36	38.2	46.7

Table 6.5.6 Herring in SD 31. Proportion Mature at Year Start.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1980	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.30	0.92	0.92	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.19	0.94	0.95	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.29	0.95	0.96	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.33	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.39	0.97	0.99	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.32	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.00	0.37	0.82	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.20	0.71	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.00	0.41	0.93	1.00	1.00	1.00	1.00	1.00	1.00
1994	0.00	0.42	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.15	0.85	1.00	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.63	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.29	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1998	0.00	0.43	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1999	0.00	0.50	0.96	1.00	1.00	1.00	1.00	1.00	1.00
2000	0.00	0.56	0.90	0.97	0.97	1.00	1.00	1.00	1.00
2001	0.00	0.64	0.94	1.00	1.00	1.00	1.00	1.00	1.00
2002	0.00	0.43	0.97	0.96	1.00	1.00	1.00	1.00	1.00
2003	0.02	0.62	1.00	0.96	1.00	1.00	1.00	1.00	1.00
2004	0.13	0.35	0.97	1.00	0.98	1.00	1.00	1.00	1.00
2005	0.00	0.49	0.96	1.00	0.95	1.00	1.00	1.00	1.00
2006	0.04	0.61	0.87	1.00	1.00	1.00	1.00	1.00	1.00

Table 6.5.7 Herring in SD 31. XSA tuning diagnostics. **1/6**

Catch data for 27 years. 1980 to 2006. Ages 1 to 9.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01:Trap	1980	2006	3	8	0.4	0.6
FLT02: Bot	1980	2006	2	8	0.4	0.8
FLT03: Pelt	1980	2006	2	8	0.4	0.8

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 0.800

Minimum standard error for population
estimates derived from each fleet = 0.300

Prior weighting not applied

Lowestoft VPA Version 3.1

########

Retrospective XSA run
Herring in Bothnian Bay SD 31
CPUE data from file ffleet31.txt
Terminal year for this assessment : 2006
Tuning converged after 59 iterations

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics. 2/6

Regression weights

0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.084	0.012	0.101	0.317	0.091	0.14	0.119	0.119	0.096
2	0.32	0.172	0.104	0.152	0.094	0.211	0.319	0.331	0.166
3	0.417	0.375	0.13	0.094	0.358	0.11	0.517	0.271	0.182
4	0.521	0.551	0.327	0.461	0.164	0.322	0.523	0.539	0.279
5	0.456	0.523	0.261	0.277	0.239	0.414	0.355	0.454	0.239
6	0.717	0.462	0.475	0.334	0.329	0.302	0.433	0.365	0.395
7	1.093	1.036	0.238	0.168	0.259	0.349	0.485	0.564	0.29
8	0.773	0.504	0.272	0.275	0.385	0.407	0.389	0.473	0.342

XSA population numbers (Thousands)

	AGE							
YEAR	1	2	3	4	5	6	7	8
1998	1.36E+05	1.67E+05	2.11E+05	1.76E+05	4.92E+04	1.79E+04	1.04E+04	6.61E+03
1999	1.31E+05	1.08E+05	1.04E+05	1.20E+05	8.98E+04	2.68E+04	7.52E+03	2.99E+03
2000	5.70E+05	1.11E+05	7.83E+04	6.18E+04	5.95E+04	4.58E+04	1.46E+04	2.30E+03
2001	2.31E+05	4.43E+05	8.62E+04	5.92E+04	3.84E+04	3.94E+04	2.45E+04	9.87E+03
2002	4.03E+05	1.45E+05	3.28E+05	6.75E+04	3.21E+04	2.50E+04	2.43E+04	1.78E+04
2003	5.30E+05	3.16E+05	1.13E+05	1.97E+05	4.93E+04	2.18E+04	1.55E+04	1.61E+04
2004	1.61E+05	3.97E+05	2.20E+05	8.75E+04	1.23E+05	2.81E+04	1.39E+04	9.42E+03
2005	2.26E+05	1.23E+05	2.48E+05	1.13E+05	4.46E+04	7.42E+04	1.57E+04	7.35E+03
2006	2.30E+05	1.72E+05	7.62E+04	1.63E+05	5.68E+04	2.44E+04	4.44E+04	7.67E+03

Estimated population abundance at 1st Jan 2007

0.00E+00	1.80E+05	1.26E+05	5.46E+04	1.06E+05	3.85E+04	1.41E+04	2.86E+04

Taper weighted geometric mean of the VPA populations:

2.63E+05	2.06E+05	1.45E+05	1.01E+05	5.73E+04	3.38E+04	2.00E+04	1.03E+04

Standard error of the weighted Log(VPA populations) :

0.5211	0.5439	0.5568	0.4942	0.4856	0.5257	0.6336	0.8559

1

Log catchability residuals.
Fleet : FLT01:Trapnetnew

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	No data for this fleet at this age								
3	0.03	-0.04	-0.36	-0.61	0.58	-0.15	0.61	0.25	-0.35
4	-0.27	-0.23	0.07	0.56	-0.78	0.46	0	0.4	-0.28
5	-0.3	-0.08	-0.03	0.17	-0.47	0.8	-0.21	0.47	-0.41
6	0.02	-0.45	0.49	0.18	0.03	0.25	-0.22	0.16	-0.46
7	0.45	0.44	-0.36	-0.54	-0.43	0.4	-0.09	0.53	-0.32
8	0.06	-0.42	-0.38	-0.01	-1.7	0.6	-0.28	0.09	-0.57

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

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

Age	3	4	5	6	7	8
Mean Log q	-15.4214	-14.835	-14.9478	-14.7552	-14.7315	-14.7315
S.E(Log q)	0.4292	0.4393	0.4296	0.3212	0.4404	0.7176

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.59	5.238	13.98	0.96	9	0.12	-15.42
4	0.97	0.076	14.75	0.54	9	0.46	-14.83
5	1.17	-0.36	15.62	0.42	9	0.53	-14.95
6	0.77	1.183	13.72	0.8	9	0.24	-14.76
7	2.3	-2.285	21.2	0.32	9	0.81	-14.73
8	1.09	-0.222	15.57	0.48	9	0.75	-15.02
1							

Fleet : FLT02: Bottraw lhours

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	-0.28	-0.27	-0.49	0.45	-0.67	-0.12	0.52	0.74	-0.01
3	-0.22	0.33	-0.47	-0.23	0.52	-0.96	0.84	0.34	-0.19
4	-0.5	0.21	-0.04	0.87	-0.84	-0.42	0.34	0.52	-0.18
5	-0.5	0.26	-0.14	0.47	-0.3	-0.06	0.05	0.41	-0.25
6	-0.22	-0.05	0.3	0.46	-0.19	-0.63	0.06	-0.01	0.26
7	0.32	0.81	-0.42	-0.23	-0.4	-0.41	0.18	0.48	-0.22
8	-0.1	0.02	-0.32	0.27	0.15	-0.23	-0.06	0.24	-0.19

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

Age	2	3	4	5	6	7	8
Mean Log q	-17.0862	-16.8917	-16.3616	-16.4991	-16.2994	-16.3112	-16.3112
S.E(Log q)	0.49	0.5641	0.5458	0.3277	0.3297	0.4468	0.2133

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

Regression statistics :

Ages w ith q independent of year class strength and constant w .r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.71	1.351	15.65	0.77	9	0.33	-17.09
3	0.61	2.057	14.95	0.81	9	0.29	-16.89
4	1.66	-0.919	19.54	0.23	9	0.92	-16.36
5	0.94	0.227	16.14	0.65	9	0.33	-16.5
6	0.75	1.296	14.79	0.8	9	0.24	-16.3
7	2.21	-2.11	24.25	0.32	9	0.82	-16.31
8	0.91	0.868	15.66	0.93	9	0.2	-16.33

Fleet : FLT03: Peltraw lhours

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	99.99	99.99	-0.36	0.39	-1.06	0.19	0.27	0.16	0.37
3	99.99	99.99	-0.17	-0.16	0.25	-0.63	0.67	-0.16	0.18
4	99.99	99.99	0.08	0.81	-1.17	-0.01	0.1	0	0.2
5	99.99	99.99	-0.02	0.42	-0.59	0.34	-0.13	-0.06	0.04
6	99.99	99.99	0.32	0.5	-0.44	-0.17	-0.06	-0.41	0.29
7	99.99	99.99	-0.11	-0.13	-0.53	0.15	0.18	0.13	0.28
8	99.99	99.99	0.25	0.37	0	0.38	-0.05	-0.01	0.12

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

Age	2	3	4	5	6	7	8
Mean Log (	-16.78	-16.6881	-16.1283	-16.2708	-16.1393	-16.2371	-16.2371
S.E(Log q)	0.5298	0.4149	0.5899	0.3335	0.3691	0.2797	0.243

Regression statistics :

Ages w ith q independent of year class strength and constant w .r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.67	1.423	15.27	0.79	7	0.33	-16.78
3	0.78	0.985	15.64	0.81	7	0.33	-16.69
4	0.94	0.115	15.85	0.43	7	0.61	-16.13
5	0.96	0.104	16.08	0.65	7	0.35	-16.27
6	1.04	-0.099	16.36	0.57	7	0.42	-16.14
7	1.01	-0.023	16.28	0.7	7	0.31	-16.24
8	1.02	-0.126	16.2	0.93	7	0.2	-16.09
1							

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

Fleet disaggregated estimates of survivors :

Age 1 Catchability dependent on age and year class strength

Year class = 2005

FLT01:Trapnetnew

Age	1
Survivors	0
Raw Weigl	0

FLT02: Bottraw lhours

Age	1
Survivors	0
Raw Weigl	0

FLT03: Peltraw lhours

Age	1
Survivors	0
Raw Weigl	0

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	1	0	0	0	0	0	0
FLT02: Bot	1	0	0	0	0	0	0
FLT03: Pel	1	0	0	0	0	0	0
P shrinka	205911	0.54				0.684	0.084
F shrinka	134874	0.8				0.316	0.126

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
180135	0.45	12.1	2	26.91	0.096
1					

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2004

FLT01:Trapnetnew

Age	2	1
Survivors	0	0
Raw Weigl	0	0

FLT02: Bottraw lhours

Age	2	1
Survivors	124949	0
Raw Weigl	3.157	0

FLT03: Peltraw lhours

Age	2	1
Survivors	182270	0
Raw Weigl	2.633	0

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	1	0	0	0	0	0	0
FLT02: Bot	124949	0.518	0	0	1	0.429	0.167
FLT03: Pel	182270	0.567	0	0	1	0.358	0.117
F shrinka	68000	0.8				0.213	0.288

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
125690	0.35	0.28	3	0.811	0.166
1					

Age 3 Catchability constant w .r.t. time and dependent on age
Year class = 2003

FLT01:Trapnetnew

Age	3	2	1
Survivors	38542	0	0
Raw Weig	4.049	0	0

FLT02: Bottraw lhours

Age	3	2	1
Survivors	45331	114205	0
Raw Weig	2.344	2.23	0

FLT03: Peltraw lhours

Age	3	2	1
Survivors	65721	64380	0
Raw Weig	4.224	1.86	0

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	38542	0.454	0	0	1	0.249	0.249
FLT02: Bot	71129	0.396	0.462	1.17	2	0.281	0.143
FLT03: Pel	65308	0.354	0.009	0.03	2	0.374	0.155
F shrinka	31111	0.8				0.096	0.301

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
54634	0.22	0.18	6	0.801	0.182
1					

Age 4 Catchability constant w .r.t. time and dependent on age

Year class = 2002

FLT01:Trapnetnew

Age	4	3	2	1
Survivors	80317	135871	0	0
Raw Weig	3.508	2.8	0	0

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

FLT02: Bottraw lhours

Age	4	3	2	1
Survivors	88613	148408	178916	0
Raw Weigl	2.273	1.621	1.558	0

FLT03: Peltraw lhours

Age	4	3	2	1
Survivors	129767	90531	138275	0
Raw Weigl	1.896	2.921	1.299	0

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	101425	0.327	0.261	0.8	2	0.325	0.29
FLT02: Bot	126267	0.334	0.218	0.65	3	0.28	0.239
FLT03: Pel	110749	0.313	0.137	0.44	3	0.315	0.269
F shrinka	57874	0.8				0.08	0.464

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
105989	0.18	0.11	9	0.615	0.279
1					

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2001

FLT01:Trapnetnew

Age	5	4	3	2	1
Survivors	25542	57308	71139	0	0
Raw Weigl	3.821	2.132	1.327	0	0

FLT02: Bottraw lhours

Age	5	4	3	2	1
Survivors	29921	64537	88763	34275	0
Raw Weigl	6.566	1.381	0.768	0.819	0

FLT03: Peltraw lhours

Age	5	4	3	2	1
Survivors	40034	38346	75056	46747	0
Raw Weigl	6.179	1.152	1.384	0.683	0

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	39004	0.287	0.319	1.11	3	0.262	0.236
FLT02: Bot	36936	0.261	0.215	0.82	4	0.343	0.248
FLT03: Pel	44181	0.259	0.13	0.5	4	0.338	0.211
F shrinka	20497	0.8				0.056	0.41

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
38511	0.15	0.12	12	0.76	0.239

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2000

FLT01:Trapnetnew

Age	6	5	4	3	2	1
Survivors	8897	22522	14141	12171	0	0
Raw Weigl	5.845	2.076	1.173	1.093	0	0

FLT02: Bottraw lhours

Age	6	5	4	3	2	1
Survivors	18397	21264	19831	5430	7261	0
Raw Weigl	5.547	3.566	0.76	0.633	0.753	0

FLT03: Peltraw lhours

Age	6	5	4	3	2	1
Survivors	18823	13311	15628	7565	4905	0
Raw Weigl	4.314	3.356	0.634	1.14	0.628	0

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Trap	11727	0.228	0.212	0.93	4	0.308	0.46
FLT02: Bot	16986	0.213	0.188	0.88	5	0.34	0.339
FLT03: Pell	13749	0.22	0.194	0.88	5	0.304	0.404
F shrinka	15383	0.8				0.047	0.368

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
14143 1	0.13	0.11	15	0.839	0.395

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1999

FLT01:Trapnetnew

Age	7	6	5	4	3	2	1
Survivors	20797	33678	23113	45511	50891	0	0
Raw Weigl	3.455	4.509	1.763	1.213	0.876	0	0

FLT02: Bottraw lhours

Age	7	6	5	4	3	2	1
Survivors	22963	28241	29957	18751	47861	44920	0
Raw Weigl	3.357	4.279	3.029	0.786	0.507	0.564	0

FLT03: Peltraw lhours

Age	7	6	5	4	3	2	1
Survivors	37916	18986	25179	28428	36697	42434	0
Raw Weigl	8.318	3.328	2.851	0.656	0.914	0.47	0

Table 6.5.7 continued Herring in SD 31. XSA tuning diagnostics.

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	29409	0.208	0.152	0.73	5	0.278	0.283
FLT02: Bot	27554	0.199	0.093	0.47	6	0.295	0.299
FLT03: Pel	30434	0.186	0.127	0.68	6	0.39	0.274
F shrinka	16074	0.8				0.037	0.468

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
28594	0.11	0.07	18	0.621	0.29
1					

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1998

FLT01:Trapnetnew

Age	8	7	6	5	4	3	2	1
Survivors	2653	7960	3779	10460	2159	2541	0	0
Raw Weigl	1.235	1.865	2.268	0.832	0.666	0.621	0	0

FLT02: Bottraw lhours

Age	8	7	6	5	4	3	2	1
Survivors	3891	7567	5001	4432	2020	3741	2867	0
Raw Weigl	7.895	1.812	2.152	1.429	0.431	0.359	0.414	0

FLT03: Peltraw lhours

Age	8	7	6	5	4	3	2	1
Survivors	5303	5343	4432	6603	1452	3978	3258	0
Raw Weigl	7.895	4.49	1.674	1.345	0.36	0.647	0.345	0

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:Tra	4424	0.213	0.241	1.13	6	0.186	0.359
FLT02: Bot	4318	0.187	0.109	0.58	7	0.36	0.366
FLT03: Pel	5058	0.172	0.09	0.53	7	0.416	0.32
F shrinka	5961	0.8				0.039	0.278

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
4691	0.11	0.07	21	0.666	0.342

Table 6.5.8 Herring in SD 31. XSA results: Fishing mortality at age (F).

At 20/04/2007 19:37

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1980	1981	1982	1983	1984	1985	1986
AGE							
1	0.0808	0.0554	0.0185	0.0101	0.0701	0.026	0.0228
2	0.3422	0.1262	0.078	0.0376	0.2352	0.2115	0.0744
3	0.0759	0.2311	0.2855	0.0915	0.1534	0.3068	0.1698
4	0.1806	0.0825	0.3094	0.2531	0.0879	0.1563	0.2725
5	0.335	0.2311	0.1074	0.1625	0.3064	0.1151	0.176
6	0.2151	0.3047	0.4963	0.3625	0.2164	0.2707	0.2083
7	0.2395	0.4547	0.2685	1.171	0.3157	0.1934	0.4212
8	0.2099	0.2618	0.2946	0.4101	0.2167	0.2091	0.2505
+gp	0.2099	0.2618	0.2946	0.4101	0.2167	0.2091	0.2505
FBAR 3- 7	0.2092	0.2608	0.2934	0.4081	0.2159	0.2085	0.2496

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.0336	0.0712	0.013	0.0467	0.0134	0.0716	0.0899	0.0501	0.0966	0.0714
2	0.1943	0.1775	0.1505	0.226	0.1188	0.175	0.3708	0.2374	0.1807	0.3123
3	0.1493	0.2402	0.1437	0.1704	0.2192	0.2446	0.3003	0.3712	0.367	0.148
4	0.1904	0.183	0.1305	0.2122	0.1336	0.2981	0.4527	0.2326	0.3529	0.4485
5	0.287	0.2573	0.1132	0.1972	0.2215	0.2379	0.5772	0.4157	0.2999	0.5608
6	0.2055	0.3932	0.1611	0.1767	0.1922	0.1905	0.6449	0.4694	0.5176	0.4845
7	0.2594	0.2305	0.2436	0.2852	0.1661	0.3936	0.2117	0.2526	0.3674	0.709
8	0.2191	0.2618	0.1588	0.209	0.1871	0.274	0.4396	0.3499	0.3828	0.4727
+gp	0.2191	0.2618	0.1588	0.209	0.1871	0.274	0.4396	0.3499	0.3828	0.4727
FBAR 3- 7	0.2183	0.2608	0.1584	0.2083	0.1865	0.2729	0.4374	0.3483	0.381	0.4702

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR **-**
AGE											
1	0.1386	0.084	0.0124	0.101	0.3167	0.0914	0.1399	0.1186	0.1188	0.0959	0.1111
2	0.1644	0.3202	0.1716	0.1043	0.1525	0.0935	0.2109	0.319	0.3311	0.1661	0.2721
3	0.2892	0.4173	0.3748	0.1302	0.0939	0.3578	0.1101	0.5175	0.2713	0.1822	0.3237
4	0.1665	0.5212	0.551	0.3268	0.4605	0.1638	0.3218	0.5234	0.5387	0.2793	0.4471
5	0.7214	0.4559	0.5225	0.2613	0.2766	0.2387	0.4141	0.3549	0.4535	0.2385	0.349
6	0.5653	0.7171	0.4616	0.4748	0.3337	0.329	0.3024	0.4331	0.3645	0.395	0.3975
7	0.6916	1.0931	1.0355	0.2383	0.1681	0.2592	0.3486	0.4848	0.5641	0.2896	0.4462
8	0.4895	0.7728	0.5044	0.2721	0.2745	0.3846	0.4065	0.3894	0.4734	0.3417	0.4015
+gp	0.4895	0.7728	0.5044	0.2721	0.2745	0.3846	0.4065	0.3894	0.4734	0.3417	
FBAR 3- 7	0.4868	0.6409	0.5891	0.2863	0.2666	0.2697	0.2994	0.4627	0.4384	0.2769	

Table 6.5.9 Herring in SD 31. XSA results: Stock numbers at age (thousands)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1980	1981	1982	1983	1984	1985	1986
AGE							
1	859712	271791	217519	872641	644670	328204	248907
2	215333	682534	221316	183788	743574	517299	275251
3	87026	131623	517788	176201	152343	505849	360355
4	88698	69430	89910	334985	138391	112475	320348
5	333933	63726	55028	56790	223846	109095	82799
6	73527	205592	43531	42538	41550	141826	83693
7	115375	51039	130474	22809	25480	28805	93125
8	103041	78152	27880	85860	6087	15994	20432
+gp	106079	84814	67697	66873	107513	76270	119673
TOTA	1982724	1638701	1371143	1842485	2083455	1835814	1604584

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	332870	102001	931323	399523	169964	252690	244438	154529	553755	361170
2	209412	277041	81763	791207	328193	144341	202463	192299	126511	432739
3	219933	148421	199672	60540	543228	250843	104289	120267	130537	90890
4	261732	163043	100471	148851	43943	375529	169051	66476	71415	77842
5	209949	186217	116861	75900	103625	33091	239909	92530	45341	43191
6	59762	135616	123911	89821	53638	71471	22451	115944	52551	28913
7	58490	41882	78781	90787	64785	38096	50847	10139	62406	26954
8	52599	38839	28626	53149	58751	47226	22120	35414	6779	37199
+gp	69876	67567	33666	60934	98228	58216	33420	15253	6066	3126
0 TOT	1474624	1160628	1695075	1770712	1464357	1271502	1088989	802852	1055361	1102026

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 80-**	AMST 80-**
AGE													
1	223145	136490	130701	569766	230781	402581	529986	161190	225582	230338	0	308644	373214
2	289431	167199	108015	111104	443304	144712	316242	396607	123222	172412	180135	252337	304067
3	272544	211356	104480	78311	86153	327596	113435	220429	248130	76162	125690	171994	208564
4	67468	175669	119850	61816	59176	67506	197149	87455	113082	162814	54634	115514	138747
5	42785	49164	89783	59459	38374	32136	49327	122992	44600	56794	105989	81406	102234
6	21217	17900	26823	45827	39408	25048	21787	28060	74232	24391	38511	51172	64496
7	15330	10376	7521	14551	24534	24295	15514	13859	15663	44375	14143	33116	44650
8	11417	6608	2993	2298	9869	17850	16137	9423	7346	7669	28594	20813	31790
+gp	6913	5945	4863	8284	3854	2884	9908	8695	10175	14965	13844		
0 TOT	950252	780707	595030	951417	935453	1044607	1269484	1048710	862030	789919	561540		

Table 6.5.10 Herring in SD 31. XSA results: Stock summary table.

Table 16 Summary (without SOP correction)

	RECRUITS	TOTALBIO	TOTSPBIC	LANDINGS	YIELD/SSI	FBAR 3-7
Age	1					
1980	859712	52183	35309	9659	0.2736	0.2092
1981	271791	45627	28915	7826	0.2707	0.2608
1982	217519	44719	32801	8652	0.2638	0.2934
1983	872641	51066	30318	7707	0.2542	0.4081
1984	644670	55196	30276	8916	0.2945	0.2159
1985	328204	51518	34601	9312	0.2691	0.2085
1986	248907	51953	39680	9090	0.2291	0.2496
1987	332870	49040	37253	8108	0.2176	0.2183
1988	102001	43027	34620	8768	0.2533	0.2608
1989	931324	42713	28436	4428	0.1557	0.1584
1990	399523	47448	29264	7898	0.2699	0.2083
1991	169964	45216	32766	7200	0.2197	0.1865
1992	252690	36094	25980	7300	0.281	0.2729
1993	244438	30405	21393	9135	0.427	0.4374
1994	154529	22501	15816	5606	0.3545	0.3483
1995	553755	18889	11386	4461	0.3918	0.381
1996	361170	20891	12926	5194	0.4018	0.4702
1997	223145	18825	11784	4281	0.3633	0.4868
1998	136490	16771	12374	5582	0.4511	0.6409
1999	130701	13338	9884	4157	0.4206	0.5891
2000	569766	15595	8318	2592	0.3116	0.2863
2001	230781	15823	10538	2822	0.2678	0.2666
2002	402581	19218	12410	3750	0.3022	0.2697
2003	529985	20186	12960	4004	0.3089	0.2994
2004	161190	19778	13265	5973	0.4503	0.4627
2005	225581	18362	12971	4970	0.3832	0.4384
2006	230338	15776	10980	2954	0.269	0.2769
Arith. Mean	362454	32673	22119	6309	0.3095	0.3261
0 Units	(Thousand	(Tonnes)	(Tonnes)	(Tonnes)		
1						

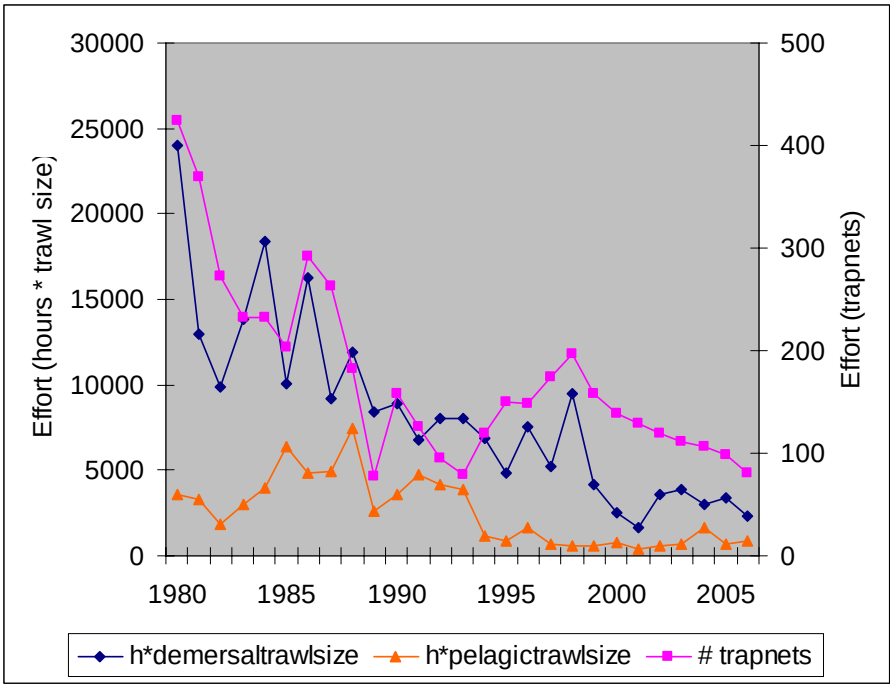
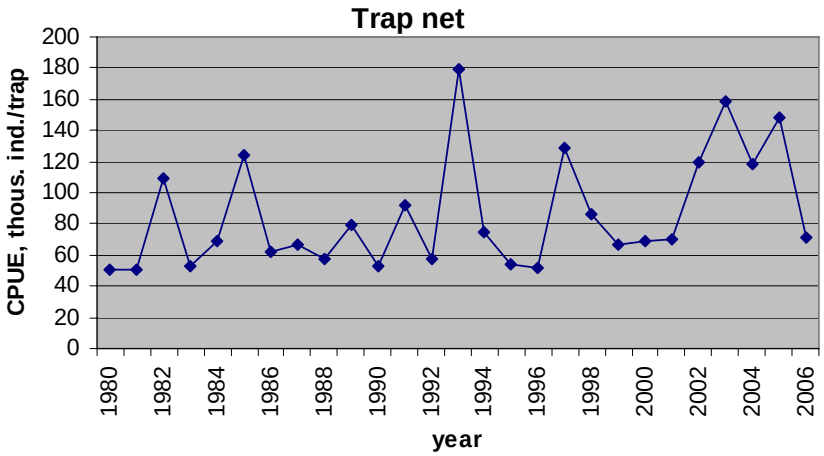
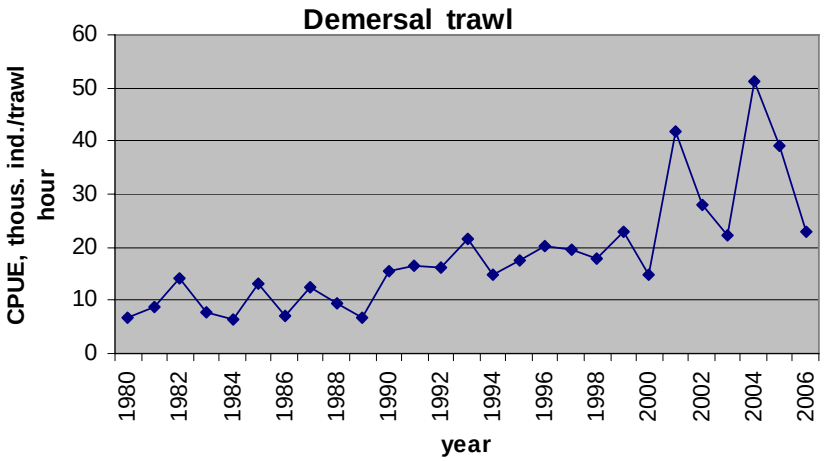


Figure 6.5.1 Herring in SD 31. Effort in Finnish commecial fleets





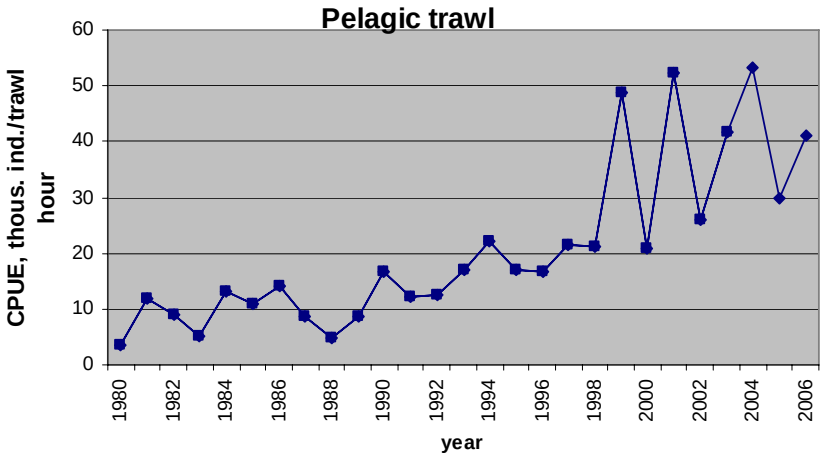


Figure 6.5.2 **Herring in SD 31.**
CPUE: thousands of individuals / trapnet (ages 3 - 8) or trawling hour (ages 2 - 8)

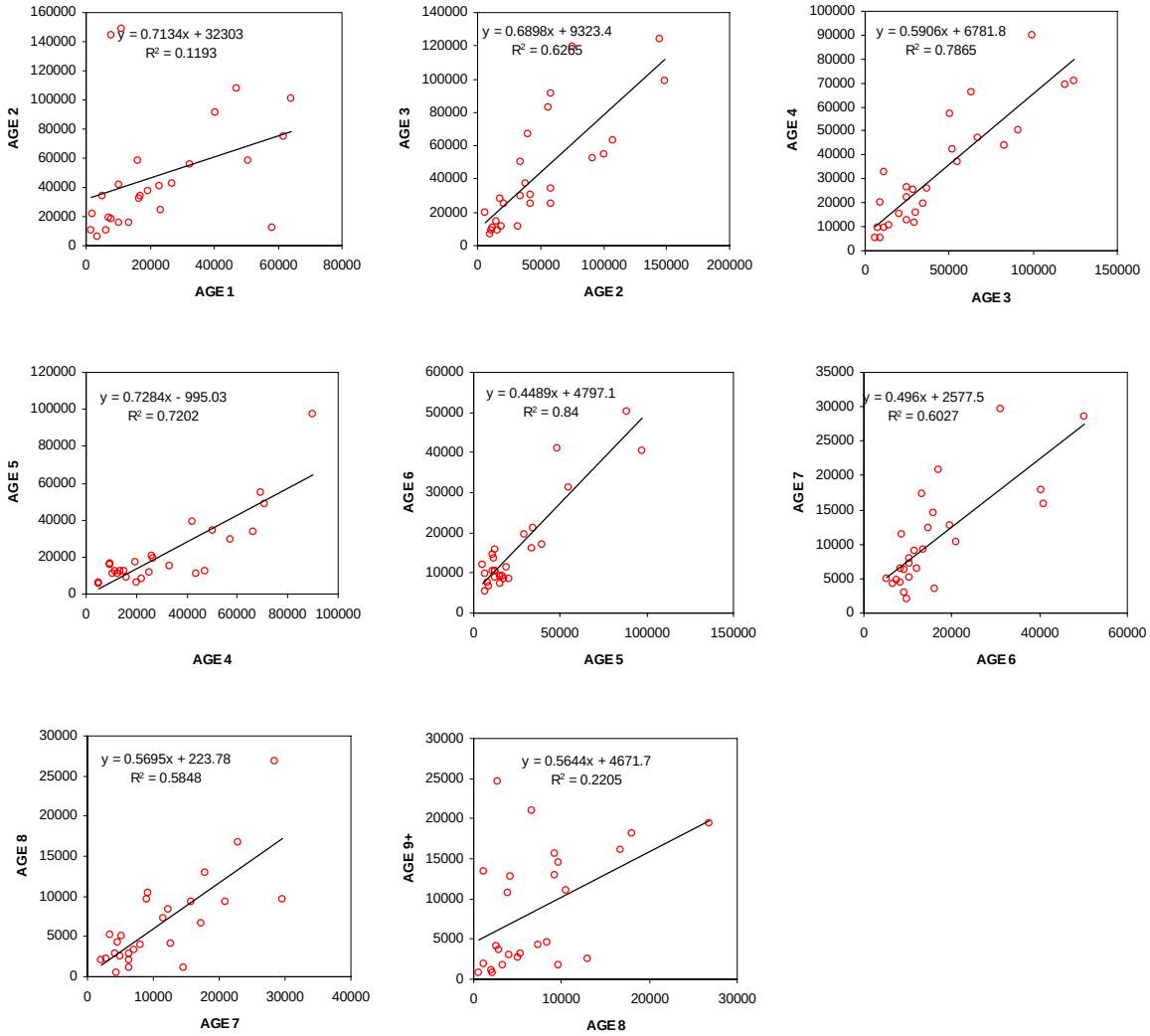


Figure 6.5.3 **Herring in SD 31. Numbers at age versus number at age +1 in the catch (all fleets combined).**

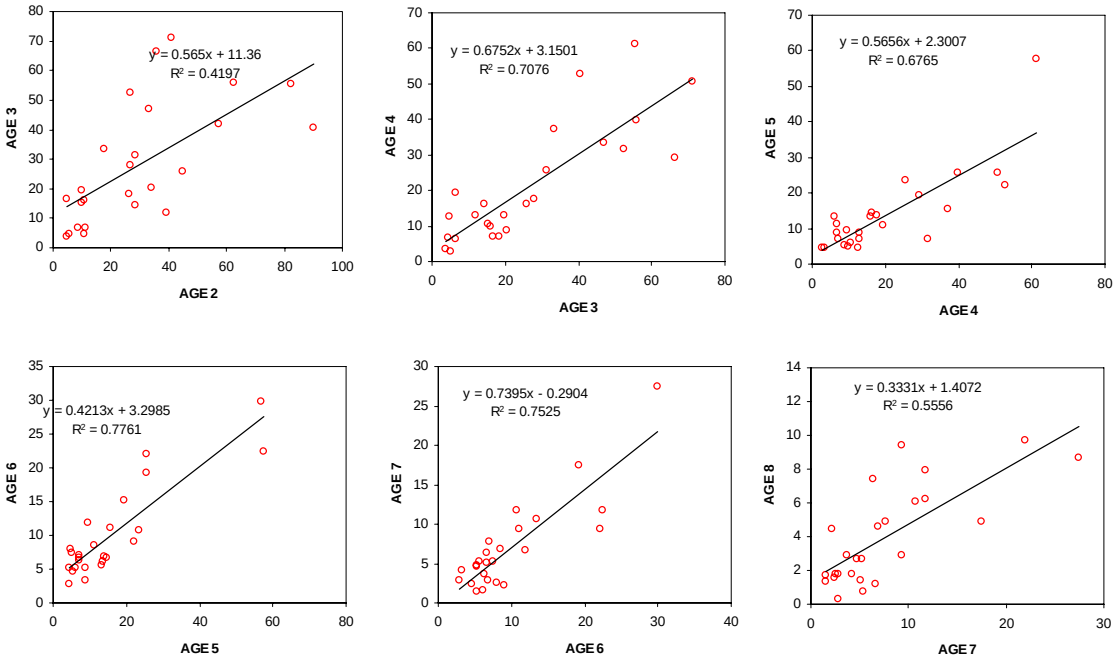


Figure 6.5.4 Herring in SD 31. Age versus age+1 in trapnet.

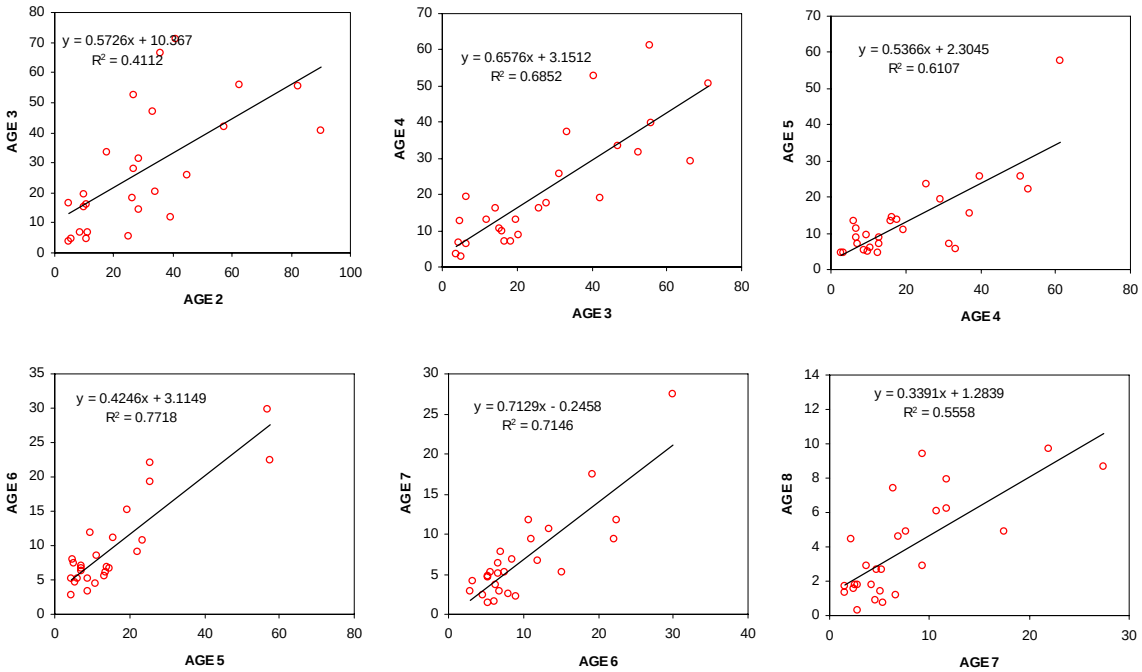


Figure 6.5.5 **Herring in SD 31. Age versus age+1 in bottom trawl.**

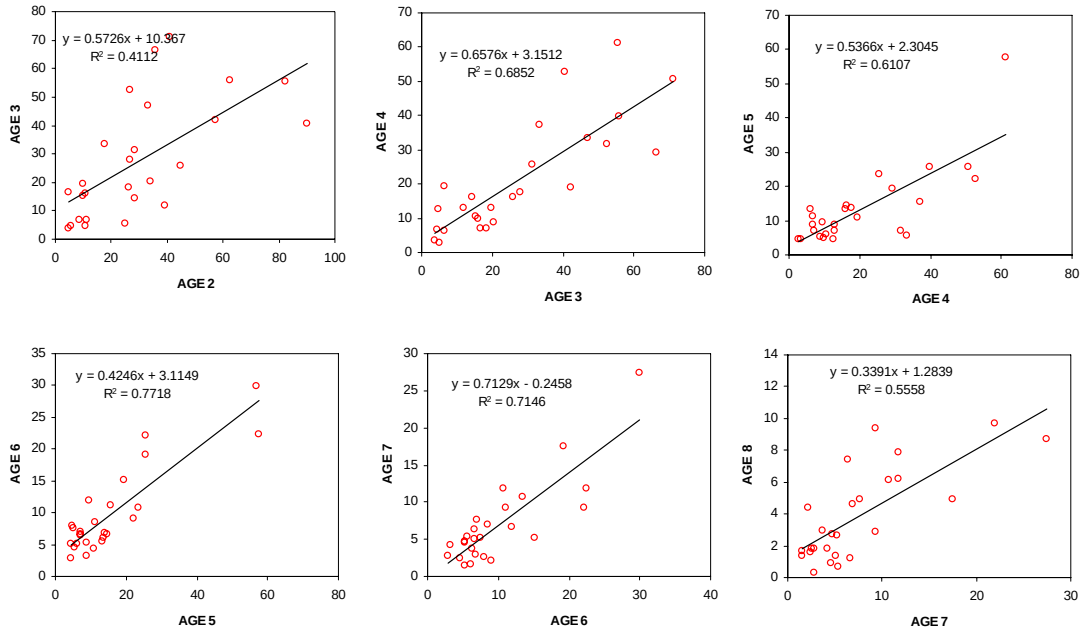


Figure 6.5.6 **Herring in SD 31. Age versus age+1 in bottom trawl.**

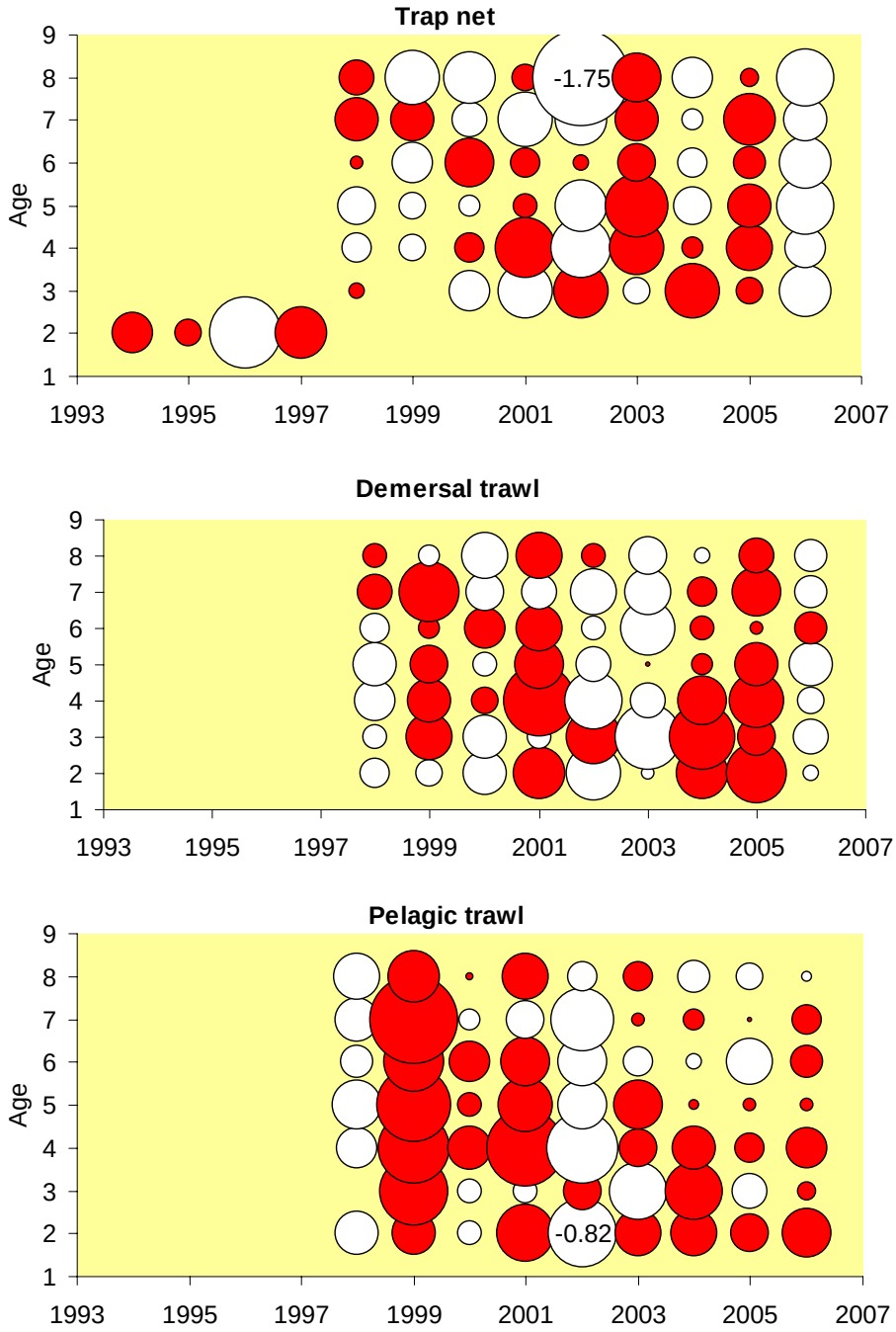


Figure 6.5.7 Herring in SD 31. Catchability residuals plots (XSA, SPALY).

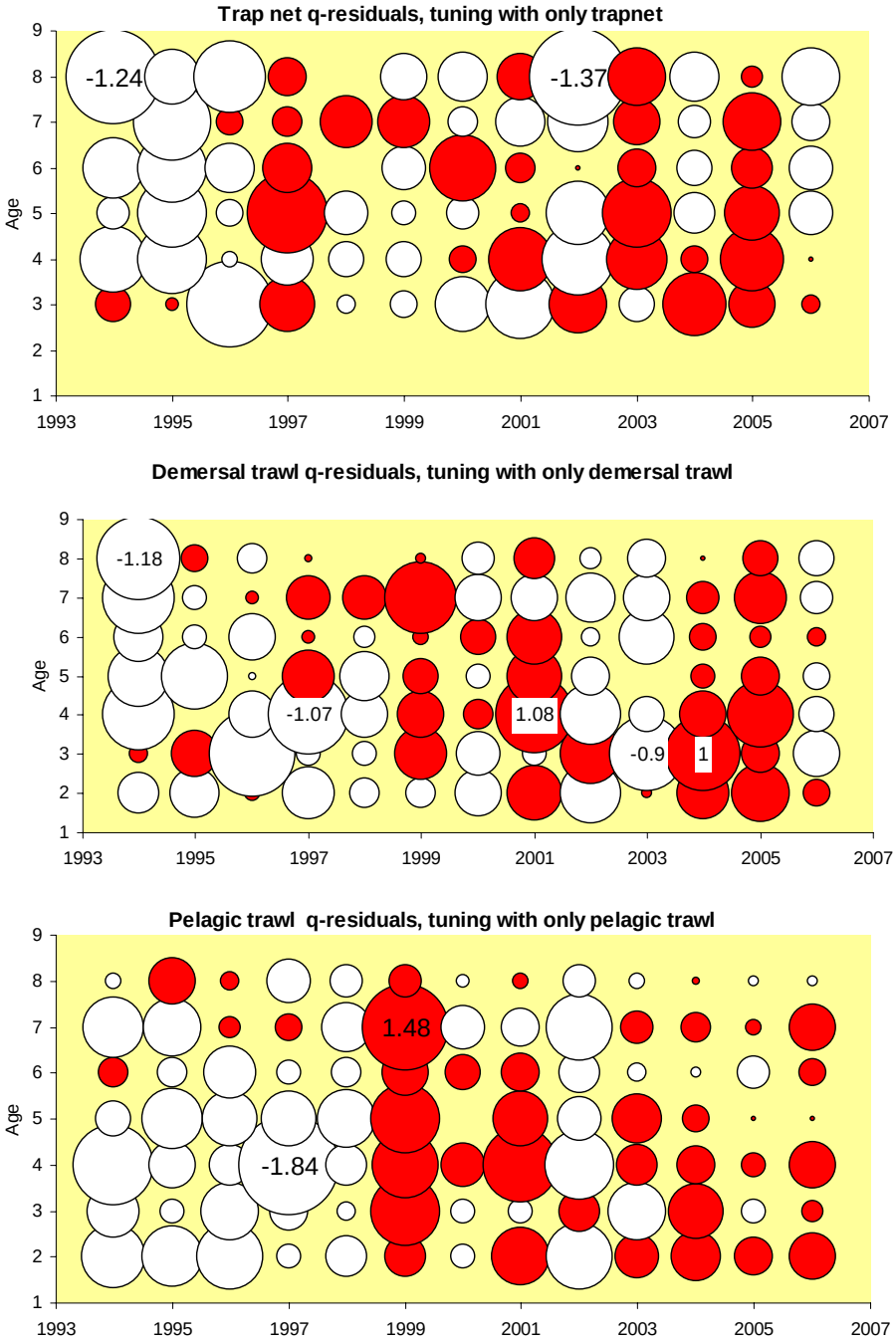


Figure 6.5.8 Herring in SD 31. Log catchability residual plots for single fleets.

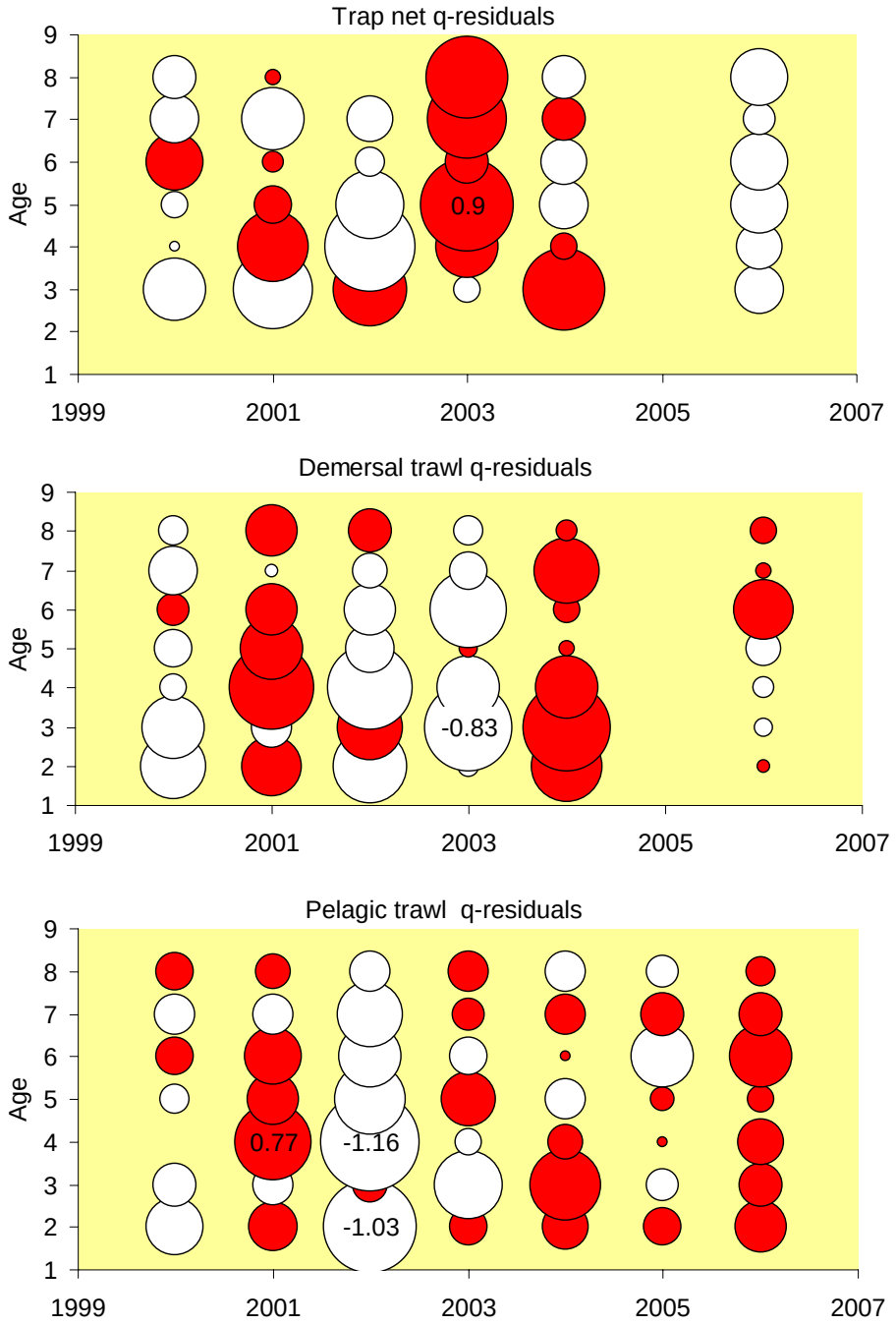


Figure 6.5.9 Herring in SD 31. Catchability residuals from trapnet, demersal trawl and pelagic trawl fleets with tuning from the year 2000 on.

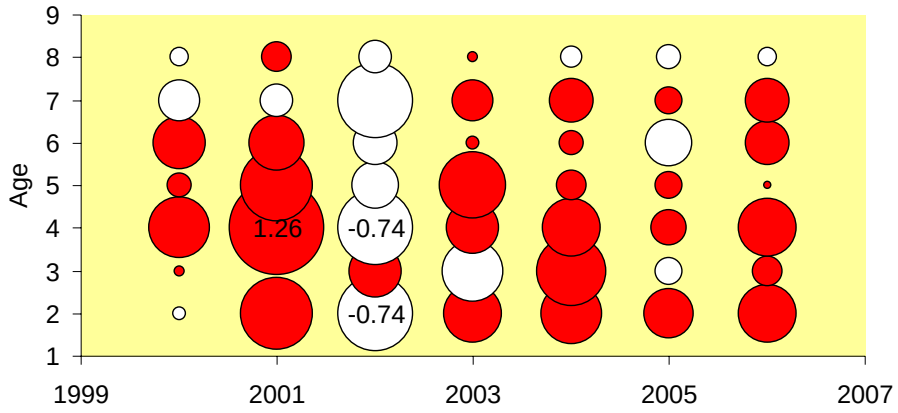


Figure 6.5.10 Herring in SD 30. Catchability residuals from trapnet fleet, tuning from the year 2000 on.

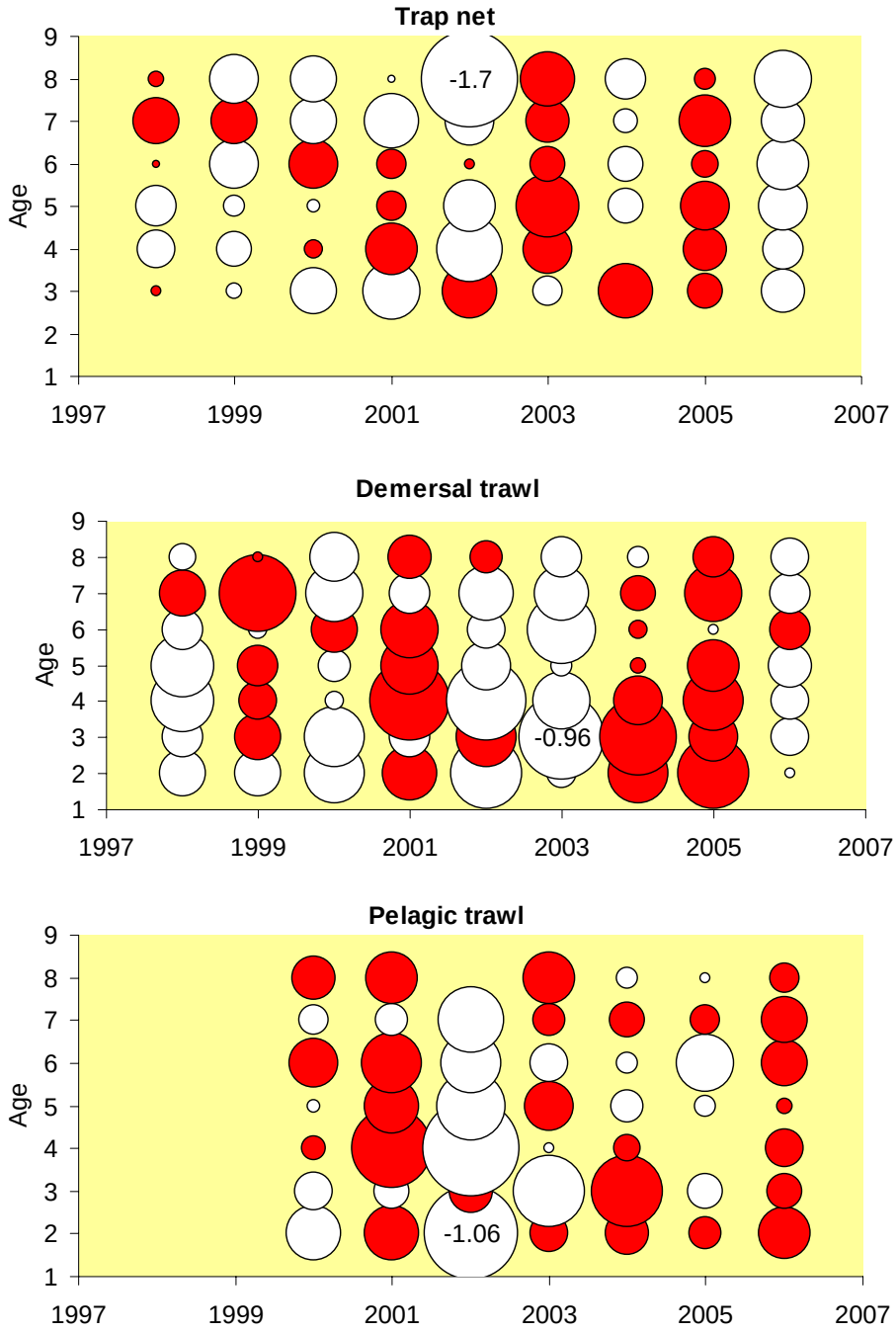
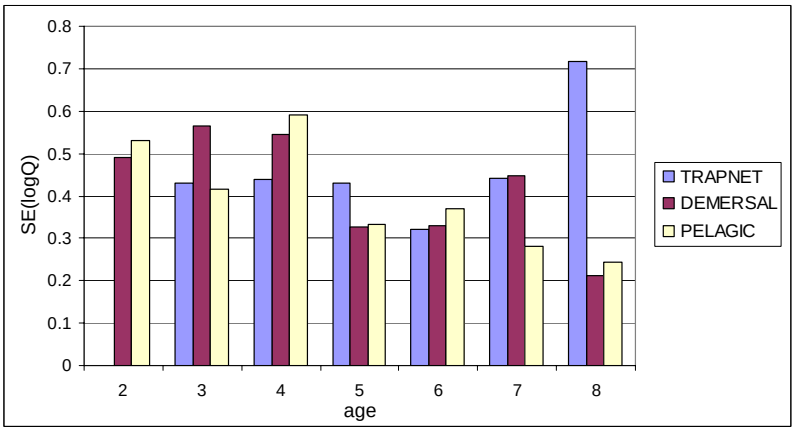


Figure 6.5.11 Herring in SD 31. Catchability residuals from trapnet, demersal trawl, and pelagic trawl fleets. Final tuning.



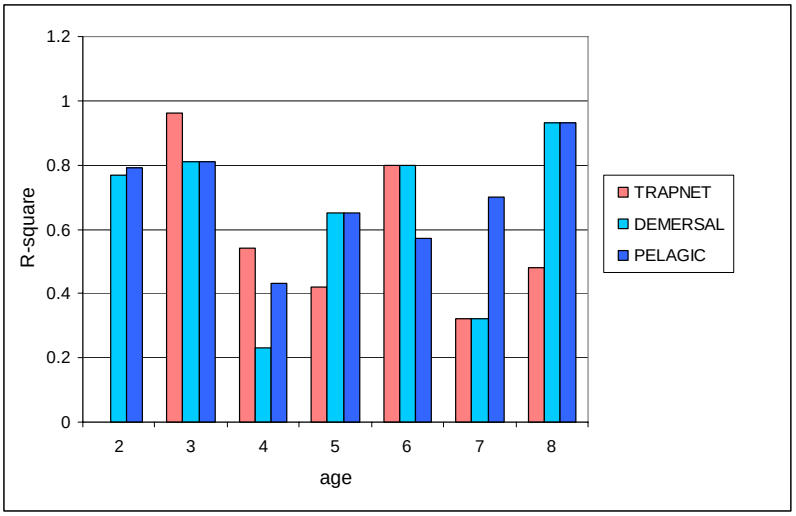


Figure 6.5.12 **Herring in SD 31. Comparative diagnostics of the standard errors of ages with catchability independent of year class strength and constant w.r.t. time.**

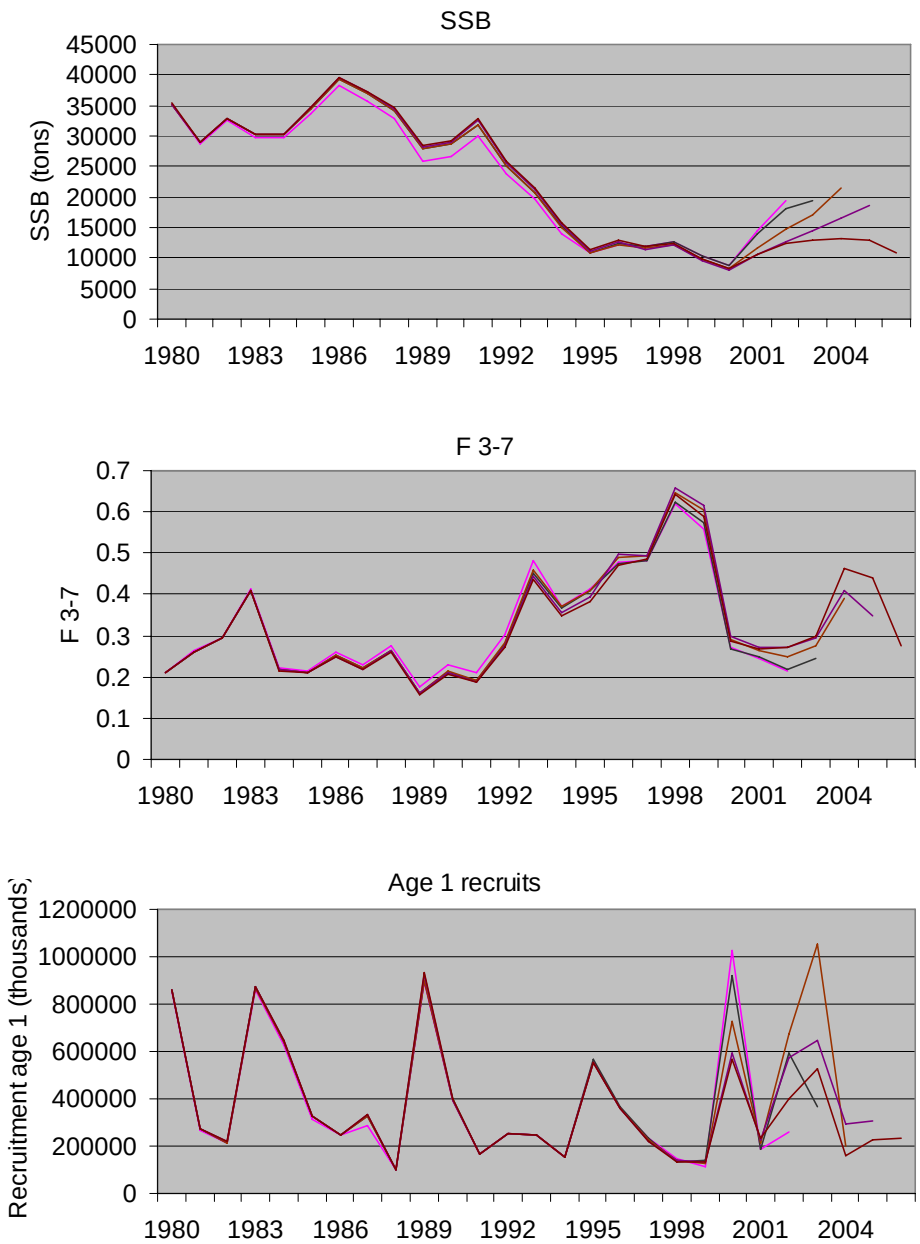


Figure 6.5.13 Herring in SD 31. Retrospective analysis.

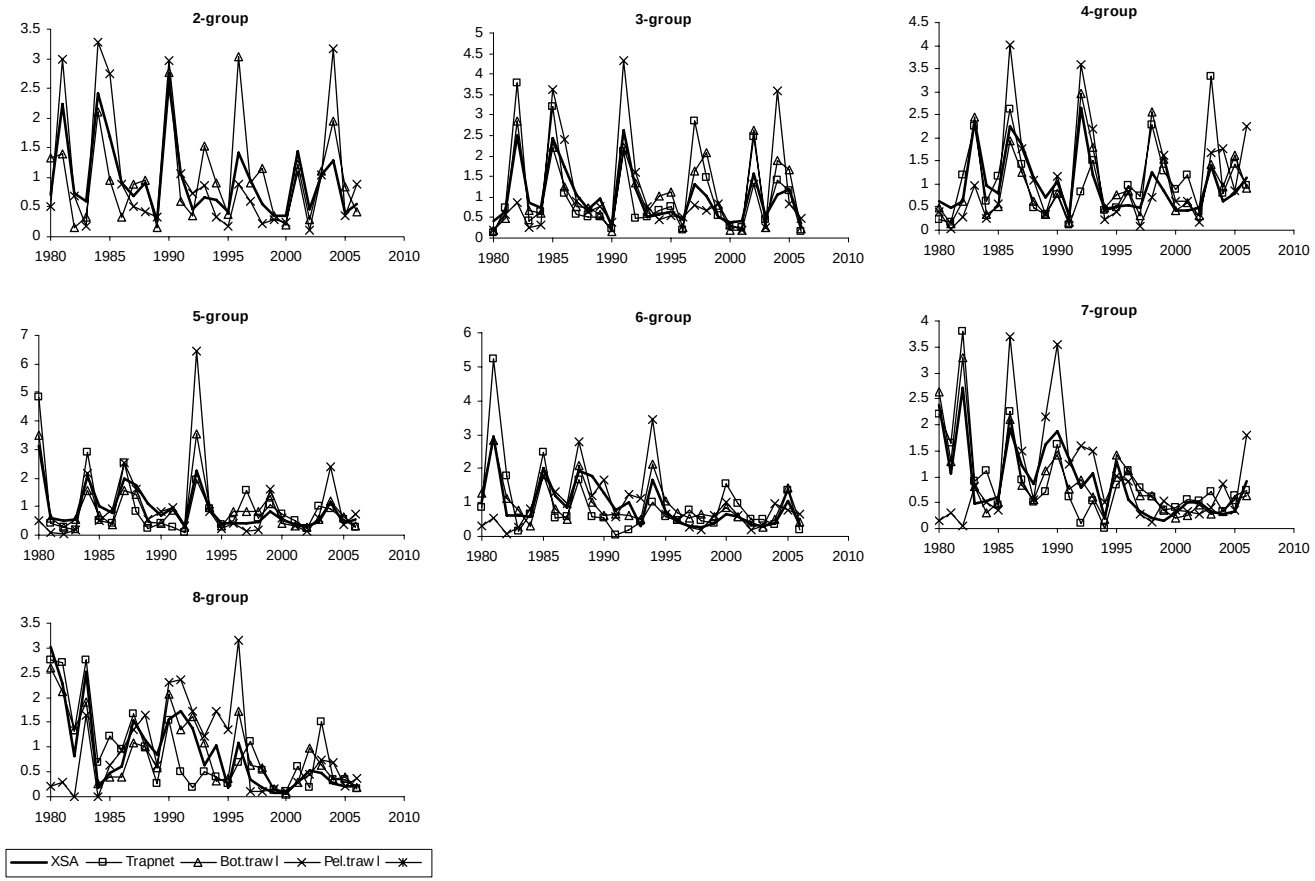


Figure 6.5.14 Herring in SD 31. Trends in CPUE indices compared with final XSA estimates, by age and year. (All values standardised to the mean)

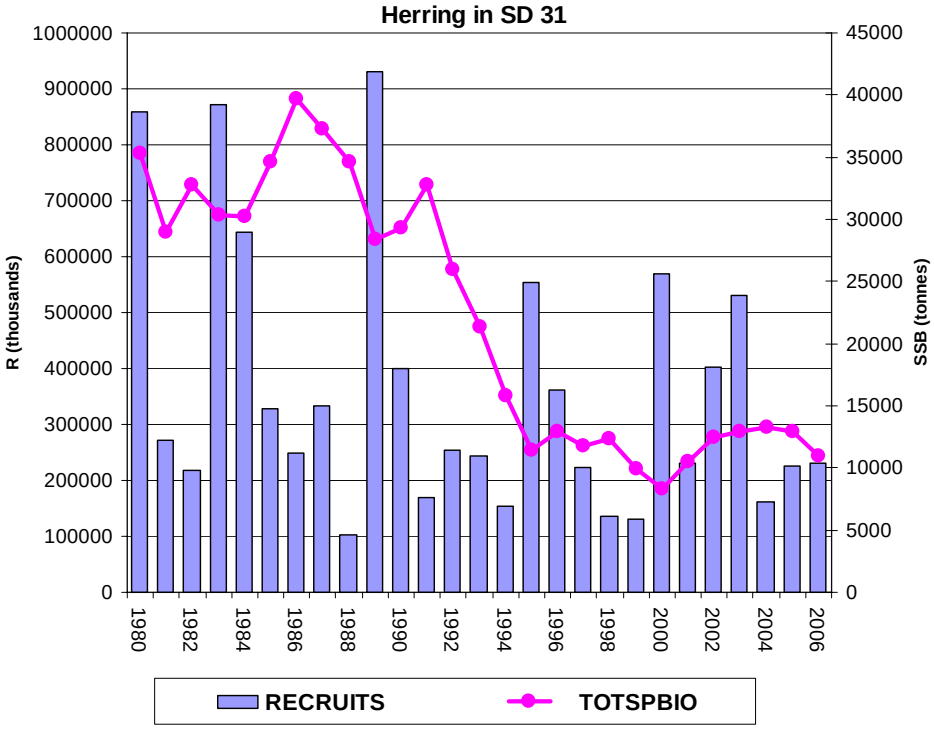


Figure 6.5.15 **Herring in SD 31. SSB and Recruitment.**

7 Sprat in Subdivisions 22–32 (update assessment)

As in previous years sprat in the Baltic Subdivisions 22–32 was assessed as a single unit.

7.1 The Fishery

7.1.1 Catch trends

Sprat catches in 2006 were 352,100 t, which is 13% lower than in 2005 and 33% less than the record high value of 529,400 t in 1997. In 2006 the TAC of 468,000 t was utilized in 75%, similarly as in 2005 (73% utilisation). In all countries except Germany and Finland catches decreased from previous year values – the highest decline was observed in Polish catches (25%), which to large extent was caused by fleet scraping. German and Finish catches increased by 6%. The 98% of the German catches were landed in foreign ports.

The spatial distribution (by Subdivision) of sprat catches was similar to 2005 distribution. Landings originated mainly from Subdivisions 26 and 28 (35% and 22%, respectively), and Subdivisions 25 and 28 (9 and 11%, respectively). Landings by country and Subdivision are presented in Tables 7.1–7.2. Table 7.3 contains landings, catch numbers, and weight at age by Subdivision and quarter.

7.1.2 Unallocated landings

No information on unallocated catches was presented to the group. It is expected, however, that misreporting of catches occurs, as the estimates of species composition of the clupeoids catches is imprecise in some mixed pelagic fisheries.

7.1.3 Discards

In most countries discards are probably small because undersized and lower quality fish can be used for production of fish meal and feeding in animal farms. In fisheries directed for human consumption, however, young fish (0 and 1 age groups) are discarded with higher rates in years when strong year classes recruit to the fishery. Recruitment to the fishery takes place in the 4th (age 0) and 1st (age 1) quarters. The amount of discarding of these age-groups is unknown.

7.1.4 Effort and CPUE data

New data on fishing effort and CPUE in Subdivision 26 (covering the 2006) were presented only by Russia this year (Table 7.4). Russian data indicate marked decline in effort in 2003-2004 compared to 2002. However, the effort of smaller vessels (27 m) increased markedly in 2005. Estonian effort markedly declined in 2003 compared to 1999-2002 level. Both Russian and Estonian CPUE series show increasing time trend, opposite to SSB which fluctuated with rather decreasing trend.

Available effort and CPUE data are restricted to only some regions and years, and are not considered representative for entire stock and therefore were not applied in the assessment.

7.2 Biological composition of the catch

7.2.1 Age composition

All countries provided age distribution of their major catches (landed in their waters) by quarter and Subdivision. The catches for which age composition was missing represented

about 8% of the total. Almost all German catches were taken outside the German waters and 14% of total catches. The unsampled catches were distributed to ages according to overall age composition in a given Subdivision and quarter. A large part of the sprat catches is taken in the fish meal fishery. In some fisheries the species composition of these catches is not very precise. Moreover, sprat age composition in these catches is not well recognized. The estimated catch at age in numbers is presented in Table 7.3 and 7.6 and the age composition of the catches is shown in Figure 7.1. The consistency of the catch at age estimates was checked in bubbles-plot (Figure 7.2). The correlation between catch at given age and the catch of the same generation 1 year later is high exceeding 0.9 in most cases.

7.2.2 Quality of catch and biological data

In all countries around the Baltic Sea fish catch statistics are based on log-book data. In some countries, such as Denmark and Poland, these data are supplemented by data collected in regional Marine Offices. In Denmark, Sweden, Finland, and to a lesser degree in Poland, much of the sprat catch is taken in industrial fisheries where large by-catches of other fish species (mostly herring) occur. The species composition of these catches is not accurately known, and can create errors in annual sprat catch statistics.

The landings and sampling activity for 2006 by quarter, ICES Subdivision and countries is presented in Table 7.5. These data show that generally in 2006 the sampling activity by Subdivision exceeded the levels indicated in the EC regulation No. 1639/2001, i.e. at least 1 sample per 2,000 t. of catch, 100 length measurements and 50 age readings per sample. On average number of samples was over 2 times higher than indicated in the directive, and about 250 length measurement and 60 age readings were recorded per 1,000 t catch. Generally, all countries collected biological samples with intensity not smaller than indicated in the EC regulation.

7.3 Mean weight-at-age

Almost all countries presented rather extensive data on weight at age in the catch by quarter and Subdivision. Mean weights at age in the catch were obtained as averages weighted by catch in numbers. The weights at age have decreased by about 40% in 1992–1998 (Figure 7.3). Next, the weights have increased since 1999 and the 2001-2002 estimates are 10–20% higher than the 1998 values. The weights have been relatively stable since then. The weight at age 3 and 4 in 2006 (year-classes 2002 and 2003) was low; it could result from density dependent effects as these two year-classes were very strong. Mean weights in the stock were assumed the same as mean weights in the catch (Table 7.7). The consistency of the weight at age estimates was explored in 2005 and was considered satisfactory.

7.4 Natural mortality

As in previous years the natural mortalities used varied between years and ages as an effect of cod predation. The estimates base on the updated MSVPA from 2006. The predation mortality for 2006 was assumed the same as the 2005 values. The new estimates of natural mortality differ generally by 2-3% from the old values, and maximum difference is 11%. To obtain total natural mortality a residual mortality of 0.2 was added to the predation mortality (Table 7.8).

7.5 Maturity at age

The maturity estimates were kept unchanged from previous years and constant throughout the time series (Table 7.9). In 2002 the WG was provided with rather extensive maturity data by the Study Group on Herring and Sprat Maturity. These data were analysed using GLM approach and year dependent estimates were obtained (ICES 2002/ACFM:17). These estimates at age 1 varied markedly from year to year but the WG felt that it was necessary to

continue sampling and perform more extensive analysis of the data. Thus the maturities were averaged over years in 2002 assessment. As new data or new analyses of the old data were not provided since then, the maturities were kept the same as in last year assessment.

7.6 Catch-at-age analysis

7.6.1 Tuning fleets

This year new tuning fleet was available – International Acoustic Surveys in May in 1999, 2001–2006 covering Subdivisions 24-28. This survey has been designed especially for sprat.

In addition, as in previous years two tuning data sets were available from International Acoustic Surveys in autumn in 1983–2006 covering Subdivisions 24-29 and Latvian/Russian Acoustic Surveys covering age 0 sprat in SD 26+28 in 1993–2006 (Tables 7.12–7.14). The survey data were corrected for area coverage.

The consistency of survey at age estimates was checked on bubbles-plots (Figures 7.4a,b). The correlation between CPUE at given age and the CPUE of the same generation 1 year later is high ranging between 0.8-0.95 in most cases.

The abundance of sprat at age 0 was used only from Latvian/Russian Acoustic Surveys in the SD 26+28 because this survey has used for trawling a trawl-net with a 6mm mesh size (bar length) in the cod-end. Other countries were using trawl-nets with a 10mm mesh size (bar length) in the cod-end. Therefore the estimation of the abundance of sprat at age 0 is much more precise in the Latvian/Russian Acoustic Surveys in SD 26+28 than in other subdivisions.

7.6.2 XSA runs

The input data for catch at age analysis are presented in Tables 7.6–7.14. In 2005 the WG performed benchmark assessment of the sprat stock, and this year assessment was an update one. Thus the settings for the parameterisation of XSA were the same as in benchmark assessment (see Annex 11: sprat Quality Handbook) :

- tricubic time weighting,
- catchability dependent on year class strength at age 1 (only for this age group the slopes of regressions were significantly different from 1),
- catchability independent of age for ages 5 and older,
- the SE of the F shrinkage mean equal 0.75.

The only difference was additional tuning fleet available. First, the assessment was run with this fleet only to check its performance. The 1999 data produced very high residuals and in the next run this tuning data year was excluded. Such run proved satisfactory, producing acceptable residuals pattern, with its SE mostly in range 0.2-0.3, and high correlations between survey and XSA estimates of stock numbers (R^2 >0.8). *The SSB and F estimates for 2005 were not very different from last year estimate of these variables.*

In final assessment all three tuning fleets were included. Table 7.15 contains the diagnostic of the run. The log q residuals are presented in Figure 7.5. The data are noisy at younger ages (1-2) for international fleet (SE of log q = 0.4-0.65). Less noise is observed at older ages (SE of log q = 0.3-0.4). Some high residuals for international fleet in 1980s have very little effect on the assessment as these data are down-weighted with time. The log q residuals from May survey have lower SE at range 0.2-0.4. The residuals from acoustic survey on age 0 (shifted to represent age 1) are less noisy but are positive for most recent years. The correlations between XSA estimates and survey indices are high (R^2 mostly at level of 0.7-0.9).

In Figure 7.7 different XSA runs are compared in terms of SSB and F estimates for 2005. assessment The final assessment, SPALY run, and last year WG estimates are quite close. The run basing solely on May survey produces somewhat lower SSB and higher F.

Retrospective analysis (Figure 7.6) shows quite consistent assessment in terms of SSB and recruitment. The average F estimates, *i.e*. F(3-5), are more noisy as they base on 3 values only. In addition, recruitment of sprat is very variable which easily can lead to overestimation of F for week year-classes when they neighbour strong year-classes, due to possible misspecification of age readings from these strong generations.

The fishing mortalities, stock numbers and summary tables are presented in Tables 7.16-7.18. Fish stock summary plots are presented in Figures 7.8 and 7.9.

7.7 Recruitment estimates

The Latvian/Russian acoustic estimates of age-0 sprat in Subdivisions 26 + 28 were analysed using the RCT3 program (Tables 7.19 and 7.20). In addition, the environmental index of year-class strength was available. MacKenzie and Köster (2004) found that sprat recruitment is significantly influenced by spring sea temperature, the area of Baltic ice coverage, and the North Atlantic Oscillation. The NAO series covering 1973-2006 was available and used in the analysis. The strong signal in RCT3 prediction (time taper included) of year-class strength comes from acoustic survey covering age 0 (R^2 of 0.8-0.98) while signal from NAO is much weaker (R^2 of 0.1-0.3) and gets the weights of a few percent in the final predicted values (Table 7.20). The 2006 year class was estimated at 111,145 millions.

7.8 Historical stock trends

In the 1990s the SSB exceeded 1 million t, being record high in 1996-1997 (1.8 million t). These values were several times higher than the SSB estimates of 200,000–250,000 t in the early 1980s. Since 1997 the SSB has decreased, and in 2003 it was almost 50% lower than its record high level of 1996-1997. Next, the SSB increased again and it reached 1.4 million t in 2005, due to strong year-classes of 2002-2003. The SSB estimate for 2006 is 1.2 million t.

7.9 Short-term forecast and management options

The RCT3 program estimate of the 2006 year class at age 1 was used in the predictions. In the basic run the 2007 and 2008 y.c. were assumed as geometric mean of the recruitments in 1991-2006 (period of recruitment fluctuations without clear trend). The natural mortalities and weights at age were assumed as averages of the 2004–2006 values. The fishing pattern was smoothed as the average F at age of 2004–2006 and scaled to the Fbar of 2006 (F decreased markedly in 2006 compared to previous two years), and Fbar of 2006 was assumed for *status quo* fishing mortality. Input data for catch prediction are presented in Table 7.21. In addition, the run with the TAC constrain of 468,000 tons in 2006 was performed.

In the basic run *status quo* catches for 2007 and 2008 were predicted to be 325,000 and 330,000 t, respectively. The SSB in 2009 is predicted to be at the level of 1.2 million t (Table 7.22). In the option assuming TAC catches in 2006, the prediction of status quo catches for 2007 is 366,000 t, which will lead to an SSB of 1.3 million t in 2008. This option, however, is less probable than status quo fishing mortality as in recent years even lower TACs were not utilised and in some countries significant fleet reduction has taken place.

Yield per recruit and short-term forecast for sprat in SD 22-32 are presented in Figure 7.10.

In Figure 7.11 the sensitivity of the projection to the assumed strength (GM) of the 2007 and 2008 year classes is presented. The assumed year classes contribute little to the predicted catch and biomass in 2008 (10% and 5%, respectively). They constitute, however, 33% of the

SSB predicted for 2009. The year class 2006 estimate from the RCT3 model constitutes 13% of the catch in 2007, 23% of the 2008 catch, and 29% of the 2009 SSB.

7.10 Medium-term projections

In the medium-term projections, the uncertainty in survivor estimates, weight at age, and the stock-recruitment model were taken into account. The mean weights at age for intermediate year were taken the same as in short term prediction (3 year average) while weights for other years were based on the 1999-2006 data. The weight at age variation was estimated from the 1993-2005 data to allow for more variation in medium-term then in recent years. Natural mortalities and exploitation patterns were constant and the same as for the short-term prediction. The Beverton and Holt stock recruitment model was used in the projections and its parameters were estimated assuming log-normal errors (Table 7.23a). The model explains only a small part of the recruitment variance (see Figure 7.14 for recruitment scatter plot). Its estimates of recruitment within the range of observed data vary from 30 to 90 billion of fish, compared to the long-term geometrical mean of XSA recruitment equal to 60 billion.

The results of the projections for fishing mortality ranging from 0.8 to 1.2 of the status quo value (0.29) are presented in Table 7.23b and in Figures 7.12 and 7.13. The median of spawning stock biomass under *status quo* fishing mortality tends towards equilibrium of about 1.2 million t., while catches stabilise at 310,000-320,000 t. For all projections there is a high probability that the stock will remain above $\mathbf{B}_{pa}$ (=275,000 t) in the medium term.

7.11 Reference points

The PA software (CEFAS, Lowestoft) was used to estimate biological reference points (Figure 7.14). As the input to the program the three years averages of mean weights and natural mortalities were taken. The estimated $\mathbf{F}_{med}$ (used by ACFM as a basis for $\mathbf{F}_{pa}$= 0.4) is now 0.27. In Figure 7.15 the graphs with equilibrium SSB and yield as well as the observed stock and yield trajectory are presented. The biological reference points derived based on the replacement lines depend on the natural mortality, weight at age, and maturity data used. At the moment the natural mortalities and the weights at age are low. If they change the biological reference points may change as well.

7.12 Quality of assessment

The major problem for this stock is the catch data for clupeids. In the mixed fishery for herring and sprat the separation of herring and sprat catches is imprecise. These uncertainties could influence the estimates of absolute stock size and fishing mortality.

The sprat in Subdivisions 22–32, now being assessed as one unit, was previously considered as composed of three stock components: sprat in Subdivisions 22–25, 26+28, and 27+29–32. An analysis of the impact of merging components on stock assessment has not been conducted since the early 1990s.

The inputs to the assessments are catch-at-age data and age-structured stock estimates from the acoustic surveys. The survey estimates of stock numbers are internally consistent and the same applies to catch at age numbers (Figures 7.2 and 7.4a,b)

7.13 Comparison with previous assessment

The comparison between the results of 2006 and 2007 assessments is presented in the text table below. The XSA settings were the same as in the last year.

Category	Parameter	Assessment 2006	Assessment 2007	Diff. (+/-) %
Data input	Maturity ogives	age 1 - 17%, age 2 - 93%	age 1 - 17%, age 2 - 93%	No
	Natural mortality	MSVPA 2003	MSVPA 2005	Yes, 2-3%, max 11%
XSA input	Catchability dependent on year class strength	Age<2	Age<2	No
	Catchability independent on age	Age >=5	Age >=5	No
	SE of the F shrinkage mean	0.75	0.75	No
	Time weighting	Tricubic, 20 years	Tricubic, 20 years	No
	Tuning data	International acoustic, automn	International acoustic, autumn International acoustic, May	No Yes
		Latvian/Russian Acoustic on age 0	Latvian/Russian Acoustic on age 0	Small revisions, <5%
XSA results	SSB 2005 (million t) TSB 2005 (million t) F(3-5) 2005 Recruitment (age 1) in 2005	1.44 2.03 0.32 458 billions	1.43 1.97 0.40 265 billions	-1% -3 % +25% -42 %

7.14 Management considerations

There are no explicit management objectives for this stock. As in previous years, sprat in Baltic Subdivisions 22–32 was assessed as a single unit, and this procedure shows relatively good assessment quality.

In Resolution XIII, September 2000, the IBSFC agreed to implement a long-term management plan for sprat in the Baltic:

"The IBSFC agreed to implement a long-term management plan for the sprat stock which is consistent with a precautionary approach and designed to ensure a rational exploitation pattern and provide for stable and high yields. This plan shall consist of the following elements:

Every effort shall be made to maintain a level of spawning stock biomass (SSB) greater than 200 000 t.

A long-term management plan, by which annual quotas shall be set for the fishery, reflecting a fishing mortality rate of 0.4 for relevant age groups as defined by ICES shall be implemented.

Should the SSB fall below a reference point of 275 000 t, the fishing mortality rate referred to under paragraph 2 will be adapted in the light of scientific estimates of the conditions then prevailing, to ensure safe and rapid recovery of the spawning stock biomass to levels in excess of 275 000 t.

The IBSFC shall, as appropriate, adjust management measures and elements of the plan on the basis of any new advice provided by ICES.

ICES considers the agreement to be consistent with the precautionary approach.

Table 7.1 Sprat landings in Subdivisions 22-32 (thousand tonnes)

Year	Denmark	Finland	German Dem. Rep.	Germany Fed. Rep.	Poland	Sweden	USSR	Total
1977	7.2	6.7	17.2	0.8	38.8	0.4	109.7	180.8
1978	10.8	6.1	13.7	0.8	24.7	0.8	75.5	132.4
1979	5.5	7.1	4.0	0.7	12.4	2.2	45.1	77.1
1980	4.7	6.2	0.1	0.5	12.7	2.8	31.4	58.1
1981	8.4	6.0	0.1	0.6	8.9	1.6	23.9	49.3
1982	6.7	4.5	1.0	0.6	14.2	2.8	18.9	48.7
1983	6.2	3.4	2.7	0.6	7.1	3.6	13.7	37.3
1984	3.2	2.4	2.8	0.7	9.3	8.4	25.9	52.5
1985	4.1	3.0	2.0	0.9	18.5	7.1	34.0	69.5
1986	6.0	3.2	2.5	0.5	23.7	3.5	36.5	75.8
1987	2.6	2.8	1.3	1.1	32.0	3.5	44.9	88.2
1988	2.0	3.0	1.2	0.3	22.2	7.3	44.2	80.3
1989	5.2	2.8	1.2	0.6	18.6	3.5	54.0	85.8
1990	0.8	2.7	0.5	0.8	13.3	7.5	60.0	85.6
1991	10.0	1.6		0.7	22.5	8.7	59.7*	103.2

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	Total
1992	24.3	4.1	1.8	0.6	17.4	3.3	28.3	8.1	54.2	142.1
1993	18.4	5.8	1.7	0.6	12.6	3.3	31.8	11.2	92.7	178.1
1994	60.6	9.6	1.9	0.3	20.1	2.3	41.2	17.6	135.2	288.8
1995	64.1	13.1	5.2	0.2	24.4	2.9	44.2	14.8	143.7	312.6
1996	109.1	21.1	17.4	0.2	34.2	10.2	72.4	18.2	158.2	441.0
1997	137.4	38.9	24.4	0.4	49.3	4.8	99.9	22.4	151.9	529.4
1998	91.8	32.3	25.7	4.6	44.9	4.5	55.1	20.9	191.1	470.8
1999	90.2	33.2	18.9	0.2	42.8	2.3	66.3	31.5	137.3	422.6
2000	51.5	39.4	20.2	0.0	46.2	1.7	79.2	30.4	120.6	389.1
2001	39.7	37.5	15.4	0.8	42.8	3.0	85.8	32.0	85.4	342.2
2002	42.0	41.3	17.2	1.0	47.5	2.8	81.2	32.9	77.3	343.2
2003	32.0	29.2	9.0	18.0	41.7	2.2	84.1	28.7	63.4	308.3
2004	44.3	30.2	16.6	28.5	52.4	1.6	96.7	25.1	78.3	373.7
2005	46.5	49.8	17.9	29.0	64.7	8.6	71.4	29.7	87.8	405.2
2006	42.1	46.8	19.0	30.8	54.6	7.5	54.3	28.2	68.7	352.1

* Sum of landings by Estonia, Latvia, Lithuania, and Russia.

Table 7.2 **Sprat landings in the Baltic Sea by country and Subdivision (thousand tonnes).**

Year 2000

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**51.5**	9.4	0.8	41.2[1)]	-	-	-	-	-	-	-
Estonia	**39.4**	-	-	-	-	-	6.1	13.9	-	-	19.4
Finland	**20.2**	-	-	-	-	-	-	3.6	4.8	0	11.9
Germany	**0**	0		-	-	-	-	-	-	-	-
Latvia	**46.2**	-	-	2.6	7.3	-	36.3	-	-	-	-
Lithuania	**1.7**	-	-	-	1.7	-	-	-	-	-	-
Poland	**79.2**	-	0.8	40.5	37.9	-	-	-	-	-	-
Russia	**30.4**	-	-	-	28.3	-	2	-	-	-	-
Sweden	**120.6**	-	2.1	31.7	13.2	31.5	23.9	18.1	-	-	-
Total	**389.1**	**9.5**	**3.7**	**116**	**88.4**	**31.5**	**68.3**	**35.5**	**4.8**	**0**	**31.4**

[1)] Danish landings in Subdivision 25 include landings in Subdivision 22 and 24.

Year 2001

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**39.7**	-	-	39.7	-	-	-	-	-	-	-
Estonia	**37.5**	-	-	-	-	-	6.3	16.1	-	-	15.1
Finland	**15.4**	-	-	-	-	-	-	4.5	3.2	0.001	7.6
Germany	**0.8**	0.02	0.8	-	-	-	-	-	-	-	-
Latvia	**42.8**	-	-	1.1	7	-	34.7	-	-	-	-
Lithuania	**3**	-	-	-	3	-	-	-	-	-	-
Poland	**85.8**	-	0.4	46.3	39.1	-	-	-	-	-	-
Russia	**32**	-	-	-	29.6	-	2.3	-	-	-	-
Sweden	**85.4**	-	1	2.9	4.8	27.8	30.2	18.1	-	-	0.5
Total	**342.2**	**0.02**	**2.1**	**90**	**83.5**	**27.8**	**73.5**	**38.7**	**3.2**	**0.001**	**23.2**

Year 2002

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**42.0**	4.7	1.0	22.5	7.7	0.7	4.6	0.9	-	-	-
Estonia	**41.3**	-	-	-	-	-	7.7	17.0	-	-	16.6
Finland	**17.2**	-	0.8	2.3	0.004	0.1	0.001	3.7	4.8	-	5.5
Germany	**1.0**	0.03	-	0.1	0.4	0.1	0.1	0.2	-	-	-
Latvia	**47.5**	-	-	1.4	4.5	-	41.7	0.0	-	-	-
Lithuania	**2.8**	-	-	0.0	2.8	-	-	-	-	-	-
Poland	**81.2**	-	0.04	39.7	41.5	-	-	-	-	-	-
Russia	**32.9**	-	-	-	29.9	-	2.9	-	-	-	-
Sweden	**77.3**	-	3.0	13.3	5.6	27.2	19.9	8.3	-	-	-
Total	**343.2**	**4.8**	**4.8**	**79.3**	**92.4**	**28.1**	**76.8**	**30.1**	**4.8**	**0.0**	**22.1**

Year 2003

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**32.0**	8.2	0.7	10.4	8.9	1.8	1.7	0.3	-	-	-
Estonia	**29.2**	-	-	-	-	-	11.1	11.6	-	-	6.5
Finland	**9.0**	-	0.03	0.4	0.04	0.2	0.1	4.6	1.5	0.001	2.0
Germany	**18.0**	0.2	0.5	0.8	3.0	9.5	2.8	1.1	-	-	-
Latvia	**41.7**	-	-	0.8	7.8	-	33.2	-	-	-	-
Lithuania	**2.2**	-	-	-	2.2	-	-	-	-	-	-
Poland	**84.1**	-	0.03	26.7	57.4	-	-	-	-	-	-
Russia	**28.7**	-	-	0.0	27.2	-	1.4	-	-	-	-
Sweden	**63.4**	-	2.1	5.5	8.6	24.1	19.3	3.8	-	-	-
Total	**308.3**	**8.3**	**3.5**	**44.6**	**115.1**	**35.6**	**69.6**	**21.5**	**1.5**	**0.001**	**8.5**

Table 7.2 continued

Year 2004

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**44.3**	16.0	5.5	16.8	0.5	0.5	3.9	1.1	-	-	-
Estonia	**30.2**	-	-	-	-	-	8.9	10.1	-	-	11.1
Finland	**16.6**	-	0.5	2.5	0.003	0.1	0.03	9.3	3.0	0.003	1.1
Germany	**28.5**	0.8	0.9	1.4	6.0	8.2	6.8	4.4	-	-	-
Latvia	**52.4**	-	-	2.3	7.5	0.2	42.4	0.0	-	-	-
Lithuania	**1.6**	-	-	-	1.6	-	-	-	-	-	-
Poland	**96.7**	-	1.4	33.6	61.6	0.04	0.02	-	-	-	-
Russia	**25.1**	-	-	-	23.9	-	1.2	-	-	-	-
Sweden	**78.3**	-	1.4	9.2	7.6	25.8	22.3	12.0	-	-	-
Total	**373.7**	**16.8**	**9.7**	**65.8**	**108.8**	**34.8**	**85.6**	**36.9**	**3.0**	**0.003**	**12.2**

Year 2005

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**46.5**	17.6	2.1	11.1	5.4	0.3	10.0	-	-	-	-
Estonia	**49.8**	-	-	-	-	-	7.1	16.6	-	-	26.0
Finland	**17.9**	-	0.1	0.6	0.6	0.1	0.3	9.0	3.2	0.005	4.0
Germany	**29.0**	1.2	0.1	0.4	4.3	10.2	6.8	6.1	-	-	-
Latvia	**64.7**	-	-	1.2	7.3	0.4	55.8	-	-	-	-
Lithuania	**8.6**	-	-	-	8.6	-	-	-	-	-	-
Poland	**71.4**	-	2.0	23.5	45.6	0.2	0.1	-	-	-	-
Russia	**29.7**	-	-	-	29.7	-	-	-	-	-	0.1
Sweden	**87.8**	-	0.7	11.1	10.3	25.1	24.5	16.2	-	-	-
Total	**405.2**	**18.8**	**5.0**	**47.9**	**111.7**	**36.2**	**104.5**	**47.9**	**3.2**	**0.005**	**30.2**

Year 2006

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**42.1**	19.4	1.7	6.9	9.9	0.3	2.6	1.2	-	-	-
Estonia	**46.8**	-	-	0.1	-	0.3	5.5	19.2	-	-	21.6
Finland	**19.0**	-	0.2	0.5	1.1	1.9	2.0	6.8	3.5	0.007	3.0
Germany	**30.8**	1.2	0.01	1.3	8.2	12.0	4.6	3.4	-	-	-
Latvia	**54.6**	-	-	1.1	6.0	-	47.5	-	-	-	-
Lithuania	**7.5**	-	-	-	7.5	-	-	-	-	-	-
Poland	**54.3**	-	0.8	16.7	36.8	-	-	-	-	-	-
Russia	**28.2**	-	-	-	27.9	-	-	-	-	-	0.3
Sweden	**68.7**	0.0	0.7	4.6	25.3	13.7	16.6	7.6	0.0	0.0	0.2
Total	**352.1**	**20.5**	**3.4**	**31.3**	**122.8**	**28.3**	**78.9**	**38.3**	**3.5**	**0.007**	**25.1**

Table 7.3 SPRAT in SD 22-32. Catch in numbers and weight at age by quarter and Sub-division in 2006

Sub-division 22

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.00	0.00	35.33	265.29	300.6	0.0	0.0	4.0	5.1
1	261.71	146.81	44.52	77.71	530.8	5.7	7.2	11.3	13.2
2	124.94	12.12	20.07	68.06	225.2	11.6	13.0	12.7	14.8
3	280.19	184.97	79.64	108.79	653.6	13.4	12.9	14.0	15.1
4	68.75	105.06	24.25	12.33	210.4	13.4	13.2	14.4	15.4
5	3.70	0.00	5.23	3.75	12.7	13.2	0.0	15.2	15.6
6	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
7	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
8	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
9	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
10	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
Sum	739.3	449.0	209.0	535.9	1933.2				
SOP	7676.0	4988.4	2440.0	5278.7	20383.1				
Catch	7676.0	5115.6	2440.0	5305.5	20537.1				

Sub-division 24

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	14.6	70.9	85.6	0.0	0.0	5.8	5.6
1	60.7	24.0	0.5	4.1	89.3	6.6	7.0	12.0	11.3
2	21.0	9.7	1.3	7.6	39.6	10.1	10.2	18.0	16.7
3	56.4	25.2	1.8	12.5	95.9	12.4	11.8	18.0	16.8
4	18.1	9.6	0.2	3.3	31.2	13.0	11.7	18.0	15.9
5	5.3	1.2	0.1	1.2	7.7	15.5	13.9	18.0	16.7
6	2.7	0.1	0.0	0.5	3.3	16.5	14.5	0.0	16.4
7	0.3	0.4	0.0	0.0	0.7	16.7	15.1	0.0	0.0
8	0.2	1.1	0.0	0.1	1.4	17.9	14.0	0.0	15.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.1	0.0	0.0	0.0	0.1	17.7	17.5	0.0	0.0
Sum	164.8	71.3	18.5	100.2	354.8				
SOP	1685.0	714.1	152.0	865.5	3416.7				
Catch	1685.0	721.0	152.0	865.5	3423.5				

Sub-division 25

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	1.2	75.3	76.5	0.0	0.0	5.3	5.5
1	374.6	140.9	1.3	7.0	523.7	5.5	5.8	8.3	10.9
2	75.7	76.8	1.2	9.9	163.6	9.8	8.9	13.4	15.5
3	756.6	640.7	11.8	19.0	1428.1	11.7	10.4	12.9	16.0
4	240.5	260.1	3.9	6.6	511.2	12.3	11.2	14.2	15.4
5	96.4	81.0	1.7	2.1	181.3	14.5	13.6	13.2	16.1
6	49.1	25.5	3.2	1.2	79.0	15.6	14.0	14.5	16.4
7	13.5	5.5	1.6	0.0	20.5	14.0	14.4	12.8	0.0
8	8.2	4.6	0.0	0.3	13.1	14.8	11.6	13.5	15.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	4.7	3.3	0.4	0.0	8.4	15.1	16.4	15.0	0.0
Sum	1619.2	1238.4	26.4	121.4	3005.4				
SOP	17152.7	12710.1	337.8	1108.7	31309.3				
Catch	17152.7	12710.1	337.8	1108.7	31309.3				

Table 7.3 continued

Sub-division 26

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	3.8	697.9	701.6	0.0	0.0	1.1	4.3
1	1971.9	2677.9	458.5	236.5	5344.9	3.9	4.4	6.1	8.3
2	436.8	512.5	60.1	64.2	1073.6	7.3	7.6	8.3	8.7
3	3791.0	2528.8	311.7	211.3	6842.9	8.4	8.3	9.0	10.2
4	1331.5	653.2	61.5	62.5	2108.7	9.3	9.2	10.1	10.4
5	330.2	154.3	11.9	14.3	510.7	10.5	10.8	11.6	11.3
6	111.9	58.7	1.9	6.7	179.2	11.3	11.1	12.7	12.5
7	48.7	57.6	1.7	1.2	109.3	11.7	12.2	11.7	12.1
8	54.0	15.0	4.6	1.6	75.2	11.6	12.4	10.4	12.9
9	1.1	0.8	0.4	0.0	2.3	15.1	16.3	13.9	0.0
10	0.7	0.0	0.0	0.0	0.7	13.9	0.0	0.0	0.0
Sum	8077.9	6658.8	916.2	1296.2	16949.1				
SOP	61207.4	45911.2	6983.5	8612.9	122715.0				
Catch	61262.9	45911.2	6984.3	8612.9	122771.3				

Sub-division 27

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	20.7	0.0	0.0	1.2	21.9	4.7	0.0	0.0	4.7
2	66.1	32.4	0.0	3.8	102.4	7.8	7.0	0.0	7.8
3	1450.0	551.0	0.0	83.8	2084.8	7.6	7.6	0.0	7.6
4	454.6	129.6	0.0	26.3	610.5	8.8	7.5	0.0	8.8
5	168.6	32.4	0.0	9.8	210.8	10.0	9.5	0.0	10.0
6	111.3	16.2	0.0	6.4	134.0	10.4	11.0	0.0	10.4
7	62.3	32.4	0.0	3.6	98.3	12.3	9.5	0.0	12.3
8	48.3	0.0	0.0	2.8	51.0	11.6	0.0	0.0	11.6
9	6.9	16.2	0.0	0.4	23.5	11.0	9.0	0.0	11.0
10	68.8	0.0	0.0	4.0	72.8	11.3	0.0	0.0	11.3
Sum	2457.6	810.3	0.0	142.1	3410.0				
SOP	20685.6	6352.5	0.0	1196.0	28234.1				
Catch	20685.6	6352.5	48.0	1196.0	28282.1				

Sub-division 28

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	21.9	21.9	0.0	0.0	0.0	4.3
1	305.8	99.9	359.6	499.5	1264.7	4.4	4.5	6.3	7.7
2	637.2	302.2	102.0	123.2	1164.5	7.0	6.5	7.4	8.4
3	2920.2	1213.8	636.0	1043.0	5813.0	7.6	7.5	7.9	9.0
4	704.3	268.2	54.8	188.0	1215.4	8.4	8.4	8.6	9.5
5	98.7	57.7	20.3	74.7	251.4	10.2	10.1	9.9	12.4
6	59.2	47.2	4.1	15.7	126.2	10.4	11.0	12.6	10.8
7	48.6	34.0	1.8	6.6	90.9	10.4	10.9	10.3	10.3
8	52.7	29.4	2.8	16.2	101.0	10.9	10.9	12.1	11.0
9	3.6	7.6	0.0	0.0	11.2	11.0	11.7	0.0	0.0
10	14.4	12.6	0.0	0.0	27.0	10.8	11.2	0.0	0.0
Sum	4844.6	2072.6	1181.3	1988.8	10087.1				
SOP	36769.6	15800.1	8807.0	17475.6	78852.4				
Catch	36769.6	15800.1	8807.0	17475.6	78852.4				

Table 7.3 continued

Sub-division 29

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	9.9	181.6	191.5	0.0	0.0	3.0	3.4
1	825.2	194.8	19.7	649.8	1689.6	2.8	2.6	6.3	5.6
2	90.9	12.5	9.0	126.8	239.1	6.3	6.0	6.8	6.9
3	1921.7	250.8	23.2	721.7	2917.4	6.3	5.8	7.7	7.5
4	744.5	197.4	21.4	223.7	1187.0	7.0	6.1	8.8	9.1
5	42.8	3.6	0.9	21.2	68.4	8.9	8.8	8.8	10.4
6	30.5	1.9	0.0	9.8	42.3	8.6	8.7	0.0	10.5
7	20.9	2.6	1.8	3.3	28.6	9.4	9.6	9.6	12.0
8	12.0	2.6	0.8	4.3	19.7	9.3	8.3	9.6	12.0
9	2.3	0.3	0.3	9.5	12.4	9.4	9.8	11.0	10.8
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	3690.8	666.5	87.0	1951.7	6395.9				
SOP	21208.7	3326.8	616.5	13108.2	38260.2				
Catch	21208.7	3326.8	616.5	13108.2	38260.2				

Sub-division 30

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	5.0
1	0.0	0.3	0.0	1.9	2.2	0.0	3.0	0.0	8.6
2	3.3	0.4	0.0	0.4	4.1	9.3	7.0	0.0	9.0
3	10.7	21.2	2.3	10.1	44.3	9.2	9.3	9.3	11.4
4	32.4	45.6	23.6	52.0	153.5	10.0	10.2	11.0	12.2
5	4.3	2.6	0.3	3.1	10.3	10.5	12.5	14.0	13.3
6	2.3	2.6	1.3	2.9	9.1	11.0	11.5	12.7	11.0
7	0.0	0.8	1.4	3.6	5.7	0.0	14.0	14.0	14.8
8	0.0	0.6	1.3	0.1	2.1	0.0	14.0	13.7	19.0
9	32.1	22.5	7.7	12.2	74.4	12.8	13.4	14.0	14.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	85.0	96.5	38.0	86.5	305.8				
SOP	933.8	1046.7	446.6	1076.6	3503.7				
Catch	933.8	1046.7	446.6	1076.6	3503.7				

Sub-division 31

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.3	0.0
4	0.0	0.0	0.3	0.0	0.3	0.0	0.0	11.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.7	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.7	0.0
9	0.0	0.0	0.1	0.0	0.1	0.0	0.0	14.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.6	0.0	0.6				
SOP	0.0	0.0	6.5	0.0	6.5				
Catch	0.0	0.0	6.5	0.0	6.5				

Table 7.3 continued

Sub-division 32

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	334.4	334.4	0.0	0.0	0.0	3.2
1	354.9	176.8	23.1	829.2	1384.0	2.5	3.1	5.6	5.7
2	72.4	40.6	19.4	121.0	253.4	5.8	6.2	6.3	7.3
3	451.4	268.6	50.5	446.7	1217.2	6.4	6.0	7.0	7.4
4	406.4	166.3	29.0	202.4	804.1	6.8	6.5	7.3	8.2
5	62.8	14.5	2.9	46.8	127.1	8.8	7.9	8.4	8.7
6	34.4	0.0	0.6	5.6	40.6	8.7	8.0	10.0	10.5
7	41.4	4.1	1.8	3.8	51.1	8.7	8.5	9.2	9.3
8	24.6	3.0	0.0	3.7	31.2	8.8	8.2	0.0	10.2
9	0.1	0.0	0.0	2.2	2.3	9.0	0.0	0.0	11.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	1448.4	674.0	127.3	1995.7	4245.3				
SOP	8383.9	3664.8	866.3	12149.7	25064.6				
Catch	8388.2	3724.7	866.3	12149.7	25128.8				

Table 7.4 SPRAT in SD 22-32. Fishing effort and CPUE data

Year	Russia - Sub-division 26			
	Type of vessels			
	SRTM (51 m length, 1100 hp)		MRTK (27 m length, 300 hp)	
	Effort [h]	CPUE, [kg/h]	Effort [h]	CPUE, [kg/h]
1995	8907	647	8760	601
1996	12129	620	7810	953
1997	17140	470	10691	746
1998	13469	646	9986	782
1999	13898	869	15967	965
2000	14417	766	13501	1031
2001	12837	937	12912	1282
2002	11789	884	18979	1012
2003	5869	958	14128	1285
2004	2973	895	14751	1394
2005	1696	1323	21908	1115
2006	1308	1576	16363	1414

	Estonia - Sub-divisions 28, 29, 32							
Year/Sub-div.	CPUE [kg/h] by quarters				Effort [h] by quarters			
1999	1	2	3	4	1	2	3	4
28	544	541	461		2776	1234	218	
29	1083	1011	495		5297	3377	427	
32	465	524	362		15513	8930	2458	
2000								
28	454	114	1300	1104	5480	1878	335	2452
29	1351	725	1397	1668	3420	3611	318	3533
32	471	364	586	719	9684	5448	2297	15259
2001								
28	788	489	832	850	4017	1732	174	2621
29	1360	883	1177	1187	5047	3551	513	4813
32	450	289	501	547	12008	9058	2527	11494
2002								
28	696	483	2556	1209	2643	2047	219	3755
29	1195	875	1974	1851	4570	3551	300	4222
32	376	320	585	943	7990	4999	2432	9575
2003								
28	1227	471	1160	854	4138	1387	513	143
29	1638	818	943	1324	2926	1914	796	5587
32	1205	638	501	765	316	702	1264	8888

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2006 available to the Working Group.

Sub-division 22	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	6653	10	2038	203
		2	4989	2	257	42
		3	2440	3	366	95
		4	5277	12	1376	257
		Total	19359	27	4037	597
	Germany	1	1023			
		2	127			
		3	0			
		4	29			
		Total	1178	0	0	0
	Total	1	7676	10	2038	203
		2	5116	2	257	42
		3	2440	3	366	95
		4	5306	12	1376	257
		Total	20537	27	4037	597
Sub-division 24	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	857	2	10	
		2	449			
		3	118			
		4	318	1	5	
		Total	1742	3	15	0
	Finland	1				
		2				
		3				
		4	150			
		Total	150	0	0	0
	Germany	1	6			
		2	4			
		3				
		4				
		Total	10	0	0	0
	Poland	1	665			
		2	71			
		3		1	294	104
		4	100			
		Total	836	1	294	104
	Sweden	1	157			
		2	197	1	50	50
		3	34			
		4	298	1	6	6
		Total	686	2	56	56
	Total	1	1685	2	10	0
		2	721	1	50	50
		3	152	1	294	104
		4	866	2	11	6
		Total	3424	6	365	160

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2006 available to the Working Group.

Sub-division 25	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	3897	10	1239	413
		2	2665	6	710	151
		3	9			
		4	330			
		Total	6901	16	1949	564
	Estonia	1				
		2	145			
		3				
		4				
		Total	145	0	0	0
	Finland	1	49			
		2	478			
		3				
		4				
		Total	527	0	0	0
	Germany	1	1030			
		2	316			
		3				
		4				
		Total	1346	0	0	0
	Latvia	1	283			
		2	690			
		3				
		4	166			
		Total	1140	0	0	0
	Poland	1	8654	16	3508	645
		2	7694	4	1007	312
		3	34	16	2388	356
		4	298	6	1230	293
		Total	16680	42	8133	1606
	Sweden	1	3240	5	205	202
		2	722	5	177	175
		3	295	3	60	58
		4	314	1	7	7
		Total	4570	14	449	442
	Total	1	17153	31	4952	1260
		2	12710	15	1894	638
		3	338	19	2448	414
		4	1109	7	1237	300
		Total	31309	72	10531	2612

cont. 3/6

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2006 available to the Working Group.

Sub-division 26	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	9884	24	2588	585
		2				
		3				
		4				
		Total	9884	24	2588	585
	Finland	1	56			
		2	1085			
		3				
		4				
		Total	1141	0	0	0
	Germany	1	6196	5	5102	209
		2	1988			
		3				
		4				
		Total	8184	5	5102	209
	Lithuania	1	2681	7	1689	579
		2	4107	7	1648	512
		3	11	3	205	160
		4	690	2	212	113
		Total	7489	19	3754	1364
	Latvia	1	2736			
		2	1564	2	400	126
		3	779	1	202	62
		4	900	1	207	72
		Total	5979	4	809	260
	Poland	1	16417	21	4864	906
		2	16731	17	4359	685
		3	908	8	1668	256
		4	2767	14	3369	395
		Total	36824	60	14260	2242
	Russia	1	7859	20	3851	376
		2	11124	12	2520	379
		3	5286	15	3170	215
		4	3656	8	1920	612
		Total	27925	55	11461	1582
	Sweden	1	15435	4	421	214
		2	9311	2	227	93
		3				
		4	600			
		Total	25345	6	648	307
	Total	1	61263	81	18515	2869
		2	45911	40	9154	1795
		3	6984	27	5245	693
		4	8613	25	5708	1192
		Total	122771	173	38622	6549

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2006 available to the Working Group.

Sub-division 27	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	330	3	325	56
		2				
		3				
		4				
		Total	330	3	325	56
	Estonia	1				
		2	344			
		3				
		4				
		Total	344			
	Finland	1	577			
		2	1253			
		3				
		4	40			
		Total	1870	0	0	0
	Germany	1	12023			
		2				
		3				
		4				
		Total	12023	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Poland	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Sweden	1	7756	6	350	343
		2	4755	1	50	50
		3	48			
		4	1156			
		Total	13715	7	400	393
	Total	1	20686	9	675	399
		2	6352	1	50	50
		3	48	0	0	0
		4	1196	0	0	0
		Total	28282	10	725	449

Sub-division 28	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	2371	6	695	274
		2				
		3				
		4	264	1	118	60
		Total	2635	7	813	334
	Estonia	1	3286	6	1023	421
		2	820	3	418	200
		3	348	2	247	89
		4	1027	8	896	151
		Total	5481	19	2584	861
	Finland	1	1254			
		2	701			
		3				
		4	87			
		Total	2042	0	0	0
	Germany	1	4619			
		2				
		3				
		4				
		Total	4619	0	0	0
	Latvia	1	20309	14	1623	1400
		2	10096	11	1100	1100
		3	7871	11	1139	993
		4	9231	14	1580	1329
		Total	47507	50	5442	4822
	Poland	1				
		2	55			
		3				
		4				
		Total	55	0	0	0
	Russia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Sweden	1	4930	4	200	199
		2	4183	2	200	198
		3	588			
		4	6867			
		Total	16568	6	400	397
	Total	1	36770	30	3541	2294
		2	15855	16	1718	1498
		3	8807	13	1386	1082
		4	17476	23	2594	1540
		Total	78907	82	9239	6414

cont. 5/6

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2006 available to the Working Group.

Sub-division 29	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	aged
	Denmark	1				
		2				
		3				
		4	1248	3	439	172
		Total	1248	3	439	172
	Estonia	1	11337	7	1266	401
		2	2955	4	1078	212
		3	254	2	218	92
		4	4687	5	822	104
		Total	19233	18	3384	809
	Finland	1	4479	5	2228	169
		2	37	4	651	91
		3	363	4	1162	118
		4	1873	6	1300	137
		Total	6751	19	5341	515
	Germany	1	3417			
		2				
		3				
		4				
		Total	3417	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Sweden	1	1976	1	108	54
		2	335			
		3				
		4	5300	1	50	50
		Total	7611	2	158	104
	Total	1	21209	13	3602	624
		2	3327	8	1729	303
		3	616	6	1380	210
		4	13108	15	2611	463
		Total	38260	42	9322	1600
Sub-division 30	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	aged
	Finland	1	934	6	290	85
		2	1047	7	745	85
		3	447	4	319	61
		4	1077	6	1325	91
		Total	3504	23	2679	322
Sub-division 31	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	aged
	Finland	1				
		2				
		3	7		1	
		4				
		Total	7	0	1	0

cont.

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2006 available to the Working Group.

Sub-division 32	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Estonia	1	7954	3	466	307
		2	3665	8	1613	214
		3	814	9	2620	150
		4	9179	18	3017	855
		Total	21612	38	7716	1526
	Finland	1	430	1	560	110
		2			2	2
		3	52	1	327	35
		4	2514	8	2690	133
		Total	2996	10	3579	280
	Russia	1	4			
		2	60			
		3				
		4	246			
		Total	310	0	0	0
	Sweden	1				
		2				
		3				
		4	210			
		Total	210	0	0	0
	Total	1	8388	4	1026	417
		2	3725	8	1615	216
		3	866	10	2947	185
		4	12150	26	5707	988
		Total	25129	48	11295	1806

Sub-divisions 22-32	**Total**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**Number of fish aged**
		1	**175763**	**186**	**34649**	**8151**
		2	**94764**	**98**	**17212**	**4677**
		3	**20705**	**83**	**14386**	**2844**
		4	**60899**	**116**	**20569**	**4837**
		Total	**352130**	**483**	**86816**	**20509**

Table 7.6 SPRAT in SD 22-32. Catch in Numbers (Thousands)

CANUM: Catch in numbers (Total International Catch) (Thousands)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	2615000	6172000	3618000	1940000	1929000	933000	1213000	278000
1975	628000	2032000	5678000	2387000	790000	878000	247000	546000
1976	4682000	818000	2106000	3510000	1040000	350000	548000	422000
1977	2371000	8399000	997000	1907000	1739000	364000	140000	399000
1978	500000	3325000	4936000	480000	817000	683000	73000	189000
1979	1340000	597000	1037000	2291000	188000	150000	335000	125000
1980	369000	1476000	378000	500000	1357000	72000	67000	235000
1981	2303000	920000	405000	94000	88000	527000	13000	99000
1982	363000	2460000	425000	225000	64000	57000	231000	51000
1983	1852000	297000	531000	107000	47000	12000	18000	148000
1984	1005000	2393000	388000	447000	77000	38000	9000	83000
1985	566000	1703000	2521000	447000	271000	30000	19000	65000
1986	495000	1142000	1425000	2099000	340000	188000	16000	50000
1987	779000	394000	1320000	1833000	1805000	227000	149000	73000
1988	78067	2695775	730495	1148801	762480	760343	64666	141159
1989	2101849	290021	1771932	403652	739242	390255	398382	137139
1990	1049000	3171000	346000	952000	188000	316000	112000	200000
1991	1043547	2649359	2438646	406536	568611	106181	160259	152226
1992	1782000	2939000	3040000	1643000	444000	311000	121000	163000
1993	1832200	5685200	3243700	1898100	883700	267100	244400	256688
1994	1079000	8169000	8176000	3525000	2201000	779000	193000	208000
1995	6373200	2341300	6643300	6636100	3366400	1901800	626600	409200
1996	8388700	27674900	4704100	6517100	3323000	1499200	690100	403400
1997	1717800	23181900	23395000	6343200	4107900	1650800	682700	279100
1998	11017500	3802500	17687600	19617500	2658600	1777800	1468100	489100
1999	2081600	19901300	5832000	9972000	8835500	1180100	686700	515400
2000	10534600	2948125	14716398	2870128	4284070	4076601	707496	760552
2001	2775600	11557200	2670400	9252400	1998800	2651400	2263500	522500
2002	6648000	5429000	10781000	3835000	4308000	998000	880000	1340000
2003	9366111	7108722	4805394	5067481	2396044	1902532	833054	1383341
2004	23263510	13094317	5447560	3086404	3245594	1333956	1143154	1364306
2005	2842586	30967900	11254006	2933589	1868255	842965	658605	615157
2006	10851128	3265522	21097242	6832239	1380358	613632	405085	529977

Table 7.7 **SPRAT in SD 22-32.**

Mean weight in the Catch and in the Stock (Kilograms)

WECA (=WEST): Mean weight in Catch (Kilograms)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.0066	0.0105	0.0122	0.0134	0.0139	0.0154	0.0141	0.0143
1975	0.0068	0.0112	0.0124	0.0134	0.0147	0.0143	0.0157	0.0135
1976	0.0069	0.0107	0.0127	0.0135	0.0145	0.0161	0.0147	0.0143
1977	0.0054	0.0110	0.0134	0.0140	0.0144	0.0159	0.0159	0.0158
1978	0.0051	0.0109	0.0125	0.0131	0.0141	0.0152	0.0158	0.0151
1979	0.0055	0.0127	0.0130	0.0137	0.0151	0.0158	0.0156	0.0162
1980	0.0078	0.0113	0.0143	0.0141	0.0143	0.0167	0.0158	0.0160
1981	0.0063	0.0141	0.0161	0.0180	0.0165	0.0159	0.0168	0.0161
1982	0.0088	0.0117	0.0160	0.0162	0.0167	0.0164	0.0163	0.0173
1983	0.0092	0.0145	0.0162	0.0171	0.0169	0.0170	0.0169	0.0168
1984	0.0097	0.0111	0.0146	0.0153	0.0158	0.0163	0.0169	0.0172
1985	0.0091	0.0113	0.0127	0.0140	0.0160	0.0171	0.0171	0.0158
1986	0.0079	0.0121	0.0129	0.0140	0.0148	0.0161	0.0170	0.0167
1987	0.0085	0.0117	0.0133	0.0145	0.0152	0.0164	0.0170	0.0176
1988	0.0056	0.0103	0.0122	0.0142	0.0152	0.0153	0.0166	0.0170
1989	0.0097	0.0136	0.0145	0.0158	0.0169	0.0173	0.0175	0.0181
1990	0.0104	0.0126	0.0149	0.0160	0.0175	0.0177	0.0184	0.0181
1991	0.0090	0.0129	0.0143	0.0158	0.0166	0.0175	0.0169	0.0169
1992	0.0087	0.0121	0.0147	0.0154	0.0173	0.0172	0.0181	0.0184
1993	0.0066	0.0111	0.0138	0.0146	0.0150	0.0162	0.0166	0.0166
1994	0.0080	0.0098	0.0121	0.0140	0.0145	0.0152	0.0155	0.0159
1995	0.0065	0.0106	0.0110	0.0126	0.0137	0.0141	0.0143	0.0145
1996	0.0043	0.0075	0.0103	0.0111	0.0124	0.0128	0.0127	0.0129
1997	0.0067	0.0074	0.0085	0.0101	0.0117	0.0124	0.0125	0.0127
1998	0.0046	0.0076	0.0083	0.0089	0.0104	0.0106	0.0108	0.0118
1999	0.0040	0.0078	0.0092	0.0091	0.0092	0.0106	0.0112	0.0110
2000	0.0062	0.0102	0.0100	0.0108	0.0113	0.0117	0.0128	0.0134
2001	0.0063	0.0093	0.0114	0.0108	0.0116	0.0113	0.0110	0.0118
2002	0.0069	0.0097	0.0102	0.0109	0.0111	0.0111	0.0115	0.0117
2003	0.0050	0.0099	0.0108	0.0109	0.0114	0.0111	0.0107	0.0108
2004	0.0044	0.0076	0.0105	0.0112	0.0111	0.0114	0.0111	0.0113
2005	0.0047	0.0069	0.0081	0.0107	0.0112	0.0116	0.0110	0.0113
2006	0.0048	0.0078	0.0082	0.0089	0.0108	0.0112	0.0111	0.0114

Table 7.8 **SPRAT in SD 22-32. Natural Mortality**

NATMOR: Natural Mortality

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.96	0.57	0.45	0.45	0.50	0.46	0.56	0.56
1975	1.39	0.76	0.57	0.55	0.63	0.59	0.73	0.73
1976	0.88	0.55	0.43	0.42	0.48	0.46	0.56	0.56
1977	0.77	0.50	0.41	0.40	0.44	0.43	0.52	0.52
1978	1.05	0.67	0.54	0.51	0.57	0.55	0.68	0.68
1979	1.17	0.80	0.65	0.59	0.67	0.68	0.86	0.86
1980	1.26	0.84	0.68	0.60	0.68	0.73	0.92	0.92
1981	1.02	0.71	0.58	0.53	0.60	0.61	0.78	0.78
1982	1.20	0.83	0.68	0.61	0.69	0.71	0.91	0.91
1983	1.06	0.78	0.63	0.59	0.69	0.69	0.88	0.88
1984	0.85	0.65	0.55	0.50	0.56	0.59	0.74	0.74
1985	0.74	0.55	0.46	0.43	0.48	0.50	0.62	0.62
1986	0.64	0.45	0.39	0.37	0.40	0.40	0.48	0.48
1987	0.53	0.40	0.35	0.34	0.36	0.36	0.42	0.42
1988	0.57	0.44	0.38	0.36	0.39	0.40	0.47	0.47
1989	0.47	0.37	0.33	0.31	0.34	0.35	0.41	0.41
1990	0.38	0.31	0.28	0.27	0.29	0.29	0.33	0.33
1991	0.32	0.27	0.25	0.24	0.25	0.25	0.28	0.28
1992	0.34	0.26	0.25	0.24	0.25	0.25	0.26	0.26
1993	0.36	0.29	0.27	0.26	0.28	0.26	0.29	0.29
1994	0.35	0.29	0.27	0.26	0.27	0.27	0.29	0.29
1995	0.33	0.28	0.26	0.26	0.27	0.27	0.30	0.30
1996	0.31	0.27	0.25	0.25	0.26	0.26	0.29	0.29
1997	0.35	0.28	0.26	0.26	0.27	0.28	0.31	0.31
1998	0.39	0.31	0.27	0.27	0.29	0.28	0.32	0.32
1999	0.41	0.32	0.28	0.28	0.29	0.29	0.33	0.33
2000	0.41	0.32	0.29	0.28	0.30	0.30	0.33	0.33
2001	0.39	0.31	0.27	0.27	0.29	0.29	0.31	0.31
2002	0.40	0.32	0.29	0.28	0.30	0.30	0.33	0.33
2003	0.30	0.26	0.24	0.24	0.25	0.25	0.26	0.26
2004	0.30	0.26	0.24	0.24	0.25	0.24	0.26	0.26
2005	0.33	0.27	0.25	0.24	0.25	0.25	0.27	0.27
2006	0.33	0.27	0.25	0.24	0.25	0.25	0.27	0.27

Table 7.9 **SPRAT in SD 22-32. Proportion Mature at Spawning Time**

MATPROP: Proportion of Mature at Spawning Time

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2006	0.170	0.930	1.0	1.0	1.0	1.0	1.0	1.0

Table 7.10 **SPRAT in SD 22-32. Proportion of M before Spawning**

MPROP: Proportion of M before Spawning

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2006	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Table 7.11 **SPRAT in SD 22-32. Proportion of F before Spawning**

FPROP: Proportion of F before Spawning

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2006	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Table 7.12 SPRAT in SD 22-32. Tuning Fleet/ Latvian and Russian Acoustic Survey in SD 26+28

		Latvian/Russian acoustic on age 0 shifted to represent age 1
Year	**Fish. Effort**	**Age 1**
1994	1	4755
1995	1	39314
1996	1	27245
1997	1	2236
1998	1	40179
1999	1	691
2000	1	22839
2001	1	4313
2002	1	6465
2003	1	32163
2004	1	62525
2005	1	2256
2006	1	18348

Table 7.13 SPRAT in SD 22-32. Tuning Fleet/InternationalAcoustic Survey in SD 24-29

		International Acoustic Survey corrected by area surveyed (Catch: Millions)							
Year	**Fish. Effort**	**Age 1**	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8+**
1983	1	44544	11578	10376	2434	409	274	156	12
1984	1	16132	27941	6751	2339	264	73	104	89
1985	1	5095	15017	12048	2799	425	116	82	82
1986	1	1625	8445	11811	3468	497	34	27	45
1987	1	15937	4315	9945	4293	1427	254	26	29
1988	1	996	8184	4624	5261	2315	269	38	16
1989	1	39567	3333	23902	5371	2915	1985	1947	324
1990	1	14715	32166	6872	5566	2124	1082	244	56
1991	1	48085	43613	44120	4376	9266	2303	1941	3227
1992	1	36510	26723	23896	9220	1897	2424	711	555
1993	1	51652	53499	27846	21983	7890	1617	2580	2024
1994	1	10531	45868	43410	17435	11847	5165	1023	1552
1995	1	184705	24230	55410	33085	14553	8174	2327	1393
1996	1	70537	133387	19524	23318	12613	6324	3640	1273
1997	1	12513	84652	90901	11049	13013	4256	3115	856
1998	1	100246	21541	55079	36508	8077	4825	1636	1082
1999	1	4796	101836	17319	42453	44890	5990	3611	1722
2000	1	57351	2751	52184	5924	14771	13185	1650	2700
2001	1	10011	31526	6977	30822	4452	11546	8061	3612
2002	1	31012	14352	36715	5716	18719	2637	5037	4344
2003	1	98387	32179	24070	24309	7916	13389	2815	10875
2004	1	124332	49586	12021	8177	5111	2584	2486	3606
2005	1	6997	123997	48131	9982	5084	2992	2350	3308
2006	1	36407	11678	102769	32353	7933	4583	2109	2947

Table 7.14 SPRAT in SD 22-32. Tuning Fleet/InternationalAcoustic Survey in SD 24-28

		International Acoustic Survey in May corrected by area surveyed (Catch: Millions)							
Year	**Fish. Effort**	**Age 1**	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8+**
2001	1	14366	56327	21268	66193	9169	7555	9103	1192
2002	1	29355	29530	56045	32508	23656	4189	5665	5575
2003	1	45557	25655	12984	25266	8319	12051	2914	6608
2004	1	228463	116764	24897	16627	21709	4958	13549	11300
2005	1	8222	171383	43274	16510	7758	5601	4029	4104
2006	1	26215	10480	111689	33826	8466	2764	1946	2493

Table 7.15 SPRAT in SD 22-32. Output from XSA: Diagnostics

Lowestoft VPA Version 3.1
18/04/2007 17:59
Extended Survivors Analysis
Sprat 22 32
CPUE data from file d:\SprDat06\FL2intAge0a.txt
Catch data for 33 years. 1974 to 2006. Ages 1 to 8.

Fleet		First year	Last year	First age	Last age	Alpha	Beta
FLT01:	International	1983	2006	1	7	0.750	0.850
FLT02:	Intenational	2001	2006	1	7	0.350	0.420
FLT03:	Latvian/Russian	1994	2006	1	1	0.000	0.010

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :
Catchability dependent on stock size for ages < 2
Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2
Catchability independent of age for ages >= 5

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = .750
Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00083

Final year F values

Age		1	2	3	4	5	6	7
Iteration	29	0.1566	0.2533	0.2561	0.3217	0.3022	0.3544	0.2964
Iteration	30	0.1566	0.2533	0.2561	0.3216	0.3021	0.3541	0.2963

Regression weights

0.751	0.820	0.877	0.921	0.954	0.976	0.990	0.997	1.000	1.000

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.039	0.083	0.050	0.135	0.070	0.148	0.098	0.109	0.135	0.157
2	0.279	0.130	0.251	0.109	0.259	0.228	0.271	0.212	0.228	0.253
3	0.286	0.391	0.336	0.337	0.151	0.465	0.356	0.366	0.303	0.256
4	0.490	0.450	0.438	0.302	0.405	0.370	0.451	0.429	0.360	0.322
5	0.471	0.429	0.413	0.379	0.395	0.370	0.454	0.628	0.534	0.302
6	0.364	0.420	0.382	0.382	0.483	0.392	0.302	0.525	0.345	0.354
7	0.311	0.749	0.320	0.478	0.431	0.330	0.756	0.319	0.579	0.296

XSA population numbers (Thousands)

	AGE						
YEAR	1	2	3	4	5	6	7
1997	5.38E+04	1.09E+05	1.07E+05	1.87E+04	1.25E+04	6.22E+03	2.99E+03
1998	1.69E+05	3.65E+04	6.26E+04	6.20E+04	8.82E+03	5.96E+03	3.27E+03
1999	5.29E+04	1.05E+05	2.35E+04	3.23E+04	3.02E+04	4.30E+03	2.96E+03
2000	1.02E+05	3.34E+04	5.95E+04	1.27E+04	1.58E+04	1.49E+04	2.19E+03
2001	4.96E+04	5.92E+04	2.17E+04	3.18E+04	7.09E+03	7.99E+03	7.55E+03
2002	5.90E+04	3.13E+04	3.35E+04	1.43E+04	1.62E+04	3.57E+03	3.69E+03
2003	1.16E+05	3.41E+04	1.81E+04	1.57E+04	7.45E+03	8.27E+03	1.79E+03
2004	2.62E+05	7.81E+04	2.00E+04	9.98E+03	7.89E+03	3.68E+03	4.76E+03
2005	2.66E+04	1.74E+05	4.87E+04	1.09E+04	5.11E+03	3.28E+03	1.72E+03
2006	8.83E+04	1.67E+04	1.06E+05	2.80E+04	6.00E+03	2.33E+03	1.81E+03

continued Table 7.15 **SPRAT in SD 22-32. Output from XSA: Diagnostics (2/4)**

Estimated population abundance at 1st Jan 2007

0.00E+00	5.43E+04	9.90E+03	6.38E+04	1.60E+04	3.45E+03	1.28E+03

Taper weighted geometric mean of the VPA populations:

8.56E+04	5.46E+04	3.65E+04	1.85E+04	9.26E+03	4.72E+03	2.56E+03

Standard error of the weighted Log(VPA populations) :

0 .6739	0.7254	0.6513	0.5916	0.5794	0.5972	0.5699

Log catchability residuals.

Fleet : FLT01: International

Age	1983	1984	1985	1986
1	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.44	-0.34	0.87	-0.05	0.63	0.04	0.24	-0.42	0.03	-0.15
2	-0.13	-0.33	-0.35	0.76	0.64	0.01	0.35	0.22	-0.13	0.25
3	-0.01	0.05	0.85	0.31	1.08	-0.01	0.01	0.22	0.45	-0.36
4	-0.16	-0.13	0.65	-0.20	0.18	-0.10	0.25	-0.03	0.52	0.13
5	-1.63	-0.21	-0.31	-0.03	0.54	-0.38	0.00	-0.05	0.26	0.01
6	-0.87	-2.60	0.39	-0.78	0.42	-0.41	-0.04	0.08	0.23	0.06
7	-2.87	-1.96	0.10	-1.11	0.26	-0.32	0.08	0.08	-0.09	0.02

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.19	0.07	-0.76	0.25	-0.21	0.40	0.39	-0.26	0.18	0.06
2	0.32	-0.05	0.55	-2.03	-0.05	-0.21	0.49	0.05	0.19	0.19
3	-0.04	0.09	-0.13	0.06	-1.11	0.38	0.45	-0.34	0.12	0.06
4	-0.30	-0.32	0.48	-0.67	0.14	-0.77	0.62	-0.04	0.02	0.22
5	0.07	-0.08	0.40	-0.09	-0.48	0.12	0.06	-0.29	0.06	0.16
6	-0.43	-0.21	0.31	-0.14	0.42	-0.31	0.36	-0.31	-0.18	0.59
7	-0.03	-0.40	0.16	-0.20	0.09	0.28	0.70	-0.75	0.43	0.04

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

Age	2	3	4	5	6	7
Mean Log q	-0.1274	0.3135	0.3713	0.5633	0.5633	0.5633
S.E(Log q)	0.6559	0.4441	0.4260	0.2433	0.3664	0.4042

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.65	2.192	4.36	0.80	20	0.36	-0.61

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.80	0.921	2.30	0.68	20	0.53	-0.13
3	0.93	0.352	0.44	0.72	20	0.43	0.31
4	0.91	0.460	0.58	0.71	20	0.40	0.37
5	0.86	1.390	0.83	0.90	20	0.20	0.56
6	1.00	-0.019	-0.62	0.73	20	0.38	0.58
7	1.14	-0.561	-1.77	0.61	20	0.48	0.58

Fleet: FLT02: International

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	99.99	99.99	99.99	99.99	-0.12	0.24	-0.16	0.19	0.11	-0.26
2	99.99	99.99	99.99	99.99	0.05	0.03	-0.20	0.46	0.05	-0.39
3	99.99	99.99	99.99	99.99	-0.13	0.53	-0.38	0.18	-0.18	-0.02
4	99.99	99.99	99.99	99.99	0.23	0.31	-0.03	0.00	-0.12	-0.36
5	99.99	99.99	99.99	99.99	-0.18	-0.06	-0.31	0.65	0.02	-0.14
6	99.99	99.99	99.99	99.99	-0.46	-0.27	-0.11	-0.11	0.07	-0.29
7	99.99	99.99	99.99	99.99	-0.22	-0.01	0.18	0.57	0.48	-0.40

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

Age	2	3	4	5	6	7
Mean Log q	0.1226	0.2721	0.7676	0.6964	0.6964	0.6964
S.E(Log q)	0.2883	0.3180	0.2421	0.3427	0.2792	0.4047

continued Table 7.15 **SPRAT in SD 22-32. Output from XSA: Diagnostics (3/4)**

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.72	2.145	3.70	0.94	6	0.23	-0.72

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.81	1.723	1.92	0.96	6	0.20	0.12
3	0.96	0.184	0.17	0.83	6	0.34	0.27
4	1.04	-0.145	-1.17	0.79	6	0.28	0.77
5	0.97	0.069	-0.42	0.59	6	0.37	0.70
6	1.09	-0.478	-1.32	0.87	6	0.22	0.50
7	1.05	-0.155	-1.25	0.70	6	0.46	0.80

Fleet : FLT03: Latvian/Russian

Age	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.07	-0.29	-0.06
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									

Age	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
1	-0.38	0.10	-1.02	0.28	0.07	0.13	0.34	-0.10	0.33	0.31
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.56	2.380	6.20	0.76	13	0.41	-2.13

Terminal year survivor and F summaries:

Age 1 Catchability dependent on age and year class strength
Year class = 2005

Fleet	Estimated	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01:	International	57867	0.372	0.000	0.00	1	0.257	0.148
FLT02:	Intenational	41971	0.300	0.000	0.00	1	0.396	0.198
FLT03:	Latvian/Russian	73717	0.429	0.000	0.00	1	0.193	0.118
P shrinkage mean		54565	0.73				0.079	0.156
F shrinkage mean		76975	0.75				0.074	0.113

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
54288	0.19	0.12	5	0.615	0.157

Age 2 Catchability constant w.r.t. time and dependent on age
Year class = 2004

Fleet	Estimated	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01:	International	11873	0.344	0.004	0.01	2	0.224	0.215
FLT02:	Intenational	8537	0.217	0.246	1.14	2	0.583	0.288
FLT03:	Latvian/Russian	13814	0.448	0.000	0.00	1	0.127	0.188
F shrinkage mean		10459	0.75				0.067	0.241

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9903	0.17	0.12	6	0.711	0.253

continued Table 7.15 **SPRAT in SD 22-32. Output from XSA: Diagnostics**

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01: International	60291	0.277	0.129	0.47	3	0.270	0.269
FLT02: Intenational	68267	0.187	0.060	0.32	3	0.590	0.241
FLT03: Latvian/Russian	57982	0.457	0.000	0.00	1	0.084	0.278
F shrinkage mean	47445	0.75				0.056	0.331

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
63805	0.14	0.06	8	0.395	0.256

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01: International	19981	0.239	0.066	0 .28	4	0.279	0.265
FLT02: Intenational	14294	0.162	0.177	1.09	4	0.612	0.353
FLT03: Latvian/Russian	22544	0.440	0.000	0.00	1	0.058	0.238
F shrinkage mean	12079	0.75				0.051	0.407

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15979	0.13	0.10	10	0.797	0.322

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01: International	3880	0.199	0.101	0.51	5	0.396	0.273
FLT02: Intenational	3303	0.157	0.081	0.52	5	0.523	0.314
FLT03: Latvian/Russian	3918	0.433	0.000	0.00	1	0.034	0.271
F shrinkage mean	1972	0.75				0.048	0.481

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3455	0.12	0.07	12	0.576	0.302

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01: International	1640	0.190	0.134	0.70	6	0.383	0.286
FLT02: Intenational	1086	0.157	0.070	0.45	6	0.543	0.405
FLT03: Latvian/Russian	1371	0.444	0.000	0.00	1	0.021	0.333
F shrinkage mean	1059	0.75				0.053	0.413

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1276	0.12	0.08	14	0.688	0.354

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	F
FLT01: International	986	0.191	0.102	0.54	7	0.425	0.307
FLT02: Intenational	1070	0.172	0.152	0.88	6	0.504	0.286
FLT03: Latvian/Russian	1363	0.450	0.000	0.00	1	0.012	0.231
F shrinkage mean	909	0.75				0.058	0.329

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1027	0.13	0.08	15	0.627	0.296

Table 7.16 **SPRAT IN SD 22-32. Output from XSA. Fishing mortality (F) at age**

Run title : Sprat 22-32
18/04/2007 17:59
Terminal Fs derived using XSA
(With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Age 1	0.0520	0.0342	0.0373	0.0900	0.0526	0.0752	0.0317	0.0614	0.0164	0.0219	0.0300
Age 2	0.1054	0.1031	0.1274	0.1463	0.3164	0.1774	0.2678	0.2424	0.1869	0.0371	0.0696
Age 3	0.3014	0.1996	0.2284	0.3114	0.1692	0.2544	0.2979	0.1880	0.2929	0.0966	0.1009
Age 4	0.3730	0.4823	0.2536	0.4335	0.3266	0.1632	0.3023	0.1720	0.2336	0.1763	0.1628
Age 5	0.2702	0.3796	0.6013	0.2482	0.4742	0.3187	0.2209	0.1201	0.2681	0.1113	0.2831
Age 6	0.5185	0.2790	0.4351	0.6067	0.2003	0.2334	0.3418	0.2020	0.1734	0.1221	0.1990
Age 7	0.3972	0.3947	0.4416	0.4400	0.3446	0.2487	0.3028	0.1702	0.2355	0.1420	0.2220
Age 8+	0.3972	0.3947	0.4416	0.4400	0.3446	0.2487	0.3028	0.1702	0.2355	0.1420	0.2220
FBAR 3-5	0.3149	0.3538	0.3611	0.3311	0.3234	0.2454	0.2737	0.1600	0.2649	0.1281	0.1823

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age 1	0.0207	0.0437	0.0280	0.0078	0.0643	0.0245	0.0222	0.0251	0.0251	0.0216	0.0310
Age 2	0.1098	0.0797	0.0617	0.1737	0.0478	0.1603	0.0907	0.0884	0.1176	0.1707	0.0672
Age 3	0.1419	0.1689	0.1543	0.1914	0.2023	0.0842	0.1947	0.1524	0.1426	0.2712	0.2222
Age 4	0.2228	0.2135	0.4170	0.2320	0.1802	0.1775	0.1439	0.2045	0.1423	0.2447	0.3999
Age 5	0.1923	0.3390	0.3493	0.3708	0.2723	0.1324	0.1632	0.2431	0.1724	0.2628	0.4232
Age 6	0.2442	0.2592	0.5008	0.2976	0.4044	0.2026	0.1105	0.1328	0.2402	0.2462	0.4158
Age 7	0.2252	0.2754	0.4360	0.3311	0.3177	0.2245	0.1639	0.1888	0.1578	0.2989	0.3550
Age 8+	0.2252	0.2754	0.4360	0.3311	0.3177	0.2245	0.1639	0.1888	0.1578	0.2989	0.3550
FBAR 3-5	0.1857	0.2405	0.3068	0.2648	0.2183	0.1314	0.1673	0.2000	0.1524	0.2596	0.3484

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR 04-06
Age 1	0.0636	0.0388	0.0826	0.0495	0.1355	0.0704	0.1481	0.0982	0.1089	0.1348	0.1566	0.1334
Age 2	0.2037	0.2791	0.1299	0.2508	0.1093	0.2589	0.2276	0.2712	0.2119	0.2277	0.2533	0.2310
Age 3	0.2009	0.2863	0.3907	0.3364	0.3369	0.1515	0.4654	0.3556	0.3660	0.3035	0.2561	0.3085
Age 4	0.3783	0.4897	0.4499	0.4381	0.3016	0.4053	0.3700	0.4510	0.4288	0.3604	0.3216	0.3702
Age 5	0.3846	0.4715	0.4288	0.4133	0.3793	0.3947	0.3703	0.4535	0.6282	0.5345	0.3021	0.4883
Age 6	0.3651	0.3642	0.4204	0.3820	0.3816	0.4835	0.3923	0.3019	0.5246	0.3447	0.3541	0.4078
Age 7	0.2843	0.3106	0.7494	0.3201	0.4781	0.4308	0.3304	0.7560	0.3191	0.5793	0.2963	0.3982
Age 8+	0.2843	0.3106	0.7494	0.3201	0.4781	0.4308	0.3304	0.7560	0.3191	0.5793	0.2963	
FBAR 3-5	0.3213	0.4158	0.4231	0.3960	0.3393	0.3171	0.4019	0.4201	0.4743	0.3994	0.2933	

Table 7.17 **SPRAT IN SD 22-32. Output from XSA. Stock number at age (Numbers*10**-5)**

Run title : Sprat 22-32
18/04/2007 17:59
Terminal Fs derived using XSA
(With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10-5**

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Age 1	83409	37407	198344	40496	16502	33212	22184	64425	40650	145310	51972	39971
Age 2	82008	30318	9004	79254	17137	5479	9561	6096	21848	12044	49254	21556
Age 3	17412	41736	12789	4573	41529	6391	2062	3158	2352	7903	5320	23984
Age 4	7804	8213	19333	6621	2223	20433	2587	775	1465	889	3821	2775
Age 5	10462	3427	2925	9858	2877	963	9621	1049	384	630	413	1970
Age 6	2902	4843	1249	992	4953	1013	358	3908	511	147	283	178
Age 7	4896	1091	2031	510	352	2339	406	123	1735	211	65	128
Age 8+	1087	2304	1513	1411	877	832	1345	901	364	1664	582	428
TOTAL	209980	129340	247188	143715	86449	70661	48124	80435	69309	168799	111710	90989

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Age 1	15928	36818	13334	42667	52394	55734	85313	88464	60095	246582	159083	53783
Age 2	18680	8039	21074	7482	25005	34962	39582	59220	60189	41443	171870	109495
Age 3	11143	10999	5066	11409	4927	15624	24375	27939	39395	37971	29287	107022
Age 4	13137	6372	6643	2861	6699	3423	10016	16301	18493	22930	23444	18657
Age 5	1444	7330	2989	3675	1752	4282	2332	6422	10902	11164	11853	12507
Age 6	1006	690	3606	1397	1992	1149	2833	1424	4085	6399	5582	6221
Age 7	84	520	292	1795	657	1217	801	1932	864	2438	3223	2987
Age 8+	259	249	619	607	1161	1148	1072	2020	921	1570	1863	1206
TOTAL	61682	71018	53623	71893	94588	117540	166323	203721	194944	370496	406205	311878

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 74-06	AMST 74-06
Age 1	168867	52882	102079	49605	58973	116297	261984	26592	88298	0	60620	80476
Age 2	36458	105267	33399	59162	31301	34088	78094	174059	16707	54288	29559	42528
Age 3	62601	23483	59481	21741	33495	18103	20041	48717	105816	9903	15437	23655
Age 4	61976	32334	12678	31778	14264	15737	9979	10933	28009	63805	8192	13054
Age 5	8816	30171	15768	7087	16175	7446	7885	5113	5998	15979	4281	6922
Age 6	5958	4296	14932	7994	3574	8275	3685	3277	2333	3455	2049	3433
Age 7	3267	2958	2194	7553	3689	1788	4765	1715	1808	1276	1023	1836
Age 8+	1062	2188	2321	1719	5541	2913	5631	1575	2343	2357		
TOTAL	349006	253579	242853	186639	167011	204649	392064	271981	251311	151062		

Table 7.18 **Sprat in SD 22-32. Output from XSA. Stock summary.**

Table 16 Summary (without SOP correction) **Run title : Sprat 22-32**
Terminal Fs derived using XSA (With F shrinkage) **At 18/04/2007 18:00**

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3-5
1974	83409	2003	1101	242	0.2195	0.3149
1975	37407	1389	815	201	0.2472	0.3538
1976	198344	2002	630	195	0.3093	0.3611
1977	40496	1433	904	181	0.2001	0.3311
1978	16502	954	633	132	0.2092	0.3234
1979	33212	696	381	77	0.2026	0.2454
1980	22184	519	244	58	0.2377	0.2737
1981	64425	653	217	49	0.2277	0.1600
1982	40650	724	270	49	0.1802	0.2649
1983	145310	1699	402	37	0.0928	0.1281
1984	51972	1209	562	53	0.0936	0.1823
1985	39971	994	522	70	0.1332	0.1857
1986	15928	723	480	76	0.1581	0.2405
1987	36818	782	404	88	0.2183	0.3068
1988	13334	564	378	80	0.2124	0.2648
1989	42667	855	406	86	0.2114	0.2183
1990	52394	1140	556	86	0.1540	0.1314
1991	55734	1361	782	103	0.1320	0.1673
1992	85313	1857	1034	142	0.1375	0.2000
1993	88464	2050	1288	178	0.1383	0.1524
1994	60095	2054	1323	289	0.2183	0.2596
1995	246582	3049	1387	313	0.2257	0.3484
1996	159083	2818	1767	441	0.2496	0.3213
1997	53783	2545	1735	529	0.3051	0.4158
1998	168867	2328	1286	471	0.3662	0.4231
1999	52882	1923	1316	421	0.3203	0.3960
2000	102079	2117	1236	389	0.3147	0.3393
2001	49605	1730	1129	342	0.3032	0.3171
2002	58973	1534	905	343	0.3794	0.4019
2003	116297	1513	794	308	0.3884	0.4201
2004	261984	2314	1059	374	0.3529	0.4743
2005	26592	1970	1439	405	0.2816	0.3994
2006	88298	1818	1176	352	0.2993	0.2933
Arith. Mean	79080	1555	865	217	0.2339	0.2914
Units	(Millions)	(Thousands tonnes)	(Thousands tonnes)	(Thousands tonnes)		

Table 7.19 Sprat in SD 22-32. Input Data for RCT3 analysis.

Sprat 22-32: YFS data from Latvian-Russian acoustic on age 0 and NAO

Yearclass	VPA	Acoustic Age 0	NAO
1973	83409	-11	4.3
1974	37407	-11	5.22
1975	198344	-11	4.42
1976	40496	-11	4.02
1977	16502	-11	1.96
1978	33212	-11	2.23
1979	22184	-11	1.08
1980	64425	-11	2.45
1981	40650	-11	4.02
1982	145310	-11	3.77
1983	51972	-11	4.79
1984	39971	-11	5.13
1985	15928	-11	1.44
1986	36818	-11	1.72
1987	13334	-11	1.82
1988	42667	-11	3.21
1989	52394	-11	6.57
1990	55734	-11	7.31
1991	85313	-11	3.93
1992	88464	-11	4.91
1993	60095	4755	5.01
1994	246582	39314	3.68
1995	159083	27245	5.92
1996	53783	2236	1.3
1997	168867	40179	4.66
1998	52882	691	4.08
1999	102079	22839	4.35
2000	49605	4313	5.36
2001	58973	6465	3.05
2002	116297	32163	5.66
2003	261984	62525	3.75
2004	26592	2256	2.48
2005	88298	18348	2.78
2006	-11	24705	2.33

Table 7.20 Sprat in SD 22-32. Output from RCT3 analysis.

Analysis by RCT3 ver3.1 of data from file recspr2l.txt
Sprat 22-32: YFS data from Latvian-Russian acoustic on age 0 and NAO

Data for 2 surveys over 34 years: 1973-2006
Regression type=C
Tapered time weighting applied
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E for any survey taken as 0.2
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction----------I			
Acoust	0.43	7.62	0.32	0.824	7	8.37	11.2	0.412	0.726
NAO	4.46	4.07	1.59	0.185	27	1.85	12.33	1.84	0.036
					VPA Mean =		11.22	0.72	0.237

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction---------I			
Acoust	0.47	7.22	0.35	0.792	8	8.77	11.31	0.435	0.692
NAO	5.32	2.56	1.88	0.126	28	1.4	10	2.181	0.028
					VPA Mean =		11.22	0.683	0.281

Yearclass = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction---------I			
Acoust	0.49	6.99	0.36	0.765	9	10.38	12.04	0.46	0.64
NAO	5.53	2.29	1.89	0.112	29	1.9	12.79	2.207	0.028
					VPA Mean =		11.24	0.638	0.332

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction---------I			
Acoust	0.47	7.12	0.35	0.755	10	11.04	12.29	0.455	0.616
NAO	5.43	2.37	1.78	0.11	30	1.56	10.84	2.039	0.031
					VPA Mean =		11.3	0.6	0.354

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction---------I			
Acoust	0.49	6.92	0.35	0.788	11	7.72	10.71	0.437	0.677
NAO	9.43	-4.04	3.01	0.048	31	1.25	7.72	3.644	0.01
					VPA Mean =		11.42	0.642	0.314

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction---------I			
Acoust	0.56	6.25	0.41	0.777	12	9.82	11.73	0.484	0.659
NAO	6.53	0.84	2.01	0.118	32	1.33	9.52	2.365	0.028
					VPA Mean =		11.35	0.702	0.314

Yearclass = 2006

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
			I----------Regression---------I			I----------Prediction---------I			
Acoust	0.56	6.2	0.41	0.764	13	10.11	11.86	0.479	0.647
NAO	6.54	1.02	1.97	0.114	33	1.2	8.88	2.383	0.026
					VPA Mean =		11.36	0.674	0.327

Year Class	Weighted Average Prediction RCT3	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1995	69587	11.15	0.7	0.57	0.67	159084	11.98
1996	35435	10.48	0.38	0.42	1.20	53784	10.89
1997	178608	12.09	0.31	0.34	1.22	168868	12.04
1998	31724	10.36	0.35	0.32	0.81	52883	10.88
1999	130962	11.78	0.35	0.24	0.47	102080	11.53
2000	76211	11.24	0.35	0.15	0.18	49605	10.81
2001	76676	11.25	0.36	0.15	0.17	58973	10.98
2002	132848	11.80	0.37	0.29	0.63	116297	11.66
2003	146701	11.90	0.36	0.36	1.00	261985	12.48
2004	54564	10.91	0.36	0.32	0.80	26592	10.19
2005	103698	11.55	0.39	0.27	0.48	88298	11.39
2006	111145	11.62	0.39	0.36	0.86		

Table 7.21 Sprat in SD 22-32. Input data for short-term prediction.

MFDP version 1a
Run: sprPr2007StatusQuo
Time and date: 17:19 2007-04-21
Fbar age range: 3-5

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	111145	0.320	0.17	0.4	0.4	0.0047	0.1006	0.0047
2	54288	0.267	0.93	0.4	0.4	0.0074	0.1741	0.0074
3	9903	0.247	1	0.4	0.4	0.0089	0.2326	0.0089
4	63805	0.240	1	0.4	0.4	0.0103	0.2791	0.0103
5	15979	0.250	1	0.4	0.4	0.0110	0.3681	0.0110
6	3455	0.247	1	0.4	0.4	0.0114	0.3074	0.0114
7	1276	0.267	1	0.4	0.4	0.0111	0.3002	0.0111
8	2357	0.267	1	0.4	0.4	0.0113	0.3002	0.0113

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	86690	0.320	0.17	0.4	0.4	0.0047	0.1006	0.0047
2	.	0.267	0.93	0.4	0.4	0.0074	0.1741	0.0074
3	.	0.247	1	0.4	0.4	0.0089	0.2326	0.0089
4	.	0.240	1	0.4	0.4	0.0103	0.2791	0.0103
5	.	0.250	1	0.4	0.4	0.0110	0.3681	0.0110
6	.	0.247	1	0.4	0.4	0.0114	0.3074	0.0114
7	.	0.267	1	0.4	0.4	0.0111	0.3002	0.0111
8	.	0.267	1	0.4	0.4	0.0113	0.3002	0.0113

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	86690	0.320	0.17	0.4	0.4	0.0047	0.1006	0.0047
2	.	0.267	0.93	0.4	0.4	0.0074	0.1741	0.0074
3	.	0.247	1	0.4	0.4	0.0089	0.2326	0.0089
4	.	0.240	1	0.4	0.4	0.0103	0.2791	0.0103
5	.	0.250	1	0.4	0.4	0.0110	0.3681	0.0110
6	.	0.247	1	0.4	0.4	0.0114	0.3074	0.0114
7	.	0.267	1	0.4	0.4	0.0111	0.3002	0.0111
8	.	0.267	1	0.4	0.4	0.0113	0.3002	0.0113

Input units are thousands and kg - output in tonnes

M =	Natural mortality
MAT =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWT =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWT =	Weight in catch (kg)

N_{2007} Age 1:	Output form RCT3 Analysis (Table 7.20)
N_{2007} Age 2-8+:	Output from XSA (Table 7.17)
$N_{2008/2009}$ Age 1:	Geometric Mean from XSA-Output of age 1 (Table 7.17) for the years 1991-2006
Natural Mortality (M):	Average for 2004-2006
Weight in the Catch/Stock (CWt/SWt):	Average for 2004-2006
Expoitation pattern (Sel):	Average for 2004-2006 (scaled to 2006 value)

Table 7.22 **Sprat in SD 22-32. Output from short-term prediction with management option table for status quo fishery in 2007**

MFDP version 1a
Run: sprPr2007StatusQuo
Sprat
Time and date: 17:19 2007-04-21
Fbar age range: 3-5

2007 Biomass	SSB	FMult	FBar	Landings
1922	1196	1.0000	0.2933	325

2008 Biomass	SSB	FMult	FBar	Landings	2009 Biomass	SSB
1885	1363	0.0	0.000	0	2152	1611
.	1349	0.1	0.029	37	2115	1563
.	1335	0.2	0.059	73	2080	1516
.	1322	0.3	0.088	108	2045	1471
.	1309	0.4	0.117	142	2011	1428
.	1295	0.5	0.147	175	1978	1386
.	1282	0.6	0.176	208	1945	1346
.	1270	0.7	0.205	239	1914	1307
.	1257	0.8	0.235	270	1883	1269
.	1244	0.9	0.264	300	1853	1233
.	1232	1.0	0.293	330	1824	1198
.	1220	1.1	0.323	358	1795	1164
.	1207	1.2	0.352	386	1767	1131
.	1195	1.3	0.381	414	1740	1099
.	1183	1.4	0.411	440	1714	1068
.	1172	1.5	0.440	466	1688	1039
.	1160	1.6	0.469	492	1662	1010
.	1149	1.7	0.499	516	1638	982
.	1137	1.8	0.528	541	1614	955
.	1126	1.9	0.557	564	1590	929
.	1115	2.0	0.587	587	1567	904

Input units are thousands and kg - output in tonnes

Table 7.23a Sprat 22-32. Input data for medium-term projection

Age	Input stock Numbers	SE(Log q)	Sel	weight in 2006	weight in 2007+	weight SD	Natural Mortality M	Maturity
1	111145	0.39	0.10	0.0047	0.0053	0.00118	0.320	0.17
2	54288	0.17	0.17	0.0074	0.0086	0.00136	0.263	0.93
3	9903	0.14	0.23	0.0089	0.0098	0.00158	0.244	1
4	63805	0.13	0.28	0.0103	0.0104	0.00165	0.242	1
5	15979	0.12	0.37	0.0110	0.0109	0.00154	0.250	1
6	3455	0.12	0.31	0.0114	0.0112	0.00168	0.248	1
7	1276	0.13	0.30	0.0111	0.0113	0.00181	0.264	1
8+	2357	0.13	0.30	0.0113	0.0116	0.00177	0.264	1

*/ weight in stock and catches assumed the same

Recruitment model:

R= ar*SSB/(br + SSB)

ar= 104.4
br= 510.3
SE(log-R)= 0.75

Table 7.23b Sprat in SD 22-32. Medium term projections.

SSB projections (thousand tons) - Sprat in SD 22-32

year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Ffactor=1.2										
10%	1074	1039	901	804	748	686	655	617	597	608
25%	1130	1150	1043	953	872	813	808	780	770	772
50%	1200	1293	1213	1157	1131	1078	1047	1050	1019	1008
75%	1283	1489	1445	1477	1464	1467	1438	1424	1336	1335
90%	1359	1655	1794	1911	1928	1905	1968	1879	1829	1876
Ffactor=1.0										
10%	1073	1084	987	875	809	784	774	762	741	705
25%	1138	1207	1126	1011	984	952	979	962	945	915
50%	1209	1335	1292	1266	1253	1211	1220	1231	1235	1203
75%	1284	1502	1566	1569	1591	1523	1602	1597	1637	1617
90%	1356	1706	1867	1962	2022	1998	2088	2095	2056	1991
Ffactor=0.8										
10%	1082	1086	1002	948	911	849	877	829	827	821
25%	1138	1190	1139	1113	1084	1059	1070	1056	1043	1075
50%	1215	1374	1332	1353	1377	1341	1403	1408	1439	1437
75%	1288	1567	1661	1672	1744	1750	1821	1821	1846	1881
90%	1363	1743	2016	2091	2239	2398	2388	2354	2328	2401

Catch projections (thousand tons) - Sprat in SD 22-32

year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Ffactor=1.2										
10%	292	332	281	253	235	218	205	195	191	187
25%	307	367	318	295	277	258	256	244	244	237
50%	327	409	367	361	353	333	328	327	320	315
75%	351	463	440	443	451	444	451	433	416	403
90%	376	521	527	561	579	562	590	554	569	547
Ffactor=1.0										
10%	292	292	257	236	228	209	202	203	199	192
25%	309	321	291	271	266	251	256	254	243	241
50%	330	351	331	330	331	320	315	317	320	312
75%	353	391	388	395	403	386	407	408	409	412
90%	375	444	453	486	500	506	518	519	535	513
Ffactor=0.8										
10%	295	237	214	205	200	180	187	182	174	175
25%	310	259	235	237	238	224	229	227	222	232
50%	330	290	276	287	289	285	287	294	302	294
75%	354	328	329	342	364	369	375	386	384	386
90%	376	368	400	419	451	478	496	481	478	492

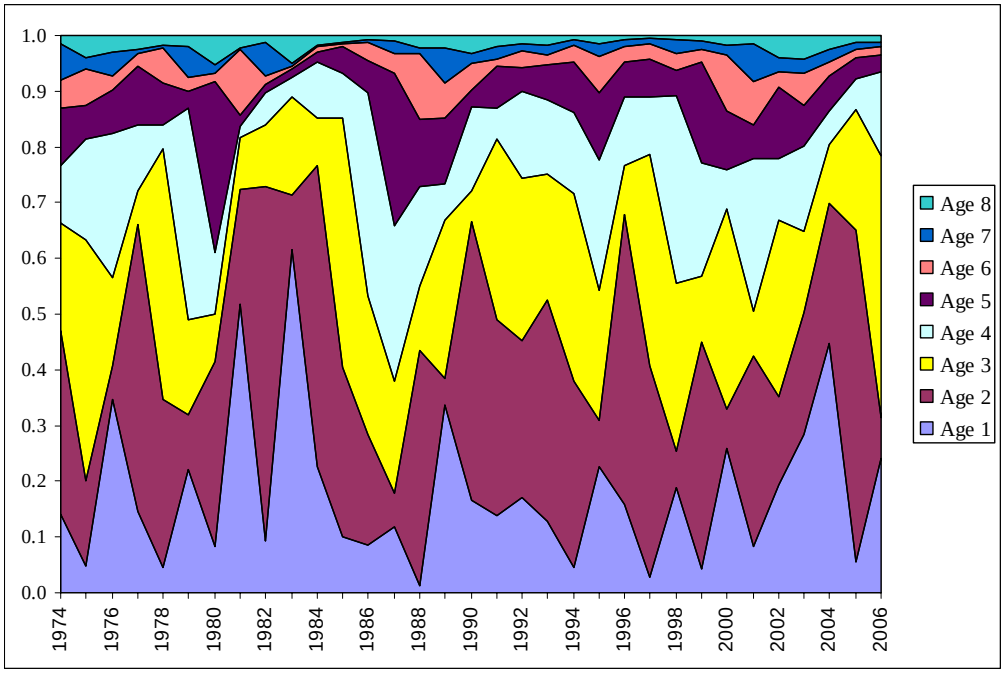


Figure 7.1 Sprat in SD 22-32. Relative catch-at-age in numbers.

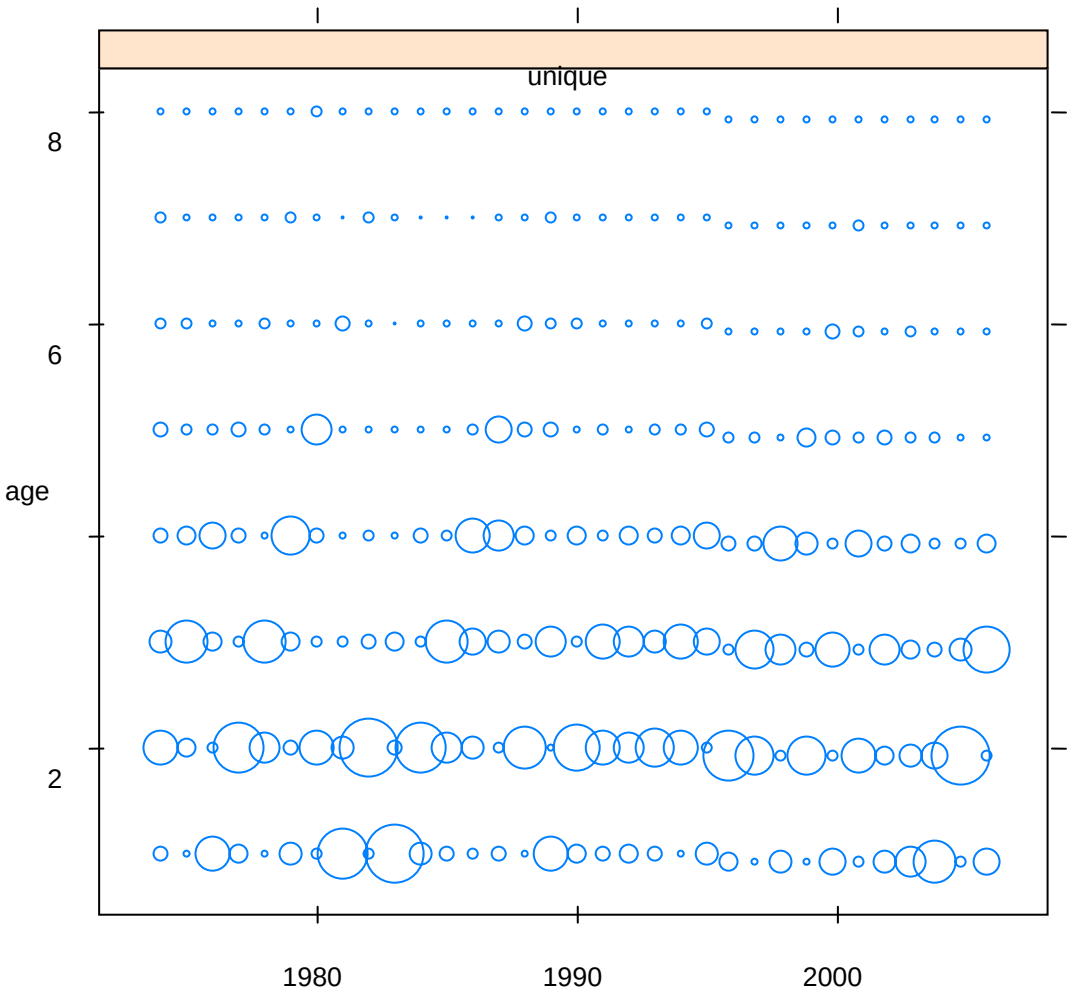


Figure 7.2 Sprat in SD 22-32. Catch-at-age numbers.

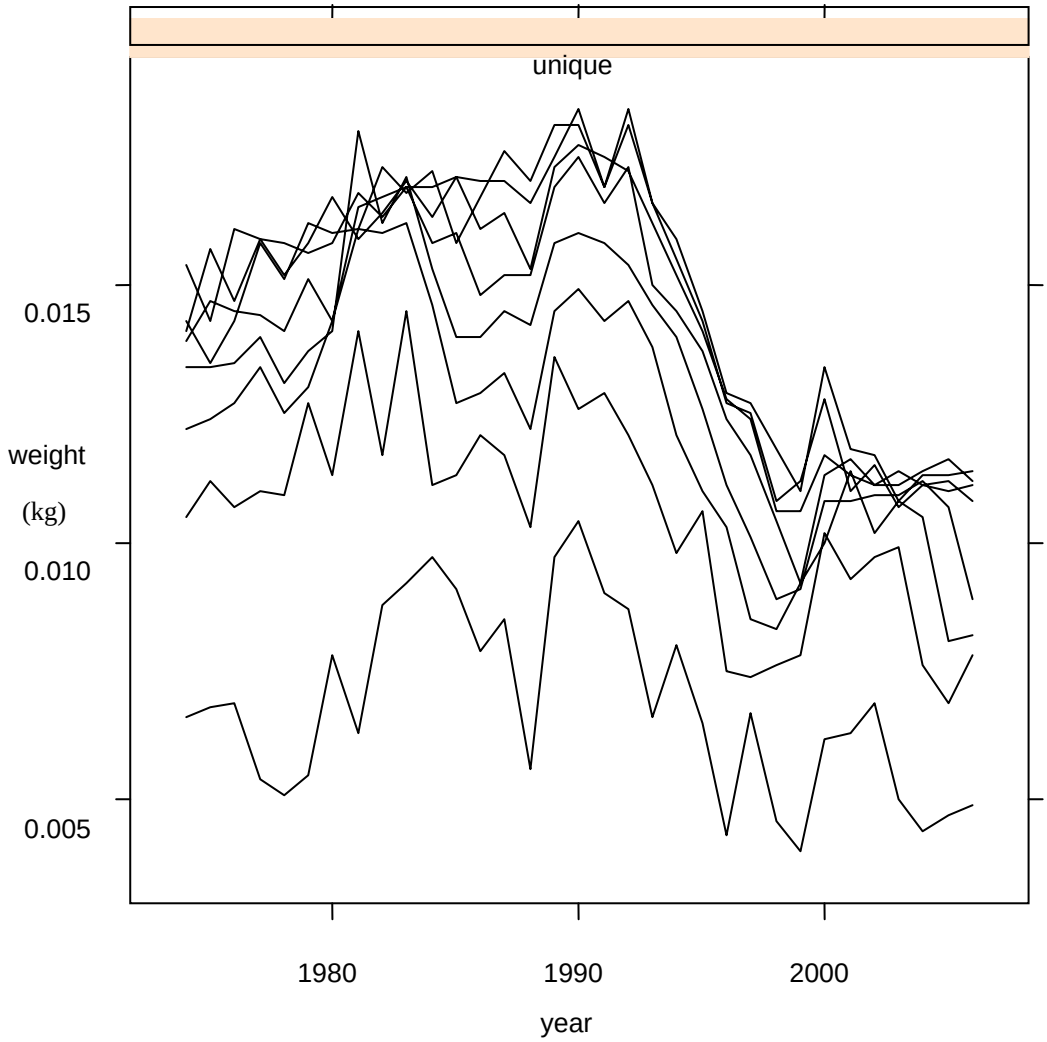


Figure 7.3 Sprat in SD 22-32. Mean weight-at-age in the catches.

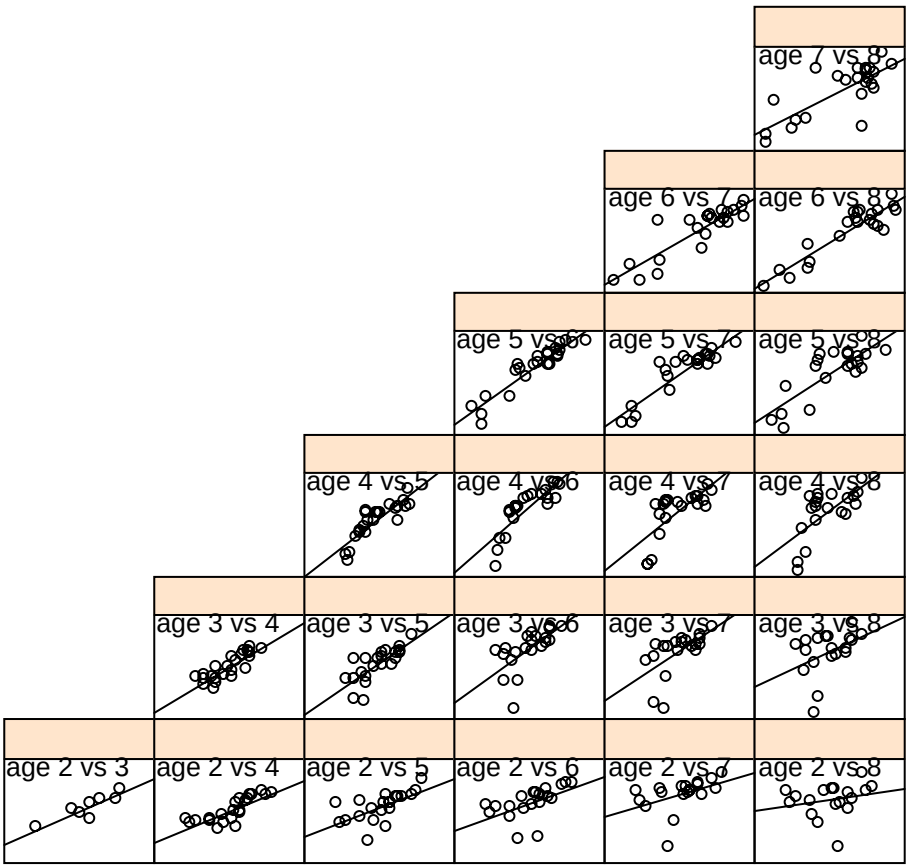


Figure 7.4a. Sprat in SD 22-32. Check for consistency in October acoustic survey estimates (log indices).

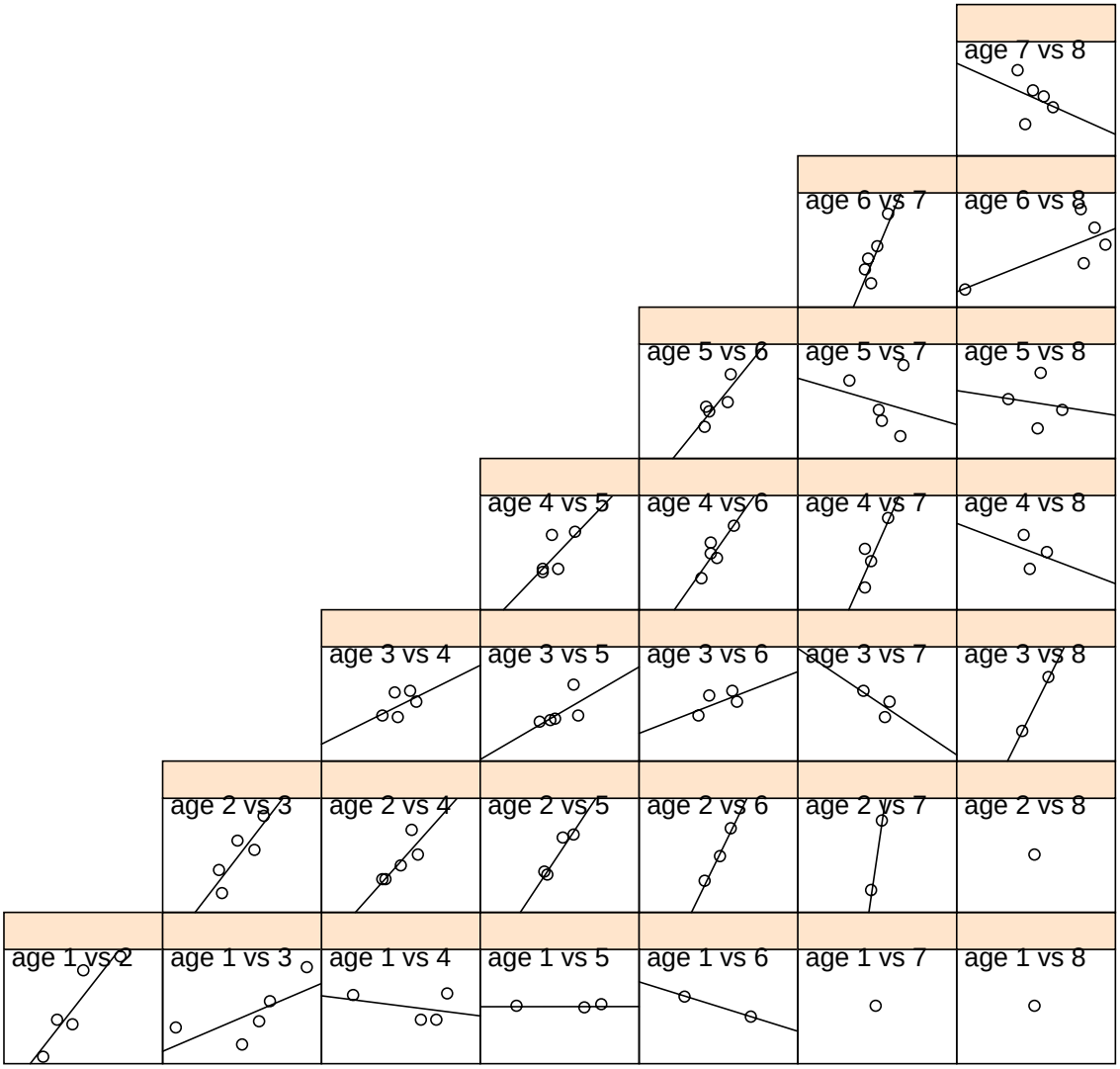
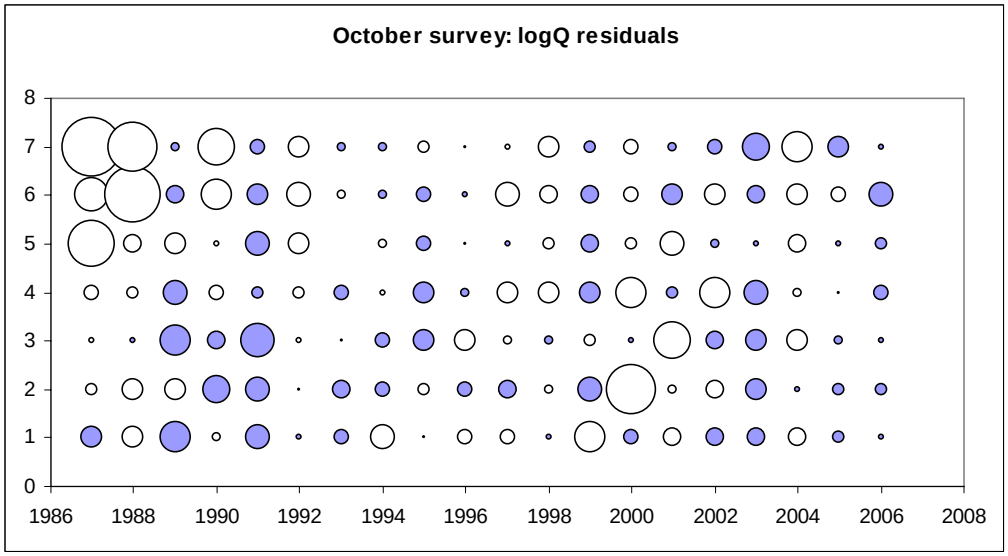
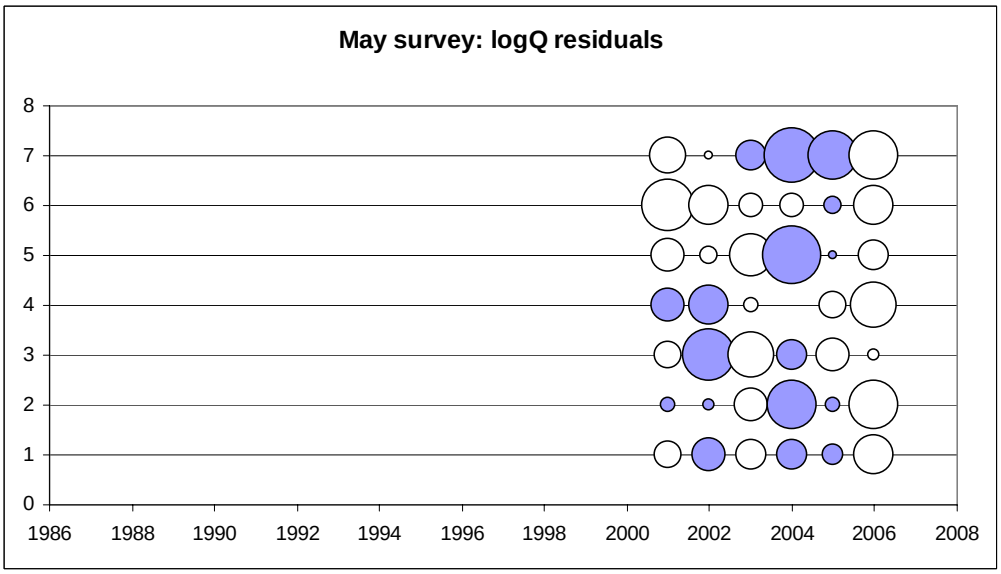


Figure 7.4b. Sprat in SD 22-32. Check for consistency in May acoustic survey estimates (log indices).





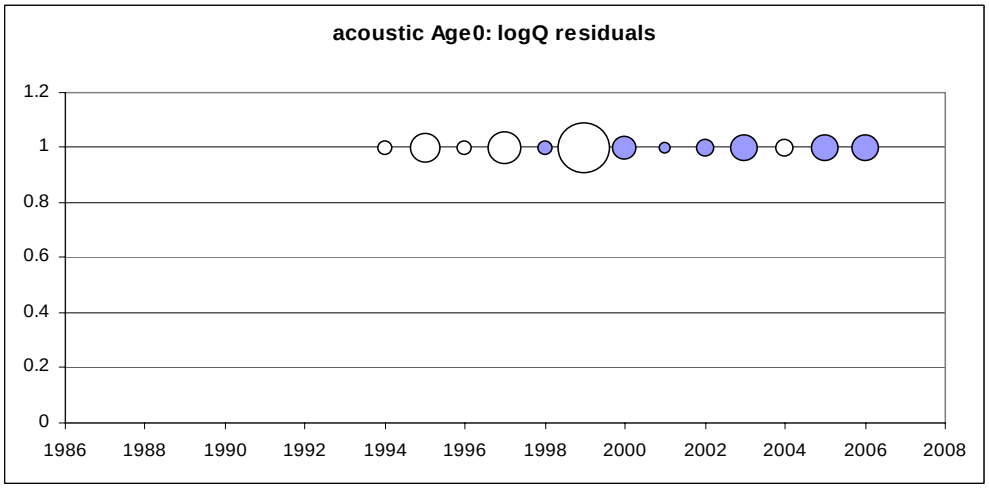


Figure 7. 5 Sprat in SD 22-32. Residuals of catchabilities.

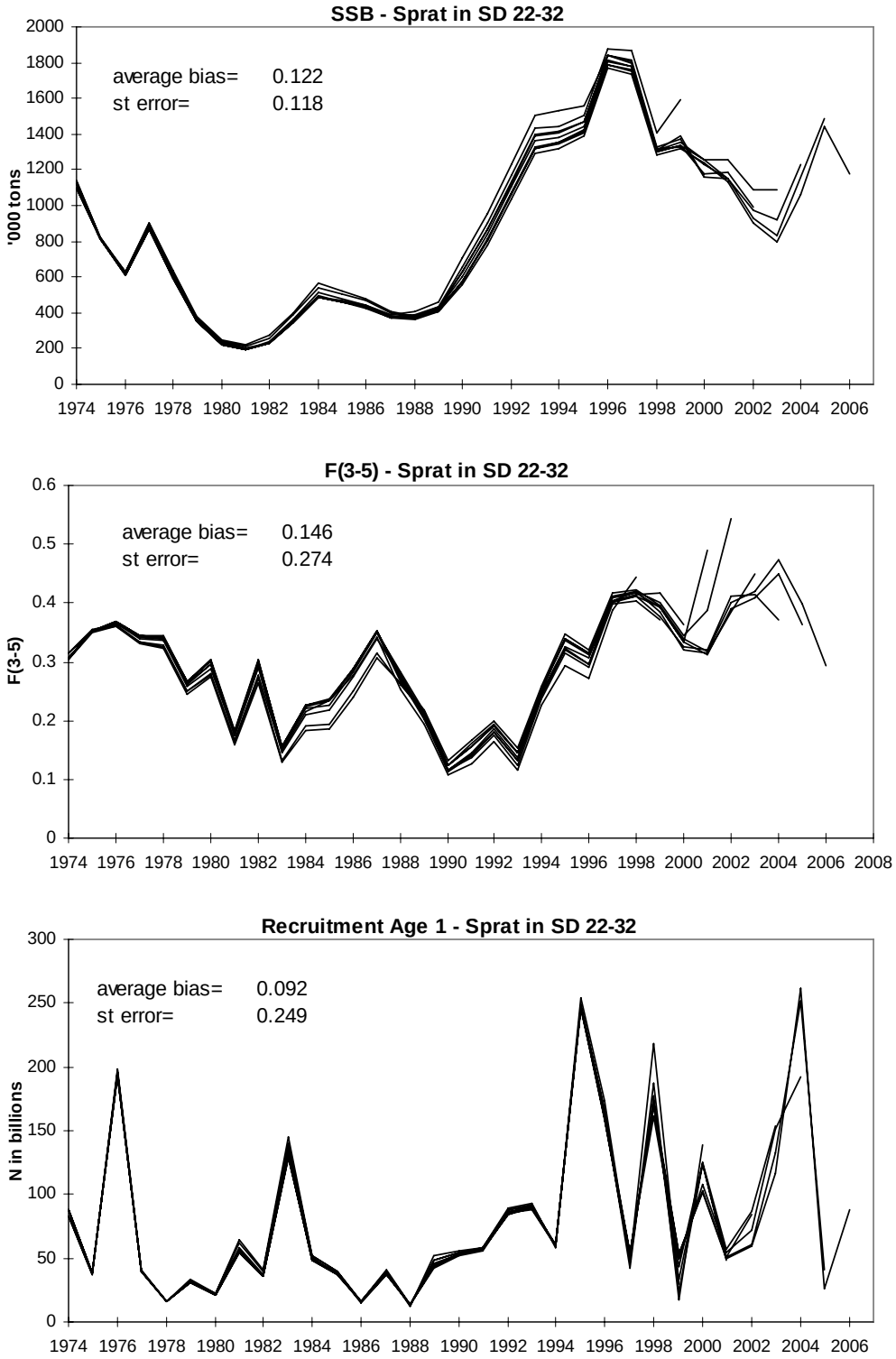


Figure 7.6 Sprat in SD 22-32. Retrospective analysis.

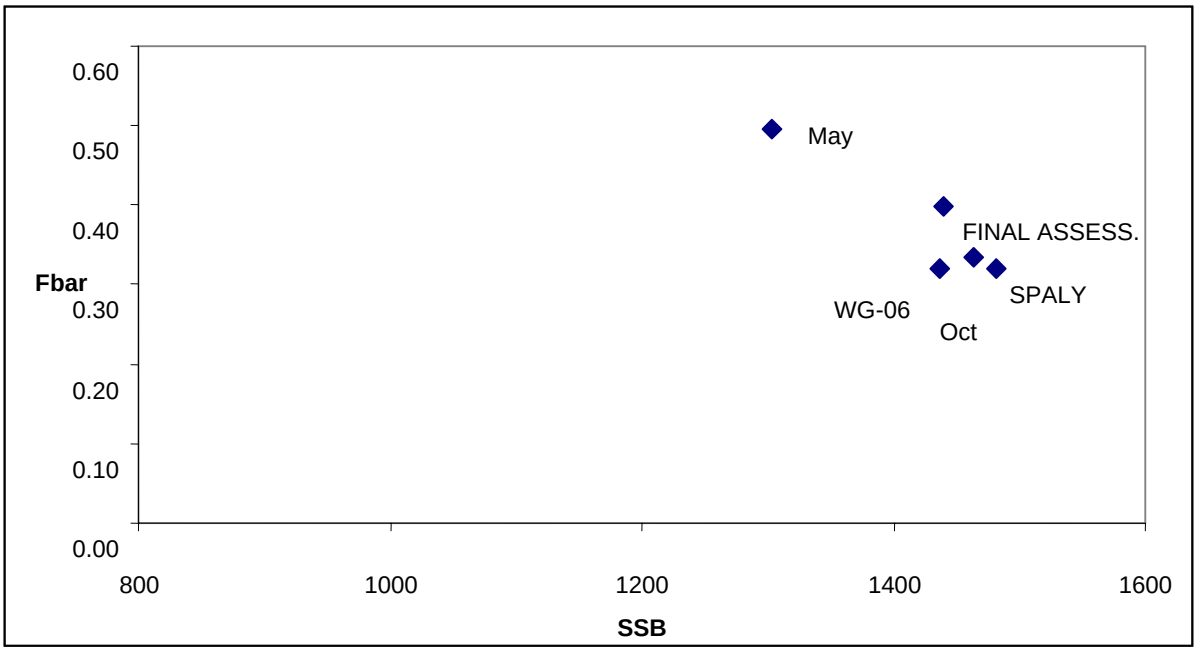


Figure 7.7 Sprat in SD 22-32. Estimates of SSB & F(3-5) for 2005 in different runs.

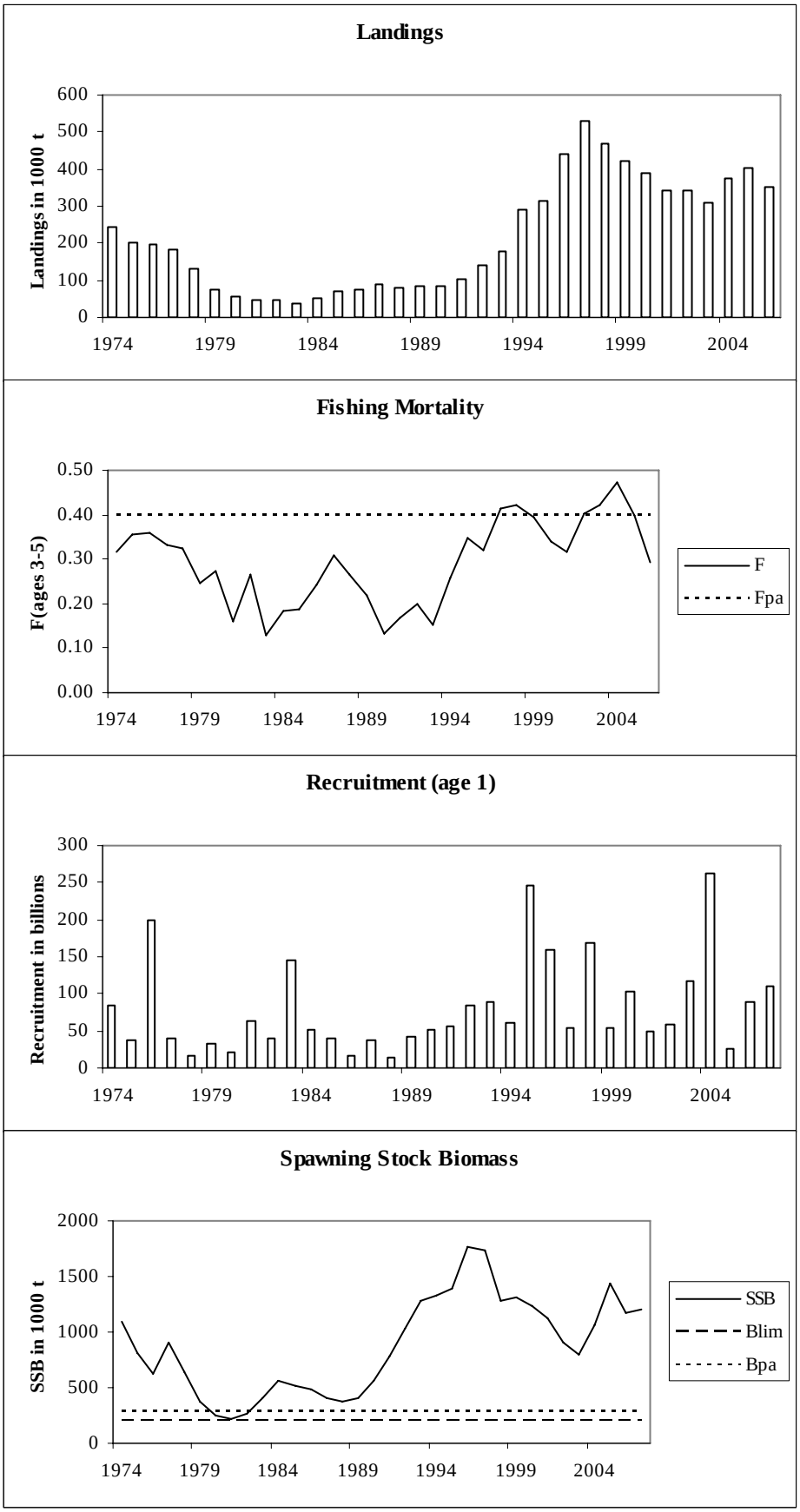


Figure 7.8 Sprat in SD 22-32. Summary sheet plots: Landings, fishing mortality,

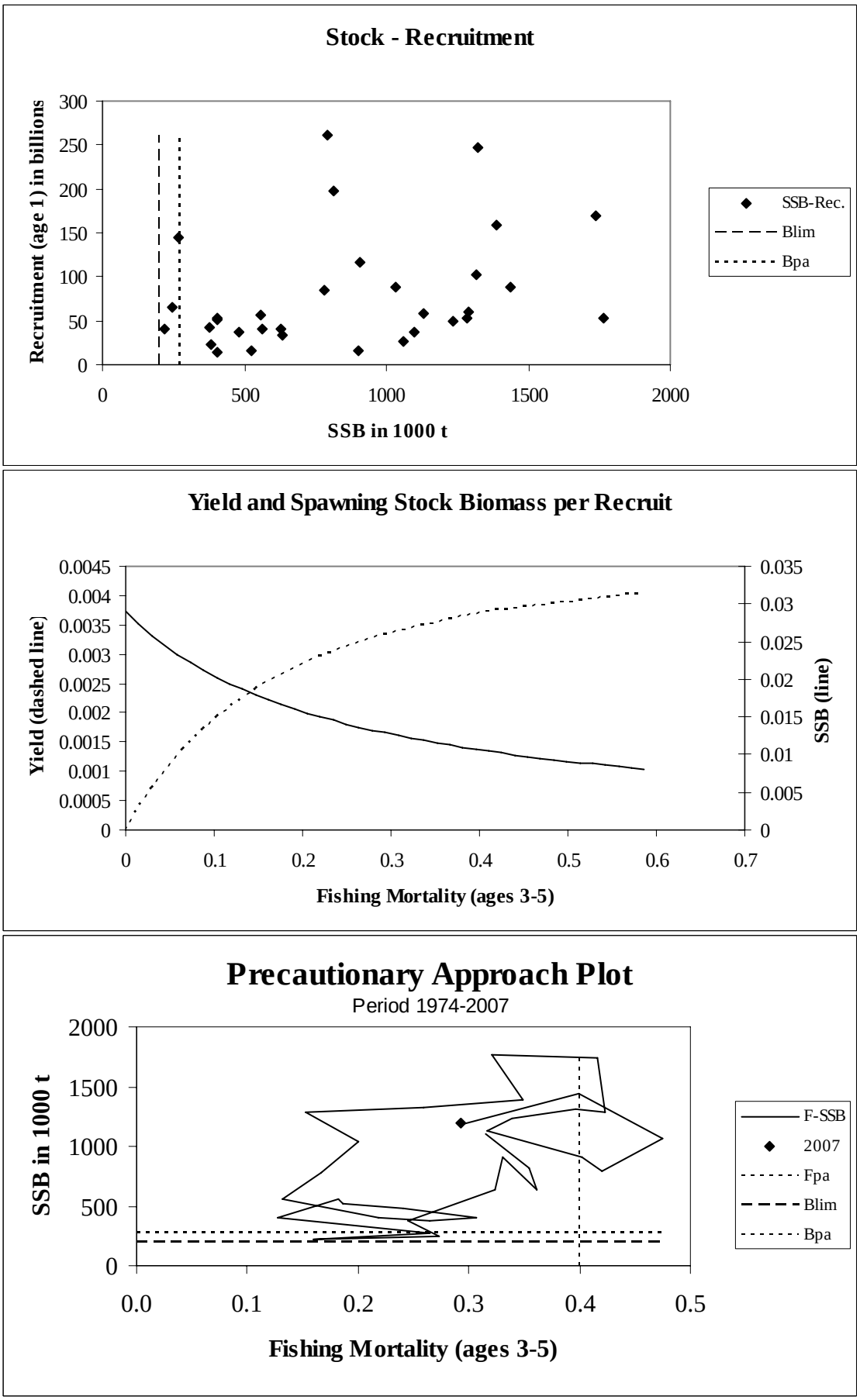
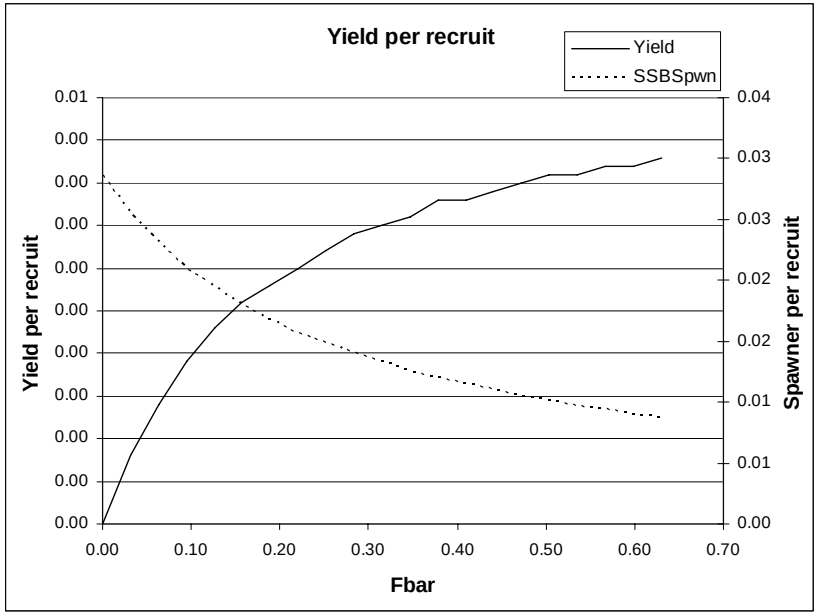
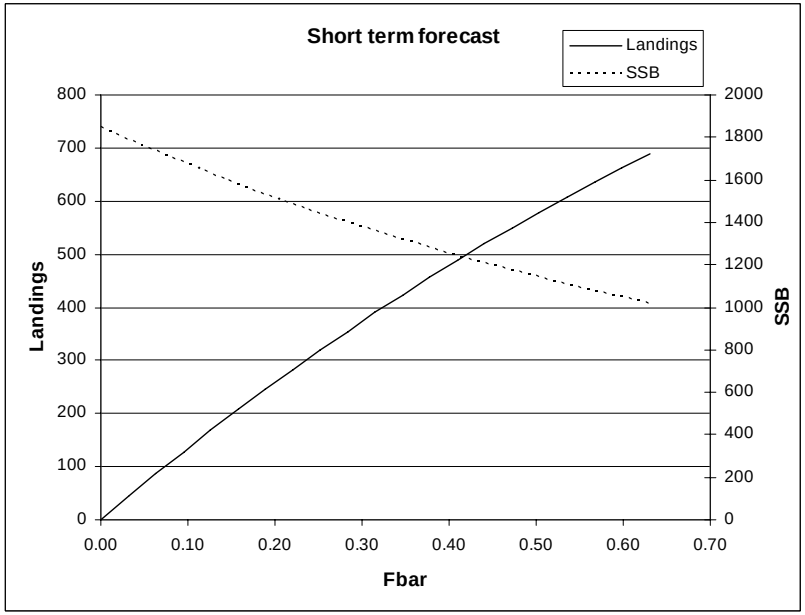


Figure 7.9 Sprat in SD 22-32. Summary sheet plots: Stock recruitment, yield and spawning biomass per recruit and precautionary approach plot.





MFYPR version 2a
Run: sprPr2007StatusQuo
Time and date: 17:20 2007-04-21

Reference point	F multiplier	Absolute F
Fbar(3-5)	1.0000	0.2933
FMax	6.4017	1.8774
F0.1	1.3217	0.3876
F35%SPR	1.4673	0.4303

Weights in kilograms

MFDP version 1a
Run: sprPr2007StatusQuo
Sprat
Time and date: 17:19 2007-04-21
Fbar age range: 3-5

Input units are thousands and kg - output in tonnes

Figure 7.10 Sprat in SD 22-32. Yield per recruit and short-term forecast.

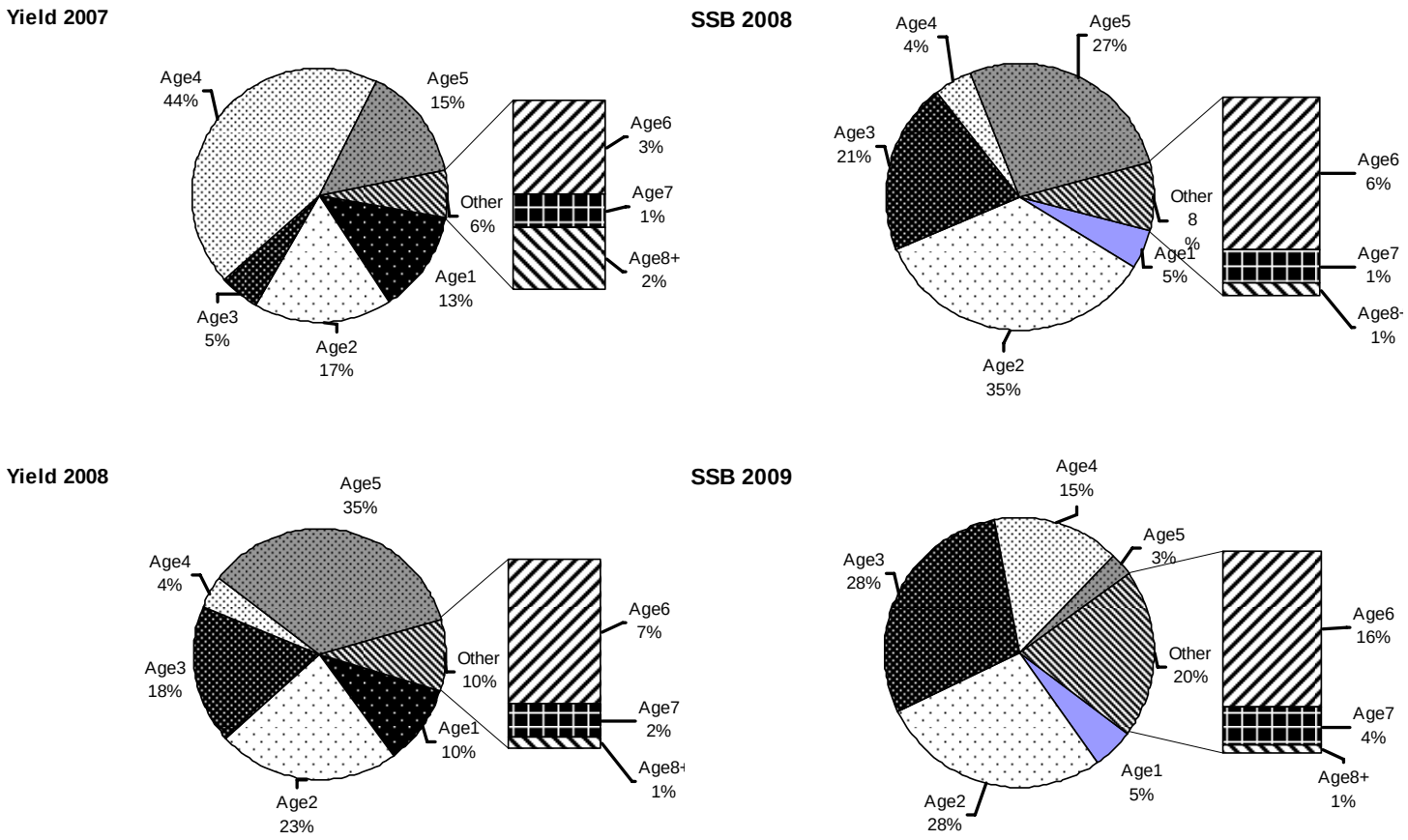
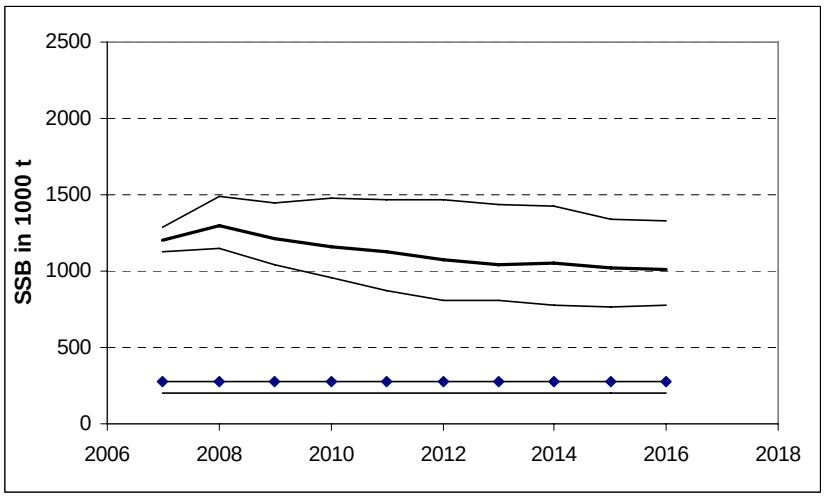
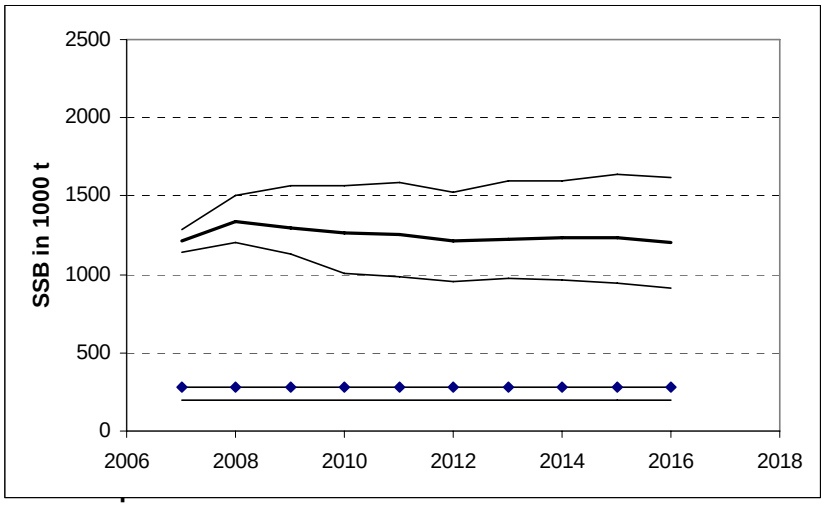


Figure 7.11 Sprat in SD 22-32. Short-term forecast for 2007-2009. Yield and SSB at age 1-8+under the status quo fishing mortality.

F-factor =1.2



F-factor =1.0



F-factor =08

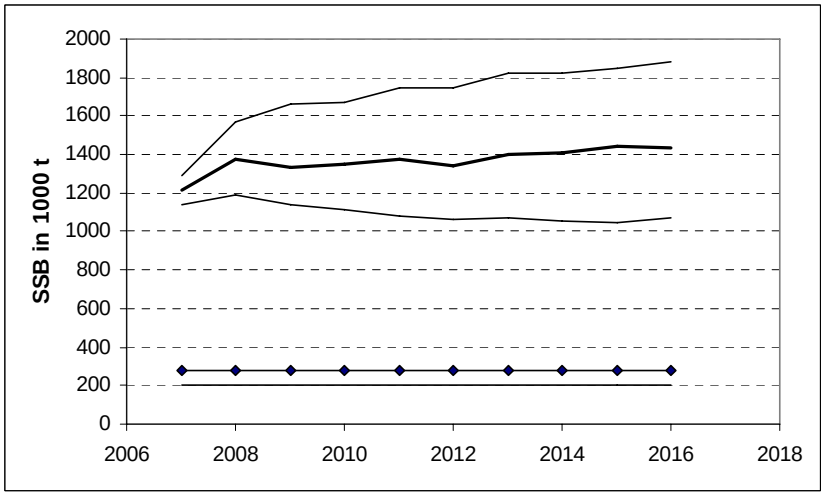
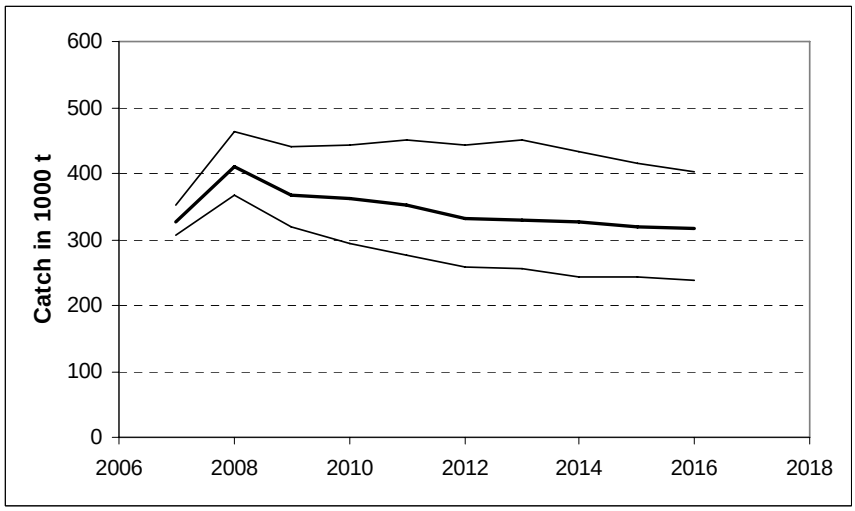
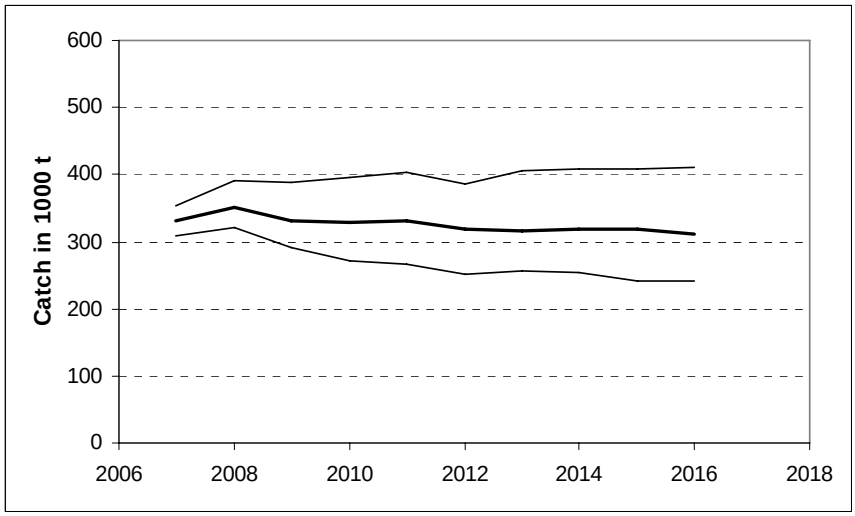


Figure 7.12 Sprat in SD 22-32. Medium term projections (25, 50, and 75 percentiles are presented) F_{sq}=0.29 (F-factor=1), B_{pa} 275000t, B_{lim} 200000t

F-factor =1.2



F-factor =1.0



F-factor =08

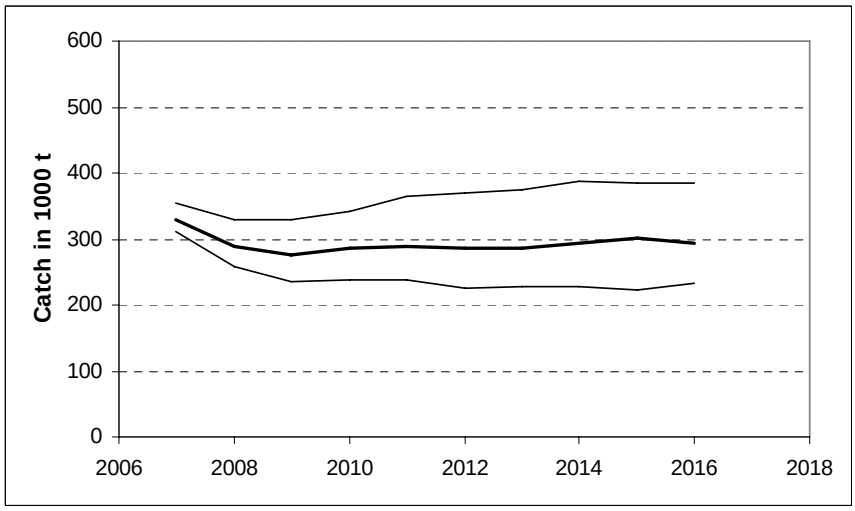
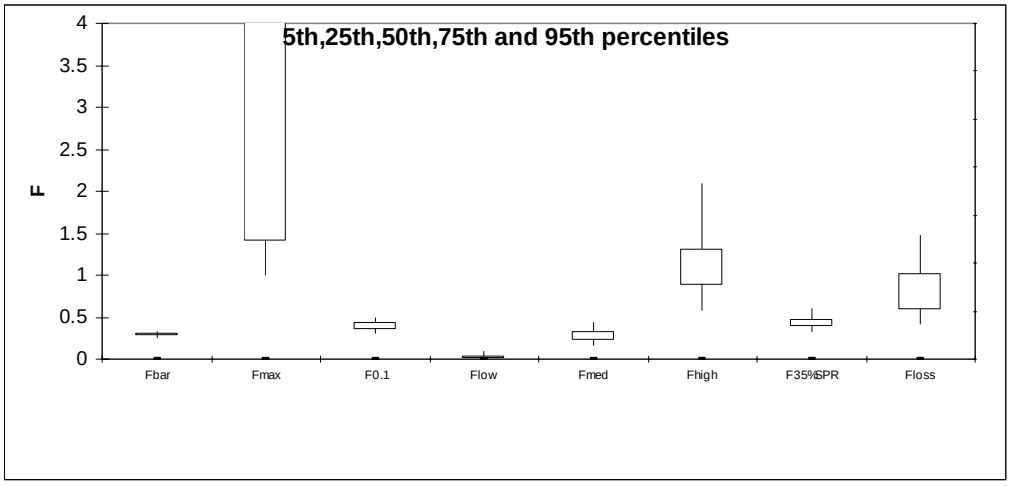


Figure 7.13 Sprat in SD 22-32. Medium term projections o catches. (25, 50 and 75 percentiles are presented).



Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	53783	53783	55734	60095	
MBAL	0				0.00
Bloss	217				
SSB90%R90%Surv	710	738	853	1031	42.42
SPR%ofVirgin	44.02	44.48	46.63	51.65	
VirginSPR	0.03	0.03	0.03	0.04	
SPRloss	0.01	0.01	0.01	0.01	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.29	0.29	0.28	0.26	51.52
Fmax	1.90	2.11	1.40	1.00	0.00
F0.1	0.38	0.39	0.34	0.30	21.21
Flow	0.00	0.00	0.00	0.00	100.00
Fmed	0.27	0.27	0.22	0.16	54.55
Fhigh	1.14	1.07	0.86	0.58	0.00
F35%SPR	0.42	0.42	0.38	0.32	6.06
Floss	0.79	0.78	0.58	0.43	0.00

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
Sprat 22 32
Steady state selection averaged over 3 years.
FBar averaged from age 3 to 5
Number of iterations = 100
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit
FishLab DLL used
FLVB32.DLL built on May 6 1999 at 12:54:28
PASoft 4 October 1999
20/04/2007 15:11

Figure 7.14 Sprat in SD 22-32. PA reference points.

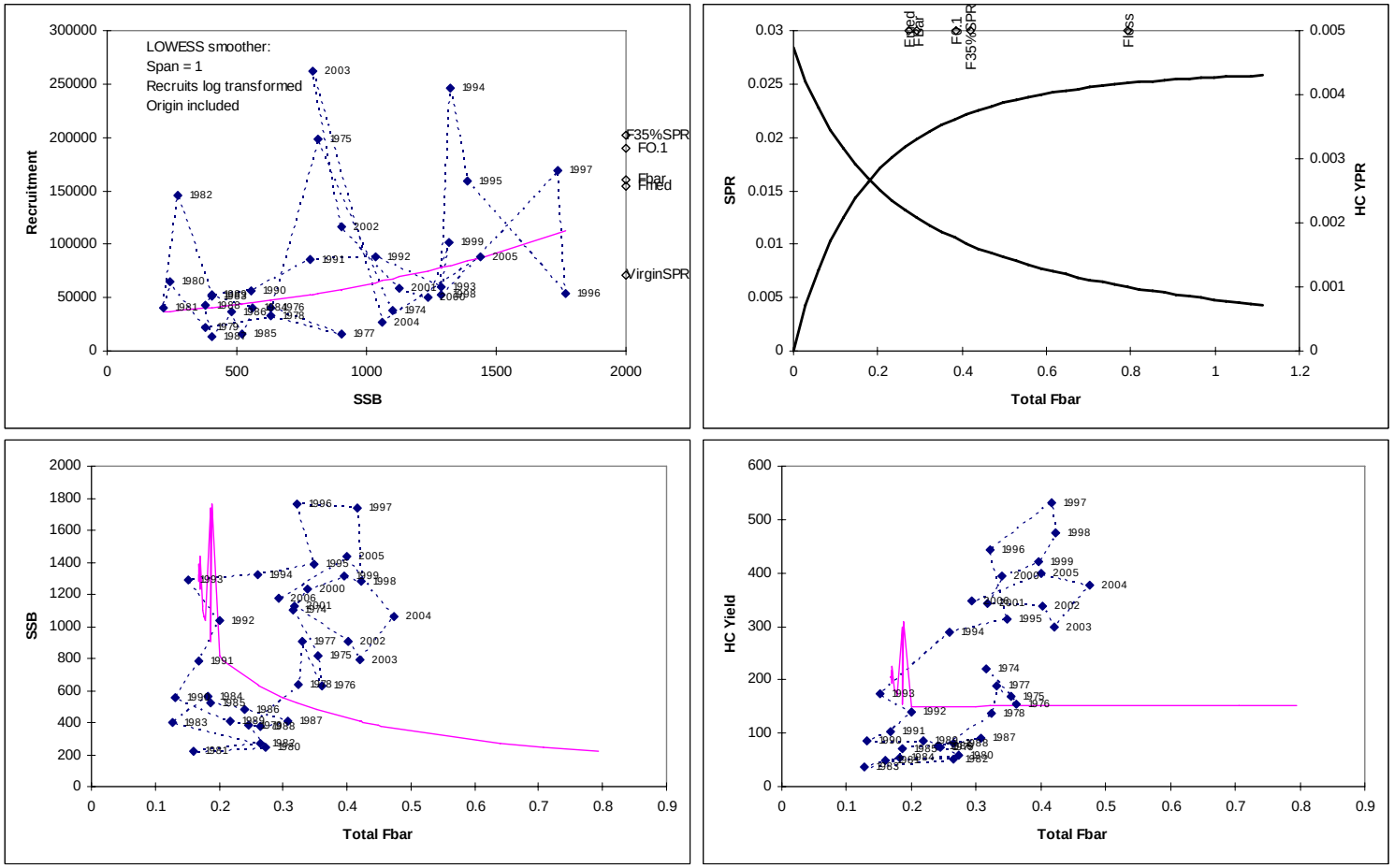


Figure 7.15 **Sprat in SD 22-32. PA graphs for present natural mortality and weights.**

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9 Working documents

Working documents available to WGBFAS 2007:

WD1: Marie Storr-Paulsen and Margit Eero: Revision of "Havfisken" survey indices for Western Baltic and Kattegat cod stocks

Survey indices from "Havfisken" in the 1st and 4th quarters for the western Baltic (SD 22-24) and Kattegat cod stocks were revised. Revision is related to the procedure for filling in missing age information in Age-Length-Keys. Standard procedure for filling in missing age information was worked out to ensure consistency from year to year. Calculation of survey indices was thereby made more transparent and documented.

WD2: Henrik Svedang: The Ancylus survey – an opportunity to enlarge fishery independent information to the Kattegat cod assessment

The increasing uncertainty in collected landing statistics, due to black landings, misreporting, discarding and high grading, limits the value of present stock assessment work and lays stress on the need for additional fishery independent data. Swedish coastal trawl surveys have been carried out by RV Ancylus since 2002 in the second and fourth quarter of the year in the Kattegat. In spite of the short duration of the time series, the proposed surveys Ancylus Q2 and Ancylus Q4 showed satisfactory results concerning the internal consistency and covariation with other indices and in different XSA exploratory runs. Taking together with the fact that the Kattegat cod is in a severely depleted state lay stress on the need for additional fishery independent data. Although the stock has diminished in value for the commercial fishery, it has to be argued that the remaining stock is precious for future fishery, as in case of a total eradication of the Kattegat cod stock, it is uncertain whether the stock will be replenished from adjacent areas. It is therefore vital for the credibility of the fisheries management that sound and reliable fishery independent data are provided for the assessment of the stock. In such an attempt, time series from different fishery independent surveys is most likely the best way of keeping track of the stock development. It was therefore suggested that Ancylus Q2 and Ancylus Q4 should be considered as well fitted for the use as tuning fleets for the assessment of Kattegat cod, propsoing the use of these surveys either singularily or in combination with other, already existing tuning fleets in the area.

WD3: O.A. Jørgensen, Danish Institute for Fisheries Research, : Joint fisheries research/fishing industry survey for sole in Skagerrak and Kattegat, November-December 2006

A survey series targeting sole in Kattegat and Skagerrak was initiated in 2004 in order to establish a time series of catch and effort data independent of the commercial fishery. The time series is split in two independent series, one series based on fixed stations selected by the fishermen, and one series based on random selected fixed stations distributed by DIFRES. In 2005 the survey design was ajusted, in order to facilitate estimation of swept area biomass and abundance based on random selected fixed stations distributed over the entire survey area. CPUE for sole has decreased slightly on the fishermen's stations during the three years, while CPUE at all stations combined has been stable. The biomass of sole increased slightly between 2005 and 2006. CPUE and biomass for cod and Norway lobster has been stable during the period, while there was a statistically insignificant increase in CPUE and biomass for plaice between 2005 and 2006

WD4: Rainer Oeberst Impact of mixing of the Baltic cod stocks on the stock assessment

Different qualitative evidences of the occurrence of cod which were spawned in the Belts Sea were given which have shown that cods which were spawned in the Belt Sea in spring occur in thestay in the Bornholm Sea based on different methoPossible effects concerning the stock assessment which are Common.

Results of different studies which are related to the mixing of both Baltic cod stocks were presented and possible effects of the variable proportion of the Belt Sea cod in the Bornholm Sea were presented. The current used model of both Baltic cod stocks is based on tagging experiments, genetic studies, meristic and morphometric analyses, requirements concerning the salinity for successful fertilization of eggs and different main spawning seasons. Bagge et al. 1994 summarised the results and concluded that mechanical mixing of both stocks is possible in the Arkona Sea. Furthermore, it was concluded that the effect of the western Baltic cod concerning the eastern Baltic cod can be neglected. Two cod stocks were defined. The western Baltic cod stock summarizes all individuals which were captured in the ICES SD 22 – 24, and all cods which were captured in the ICES subdivisions 25 – 32 are defined as eastern Baltic cod stock. That means that the assignment if single cod is only based on the location of capture. This discrimination of both cod stocks was conducted at a time where the eastern Baltic cod stock was several times larger than now. Qualitative evidences of the occurrence of cod in the Bornholm Sea which were spawned in the Belt Sea in spring were given by Oeberst and Böttcher (1998) based on the analyses of the otolith micro structure and by Hinrichsen et al. 2001 based on wind driven transport models. These studies taken into account the stable main spawning seasons of the spring (March – April) and summer spawners (June – August/September) with a minimum of spawning activities in May. This bimodal intensity of spawning activities results in bimodal length frequencies of the same year class with a mean distance between the mean length of both cohort of about 8 cm and a standard deviation of the length of both cohorts of about 2.5. The bimodal length frequency was used the separate the length frequencies of the stock which are estimated by the Baltic International Trawl Surveys (BITS) in normally distributes cohorts. These detected cohorts can be assigned to the spring and summer spawners for age groups 0 to 2 in November and for the age groups 1 to 3 in spring (Oeberst 2001). The proportion of spring spawners in the Bornholm Sea which were spawned in the Belt Sea were estimated based on this procedure for the period from 1993 to 2000. The estimates were supported by the very poor year class 1995. This year-class can be clearly detected in the length frequencies of subsequent BITS in spring and November. It could be estimated that between 10% and 90% of age group 1 cod in the Bornholm Sea in spring were spawned in the Belt Sea. These data overestimate the proportion of spring spawners in the Bornholm Sea because the smallest individuals of the summer spawners were not representative captures by the used trawl. However, between 15 % and 45 % of the age groups 2 and 3 cod which were captured in the Bornholm Sea in spring were spawned in the Belt Sea. These estimates were supported by analyses by Müller (2002) who assigned the cod of commercial samples to the both cod stocks based in discrimination analyses and estimated that between 25 % and 60% of captured individuals were spawned in the Belt Sea in spring.

These spring spawners in the Bornholm Sea which are larger with higher individual weight and other main spawning season influence different parameters of the stock assessment of eastern Baltic cod when the individuals migrate back into the Belt Sea at least when the maturation starts (homing). The variable proportion of spring and summer spawners which have different mean individual weight results in higher variability of the weight at age. The new year-class of the recruits in the Bornholm Sea which is estimated based on the trawl surveys is influenced by the variable fraction of spring spawners. The variable mixing of spring and summer spawners in the different ICES subdivisions is one possible reason of the uncertainty of the year-class indices. Consequently, the relation between SSB and the

recruitment is affected by the variable mixing of both stocks. Additionally, the maturity ogive is influenced because in the Bornholm Sea only those spring spawners are expected during the

$$\frac{Number\ of\ summer\ spawners\ with\ maturing\ sexual\ products}{Number\ of\ summer\ spawner + Number\ of\ spring\ spawners}$$

spring survey which do not develop their sexual products.

The possibility to assign individuals to one of the cod stock is a basic requirement for better understanding of the dynamic of the spatial mixing of both cod stocks and the dynamic of both cod stocks like, abundance of the new year-class, main factors which determine the strength of the new year-class etc.

The studies have shown that the uncertainties of the stock assessment are determined by the variable dynamic of the mixing of both cod stocks in the Baltic Sea. The discussions have shown that such type of analyses must be intensified because the results of the BITS in the Bornholm Sea in spring 2007 indicated a significant change of the maturation process in this area (higher proportion of cod with more developed sexual products was observed by Denmark).

Common studies of Germany, Latvia and Russia were presented during the meeting of WGBFAS in 2007 which described the seasonal development of the edge of the Sagitta otolith of cod in the different ICES subdivisions. These investigations were initiated because inter-calibration of the ageing of cod during the different meetings of SGABC documented differences in the interpretation of the otolith structure. The edges of all otoliths which were used for ageing were classified as small hyaline zone (1), large hyaline zone (2), small opaque zone (3) and large opaque zone (4). Data from the trawl surveys and the commercial samples were used to describe the seasonal development of the otolith structure. It could be shown that seasonal changes between the hyaline and opaque zone at the edge of the otolith correspond with the maturation of cod in the different ICES subdivisions. Dominance of opaque edge of otolith can be observed in the ICES subdivision 22 in May/ June, immediately after the main spawning season in this area. The same development starts in the Arkona Sea (ICES SD 24) between two and three month later (August). The data which were sampled in the ICES subdivisions 26 and 28 showed that opaque edge of otolith begins to be dominant in October/ November in mean. The seasonal developments of the hyaline zone which commonly interpreted as wintering show the same temporal postponement between the ICES subdivisions. The maximum proportion of cod with hyaline edge was observed in all ICES subdivisions in the periods of main spawning activities. It can be concluded that the hyaline zone of the Sagitta otolith of Baltic cod does present a spawning ring and not a winter ring. Comparable results were presented by Berner 1968 and were found by Baranova and Berner in the seventies of the last century (personal information). It can be concluded that the difference in the seasonal development of the hyaline and opaque zones of the otoliths from south west to north east is a stable phenomena and that the different development of the otolith structure in the different areas must be taken into account during the ageing process. Preliminary modes which describe the mean expected temporal development of the otolith based on the main spawning seasons, the Bertalanffy growth of cod and the relation between the total length and height of the otolith were presented. Unfortunately, data from the ICES subdivisions 25, the main spawning area of the summer spawners, were not available for describing the seasonal development. This problem was discussed during the meeting and Denmark and Sweden expressed the possibility to make otoliths available from this ICES subdivision. Details of such further working steps will be discussed between the participating institutes.

WD5: Rainer Oeberst Seasonal development of the edge of the Sagitta otolith of cod, preliminary results

Common studies of Germany, Latvia and Russia were presented during the meeting of WGBFAS in 2007 which described the seasonal development of the edge of the Sagitta otolith of cod in the different ICES subdivisions. These investigations were initiated because inter-calibration of the ageing of cod during the different meetings of SGABC documented differences in the interpretation of the otolith structure. The edges of all otoliths which were used for ageing were classified as small hyaline zone (1), large hyaline zone (2), small opaque zone (3) and large opaque zone (4). Data from the trawl surveys and the commercial samples were used to describe the seasonal development of the otolith structure. It could be shown that seasonal changes between the hyaline and opaque zone at the edge of the otolith correspond with the maturation of cod in the different ICES subdivisions. Dominance of opaque edge of otolith can be observed in the ICES subdivision 22 in May/ June, immediately after the main spawning season in this area. The same development starts in the Arkona Sea (ICES SD 24) between two and three month later (August). The data which were sampled in the ICES subdivisions 26 and 28 showed that opaque edge of otolith begins to be dominant in October/ November in mean. The seasonal developments of the hyaline zone which commonly interpreted as wintering show the same temporal postponement between the ICES subdivisions. The maximum proportion of cod with hyaline edge was observed in all ICES subdivisions in the periods of main spawning activities. It can be concluded that the hyaline zone of the Sagitta otolith of Baltic cod does present a spawning ring and not a winter ring. Comparable results were presented by Berner 1968 and were found by Baranova and Berner in the seventies of the last century (personal information). It can be concluded that the difference in the seasonal development of the hyaline and opaque zones of the otoliths from south west to north east is a stable phenomena and that the different development of the otolith structure in the different areas must be taken into account during the ageing process. Preliminary modes which describe the mean expected temporal development of the otolith based on the main spawning seasons, the Bertalanffy growth of cod and the relation between the total length and height of the otolith were presented. Unfortunately, data from the ICES subdivisions 25, the main spawning area of the summer spawners, were not available for describing the seasonal development. This problem was discussed during the meeting and Denmark and Sweden expressed the possibility to make otoliths available from this ICES subdivision. Details of such further working steps will be discussed between the participating institutes.

WD6: Maria Storr_Paulsen and Ole Folmer: Revision of the tuning fleets used in the Western Baltic cod stock assessment

The commercial tuning series have been revised and a new GLM model is proposed for standardisation of the fleet used in the western Baltic cod assessment. In former assessment three commercial fleets have been used; the Danish gillnetters, Danish trawler and Danish seines. In this revision two more commercial fleets have been analysed on metiers subset level. Furthermore, two surveys from the Danish “Havfisken” are introduced covering subdivision 22 and 23. All fleets have been tested for internal consistency and runed in a single fleet xsa assessment. Main results are that the SPALY should not be kept, and that a GLM model standardized by kW, vessel length, year and month are performing better for all commercial fleets. Furthermore, we propose to include the two surveys from the Danish vessel “Havkatten” in the stock assessment of the Western Baltic cod.

WD7: Tomas Gröhsler, Federal Research Centre for Fisheries, Institute for Baltic Sea Fisheries, Rostock: Fisheries & Stock assessment data in the Baltic Sea in 2006

The present WD is giving an overview on the German fisheries on herring and sprat in the Baltic Sea including information on spatial distribution of landings, fleets operating, species composition in the landings and the final stock assessment input.

In 2006 the total German herring landings in the Baltic Sea (SD 22-29) reached 26,103 t (2005: 24,357 t: 2004: 22,332 t). The herring landings in SD 22 and 24 amounted to about 22,870 t, which is about 9% higher than in 2005 (21,040 t). Almost all landings originated from SD 25-29 were landed in foreign ports (3,205 t of 3,234 t). As in 2005 the main part in SD 25-29 was caught in quarter 1 (2006: 2,944 and 2005: 2,336 t).

The main fishing season was during spring time as in former years. About 77% of all herring was caught between March and May (2005: 74%). The dominant part of the German herring landings was taken in SD 24 (2006: 75% and 2005: 77%). About 39% of the total landings are originating from waters around Rügen Island in SD 24 (2005: 44%). The German fishing fleet in the Baltic Sea consists of two parts where all catches for herring are taken in a directed fishery:

1) coastal fleet with open boats (rowing/motor boats <=10 m and engine power <=100 HP)
2) cutter fleet of total length between 12 m and 30 m.

No assessment input data could be submitted for SD 25-29 to WGBFAS 2007. Herring could not be sampled in SD 25-29 since most herring (93%) was landed in foreign ports.

In 2006 the total German **sprat** landings in the Baltic Sea reached the record high level of 30,778 t (2005: 28,974 t: 2004: 28,490 t). As in last years most sprat:

(1) was landed foreign ports (2006: 98%; 2005: 96%),
(2) was caught in the first quarter (2006: 92%; 2005: 75%),
(3) was caught in SD 25-29 (2006: 29,590 t = 96%; 2005: 27,707.8 t = 96%),
(4) originated from SD 25-29 area was landed in foreign ports
(2006: 29,590 t = 98%; 2005: 27,336.5 t = 99%).

The German fishing fleet in the Baltic Sea consists only of one part where all catches for sprat are taken in a directed trawl fishery (cutter fleet of total length between 12 m and 30 m).

No samples could be taken within SD 22 and 24 in 2006 for following reasons:

(1) low overall fishing activity (1,188 t)
(2) higher proportion of sprat landed in foreign ports (40%).

Assessment input data could be submitted to WGBFAS 2007 only for SD 26 in quarter 1. Even so all landings of SD 26 were landed abroad, sprat could be sampled in quarter 1 in SD 26 at sea within the frame of the EU sampling programme. The officially reported trawl landings in SD 26 and the referring assessment input data were not corrected for the overall small differences in species composition in the samples.

WD8: Anna Gardmark Analyses of flounder BITS data, as an input to length based assessments

Problems with age determination of flounder (*Platichtys flesus*) in the Baltic Sea, in particular from whole otoliths (ICES 2007a), have prevented age based analytical assessments (ICES 2006). An alternative is to use length based assessments, either directly made on length data using size transition matrices, or by converting length data into age equivalent data using a growth function. To this end, we here estimate von Bertanlanffy growth parameters from flounders in different areas of the Baltic Sea, for which ages have been determined using

stained slices from cut otoliths, and where the method has been corroborated by determinations from burned and cracked otoliths (see Gårdmark et al. 2007, ICES 2007a).

To complement genetic analyses of stock structure in flounder (Florin and Höglund, in prep.), and evaluate the stock units proposed by the Workshop on Alternative Assessment Strategies for Flounder in the Baltic, WKAFAB (Gårdmark et al. 2007), we also analyse whether there are spatial differences in length distributions of flounder.

Annex 1: List of Participants

Baltic Fisheries Assessment Working Group
Federal Research Centre for Fisheries, Institute for Baltic Sea Fisheries Rostock,
17 - 26 April 2007

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Annex 2: Recommendations

RECOMMENDATION	ACTION
Intercessional WGBFAS meeting to improve working procedures with regard to quality assurence and preparation of assessment data. The meeting will also deal with consequenses of potentual new ICES structure. Autum 2007.	National labs
Upload discard data from all three cod stocks dealt with by WGBFAS to FishFrame prior to a data preparation meeting to be held in the early spring 2008.	National labs
Perform an evaluation of tuning data compilation for BITS autumn survey. Taking into account possible cod distribution differences during spring and autumn surveys (e.g. pre-spawning season and feeding season in homothermic conditions). Is it appropriate for autumn surveys to apply the same calculation procedure for survey index estimation by ages and years as for spring survey?	WGBIFS & ICES
Perform an evaluation of tuning data available for the Kattegat cod assessment in order to explore the possibility of combining the indices that could potentially result in fewer, but more consistent time series. Taking into account possible spatial distribution differences between spawning (i.e. first quarter of the year) and non-spawning periods.	WGBIFS & ICES
The regional ecosystem description of the Baltic Sea should (i) be basin specific and include the points listed by the SGBFFI (ICES 2006); and (ii) focus on identifying ecosystem changes important for stock assessments, using results from and methods suggested by the WKIAB (ICES 2007).	WGRED
WGBFAS suggests that WGIAB addresses the following six topics, to further advance the usefulness of WGIAB results to the fisheries assessments: • How well do the periods of the different ecosystem regimes correspond to the years identified by e.g. WKREF and to years for averaging recruitment used in predictions by WGBFAS? • Can observed trends in fisheries data (e.g. growth changes) be explained by environmental data • Why is the correlation between the temperature-zooplankton and herring recruitment in the Gulf of Riga (used for short term predictions) breaking down in recent years? • Why does the current regime in the Central Baltic Sea show lower herring biomass compared to the previous regime, whereas the regime shift in all other areas correspond to increases in herring biomass? In particular when the explanatory variables, salinity and temperature, are the same across all areas? • Are there environmental factors that can explain why the 2002 year class is so strong in all herring stocks in the Baltic Sea? Preparation of descriptions of both long term trends, and changes in the last years in the ecosystem, to identify environmental changes important to consider in the assessment.	WGIAB

Reviews potential species interactions and environmental factors that connect the coastal and pelagic ecosystems, to assess their relevance for stocks assessed by the WGBFAS.	SGBFFD
WGBFAS recommends that WGITMO provide the WGIAB and the Baltic Committee with a summary of non-native species known to occur in the Baltic Sea, to support integrated assessments of the Baltic Sea ecosystem, as done for the North Sea to REGNS. This will ensure that the input from such integrated assessments to WGBFAS is based on best available information	WGITMO
A regular quality control of age reading consistency for Baltic Herring, sprat, sole, cod and flounder should be organized. a) regular exchange of an agreed number of otolith samples which are circulated among the national fisheries institutes. The results are sent to persons who coordinate the sample exchange for the certain species and who conduct the analysis of age determination results and distribute them between the participants; b) organization of regular Age Reading Workshops on triannual basis. The differences in age determination of sprat and flounder revealed by Age Reading Workshops in 2006 identified the need of further work between national experts that will manifest in exchange of otolith samples starting in spring 2006. It would be essential that the results of these exchanges are discussed in Age Reading Workshops held in 2007. Besides bilateral or trilateral meetings on regional basis of the Baltic Sea could also be useful and should be supported. c) WGBFAS emphasizes the importance that national institutes pay attention to recommendations of the Age Reading Workshops concerning collection of otolith samples for age reading, necessary age reading technique and the general results of age determination in otolith sample exchanges and at the Workshops.	ICES, PGCCDBS
All available maturity and mean weight data from 1st quarter surveys in the Western Baltic should be uploaded to Datras	National institutes
Evaluate the BITS first quarter surveys in the western Baltic (RV Havfisken & RV Solea) in order to explore the possibilities to establish only one tuning index for the cod stock assessment in this area.	WGBIFS
Kattegat cod discard data and estimation procedures by Denmark and Sweden are adjusted to Fishframe for estimations on discard rates in next year assessment.	National Labs
It is recommended to provide WGBFAS for the herring stock assessment in the Central Baltic (SD 25-27, 28.2, 29 and 32) with the following area corrected acoustic time series at least back to 1991: - tuning fleet index by age (numbers in millions) - biomass estimates by age and SD (t) - 0-group estimates (numbers in millions)	WGBIFS

After submission of the report, the ICES Secretariat will follow up on the recommendations, which will also include communication of proposed terms of reference to other ICES Expert Group Chairs. The "Action" column is optional, but in some cases, it would be helpful for ICES if you would specify to whom the recommendation is addressed.

Annex 3 – Stock Annex

Quality Handbook ANNEX: WGBFAS_Kattegat cod

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Cod in the Kattegat

Working Group: Baltic Fisheries Working Group

Date: 25.04.2007

A. General

A.1. Stock definition

Cod in the Kattegat (centroid of the area distribution, 57° latitude, 12° longitude) is currently assessed as a separate stock. However, although cod spawning aggregations are well known in the central and southern part of the Kattegat (Hagström et al., 1990, Vitale et al., in prep.), there are indications of a significant transportation of cod larvae from the North Sea stocks into the Kattegat (Munk et al., 1995; 1999; Cardinale and Svedäng, 2004). This implies that North Sea cod stock components may be suppliers of cod larvae via transportation to the Skagerrak-Kattegat area. Recent tagging studies also suggest that the Kattegat may function as nursery area for North Sea cod, and that return migration to the North Sea are commonplace (Svedäng and Svenson, 2006; Svedäng et al., 2006). The existence of separate subpopulations in the Kattegat in relation to putative subpopulations in the Skagerrak and the North Sea has also been further corroborated by genetic surveys, supporting the proposition of a spatially segregated stock structure in the eastern North Sea region (André et al. in prep.). This implies that immature cod in the Kattegat are an assortment of North Sea and Kattegat cod stock components, where the proportion of the two stocks in the area varies between years. The principal age when most return migration from the Kattegat towards the North Sea seems to take place is observed to be at age 2 to 3 (Svedäng et al. 2006).

A.2. Fishery

The fishery is almost exclusively Danish and Swedish, with these countries taking about 60-70% and 30-40% of the catches, respectively. Kattegat cod are mainly taken by trawls, Danish seines and gill-nets, the former being the most important. Within the trawling group, three fleets have historically been important, the *Nephrops* fleet (mesh size 70-89 mm), the flatfish fleet (mesh sizes 90-104 mm) and the cod directed fleet (mesh sizes >105 mm). The effort of 70-89 mm trawl fishery after *Nephrops* has almost ceased due to new technical measures that require sorting grids for mesh size below 90 mm. Other Danish Kattegat fleets of importance in the cod fisheries are the Danish seine fishery (mesh sizes 100-120mm) and, to a lesser extent, gill-netters targeting plaice and cod (mesh sizes 120-160mm). In the Swedish fishery, the otter trawl fishery using >90 mm mesh size has accounted for more than 90% of the total landings in the last five years. This fishery has been shown to a large extent targeting spawning aggregations in the southeastern part of the Kattegat in the first quarter of the year.

A.3 Ecosystem aspects

Recruitment is possibly partially dependent on inflow of eggs and larvae from the Skagerrak-North Sea cod stock and on favourable wind-temperature conditions (Munk et al., 1999; Cardinale and Svedäng, 2004).

The decline of the cod stock in the Kattegat has shown associations with the disappearance of separate spawning aggregations/subpopulations in the Kattegat area (Svedäng, and Bardon, 2003; Cardinale and Svedäng, 2004).

B. Data

B.1 Commercial landings

Landings of cod from the Kattegat have declined steadily from annual totals of around 15,000t in the 1970s to a level of around 5-6,000t in the 1990s. After 2000 the reported landings have declined further and were in 2006 estimated at 876 tonnes, which is the lowest value in the time-series. The landings statistics are considered unreliable from the period 1991 and up to 1994. During this period, a considerable amount of the catches were possibly not reported or mis-reported by area or species. The control and enforcement measures have been tightened considerably since the late 1994. However, Kattegat cod stock is currently subject to stringent management measures and one obvious consequence can be a serious decline in the quality of reported landings due to mis-reporting and discarding. The problem of mis-reporting of Kattegat cod landings was explicitly addressed last year (Hovgård, 2006), however total level of non reported landings cannot be estimated based on the available data. Anecdotal information from the Danish industry indicates that the landings that do not appear in reported statistics for Kattegat area are in the order of 2000-2500 tons in the last three years.

B.2 Discard

Time series of discard estimates were available from Sweden for 1997-2006 and from Denmark for 2000-2006. The Danish time series differed from the data presented in last year's report due to a different calculation procedure. The sampling procedure differs also somewhat between Denmark and Sweden which could not be handled in a central estimation process. The discard estimation was therefore conducted independently by the two countries. Further details of calculation procedures of Danish and Swedish discard numbers that were used in the assessment in 2007 are provided in the main part of the WG report.

Estimated numbers of cod discarded by Sweden and Denmark were summed to obtain the total discard numbers by age-groups. Discard estimates for the Danish fishery in 1997-1999 were obtained based on Swedish data, assuming similar amount of cod discarded per numbers of cod landed by age-groups as in Swedish fisheries. Therefore the discard estimates for 1997-1999 are not entirely comparable with the years 2000-2006.

Discarding of cod in the Kattegat is mainly taking place in Nephrops fishery. Therefore, extrapolating discard estimates back in time, assuming the numbers of cod discarded to be proportional to the numbers of cod landed is not appropriate for Kattegat and would also be inconsistent with the raising procedures applied for the time period were discard data were available. Besides, the fishery has changed shape several times during the time period since 1971; in the beginning of the time period it was hardly any nephrops fishery going on, and the fishery for cod and gadoid species dominated the fishery. Since then, the Nephrops fishery developed and cod is virtually the only gadoid species of any importance left. Therefore, extrapolation of discard estimates back from 1997 was not conducted.

Due to relatively low sampling levels and high variability in the data, our discard estimates are considered to be sensitive to the calculation procedures. In this reason and as data for several years were combined to produce discard estimates, these data cannot be used to analyse annual variability in discarding practice. Therefore, present discard estimates can only be used as an indication of the level of discarding and its impact on the stock. More detailed analyses of discard data from both countries and sensitivity analyses of discard estimates to calculation procedures is suggested for the future. A central estimation of all discard rates and raising to

the total levels will be available next year and a revision of the estimates can be expected. However, the problems with data coverage would still remain.

B.2 Biological

Information about quarterly catch composition and catch mean weight by age was made available from Danish and Swedish sampling onboard commercial vessels and in ports. For each country, the annual catch mean weights by age were derived by weighing the quarterly mean weight by the respective catch in numbers.

The data on the stock weights for age-groups 1-3 were based on the Swedish IBTS 1st quarter survey, whereas the weights at age 4-8+ were set equal to the catch mean weights at age.

The historical time series of maturity ogives has been based on the macroscopic analysis of the gonads collected during Swedish 1st quarter IBTS in the Kattegat. However, a three years histological study of Kattegat cod gonads (Vitale et al., 2005, 2006) has shown that the macroscopic analysis overestimates the proportion of mature females for all age classes, especially for first spawners. In 2005, a reconstructed historical time series of maturity ogives was applied by using a correction factor, based on the proportion of mature females, as estimated by the histological analysis of cod female gonads in 2003 and 2004. Since only females were analysed, the deviation for males was set at the same values as for females. The WG 2006 was however insecure of the quality of the historical revisions that are based on comparing concurrent maturity classifications for only two spawning seasons and that male maturity was corrected using the information from females. It may however be argued that dimorphic growth and maturation is common for gadoids and using a combined female and male maturity ogives might lead to an overestimation of the potential egg production. The WG in 2006 decided to use the traditional visual classification face value until a better correction factor for a historical revision of the female maturity can be supplied.

A constant natural mortality of 0.2 was assumed for all ages and years.

B.3 Surveys

Survey data were available from the IBTS 1st and 3rd quarter surveys (Swedish R/V Argos) and from the Danish Kattegat Bottom trawl 1st and 4th quarter surveys (Danish R/V Havfisken). Both surveys cover the entire distribution area of the stock. In addition, two new surveys were presented to the WG, i.e the Swedish coastal surveys by "Ancylus" conducted in the 2nd and 4 th quarter of the year.

IBTS 1st and 3rd quarter surveys:

Data for ages 2+ from the Kattegat portion of the International Bottom Trawl Survey in the first quarter were treated as if the survey took place at the end of the previous year, in order to permit the inclusion of information from the 2007 survey in the tuning. Thus, the IBTS survey is split into two and treated as if they were independent surveys, and one of them is deliberately assigned wrong timing parameters (α and β)

The IBTS tuning data were derived from arithmetic mean value over ICES rectangles, not weighed by the area of the rectangle. Age distribution of the IBTS 1st quarter survey indices for the years before 1996 are based on a combination of commercial age-length keys and modal separation for the fish below commercial sizes (Hovgård, 1995). This year the ALKs from Hovgård (1995) were submitted to DATRAS database in ICES. Consequently, in this year's assessment the entire time series of IBTS 1st quarter indices were produced by ICES.

"Havfisken" 1st and 4th quarter surveys:

Time series of indices from the 1st and 4th quarter surveys by Havfisken were subject to minor changes in 2007. A consistent procedure for filling in missing age information in Age-Length-Key was implemented in 2007. The effect of this revision on indices for age-groups 1-3 was negligible. Changes appeared for age-groups 4 and 5, especially for the 4th quarter survey.

This is due to the fact that very few larger fish are caught in this survey and age information is largely not available and therefore heavily dependent on the procedure for filling in missing age data. The age-groups 4 and 5 were excluded from the assessment as in previous year.

The procedure for filling in missing age information is the following:

At first, length distribution data are merged with annual available ALK-s, separately for the 1st and 4th quarter surveys. When no age information in ALK is found for a given length-group, then:

if the length of the fish <15 cm then

in the 1st quarter the age is set to 0

in the 4th quarter the age is set to 1

-if no match is found,

use the age information for 1cm smaller fish than itself

- if no match is found,

use the age information for 1cm larger fish than itself

-if no match is found,

use the age information for 2 cm smaller fish than itself

-if no match is found,

use the age information for 2 cm larger fish than itself

-if no match is found,

use the age information for 3 cm smaller fish than itself

-if no match is found,

use the age information for 3cm larger fish than itself

-if no match is found

use the age information for a given length using the average ALK for all year combined, separately by 1 st and 4th quarter surveys

-if no match is still found,

if the length of the fish >= 60 cm and < 70 cm the age is set to 4 and if the length > 70 cm the age is set to 5

As no age information is available for the 4th quarter survey in 1994 in the Kattegat, the average ALK for the years 1995-2000 is at first applied. For filling in the still missing age information, the general procedure is applied, as described above.

"Ancylus" 2nd and 4th quarter surveys:

Coastal trawl surveys have been carried out by RV Ancylus since 2001 in the Kattegat and Öresund. The stations were selected partly based on previously used trawling stations or information from fishers, partly on trial and error, especially inside the trawling limit. The surveys in the Kattegat were conducted twice a year in the second and fourth quarter of the year. However, as the number of stations and locations shifted in 2001, the time series are restricted to 2002-2006. In total, 16 trawling stations have been established in the Kattegat. Of

them, 14 were included from the start in 2002, whereas two more stations were added to the survey in 2004. Between 11-16 hauls have been considered as valid per seasonal survey. The gear was a 140-feet Nephrops trawl, with small bobbins (10 cm in diameter), and a codend mesh size of 70 mm. All hauls were made in full daylight at a speed of 2.5 knots. In most cases, haul duration was 30 min.

Because no otoliths were collected before 2006, LT groups (1 cm) were transformed into age groups using ALKs from other available sources between 2002 and 2005: Swedish IBTS in the first and Havfisken Q4 for the fourth quarter of the year. ALKs coming from the first quarter of the year were applied to the survey conducted in the second quarter, whereas ALKs coming from the fourth quarter of the year were used for the survey conducted in the same quarter, accordingly. When no age information in the ALK was found for a given length-group, then information from up to 3 cm smaller or larger than itself was used. If still no match was found as was the case using the ALKs from Havfisken Q4, the ALK from the preceding quarter of the year was used, i.e. Swedish IBTS Q3. During 2006, the ALKs have been based on individual sampling on the Ancylus surveys Q2 and Q4. In the two surveys, 123 and 113 individual cod were sampled for the second and fourth quarter of the year, respectively.

The numbers of valid stations from all available surveys included in calculation of tuning indices are shown in the table below:

Year/ Survey	IBTS Q1	IBTS Q3	Havfisken Q1	Havfisken Q4	Ancylus Q2	Ancylus Q4
1983	13					
1984	14					
1985	11					
1986	15					
1987	16					
1988	17					
1989	19					
1990	21					
1991	15	23				
1992	22	23				
1993	22	22				
1994	22	22		25		
1995	22	24		20		
1996	22	22	24	20		
1997	18	16	21	28		
1998	18	19		17		
1999	19	19	25	26		
2000	19		25	17		
2001	19	19	25	17		
2002	19	19	25	26	14	11
2003	19	19	26	26	14	13
2004	19	19	26	25	15	16
2005	19	19	26	26	16	14
2006	19	19	27	26	16	14
2007	19					

Internal consistency of all six surveys (numbers at age plotted against numbers at age+1 of the same cohort in the following year) were inspected. The agreement of indices between surveys was examined by plotting survey time series by age-groups against each other. These analyses reveal that for younger age-groups all six surveys show similar patterns both in internal consistency analysis and between the surveys, i.e. all time series are relatively noisy but contain information that is to certain extent consistent between years in single surveys and agrees on the same level with estimates from other surveys. Accordingly, these analyses revealed no justification for excluding any of the time series from the assessment completely.

The conclusion from the last year concerning the selection of age-groups for the assessment was unchanged. The new time series from Ancylus surveys showed similar consistency patterns for age-groups 1-3 as the other surveys, while age-group 4 was chosen to be excluded from the further analyses due to lack of consistency with younger age-groups or other surveys.

The consistency of fishery independent information on relative stock development could potentially be improved by pooling the information from different surveys. The working group therefore strongly recommends WGBIFS to look into the possibility for combining the indices from some of the surveys that could potentially result in fewer, but more consistent time series.

B.4 Commercial CPUE

CPUE information for the Danish commercial fisheries was extracted from the Danish logbook database. This database provides information by vessel size, fishing gear and mesh-size used, effort measured as days at sea and catches reported in the five market categories (i.e., size groups) used in the cod trading. This information is given on a trip-by-trip basis.

CPUE were standardised by fleets by the ANOVA ln(CPUE)=Year*month + Vessel size. The estimated vessel size effects were used to convert the fishing power of different vessel sizes to a common standard vessel.

In the present situation with historical low catch rations the WG doubted whether commercial catch rates based on official catch figures are at all useful as stock indicators as the CPUE may either be compromised due to discarding or misreporting or reflecting catch ceilings rather than stock size. The group therefore decided to only use fishery independent catch rate information from the scientific surveys as stock size indicators.

C Historical Stock Development

Model used: XSA

Software used: IFAP/Lowestoft VPA suite

Model Options chosen:

Tapered time weighting = Tricubic over 20 years

First age of independent catchability = 1

Catchability independent of age for ages >= 4

Survivors estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

1) XSA run not including discards

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Landings in tonnes	1971 – last data year	1-6+	Yes
Canum	Landings at age in numbers	1971 – last data year	1-6+	Yes
Weca	Weight at age in the commercial landings	1971 – last data year	1-6+	Yes/No – constant from 1971-1977
West	Weight at age of the spawning stock at spawning time.	1971 – last data year	1-6+	Yes/No – constant from 1971-1977
Mprop	Proportion of natural mortality before spawning	1971 – last data year	1-6+	No – set 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1971 – last data year	1-6+	No – set 0 for all ages in all years
Matprop	Proportion mature at age	1971 – last data year	1-6+	Yes/No – constant from 1971-1990
Natmor	Natural mortality	1971 – last data year	1-6+	No – set 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	IBTS Q3	1991-2006	1-4
Tuning fleet 2	IBTS Q1	1983-2007 (Shifted one year back, excl. 1994)	2-6 (1-5 in shifted series)
Tuning fleet 3	Havfisken Q1	1996-2006	1-3
Tuning fleet 4	Havfisken Q4	1994-2006	1-3
Tuning fleet 5	IBTS Q1	1983-2006 (excl. 1994)	1

2) XSA run including discards

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1997 – last data year	1-6+	Yes
Canum	Catch at age in numbers	1997 – last data year	1-6+	Yes
Weca	Weight at age in the commercial catch	1997 – last data year	1-6+	Yes/No – constant from 1971-1977
West	Weight at age of the spawning stock at spawning time.	1997 – last data year	1-6+	Yes/No – constant from 1971-1977
Mprop	Proportion of natural mortality before spawning	1997 – last data year	1-6+	No – set 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1997 – last data year	1-6+	No – set 0 for all ages in all years
Matprop	Proportion mature at age	1997 – last data year	1-6+	Yes/No – constant from 1971-1990
Natmor	Natural mortality	1997 – last data year	1-6+	No – set 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	IBTS Q3	1997-2006	1-4
Tuning fleet 2	IBTS Q1	1998-2007 (Shifted one year back, excl. 1994)	2-6 (1-5 in shifted series)
Tuning fleet 3	Havfisken Q1	1997-2006	1-3
Tuning fleet 4	Havfisken Q4	1997-2006	1-3
Tuning fleet 5	IBTS Q1	1997-2006 (excl. 1994)	1

Model used: B-Adapt

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting = not applied

First age of independent catchability = 1

Catchability independent of age for ages >= 4

Bias estimated for the final 6 years.

Oldest age F estimates in 1971 to 2007 calculated as 1.000 * the mean F of ages 3- 4

Total F penalty applied, lambda = 0.500

Individual fleet weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Landings in tonnes	1971 – last data year	1-6+	Yes
Canum	Landings at age in numbers	1971 – last data year	1-6+	Yes
Weca	Weight at age in the commercial landings	1971 – last data year	1-6+	Yes/No – constant from 1971-1977
West	Weight at age of the spawning stock at spawning time.	1971 – last data year	1-6+	Yes/No – constant from 1971-1977
Mprop	Proportion of natural mortality before spawning	1971 – last data year	1-6+	No – set 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1971 – last data year	1-6+	No – set 0 for all ages in all years
Matprop	Proportion mature at age	1971 – last data year	1-6+	Yes/No – constant from 1971-1990
Natmor	Natural mortality	1971 – last data year	1-6+	No – set 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	IBTS Q3	1991-2006	1-4
Tuning fleet 2	IBTS Q1	1983-2007 (Shifted one year back, excl. 1994)	2-6 (1-5 in shifted series)
Tuning fleet 3	Havfisken Q1	1996-2006	1-3
Tuning fleet 4	Havfisken Q4	1994-2006	1-3
Tuning fleet 5	IBTS Q1	1983-2006 (excl. 1994)	1

Discards estimates were for the first time included in the assessment in 2006. The annual discard numbers can be considered uncertain, however these can be used to represent the level of discarding and its impact on the stock as indicated by high mortality on young ages. Annual variability in year-class strength can be considered to be best represented in survey-based analyses.

Inconsistencies were observed in the information provided by surveys and catch at age analyses using XSA. Therefore, alternative model (B-Adapt) was applied that allows to stimate the potential bias in the catch at age data.

The fishing mortality estimated from XSA showed a very deviant trend in last years compared to SURBA and B-Adapt estimates. Fishery independent survey information indicated increased unallocated mortality in the last years as demonstrated by B-Adapt analysis. The results from B-Adapt can be considered as providing likely more realistic level of the removals, however, the fishing mortality estimates suffer as well from the noise in survey indices.

The face value for SSB from both XSA and B-Adapt analyses should be treated with caution due to problematic catch data and relatively noisy survey indices. However, the estimate for SSB in latest years showed to be relatively little sensitive to bias in landings data and XSA and B-Adapt estimates were relatively similar. Therefore, the current SSB is with high probability not exceeding the level set for Blim.

D Short-term Projections

Short -term prediction was not conducted due to uncertainty in estimates for recent years.

E Medium-term Projections

Not performed

F Long-Term Projections

Not performed

G Biological Reference Points

The S-R relationship has been analysed in previous years and the change point estimate from segment regression has been found unrealistic, because it is close to the highest observed biomass and thus poorly estimated. The exploitation level has been high for most of the historical records of the stock and it may be considered that the biomass reference points have been bypassed before the start of historical time series. Revaluating the reference points should therefore be considered. It has been also pointed out that establishing meaningful S-R relationship for this stock is difficult due to inflow of recruits from adjacent areas (Cardinale and Svedäng, 2004).

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Annex 4: – Stock Annex

Quality Handbook **ANNEX: WGBFAS_ Cod in SD 22-24**

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Cod in the Western Baltic ICES 22-24

Working Group WGBFAS

Date: April 2007 by Marie Storr-Paulsen

A. General

A.1 Stock definition

The distribution area of the Western Baltic cod stock is defined as the ICES Subdivisions 22-24 of the Baltic Sea. The stock is biologically distinct from the adjacent Eastern Baltic cod stock distributed Sub-divisions 25-32, although the stocks overlap in the boarder area. In 1997 subdivision 23 was included in the Western Baltic stock

A.2 Fishery

Catches are taken by both trawlers and gillnetters in Sub-divisions 22-24. In 1932 a trawling ban was implemented in Sub-division 23 (Øresund), except for a minor area adjacent to Kattegat (SD 21), due to the large shipping activity. Therefore the major commercial catch in this SD is landed by the gillnetters. Catches are predominantly Danish, Swedish and German, with smaller amounts occasionally reported by other Baltic coastal states.

A.2.2 Fishery regulation

A 'Bacoma' codend with a 120-mm mesh was introduced by IBSFC in 2001 in parallel to an increase in diamond mesh size to 130 mm in traditional codends. The expected effect of introducing the Bacoma 120-mm exit window was nullified by compensatory measures in the industry. This was to some extent explained by the mismatch between the selectivity of the 120-mm Bacoma trawl and the minimum landing size. In October 2003 the regulation was changed to a 110-mm Bacoma window which was expected to enhance the compliance by the fishing industry and to be in better accordance with the minimum landing size, changed from 35 to 38 cm in the same year. This appears to have been accepted by the fishing industry, although it has not yet been possible to evaluate its effects. New EU countries (Estonia, Lithonia, Polen and implemented the BECOMA window a bit later in May 2004.

In addition to this, the fisheries are regulated by a seasonal closure from 15 March to 14 May in 2006 and an additional 30 days of closure, to be allocated individually by the member states.

A.3 Ecosystem aspects

B. Data

B.1 Commercial catch

National landings and estimates of catch composition in numbers and weights at age data are available from national sampling programs back to 1970. Since mid 1990s, the national landing information is provided by quarter, Subdivision and gear (active gear and passive gear) and documented in the WG report.

The amounts of cod discarded by the fishermen are estimated based on the data collected by observers onboard commercial fishing vessels, collecting the data during normal fishery. All relevant biological information and information concerning the catch is recorded. Discard data are available from 1996 and onwards. The discard results obtained by sampling are aggregated by year, country, Subdivision, quarter, and metier (fishery). For each stratum the age distribution in numbers of the discard were compiled.

The discard by age group was raised by the ratio:

Total commercial landings of cod by stratum / total landings in samples by stratum.

National landing statistics are available un-aggregated into landings for a number of fisheries defined in respect to discard patterns and covering all fisheries where significant discards are present. The fisheries are defined independently in each country. After being raised to total national level, the data were aggregated to the fleets comparable to the assessment input (trawl and gillnet).

In strata where there have been landings but no biological information exists on discarding, data from other strata have been applied.

The extrapolations of biological information are made taking into account the following priorities:

1) Same country, same quarter, adjacent Subdivision.
2) Same quarter, another country.
3) Another country, same quarter, adjacent Subdivision

Discard data are included in the assessment as standard. The CANUM input for the XSA consist therefore of the sum of the landings and the discards. The estimated discard numbers for years prior to 1996 (where sampling commenced) are based on average proportions discarded at age in the period 1996 to 2003.

B.2 Biological

Weight information:

- The historical record of weight-at-age in the catches is a weighted average of the weights sampled from the landings and the discard.
- Weights-at-age in the stock are for ages 1-3 kept constant since 1995, on the basis of relevant surveys information from the stock area. In the previous assessments the weight at age were set constant for age 4-11 between 1990 and 2005. In 2007, weight at age 4-11 was set equal to the annual weights in catches from 1982 to2006.

Updated weight at age information was presented from the Danish Havfisken survey in the years 2001–2006. However, due to low sampling level and incomplete coverage of the stock area, these data were not used in the final assessment.

- Mean weights at age in discard was in former year's assessment set constant based on the discard value from 2002. Do to the large variance in discard weights between years it was decided to use a weighted average of the discard weights from 2001-2006. Discard weights from earlier time were not available. The time series is presented in Table 2.3.8.

B.3 Surveys

Six different surveys have since 1996 been included in the assessment of the Western Baltic stock. Three German surveys; the Solea 1st and 4th quarter and the Sonderborg (Clupea) 1st quarter, furthermore Denmark have conducted three surveys in the area with "Dana" and "Havfisken" 1st and 4th quarter. The Dana survey was only used in the Western Baltic stock assessment in 1997 and the later two was introduced in the final assessment in 2007.

Table 1. The survey tuning settings used in different years.

Year\survey	"Solea"1th Q	"Solea"4th Q	"Sonderborg"1thQ	KASU 1st Q	KASU 4thQ
1997	1979- Age 1-6	1978- Age 1-6	1980- Age 1-6		
1999	1979- Age 1-2	1978- Age 1-2	1980- Age 1-2		
2000	1979- Age 1	1978- Age 1	1980- Age 1		
2002			Excluded in XSA		
2003	1984- Age 1	1981- Age 1			
2004	1994- Age 1	1981- Age 1			
2007	Excluded in XSA	1994- Age 1-3		1995- Age 1-3	1994- Age 1-3

Danish 'Havfisken' surveys in SD 22-23 in 1st and 4th quarter.

The KASU survey is conducted twice a year in Øresund (SD 23) and Western Baltic (SD 22, 24) in February and November by a Danish vessel, "Havfisken" from DIFRES. The KASU is a part of BITS, and designed to provide annual abundance indices for cod, plaice and sole. The trawl is a standard TV3-520 with rubber discs of 10cm diameter on the groundrope and with a trawl speed at 3 knots. Time series

from "Havfisken" start in 1996 for the first quarter and in 1994 for the fourth quarter. The spatial coverage has changed through time; between 1994-2000 the survey covered SD 23 and 22 down to Mecklenburg Bay, in 2001 the survey covered SD 23 and 22 to the Kiel Bay and since 2004 the survey has covered SD 23 and from Little Belt and Great Belt to the Northern part of SD 22 (figure 1).

The surveys have in 2007 been implemented in the assessment for the first time due to the high internal consistency between age groups and analysis of the catchability residuals. The reason for rejecting the surveys in former time was the low cover of the stock area, but as the

survey is covering the part were the "Solea" do not cover – Northern part of SD 22 and SD 23 it was decided to include the survey in this years assessment. Age group larger than 3 had S.E in the log residuals above 0.8 and was for this reason excluded from the tuning.

German "Solea" survey in SD24. 1st and 4th quarter.

The time series cover the period 1978 from the 4th, and 1979 from the 1st quarter to present. Since 1997 until 2006 data from the 1st quarter survey has been used in the assessment, although with changing age groups and timeframe. In 2007 it was decide to exclude the survey from the final run as the data showed a low internal consistency for age group 1- 2 and as the other surveys very high S.E in the log residuals from the XSA output for larger age groups. The 4th quarter survey was used for age 1-3

Stock indices were derived from survey data as was done in the previous year, applying a stratified sampling design using Sub-division and depth as strata. The stratified mean CPUE and the variation in the means were calculated by:

$$E(\bar{y}_{st}) = \sum_{i=1}^{L} W_i \bar{Y}_i$$

$$V(\bar{y}_{st}) = \sum \frac{W_i^2 S_i^2}{n_i}$$

where Y_i and S_i are the estimated means and standard deviations found in stratum i, W_i is the stratum weight (stratum area/total area) and n_i is the number of hauls in the stratum. The strata areas were calculated using topographical data from the Institute of Baltic Sea Research in Warnemünde. No correction has made for the change of gear in surveys since 2000, however inter-comparisons indicate that the efficiency of the two gears is very similar.

B.4 Commercial CPUE

The commercial tuning fleets used in this assessment are all from the Danish fishery. The Danish commercial tuning fleets coved almost the total Danish landings, which covered themselves a very large part of the total landings of the stock. This created a de facto high correlation between the tuning fleets and the catch-at-age matrix, furthermore a change in DIFRES databases and data extraction programs made it difficult to reproduce the earlier years of the time series, and to modify it for testing of alternative series. Therefore, a larger revision of the commercial tuning fleet was conducted in 2007.

Danish commercial trawl fleet (mesh size 105 to 120 mm).

The time series cover the period 1987 – present, whereas only data from 1992 to present were used. The CPUE information for the commercial fisheries was extracted from the Danish log-book database. This database provides information by vessel size, kgwatt, fishing gear and mesh-size, effort measured as days at sea and catches separated into five market categories (i.e., size groups) on a trip-by-trip basis. The age composition in the catches is derived by linking the landings in each market category with information on age composition by market category (a market category-age key). CPUE were standardised by fleets by the ANOVA ln(CPUE)=Year*month + Vessel size + kgwatt. The estimated vessel size effect were re-transformed and used to correct the fishing power of different vessel sizes to a common size standard. The input data is presented as catch in numbers in age groups 1 to 6 and standardised effort unit by fleet. Selectivity in age 1 and 2 in this fleet is believed to have changed after the introduction of the BACOMA window.

Danish gillnet fleet (mesh size 120 to 159 mm).

The time series cover the period 1987 – present, whereas only data from 1994 – present were used as a very pronounced negative trend was present between 1987 and 1993. The CPUE information for the commercial fisheries was extracted from the Danish log-book database and is calculated the same way as for the trawlers.

Danish seine fleet.

The time series cover the period 1987 – present and age groups 1-6. The complete period, but only AGs 2-6 were used for calculations as age group 1 showed very large residuals with a positive trend. The CPUE information for the commercial fisheries was extracted from the Danish log-book database and is calculated the same way as for the trawlers and gillnetters. A trend in time was evident for this fleet and for this reason it was excluded in the final run in 2007.

B.5 Other relevant data

C Historical Stock Development

Model used: XSA

Software used: VPA-95 (Darby & Flatman, 1994)

Model Options chosen:
Tapered time weighting applied, power = 3 over 20 years

Catchability dependent on stock size for ages < 2

Catchability independent of age for ages >= 4

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.5

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Available Age range	Used Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1970-last data year	1+	1+	Yes
Canum	Catch at age in numbers	1970-last data year	1-11+ (-1996) 1-10+ (1997-)	1-7	Yes
Weca	Weight at age in the commercial catch and discard	1970-last data year	1-11+ (-1996) 1-10+ (1997-)	1-7	Yes (constant 1970-1981)
West	Weight at age of the spawning stock at spawning time .	1970-last data year	1-11+	1-7	Yes (constant during different periods: 1966-1984; 1990-1994; 1995-present) for age 1-3. For age 4-11 weights in catch
Mprop	Proportion of natural mortality before spawning	1970-last data year	1-11+	1-7	No - set to 0 for all ages and all years
Fprop	Proportion of fishing mortality before spawning	1970-last data year	1-11+	1-7	No - set to 0 for all ages and all years
Matprop	Proportion mature at age	1970-last data year	1-11+	1-7	Yes – ocassionally revised, but unchanged since 1995
Natmor	Natural mortality	1970-last data year	1-11+	1-7	No- from AG 2 set to 0.2 for all ages and all years Y-AG 1 according to MSVPA, but unchanged since 1997

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	”Solea”, Q1, SD24	1994-present	AG 1-3
Tuning fleet 2	”Solea”, Q4, SD22-24	1981- present	AG1-3
Tuning fleet 3	Danish Gillnetters	1994- present	AGs 2-6
Tuning fleet 4	Danish Trawlers	1993- present	AGs 3-6
Tuning fleet 5	“Havfisken”, 1Q SD22-23	1995- present	AG1-3
Tuning fleet 6	“Havfisken”, 4Q SD22-23	1994- present	AG1-3
Tuning fleet 7	Danish Seiners	Excluded in 2007	

D Short-Term Projection

Model used: Age structured.

Software used: MFDP

Initial stock size: Age 3 and older are derived from the XSA survivors. RCT3 estimates are used for the most recent year-classes.

Natural Mortality: For AG 1 average of last 3 years (latest MSVPA results).

Maturity: Proportion mature at age is the average of last 3 years.

F and M before spawning: Set to 0.

Weight at age in the stock: Average of last 3 years.

Weight at age in the catch: Average of last 3 years.

Exploitation pattern: Average of last 3 years, and was scaled to the point estimate of F in 2005.

Intermediate year assumptions: Present exploitation level.

Stock recruitment model used: RCT3 estimates were used to estimate the two most recent year classes, i.e. 2005 and 2006. For subsequent year-classes, a geometric mean over 1986 to 2004 was used.

Procedures used for splitting projected catches: Discards and landing split based on F by ages.

E Medium-Term Projections

Was not applied in 2007.

Model used: Model that was used by the Study Group on Management Strategies for Baltic Fish Stocks (ICES, 1998) and developed in DIFRES. In this model stochastic variation has been included for some parameters (e.g., stock-recruitment relationship, mean weight in catch, mean weight in stock and maturity ogive). No medium term projection was calculated in 2007.

Software used:

Initial stock size: Age 3 and older are the XSA survivors. RCT3 estimates are used for the two most recent year-classes.

Natural mortality: For AG 1 average of last 3 years (latest MSVPA results), AGs 2 and older is set to 0.2.

Maturity: Proportions mature was taken as the average from the last three years.

F and M before spawning: Set to 0.

Weight at age in the stock: Correction factors to weight at age in the catch: AG 1 = 0.109, AG 2 = 0.445, AG 3 = 0.788, AGs 4+ = 1.

Weight at age in the catch: Average of last 3 years.

Exploitation pattern: Average of last 3 years.

Intermediate year assumptions:

Stock recruitment model used: Ricker stock-recruitment relationship

Uncertainty models used:

1. Initial stock size: The uncertainty in survivors estimates were taken as the SE's from the XSA runs

2. Natural mortality:
3. Maturity: Standard deviation.
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch: Standard deviation.
7. Exploitation pattern:
8. Intermediate year assumptions:
9. Stock recruitment model used:

F Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G Biological Reference Points

ICES has proposed $\mathbf{B}_{pa}$ at 23,000 t equal to the former established MBAL. IBSFC have established a SSB reference point of 23,000 t for the stock and a fishing mortality reference point of 1.0. (ICES, CM 1998/ACFM:11).

H `Other Issues

I References

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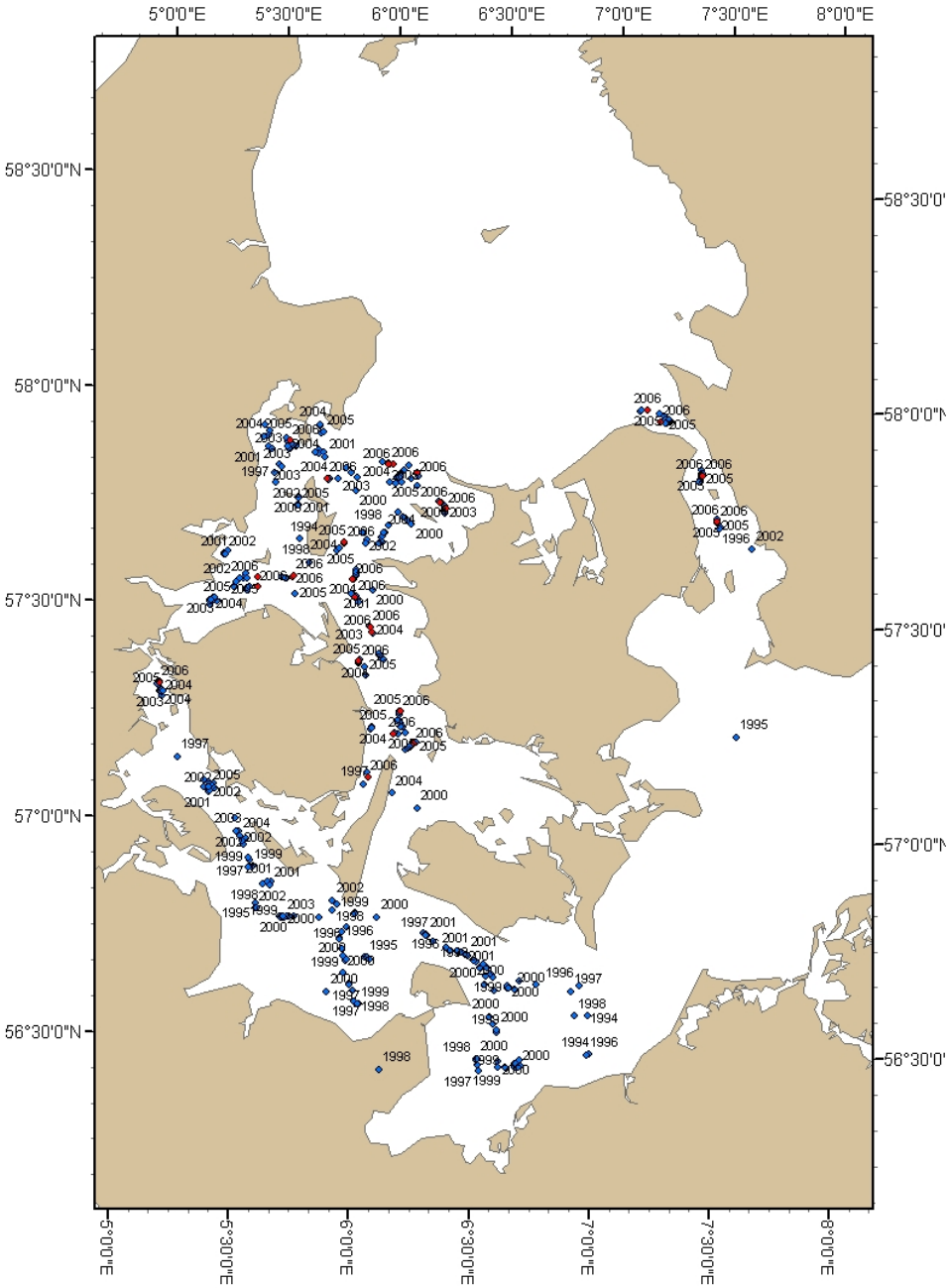

Figure 1. The spatial distribution of the Danish survey with "Havfisken" from 1994-2006.

Annex 5: – Stock Annex

Quality Handbook **ANNEX: WGBFAS_Cod in 25-32**

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Eastern Baltic Cod in ICES Subdivisions 25-32

Working Group: Baltic Fisheries Working Group

Date: 26 April 2007

A General

A.1 Stock definition

The distribution area of the Eastern Baltic cod stock is defined as the ICES Subdivisions 25-32 of the Baltic Sea. The stock is biologically distinct from the adjacent Western Baltic cod stock distributed Sub-divisions 22-24, although the stocks overlap in the boarder area. The stock separation that has recently been confirmed by genetic studies (Nielsen et al. 2001) is maintained primary trough differences in spawning areas, spawning time and egg characteristics. The timing of spawning differs between the two stocks with little the overlap in time, which is reproductively separating the stocks. Spawning of the eastern stock is confined to the deep areas where salinities in the deeper water where salinities are sufficiently high to allow egg fertilisation and to keep the fertilised eggs float. The eggs of Baltic cod reach neutral buoyancy at lower salinities (app. 12-14 PSU) than other cod stocks, which is an essential adaptation to living in a brackish water area. Sufficient oxygen contents in the deep saline water layer where the fertilised eggs float, is crucial to egg survival and recruitment success. Limited inflow of oceanic water from the North Sea has in oxygen depletion in the deep saline water and since the mid-1980s and cod reproduction has only been successful in the southern spawning areas Bornholm Basin and Slupsk Furrow located mainly in Sub-division 25. The reproduction failure in Gotland Deep (Sub-div. 28 and 26 north) and to some extent Gdansk Deep (Sub-div. 26 south) has reduced recruitment to the northern areas (Sub-div. 28-32), which do not have any cod spawning areas, and the stock distribution is presently limited to Sub-div. 25, 26 and the southern part of Sub-div.28.

A.2 Fishery

Cod in the eastern Baltic have traditionally been taken in a directed fishery while catches of cod as by-catch in pelagic fish fisheries have been very limited. The main fisheries for cod in the Eastern Baltic use demersal trawls, pelagic trawls and gillnets. The cod fishery was intensified the early 1980's when the stock biomass substantially increased due to favourable reproduction conditions with particularly abundant year classes in 1976, 1977 and 1980 and landings increased to 350-400.000 tons in the mid 1980's. During this time, a considerable share of the catches was taken in Sub-div.s 28-32. However, the spawning stock declined from a high level on record during 1982–1983 to an extremely low level in the early 1990'ies as a result of the increased effort of the traditional bottom trawl fishery, introduction of gillnet fishery, and decreased egg survival due to oxygen depletion of deep water layers. During the 1990s when the proportion of older cod in the stock was large, the gillnet fisheries expanded. However, with the change in stock age composition in late 1990's and early 2000 towards younger ages, the share of the total catch of cod taken by gillnets has decreased while that of demersal trawl increased. During the most recent years, the cod catches are largely taken in

Subdivisions 25 and 26 with approximately 40% being taken by gillnets. The landings ranges between 50.000 and 100.000 t, however the landing estimates are presently inaccurate due to landing misreporting.

A.3. Ecosystem aspects

The eastern Baltic Sea is brackish water area with characterised by an estuarine circulation with a low salinity surface layer (app. 7 PSU) and deeper saline layer (between 12-18 PSU). A permanent halocline separates to the low and high saline layers. The salinity and oxygen contents largely depend on the frequency and intensity of inflows of saline oxygenated water from the North Sea. The water volume suitable for egg fertilisation and development is defined as the volume of water with a PSU > 12 PSU and oxygen content > 2 ml/l, i.e. the reproductive volume. The critical stages for the recruitment success are the egg and early larval stage (Köster et al. 2003a). Low oxygen contents in ambient water increases egg mortality and predation by clupeids is another mortality factor while prey availability is crucial to the survival at the first feeding larval stage.

A substantial predation on cod eggs by sprat and herring has been described for the Bornholm Basin presently the most important spawning area due to adverse hydrograhic condition in the Gotland Deep and Gdansk Deep. Egg predation is most intense at the beginning of the cod spawning season, with sprat being the major predator (Köster and Möllmann 2000). The shift of cod peak spawning time from spring to summer (Wieland et al. 2000) resulted in a decreasing predation pressure on cod eggs by sprat, due to a reduced temporal overlap between predator and prey. Due to the increased salinity after the 1993 major Baltic inflow (Matthäus and Lass 1995), cod eggs were floating in shallower water layers, while clupeids occurred deeper, due to enhanced oxygen concentration in the bottom water (Köster and Möllmann 2000). Thus, predation pressure on cod eggs appears to be higher in stagnation periods. Cod egg predation by clupeids appears to be less import in the more eastern spawning areas. This has been explained by a more limited vertical overlap between predator and prey in these areas (STORE 2003).

Copepod nauplii and copepodites are the dominating prey organisms of cod larvae in the Central Baltic (Voss et al. 2003). In contrast to cod stocks outside the Baltic, phytoplankton does not contribute a relevant proportion to the cod larval diet. The composition and distribution of the zooplankton is important for læarval survival and growth. The calanoid copepod *Pseudocalanus elongates* that is related to more sline water is preferable to *Temora longicornis* and *Acartia* spp. which dominate at low salinities. Using a coupled hydrodynamic-trophodynamic model to analyse intra- and inter-annual variability in growth and survival of cod larvae in the Eastern Baltic, it was identified that the strong decline in *P. elongatus* abundance during the last two decades as a result of low salinities (Möllmann et al. 2000), meant that early cod larvae changed from a non-food limited to a food limited state. If P. elongatus nauplii are present in the model, high survival rates occurred during spring and early summer, whereas omitting P. elongatus resulted in high mortality rates and only late hatched larvae or larvae transported rapidly out of the basins into shallow water areas survived (Hinrichsen et al. 2002a). Thus, low *P. elongatus* availability is likely to have contributed to the reduced recruitment of cod since the late 1980s.

After settling fish increased in the diet of cod and sprat and herring become the main food for the larger cod. At the present low stock size cod seems not be food limited, however this may not have been the case in the 1980's, when the cod stock was at a high level relative to the clupeid abundance. Juvenile cod also suffer from cannibalism (Sparholt 1994; Neuenfeldt and Köster 2000). As in other cod stocks, the intensity of cannibalism is related to predator abundance, but also the juvenile concentrations, which depend upon the habitat volume occupied and the overall abundance of cod. Apart from medium- to long-term distribution

changes related to stock size, inter-annual variability in cannibalism may be influenced by changing hydrographic conditions as well (Uzars and Plikshs 2000).

B Data

B.1 Commercial catch

National landings and estimates of catch composition in numbers and weights at age data are available from national sampling programs back to 1966, although data prior to about 1970 are of unknown and possibly poor quality. Since mid 1990's, the national landing information is provided by quarter, Subdivision and gear (trawl and gillnet) and documented in the WG report. Misreporting has been significant problem over the last years (2000-2006) and the reported catches been increased by 35-40%. Misreporting similarly cause problems estimating the commercial catches in the early 1990's. Information about discard data that is available from internationally co-ordinated sampling since 1996 was introduced in the assessment in 2001. National data are provided as discard in numbers and weight at age per quarter, Sub-division and gear (trawl and gillnet). Landing estimates for years previous 1996 have been raised assuming fixed discarding rates at age based on the mean values for the period 1996 to 2001. Sampling intensities are provided by each country as number of samples, fish length measured and otoliths age determined. Sampling intensity and coverage substantially decreased during 2001-2006 due withdrawal of EU-funding to non-EU countries.

B.2 Biological

Data on weight at age in the stock are available from 1995-2004 based on data from the first quarter BITS survey in Sub-divisions 25, 26 and 28. The weight at age is estimated using the mean weight at age per Sub-division weighted by survey estimates of the relative abundance of cod among Sub-divisions. Data for the previous period have been adjusted to the mean weight at age for the older age groups. Mean weight in stock for 2005 and 2006 were not available at the WG meeting. As a fill-in values were estimated by applying the mean ratio between stock and catch weights at age over 2002-2004 to the 2005 and 2006 catch weights at age in stock.

In 1998, variable combined maturity ogives were introduced for the period 1966-1997 based on national data from the first quarter BITS survey. The ogives were based on compiled national sex-specific data, sex ratios, and number sampled at age per Sub-division (Tomkiewicz et al. 1997). Data for the period 1980-1994 were averaged over 5 year periods due to low sample sizes, while the years 1995-1998 were annual estimates. The average for the period 1980-1984 was used for the period prior to 1980. The annual was updated in 1998 and 1999, but not subsequently and the average maturity-at-age for the years 1997 to 1999 has been used for 2000-2004. An analysis of maturity and weight at age respectively length in the stock is intended as part of the EU-funded BECAUSE project under the 6th framework programme. The assessment presently uses a combined female and male maturity ogive, but sex-specific ogives and sex ratios age available. Maturation is dimorphic with females maturing on average one year later than males in this stock, which makes the female-only SSB is a more reliable estimator of the egg production (Köster et al. 2003) than the SSB due to the large changes in age composition stock. A fecundity time series and model also exists for the Eastern Baltic cod base on relative fecundity estimates and prey availability.

A constant natural mortality of 0.2 is assumed for all years and ages. Predation mortalities (cannibalism) have been estimated by the Multi-species VPA for the Baltic Sea, but are presently not used in the stock assessment.

Otoliths from cod in the Eastern Baltic generally do no show well-defined seasonal growth zones. Recent investigations show that the development of winter rings differs between the eastern and western Baltic Sea probably due to differences in the ambient water temperature.

The later spawning time in the eastern Baltic compared with the western Baltic and Kattegat is reflected in a smaller nucleus and a less evident juvenile ring as the growth period during the winter is shorter (Hüssy et al. 2003). These features causes age substantial reading problems for this stock.

B.3. Surveys

Stock abundance indices are available from Baltic international Trawl Surveys (BITS) conducted in 1st quarter of the year from 1991 and additionally in 4th quarter (since 2001). Denmark, Germany, Latvia, Poland, Russia and Sweden participate with research vessels. The survey has been internationally coordinated since 2001, when also major changes in survey and gear design were introduced. Previously, all research vessels used different trawls and the change to a standardised trawl implies that indices from the period 2001-2007 are not directly comparable with indices from earlier surveys. Consequently, inter-comparison trials were made before the new gear was implemented as the survey standard gear and the results have been used to estimate conversion factors among gears. The issue of estimating conversion factors is considered by WGBIFS (ICES CM 2003/G:05). The abundance indices from the 1st quarter are used as tuning fleet in the assessment, while data from the four quarter surveys have not yet been applied in the assessment due to the short time series.

Ichthyoplankton surveys exist from the spawning area in the Bornholm Basin, the Gdansk Deep and the Gotland Basin. The time series for Bornholm Basin based on German and Polish surveys during the spawning period is comprehensive and allow estimation of the average daily egg production indices and the seasonal egg production. These time series have been use to validate estimates the egg production of Baltic cod (Kraus et al. 2002, Köster et al. 2002). Ichthyplankton data also exist for the Gdansk Deep and the Gotland Deep but survey frequency and coverage is more limited. These data are not used in the standard assessment.

B.4 Commercial CPUE

Sweden has provided effort data annually since 1982 based on logbook records from commercial trawl fleet. Information about relative catch rates also exist from Latvian, Polish, Swedish, German and Danish commercial national trawl fleets in national laboratories. Age disaggregated tuning data since 1994 are available from 3 commercial fleets: Danish Trawlers and Gillnetters and Swedish trawlers. The Danish vessels take the majority of their catch in SD 25, with a smaller proportion taken in SD 26. The Swedish vessels take a higher proportion of their catch in SD 26 as well as smaller amounts in SDs 27-29. One possible concern with using these CPUE data as indices of stock size is that the distribution of the stock can change with stock size and environmental conditions, in which case CPUE from only one part of the distribution may not be representative for the whole stock. However, in recent years the majority of the stock has been concentrated in SDs 25 and 26 so this problem is not anticipated in the current assessment.

B.5 Other relevant data

Historic information on cod migrations patterns within and between the eastern and western Baltic exists from comprehensive tagging programs. Detailed studies of cod migration and behaviour using data-storage tags have recently been initiated within the EU-funded research project CODYSSEA.

While the standard stock assessment is performed by an XSA covering age-groups 2-8+, a Baltic multi species VPA exist that provides recruitment estimates for the same stock units from age-group 0 onwards (ICES 2003). To establish time series of spawning stock sizes and recruitment in the different spawning areas of the Central Baltic area-disaggregated MSVPA's are available for Sub-division 25, 26 and 28 (Köster et al. 2001, ICES 2001).

Comprehensive hydrography databases exist as well as 3D hydrodynamic models describing the changes in the cod habitat, suitability of spawning areas (spawning volume) and larval drift. Also zooplankton time series exist for different areas of the Baltic.

An environmentally sensitive and spatially explicit stock-recruitment relationship has been established (Köster et al. 2001, Köster et al. 2003). The most recent statistical model includes: the potential egg production based on the female-SSB and relative fecundity time series, oxygen related egg survival factors in each spawning area, and prey availability for first feeding larvae as the product of *P. elongatus* nauplii abundance and turbulent velocity. If predicting recruitment at age 1 and 2, additionally area specific cannibalism rates on 0- and 1-group specimen are applied. The statistical model is highly significant and explains 73% of the variability in age-group 0 recruitment.

C Historical Stock Development

Model used: XSA

Software used: VPA-95 (Darby & Flatman, 1994)

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 6

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.5

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1966-2006	2-8+	Yes
Canum	Catch at age in numbers	1966-2006	2-8+	Yes
Weca	Weight at age in the commercial catch	1966-2006	2-8+	Yes (constant at age 2-7 from 1966-1980
West	Weight at age of the spawning stock at spawning time.	1966-2006	2-8+	Yes (constant at age 2-7 from 1966-1982)
Mprop	Proportion of natural mortality before spawning	1966-2006	2-8+	No - set to 0 for all ages and all years
Fprop	Proportion of fishing mortality before spawning	1966-2006	2-8+	No - set to 0 for all ages and all years
Matprop	Proportion mature at age	1966-2006	2-8+	No - set to 0 for all ages and all years
Natmor	Natural mortality	1966-2006	2-8+	No - set to 0.2 for all ages and all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	BITS Q2 shifted	1990-2000	2-5
Tuning fleet 2	BITS Q2 shifted	2001-2007	2-5
Tuning fleet 3	BITS Q2 unshifted	1991-2000	2
Tuning fleet 4	BITS Q2 unshifted	2001-2006	2
Tuning fleet 5	BITS Q4	2002-2006	2-5
Tuning fleet 6	Denish Gillnet < 160 mm	1994-2006	3-7
Tuning fleet 7	Danish Trawl > 90 mm	1994-2006	3-7
Tuning fleet 8	Swedish Trawls	1994-2006	3-7

D Short-Term Projection

Model used: age structured

Software used: MFDP

Initial stock size: survivors from XSA run for ages 3+. Recruitment at age 2 for year-class 2005 is estimated by RCT3, for year class 2006 and onwards - geometric men over 1987-2004 (period of low recruitment due to unfavourable conditions for reproduction in the Baltic).

Natural mortality: Set to 0.2 for all ages in all years

Maturity: Average of last 3 year if no time trend, otherwise – average of last 3 years scaled to the last year

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average of last 3 year if no time trend, otherwise – last year, separated for landings and discards

Weight at age in the catch: Average of last 3 year if no time trend, otherwise – last year, separated for landings and discards

Exploitation pattern: Average of last 3 year if no time trend, otherwise – last year, separated for landings and discards

Intermediate year assumptions: F status quo

Stock recruitment model used: For age two in all projection years geometric mean (1989-2004) is used.

Procedures used for splitting projected catches: Discards and landing split based on F by ages

E. Medium-Term Projections *(not conducted in 2007; settings below apply for analyses conducted in 2005)*

Model used: Age structured. Calculated for a 10 year period by Monte Carlo simulation

Software used: Excel spreadsheet

Initial stock size: survivors from XSA run for ages 3+. Recruitment at age 2 is estimated by geometric men over 1989-2003 (period of low recruitment due to unfavourable conditions for reproduction in the Baltic).

Natural mortality: Set to 0.2 for all ages in all years

Maturity: Average of last 3 year if no time trend, otherwise – last year

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average of last 3 year if no time trend, otherwise – last year, separated for landings and discards

Weight at age in the catch: Average of last 3 year if no time trend, otherwise – last year, separated for landings and discards

Exploitation pattern: Average of last 3 year if no time trend, otherwise – last year, separated for landings and discards

Intermediate year assumptions: F status quo

Stock recruitment model used: A two line 'hockey-stick' model for period of low recruitment (1989-2003)

Uncertainty models used:

1. Initial stock size: yes
2. Natural mortality: no
3. Maturity: yes
4. F and M before spawning: no
5. Weight at age in the stock: yes
6. Weight at age in the catch: yes
7. Exploitation pattern: no
8. Intermediate year assumptions: no
9. Stock recruitment model used: yes

F. Long-Term Projections

Not done for this stock

G. Biological Reference Points

B_{LIM} 160 000 T **TECHNICAL BASIS: SSB BELOW WHICH RECRUITMENT IS IMPAIRED (ICES, 1998)** **F_{LIM} 0.96** **TECHNICAL BASIS: FMED98**	**B_{PA} 240 000 T** **TECHNICAL BASIS: MBAL (ICES, 1998)** **F_{PA} 0.6** **TECHNICAL BASIS: 5 PERCENTILE OF F_{MED}**

H Other Issues

None

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Annex 6: – Stock Annex

Quality Handbook ANNEX: WGBFAS_Sole in IIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Sole in Division IIIa

Working Group: Baltic Fisheries Working Group

Date: 25 May 2007

A. General

A.1. Stock definition

Division IIIA represents the Skagerrak (ICES Subdivision 20) and Kattegat (ICES Subdivision 21), and is therefore part of the transition area between the North Sea and Baltic Sea. Sole are more abundant in the Kattegat than Skagerrak and spawning areas are believed to be located in the Kattegat and Skagerrak. Distribution of sole beyond the Kattegat into the Baltic Sea is limited by salinity which decreases further eastward. Sole are therefore found only in low abundances in the Belt Sea (ICES Subdivision 22) and the Øresund (ICES Subdivision 23).

Sole in the Skagerrak and Kattegat are geographically close to the northern limit of the long-term geographical distribution of the species (Muus and Nielsen, 1999), which ranges from Scotland and southern Norway south to the Mediterranean and Black Sea. Sole in IIIA typically spawn in late May/early June, which is later than spawning times for sole in the southern North Sea (April-June) and the Mediterranean (February; (Muus and Nielsen, 1999).

Interactions and exchanges between sole in IIIA and neighboring stocks, or within IIIA (i. e., between Kattegat and Skagerrak) may occur but are poorly documented. The stock boundary in the east (i. e., limit at border between Kattegat and Subdivisions 22-23) is biologically based because the species is rare beyond the Kattegat. The boundary to the west (i. e., between Skagerrak and the North Sea) is likely porous to some extent due to migration of adults and/or drift of sole eggs and larvae. However, neither the direction nor magnitudes of exchanges have been described. It is more likely that there is exchange within the stock (between Skagerrak and Kattegat) because hydrographic conditions influence drift of eggs and larvae of another flatfish species (plaice) from Skagerrak to Kattegat (Nielsen *et al.*, 1998). Muus and Nielsen (1999) state that sole in the Kattegat is separated from the North Sea and better adapted for hard winters. New genetic studies are helping to clarify the genetic and biological basis for population differences (Draisma *et al.*, 2003).

Sole for assessment purposes in IIIA are assumed to mature at age 3 although there is little empirical data and no time series to support this assumption. A similar assumption is used for assessment of North Sea sole and is consistent with Muus and Nielsen (1999) who state that sole mature between ages 3-5 and at sizes of 25-35 cm. A new sampling scheme to collect maturity information for sole in the Kattegat was started by Denmark in May 2003.

Sole in IIIA is a small stock compared with other sole stocks in the ICES area (e. g., North Sea, Bay of Biscay). Sole are nocturnal predators (Muus and Nielsen, 1999) and therefore more susceptible to capture by fisheries at night than in daylight.

A.2. Fishery

The major part of the sole catches in Kattegat and Skagerrak are taken in the mixed species trawl fishery using mesh sizes 70–105 mm and with gill nets using mesh sizes of 90–120 mm. Minimum legal landing size is 24.5 cm.

Sole have been exploited in the Kattegat and Skagerrak since at least 1952. The fishery fluctuated between 200 and 500 t annually prior to the mid-1980s. Landings increased to a maximum of 1400 t in 1993 and since then have decreased almost every year to a level about 600 t by the end of the 1990'ties. In 2003 and 2004 the reported landings were 300 and 391 t respectively but during the past 2 or 3 years the fishery has become increasingly limited by quota restrictions, increasing the incentive for misreporting.

Denmark takes more than 90% of the total Kattegat-Skagerrak catch. Kattegat is traditionally the most important area accounting for 70–80% of the annual catches. Sweden and Germany are the other nations participating in the fishery.

Sole has been one of the most important species in the late 1990s in the Danish Kattegat fisheries and accounted for about 25% of the total value of the human consumption fisheries. The economic importance of sole is more limited in Skagerrak where it accounts for less than 5% of the total value of the Danish human consumption fisheries.

For the period 1991–1993 the official catch statistics are disputable with a very significant amount of sole assumed landed without being properly recorded. For Kattegat, where most of the sole catches in 1994–2000 were taken under the effort regime the official statistics are assumed fairly accurate as there are no catch constraints.

However in 2000 and 2001, some catches from the North Sea were reported as being caught in the Skagerrak. These reported landings have been subtracted from working group estimates for these years, and assessments from 2003 and onwards are based on the revised landings and catch numbers-at-age.

Danish discard sampling at sea is carried out within EU programmes that began in 1995 in both Kattegat and Skagerrak. However, the data from this programme is still incomplete and not applied in the assessment.

Discard levels are in general believed to be only a few percent when measured relative to the sole landings. However, aanalyses of private logbooks, survey data, and observer data indicate that in 2002-2004 there was considerable economic incentive to landing without reporting as the entire two week ration in many cases could be taken in just a few hauls. However, it is not known to what extend the catches are discarded or landed as black landings (i.e. without providing both catch and effort data to the official statistics), or distributed to and landed by vessels not having caught their rations. Based on information from the industry estimates of non-reporting and discarding at 50% in 2002 and 100% in both 2003 and 2004 was included in the assessment from 2005. In June 2005 a new regulation was put in force with total quotas and weekly rations that not any longer limited the fishery, and therefore it is assumed that since June 2005 there is no incentive to mis- or nonreport the catches. The total misreporting for 2005 was due to those circumstances assumed to be approximately 20% for the entire year. For 2006 an onwards no misreporting is assumed to occur.

Mean fishing mortality (ages 4 - 8) has usually been 0.3–0.5 for all years (ICES, 2003).

A.3. Ecosystem aspects

Both salinity and temperature probably influence sole distribution and production in IIIA because the species' geographical distribution is confined to relatively warm, saline water

(Muus and Nielsen, 1999). Large variations in either factor will therefore influence stock productivity and therefore availability to the fishery.

The Kattegat has also been eutrophied over the past 50 years and eutrophication has influenced many aspects of the Kattegat ecosystem, including occasional severe anoxia periods (Pihl, 1994; Isaksson *et al.*, 1994), increased primary production and possibly a change in fish productivity and species composition (Nielsen and Richardson, 1996). The specific effects of eutrophication on sole have not been investigated.

The large increase in landings in the early 1990s compared to long-term historical levels (1950s-1980s) may represent both changes in environmental conditions and fishery developments (e. g., increased effort) but the relative importance of the two factors is not known.

B. Data

B.1. Commercial catch

Denmark collects biological information (lengths, weights, ages) on a quarterly basis from commercial fisheries which is used for stock assessment. Landings data are supplied by Sweden and Germany by quarter separately for Kattegat and Skagerrak.

Data files are available from ICES.

Representative commercial fishing vessels are also monitored by DIFRES fisheries observers. These data provide information on catch rates and locations, and discarding rates.

B.2. Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) have been historically set to 0.

Knife-edge maturity at age 3 is used for this stock. This is the same ogive as used for the North Sea. No time series of maturity information is available for sole in IIIA. Danish sampling started in 2003 will develop a new time series.

B.3. Surveys

Three surveys are being conducted. One survey samples in shallow coastal waters (RV Havkat) and the other two surveys sample in open waters of the Kattegat and Belt Sea (RV Havfisken; RV Argos-IBTS).

Two research vessels (RV Argos and RV Havfisken) capture sole in the Kattegat-Skagerrak. Descriptions of the sampling design, gears used and results are available in WG Docs. 11 (Jørgensen, 2005) and 10 (MacKenzie *et al.*, 2005) from the 2005 Assessment Working Group meeting. The main features of the surveys and findings are summarized here.

RV Argos IBTS survey:

The ICES database includes four IBTS survey series covering Subdivision 3A. The surveys have mainly been conducted by the Swedish vessel Argos, but (very) few hauls have been conducted by vessels from other countries. The 1st quarter survey series dates back to 1983, the 2nd, 3rd and 4th quarter series cover the periods 1991-1995, 1991-2003, and 1991-1996, respectively.

Mean catches were very low (< 2.0 sole per hour) in the 2nd and 3rd quarter and the time series from the 4th quarter was very short; only the time series from the 1st quarter have been used (ICES, 2005; Jørgensen 2005).

There were very few soles in hauls at depth > 110 m in the first quarter surveys. These hauls have been excluded from further analyses. The number of valid hauls (including hauls without sole) varied from 28-41 per year. Catches were low before 1990 (mean number of sole per hour < 2.0; Fig. 3.1). Since then mean catches have fluctuated between 1.0 (2001) and 23.1 (1993) sole per hour (ICES 2005; Jørgensen 2005).

None of the sole from the IBTS survey are aged using otoliths. Ages were estimated by applying age-length-keys from the commercial Danish fishery in Skagerrak and Kattegat for 1984-2004. In the pooled key there were no observations < 17 cm and data from the Danish sole survey in autumn 2004 were applied (MacKenzie *et al.*, 2005). The age-specific abundance indices were used as an exploratory tuning fleet in XSA runs at the 2005 assessment meeting but not included in the final run.

RV Havfisken survey description:

The RV Havfisken typically visits 30-40 stations per year in the Kattegat and Belt Sea. The surveys started in October 1994 and since 1996, surveys are also conducted in March. Average abundances for the Kattegat have been calculated. All soles captured by the survey are length-measured. The Havfisken survey is a general survey of juvenile demersal fish abundances in the region, and is not designed specifically to estimate sole abundance.

In the early years of the survey, only a small non-representative part of the sole catches were aged using otoliths. It is therefore not possible to produce annual age-length keys for the spring or fall surveys. Age information from all years has been combined by quarter to increase sample size. Age-specific abundance indices from the surveys were then derived from length measurements converted into ages indices using the combined quarter specific age-length key

The age-specific catch rates for the Kattegat (Subdivision 21) have been averaged across stations to produce annual abundance indices. Abundances in the Kattegat are higher in fall surveys than spring surveys, particularly among the younger age-groups (ICES 2005; MacKenzie et al. 2005).

Sole abundances increased from 2001-2004 and the spatial distribution has expanded during the same years (ICES 2005; MacKenzie *et al.*, 2005). However, in 2005, sole abundances decreased compared to 2004; the decrease was approximately 50% for the age – groups 2 and 3, which are the ages most commonly caught in this survey. Sole abundances appear to have decreased, relative to 2004, more in the Kattegat than in the Belt Sea.

The relative abundance of year classes within the survey shows some consistency across years. Abundant year classes of particular age-groups generally appear as abundant in the following year. This is particularly true for the younger age-groups (2 and 3 year-olds).

The age-specific indices is used as tuning fleets in exploratory runs of XSA.

RV Havkat survey description:

This survey is conducted in summer (ca. mid-July to early-mid August) along the Danish coast of the Kattegat. It has been conducted since the 1950s but with a large gap in sampling in the 1970s to 1985. Since 1985 the survey has been conducted almost annually. These data are reported here because the database for earlier years is still under preparation. Some additional details of the survey are given elsewhere (Nielsen *et al.*, 1998; MacKenzie *et al.*, 2005).

The survey typically captures several hundred juvenile sole annually, but abundances differ between areas along the coast. The frequency distribution of sole body lengths shows that most sole captured are 10-14 cm long. For purposes of estimating yearclass strength, the length range 7-16 cm was chosen to represent 1-group sole (MacKenzie *et al.*, 2005) applied in exploratory RCT3 runs by WGBFAS 2005.

The average abundance of 1-group sole at all sites along the Danish Kattegat coast was ca. 10/10 min. haul (MacKenzie et al. 2005). However since 1997 there have been three years with somewhat higher abundances (15-20/10 min. haul). In 2004 the abundance was only about half the long-term average.

There are spatial differences in the abundance of 1-group sole along the Danish coast. Abundances are highest at area 2 (central-northern Kattegat) and lowest in area 7 (southern Kattegat). As expected therefore the time trend at site 2 is most similar to the Kattegat-wide time series. Site 7 (southern Kattegat) however has a large increase in 2003 and 2004 compared to previous years. This pattern is not present at site 2 or the Kattegat-wide time series (MacKenzie *et al.*, 2005).

B.4. Commercial CPUE

In former assessments the WG used overall CPUE averages from two commercial trawl fisheries (using 70-90mm and 90-104mm mesh size respectively) to calibrate the XSA. However, both ACFM and STECF expressed doubts on the extent to which these CPUE indices were compromised due to lack of knowledge of fisherman targeting behavior and the effect of misreporting. Taking into consideration the concern expressed a working paper was presented during WGBFAS 2005 meeting evaluating the impact of the ration system on the incentive to misreport (Hovgård, 2005). The study concluded that since 2000 the rations (allocated as individual weekly or half monthly rations) have been increasingly restrictive in the sole fishing seasons as most vessels reached the ceiling of their rations due to the mismatch between the catch potential and the ration. During these periods the incentive to misreport is considered to be high. Outside the peak seasons for sole fishery (i.e. April to August for trawlers and January to April for grill-netters) it was found that most often the sole rations were not entirely utilized and therefore not constraining the fishery. During these periods there is no incentive to misreport the sole. Therefore WGBFAS in 2005 replaced these commercial tuning fleets with tuning fleets based on data from private logbooks and from official logbooks fishing outside the main sole fishing seasons where rations were shown not to be restrictive. The WGBFAS assessment was calibrated with 4 commercial tuning fleets based on data from private logbooks (a trawler fleet and a gill-netter fleet both fishing in two areas) and 3 commercial tuning fleets based on data from official logbooks (large trawlers, small trawlers and small gill netters).

Prior to the WGBFAS 2006 meeting the logbook database was updated. In addition to entering the 2005 data, also data from former years was re-evaluated. In some cases information about fishing location were corrected or added if missing. The impact of updating the historical data on the WGBFAS 2005 assessment was insignificant

The number of commercial tuning fleets was reduced by WGBFAS 2006 to 4 by combining the two trawler fleets based on the private logbooks into one, combining the two gillnet fleets based on the private logbooks into one and combining the two trawler fleets based on the official logbooks into one. In addition to these is the commercial gillnet fleet.

At the WGBFAS 2007 meeting the commercial gillnet fleet was rejected due to an abnormal increase in CPUE since 2004, which could have been caused by a shift in the fishery pattern from June 2005 when non-restrictive quotas were introduced. The rejection of the gillnet fleet from the 2007 assessment will be accompanied by inter-sessional analyses on the effects of such shifts in order to revise the time window and include the series in future assessments.

Sensitivity analysis indicated that aggregating the tuning fleets did not have a major impact on XSA result in the final run.

B.5. Other relevant data

None.

C. Historical Stock Development

Model used: XSA
Software used: IFAP / Lowestoft VPA suite
Model Options chosen for the final assessment by WGBFAS since 2006:
Tapered time weighting applied, power = 3 over 20 years
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 7
Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages
S.E. of the mean to which the estimate are shrunk = 1.500
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1984-last data year	2-11+ [2-9+ since 2007]	Yes
Canum	Catch at age in numbers	1984-last data year	2-11+ [2-9+ since 2007]	Yes
Weca	Weight at age in the commercial catch	1984-last data year	2-11+ [2-9+ since 2007]	Yes
West	Weight at age of the spawning stock at spawning time.	1984-last data year	2-11+ [2-9+ since 2007]	Yes/No – assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1984-last data year	2-11+ [2-9+ since 2007]	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1984-last data year	2-11+ [2-9+ since 2007]	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1984-last data year	2-11+ [2-9+ since 2007]	No
Natmor	Natural mortality	1984-last data year	2-11+ [2-9+ since 2007]	No – set to 0.1 for all ages in all years

Tuning data of final XSA run WGBFAS since 2006:

TYPE	NAME	SOURCE OF DATA	YEAR RANGE	AGE RANGE
Tuning fleet 1	6 trawlers	Private logbooks	1987-assess year	2-6
Tuning fleet 2	3 gill netters	Private logbooks	1994- assess year	2-10
Tuning fleet 3	Trawlers	Official logbooks	1994- assess year	3-10
Not used since WG 2007	Gillnetters small	Official logbooks	1998- 2005	3-10
Tuning fleet 5	Havfisken 4th quarter	Scientific survey	1994- assess year	2-6

D. Short-Term Projection

Model used: Age structured

Software used: ICES standard assessment tools with management option table and yield per recruit routines. In 2007 the XSA, YR and short term prediction were run in the FLR environment.

Initial stock size. Taken from the XSA for age 3 and older.

Recruitment: Age 2 (recruit) abundance in forecast years is the geometric mean from 1993-94 up to recent years. presently corresponding to a period when recruitment has been relatively low.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: Knife-edge 3+ for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average of recent three years

Exploitation pattern: Average of recent three years.

Intermediate year assumptions:

Stock recruitment model used: None, Age 2 (recruit) abundance in in forecast years is the geometric mean from 1993-94 up to recent years

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Medium term analysis by WGBFAS 2006 indicate that in 2015 there is less that 5% probability that SSB would be below Bpa provided Fpa is applied every year. No medium term analysis was carried out in 2007.

Model used: Age structured

Software used: @RISK for excel. The Study Group on Management Strategies for Baltic Fish Stocks (ICES CM 1998/ACFM:11) used a spreadsheet macro program for producing medium-term projections. This program was made available to the Working Group in the 1999 assessment and was modified (i.e., biological inputs) for application to sole in Division IIIA. The program allows the user to include stochastic variations in several input parameters and has been used in assessments of sole in IIIA since then, including this year's assessment.

Initial stock size: Recruit (age 2) abundance for all years in projection is geometric mean of the years 1993-2003 with random variability (sd of ln recruitment). Initial abundances for ages 3-11+ assume random variability based on log int. s.e. from XSA diagnostics.

Natural mortality: Set to 0.1 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Weights-at-age were drawn randomly from mean and standard deviations based on those in the catch for the years 1998-2005.

Exploitation pattern: Average of the years 2003-2005, scaled by the Fbar (4-8) to the level of the last year

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock recruitment model used: None, the geometric mean recruitment at age 2 for the years 1993-2003 with random variability (sd of ln recruitment) was used

F. Long-Term Projections

Standard yield-per-recruit analyses are conducted as part of stock assessment using long-term average as input.

G. Biological Reference Points

ICES has proposed the following reference points in 1999 in its stock summary:

ICES CONSIDERS THAT	ICES PROPOSES THAT:
$\mathbf{B}_{lim}$ is 770 t	$\mathbf{B}_{pa}$ be set at 1060 t
$\mathbf{F}_{lim}$ is 0.47	$\mathbf{F}_{pa}$ be set at 0.30

The reference point definitions follow the guidelines given by the Study Group on the Precautionary Approach to Fishery Management (ICES CM 1998/ACFM:10):

$\mathbf{B}_{lim}$: the biomass at which there is a high probability of recruitment failure, or the biomass below which stock dynamics are unknown.

$\mathbf{B}_{pa}$: the biomass below which the stock is regarded as potentially depleted or over fished.

$\mathbf{F}_{lim}$: the level of fishing mortality which should be avoided with high probability due to possible stock collapse or unknown stock dynamics.

$\mathbf{F}_{pa}$: the upper limit of fishing mortality used by ACFM when providing advice. In the specific case of Baltic stocks, the Study Group on Fisheries Management Strategies for Baltic Fish Stocks recommends that $\mathbf{F}_{pa}$ be the level of F for which there is less than 10% probability that SSB fall below $\mathbf{B}_{lim.}$

Based on the observed time-series of spawning stock biomasses, the following biomass reference points have been proposed in 1999 by ICES/ACFM:

$\mathbf{B}_{lim}$ = 770 t

$\mathbf{B}_{pa}$ = 1060 t

H. Other Issues

Reference List

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Annex 7: – Stock Annex

Quality Handbook **ANNEX:_Flounder in SD 24-25**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Flounder SD 24 and 25…….
Working Group:	WGBFAS
Date:	26.04.2007

A General

A.1 Stock definition

The stock structure of the flounder in the Baltic Sea is not yet clear. Stock identifications differ between studies relying on migration patterns (Aro 1989), spawning behaviour (Nissling et al. 2000), or micro-satellite analyses (Florin and Höglund, in prep.). Migration studies indicate that there are several rather distinct flounder stocks (populations). Flounder is regularly distributed in all parts of the Baltic Sea, except in the northern Bothnian Bay, the eastern-most part of the Gulf of Finland and the deepest areas of the Gotland Deep. According to Aro's migration studies (Aro 1989), there are at least three stocks in the southern Baltic (ICES Subdivisions 22-26), three in the central and north eastern Baltic (ICES Subdivisions 27-28), one in the Åland Sea, one in the Archipelago and southern Bothnian Sea, and two in the Gulf of Finland.

The migrations between the mature flounder stocks are quite sparse (Aro 1989). The natural boundaries of the stock in the southern Baltic (ICES Subdivisions 24 and 25) may be drawn from the southern part of the Öland Island to the Rozewie on the Polish coast in the east and the Darss Sill in the west. Spawning takes place in the Arkona basin, the Slupsk furrow and the Bornholm deep at a depth of 40-80 m in the period from the second half of February till the end of May. After spawning, the feeding migrations are directed to the shallow coastal areas, southward to the German and Polish coasts (to the west till Ruegen island and to the east to the areas of Rozewie) as well as northward to the Swedish coast. During late autumn and early winter the spawning migration to the main spawning grounds sets on. One part of the mature stock feeding in the Arkona Sea migrates to the Bornholm basin to spawn.

A preliminary genetic study (Florin and Höglund, in prep.) on Baltic flounder from 12 different places ranging from Åland in the northern Baltic Sea to the Danish west coast supports the notion of genetically differentiated flounder stocks, by showing that genetic distance is significantly correlated to geographic distance. However, the results indicate that rather than a high number of small stocks, three major different groups of flounder could be identified: (1) Skagerrakk/Kattegat (subdivisions 20-21), (2) Southwest Baltic Sea (subdivisions 22-25), and (3) Eastern Baltic Sea (subdivisions 26-32) (for more details, see Gårdmark et al., 2006).

A.2 Fishery

On an average (1973-2002, misreporting years 1994-1996 excluded) about 50% of the total flounder landings of the Baltic Sea (13 000 t in the same period), were taken from ICES Subdivisions 24 and 25. About 45% of the landings from the stock come from the Subdivision

25. In the Subdivisions 24 and 25, Poland, Denmark and Germany are the main fishing nations.

There is no Danish flounder directed fishery. The species is the most important by-catch in the cod-fishery. The major season for flounder by-catch is the winter where some fishing boats may catch up to two tons per day, depending on depth and area. Most flounder are caught in the area east and southeast of Bornholm (SD 25). There is a high variability between years. The amount of the flounder catch discarded depends on price for and size of the flounder. In the most recent years the price declined and therefore the amount of flounder discarded increased.

German flounder landings are also mainly by-catch in the cod-directed fishery. In ICES Subdivision 24 a German trawl fishery directed to flounder, in particular in the 3rd and in the 4th quarter has a tradition. This fishery contributes a maximum of about 35 % to the total German flounder landing.

In SD 24 about 85% of the landings are caught in the trawl fishery. In SD 25 nearly all German flounder landing are caught by trawl. The German flounder landing depends largely on the market situation (price and demand for flounder). Therefore the variation in the landing can not necessarily be considered an indicator for the stock size.

Directed to flounder trawl and gillnet fisheries exist also in Poland. Polish flounder catches increase when cod resources decrease. A share of about 60% of the Polish flounder landing is caught by the directed flounder fishery in the Polish EEZ (SD 26 included).

The fishing season spans the months January and February and from June to November.

IBSFC Fishery Rules concerning the flounder stock in ICES Sub-divisions 24 and 25 are:

> Under the Rule 8 it is prohibited to land, to sell, to process or to store flounder fished in Subdivisions 22-25 having a total length less than 25 cm.
>
> Under the Rule 10.1 it is prohibited to use trawls, Danish seines or gillnets having a mesh opening smaller than 120 mm in the flatfish fishery in Subdivisions 22-27.

Additional national rules concerning flounder are in force:

Based on the German national fishery rules it is not allowed to land female flounders, caught in the German 12 Nm zone from 1st February to 30th April.

In Poland, a closed season from 15 February to 15 May is in force.

A.3 Ecosystem aspects

Based on measurements of the salinity necessary for spermatozoon activation and egg buoyancy, flounder of the Baltic Sea may be separated into different populations: the pelagic spawning flounder consisting of three stocks one respectively in the Oeresund , the Arkona- and Bornholm basin and the Gdansk- and Gotland basin and the demersal spawning flounder with one stock (Nissling et al. 2000, 2002).

For the flounder stock in SD 24 and 25 the reproductive volume is defined by >=12.0 psu and >= 2 ml O_2 /l. Therefore the recruitment success varies dependent on hydrological condition on the spawning grounds.

B Data

B.1 Commercial catch

Catch at age (CANUM) and mean weight at age in the catch (WECA) data are available on yearly basis from Germany, Poland and Sweden.

According to the statements of WKAFAB (Gardmark et al., 2007) the commercial catch data were not used for an assessment due to discarding and age reading problems.

Instead of commercial catch data, the survey data from the German BITS SD 24 quarter 1 were used for an exploratory assessment (SURBA).

B.2 Biological

The mean weights at age equivalent in the stock for SURBA are calculated from the German BITS in SD 24 in quarter 1 from 1993-2007.

A fixed natural mortality of 0.2 is used in the assessment.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

B.3 Surveys

In the period 1978-2000 Germany carried out a stratified fixed station bottom trawl survey in sub-divisions 24 and 25 in the 1st quarter as well as in 22 and 24 in the 4th quarter. These surveys were planned for recruitment investigations of cod. Flounder data were sampled regularly and stock indices could be estimated. The station grids and a description of the herring bottom trawl (HG20/25) used are presented by Schulz and Vaske (1988). In 1991, R/V "Eisbär" was replaced by R/V "Solea" and in 1993 the positions of the stations in SD 25 had been changed.

A special young fish survey on flounder has been carried out in the Oderbank area (SD 24) since 1978. This survey proved not suitable to estimate the recruits for the total stock in SD 24 and 25. It is supposed that the Oderbank stock is a local one (Westernhagen, 1970).

In 2001, the Baltic International Trawl Survey (BITS) has been changed to a new (stratified random) design and a new standard gear (TV3). In this context Germany terminated the survey in SD 25 and continued with the survey only in SD 22 and 24. The TV3#520 has about the same catchability for demersal species as HG20/25 and thus a conversion factor close to 1.

The survey data from the German BITS SD 24 quarter 1 formed the basis for an exploratory SURBA assessment.

B.4 Commercial CPUE

None

B.5 Other relevant data

Non

C Historical Stock Development

No analytical assessment on commercial catch data possible until remarkable improvement in basic data can be demonstrated.

An exploratory SURBA on the female age equivalents in the number at length per hour data of the German BITS SD24 quarter 1 from 1992 to 2007 was made (ICES, 2007c).

Model used: SURBA on age equivalents in length

Software used: SURBA ver 2. (Needle et al., 2004)

Model Options chosen:

Data Source: DATRAS

Survey: German BITS in SD 24 quarter 1

Time series: 1992-2007

Age determination: Growth derived from sliced and stained otoliths

Age equivalent class: Length distribution slice between half distance points of mean length at age equivalent from growth estimate

Age composition: Area weighted average female number at age equivalent class per hour

Age range: 2 - 5

Smoothing: Index smoothing rho=2

Catchability: 0.8 for age equivalent 2, 1.0 for 3 and older

Spawning stock: maturity 2 and higher

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	na		
Canum	Catch at age in numbers	1992- last data year	3 – 5	No
Weca	Weight at age in the commercial catch	na		
West	Weight at age of the spawning stock at spawning time.	1993- last data year	3 – 5	Yes
Mprop	Proportion of natural mortality before spawning	1992- last data year	3 – 5	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	na		
Matprop	Proportion mature at age	1992- last data year	3 -5	Yes
Natmor	Natural mortality	1992- last data year	3 – 5	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	na		
Tuning fleet 2	na		

D Short-Term Projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern:

8. Intermediate year assumptions:
9. Stock recruitment model used:

F Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G Biological Reference Points

H Other Issues

I References

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Annex 8: – Stock Annex

Quality Handbook Herring in SD 25-29, 32 (excl. Gulf of Riga)

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Herring in Subdivisions 25-29, 32 (excl. Gulf of Riga)

Working Group: Baltic Fisheries Working Group (WGBFAS)

Date: 25 April 2007

A General

A.1 Stock definition

The herring (*Clupea harengus*) in Subdivisions 25-29+32(excl. Gulf of Riga) contains fast- (southern Baltic) as well slow-growing (northern Baltic) individuals. The stock comprises mainly spring-spawning herring and a small autumn-spawning population. Spring-spawning occurs at the coast with a temporal gradient from south to north. After spawning individuals migrate to the deep basins for feeding. In addition migrations between subareas of the Baltic have been observed (Aro, 1989).

A.2 Fishery

A.3 Ecosystem aspects

Drastic changes in the weight-at-age (WAA) of herring, one of the most important commercial fishes the Baltic Sea, have been observed since the late 1980s (Parmanne et al., 1994; Cardinale and Arrhenius, 2000). This decrease was observed in almost all age groups and in all open areas of the Central Baltic, with the exception of the most northerly (Cardinale and Arrhenius, 2000). The low WAA has dramatic effects on the biomass and further on the catches of herring. Additionally the poor condition of the fish (i.e. low fat content) has important implications on the marketing for human consumption (Raid and Lankov, 1995).

Three different hypotheses have been put forward to explain the decrease in WAA of Baltic herring, which involve (i) a reduction in selective predation of cod on smaller herring (Sparholt and Jensen, 1992; Beyer and Lassen, 1994), (ii) an influx of slow-growing individuals from the northern areas, and (iii) a real decrease in growth rates due to changes in stock size and feeding environment.

Recent latter hypothesis has been supported by Flinkman et al. (1998) showing changes in WAA in the Northern Baltic to be related to the mesozooplankton species composition. For the Central Baltic Horbowy (1997) modelled growth of herring in relation to the biomass of *Mysis mixta*. Similarly Szypula et al. (1997) stressed the importance of the macrozooplankton fraction in the diet of planktivores. Other studies have shown the importance of the copepod *Pseudocalanus* sp. for nutrition of Baltic herring (Davidyuka, 1996, Möllmann et al. 2003). Low salinity conditions have been negatively affected the stock development of this copepod (Möllmann et al. 2000), being the most important food item for open-sea herring in spring.

B Data

B.1 Commercial catch.

B.2 Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

Natural mortalities were derived by MSVPA-runs performed by SGMAB and are used both in the assessment and the forecast. In 2007 the latest update from 2006 including the whole time series were used (1974-2005). The latest year was taken as the average of the last 5 years.

The proportion of natural mortality before spawning (Mprop) is set at 0.30 and the proportion of fishing mortality before spawning (Fprop) are set at 0.35.

Maturity ogives were used as 0 for age 1, 0.7 for age 2, 0.9 for age 3 and 1 for older.

B.3 Surveys

The data on clupeids stock size in the Baltic Sea, estimated by hydroacoustic methods, are submitted to the WGBFAS from 1982 onwards. Data are collected annually in autumn (October) and provided by most of the countries around the Baltic. In the assessment procedure data of the international hydroacoustic survey are applied as tuning fleets for the XSA.

The results from the individual vessels are placed in the database BAD1. For each ICES rectangle the following data was compared between vessels - the covered area of the rectangle and the number of hauls in the rectangles.

The differences between herring and sprat and length composition were being supposed as stochastic variations. If the whole rectangle was investigated by both vessels and the number of hauls was more than one the arithmetic mean of both data sets was used. If the coverage of the rectangles were quite different or the number of hauls were zero for one vessel the handling of the data were discussed.

During the last meeting (April 2006) WGBIFS recommends that the data from 2006 can be used in the assessment process of the Baltic herring and sprat stocks.

B.4 Commercial CPUE

Not used.

B.5 Other relevant data

None.

C Historical Stock Development

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability dependent on stock size for ages < 3

Catchability independent of age for ages >= 6

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Model Options chosen:

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1974-last data year	0-8+	No
Canum	Catch at age in numbers	1974-last data year	0-8+	No
Weca	Weight at age in the commercial catch	1974-last data year	0-8+	No
West	Weight at age of the spawning stock at spawning time.	1974-last data year	0-8+	No
Mprop	Proportion of natural mortality before spawning	1974-last data year	0-8+	No
Fprop	Proportion of fishing mortality before spawning	1974-last data year	0-8+	No
Matprop	Proportion mature at age	1974-last data year	0-8+	No
Natmor	Natural mortality	1974-last data year	0-8+	Yes ?

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Acoustics	1982-last data year*	1-8+

*The 2005 value was corrected at the WGBFAS 2007 meeting

D Short-Term Projection

Model used: Age structured

Software used: MDFP vers. 1a

Initial stock size: In the 2006 assessment from the XSA for age 2-8+. The recruitment at age 1 from RCT3. The long-term geometric mean recruitment for a period of unchanged pattern in recruitment is used for age 1 in all projection years.

Natural mortality: Age-specific means for 2001-2005 from MSVPA

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set respectively to 0.3 and 0.35 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year, due to the decreasing time trend in F(3-6) in recent years

Intermediate year assumptions: TAC constraint or status quo F or both

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

E Medium-Term Projections

Model used: applied in the SGBFS, 1998

Software used: Excel spreadsheet

Initial stock size: Same as in the short term projections

Natural mortality: Age-specific means for 2001-2005 from MSVPA

Maturity: The same as in the assessment

F and M before spawning: Respectively 0.3 and 0.35 in all ages and years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Same as in the short term projections - average weight of the three last years

Exploitation pattern: Same as in the short term projections

Intermediate year assumptions: Fsq

Stock recruitment model used: the double-linear stock recruitment relation that was estimated by SGPA in 2003 has been performed. It has the breaking point at 1 130 000 ton of SSB.

Uncertainty models used: log-normal errors assumed for the starting population, mean weights at age and for recruitment residuals around the stock recruitment relation.

F Long-Term Projections

G Biological Reference Points

The PA-reference points

The values proposed for the stock in 25-29, 32 (including. Gulf of Riga) by ACFM 1999 were $\mathbf{B}_{lim}$ = approx. $\mathbf{B}_{loss}$ = 750 000 tonnes; $\mathbf{B}_{pa} = \mathbf{B}_{lim}$ *1.33 = 1 million tonnes; $\mathbf{F}_{pa} = \mathbf{F}_{med} = 0.17$ and $\mathbf{F}_{lim} = \mathbf{F}_{loss} = 0.33$.

For the stock herring in 25-29, 32 (excl. Gulf of Riga) a $\mathbf{F}_{pa}$ of 0.19 (based on $\mathbf{F}_{med}$) was adopted in 2002.

The Study Group on Precautionary Reference Points for Advice on Fishery Management (ICES CM 2003/ACFM:15) estimated $\mathbf{B}_{lim}$ as 1 130 000 tonnes and a corresponding $\mathbf{F}_{lim}$ as 0.19. These values were commented as follows:

“There was no defined biomass reference points for this stock. Segmented regression is highly significant however results reveals similar patterns as for previous stocks: 1) time-series effect in S-R relationship, 2) breaking point is placed close to maximal observed recruitment. For estimation of $\mathbf{B}_{lim}$ a stock-specific approach may be appropriate.”

H Other Issues

None

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Annex 9: – Stock Annex

Quality Handbook **ANNEX: WGBFAS_Herring GOR**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Gulf of Riga Herring
Working Group:	Baltic Fisheries Working Group
Date:	26 April 2007

A. General

A.1. **Stock definition.**

Gulf of Riga herring is a separate population of Baltic herring (*Clupea harengus membras*) that is met mainly in the Gulf of Riga the eastern part of ICES Sub-division 28. It is a slow-growing herring with one of the smallest length and weight at age in the Baltic and thus considerably differs from the neighbouring herring stocks in the Baltic Proper (Subdivisions 25-29). The differences in otolith structure serve as a basis for discrimination of Baltic herring populations. The stock does not perform migrations into the Baltic Proper; only minor part of the older herring leaves the gulf after spawning season in summer –autumn period but afterwards returns to the gulf. There is evidence, that the migrating fishes mainly stay close to the Irben Strait region in Sub-division 28 and do not perform longer trips. The extent of this migration depends on the stock size and the feeding conditions in the Gulf of Riga. In 1970s and 1980s when the stock was on low level the amount of migrating fishes was considered negligible. In the beginning of 1990s when the stock size increased also the number of migrating fishes increased and the catches of Gulf of Riga herring outside the Gulf of Riga in Sub-division 28 were taken into account in the assessments.

A.2. Fishery.

Gulf of Riga herring fishery is performed only by Latvia and Estonia. There are two main kinds of fishery: trawl fishery and trap-net fishery. Trawl fishery could be performed all year around except a 30 day ban in May-June during the peak spawning of herring. In Estonia, additional ban for trawl fishery is introduced from the 15th of June to 15th of September. In most winters fishery is stopped or reduced due to ice coverage of the gulf. In Latvia the number of trawlers as well as the total engine power is not allowed to increase since the end of 1990s. Each fishing company perform fishery according its personal catch quota. . In Estonia, max. 300 HP vessels are allowed to fish in the gulf. The trap-net fishery takes place during the spawning period from mid-April till July. The trap-net fishery is aimed exclusively on spawning fishes. In Latvia the number of trap-nets is limited and has been rather stable since the mid-1990s, as well as in Estonia. The relative importance of these two fisheries is different in Latvia and Estonia. From the total Latvian catches about 85% are taken by trawls and 15% by trap-nets. In Estonia the trap-net fishery is more important constituting about 70% of the total catches while trawl catches make on average only 30% of the total catches.

A.3. Ecosystem aspects.

The Gulf of Riga is a separate semi-enclosed ecosystem of the Baltic Sea characterising with low salinity of about 5 PSU and delimiting it from the Baltic Proper by a strong hydrological front in the Irben Strait. That limits the residence of marine species in the Gulf of Riga.

Therefore Gulf of Riga herring is the dominant species in the gulf unlike the Baltic Proper. The trawl fishery in the gulf is herring- targeted. There is some by-catch of sprat only when the sprat stock is on a high level. There is also a lack of abundant predators in the gulf since cod are met in the Gulf of Riga only in the periods when cod stock is on a very high level (last time in early 1980s).

The investigations of herring spawning grounds in 1980s showed that their overall area was decreased in comparison with the situation in 1950s. That happened due to disappearance of demersal vegetation from larger depths as a result of increased eutrophication of the gulf. This led to increased mortality of eggs. Since then the spawning grounds have not been investigated. However, it could be stated that the pollution of gulf has considerably decreased since the end of 1980s. That happened because of the changes in industry and agriculture and several sewage treatment plants have been built.

The year class strength of Gulf of Riga herring strongly depends on the severity of winter. It has been stated already in 1960s that after mild winters rich year classes appear (Rannak 1971). After mild winters the spawning starts earlier and the spawning activity is more evenly distributed over the spawning season. This results in more even distribution and lower mortality of egg on the spawning grounds. Additionally, after mild winters the zooplankton is more abundant providing better feeding conditions for feeding of herring larvae. The relationships with average water temperature in April when the spawning starts and the abundance of *Copepoda* in May when the hatching of larvae begins were used for the prediction of recruitment till 2006. However, in the recent RCT3 predictions the weight of zooplankton abundance in the prediction of recruitment has considerably decreased due to appearance of two very rich year classes. Zooplankton abundance in May in those years was only slightly above the average and thus these years stand out of line in the relationship between zooplankton abundance and year-class strength. Therefore during the ICES Workshop of Recruitment processes of herring in the Baltic Sea (ICES 2007, not finalised yet) other factors explaining the year-class strength were analysed. It was stated that the average water temperature of 0-20 m layer in May and the biomass of *Eurytemora affinis* have significant relationship with year-class strength of Gulf of Riga herring. Therefore for prediction of 2006 year-class at age 1 in 2007 we used new data mentioned above.

B. Data

B.1. Commercial catch.

Estonian and Latvian catch data by quarter and separately for trawls and trap-nets are available. No discards are reported or accounted for. There is confidence that some misreporting takes place in Latvian fishery and the official catch figures have been raised in the recent decade in the range of 15-25% based on the interviews with the fishermen. The sampling strategy is similar in Estonia and Latvia. Mainly random samples are collected in the fishing harbours of the Gulf of Riga. In Latvia from the trawl fishery monthly about three samples (each including 100 fishes) are collected from different parts of the gulf. The biological analysis of the sample is performed in laboratory where length, weight, sex, maturity stage is recorded and the otoliths for age determination are taken. All fishes in the sample are aged. Occasionally the samples are collected onboard fishing vessels participating in the commercial fishery. The catch in numbers and mean weight-at-age is obtained on a monthly basis applying the average age composition and average mean weight-at-age (from samples collected during a certain month) on monthly catches separately for trawl and trap-net fishery. From trap-net fishery random samples are taken more frequently due to large differences in age composition during the spawning season. In general in Latvia 4 samples from different parts of the gulf are taken per 10 days resulting in about 36 samples during the spawning season.

B.2. Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

The proportion of natural mortality before spawning (Mprop) is set at 0.35 and the proportion of fishing mortality before spawning (Fprop) are set at 0.2.

A permanent maturity ogive is used for the whole time series. The gulf of Riga herring starts to spawn at the age of 2, when 93% of this age group spawns and by the age of 5 it is considered that all fishes are mature. No special survey to determine the proportion mature is carried out. However, the data from commercial samples before spawning (March-April) indicate that the used maturity ogive could be reasonable.

B.3. Surveys

Since 1999 a joint Estonian-Latvian acoustic survey specially designed for the Gulf of Riga herring has been conducted annually in the end of July – beginning of August in the Gulf of Riga. The survey covers all the area of the gulf till the depth of 10 m. Since there are no other abundant pelagic species in the gulf, the survey is targeted exclusively on the Gulf of Riga herring and the aim was to use acoustic index in tuning XSA. That was made for the first time in the stock assessment in 2004.

Since the end of 1970s Latvian Fisheries Research Institute (LATFRI) performs herring larvae survey in the Gulf of Riga in July. On average 30 trawls with Isaac Kidd trawl are carried out over the 10-40 m depth in 0-10 m layer in the southern half of the gulf. The data presently are not used for assessment purposes.

B.4. Commercial CPUE

In the period 1993-2004 the XSA for the Gulf of Riga herring was tuned using data on the effort (number of trap-nets) directed at the Gulf of Riga herring in the Estonian and Latvian trap-net fishery and the corresponding abundance (catch in numbers at age) of gulf herring in the trap-net catches. The data series starts in 1980. The CPUE data for trawl fishery are not available. In 2007 assessment the trap-net data series was shortened and started from 1996 due to positive trend in log catchability residuals.

B.5. Other relevant data

Data from hydrological and zooplankton surveys performed by LATFRI are used for the prediction of recruitment. The corresponding data series start from 1970.

C. Historical Stock Development

Model used: XSA
Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
Tapered time weighting applied, power = 3 over 20 years

Catchability dependent on stock size for ages < 4

Catchability independent of age for ages >= 5

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Model Options chosen:

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1970-last data year, 1977 – last data year since 2003	0-10+	no
Canum	Catch at age in numbers	1970-last data year, 1977 – last data year since 2003	0-10+	no
Weca	Weight at age in the commercial catch	1970-last data year, 1977 – last data year since 2003	0-10+	no
West	Weight at age of the spawning stock at spawning time.	1970-last data year, 1977 – last data year since 2003	0-10+	no
Mprop	Proportion of natural mortality before spawning	1970-last data year, 1977 – last data year since 2003	0-10+	no
Fprop	Proportion of fishing mortality before spawning	1970-last data year, 1977 – last data year since 2003	0-10+	no
Matprop	Proportion mature at age	1970-last data year, 1977 – last data year since 2003	0-10+	no
Natmor	Natural mortality	1970-last data year, 1977 – last data year since 2003	0-10+	yes, in 1979-1983 M=0.25, in all other years M=0.2

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Trap-nets	21 years including last data year, 1996 – last data year since 2007	2-10+
Tuning fleet 2	Acoustics	1999-last data year	1-10+
Tuning fleet 3			
….			

D. Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: In assessments till 2003 taken from the XSA for age 2 and older, in the assessment performed in 2004-2005 taken from the XSA for age 1 and older because a new acoustic tuning fleet containing abundance index for age group 1 is available The recruitment at age 1 in the intermediate year is estimated using RCT3 where the values of mean water temperature in April and abundance of zooplankton in May is regressed to the 1-group from

the XSA. Till 2002 the numbers at age 2 in the start of the intermediate year was calculated from the number of 1-year-olds at the beginning of the previous year (RCT3 estimate) applying a natural mortality of 0.2 and fishing mortality according to the catches taken of this age group. The long-term (starting with 1986 year-class; before a period of low recruitment could be observed) geometric mean recruitment is used for age 1 in all projection years.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set respectively to 0.2 and 0.35 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-7) to the level of the last year in the case of obvious trend.

Intermediate year assumptions: TAC constraint or status quo F or both

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Not performed in 2004-2005. Environmental factors, particularly the winter temperature and zooplankton abundance are believed to have significant effect on the recruitment of the Gulf of Riga herring (e.g. ICES, 1995). A number of abundant year classes have been recruited into the stock on the background of increasing trends observed in temperature and zooplankton during the recent decades. So, the period since the late 1980, when most of the winters were mild, a series of rich recruitments can be observed. The severe winter of 2002/2003 resulted in a poor year-class. Hence, no obvious relationship between SSB and recruitment can be defined for that stock and the WG was not in the position to present any medium-term predictions like in the previous year.

Medium-Term projection performed till 2003:

Model used: Age structured double linear model

Software used: Excel spreadsheet

Initial stock size: Same as in the short term projections

Natural mortality: M=0.2 in all ages and years

Maturity: Permanent and the same as in the assessment

F and M before spawning: Respectively 0.1 and 0.33 in all ages and years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Same as in the short term projections - average weight of the three last years

Exploitation pattern: *statusquo* F

Intermediate year assumptions: stock size from XSA

Stock recruitment model used: Beverton-Holt stock-recruitment relationship

Uncertainty models used: none

F. Long-Term Projections

Not performed

G. Biological Reference Points

In 1996 the WGBFAS proposed a MBAL of 50,000 t, based on the frequent occurrence of poor year classes below this level of SSB. The MBAL value was treated as an estimate of B_{pa} since there were many points left of the MBAL in the stock recruitment plot. Assuming a standard error of log at the 0.2 level (based on XSA estimates of standard errors), the estimate of B_{lim} was 36 500 t. In 2003 it was proposed to shorten the time series for the assessment because the fishing mortalities in the years 1970-1976 were considered to be too high for pelagic fish stock. It resulted in a loss of few high recruitment estimates in the left side of stock-recruitment. Therefore it was necessary to change the MBAL estimate which was obtained as previously and was defined at the level of 60 000 t, and correspondingly Blim was calculated at the level of 43 800 t. B_{loss} value obtained from PA analysis in 2004 was 38 600 t.

The F_{pa}=O.4 has been obtained from the medium term simulations (ICES 1998).

H. Other Issues

None

I. References

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ICES 1998. Report of the Baltic Fisheries Assessment Working Group. ICES CM 1998/ACFM:16.

ICES 2003. Report of the Baltic Fisheries Assessment Working Group. ICES CM 2003/ACFM:21.

ICES 2004. Report of the Baltic Fisheries Assessment Working Group. ICES CM 2004/ACFM:.

Annex 10: Stock annex – Herring in Subdivision 30

Quality Handbook **ANNEX: WGBFAS_Herring SD 30**

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Herring in Subdivision 30 (Bothnian Sea)

Working Group: Baltic Fisheries Working Group

Date: 24 April 2007

A General

A.1 Stock definition

According to tagging studies, there are two spring-spawning coastal herring populations in the Bothnian Sea (Sub-division 30) (Hannerz, 1955, 1956; Otterlind, 1957, 1962b, 1976; Sjöblom, 1961; Parmanne and Sjöblom, 1982, 1986), one along the west coast and one on the east coast. The autumn spawning stock is very sparse (Sjöblom, 1978). The separation into the coastal and open sea components is not applied to these populations, although different spawning groups have been presented (Ehnholm, 1951). The migration pattern on both sides of the Bothnian Sea is the same and a mirror image of each other. The spring-spawning coastal herring on the Swedish coast spawn in May-July in the coastal areas starting in the shallowest areas and shifting with a rising water temperature to deeper waters (Neuman, 1982). The spawning occurs along the whole coastline. The migration of the adult population near to the spawning grounds takes place in late autumn and early winter mainly from the open sea areas (Aro 1989). The new spawners, as well as immatures, winter inside the Archipelagoes and near to the coast and new spawners join the spawning stock later during the spawning time. The feeding migration starts soon after spawning. The main feeding areas are the slopes of the Bothnian Sea Basin and the outer Archipelago. The herring in the western side of the Bothnian Sea seem to be more bound to the coast than the southern Baltic stocks (Otterlind, 1976).

The feeding migration of the specimens occurs mainly along the coast to the south and north and there seem to be some connections to the Åland Sea and to the Quark (Otterlind, 1957, 1962b), which are transition areas for the southern and northern stocks. The proportion of the eastward migration to the Finnish coast is very low. The spring-spawning coastal herring on the Finnish coast spawn also in May-July along the whole coastline from the northern side of the Archipelago Sea up to the Quark. The migration of the adult population to the spawning grounds from the feeding and wintering areas, which are in the open sea and partly in the Archipelago Sea and in the Quark Archipelago, occur during the winter and in late winter, when the first spawning shoals are quite near to the coast. Some of the younger mature age groups winter nearer to the coastline and in the Archipelago Sea (Sjöblom, 1961). After spawning, the feeding migration is quite rapid to the open sea near to the slopes of the Bothnian Sea Basin and in the outer archipelago. They are in the feeding grounds usually in July-December. The feeding migration extends to southern parts of the Bothnian Sea and inside the Archipelago Sea, in the Quark and sometimes inside the Bothnian Bay, too. There is also some exchange between the Finnish and Swedish coasts (Parmanne and Sjöblom, 1982, 1986). The spring-spawning coastal herring in the east coast of the Bothnian Sea has a clear homing behaviour and about 95 % of recaptures have been obtained inside 150 km from the tagging place (Parmanne and Sjöblom, 1986).

The stock boundary is set between Sub-divisions 30 (Bothnian Sea) and Sub-division 31(Bothnian Bay) at 63° 30’ N in the north and southern border at 60° 30’ N in the south. These borders seem to be useful for management purposes and a reasonable biological basis for stock separation.

A.2 Fishery

Since mid-1970s the fishery has been dominated by pelagic and demersal trawl fisheries and trapnet fisheries. In 2006, trawl fisheries accounted for 95 % of the catches. Locally along the Swedish coast there is also a traditional gill net fishery for spawning herring, but without significant impact on the stock. The remaining catches are taken by trapnet fishing targeting spawning component of the stock in May-June. Catches have increased in late 1990s because of intensified fishery. The fishery has been regulated by TACs and Bothnian Sea belongs to Management Unit 3 of International Baltic Sea Fishery Commission (IBSFC).

In the herring fishery, pelagic trawl and demersal trawl fleets and fishing vessels overlap. Many of the vessels use both a pelagic and a demersal trawl, and some vessels use the same gear as a pelagic trawl and a demersal trawl. In herring fishery pelagic trawl fleet exploit younger part of the Baltic herring stock and bottom trawling is directed to more adult part of the stock. Usually Baltic herring fishing is conducted as a single trawling. At certain times of the year vessels may switch to bottom trawling. In autumn and early winter before ice is covering Bothnian Sea pelagic pair trawling is used for industrial purposes. In common with pelagic trawlers, many vessels transfer between the Bothnian Sea (SD 30) and the Åland Sea and northern Baltic proper (SD 29), depending on fishing possibilities and ice cover during winter.

Bottom trawls are used exclusively for Baltic herring. As pelagic trawlers, the bottom trawlers transfer between fishing grounds depending on fishing possibilities and ice cover.

Trap-net fishery includes a variety of trap-net types for Baltic herring. Fishery is conducted near the coast and inside the archipelagos. Trap-net fishery for Baltic herring is conducted mainly during the spawning season in spring/ early summer (May-June) targeting spawning component of Baltic herring stock.

A.3 Ecosystem aspects

Stock trends in Bothnian Sea herring have since the 1990s been driven mainly by good recruitment and lower fishing mortality in the most recent years. The recruitment of herring is dependent on environmental events, but a stock-recruitment relationship has been established.

Growth rate of herring has decreased during the 1990s. This is related to the decrease in the abundance of the copepod *Pseudocalanus* sp., one of the most important food items of Baltic herring, and a concurrent increase of herring density.

Herring is the main prey for Grey seals in the Bothnian Sea, which preferably feeds on larger individuals (20-30 cm; Lundström et al. 2007). Despite the rapid increase of the Grey seal population, there are no studies documenting the possible effects of seal predation on the herring stock development.

B Data

B.1 Commercial catch

Commercial herring catch statistics is based on catch notifications submitted by fishermen at set intervals. The application of the Act (1139/94) on implementing the Common Fisheries Policy of the European Community obliges all professional fishermen to submit a catch notification.

The fishing data of vessels at least 10 metres long are entered in the EU fishing logbook. The data entered are the dates of fishing by fishing trip, the size of the catch by species, the fishing (statistical) rectangle, the gear and number of gears used in fishing, and the trawling time in hours. A fisherman is obliged to keep an up to date logbook onboard his vessel. The logbook must be returned to the regional authorities within 48 hours of the catch being landed.

With the exception of salmon catches, the Finnish fishing data of vessels under 10 metres long are entered in a monthly coastal fishery form. The data entered are the size of the catch by species by the statistical rectangle, the type and number of gears used in fishing, and the number of fishing days. The forms must be returned to the regional authorities by the fifth day of the following month. All logbooks and most of the other catch notification forms are checked by national authorities.

The proportion of the Baltic herring catch landed in Finland for the food and processing industry in relation to the total catch of that species was estimated with the aid of the fish purchasing register maintained by the Ministry of Agriculture and Forestry.

Because all the main fisheries (pelagic trawls, demersal trawls and trap-nets) have different exploitation patterns and are used as separate fleets in stock evaluations, they also need to be sampled separately. Instead of following European Council Regulation sampling scheme, the primary requirement in Bothnian Sea herring sampling is to properly cover all the 12 strata (3 fleets and 4 year-quarters) to meet the assessment-criteria.

Since the study projects funded by DG XIV (International Baltic Sea Sampling Programs I & II) in 1998-2001, a length stratified sub-sampling scheme has been applied to estimate age compositions of Finnish catches of Baltic herring. This sampling scheme is designed to support the development of international databases and standardized methodologies in data processing. Baltic herring samples are collected mainly in fishing harbours and, if necessary, also onboard commercial fishing vessels. In sampling scheme the annual life cycle of Baltic herring has been taken into account and the presence of the ice coverage during the winter in the Bothnian Sea. Because of these conditions, all three fishing gears are not in use in all year quarters, e.g. trap net fishery is usually conducted only in spawning time, in quarters 2 and 3. The sampling is roughly based on the proportions of regional catches in different fisheries. Moreover, the sampling intensity in general is locally adjusted during the year according to temporal and regional changes in fisheries. The seasonal herring fishing intensity in each area is predominantly dependent on the TAC, which causes fishing restrictions in certain fisheries and/or seasons and may therefore influence the sampling intensity from the planned.

According to assumed catches by ICES Sub-divisions, gears in use, fishing intensity and taking into account, regardless of the amount of catches, a minimum coverage requirement of one sample by fishery per month.

The sampling strategy is to have age-length samples from all major gears in each quarter.

	KIND OF DATA				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Finland	x	x	x	x	x
Sweden	x	x	x		x

The Finnish and Swedish input files are Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator. The national data have been aggregated to international data on Excel spreadsheet files. Weight at age data and age composition is obtained from the Swedish and the Finnish landings, whereas the maturation data used comes only from Finnish samples. In some years the final combined data on numbers at age have been adjusted to remove SOP discrepancies.

B.2 Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

The proportion of natural mortality before spawning (Mprop) was set to 0.33 and the proportion of fishing mortality before spawning (Fprop) to 0.15.

The maturity ogives are based on the proportions of mature individuals of each age class in Finnish sampling data, and are updated every year.

Since 2002 Finnish samples have been age determined with two different methods in parallel, using either whole otoliths or neutral red stained slices of cut otoliths. The effects of the age determination method were presented at the WGBFAS meeting in 2006 (Raitaniemi & Pönni 2006). The method affects the age distribution as well as the proportion mature at age. Determination from cut otoliths generally results in an older assessed age compared to whole otoliths. The numbers at age in the total catch on average differs about 2%, but ranges from 0.4% to 52% depending on year and age. On average the proportion of four- to eight-year-olds in the catch is 11% lower, and the proportion of ages 9+ are 32% higher, when using cut compared to whole otoliths.

Age distribution in Swedish samples have been only determined using whole otoliths. However, the proportion of catches from Swedish demersal trawls and gill-nets for which the Swedish samples were used corresponds to only 2% of the total landings. Thus, when combining the catch composition data from the different fleets and countries, the different age determination method employed by Sweden has only a minor effect on the age composition of the total catches. The aim is that Swedish samples will also be determined using cut otoliths as soon as the method has been calibrated between Finland and Sweden.

Since age determination using cut otoliths is considered to be more accurate (Raitaniemi & Pönni 2006), this method will continue to be used as the standard method for ageing all the samples. Below we present the resulting biological composition of the catches based on the data containing ages determined from whole otoliths for 1973-2001, and from cut otoliths for 2002-2006. Since determination from cut otoliths will continue to be the standard method, the time series including ages from cut otoliths will be used in the assessments of this stock.

Preferably, the use of a time series with different age determination methods in different periods should be avoided. However, the current time series with ages determined with both methods is too short to obtain any reliable estimates of a conversion factor between the two methods. Finnish samples from years before 2002 will therefore be reread using neutral stained slices of cut otoliths to both lengthen the time series and to enable such estimates. The possibility of recalculating input data from 1973-2001 based on an estimate of the difference in assessed age between the two age determination methods should be explored, and its impact on the assessment should be evaluated at the next benchmark assessment of this stock.

B.3 Surveys

No surveys

B.4 Commercial CPUE

The three main fleets operating in Baltic herring fisheries in the Bothnian Sea are:

- Pelagic trawling (single- and pair-trawling)
- Demersal trawling
- Trapnet fisheries (spawning fishery)

In Finnish trawl fishery same trawls are often used as pelagic and demersal trawl. There has been an increase in trawl gear size and changes in gear properties since early 1980s in Finnish Baltic herring fishery. In the past reported fishing, effort data (trawling hours) may not have indicated correctly fishing mortalities generated by reported total fishing effort. Thus a correction coefficient for trawl fishing effort data in 1980-2006 has been applied to remedy this bias in calibrating XSA. This method estimates the increase in average trawl size to quantify the relative change in fishing power of herring trawl fleet. The annual correction coefficient is derived using a model which estimates the average size of fishing circle of trawl (Rahikainen and Kuikka 2002). The model uses yearly data of trawls sold, their size and an estimated annual abolition rate. The total reported fishing effort in trawling hours by year has then been multiplied by estimated coefficient. As the same gear is used both in demersal trawling and pelagic trawling, the same coefficient has been used for both fleets. In assessments, correction factors of CPUE data has been used since 1997 assessment.

The total fishing effort for stock assessment is reported as trawling hours (multiplied by fishing power index) in trawl fisheries and number of trap nets set annually in trap net fishery. According to the effort data, the trawling hours in demersal trawling have increased in 2006 from 2005 (7,426 hours in 2005 and 8,156 hours in 2006) and in pelagic trawling from 16,965 hours in 2005 to 20,281 hours (increase of 3,316 trawling hours). The number of trapnets decreased from 233 in 2005 to 197 in 2006.

B.5 Other relevant data

None.

C Historical Stock Development

Classified as an update assessment in 2006

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options:

Tapered time weighting applied, power = 3 over 20 years

Catchability dependent on the stock size for ages < 2

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1973 – last data year		Yes
Canum	Catch at age in numbers	1973 – last data year	1 – 9+	Yes
Weca	Weight at age in the commercial catch	1973 – last data year	1 – 9+	Yes
West	Weight at age of the spawning stock at spawning time.	1973 – last data year	1 – 9+	Yes - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1973 – last data year	1 – 9+	No – set to 0.33 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1973 – last data year	1 – 9+	No – set to 0.15 for all ages in all years
Matprop	Proportion mature at age	1973 – last data year	1 – 9+	Yes
Natmor	Natural mortality	1973 – last data year	1 – 9+	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Finnish trap net fleet	1994 – last data year	2-9+
Tuning fleet 2	Finnish pelagic trawl fleet	1999 – last data year	2-9+

D Short-Term Projection

Model used: Age structured

Software used*:* ICES Standard Assessment Tools (MFDP, MFYPR)

Initial stock size. Taken from the XSA for age 2 and older. The geometric mean recruitment of years 1989 – 2005 (except the exceptionally high year class in 2002) is used for age 1 in all projection years.

Natural mortality: Set to 0.2 for all ages in all years
Maturity: Average of last 3 years

F and M before spawning: Set to 0.15 and 0.33 respectively

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years

Intermediate year assumptions: Status quo F

Stock recruitment model used: None, the geometric mean recruitment of years 1989-2005 (except 2002) is used for age 1

Procedures used for splitting projected catches: Not relevant

E Medium-Term Projections

Not done

F Long-Term Projections

Not done

G Biological Reference Points

The following precautionary approach reference points have been proposed in 2000 to Baltic herring in SD 30:

ICES CONSIDERS THAT:	ICES PROPOSES THAT:
B_{lim} is 145 000 t	B_{pa} be set at 200 000 t
F_{lim} is 0.30	F_{pa} be set at 0.21

Technical basis:

B_{LIM}: SPAWNING STOCK BIOMASS, WHERE PROBABILITY OF LOWER RECRUITMENT INCREASES	B_{PA}: B_{LIM} (IN 2000) *EXP(1.645*0.2)
F_{lim}: F_{loss} (in 2000)	F_{pa}: F_{med} (in 2000)

H Other Issues

None.

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Annex 11: Stock annex – Herring in Subdivision 31

Quality Handbook **ANNEX: WGBFAS_Herring SD 31**

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Herring in Subdivision 31 (Bothian Bay)

Working Group: Baltic Fisheries Working Group

Date: 27 April 2006

A General

A.1 Stock definition

The separation into coastal and open sea components is not applied to this spring spawning herring population although different spawning groups have been presented (Ehnholm, 1951). The autumn spawning stock is at a very low level (Sjöblom, 1966). The spawning of the spring spawning herring starts late in May and the spawning is over in late July. Spawning occurs in May-July in the coastal areas starting in the shallowest areas and shifting with a rising water temperature to deeper waters. The spawning occurs along the whole coastline although there are some areas, which are more preferred. The feeding migration starts soon after spawning, and coastal spawning groups intermix during feeding period in the open sea area. The main feeding areas are the slopes of the Bothnian Bay Basin and the outer Archipelago. The feeding migration of the specimens occurs mainly along the coast to the south and north and there seem to be some connections to the Bothnian Sea and to the Quark (Otterlind, 1957, 1962b), which is a transition area. Mixing of the Bothnian Bay stock and the Bothnian Sea (Sub-division 30) stock occur, but on annual basis the amount is small. The migration pattern on both sides of the Bothnian Bay is the same and a mirror image of each other (Aro, 1989):

- The feeding migration occurs mainly inside the Bothnian Bay.
- There is to a certain extent an exchange between the Swedish and Finnish coastal stocks especially near the Quark (Otterlind, 1962b; Parmanne and Sjöblom, 1986).
- The mixing of Bothnian Bay stock with Bothnian Sea stock is of minor importance.

The stock boundary is set between Sub-divisions 30 (Bothnian Sea) and Sub-division 31(Bothnian Bay) 63° 30’ N, and is useful both for management purposes and biological basis for stock separation.

A.2 Fishery

Since mid-1970s the fishery has been dominated by pelagic and demersal trawl fisheries and trapnet fisheries. In 2005 trawl fisheries accounted for 90% of the catches. A traditional gill net fishery for spawning herring has disappeared and does not have any significance. The remaining catches are taken by trapnet fishing targeting spawning component of the stock in June-July. Catches declined in the 1990s because of intensive fishery and poor year classes. Since 2001, the annual catch has been increasing. The fishery has been regulated by TACs and Bothnian Bay belongs to Management Unit 3 of International Baltic Sea Fishery Commission (IBSFC).

In the herring fishery, the categories of pelagic trawl and bottom trawl fishing vessels overlap. Many of the vessels use both pelagic trawl and bottom trawl or the same gear is used in both fisheries. In herring fishery pelagic trawl fleet exploit younger part of the Baltic herring stock and bottom trawling is directed to more adult part of the stock. Usually Baltic herring fishing is conducted as a single trawling. At certain times of the year vessels may switch to bottom trawling. In autumn and before ice is covering Bothnian Bay pelagic pair trawling is used for industrial purposes. In common with pelagic trawlers, many vessels transfer between the Bothnian Bay (SD 31) and the Bothnian Sea (SD 30), depending on fishing possibilities and ice cover during the winter. As pelagic trawlers, the bottom trawlers transfer between fishing grounds depending on fishing possibilities and ice cover. Herring is also caught as a by-catch in pair bottom trawling of vendace (*Coregonus albula*).

Trap-net fishery includes a variety of trap-net types for Baltic herring, Baltic salmon and whitefish (Coregonus). Fishery is conducted near the coast and inside archipelagos. Trap-net fishery for Baltic herring is conducted mainly during the spawning season in spring/ early summer (May-July) targeting spawning component of Baltic herring stock.

A.3. Ecosystem aspects

The recruitment of herring is very much dependent on environmental events, such as duration of ice cover and temperature, and no stock-recruitment relationship has been established.

B Data

B.1 Commercial catch

Commercial herring catch statistics is based on catch notifications submitted by fishermen at set intervals. The application of the Act (1139/94) on implementing the Common Fisheries Policy of the European Community obliges all professional fishermen to submit a catch notification.

The fishing data of vessels at least 10 metres long are entered in the EU fishing logbook. The data entered are the dates of fishing by fishing trip, the size of the catch by species, the fishing (statistical) rectangle, the gear and number of gears used in fishing, and the trawling time in hours. Fishermen are obliged to keep an up to date logbook onboard their vessels. The logbook must be returned to the regional authorities within 48 hours of the catch being landed.

With the exception of salmon catches, the Finnish and Swedish fishing data of vessels less than 10 metres in length are entered in a monthly coastal fishery form. The data entered are the size of the catch by species by the statistical rectangle, the type and number of gears used in fishing, and the number of fishing days. The forms must be returned to the regional authorities by the fifth day of the following month. All logbooks and most of the other catch notification forms are checked by national authorities.

The proportion of the Baltic herring catch landed in Finland for the food and processing industry in relation to the total catch of that species was estimated with the aid of the fish purchasing register maintained by the Ministry of Agriculture and Forestry.

Because all the main fisheries (pelagic trawls, demersal trawls and trap-nets) have different exploitation patterns and are used as separate fleets in stock evaluations, they also need to be sampled separately. Instead of following Council Regulation sampling scheme, the primary requirement in Bothnian Bay herring sampling is to properly cover all the 12 strata (1 stocks, 3 fleets and 4 year-quarters) to meet the assessment-criteria.

Since the study projects funded by DG XIV (International Baltic Sea Sampling Programs I & II) in 1998-2001, a length stratified sub-sampling scheme has been applied to estimate age compositions of Baltic herring. This sampling scheme is designed to support the development

of international databases and standardized methodologies in data processing. Baltic herring samples are collected mainly in fishing harbours and, if necessary, also onboard commercial fishing vessels. The sampling strategy is to have age-length samples from all major gears in each quarter. In sampling scheme the annual life cycle of Baltic herring has been taken into account and the presence of the ice coverage during the winter in the Bothnian Bay (on average 5 months per year). Because of these conditions, all three fishing gears are not in use in all year quarters. Trap net fishery is conducted only in quarter 2 and 3 and in the season covers in total 3 quarters. Taking into account the exceptions for ICES Sub-division 31 and trap-net fisheries, the 2005 sampling plan is roughly based on the proportions of regional catches in different fisheries. Moreover, the sampling intensity in general is locally adjusted during the year according to temporal and regional changes in fisheries. The seasonal herring fishing intensity in each area is predominantly dependent on the TAC, which may cause fishing restrictions in certain fisheries and/or seasons, and may therefore influence the sampling intensity from the planned.

	KIND OF DATA				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Finland	x	x	x	x	x
Sweden	x	x	x		x

The Finnish and Swedish input files are Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator. The national data have been aggregated to international data on Excel spreadsheet files. Weight at age data is mainly obtained from the Finnish landings, and Swedish catches were assumed to have the same age composition and weight at age as the Finnish landings. In some years the final combined data on numbers at age have been adjusted to remove SOP discrepancies.

B.2 Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.15 is used both in the assessment and the forecast.

The proportion of natural mortality before spawning (Mprop) was set to 0.4 and the proportion of fishing mortality before spawning (Fprop) to 0.15.

The maturity ogives are based on the proportions of mature individuals of each age class in Finnish sampling data, and are updated every year.

B.3 Surveys

No surveys are conducted for the herring in Bothnian Bay.

B.4 Commercial CPUE

Three CPUE data series are used, one from the Finnish pelagic trawl fishery, one from the Finnish demersal trawl fishery and one from the Finnish trap net fishery.

The indices of fishing effort in the pelagic and demersal trawl fishery are based on the trawling hours of these fleets, and on the number of trap nets in the trap net fishery. The trawling hours in both fleets and the number of trap nets have decreased dramatically since the 1980s. From the year 2002 on, the number of trawling hours in SD 31 has been fairly stable.

In both demersal and in pelagic trawl fishery, the CPUE has been higher in the 1990's and the 2000's than in the 1980's, and especially in pelagic trawl fishery the CPUE is clearly affected by the year class strength. There is no clear long-term trend in the trapnet CPUE.

B.5 Other relevant data

None.

C Historical Stock Development

Classified as an update assessment in 2005

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options:

Tapered time weighting applied, power = 3 over 20 years

Catchability dependent on the stock size for ages <2

Catchability independent of age for ages >= 7

Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.800

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1980 – last data year		Yes
Canum	Catch at age in numbers	1980 – last data year	1 – 9+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	1 – 9+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	1 – 9+	Yes - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	1 – 9+	No – set to 0.4 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	1 – 9+	No – set to 0.15 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	1 – 9+	Yes
Natmor	Natural mortality	1980 – last data year	1 – 9+	No – set to 0.15 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Finnish trap net fleet	1980 – last data year	3-8
Tuning fleet 2	Finnish bottom trawl fleet	1980 – last data year	2-8
Tuning fleet 3	Finnish pelagic trawl fleet	1980 – last data year	2-8

D Short-Term Projection

Model used: Age structured

Software used*:* ICES Standard Assessment Tools (MFDP, MFYPR)

Initial stock size. Taken from the XSA for age 2 and older. The geometric mean recruitment of years 1980 - 2002 is used for age 1 in all projection years.

Natural mortality: Set to 0.15 for all ages in all years

Maturity: Last three years average.

F before spawning: Set to 0.15 for all ages in all years

M before spawning: Set to 0.4 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Average weight of the three last years

Exploitation pattern: Not scaled

Intermediate year assumptions: Status quo F

Stock recruitment model used: None, the geometric mean recruitment of years 1980-2003

Procedures used for splitting projected catches: Not relevant

E Medium-Term Projections

Because the relation between SSB and recruitment is missing in this stock, it was considered that there is not reliable basis for medium-term projections, and therefore they are not performed.

F Long-Term Projections

None

G Biological Reference Points

Not defined.

H Other Issues

None.

I References

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Annex 12: – Stock Annex – Baltic Sprat

Quality Handbook **ANNEX: WGBFAS_Baltic Sprat**

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Baltic Sprat in Subdivisions 22-32

Working Group: Baltic Fisheries Working Group

Date: 18 April 2005

A General

A.1 Stock definition

Sprat is distributed mainly in the open sea areas of the whole Baltic Sea. However high concentrations of YOY specimens appears in coastal areas (especially in mixed fresh water from rivers and sea waters), primarily in autumn and in 1st quarter of the year. Above mentioned areas are preferred in the some season also by juvenile herring. During the year mixed sprat and herring shoals occur very often in both open sea and coastal areas.

Based on the ICES WGs and ACFM advice's sprat in the Baltic Sea was assessed from last 15 years as a single unit within the ICES Subdivisions 22–32. In the 1980s and on the beginning of 1990s some attempts to distinguish different Baltic sprat stocks/populations were conducted, but significant evidence about sprat stock heterogeneity was not published.

A.2 Fishery

The main part of the sprat catches is taken by pelagic single and pair trawling (using a mesh size of 16mm in the codend). In addition there are demersal trawling activities for Baltic sprat in some parts of the Baltic. The sprat fishery is carried out in the whole year around. However the main fishing season in most countries is in the first half of the year, but in the northern part of the Baltic ice covering is limiting factor for all fishing operations.

In a part of countries Baltic sprat is fished by two type of fleets - small cutters (17-24 m length) with engine power up to 300 h.p., and by medium size cutters (25-27 m length) with engine power up 570 h.p. In some countries third type of vessels is engaged in sprat fishery, i.e. large vessels – over 40 m length with engine power of 1050 h.p. The last type of fleet, having the trawls with high vertical opening and operate in the areas deeper than 50 m and according to national regulation (e.g. in Russia) they obliged to use the sorting machines, that can separate herring from sprat. This fleet, targeting sprat for the human consumption, during 1st and 2nd quarters. During summer this fleet targets sprat for the animal food and by-catches of small herring is increased.

Up to now in most countries annual sprat quota was not fully utilized, and in opposite low herring quota was fully utilized. This fact with increasing sprat TAC and decreasing herring TAC created a strong incentive to misreport herring as sprat.

A.3 Ecosystem aspects

Stock trends in Baltic sprat have been driven since the 1990s mainly by released predation by cod and high (although varying) recruitment success (Köster et al. 2003). The latter may be related to

the unusual high state of the North Atlantic Oscillation (NAO), resulting in unusual high temperature conditions. Variations in temperature may be large enough to affect sprat biology (Kalejs and Ojaveer, 1989). Sprat in the Baltic Sea are located near the northern limit of the species' geographic distribution (Muus and Nielsen, 1999), which ranges from the Black Sea to southern-central Norway. Low temperatures can therefore be expected to be detrimental for production and survival in the Baltic Sea. Laboratory experiments have shown that cold water prevents hatching of sprat eggs from the North and Baltic Seas (Thompson *et al.*, 1981; Nissling, 2004). Field studies show that the temperatures which suppress sprat egg development in the laboratory also occur in the Baltic Sea at times, places and depths where sprat eggs occur (MacKenzie and Köster, 2004). Comparison of interannual variability in sea temperatures at main sprat spawning time (May) with sprat recruitment shows a statistically significant positive relationship (MacKenzie and Köster 2004). The same temperatures that affect sprat recruitment are themselves influenced by winter severity indices, including ice coverage in the Baltic Sea and a winter index (January-February) of the North Atlantic Oscillation (MacKenzie and Köster 2004).

Another mechanism how the increase in temperature may have affected sprat recruitment is the change in the food environment. Sprat larvae have a strong preference for the copepod *Acartia* spp. (Voss et al. 2003), which has been drastically increased since the 1990s in parallel to the increase in temperature (Möllmann et al. 2000). This may have lead to in general higher larval survival.

Beside an increase in temperature, the unusual climate situation during the 1990s have been resulted in a change in the circulation pattern and thus in the drift pattern of sprat larvae (Hinrichsen et al. 2003). Recent investigation using 3d-hydrodynamic modelling have shown that retention vs. dispersion in the Baltic deep basins have a strong influence on recruitment success of sprat (Baumann et al. 2004).

Beside recruitment a further important ecosystem-related aspect of sprat in the Baltic is the decrease in growth during the 1990s (Grygiel and Wyszynski 2003, Götze and Gröhsler 2004). This is related to the decrease in abundance of the copepod *Pseudocalanus* sp., one of the most important food item of sprat during spawning in spring (Szypuła et al. 1997, Möllmann et al. submitted), and the strong intraspecific competition due to the large stock during the 1990s.

B Data

B.1 Commercial catch

In 1997 sprat catches were at a record high of 529,400 t for the whole Baltic, and have since decreased to 308,260 t in 2003. In 2003 sprat catches decreased about of 34-81thousand tonnes in comparison with the recent three years. They were 10% less than in 2002 and 42% less than the record high level in 1997.

Sprat catches are utilized for industrial purposes and human consumption. In most of the countries discards of sprat are not supposed to exist because small and lower quality fish can be used for production of fish meal and feeding in animal farms. In fishery directed for human consumption, however, young fish are discarded with higher rates in the years with strong year classes recruiting to the fishery. The amount of this discard is unknown.

The species composition of the mixed catches is defined from logbooks and, partly, by observers on board of larger commercial vessels in compliance with the special agreement between institute and vessel owners. In some countries e.g. in Denmark and Sweden, data about catch composition and other biological data are delivered by fishery inspection in harbors and by managers of fish stock exchange.

B.2 Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

The natural mortality coefficient used for assessment varied between years and ages (0.250-1.187). For forecast values (0.276-0.407) from year 2003 were taken.

Both proportion of natural mortality (Mprop) and proportion of fishing mortality (Fprop) before spawning are set to 0.4.

In the years 1974-2003 knife-edge maturity at age 3 was used for this stock. At the assessment in 2002 a new maturity ogive was introduced for the whole time series. This ogive is based on the distribution of age at first spawning estimated for the last 20 years.

B.3 Surveys

The data on clupeids stock size in the Baltic Sea, estimated by hydroacoustic methods, are submitted to the WGBFAS from 1983 till recent years. Mentioned data are collected in autumn (October) each year and elaborated by most of the countries around the Baltic. In the assessment procedure two sets of tuning data has been used applied:

- one is the Russian-Latvian data for recruitment estimates,
- second is the international and the Russian-Latvian data for tuning fleets for XSA input data.

In addition, in 2007 the third set was available from international acoustic survey on sprat in May. The set comprised data from 1999 and 2001-2006. The fleet performed well as tuning indices and was used in assessment in 2007. Its inclussion provided stock estimates consistent with those obtained with fleets used in previous assessments. The 1999 data were excluded as it produced very high log(q) residuals.

The results from the individual vessels are placed in the database BAD1. For each ICES rectangle the following data was compared between vessels - the covered area of the rectangle and the number of hauls in the rectangles.

The differences between herring and sprat and length composition were being supposed as stochastic variations. If the whole rectangle was investigated by both vessels and the number of hauls was more than one the arithmetic mean of both data sets were used. If the coverage of the rectangles were quite different or the number of hauls were zero for one vessel the handling of the data were discussed.

During the last meeting (April 2004) WGBIFS recommends that the data from 2003 can be used in the assessment process of the Baltic herring and sprat stocks.

B.4 Commercial CPUE

Preliminary and very limited in time and areas, new submitted to WGBFAS meeting 2004 data on fishing effort and CPUE in sprat fishery not allowed on analyses of the effect of changes in mentioned parameters on sprat stock assessment.

B.5 Other relevant data

New data about recruitment, estimated from statistical relationship between sprat recruitment and NAO, were applied for short-term forecast for 2005.

C Historical Stock Development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Benchmark assessment in 2005:

The tuning data for catch at age analysis were recalculated. Two tuning data sets were available: from International Acoustic Surveys in 1983–2004 in SD 24-29S and Latvian/Russian Acoustic Surveys covering age 0 sprat in SD 26+28 in 1983–2004. The age 0 survey indices were forward shifted to represent age 1 at the beginning of next year because first age group in the assessment is age 1. The survey data were corrected for area coverage. Survey estimates, area coverage, and calculations were revised. The revisions resulted in differences in present tuning data and the values used in previous assessments. These differences refer mainly to data for 1990s: international acoustic tuning indices are now different from the previous by -5% to + 32%; the indices for the 0 age group are now higher by 3 – 50% (100% in 1993). Contrary to previous assessment the Latvian/Russian acoustic in Subdivision 26+28 (age 1+) was not used as separate tuning series because these data are included in the International Acoustic tuning fleet.

First, separable VPA was run to screen possible outliers in the catch at age data and to investigate exploitation pattern. Several runs were performed with selectivity reference age at 3 and selectivity at terminal age at 0.8, 1, 1.2, and 1.4. The terminal F was assumed 0.2 and 0.3. The best fit (in terms of minimum sum of squared residuals) was obtained with reference F of 0.2 (reflects Fbar of 0.25) and selectivity of 1.4 at terminal age. With these parameters selectivity was flat for age 5 and alder. It is recognized, however, that the minimized function is very flat and there is little information in it on appropriate choice of terminal F and selectivity. The residuals did show neither higher outliers nor time pattern.

Next, series of XSA runs with different inclusion of fleets and different parameterisation of the model were performed. These included:

- separate runs of each (of two) fleet,
- combined runs,
- runs with and without time taper (only tricubic considered),
- run with catchability dependent on year class strength up to oldest but one age (excluding plus group),
- run with catchability dependent on age up to oldest but one age (excluding plus group),
- runs with no shrinkage at all, only population shrinkage, and selected SE of the F shrinkage mean (SE = 1.5, 0.75, 0.5),
- some runs with different combination of age of constant q, age of q dependency on year class strength and the SE of F shrinkage mean.

The runs with no shrinkage option were considered inappropriate as they produced very high F at some years and ages. Results of some simulations in terms of fishing mortality and spawning stock biomass in the terminal year are presented in the text Figure 11.1. In addition to terminal F and SSB in terminal year, the SE of logQ and average R^2 for different parameterisations of XSA and fleets inclusion in the tuning are provided in text Table 11.1 These parameters do not differ markedly between runs, although it is recognised that the averages provide simplify interpretation of the XSA diagnostic.

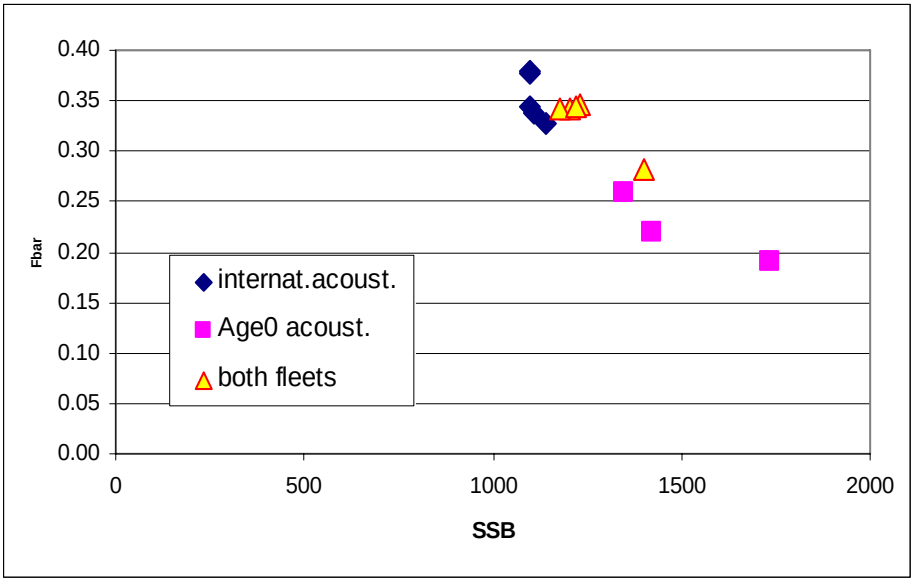

Figure. 12.1. The sensitivity of the assessment to choice of fleets and parameterisation of XSA

Table 12.1. The sensitivity of the assessment to choice of fleets and parameterisation of XSA

Fleets	av.SE(log-q)	av.-Rsquare	SSB	Fbar	option	comments, concl.
com. catches: Separable VPA				0.25		no outliers in catch residuals, no time effect in q
international acoustic:XSA	0.48	0.77	1098	0.34	sh=0.75, recr<7,q-const = 6	q y-c dep. at age 1, q const at age 5+
	0.48	0.76	1142	0.33	sh=0.75, recr<2,q-const = 5	
	0.46	0.77	1108	0.34	sh=1.5, recr<2,q-const = 5	
	0.46	0.76	1097	0.38	NO shrink at all, recr<2, q-const=5	large F at old ages in earlier years
	0.58	0.81	1098	0.38	sh=0.75, recr<2,q-const = 5,NO time weight	
Lat./Russ.		0.99	1737	0.19	NO shrink at all	
		0.91	1349	0.26	sh=0.75, recr<2,q-const=5	
		0.94	1420	0.22	sh=1.5, recr<2,q-const=5	
both fleets: int. acoust. & Lat/Rus on age 0: XSA	0.48	0.76	1230	0.35	sh=0.75, recr<2,q-const=5	
	0.58	0.81	1206	0.34	sh=0.75, recr<2,q-const=5, NO time weight.	
	0.46	0.77	1180	0.34	sh=1.5, recr<2,q-const=5	
	0.51	0.73	1221	0.34	sh=0.5, recr<2,q-const=5	
	0.47	0.77	1401	0.28	sh=0.5, recr<2,q-const=3	

The runs show relatively small variation in both F and SSB estimates except the run basing only on age0 survey without shrinkage option (deviation of such run from the others could not be a surprise and its performance was tested more for curiosity than for hope that it can give stable assessment).

On the basis of the series of runs the option below was selected as a best one.

Model Options chosen:

- Two tuning fleets: from International Acoustic Surveys in 1983–2004 in Subdivisions 24-29S and Latvian/Russian Acoustic Surveys covering age 0 sprat in SD 26+28 in 1983–2004 (shifted to represent age 1)
- Tapered time weighting applied, power = 3 over 20 years
- Calibration regression
- Catchability dependent of stock size for age 1 (only for this age group the slope of re gression was significantly different from 1)
- Catchability independent of age for ages >= 5
- Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages
- S.E. of the mean to which the estimate are shrunk = 0.75
- Minimum standard error for population estimates derived from each fleet = 0.300
- Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1974 – last data year		Yes
Canum	Catch at age in numbers	1974 – last data year	1 – 8+	Yes
Weca	Weight at age in the commercial catch	1974 – last data year	1 – 8+	Yes
West	Weight at age of the spawning stock at spawning time.	1974 – last data year	1 – 8+	Yes - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1974 – last data year	1 – 8+	No – set to 0.4 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1974 – last data year	1 – 8+	No – set to 0.4 for all ages in all years
Matprop	Proportion mature at age	1974 – last data year	1 – 8+	No – the same ogive for all years, averaged over noisy long time series (1981-2002)
Natmor	Natural mortality	1974 – last data year	1 – 8+	Yes – estimated from most recent MSVPA

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	International acoustic in SD 24-29S	1983 – last data year	1 - 7
Tuning fleet 2	Latvian/Russian acoustic on Age 0 sprat in SD. 26 + 28	1983 – last data year	0

.

D Short-Term Projection

Model used: Age structured

Software used: MFDP ver 1.a

Initial stock size: Taken from the XSA – survivors for assessment year at age 2 and older. The recruitment at age 1 for year in which assessment is conducted is estimated using RCT3. The recruitment in next 2 years is taken as the long-term geometric mean since 1989.

Natural mortality: Set to average of the 3 last years in assessment.

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: The same values as in assessment

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Set to average weight of the 3 last years in assessment

Exploitation pattern: Average of the 3 last years in assessment. Un-scaled if no clear trend in Fbar (3-5) is observed, otherwise scaled to Fbar level of the last assessment year.

Intermediate year assumptions: Usually both Fsq and TAC constraint options are presented and the option preferred WG is indicated.

Stock recruitment model used: None.

Procedures used for splitting projected catches: Not relevant

E Medium-Term Projections

Model used: Age structured

Software used: Excel spreadsheet

Initial stock size: The same as in the short-term predictions.

Natural mortality: The same as in the short-term predictions (the 3 years average of recent MSVPA estimates)

Maturity: The same as in the short-term predictions

F and M before spawning: The same as in the short-term predictions i.e. set to 0.4 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Assumed as average of the data from 1997 onwards (period of data fluctuation without trend)

Exploitation pattern: The same as in the short-term predictions, i.e. average of the last three years, scaled or unscaled to the Fbar (3-5), depending on existence of a trend in Fbar

Intermediate year assumptions: The same as in the short-term predictions

Stock recruitment model used: Beverton and Holt model

Uncertainty models used:

- Initial stock size: for age 2 and older the lognormal distribution with mean as in the short-term predictions and standard deviation assumed to be the larger value of the internal or external standard error estimated for the survivors in XSA; for recruiting age (age 1) the lognormal distribution with mean and standard deviation estimated by RCT3
- Natural mortality: no uncertainty is assumed
- Maturity: no uncertainty is assumed
- F and M before spawning: no uncertainty is assumed
- Weight at age in the stock: Assumed to be the same as weight at age in the catch.
- Weight at age in the catch: normal error distribution with the 1997-present average and standard deviation estimated from the same series
- Exploitation pattern: no uncertainty is assumed
- Intermediate year assumptions: no uncertainty is assumed
- Stock recruitment model used: Beverton and Holt model with lognormal errors, the model is fitted to whole time series of data, i.e. 1974 onwards.

F Long-Term Projections

The PA software (CEFAS, Lowestoft) has been used.

The F_{max} is not reliably estimated.

The $F_{0.1}$ is estimated as 0.56

G Biological Reference Points

In 1996 the WG estimated MBAL at 200,000 t, based on the Mayer *et al* (1994) approach. The approach assumes the MBAL as biomass which produce half of maximal recruitment on fitted stock-recruitment curve. Next, this MBAL was treated as the estimate of B_{lim} as only few points left to the MBAL were observed in stock-recruitment plot. The B_{pa} was consequently estimated at about 275,000 tons, multiplying of B_{lim} by exp(1.65*SE), where SE was assumed 0.2 (approximately SE of XSA estimates of survivors). However, re-estimation of B_{lim} in 2003 using Mayer *et al* (1994) method produces the B_{lim} of 510,000 tons. This change from the 1996 estimate is the effect of new maturity ogives as well as new observations on stock-recruitment graph.

The segmented regression analysis conducted recently by ICES Secretariat produces estimate of Blim as 200,000 tons.

The F_{pa} was adopted as F_{med} by ACFM in 1998. This value is not stable and varies from year to year assessment within 0.3 – 0.45. Presently F_{pa} of 0.4 is assumed.

H Other Issues

None.

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Annex 13: Limit reference points for eastern Baltic cod

WKREF conducted a review of data sets and methodology used to determine the present limit reference points for Eastern Baltic cod. The F reference points are based on an assessment revised with respect to weight at age and maturity ogives in 1997, while the biomass reference points are based on an older assessment. Since then also discards have been included in the assessment. The biomass reference points are also not based on the full data series from 1966 onwards available, but are based on a time series starting in 1976, covering also a period of outstanding high recruitment, while the F reference points determined by ACFM in 1998 are based on the entire time series. As such the F and biomass reference points are not consistent and the biomass reference points cannot be considered as adequately determined.

These inconsistencies are also obvious from simulations conducted by AGLTA (ICES 2005) and SGMAB (ICES 2005) suggesting that rebuilding to Bpa in the medium-term is impossible when fishing at Fpa and that rather a reduction to about half of Fpa is required to achieve this.

According to WGBFAS (2005), the eastern Baltic cod stock has been below or close to Blim in the last 15 years and there are no indications that recruitment has been further diminished due to this low stock size. Instead the indications are that the reduction in recruitment is primarily environmentally driven and that the spawning stock has decreased following the decline in recruitment rather than vice versa. As a result it is difficult to justify the existing Blim, although for similar reasons it is equally difficult to suggest a more appropriate value.

WKREF concluded that there are inconsistencies in the way the fishing mortality and biomass reference points have been established. The biomass reference point need revisiting in the light of the new information that is now available. Evaluation of management plans should take account of different environmental regimes and possible new reference points.

Considering productivity and regime shifts

According to SGPA (2002) and SGPA (2003), the apparent change in productivity of the Baltic Sea should be considered by identifying environmental regimes, either by separating time series into shorter periods of similar environment, or preferably by incorporation of the environmental drivers into stock recruitment relationships. Identification of different productivity regimes requires sound understanding of the underlying processes driving the stock in questions and related system components including presentation of data substantiating the shift in regimes. For the eastern Baltic cod stock such information is presented in the WKREF report. WGBFAS considers the presented information as sufficient basis to justify a revision of the limit biomass reference points accordingly.

A determination of biomass reference points for a specific productivity regime requires rules on revision procedures to be evoked if the regime shifts into another state, with indicators how to measure these being in place and monitored. This includes as well rules on related time lines of actions and identification of actors.

Regime shift in the Central Baltic

As summarized by WKREF, the upper trophic levels of the Central Baltic changed during the last 25 years from a cod- to a sprat-dominated system (Alheit et al., 2005). The decline of the cod stock in the 1980's was caused by a recruitment failure, which was mainly driven by: i) anoxic conditions in deep water layers of both eastern spawning sites causing high egg mortalities, ii) high egg predation by clupeid predators in the remaining productive spawning area, iii) reduced larval survival due to the decrease in abundance of the main food item Pseudocalanus acuspes, and to a lesser extent also iv) high juvenile cannibalism at high stock

size. The intensity and significance of all these processes are in one way or the other steered by the hydrographic conditions, which were in the 1990´s characterized by low salinity due to lacking inflow of saline water from the North Sea and increased river run off, but as well by warmer thermal conditions (Köster et al., 2005). An increasing fishing pressure accelerated the decline of the cod stock, with current exploitation levels being still on a very high level. A change in spawning stock structure towards younger fish caused by high fishing pressure has probably affected the survival of eggs and larvae negatively (Vallin et al. 1999).

The decline of the cod stock released sprat from predation pressure, and in combination with high reproductive success, due to in general favourable temperature conditions, this resulted in exceptionally high sprat stock sizes in the 1990s (Köster et al., 2003). The sprat stock affected cod recruitment negatively by acting as predator on cod eggs (Köster and Möllmann, 2000) and on Pseudocalanus adults (Möllmann et al., 2004), thus affecting the production of food for cod larvae. Indications for compensatory processes in growth, maturation and individual egg production exist for both species (Köster et al. 2003, Möllmann et al., 2005), however, appear to be of limited impact on the overall stock and system dynamics.

Concurrent with a shift from a cod to a sprat dominated system, the meso-zooplankton community showed pronounced changes as well (Hänninen, et al. 2000; Dippner et al., 2000). While the marine copepod zooplankton declined in abundance, the neritic copepod species Acartia spec. and Temora increased in abundance, mainly caused by increasing winter temperatures.

Furthermore, climate mediated changes in the Baltic ecosystem during the 2nd half of the 1980's are apparent for lower trophic levels as well (Alheit et al. 2005, ICES 2006/BBC:09). This regime shift cannot be allocated to a single year or event, as the response time of different species and life stages depends on whether the critical environmental factor is oxygen concentration or salinity in the deep Baltic basins, or water temperature in bottom or intermediate water layers. Cod egg survival already declined in eastern spawning areas with the absence of inflows in 1981 and 1982, while it declined in the Bornholm Basin not before 1986. Cod larval survival, being coupled via Pseudocalanus production to salinity, was seriously affected in eastern spawning areas in the 2nd half of the 1980's and in the Bornholm Basin after an extended stagnation period and increased predation pressure by sprat in early 1990's. The decline in the cod stock released sprat from predation pressure, but the low temperatures until winter 1986/87 prevented a successful sprat recruitment before 1988. Similarly, Acartia spp. production increases first in 1988 sustaining high sprat larval survival.

In conclusion, while cod recruitment declined at high SSB already in the first half of the 1980's a shift in a series of environmental conditions caused a further decline in cod reproductive success in the second half of the 1980's. While major inflows in 1986 and/or 1987 could have halted the development as still a sufficient SSB was available, the major inflow in 1993 came too late to destabilize the new regime state. If choosing a date for a regime shift, 1987 or 1988 are thus the most obvious candidates.

Candidate limit reference points for Baltic cod

The regime shift in environmental conditions and upper trophic level ecosystem structure lead WKREF to the separation of stock recruitment relationships into two levels representing favourable environmental conditions until early 1980's and after a transition phase unfavourable hydrographic conditions (Jarre-Teichmann et al., 2000). This separation into two distinct environmental regimes has been acknowledged by SGBFS (ICES, 1998) when determining the present F reference points. While SGBFS (ICES, 1998) considered stock and recruitment data from 1981 onwards, information compiled by WKREF suggests that the shift into another regime happened gradually between 1981 and 1987 and consequently, WKREF

utilized data from 1987 onwards if environmental variables are not directly included in stock-recruitment model. A variety of different methods was applied to estimate Blim:

1) segmented regression (ICES, 2002),
2) method used by ICES (1996) to determine MBAL according to Myers et al. (1994) applying a Ricker stock - recruitment relationship,
3) Simmonds methods (described in WKREF),
4) inclusion of reproductive volume as additional variable in a Ricker stock-recruitment relationship.

In order to explore the sensitivity of the methods to the truncation of the time series, alternatively the entire time series from standard assessment output (1966-2003) and the period characterized by more favourable hydrographic conditions (1966-1986) from standard assessment output were applied. In all cases recruitment at age 2 was considered, but in order to test for the sensitivity of the methods to cannibalism, methods 1) and 2) were applied additionally to recruitment at age 0 from MSVPA output prepared by SGMAB (ICES 2007) for the time series 1987-2003.

The segmented regression produced a breakpoint of 91,000 tons for the stock recruitment time series derived from standard assessment output covering years 1987 onwards. However, the point is not well estimated and the scatterplot of data points suggests that recruitment is not dependent on SSB above ca. 90,000 tons. The use of entire assessment time series (1966-2003) reveals a breakpoint of 356,000 tons, i.e. the SSB at which the highest recruitment of the 1976 year-class occurred, which is considerably higher than the breakpoint of 278 000 t derived when using the time series characterized by favourable environmental conditions alone (1966-1986). This seems to be inconsistent and can be explained by the higher contrast in the data. When utilizing MSVPA output, the breakpoint for the data series 1987-2003 is 109,000 tons and thus quite similar to the one determined on basis of the standard assessment output. Utilising the entire time series, however, results in a unrealistically high breakpoint of 780,000 tons.

The method proposed by Myers et al. (1994) applied earlier to estimate the present Bpa value produced very low values outside the observed data range when using data from 1987-2003, independent whether a Ricker or Beverton and Holt stock recruitment relationship is used. Using the data series characterizing favourable recruitment (1966-86) revealed 150,000 ton as candidate for Blim, while including the entire data series increased it to about 200,000 tons. Applying MSVPA derived data resulted for the time series 1987-2003 resulted in a very similar unrealistically low Blim candidate.

Results from Simmonds methods were very dependent on the time series applied. For the data since 1987, the interpretation is that at above ca. 100,000 tons the probability of having above or below average recruitment (as observed in 1987-2003) is 50%. However, at lower SSB the recruitment is in fact higher indicating only that there is no stock recruitment relationship apparent in the data.

Inclusion of the reproductive volume as additional variable in stock recruitment relationships resulted in an overall improved fit over all time periods compared to a corresponding fit of the traditional environmentally insensitive model, but application of a model based on the entire time series to an environment characterised by low reproductive volume overestimated recruitment substantially. This indicates that RV alone does not explain recruitment variability, and more complex approaches are needed to utilise the entire time series. Splitting the time series and refitting the model to data from 1987-2002, revealed a dome-shaped response to SSB at average reproductive volumes with a maximum at 150,000 tons, but a relatively flat contour between 100,000 and 200,000 tons.

On the basis of the material presented, WKREF could not agree on a candidate reference point for Blim. The discussion focused on the separation in two different time periods for recruitment and on the methodology to derive a limit reference point in such a situation. The preferred methodology would have been to include the main environmental drivers into the estimation procedure and to estimate a limit reference points dependent on level of variables characterising environmental regimes. This could not be achieved during the workshop. WGBFAS was invited to further develop this methodology and to come with recommendations for a possible revision of Blim.

WGBFAS concludes that recruitment is largely driven by environmental forcing and a regime shift is well documented during mid 1980's. A variety of different methods was applied to estimate Blim based on the time series 1987-2003 and although none of the methods did perform very well, application of segmented regression and Simmonds method suggest revision of Blim to 91,000 -95,000 t..

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Annex 14: Technical Minutes. Review Group for Baltic Fisheries Assessment (RGBFAS)

21–23 May 2007, ICES

Review-group chair: Christopher Zimmermann, Presenter: Steen Christensen (WG chair), Reviewers: Christopher Legault, Willy Vanhee, Sarunas Toliusis, Jesper Boje (part-time), Barbara Schoute (ICES)

1 General Comments

The Working Group is complimented for a clearly structured and understandable report, which was presented by a well-informed chair. RG members familiar with the reports of this WG over a longer period indicated that the report has constantly improved over the last years. Most of last year's RG comments have been taken into account by the WG, which was welcomed by this year's RG. As usual, the following comments highlight suggestions for improvement, which should in no way balance the very positive impression the report has left with the reviewers.

- Input data available for the assessments and finally used in the assessment should be displayed in the report. For a number of stocks, this information is given in separate summary text tables, which is thought to be a very good idea. It would be good, however, if also the raw data available would be given and not only the raw data actually used in the final run – the difference could be highlighted e.g. by displaying the data used in bold typeface in raw data tables.
- Any assumptions made for discards and unallocated catch should be explained in detail. The WG progressed on this in the present report but e.g. complete discard biomass by year-tables were still missing (or contained only the assessment year). This was corrected by the chair and included in the draft report.
- Inputs and resulting diagnostics of exploratory runs should be available for the RG (on WG sharepoint site), not just the final runs. It proved to be time consuming to get hold of the figures needed to judge the quality of the assessments in some cases.
- The RG recommends that each stock section should start with a brief introduction with the ACFM advice for the most recent years and the management measures for those years, as done by a number of WGs (and given in a similar way for the pelagic stocks in the WGBFAS report). This would ease a comparison of e.g. official catch and TACs.
- The WG is asked to mind the colouring of graphs (use graphic symbols rather than coloured lines without symbols). Residual bubble plots should give information on the scaling, either by using the same scale for all plots or by indicating the actual scale, possibly accompanied by the graphs showing the actual order of magnitude of the residuals.
- General point on ref points: RG notices that the basis for SSB reference points for herring GOR and sole in IIIa seem inconsistent (Bpa = MBAL, Blim = Bpa – X < Bloss). There are also doubts on the consistency of the SSB reference points for herring in SD 30 with the precautionary approach. This should be investigated, preferably before the next benchmark assessment.
- A paragraph on the follow up of last year's RG recommendations by per stock chapter was welcomed. It would be good to do this for all stocks.

Note on diagnostic plots of successive cohort abundances

A common practice in the WGBFAS is to plot successive cohort abundances against each other, either on normal or lognormal scale, for potential tuning indices to determine if the data

should be used in the assessment. Plots that diverge from a strong positive linear relationship are considered not useful for tuning. However, the assumption underlying these plots is that total mortality has not changed much during the time period of observations. If this assumption is met, then the diagnostic plot is useful for determining ages that are too noisy for use as a tuning index. If this assumption is not met, then ages may be eliminated incorrectly due to chance observation of combinations of abundance and total mortality.

A plot of N(y+1,a+1) vs N(y,a) is based on the relationship N(y+1,a+1)=N(y,a)exp(-Z(y,a)). If Z(y,a) is constant over all observed years, then a linear relationship results with slope exp(-Z(y,a)) and intercept of zero. If the same data are plotted on a logarithmic scale, then a linear relationship results with slope of one and intercept of –Z(y,a). However, if Z(y,a) varies considerably during the time period observed, then points on different lines will be generated. If the Z(y,a) depend upon N(y,a) then negative relationships can arise with no observation error. Since the oldest ages most commonly have the lowest numeric values, these ages are particularly prone to being excluded from the tuning series. This is because on a normal scale, low N are close to the origin where all the lines for different Z(y,a) converge while on a lognormal scale, low N cause the parallel lines for different Z(y,a) to appear farther apart thus creating more possibility for negative relationships to be observed. While some of the exclusions due to this diagnostic are certainly correct, there may be cases when good tuning information is not being used in the assessment due to the use of these diagnostic plots when total mortality has changed considerably during the time period.

2 Specific comments

2.1 Introduction

- The RG appreciates the work invested in giving information on the national fisheries and fleets
- RG suggests to include figures for F, SSB and Recr for all stocks with an agreed or indicative assessment in Sec.1.9 to make the stock overviews even more useful.
- A number of sections in the Introduction needed updating (1.7 and 1.8), some tables were still missing (e.g. in Sec 1.5.5). This was resolved during the meeting.

2.2 Cod in the Western Baltic (SD 22–24)

Benchmark assessment, stock was around B_{pa} in recent years, catch 2006 23 kt, no management plan (yet), ICSFC man. plan and target F abandoned. Number of different tuning fleets (2 new, 3 old), sampling satisfactorily (but could be improved). Little misreporting, discards included. General comment: a huge amount of work has been done, but there are things which should have been done in addition during a benchmark assessment. Final XSA run is not very different from last year's, F declined in last yr.

- discards now raised to total mixed fisheries landings, not only to cod landings – not much difference expected, but there was no sensitivity analysis performed and this could have been done in a benchmark assessment.
- 3 commercial tuning fleets revised – reduced to a smaller subset to make them more independent from the catch data, only two of them finally used – RG agrees
- fishery independent information: "Solea" 1Q removed, "Solea" 4Q truncated to reduce catchability residuals, but the truncated series still shows a trend in the 1st 3 yrs – reasons and effect should be explored next yr.
- Population shrinkage was used but the choice was not properly explained. This should be better investigated (especially since this is a benchmark assessment) with all ages included. First age of constant q should be investigated: diagnostics do not indicate age 2 is appropriate, should be all age classes.
- Shrinkage has a big influence on results, 0.5 appears to be appropriate.

- retrospectives are worse than last year – likely because of two new scientific surveys and mor independent commercial tuning fleets. F slightly overestimated.
- Recruitment estimates: sensitivity to recruitment assumptions should be explored. Geometric mean of only the last (5?) years might be more appropriate (regime shift?) than using a long period (1986-2006), which makes the geometric mean rather optimistic.
- Stock weights for 4+ fish should be taken from Catch Weights 4+ from 1982 but this is apparently not the case – problem solved during RG meeting, wrong table displayed but correct data used in the assessment.
- Short term forecast: RG agrees that survey data for recruitment are consistent enough to be used as the best available information.
- Short term forecast F assumption: WG presented two different options, with F scaled or unscaled to the terminal F. RG could not find sufficient justification for the first option: the assumed trend in F might be just noise, there is no convincing external information to believe in a significant decline in F – apart from the increasing misreporting of fish from the Kattegat into 22-24. This could, however, have been balanced by misreporting between 22-24 and 25-32. Closed areas or periods have apparently not been significantly expanded. Also, F for the important ages 2 and 4 has not shown a reduction (table 2.3.20). RG concludes that the mean unscaled F should be used for the forecast, which gives a more pessimistic view in the medium term.
- removal of likely misreporting from IIIa improved residuals significantly – not removed in final run because of uncertainty of the magnitude (anecdotal information only)

Full analytical assessment accepted, forecasts accepted with the "no scaling to terminal F" option. Please take care that data is available in the ICES database to produce the standard graphs for the summary sheets.

2.3 Cod in the Kattegat (SD 21)

Observation list assessment. Stock considered to be well below Blim since the late 1990ies. Huge problem with unallocated catch – anecdotal info from the industry that this might be 2000-2500 t in recent 3 yrs compared to 876 kt official lndgs. Increasing problem with discards (now in the order of landings) as quota is very restrictive. Three models explored: XSA with and without discards, B-Adapt to get a feeling for total removals, SURBA for survey info only. No commercial fleets used because of uncertainty of actual catch, 5 scientific surveys used. WG has explored a wide variety of options to explain the problems with the assessment of this stock, which is appreciated by the RG

- RG asks for total discard weight by age for the used time series– done in final report
- Discard sampling is apparently insufficient and suffers from lack of access to vessels. WG states that discards have raised over last years but this is not reflected in the data – they just get more important as the landings were reduced. It should be explored if the discard trips are a random sample from the fleet, e.g. by looking at the area distribution of the discard trips compared to the commercial fleet.
- RG asks for explanation of exclusion of IBTS 1st quarter 1994. Explanation of large residuals is not sufficient to delete datapoints, if there is no additional information on why this year was an outlier. (e.g. too few days at sea for a survey. WG is asked to revisit the exclusion of (parts of) the dataset 1983-1994.
- Evident difference between survey and catch data; clear trends in SURBA catchability residuals for IBTS 1Q, masked only when put together with the catch matrix (which is unreliable as we know). Trends in other surveys are possible but not so apparent as their time series is much shorter. The SURBA output for F appears to be very unreliable and very much the same for very different stocks – is this a software error? Log residuals (plot 2.2.33) shows definite trends, proves the

problems with survey, which are expected to have little influence on the assessment at this stage.

- Plus group has been adapted this year (6+ instead of 8+), catchability now set to constant from age 4+ (was 5+ before)
- RG encourages the further exploration of B-Adapt to use this as the basis for an agreed assessment in the future.
- RG recognises huge unofficial landings, this should be mentioned more strongly in mgt considerations.

Assessments accepted as indicative for trends only, SSB and Recruitment fits nicely for XSA and B-Adapt outputs but with slightly different absolute levels. The biomass is still at a record low, recruitment is low. B-Adapt should give more reliable results as it includes the misreported catch, however, the input age disaggregated matrix for B-Adapt did not include discard information. F is very different between the two models. Therefore decision to remove the summary plot and replace by B-ADAPT / XSA (incl. F1-2) plots without absolute values or lim/pa lines.

2.4 Cod in Subdivisions 25-32

Observation list assessment. 37% unallocated landings (since 1992 in the assessment) estimated by expert knowledge on a confidential (intransparent) level. Biomass still at record low, 2003 yc little stronger, F increased. Landings 2006 65 kt. Management plan proposed but not yet implemented.

- RG questions the implied precision of unallocated catch estimates: change from 38% to 37%. This helps in the overview over the years but should be accompanied by text on the actual exactness of the figure.
- The use of the word 'strata' is confusing in relation to metiers.
- Age distribution of illegal catch is believed to be the same as for the same nation's legal catch – this might be a wrong assumption if undersized fish is landed illegal over-proportionally.
- Related to this (and in contradiction to the point above): Discards are raised to legal catch only! That implies there are no discards in the illegal fishery – hard to imagine. RG concludes that raising should be done to the total catch including illegal catches.
- Why have discards only been raised to age groups 1-2? If the same would have applied to age group 3, then this would result in 40% discards of this age group!
- Apparent error in table 2.4.5.a: check the number 799 active gear in 2005 – active and passive gear appears to have been exchanged be when compared to Tab 2.4.2 in last years report. Please provide a sum line in Tab 2.4.2 to ease such comparisons. Please also provide a sum catch by gear over the years table as a change in relative contribution of those fleets since 1990 is mentioned.
- The change in discarding per metier per year between 2005 and 2006 raises questions. Should be checked. Changes should be mentioned in the discard paragraph.
- RG: Table 2.4.15a and 2.4.16
- Para 2.4.6.1: quarter 4 surveys was not included last year due to 'poor diagnostics' but was included this year. An overview of the diagnostics is needed. Figure 2.4.7.a needs text.
- Table in para 2.6.4.2: please include all data available here and all data finally used in the following table, or combine both and highlight what was finally used.
- WG uses graphs like 2.4.3.a etc. to assess internal consistency. RG sees this consistency dependent on a constant mortality rate, not telling anything about observation errors. Especially on higher age groups. The graphs might lead to an omission of information that looks inconsistent but is still valuable.
- Comparison tables on XSA results are very informative.

- SURBA comparisons seem uninformative since this analysis includes longer dataseries, compared to the XSA with truncated shorter tuning series. For this reason B-ADAPT was not presented, even though it was run.
- Possible errors in table 2.4.22: and 2.4.15.a: XSA output table 2.4.15.a yearclasses are not the same as the summary table 2.4.19 and 20. Tab 2.4.22 RTC3 might be wrong, should match with XSA and 2.4.15a. column 1 – errors were corrected during the RG meeting and WG provided new forecasts, which were minimally different.
- The problem of aging is unresolved and is a main issue according to the WG report. However, more attention is given to tweeking the assessment to the noisy data than to aging. The RG encourages the WG to balance their approach in the future. Also, a piece of text summarising the possible effect age reading uncertainty would have on the assessment and forecast (order of magnitude, direction) should be provided. RG added a paragraph in the stock sum. Reference to EU-study DECODE if this is thought to help.
- RG was informed that WECA information could not be taken from recent surveys as the ICES DATRAS database was down, WG had to extrapolate from 2002-04. ICES should make sure that this does not happen again!
- Forecast: the catch assumption for the interim year (based on Fsp) appears to be unrealistically high (increase in catch by 25% compared to 2006, TAC overshoot 90%!). Such an assumption needs some explaining text in the report.

RG concludes that the XSA assessment can be accepted. Datasets are apparently not long enough (and too imprecise to define a reference period?) for the use of B-ADAPT, which the RG would be happy to look at next year. Length-based assessments should be explored if possible to get around the ageing problems. Compliments for the textual interpretation of the results.

The RG followed a presentation by F. Köster, DIFRES, on an evaluation of the proposed EU management plan. A number of questions were raised on how to interpret the legal text and if this would be properly reflected in the evaluation. The study concluded that the management plane would be consistent with the precautionary approach if the aim (reduction of F to 0.3) would have been reached, but it was still unclear if the plan would also reach the target of a stock recovery in the medium term. A paragraph on this evaluation was included in the summary sheet.

2.5 Sole in Division IIIa

Observation list assessment. Low TAC was advised by ACFM until 2004, when tuning fleets were revised. This led to a very different perception of the stock and increase in TAC advice. Full assessment not accepted in recent years due to problems with this abrupt change and uncertainty on the amount of unallocated landings. This year, new tuning series extended and misreporting for 2006 estimated to be minimal – full analytical assessment presented.

- RG agrees with the WG that the use of the Havfisken dataset is ok for the time being, until a more suitable dataset (sole directed survey) is available.
- privat logbooks and validation of the tuning fleet's data appears to be satisfactorily – much more effort put into the development of this tuning data than for most other fleets. However, contradiction with official logbook series which indicates in increase in CPUE should be explored in detail.
- No discard data available, RG was informed this is not considered a problem for sole but might be for bycatch!
- At the recommendation from the RG last year the +group was reduced from 11+ to 9+. This improved the retrospectives. RG suggests investigating survivor estimates shrunk towards the mean F of the final 5 and 4 oldest ages (only done for 5 which is already very close to 3yr olds – recruits).

- Management considerations: RG recommends a revision of the reference points, basis appears to be weak, especially for B-Ref points (likely to be much higher)
- RG would expect to see remarks on management/assessment area mismatch and the quality of catch data in this paragraph. RG encouraged the WG to explore the inclusion of sole catches from the whole Baltic in a general Baltic sole assessment, be it on the basis of stock identity.

Assessment and forecasts accepted by the RG. Please make sure data for standard graphs is uploaded properly.

2.6 Flounder 22-32

Exploratory assessment. Analytical assessment for a subset until 2004, when huge difficulties in age determination and stock definition became apparent. No directed survey available.

RG welcomes the improvement in this assessment (Age reading was looked into) but considered the assessment still very preliminary. RG encourages the progress on the use of length based assessment models. Catch tables currently presented in the summary sheets should be condensed in the future.

2.7 Other Flatfish in the Baltic (brill, dab, plaice, turbot)

No assessment, no directed fishery, no advice, only catch data available.

2.8 Herring in SD 25-29, 32, excluding Gulf of Riga

Update assessment. SSB reduced constantly over the whole assessment period, partly due to a reduction of mean weights at age. 3 different survey series available for tuning. Assessment and forecast accepted.

- The introduction section giving management and stock definition overview is welcomed and eases the work of the reviewers.
- Unclear level of species misreporting – please explore how much this could be where, in the light of recent changes in EU legislation, and give an indication what influence such species misreporting (herring landed as sprat) could have on the perception of the stock.
- Strange behaviour of the XSA noted this year – had to be stopped after 50 iterations.
- No acoustic data used in 1993 and 1997 – please provide an explanation (and "bad residuals" is no acceptable explanation to exclude data points)
- It's unclear to the RG why catch weights were used as stock weights – could be taken either from pre-spawning surveys or catch weights at that time. Could have an influence on the perception of a reduction of these weights in the last decade and should therefore be explored. This was already recommended by last year's RG.
- In this context: a brief section to reply on RG's suggestions would be good, as done for other stocks in this group.
- RG recommends: reference points are weak, these should be revisited during the next benchmark assessment (SG PA points 2003 recommends stock–specific approach).

2.9 Herring in Gulf of Riga (update assessment)

Update assessment. Very different stock development compared to the "open sea" herring. Movements in and out of the GoR, on average 9% of the catch in the GoR consisting of open sea (Her 25-29,32 exGoR) herring. Mostly caught by trawlers, only two nations participating in the fishery. Acoustic survey index available. Changes to last year: trap net tuning fleet

truncated, which improved residuals significantly. F at Fpa – this is the trigger for the advice as SSB is well above Bpa.

- Separation of GoR and open Sea herring is unclear to the RG (otolith microstructure – but are these spawning at different times?). Please provide some more information in the text.
- Same problem with WEST=WECA as for Central Baltic Herring, please explore other ways to derive stock weights.
- If the WG decides to deviate from a SPALY assessment even during an update assessment (as done here with the truncation of a tuning fleet), the full diagnostics should be provided. This was done during the RG on request. RG agrees with the proposed assessment.
- RG notices a possible trend in F, supported by a decline of the effort data (table 6.3.8). If a trend in F and effort occurs next year, scaling should be reconsidered.
- Also for this stock, reference points need reconsideration (Bpa = MBAL, Blim well below Bloss). Updated biomass reference points might be much higher.

Assessment and forecast accepted.

2.10 Herring in SD 30 (update assessment)

Update assessment, benchmark last year. No survey information, Commercial CPUEs used for tuning, corrected for changes in technology. 98% of the catch taken by Finland. TAC not restrictive. Very small fish, due to the old mean age problems with contaminants. Age reading problems.

- The RG is discontent with the use of commercial CPUEs, specifically from trawlers, as tuning index for the assessment. Such CPUEs are useless for schooling species as they are known to be stable even when the stock is rapidly declining (see North Sea herring). Huge problems with the residuals support this view. The RG appreciates efforts to start an acoustic survey on this stock and added a health warning to the stock sums that the perception of the stock might drastically change once this series is long enough to be used in the assessment. Until then, the assessment is considered very uncertain and can only be used to guide the management.
- The way how commercial tuning series are “corrected” appears to be intransparent, this needs more explanation.
- Reference points need revision, maybe not useful before the new survey is available.

2.11 Herring in SD 31 (update assessment)

Update assessment. Commercial CPUEs used for the assessment of a pelagic species, no survey data available. Management together with Herring in SD 30, minimal catch compared to the southern stock.

- Very poor assessment as indicated by diagnostics and retrospectives. Was rejected by last year’s RG (according to their notes) but then apparently reconsidered by ACFM.
- Unclear why the CPUE of the commercial vessels was not corrected, as was done for herring in 30.

RG decided not to accept this assessment and to remove the summary table and graphs from the summary sheet. Advice should then be based on a status quo F. This raised a discussion on the possibilities to reject update assessments in general. The RG concluded that it was apparently an error to accept this assessment last year, and that this error would be perpetuated if the only possibility to reject it would be after the next benchmark assessment. The RG was informed later by the former chair that this assessment was always considered exploratory or even experimental, and that the assessment output graphs appeared by mistake in last year’s

advice. As there is little hope that the data situation could be improved over the next few years, this assessment should be classified as an experimental assessment in the future.

2.12 Sprat in SD 22-32

Update assessment. Sprat SSB at a very high level, TACs not restrictive. Benchmark assessment 2005. Acoustic surveys used for tuning, inclusion of a new survey series developed for this purpose for the first time this year. Assessment and forecast accepted.

- Information is very well presented in this section. However, the information on the new acoustic index could have been more extensive, especially when such a major change is done in an update assessment, and when the new (spring) survey gives a different perception than the two other acoustic surveys.
- It is mentioned in the herring section that species misreporting might be a problem in the sprat fishery. This is not taken up here and the RG would encourage the WG to provide information on the effect this could have on the assessment (order of magnitude, direction).
- RG notices that the estimate of the incoming year class by RCT3 is uncertain (40% deviation to last year's estimate). RG agrees with the use of the estimate but this should be mentioned as an uncertainty in para 7.12, Quality of the Assessment.
- RG encourages better explanation on the cause of perceived trends in F in case the WG chooses to scale the F. This refers specifically to sprat – the "trend" could also just be noise.
- Reference points needs to be revisited.
- RG concludes that the stock recruitment shows a shift over time, this could be looked into.