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Contents

Executive summary 1

1 Introduction 7

1.1 Terms of Reference (ToR) 7

1.1.1 Specific ToR 7

1.1.2 Generic ToRs for Regional and Species Working Groups 7

1.2 NWWG 2009 work in relation to the ToR 8

1.3 Assessment methods applied to NWWG stocks 9

1.4 InterCatch 9

1.5 NWWG Draft of Advice Summary Sheets 10

1.6 Recommendations 10

2 Demersal Stocks in the Faroe Area (Division Vb and Subdivision IIa4).......... 11

2.1 Overview.. 11

2.1.1 Fisheries.. 11

2.1.2 Fisheries and management measures 12

2.1.3 The marine environment 14

2.1.4 Catchability analysis.. 15

2.1.5 Summary of the 2009 assessment of Faroe Plateau cod, haddock and saithe.. 16

2.1.6 Reference points for Faroese stocks and evaluation of the Faroese management system... 17

2.1.7 Faroe saithe 17

2.1.8 Review of the management system.. 17

2.1.9 References: 17

3 Faroe Bank Cod 26

3.1 State of the stock - historical and compared to what is now. 26

3.2 Comparison with previous assessment and forecast.................................... 27

3.3 Management plans and evaluations (Could just be a reference to the year when the plan was agreed/evaluated. Include proposed/agreed management plan.) 27

3.4 Management considerations (what do managers need to consider when managing this stock.).. 27

3.5 Regulations and their effects (Include new regulations (e.g. gear restrictions, TAC etc). Focus on effects of regulations.) 27

3.6 Changes in fishing technology and fishing patterns 28

3.7 Changes in the environment 28

4 Faroe Plateau cod 37

4.1 Stock description and management units 37

4.2 Scientific data 37

4.3 Information from the fishing industry.. 39

4.4 Methods 39
4.5 Reference points....39
4.6 State of the stock - historical and compared to what is now 39
4.7 Short term forecast....40
4.8 Long term forecast....41
4.9 Uncertainties in assessment and forecast 41
4.10 Comparison with previous assessment and forecast....41
4.11 Management plans and evaluations 41
4.12 Management considerations 41
4.13 Ecosystem considerations....43
4.14 Regulations and their effects....43
4.15 Changes in fishing technology and fishing patterns 43
4.16 Changes in the environment 43
4.17 References....43

5 Faroe haddock 82

5.1 Stock description and management units 82
5.2 Scientific data 82
5.2.1 Trends in landings and fisheries....82
5.2.2 Catch-at-age....83
5.2.3 Weight-at-age 83
5.2.4 Maturity-at-age 83
5.3 Information from the fishing industry....84
5.4 Methods 84
5.4.1 Tuning and estimates of fishing mortality 84
5.5 Reference points....85
5.6 State of the stock - historical and compared to what is now. 85
5.7 Short term forecast....86
5.7.1 Input data....86
5.7.2 Results 86
5.8 Medium term forecasts and yield per recruit 86
5.9 Uncertainties in assessment and forecast 87
5.10 Comparison with previous assessment and forecast....87
5.11 Management plans and evaluations 87
5.12 Management considerations 87
5.13 Ecosystem considerations....88
5.14 Regulations and their effects....88
5.15 Changes in fishing technology and fishing patterns 88
5.16 Changes in the environment 88

6 Faroe Saithe....139

6.1 Stock description and management units. 139

6.2 Scientific data 139
6.2.1 Trends in landings and fisheries 139
6.2.2 Catch at age 140
6.2.3 Weight at age 140
6.2.4 Maturity at age 140
6.2.5 Indices of stock size 140
6.3 Information from the fishing industry 141
6.4 Methods 141
6.5 Reference points 142
6.5.1 Biological reference points 142
6.6 State of the stock – historical and compared to what is now 143
6.7 Short term forecast 143
6.7.1 Input data 143
6.7.2 Projection of catch and biomass 143
6.8 Medium term forecasts and yield per recruit 144
6.8.1 Input data to yield per recruit 144
6.9 Uncertainties in assessment and forecast 144
6.9.1 Assessment quality 144
6.10 Comparison with previous assessment and forecast 144
6.11 Management plans and evaluations 144
6.12 Management considerations 145
6.13 Ecosystem considerations 145
6.14 Regulations and their effects 145
6.15 Changes in fishing technology and fishing patterns 145
6.16 Changes in the environment 145
6.17 Response to technical minutes 146
6.18 References 146

7 Overview on ecosystem, fisheries and their management in Icelandic waters 179

7.1 Environmental and ecosystem information 179
7.2 Environmental drivers of productivity 181
7.3 Ecosystem considerations (General) 181
7.4 Description of fisheries [Fleets] 182
7.5 Regulations 183
7.5.1 The ITQ system 184
7.5.2 Mesh size regulations 184
7.5.3 Area closures 184
7.5.4 Discards 185
7.6 Mixed fisheries, capacity and effort 185
7.7 References 186

8 Saithe in Icelandic waters 202
8.1 Summary..202
8.1 Stock description and management units 202
8.2 Fisheries dependent data 202
8.2.1 Landings, advice and TAC 202
8.2.2 Landings by age 203
8.2.3 Mean Weight and maturity at age 204
8.2.4 Log book data 204
8.3 Scientific surveys 204
8.4 Assessment methods 205
8.5 Reference points...206
8.6 State of the stock 208
8.7 Short term forecast...208
8.8 Uncertainties in assessment and forecast 209
8.9 Comparison with previous assessment and forecast.....................209
8.10 Ecosystem considerations..209
8.11 Changes in fishing technology and fishing patterns 209

9 Icelandic cod 231
9.1 Stock description and management units 231
9.2 Scientific data 232
9.2.1 Catch: Landings, discards and misreporting 232
9.2.2 Landings and weight by age 233
9.2.3 Surveys 233
9.3 Information from the fishing industry...234
9.4 Methods 234
9.5 Reference points THIS WILL BE EXPANDED 237
9.6 State of the stock 237
9.7 Short term forecast...237
9.8 Medium term forecasts 238
9.9 Uncertainties in assessment and forecast 239
9.10 Comparison with previous assessment and forecast...................240
9.11 Management plans and evaluations 240
9.12 Management considerations 241
9.13 Ecosystem considerations...241
9.14 Regulations and their effects..242
9.15 Changes in fishing technology and fishing patterns 242
9.16 Changes in the environment 242
9.17 References 243

10 Icelandic haddock..271
10.1 Stock description and management units 271

10.2 Scientific data 271

10.2.1 Landings..271

10.2.2 Landings by age 271

10.2.3 Surveys 272

10.2.4 Mean Weight and maturity at age 272

10.3 Information from the fishing industry..273

10.4 Methods 273

10.5 Reference points..274

10.6 State of the stock 274

10.7 Short term forecast...275

10.8 Medium term forecasts 276

10.9 Uncertainties in assessment and forecast 277

10.10 Comparison with previous assessment and forecast..................................277

10.11 Management plans and evaluations 277

10.12 Management considerations 277

10.13 Ecosystem considerations..278

10.14 Regulations and their effects..278

10.15 Changes in fishing technology and fishing patterns 278

10.16 Changes in the environment. 278

11 Icelandic summer spawning herring 313

11.1 Scientific data 314

11.2 Information from the fishing industry..315

11.2.1 Fleets and fishing grounds 315

11.2.2 Catch in numbers, weight at age and maturity 316

11.3 Analytical assessment 317

11.3.1 Analysis of input data 317

11.3.2 Exploration of different assessment models 318

11.3.3 Final assessment...319

11.4 Reference points..320

11.5 State of the stock 320

11.6 Short term forecast...320

11.6.1 The input data 320

11.6.2 Prognosis results...321

11.7 Medium term predictions...321

11.8 Uncertainties in assessment and forecast 321

11.8.1 Assessment 321

11.8.2 Forecast...322

11.8.3 Assessment quality 322

11.9 Comparison with previous assessment and forecast...................................323

11.10 Management plans and evaluations 323

11.11 Management consideration 323

11.12 Ecosystem considerations 323

11.13 Regulations and their effects 324

11.14 Changes in fishing technology and fishing patterns 324

11.15 Comments on the PA reference points 324

11.16 Comments on the assessment 324

11.17 References 325

12 Capelin in the Iceland-East Greenland-Jan Mayen area 352

12.1 Stock description and management units 352

12.2 Scientific data 352

12.3 Information from the fishing industry 354

12.4 Methods 355

12.5 Reference points 355

12.6 State of the stock 355

12.7 Short term forecast 356

12.8 (Medium term forecasts) 356

12.9 Uncertainties in assessment and forecast 356

12.10 Comparison with previous assessment and forecast 357

12.11 Management plans and evaluations 357

12.12 Management considerations 357

12.13 Ecosystem considerations 357

12.14 Regulations and their effects 357

12.15 Changes in fishing technology and fishing patterns 358

12.16 Changes in the environment 358

13 Overview on ecosystem, fisheries and their management in Greenland waters. 375

13.1 Ecosystem considerations 375

13.2 Description of the fisheries 377

13.2.1 Inshore fleets; 377

13.2.2 Offshore fleets 378

13.3 Overview of resources 378

13.3.1 Shrimp 378

13.3.2 Snow crab 378

13.3.3 Scallops 379

13.3.4 Squids 379

13.3.5 Cod 379

13.3.6 Redfish 379

13.3.7 Greenland halibut 379

13.3.8 Lump sucker 379

13.3.9 Capelin 379

13.4 Advice on demersal fisheries 380

14 Cod Stocks in the Greenland Area (NAFO Area 1 and ICES Subdivision XIVB) 381
14.1 Stock definition 381
14.2 Information from the fisheries 381
14.2.1 The emergence and collapse of the Greenland cod fisheries 381
14.2.2 The Fishery in 2008 381
14.2.3 Length and age distributions, catch in weight at age in 2008 382
14.2.4 Information on spawning 382
14.3 Surveys 383
14.3.1 Results of the German groundfish survey off West and East Greenland 383
14.3.2 Results of the 2008 Greenland surveys in West Greenland 383
14.3.3 Results of the 2008 Greenland surveys in East Greenland 383
14.3.4 West Greenland young cod survey 383
14.3.5 State of the stock 383
14.4 Implemented management measures for 2009 383
14.5 Management considerations. 383
15 Greenland Halibut in Subareas V, VI, XII, and XIV 424
15.1 Executive summary 424
15.2 Landings, Fisheries, Fleet and Stock Perception 425
15.3 Trends in Effort and CPUE 426
15.4 Catch composition 427
15.5 Survey information 428
15.6 Stock Assessment 428
15.6.1 Summary of the various observation data 428
15.6.2 A model based assessment 429
15.6.3 Precautionary reference points 433
15.7 Management Considerations 434
15.8 Data consideration 434
15.8.1 Assessment quality 435
15.9 Communication with RG, ACOM 435
16 Redfish in Subareas V, VI, XII and XIV 475
16.1 Environmental and ecosystem information 476
16.2 Environmental drivers of productivity 476
16.2.1 Abundance and distribution of 0-group and juvenile redfish 476
16.3 Ecosystem considerations (General) 477
16.4 Description of fisheries 477
16.5 Demersal *S. mentella* in Vb, VI, and XIV 478
16.5.1 Demersal *S. mentella* in Vb 478
16.5.2 Demersal *S. mentella* in VI 478
16.5.3 Dermsal *S. mentella* in XIV 478

16.6 Regulations (TAC, effort control, area closure, mesh size etc.) 479
16.6.1 Discards and by-catches 479
16.7 Mixed fisheries, capacity and effort 480
16.8 Special comment by Sergey Melnikov 480

17 Golden redfish (*Sebastes marinus*) in Subareas V, VI and XIV 496

Summary 496
17.1 Stock description and management units 496
17.2 Scientific data 496
17.2.1 Division Va 496
17.2.2 Division Vb 497
17.2.3 Subarea XIV – not updated 497
17.3 Information from the fishing industry 498
17.3.1 Landings 498
17.3.2 Discard 498
17.3.3 Biological data from the commercial fishery 499
17.3.4 Landings by length and age 499
17.3.5 CPUE 499
17.4 Methods 500
17.4.1 Results 501
17.5 Reference points 502
17.6 State of the stock 502
17.7 Short term forecast 503
17.8 Medium term forecast 503
17.9 Uncertainties in assessment and forecast 503
17.10 Comparison with previous assessment and forecast 505
17.11 Management plans and evaluation 505
17.12 Management consideration 505
17.13 Ecosystem consideration 506
17.14 Regulation and their effects 506
17.15 Changes in fishing technology and fishing patterns 507
17.16 Changes in the environment 507

18 Icelandic slope *Sebastes mentella* in Va and XIV 530

Executive summary 530
18.1 Stock description and management units 530
18.2 Scientific data 530
18.3 Information from the fishing industry 531
18.3.1 Landings 531
18.3.2 Fisheries and fleets 531

18.3.3 Sampling from the commercial fishery 531

18.3.4 Length distribution from the commercial catch 531

18.3.5 Catch per unit effort 532

18.4 Methods 532

18.5 Reference points 532

18.6 State of the stock 532

18.7 Management considerations 533

19 Shallow Pelagic and Deep Pelagic *Sebastes mentella* 544

19.1 Stock description and management units 544

19.2 Splitting the catches between shallow pelagic and deep pelagic *S. mentella* 544

19.3 Shallow pelagic *S. mentella* 545

19.3.1 Biological sampling from the fishery 545

19.3.2 Summary of the development of the fishery 545

19.3.3 Biological information 546

19.3.4 Discards 546

19.3.5 Illegal Unregulated and Unreported Fishing (IUU) 546

19.3.6 Surveys 547

19.3.7 Methods 548

19.3.8 Reference points 548

19.3.9 State of the stock 548

19.3.10 Short term forecast 548

19.3.11 Uncertainties in assessment and forecast 548

19.3.12 Comparison with previous assessment and forecast 549

19.3.13 Management considerations 549

19.3.14 Ecosystem considerations 549

19.3.15 Changes in the environment 549

19.4 Deep pelagic *S. mentella* 550

19.4.1 Biological sampling from the fishery 550

19.4.2 Summary of the development of the fishery 550

19.4.3 Biological information 551

19.4.4 Discards 551

19.4.5 Illegal Unregulated and Unreported Fishing (IUU) 551

19.4.6 Surveys 552

19.4.7 Methods 552

19.4.8 Reference points 553

19.4.9 State of the stock 553

19.4.10 Short term forecast 553

19.4.11 Uncertainties in assessment and forecast 553

19.4.12 Comparison with previous assessment and forecast 553

19.4.13 Management considerations 553

19.4.14 Ecosystem considerations 554

Annex 1 – List of Participants **575**

Annex 2 -Technical Minutes of a review of the ICES North Western Working Group (NWWG) Report 2009 (by correspondence) **577**

Annex 3 – Stock Annexes **602**

Annex 4 Recommendations **655**

Executive summary

Demersal stocks in the Faroe Area (Division Vb and Subdivision IIa4)

Faroe Bank Cod

Landings of Faroe Bank cod amounted to 219 tonnes in 2008, which is the lowest recorded since 1992. Results from the summer and spring surveys indicate that the stock is currently well below its average level and there is no indication of strong year classes from the surveys. Exploitation The exploitation ratio has sharply decreased since 2006. In 2008 it is estimated to levels comparable to those in the 1990's for both survey indices.

Faroe Plateau cod

The assessment settings and input data were the same as in the 2008 assessment. Based on an XSA fishing mortality in 2008 (average of ages 3-7 years) was estimated at 0.76, which was considerably higher than the precautionary fishing mortality of 0.35 and also higher than the limit fishing mortality of 0.68. The total stock size (age 2+) in the beginning of 2008 was estimated at 25 000 tonnes and the spawning stock biomass at 19 000 tonnes, which was slightly below the limit biomass of 21 000 tonnes. The estimates of stock size were amongst the lowest during the 1906-2008 period.

The short term prediction until year 2011 showed a situation with a stock size of around 31 000 tonnes and a spawning stock biomass of around 19 000 tonnes.

Managers should realize the poor state of the stock. Of importance, especially the recruitment seems to be positively correlated with the total stock size of cod. It is, therefore, urgent to reduce the fishing mortality so that the stock increases. This could be achieved by extending area-closures, preferably for all fishing.

Faroe haddock

Being an update assessment, the only changes compared to last year are additions of new data from 2008 and some minor revisions of the landings data for 2006 and 2007 with corresponding revisions of the catch@age data. Based on an XSA the results are in line with those from 2008, showing a declining SSB mainly due to poor recruitment. SSB is now estimated just below B_{pa} and is predicted to be close to B_{lim} in 2010 and 2011 with status quo fishing mortality. Fishing mortality in 2008 is estimated at 0.22 (F_{pa} = 0.25) and landings in 2008 were only 7 500t. In recent years there has been a tendency to overestimate SSB and underestimate F.

Faroe Saithe

The most recent benchmark assessment was completed in 2005. Since 2006 assessments have been rejected because of a retrospective pattern believed to be due to decreased size at age. As size at age has not increased markedly, the retrospective pattern, which underestimates stock size and overestimates fishing mortality, is expected to continue to exist.

The working group concludes that the XSA assessment is useful to indicate stock trends, although the values themselves may be questionable.

Recent year classes are probably underestimated because of changes in catchability (q) due to slower growth, and fishing mortality is probably overestimated. The Faroe saithe total biomass is estimated to be above average in 2008, whereas the spawning stock biomass is estimated below average for the whole time series back to 1961.

Biological reference points for this stock need revision. This will hopefully be accomplished at a scheduled benchmark assessment in 2010.

Demersal stocks in Icelandic waters (Division Va)

Icelandic saithe

The assessment is a SALY (Same As Last Year) using the same input data with addition of one year and the same model with the same parameter settings as last year. The assessment results are very much in line with that of last year.

The stock size (B4+ and SSB) is around the long term average but fishing mortality is high in most recent year. Relatively strong recruitment is now being replaced by much lower average recruitment. A SALY advice, based on the short term prediction provided would imply very harsh measures if the stock is to be maintained above Bpa, following the advisory year.

The major issue in the development of the saithe stock, are low mean weight at age for most ages in recent years and recent changes in fishing pattern, with increasing mortality on younger fish. In addition weight at age of the older age groups, in the early part of the time series seem to be abnormally high. If they are artificially high, the dynamic range of historical SSB is much narrower than what has been used in past assessments. All the above points have implications with regards to the appropriateness of using the current reference points as the basis of the advice.

The scheduled benchmark assessment in 2010 will explore both assessment inputs and reference points. However, for next years advice the WG suggests interim reference F values to be used as the basis of the advice. The approach used is similar as has been done for Icelandic haddock, in part due to similar issues.

Icelandic cod

The total reported landings in 2008 were 147 kt. Total landings in the last 4 fishing year have been relatively close to the set TAC for the Icelandic fleet. The TAC for the current fishing year is set to 160 kt.

Mean weight at age in landings have been declining in the last 6-7 years and are in 2008 about 9 to 12 % (20 % for the small 2001 year class) below the long term average in age groups 4 to 9. Weights at age in the spring survey have also been declining over the same period and are generally very low in the 2009 survey.

Abundance indices by age from the spring and the fall surveys show that the year classes from 2001 onward are on average smaller than the ones from 1997 to 2000. The first measurement of the 2008 year class indicates that it may be above average. That year class will however not contribute significantly to the fisheries until 2013.

Based on the statistical Catch at Age Model (ADCAM), fishing mortality in 2007 is now 0.52 compared with 0.55 estimated last year. The SSB in 2008 is now estimated to have been 253 kt compared with 230 kt estimate last year. Half of this difference is caused by inclusion of the Iceland-Faeroe ridge in the survey area. The retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicates a minor but constantly downward revision of year classes 2002 and younger. Since these revisions are on pre-recruits that have not entered the fishery they have minor effect on the estimates of the post-recruit metrics.

The spawning stock has been relatively small in the last 40 year compared with the time before that. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 220 kt at present. Fishing mortality has declined significantly in recent years, the present estimate of about 0.4 not seen since the early 1960's. Year classes from 2001 to 2007 are estimated to be below the long-term average. First measurement of the 2008 year class indicates that it may above medium size or even larger. The low recruitment in recent years in addition to very low mean weight at age means that the productivity of the stock at present is very low.

Icelandic haddock

The assessment is a SALY (Same As Last Year) using the same input data with addition of one year and the same model with the same parameter settings as last year. Year-classes that are entering the fishable stock are much smaller than those disappearing so the stock is rapidly decreasing. Growth of haddock has been very slow in recent years leading to late recruitment of incoming year classes to the fishery. In this situation same age based fishing mortality means higher fishing effort than earlier. This has led to too high effort towards haddock compared to cod causing problems in mixed fisheries. The group proposes lowering the target F from 0.47 to 0.35 to keep target effort comparable to what 0.47 led to earlier.

Based on an Adapt type model tuned with both spring and autumn surveys SSB is estimated to decrease from a high since 2004 and fishing mortality has been maintained at approx 0.5 which is above Fpa. (0.47).

The main problem in current assessment is prediction of mean weight at age in the stock that is used to predict selection at age. There is still no indication of improved growth in spite of smaller year-classes.

Short term predictions show that both stock size and landings will decrease rapidly in coming years when the large year classes disappear.

Icelandic summer spawning herring

The total reported landings in 2008/09 were 152 kt, the recommended TAC was 130 kt, while the TAC was 150 kt. Around 137 kt of the catch was taken in a relatively small area in Breidafjörður, in W Iceland, similar to the preceding fishing season.

In November 2008, the herring stock was found to be seriously infected by *Ichthyophonus*. Around 32.2% of the fishing stock, as estimated in the January survey 2009, will die in the winter/spring 2009 because of the infections, which corresponds to $M_{infection}$=0.39.

Based on the SALY approach, the NFT-Adapt, the biomass of age 3+ is 628 kt and SSB is 542 kt in the beginning of year 2009. Accounting for the observed *Ichthyophonus* infection (32.2%) in that period gives estimates of surviving fish, or 426 kt of age 3+ and SSB of 367 kt. Fishing at $F_{0.1}$= 0.22 in the fishing season 2009/10 will give at catch of 75 kt, where 17% derives from the 1999 year class. This prediction is under the premises that no further *Ichthyophonus* infection occurs, which is considered unlikely because similar outbreaks in other herring stocks often last for two years. This will be verified in a survey in July 2009.

Capelin in the Iceland-East Greenland-Jan Mayen area

In 2008 no starting quota was issued due to the 2007 year class being very low. There was no official fishery because the acoustic measurements prior to the spawning gave only SSB of 320 000 t. The only catch was 15 000 t that was allocated to scouting vessels in February 2009. The stock has been at low levels the last 4 years. Only very low abundance of 1 year old capelin was measured in November- December 2008.

The advice is therefore not to open the fishery in the season 2009/10 until acoustic assessment surveys have verified that a catch can be allowed with the usual prerequisite of a remaining spawning stock of 400 000 t in March 2010 after accounting for the natural mortality.

Demersal stocks in Greenland waters

Cod stocks in Greenland

The two survey abundance indices both indicate that the Greenland cod stock is presently significantly above the very depressed state that was experienced in the 1990's. The stock is however well below historical levels. Some of the increase may be due to inflow of recruits (2003 year-class) from Iceland. Off East Greenland a small offshore spawning stock has been building up in the most recent years and spawning has been inferred since 2004. Both surveys indicate that all year classes since 2002 are larger than any of the year class since the 1985 year class. The increase is mainly attributed to occurrence of the 2003 year class that show the characteristic usually associated with Year classes of Icelandic origin. This year-class is estimated at approx. 25% of the size of the very large 1984 year class.

A multi-annual management plan should be developed to ensure that the quotas are sat at low levels until a substantial increase in biomass and recruitment is evident in the Greenland cod stocks. The management plan may incorporate the knowledge on the stock structure, inter alia, by differentiating management objectives and regulatory measures for the inshore and offshore stock components.

Greenland halibut

Input data to the Greenland halibut assessment this year is unchanged from recent years. As in 2008 a logistic production model in a Bayesian framework was used to assess stock status and for making predictions.

Estimated stock biomass showed an overall decline throughout most of the time series. Since 2004 the stock has been stable at relative low levels well below B_{MSY} and fishing mortality exceeds the value that maximizes yield (F_{MSY}). Stock biomass is estimated at $0.4B_{MSY}$, and the projected risk of exceeding this reference point will be relatively high at any catch level. Maintaining catches of 20 kt will result in a further decline of the stock and a high probability of being above F_{MSY}. Setting TAC at 5kt will likely result in an increase in stock biomass ($0.7B_{MSY}$ over a decade) and F is projected to decrease to below $0.5F_{MSY}$.

At present no formal agreement on the management of the Greenland halibut exists among the three coastal states, Greenland, Iceland, and the Faroe Islands. The regulation schemes of those states have in the recent past resulted in catches of about 25 kt compared to the recent advice by ICES of 5 kt. A basis for the advice is therefore an adaptive management plan that is coordinated among the three coastal states.

Redfish in Subareas V, VI, XII and XIV

Redfish are found in the entire North Atlantic and contribute important fishery resources around Iceland, the Faroe Islands, off Greenland and in the Irminger Sea. The management does not separate the two most important species, *Sebastes marinus* and *S. mentella*. In early 2009 the stock structure of *S. mentella*, which is found on demersal grounds and in the pelagic zone, was reviewed by WKREDS and based on their review advice is now given separately for *S. marinus*, demersal *S. mentella* on the Icelandic slope, shallow pelagic *S. mentella* and deep pelagic *S. mentella*. Adult *S.mentella* on the Greenland continental slopes likely belongs to more of the newly identified stocks and are only tabulated with respect to catches in the introductory chapter on redfish. The issue of stock structure within the S.mentella stocks was requested by NEAFC, and in ICES response to NEAFC request (as of March 2009) a complete description of the re-interpreted stock structure can be found.

*Golden redfish (*S. marinus*)*

Total landings in 2008 were about 45,000 t, about 5,000 t more than in 2007. About 99% of the catches were taken in Division Va.

The basis for advice and the relative state of the stock is based on projection derived from the analytical GADGET model and survey index series. The approach is unchanged from last year. Catch-at-age data from Va shows that the catch is dominated by two strong year classes from 1985 and 1990. It is expected that the 1990 year class will be important in the catches in the next few years, but the 1985 year class is disappearing.

Survey indices of the fishable stock in Va have decreased in recent years but increased in 2008 and is now in the vicinity of safe biological limits (Bpa). The fishable stock situation in Subarea Vb remains at a low level, but has improved in Subarea XIV. Recruitment in Va has been low since 1993 compared to the big 1985- and 1990 year-classes, but there is an indication of strong new year classes observed as 9-11 years old fish in the October survey in 2008. There are signs of improved recruitment in XIV as well.

The assessment predicts that catches in Va below 30 000 t would provide a fishable stock size above current biomass level for the next 5 year.

Demersal S.mentella *on Icelandic slopes*

Total landings of demersal *S. mentella* in Icelandic waters in 2008 were about 25 500 t, about 8 500 t more than in 2007.

No formal assessment was conducted and there are no biological reference points for the species. Survey indices are used as basis for advice. Available survey biomass indices show that in Division Va the biomass has been low but stable in the last 6 years. In recent years, good recruitment has been observed on the East-Greenland shelf which is assumed to contribute to the three stocks at unknown shares.

Deep Pelagic S.mentella

The WG was not able to evaluate the state of the stock. Based on a scheduled acoustic-trawl survey in June 2009, an assessment and advice will be provided in the autumn 2009.

Shallow *Pelagic* S.mentella

The WG was not able to evaluate the state of the stock. Based on a scheduled acoustic-trawl survey in June 2009, an assessment and advice will be provided in the autumn 2009.

1 Introduction

1.1 Terms of Reference (ToR)

1.1.1 Specific ToR

2008/2/ACOM04 The **North-Western Working Group** [NWWG] (Chair: Jesper Boje, Denmark) will meet at ICES Headquarters, 29 April – 5 May 2009 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below).

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

NWWG will report by 11 May 2009 for the attention of ACOM.

FishStock	**Stock Name**	**Stock Co-ord.**	**Assess. Coord. 1**	**Assess. Coord. 2**	**Advice**
cod-farp	Cod in Subdivision Vb2 (Faroe Bank)	Faroe Is-	Faroe Is-	Faroe	Advice
cod-farb	Cod in Subdivision Vb2 (Faroe Bank)	Faroe Is-	Faroe Is-	Faroe	Same
had-faro	Haddock in Division Vb	Faroe Is-	Faroe Is-	Faroe	Advice
sai-faro	Saithe in Division Vb	Faroe Is-	Faroe Is-	Faroe	Advice
cod-iceg	Cod in Division Va (Icelandic cod)	Iceland	Iceland	Iceland	Advice
had-iceg	Haddock in Division Va (Icelandic haddock)	Iceland	Iceland	Iceland	Advice
sai-icel	Saithe in Division Va (Icelandic saithe)	Iceland	Iceland	Iceland	Advice
her-vasu	Herring in Division Va (Icelandic summer-	Iceland	Iceland	Iceland	Advice
cap-icel	Capelin in Subareas V, XIV and Division IIa	Iceland	Iceland	Iceland	Advice
ghl-grn	Greenland halibut in Subareas V, VI, XII and	Greenland	Greenland	Iceland	Advice
smr-5614	Redfish (*Sebastes marinus*) in Subareas V, VI, XII	Iceland	Iceland	Faroe	Advice
smn-con	Redfish (*Sebastes mentella*) on the continental	Iceland	Iceland	Germany	Advice
smn-ocn	Redfish (*Sebastes mentella*) in Subareas V, VI,	Germany	Iceland	Spain	Advice
cod-ewgr	Cod in ICES Subarea XIV and NAFO Subarea 1	Greenland	Germany	Germany	Advice

1.1.2 Generic ToRs for Regional and Species Working Groups

The working group should focus on:

ToRs a) to g) for stocks that will have advice,

ToRs b) to d) and f) for stocks with same advice as last year.

ToRs b) to c) and f) for stocks with no advice.

a) Produce a first draft of the advice on the fish stocks and fisheries under considerations and the regional overview according to ACOM guidelines.

b) Update, quality check and report relevant data for the working group:

  i) Load fisheries data on effort and catches (landings, discards, bycatch, including estimates of misreporting when appropriate) in the INTERCATCH database by fisheries/fleets;

  ii) Abundance survey results;

  iii) Environmental drivers.

iv) Propose specific actions to be taken to improve the quality of the data (including improvements in data collection).

c) Produce an overview of the sampling activities on a national basis based on the INTERCATCH database);

d) In cooperation with the Secretariat, update the description of major regulatory changes (technical measures, TACs, effort control and management plans) and comment on the potential effects of such changes including the effects of newly agreed management and recovery plans.

e) For each stock update the assessment by applying the agreed assessment method (analytical, forecast or trends indicators) as described in the stock annex. If no stock annex is available this should be prepared prior to the meeting.

f) Produce a brief report of the work carried out by the Working Group. This report should summarise for the stocks and fisheries where the item is relevant:

i) Input data (including information from the fishing industry and NGO that is pertinent to the assessments and projections);

ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

iii) Stock status and 2010 catch options;

iv) Historical performance of the assessment and brief description of quality issues with the assessment;

v) Mixed fisheries overview and considerations;

vi) Species interaction effects and ecosystem drivers;

vii) Ecosystem effects of fisheries;

viii) Effects of regulatory changes on the assessment or projections;

g) Where appropriate, check for the need to reopen the advice in autumn based on the new survey information and the guidelines in AGCREFA

1.2 NWWG 2009 work in relation to the ToR

The ToR where not addressed systematically for all the stocks. The following points highlight the WG response to these ToR.

As follows of section 1.4, no data was uploaded to the ICES INTERCATCH database.

The updates of the stock annexes were only completed for some stocks. Due to limited time available some annexes were left at a status almost of last year. As has been pointed by the ICES secretariat, the updating of the annexes is most efficiently an inter-sessional task, but this task was not fulfilled by stock/assessment coordinators. It is, however, the perception of the WG that fulfilling this task is a continuous process along with change of objectives by ICES.

Due to the number of tasks that is put on WGs (Generic ToRs and bookkeeping) together with the reduced number of days allocated for the meeting, the NWWG had no time to ensure the quality of the report. Although an internal review system is setup in NWWG, the priority was put on the adoption of assessments that were basis for stock status and the premises for the forecasts. This procedure was to ensure that the basis for a proper advice was agreed upon. Further, the time allocated for advice draft (approx 2 days) reduced the number days for assessments and other business to 4-5 days.

Although a system on update and benchmark assessments has been established by ICES, arrival of new data always give rise to discussions on whether to change options for an assessment or await a benchmark assessment. For example, parasite infestations in Icelandic herring gave rise to a high mortality and question was how these infestations is expected to develop within the short time frame. It was decided to await a parasite survey in July 2009 and to implement the measured infestation rates (mortality) into a forecast that will be released after July.

S. mentella redfish stock structure was reviewed by ICES WKREDS in the early 2009 and resulted in a revised view of the stock structure. This new structure has been implemented in this report, but due to the fact that most of the data input to especially the pelagic stocks needed to be split and re-interpreted, combined with data compilation from a number of nations, these sections appears in a preliminary state with regard to conclusive statements of state of the stock. For the same reason, both pelagic stocks are provisionally put under same section (section 19), but sub-sectioned by stock. The advice for the pelagic stocks are awaiting an acoustic-trawl survey to be conducted in June/July 2009, and it is anticipated that final advice will be available in the autumn prior to the annual NEAFC meeting.

1.3 Assessment methods applied to NWWG stocks

The methods applied to assess the stock status of the NWWG stocks covers a wide range from descriptive to age based analytical assessments as follows:

Stock	*ASSESSMENT model*	*input**
Faroe Bank cod	*Descriptive*	*survey*
Faroe Haddock	*XSA*	*survey*
Faroe Saithe	*XSA*	*CPUE*
Faroe Plateau cod	*XSA*	*survey*
Iceland Saithe	*ADCAM (statistical catch at age)*	*survey*
Iceland cod	*ADCAM (statistical catch at age)*	*survey*
Iceland haddock	*Adapt type model*	*survey*
Iceland herring	*NFT-Adapt*	*survey*
Capelin	*Acoustics (absolute biomass)*	*survey*
Greenland cod	*Descriptive*	*survey*
Greenland halibut	*Stock production model (Bayesian)*	*survey+ CPUE*
S. marinus	*GADGET (age-length based cohort model)*	*survey*
S. mentella Iceland slope	*Descriptive*	*survey*
Deep pelagic S. mentella	*Descriptive*	*survey+CPUE*
Shallow pelagic S. mentella	*Descriptive*	*survey+CPUE*

* landings or landings by age are input to all assessments

1.4 InterCatch

Henrik Kjems-Nielsen from the ICES secretariat gave a presentation of the status of InterCatch (IC). Presently, the age-based assessments in the WG do not use IC. This is mainly due to the fact that most stocks in the WG, where advice is based on age-based analytical assessments, are national stocks where data are compiled at the national lab, i.e. only national fleets and surveys contribute to the assessment input. However, it is the aim that data from the gadoid stocks at Iceland and Faroe Islands will be uploaded at IC within 2009/2010.

1.5 NWWG Draft of Advice Summary Sheets

The WG used more effort this year than previously to improve and finalise the summary advice sheets. The group spent three days drafting and going through the draft advice sheets in plenary. The WG therefore appreciates any feed-back from the ADG in form of minutes that reflect justification for major changes in the advice sheet compared to the suggestion by the WG.

1.6 Recommendations

The WG experienced a number of problematic issues related to survey stratification and likely stock distribution. The character of the problems differed slightly by stock but it was recognised that a common multinational effort on this is needed to improve the quality and use of surveys as stock indicators. A survey workshop is therefore suggested to take place in 2010 within the framework of ICES as provided in the recommendation in Annex 04.

2 Demersal Stocks in the Faroe Area (Division Vb and Subdivision IIa4)

2.1 Overview

2.1.1 Fisheries

The main fisheries in Faroese waters are mixed-species, demersal fisheries and single-species, pelagic fisheries. The demersal fisheries are mainly conducted by Faroese fishermen, whereas the major part of the pelagic fisheries are conducted by foreign fishermen licensed through bilateral and multilateral fisheries agreements.

Pelagic Fisheries. Three main species of pelagic fish are fished in Faroese waters: blue whiting, herring and mackerel; several nations participate. The Faroese pelagic fisheries are almost exclusively conducted by purse seiners and larger purse seiners also equipped for pelagic trawling. The pelagic fishery by Russian vessels is conducted by large factory trawlers. Other countries use purse seiners and factory trawlers.

Demersal Fisheries. Although they are conducted by a variety of vessels, the demersal fisheries can be grouped into fleets of vessels operating in a similar manner. Some vessels change between longlining, jigging and trawling, and they therefore can appear in different fleets. The following describes the Faroese fleets first followed by the fleets of foreign nations. The number of licenses can be found in Table 2.1.3.

Open boats. These vessels are below 5 GRT. They use longline and to some extent automatic, jigging engines and operate mainly on a day-to-day basis, targeting cod, haddock and to a lesser degree saithe. A majority of open boats participating in the fisheries are operated by part-time fishermen.

Smaller vessels using hook and line. This category includes all the smaller vessels, between 5 and 110 GRT operating mainly on a day-to-day basis, although the larger vessels behave almost like the larger longliners above 110 GRT with automatic baiting systems and longer trips. The area fished is mainly nearshore, using longline and to some extent automatic, jigging engines. The target species are cod and haddock.

Longliners > 110 GRT. This group refers to vessels with automatic baiting systems. The main species fished are cod, haddock, ling and tusk. The target species at any one time is dependent on season, availability and market price. In general, they fish mainly for cod and haddock from autumn to spring and for ling and tusk during the summer. The spatial distribution is concentrated mainly around the areas closed to trawling (Figure 2.1.2). On average 92% of their catch is taken within the permanent exclusion zone for trawlers. During summer they also make a few trips to Icelandic waters.

Otter board trawlers < 500 HP. This refers to smaller fishing vessels with engine powers up to 500 Hp. The main areas fished are on the banks outside the areas closed for trawling. They mainly target cod and haddock. Some of the vessels are licensed during the summer to fish within the twelve nautical miles territorial fishing limit, targeting lemon sole and plaice.

Otter board trawlers 500-1000 HP. These vessels fish mainly for cod and haddock. They fish primarily in the deeper parts of the Faroe Plateau and the banks to the southwest of the islands.

Otter board trawlers >1000 HP. This group, also called the deep-water trawlers, target several deep-water fish species, especially redfish, blue ling, Greenland halibut, grenadier and black scabbard fish. Saithe is also a target species and in recent years they have been allocated individual quotas for cod and haddock on the Faroe Plateau. The distribution of hauls by this fleet in 2000-2005 is shown in Figure 2.1.1.

Pair trawlers <1000 HP. These vessels fish mainly for saithe, however, they also have a significant by-catch of cod and haddock. The main areas fished are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands.

Pair trawlers >1000 HP. This category targets mainly saithe, but their by-catch of cod and haddock is important to their profit margin. In addition, some of these vessels during the summers have special licenses to fish in deep water for greater silver smelt. The areas fished by these vessels are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands (Figure 2.1.1).

Gill netting vessels. This category refers to vessels fishing mainly Greenland halibut and monkfish. They operate in deep waters off the Faroe Plateau, Faroe Bank, Bill Bailey's Bank, Lousy Bank and the Faroe-Iceland Ridge. This fishery is regulated by the number of licensed vessels (8) and technical measures like depth and gear specifications.

Jiggers. Consist of a mixed group of smaller and larger vessels using automatic jigging equipment. The target species are saithe and cod. Depending on availability, weather and season, these vessels operate throughout the entire Faroese region. Most of them can change to longlines.

Foreign longliners. These are mainly Norwegian vessels of the same type as the Faroese longliners larger than 110 GRT. They target mainly ling and tusk with by-catches of cod, haddock and blue ling. Norway has a bilateral fishery agreement with the Faroes for a total quota of these species while the number of vessels can vary from year to year.

Foreign trawlers. These are mainly otter board trawlers of the same type as the Faroese otter board trawlers larger than 1 000 HP. Participating nations are United Kingdom, France, Germany and Greenland. The smaller vessels, mainly from the United Kingdom and Greenland, target cod, haddock and saithe, whereas the larger vessels, mainly French and German trawlers, target saithe and deep-see species like redfish, blue ling, grenadier and black scabbardfish. As for the foreign longliners, the different nations have in their bilateral fishery agreement with the Faroes a total quota of these species while the number of vessels can vary from year to year

2.1.2 Fisheries and management measures

The fishery around the Faroe Islands has for centuries been an almost free international fishery involving several countries. Apart from a local fishery with small wooden boats, the Faroese offshore fishery started in the late 19th century. The Faroese fleet had to compete with other fleets, especially from the United Kingdom with the result that a large part of the Faroese fishing fleet became specialised in fishing in other areas. So except for a small local fleet most of the Faroese fleet were fishing around Iceland, at Rockall, in the North Sea and in more distant waters like the Grand Bank, Flemish Cap, Greenland, the Barents Sea and Svalbard.

Up to 1959, all vessels were allowed to fish around the Faroes outside the 3 nm zone. During the 1960s, the fisheries zone was gradually expanded, and in 1977 an EEZ of 200 nm was introduced in the Faroe area. The demersal fishery by foreign nations has since decreased and Faroese vessels now take most of the catches. The fishery may be considered a multi-fleet and multi-species fishery as described below.

During the 1980s and 1990s the Faroese authorities have regulated the fishery and the investment in fishing vessels. In 1987 a system of fishing licenses was introduced. The demersal fishery at the Faroe Islands has been regulated by technical measures (minimum mesh sizes and closed areas). In order to protect juveniles and young fish, fishing is temporarily prohibited in areas where the number of small cod, haddock and saithe exceeds 30% (in numbers) in the catches; after 1–2 weeks the areas are again opened for fishing. A reduction of effort has been attempted through banning of new licenses and buy-back of old licenses.

A quota system, based on individual quotas, was introduced in 1994. The fishing year started on 1 September and ended on 31 August the following year. The aim of the quota system was, through restrictive TACs for the period 1994–1998, to increase the SSBs of Faroe Plateau cod and haddock to 52 000 t and 40 000 t, respectively. The TAC for saithe was set higher than recommended scientifically. It should be noted that cod, haddock and saithe are caught in a mixed fishery and any management measure should account for this. Species under the quota system were Faroe Plateau cod, haddock, saithe, redfish and Faroe Bank cod.

The catch quota management system introduced in the Faroese fisheries in 1994 was met with considerable criticism and resulted in discarding and in misreporting of substantial portions of the catches. Reorganisation of enforcement and control did not solve the problems. As a result of the dissatisfaction with the catch quota management system, the Faroese Parliament discontinued the system as from 31 May 1996. In close cooperation with the fishing industry, the Faroese government has developed a new system based on individual transferable effort quotas in days within fleet categories. The new system entered into force on 1 June 1996. The fishing year from 1 September to 31 August, as introduced under the catch quota system, has been maintained.

The individual transferable effort quotas apply to 1) the longliners less than 110 GRT, the jiggers, and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 110 GRT. The single trawlers greater than 400 HP do not have effort limitations, but they are not allowed to fish within the 12 nautical mile limit and the areas closed to them, as well as to the pair trawlers, have increased in area and time. Their catch of cod and haddock is limited by maximum by-catch allocation. The single trawlers less than 400 HP are given special licenses to fish inside 12 nautical miles with a by-catch allocation of 30% cod and 10% haddock. In addition, they are obliged to use sorting devices in their trawls in order to minimize their by-catches. One fishing day by longliners less than 110 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 110 GRT could therefore double their allocation by converting to jigging. Table 2.1.1 shows the number of fishing days used by fleet category for 1985–1995 and 1998–2008 and Table 2.1.2 shows the number of allocated days inside the outer thick line (the "ring") in Figure 2.1.2. Holders of individual transferable effort quotas who fish outside this line can fish for 3 days for each day allocated inside the line. Trawlers are generally not allowed to fish inside the 12 nautical mile limit. Inside the innermost thick line only longliners less than 100 GRT and jiggers less than 110 GRT are allowed to fish. The Faroe Bank shallower than 200 m is closed to trawling. Due to the serious decline of the Faroe Bank cod, the Bank has been closed since 1 January 2009 for all gears.

The fleet segmentation used to regulate the demersal fisheries in the Faroe Islands and the regulations applied are summarized in Table 2.1.3.

The effort quotas are transferable within gear categories. The allocations of number of fishing days by fleet categories was made such that together with other regulations of the fishery they should result in average fishing mortalities on each of the 3 stocks of 0.45, corresponding to average annual catches of 33% of the exploitable stocks in numbers. Built into the system is also an assumption that the day system is self-regulatory, because the fishery will move between stocks according to the relative availability of each of them and no stock will be overexploited. These target fishing mortalities have been evaluated during the 2005 and 2006 NWWG meetings (2.1.6) The realized fishing mortalities have been substantially higher than the target for cod, appear to have exceeded the target for saithe in recent years, while for haddock, fishing mortality remains below the target.

As can been seen in Table 2.1.2, there have been some reductions in the number of allocated fishing days in order to reduce the fishing mortality; for the present fishing year the number of days were reduced by 10%. From Table 2.1.1 it can be seen that the actual number of fishing days used by the fleets was reduced for 2008 and available information indicate that this also applies to 2009. Reasons are small catch rates combined with high costs of fishing.

In addition to the number of days allocated in the law, it is also stated in the law what percentage of total catches of cod, haddock, saithe and redfish, each fleet category on average is expected to fish. These percentages are as follows:

Fleet category	Cod	Haddock	Saithe	Redfish
Longliners < 110GRT,				
jiggers, single trawl. < 400HP	51 %	58 %	17.5 %	1 %
Longliners > 110GRT	23 %	28 %		
Pairtrawlers	21 %	10.25 %	69 %	8.5 %
Single trawlers > 400 HP	4 %	1.75 %	13 %	90.5 %
Others	1 %	2 %	0.5 %	0.5 %

The technical measures as mentioned above are still in effect.

2.1.3 The marine environment

The waters around the Faroe Islands are in the upper 500 m dominated by the North Atlantic current, which to the north of the islands meets the East Icelandic current. Clockwise current systems create retention areas on the Faroe Plateau (Faroe shelf) and on the Faroe Bank. In deeper waters to the north and east and in the Faroe Bank channel is deep Norwegian Sea water, and to the south and west is Atlantic water. From the late 1980s the intensity of the North Atlantic current passing the Faroe area decreased, but it has increased again in the most recent years. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. This applies also to the recruitment of many fish stocks, and the growth of the fish was poor as well. From 1992 onwards the conditions have returned to more normal values which also is reflected in the fish landings. There has been observed a very clear relationship, from primary production to the higher trophic levels (including fish and seabirds), in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Gaard, E. et al. 2001). There is a positive relationship between primary production and the cod and haddock individual fish growth and recruitment 1-2 years later. The primary production indices have been below average since 2002 except for 2004 and 2008 when it was above average. The estimate of primary production in 2009 will not be available until July, but preliminary estimates suggest it to be at the same level as in 2008. It will have little effect on the spawning stock size in the short term, but recruitment and total stock biomass will likely be improved. Potential positive effect on the recruitment will not influence the fishery before 2-3 years. The effects of primary production on catchability are discussed further in section 2.1.4 below.

The index of primary production applies to the shallow waters around Faroe Island (Faroe Shelf, depth < 130 m) whereas little has been known about the primary production or food availability over the deeper areas. In 2008 new information became available on the productivity over the deep areas and is outlined in Working Document 20 from last year (Steingrund and Hátún, 2008). The working document describes an empirical relationship between the strength of the subpolar gyre (SPG) and the biomass of saithe in Faroese waters four years later. An index was developed that described the strength of the gyre. The gyre index was given the opposite sign of the strength/extension of the SPG so that the index was positively related to temperature and phytoplankton/zooplankton abundance in a large area south-west of the Faroe Islands and saithe biomass at the Faroes. There was a strong positive relationship between the gyre index and the total biomass of saithe in Faroese waters four years later over a 40-year period, the causal link hypothesized to be food availability. The relationship between the gyre index and saithe suggested that saithe biomass estimated in the 2008 SPALY XSA assessment was underestimated in the recent years.

The temporal development of the gyre index was different from the phytoplankton index over the shallow areas, these two indices often showing opposite trends, especially during recent years when phytoplankton production has been low whereas the gyre index has been high (Figure 2.1.3). This means that the conditions are poor for cod and haddock, which are strongly influenced by the phytoplankton index whereas the conditions for saithe are good. The overall situation for the Faroese fisheries in 2009 seems therefore not as bad as in the beginning of the 1990s when both these indices were low and the three species had low biomasses.

The hydrographical conditions over the deep areas also seem to affect Greenland halibut. There seems to be a negative relationship between the gyre index and the abundance/catches of Greenland halibut in Faroese waters some three years later (Steingrund and Hátún, 2009: working document 9). It is hypothesized that warmer-than-average surface water masses lead to a decrease in the preferred water masses for Greenland halibut in the deep waters (400-600 m) at the Faroes around three years later and vice versa.

2.1.4 Catchability analysis

In an effort management regime with a limited numbers of fishing days, it is expected that vessels will try to increase their efficiency (catchability) as much as possible in order to optimise the catch and its value within the number of days allocated. "Technological creeping" should therefore be monitored closely in such a system. However, catchability of the fleets can change for other reasons, e.g. availability of the fish to the gears. If such effects are known or believed to exist, catchability changes may need to be incorporated in the advice on fisheries.

The primary production of the Faroe Shelf ecosystem may vary by as much as a factor of five and given the link between primary production and recruitment and growth (production) of cod as demonstrated by Steingrund & Gaard (2005), this could have pronounced effects on catchability and stock assessment as a whole. Below are the results from an analysis regarding Faroe Plateau cod, Faroe haddock and Faroe saithe.

For cod there seems to be a link between the primary production and growth of cod (Fig. 2.1.4). The primary production seems to be negatively correlated with the catchability of longlines (Figure 2.1.5), suggesting that cod attack longline baits more when natural food abundance is low. Since longliners usually take a large proportion of the cod catch, the total fishing mortality fluctuates in the same way as the long line catchability and thus there is a negative relationship between primary production and fishing mortality (Fig. 2.1.6).

Also for haddock there seems to be similar relationship between primary production, growth, catchability and fishing mortality as for cod. The negative relationship between primary production and fishing mortality as shown in Fig. 2.1.7 suggests, that the same mechanism is valid for haddock as for cod.

It is, however, important to note that the relationship between the productivity of the ecosystem and the catchability of long lines depends on the age of the fish. For cod, the relationship is most clear for age 5 and older; for age 3 and 4, the relationship is less clear. For young haddock there apparently is no such relationship between productivity and catchability.

For saithe no clear relationship was observed between the catchability for the Cuba pair trawlers (pair trawlers take the majority of the catch) and other variables such as primary production, growth and stock size.

The analysis reported above suggests that natural factors may have a larger influence than technological ones, at least for Faroe Plateau cod and Faroe haddock on changes in catchability. In addition, the available data indicate that there has not been sufficient time since the implementation of the effort management system in 1996 to detect convincing changes in catchability. However, from a management perspective, if the hypothesis that catchability is related to productivity is true, and if productivity is low, there is the potential for very high fishing mortality to be exerted on cod. It could therefore be prudent to consider substantial reductions in fishing effort when periods with low primary production occur.

2.1.5 Summary of the 2009 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the 2009 assessment of Faroe Plateau cod, Faroe haddock and Faroe saithe is shown in Figure 2.1.8. As mentioned in previous reports of this WG, landings of cod, haddock and saithe on the Faroes appear to be closely linked with the total biomass of the stocks. For cod, the exploitation ratio and fishing mortality has remained relatively stable over time, although they have been more fluctuating in recent years. For haddock, the exploitation rate was decreasing from the 1950s and 1960s, , while it would have been relatively steady since the mid 1970s. For saithe, there is a suggestion that the exploitation rate was increasing at the beginning of the period, it decreased from the early 1990s to 1998 and has increased since to close to the highest values observed.

Another main feature of the plots of landings, biomasses, mortalities and recruitment is the apparent periodicity during the time series with cod and haddock showing almost the same trends..

2.1.6 Reference points for Faroese stocks and evaluation of the Faroese management system

The NWWG has evaluated the relevance of existing reference points for Faroese demersal stocks on several occasions in recent years, mostly by investigating the development of fishing mortality and SSB and by doing medium term simulations. Except for the biomass reference points for Faroe Plateau cod, which are considered appropriate, the NWWG suggested changes to all other reference points and did so again in 2007 based on the guidelines provided in the report of the Study Group on Precautionary Reference Points for Advice on Fishery Management, held at ICES HQ from 24-26 February 2003 (SGPRP 2003) and the results of the current assessments. A summary of past work by the NWWG was presented at the end of this reference points section in the 2007 overview. ICES revised the haddock biomass reference points in 2007 but not those for saithe because the assessment was not accepted due to retrospective pattern where biomass was consistently underestimated. The fishing mortality reference points need also to be revised for the three Faroese stocks.

2.1.7 Faroe saithe

The NWWG understands that ICES could not revise the biomass reference points for Faroe saithe because the assessment was not accepted. Figure 6.5.1.2 of the 2009 SPALY XSA assessment shows that recruitment is not impaired at 60 000t, the current Blim. Larger year classes appear to have been observed at the lower end of the SSB range. As suggested by SGPRP 2003, NWWG 2005 and NWWG 2006, Bloss for Faroe saithe should be interpreted as Bpa, not as Blim, that is Bpa = 60 000t. Blim could be arbitrarily set prudently lower at 45-50 000t until more stock and recruitment pairs are observed or it could be left undefined. Fishing mortality reference points remain to be identified.

2.1.8 Review of the management system

The Faroese authorities have set up a committee to review the effort management system implemented in 1996, consistent with a NWWG 2007 recommendation. The members of the Fisheries Efficiency Committee participate in a personal capacity and cover expertise in trawl and linefisheries, fisheries biology and stock assessment, the Faroese fishing industry, fisheries technology and capacity, fisheries economy and fisheries law and administration. A report was made available during summer 2008 but the results are not very conclusive and could not be used directly by this WG.

2.1.9 References:

Gaard. E., Hansen, B., Olsen, B and Reinert, J. 2001. Ecological features and recent trends in physical environment, plankton, fish stocks and sea birds in the Faroe plateau ecosystem. In: K- Sherman and H-R Skjoldal (eds). Changing states of the Large Marine Ecosystems of the North Atlantic.

Steingrund, P., and Gaard, E. 2005. Relationship between phytoplankton production and cod production on the Faroe Shelf. ICES Journal of Marine Science, 62: 163-176.Steingrund, P., and Hátún, H. 2008. Relationship between the North Atlantic subpolar gyre and fluctuations of the saithe stock in Faroese waters. NWWG 2008 Working Document 20.

Table 2.1.1. Number of fishing days used by various fleet groups in Vb1 1985-95 and 1998-08. For other fleets there are no effort limitations. Catches of cod, haddock saithe and redfish are regulated by the by-catch percentages given in section 2.1.1. In addition there are special fisheries regulated by licenses and gear restrictions. (This is the real number of days fishing not affected by doubling or tripling of days by changing areas/gears)

Year	Longliner 0-110 GRT, jiggers, trawlers < 400 HP	Longliners > 110 GRT	Pairtrawlers
1985	13449	2973	8582
1986	11399	2176	11006
1987	11554	2915	11860
1988	20736	3203	12060
1989	28750	3369	10302
1990	28373	3521	12935
1991	29420	3573	13703
1992	23762	2892	11228
1993	19170	2046	9186
1994	25291	2925	8347
1995	33760	3659	9346
Average(85-95)	22333	3023	10778
1998	23971	2519	6209
1999	21040	2428	7135
2000	24820	2414	7167
2001	29560	2512	6771
2002	30333	2680	6749
2003	27642	2196	6624
2004	22211	2728	7059
2005	21829	3123	6377
2006	14094	2764	5411
2007	10653	3279	5971
2008	10212	2827	3722
Average(98-08)	21488	2679	6290

Table 2.1.2. Number of allocated days for each fleet group since the new management scheme was adopted and number of licenses per fleet (by May 2006).

Fishing year	Group 1 Single trawlers > 400 HP	Group 2 Pair trawlers > 400 HP	Group 3 Longliners > 110 GRT	Group 4 Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	Group 5 Longliners and jiggers < 15 GRT
1996/1997	Regulated by area and by-catch limitations	8225	3040	9320	22000
1997/1998		7199	2660	9328	23625
1998/1999		6839	2527	8861	22444
1999/2000		6839	2527	8861	22444
2000/2001		6839	2527	8861	22444
2001/2002		6839	2527	8861	22444
2002/2003		6771	2502	8772	22220
2003/2004		6636	2452	8597	21776
2004/2005		6536	2415	8468	21449
2005/2006		5752	3578	5603	21335
2006/2007		5752	3471	5435	20598
2007/2008		5637	3402	5327	20186
2008/2009		5073	3062	4795	18167
No. of licenses	12	29	25	65	593

	Fleet segment	Sub groups		Main regulation tools
1	Single trawlers > 400 HP	*none*		Bycatch quotas, area closures
2	Pair trawlers > 400 HP	*none*		Fishing days, area closures
3	Longliners > 110 GRT	*none*		Fishing days, area closures
4	Coastal vessels>15 GRT	4A	Trawlers 15-40 GRT	Fishing days
		4A	Longliners 15-40 GRT	Fishing days
		4B	Longliners>40 GRT	Fishing days
		4T	Trawlers>40 GRT	Fishing days
5	Coastal vessels <15 GRT	5A	Full-time fishers	Fishing days
		5B	Part-time fishers	Fishing days
6	Others		Gillnetters	Bycatch limitations, fishing depth, no. of nets
			Others	Bycatch limitations

Table 2.1.3. Main regulatory measures by fleet in the Faroese fisheries in Vb. The fleet capacity is fixed, based on among other things no. of licenses. Number of licenses within each group (by May 2006) are as follows: 1: 12; 2:29; 3:25; 4A: 25; 4B: 21; 4T: 19; 5A:140; 5B: 453; 6: 8. These licenses have been fixed in 1997, but in group 5B a large number of additional licenses can be issued upon request.

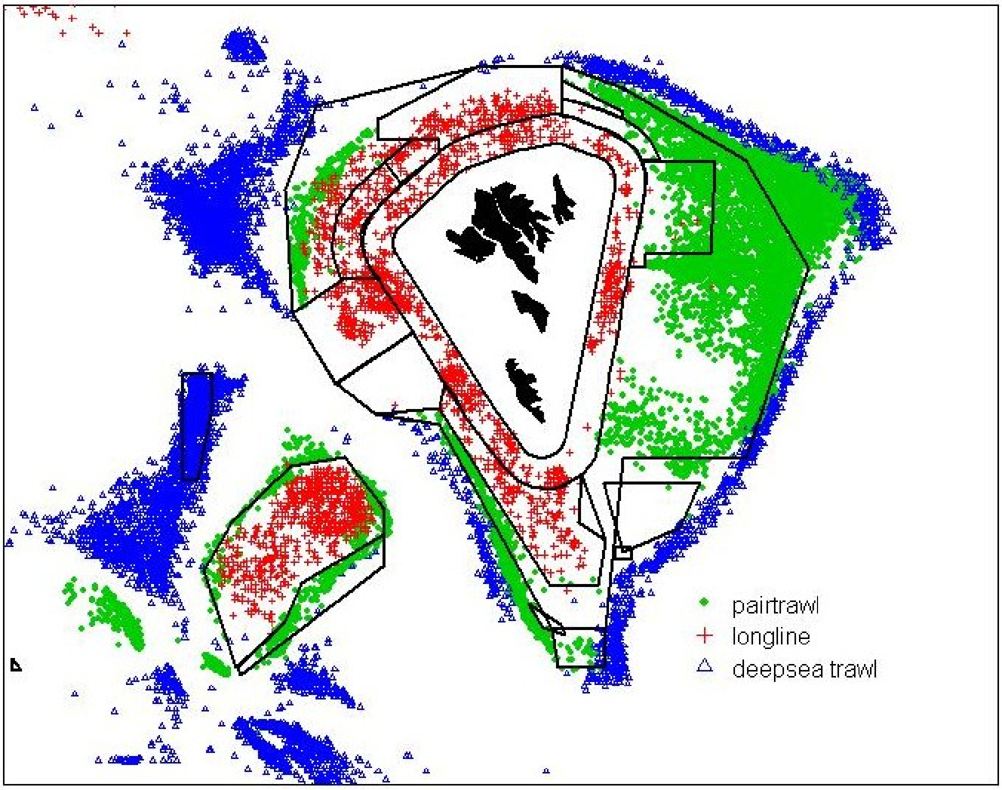
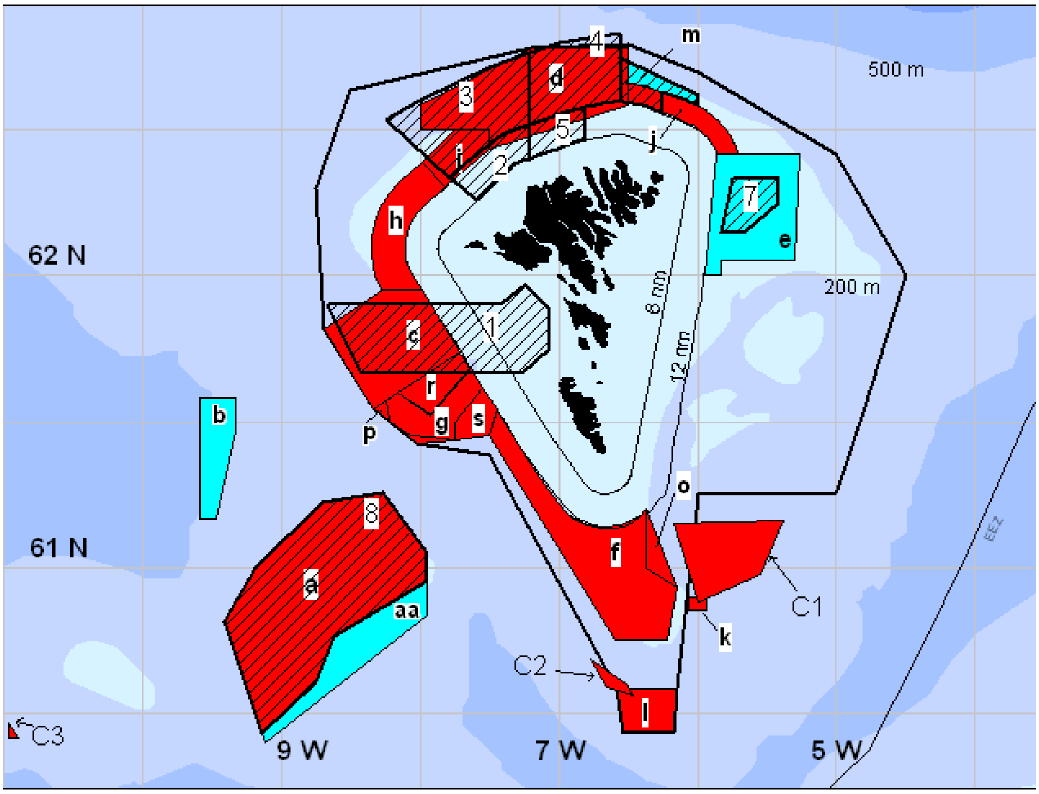


Figure 2.1.1. The 2000-2005 distribution of fishing activities by some major fleets.



Exclusion zones for trawling

Area	Period
a	1 jan - 31 des
aa	1 jun - 31 aug
b	20 jan - 1 mar
c	1 jan - 31 des
d	1 jan - 31 des
e	1 apr - 31 jan
f	1 jan - 31 des
g	1 jan - 31 des
h	1 jan - 31 des
i	1 jan - 31 des
j	1 jan - 31 des
k	1 jan - 31 des
l	1 jan - 31 des
m	1 feb - 1 jun
n	31 jan - 1 apr
o	1 jan - 31 des
p	1 jan - 31 des
r	1 jan - 31 des
s	1 jan - 31 des
C1	1 jan - 31 des
C2	1 jan - 31 des
C3	1 jan - 31 des

Spawning closures

Area	Period
1	15 feb - 31 mar
2	15 feb - 15 apr
3	15 feb - 15 apr
4	1 feb - 1 apr
5	15 jan - 15 mai
6	15 feb - 15 apr
7	15 feb - 15 apr
8	1 mar - 1 may

Figure 2.1.2. Fishing area regulations in Division Vb. Allocation of fishing days applies to the area inside the outer thick line on the Faroe Plateau. Holders of effort quotas who fish outside this line can triple their numbers of days. Longliners larger than 110 GRT are not allowed to fish inside the inner thick line on the Faroe Plateau. If longliners change from longline to jigging, they can double their number of days. The Faroe Bank shallower than 200 m depths (a, aa) is regulated separate from the Faroe Plateau. It is closed to trawling and the longline fishery is regulated by individual day quotas.

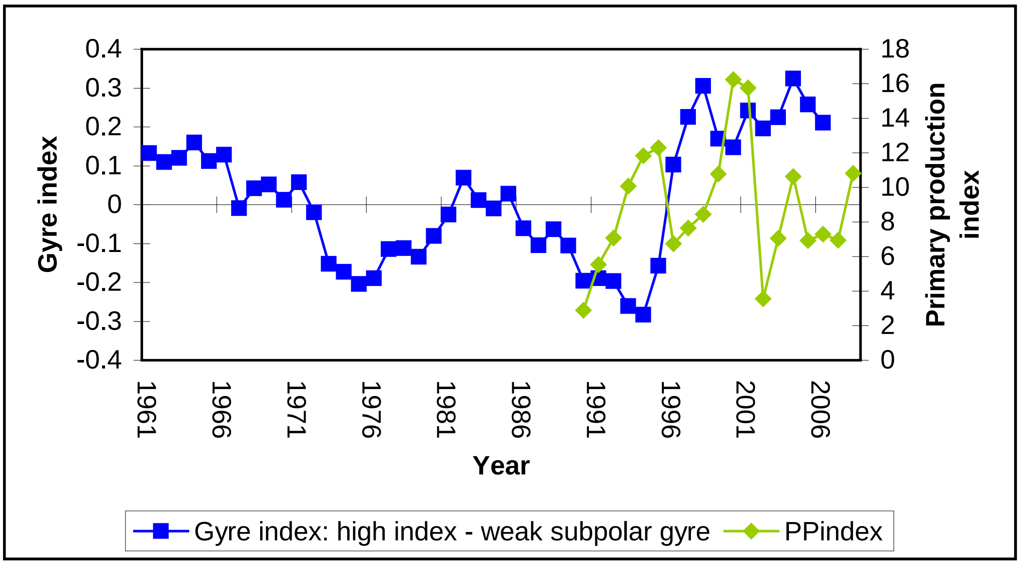


Figure 2.1.3. Temporal development of the phytoplankton index over the Faroe Shelf area (< 130 m) and the subpolar gyre index which indicates productivity in deeper waters.

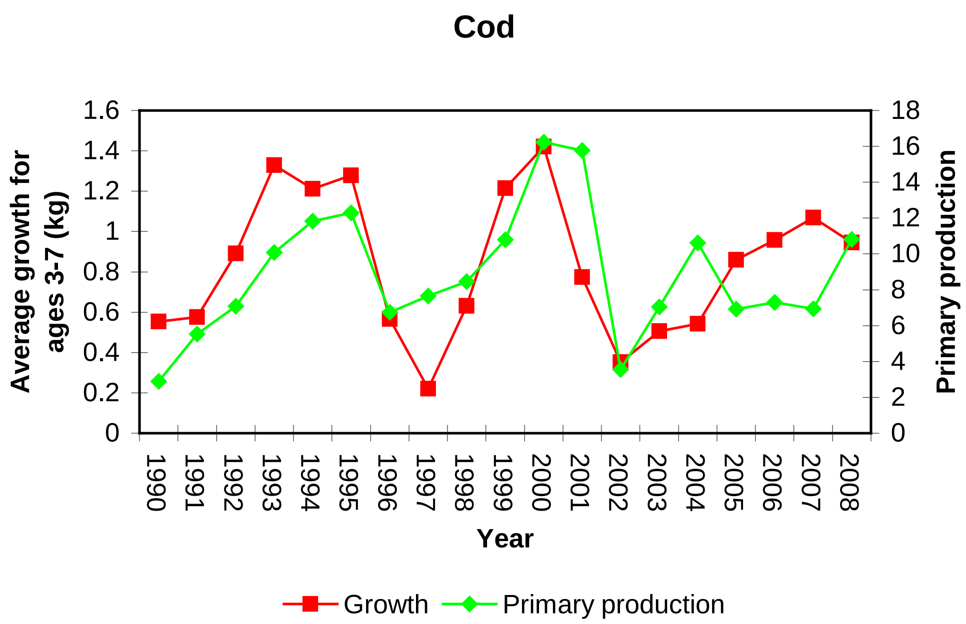


Figure 2.1.4 Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

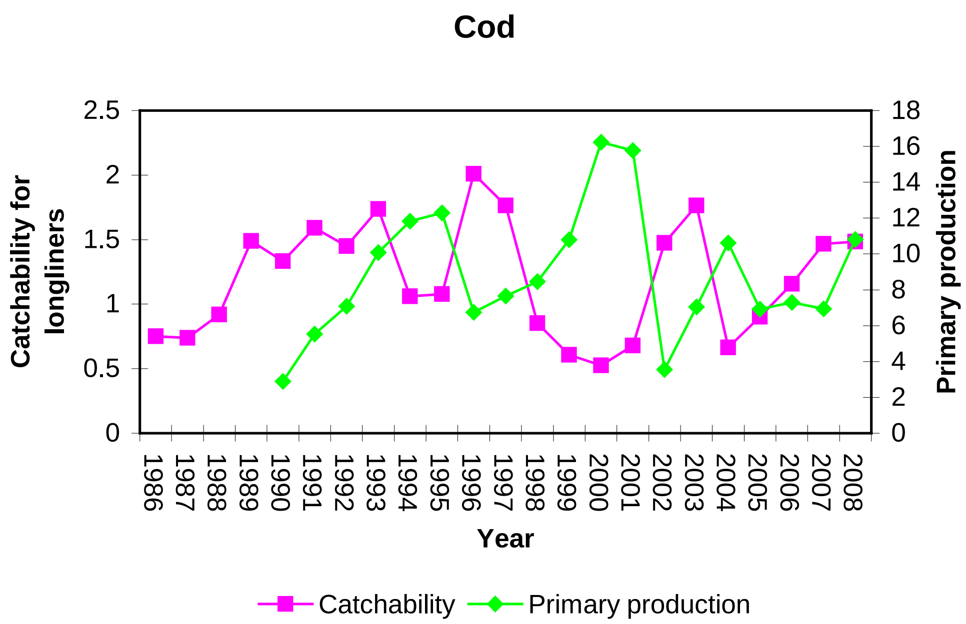


Figure 2.1.5. Faroe Plateau Cod. Relationship between long line catchability and primary production.

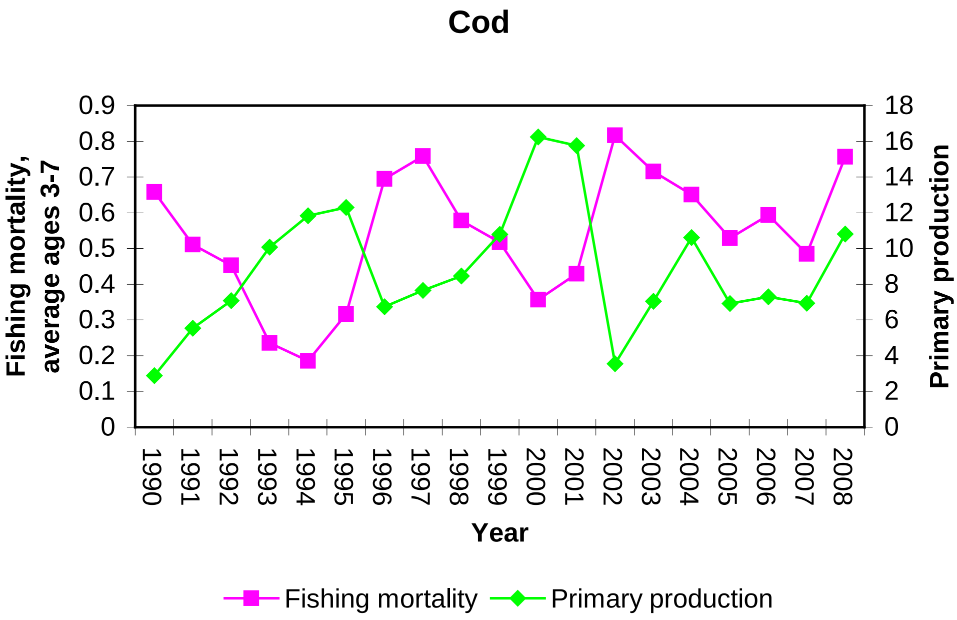


Figure 2.1.6. Faroe Plateau Cod. Relationship between fishing mortality and primary productivity.

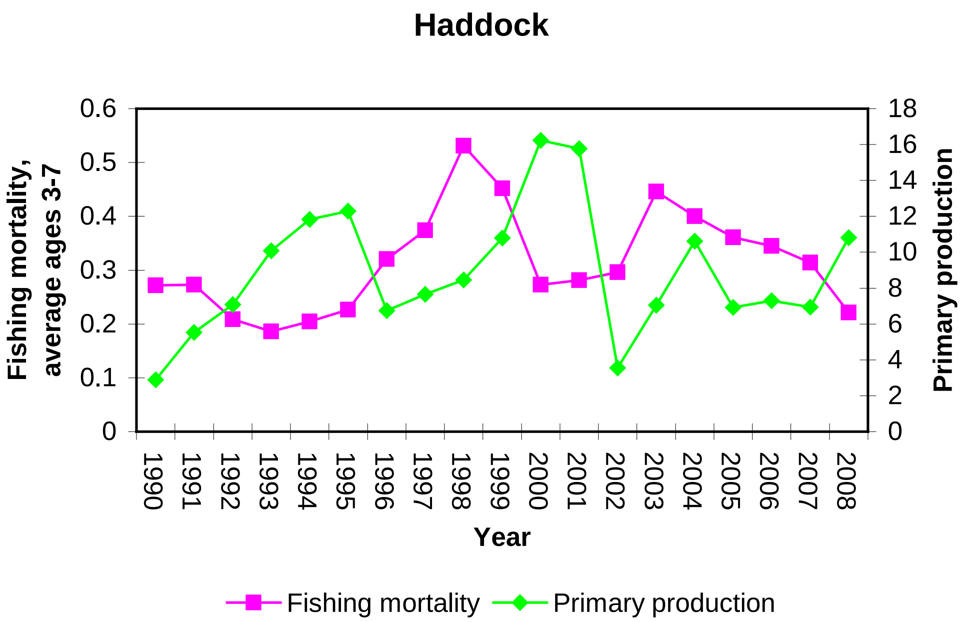


Figure 2.1.7. Faroe Haddock. Relationship between fishing mortality and primary productivity.

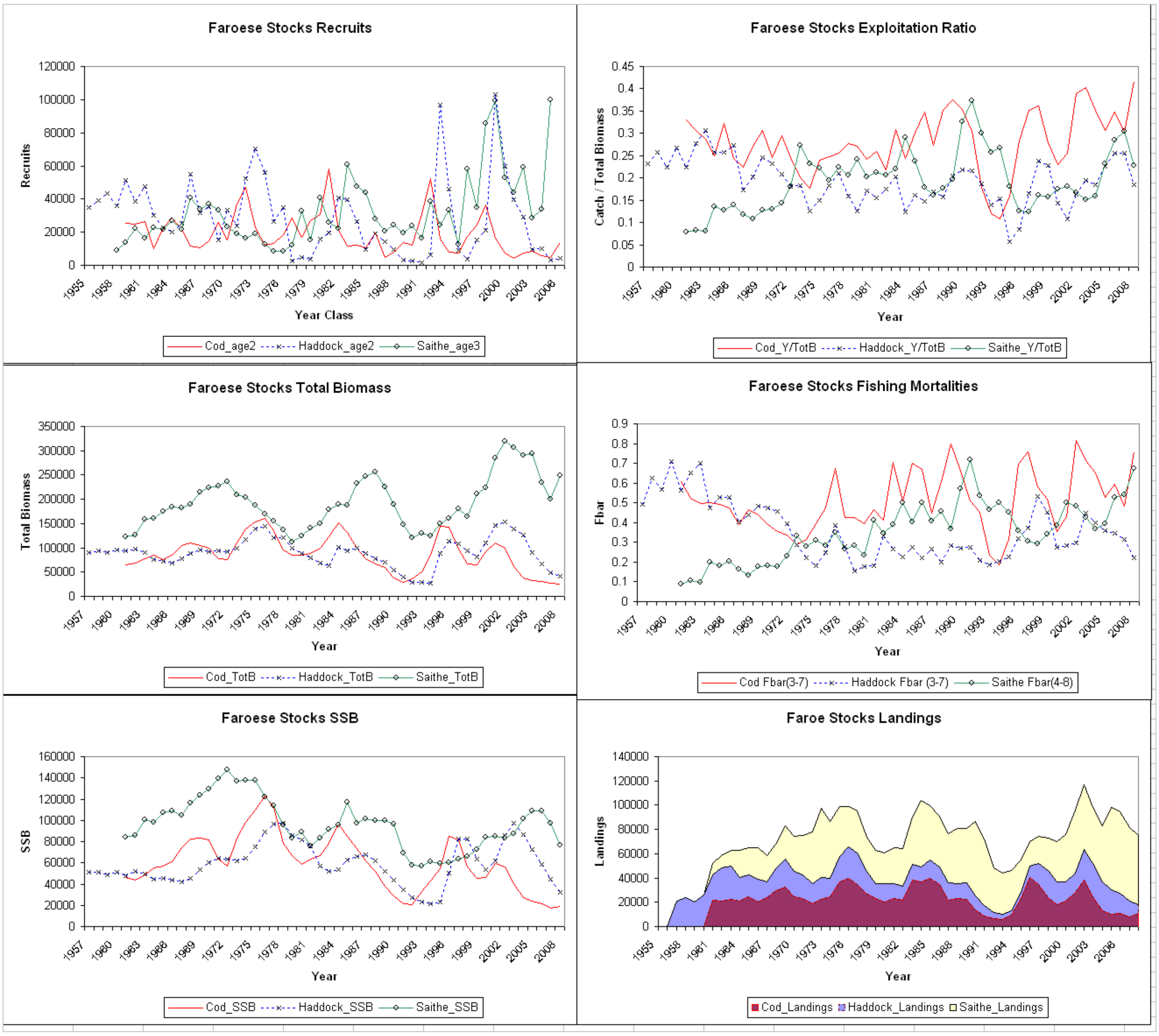


Figure 2.1.8. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2009 stock summary. The Faroe saithe assessment is exploratory, recent estimates uncertain.

3 Faroe Bank Cod

Summary

- The total reported landings in 2008 were 219 tonnes the lowest since 1992.
- The summer and spring index suggest the stock is well below average while there is no indication of strong incoming year classes.
- The exploitation ratio has sharply decreased since 2006. In 2008 it is estimated to levels comparable to those in the 1990’s for both survey indices.

3.1 State of the stock - historical and compared to what is now.

Total nominal catches of the Faroe Bank cod from 1987 to 2008 as officially reported to ICES are given in Table 3.7.1 and since 1965 in Figure 3.7.1 UK catches reported to be taken on the Faroe Bank are all assumed to be taken on the Faroe Plateau and are therefore not used in the assessment. Landings have been highly variable from 1965 to the mid-1980s, reflecting the opportunistic nature of the cod fishery on the Bank, with peak landings slightly exceeding 5 000t in 1973 and 2003. The trend of landings has been smoother since 1987, declining from about 3 500t in 1987 to only 330 t in 1992 before increasing to 3 600t in 1997. In 2008 landings were estimated at 219t less than half the previous year (Figure 3.7.1). Longline fishing effort increased substantially in 2003 and although it decreased in 2004 and 2005 the latter remains the second highest fishing effort observed since 1988 (Figure 3.7.1). Since 2006 the effort has been reduced substantially to about the same levels as in early 1990s.

[ToR 11] The Faroese groundfish surveys (spring and summer) cover the Faroe Bank and cod is mainly taken within the 200 m depth contour. The catches of cod per trawl hour in depths shallower than 200 meter are shown in Figure 3.7.2.

The spring survey was initiated in 1983 and discontinued in 2004 and 2005. The summer survey has been carried out since 1996. The CPUE of the spring survey was low during 1988 to 1995 varying between 73 and 95 kg per tow. Although noisy, the survey suggests higher, possibly increasing biomass during 1995 - 2003. The 2009 index is 74 kg per tow, which is slightly lower than in 2007 and thus well below the average in the period 1996-2004. The 2008 summer index (33 kg per tow) is almost the same as in 2007. The agreement between the summer and spring index is good during 1996 to 2001 and since 2006, but they diverged in 2002 and 2003.

The figure of length distributions (figure 3.7.3 and figure 3.7.4) show in general good recruitment of 1 year old in the summer survey from 2000 – 2002 (lengths 26 – 45 cm), corresponding to good recruitment of 2 years old in the spring surveys from 2001 to 2003 (40 – 60 cm). The spring index shows poor recruitment from 2006 to 2009 reflecting the weak year classes observed in the summer survey since 2004.

The recruitment is estimated by simply counting the number of fish in length groups in the surveys. In the spring index, recruitment was estimated as total number of fish below 60 cm (2-year old) and in the summer index as number of fish below 45 cm (1-year old). According to the summer index the recruitment of 1 year old has been good from 2000 to 2003, while the recruitment has been relatively poor since 2004. The spring recruitment index in 2009 shows no sign of incoming year classes (Figure 3.7.5a). Figure 3.7.5b shows a fairly good correlation between spring and summer survey recruitment (r^2=0.82)

Figure 3.7.6 shows a positive correlation between the survey indices and the landings in the same year, but the relationship between the summer survey and the landings deteriorates in 2003. The ratio of landings to the survey indices provides an exploitation ratio, which can be used as a proxy to relative changes in fishing mortality. For the summer survey, the results suggest that fishing mortality has been reasonably stable during 1996 to 2002, but that it increased steeply in 2003, consistent with the 160% increase in longline fishing days in that year (Figure 3.7.1). The exploitation ratio has decreased since 2006 and in 2008 it is estimated to levels close to those in the 1996-2002.

3.2 Comparison with previous assessment and forecast

The status of the stock remains almost unchanged with respect to last year assessment. Both the spring and the summer indexes suggest the stock is well below average while there are no indications of incoming recruitment.

3.3 Management plans and evaluations (Could just be a reference to the year when the plan was agreed/evaluated. Include proposed/agreed management plan.)

None

3.4 Management considerations (what do managers need to consider when managing this stock.)

The landing estimates are uncertain because since 1996 vessels are allowed to fish both on the Plateau and on Faroe Bank during the same trip, rendering landings from both areas uncertain. Given the relative size of the two fisheries, this is a bigger problem for Faroe Bank cod than for Faroe Plateau cod, but the magnitude remains unquantified for both. The ability to provide advice depends on the reliability of input data. If the cod landings from Faroe Bank are not known, it is difficult to provide advice. If the fishery management agency intends to manage the two fisheries to protect the productive capacity of each individual unit, then it is necessary to identify the catch removed from each stock. Simple measures should make it possible to identify if the catch is originating from the Bank or from the Plateau e.g. by storing in different section of the hold and/or by tagging of the different boxes.

Consistent with the advice given in 2008 the WG suggests the closure of the fishery until the recovery of the stock is confirmed. The reopening of the fishery should not be considered until both surveys indicate a biomass at or above the average that of the period 1996-2002.

3.5 Regulations and their effects (Include new regulations (e.g. gear restrictions, TAC etc). Focus on effects of regulations.)

In 1990, the decreasing trend in cod landings from Faroe Bank lead ACFM to advise the Faroese authorities to close the bank to all fishing. This advice was followed for depths shallower than 200 meters. In 1992 and 1993 longliners and jiggers were allowed to participate in an experimental fishery inside the 200 meters depth contour. For the quota year 1 September 1995 to 31 August 1996 a fixed quota of 1 050 t was set. The new management regime with fishing days was introduced on 1 June 1996 allowing longliners and jiggers to fish inside the 200 m contour. The trawlers are allowed to fish outside the 200 m contour.

A total fishing ban during the spawning period (1 March to 1 May) has been enforced since 2005. In 2009 fishing was restricted to all fishing gears from 1 January to 31 August.

3.6 Changes in fishing technology and fishing patterns

None

3.7 Changes in the environment

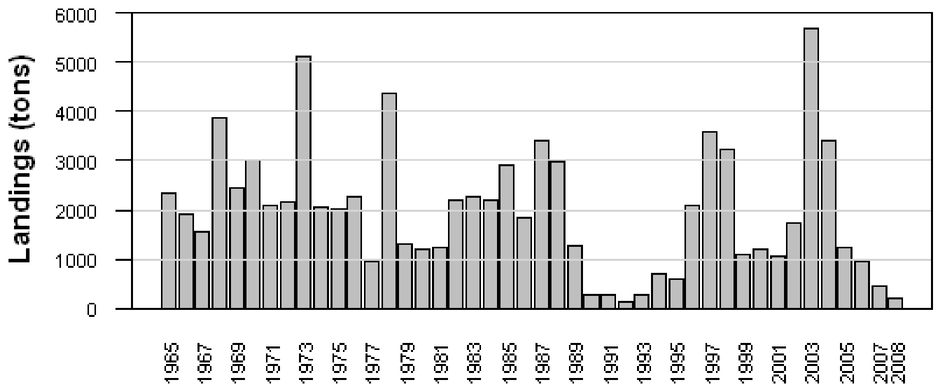
None

Table 3.7.1. Faroe Bank (sub-division Vb2) cod. Nominal catches (tonnes) by countries 1986-2008 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	
Faroe Islands	1836	3409	2966	1270	289	297	122	264	717	561	2051	
Norway	6	23	94	128	72	38	32	2	8	40	55	
UK (E/W/NI)	-	-	-	-	2 [2]	1 [2]	74 [2]	186 [2]	56 [2]	43 [2]	126 [3]	
UK (Scotland)	63 [3]	47 [3]	37 [3]	14 [3]	205 [3]	90 [3]	176 [3]	118 [3]	227 [3]	551 [3]	382 [3]	
Total	1905	3479	3091	1412	566	425	330	385	953	1152	2488	
Used in assessment					289	297	154	266	725	601	2106	

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Faroe Islands	3459	3092	1001		1094	1840	5957	3607	1270	1005	471	232 *
Norway	135	147	88	49	51	25	72	18	37	10	7	1 *
UK (E/W/NI)	61 [3]	27 [3]	51 [3]	18 [3]	50 [3]	42 [3]	15 [3]	15 [3]	24 [3]	1 [3]		
UK (Scotland)	277 [3]	265 [3]	210 [3]	245 [3]	288 [3]	218 [3]	254 [3]	244 [3]	1129 [3]	278 [3]	53	
Total	3871	3504	1350	312	1483	2125	6298	3884	2460	1294	531	233 *
Correction of Faroese catches in Vb2					-65	-109	-353	-214	-75	-60	-28	-14
Used in assessment	3594	3239	1089	1194	1080	1756	5676	3411	1232	955	450	219 *

[*] Preliminary
[1] Includes Vb1.
[2] Included in Vb1.
[3] Reported as Vb.



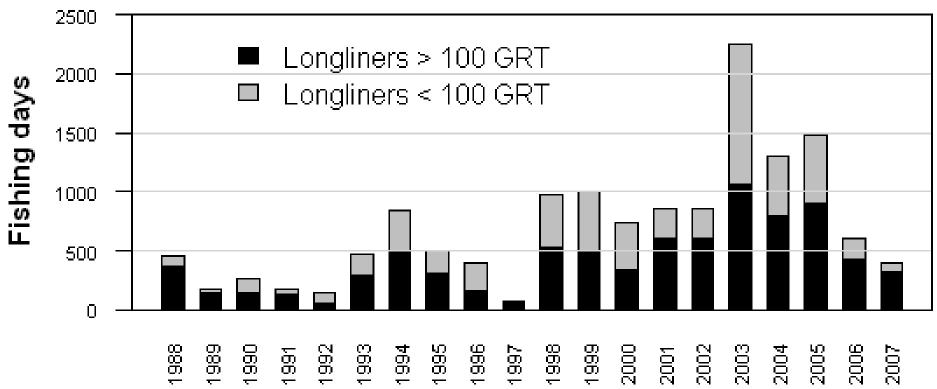


Figure 3.7.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2008. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days 1988-2007 for long line gear type in the Faroe Bank (exerted)(fishing days for 2008 were not available to the WG.)

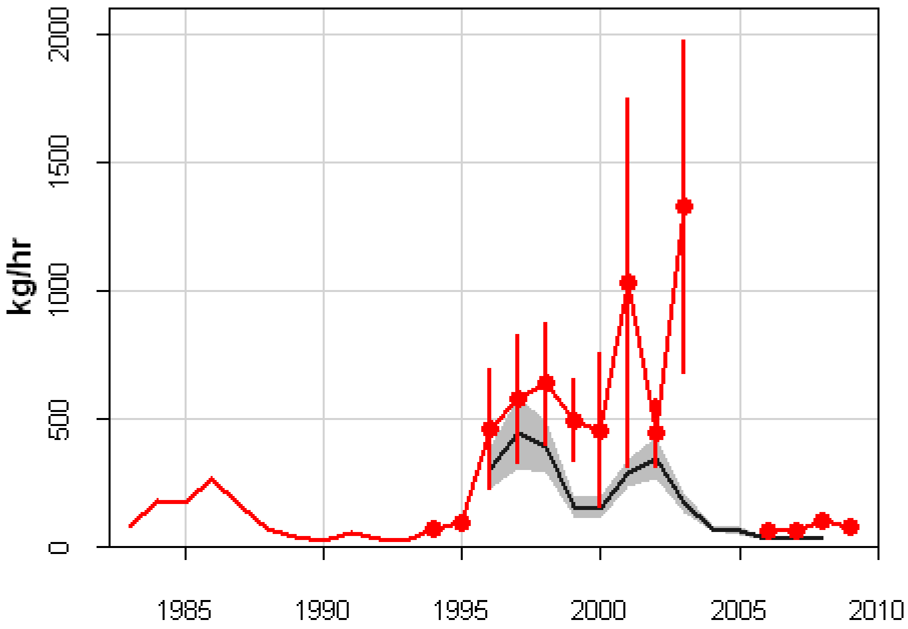


Figure 3.7.2. Faroe Bank (sub-division Vb2) cod. Catch per unit of effort in the spring groundfish survey and summer survey. Vertical bars and shaded areas show the standard error in the estimation of indexes.

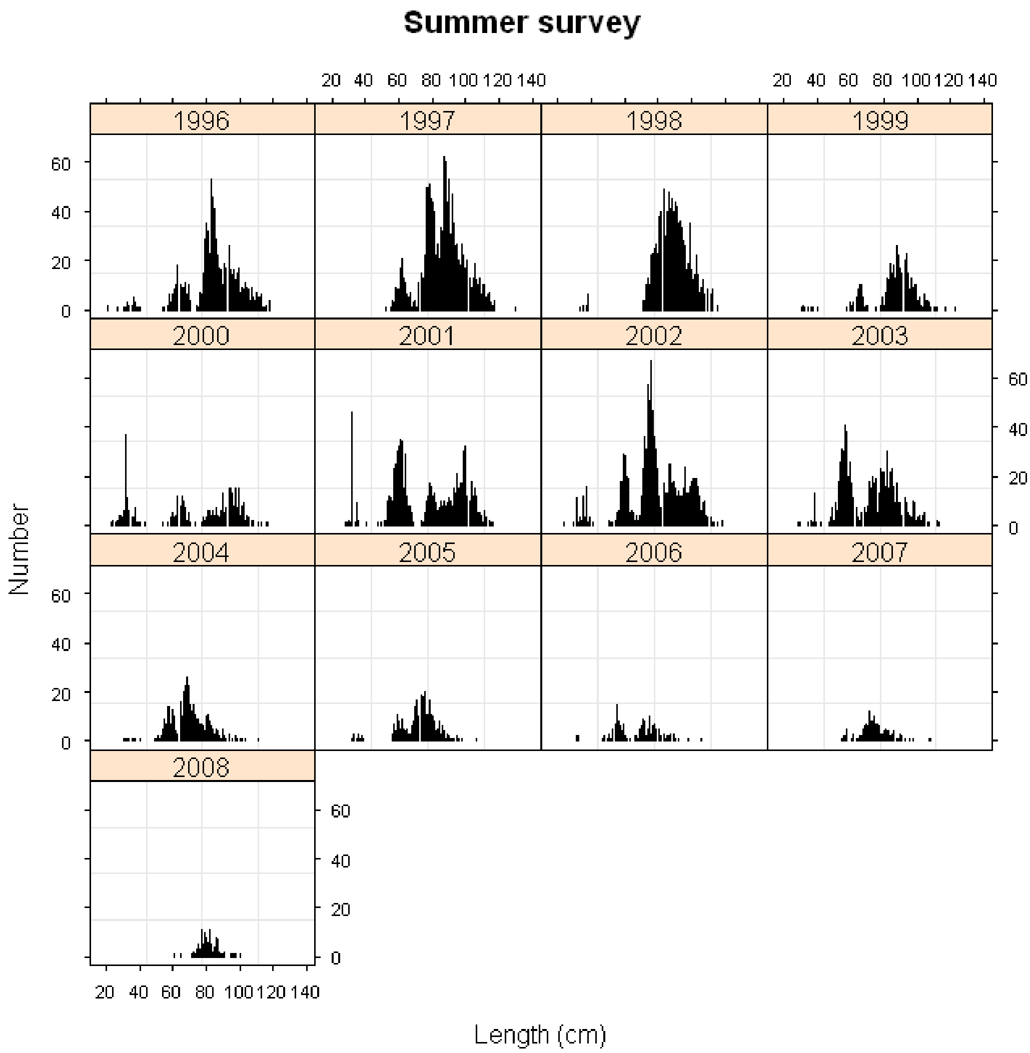


Figure 3.7.3. Faroe Bank (sub-division Vb2) cod. Length distributions in summer survey (1996-2008.)

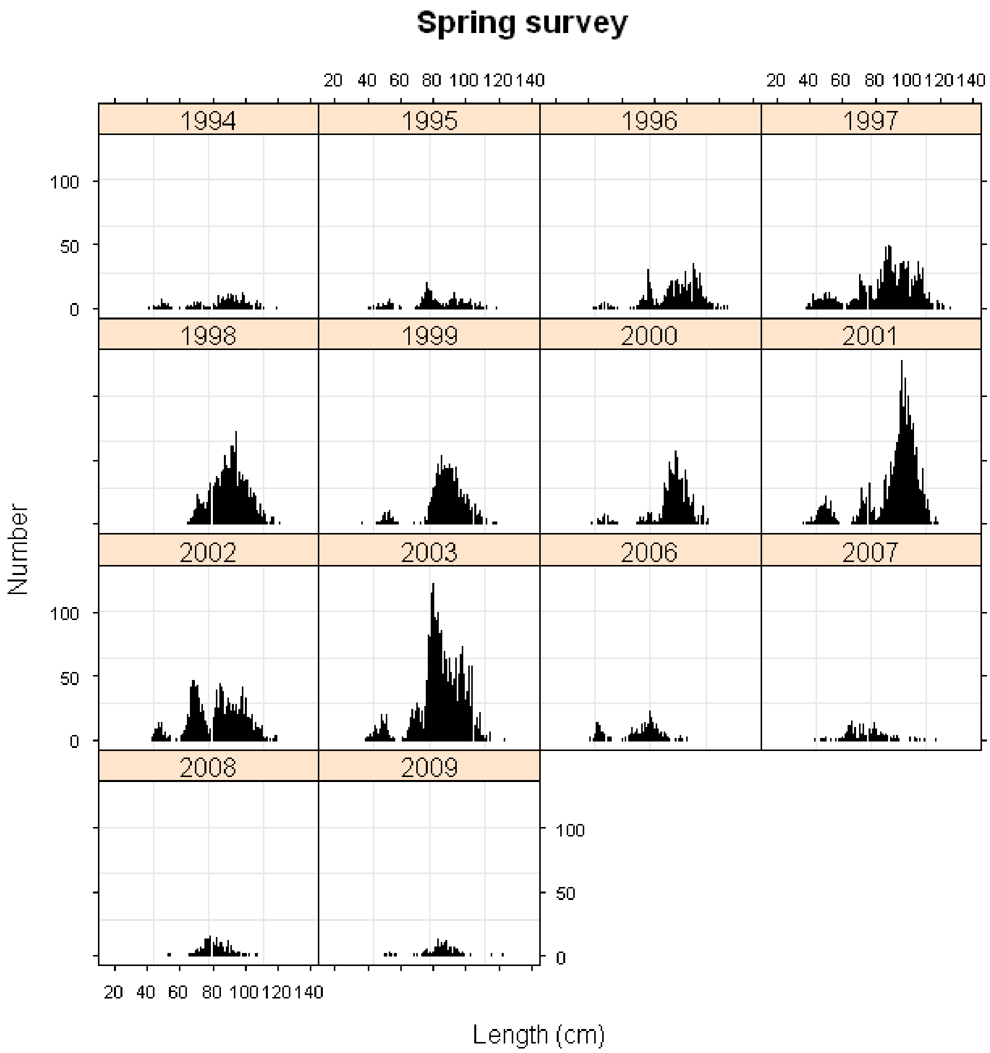


Figure 3.7.4. Faroe Bank (sub-division Vb2) cod. Length distributions in spring survey (1994-2003, 2006-2009.)

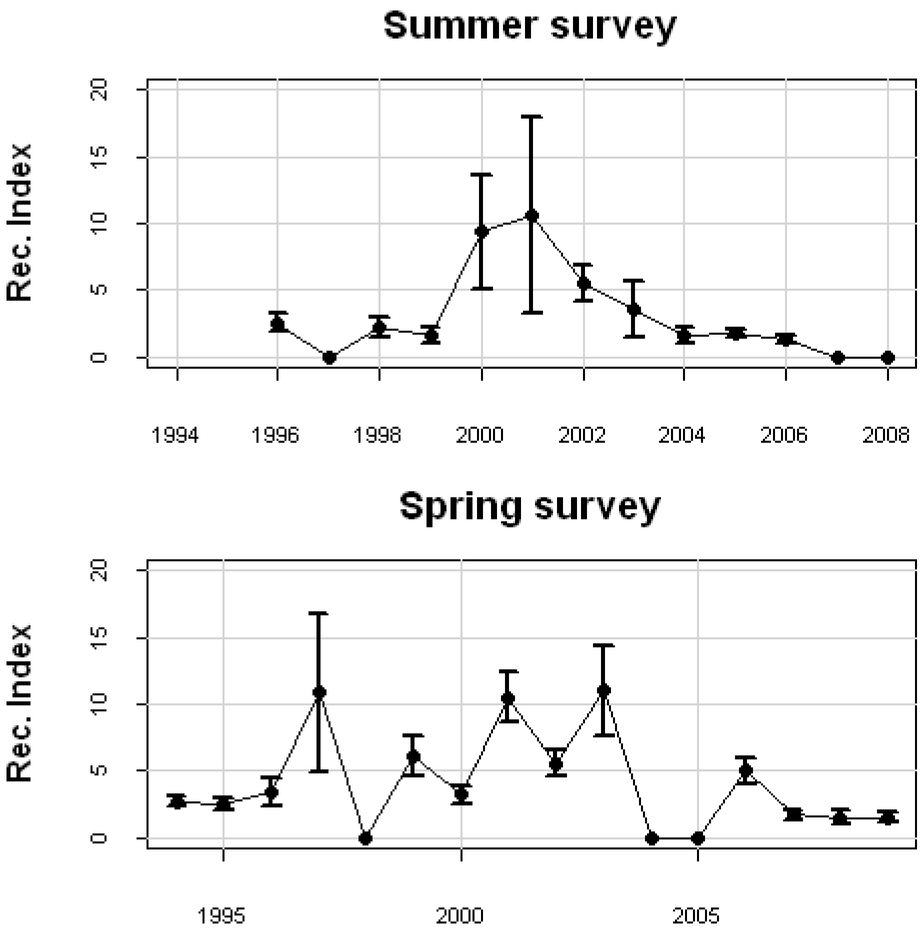


Figure 3.7.5a. Faroe Bank (sub-division Vb2) cod. Estimated recruitment index in summer (upper panel) and in spring survey (lower panel). In summer surveys the 1 year old recruitment is estimated. In spring surveys the recruitment of 2 year old is estimated. Dashed lines show the standard error in the estimated indices.

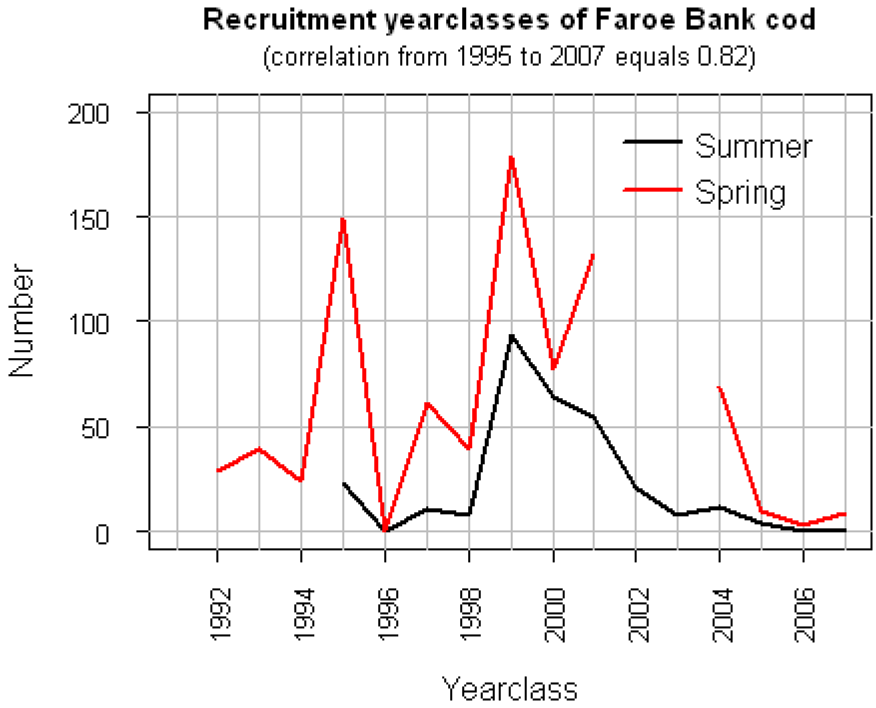


Figure 3.7.5b. Faroe Bank (sub-division Vb2) cod. Correlation between recruitment year classes.

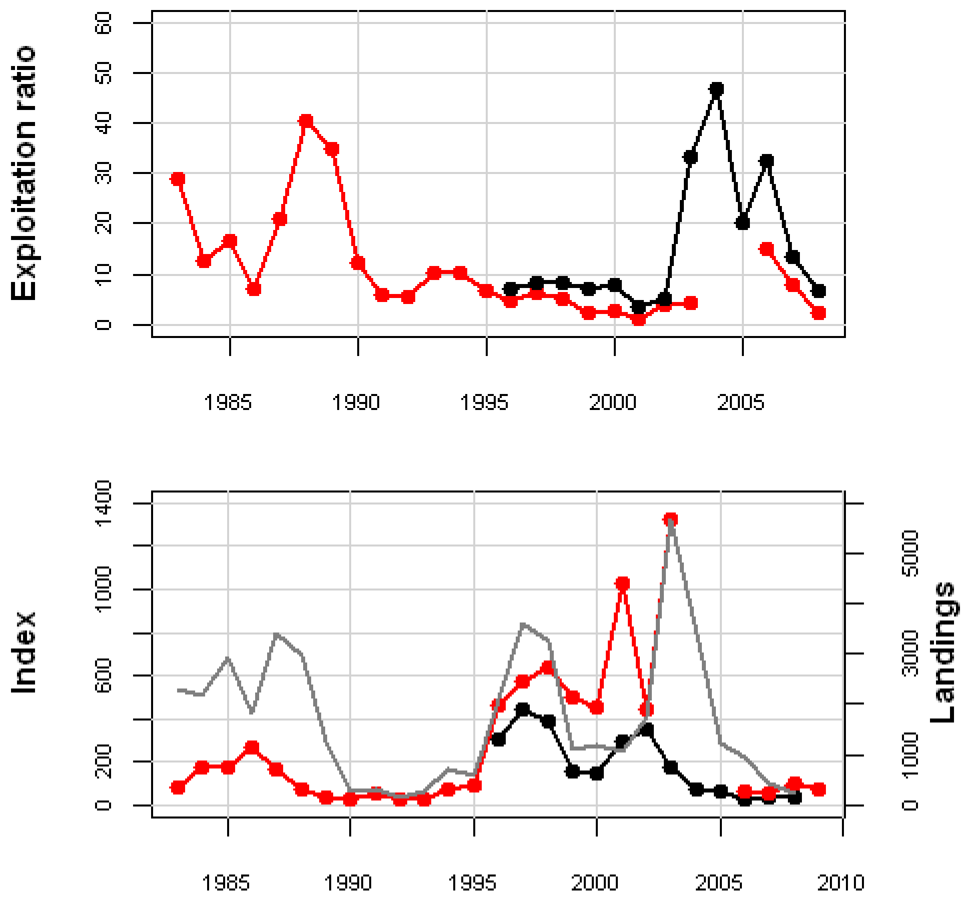


Figure 3.7.6. Faroe Bank (Subdivision Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate). Lower plot: Landings and cpue (kg/hr) in spring and summer survey.

4 Faroe Plateau cod

Summary

The input data consisted of the catch-at-age matrix (ages 2-10+ years) for the period 1961-2008 and two age-disaggregated abundance indices obtained from the two Faroese groundfish surveys: the spring survey 1994-2009 (shifted back to the previous year) and the summer survey 1996-2008. The maturities were obtained from the spring survey 1983-2009.

The assessment settings were the same as in the 2008 assessment. An XSA was run and tuned with the two survey indices. The fishing mortality in 2008 (average of ages 3-7 years) was estimated at 0.76, which was considerably higher than the precautionary fishing mortality of 0.35 and also higher than the limit fishing mortality (when 'bad things' may happen) of 0.68. The total stock size (age 2+) in the beginning of 2008 was estimated at 25 000 tonnes and the spawning stock biomass at 19 000 tonnes, which was slightly below the limit biomass (which should be avoided) of 21 000 tonnes. The estimates of stock size were amongst the lowest during the 1906-2008 period.

The short term prediction until year 2011 showed a steady-state situation with a stock size of around 31 000 tonnes and a spawning stock biomass of around 19 000 tonnes.

Managers should realize the poor state of the stock. Very importantly, the recruitment seems to be positively correlated with the total stock size of cod. It is, therefore, urgent to reduce the fishing mortality so that the stock increases. It will therefore be necessary to extend area-closures, preferably for all fishing. Candidate areas are parts of Mýlingsgrunnur (north of the Faroes), Mykinesgrunnur (west of the Faroes) as well as areas east of Faroe Islands.

4.1 Stock description and management units

Both genetic and tagging data suggest that there are three cod stocks present in Faroese waters: on the Faroe Bank, on the Faroe Plateau and on the Faroe-Iceland Ridge. Cod on the Faroe-Iceland Ridge seem to belong to the cod stock at Iceland, and the WG in 2005 decided to exclude these catches from the catch-at-age calculations. The annex provides more information.

4.2 Scientific data

The landing figures were obtained from the Fisheries Ministry and Statistics Faroe Islands (Table 4.2.1) and the working group estimates are presented in Table 4.2.2. The catches on the Faroe-Iceland ridge, i.e. for the large single trawlers (Table 4.2.3) and the large longliners were not included in the catch-at-age calculations. In recent years the longliners have taken the majority of the cod catches (Table 4.2.4). The catch-at-age was updated to account for a change in the nominal landings for 2006 and 2007. Landings-at-age for 2008 are provided for the Faroese fishery in Table 4.2.5. Faroese landings from most of the fleet categories were sampled (see text table below). Catch-at-age from 1961 to 2008 are shown in Table 4.2.6. Catch curves are shown in Fig. 4.2.1. They show atypical patterns in 1996 and to some extent in 2001-2002 when there appears to be an increase over the previous year for ages where a decrease would normally have been expected. This could be due to catchability for longliners depending on fish growth, causing atypical catch curves for longliners.

Samples from commercial fleets in 2008.

Fleet	Size	Samples	Lengths	Otoliths	Weights
Open boats		15	193	339	1,457
Longliners	<100 GRT	24	395	780	3,624
Longliners	>100 GRT	22	0	589	4,297
Jiggers		2	0	0	446
Gillnetters		1	0	60	243
Sing. trawlers	<400 HP	0	0	0	0
Sing. trawlers	400-1000 HP	6	0	120	1,153
Sing. trawlers	>1000 HP	5	676	0	237
Pair trawlers	<1000 HP	3	135	120	344
Pair trawlers	>1000 HP	18	454	477	2,887
Total		81	1,660	2,146	13,231

Mean weight-at-age data for 1961-2008 are provided for the Faroese fishery in Table 4.2.7. These were calculated using the length/weight relationship based on individual length/weight measurements of samples from the landings. The sum-of-products-check for 2008 showed a discrepancy of 0 %.

Figure 4.2.2 shows the mean weight-at-age for 1961 to 2008. For 2009-2011 the values used in the short term predictions are shown on this graph in order to put them in perspective with previous observations. The weights increased from 1998 to 2000, but have decreased since, although they appear to have increased in 2008 and 2009.

The proportion of mature cod by age during the Faroese groundfish surveys carried out during the spawning period (March) are given in Table 4.2.8 (1961 - 2008) and shown in Figure 4.2.3 (1983 - 2008). The observed values in 2009 and the estimated values in 2010-2011 are also shown in order to put them in perspective with previous observations. Full maturity is generally reached at age 5 or 6, but considerable changes have been observed in the proportion mature for younger ages between years.

The spring groundfish surveys in Faroese waters with the research vessel *Magnus Heinason* is used as a tuning series. The catch curves showed a normal pattern (Figure 4.2.4). The stratified mean catch of cod per unit effort in 1994-2009 is given in Figure 4.2.5. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased from 2002 to 2004 and was low in 2006-2008 and increased considerably in 2009. Normally the stratified mean catch per trawl hour increases for the first 3-4 years of life of a year class, and decreases afterwards (Figure 4.2.4). From 1994 to 1995, however, there was an increase for all year classes, possibly because of increased availability. A more normal pattern was observed from 1996-2009.

The other tuning series used is the Summer Groundfish Survey. The stratified mean catch of cod per unit effort (kg/trawl hour) 1996-2008 is shown in Figure 4.2.5, and catch curves in Figure 4.2.6. The catch curves show that the fish are fully recruited to the survey gear at an age of 4 or 5 years. Both tuning series are presented in Table 4.2.9.

Two commercial cpue series (longliners and Cuba trawlers) are also presented (Tables 4.2.10 and 4.2.11, as well as Figure 4.2.7), although they are not used as tuning series.

4.3 Information from the fishing industry

The sampling of the catches is included in the 'scientific data'. The fishing industry has during a ten year period gathered data on the size composition of the landings but this information has not been used in this assessment.

4.4 Methods

This an update assessment and the results of the assessment is mostly data-driven implying that there may be limited need to use other assessment methods.

4.5 Reference points

The reference points are dealt with in the general section of Faroese stocks. The reference points for Faroe Plateau cod are the following: Bpa = 40kt, Blim = 21kt, Fpa = 0.35 and Flim = 0.68.

4.6 State of the stock - historical and compared to what is now

Since the current assessment is an update assessment, the same procedure is followed as in the 2008 assessment: to use the two surveys for tuning and not the commercial series. The commercial series showed a similar overall tendency as the surveys (Figure 4.2.7). The XSA-run is presented in Table 4.6.1 and the results are shown in the Table 4.6.2 (fishing mortality at age), Table 4.6.3 (population numbers at age) and Table 4.6.4 (summary table).

The log catchability residuals from the adopted XSA run are shown in Figure 4.6.1.. There were year effects in both surveys since 2005. The stock estimates for 2008 seemed to be determined mostly by the summer survey.

The results from the retrospective analysis of the XSA (Figure 4.6.2) show that there has been a tendency to underestimate the recruitment and total stock/spawning stock biomass slightly, and to overestimate the fishing mortality.

The estimated fishing mortalities are shown in Tables 4.6.2 and 4.6.4 and Figures 4.6.3 and 4.6.4. The average F for age groups 3 to 7 in 2008 (F3-7) is estimated at 0.76, considerably higher than Fpa = 0.35 and also higher than Flim = 0.68.

The F3-7 (Figure 4.6.4) seems to be a problematic measure of fishing mortality for two reasons. Firstly, the fishing mortalities for ages 6-7 are generally overestimated in the terminal year leading to an overestimation of F3-7 for the terminal year. Secondly, the proportion of 6-7 year old cod in the stock or catch is small (normally less than 20%) and therefore get a disproportionate influence on the F3-7. The yield over exploitable biomass (3 years and older) was introduced in the 2004 assessment, but has the drawback not being proportional to fishing effort. Another approach is to weight the fishing mortalities and three weighting procedures are presented in Figure 4.6.5: weighting by stock numbers, stock biomasses or catch weights. All measures of fishing mortality show, however, that the fishing mortality has increased since the introduction of the effort management system in 1996 but that there have been oscillations around this increasing trend. The fishing mortality in 2008 was above Flim.

The stock size in numbers is given in Table 4.6.3. A summary of the XSA, with recruitment, biomass and fishing mortality estimates is given in Table 4.6.4 and in Figure 4.6.3. The stock-recruitment relationship is presented in Figure 4.6.6. The stock trajectory with respect to existing reference points is illustrated in Figure 4.6.7.

Figure 4.6.8, which is taken from last year's report (ICES, 2008), shows the F and SSB's from a 1000 bootstraps of the ADAPT with the two surveys. The figure also shows the point estimate of F and SSB from the XSA assessment. The ratio between the 75% percentiles and 25% percentiles of F is 1.28, and 1.16 for SSB. This means that there is a greater uncertainty associated with the estimation of F than with SSB.

The assessment shows the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 21 000 t. It increased sharply to above 80 000 t in 1996 and 1997 before declining to about 45 000 t in 1999. The spawning stock biomass increased to 59 000 t in 2001 but dropped to about 17 000 t in 2007 which is the lowest value observed during the assessment period from 1961-2008. The 2002 year class is likely the lowest observed and the 2003-2006 year classes are also weak according to the XSA run. The 2007 year class seems to be a bit stronger (11 millions), but relies solely on the spring survey estimate in 2009 (shifted to 2008 in the tuning) and is also low.

In order to put the stock estimates in 2008 into a wider perspective, we have estimated the stock biomass back to 1906. A cpue series (tonnes per million tonn-hours) for British trawlers 1924-1972 was available from the data presented in Jákupsstovu and Reinert (1994). The cpue series was also used, and explained, in Jones (1966). There was an overlap between the cpue series and the stock assessment for the years 1961-1972. Another cpue series (cwts per day of absence from port) was available for British steam trawlers 1906-1925. The overlap was two years (1924 and 1925) and the 1906-1925 series was scaled to the 1924-1972 series. The results are presented in Figure 4.6.9. There was a decreasing trend in biomass from around 100 thousand tonnes to around 80 tonnes prior to World War II, and since then a decreasing trend from around 100 thousand tonnes to around 50 thousand tonnes. The biomass in 2008 was the lowest during the entire period, although comparable values were observed in 1991-1992.

4.7 Short term forecast

The input data for the short term prediction are given in Table 4.7.1. The 2008-2009 year classes were estimated as the average of the 2003-2007 year classes. Estimates of stock size (ages 3+) were taken directly from the XSA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 2006-2008. The weights at age in the catches in 2009 were estimated from the commercial catches in January-February or the spring survey (ages 2-5 years). The weights in the catches in 2010-2011 were set to the values in 2009, i.e., rather high values. The proportion mature in 2009 was set to the 2009 values from the spring groundfish survey, and for 2010-2011 to the average values for 2007-2009.

Table 4.7.2 shows that the landings in 2009 are expected to be 9 000 tonnes (the landings from the Faroe-Icelandic ridge should be added to this figure in order to get the total Faroese landings within the Vb1 area). The spawning stock biomass is expected to be 16 000 tonnes in 2009, 21 000 tonnes in 2010 and eventually 21 000 tonnes in 2011. The current short term prediction is therefore quite pessimistic. The contribution of the various year-classes to the SSB in 2010 and 2011 is shown in Figure 4.7.1. It shows that the incoming year-classes (YC 2005-YC 2008) dominate the SSB. Setting the recruitment in 2009-2011 to 5328 millions (average of the recruitment in 2005-2008), the landings in 2009 are expected to be 7 000 tonnes. The SSB in 2009 to 2011 is expected to be 15 000 tonnes. This figure is further reduced to 12 000 tonnes if the weights in 2010-2011 are set to the average values observed in 2006-2008. This shows that the short-term projection depends much on the assumptions of recruitment and weights-at-age.

4.8 Long term forecast

The input to the long term forecast is presented in Table 4.8.1 and the result is presented in Table 4.8.2 and Figure 4.8.1.

4.9 Uncertainties in assessment and forecast

Misreporting is not believed to be a problem under the current effort management system. The total catch figures (in subdivisions Vb1+Vb2) are believed to be accurate although there may be some minor problems when allocating the catches between the two subdivisions.

The sampling of the catches for length measurements and length-weight relationships is considered to be adequate but the number of otoliths could be higher.

The quality of the tuning data is considered high. The same research vessel has been used all the time and the gear as well as sampling procedures of the catch have remained the same. The only exception may be the otolith sampling during 1994-1996 when larger otolith samples were collected from fewer hauls than during the other years (1997 to present).

The quality of the assessment is believed to be high – in the sense that there seems to be no doubt that the stock size is amongst the lowest observed during a century. There was a good agreement between the survey indices and when compared to the commercial tuning series.

A model incorporating cannibalism gave approximately the same recruitment for the most recent years as the values used in the short term prediction.

4.10 Comparison with previous assessment and forecast

New or changed things compared to last years report: the assessment settings were the same as last year.

4.11 Management plans and evaluations

The effort management system was introduced in 1996 and aims at a target F of 0.45. The management plan is discussed in the overview section for Faroese stocks.

4.12 Management considerations

The current assessment shows that the spawning stock biomass in 2008 was below Blim of 21 000 tonnes and that it is expected to stay around 21 000 tonnes during 2010-2011. The catch in 2009-2010 is predicted to be around 10 000 tonnes, which is slightly above the catch in 1991-1993. The decrease in the stock is due to a combination of poor recruitment since 2002 and high fishing mortality. The low recruitment is believed to be a result of poor primary production since 2002 and the poor state of the stock. The primary production was above average in 2008, and a similar value in 2009 could produce stronger recruitment than has been assumed in the short-term prediction, i.e., a larger cod stock. However, a low primary production in 2009, i.e., poorer recruitment and slower growth, could cause the SSB in 2011 to become as low as 12 000 tonnes.

Biomass estimates of Faroe Plateau cod reconstructed back in time (Figure 4.6.9) show that the biomass fluctuated around 100 000 tonnes during the period 1906-1957, around 80 000 tonnes during 1958-1987 and eventually around 60 000 tonnes since 1988. The catches fluctuated between 20 000 and 40 000 tonnes, except in 1990-1994 and 2004-2008. Similar catches from smaller biomasses imply that the exploitation rates have increased.

There has been a long held view on the Faroe Islands that the cod stock is very resilient to exploitation and that a collapse in the fishery is nearly impossible – people bear in mind the rapid recovery of the cod stock during 1994-1996. The collapse in the fisheries during 1991-1994 has been regarded as an exceptional event. Figure 4.6.9 indicates that, although more resilient than some other cod stocks in the North Atlantic, Faroe Plateau cod does show a decreasing trend since World War II. This trend is likely caused by a combination of environmental factors and fishing effort, but the contribution from each of these two factors is unknown. While there is no direct information about environmental condition for cod such as the primary production index to evaluate possible environmental changes prior to 1990, there are reasons to believe that the fishing effort has increased during the period.

The catchability hypothesis presented in the overview section for Faroese stocks states that the fishing mortality is high when the primary production is low and *vice versa*. The primary production was low, or average, during 2002-2007 and the high fishing mortalities in 2005-2007 were therefore expected. The primary production in 2008 was above average, and there are signs that it will be above average in 2009 also. Hence, the high fishing mortality in 2008 may be overestimated in the current stock assessment, i.e., the stock size might be underestimated. More data are required before any conclusions can be made, for example the summer survey in 2008 and the spring survey in 2009.

Although the extremely low cod stock biomass is a serious problem for the Faroese fisheries sector it may not cause as intense a crisis as occurred in the early 1990s because the biomass of saithe is higher than in the early 1990s.

Given the very poor state of the cod stock the WG considers that measures should be taken to reduce fishing mortality significantly in 2009. This is would require a substantial reduction in the number of fishing days in 2009/2010. A small reduction in the number of days is unlikely to have a detectable effect because the price of cod is higher than for the other two groundfish species, although the difference has become smaller during the last year. Also, the use of snail-baits in the longline fishery close to land has probably increased fishing efficiency. Area closures may therefore be necessary in order to reduce fishing mortality on the cod stock. Figures 4.12.1 and 4.12.2 show the average abundance of cod in March (1998-2006) and August (1997-2005) and provides a basis which areas should be closed for the fishery.

The continued high fishing mortality on cod also questions some of the underlying assumptions in the effort management system. The system assumes that the fleets would concentrate on abundant species, but, as mentioned earlier, fishing effort directed on cod has remained high. Another assumption is that the fishing mortality could be regulated by the number of fishing days. While the average fishing mortality is undoubtedly related to fishing effort, as indicated in the overview section, short term fluctuations in fishing mortality may depend as much upon natural processes than on the number of fishing days. Given the current very low cod stock extra means are necessary to protect that stock.

As indicated above, a substantial reduction in the number of fishing days would be required to reduce the fishing mortality on cod. Other means, such as area closures would also be necessary and may actually be more effective.

A Dr. Philos thesis, submitted by P. Steingrund to the University of Bergen in March 2009, suggests that there is a positive relationship between recruitment of Faroe Plateau cod (age 2) and the stock size of cod (age 3+). This relationship is valid up to a stock size of around 100 000 tonnes, above which there is a decline in recruitment. A simulation model, which was primarily based on this relationship, suggests that the fishing mortality should be reduced by some 30-50%, relative to the 1997-2006 level, in order to get the highest long-term catch (around 23 000 tonnes per year) during the next 100 years. The simulations also showed that the current (1997-2006) fishing mortality will almost certainly lead to a virtual extinction of the cod stock within the next 50 years. Thus, the simulations show that it should be in the interest of the Faroese fishing industry to reduce the fishing mortality on cod.

4.13 Ecosystem considerations

The issue is not dealth with in this assessment and there is little information available how the fisheries affect the ecosystem.

4.14 Regulations and their effects

As mentioned earlier, there seems to be a poor relationship between the number of fishing days and the fishing mortality because of large fluctuations in catchability. Area restrictions may be the only alternative that may reduce fishing mortality.

4.15 Changes in fishing technology and fishing patterns

Fishing effort per fishing day may have increased gradually since the effort management system was introduced in 1996, although little direct quantitative information exists. There also seems to have been substantial increases in fishing power when new vessels are replacing old vessels.

The fishing pattern in 2006-2008 has changed in comparison to previous years. The large longliners seem to have exploited the deep areas (> 200 m) to a larger extent (ling and tusk) because the catches in shallower waters of cod and haddock have been so poor – which was also observed in the beginning of the 1990s. This could reduce the fishing mortality on cod and haddock, but the small longliners still exploit the shallow areas.

4.16 Changes in the environment

The primary production has been low for a number of years, except in 2008, but it is not believed that this has any relationship with a change in the environment.

4.17 References

ICES, 2008. Report of the North-Western Working Group. ICES CM 2008/ACOM:03.

Jákupsstovu, S. H. and Reinert, J. 1994. Fluctuations in the Faroe Plateau cod stock. ICES Marine Science Symposia, 198:194-211.

Jones, B. W. 1966. The cod and the cod fishery at the Faroe. Fishery Investigations, London, 24.

Table 4.2.1. Faroe Plateau (Subdivision Vb1) COD. Nominal catches (tonnes) by countries, 1986-2008, as officially reported to ICES.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	8	30	10	-	-	-	-	-	-	-	-	-	-
Faroe Islands	34,492	21,303	22,272	20,535	12,232	8,203	5,938	5,744	8,724	19,079	39,406	33,556	23,308
France	4	17	17	-	-	- [1]	3 [2]	1 [2]	-	2 [2]	1 [2]	-	- *
Germany	8	12	5	7	24	16	12	+	2 [2]	2	+	+	-
Norway	83	21	163	285	124	89	39	57	36	38	507	410	405
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (E/W/NI)	-	8	-	-	-	1	74	186	56	43	126	61 [2]	27 [2]
UK (Scotland)	-	-	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	34,595	21,391	22,467	20,827	12,380	8,309	6,066	5,988	8,818	19,164	40,040	34,027	23,740

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 *
Denmark	-									
Faroe Islands	19,156		29,762	40,602	30,259	17,540	13,556	11,629	9,905	9,293
France	- *	1	9 [2]	20	14	2	-	7	1 [2]	
Germany	39	2	9	6	7	3 [2]		1 [2]		
Iceland	-	-	-	5	-					
Norway	450	374	531 *	573	447	414	201	49	71	43
Greenland	-	-	-		-			5		
Portugal						1				
UK (E/W/NI)[2]	51	18	50	42	15	15	24	1	3	
UK (Scotland)[1]	-	-	-	-	-	-	-	-	358	
United Kingdom										439
Total	19,696	395	30,361	41,248	30,742	17,975	13,781	11,692	10,338	9,775

* Preliminary

1) Included in Vb2.

2) Reported as Vb.

Table 4.2.2. Nominal catch (tonnes) of COD in subdivision Vb1 (Faroe Plateau) 1986-2008, as used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Officially reported	34,595	21,391	22,467	20,827	12,380	8,309	6,066	5,988	8,818	19,164	40,040	34,027	23,740
Faroese catches in IIA within													
Faroe area jurisdiction			715	1,229	1,090	351	154						
Expected misreporting/discard										3330			
French catches as reported													
to Faroese authorities				12	17								
Catches reported as Vb2:													
UK (E/W/NI)					-	-	+	1	1	-	-	-	-
UK (Scotland)					205	90	176	118	227	551	382	277	265
Used in the assessment	34,595	21,391	23,182	22,068	13,487	8,750	6,396	6,107	9,046	23,045	40,422	34,304	24,005

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 *
Officially reported	19,696	395	30,361	41,248	30,742	17,975	13,781	11,692	10,338	9,775
Faroese catches in Vb1		21,793 *								
Correction of Faroese catches in Vb1 [1]			-1,766	-2,409	-1,795	-1,041	-804	-690	-588	-749
Correction of Faroese catches in Vb1 [2]										3,325
Faroese catch on the Faroe-Iceland ridge	-1,600	-1,400	-700	-600	-4,700	-4,000	-4,200	-800	-1,800	-1,828
Greenland[3]									6	
France[3]										
Catches reported as Vb2:										
UK (E/W/NI)	-	-	-	-	-	-				
UK (Scotland)	210	245	288	218	254	244	1,129	278	53	
United Kingdom				-	-	-	-			
Used in the assessment	18,306	21,033	28,183	38,457	24,501	13,178	9,906	10,480	8,009	10,523

*) Preliminary

1) In order to be consistent with procedures used previous years.

2) Data from the Coastal Guard (CG) regarded more reliable than the preliminary Statlant: 12608 - 9293 = 3325.

CG catch Vb1+Vb2 = 12756 t. CG catch Vb2 = 148 t, i.e. CG catch Vb1 = 12756-148 = 12608 t.

3) Reported to Faroese Coastal Guard.

Table 4.2.3. Faroe Plateau (subdivision Vb1) COD. Estimate of the landings from the Faroe-Icelandic ridge. The landings were estimated from total landings by the single trawlers larger thant 1000 HP (ST>1000 HP) and the proportion of the catch taken on the Faroe-Icelandic ridge (obtained from logbooks). Not updated from last year.

Year	ST>1000HP Landings	Round weight	Ratio Icelandic ridge	Tonnes Icelandic ridge (rounded)
1991	329	365	0.23	100
1992	196	218	0.51	100
1993	179	199	0.38	100
1994	449	498	0.02	0
1995	862	957	0.05	0
1996	667	740	0.06	0
1997	985	1093	0.15	200
1998	1359	1508	0.13	200
1999	2074	2302	0.7	1600
2000	2515	2792	0.49	1400
2001	1649	1831	0.37	700
2002	2267	2516	0.26	600
2003	4492	4986	0.94	4700
2004	3826	4247	0.94	4000
2005	3933	4365	0.95	4200
2006	1097	1217	0.63	800
2007	1335	1482	0.25	400

Table 4.2.4. Faroe Plateau (subdivision Vb1) COD. The landings of Faroese fleets (in percents) of total catch. Note that the catches on the Faroe-Iceland ridge (mainly belonging to single trawlers > 1000 HP) are included in this table, but excluded in the XSA-run.

Year	Open boats	Longliners <100 GRT	Singletrawl <400 HP	Gill net	Jiggers	Singletrawl 400-1000 HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000 HP	Longliners >100 GRT	Industrial trawlers	Others	Faroe catch Round.weight
1986	9.5	15.1	5.1	1.3	2.9	6.2	8.5	29.6	14.9	5.1	0.4	1.3	34,492
1987	9.9	14.8	6.2	0.5	2.9	6.7	8.0	26.0	14.5	9.9	0.5	0.1	21,303
1988	2.6	13.8	4.9	2.6	7.5	7.4	6.8	25.3	15.6	12.7	0.6	0.2	22,272
1989	4.4	29.0	5.7	3.2	9.3	5.7	5.5	10.5	8.3	17.7	0.7	0.0	20,535
1990	3.9	35.5	4.8	1.4	8.2	3.7	4.3	7.1	10.5	19.6	0.6	0.2	12,232
1991	4.3	31.6	7.1	2.0	8.0	3.4	4.7	8.3	12.9	17.2	0.6	0.1	8,203
1992	2.6	26.0	6.9	0.0	7.0	2.2	3.6	12.0	20.8	13.4	5.0	0.4	5,938
1993	2.2	16.0	15.4	0.0	9.0	4.1	3.6	14.2	21.7	12.6	0.8	0.4	5,744
1994	3.1	13.4	9.6	0.5	19.2	2.7	5.3	8.3	23.7	13.7	0.5	0.1	8,724
1995	4.2	17.9	6.5	0.3	24.9	4.1	4.7	6.4	12.3	18.5	0.1	0.0	19,079
1996	4.0	19.0	4.0	0.0	20.0	3.0	2.0	8.0	19.0	21.0	0.0	0.0	39,406
1997	3.1	28.4	4.4	0.5	9.8	5.1	2.9	4.8	11.3	29.7	0.0	0.1	33,556
1998	2.4	31.2	6.0	1.3	6.5	6.3	5.5	3.1	8.6	29.1	0.1	0.0	23,308
1999	2.7	24.0	5.4	2.3	5.4	5.2	11.8	6.4	14.5	21.9	0.4	0.1	19,156
2000	2.3	19.3	9.1	0.9	10.5	9.6	12.7	5.7	13.9	15.7	0.1	0.1	21,793
2001	3.7	28.3	7.4	0.2	15.6	6.4	6.4	5.2	9.2	17.8	0.0	0.0	28,838
2002	3.8	32.9	5.8	0.3	9.9	6.7	6.6	2.5	7.2	24.4	0.0	0.0	38,347
2003	4.9	28.7	4.0	1.5	7.4	3.0	14.4	2.2	7.4	26.5	0.0	0.0	29,382
2004	4.4	31.1	2.1	0.5	6.6	1.6	12.9	2.2	11.7	26.8	0.0	0.0	16,772
2005	3.7	27.5	5.1	0.8	5.4	2.4	28.1	1.7	6.4	18.8	0.0	0.0	15,472
2006	6.2	35.0	3.2	0.2	7.1	1.6	12.9	2.5	6.6	24.7	0.0	0.0	8,636
2007	5.1	28.2	2.6	0.3	6.1	1.7	17.5	1.7	4.8	32.0	0.0	0.0	8,866
2008	5.1	32.7	4.7	0.7	6.4	3.2	14.6	1.0	3.1	28.6	0.0	0.0	7,666
Average	**4.3**	**25.2**	**5.9**	**0.9**	**9.4**	**4.4**	**8.8**	**8.5**	**12.1**	**19.9**	**0.5**	**0.1**	

Table 4.2.5. Faroe Plateau COD. Catch in numbers at age per fleet in 2008. Numbers are in thousands and the catch is in tonnes, round weight.

Age\Fleet	Open boats	Longliners < 100 GRT	Jiggers	Single trwl 0-399HP	Single trwl 400-1000H	Single trwl > 1000 HP	Pair trwl 700-999 HI	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Others (scaling)	Catch-at-age
2	40	168	50		65	6	1	4	65	0	14	413
3	94	559	114		105	28	5	18	129	4	38	1094
4	76	462	83		120	66	15	44	207	12	41	1126
5	47	212	50		51	43	9	28	140	16	22	618
6	10	77	14		21	30	6	19	70	13	9	269
7	6	46	8		18	22	5	14	93	6	8	226
8	7	58	13		13	21	4	14	85	2	8	225
9	2	14	3		6	7	1	4	41	0	4	82
10+	0	4	0		2	1	0	1	19	0	1	28
Sum	282	1600	335		401	224	46	146	849	53	145	4081
G.weight	445	2867	569		851	866	181	569	2627	173	332	9480

Others include industrial bottom trawlers, longlining for halibut, foreign fleets, **and scaling to correct catch.**

Gutted total catch is calculated as round weight divided by 1.11.

Table 4.2.6. Faroe Plateau COD. Catch in numbers at age 1961-2008.

	age									
year	1	2	3	4	5	6	7	8	9	10
1961	0	3093	2686	1331	1066	232	372	78	29	0
1962	0	4424	2500	1255	855	481	93	94	22	0
1963	0	4110	3958	1280	662	284	204	48	30	0
1964	0	2033	3021	2300	630	350	158	79	41	0
1965	0	852	3230	2564	1416	363	155	48	63	0
1966	0	1337	970	2080	1339	606	197	104	33	0
1967	0	1609	2690	860	1706	847	309	64	27	0
1968	0	1529	3322	2663	945	1226	452	105	11	0
1969	0	878	3106	3300	1538	477	713	203	92	0
1970	0	402	1163	2172	1685	752	244	300	44	0
1971	0	328	757	821	1287	1451	510	114	179	0
1972	0	875	1176	810	596	1021	596	154	25	0
1973	0	723	3124	1590	707	384	312	227	120	97
1974	0	2161	1266	1811	934	563	452	149	141	91
1975	0	2584	5689	2157	2211	813	295	190	118	150
1976	0	1497	4158	3799	1380	1427	617	273	120	186
1977	0	425	3282	6844	3718	788	1160	239	134	9
1978	0	555	1219	2643	3216	1041	268	201	66	56
1979	0	575	1732	1673	1601	1906	493	134	87	38
1980	0	1129	2263	1461	895	807	832	339	42	18
1981	0	646	4137	1981	947	582	487	527	123	55
1982	0	1139	1965	3073	1286	471	314	169	254	122
1983	0	2149	5771	2760	2746	1204	510	157	104	102
1984	0	4396	5234	3487	1461	912	314	82	34	66
1985	0	998	9484	3795	1669	770	872	309	65	80
1986	0	210	3586	8462	2373	907	236	147	47	38
1987	0	257	1362	2611	3083	812	224	68	69	26
1988	0	509	2122	1945	1484	2178	492	168	33	25
1989	0	2237	2151	2187	1121	1026	997	220	61	9
1990	0	243	2849	1481	852	404	294	291	50	26
1991	0	192	451	2152	622	303	142	93	53	24
1992	0	205	455	466	911	293	132	53	30	34
1993	0	120	802	603	222	329	96	33	22	25
1994	0	573	788	1062	532	125	176	39	23	16
1995	0	2615	2716	2008	1012	465	118	175	44	49
1996	0	351	5164	4608	1542	1526	596	147	347	47
1997	0	200	1278	6710	3731	657	639	170	51	120
1998	0	455	745	1558	5140	1529	159	118	28	25
1999	0	1185	993	799	1107	2225	439	59	17	7
2000	0	2091	2637	782	426	674	809	104	7	1
2001	0	3912	3759	2101	367	367	718	437	36	6
2002	0	2079	7283	3372	1671	470	533	413	290	7
2003	0	678	2128	4572	1927	640	177	91	115	20
2004	0	100	691	1263	2105	736	240	65	42	37
2005	0	494	592	877	1122	823	204	41	19	30
2006	0	1182	1168	499	706	852	355	81	11	3
2007	0	540	1307	771	336	308	272	91	21	3
2008	0	413	1094	1126	618	269	226	225	82	28

Table 4.2.7. Faroe Plateau COD. Catch weight at age 1961-2008.

year \ age	1	2	3	4	5	6	7	8	9	10
1961	0	1.080	2.220	3.450	4.690	5.520	7.090	9.910	8.030	0.000
1962	0	1.000	2.270	3.350	4.580	4.930	9.080	6.590	6.660	0.000
1963	0	1.040	1.940	3.510	4.600	5.500	6.780	8.710	11.720	0.000
1964	0	0.970	1.830	3.150	4.330	6.080	7.000	6.250	6.190	0.000
1965	0	0.920	1.450	2.570	3.780	5.690	7.310	7.930	8.090	0.000
1966	0	0.980	1.770	2.750	3.510	4.800	6.320	7.510	10.340	0.000
1967	0	0.960	1.930	3.130	4.040	4.780	6.250	7.000	11.010	0.000
1968	0	0.880	1.720	3.070	4.120	4.650	5.500	7.670	10.950	0.000
1969	0	1.090	1.800	2.850	3.670	4.890	5.050	7.410	8.660	0.000
1970	0	0.960	2.230	2.690	3.940	5.140	6.460	10.310	7.390	0.000
1971	0	0.810	1.800	2.980	3.580	3.940	4.870	6.480	6.370	0.000
1972	0	0.660	1.610	2.580	3.260	4.290	4.950	6.480	6.900	0.000
1973	0	1.110	2.000	3.410	3.890	5.100	5.100	6.120	8.660	7.570
1974	0	1.080	2.220	3.440	4.800	5.180	5.880	6.140	8.630	7.620
1975	0	0.790	1.790	2.980	4.260	5.460	6.250	7.510	7.390	8.170
1976	0	0.940	1.720	2.840	3.700	5.260	6.430	6.390	8.550	13.620
1977	0	0.870	1.790	2.530	3.680	4.650	5.340	6.230	8.380	10.720
1978	0	1.112	1.385	2.140	3.125	4.363	5.927	6.348	8.715	12.229
1979	0	0.897	1.682	2.211	3.052	3.642	4.719	7.272	8.368	13.042
1980	0	0.927	1.432	2.220	3.105	3.539	4.392	6.100	7.603	9.668
1981	0	1.080	1.470	2.180	3.210	3.700	4.240	4.430	6.690	10.000
1982	0	1.230	1.413	2.138	3.107	4.012	5.442	5.563	5.216	6.707
1983	0	1.338	1.950	2.403	3.107	4.110	5.020	5.601	8.013	8.031
1984	0	1.195	1.888	2.980	3.679	4.470	5.488	6.466	6.628	10.981
1985	0	0.905	1.658	2.626	3.400	3.752	4.220	4.739	6.511	10.981
1986	0	1.099	1.459	2.046	2.936	3.786	4.699	5.893	9.700	8.815
1987	0	1.093	1.517	2.160	2.766	3.908	5.461	6.341	8.509	9.811
1988	0	1.061	1.749	2.300	2.914	3.109	3.976	4.896	7.087	8.287
1989	0	1.010	1.597	2.200	2.934	3.468	3.750	4.682	6.140	9.156
1990	0	0.945	1.300	1.959	2.531	3.273	4.652	4.758	6.704	8.689
1991	0	0.779	1.271	1.570	2.524	3.185	4.086	5.656	5.973	8.147
1992	0	0.989	1.364	1.779	2.312	3.477	4.545	6.275	7.619	9.725
1993	0	1.155	1.704	2.421	3.132	3.723	4.971	6.159	7.614	9.587
1994	0	1.194	1.843	2.613	3.654	4.584	4.976	7.146	8.564	8.796
1995	0	1.218	1.986	2.622	3.925	5.180	6.079	6.241	7.782	8.627
1996	0	1.016	1.737	2.745	3.800	4.455	4.978	5.270	5.593	7.482
1997	0	0.901	1.341	1.958	3.012	4.158	4.491	5.312	6.172	7.056
1998	0	1.004	1.417	1.802	2.280	3.478	5.433	5.851	7.970	8.802
1999	0	1.050	1.586	2.350	2.774	3.214	5.496	8.276	9.129	10.652
2000	0	1.416	2.170	3.187	3.795	4.048	4.577	8.182	11.895	13.009
2001	0	1.164	2.076	3.053	3.976	4.394	4.871	5.563	7.277	12.394
2002	0	1.017	1.768	2.805	3.529	4.095	4.475	4.650	6.244	7.457
2003	0	0.820	1.362	2.127	3.329	4.092	4.670	6.000	6.727	6.810
2004	0	1.037	1.154	1.693	2.363	3.830	5.191	6.326	7.656	9.573
2005	0	0.986	1.373	1.760	2.293	3.138	5.287	8.285	8.703	9.517
2006	0	0.839	1.304	1.988	2.386	3.330	4.691	7.635	9.524	11.990
2007	0	0.937	1.324	1.970	3.076	3.529	4.710	6.464	9.461	9.509
2008	0	1.209	1.478	2.104	2.714	3.804	4.669	5.915	7.233	9.559

Table 4.2.8. Faroe Plateau (subdivision Vb1) COD. Proportion mature at age 1983-2008. From 1961-1982 the average from 1983-1996 is used.

	age									
year	1	2	3	4	5	6	7	8	9	10
1961	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1962	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1963	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1964	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1965	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1966	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1967	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1968	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1969	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1970	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1971	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1972	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1973	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1974	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1975	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1976	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1977	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1978	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1979	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1980	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1981	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1982	0	0.17	0.64	0.87	0.95	1.00	1.00	1.00	1	1
1983	0	0.03	0.71	0.93	0.94	1.00	1.00	1.00	1	1
1984	0	0.07	0.96	0.98	0.97	1.00	1.00	1.00	1	1
1985	0	0.00	0.50	0.96	0.96	1.00	1.00	1.00	1	1
1986	0	0.00	0.38	0.93	1.00	1.00	0.96	0.94	1	1
1987	0	0.00	0.67	0.91	1.00	1.00	1.00	1.00	1	1
1988	0	0.06	0.72	0.90	0.97	1.00	1.00	1.00	1	1
1989	0	0.05	0.54	0.98	1.00	1.00	1.00	1.00	1	1
1990	0	0.00	0.68	0.90	0.99	0.96	0.98	1.00	1	1
1991	0	0.00	0.72	0.86	1.00	1.00	1.00	1.00	1	1
1992	0	0.06	0.50	0.82	0.98	1.00	1.00	1.00	1	1
1993	0	0.03	0.73	0.78	0.91	0.99	1.00	1.00	1	1
1994	0	0.05	0.33	0.88	0.96	1.00	0.96	1.00	1	1
1995	0	0.09	0.35	0.33	0.66	0.97	1.00	1.00	1	1
1996	0	0.04	0.43	0.74	0.85	0.94	1.00	1.00	1	1
1997	0	0.00	0.64	0.91	0.97	1.00	1.00	1.00	1	1
1998	0	0.00	0.62	0.90	0.99	0.99	1.00	1.00	1	1
1999	0	0.02	0.43	0.88	0.98	1.00	1.00	1.00	1	1
2000	0	0.02	0.39	0.69	0.92	0.99	1.00	1.00	1	1
2001	0	0.07	0.47	0.86	0.94	1.00	1.00	1.00	1	1
2002	0	0.04	0.37	0.76	0.97	0.93	0.97	1.00	1	1
2003	0	0.00	0.29	0.79	0.88	0.98	1.00	1.00	1	1
2004	0	0.00	0.51	0.78	0.92	0.89	0.87	1.00	1	1
2005	0	0.05	0.66	0.90	0.93	0.98	0.92	1.00	1	1
2006	0	0.04	0.59	0.80	0.99	0.99	1.00	1.00	1	1
2007	0	0.00	0.47	0.78	0.91	0.99	0.97	1.00	1	1
2008	0	0.10	0.78	0.91	0.90	0.95	1.00	1.00	1	1

Table 4.2.9. Faroe Plateau (subdivision Vb1) COD. Summer survey tuning series (number of individuals per 200 stations) and spring survey tuning series (number of individuals per 100 stations).

```
FAROE PLATEAU COD (ICES SUBDIVISION VB1)        Surveys.TXT
102
SUMMER SURVEY
1996 2008
1 1 0.6 0.7
2 8
 200  707.3   6614.6   3763     1322.2   714    236.2   49
 200  513.1   1502.1   6771     1479.9   180.8  139.5   30.4
 200  527      509.1    989.1   3723.7   915.6   50.5   37.2
 200  373.4   1257.4    753.8    676.1  1424.8  239.1   40.5
 200 1364.1   1153.3    673.8    309.6   436.9  600.8   35.4
 200 3422.1   2458.7   1537.8    415.9   234.8  283    242
 200 2326     5562.9   1816.5    810.8   147.7   83.3   69.5
 200  354     1038.8   2209.2    565.9   123.4   17.6   11.9
 200  437      839.9   1080.2   1550.2   344.2   80.2   25.7
 200  616.5    735.1    872.1   1166.3   756    142.5   44.8
 200  978.4    684.2    349.3    312     256.6  123     28.2
 200  234.1    448.7    314.2    179.7   134.5   75.9   30.9
 200   68.8    370.1    328      401.2   160.1   52.4   27.5
SPRING SURVEY (shifted back to december)
1993 2008
1 1 0.9 1.0
1 8
 100   567.8    335.1     906.5     504.7     128.9    186.1    28.5     0.1
 100   706      785.9    1453.4    1480.1    1179      284     349      48.6
 100   393.6   3975      3606.1    1768.2    1314.2    403.6    79.6   161.3
 100    90.7    935.7    5474      2309.5     328.8    223.9    57.8     5.2
 100    76.2    424.4    1548.5    4857.6    1126.2     81.7    40.5    34.8
 100   530.1    644.9     972.5    1204.4    2047.4    250      25.1    13.3
 100   288.8   1402.2     735.7     436.6     502.1    829.6    63.4     3.1
 100   874.1   2282.9    1953.5     448.8     320.4    572.5   128       3.9
 100   345.9   4193.7    2789.9    1544.1     323.2    225.7   174.1   128.1
 100   79.1     720.2    4343.4    1350.6     548.9     63.3    48.2    36.9
 100   426.8    450.2     786.3    1198.8     297.7     65.8    21.9    11.8
 100   293.4    400.4    1100.5    1409.9     837.9    139.7    14       3.8
 100   129.7    144.5     166.1     340.7     281.1     92.1    15.2     3.9
 100    40.5    255.7     270.6     148.3     164.1    102.9    37.5    14.3
 100   147.2    411.3     764.3     445.6     144.4     80.9    38.5    13.3
 100   266.8    464       968.1    1151.1     425.1     73.4    31.4    24.8
```

Table 4.2.10. Faroe Plateau (subdivision Vb1) COD. Pairtrawler abundance index (number of individuals per 1000 fishing hours). This series was not used in the tuning of the XSA.

Year	Standardized effort	1	2	3	4	5	6	7	8	9	10
1985	1000	0	332	8712	5134	2308	918	1108	400	142	93
1986	1000	0	211	3288	12317	4777	2043	544	333	98	88
1987	1000	0	77	1313	3584	5438	1944	515	112	90	21
1988	1000	0	73	1707	2067	1942	2962	713	265	47	42
1989	1000	0	137	991	2061	1616	1409	1343	339	97	26
1990	1000	0	31	2130	2282	1409	720	444	444	76	31
1991	1000	0	12	245	1562	956	525	291	199	92	34
1992	1000	0	25	366	694	1993	807	366	151	63	63
1993	1000	20	78	1551	2081	942	1258	472	136	99	78
1994	1000	0	497	1615	2182	2679	763	939	211	141	35
1995	1000	0	1142	3129	5199	3864	1930	434	517	162	83
1996	1000	0	407	13198	12929	4454	2764	667	17	269	43
1997	1000	0	38	1201	10428	8738	1569	795	165	0	104
1998	1000	0	27	1082	2611	5887	3666	554	306	57	0
1999	1000	0	350	2114	2336	2482	4412	1508	93	38	0
2000	1000	0	2717	3467	1896	949	1217	1317	185	0	0
2001	1000	0	3298	7725	3205	642	351	899	407	14	8
2002	1000	0	497	6856	5154	1362	272	203	132	211	9
2003	1000	0	61	1652	5102	2866	679	107	56	73	10
2004	1000	0	0	307	1622	3809	2321	745	149	39	80
2005	1000	0	57	489	797	2470	2113	510	124	45	12
2006	1000	0	124	588	986	1020	1579	707	208	43	7
2007	1000	0	138	1132	1614	1038	566	541	254	64	0
2008	1000	0	82	418	1014	651	447	332	312	98	12

Table 4.2.11. Faroe Plateau (subdivision Vb1) COD. Longliner abundance index (number of individuals per 100000 hooks). This series was not used in the tuning of the XSA. The age composition was obtained from all longliners > 100 GRT. The area was restricted to the area west of Faroe Islands at depths between 100 and 200 m.

Year	Stand. effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1986	100000	0	0	250	875	375	188	63	63	0
1987	100000	0	0	53	263	447	237	105	53	26
1988	100000	0	44	393	393	349	480	131	87	0
1989	100000	0	587	573	545	307	363	349	98	28
1990	100000	0	56	585	304	225	152	129	129	22
1991	100000	0	28	138	799	275	138	83	55	28
1992	100000	0	80	208	208	384	144	64	32	16
1993	100000	7	23	583	570	195	352	91	46	23
1994	100000	39	705	904	452	282	88	160	58	34
1995	100000	0	405	1039	596	410	242	75	158	42
1996	100000	0	49	1528	1492	598	822	360	110	248
1997	100000	0	26	302	2094	1336	300	293	87	38
1998	100000	16	101	159	270	1016	339	48	26	11
1999	100000	4	331	180	136	151	324	96	22	7
2000	100000	75	517	653	125	59	117	189	35	5
2001	100000	11	1030	746	393	62	80	200	157	22
2002	100000	0	544	2085	816	442	164	181	123	137
2003	100000	0	151	697	1653	729	271	76	44	76
2004	100000	0	11	57	210	335	132	43	18	14
2005	100000	0	10	39	102	220	234	83	24	10
2006	100000	5	136	233	112	102	277	165	49	10
2007	100000	5	60	410	295	137	137	144	74	14
2008	100000	20	80	154	248	168	87	114	101	47

Table 4.6.1. Faroe Plateau (subdivision Vb1) COD. The XSA-run.

```
Lowestoft VPA Version 3.1

   21/04/2009  15:38

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_ind_Surveys10.txt

 CPUE data from file Surveys.TXT

 Catch data for  48 years. 1961 to 2008. Ages  1 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2008,   2,     8,   .600,   .700
 SPRING SURVEY (shift,   1993, 2008,   1,     8,   .900,  1.000


 Time series weights :

      Tapered time weighting not applied


 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   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   2.000

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

      Prior weighting not applied


 Tuning converged after   34 iterations

1


 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,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008

      1,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      2,  .096,  .124,  .157,  .189,  .127,  .031,  .098,  .209,  .137,  .127
      3,  .283,  .318,  .344,  .488,  .300,  .185,  .255,  .351,  .376,  .451
      4,  .290,  .379,  .453,  .598,  .658,  .293,  .379,  .354,  .414,  .654
      5,  .318,  .247,  .306,  .814,  .846,  .742,  .461,  .604,  .431,  .696
      6,  .644,  .326,  .350,  .822,  .888,  .969,  .746,  .783,  .582,  .747
      7, 1.050,  .514,  .695, 1.361,  .883, 1.064,  .806,  .876,  .622, 1.233
      8,  .716,  .771,  .585, 1.223,  .929, 1.011,  .504,  .919,  .578, 2.049
      9,  .432,  .164,  .676, 1.034, 1.687, 1.988,  .979,  .242,  .649, 1.975
```

1
XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1999	2.41E+04	1.44E+04	4.45E+03	3.51E+03	4.50E+03	5.18E+03	7.46E+02	1.28E+02	5.36E+01
2000	3.64E+04	1.97E+04	1.07E+04	2.74E+03	2.15E+03	2.68E+03	2.23E+03	2.14E+02	5.11E+01
2001	1.63E+04	2.98E+04	1.43E+04	6.37E+03	1.54E+03	1.37E+03	1.58E+03	1.09E+03	8.10E+01
2002	7.65E+03	1.34E+04	2.08E+04	8.28E+03	3.31E+03	9.27E+02	7.92E+02	6.47E+02	4.97E+02
2003	4.48E+03	6.27E+03	9.07E+03	1.05E+04	3.73E+03	1.20E+03	3.34E+02	1.66E+02	1.56E+02
2004	7.18E+03	3.67E+03	4.52E+03	5.50E+03	4.44E+03	1.31E+03	4.05E+02	1.13E+02	5.38E+01
2005	8.48E+03	5.87E+03	2.91E+03	3.07E+03	3.36E+03	1.73E+03	4.07E+02	1.14E+02	3.36E+01
2006	5.70E+03	6.94E+03	4.36E+03	1.85E+03	1.72E+03	1.73E+03	6.72E+02	1.49E+02	5.66E+01
2007	4.68E+03	4.66E+03	4.61E+03	2.52E+03	1.06E+03	7.71E+02	6.49E+02	2.29E+02	4.86E+01
2008	1.38E+04	3.83E+03	3.33E+03	2.59E+03	1.36E+03	5.65E+02	3.53E+02	2.85E+02	1.05E+02

Estimated population abundance at 1st Jan 2009

, 0.00E+00, 1.13E+04, 2.77E+03, 1.74E+03, 1.10E+03, 5.56E+02, 2.19E+02, 8.42E+01, 3.01E+01,

Taper weighted geometric mean of the VPA populations:

, 1.59E+04, 1.31E+04, 9.94E+03, 6.27E+03, 3.44E+03, 1.69E+03, 7.69E+02, 3.10E+02, 1.26E+02,

Standard error of the weighted Log(VPA populations) :

, .6362, .6360, .6081, .5857, .5676, .5795, .6122, .6907, .8081,

1

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997	1998
1	No data for this fleet at this age					
2	99.99	99.99	99.99	-.31	.06	.20
3	99.99	99.99	99.99	.18	-.17	-.54
4	99.99	99.99	99.99	.28	.39	-.50
5	99.99	99.99	99.99	.74	.01	.31
6	99.99	99.99	99.99	.28	-.09	.71
7	99.99	99.99	99.99	.39	.05	-.32
8	99.99	99.99	99.99	-.13	-.23	.12

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	No data for this fleet at this age									
2	-1.02	-.02	.51	.94	-.22	.46	.38	.74	-.34	-1.37
3	.57	-.37	.12	.65	-.32	.09	.44	.03	-.43	-.25
4	-.04	.15	.18	.18	.18	-.13	.29	-.13	-.51	-.34
5	-.62	-.71	-.04	.18	-.27	.49	.31	-.25	-.43	.29
6	.20	-.53	-.47	-.23	-.63	.36	.73	-.33	-.30	.30
7	.62	.10	-.20	-.30	-1.30	.14	.55	-.06	-.67	-.03
8	.39	-.23	-.05	-.36	-.96	.25	.46	.01	-.56	.06

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	-7.7358	-6.8208	-6.4743	-6.2326	-6.2405	-6.2405	-6.2405
S.E(Log q)	.6631	.3880	.3020	.4400	.4583	.5181	.4014

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,	.84,	.630,	7.94,	.59,	13,	.57,	-7.74,
3,	.92,	.586,	6.99,	.82,	13,	.37,	-6.82,
4,	.83,	2.012,	6.83,	.93,	13,	.22,	-6.47,
5,	.85,	.968,	6.50,	.79,	13,	.37,	-6.23,
6,	.86,	.756,	6.40,	.71,	13,	.40,	-6.24,
7,	.82,	.880,	6.35,	.69,	13,	.42,	-6.32,
8,	1.21,	-1.017,	6.52,	.68,	13,	.47,	-6.33,

1

Fleet : SPRING SURVEY (shift

Age	1993,	1994,	1995,	1996,	1997,	1998
1 ,	-.04,	-.36,	.26,	-.52,	-.61,	.45
2 ,	-.83,	-.87,	.26,	-.02,	-.12,	.43
3 ,	-.57,	.02,	.08,	.04,	-.10,	.15
4 ,	-.52,	.02,	.58,	-.02,	.23,	-.17
5 ,	-.58,	.77,	.37,	-.12,	.27,	.19
6 ,	-.56,	.85,	.48,	-.11,	-.08,	.23
7 ,	-.37,	.44,	.09,	-.18,	-.27,	-.29
8 ,	-4.70,	.69,	.11,	-1.61,	.80,	-.07

Age	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008
1 ,	-.48,	.22,	.09,	-.62,	1.60,	.75,	-.23,	-1.00,	.49,	.00
2 ,	.33,	.53,	.76,	-.17,	.06,	.38,	-1.04,	-.53,	.27,	.58
3 ,	.11,	.25,	.34,	.54,	-.52,	.41,	-.98,	-.80,	.20,	.84
4 ,	-.45,	-.09,	.37,	.11,	-.19,	.27,	-.48,	-.83,	.02,	1.16
5 ,	-.54,	-.31,	.09,	.33,	-.37,	.39,	-.69,	-.42,	-.23,	.85
6 ,	.36,	.34,	.10,	-.33,	-.49,	.26,	-.65,	-.51,	-.13,	.24
7 ,	.11,	-.79,	.03,	.07,	-.31,	-.78,	-.95,	-.48,	-.66,	.33
8 ,	-1.46,	-1.70,	-.01,	-.13,	-.19,	-.86,	-1.33,	.10,	-.72,	1.08

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,	8
Mean Log q,	-8.3631,	-6.9839,	-6.0587,	-5.7713,	-5.7691,	-5.9901,	-5.9901,	-5.9901,
S.E(Log q),	.6383,	.5565,	.4916,	.4785,	.4775,	.4281,	.4861,	1.5290,

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,	1.16,	-.619,	8.19,	.52,	16,	.76,	-8.36,
2,	.98,	.127,	7.04,	.66,	16,	.56,	-6.98,
3,	.88,	.730,	6.40,	.74,	16,	.44,	-6.06,
4,	.87,	.802,	6.13,	.74,	16,	.42,	-5.77,
5,	.89,	.633,	6.00,	.72,	16,	.44,	-5.77,
6,	1.02,	-.085,	5.97,	.64,	16,	.45,	-5.99,
7,	.93,	.444,	6.26,	.72,	16,	.39,	-6.24,
8,	.54,	1.887,	6.08,	.55,	16,	.69,	-6.62,

1

Terminal year survivor and F summaries :

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

Year class = 2007

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	1.,	.000,	.000,	.00,	0,	.000,	.000
SPRING SURVEY (shift,	11321.,	.658,	.000,	.00,	1,	1.000,	.000
F shrinkage mean ,	0.,	2.00,,,,				.000,	.000

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
11321.,	.66,	.00,	1,	.000,	.000

1

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

Year class = 2006

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	702.,	.688,	.000,	.00,	1,	.273,	.427
SPRING SURVEY (shift,	4740.,	.432,	.044,	.10,	2,	.691,	.076
F shrinkage mean ,	2915.,	2.00,,,,				.037,	.121

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2766.,	.36,	.49,	4,	1.355,	.127

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

Year class = 2005

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	1324.,	.348,	.035,	.10,	2,	.472,	.558
SPRING SURVEY (shift,	2184.,	.330,	.511,	1.55,	3,	.505,	.374
F shrinkage mean ,	2885.,	2.00,,,,				.023,	.295

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1736.,	.24,	.26,	6,	1.081,	.451

1

Age 4 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
SUMMER SURVEY ,	833.,	.238,	.209,	.88,	3,	.603,	.799
SPRING SURVEY (shift,	1685.,	.282,	.392,	1.39,	4,	.378,	.473
F shrinkage mean ,	1937.,	2.00,,,,				.019,	.423

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1105.,	.18,	.22,	8,	1.221,	.654

Age 5 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
SUMMER SURVEY ,	501.,	.217,	.214,	.99,	4,	.573,	.749
SPRING SURVEY (shift,	637.,	.255,	.368,	1.44,	5,	.409,	.630
F shrinkage mean ,	648.,	2.00,,,,				.019,	.622

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
556.,	.17,	.19,	10,	1.124,	.696

1

Age 6 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
SUMMER SURVEY ,	229.,	.205,	.163,	.79,	5,	.529,	.724
SPRING SURVEY (shift,	209.,	.231,	.284,	1.23,	6,	.452,	.772
F shrinkage mean ,	198.,	2.00,,,,				.019,	.802

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
219.,	.16,	.15,	12,	.954,	.747

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 2001

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	80.,	.224,	.095,	.42,	6,	.491,	1.270
SPRING SURVEY (shift,	85.,	.242,	.135,	.56,	7,	.471,	1.228
F shrinkage mean ,	150.,	2.00,,,,				.039,	.859

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
84.,	.18,	.08,	14,	.469,	1.233

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 2000

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	27.,	.240,	.129,	.54,	7,	.599,	2.142
SPRING SURVEY (shift,	21.,	.256,	.186,	.73,	8,	.298,	2.384
F shrinkage mean ,	167.,	2.00,,,,				.103,	.796

```
 Weighted prediction :

 Survivors,         Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        30.,       .26,      .19,   16,    .711,  2.049


 Age  9   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
 SUMMER SURVEY       ,         9.,   .278,       .187,    .67,   7,  .565,    2.182
 SPRING SURVEY (shift,         8.,   .296,       .147,    .50,   8,  .239,    2.312

   F shrinkage mean  ,        38.,   2.00,,,,                          .196,    1.088

 Weighted prediction :

 Survivors,         Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        12.,       .43,      .19,   16,    .451,  1.975
```

Table 4.6.2. Faroe Plateau (subdivision Vb1) COD. Fishing mortality at age.

YEAR	2	3	4	5	6	7	8	9	10+	FBAR 3- 7
1961	0.3346	0.5141	0.4986	0.5737	0.4863	0.9566	0.8116	0.6715	0.6715	0.6059
1962	0.2701	0.4982	0.4838	0.7076	0.5569	0.3662	0.6826	0.5641	0.5641	0.5226
1963	0.2534	0.4138	0.5172	0.5124	0.5405	0.4879	0.3269	0.4806	0.4806	0.4944
1964	0.1086	0.2997	0.4523	0.5229	0.5659	0.6677	0.3531	0.5164	0.5164	0.5017
1965	0.1209	0.2518	0.4498	0.5622	0.6604	0.5305	0.4345	0.5318	0.5318	0.4909
1966	0.0829	0.1969	0.2552	0.4499	0.5016	0.968	0.852	0.6106	0.6106	0.4743
1967	0.0789	0.2389	0.2687	0.3442	0.5779	0.5203	1.0438	0.5556	0.5556	0.39
1968	0.101	0.2318	0.3949	0.5339	0.4472	0.7132	0.3331	0.4882	0.4882	0.4642
1969	0.1099	0.3063	0.3806	0.418	0.5709	0.5118	0.8457	0.5499	0.5499	0.4375
1970	0.053	0.2081	0.3654	0.3409	0.3709	0.6559	0.4208	0.4339	0.4339	0.3882
1971	0.0309	0.1337	0.2225	0.3845	0.5572	0.4651	0.7528	0.48	0.48	0.3526
1972	0.0464	0.1476	0.207	0.2497	0.6058	0.4686	0.2464	0.3578	0.3578	0.3358
1973	0.0657	0.2322	0.3048	0.2813	0.2526	0.3722	0.3259	0.3091	0.3091	0.2886
1974	0.0816	0.1568	0.2046	0.2953	0.3797	0.533	0.3052	0.3457	0.3457	0.3139
1975	0.0774	0.3193	0.4359	0.4134	0.4544	0.3504	0.4485	0.4235	0.4235	0.3947
1976	0.0933	0.1723	0.3665	0.5568	0.5167	0.7619	0.6429	0.5738	0.5738	0.4749
1977	0.0481	0.3036	0.4748	0.7532	0.7333	1.1138	0.7776	0.7783	0.7783	0.6757
1978	0.0588	0.1896	0.4291	0.4289	0.4851	0.5968	0.5674	0.5054	0.5054	0.4259
1979	0.0433	0.2623	0.4309	0.5049	0.4906	0.448	0.6903	0.517	0.517	0.4273
1980	0.0544	0.2391	0.3695	0.4337	0.5182	0.4119	0.6437	0.479	0.479	0.3945
1981	0.0523	0.2877	0.3409	0.4369	0.5644	0.694	0.5015	0.5115	0.5115	0.4648
1982	0.0586	0.2227	0.3602	0.3887	0.4047	0.6926	0.5526	0.4834	0.4834	0.4138
1983	0.0992	0.4673	0.5585	0.6411	0.7836	1.078	0.9417	0.8088	0.8088	0.7057
1984	0.1073	0.3712	0.5791	0.6609	0.4534	0.4761	0.4792	0.5341	0.5341	0.5082
1985	0.0658	0.3545	0.5077	0.6135	0.9236	1.1084	1.3206	0.9044	0.9044	0.7015
1986	0.0247	0.3547	0.6229	0.7035	0.8259	0.8403	0.5411	0.7135	0.7135	0.6694
1987	0.0291	0.221	0.4758	0.4855	0.5562	0.4899	0.6227	0.5303	0.5303	0.4457
1988	0.0669	0.3535	0.5644	0.5498	0.7749	0.7999	0.8654	0.7177	0.7177	0.6085
1989	0.1681	0.4414	0.763	0.7633	0.9646	1.0623	1.1062	0.9422	0.9422	0.7989
1990	0.0755	0.3351	0.6286	0.7867	0.7015	0.8401	1.1236	0.8245	0.8245	0.6584
1991	0.0323	0.1957	0.4577	0.5957	0.733	0.5736	0.7106	0.6196	0.6196	0.5111
1992	0.02	0.0997	0.3185	0.3569	0.632	0.8564	0.4357	0.5241	0.5241	0.4527
1993	0.0132	0.1017	0.186	0.2462	0.2097	0.435	0.5339	0.3241	0.3241	0.2357
1994	0.0255	0.1125	0.1901	0.2488	0.2132	0.1654	0.3153	0.9179	0.9179	0.186
1995	0.0699	0.1616	0.463	0.2794	0.3589	0.3202	0.2464	0.7148	0.7148	0.3166
1996	0.0306	0.192	0.4518	0.8036	0.9003	1.1267	0.8538	1.1294	1.1294	0.6949
1997	0.0348	0.1487	0.4093	0.8319	1.0271	1.3741	1.2967	0.8473	0.8473	0.7582
1998	0.0885	0.1758	0.2727	0.6409	1.0486	0.7551	1.0959	0.7647	0.7647	0.5786
1999	0.0955	0.2834	0.2901	0.3176	0.6442	1.0499	0.7156	0.4315	0.4315	0.517
2000	0.1245	0.3181	0.3786	0.2474	0.3258	0.5136	0.7709	0.1643	0.1643	0.3567
2001	0.1568	0.344	0.4533	0.3062	0.3501	0.6953	0.585	0.6757	0.6757	0.4298
2002	0.1885	0.488	0.5976	0.8144	0.822	1.3612	1.2226	1.034	1.034	0.8166
2003	0.1274	0.3003	0.6584	0.8459	0.8877	0.8831	0.9286	1.6866	1.6866	0.7151
2004	0.0306	0.1852	0.2929	0.7422	0.9689	1.0636	1.0111	1.9879	1.9879	0.6506
2005	0.0975	0.2546	0.379	0.4608	0.7457	0.8063	0.5038	0.9789	0.9789	0.5293
2006	0.2085	0.3508	0.3545	0.6035	0.7827	0.8764	0.9193	0.2416	0.2416	0.5936
2007	0.137	0.3757	0.4136	0.4306	0.5825	0.6217	0.578	0.6489	0.6489	0.4848
2008	0.1267	0.4513	0.6535	0.6963	0.7472	1.2325	2.0487	1.975	1.975	0.7562

Table 4.6.3. Faroe Plateau (subdivision Vb1) COD. Stock number at age.

YEAR	2	3	4	5	6	7	8	9	10+	TOTAL
1961	12019	7385	3747	2699	666	668	155	66	0	52630
1962	20654	7042	3616	1863	1245	335	210	56	0	59804
1963	20290	12907	3503	1825	752	584	190	87	0	66807
1964	21834	12893	6986	1710	895	358	294	112	0	55183
1965	8269	16037	7823	3639	830	416	151	169	0	60009
1966	18566	5999	10207	4085	1698	351	200	80	0	69829
1967	23451	13990	4034	6475	2133	842	109	70	0	72579
1968	17582	17744	9020	2525	3757	980	410	31	0	63439
1969	9325	13012	11522	4976	1212	1967	393	240	0	53161
1970	8608	6840	7843	6447	2682	561	965	138	0	48654
1971	11928	6684	4548	4456	3754	1516	238	519	0	59683
1972	21320	9469	4788	2981	2483	1760	779	92	0	59029
1973	12573	16664	6689	3187	1901	1109	902	499	400	81153
1974	30480	9639	10816	4037	1969	1209	626	533	342	106456
1975	38319	23000	6747	7217	2460	1103	581	378	476	102968
1976	18575	29035	13683	3572	3908	1279	636	304	466	83665
1977	9995	13853	20010	7765	1676	1909	489	274	18	69116
1978	10748	7799	8372	10190	2993	659	513	184	154	59930
1979	14997	8298	5282	4463	5433	1509	297	238	103	69423
1980	23582	11759	5226	2811	2206	2723	789	122	52	66369
1981	14000	18286	7579	2957	1491	1076	1477	339	150	74382
1982	22127	10878	11228	4413	1564	694	440	732	348	83152
1983	25157	17086	7128	6412	2449	854	284	207	200	118106
1984	47755	18653	8767	3339	2765	916	238	91	174	103844
1985	17314	35120	10535	4022	1411	1439	466	121	146	82186
1986	9506	13273	20173	5192	1783	459	389	102	81	63054
1987	9904	7593	7622	8859	2104	639	162	185	69	47762
1988	8699	7877	4984	3878	4464	988	321	71	53	50850
1989	15979	6661	4529	2321	1832	1684	363	110	16	38007
1990	3694	11058	3508	1729	886	572	477	98	50	30236
1991	6685	2805	6476	1532	645	360	202	127	57	32836
1992	11421	5299	1888	3355	691	254	166	81	91	35618
1993	10129	9166	3927	1124	1922	301	88	88	99	57623
1994	25200	8185	6778	2669	720	1276	159	42	29	97332
1995	42798	20113	5988	4589	1704	476	886	95	105	92477
1996	12874	32674	14010	3086	2841	975	283	567	75	75271
1997	6458	10222	22078	7301	1131	945	259	99	229	55970
1998	5934	5106	7213	12005	2601	332	196	58	51	51052
1999	14373	4447	3507	4496	5178	746	128	54	22	57063
2000	19743	10696	2742	2148	2679	2226	214	51	7	76882
2001	29783	14272	6371	1538	1373	1584	1090	81	13	72438
2002	13372	20844	8283	3315	927	792	647	497	12	56343
2003	6266	9067	10476	3731	1202	334	166	156	26	35902
2004	3666	4516	5498	4440	1311	405	113	54	46	27225
2005	5875	2911	3072	3359	1731	407	114	34	52	26032
2006	6940	4363	1848	1722	1735	672	149	57	15	23195
2007	4663	4612	2515	1061	771	649	229	49	7	19240
2008	3835	3329	2594	1362	565	353	285	105	35	26290
2009	11321	2766	1736	1105	556	219	84	30	16	17833

Table 4.6.4. Faroe Plateau (subdivision Vb1) COD. Summary table (1961-2007) and results from the short term prediction (2008-2010) are shown in bold.

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1961	12019	65428	46439	21598	0.4651	0.6059
1962	20654	68225	43326	20967	0.4839	0.5226
1963	20290	77602	49054	22215	0.4529	0.4944
1964	21834	84666	55362	21078	0.3807	0.5017
1965	8269	75043	57057	24212	0.4244	0.4909
1966	18566	83919	60629	20418	0.3368	0.4743
1967	23451	105289	73934	23562	0.3187	0.39
1968	17582	110433	82484	29930	0.3629	0.4642
1969	9325	105537	83487	32371	0.3877	0.4375
1970	8608	98398	82035	24183	0.2948	0.3882
1971	11928	78218	63308	23010	0.3635	0.3526
1972	21320	76439	57180	18727	0.3275	0.3358
1973	12573	110713	83547	22228	0.2661	0.2886
1974	30480	139266	98434	24581	0.2497	0.3139
1975	38319	153663	109566	36775	0.3356	0.3947
1976	18575	161260	123077	39799	0.3234	0.4749
1977	9995	136211	112057	34927	0.3117	0.6757
1978	10748	96227	78497	26585	0.3387	0.4259
1979	14997	85112	66722	23112	0.3464	0.4273
1980	23582	85037	58886	20513	0.3483	0.3945
1981	14000	88410	63561	22963	0.3613	0.4648
1982	22127	98960	67031	21489	0.3206	0.4138
1983	25157	123246	78539	38133	0.4855	0.7057
1984	47755	152133	96761	36979	0.3822	0.5082
1985	17314	131206	84768	39484	0.4658	0.7015
1986	9506	99230	73664	34595	0.4696	0.6694
1987	9904	78306	62198	21391	0.3439	0.4457
1988	8699	66088	52070	23182	0.4452	0.6085
1989	15979	58743	38319	22068	0.5759	0.7989
1990	3694	38036	29045	13487	0.4643	0.6584
1991	6685	28689	21060	8750	0.4155	0.5111
1992	11421	35741	20749	6396	0.3083	0.4527
1993	10129	51159	33114	6107	0.1844	0.2357
1994	25200	84043	42583	9046	0.2124	0.186
1995	42798	144675	54367	23045	0.4239	0.3166
1996	12874	142748	85325	40422	0.4737	0.6949
1997	6458	97290	81986	34304	0.4184	0.7582
1998	5934	66467	56096	24005	0.4279	0.5786
1999	14373	65378	45330	18306	0.4038	0.517
2000	19743	91541	46517	21033	0.4522	0.3567
2001	29783	110427	59394	28183	0.4745	0.4298
2002	13372	98928	56355	38457	0.6824	0.8166
2003	6266	60892	40718	24501	0.6017	0.7151
2004	3666	37503	27434	13178	0.4803	0.6506
2005	5875	32220	23998	9906	0.4128	0.5293
2006	6940	30084	21328	10480	0.4914	0.5936
2007	4663	26480	17372	8009	0.461	0.4848
2008	3835	25286	19063	10523	0.552	0.7562
2009	**11321**	**30745**	**15877**	**8615**	**0.5426**	**0.61152**
2010	**6527**	**34997**	**20764**	**10572**	**0.5091**	**0.61152**
2011	**6527**	**34257**	**21554**			
Avg.61-08	15776	86679	60080	23317	0.4023	0.5086

Table 4.7.1. Faroe Plateau (subdivision Vb1) COD. Input to management option table.

	Recr.	Source
YC2006	3835	XSA-output
YC2007	11321	XSA-output
YC2008	6527	Average R in 2005-2009
YC2009	6527	Same as YC2008

Age	Stock size 2009	Source
2	11321	XSA-output
3	2766	XSA-output
4	1736	XSA-output
5	1105	XSA-output
6	556	XSA-output
7	219	XSA-output
8	84	XSA-output
9	30	XSA-output
10+	16	XSA-output

	Maturity			Exploitation pattern (not rescaled)			Weights		
	Observed	Av. 07-09	Av. 07-09	Av. 06-08	Av. 06-08	Av. 06-08		As 2009	As 2009
Age	2009	2010	2011	2009	2010	2011	2009	2010	2011
2	0.09	0.06	0.06	0.1574	0.1574	0.1574	1.104	1.104	1.104
3	0.61	0.62	0.62	0.3926	0.3926	0.3926	2.148	2.148	2.148
4	0.81	0.83	0.83	0.4739	0.4739	0.4739	2.586	2.586	2.586
5	0.96	0.92	0.92	0.5768	0.5768	0.5768	2.965	2.965	2.965
6	0.94	0.96	0.96	0.7041	0.7041	0.7041	4.308	4.308	4.308
7	0.96	0.98	0.98	0.9102	0.9102	0.9102	5.689	5.689	5.689
8	1.00	1.00	1.00	1.1820	1.1820	1.1820	5.6	5.6	5.6
9	1.00	1.00	1.00	0.9552	0.9552	0.9552	9.714	9.714	9.714
10+	1.00	1.00	1.00	0.9552	0.9552	0.9552	8.557	8.557	8.557

Table 4.7.2. Faroe Plateau (subdivision Vb1) COD. Management option table.

2009				
Biomass	SSB	FMult	FBar	Landings
30745	15877	1	0.6115	8615

2010					2011	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
34997	20764	0	0	0	46506	31927
.	20764	0.1	0.0612	1300	44998	30627
.	20764	0.2	0.1223	2537	43562	29393
.	20764	0.3	0.1835	3715	42195	28222
.	20764	0.4	0.2446	4838	40894	27109
.	20764	0.5	0.3058	5908	39654	26052
.	20764	0.6	0.3669	6930	38471	25046
.	20764	0.7	0.4281	7904	37343	24089
.	20764	0.8	0.4892	8834	36267	23178
.	20764	0.9	0.5504	9723	35239	22310
.	20764	1	0.6115	10572	34257	21484
.	20764	1.1	0.6727	11383	33319	20696
.	20764	1.2	0.7338	12160	32422	19944
.	20764	1.3	0.795	12902	31563	19227
.	20764	1.4	0.8561	13613	30742	18542
.	20764	1.5	0.9173	14294	29956	17889
.	20764	1.6	0.9784	14946	29203	17264
.	20764	1.7	1.0396	15571	28482	16667
.	20764	1.8	1.1007	16170	27790	16097
.	20764	1.9	1.1619	16744	27127	15551
.	20764	2	1.223	17295	26491	15028

Input units are thousands and kg - output in tonnes

Table 4.8.1. Faroe Plateau (subdivision Vb1) COD. Input to yield per recruit calculations (long term prediction).

	Expl. pattern	Weight at age	Prop mature
Age	Average 2000-2008 Not rescaled	Average 1978-2008	Average 1983-2009
2	0.1331	1.0540	0.08
3	0.3409	1.5729	0.56
4	0.4646	2.2611	0.84
5	0.5719	3.0562	0.94
6	0.6903	3.8339	0.98
7	0.8949	4.8511	0.98
8	0.952	6.0742	1.00
9	1.0437	7.6450	1.00
10+	1.0437	9.5190	1.00

Table 4.2.19. Faroe Plateau (subdivision Vb1) COD. Output from yield per recruit calculations (long term prediction).

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5925
FMax	0.4249	0.2518
F0.1	0.1955	0.1158
F35%SPR	0.2928	0.1735
Flow	0.1657	0.0982
Fmed	0.5554	0.3291
Fhigh	1.5154	0.8979

Weights in kilograms

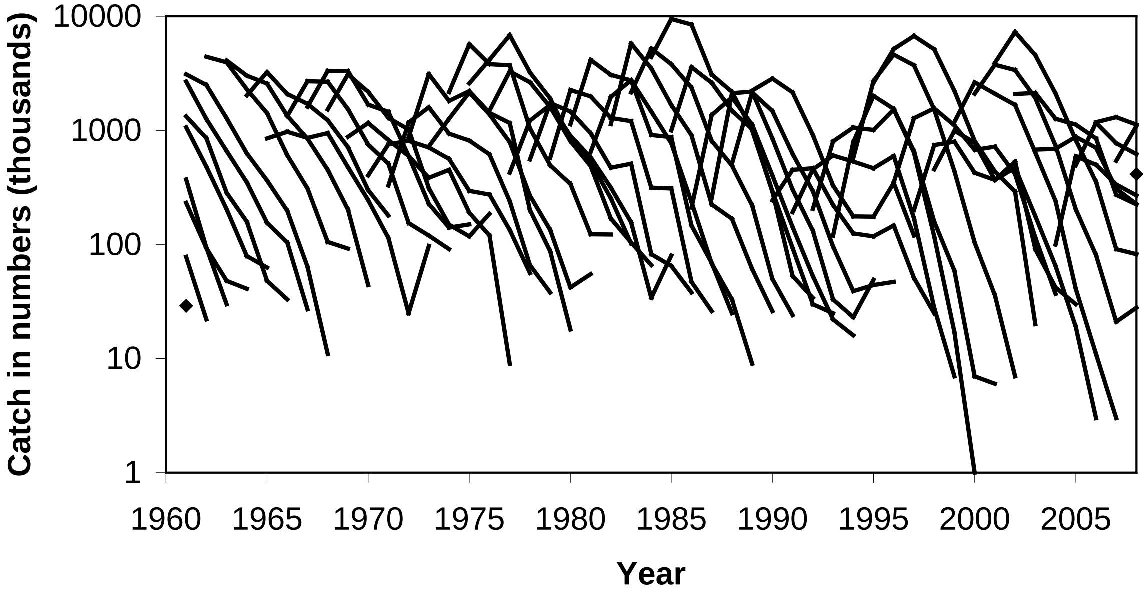


Figure 4.2.1. Faroe Plateau (subdivision VB1) COD. Catch in numbers at age shown as catch curves.

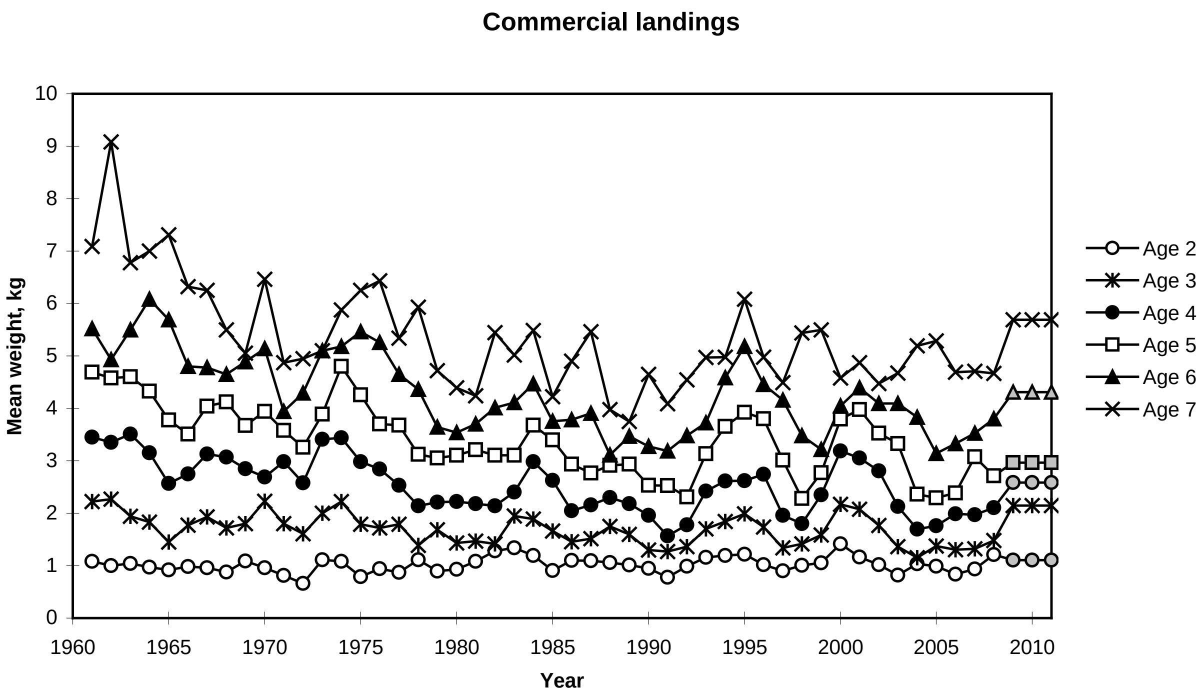


Figure 4.2.2. Faroe Plateau (subdivision VB1) COD. Mean weight at age 1961-2008. The estimated weights in 2009 are also shown. The weights in 2010 and 2011 are set to the 2009 values.

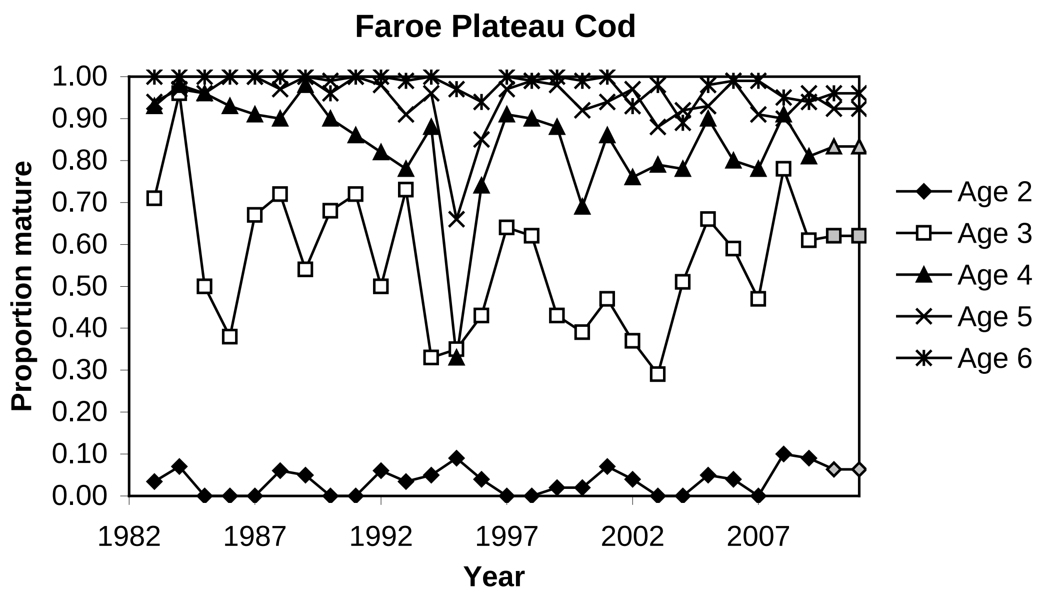


Figure 4.2.3. Faroe Plateau (subdivision VB1) COD. Proportion mature at age as observed in the spring groundfish survey. The values in 2009 and 2010 are estimated as the average of the 2006-2008 values.

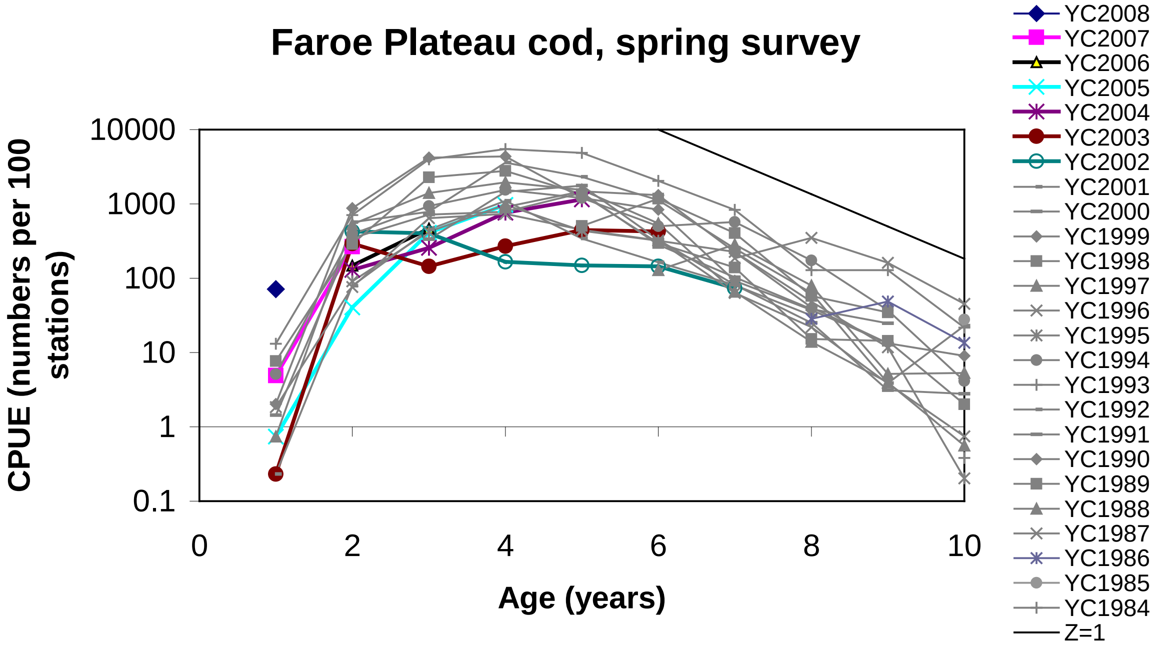


Figure 4.2.4. Faroe Plateau (subdivision VB1) COD. Catch curves from the spring groundfish survey.

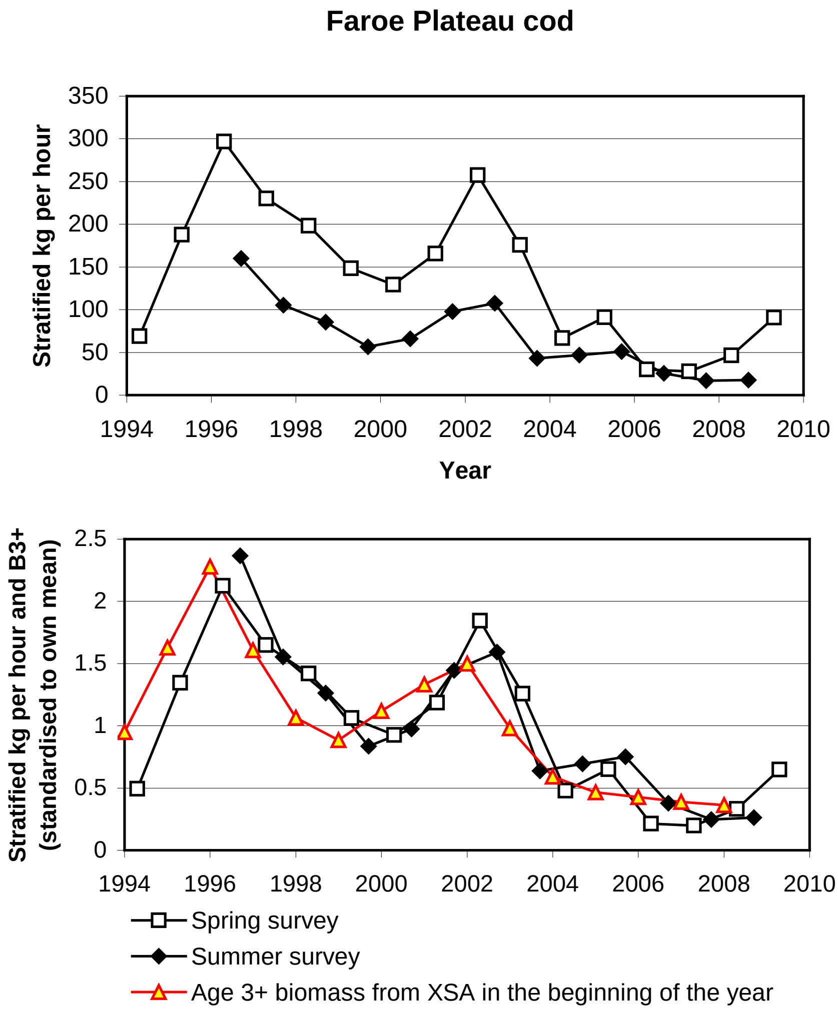


Figure 4.2.5. Faroe Plateau (subdivision VB1) COD. Stratified kg/hour in the spring and summer surveys. The age 3+ biomass obtained from the assessment is also included as an index.

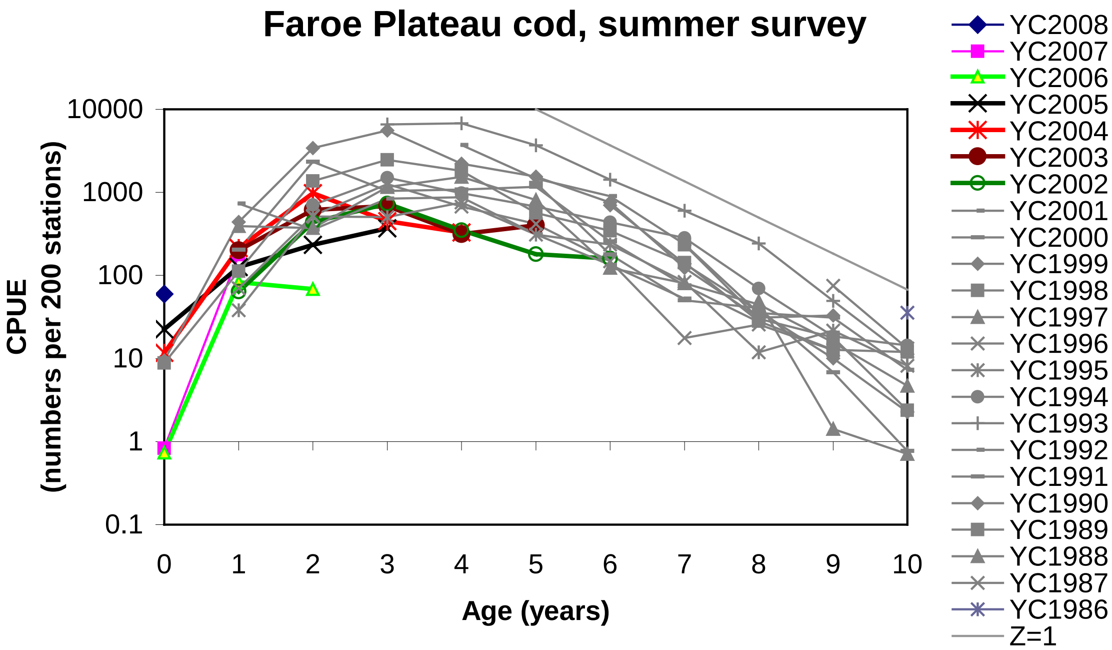


Figure 4.2.6. Faroe Plateau (subdivision VB1) COD. Catch curves from the summer groundfish survey.

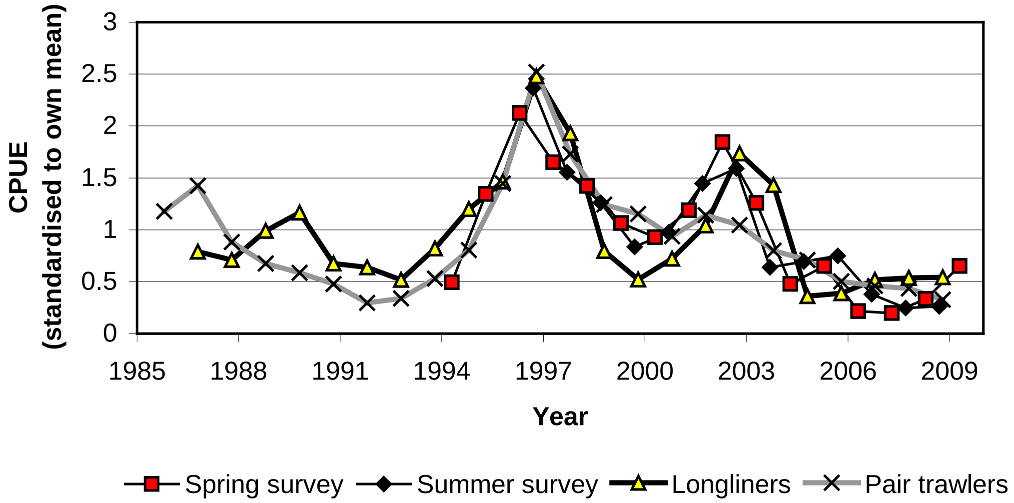
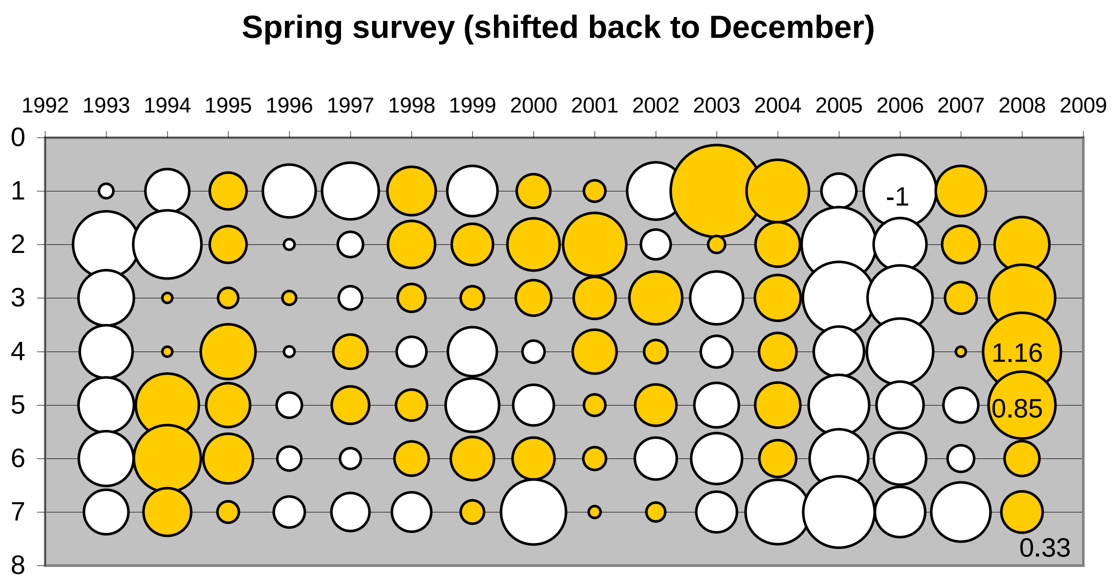


Figure 4.2.7. Faroe Plateau (subdivision VB1) COD. Standardised catch per unit effort for pair trawlers and longliners. The two surveys are shown as well.



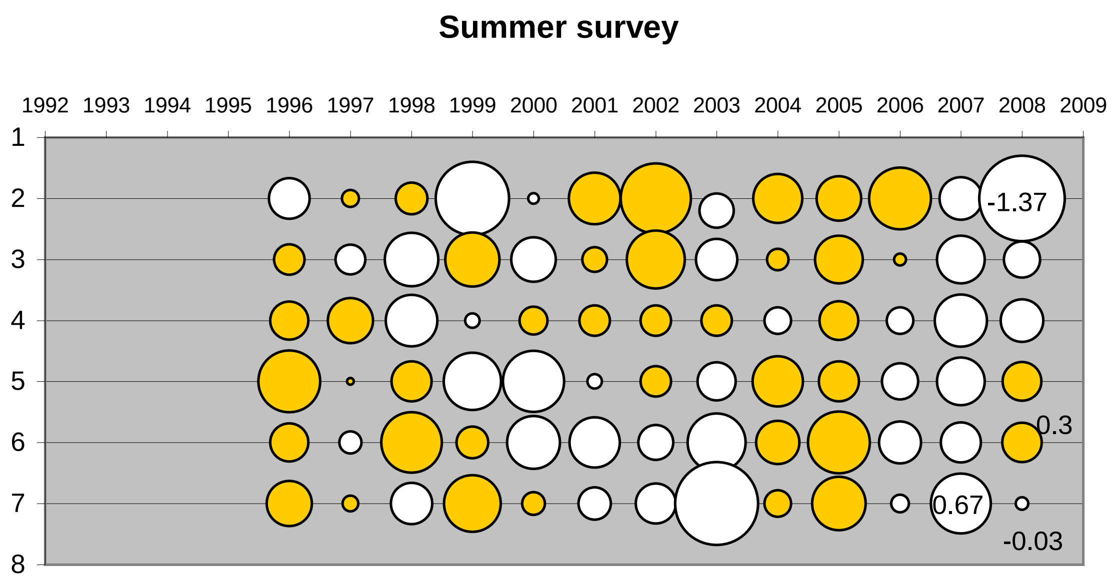


Figure 4.6.1. Faroe Plateau (subdivision VB1) COD. Log catchability residuals for the spring and summer survey. The residuals for age 8 are not presented because some values were off scale. White bubbles indicate negative residuals.

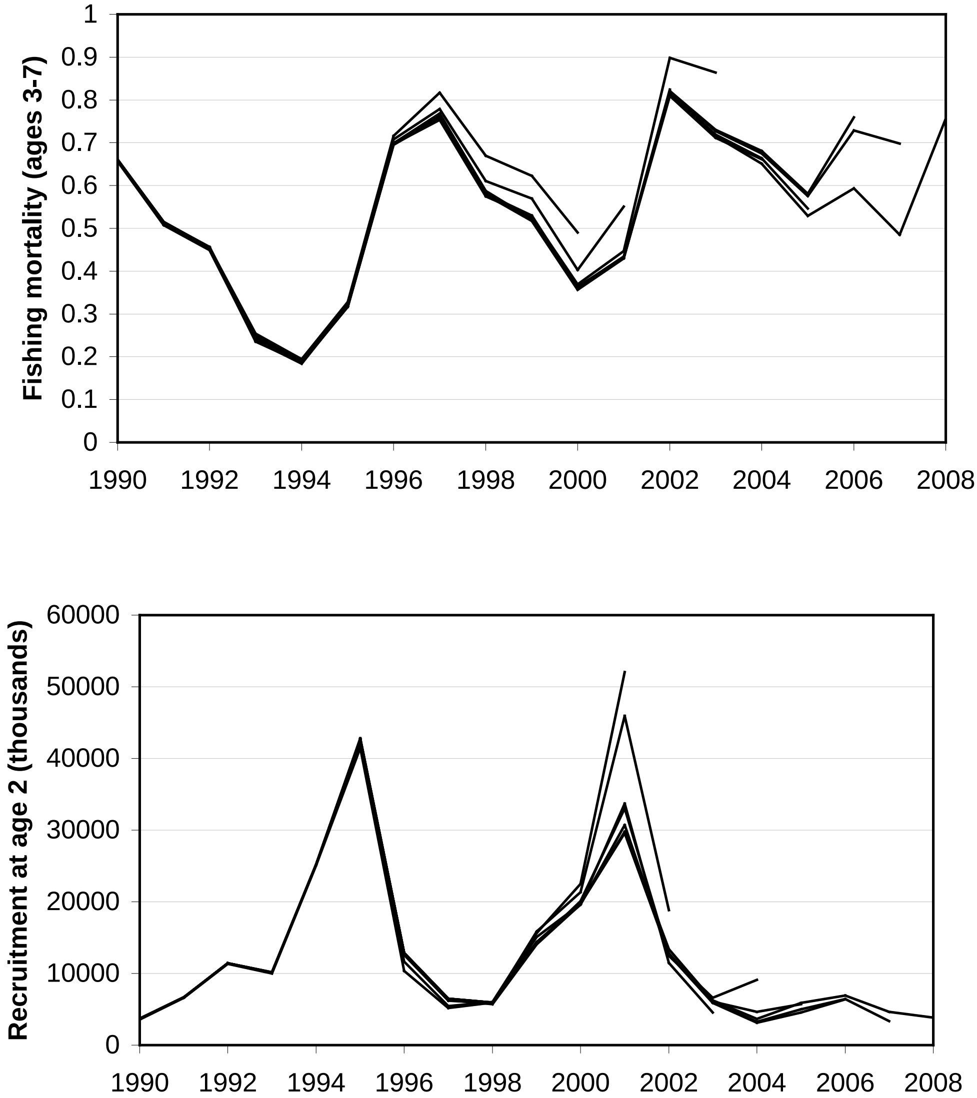
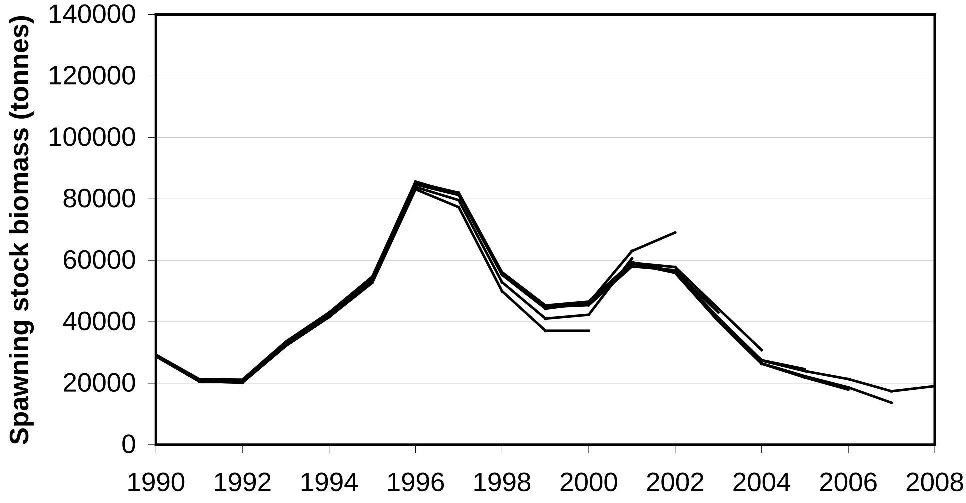


Figure 4.6.2. Faroe Plateau (subdivision VB1) COD. Results from the XSA retrospective analysis.



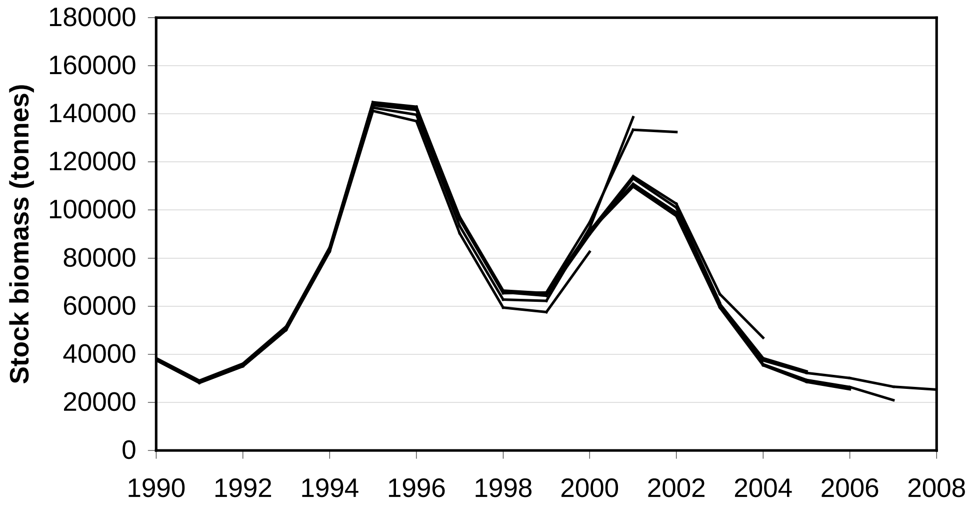
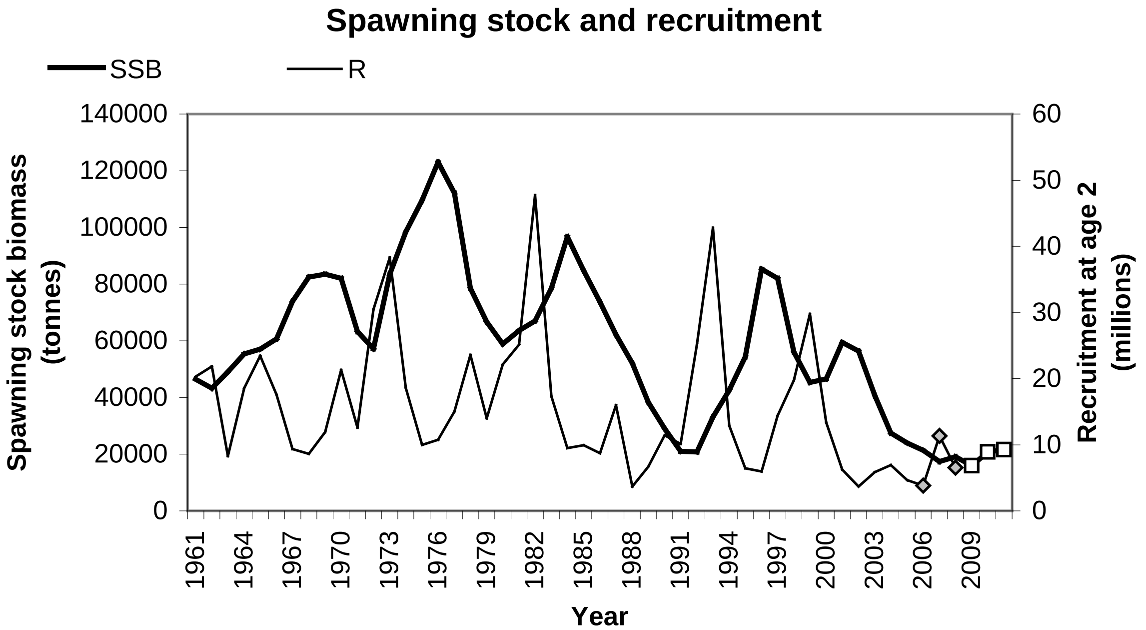


Figure 4.6.2. Faroe Plateau (subdivision VB1) COD. Results from the XSA retrospective analysis (continued).



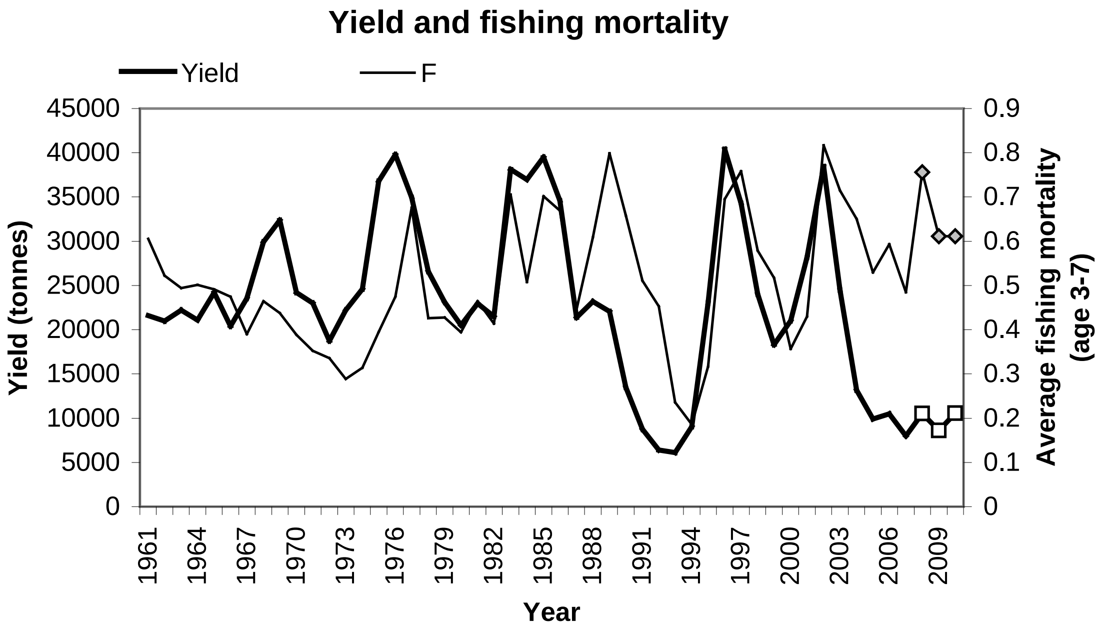


Figure 4.6.3. Faroe Plateau (subdivision VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year. Points (white and grey) are taken from the short term projections.

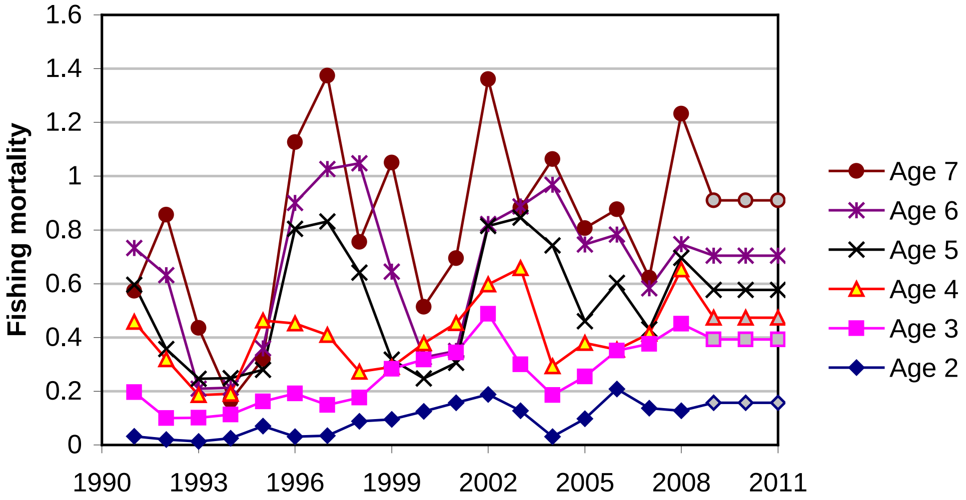


Figure 4.6.4. Faroe Plateau (subdivision VB1) COD. Fishing mortalities by age. The F-values in 2009-2011 are set to the average values in 2006-2008.

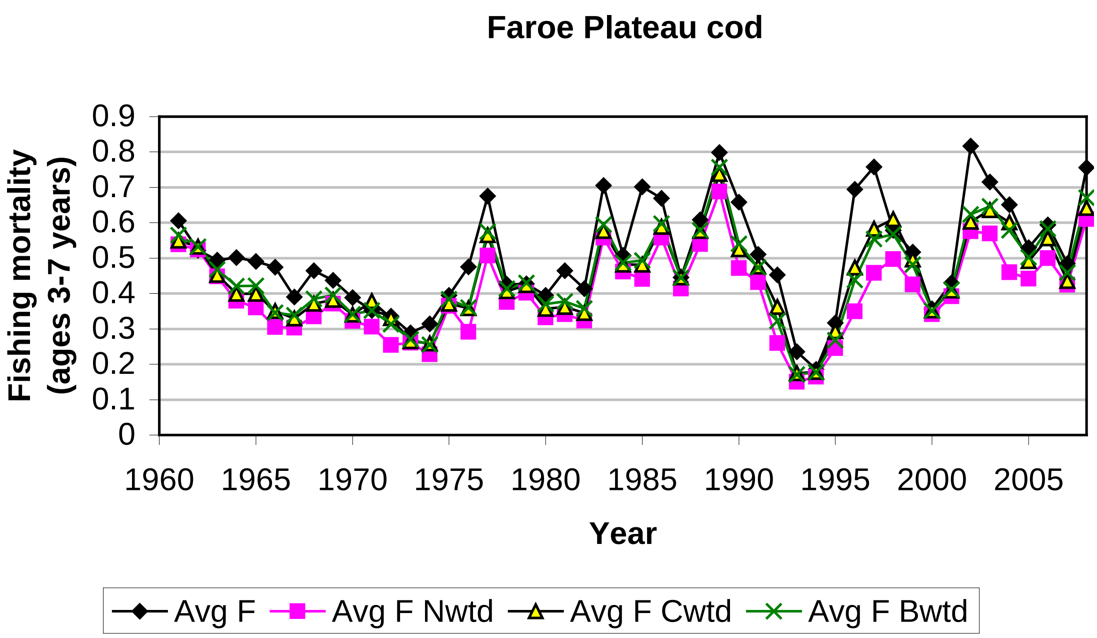


Figure 4.6.5. Faroe Plateau (subdivision VB1) COD. Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

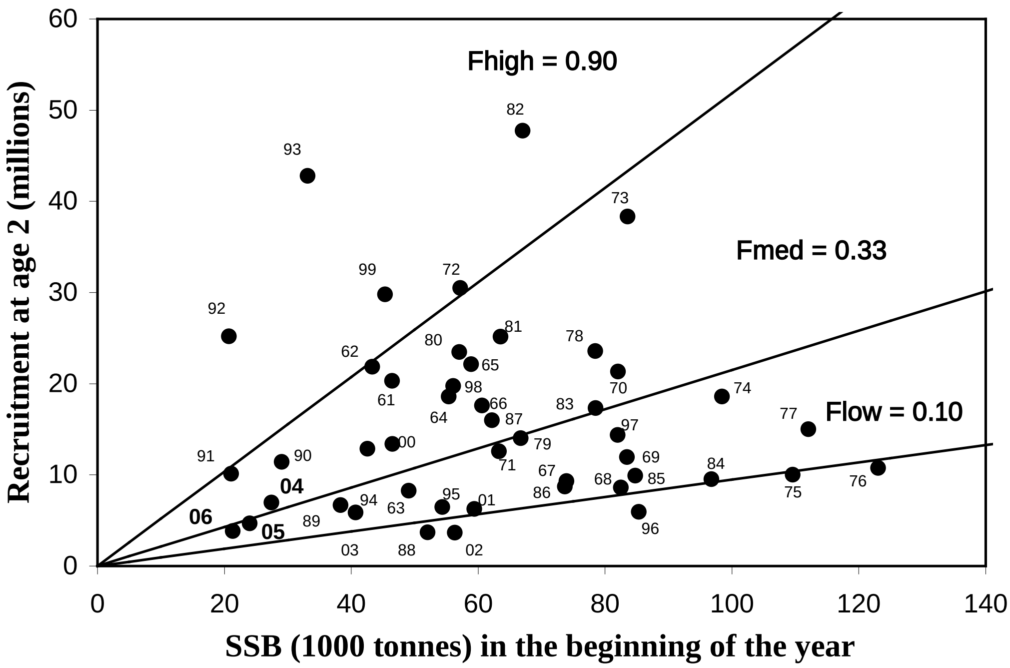


Figure 4.6.6. Faroe Plateau (subdivision VB1) COD. Spawning stock – recruitment relationship 1961-2006. Years are shown at each data point.

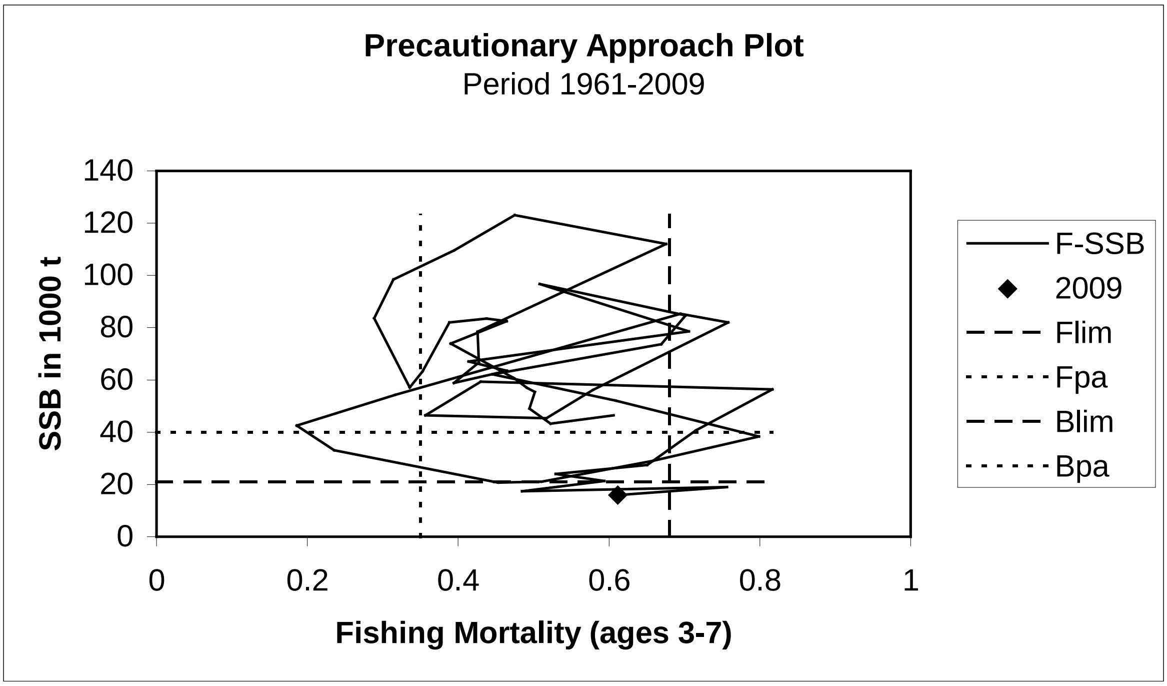


Figure 4.6.7. Faroe Plateau (subdivision VB1) COD. Spawning stock biomass versus fishing mortality 1961-2009.

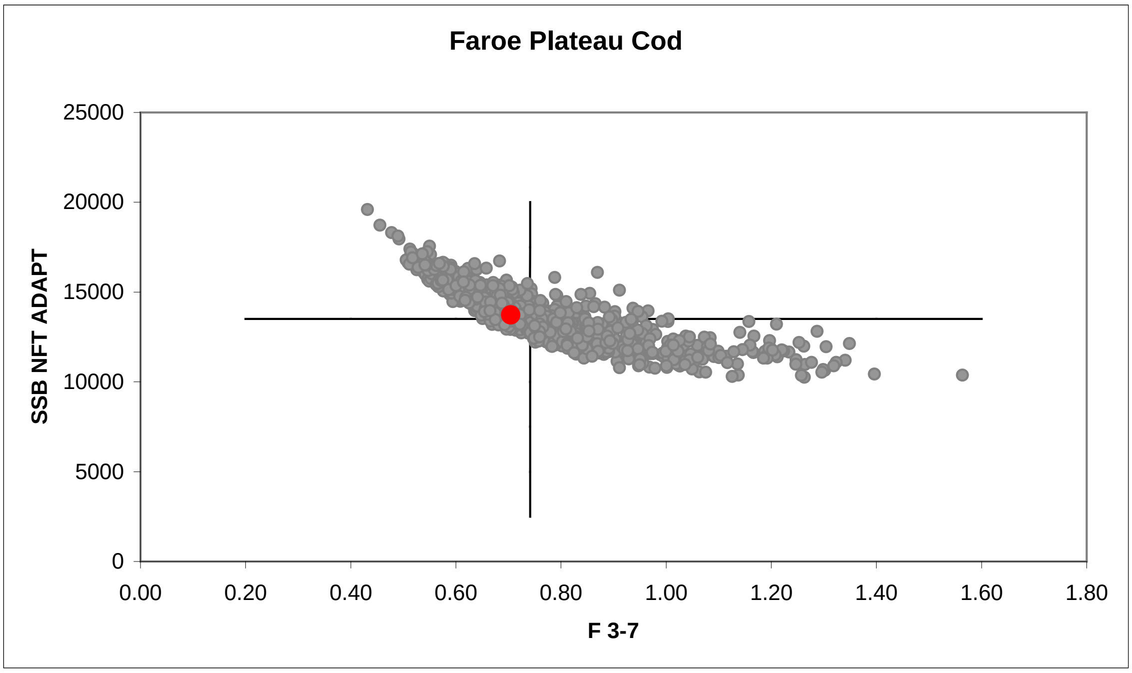


Figure 4.6.8. F and SSB's for 2007 from a 1000 bootstraps of the ADAPT with the two surveys. The XSA estimate is shown as a red point. This figure is the same as in last year's report.

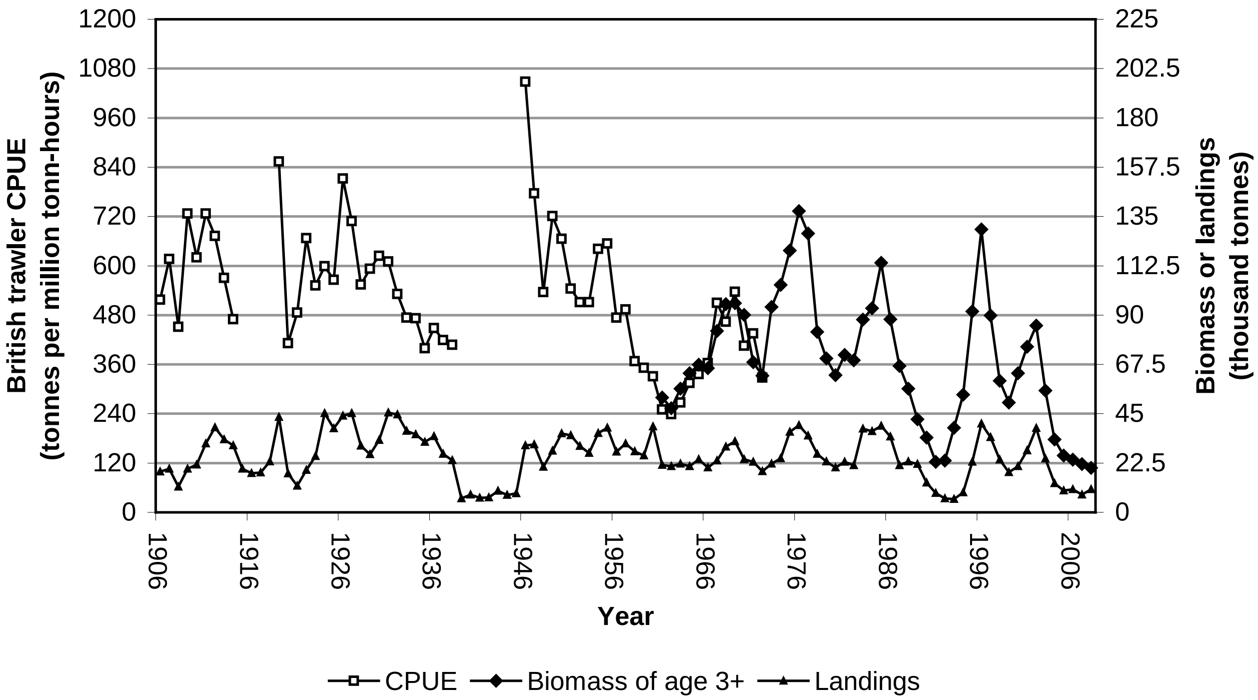
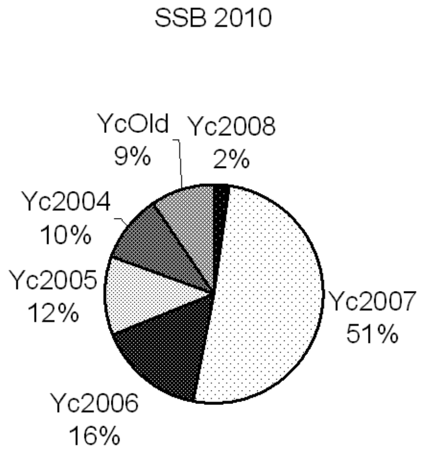


Figure 4.6.9. Faroe Plateau Cod. Stock development 1906-2008 based on cpues from british steam trawlers (1906-1925: cwts per days of absence from port), cpues from british trawlers (1924-1972: tonnes per million tonn hours) and the XSA-estimates (1961-2008: absolute biomass). The 1906-1925 series was scaled to the 1924-1972 series and the CPUEs refer to the first (left) axis while the XSA-estimates refer to the second axis.



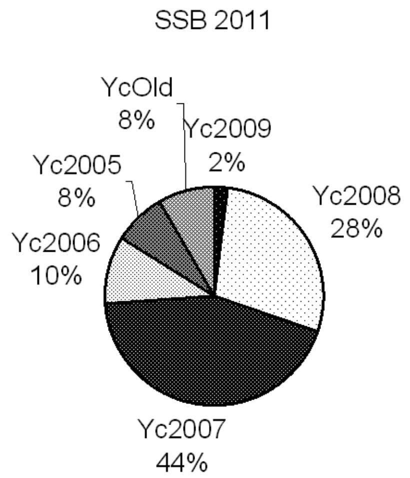
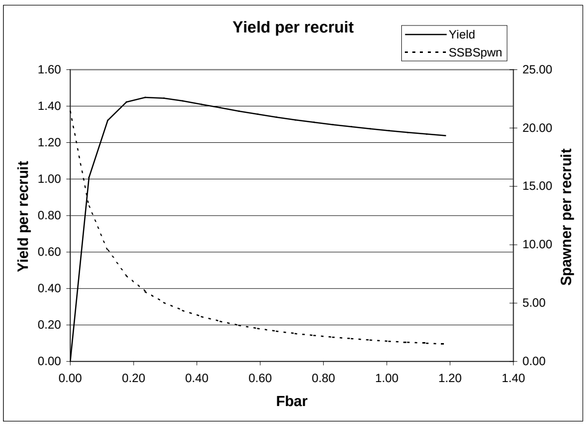
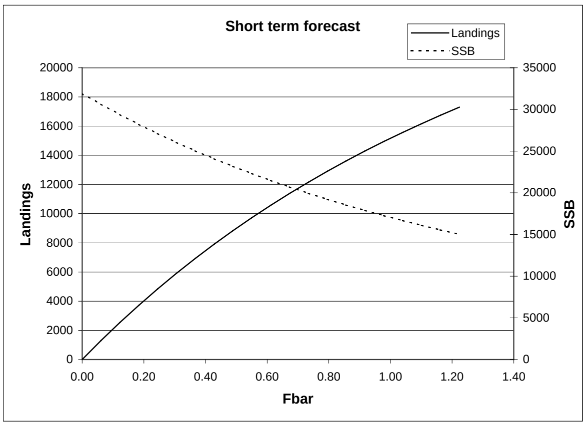


Figure 4.7.1. Contribution of various year classes to the spawning stock biomass in 2010 and 2011.





MFYPR version 1
Run: Run2
Time and date: 08:52 29/04/2009

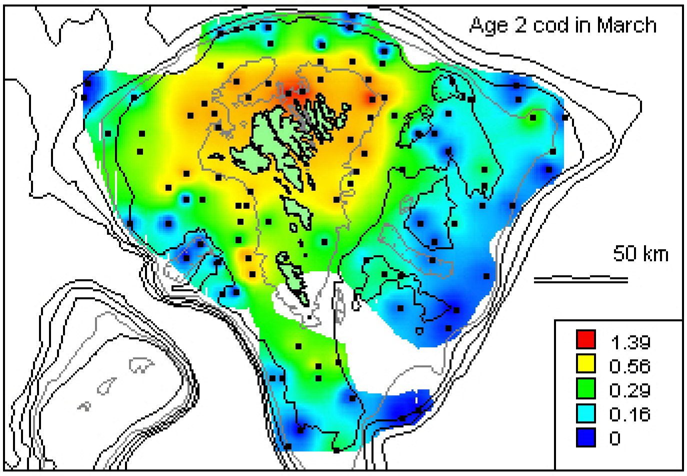
Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5925
FMax	0.4249	0.2518
F0.1	0.1955	0.1158
F35%SPR	0.2928	0.1735
Flow	0.1657	0.0982
Fmed	0.5554	0.3291
Fhigh	1.5154	0.8979

Weights in kilograms

MFDP version 1
Run: Run1
Index file 29/4-2009
Time and date: 08:37 29/04/2009
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 4.8.1. Faroe Plateau (subdivision VB1) COD. Yield per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality (left figure). Landings and SSB versus Fbar (3-7).



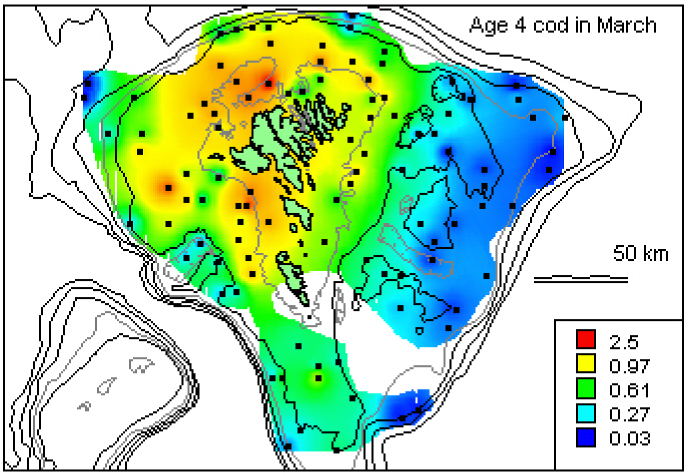
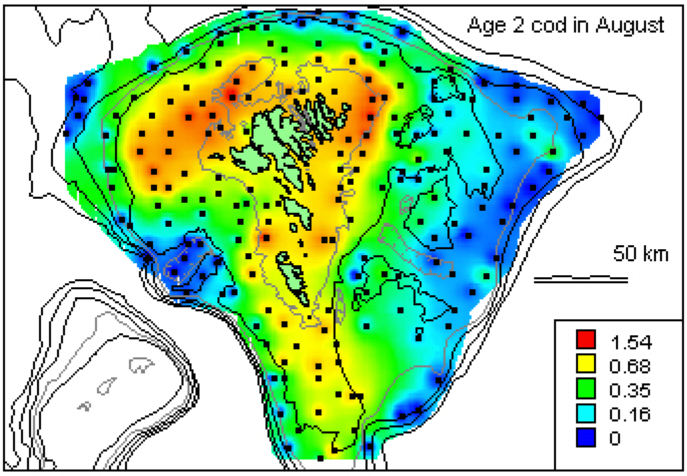


Figure 4.12.1. Mean abundance ($\log_{10}$(numbers+1)) of 2 and 4 year-old cod in March 1998-2006 as observed in the spring groundfish survey (from Steingrund et al., in prep.). 100 m depth contours are shown.



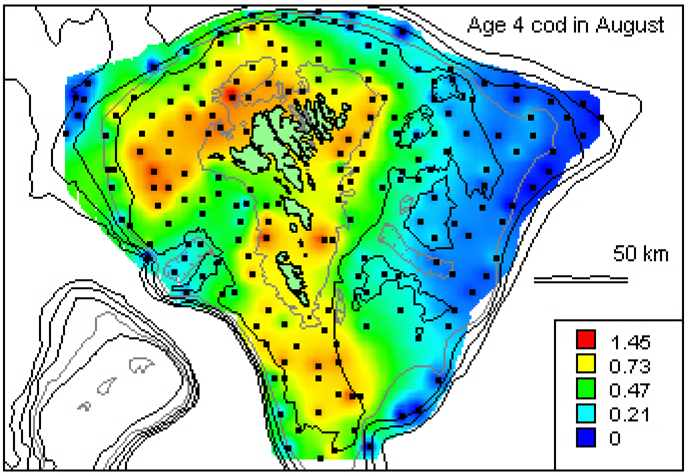


Figure 4.12.2. Mean abundance ($\log_{10}$(numbers+1)) of 2 and 4 year-old cod in August 1997-2005 as observed in the summer groundfish survey (from Steingrund et al., in prep.). 100 m depth contours are shown.

5 Faroe haddock

Executive summary

Being an update assessment, the only changes compared to last year are additions of new data from 2008 and some minor revisions of the landings data for 2006 and 2007 with corresponding revisions of the catch@age data. The main assessment tool is XSA tuned with 2 research vessel bottom trawl surveys. The results are in line with those from 2008, showing a declining SSB mainly due to poor recruitment. SSB is now estimated just below B_{pa} and is predicted to be close to B_{lim} in 2010 and 2011 with status quo fishing mortality. Fishing mortality in 2008 is estimated at 0.22 (F_{pa} = 0.25) and landings in 2008 were only 7 500t. In recent years there has been a tendency to overestimate SSB and underestimate F.

5.1 Stock description and management units

Haddock in Faroese Waters, i.e. ICES Subdivisions Vb1 and Vb2 and in the southern part of ICES Division IIa, close to the border of Subdivision Vb1, are generally believed to belong to the same stock and are treated as one management unit named Faroe haddock. Haddock is distributed all over the Faroe Plateau and the Faroe Bank from shallow water down to more than 450 m. Spawning takes place from late March to the beginning of May with a peak in the middle of April and occurs in several areas on the Faroe Plateau and on the Faroe Bank. Haddock does not form as dense spawning aggregations as cod and saithe, nor does it perform ordinary spawning migrations. After spawning, eggs and fry are pelagic for about 4 months over the Plateau and Bank and settling starts in August. This is a prolonged process and pelagic juveniles can be found at least until September. Also during the first years of life they can be pelagic and this vertical distribution seems to be connected to year class strength, with some individuals from large year classes staying pelagic for a longer time period. No special nursery areas can be found, because young haddock are distributed all over the Plateau and Bank. After settling the haddock is considered very stationary as seen in tagging experiments. Figures 5.8-5.9 show the age-aggregated distribution by year as seen in the two regular groundfish surveys in the area.

5.2 Scientific data

5.2.1 Trends in landings and fisheries

Nominal landings of Faroe haddock have in recent years increased very rapidly from only 4 000 t in 1993 to 27 000 t in 2003; they have declined since and amounted in 2008 to about 7 600 t. Most of the landings are taken from the Faroe Plateau; the landings from the Faroe Bank (Subdivision Vb2) in 2008 were about 360 t (Tables 5.1 and 5.2). As can be seen from Figure 5.1, landings in 2002-2004 reached historical highs. The cumulative landings by month (Figure 5.2) suggest that landings in 2009 may be smaller than those in 2008.

Faroese vessels have taken almost the entire catch since the late 1970s (Figure 5.1). Table 5.3 shows the proportion of the Faroese landings taken by each fleet category since 1985. The longliners have taken most of the catches in recent years followed by the trawlers; the proportions in 2008 were: longliners 81% and trawlers 19% (Figure 5.3).

5.2.2 Catch-at-age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau and the Faroe Bank. The sampling intensity in 2008 is shown in Table 5.4 and was somewhat lower than in recent years. The main reasons for this are illness, small catches and difficulties to get access to some of the landings.

Due to the low sampling level in 2008, the practise in the past to disaggregate samples from each fleet category by season (Jan-Apr, May-Aug and Sep-Dec) and then raise them by the corresponding catch proportions to give the annual catch-at-age in numbers for each fleet, had to be replaced by using 2 seasons only (Jan-Jun, Jul-Dec. The results are given in Table 5.4. Catches of some minor fleets have been included under the "Others" heading. No catch-at-age data were available from other nations fishing in Faroese waters. Therefore, catches by trawlers from France, Russia and UKwere assumed to have the same age composition as Faroese otter board trawlers larger than 1 000 HP. The Norwegian longliners were assumed to have the same age distribution as the Faroese longliners greater than 100 GRT. The most recent data were revised according to the final catch figures. The resulting total catch-at-age in numbers is given in Tables 5.4 and 5.5, and in Figure 5.4 the LN(catch-at-age in numbers) is shown for the whole period of analytical assessments.

In general the catch-at-age matrix in recent years appears consistent although from time to time a few small year classes are disturbing this consistency, both in numbers and mean weights at age. Also there are some problems with what ages should be included in the plus group; there are some periods where only a few fishes are older than 9 years, and other period with a quite substantial plus group (10+). These problems have been addressed in former reports of this WG and will not be further dealt with here. No estimates of discards of haddock are available. However, since almost no quotas are used in the management of the fisheries on this stock, the incentive to discard in order to high grade the catches should be low. The landings statistics is therefore regarded as being adequate for assessment purposes. The ban on discarding as stated in the law on fisheries should also – in theory – keep the discarding at a low level.

5.2.3 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery (Table 5.4). Figure 5.5 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. During the period, weights have shown cyclical changes, and have decreased during the most recent years to very low values in 2006; in 2007 and 2008, mean weights for ages up to 5 years included show a small increase, age 6 show a small increase in 2008 while older fish continue to decline. The mean weight at age in the stock are assumed equal to those in the landings.

5.2.4 Maturity-at-age

Maturity-at-age data is available from the Faroese Spring Groundfish Surveys 1982–2009. The survey is carried out in February-March, so the maturity-at-age is determined just prior to the spawning of haddock in Faroese waters and the determinations of the different maturity stages is relatively easy.

In order to reduce eventual year-to-year effects due to possible inadequate sampling and at the same time allow for trends in the series, the routine by the WG has been to use a 3-year running average in the assessment. For the years prior to 1982, average maturity-at-age from the surveys 1982–1995 was adopted (Table 5.7 and Figure 5.6).

5.3 Information from the fishing industry

There exists a considerable amount of data on fish size in the fishing industry. No such information was used in the 2009 assessment.

5.4 Methods

This assessment is an update of the 2008 assessment, with exactly the same settings of the XSA. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the c@age input file. All other input files (VPA and tuning fleets) are the same except for the addition of the 2008 and 2009 data.

5.4.1 Tuning and estimates of fishing mortality

Commercial cpue series. Several commercial catch per unit effort series are updated every year, but as discussed in previous reports of this WG they are not used directly for tuning of the VPA due to changes in catchability caused by e.g. productivity variations in the area (see Faroe Plateau cod), a different behaviour of the fleets after the introduction of the management system and in years when haddock prices are low as compared to cod the fleets apparently try to avoid grounds with high abundances of haddock, especially the younger age groups. The opposite may also happen if prices of haddock become high as compared to other species. The distribution of fishing activities by year for some major fleets (selected vessels) can be seen in chapter 2; the data are based on logbooks. These are mixed fisheries and not directly targeting haddock. It is not possible to show the fishing activities for the longliners below 100 GRT because part of this fleet is not obliged to keep logbooks. The age-aggregated cpue series for longliners and pair trawlers are presented in Figure 5.7. In general the two series show the same trends although in some periods the two series are conflicting; this has been explained by variations in catchability of the longlines due to the above mentioned changes in productivity of the ecosystem (see chapter 2).

Fisheries independent cpue series. Two annual groundfish surveys are available, one carried out in February-March since 1982 (100 stations per year down to 500 m depth), and the other in August-September since 1996 (200 stations per year down to 500 m depth). The distribution of haddock catches in the surveys are shown in Figure 5.9 (spring surveys 1994-2009) and Figure 5.10 (summer surveys 1996-2008). Biomass estimates (kg/hour) are available for both series since they were initiated (Figure 5.8), and in general, there is a good agreement between them. Age disaggregated data are available for the whole summer series, but due to problems with the database (see earlier reports), age disaggregated data for the spring survey are only available since 1994. The calculation of indices at age is based on age-length keys and a smoother is applied. This is a useful method but by analyzing the number of otoliths for the youngest ages and comparing it with the length distributions some artifacts may be introduced because the smoothing can assign wrong ages to some lengths, especially for the youngest and oldest specimen. As last year the length distributions have been used more directly for calculation of indices at age for ages 0-3. LN(numbers at age) for the surveys are presented in Figures 5.11-5.12 and show consistent patterns. Further analysis of the performances of the two series are shown in figures 5.13 – 5.15. In general there is a good relationship between the indices for one year class in two successive years (Figures 5.13-5.14). The same applies when comparing the corresponding indices at age from the two surveys (Figure 5.15).

A spaly (same procedure as last year) run, with the same settings of the XSA as in 2008 and tuned with the two surveys combined (Table 5.8), with 2008 data included and some minor revisions of recent catch figures (Table 5.9), gave similar 2007 estimates as the 2008 assessment, although the recruitment and biomass were overestimated and the fishing mortality underestimated in the 2008 assessment (Section 5.10). The log q residuals for the two surveys are shown in Figure 5.16.

The retrospective pattern for fishing mortality, recruitment and spawning stock biomass of this XSA is shown in Figure 5.17. There has been a tendency to overestimate SSB and underestimate F in recent years. The retrospective pattern of the fishing mortality is hampered by strange values of some small poorly sampled year classes which in some years are included in the FBAR reference ages and consequently they will create problems for estimation of the stock (see the 2005 NWWG report); this is not a problem for the time being but the behaviour of the small year classes from 2005 and 2006 should be carefully inspected. In order to investigate the retrospective pattern, an exploratory XSA was run without shrinkage (Shr. 2.0). The resulting retrospective pattern was worse than with the spaly shrinkage of 0.5, and the Fbar from this run for 2008 was only 0.18.

Results. The fishing mortalities from the final XSA run are given in Table 5.10 and in Figure 5.18. According to this the fishing mortality showed an overall decline since the early 1960s and has been estimated to be below or at the natural mortality of 0.2 in several years from the late 1970s. It increased again in the years 1993-1998 to reach more than 0.5 in 1998. After that there was a drop to below 0.3 in 2000-2002 followed by an increase in 2003 to about 0.45. Since then the fishing mortality has decreased every year and is estimated in this years assessment to only 0.22 in 2008.

5.5 Reference points

The yield- and spawning stock biomass per recruit (age 2) based on the long-term data are shown in Table 5.17 and Figure 5.20. From Figure 5.19, showing the recruit/spawning stock relationship, and from Table 5.17, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.28 and 1.45, respectively. F_{max} is estimated at 0.61, and $F_{0.1}$ at 0.18; these values are slightly higher than last year.

The precautionary reference fishing mortalities were set in 1998 by ACFM with F_{pa} as the $\mathbf{F}_{med}$ value of 0.25 and F_{lim} two standard deviations above $\mathbf{F}_{pa}$ equal to 0.40. The precautionary reference spawning stock biomass levels were changed by ACFM in 2007. B_{lim} was set at 22 000 t (B_{loss}) and B_{pa} at 35 000 t based on the formula $B_{pa} = B_{lim}e^{1.645\sigma}$, assuming a σ of about 0.3 to account for the uncertainties in the assessment.

5.6 State of the stock – historical and compared to what is now.

The stock size in numbers is given in Table 5.11 and a summary of the VPA with the biomass estimates is given in Table 5.12 and in Figure 5.18. According to this assessment, the spawning stock biomass has shown big changes in recent years. It decreased from 67 000 t in 1987 to 22 000 t in 1994, increased again to 83 000 t in 1997 and 1998, decreased to 54 000 t in 2000 and increased after that to 98 000 t in 2003. After 2003 the spawning stock biomass has declined steadily, and the 2008 point estimate is 32 000 t. The decline in the spawning stock began in the late 1970s due to very poor recruitment in the years before. The stabilization at relatively high SSB's in the mid–1980s was due to the relatively good 1982 and 1983 year classes, but the decline since was partly due to poor year classes since the mid–1980s, as well as the pronounced decline in the mean weights-at-age in the stock. The main reason for the very abrupt increase in the spawning stock biomass is the recruitment and growth of the very large 1993 year class and the well-above-average 1994 year class. The most recent increase in the spawning stock is due to new strong year classes entering the fishery of which the 1999 year class is the highest on record (105 mio. at age 2). Also the YC's from 2000 and 2001 are estimated well above average and the 2002 YC slightly above average, but all more recent YC's are estimated or predicted to be small.

5.7 Short term forecast

5.7.1 Input data

The input data for the short-term predictions are estimated in the same way as last year and given in Tables 5.13-14. All year classes up to 2007 are taken directly from the 2009 final XSA, the 2008 year class at age 2 is estimated from the 2009 XSA age 1 applying a natural mortality of 0.2 in a forward calculation of the numbers using basic VPA equations. The YC 2009 at age 2 in 2011 is estimated as the geometric mean of the 2-year-olds since 1980. This period has been selected, because the recruitment in earlier years was more stable and not characteristic for the recent years.

The exploitation pattern used in the prediction was derived from averaging the 2006–2008 fishing mortality matrices from the final VPA and re-scaling to 2008. The same exploitation pattern was used for all three years.

The mean weight@age have been declining in recent years to low values but from inspection of Figure 5.5 and Table 5.6, most ages have increasing again in 2007 and 2008. The mean weight-at-age for ages 2-10 in 2009-2011 was set equal to the average of the weights for 2006-2008.

The maturity ogive for 2009 is based on samples from the Faroese Groundfish Spring Survey 2008 and 2009, and the ogives in 2010-2011 are estimated as the average of the smoothed 2007-2009 values.

5.7.2 Results

Although the allocated number of fishing days for the fishing year 2008-2009 was reduced by 10% as compared to the year before, it should not be unrealistic to assume fishing mortalities in 2010 as the average of some recent years, here the average of F(2006-2008); however, possible changes in the catchability of the fleets (which seem to be linked to productivity changes in the environment) could undermine this assumption; low prices on haddock will also have a similar effect. The landings in 2009 are then predicted to be about 6 000 t, and continuing with this fishing mortality will result in 2010 landings of about 5 000 t. The SSB will decrease to 27 000 t in 2009, 23 000 t in 2010, and to 22 000 t in 2011 which is equal to B_{lim}. The results of the short-term prediction are shown in Table 5.15 and in Figure 5.20. The contribution by year-classes to the age composition of the predicted 2010 and 2011 SSB's is shown in Figure 5.22.

5.8 Medium term forecasts and yield per recruit

No medium term projections are presented in this years report.

The input data for the long-term yield and spawning stock biomass (yield-per-recruit calculations) are listed in Table 5.16. Mean weights-at-age (stock and catch) are averages for the 1977–2008 period. The maturity ogives are averages for the years 1982-2008. The exploitation pattern is the same as in the short term prediction.

The results are given in Table 5.17, Figure 5.20 and under Biological reference points.

5.9 Uncertainties in assessment and forecast

Misreporting is not believed to be a problem under the current effort management system and since almost no quotas are used in the management of the fisheries on this stock, the incentive to discard in order to high grade the catches should be low. The landings statistics is therefore regarded as being adequate for assessment purposes. The ban on discarding as stated in the law on fisheries should also – in theory – keep the discarding at a low level.

The sampling of the catches for length measurements, otolith readings and length-weight relationships is considered to be adequate.

The quality of the tuning data is considered high. The same research vessel has been used in all years and the gear as well as sampling procedures of the catch have remained the same.

The ADAPT component of the assessment toolbox developed by the USA National Marine Fisheries Service (http://nft.nefsc.noaa.gov/) has been systematically applied to the main stocks in the Faroes (Faroe Plateau cod, haddock and saithe). One of the objectives of the exercise was to use the bootstrap feature of the toolbox to evaluate the uncertainties in the assessment.

This exercise was not repeated this year, but Figure 5.21 shows the F and SSB's from a 1000 bootstraps of the 2008 ADAPT. The figure also shows the F and SSB from the XSA assessment. F in both methods is the Fbar(3-7). The XSA results fall almost in the middle of the cloud of bootstrapped ADAPT results.

5.10 Comparison with previous assessment and forecast

As explained previously in the report, this assessment is an update of the 2008 assessment. The only changes are minor revisions of recent landings according to revised data and corresponding revisions of the c@age input file. All other input files (VPA and tuning fleets) are the same except for the addition of the 2008-2009 data.

Following differences in the 2007 estimates were observed as compared to last year:

Text table Comparisons between 2008 and 2009 assessment of 2007data
The year of comparison is 2007

	R at age 2 (thousands)	Total B (tonnes)	SSB (tonnes)	Landings (tonnes)	F (3-7)
2008 spaly	3,750	54,400	49,100	12,633	0.28
2009 spaly	3,275	49,450	44,350	12,656	0.31
%-change	-13	-9	-10	0	11

It can be seen, that recruitment and biomass has been overestimated while fishing mortality has been underestimated, but the differences are relatively small, in the order of 10%.

5.11 Management plans and evaluations

A management system based on number of fishing days, closed areas and other technical measures was introduced in 1996. See overview in section 2 for details.

5.12 Management considerations

Management of fisheries on haddock also needs to take into account measures for cod and saithe.

5.13 Ecosystem considerations

Since about 80% of the catches are taken by longlines and the remaining by trawls, effects of the haddock fishery on the bottom is moderate.

5.14 Regulations and their effects

As explained in the overview (section 2), the fishery for haddock in Vb is regulated through a maximum number of fishing days, closed areas during spawning times and large areas closed to trawling. As a consequence, around 80% of the landings derive from long line fisheries. Since the minimum mesh size in the trawls (codend) is 145 mm, the trawl catches consist of fewer small fish than the long line fisheries. Other nations fishing in Faroese waters are regulated by TAC's obtained during bilateral negotiations; their total landings are minimal, however. Discarding of haddock is considered minimal and there is a ban to discarding.

5.15 Changes in fishing technology and fishing patterns

See section 2.

5.16 Changes in the environment

See section 2.

Table 5.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2008, I.e. Working Group estimates in Vb1.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Denmark	-	-	-	-	1	8	4	-	-	-			
Faroe Islands	10,319	11,898	11,418	13,597	13,359	13,954	10,867	13,506	11,106	8,074	4,655	3,622	3,675
France[1]	2	2	20	23	8	22	14	-	-	-	164	-	
Germany	1	+	+	+	1	1	-	+	+	+		-	
Norway	12	12	10	21	22	13	54	111	94	125	71	28	22
UK (Engl. and Wales)	-	-	-	-	-	2	-	-	7	-	54	81	31
UK (Scotland)[3]	1	-	-	-	-	-	-	-	-	-	-	-	
United Kingdom													
Total	10,335	11,912	11,448	13,641	13,391	14,000	10,939	13,617	11,207	8,199	4,944	3,731	5,722
Working Group estimate[4,5]	11,937	12,894	12,378	15,143	14,477	14,882	12,178	14,325	11,726	8,429	5,476	4,026	4,252

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 #	2005	2006	2007	2008 [2]
Faroe Islands	4,549	9,152	16,585	19,135	16,643	13,620 [8]	13,457 [8]	20,776 [8]	21,615	18,995	18,022	15,600	11,688	7,119
France[1]				2 [2,7]	- [2]	6	8 [7]	2	4	1 [5]	+	12 [7]	4 [7]	1 [7]
Germany	5	-	-		33	1	2	6	1	6		1		
Greenland					30 [6]	22 [6]	0 [6]	4 [6]				1	13 [5]	
Iceland								4						
Norway	28	45	45	71	411	355	257 [2]	227	265	229	212	57	61	26
Russia										16				10 [7]
Spain										49				
UK (Engl. and Wales)	23	5	22	30 [1]	59 [7]	19 [7]	4 [7]	11 [7]	14 [7]	8 [7]	1 [7]	1 [7]		
UK (Scotland)[11]	-	…	…	…					185 [7]	186 [7]	126 [7]	106 [7]	35 [7]	
United Kingdom														65 [7]
Total	4,605	9,202	16,652	19,238	17,176	14,023	13,728	21,030	22,084	19,490	18,361	15,778	11,801	7,221
Working Group estimate[4,5,8]	4,948	9,642	17,924	22,210	18,482	15,821	15,890	24,933	27,128	23,287	20,305	17,082	12,656	7,582

1) Including catches from Sub-division Vb2. Quantity unknown 1989-1991, 1993 and 1995-2001.

2) Preliminary data

3)From 1983 to 1996 catches included in Sub-division Vb2.

4) Includes catches from Sub-division Vb2 and Division IIa in Faroese waters.

5)Includes French and Greenlandic catches from Division Vb, as reported to the Faroese coastal guard service

6) Reported as Division Vb, to the Faroese coastal guard service.

7) Reported as Division Vb.

8) Includes Faroese landings reported to the NWWG by the Faroese Fisheries Laboratory

9) Included in Vb2

10) Includes 14 reported as Vb

Table 5.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries,
1982-2008, I.e. Working Group estimates in Vb2.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Faroe Islands	1,533	967	925	1,474	1,050	832	1,160	659	325	217	338	185	353
France1	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	1	2	5	3	10	5	43	16	97	4	23	8	1
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	-	+	+	+
UK (Scotland)3	48	13	+	25	26	45	15	30	725	287	869	102	170
Total	1,582	982	930	1,502	1,086	882	1,218	705	1,147	508	1,230	295	524

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 [2]
Faroe Islands	303	338	1,133	2,810	1,110	1,565 [5]	1,948	3,698	4,804	3,594	1,899	1,412	832	361
France1	-	-	-								+			
Norway	1	40	4	60	3	48	66	28	54	17	45	1	8	
UK (Engl. and Wales)	... [1]	… [1]	… [1]	… [1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[4]	[4]	
UK (Scotland)3	39	62	135	102	193	185	148	177	[4]	[1]	[4]	[4]	15	
Total	343	440	1,272	2,972	1,306	1,798	2,162 1	3,903	5,044	3,797	1,944	1,304	855	361

1) Catches included in Sub-division Vb1.

2) Provisional data

3)From 1983 to 1996 includes also catches taken in Sub-division Vb1 (see Table 2.4.1)

4) Reported as Division Vb.

5) Provided by the NWWG

Table 5.3 Total Faroese landings of haddock from Division Vb 1985-2008 by each fleet category (%).

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	4	4	4	6	6	6
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	34	40	41	47	35	34
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	42	42	43	36	39	41
Otter board trawlers < 1000HP	7	5	7	6	4	4	3	3	11	10	12	13	9	8	7	9	7	6	4	3	3	1	4	7
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	11	3	1	1	2	8	2
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	4	2	2	2	3	3
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	10	8	7	4	5	6	7
Nets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jigging	1	0	0	0	1	1	1	0	0	0	0	1	1	0	0	0	1	2	1	1	1	0	1	0
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5.4

Catch at age 2009

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 1000HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese Pairtrawlers	Vb2 All Faroese Fleets	Vb Foreign Trawlers	Vb1 Foreign LLiners
1	1	4	0	0	0	0	0	0	6	0.00	0	0	0	0
2	9	50	6	5	0	0	0	0	68	0.00	0	0	0	0
3	16	95	76	16	2	1	2	0	205	0.01	1	3	1	1
4	68	416	277	132	6	10	36	1	927	0.02	3	10	3	2
5	16	106	178	38	12	19	67	1	427	0.00	0	1	6	2
6	42	274	721	93	37	48	193	2	1382	0.17	32	105	17	7
7	58	385	693	146	49	68	274	2	1641	0.13	25	81	23	6
8	42	248	586	104	30	42	199	1	1226	0.06	13	42	14	5
9	14	76	142	35	7	6	33	0	308	0.03	5	16	3	1
10	0	0	24	0	1	1	8	0	33	0.00	0	0	1	0
11	0	1	0	0	0	0	2	0	4	0.00	0	1	0	0
12	0	0	0	0	0	0	1	0	1	0.00	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Total no.	267	1655	2703	569	145	195	817	8	6227	0.40	80	258	67	24
Catch, t.	271	1649	2884	588	142	185	823	8	6414	1	100	325	66	26

Notes: Numbers in 1000'
Catch, gutted weight in tonnes
Others includes netters, jiggers, other small categories and catches not otherwise accounted for
LLiners = Longliners OB.trawl. = Otterboard tr Pair Trawl. = Pair trawlers

Sampling 2007	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 1000HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese trawlers	Vb2 All Faroese Fleets	Vb Foreign Trawlers	Vb1 Foreign LLiners
No. samples	12	19	25	5	1	6	23	0	91	4	0	4	0	0
No. lengths	2051	3798	5147	1080	248	1192	4852	0	18368	846	0	846	0	0
No. weights	1811	3441	3950	1080	248	736	4290	0	15556	846	0	846	0	0
No. ages	300	359	660	120	60	120	538	0	2157	120	0	120	0	0

Tabel 5.5 Faroe haddock. Catch number-at-age

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 23/04/2009 17:34

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1957	1958
AGE		
0	0	0
1	45	116
2	4133	6255
3	7130	8021
4	8442	5679
5	1615	3378
6	894	1299
7	585	817
8	227	294
9	94	125
+gp	58	105
TOTALNUM	23223	26089
TONSLAND	20995	23871
SOPCOF %	89	90

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	525	854	941	784	356	46	39	90	70	49
2	3971	6061	7932	9631	13552	2284	1368	1081	1425	5881
3	7663	10659	7330	13977	8907	7457	4286	3304	2405	4097
4	4544	6655	5134	5233	7403	3899	5133	4804	2599	2812
5	2056	2482	1937	2361	2242	2360	1443	2710	1785	1524
6	1844	1559	1305	1407	1539	1120	1209	1112	1426	1526
7	721	1169	838	868	860	728	673	740	631	923
8	236	243	236	270	257	198	1345	180	197	230
9	98	85	59	72	75	49	43	54	52	68
+gp	47	28	13	22	23	7	8	9	13	12
TOTALNUM	21705	29795	25725	34625	35214	18148	15547	14084	10603	17122
TONSLAND	20239	25727	20831	27151	27571	19490	18479	18766	13381	17852
SOPCOF %	90	88	88	89	89	101	94	109	101	102

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	95	57	55	43	665	253	94	40	0	0
2	2384	1728	717	750	3311	5633	7337	4396	255	32
3	7539	4855	4393	3744	8416	2899	7952	7858	4039	1022
4	4567	6581	4727	4179	1240	3970	2097	6798	5168	4248
5	1565	1624	3267	2706	2795	451	1371	1251	4918	4054
6	1485	1383	1292	1171	919	976	247	1189	2128	1841
7	1224	1099	864	696	1054	466	352	298	946	717
8	378	326	222	180	150	535	237	720	443	635
9	114	68	147	113	68	68	419	258	731	243
+gp	20	10	102	95	11	147	187	318	855	312
TOTALNUM	19371	17731	15786	13677	18629	15398	20293	23126	19483	13104
TONSLAND	23272	21361	19393	16485	18035	14773	20715	26211	25555	19200
SOPCOF %	108	102	97	96	97	97	117	107	98	99

Table 5.5 Faroe haddock. Catch number-at-age (cont.)

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	25	0	0	0	0
2	1	143	74	539	441	1195	985	230	283	655
3	1162	58	455	934	1969	1561	4553	2549	1718	444
4	1755	3724	202	784	383	2462	2196	4452	3565	2463
5	3343	2583	2586	298	422	147	1242	1522	2972	3036
6	1851	2496	1354	2182	93	234	169	738	1114	2140
7	772	1568	1559	973	1444	42	91	39	529	475
8	212	660	608	1166	740	861	61	130	83	151
9	155	99	177	1283	947	388	503	71	48	18
+gp	74	86	36	214	795	968	973	712	334	128
TOTALNUM	9326	11417	7051	8373	7234	7883	10773	10443	10646	9510
TONSLAND	12424	15016	12233	11937	12894	12378	15143	14477	14882	12178
SOPCOF %	104	100	109	92	106	106	106	101	102	97

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	43	1	0	1	0	0
2	63	105	77	40	113	277	804	326	77	106
3	1518	1275	1044	154	298	191	452	5234	2913	1055
4	658	1921	1774	776	274	307	235	1019	10517	5269
5	2787	768	1248	1120	554	153	226	179	710	9856
6	2554	1737	651	959	538	423	132	163	116	446
7	1976	1909	1101	335	474	427	295	161	123	99
8	541	885	698	373	131	383	290	270	93	87
9	133	270	317	401	201	125	262	234	220	95
+gp	81	108	32	162	185	301	295	394	516	502
TOTALNUM	10311	8978	6942	4320	2811	2588	2991	7981	15285	17515
TONSLAND	14325	11726	8429	5476	4026	4252	4948	9642	17924	22210
SOPCOF %	100	102	106	106	103	100	103	100	103	101

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	9	73	19	0	0	3	0	0	0	6
2	174	1461	4380	1515	133	245	84	246	76	68
3	1142	3061	3128	14039	3443	2023	1659	444	984	209
4	942	210	2423	2879	13579	4841	3824	2555	548	942
5	4677	682	173	1200	2229	10510	6703	3933	2737	435
6	6619	2685	451	133	951	1172	6082	5400	3316	1510
7	226	2846	1151	239	163	412	538	3265	2763	1751
8	26	79	1375	843	335	90	146	136	1119	1287
9	20	1	17	1095	860	167	28	63	89	328
+gp	192	71	18	33	935	818	153	70	9	40
TOTALNUM	14027	11169	13135	21976	22628	20281	19217	16112	11641	6576
TONSLAND	18482	15821	15890	24933	27128	23287	20305	17082	12656	7582
SOPCOF %	100	103	100	100	100	99	100	100	100	101

Table 5.6 Faroe haddock. Catch weight-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 23/04/2009 17:34

Table 2 Catch weights at age (kg)

YEAR,	1957,	1958,
AGE		
0,	.0000,	.0000,
1,	.2500,	.2500,
2,	.4700,	.4700,
3,	.7300,	.7300,
4,	1.1300,	1.1300,
5,	1.5500,	1.5500,
6,	1.9700,	1.9700,
7,	2.4100,	2.4100,
8,	2.7600,	2.7600,
9,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,
SOPCOFAC,	.8937,	.8983,

Table 2 Catch weights at age (kg)

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,
SOPCOFAC,	.9034,	.8832,	.8832,	.8929,	.8915,	1.0111,	.9383,	1.0885,	1.0117,	1.0246,

Table 2 Catch weights at age (kg)

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.2500,	.0000,	.0000,
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.3110,	.3570,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.6330,	.7900,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.0440,	1.0350,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.4260,	1.3980,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.8250,	1.8700,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.2410,	2.3500,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.2050,	2.5970,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	2.5700,	3.0140,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	2.5910,	2.9200,
SOPCOFAC,	1.0787,	1.0249,	.9688,	.9597,	.9690,	.9678,	1.1696,	1.0741,	.9784,	.9947,

Table 5.6 Faroe haddock. Catch weight-at-age (cont.).

Table 2 Catch weights at age (kg)

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.3000,	.0000,	.0000,	.0000,	.0000,	.3590,	.0000,	.0000,	.0000,	.0000,
2,	.3570,	.6430,	.4520,	.7000,	.4700,	.6810,	.5280,	.6080,	.6050,	.5010,
3,	.6720,	.7130,	.7250,	.8960,	.7400,	1.0110,	.8590,	.8870,	.8310,	.7810,
4,	.8940,	.9410,	.9570,	1.1500,	1.0100,	1.2550,	1.3910,	1.1750,	1.1260,	.9740,
5,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,	1.8120,	1.7770,	1.6310,	1.4620,	1.3630,
6,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,	2.0610,	2.3260,	1.9840,	1.9410,	1.6800,
7,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,	2.0590,	2.4400,	2.5190,	2.1730,	1.9750,
8,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,	2.1370,	2.4010,	2.5830,	2.3470,	2.3440,
9,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,	2.3680,	2.5320,	2.5700,	3.1180,	2.2480,
+gp,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,	2.6860,	2.6860,	2.9220,	2.9330,	3.2950,
SOPCOFAC,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,	1.0593,	1.0559,	1.0141,	1.0197,	.9695,

Table 2 Catch weights at age (kg)

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.3600,	.0000,	.0000,	.3600,	.0000,	.0000,
2,	.5800,	.4380,	.5470,	.5250,	.7550,	.7540,	.6660,	.5340,	.5190,	.6220,
3,	.7790,	.6990,	.6930,	.7240,	.9820,	1.1030,	1.0540,	.8580,	.7710,	.8460,
4,	.9230,	.9390,	.8840,	.8170,	1.0270,	1.2540,	1.4890,	1.4590,	1.0660,	1.0160,
5,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,	1.4650,	1.7790,	1.9930,	1.7990,	1.2830,
6,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,	1.5930,	1.9400,	2.3300,	2.2700,	2.0800,
7,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,	1.8040,	2.1820,	2.3510,	2.3400,	2.5560,
8,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,	2.0490,	2.3570,	2.4690,	2.4750,	2.5720,
9,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,	2.2250,	2.4900,	2.7770,	2.5010,	2.4520,
+gp,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,	2.4230,	2.6780,	2.5820,	2.6760,	2.7530,
0 SOPCOFAC,	1.0025,	1.0195,	1.0635,	1.0554,	1.0320,	.9969,	1.0331,	1.0043,	1.0250,	1.0106,

Table 2 Catch weights at age (kg)

YEAR,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.2780,	.2800,	.2800,	.0000,	.0000,	.3670,	.0000,	.0000,	.0000,	.4910,
2,	.5040,	.6610,	.6080,	.5840,	.5710,	.5740,	.5380,	.4750,	.6280,	.6360,
3,	.6240,	.9360,	.9400,	.8570,	.7150,	.7700,	.6490,	.6010,	.6690,	.7540,
4,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,	.8870,	.7970,	.7680,	.8590,	.8600,
5,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,	1.1590,	1.0200,	.9110,	.9690,	.9910,
6,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,	1.6380,	1.2450,	1.1260,	1.0600,	1.0820,
7,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,	1.8700,	1.8430,	1.3740,	1.2450,	1.1510,
8,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,	2.4380,	2.0610,	2.1580,	1.4750,	1.3790,
9,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,	2.3570,	2.2630,	2.2110,	2.2660,	1.7270,
+gp,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,	2.4170,	2.5790,	2.5690,	2.2560,	2.4350,
0 SOPCOFAC,	.9973,	1.0349,	.9960,	1.0010,	1.0040,	.9928,	.9988,	.9985,	1.0000,	1.0065,

Table 5.7 Faroe haddock. Proportion mature-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 23/04/2009 17:34

Table 5 Proportion mature at age

AGE	1957	1958
0	.0000	.0000
1	.0000	.0000
2	.0600	.0600
3	.4800	.4800
4	.9100	.9100
5	1.0000	1.0000
6	1.0000	1.0000
7	1.0000	1.0000
8	1.0000	1.0000
9	1.0000	1.0000
+gp	1.0000	1.0000

Table 5 Proportion mature at age

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600
3	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800
4	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5 Proportion mature at age

AGE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600
3	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800
4	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.7 Faroe haddock. Proportion mature-at-age (cont.).

Table 5 Proportion mature at age

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0600	.0600	.0600	.0800	.0800	.0800	.0300	.0300	.0500	.0500
3	.4800	.4800	.4800	.6200	.6200	.7600	.6200	.4300	.3200	.2400
4	.9100	.9100	.9100	.8900	.8900	.9800	.9600	.9500	.9100	.8900
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9900	.9800	.9800
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5 Proportion mature at age

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0200	.0800	.1600	.1800	.1100	.0500	.0300	.0300	.0100	.0100
3	.2200	.3700	.5800	.6500	.5000	.4200	.4700	.4700	.4700	.3600
4	.8700	.9000	.9300	.9100	.8500	.8600	.9100	.9300	.9100	.8700
5	.9900	1.0000	1.0000	1.0000	.9700	.9600	.9600	.9800	1.0000	.9900
6	1.0000	1.0000	1.0000	1.0000	.9900	.9900	.9900	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5 Proportion mature at age

AGE	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0100	.0200	.0900	.0800	.0700	.0000	.0100	.0100	.0200	.0100
3	.3500	.3600	.5400	.4900	.4500	.3500	.3400	.4200	.5200	.6400
4	.8600	.8700	.9300	.9700	.9700	.9400	.9100	.9100	.9100	.9500
5	.9900	.9900	1.0000	1.0000	.9900	.9900	.9900	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.8 Faroe haddock. 2009 tuning file.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY-09-jr.txt
102
SUMMER SURVEY
1996 2008
1 1 0.6 0.7
1 8
200   42362.00 38050.46 60866.49   1138.05   210.25   286.72  238.48  416.44
200    6851.83 12379.93 24184.20  47016.45   852.22   177.11   81.49  163.30
200   18825.00  2793.18  2545.32  14600.59 18399.09   285.78   89.61   73.64
200   24115.03  9521.26  5553.74   1548.70  8698.75  9829.62  204.06    7.89
200  161583.90 18837.41  7340.20    371.40  1301.41  4638.88 5699.14   85.81
200   98708.03 96675.44 11962.07   4424.74   174.57   629.27 2615.71 3209.95
200   89340.23 52092.34 57922.78   5538.84  1909.63   162.47  395.07 1256.27
200   47450.28 36196.89 22847.00  35941.83  3962.64   621.93  101.63  428.87
200    9049.95 33653.00 15117.67  16561.09 16561.09   885.34  185.66   24.20
200   14574.15  7694.99 12936.61  16513.01 11635.42 11963.56  517.84   36.46
200    3484.57  9591.77  2004.49   8969.12  8908.60  6973.94 3364.52  125.74
200    3295.49  3250.16  1707.14   6581.63  5809.35  3985.64 1821.87   56.85
200    3241.71  3492.73   568.99   3408.02  3734.64  3331.06 1623.97   53.26
SPRING SURVEY SHIFTED
1993 2008
1 1 0.95 1.0
0 6
100  16009.60   1958.70    216.70    338.10    172.80   305.30    399.60
100  35395.20  19462.60    702.20    216.60    150.70    48.80    141.10
100   6611.80  33206.50  19338.50    663.10     98.20    73.90     56.00
100    371.70   8095.00  15618.00  25478.90    628.10   146.10     37.00
100   3481.60   1545.80   3353.40  10120.10  12687.60   336.20      9.90
100   4459.50   6739.70    112.20   1517.30   4412.30  3139.20     48.70
100  25964.40   8354.40   4858.70    198.10    443.90  1669.60   1940.70
100  25283.30  36311.20   3384.70   1056.60     26.70   106.60    427.70
100  21111.90  17809.30  25760.60   1934.70    684.90    40.60    101.70
100   9391.10  22335.10  13272.70  12734.40    776.10   230.10     19.30
100   1823.10  16068.30  10327.10   7487.70  11212.50   487.50     79.10
100   5798.80   6022.70   7742.00   6165.00   4565.90  4912.80    238.60
100    705.50   6284.80   1574.60   4457.00   3250.40  3267.50   1577.20
100   1173.20   1891.90   4313.40   1010.00   3511.30  3712.50   2874.90
100    637.40   1688.00   1924.00    591.00   1745.90  1626.20   1027.20
100   3251.80   2316.40   1352.70    321.90   1057.40  1099.60    917.20
```

Table 5.9 Faroe haddock 2009 xsa.

```
Lowestoft VPA Version 3.1

  23/04/2009  17:32

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb)                 HAD_IND

CPUE data from file D:\vpa\vpa2009\vpa\input-files\comb-survey-spaly-09-jr.txt

Catch data for  52 years. 1957 to 2008. Ages  0 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
SUMMER SURVEY       ,   1996, 2008,   1,     8,   .600,   .700
SPRING SURVEY SHIFTE,   1993, 2008,   0,     6,   .950,  1.000

Time series weights :

     Tapered time weighting not applied


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   5 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   42 iterations


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,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008

     0,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
     1,  .000,  .001,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .001
     2,  .012,  .079,  .048,  .028,  .004,  .009,  .010,  .027,  .026,  .019
     3,  .553,  .313,  .240,  .215,  .084,  .072,  .080,  .066,  .143,  .093
     4,  .230,  .181,  .439,  .364,  .333,  .162,  .188,  .171,  .108,  .198
     5,  .339,  .260,  .223,  .406,  .537,  .467,  .353,  .300,  .281,  .117
     6,  .381,  .332,  .274,  .268,  .663,  .610,  .547,  .539,  .447,  .246
     7,  .758,  .279,  .231,  .228,  .615,  .688,  .638,  .648,  .592,  .452
     8, 1.944,  .661,  .211,  .265,  .578,  .850,  .560,  .322,  .481,  .615
     9,  .747,  .330,  .283,  .259,  .474,  .647,  .711,  .504,  .362,  .250
```

Table 5.9 Faroe haddock 2009 xsa (cont.)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1999	1.54E+05	2.61E+04	1.56E+04	2.97E+03	5.06E+03	1.80E+04	2.31E+04	4.70E+02	3.35E+01	4.20E+01
2000	8.90E+04	1.26E+05	2.14E+04	1.26E+04	1.40E+03	3.29E+03	1.05E+04	1.29E+04	1.80E+02	3.93E+00
2001	5.92E+04	7.29E+04	1.03E+05	1.62E+04	7.53E+03	9.56E+02	2.08E+03	6.16E+03	7.99E+03	7.63E+01
2002	4.36E+04	4.85E+04	5.97E+04	8.03E+04	1.04E+04	3.97E+03	6.26E+02	1.29E+03	4.01E+03	5.30E+03
2003	1.42E+04	3.57E+04	3.97E+04	4.75E+04	5.30E+04	5.93E+03	2.17E+03	3.92E+02	8.44E+02	2.52E+03
2004	1.53E+04	1.16E+04	2.93E+04	3.24E+04	3.58E+04	3.11E+04	2.84E+03	9.15E+02	1.74E+02	3.88E+02
2005	4.89E+03	1.25E+04	9.53E+03	2.37E+04	2.47E+04	2.49E+04	1.60E+04	1.26E+03	3.76E+02	6.08E+01
2006	5.95E+03	4.00E+03	1.02E+04	7.73E+03	1.79E+04	1.68E+04	1.43E+04	7.56E+03	5.45E+02	1.76E+02
2007	1.33E+04	4.87E+03	3.27E+03	8.16E+03	5.93E+03	1.24E+04	1.02E+04	6.84E+03	3.24E+03	3.24E+02
2008	1.76E+04	1.09E+04	3.99E+03	2.61E+03	5.79E+03	4.36E+03	7.65E+03	5.32E+03	3.10E+03	1.64E+03

Estimated population abundance at 1st Jan 2009

0.00E+00	1.44E+04	8.91E+03	3.21E+03	1.95E+03	3.89E+03	3.17E+03	4.89E+03	2.77E+03	1.37E+03

Taper weighted geometric mean of the VPA populations:

2.74E+04	2.30E+04	1.93E+04	1.54E+04	1.06E+04	6.34E+03	3.73E+03	1.99E+03	9.34E+02	4.22E+02

Standard error of the weighted Log(VPA populations) :

1.0269	1.0302	1.0268	.9801	.9524	.9448	.9432	.9713	1.1248	1.3968

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997	1998
0	No data for this fleet at this age					
1	99.99	99.99	99.99	1.24	.31	-.11
2	99.99	99.99	99.99	-.09	.41	-.18
3	99.99	99.99	99.99	.37	.20	-.38
4	99.99	99.99	99.99	-.45	.40	.00
5	99.99	99.99	99.99	-.19	-.04	.01
6	99.99	99.99	99.99	.20	.41	-.29
7	99.99	99.99	99.99	-.04	-.36	.96
8	99.99	99.99	99.99	-.12	.14	.62

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	No data for this fleet at this age									
1	-.18	.15	.21	.51	.19	-.35	.06	-.24	-.49	-1.31
2	-.39	.01	.06	-.03	.00	.23	-.12	.04	.10	-.03
3	1.55	.23	.42	.38	-.11	-.15	.01	-.74	-.90	-.90
4	-.55	-.72	.24	.09	.31	-.18	.21	-.09	.66	.09
5	.04	-.21	-1.00	.08	.50	.22	.02	.11	-.02	.47
6	.02	.03	-.39	-.55	-.19	-.14	.70	.26	-.02	-.04
7	.29	-.01	-.08	-.41	-.32	-.52	.15	.24	-.31	-.26
8	.44	.31	-.15	-.36	.33	-.79	-1.34	-.63	-3.10	-3.03

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	8
Mean Log q	-5.0709	-5.2570	-5.7371	-5.6551	-5.7192	-5.7969	-5.7969	-5.7969
S.E(Log q)	.5902	.1935	.6649	.3951	.3691	.3349	.4001	1.3730

Table 5.9 Faroe haddock 2009 xsa (cont.)

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,	.88,	.856,	5.63,	.82,	13,	.53,	-5.07,
2,	.99,	.127,	5.29,	.97,	13,	.20,	-5.26,
3,	.91,	.576,	6.10,	.78,	13,	.62,	-5.74,
4,	.84,	2.146,	6.25,	.94,	13,	.29,	-5.66,
5,	.88,	1.802,	6.08,	.96,	13,	.30,	-5.72,
6,	.94,	1.023,	5.95,	.96,	13,	.31,	-5.80,
7,	1.07,	-.872,	5.74,	.93,	13,	.43,	-5.85,
8,	1.63,	-1.912,	6.34,	.45,	13,	1.81,	-6.39,

Fleet : SPRING SURVEY SHIFTE

Age	1993	1994	1995	1996	1997	1998
0	-.51	1.03	.98	-1.02	-.21	-.28
1	-.37	-.79	.49	.70	-.07	-.02
2	-.56	-.67	-.10	.43	.51	-1.98
3	.08	.07	-.15	.72	.55	.36
4	-.30	-.18	-.12	.45	.53	.25
5	-.30	-1.08	-.24	1.04	.64	-.20
6	.40	-.35	-.25	-.04	-.62	-.17
7	No data for this fleet at this age					
8	No data for this fleet at this age					

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	-.09	.43	.66	.16	-.36	.72	-.24	.07	-1.35	.00
1	-.13	-.23	-.40	.24	.21	.35	.32	.26	-.05	-.53
2	.34	-.27	.16	.02	.15	.18	-.29	.66	.99	.43
3	-.40	-.41	-.12	.13	.00	.18	.17	-.21	-.72	-.24
4	-.35	-1.92	-.11	-.38	.63	-.04	.02	.40	.75	.36
5	-.04	-1.17	-.94	-.45	.03	.61	.32	.79	.25	.74
6	.21	-.56	-.44	-.91	-.35	.43	.53	1.23	.46	.43
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 ,	0,	1,	2,	3,	4,	5,	6
Mean Log q,	-6.1014,	-5.4232,	-5.9068,	-6.1754,	-6.2728,	-6.4141,	-6.7224,
S.E(Log q),	.6643,	.4010,	.6881,	.3670,	.6269,	.6828,	.5564,

Table 5.9 Faroe haddock 2009 xsa (cont.)

```
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

  0,     .86,    1.083,      6.68,     .80,     16,     .57,   -6.10,
  1,    1.11,   -1.060,      4.95,     .88,     16,     .44,   -5.42,
  2,     .89,     .847,      6.31,     .81,     16,     .62,   -5.91,
  3,     .88,    2.064,      6.56,     .95,     16,     .29,   -6.18,
  4,     .80,    2.292,      6.80,     .91,     16,     .44,   -6.27,
  5,     .88,    1.012,      6.66,     .84,     16,     .60,   -6.41,
  6,     .79,    3.203,      7.00,     .94,     16,     .34,   -6.72,

 Terminal year survivor and F summaries :

 Age  0   Catchability constant w.r.t. time and dependent on age

 Year class = 2008

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SPRING SURVEY SHIFTE,     14446.,   .685,       .000,    .00,   1, 1.000,     .000

   F shrinkage mean  ,         0.,    .50,,,,                        .000,     .000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     14446.,       .68,      .00,    1,    .000,   .000


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

 Year class = 2007

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      2407.,   .613,       .000,    .00,   1,  .182,     .002
 SPRING SURVEY SHIFTE,      4204.,   .354,       .360,   1.02,   2,  .545,     .001

   F shrinkage mean  ,     95179.,    .50,,,,                        .273,     .000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      8906.,       .26,     1.00,    4,   3.837,   .001
```

Table 5.9 Faroe haddock 2009 xsa (cont.)

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

Year class = 2006

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      2842.,   .269,       .180,    .67,   2,  .495,     .021
SPRING SURVEY SHIFTE,      3448.,   .317,       .131,    .41,   3,  .358,     .018

  F shrinkage mean  ,      4026.,    .50,,,,                        .147,     .015

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3205.,       .19,      .10,    6,    .509,   .019


Age  3   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
SUMMER SURVEY       ,      1778.,   .251,       .241,    .96,   3,  .424,     .101
SPRING SURVEY SHIFTE,      2102.,   .243,       .233,    .96,   4,  .456,     .086

  F shrinkage mean  ,      2030.,    .50,,,,                        .120,     .089

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1950.,       .16,      .14,    8,    .826,   .093


Age  4   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
SUMMER SURVEY       ,      3765.,   .215,       .162,    .76,   4,  .471,     .204
SPRING SURVEY SHIFTE,      4005.,   .228,       .289,   1.27,   5,  .410,     .193

  F shrinkage mean  ,      3999.,    .50,,,,                        .119,     .193

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3889.,       .15,      .14,   10,    .930,   .198
```

Table 5.9 Faroe haddock 2009 xsa (cont.)

```
 Age  5   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
 SUMMER SURVEY       ,      3653.,   .187,       .216,   1.15,   5,  .526,     .102
 SPRING SURVEY SHIFTE,      3633.,   .217,       .187,    .86,   6,  .380,     .103

   F shrinkage mean  ,       824.,    .50,,,,                        .093,     .390

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3173.,       .14,      .18,   12,   1.342,   .117


 Age  6   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
 SUMMER SURVEY       ,      5083.,   .169,       .057,    .34,   6,  .556,     .238
 SPRING SURVEY SHIFTE,      6335.,   .207,       .043,    .21,   7,  .336,     .195

   F shrinkage mean  ,      1795.,    .50,,,,                        .108,     .566

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4894.,       .13,      .11,   14,    .859,   .246


Age  7   Catchability constant w.r.t. time and age (fixed at the value for age)  6

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      2722.,   .165,       .078,    .47,   7,  .579,     .459
 SPRING SURVEY SHIFTE,      3825.,   .207,       .092,    .44,   7,  .259,     .347

   F shrinkage mean  ,      1760.,    .50,,,,                        .162,     .642

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2769.,       .14,      .09,   15,    .627,   .452
```

Table 5.9 Faroe haddock 2009 xsa (cont.)

```
Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  6

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      1160.,   .173,       .240,   1.39,   8,  .491,     .695
SPRING SURVEY SHIFTE,      1720.,   .208,       .228,   1.09,   7,  .202,     .517

  F shrinkage mean  ,      1541.,    .50,,,,                         .307,     .563

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1371.,       .18,      .14,   16,    .772,   .615


Age  9   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
SUMMER SURVEY       ,      1241.,   .187,       .296,   1.58,   8,  .455,     .214
SPRING SURVEY SHIFTE,      1361.,   .223,       .130,    .58,   7,  .159,     .197

  F shrinkage mean  ,       765.,    .50,,,,                         .386,     .328

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1045.,       .21,      .16,   16,    .760,   .250
```

Table 5.10 Faroe haddock. Fishing mortality (F) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 23/04/2009 17:34

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,
AGE		
0,	.0000,	.0000,
1,	.0010,	.0024,
2,	.1394,	.1939,
3,	.3707,	.4378,
4,	.6163,	.5737,
5,	.3909,	.5386,
6,	.4380,	.6346,
7,	.6340,	.9504,
8,	.5599,	.7839,
9,	.5321,	.7028,
+gp,	.5321,	.7028,
FBAR 3- 7,	.4900,	.6270,

Table 8 Fishing mortality (F) at age

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0132,	.0150,	.0219,	.0149,	.0106,	.0018,	.0017,	.0032,	.0012,	.0014,
2,	.1066,	.2074,	.1875,	.3232,	.3801,	.0876,	.0691,	.0610,	.0641,	.1261,
3,	.3860,	.4599,	.4162,	.5866,	.5639,	.3723,	.2354,	.2370,	.1873,	.2647,
4,	.4782,	.6926,	.4209,	.5980,	.7261,	.5193,	.4767,	.4515,	.2971,	.3483,
5,	.4195,	.5260,	.4387,	.3480,	.5591,	.5369,	.3678,	.5006,	.2997,	.2847,
6,	.6458,	.6591,	.5879,	.6706,	.4026,	.6107,	.5882,	.5421,	.5406,	.4540,
7,	.9184,	1.2130,	.9483,	1.0499,	1.2493,	.3375,	.9618,	.9128,	.6906,	.8367,
8,	.8206,	.9667,	.8742,	.9736,	1.1139,	1.2027,	2.3618,	.7509,	.6634,	.5851,
9,	.6625,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,
+gp,	.6625,	.8198,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,
FBAR 3- 7,	.5696,	.7101,	.5624,	.6506,	.7002,	.4753,	.5260,	.5288,	.4031,	.4377,

Table 8 Fishing mortality (F) at age

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0024,	.0033,	.0015,	.0016,	.0114,	.0033,	.0015,	.0014,	.0000,	.0000,
2,	.0860,	.0551,	.0526,	.0253,	.1677,	.1266,	.1230,	.0908,	.0108,	.0010,
3,	.2363,	.2528,	.1936,	.4225,	.4320,	.2172,	.2650,	.1878,	.1128,	.0547,
4,	.5320,	.3344,	.4186,	.2853,	.2392,	.3730,	.2412,	.3810,	.1815,	.1665,
5,	.3330,	.3639,	.2754,	.4517,	.3143,	.1279,	.2116,	.2216,	.5273,	.2115,
6,	.4975,	.5561,	.5560,	.1495,	.2703,	.1714,	.0957,	.2871,	.7246,	.3819,
7,	.8277,	.8740,	.8385,	.6720,	.1951,	.2134,	.0859,	.1601,	.3904,	.5759,
8,	1.0631,	.5430,	.4224,	.4066,	.2907,	.1433,	.1599,	.2538,	.3788,	.4968,
9,	.6566,	.5386,	.5061,	.3957,	.2633,	.2067,	.1595,	.2621,	.4437,	.3689,
+gp,	.6566,	.5386,	.5061,	.3957,	.2633,	.2067,	.1595,	.2621,	.4437,	.3689,
FBAR 3- 7,	.4853,	.4762,	.4564,	.3962,	.2902,	.2206,	.1799,	.2475,	.3873,	.2781,

Table 5.10 Faroe haddock. Fishing mortality (F) at age (cont.).

Table 8 Fishing mortality (F) at age

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0002,	.0000,	.0000,	.0000,	.0000,	.0006,	.0000,	.0000,	.0000,	.0000,
2,	.0004,	.0325,	.0237,	.0383,	.0251,	.0329,	.0279,	.0096,	.0336,	.0393,
3,	.0458,	.0285,	.1373,	.4616,	.1916,	.1166,	.1692,	.0938,	.0924,	.0678,
4,	.1255,	.2024,	.1313,	.3707,	.3479,	.3893,	.2389,	.2487,	.1840,	.1857,
5,	.1913,	.2749,	.2111,	.2916,	.3496,	.2169,	.3471,	.2593,	.2617,	.2359,
6,	.1408,	.2135,	.2264,	.2774,	.1381,	.3333,	.4158,	.3583,	.3074,	.3053,
7,	.2721,	.1701,	.2004,	.2523,	.2989,	.0852,	.2081,	.1570,	.4737,	.2076,
8,	.3302,	.3953,	.0919,	.2265,	.3100,	.2927,	.1718,	.5171,	.5835,	.2373,
9,	.2130,	.2525,	.1729,	.2853,	.2905,	.2649,	.2779,	.3099,	.3644,	.2355,
+gp,	.2130,	.2525,	.1729,	.2853,	.2905,	.2649,	.2779,	.3099,	.3644,	.2355,
FBAR 3- 7,	.1551,	.1779,	.1813,	.3307,	.2652,	.2283,	.2758,	.2235,	.2638,	.2005,

Table 8 Fishing mortality (F) at age

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0061,	.0000,	.0000,	.0001,	.0000,	.0000,
2,	.0049,	.0124,	.0290,	.0167,	.0709,	.0490,	.0092,	.0079,	.0094,	.0318,
3,	.1203,	.1291,	.1639,	.0745,	.1664,	.1645,	.1055,	.0768,	.0906,	.1727,
4,	.1357,	.2201,	.2668,	.1763,	.1841,	.2586,	.3129,	.3657,	.2179,	.2351,
5,	.3314,	.2322,	.2173,	.2689,	.1841,	.1484,	.3084,	.4183,	.4713,	.3267,
6,	.3194,	.3554,	.3155,	.2585,	.1997,	.2089,	.1846,	.3830,	.5295,	.6197,
7,	.5152,	.4208,	.4011,	.2654,	.1962,	.2412,	.2205,	.3595,	.5623,	1.3006,
8,	.3870,	.4599,	.2661,	.2284,	.1569,	.2407,	.2565,	.3226,	.3641,	1.0557,
9,	.3398,	.3398,	.2950,	.2407,	.1850,	.2206,	.2579,	.3399,	.4762,	.7942,
+gp,	.3398,	.3398,	.2950,	.2407,	.1850,	.2206,	.2579,	.3399,	.4762,	.7942,
FBAR 3- 7,	.2844,	.2715,	.2729,	.2088,	.1861,	.2043,	.2264,	.3207,	.3743,	.5310,

Table 8 Fishing mortality (F) at age

YEAR,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0004,	.0006,	.0003,	.0000,	.0000,	.0003,	.0000,	.0000,	.0000,	.0006,
2,	.0124,	.0785,	.0482,	.0285,	.0037,	.0093,	.0098,	.0269,	.0260,	.0190,
3,	.5528,	.3131,	.2403,	.2148,	.0835,	.0715,	.0804,	.0656,	.1430,	.0926,
4,	.2302,	.1813,	.4393,	.3643,	.3329,	.1621,	.1877,	.1714,	.1078,	.1982,
5,	.3387,	.2599,	.2231,	.4059,	.5373,	.4674,	.3532,	.3003,	.2806,	.1169,
6,	.3812,	.3323,	.2740,	.2675,	.6629,	.6104,	.5467,	.5393,	.4474,	.2462,
7,	.7576,	.2793,	.2311,	.2282,	.6146,	.6885,	.6379,	.6483,	.5919,	.4525,
8,	1.9442,	.6613,	.2109,	.2648,	.5779,	.8498,	.5600,	.3223,	.4810,	.6149,
9,	.7469,	.3303,	.2829,	.2593,	.4743,	.6468,	.7111,	.5036,	.3624,	.2500,
+gp,	.7469,	.3303,	.2829,	.2593,	.4743,	.6468,	.7111,	.5036,	.3624,	.2500,
FBAR 3- 7,	.4521,	.2732,	.2816,	.2962,	.4462,	.4000,	.3612,	.3450,	.3141,	.2213,

Table 5.11 Faroe haddock. Stock number (N) at age.

```
Run title : FAROE HADDOCK (ICES DIVISION Vb)                HAD_IND

At 23/04/2009  17:34

               Terminal Fs derived using XSA (With F shrinkage)
```

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

YEAR,	1957,	1958,
AGE		
0,	64927,	54061,
1,	47944,	53158,
2,	35106,	39212,
3,	25440,	25003,
4,	20280,	14377,
5,	5517,	8965,
6,	2786,	3055,
7,	1377,	1472,
8,	585,	598,
9,	252,	274,
+gp,	154,	227,
TOTAL,	204367,	200401,

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

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	77651,	58761,	71715,	45400,	33843,	30192,	37948,	81924,	47768,	53238,
1,	44261,	63576,	48109,	58715,	37170,	27709,	24719,	31069,	67074,	39109,
2,	43417,	35763,	51279,	38537,	47362,	30110,	22644,	20203,	25356,	54852,
3,	26445,	31954,	23796,	34806,	22837,	26515,	22585,	17302,	15563,	19470,
4,	13213,	14717,	16517,	12850,	15850,	10638,	14961,	14613,	11176,	10566,
5,	6632,	6706,	6028,	8877,	5786,	6278,	5182,	7604,	7617,	6798,
6,	4284,	3570,	3245,	3182,	5132,	2708,	3005,	2937,	3774,	4622,
7,	1326,	1839,	1512,	1476,	1332,	2809,	1204,	1366,	1398,	1800,
8,	466,	433,	448,	480,	423,	313,	1641,	377,	449,	574,
9,	224,	168,	135,	153,	148,	114,	77,	127,	146,	189,
+gp,	106,	54,	29,	46,	45,	16,	14,	21,	36,	33,
TOTAL,	218024,	217540,	222811,	204522,	169929,	137402,	133981,	177543,	180357,	191251,

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

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	23136,	49623,	35419,	78973,	104864,	83640,	39135,	52374,	4155,	7378,
1,	43588,	18943,	40628,	28998,	64657,	85855,	68478,	32041,	42880,	3402,
2,	31976,	35601,	15457,	33213,	23703,	52335,	70063,	55980,	26197,	35107,
3,	39588,	24022,	27584,	12007,	26514,	16410,	37752,	50724,	41855,	21218,
4,	12234,	25590,	15275,	18609,	6442,	14093,	10813,	23713,	34419,	30613,
5,	6106,	5884,	14997,	8229,	11454,	4153,	7946,	6955,	13264,	23504,
6,	4187,	3583,	3348,	9322,	4289,	6849,	2992,	5265,	4562,	6409,
7,	2403,	2084,	1682,	1572,	6573,	2680,	4724,	2226,	3235,	1810,
8,	638,	860,	712,	595,	657,	4428,	1772,	3549,	1553,	1793,
9,	262,	180,	409,	382,	325,	402,	3141,	1237,	2255,	871,
+gp,	45,	26,	281,	319,	52,	865,	1396,	1515,	2613,	1109,
TOTAL,	164163,	166396,	155791,	192219,	249530,	271710,	248212,	235580,	176989,	133214,

Table 5.11 Faroe haddock. Stock number (N) at age (cont.).

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

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	5209,	23632,	29289,	60865,	58959,	39576,	14116,	28056,	21304,	14083,
1,	6041,	4265,	19348,	23979,	49832,	48272,	32402,	11557,	22970,	17442,
2,	2785,	4945,	3492,	15841,	19633,	40799,	39499,	26529,	9462,	18807,
3,	28715,	2280,	3919,	2792,	12482,	15675,	32322,	31448,	21512,	7491,
4,	16447,	22458,	1814,	2797,	1441,	8438,	11421,	22344,	23441,	16058,
5,	21220,	11877,	15018,	1302,	1581,	833,	4681,	7364,	14265,	15966,
6,	15575,	14349,	7387,	9955,	797,	912,	549,	2708,	4652,	8990,
7,	3582,	11077,	9489,	4823,	6176,	568,	535,	297,	1550,	2801,
8,	833,	2234,	7650,	6359,	3068,	3750,	427,	356,	208,	790,
9,	893,	490,	1232,	5713,	4151,	1843,	2291,	294,	174,	95,
+gp,	424,	423,	249,	947,	3462,	4569,	4405,	2933,	1199,	670,
TOTAL,	101724,	98031,	98888,	135375,	161582,	165235,	142648,	133884,	120735,	103192,

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

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	4445,	3980,	2722,	9607,	143970,	68262,	13523,	5590,	23215,	31911,
1,	11530,	3639,	3258,	2229,	7866,	117873,	55888,	11071,	4577,	19007,
2,	14280,	9440,	2979,	2668,	1825,	6401,	96505,	45757,	9064,	3747,
3,	14805,	11635,	7634,	2370,	2148,	1392,	4990,	78284,	37168,	7351,
4,	5731,	10748,	8372,	5306,	1801,	1489,	967,	3677,	59358,	27795,
5,	10918,	4097,	7061,	5249,	3642,	1226,	941,	579,	2088,	39082,
6,	10325,	6418,	2659,	4652,	3284,	2480,	866,	566,	312,	1067,
7,	5424,	6142,	3683,	1588,	2941,	2202,	1648,	589,	316,	150,
8,	1863,	2653,	3301,	2019,	997,	1979,	1417,	1082,	337,	147,
9,	510,	1036,	1371,	2071,	1315,	698,	1274,	897,	642,	192,
+gp,	308,	411,	138,	832,	1205,	1672,	1426,	1500,	1491,	997,
TOTAL,	80140,	60198,	43179,	38590,	170993,	205673,	179443,	149593,	138567,	131446,

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

YEAR,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,
AGE											
0,	153554,	89036,	59244,	43637,	14225,	15276,	4885,	5952,	13294,	17645,	0,
1,	26126,	125719,	72896,	48505,	35727,	11647,	12507,	4000,	4873,	10884,	14446,
2,	15562,	21382,	102864,	59665,	39712,	29251,	9533,	10240,	3275,	3990,	8906,
3,	2972,	12583,	16184,	80255,	47479,	32393,	23727,	7729,	8161,	2612,	3205,
4,	5064,	1400,	7533,	10420,	53004,	35757,	24691,	17925,	5926,	5792,	1950,
5,	17989,	3294,	956,	3975,	5926,	31109,	24895,	16755,	12364,	4356,	3889,
6,	23079,	10496,	2079,	626,	2169,	2835,	15960,	14317,	10159,	7646,	3173,
7,	470,	12907,	6164,	1294,	392,	915,	1261,	7564,	6836,	5317,	4894,
8,	34,	180,	7992,	4005,	844,	174,	376,	545,	3239,	3097,	2769,
9,	42,	4,	76,	5299,	2516,	388,	61,	176,	324,	1639,	1371,
+gp,	398,	277,	80,	159,	2710,	1875,	328,	194,	32,	199,	1172,
TOTAL,	245289,	277278,	276069,	257841,	204705,	161620,	118224,	85397,	68482,	63176,	45775,

Table 5.12. Faroe haddock. Stock summary of the 2009 VPA.

Run	title	FAROE	HADDOCK	(ICES	DIVISION	Vb)	HAD_IND
At	23/04/2009	17:34					
Table	16		Summary	(without	SOP	correction)	
Terminal	Fs	derived	using	XSA	(With	F	shrinkage)
	Recruits Age 0	Recruits Age 2	Total Biomass	Total SSB	Landings	Yield/SSB	FBAR(3-7)
1957	64927	35106	90264	51049	20995	0.4113	0.49
1958	54061	39212	92975	51409	23871	0.4643	0.627
1959	77651	43417	89969	48340	20239	0.4187	0.5696
1960	58761	35763	96422	51101	25727	0.5035	0.7101
1961	71715	51279	93296	47901	20831	0.4349	0.5624
1962	45400	38537	98262	52039	27151	0.5217	0.6506
1963	33843	47362	90204	49706	27571	0.5547	0.7002
1964	30192	30110	75561	44185	19490	0.4411	0.4753
1965	37948	22644	71884	45605	18479	0.4052	0.526
1966	81924	20203	68774	44027	18766	0.4262	0.5288
1967	47768	25356	77101	42086	13381	0.3179	0.4031
1968	53238	54852	87972	45495	17852	0.3924	0.4377
1969	23136	31976	94879	53583	23272	0.4343	0.4853
1970	49623	35601	92144	59958	21361	0.3563	0.4762
1971	35419	15457	92931	63921	19393	0.3034	0.4564
1972	78973	33213	91508	63135	16485	0.2611	0.3962
1973	104864	23703	98979	61623	18035	0.2927	0.2902
1974	83640	52335	116881	64632	14773	0.2286	0.2206
1975	39135	70063	138911	75408	20715	0.2747	0.1799
1976	52374	55980	143634	89225	26211	0.2938	0.2475
1977	4155	26197	121054	96385	25555	0.2651	0.3873
1978	7378	35107	120594	97245	19200	0.1974	0.2781
1979	5209	2785	99519	85415	12424	0.1455	0.1551
1980	23632	4945	87656	81920	15016	0.1833	0.1779
1981	29289	3492	78984	75867	12233	0.1612	0.1813
1982	60865	15841	68329	56823	11937	0.2101	0.3307
1983	58959	19633	63993	51833	12894	0.2488	0.2652
1984	39576	40799	100760	53854	12378	0.2298	0.2283
1985	14116	39499	94065	62649	15143	0.2417	0.2758
1986	28056	26529	98653	65675	14477	0.2204	0.2235
1987	21304	9462	87793	67407	14882	0.2208	0.2638
1988	14083	18807	77582	62030	12178	0.1963	0.2005
1989	4445	14280	69801	51869	14325	0.2762	0.2844
1990	3980	9440	53809	43873	11726	0.2673	0.2715
1991	2722	2979	38961	34852	8429	0.2419	0.2729
1992	9607	2668	29290	27151	5476	0.2017	0.2088
1993	143970	1825	28949	23384	4026	0.1722	0.1861
1994	68262	6401	27607	21759	4252	0.1954	0.2043
1995	13523	96505	88249	22904	4948	0.216	0.2264
1996	5590	45757	113847	50162	9642	0.1922	0.3207
1997	23215	9064	108268	82728	17924	0.2167	0.3743
1998	31911	3747	93130	82670	22210	0.2687	0.531
1999	153554	15562	80755	63612	18482	0.2905	0.4521
2000	89036	21382	110433	53581	15821	0.2953	0.2732
2001	59244	102864	146869	61823	15890	0.257	0.2816
2002	43637	59665	153533	85960	24933	0.2901	0.2962
2003	14225	39712	138990	97536	27128	0.2781	0.4462
2004	15276	29251	126003	86462	23287	0.2693	0.4
2005	4885	9533	89552	72287	20305	0.2809	0.3612
2006	5952	10240	67117	58369	17082	0.2927	0.345
2007	13294	3275	49450	44356	12656	0.2853	0.3141
2008	17645	3990	41127	32312	7582	0.2346	0.2213
Arith. Mean	41446	28719	89563	58830	16905	0.2938	0.3591
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 5.13. Management options table - INPUT DATA descriptions.

Stock size

The stock in numbers 2009 is taken directly from the 2009 XSA. The year class 2008 at age 2 (in 2010) is estimated from the 2009 XSA age 1 applying a natural mortality of 0.2 in foreward calculation of the number using the standard VPA equation. The year class 2009 at age 2 (in 2011) is estimated as the geomean of the year classes since 1980.

Age	2009	2010	2011
2	8906	11827	12898
3	3205		
4	1950		
5	3889		
6	3173		
7	4894		
8	2769		
9	1371		
10+	1172		

Numbers in thousands (rounded).

Proportion mature at age

The proportion mature at age in 2009 is estimated as the average of the observed data in 2008 and 2009. For 2010 and 2011, the average for 2007 to 2009 is used.

Age	2009	2010	2011
2	0.01	0.01	0.01
3	0.63	0.60	0.60
4	0.93	0.93	0.93
5	1.00	1.00	1.00
6	1.00	1.00	1.00
7	1.00	1.00	1.00
8	1.00	1.00	1.00
9	1.00	1.00	1.00
10+	1.00	1.00	1.00

Catch&Stock weights at age

Catch and stock weights at age 2009-2011 were estimated as the average weights at age in the catch 2007-2009 and kept constant for all years.

Age	2009	2010	2011
2	0.580	0.580	0.580
3	0.675	0.675	0.675
4	0.829	0.829	0.829
5	0.957	0.957	0.957
6	1.089	1.089	1.089
7	1.257	1.257	1.257
8	1.671	1.671	1.671
9	2.068	2.068	2.068
10+	2.420	2.420	2.420

Exploitation pattern

The exploitation pattern is estimated as the average fishing mortality matrix in 2006-2008 from the final VPA in 2009, re-scaled to 2008, and kept constant for all 3 years. Justification for changing procedures from last year, when the 3-years average was used un-scaled is, that there has been a declining trend in fishing mortality for many years, and there has been a retrospective pattern in recent years of overestimations of fishing mortality.

Age	2009	2010	2011
2	0.0181	0.0181	0.0181
3	0.0757	0.0757	0.0757
4	0.1200	0.1200	0.1200
5	0.1754	0.1754	0.1754
6	0.3099	0.3099	0.3099
7	0.4255	0.4255	0.4255
8	0.3565	0.3565	0.3565
9	0.2805	0.2805	0.2805
10+	0.2805	0.2805	0.2805

Table 5.14 Faroe haddock. Management option table - Input data

MFDP version 1
Run: jr1
Time and date: 21:37 4/24/2009
Fbar age range: 3-7

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	8906	0.2	0.01	0	0	0.580	0.0181	0.580
3	3205	0.2	0.63	0	0	0.675	0.0757	0.675
4	1950	0.2	0.93	0	0	0.829	0.1200	0.829
5	3889	0.2	1	0	0	0.957	0.1754	0.957
6	3173	0.2	1	0	0	1.089	0.3099	1.089
7	4894	0.2	1	0	0	1.257	0.4254	1.257
8	2769	0.2	1	0	0	1.671	0.3565	1.671
9	1371	0.2	1	0	0	2.068	0.2805	2.068
10	1172	0.2	1	0	0	2.420	0.2805	2.420

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	11827	0.2	0.01	0	0	0.580	0.0181	0.580
3	.	0.2	0.6	0	0	0.675	0.0757	0.675
4	.	0.2	0.93	0	0	0.829	0.1200	0.829
5	.	0.2	1	0	0	0.957	0.1754	0.957
6	.	0.2	1	0	0	1.089	0.3099	1.089
7	.	0.2	1	0	0	1.257	0.4254	1.257
8	.	0.2	1	0	0	1.671	0.3565	1.671
9	.	0.2	1	0	0	2.068	0.2805	2.068
10	.	0.2	1	0	0	2.420	0.2805	2.420

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12898	0.2	0.01	0	0	0.580	0.0181	0.580
3	.	0.2	0.6	0	0	0.675	0.0757	0.675
4	.	0.2	0.93	0	0	0.829	0.1200	0.829
5	.	0.2	1	0	0	0.957	0.1754	0.957
6	.	0.2	1	0	0	1.089	0.3099	1.089
7	.	0.2	1	0	0	1.257	0.4254	1.257
8	.	0.2	1	0	0	1.671	0.3565	1.671
9	.	0.2	1	0	0	2.068	0.2805	2.068
10	.	0.2	1	0	0	2.420	0.2805	2.420

Input units are thousands and kg - output in tonnes

Table 5.15 **Faroe haddock. Management option table - Results**

MFDP version 1
Run: jr1
Index file 24/04/2009
Time and date: 21:37 4/24/2009
Fbar age range: 3-7

2009				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
32567	26543	1	0.2213	6249

2010					**2011**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
31827	22966	0	0	0	38089	27734
.	22966	0.1	0.0221	575	37475	27127
.	22966	0.2	0.0443	1134	36879	26538
.	22966	0.3	0.0664	1677	36301	25967
.	22966	0.4	0.0885	2204	35740	25414
.	22966	0.5	0.1106	2717	35195	24876
.	22966	0.6	0.1328	3216	34667	24355
.	22966	0.7	0.1549	3700	34154	23849
.	22966	0.8	0.177	4171	33656	23358
.	22966	0.9	0.1992	4629	33172	22881
.	22966	1	0.2213	5075	32702	22419
.	22966	1.1	0.2434	5508	32246	21970
.	22966	1.2	0.2655	5929	31803	21533
.	22966	1.3	0.2877	6339	31373	21110
.	22966	1.4	0.3098	6738	30954	20699
.	22966	1.5	0.3319	7126	30548	20299
.	22966	1.6	0.354	7504	30153	19912
.	22966	1.7	0.3762	7871	29770	19535
.	22966	1.8	0.3983	8229	29397	19169
.	22966	1.9	0.4204	8577	29034	18813
.	22966	2	0.4426	8916	28682	18467

Input units are thousands and kg - output in tonnes

Table 5.16 Faroe haddock. Long-term Prediction - Input data

MFYPR version 1
Run: jr2
Index file 24/04/2009
Time and date: 21:53 4/24/2009
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.05	0	0	0.560	0.0181	0.560
3	0.2	0.47	0	0	0.799	0.0757	0.799
4	0.2	0.91	0	0	1.060	0.1200	1.060
5	0.2	0.99	0	0	1.378	0.1754	1.378
6	0.2	1.00	0	0	1.680	0.3099	1.680
7	0.2	1.00	0	0	1.967	0.4254	1.967
8	0.2	1.00	0	0	2.206	0.3565	2.206
9	0.2	1.00	0	0	2.448	0.2805	2.448
10	0.2	1.00	0	0	2.766	0.2805	2.766

Weights in kilograms

Table 5.17 Faroe haddock. Long-term Prediction - Results

MFYPR version 1
Run: jr2
Time and date: 21:53 4/24/2009
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.5087	4.0671	7.5582	4.0671	7.5582
0.1	0.0221	0.0825	0.1597	5.1058	7.469	3.6576	6.5198	3.6576	6.5198
0.2	0.0443	0.1465	0.2744	4.7872	6.679	3.3406	5.7312	3.3406	5.7312
0.3	0.0664	0.1976	0.3586	4.5332	6.0618	3.0879	5.1153	3.0879	5.1153
0.4	0.0885	0.2394	0.4217	4.3256	5.5685	2.8819	4.6235	2.8819	4.6235
0.5	0.1106	0.2743	0.4698	4.1528	5.1668	2.7105	4.2231	2.7105	4.2231
0.6	0.1328	0.3038	0.5068	4.0065	4.8343	2.5655	3.8919	2.5655	3.8919
0.7	0.1549	0.3292	0.5357	3.8808	4.555	2.4412	3.614	2.4412	3.614
0.8	0.177	0.3513	0.5584	3.7714	4.3176	2.3333	3.3779	2.3333	3.3779
0.9	0.1992	0.3708	0.5765	3.6752	4.1134	2.2384	3.175	2.2384	3.175
1	0.2213	0.3881	0.5908	3.5897	3.9361	2.1544	2.999	2.1544	2.999
1.1	0.2434	0.4037	0.6024	3.5132	3.7807	2.0792	2.8448	2.0792	2.8448
1.2	0.2655	0.4177	0.6117	3.444	3.6433	2.0114	2.7087	2.0114	2.7087
1.3	0.2877	0.4305	0.6192	3.3811	3.5209	1.9499	2.5876	1.9499	2.5876
1.4	0.3098	0.4422	0.6253	3.3236	3.4112	1.8937	2.4792	1.8937	2.4792
1.5	0.3319	0.453	0.6302	3.2706	3.3121	1.842	2.3814	1.842	2.3814
1.6	0.354	0.463	0.6342	3.2216	3.2222	1.7944	2.2927	1.7944	2.2927
1.7	0.3762	0.4723	0.6375	3.176	3.1401	1.7501	2.2118	1.7501	2.2118
1.8	0.3983	0.481	0.6401	3.1335	3.0648	1.7089	2.1377	1.7089	2.1377
1.9	0.4204	0.4891	0.6422	3.0937	2.9953	1.6704	2.0695	1.6704	2.0695
2	0.4426	0.4968	0.6439	3.0562	2.9311	1.6342	2.0064	1.6342	2.0064

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2213
FMax	2.7482	0.6081
F0.1	0.8271	0.183
F35%SPR	1.2509	0.2768
Flow	-99	
Fmed	1.2729	0.2817
Fhigh	6.5473	1.4488

Weights in kilograms

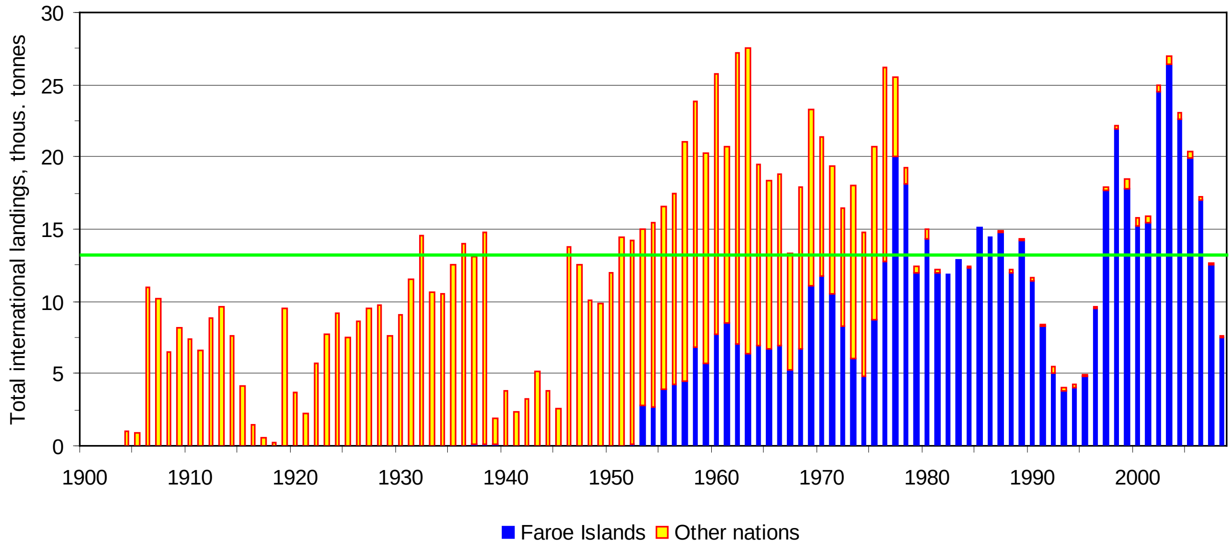


Figure 5.1. Haddock in ICES Division Vb. Landings by all nations 1904-2008. Horisontal line average for the whole period.

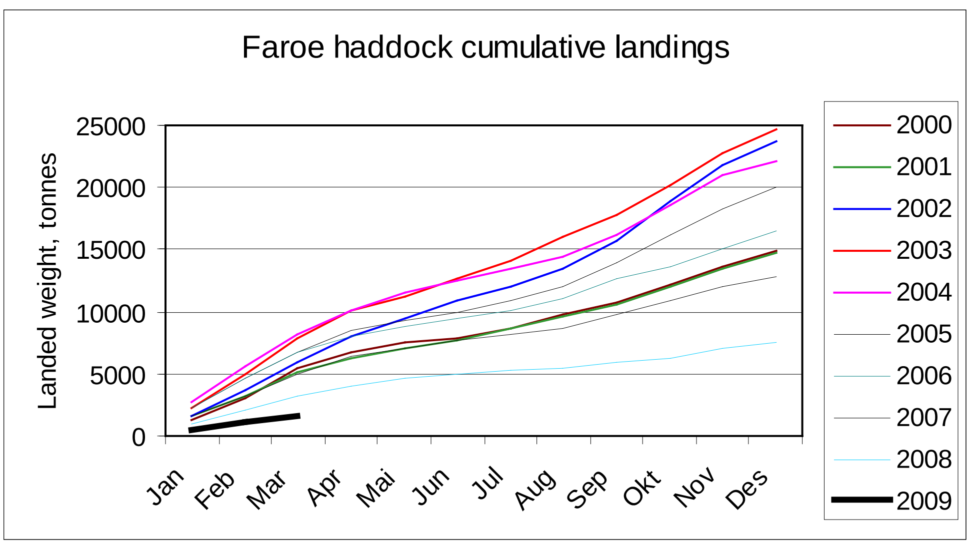


Figure 5.2. Faroe haddock. Cumulative Faroese landings from Vb.

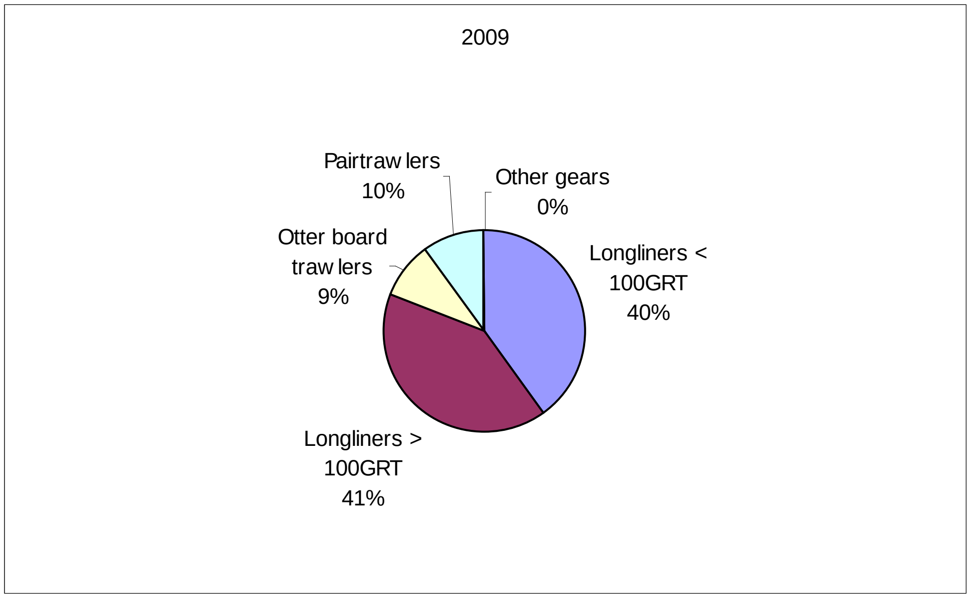


Figure 5.3. Faroe haddock. Contribution (%) by fleet to the total Faroese landings 2009.

Figure 5.4. Faroe haddock. LN(catch@age in numbers) for YC's 1948 onwards.

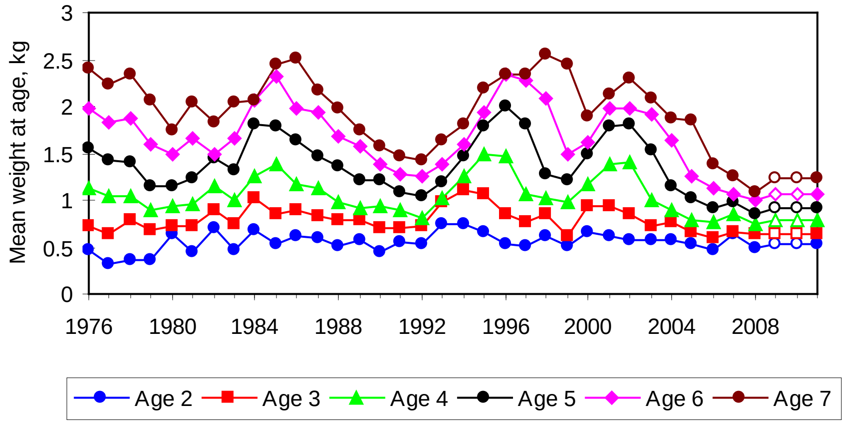


Figure 5.5. Faroe haddock. Mean weight at age (2-7). 2009-2011 are predicted values used in the short term prediction (open symbols).

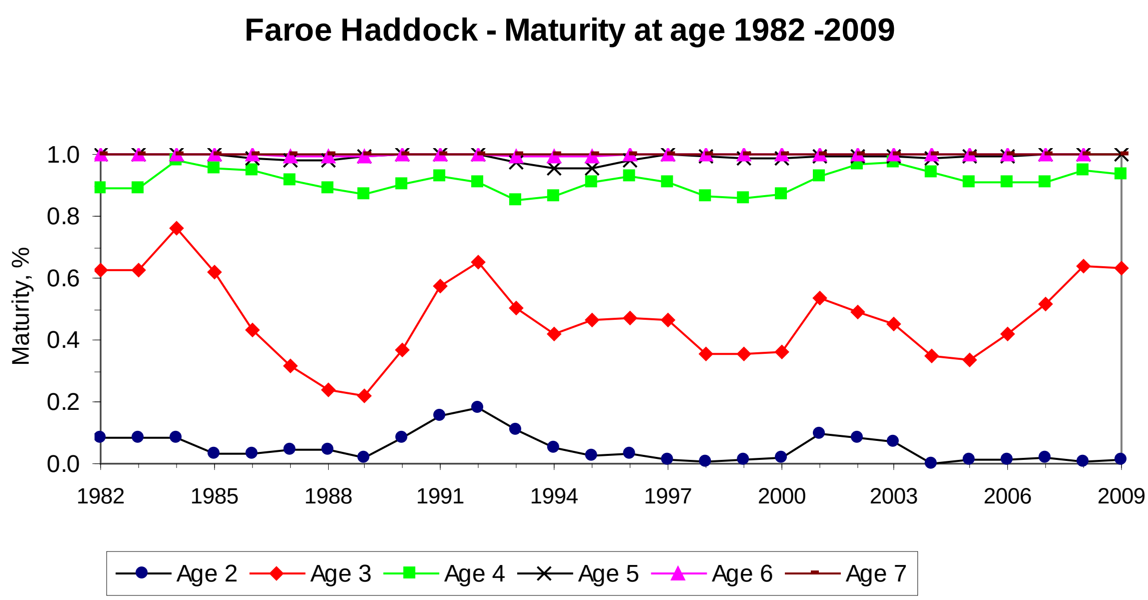


Figure 5.6. Faroe haddock. Maturity at age since 1982. Running 3-years average of survey observations.

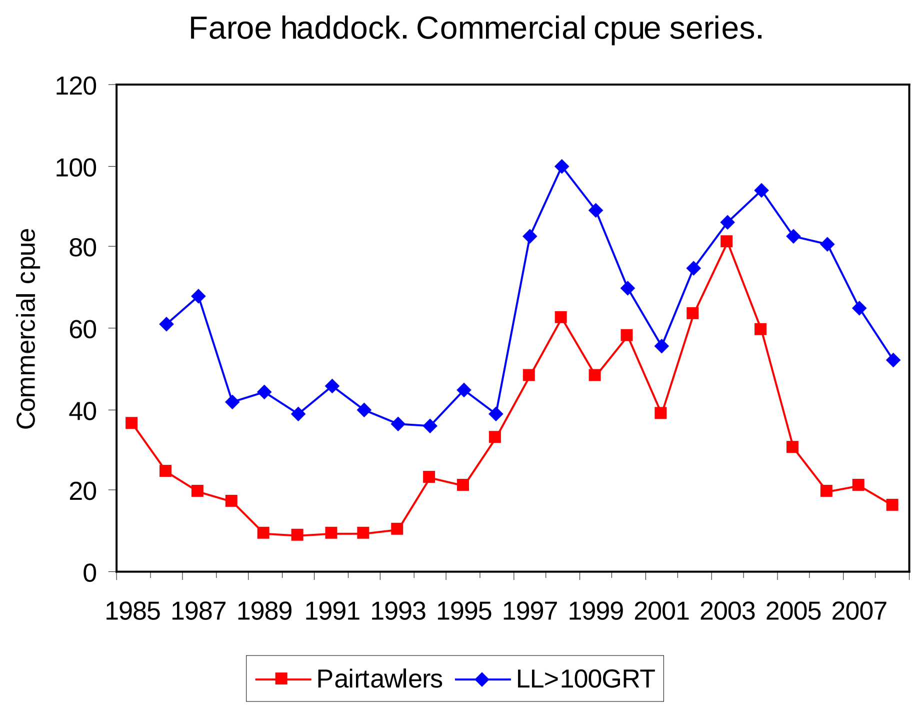


Figure 5.7. Pair trawlers > 1000 HP and longliners > 100 HP.

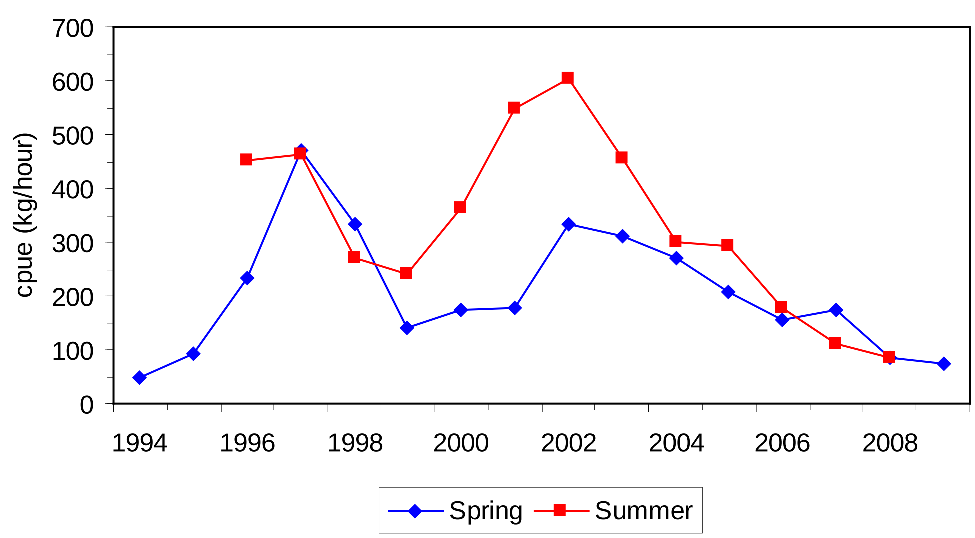
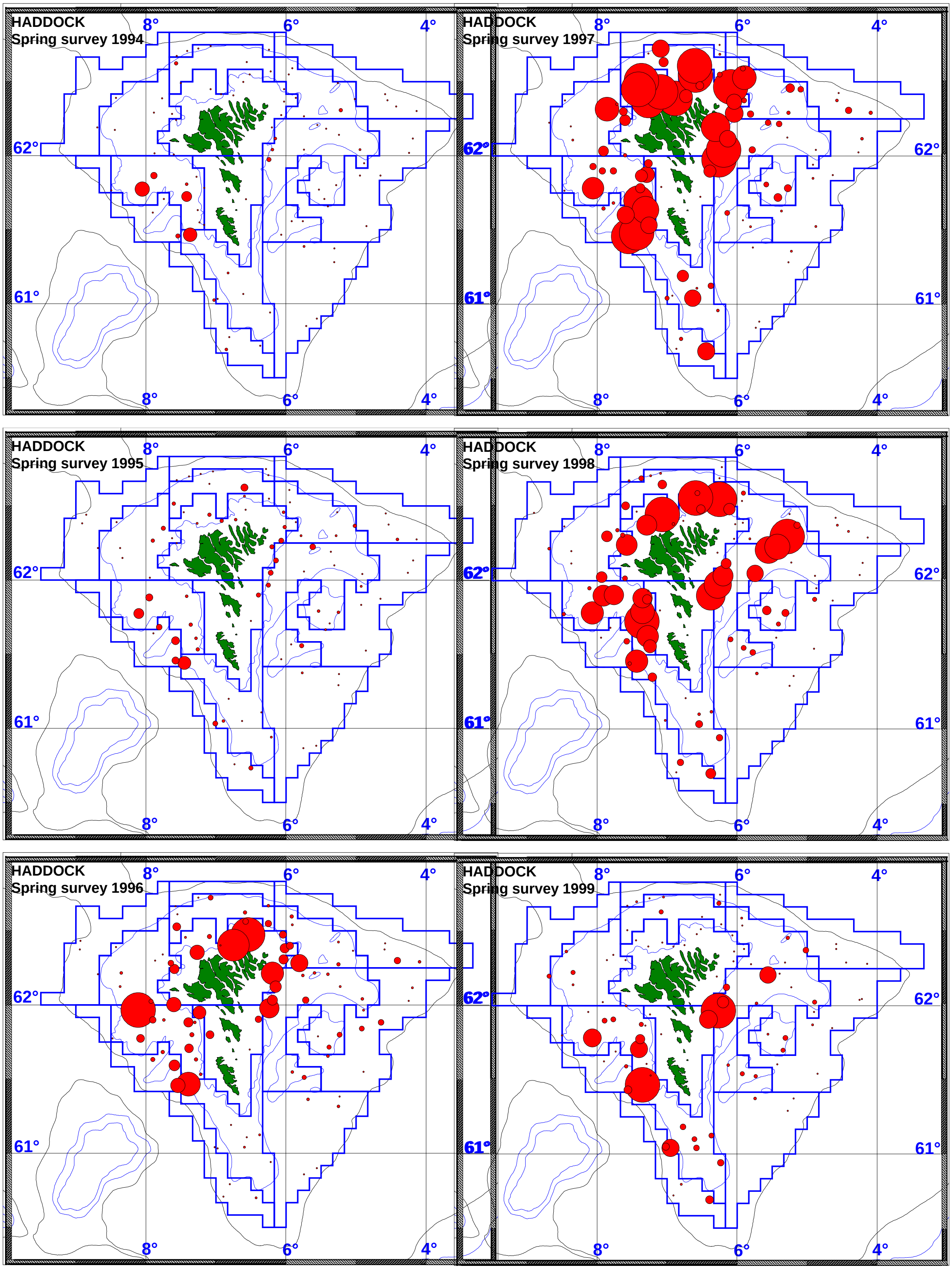
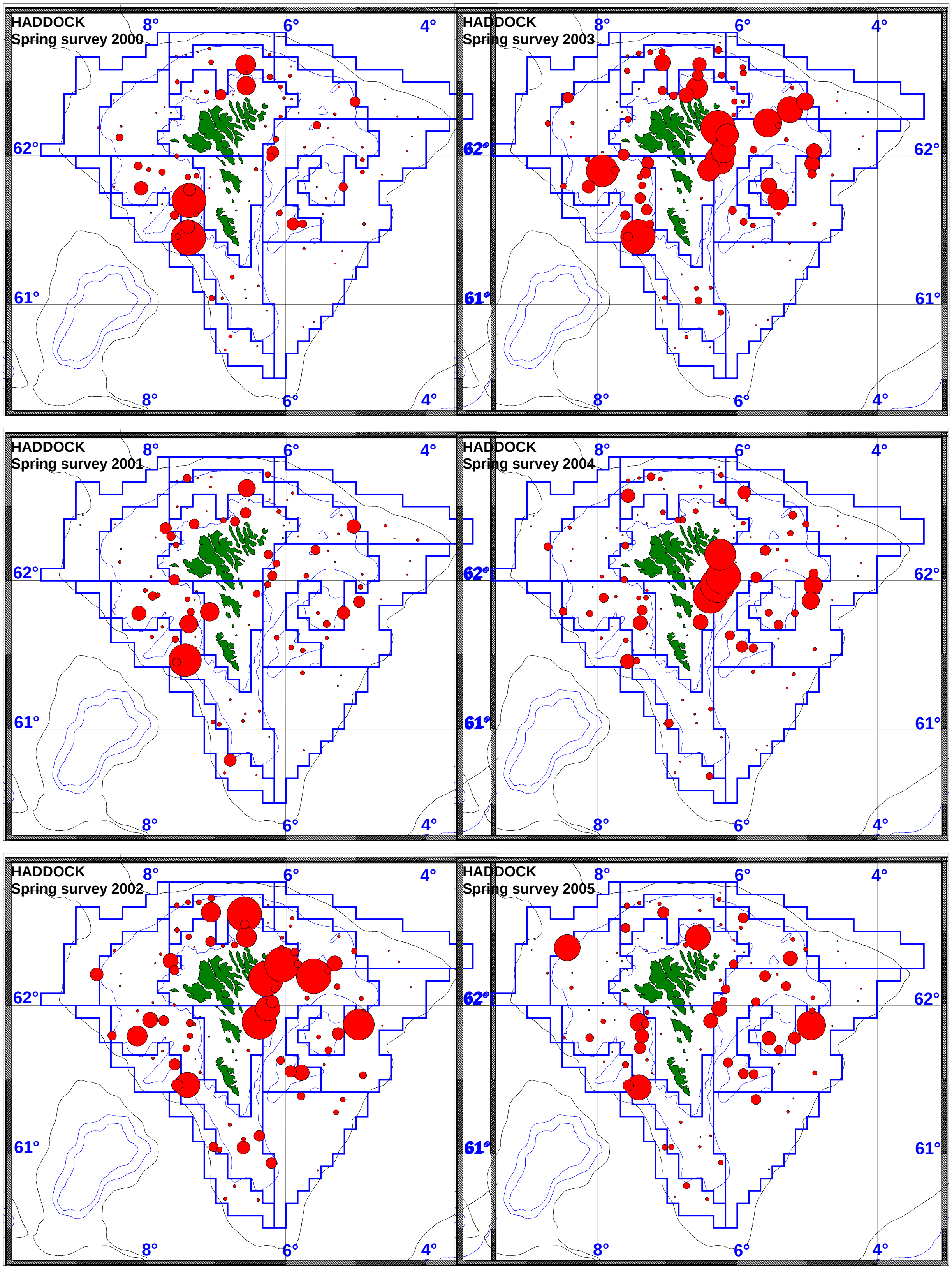
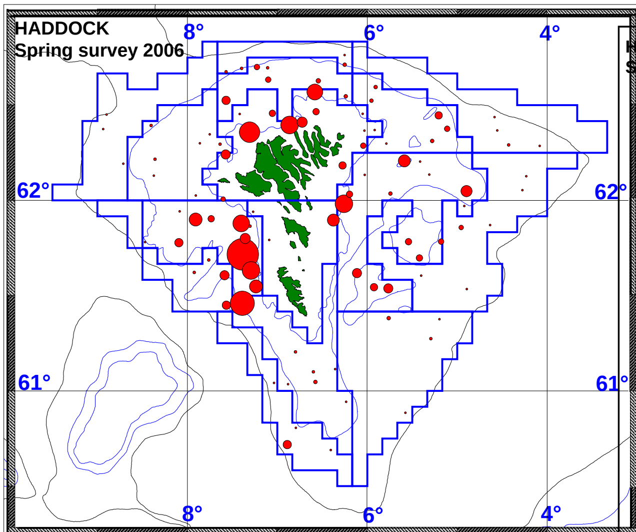
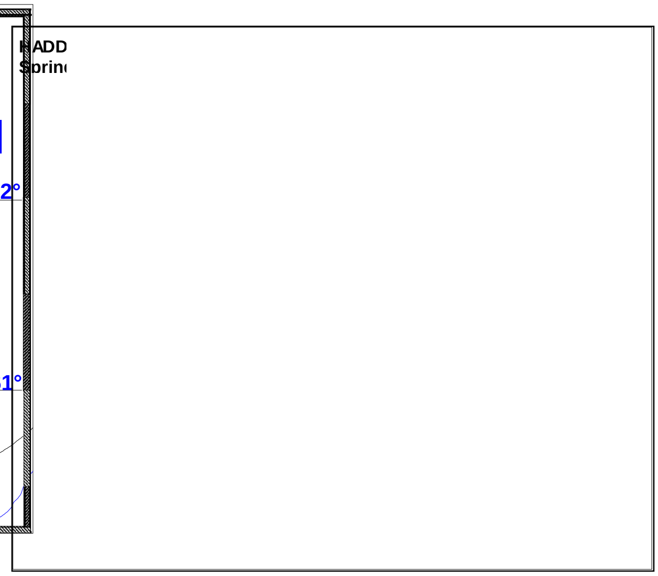


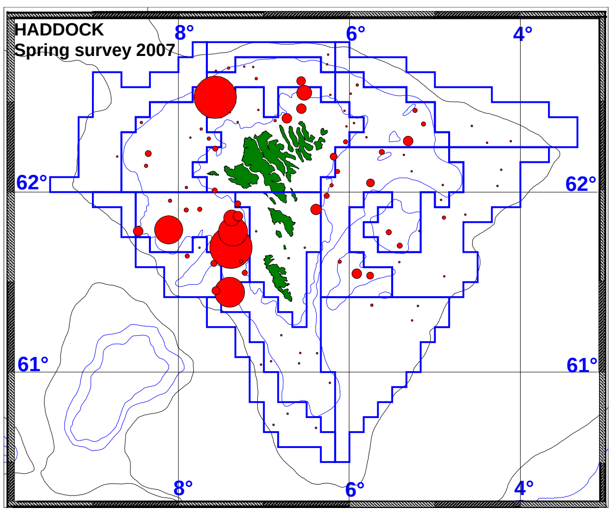
Figure 5.8. Faroe haddock. CPUE (kg/trawlhour) in the spring and summer surveys.

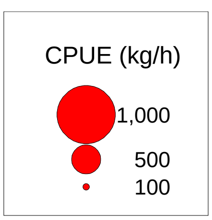

HADDOCK
Spring survey 1994
HADDOCK
Spring survey 1997
HADDOCK
Spring survey 1995
HADDOCK
Spring survey 1998
HADDOCK
Spring survey 1996
HADDOCK
Spring survey 1999
8°
6°
4°
62°
61°

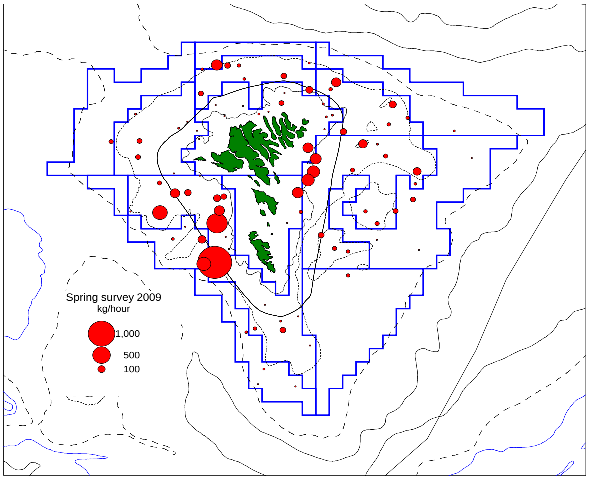

HADDOCK
Spring survey 2000
HADDOCK
Spring survey 2003
HADDOCK
Spring survey 2001
HADDOCK
Spring survey 2004
HADDOCK
Spring survey 2002
HADDOCK
Spring survey 2005
8°
6°
4°
62°
61°

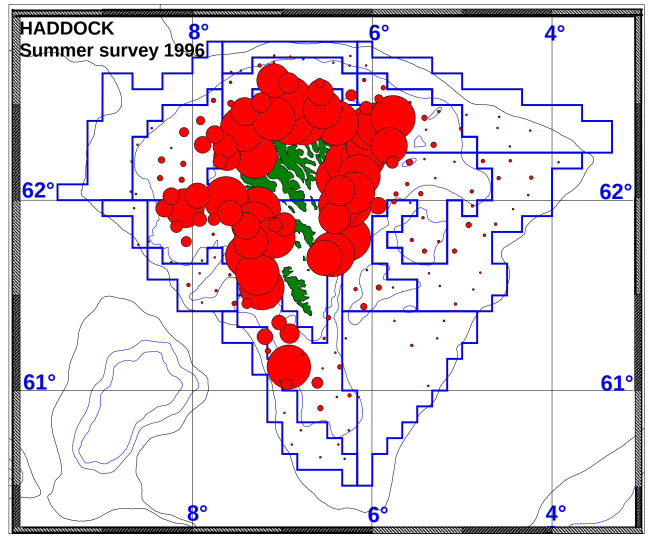

HADDOCK
Spring survey 2006
8°
6°
4°
62°
61°


HADD
Sprin


HADDOCK
Spring survey 2007
8°
6°
4°
62°
61°


CPUE (kg/h)
1,000
500
100





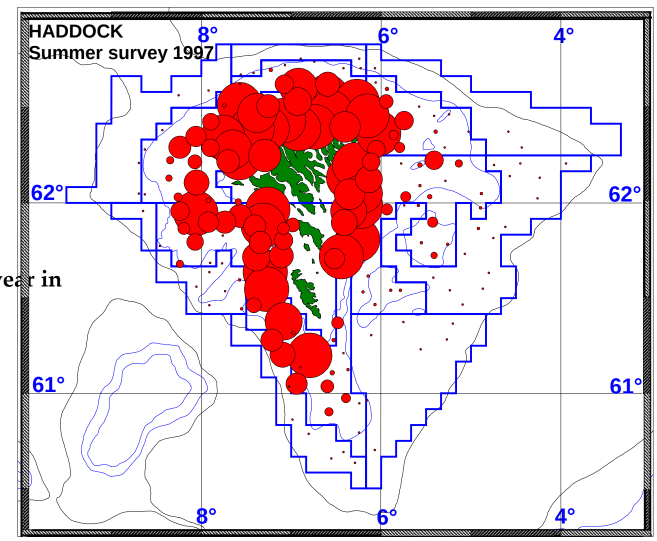
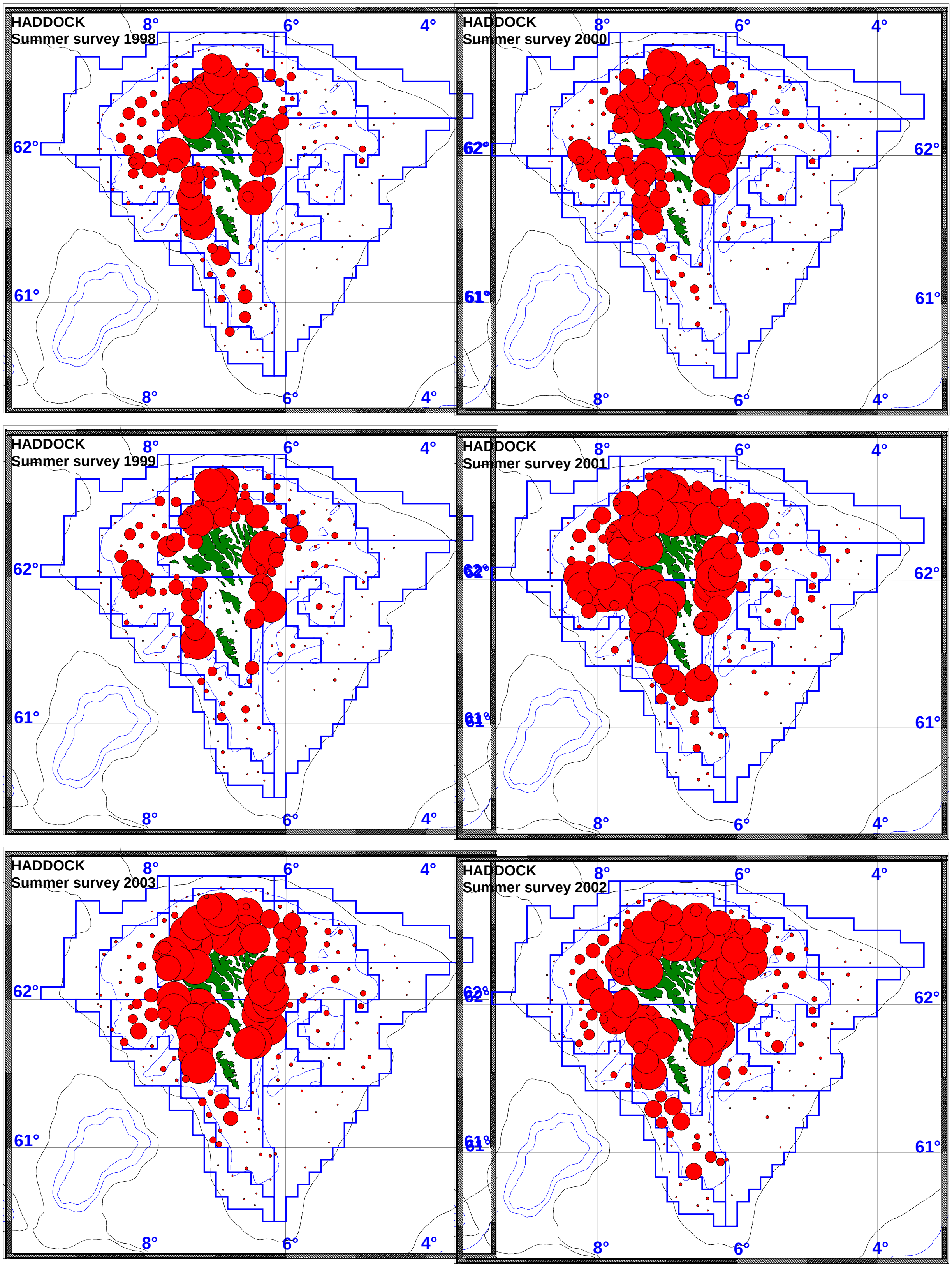
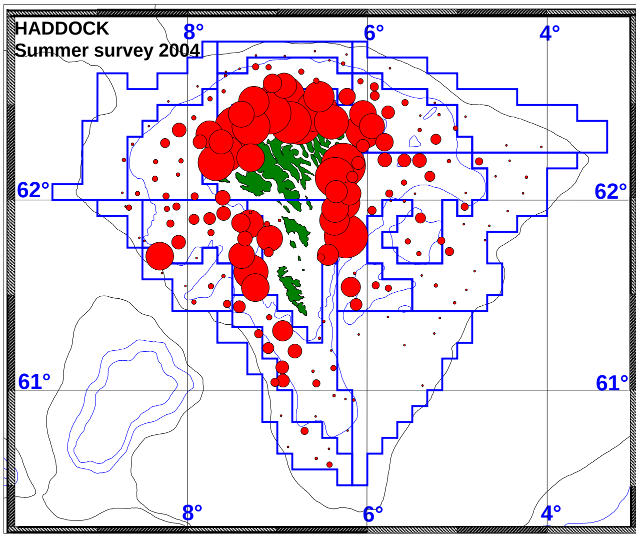
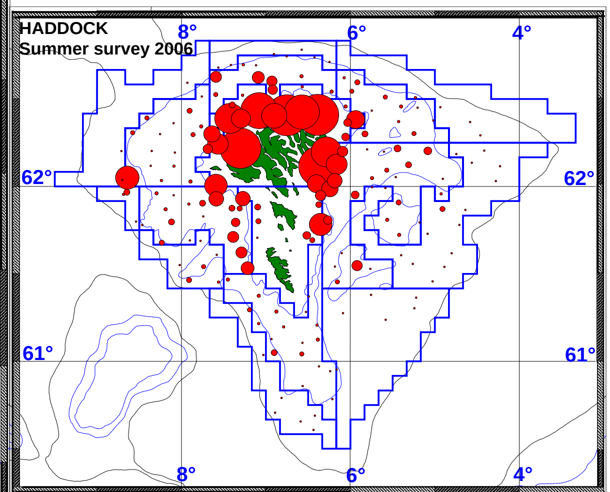
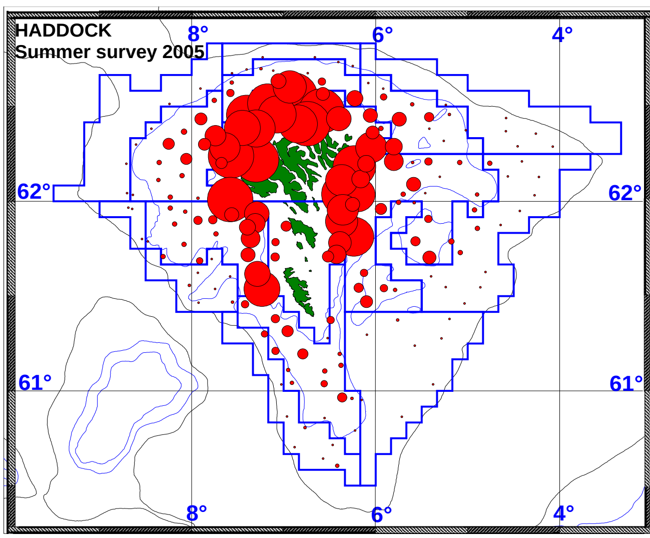


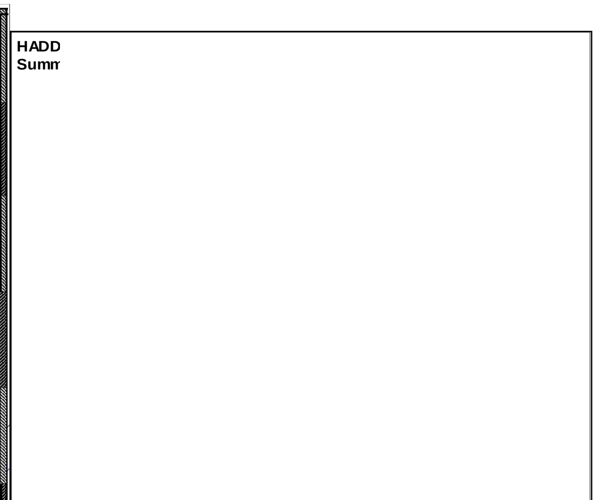
Figure 5.9. Distribution of Faroe haddock catches by year in the spring surveys 1994-2009.

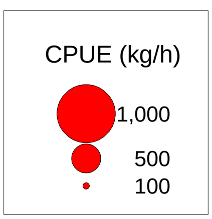

HADDOCK
Summer survey 1998
HADDOCK
Summer survey 2000
HADDOCK
Summer survey 1999
HADDOCK
Summer survey 2001
HADDOCK
Summer survey 2003
HADDOCK
Summer survey 2002
8°
6°
4°
62°
61°

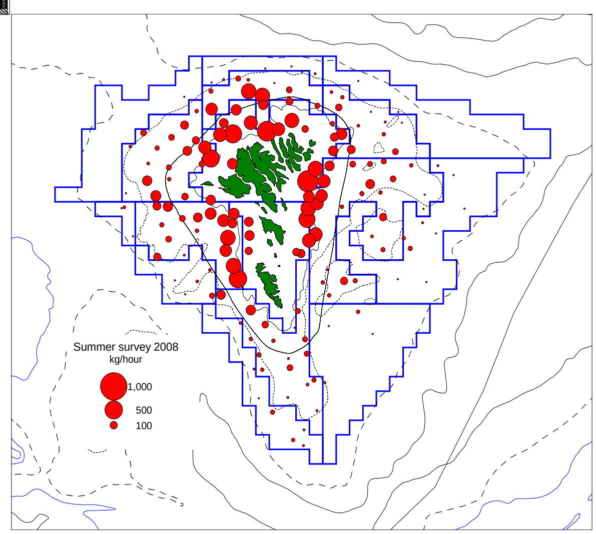












1996-2007

Figure 5.10. Distribution of Faroe haddock catches by year in the summer surveys 1996-2009

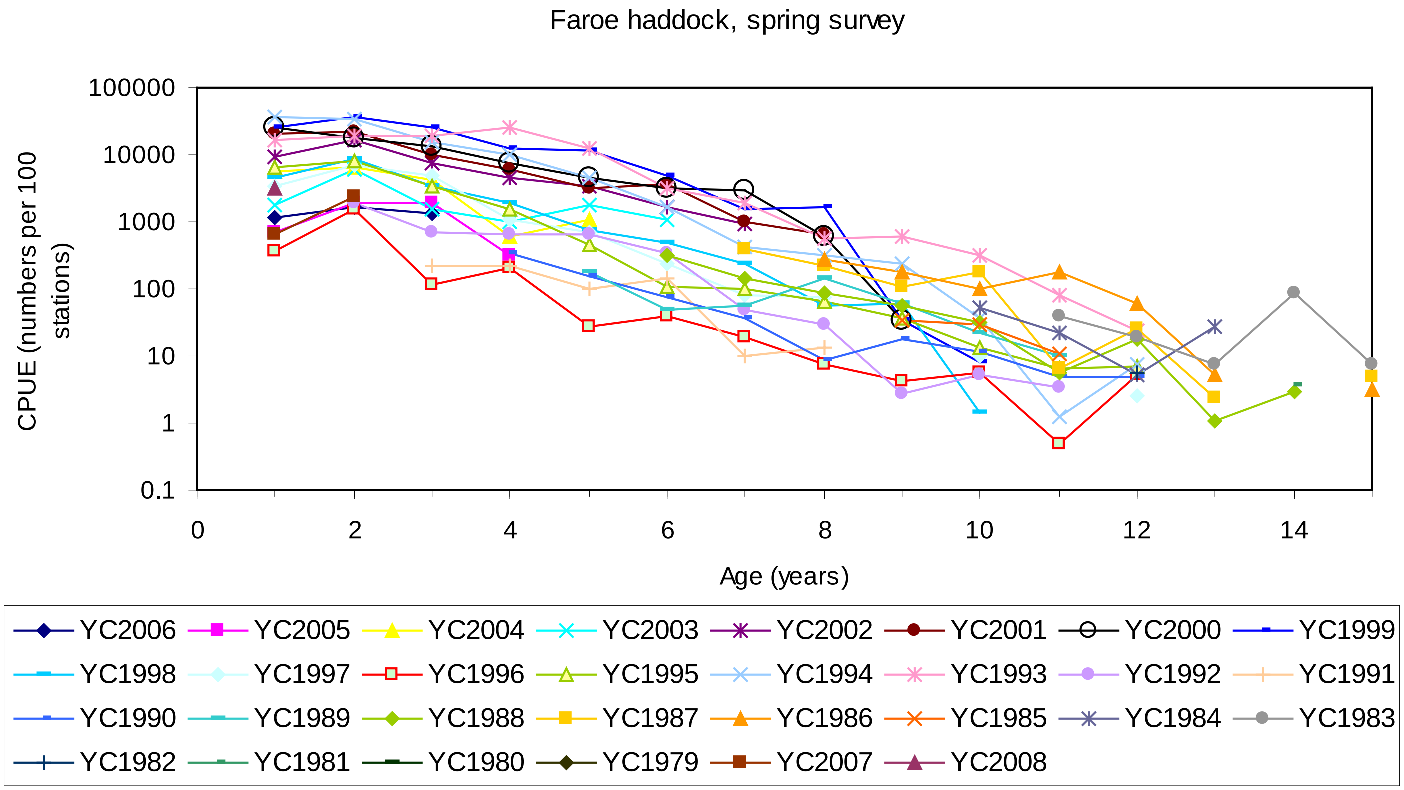


Figure 5.11. Faroe haddock. LN (c@age in numbers) in the spring survey.

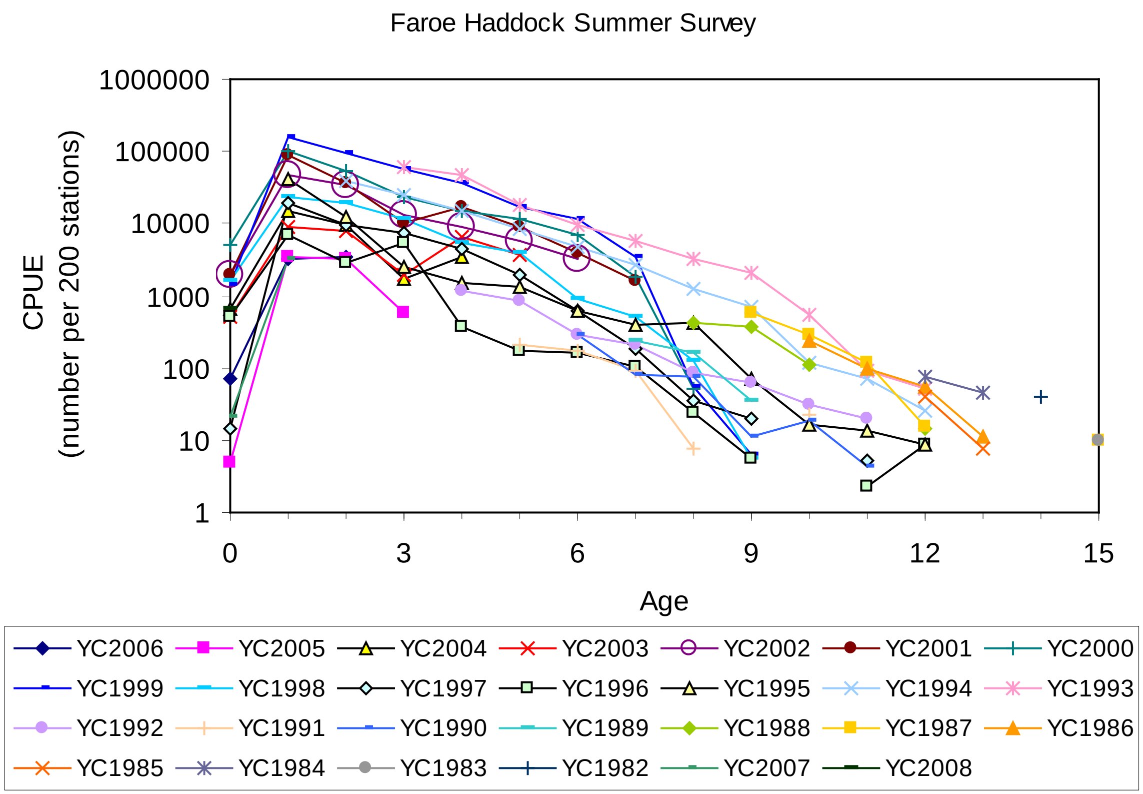


Figure 5.12. Faroe haddock. LN (c@age in numbers) in the summer survey.

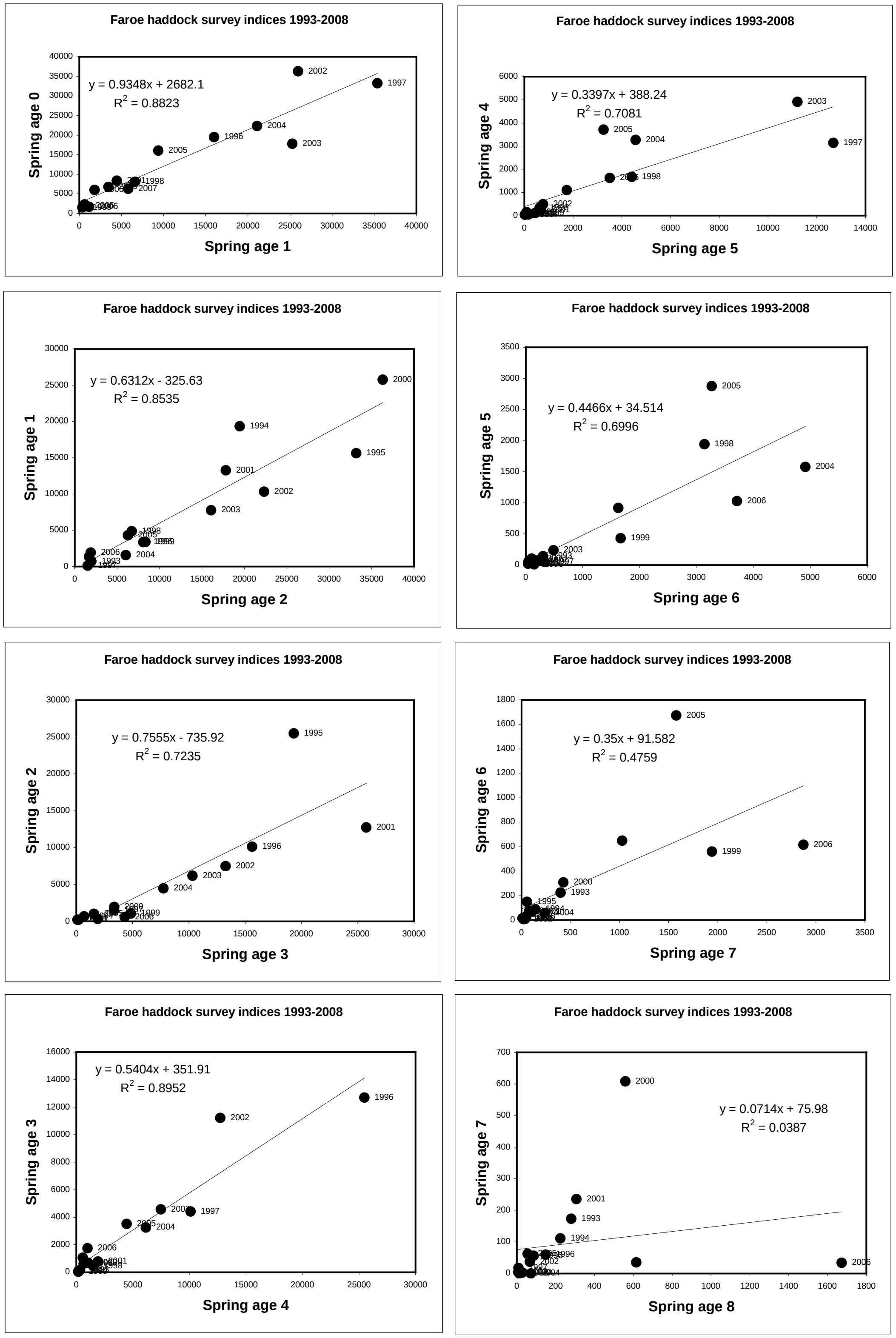


Figure 5.13. Faroe haddock. Comparison between spring survey indices (shifted) at age and the indices of the same YC one year later.

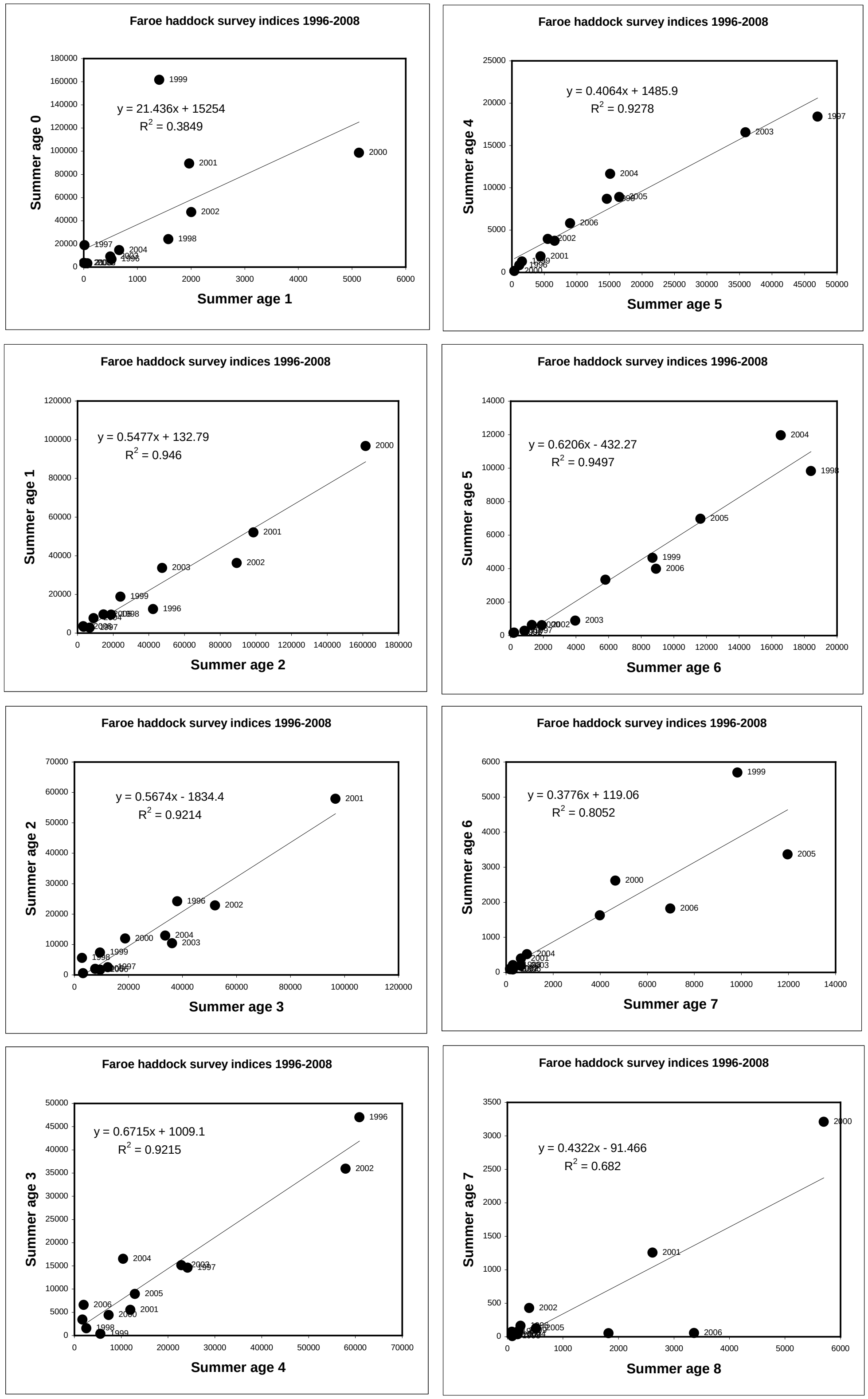


Figure 5.14. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

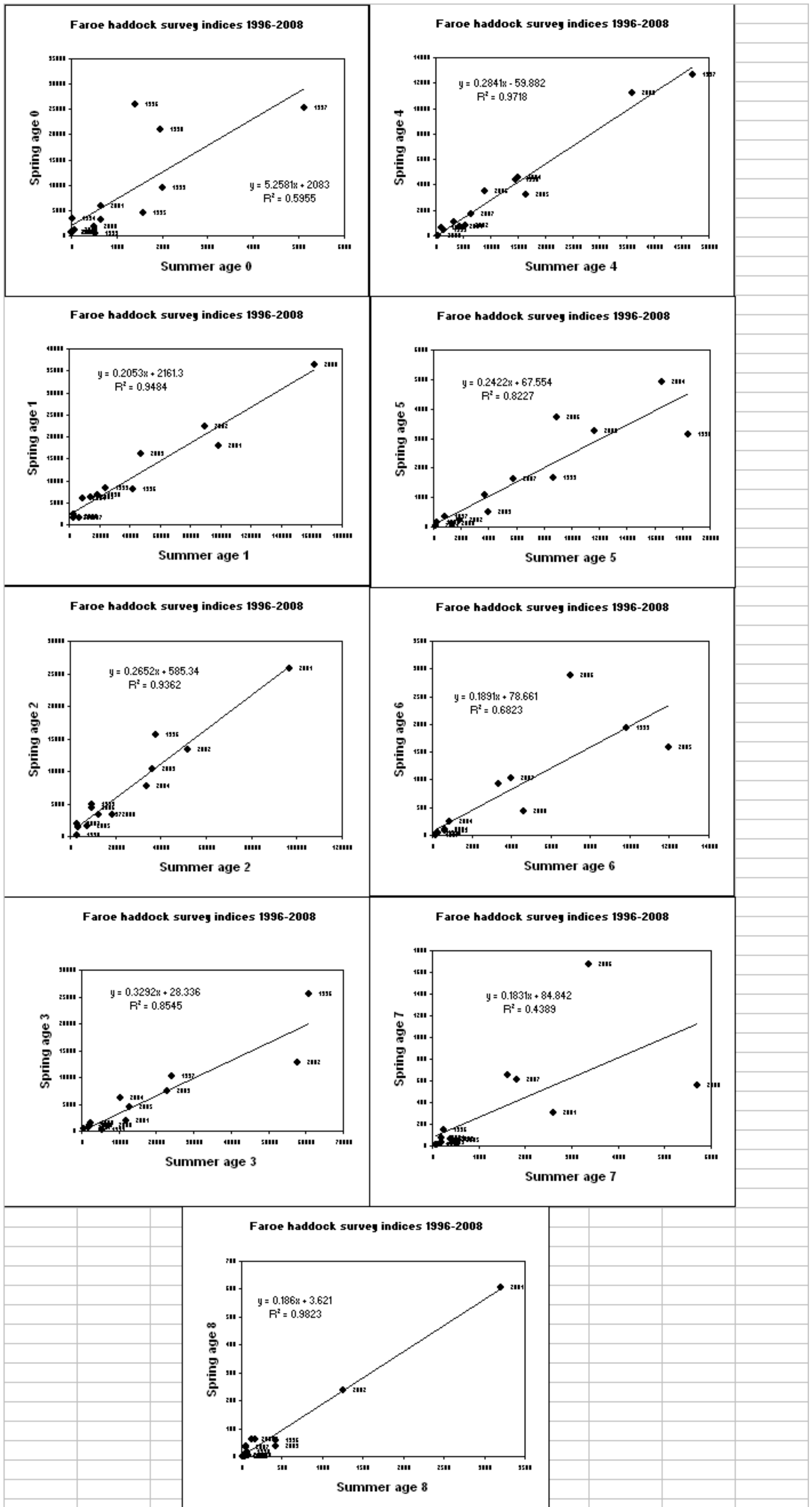
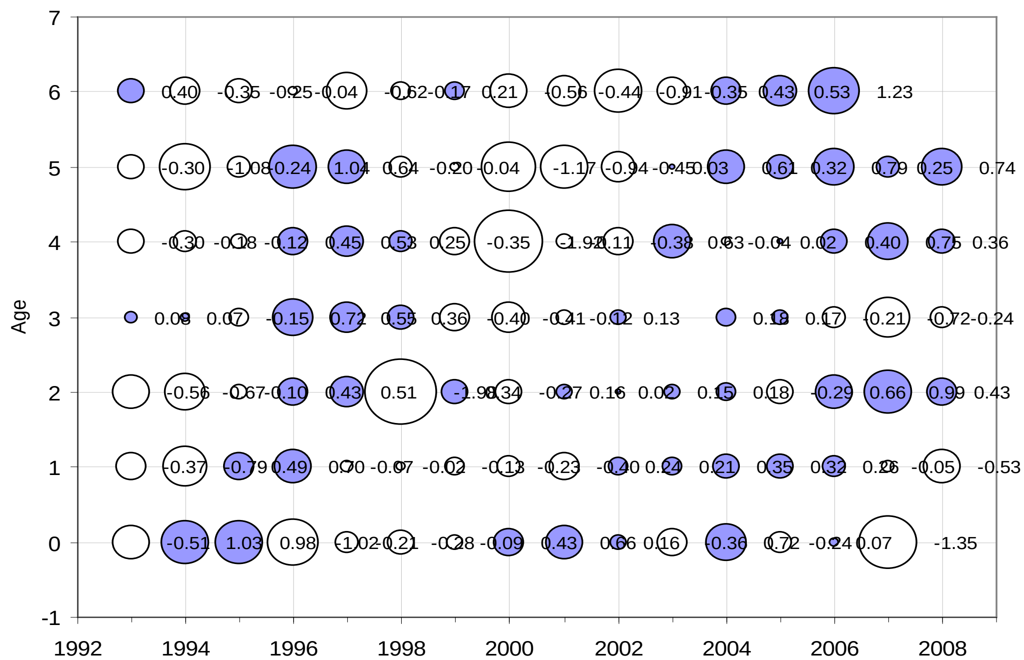


Figure 5.15. Faroe haddock. Comparison between indices at age from the spring (shifted) and summer surveys.

Faroe haddock. Spring survey log q residuals.



Faroe haddock. Summer survey log q residuals.

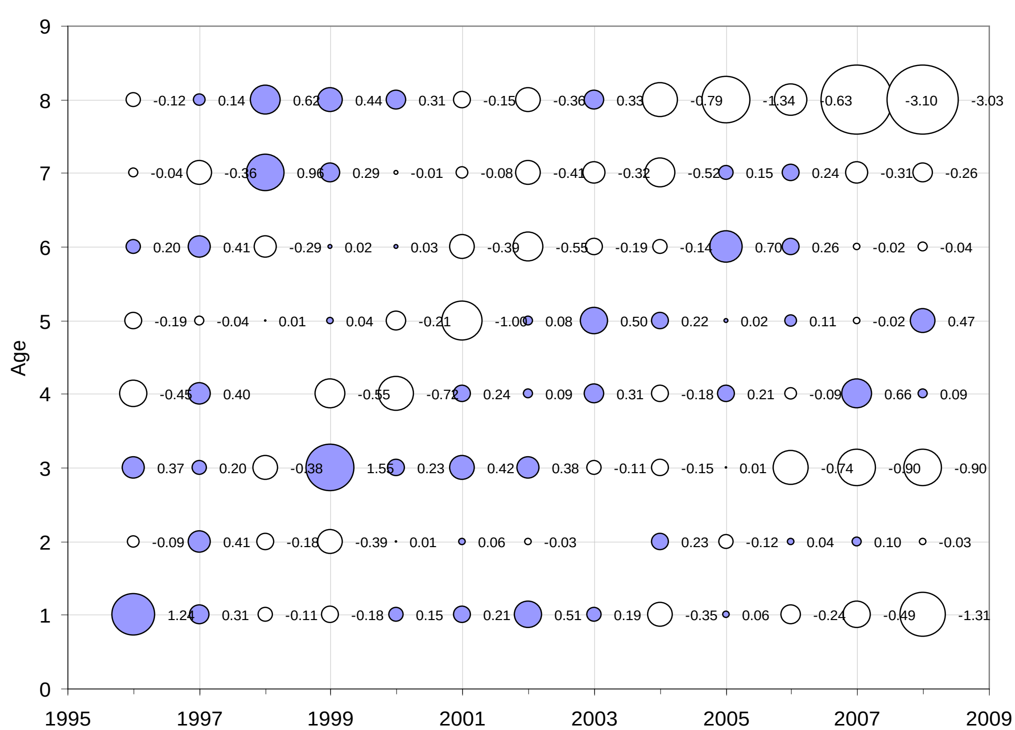
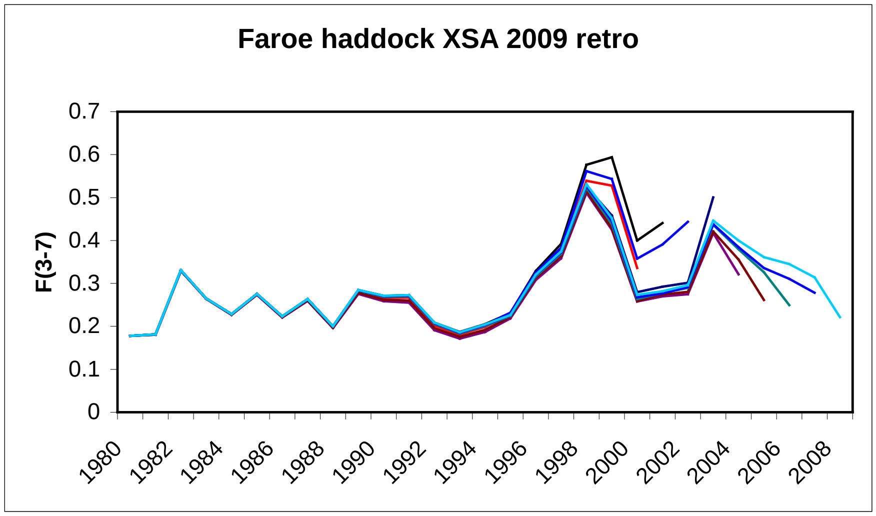
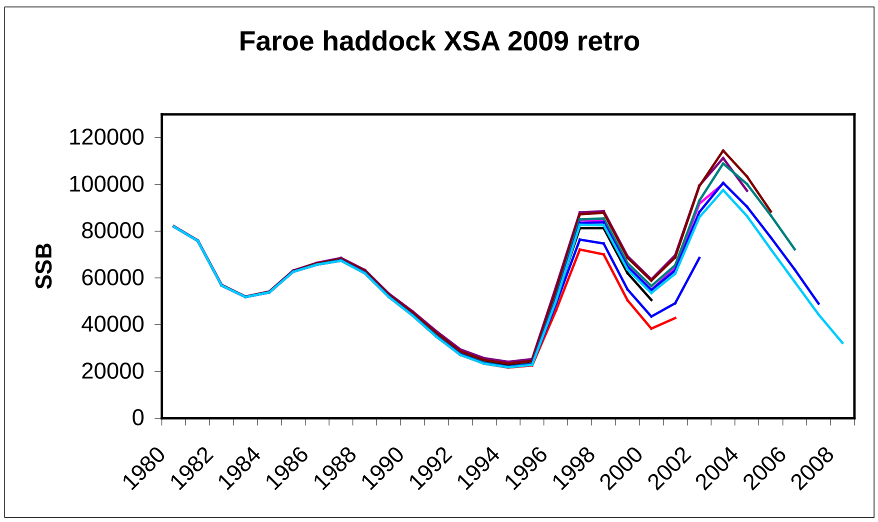


Figure 5.16. Faroe haddock survey log q residuals.





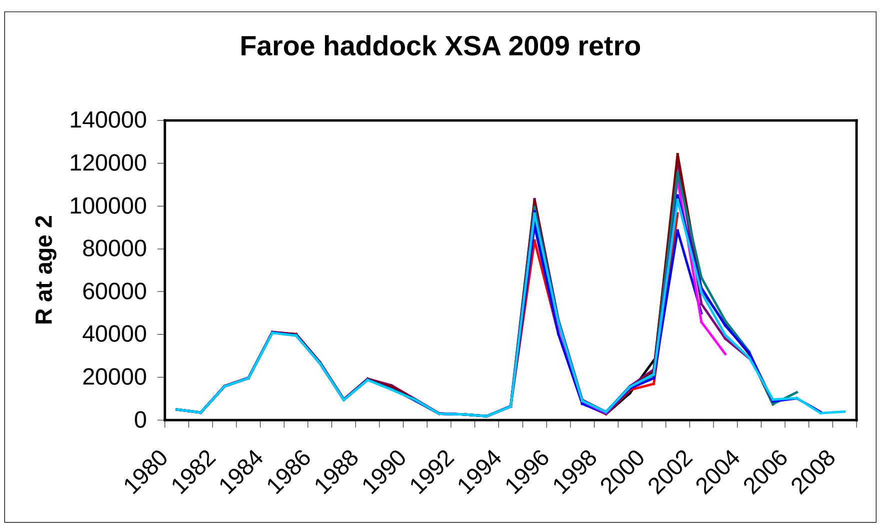


Figure 5.17. Faroe haddock. Retrospective analysis on the 2009 XSA.

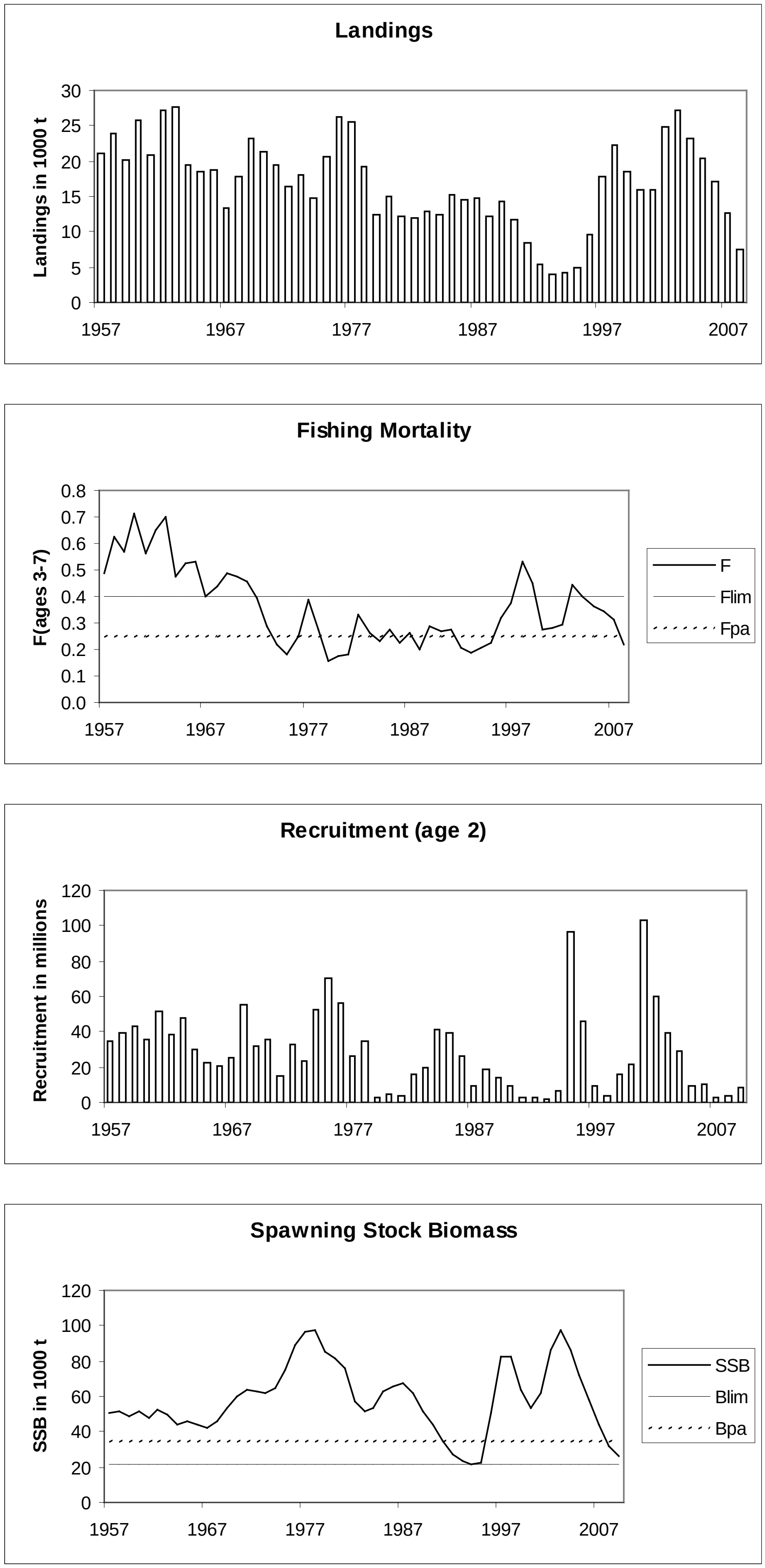


Figure 5.18. Faroe haddock (Division Vb) standard graphs from the 2009 assessment.

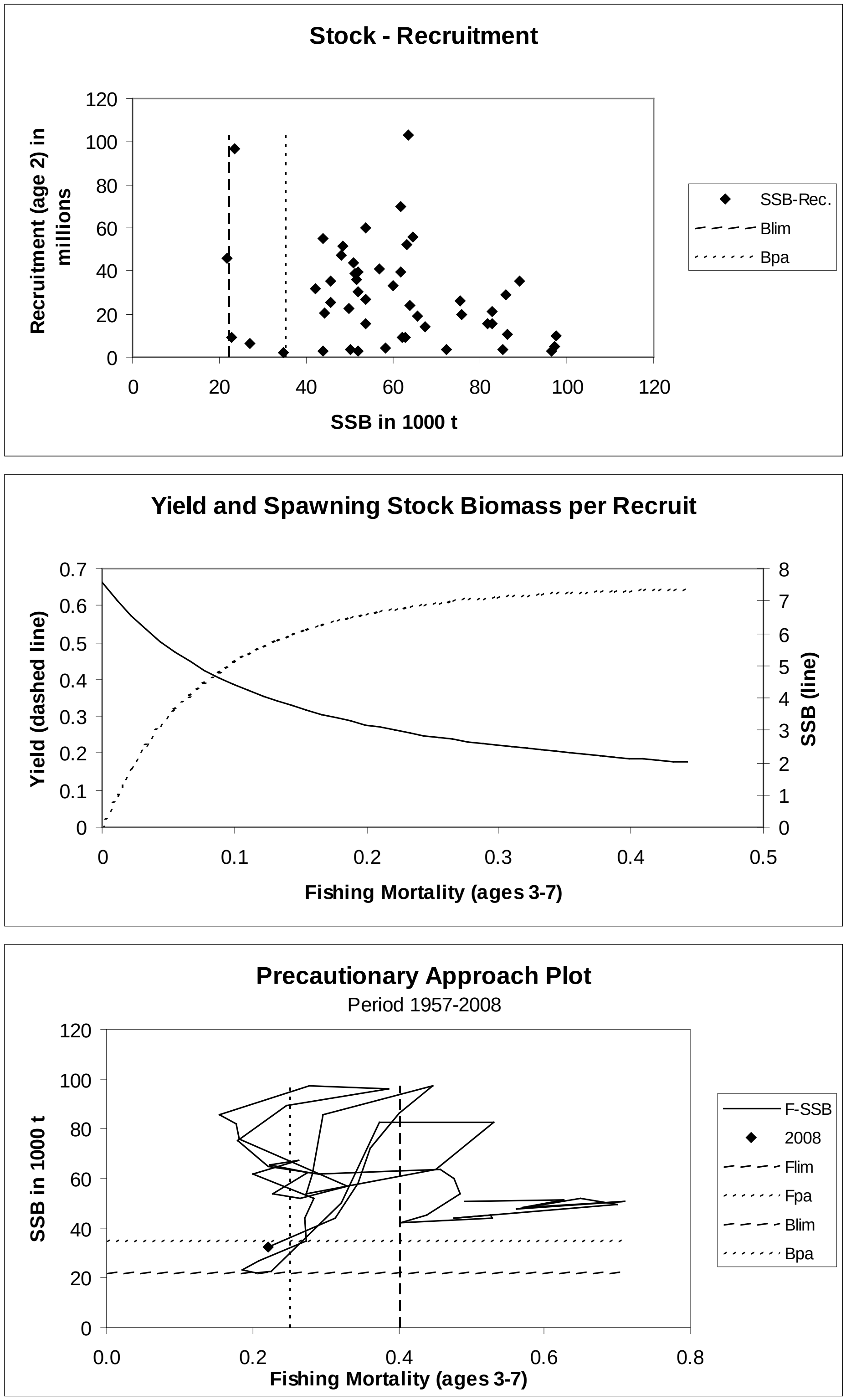


Figure 5.18 (cont.). Faroe haddock (Division Vb) standard graphs from the 2009 assessment.

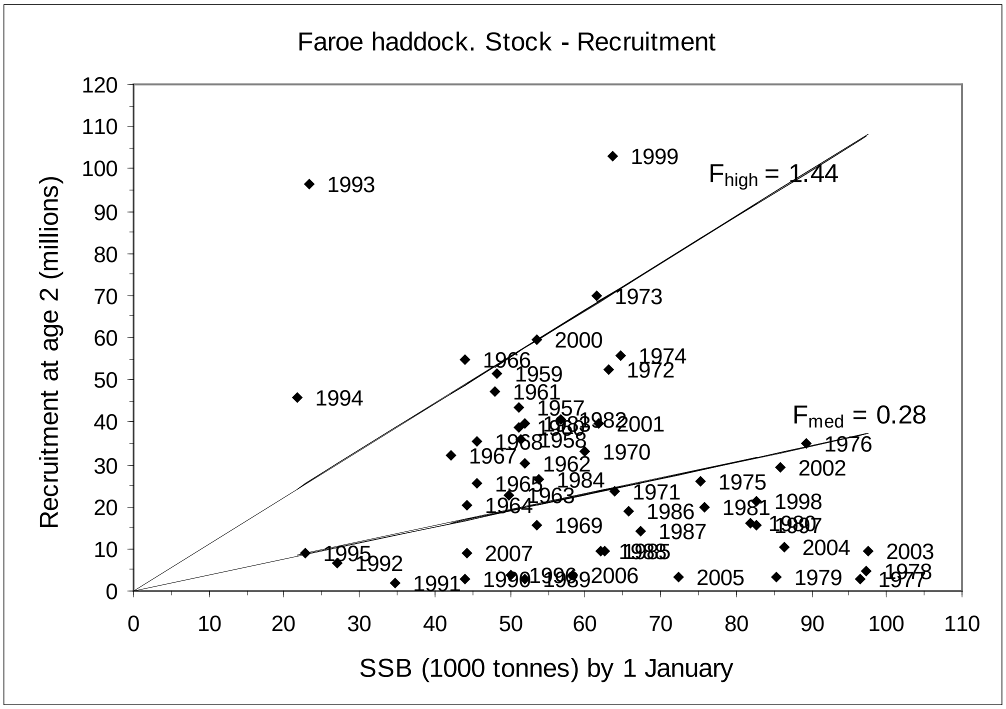
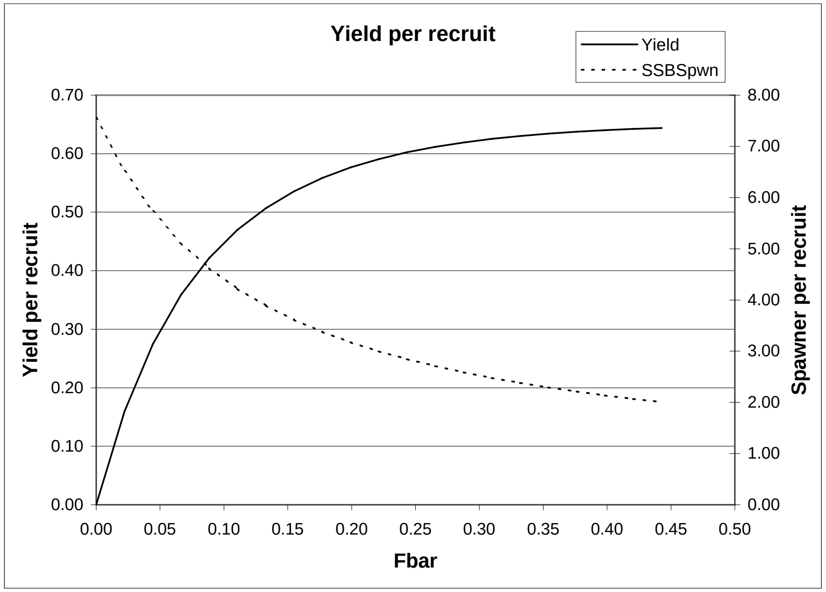
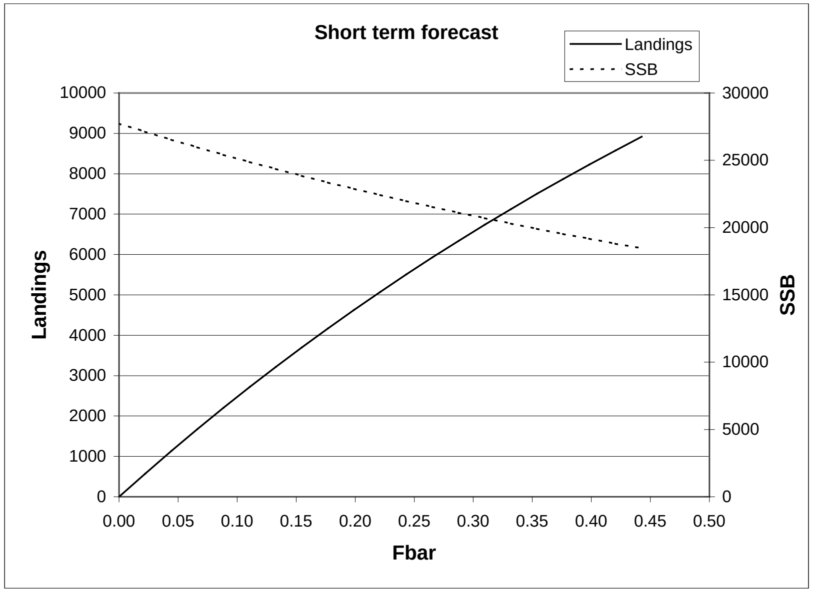


Figure 5.19. Faroe haddock. SSB-R plot.





MFYPR version 1
Run: jr2
Time and date: 21:53 4/24/2009

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.2213
FMax	2.7482	0.6081
F0.1	0.8271	0.183
F35%SPR	1.2509	0.2768
Flow	-99	
Fmed	1.2729	0.2817
Fhigh	6.5473	1.4488

Weights in kilograms

MFDP version 1
Run: jr1
Index file 24/04/2009
Time and date: 21:37 4/24/2009
Fbar age range: 3-7

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Figure 5.20. Faroe haddock. Prediction output.

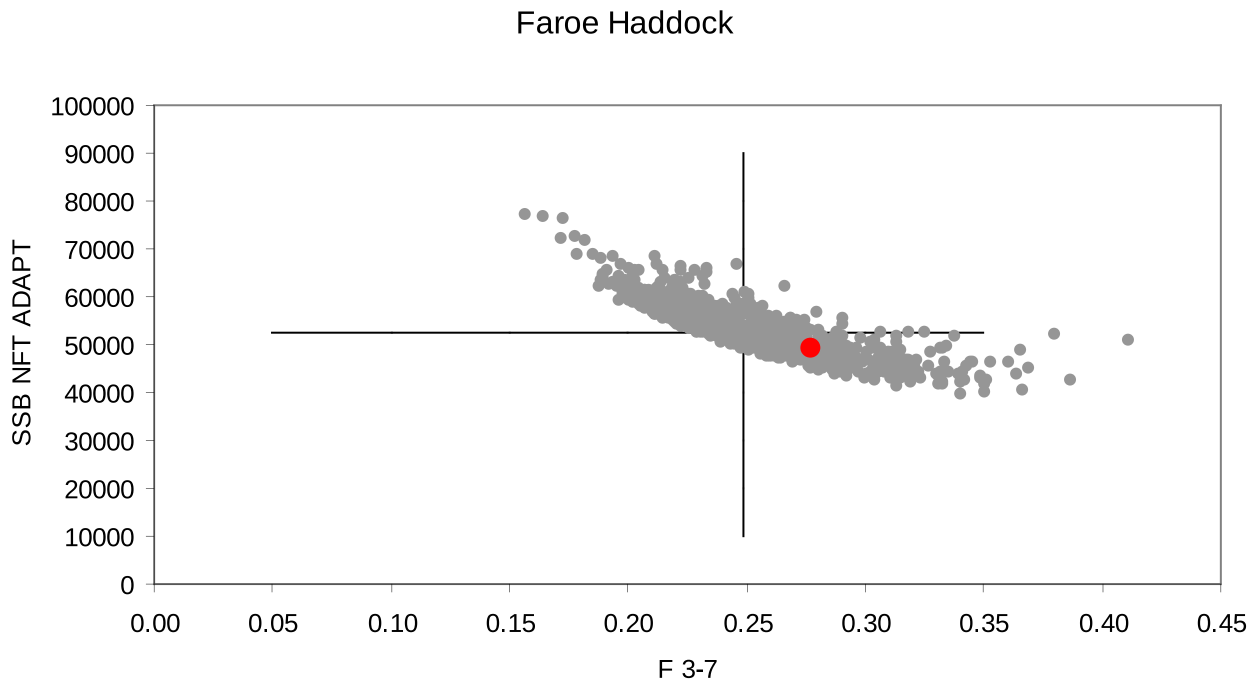
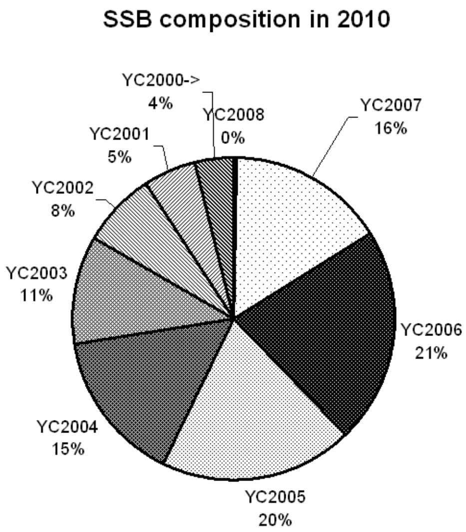


Figure 5.21. The F's and SSB's from a 1000 bootstraps of the ADAPT. Inserted are the point values of F and SSB from the accepted XSA 2008!.



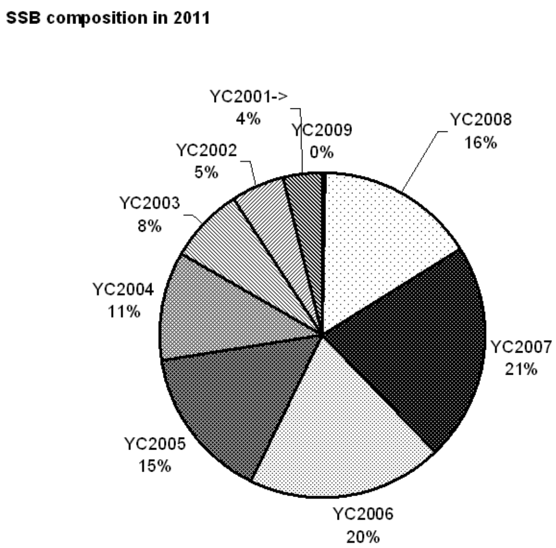


Figure 5.22. Faroe haddock. Projected composition of the number by year-classes in the SSB's in 2010 and 2011.

6 Faroe Saithe

Executive summary

The most recent benchmark assessment was completed in 2005. The 2006-2009 assessments have been rejected because of a retrospective pattern believed to be due to decreased size at age. As size at age has not increased markedly, the retrospective pattern, which underestimates stock size and overestimates fishing mortality, is expected to continue to exist.

The working group concludes that the XSA assessment is useful to indicate stock trends, although the values themselves may be questionable.

Recent year classes are probably underestimated because of changes in catchability (q) due to slower growth, and fishing mortality is probably overestimated. The Faroe saithe total biomass is estimated to be above average in 2008, whereas the spawning stock biomass is estimated below average for the whole time series back to 1961.

For Faroe saithe, the highest recruitment has been observed at or near the lowest SSB. The NWWG in 2007 therefore suggested that Bloss should be used as Bpa, not Blim. The working group recommended that Bpa for saithe be set at Bloss = 60 000t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. NWWG 2009 re-iterates this recommendation. Fishing mortality reference points need to be further considered.

6.1 Stock description and management units.

See the stock annex.

6.2 Scientific data

6.2.1 Trends in landings and fisheries

Nominal landings of saithe from the Faroese grounds (Division Vb) have varied cyclically between 10 000 t and 68 000 t since 1960. After a third high of about 60 000 t in 1990, landings declined steadily to 20 000 t in 1996. Since then landings have increased to 68 000 tonnes in 2005 (Table 6.2.1.1, Figure 6.2.1.1) but has declined slightly to 57 000 tonnes in 2008.

Since the introduction of the 200 miles EEZ in 1977, the saithe fishery has been prosecuted mostly by Faroese vessels. The principal fleet consists of large pair trawlers (>1000 HP), which have a directed fishery for saithe, about 50 - 60% of the reported landings in 1992-2008 (Table 6.2.1.2). The smaller pair trawlers (<1000 HP) and larger single trawlers have a more mixed fishery and they have accounted for about 10-20% of the total landings of saithe in the 1997—2008 period while larger single trawlers contributed about 20% in 2008. The share of catches by the jigger fleet only account for 3 % of the total landings in 2008.

Cumulative landings of saithe from January to March in 2009 are shown in Figure 6.2.1.2, together with cumulative landings in the resent years.

Catches used in the assessment are presented in Table 6.2.1.1. Foreign catches that have been reported to the Faroese Authorities but not officially reported to ICES are also included in the Working Group estimates. Catches in Subdivision IIa, which lies immediately north of the Faroes, have also been included. Little discarding is thought to occur in this fishery.

6.2.2 Catch at age

Catch at age is based on length, weight and otoliths samples from Faroese landings of small and large single and pair trawlers, and landing statistics by fleet provided by the Faroese Authorities. Catch at age was calculated for each fleet by four-month periods and the total was raised by the foreign catches. The catch-at-age data for previous years were also revised according to the final catch statistics (Tables 6.2.2.1 and 6.2.2.2). Sampling intensity in 2008 was less than that in previous years (Table 6.2.2.3).

6.2.3 Weight at age

Mean weights at age have varied by a factor of about 2 during the 1961—2008 period. Mean weights at age were generally high during the early 1980s and they subsequently decreased from the mid 1980s to the early 1990s (Table 6.2.3.1 and Figure 6.2.3.1). Mean weights increased again in the period 1992-96 but have shown a general decrease thereafter. Since 2006 weights at age for some age groups have showed a slight increase.

The observed decline in weights at age since the mid-1990s may cause overestimation in the catchability parameter (estimated as the ratio of tuning fleet CPUE at age by predicted numbers at age from the XSA assessment). The relation between catchability and weights at age (Figure 6.2.3.2) suggests that the former has declined in recent years.

Lower catchabilities will affect the assessment, in that partially recruited ages will be underestimated in the tuning when weights at age are low. These year classes will subsequently show up as stronger than initially estimated as they recruit to the fishery and appear in the catches. The SOP for weight at age in 2008 was 100%.

6.2.4 Maturity at age

Maturity at age data from the spring survey is available from 1983 onward (Steingrund, 2003). Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. The working group examined various smoothers in previous meetings and decided to use a three years running average to predict the maturity at age; this was repeated for 1983-2008 (Table 6.2.4.1 and Figure 6.2.4.1.) For 1961 to 1982, the average maturity at age for 1983 to 1996 was used. The proportion mature for most ages has been slightly increasing in recent years.

6.2.5 Indices of stock size

6.2.5.1 Surveys

Two survey indices conducted in the spring and the summer time are available to the Working Group. However the survey series have not been aiming due to high CVs. In order to address this issue, a data-driven post-stratification analysis was applied in 2008. The analysis suggested that the optimal number of strata to estimate relative stock abundances should be between 5 and 7 for both surveys. The new stratification results in less variable survey estimates while improving year class consistency from one year to the next (Ridao Cruz, L. 2008, WD 5). The NWWG agreed this approach should be explored further. The survey data were not used in the 2008 SPALY (Same

Procedure as Last Year) XSA assessment but they were used in an exploratory XSA using FLR, in NFT ADAPT and in TSA (2008 assessment report). In 2009 the assessment was updated and therefore survey indices were not used. Trends in CPUEs from both surveys are are presented in Figure 6.2.5.1.1.

6.2.5.2 Commercial CPUE

The CPUE series that has been used in the assessment since 2000 was introduced in 1998 (ICES C.M. 1998/ACFM:19), and consists of saithe catch at age and effort in hours, referred to as the pair trawler series. All vessels use 135mm mesh size, the catch is stored on ice on board and landed as fresh fish. The data on which the tuning series are based origin from all available logbooks from the above mentioned trawlers since 1995. The data are stored in the database at the Faroe Marine Research Institute in Torshavn where their quality is controlled and the logbooks are corrected if necessary. Effort is estimated as the number of fishing (trawling) hours, i.e. from when the trawl meets the bottom until hauling starts. It is not possible to get effort as fishing days because the logbooks do not tell when the trip ends (day and time). The series is based on data from 4-10 pair trawlers greater than 1000 HP which have specialized in fishing on saithe and account for 5 000-10 000 t of saithe each year. During 2002-2005 four pairs of these trawlers left the fleet. In 2004 and 2005 two new pairs of trawlers (>1000 HP) were introduced in the tuning series; one pair had been fishing saithe since 1986 and the other since 1995. These two new pairs showed approximately the same trends as the other pair trawlers in the series during 1999-2003. In 2009 two new pairs of trawlers were used to extend the tuning series (referred as pair 7 and 8). The observed CPUE for the new trawlers are well above that of the existing pairs but show roughly the same trend (Figure 6.2.5.2.1).

In the CPUE at age series (1995-2008) information for each haul was supplied and only those hauls where saithe contributed to more than 50% of the total catches were used. The effort distribution of the pair trawl fleet (hauls) since 1995 is presented in Figure 6.2.5.2.2.

A systematic check of the age based indices from the different pairs of the commercial series showed that there were differences between the pairs (ICES C.M. 2005/ACFM:21), especially in 2004. A GLM model was used to standardize the CPUE-data (WD 37, 2005) including year, month, pair, effort and statistical square as explanatory variables for the 1995-2007 period.

During the 2009 meeting, some of the GLM results seemed unreasonable. Hence, a simple standardization process was applied. The fishing area was standardized to four statistical squares, where the pair trawlers fished most of the time. The two new pairs were scaled down to the level of the old pair trawlers (simple regression with one parameter to be estimated). The CPUE of this year tuningseries is showed in Figure 6.2.5.2.3.

6.3 Information from the fishing industry

There is no direct information from the fishing industry.

6.4 Methods

The 2005 Faroe saithe assessment was a benchmark assessment, where several different settings and combinations of tuning series were run in the XSA (WD 16, 2005). The 2006-2007 assessments were not accepted because of the catchability problem discussed above (see section 6.2.2). The 2009 SPALY XSA assessment, with extended tuning series, described below uses the assessment formulation accepted at the last benchmark assessment in 2005 and explores the implications for providing scientific advice.

The 2009 SPALY XSA is calibrated with the standarized pair trawlers with catchability independent of stock size for all ages, catchability independent of age for ages ≥ 8, the shrinkage of the SE of the mean = 2.0, and no time tapered weighting. The tunings series used are shown in Table 6.4.1. The diagnostics are in Table 6.4.2 and the outputs from these are presented in Tables 6.4.3-5. Log catchability residuals are relatively random in recent years (Figure 6.4.1). In the 2009 assessment, the recruitment estimate from the XSA calibration was adjusted down to the highest previously observed (Figure 6.4.2).

The 2009 XSA assessment indicates that the point estimator of SSB in 2008 is close to 76 000 t and that fishing mortality is close to F=0.67. As indicated above, if the 2009 XSA assessment continues to underestimate stock size and overestimate fishing mortality, SSB is probably higher and F lower than indicated in the assessment results, but by an unknown amount.

Retrospective analysis of the average fishing mortality from the XSA for age groups 4-8 (Figure 6.4.3 (middle) continues to show a tendency to overestimate F in the last years. This implies that biomass was correspondingly underestimated (Figure 6.4.3 (top). With respect to recruitment, the analysis indicated an underestimate (Figure 6.4.3 bottom). The fishing mortalities for 1961-2008 are presented in Table 6.4.3 and in Figure 6.4.4. The average fishing mortality for age groups 4-8 was 0.67 in 2008.

6.5 Reference points

6.5.1 Biological reference points

Yield per recruit and spawning stock biomass per recruit curves are presented in Figure 6.5.1.1. Compared to the 2008 average fishing mortality of 0.67 in age groups 4-8, $\mathbf{F}_{max}$ is 0.43, $\mathbf{F}_{0.1}$ is 0.14, $\mathbf{F}_{med}$ is 0.37 and $\mathbf{F}_{high}$ is 1.28 (Figure 6.5.1.1 and Figure 6.5.1.2).

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average last 3 years	0.58	1.47	2.39
Fmax	0.43	1.47	3.02
F0.1	0.14	1.29	7.08
Fmed	0.37	1.47	3.44

The history of the stock/fishery in relation to the existing four reference points can be seen in Figure 6.5.1.3.

Biological reference points for saithe in Vb are listed in the table below.

Reference point Type	Value
B_{lim}	60 000 t
B_{pa}	85 000 t
F_{lim}	0.40
F_{pa}	0.28
F_{Y}	~ 0.45

For Faroe saithe, the highest recruitment has been observed at or near the lowest SSB. The NWWG in 2007 therefore suggested that Bloss should be used as Bpa, not Blim. The working group recommended that Bpa for saithe be set at Bloss = 60 000t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. NWWG 2009 reiterates those recommendations. Fishing mortality reference points need to be further considered.

6.6 State of the stock – historical and compared to what is now

Recruitment in the 1980s was above or close to average (28 millions). The strongest year class since 1986 was produced in the 1990s and the average for that decade is about 29 millions (Figure 6.6.1.1). The 1998 year class (87 millions) and the 1999 year class (93 millions) are the largest in the available time series. Even though recruitment had been above average in the 1960s and 1970s, SSB declined from nearly 115 000 t in 1985 to 64 000 t in 1991 as a result of high fishing mortality yielding the highest (1990) and third highest (1991) landings of the whole 1961-2001 period. The historically low SSB persisted in 1992-1995 (Table 6.4.5 and Figure 6.6.1.2). The SSB has increased since 1996 to above 100 000t in 2004 with the maturation of the 1992, 1994, 1996, 1998 and 1999 year classes but since 2006 the SSB has decreased to 76 000 t. The relation between stock and recruitment (Figure 6.6.1.3) shows that the highest recruitment has been observed at or near the lowest SSBs. While the spawning stock biomass graph shows three cycles of decreasing magnitude, that of total biomass (Figure 6.6.1.4) shows three cycles of increasing magnitude. This could be due to higher exploitation rates since the early 1990s.

The 76 000t SSB in 2008 is below both B_{pa} and B_{lim}. Fishing mortality, however, is higher than Ftarget, Fpa and Flim. Bearing in mind that the 2009 XSA is likely to underestimate SSB and overestimate F, the stock has full reproductive capacity but, even considering the likely overestimation of F, the stock is likely to be harvested unsustainably.

6.7 Short term forecast

Although the 2009 assessment is accepted to illustrate historical trends only, it was decided by the WG to carry on with the assessment results to make a short term prediction. This may provide some information on stock development, and may be useful when/if analytical assessment of this stock is accepted again in the future.

6.7.1 Input data

Input data for prediction with management options are presented in Table 6.7.1.1.

Population numbers for the base short term prediction up to the 2005 year class are from the final 2009 XSA run whereas values for the 2006-2008 year classes are the geometric mean of the 1977 to 2005 year classes. The 2008 values were used for 2009-2011 weights (Table 6.7.1.1). The value of natural mortality is 0.2.

The average of 2008-2009 proportion mature values from the spring survey were used for 2009. For 2010 and 2011 the average for 2007-2009 was used. For all three years the average exploitation pattern in the final VPA for 2006-2008, unscaled to Fbar (ages 4-8) in 2008 in view of a retrospective problem (as suggested by ACFM, 2004), was used.

6.7.2 Projection of catch and biomass

Results from predictions with management option are presented in Table 6.7.2.1. Catches at status quo F would be 46 300 t in 2009 and 52 500 t in 2010. The spawning stock biomass would be about 71 000 tonnes in 2009 and about 78 000 in 2010. The

SSB is above above the B_{pa} = 60 000 t suggested by NWWG in 2007, but below the ICES B_{pa} of 85 000 t.

A projection of catch in number by year classes in 2008 and weight composition in SSB by year classes in 2010 is presented in Figure 6.7.1.1. The catch in 2009 is predicted to rely on the three most recent year classes (88%). In 2010 the year classes from 2002 to 2005 are expected to contribute about 85% of the SSB.

6.8 Medium term forecasts and yield per recruit

No medium term projections were done in 2009.

6.8.1 Input data to yield per recruit

Mean weights for 1961-2008 were used. The value of natural mortality is 0.2. For proportion mature in the long term prediction the average of smoothed values for 1983-2009 was used.

The exploitation pattern was set equal to the average of exploitation patterns for 2004-2008 (as suggested from ACFM, 2004). The input data to long term prediction are shown in Table 6.8.1.1.

Results from the yield per recruit estimates are shown in Table 6.8.1.2 and Figure 6.5.1.1.

6.9 Uncertainties in assessment and forecast

As discussed above, XSA results, with extended pair trawler tuningseries, are likely to continue to underestimate stock size and overestimate fishing mortality.

6.9.1 Assessment quality

The assessment is calibrated exclusively with commercial CPUE data. The WG recognises that these are high quality data, but the problems associated with the use of commercial CPUE data (e.g. increased efficiency due to technological creep etc.) may affect the assessment. The introduction of GLM standardisation could mitigate the problems of vessel replacement if sufficient overlap occurs with other vessels.

The 2006-2008 assessments have been rejected because of the retrospective pattern which is expected to continue to exist; also the 2009 assessment was therefore rejected by the WG, although it was accepted to illustrate historical trends. Given that the survey estimates are now available, a benchmark assessment should be done prior to the next NWWG to provide a firmer basis to the formulation of scientific advice.

6.10 Comparison with previous assessment and forecast

The 3 previous assessments have not been accepted. This assessment is consistent with previous results in the sense that stock size seem to continue to be underestimated and fishing mortality overestimated presumably because of decreased catchability related to reduced growth.

6.11 Management plans and evaluations

Although the 2009 XSA result is expected to continue to overestimate fishing mortality, the probability that F 4-8 is at or less than the target is low. This implies that current management measures are probably insufficient to meet the stated fishing mortality target of F = 0.45.

A Ph.D. project is launched, that is aiming to investigate the role of climatic and oceanographic factors in the biology of Faroe saithe. Relationships between food, growth and climatic factors will be investigated by relating the stomach contents and growth to physical data available. Existing tagging data may illuminate migration of saithe in the North Atlantic; this together with data on ocean currents might reveal how the environment affects the migration. It is hoped that the output of the Ph.D. can become useful input to the assessment of the Faroese saithe stock by illuminating ecological factors.

6.12 Management considerations

Management consideration for saithe is under the general section for Faroese stocks.

The spawning stock biomass is above the suggested B_{pa} =60 000 t, and is expected to reduce to 71 000 t at status quo fishing mortality, due to poor recruitment in the short term. However, if the 2009 XSA continues to underestimate SSB and if recent year-classes are stronger than used in the base case, the 2009 assessment could indicate that the SSB had remained above B_{pa}.

The XSA suggests that the abundance of the strong year classes of the early 2000s will be considerably decreased in 2009 but there are indications in the surveys that this may be strong year classes.

6.13 Ecosystem considerations

There is little information aviable on how the fisheries of Faroe saithe affect the ecosystem.

6.14 Regulations and their effects

It seems to be no relationship between number of fishing days and fishing mortality, probably because of large fluctuations in catchability. Area restriction is an alternative to reduce fishing mortality- and this is used to protect small saithe in Faroese area.

6.15 Changes in fishing technology and fishing patterns

See section 2.

6.16 Changes in the environment

The shallow areas on the Faroe Plateau have been coupled to primary production for some years. A possible ecosystem driver in the deeper areas on the Faroe Plateau is the North Atlantic subpolar gyre. When comparing a gyre index (GI), described by Hatun et al., 2005, to saithe in Faroese waters there was a marked positive relationship between annual variations in GI and the total biomass of saithe lagged 4 years (Figure 6.16.1). This is further described in section 2 and in WD 20 (Steingrund, P. and Hatun, H., 2008).

There is a negative relationship between mean weight-at-age and the stock size of saithe in Faroese waters. This could be due to simple density-dependence, where there is a competition for limited food resources. Stomach content data show that the food of saithe is dominated by blue whiting, Norway pout, and krill, and the annual variations in the stomach fullness are mainly attributable to variations in the feeding on blue whiting. The way stomach fullness was related to weights-at-age of saithe, there seemed to be no relationship between them (í Homrum *et al*. WD 2009).

6.17 Response to technical minutes

2006

Technical minutes suggested that a length based assessment should be attempted. This will be further investigated with Bormicon for next year's meeting, time permitting.

The question of migration has been brought up previously. Although tagging data indicate that saithe migrates between management areas, and some indications are seen in the assessment as well, no attempts have been made to quantify the migration rate of saithe.

Bycatch has been mentioned in the latest technical minutes. The results presented in NWWG 2007 indicate that the bycatch issue is a minor problem in the saithe assessment (ICES C.M. 2007/ACFM:17). Mandatory use of sorting grids in the blue whiting fishery was introduced from April 15, 2007 in the areas west and northwest of the Faroe Islands.

2007

Technical minutes pointed out the problem of variability in weight-at-age and suggested the possibility of using different modelling approaches that the WG could explore in the future. It was discussed whether there was possibility for Faroe Saithe to be part of the benchmark workshop in winter 2008; but this session was already closed for additional participants. Alternatively the group discussed the possibility of working intersessionally to explore usable models for next years meeting.

2008

Technical minutes pointed out the problem of variability in pelagic/demersal occurrence of saithe, hence the problems in reliability of survey indices (high CV). Commercial CPUE indices were used for tuning. However, declining weight-at-age leading to declining catchabilities not accounted for in XSA.

At this point, there is no improvement in this year's assessment compared to last year. In the benchmark assessment the surveys should be closer investigated. The summer survey shows that the spatial distribution of saithe on the Faroe Plateau has become wider (Figure 6.17.1). An attempt should be made to incorporate this information into the index of stock size.

6.18 References

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Table 6.2.1.1. Faroe saithe (Division Vb). Nominal catches (tonnes round weight) by countries, 1989-2008, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	2	-	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	16	-
Faroe Islands	43,624	59,821	53,321	35,979	32,719	32,406	26,918	19,267	21,721	25,995
France [3]	-	-	-	120	75	19	10	12	9	17
Germany	-	-	32	5	2	1	41	3	5	-
German Dem.Rep.	9	-	-	-	-	-	-	-	-	-
German Fed. Rep.	20	15	-	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	-	-	-	-
Netherlands	22	67	65	-	-	-	-	-		-
Norway	51	46	103	85	32	156	10	16	67	53
Portugal	-	-	-	-	-	-	-	-	-	-
UK (Eng. & W.)	-	-	5	74	279	151	21	53	-	19
UK (Scotland)	9	33	79	98	425	438	200	580	460	337
USSR/Russia [2]	-	30	-	12	-	-	-	18	28	-
Total	43,735	60,014	53,605	36,373	33,532	33,171	27,200	19,949	22,306	26,065
Working Group estimate [4,5]	44,477	61,628	54,858	36,487	33,543	33,182	27,209	20,029	22,306	26,421

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 [1]
Denmark	-	-	-	-	-	-	-	34	-	
Estonia	-	-	-	-	-	-	-	-	-	
Faroe Islands	32,439		49,676	55,165	47,933	48,222	71,496	70,696	64,552	61,137
France	-	273	934	607	370	147	123	315	108	38
Germany	100	230	667	422	281	186	1	49	3	3
Greenland	-	-		125	-			73		
Irland	-	-	5	-	-	-	-	-	-	
Norway	160	72	60	77	62	82	82	35	81	37
Portugal	-	-	-	-	-	5	-	-	-	
Russia	-	20	1	10	32	71	210	104	114	38
UK (E/W/NI)	67	32	80	58	89	85	32	88	4	
UK (Scotland)	441	534	708	540	610	748	4,322	1,011	408	
United Kingdom										358
Total	33,207	1,161	52,131	57,004	49,377	49,546	76,266	72,405	65,270	61,611
Working Group estimate [4,5,6,7]	33,207	39,020	51,786	53,546	46,555	46,355	68,008	67,103	60,819	57,025

[1] Preliminary.

[2] As from 1991.

[3] Quantity unknown 1989-91.

[4] Includes catches from Subdivision Vb2 and Division IIa in Faroese waters.

[5] Includes French, Greenlandic, Russian catches from Division Vb, as reported to the Faroese coastal guard service.

[6] Includes Faroese, French, Greenlandic catches from Division Vb, as reported to the Faroese coastal guard service.

[7] The 2001-2008 catches from Faroe Islands, as stated from Faroese coastal guard service, are corrected in order to be consistent with procedures used previous years.

Table 6.2.1.2. Faroe saithe (Division Vb). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category. Averages for 1985-2008 are given at the bottom.

Year	Open boats	Long-liners <100 GRT	Single trawl <400 HP	Gill-nets	Jiggers	Single trawl 400-1000 HP	Single trawl >1000 HP	Pair trawl <1000 HP	Pair trawl >1000 HP	Long-liners >100 GRT	Indust-rial trawlers	Others	Total round weight (tonnes)
1985	0.2	0.1	0.1	0.0	2.6	6.6	33.7	28.2	28.2	0.1	0.2	0.2	42598
1986	0.3	0.2	0.1	0.1	3.6	2.8	27.3	27.5	36.5	0.1	0.7	0.9	40107
1987	0.7	0.1	0.3	0.4	5.6	4.1	20.4	22.8	44.2	0.1	1.1	0.0	39627
1988	0.4	0.3	0.1	0.3	6.5	6.8	20.8	19.6	43.6	0.1	1.3	0.1	43940
1989	0.9	0.1	0.3	0.2	9.3	5.4	17.7	23.5	41.1	0.1	1.3	0.0	43624
1990	0.6	0.2	0.2	0.2	7.4	3.9	19.6	24.0	42.8	0.2	0.9	0.0	59821
1991	0.6	0.1	0.1	0.6	9.8	1.3	13.9	26.5	46.2	0.1	0.8	0.0	53321
1992	0.4	0.4	0.0	0.0	10.5	0.5	7.1	24.4	55.6	0.1	1.0	0.0	35979
1993	0.6	0.2	0.1	0.0	9.3	0.6	6.5	21.4	60.6	0.1	0.7	0.0	32719
1994	0.4	0.4	0.1	0.0	12.6	1.1	6.8	18.5	59.1	0.2	0.7	0.0	32406
1995	0.2	0.1	0.4	0.0	9.6	0.9	9.9	17.7	60.9	0.3	0.0	0.0	26918
1996	0.0	0.0	0.1	0.0	9.2	1.2	6.8	23.7	58.6	0.2	0.0	0.0	19267
1997	0.0	0.1	0.1	0.0	8.9	2.5	10.7	17.8	58.9	0.4	0.4	0.0	21721
1998	0.1	0.4	0.1	0.0	8.1	2.8	13.8	16.5	57.6	0.3	0.4	0.0	25995
1999	0.0	0.1	0.1	0.0	5.7	1.2	12.6	18.5	60.0	0.2	1.6	0.0	32439
2000	0.1	0.1	0.2	0.0	3.7	0.3	15.0	17.5	62.3	0.1	0.7	0.0	37859
2001	0.1	0.1	0.1	0.0	2.8	0.3	20.2	16.5	58.8	0.2	0.8	0.1	49676
2002	0.1	0.2	0.1	0.0	1.6	0.1	26.5	10.5	60.8	0.1	0.0	0.0	51028
2003	0.0	0.0	1.9	0.0	0.9	0.4	17.4	14.7	64.7	0.1	0.0	0.0	44338
2004	0.1	0.2	3.7	0.0	1.9	0.4	15.1	14.4	63.8	0.2	0.0	0.0	44605
2005	0.2	0.1	4.4	0.0	2.4	0.2	12.7	20.6	59.2	0.2	0.0	0.0	66134
2006	0.2	0.4	0.3	0.0	3.9	0.1	19.8	20.6	54.1	0.6	0.0	0.0	65394
2007	0.2	0.2	0.2	0.0	2.0	0.1	30.4	16.0	50.6	0.3	0.0	0.0	59711
2008	0.2	0.3	1.5	0.0	3.2	0.2	20.4	16.0	57.7	0.5	0.0	0.0	56552
Average	0.3	0.2	0.6	0.1	5.9	1.8	16.9	19.9	53.6	0.2	0.5	0.1	42741

Table 6.2.2.1. Faroe saithe (Division Vb). Catch number at age by fleet categories (calculated from gutted weights).

Age	Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000HP	Others	Total Faroese fleet	Foreign fleet	Total Division Vb
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	6	0	0	0	6	0	6
3	81	2126	487	1751	72	4517	109	4626
4	68	924	298	1678	47	3014	48	3062
5	65	698	710	2084	40	3597	36	3632
6	163	1650	1650	5812	118	9393	85	9478
7	69	494	679	2340	44	3626	25	3652
8	36	253	343	1597	30	2259	13	2272
9	33	213	477	1345	21	2090	11	2101
10	6	34	69	342	5	457	2	458
11	3	30	13	112	2	159	2	161
12	0	1	0	11	0	13	0	13
13	0	0	0	6	0	7	0	7
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
Total No.	524	6429	4724	17080	379	29137	331	29468
Catch, t.	999	10207	9655	34928	763	56552	473	57025

Table 6.2.2.2. Faroe saithe (Division Vb). Catch number at age (thousands) from the commercial fleet.

	Age											
YEAR	3	4	5	6	7	8	9	10	11	+gp	TOTNUM	SOP%
1961	183	379	483	403	216	129	116	82	45	82	2118	108
1962	562	542	617	495	286	131	129	113	71	105	3051	93
1963	614	340	340	415	406	202	174	158	94	274	3017	96
1964	684	1908	1506	617	572	424	179	150	100	174	6314	99
1965	996	850	1708	965	510	407	306	201	156	285	6384	92
1966	488	1540	1201	1686	806	377	294	205	156	225	6978	98
1967	595	796	1364	792	1192	473	217	190	97	140	5856	104
1968	614	1689	1116	1095	548	655	254	128	89	187	6375	102
1969	1191	2086	2294	1414	1118	589	580	239	115	190	9816	97
1970	1445	6577	1558	1478	899	730	316	241	86	132	13462	96
1971	2857	3316	5585	1005	828	469	326	164	100	100	14750	109
1972	2714	1774	2588	2742	1529	1305	1017	743	330	210	14952	100
1973	2515	6253	7075	3478	1634	693	550	403	215	186	23002	120
1974	3504	4126	4011	2784	1401	640	368	340	197	265	17636	113
1975	2062	3361	3801	1939	1045	714	302	192	193	298	13907	116
1976	3178	3217	1720	1250	877	641	468	223	141	287	12002	107
1977	1609	2937	2034	1288	767	708	498	338	272	330	10781	104
1978	611	1743	1736	548	373	479	466	473	407	535	7371	100
1979	287	933	1341	1033	584	414	247	473	368	691	6371	102
1980	996	877	720	673	726	284	212	171	196	786	5641	99
1981	411	1804	769	932	908	734	343	192	92	1021	7206	96
1982	387	4076	994	1114	380	417	296	105	88	902	8759	96
1983	2483	1103	5052	1343	575	339	273	98	98	540	11904	100
1984	368	11067	2359	4093	875	273	161	52	65	253	19566	100
1985	1224	3990	5583	1182	1898	273	103	38	26	275	14592	94
1986	1167	1997	4473	3730	953	1077	245	104	67	158	13971	94
1987	1581	5793	3827	2785	990	532	333	81	43	97	16062	96
1988	866	2950	9555	2784	1300	621	363	159	27	60	18685	99
1989	451	5981	5300	7136	793	546	185	83	55	39	20569	97
1990	294	3833	10120	9219	5070	477	123	61	60	79	29336	98
1991	1030	5125	7452	5544	3487	1630	405	238	128	118	25157	99
1992	521	4067	3667	2679	1373	894	613	123	63	108	14108	105
1993	1316	2611	4689	1665	858	492	448	245	54	52	12430	102
1994	690	3961	2663	2368	746	500	307	303	150	49	11737	102
1995	398	1019	3468	1836	1177	345	241	192	104	117	8897	102
1996	297	1087	1146	1449	1156	521	132	77	64	82	6011	103
1997	344	832	2440	1767	1335	624	165	71	29	100	7707	100
1998	163	1689	1934	3475	1379	683	368	77	32	73	9873	102
1999	322	655	3096	2551	4113	915	380	147	24	69	12272	102
2000	811	2830	1484	4369	2226	2725	348	186	56	25	15060	102
2001	1125	2452	8437	2155	3680	1539	1334	293	90	56	21161	100
2002	302	8399	5962	9786	862	1280	465	362	33	45	27496	100
2003	330	2432	11152	3994	4287	417	419	304	91	43	23469	100
2004	76	2011	8544	8762	2125	1807	265	293	146	112	24141	100
2005	454	2949	9490	16613	7102	843	810	32	102	30	38425	100
2006	1479	5060	7804	7735	10327	3771	642	283	32	29	37162	100
2007	830	3316	11292	6466	3777	4289	1536	406	81	23	32016	100
2008	4626	3062	3632	9478	3652	2272	2101	458	161	20	29462	100

Table 6.2.2.3. Faroe saithe (Division Vb). Sampling intensity in 2000-2008.

Year		Jiggers	Single trawlers >1000 HP	Pair trawlers <1000 HP	Pair trawlers >1000 HP	Others	Total	Amount sampled pr tonnes landed (%)
2000	Lengths	2443	2429	9910	28724		43506	10.7
	Otoliths	300	301	1019	2816		4436	
	Weights	300	241	959	2816		4316	
2001	Lengths	1788	4388	5613	30341		42130	7.7
	Otoliths	180	450	480	3237		4347	
	Weights	180	420	420	3177		4197	
2002	Lengths	1197	9235	5049	30761		46242	5.8
	Otoliths	120	1291	422	3001		4834	
	Weights	120	420	240	2760		3540	
2003	Lengths		4959	6393	34812	1388	47552	7.0
	Otoliths		719	960	3719	180	5578	
	Weights		420	239	2999		3658	
2004	Lengths	916	2665	3455	35609	1781	44426	5.9
	Otoliths	180	180	240	3537	240	4377	
	Weights	180	120	120	3357	1364	5141	
2005	Lengths	1048	4266	6183	32046	1564	45107	3.6
	Otoliths	120	413	690	2760	240	4223	
	Weights	340	385	791	3533	1564	6613	
2006	Lengths	1059	7979	8115	23082	1139	41374	3.5
	Otoliths	180	598	1138	2096	60	4072	
	Weights	180	60	1620	5678	812	8350	
2007	Lengths	683	10525	10593	18045	381	40227	4.1
	Otoliths	120	748	960	1977	0	3805	
	Weights	120	697	5603	9884	120	16424	
2008	Lengths	0	6892	3694	13995	234	24815	2.6
	Otoliths	0	690	600	1500	0	2790	
	Weights	0	0	2517	12914	234	15665	

Table 6.2.3.1. Faroe saithe (Division Vb). Catch weights at age (kg) from the commercial fleet.

	Age										
YEAR	3	4	5	6	7	8	9	10	11	+gp	SOP
1961	1.430	2.302	3.348	4.287	5.128	6.155	7.060	7.265	7.497	9.340	1.078
1962	1.273	2.045	3.293	4.191	5.146	5.655	6.469	6.706	7.150	9.024	0.934
1963	1.280	2.197	3.212	4.568	5.056	5.932	6.259	8.000	7.265	8.859	0.959
1964	1.175	2.055	3.266	4.255	5.038	5.694	6.662	6.837	7.686	8.559	0.993
1965	1.181	2.125	2.941	4.096	4.878	5.932	6.321	7.288	8.074	8.904	0.922
1966	1.361	2.026	3.055	3.658	4.585	5.520	6.837	7.265	7.662	9.223	0.977
1967	1.273	1.780	2.534	3.572	4.368	5.313	5.812	6.554	7.806	8.149	1.036
1968	1.302	1.737	2.036	3.120	4.049	5.183	6.238	7.520	8.049	9.093	1.019
1969	1.188	1.667	2.302	2.853	3.673	5.002	5.714	6.405	6.554	8.087	0.966
1970	1.244	1.445	2.249	2.853	3.515	4.418	5.444	5.733	6.662	8.584	0.963
1971	1.101	1.316	1.818	2.978	3.702	4.271	5.388	5.972	6.490	8.005	1.094
1972	1.043	1.485	2.055	2.829	3.791	4.175	4.808	5.294	6.948	7.515	1.004
1973	1.088	1.461	1.582	2.249	3.687	4.385	5.128	5.276	6.727	8.031	1.201
1974	1.430	1.525	2.207	2.500	3.120	4.601	5.559	5.714	6.259	8.010	1.130
1975	1.114	1.658	2.260	3.120	3.557	4.096	5.128	6.094	7.196	8.598	1.161
1976	1.088	1.676	2.878	3.081	4.287	4.352	4.790	5.912	6.619	7.894	1.068
1977	1.223	1.641	2.660	3.790	4.239	5.597	5.350	5.912	6.837	7.709	1.044
1978	1.493	2.324	3.068	3.746	4.913	4.368	5.276	5.832	6.053	7.576	1.005
1979	1.220	1.880	2.620	3.400	4.180	4.950	5.690	6.380	7.020	8.626	1.025
1980	1.230	2.120	3.320	4.280	5.160	6.420	6.870	7.090	7.930	9.215	0.994
1981	1.310	2.130	3.000	3.810	4.750	5.250	5.950	6.430	7.000	8.962	0.956
1982	1.337	1.851	2.951	3.577	4.927	6.243	7.232	7.239	8.346	10.041	0.963
1983	1.208	2.029	2.965	4.143	4.724	5.901	6.811	7.051	7.248	10.055	1.000
1984	1.431	1.953	2.470	3.850	5.177	6.347	7.825	6.746	8.636	10.098	0.999
1985	1.401	2.032	2.965	3.596	5.336	7.202	6.966	9.862	10.670	11.950	0.942
1986	1.718	1.986	2.618	3.277	4.186	5.589	6.050	6.150	9.536	10.218	0.942
1987	1.609	1.835	2.395	3.182	4.067	5.149	5.501	6.626	6.343	10.244	0.962
1988	1.500	1.975	1.978	2.937	3.798	4.419	5.115	6.712	9.040	9.337	0.993
1989	1.309	1.735	1.907	2.373	3.810	4.667	5.509	5.972	6.939	9.936	0.970
1990	1.223	1.633	1.830	2.052	2.866	4.474	5.424	6.469	6.343	8.287	0.981
1991	1.240	1.568	1.864	2.211	2.648	3.380	4.816	5.516	6.407	7.729	0.994
1992	1.264	1.602	2.069	2.554	3.057	4.078	5.012	6.768	7.754	8.230	1.051
1993	1.408	1.860	2.323	3.131	3.730	4.394	5.209	6.540	8.403	8.050	1.017
1994	1.503	1.951	2.267	2.936	4.214	4.971	5.657	5.950	6.891	9.109	1.024
1995	1.456	2.177	2.420	2.895	3.651	5.064	5.440	6.167	7.080	7.539	1.021
1996	1.432	1.875	2.496	3.229	3.744	4.964	6.375	6.745	7.466	7.981	1.032
1997	1.476	1.783	2.032	2.778	3.598	4.766	5.982	7.658	7.882	9.245	0.999
1998	1.388	1.711	1.954	2.405	3.300	4.220	4.999	6.391	6.665	8.485	1.022
1999	1.374	1.712	1.905	2.396	2.845	4.124	5.256	5.526	6.956	8.524	1.018
2000	1.477	1.606	2.077	2.360	2.977	3.480	4.851	5.268	6.523	5.902	1.015
2001	1.330	1.590	1.785	2.586	3.059	3.871	4.374	5.565	6.703	6.908	1.002
2002	1.142	1.460	1.652	1.969	3.130	3.589	4.513	5.138	6.422	7.519	1.000
2003	1.123	1.304	1.614	1.977	2.532	3.970	4.834	5.499	6.099	6.915	1.001
2004	1.143	1.333	1.450	1.789	2.560	3.159	4.154	5.167	6.015	6.321	1.004
2005	1.148	1.325	1.516	1.672	2.087	2.975	3.790	6.087	6.134	6.728	1.000
2006	1.126	1.218	1.462	1.790	2.035	2.436	3.861	4.222	5.149	6.446	0.997
2007	1.058	1.391	1.413	1.824	2.361	2.682	3.278	4.104	4.998	7.137	0.998
2008	1.146	1.312	1.672	1.816	2.395	2.902	3.100	3.728	4.769	6.205	1.000

Table 6.2.4.1. Faroe saithe (Division Vb). Proportion mature at age from the spring survey (three years running average).

	Age								
YEAR	3	4	5	6	7	8	9	10	11	+gp
1961	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1962	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1963	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1964	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1965	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1966	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1967	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1968	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1969	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1970	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1971	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1972	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1973	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1974	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1975	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1976	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1977	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1978	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1979	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1980	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1981	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1982	0.04	0.26	0.57	0.82	0.91	0.98	1.00	1.00	1.00	1.00
1983	0.00	0.28	0.63	0.99	1.00	1.00	1.00	1.00	1.00	1.00
1984	0.03	0.25	0.56	0.94	0.98	1.00	1.00	1.00	1.00	1.00
1985	0.04	0.37	0.71	0.92	0.98	1.00	1.00	1.00	1.00	1.00
1986	0.11	0.31	0.55	0.86	0.98	1.00	1.00	1.00	1.00	1.00
1987	0.11	0.32	0.59	0.83	0.97	0.97	1.00	1.00	1.00	1.00
1988	0.10	0.22	0.52	0.75	0.91	0.92	1.00	1.00	1.00	1.00
1989	0.03	0.20	0.57	0.67	0.83	0.92	1.00	1.00	1.00	1.00
1990	0.00	0.20	0.55	0.68	0.80	0.94	1.00	1.00	1.00	1.00
1991	0.00	0.16	0.44	0.70	0.83	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.17	0.47	0.78	0.89	1.00	1.00	1.00	1.00	1.00
1993	0.01	0.15	0.51	0.83	0.94	1.00	1.00	1.00	1.00	1.00
1994	0.04	0.18	0.66	0.86	0.96	1.00	1.00	1.00	1.00	1.00
1995	0.04	0.14	0.65	0.86	0.95	1.00	1.00	1.00	1.00	1.00
1996	0.02	0.13	0.59	0.80	0.94	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.13	0.43	0.64	0.87	0.99	1.00	1.00	1.00	1.00
1998	0.01	0.16	0.37	0.54	0.79	0.97	0.97	1.00	1.00	1.00
1999	0.03	0.20	0.35	0.52	0.74	0.92	0.97	1.00	1.00	1.00
2000	0.03	0.21	0.36	0.62	0.76	0.93	0.96	1.00	1.00	1.00
2001	0.02	0.20	0.36	0.60	0.75	0.91	0.97	1.00	1.00	1.00
2002	0.00	0.18	0.41	0.60	0.73	0.94	0.97	1.00	1.00	1.00
2003	0.00	0.15	0.37	0.51	0.67	0.87	0.99	1.00	1.00	1.00
2004	0.00	0.13	0.38	0.55	0.71	0.87	0.99	1.00	1.00	1.00
2005	0.00	0.17	0.35	0.56	0.71	0.85	0.97	1.00	1.00	1.00
2006	0.00	0.22	0.40	0.62	0.78	0.88	0.96	1.00	1.00	1.00
2007	0.00	0.25	0.43	0.65	0.84	0.91	0.97	1.00	1.00	1.00
2008	0.00	0.20	0.38	0.66	0.87	0.92	0.99	1.00	1.00	1.00

Table 6.4.1. Faroe saithe (Division Vb). Effort (hours) and catch in number at age for commercial pair trawlers.

Faroe Saithe (ICES Div. Vb) Allpair3-11sq4.dat

101

All pair (GLM) >1000 HP

1995 2008

1 1 0 1

3 11

6564	58	224	717	293	181	61	30	24	17
4543	68	211	180	246	111	62	29	28	15
6282	50	133	372	254	192	83	18	8	3
7185	33	199	349	451	222	99	52	12	4
10012	69	192	612	795	798	322	75	33	5
8712	144	519	303	895	442	532	64	35	10
9053	229	538	1851	436	694	280	231	48	11
9013	41	1241	1237	2150	162	213	77	55	8
10574	63	664	2917	1055	1006	88	94	55	16
6686	13	378	1604	1613	326	240	36	37	17
10482	85	537	1824	3281	1413	145	131	3	19
10085	72	609	1250	1340	1918	714	139	44	7
11701	110	475	1574	981	558	656	235	59	10
14652	543	520	646	1801	725	495	417	106	35

Table 6.4.2. Faroe saithe (Division Vb). Diagnostics from XSA with commercial pair trawler tuning series.

Lowestoft VPA Version 3.1
1/05/2009 11:38

Extended Survivors Analysis

FAROE SAITHE (ICES Division Vb) SAI_IND

CPUE data from file D:\Stovnsmeting\Ices2009\XSA\allpair3-11sq4.DAT

Catch data for 48 years. 1961 to 2008. Ages 3 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
All pair (GLM) >1000	1995	2008	3	11	0	1

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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 = 2.000

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

Prior weighting not applied

Tuning converged after 26 iterations

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.006	0.026	0.014	0.003	0.007	0.002	0.008	0.058	0.027	0.025
4	0.073	0.068	0.101	0.143	0.033	0.052	0.094	0.122	0.180	0.133
5	0.182	0.236	0.295	0.379	0.286	0.157	0.370	0.385	0.437	0.305
6	0.303	0.422	0.641	0.665	0.473	0.382	0.517	0.590	0.644	0.827
7	0.499	0.474	0.776	0.578	0.705	0.500	0.616	0.722	0.653	0.978
8	0.643	0.743	0.719	0.691	0.620	0.749	0.377	0.804	0.770	1.128
9	0.629	0.544	1.075	0.492	0.507	1.098	0.942	0.556	0.952	1.186
10	0.722	0.741	1.357	1.021	0.707	0.830	0.349	1.103	0.854	0.865
11	0.638	0.679	1.045	0.505	0.788	0.924	0.799	0.715	1.216	1.060

XSA population numbers (Thousands)

AGE

YEAR	3	4	5	6	7	8	9	10	11
1999	58600	10200	20600	10800	11600	2130	900	316	56
2000	35400	47700	7790	14000	6510	5750	917	393	126
2001	86600	28200	36500	5030	7530	3320	2240	436	153
2002	101000	69900	20900	22300	2170	2840	1320	625	92
2003	53700	82000	49600	11700	9370	998	1160	663	184
2004	44300	43700	65000	30500	5970	3790	439	574	268
2005	59900	36200	33900	45500	17100	2960	1470	120	205
2006	28900	48600	27000	19200	22200	7550	1660	468	69
2007	34100	22300	35200	15000	8710	8820	2770	781	127
2008	204000	27200	15300	18600	6470	3710	3340	874	272

Estimated population abundance at 1st Jan 2009

	0	163000	19500	9200	6670	1990	984	836	301

Taper weighted geometric mean of the VPA populations:

	27600	20200	13600	8100	4340	2300	1210	621	320

Standard error of the weighted Log(VPA populations) :

	0.6376	0.6024	0.6391	0.6395	0.611	0.6006	0.6575	0.7987	0.9688

Log catchability residuals.

Fleet : All pair (GLM) >1000

Age	1995	1996	1997	1998
3	0.19	1.18	0.23	0.65
4	0.59	0	-0.31	-0.35
5	0.86	-0.13	-0.66	-0.36
6	0	0.13	-0.28	-0.82
7	0.33	-0.15	-0.04	-0.15
8	0.22	0.44	-0.19	-0.26
9	0.15	0.64	-0.16	0.03
10	-0.41	1.45	-0.2	0.24
11	0.01	0.09	-0.18	-0.19

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	-0.48	0.91	0.44	-1.43	-0.53	-1.47	-0.33	0.29	0.38	-0.04
4	0.25	-0.16	0.38	0.34	-0.66	-0.13	-0.02	-0.14	0.27	-0.08
5	-0.41	0.02	0.27	0.47	0.26	-0.21	0.22	0.11	-0.05	-0.39
6	-0.04	0	0.37	0.49	0.18	0.06	-0.02	0.02	-0.17	0.07
7	-0.21	-0.1	0.3	0.01	0.26	-0.04	-0.02	0.1	-0.38	0.09
8	0.5	0.19	0.05	-0.08	-0.11	0.08	-0.79	0.09	-0.31	0.19
9	-0.11	-0.18	0.39	-0.42	-0.24	0.48	0.05	-0.14	-0.11	0.15
10	0.16	0.15	0.57	0.22	-0.13	0.13	-1.48	0.2	-0.26	-0.01
11	-0.04	0.01	0.02	-0.01	-0.05	0.15	0.03	0.12	-0.08	0.13

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	9	10	11
Mean Log q	-15.3774	-13.3068	-12.1261	-11.5328	-11.3433	-11.2053	-11.2053	-11.2053	-11.2053
S.E(Log q)	0.7847	0.336	0.4034	0.3055	0.2015	0.3318	0.2997	0.6276	0.1042

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	2.26	-1.902	21.21	0.16	14	1.62	-15.38
4	1.39	-1.953	14.47	0.67	14	0.42	-13.31
5	1.01	-0.07	12.15	0.7	14	0.43	-12.13
6	1.05	-0.331	11.63	0.81	14	0.33	-11.53
7	1.02	-0.215	11.39	0.92	14	0.21	-11.34
8	1.1	-0.701	11.53	0.81	14	0.37	-11.21
9	1.13	-1.057	11.73	0.84	14	0.34	-11.17
10	0.96	0.168	10.93	0.55	14	0.62	-11.16
11	0.91	2.537	10.61	0.98	14	0.08	-11.21

Terminal year survivor and F summaries :

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	157539	0.812	0	0	1	0.855	0.026
F shrinkage mean	201354	2				0.145	0.021

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
163233	0.75	0.09	2	0.124	0.025

Age 4 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
All pair (GLM) >1000	19293	0.32	0.167	0.52	2	0.972	0.134
F shrinkage mean	27313	2				0.028	0.097

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19485	0.32	0.12	3	0.39	0.133

Age 5 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
All pair (GLM) >1000	9222	0.255	0.231	0.91	3	0.976	0.305
F shrinkage mean	8438	2				0.024	0.329

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9203	0.25	0.19	4	0.736	0.305

Age 6 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
All pair (GLM) >1000	6545	0.205	0.064	0.31	4	0.971	0.837

F shrinkage mean	12407	2				0.029	0.525

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6667	0.21	0.08	5	0.373	0.827

Age 7 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
All pair (GLM) >1000	1955	0.183	0.124	0.68	5	0.97	0.99
F shrinkage mean	3648	2				0.03	0.645

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1992	0.19	0.12	6	0.638	0.978

Age 8 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
All pair (GLM) >1000	955	0.178	0.112	0.63	6	0.963	1.148
F shrinkage mean	2153	2				0.037	0.67

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
984	0.19	0.12	7	0.636	1.128

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	817	0.182	0.108	0.59	7	0.96	1.202
F shrinkage mean	1498	2				0.04	0.819

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
836	0.19	0.11	8	0.564	1.186

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	298	0.204	0.042	0.21	8	0.945	0.871
F shrinkage mean	353	2				0.055	0.776

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
301	0.22	0.04	9	0.185	0.865

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	77	0.192	0.096	0.5	9	0.962	1.06
F shrinkage mean	76	2				0.038	1.072

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
77	0.2	0.09	10	0.446	1.06

Table 6.4.3. Faroe saithe (Division Vb). Fishing mortality (F) at age.

	Age									
YEAR	3	4	5	6	7	8	9	10	11	+gp	FBAR 4- 8
1961	0.023	0.056	0.099	0.121	0.093	0.085	0.096	0.091	0.091	0.091	0.091
1962	0.047	0.086	0.121	0.140	0.119	0.075	0.114	0.128	0.106	0.106	0.108
1963	0.031	0.036	0.072	0.111	0.163	0.115	0.135	0.199	0.150	0.150	0.099
1964	0.048	0.126	0.219	0.179	0.220	0.255	0.141	0.164	0.187	0.187	0.200
1965	0.050	0.077	0.159	0.213	0.221	0.241	0.296	0.233	0.257	0.257	0.182
1966	0.025	0.101	0.149	0.232	0.277	0.252	0.275	0.331	0.286	0.286	0.202
1967	0.025	0.052	0.122	0.138	0.255	0.260	0.225	0.287	0.257	0.257	0.165
1968	0.032	0.091	0.095	0.135	0.134	0.217	0.217	0.201	0.212	0.212	0.135
1969	0.033	0.145	0.172	0.168	0.199	0.208	0.304	0.325	0.279	0.279	0.178
1970	0.048	0.254	0.154	0.159	0.153	0.194	0.164	0.199	0.186	0.186	0.183
1971	0.089	0.148	0.357	0.140	0.126	0.112	0.124	0.120	0.119	0.119	0.176
1972	0.094	0.073	0.165	0.297	0.327	0.298	0.373	0.455	0.375	0.375	0.232
1973	0.128	0.322	0.456	0.347	0.290	0.241	0.197	0.247	0.228	0.228	0.331
1974	0.230	0.317	0.354	0.326	0.229	0.176	0.195	0.180	0.183	0.183	0.280
1975	0.151	0.359	0.543	0.289	0.195	0.175	0.118	0.148	0.147	0.147	0.312
1976	0.206	0.370	0.315	0.343	0.205	0.176	0.166	0.120	0.154	0.154	0.282
1977	0.148	0.298	0.424	0.413	0.366	0.253	0.202	0.173	0.209	0.209	0.351
1978	0.084	0.237	0.289	0.192	0.200	0.411	0.263	0.300	0.325	0.325	0.266
1979	0.038	0.178	0.290	0.279	0.321	0.357	0.386	0.466	0.403	0.403	0.285
1980	0.093	0.154	0.203	0.231	0.322	0.255	0.312	0.507	0.358	0.358	0.233
1981	0.014	0.242	0.197	0.438	0.555	0.630	0.556	0.517	0.568	0.568	0.412
1982	0.029	0.184	0.204	0.482	0.320	0.538	0.566	0.327	0.477	0.477	0.346
1983	0.070	0.107	0.364	0.466	0.495	0.527	0.838	0.370	0.578	0.578	0.392
1984	0.016	0.496	0.346	0.567	0.636	0.464	0.515	0.368	0.449	0.449	0.502
1985	0.063	0.238	0.504	0.293	0.567	0.415	0.319	0.217	0.317	0.317	0.403
1986	0.021	0.140	0.456	0.760	0.406	0.748	0.823	0.617	0.729	0.729	0.502
1987	0.037	0.140	0.429	0.578	0.463	0.418	0.548	0.727	0.564	0.564	0.406
1988	0.022	0.090	0.358	0.644	0.590	0.599	0.565	0.554	0.573	0.573	0.456
1989	0.018	0.207	0.231	0.497	0.380	0.533	0.356	0.240	0.376	0.376	0.370
1990	0.016	0.206	0.639	0.793	0.813	0.414	0.216	0.190	0.273	0.273	0.573
1991	0.047	0.417	0.770	0.905	0.817	0.681	0.753	0.833	0.756	0.756	0.718
1992	0.030	0.265	0.599	0.713	0.593	0.507	0.595	0.542	0.548	0.548	0.535
1993	0.064	0.207	0.555	0.606	0.524	0.439	0.518	0.507	0.488	0.488	0.466
1994	0.047	0.275	0.336	0.611	0.609	0.672	0.544	0.817	0.677	0.677	0.500
1995	0.012	0.091	0.412	0.409	0.714	0.641	0.826	0.798	0.755	0.755	0.453
1996	0.014	0.039	0.140	0.302	0.491	0.825	0.545	0.697	0.689	0.689	0.360
1997	0.012	0.048	0.116	0.332	0.504	0.540	0.687	0.646	0.624	0.624	0.308
1998	0.015	0.072	0.151	0.241	0.469	0.526	0.721	0.826	0.691	0.691	0.292
1999	0.006	0.074	0.181	0.303	0.496	0.660	0.635	0.725	0.673	0.673	0.343
2000	0.026	0.068	0.238	0.417	0.473	0.730	0.570	0.753	0.685	0.685	0.385
2001	0.015	0.102	0.296	0.643	0.754	0.710	1.022	1.510	1.081	1.081	0.501
2002	0.003	0.143	0.380	0.663	0.582	0.653	0.483	0.894	0.677	0.677	0.484
2003	0.007	0.034	0.287	0.474	0.699	0.629	0.461	0.682	0.590	0.590	0.425
2004	0.002	0.053	0.158	0.384	0.501	0.736	1.120	0.689	0.848	0.848	0.366
2005	0.009	0.095	0.372	0.519	0.618	0.379	0.900	0.369	0.550	0.550	0.397
2006	0.059	0.123	0.387	0.592	0.724	0.805	0.559	0.974	0.779	0.779	0.526
2007	0.027	0.180	0.440	0.647	0.656	0.774	0.951	0.856	0.860	0.860	0.539
2008	0.052	0.133	0.305	0.827	0.978	1.128	1.186	0.865	1.060	1.060	0.674
FBAR	0.046	0.145	0.377	0.689	0.786	0.902	0.898	0.898	0.900		

Table 6.4.4. Faroe saithe (Division Vb). Stock number at age (start of year) (Thousands).

	Age										
YEAR	3	4	5	6	7	8	9	10	11	+gp	TOTAL
1961	9032	7722	5631	3884	2685	1750	1391	1042	572	1043	34753
1962	13619	7230	5980	4175	2816	2004	1316	1034	779	1153	40106
1963	22363	10643	5430	4340	2972	2048	1522	961	745	2170	53195
1964	16181	17755	8407	4139	3179	2067	1495	1090	645	1122	56080
1965	22750	12630	12816	5528	2833	2088	1311	1062	757	1383	63158
1966	21787	17727	9574	8954	3657	1861	1343	798	689	994	67384
1967	26822	17397	13125	6756	5814	2269	1184	835	470	678	75350
1968	21451	21423	13525	9516	4818	3688	1433	774	513	1078	78219
1969	40612	17008	16016	10067	6804	3451	2430	944	519	857	98707
1970	34010	32175	12045	11047	6968	4564	2295	1468	558	857	105988
1971	37084	26541	20426	8458	7713	4895	3079	1594	985	985	111760
1972	33414	27785	18742	11708	6019	5568	3585	2227	1157	737	110942
1973	23106	24909	21148	13013	7121	3554	3386	2022	1157	1001	100418
1974	18771	16650	14775	10971	7530	4361	2287	2277	1293	1739	80655
1975	16196	12215	9925	8495	6481	4905	2994	1541	1558	2405	66714
1976	18780	11402	6983	4723	5212	4365	3372	2179	1088	2216	60321
1977	12842	12515	6447	4171	2744	3478	2997	2340	1583	1921	51037
1978	8357	9064	7607	3454	2260	1558	2210	2005	1611	2118	40243
1979	8568	6291	5853	4667	2334	1514	846	1391	1217	2284	34964
1980	12346	6755	4310	3586	2892	1386	868	471	715	2865	36195
1981	33021	9210	4741	2881	2331	1716	880	520	232	2577	58107
1982	15097	26664	5918	3189	1523	1095	748	413	254	2602	57503
1983	40553	12011	18160	3950	1613	905	523	348	244	1344	79650
1984	25707	30961	8839	10332	2030	805	438	185	197	766	80260
1985	21951	20715	15434	5118	4796	880	414	214	105	1111	70738
1986	61015	16867	13370	7635	3128	2228	476	247	141	333	105439
1987	47828	48901	12010	6936	2923	1706	863	171	109	246	121694
1988	43912	37731	34816	6401	3187	1506	919	409	68	150	129099
1989	28201	35170	28231	19925	2752	1446	677	428	192	136	117159
1990	20451	22682	23411	18344	9920	1541	695	388	276	363	98071
1991	24553	16478	15120	10121	6799	3602	834	458	263	243	78471
1992	19369	19172	8894	5732	3352	2458	1493	321	163	280	61236
1993	23544	15388	12039	4002	2301	1516	1212	674	153	147	60977
1994	16526	18089	10248	5660	1787	1116	800	591	333	109	55259
1995	38468	12908	11248	5998	2516	796	467	380	214	241	73236
1996	24122	31136	9649	6098	3263	1009	343	167	140	180	76108
1997	33305	19481	24510	6867	3690	1636	362	163	68	235	90319
1998	12530	26957	15199	17868	4035	1825	781	149	70	160	79573
1999	58131	10111	20547	10701	11502	2067	883	311	53	154	114461
2000	35043	47303	7688	14034	6469	5732	875	383	123	55	117705
2001	85757	27959	36175	4959	7571	3301	2261	405	148	92	168626
2002	99379	69196	20679	22033	2134	2915	1328	666	73	100	218504
2003	53062	81092	49084	11579	9295	976	1243	671	223	105	207330
2004	43822	43145	64197	30160	5900	3782	426	642	278	213	192566
2005	59167	35810	33509	44862	16828	2927	1484	114	264	78	195043
2006	28687	48032	26659	18915	21851	7428	1640	494	64	58	153828
2007	34000	22152	34764	14822	8567	8672	2719	768	153	43	126660
2008	100078	27087	15150	18336	6356	3639	3275	860	267	33	175082
2009	0	77762	19417	9139	6566	1957	964	819	297	85	117007
GMST 61-**	26053	19835	13222	7779	4192	2183	1146	604	321		
AMST 61-**	30680	23891	16286	9695	5138	2572	1400	825	501		

Table 6.4.5. Faroe saithe (Division Vb). Summary table.

	R (Age 3)	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1961	9032	122159	84047	9592	0.1141	0.0907
1962	13619	126558	85825	10454	0.1218	0.1080
1963	22363	158306	100859	12693	0.1258	0.0993
1964	16181	160324	98419	21893	0.2224	0.2000
1965	22750	174701	107272	22181	0.2068	0.1821
1966	21787	184036	108806	25563	0.2349	0.2020
1967	26822	181502	104636	21319	0.2037	0.1653
1968	21451	189683	116011	20387	0.1757	0.1345
1969	40612	214702	123787	27437	0.2216	0.1783
1970	34010	224052	129102	29110	0.2255	0.1828
1971	37084	227929	139397	32706	0.2346	0.1764
1972	33414	236417	147387	42663	0.2895	0.2318
1973	23106	209953	136561	57431	0.4206	0.3314
1974	18771	203579	137545	47188	0.3431	0.2804
1975	16196	187008	137809	41576	0.3017	0.3120
1976	18780	169263	121855	33065	0.2713	0.2818
1977	12842	155790	113860	34835	0.3059	0.3509
1978	8357	136872	95807	28138	0.2937	0.2658
1979	8568	112662	83398	27246	0.3267	0.2848
1980	12346	124362	88748	25230	0.2843	0.2331
1981	33021	141447	76135	30103	0.3954	0.4122
1982	15097	149398	83124	30964	0.3725	0.3457
1983	40553	177824	91204	39176	0.4295	0.3916
1984	25707	188594	95357	54665	0.5733	0.5020
1985	21951	188335	117039	44605	0.3811	0.4032
1986	61015	233029	97106	41716	0.4296	0.5021
1987	47828	247287	101612	40020	0.3939	0.4057
1988	43912	256271	99488	45285	0.4552	0.4562
1989	28201	225264	99565	44477	0.4467	0.3696
1990	20451	188897	96830	61628	0.6365	0.5728
1991	24553	147129	69423	54858	0.7902	0.7179
1992	19369	121739	57663	36487	0.6328	0.5354
1993	23544	130709	57214	33543	0.5863	0.4661
1994	16526	124382	61071	33182	0.5433	0.5003
1995	38468	150125	59772	27209	0.4552	0.4532
1996	24122	159722	60535	20029	0.3309	0.3595
1997	33305	179976	63538	22306	0.3511	0.3079
1998	12530	163880	66297	26421	0.3985	0.2916
1999	58131	211253	72850	33207	0.4558	0.3430
2000	35043	223411	84198	39020	0.4634	0.3854
2001	85757	285611	84580	51786	0.6123	0.5010
2002	99379	319842	83390	53546	0.6421	0.4843
2003	53062	306641	87713	46555	0.5308	0.4245
2004	43822	289801	101731	46355	0.4557	0.3662
2005	59167	293468	108477	68008	0.6269	0.3967
2006	28687	235323	108931	67103	0.6160	0.5263
2007	34000	199566	97426	60819	0.6243	0.5393
2008	100078	249479	76407	57025	0.7463	0.6743
2009	**33537**	**218909**	**71131**	**46304**	**0.6510**	**0.5799**
2010	**33537**	**206098**	**77960**	**52493**	**0.6733**	**0.5799**
2011	**33537**	**179479**	**74917**			
Arith. Mean	32195	193506	96246	37100	0.4021	0.3526
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.7.1.1. Faroe saithe (Division Vb). Input data for prediction with management options (recruitment for year classes 2006 to 2008 is geometric mean of year 1980 to 2008)

MFDP version 1a

Run: man5

Time and date: 19:21 02/05/2009

Fbar age range: 4-8

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	33537	0.2	0.00	0	0	1.146	0.05	1.146
4	77762	0.2	0.19	0	0	1.312	0.15	1.312
5	19417	0.2	0.43	0	0	1.672	0.38	1.672
6	9139	0.2	0.68	0	0	1.816	0.69	1.816
7	6566	0.2	0.88	0	0	2.395	0.79	2.395
8	1957	0.2	0.95	0	0	2.902	0.90	2.902
9	964	0.2	1.00	0	0	3.100	0.90	3.100
10	819	0.2	1.00	0	0	3.728	0.90	3.728
11	297	0.2	1.00	0	0	4.769	0.90	4.769
12	85	0.2	1.00	0	0	6.205	0.90	6.205

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	33537	0.2	0.00	0	0	1.146	0.05	1.146
4	.	0.2	0.21	0	0	1.312	0.15	1.312
5	.	0.2	0.41	0	0	1.672	0.38	1.672
6	.	0.2	0.66	0	0	1.816	0.69	1.816
7	.	0.2	0.86	0	0	2.395	0.79	2.395
8	.	0.2	0.93	0	0	2.902	0.90	2.902
9	.	0.2	0.99	0	0	3.100	0.90	3.100
10	.	0.2	1.00	0	0	3.728	0.90	3.728
11	.	0.2	1.00	0	0	4.769	0.90	4.769
12	.	0.2	1.00	0	0	6.205	0.90	6.205

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	33537	0.2	0.00	0	0	1.146	0.05	1.146
4	.	0.2	0.21	0	0	1.312	0.15	1.312
5	.	0.2	0.41	0	0	1.672	0.38	1.672
6	.	0.2	0.66	0	0	1.816	0.69	1.816
7	.	0.2	0.86	0	0	2.395	0.79	2.395
8	.	0.2	0.93	0	0	2.902	0.90	2.902
9	.	0.2	0.99	0	0	3.100	0.90	3.100
10	.	0.2	1.00	0	0	3.728	0.90	3.728
11	.	0.2	1.00	0	0	4.769	0.90	4.769
12	.	0.2	1.00	0	0	6.205	0.90	6.205

Input units are thousands and kg - output in tonnes

Table 6.7.2.1. Faroe saithe (Division Vb). Prediction with management option, recruitment for year classe 2006 to 2008 is geometric mean of year 1980 to 2008.

MFDP version 1a

Run: man5

Index file 2/5/2009

Time and date: 19:21 02/05/2009

Fbar age range: 4-8

2009

Biomass	SSB	FMult	FBar	Landings
218909	71131	1.0000	0.5799	46304

2010					**2011**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
206098	77960	0.0000	0.0000	0	234003	114759
.	77960	0.1000	0.0580	6485	227202	109667
.	77960	0.2000	0.1160	12649	220752	104867
.	77960	0.3000	0.1740	18512	214631	100338
.	77960	0.4000	0.2320	24092	208820	96064
.	77960	0.5000	0.2900	29406	203300	92028
.	77960	0.6000	0.3480	34469	198052	88215
.	77960	0.7000	0.4060	39296	193061	84610
.	77960	0.8000	0.4639	43900	188311	81200
.	77960	0.9000	0.5219	48296	183788	77972
.	77960	1.0000	0.5799	52493	179479	74917
.	77960	1.1000	0.6379	56504	175370	72021
.	77960	1.2000	0.6959	60339	171452	69277
.	77960	1.3000	0.7539	64008	167712	66674
.	77960	1.4000	0.8119	67519	164141	64204
.	77960	1.5000	0.8699	70882	160728	61859
.	77960	1.6000	0.9279	74105	157466	59631
.	77960	1.7000	0.9859	77194	154346	57514
.	77960	1.8000	1.0439	80157	151360	55500
.	77960	1.9000	1.1019	83001	148501	53584
.	77960	2.0000	1.1599	85732	145762	51761

Input units are thousands and kg - output in tonnes

Table 6.8.1.1. Faroe saithe (Division Vb). Yield per recruit input data.

MFYPR version 2a

Run: man5

Index file 2/5/2009

Time and date: 19:35 02/05/2009

Fbar age range: 3-12

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.023	0	0	1.292	0.03	1.292
4	0.2	0.202	0	0	1.758	0.12	1.758
5	0.2	0.482	0	0	2.328	0.33	2.328
6	0.2	0.712	0	0	3.011	0.59	3.011
7	0.2	0.854	0	0	3.826	0.70	3.826
8	0.2	0.950	0	0	4.714	0.76	4.714
9	0.2	0.989	0	0	5.514	0.94	5.514
10	0.2	1.000	0	0	6.257	0.75	6.257
11	0.2	1.000	0	0	7.102	0.82	7.102
12	0.2	1.000	0	0	8.398	0.82	8.398

Weights in kilograms

Table 6.8.1.2. Faroe saithe (Division Vb). Yield per recruit, summary table.

MFYPR version 2a
Run: man5
Time and date: 19:35 02/05/2009
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	21.6940	3.2941	17.6438	3.2941	17.6438
0.1000	0.0587	0.1724	0.8253	4.6584	15.5683	2.4606	11.5990	2.4606	11.5990
0.2000	0.1173	0.2702	1.1650	4.1731	12.3905	1.9984	8.4952	1.9984	8.4952
0.3000	0.1760	0.3342	1.3222	3.8562	10.4837	1.7028	6.6563	1.7028	6.6563
0.4000	0.2346	0.3801	1.3999	3.6298	9.2266	1.4965	5.4616	1.4965	5.4616
0.5000	0.2933	0.4150	1.4394	3.4580	8.3399	1.3436	4.6328	1.3436	4.6328
0.6000	0.3519	0.4427	1.4595	3.3218	7.6820	1.2252	4.0285	1.2252	4.0285
0.7000	0.4106	0.4655	1.4691	3.2102	7.1738	1.1304	3.5702	1.1304	3.5702
0.8000	0.4692	0.4847	1.4728	3.1165	6.7685	1.0526	3.2116	1.0526	3.2116
0.9000	0.5279	0.5012	1.4732	3.0362	6.4368	0.9873	2.9236	0.9873	2.9236
1.0000	0.5865	0.5156	1.4717	2.9662	6.1594	0.9317	2.6874	0.9317	2.6874
1.1000	0.6452	0.5284	1.4691	2.9044	5.9233	0.8835	2.4900	0.8835	2.4900
1.2000	0.7038	0.5398	1.4658	2.8492	5.7194	0.8414	2.3226	0.8414	2.3226
1.3000	0.7625	0.5501	1.4622	2.7994	5.5409	0.8042	2.1787	0.8042	2.1787
1.4000	0.8211	0.5594	1.4584	2.7542	5.3830	0.7709	2.0537	0.7709	2.0537
1.5000	0.8798	0.5680	1.4546	2.7128	5.2421	0.7411	1.9440	0.7411	1.9440
1.6000	0.9384	0.5759	1.4508	2.6748	5.1153	0.7141	1.8469	0.7141	1.8469
1.7000	0.9971	0.5833	1.4470	2.6395	5.0003	0.6895	1.7603	0.6895	1.7603
1.8000	1.0557	0.5901	1.4434	2.6067	4.8954	0.6670	1.6826	0.6670	1.6826
1.9000	1.1144	0.5965	1.4399	2.5761	4.7991	0.6463	1.6123	0.6463	1.6123
2.0000	1.1730	0.6025	1.4365	2.5474	4.7104	0.6272	1.5485	0.6272	1.5485

Reference point	F multiplier	Absolute F
Fbar(3-12)	1.0000	0.5865
FMax	0.8649	0.5073
F0.1	0.2724	0.1598
F35%SPR	0.3356	0.1969
Flow	0.2028	0.1189
Fmed	0.7327	0.4298
Fhigh	2.187	1.2827

Weights in kilograms

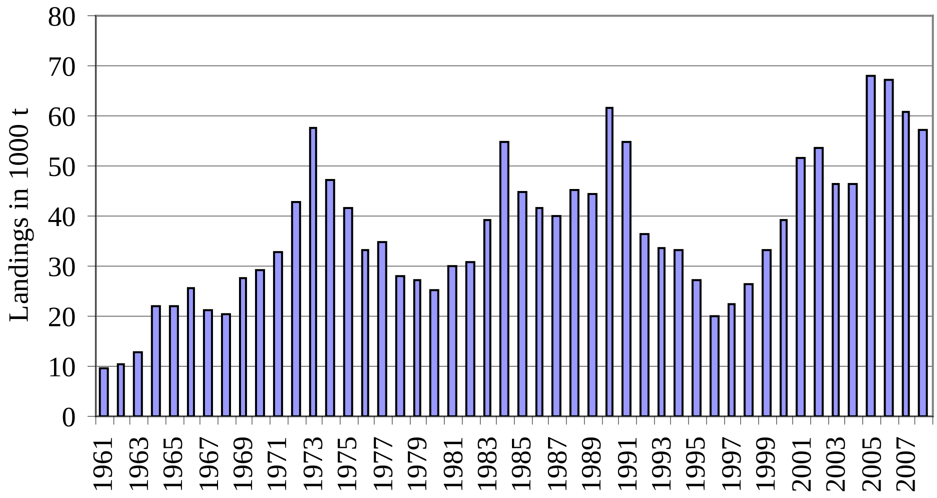

Figure 6.2.1.1. Faroe saithe (Division Vb). Landings in 1000 tonnes.

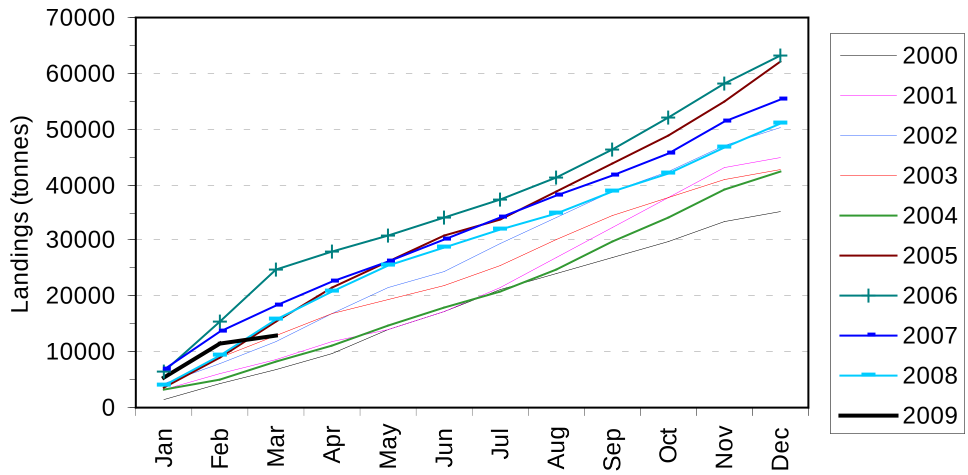

Figure 6.2.1.2. Saithe in the Faroes (Division Vb). Cumulative Faroese landings.

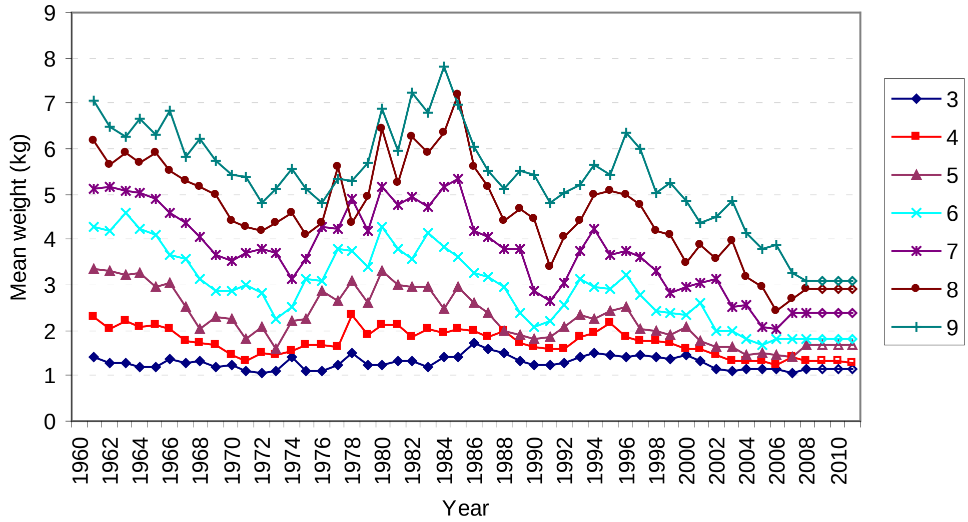

Figure 6.2.3.1. Faroe saithe (Division Vb). Mean weight at age (kg) in the commercial catches for the period 1961-2008. 2009-2011 values are predicted.

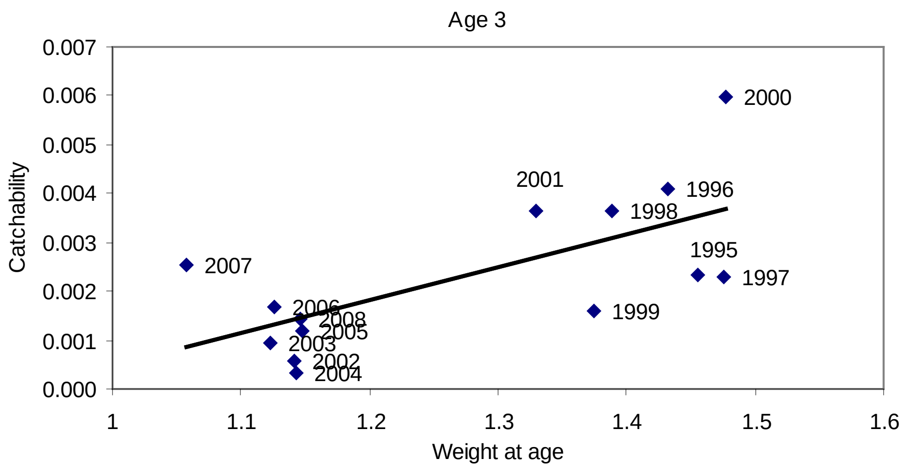

Figure 6.2.3.2. Faroe saithe (Division Vb). Relation between weight at age and catchability at age 3.

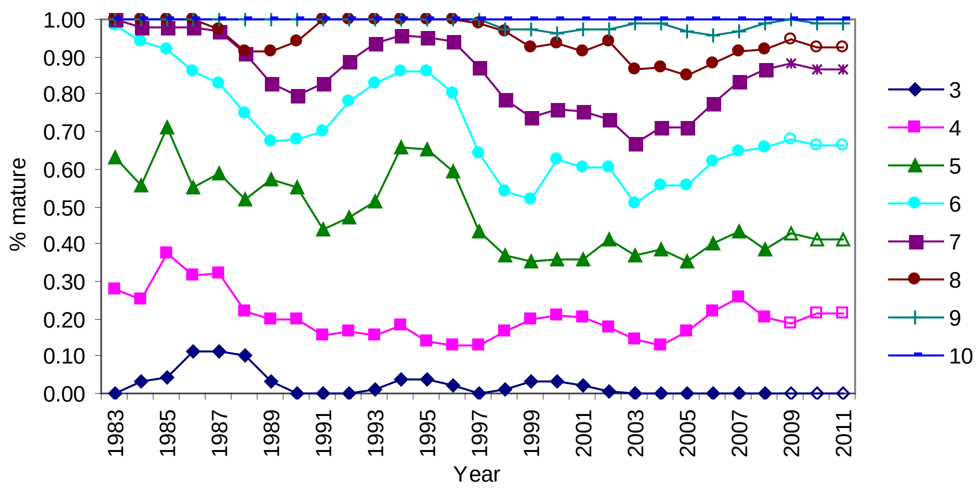

Figure 6.2.4.1. Faroe saithe (Division Vb). Three years running average of proportion mature at age from the spring survey for the period 1983-2008. 2009-2011 values are predicted.

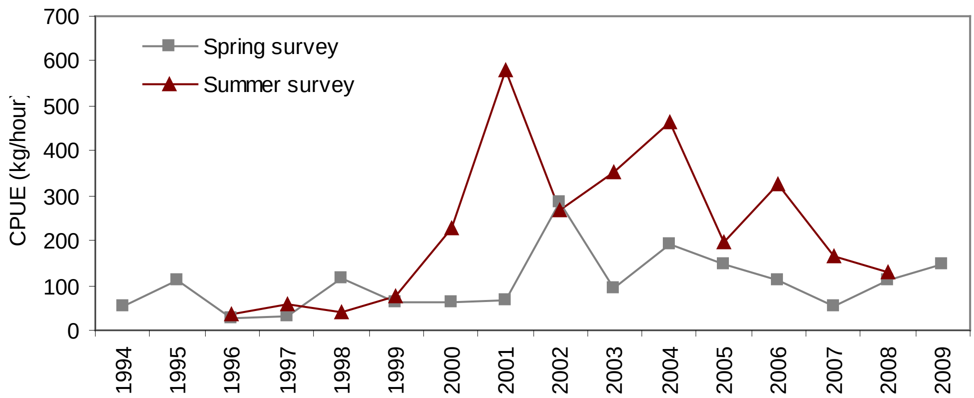

Figure 6.2.5.1.1. Faroe saithe (Division Vb). CPUE (kg/hour) from the spring- and summer surveys.

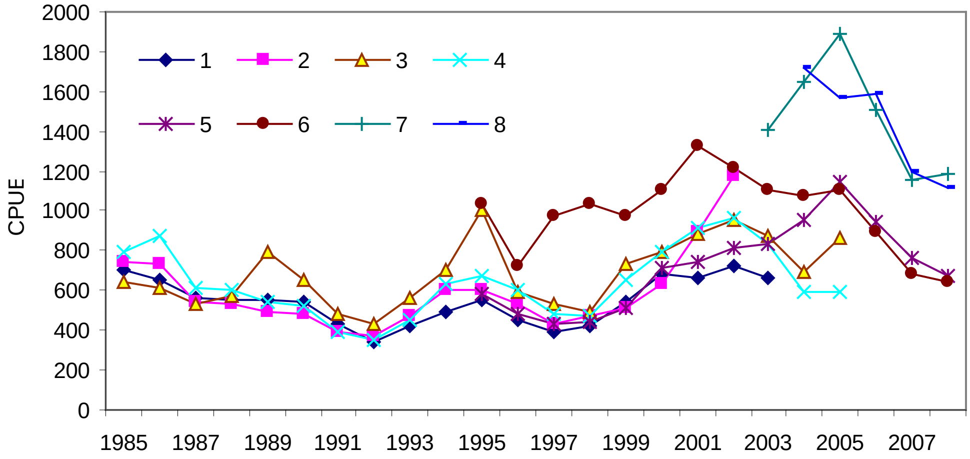

Figure 6.2.5.2.1 Faroe saithe (Division Vb). CPUE from the different pairs of pairtrawlers used in tuning series. Pair 7 and 8 are the new trawlers in the extended tuningseries.

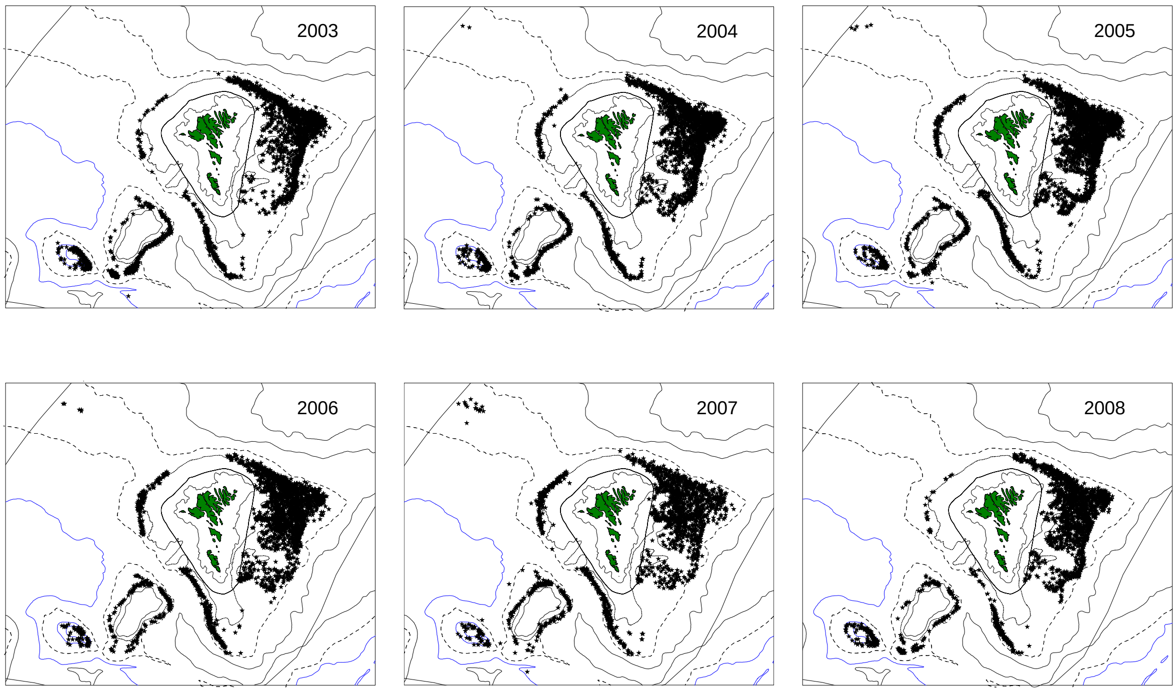

Figure 6.2.5.2.2. Faroe saithe (Division Vb). Distribution of saithe hauls from the pair trawlers in extended tuningseries.

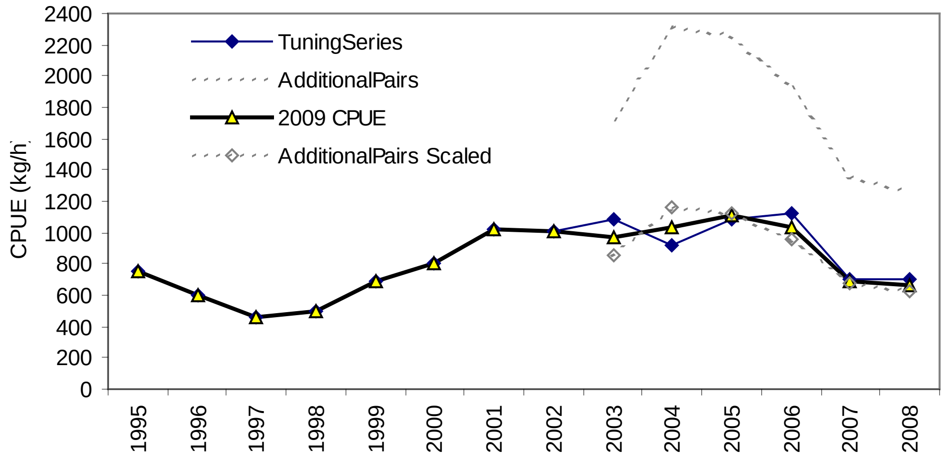

Figure 6.2.5.2.3. Faroe saithe (Division Vb). CPUE (kg/hour) from the commercial pair trawlers. Pair trawlers CPUE scaled (used in this years XSA).

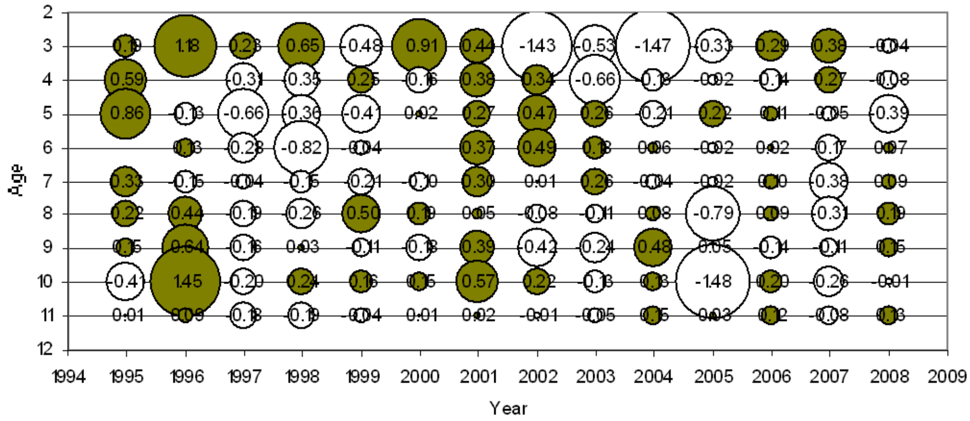

Figure 6.4.1. Faroe saithe (Division Vb). Log catchability residuals for age groups 3 –11 from XSA.

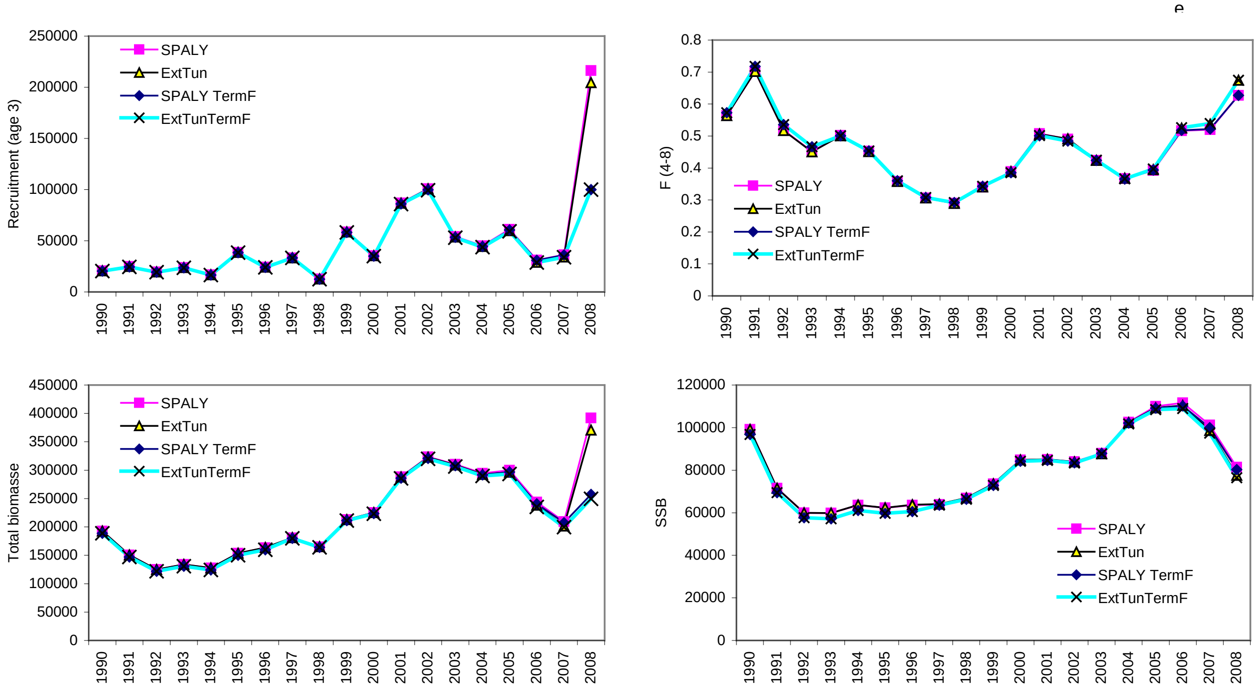

Figure 6.4.2. Faroe saithe (Division Vb). Comparison of output values from XSA before and after recruitment 2008 age 3 was adjusted down to the highest previosly observed.

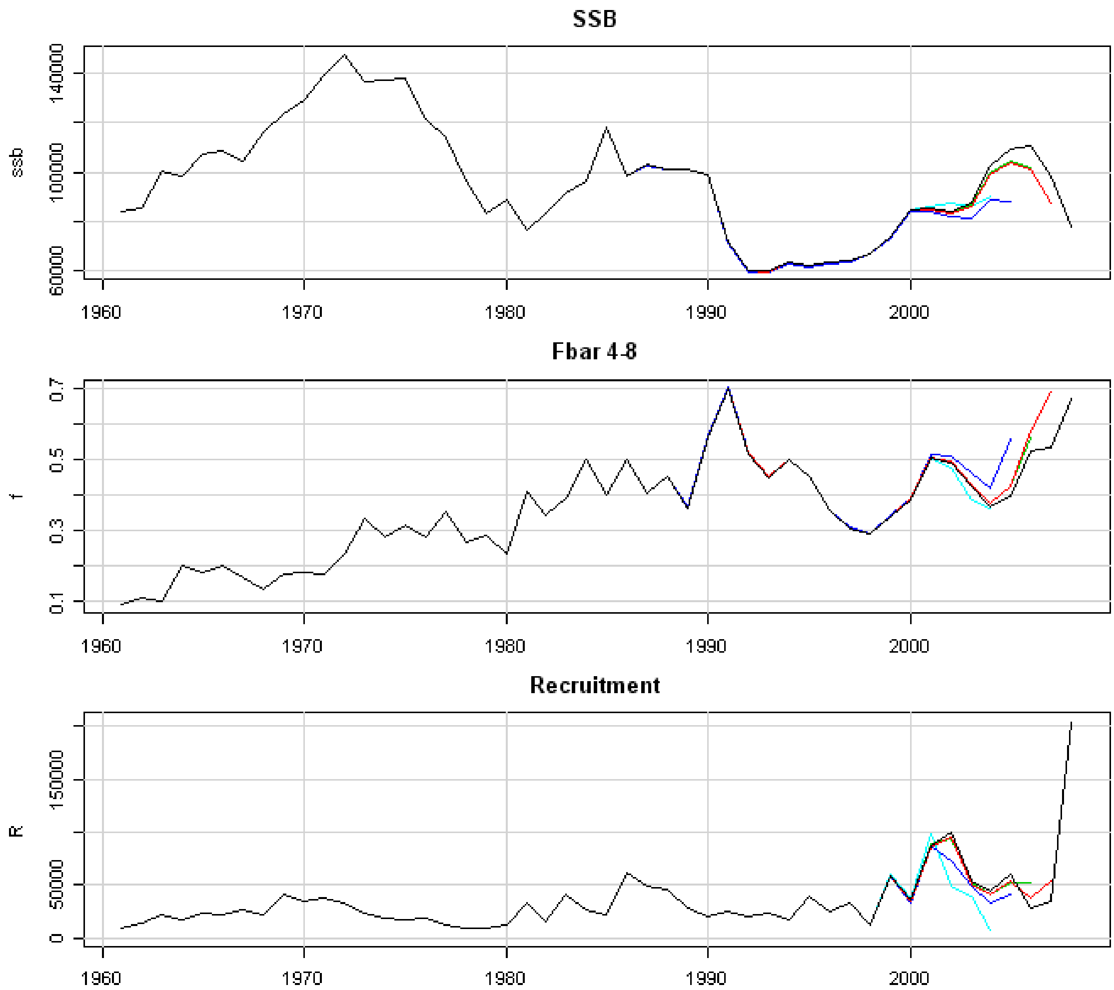

Figure 6.4.3. Faroe saithe (Division Vb). Retrospective analysis of average spawning stock biomass, fishing mortality of age groups 4-8 and recruitment for age 3 from XSA for the years 2003-2008.

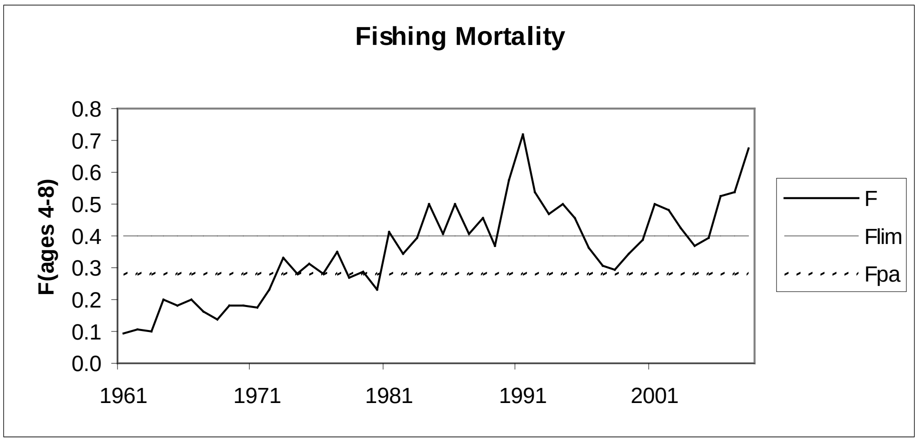

Figure 6.4.4. Faroe saithe (Division Vb). Fishing mortality (average F ages 4-8).

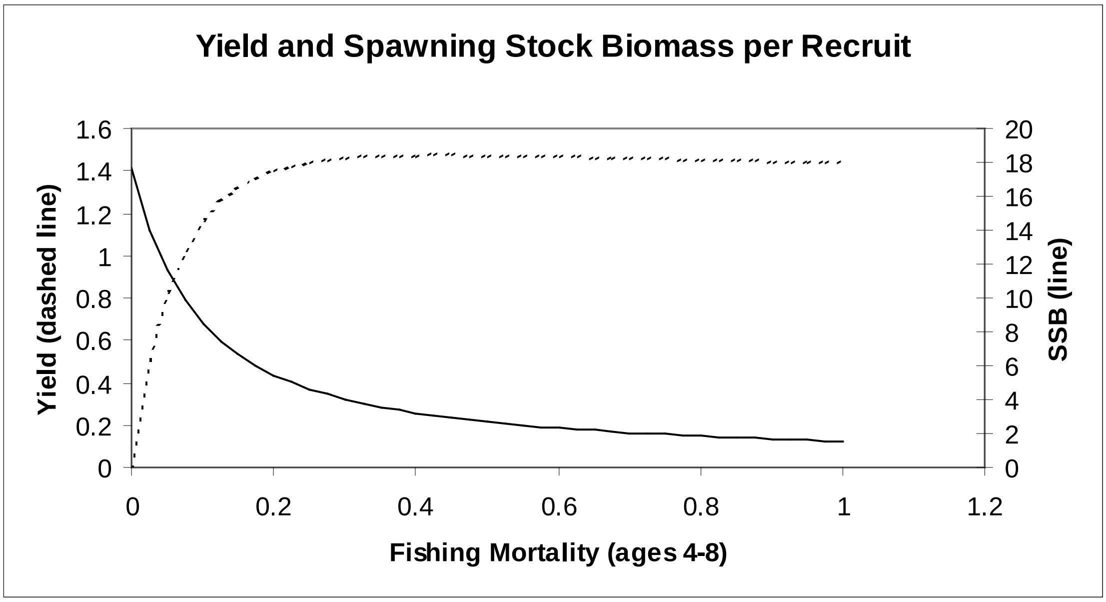

Figure 6.5.1.1. Faroe saithe (Division Vb). Fish stock summary.

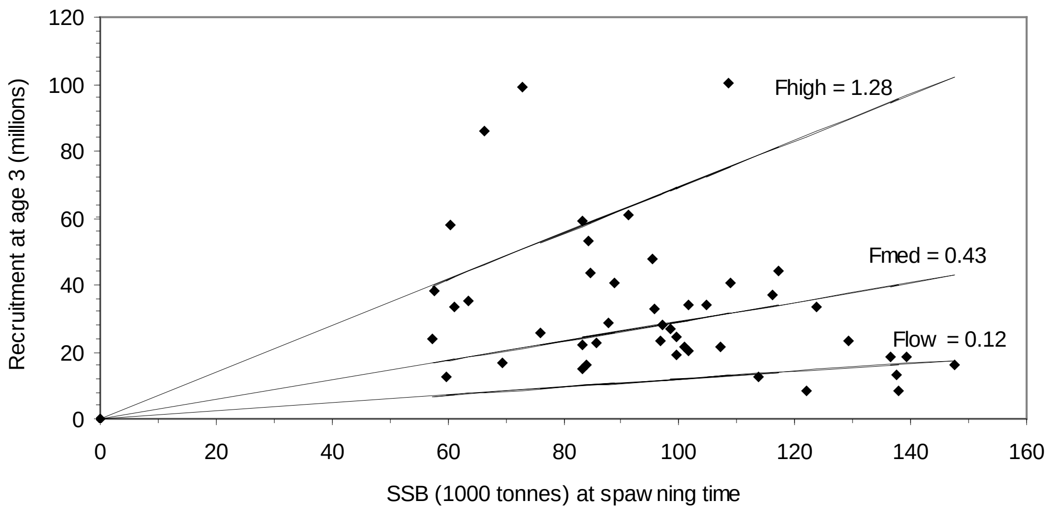

Figure 6.5.1.2. Faroe saithe(Division Vb). Stock-Recruitment plot.

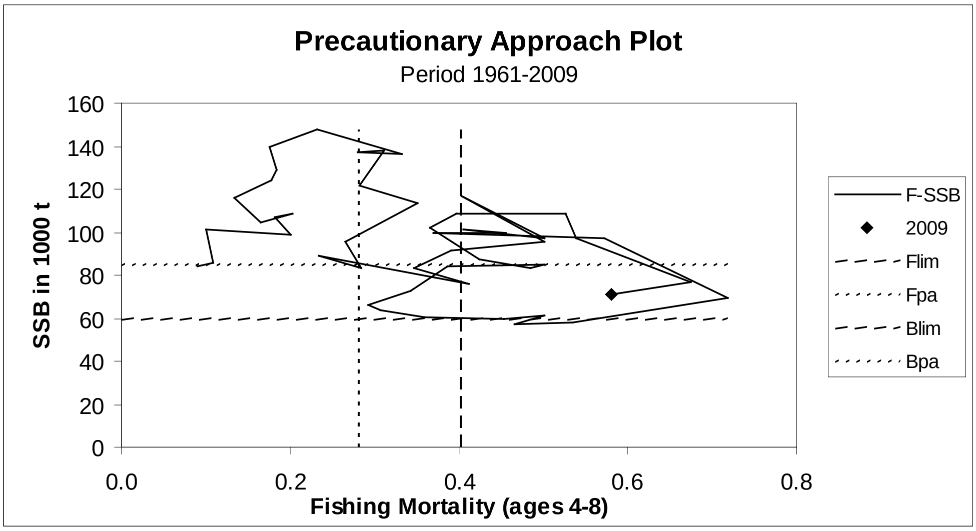

Figure 6.5.1.3. Faroe saithe(Division Vb). Precautionary approach plot, period 1961-2008. The history of the stock/fishery in relation to the four reference points.

Figure 6.6.1.1. Faroe saithe (Division Vb). Recruitment at age 3 (millions).

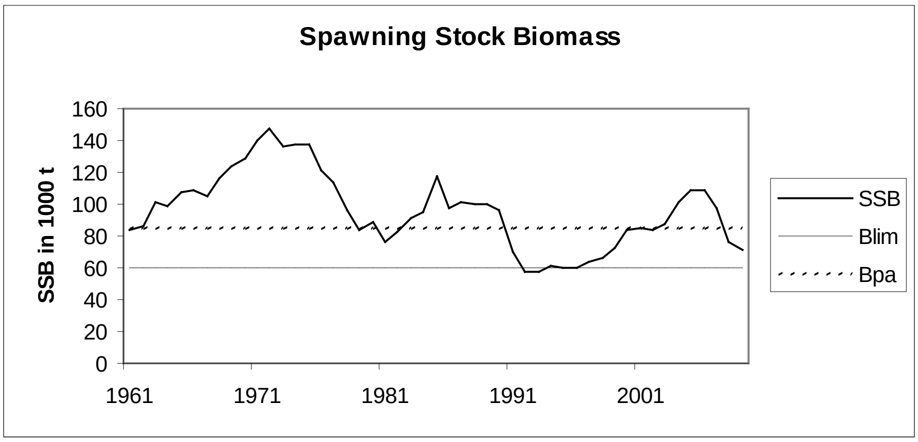

Figure 6.6.1.2. Faroe saithe (Division Vb). Spawning stock biomass (1000 tonnes).

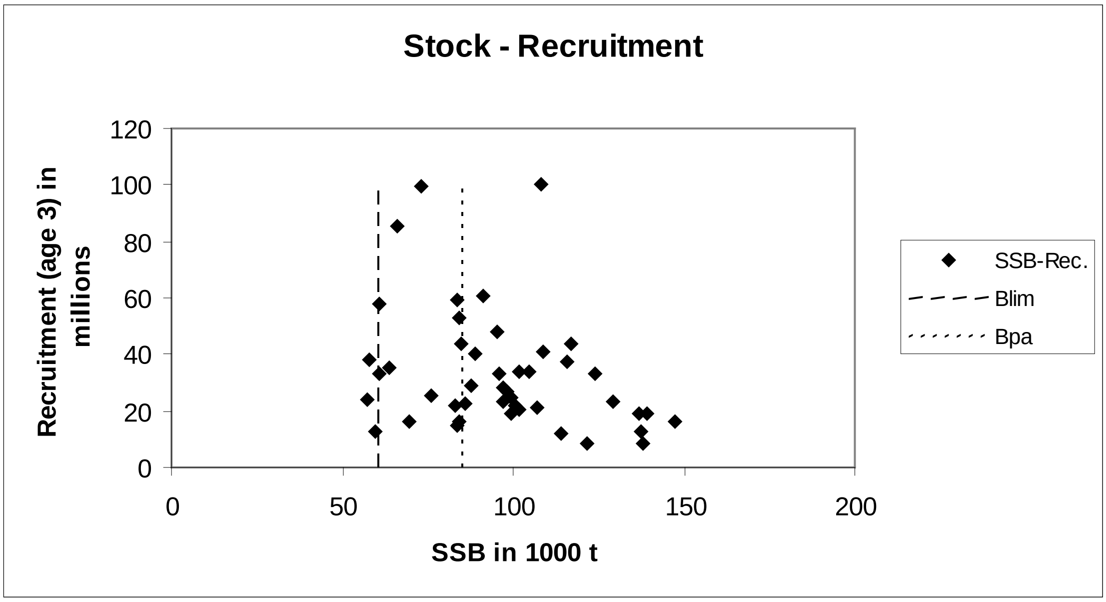

Figure 6.6.1.3. Faroe saithe (Division Vb). Stock-Recruitment plot.

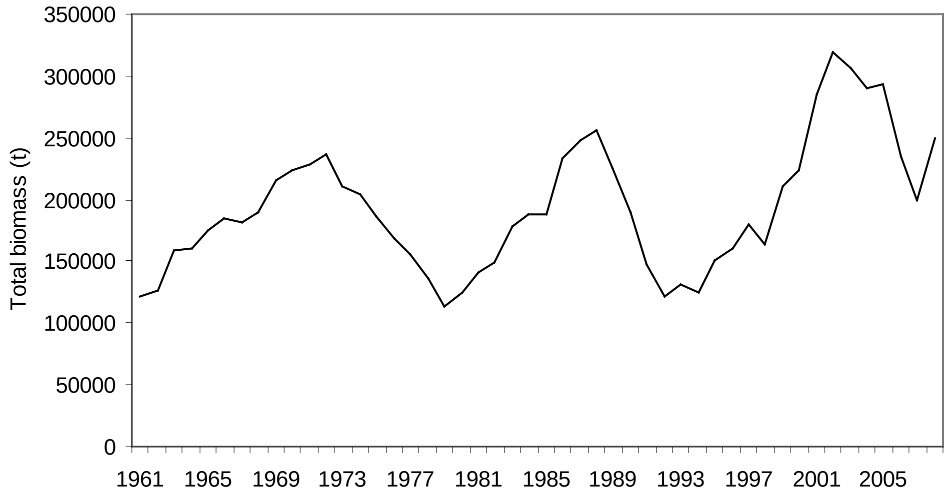

Figure 6.6.1.4. Faroe saithe (Division Vb). Total biomass (1000 tonnes).

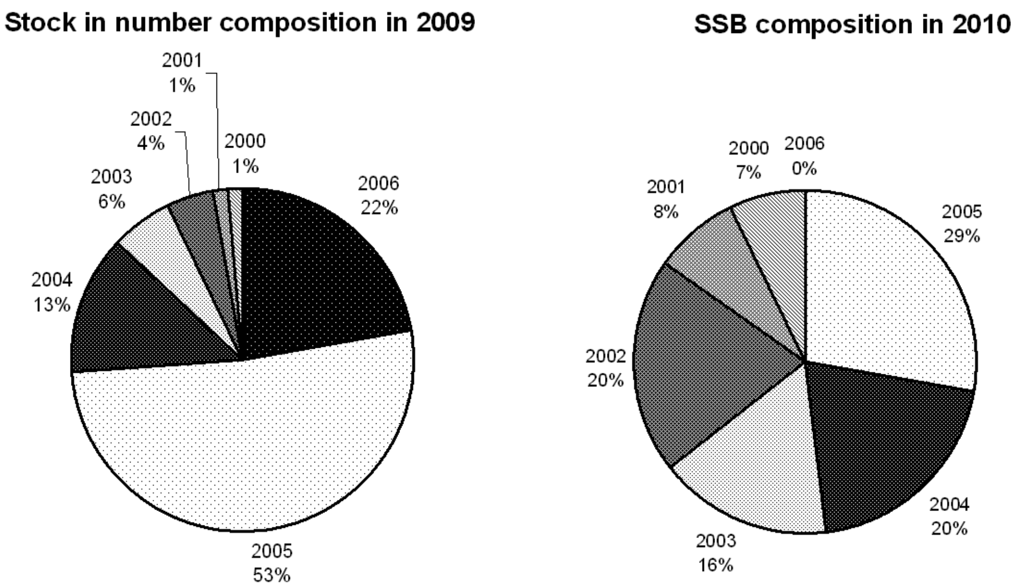

Figure 6.7.1.1. Faroe saithe (Division Vb). Projected composition in number by year classes in the catch in 2009 (left figure) and the composition in SSB in 2010 by year classes (right figure).

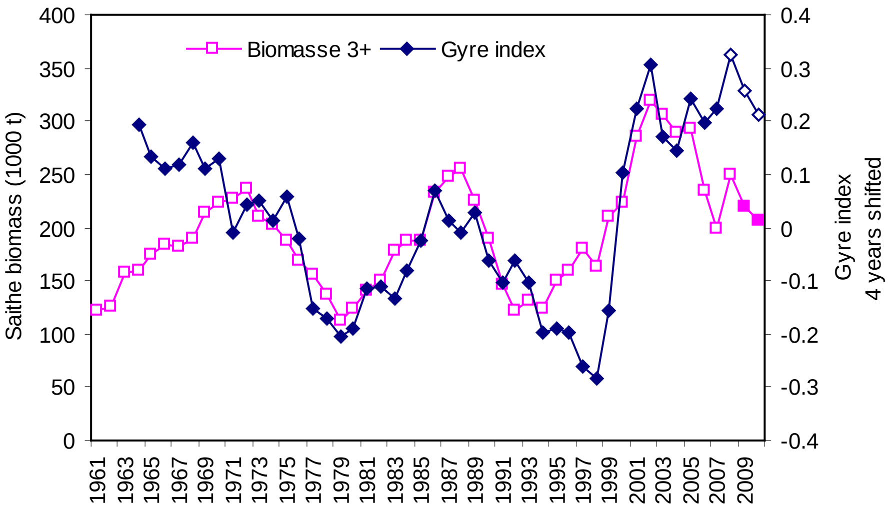

Figure 6.16.1. Faroe saithe (Division Vb). Relationship between the Gyre index (4 years shifted) and saithe biomasse (age 3+) in Faroese waters. Biomasse is from XSA tuned with pair trawler serie, and value for 2009-2010 is from short term prediction.

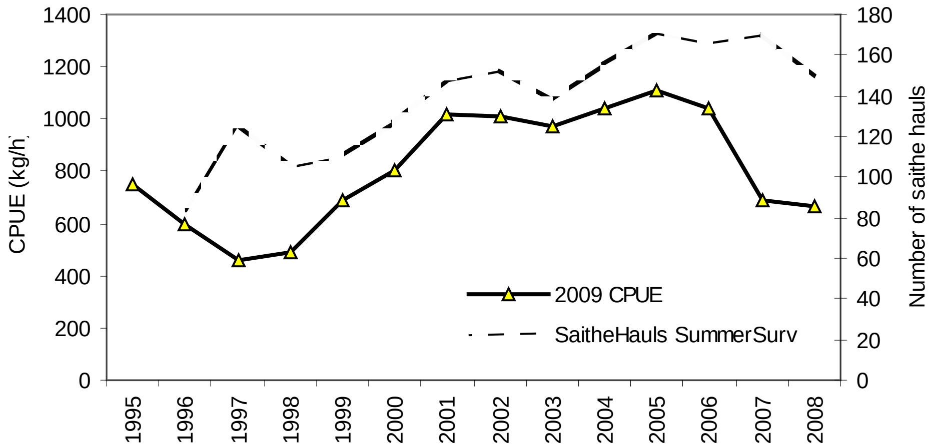

Figure 6.17.1. Faroe saithe (Division Vb). CPUE (kg/hour) from the commercial pair trawlers used in this years XSA and number of saithe halus from the summer survey.

7 Overview on ecosystem, fisheries and their management in Icelandic waters

This section gives a very broad and general overview of the ecosystem, fishery, fleet, species composition and some bycatch analysis of the commercially landed species as well as management measures in the Icelandic Exclusive Economic Zone. The zone covers a number of different ICES statistical regions. These include parts of IIa2, Va1, Va2, Vb1b, XIIa4, XIVa and XIVb2. Although the Icelandic EEZ covers quite a number of different areas, in practice, the Icelandic landings of different species are generally reported as catches/landings in Va.

The information on the ecosystem of Icelandic waters is brief but a more detailed description is available in the WGRED report.

7.1 Environmental and ecosystem information

Iceland is located at the junction of the Mid-Atlantic Ridge and the Greenland-Scotland Ridge just south of the Arctic Circle. The bottom topography of this region is generally irregular, with hard rocky bottom prevailing in most areas. The shelf around Iceland is cut by many sub-sea canyons. It is narrowest off the south coast where in places it extends out only a few km. From there, the continental slope falls away to over 1000 m. Off the west, north and east coasts, however, the shelf is relatively broad and extends often over 150 km from the coast.

The Polar Front lies between Greenland and Iceland and separates the cold and relatively low saline south-flowing East Greenland Current from the Irminger Current, the westernmost branch of the warmer and more saline North Atlantic Current. South and east of Iceland the North Atlantic Current flows towards the Norwegian Sea. The Irminger Current flows northwards over and along the Reykjanes Ridge and into the Denmark Strait where it divides. One branch continues northeastward and eastward to the waters north of Iceland and the other branch flows south-westward parallel to the East Greenland Current. In the Iceland Sea north of Iceland a branch out of the cold East Greenland Current flows over the Kolbeinsey Ridge and continues to the southeast along the northeastern shelf brake as the East Icelandic Current. This current is part of a cyclonic gyre in the Iceland Sea.

The Icelandic Shelf is a high (150-300 gC/m2-yr) productivity ecosystem based on SeaWiFS global primary productivity estimates. Productivity is higher in the southwest regions than to the northeast and higher on the shelf areas than in the oceanic regions (Gudmundsson 1998). In terms of numbers of individuals, copepods dominate the mesozooplankton of Icelandic waters with *Calanus finmarchicus* being the most abundant species, often comprising between 60-80% of net-caught zooplankton in the uppermost 50 m (Astthorsson and Vilhjalmsson 2002, Astthorsson et al. 2007).

The underlying features which appear to determine the structures of benthic communities around Iceland are salinity (as indicator of water masses) and sediment types. Accordingly, the distribution of benthic communities is closely related to existing water masses and, on smaller scale, with bottom topography (Weisshappel and Svavarsson 1998). Survey measurements indicate that shrimp biomass in Icelandic waters, both in inshore and offshore waters, has been declining in recent years. Consequently the shrimp fishery has been reduced and is now banned in most inshore areas. The decline in the inshore shrimp biomass is in part considered to be environmentally driven, both due to increasing water temperature north of Iceland and due to increasing biomass of younger cod, haddock and whiting.

Based on information from fishermen, eleven coral areas were known to exist close to the shelf break off northwest and southeast Iceland at around 1970. Since then more coral areas have been found, reflecting the development of the bottom trawling fisheries extending into deeper waters in the 70s and 80s. At present considerably large coral areas exist on the Reykjanes Ridge and off southeast Iceland. Other known coral areas are small (Steingrímsson and Einarsson 2004).

The database of the BIOICE programme provides information on the distribution of soft corals, based on sampling at 579 locations within the territorial waters of Iceland. The results show that gorgonian corals occur all around Iceland. They were relatively uncommon on the shelf (< 500 m depth) but are generally found in relatively high numbers in deep waters (> 500 m) off south, west and north coasts of Iceland. Similar patterns were observed in the distribution of pennatulaceans off Iceland. Pennatulaceans are relatively rare in waters shallower than 500 m but more common in deep waters, especially off South Iceland (Guijarro et al. 2007).

Icelandic waters are comparatively rich in species and contain over 25 commercially exploited stocks of fish and marine invertebrates. Main species include cod, haddock, saithe, redfish, Greenland halibut and various other flatfish, wolffish, tusk *(Brosme brosme)*, ling *(Molva molva)*, herring, capelin and blue whiting. Most fish species spawn in the warm Atlantic water off the south and southwest coasts. Fish larvae and 0-group drift west and then north from the spawning grounds to nursery areas on the shelf off northwest, north and east Iceland, where they grow in a mixture of Atlantic and Arctic water.

Capelin is important in the diet of cod as well as a number of other fish stocks, marine mammals and seabirds. Unlike other commercial stocks, adult capelin undertake extensive feeding migrations north into the cold waters of the Denmark Strait and Iceland Sea during summer. Capelin abundance has been oscillating on roughly a decadal period since the 1970s, producing a yield of up to 1600 Kt at the most recent peak. In recent years the stock size of capelin has decreased from about 2000 Kt in 1996/97 to about 1000 Kt in 2006/07 (Anon. 2007). Herring were very abundant in the early 1960s, collapsed and then have increased since 1970 to a historical high level in the last decade. Abundance of demersal species has been trending downward irregularly since the 1950s, with aggregate catches dropping from over 800 Kt to under 500 Kt in the early 2000s.

A number of species of sharks and skates are known to be taken in the Icelandic fisheries, but information on catches is incomplete, and the status of these species is not known. Information on status and trends of non-commercial species are collected in extensive bottom trawl surveys conducted in early spring and autumn, but information on their catches in fisheries, is not available.

The seabird community in Icelandic waters is composed of relatively few but abundant species, accounting for roughly ¼ of total number and biomass of seabirds within the ICES area (ICES 2002). Auks and petrel are most important groups comprising almost 3/5 and 1/4 of abundance and biomass in the area, respectively. The estimated annual food consumption is on the order of 1.5 million tonnes.

At least 12 species of cetaceans occur regularly in Icelandic waters, and additional 10 species have been recorded more sporadically. In the continental shelf area minke whales (*Balaenoptera acutorostrata*) probably have the largest biomass. According to a

2001 sightings survey, 67 000 minke whales were estimated in the Central North Atlantic stock region, with 44 000 animals in Icelandic coastal waters (NAMMCO 2004, Borchers *et al.* 2003, Gunnlaugsson 2003). Two species of seals, common seal (*Phoca vitulina*) and grey seal (*Halicoerus grypus*) breed in Icelandic waters, while 5 northern vagrant species of pinnipeds are found in the area (Sigurjonsson and Hauksson, 1994; Hauksson, 1993, 2004).

7.2 Environmental drivers of productivity

Mean weight at age of Icelandic cod have been shown to correlate well with the size of the capelin stock and therefore the capelin stock has been used as a predictor of weights in the landings since 1991. In 1981-1982 weights were low following collapse of the capelin stock and were also relatively low in 1990-1991 when the capelin stock was small. In recent years this relationship seems to be much weaker, most likely due to changes in the spatial distribution of capelin or uncertainties in the estimation of the capelin stock size.

No other ecosystem drivers of productivity that may affect the assessment of the Icelandic stocks assessed in this report were presented to the NWWG in 2008.

7.3 Ecosystem considerations (General)

Around the mid-1990s a rise in both temperature and salinity were observed in the Atlantic water south and west of Iceland. The positive trend has continued ever since and west of Iceland amounts to an increase of temperature of about 1˚C and salinity by one unit (Figure 7.3.1.). These are very large changes for Atlantic water in this area. Off central N-Iceland a similar trend is observed. The increase of temperature and salinity north of Iceland in the last 10 years is on average about 1.5˚C and 1.5 salinity units. (Figure 7.3.2)

It appears that these changes have had considerable effects on the fish fauna of the Icelandic ecosystem. Species which are at or near their northern distribution limit in Icelandic waters have increased in abundance in recent years (Figure 7.3.3). The most obvious examples of increased abundance of such species in the mixed water area north of Iceland are haddock, whiting, monkfish, lemon sole and witch. The semi-pelagic blue whiting has lately been found and fished in E-Icelandic water in far larger quantities than ever before.

On the other hand, coldwater species like Greenland halibut and northern shrimp have become scarcer. Capelin have both shifted their larval drift and nursing areas far to the west to the colder waters off E-Greenland, the arrival of adults on the over-wintering grounds on the outer shelf off N-Iceland has been delayed and migration routes to the spawning grounds off S- and W-Iceland have been located farther off N- and E-Iceland and not reached as far west along the south coast as was the rule in most earlier years (Figure 7.3.4. and 7.3.5.). The change in availability of capelin in the traditional grounds may have had an effect on the growth rate of various predators, as is reflected in low weight of cod in recent years.

There is one demersal stock, which apparently has not taken advantage, or not been able to take advantage, of the milder marine climate of Icelandic waters. This is the Icelandic cod, which flourished during the last warm epoch, which began around 1920 and lasted until 1965. By the early 1980s the cod had been fished down to a very low level as compared to previous decades and has remained relatively low since. During the last 20 years the Icelandic cod stock has not produced a large year class and the average number of age 3 recruits in the last 20 years is about 150 million fish per annum, as compared to 205-210 recruits in almost any period prior to that, even the ice years of 1965-1971. Immigrants from Greenland are not included in this comparison. It is not possible to pinpoint exactly what has caused this change, but a very small and young spawning stock is the most obvious common denominator for this protracted period of impaired recruitment to the Icelandic cod stock. Regulations, particularly the implementation of the catch rule in 1993 have resulted in lower fishing mortalities in the last ten years compared with the ten years prior and has, despite low recruitment, resulted in almost doubling of the spawning stock biomass since 1993. These improvements in the SSB biomass have however not resulted in significant increase in production in recent years, despite increased inflow of warmer Atlantic water.

Associated with the large warming of the 1920s, was a well documented drift of larval and 0-group cod as well as some other fish species, from Iceland across the northern Irminger Sea to E- and then W-Greenland. Although many of these fish apparently returned to Iceland to spawn and did not leave again, there is little doubt that the cod, remaining in W-Greenland waters which also had warmed, were instrumental in establishing a self-sustaining Greenlandic cod stock that eventually became very large. It seems that significant numbers of cod of the 2003 year class have drifted across to Greenland in that year and are now growing at W-Greenland.

7.4 Description of fisheries [Fleets]

Only Icelandic vessels are considered in the following analysis since they constitute the largest operational players in Icelandic waters. Few trawlers and longliners of other nationalities operate in the Icelandic region principally targeting deep-sea redfish, tusk, ling and Atlantic halibut, with some bycatch of gadoids species. Additionally some limited pelagic fishery of foreign boats on capelin, herring and blue whiting also takes place in Icelandic waters.

The data sources used in this section are centralized electronic landings, boat, log book and discard databases. Landings of species by each boat and gear are effectively available electronically in real time (end of day of landing). Log-book statistics are generally available in a centralized database 1-2 months after the day of fishing operation. The electronic data base is available to fisheries scientists, the logbook data alone counting in 2005 for a total of 189.266 individual hauls/sets.

The Icelandic fishing fleet can be characterised by the most sophisticated technological equipment available in this field. This applies to navigational techniques and fish-detection instruments as well as the development of more effective fishing gear. The most significant development in recent years is the increasing size of pelagic trawls and with increasing engine power the ability to catch pelagic fishes at greater depths than previously possible. There have also been substantial improvements with respect to technological aspects of other gears such as bottom trawl, longline and handline. Each fishery uses a variety of gears and some vessels frequently shift from one gear to another within each year. The most common demersal fishing gear are otter trawls, longlines, seines, gillnets and jiggers while the pelagic fisheries use pelagic trawls and purse seines. The total recorded landings of the Icelandic fleets in 2007 amounted to 1.4 million tonnes where pelagic fishes amounted to 0.9 million tonnes. Spatial distributions of the catches are shown in figure 7.4.1. Detailed information of landings by species and gear type are given in Table 7.1. Spatial overviews of the removal of the some important species by different gear are given in Figures 7.4.2. – 7.4.5.

A simple categorization of boats among the different fisheries types is impossible as many change gear depending on fish availability in relation to season, quota status of the individual companies, fish availability both in nature and on the quota exchange market, market price, etc. E.g. larger trawl vessels may operate both on demersal species using bottom trawls as well as using purse seine and pelagic trawls on pelagic species. Total number of vessels within each fleet category in 2008 is thus limited to the broad categories given below:

Type	No. vessels[1)]	Gear type used
Trawlers	60	Pelagic and bottom trawl
Vessels > 100 t	145	Purse seine, longline, trawl, gillnet
Vessels > 10< 100 t	312	Gillnet, longline, danish seine, trawl, jiggers
Vessels < 10 t	312	Jiggers, longline
Open boats	700	Jiggers, longliners (including recreational fishers)
Total	1469	

[1)]*Source: Statistic Iceland - http://www.statice.is/*

The demersal fisheries take place all around Iceland including variety of gears and boats of all sizes. The most important fleets targeting them are:

- Large and small trawlers using demersal trawl. This fleet is the most important one fishing cod, haddock, saithe, redfish as well as a number of other species. This fleet is operating year around; mostly outside 12 nautical miles from the shore.
- Boats (< 300 GRT) using gillnet. These boats are mostly targeting cod but haddock and a number of other species are also target. This fleet is mostly operating close to the shore.
- Boats using longlines. These boats are both small boats (< 10 GRT) operating in shallow waters as well as much larger vessels operating in deeper waters. Cod and haddock are the main target species of this fleet but a number other species are also caught, some of them in directed fisheries.
- Boats using jiggers. These are small boats (<10 GRT). Cod is the most important target species of this fleet with saithe of secondary importance.
- Boats using Danish seine. (20-300 GRT) Cod, haddock and variety of flatfishes, e.g. plaice, dab, lemon sole and witch are the target species of this fleet.

Although different fleets may be targeting the main species the spatial distribution of effort may different. In general it can be observed that the bottom trawl fleet is fishing in deeper waters than the long line fleet (Figures 7.4.6. and 7.4.7).

The pelagic fisheries targeting capelin, herring, blue whiting and mackerel is almost exclusively carried out by larger vessels. The fisheries in Icelandic waters for capelin and herring are carried out using both purse seine and pelagic trawl while that of blue whiting and mackerel is exclusively carried out with pelagic trawl. Additionally a significant part of the pelagic fisheries of the Icelandic fleet is caught outside the Icelandic EEZ, both on the Atlanto-Scandian herring and on blue whiting.

7.5 Regulations

The Ministry of Fisheries is responsible for management of the Icelandic fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year, including an allocation of the TAC for each of the stocks subject to such limitations. Below is a short account of the main feature of the management system.

7.5.1 The ITQ system

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account, as a rule to increase the quotas. Until 1990, the quota year corresponded to the calendar year but since then the quota, or fishing year, starts on September 1 and ends on August 31 the following year. This was done to meet the needs of the fishing industry. In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. Since 2006/2007 fishing season, all boats operate under the TAC system.

With some minor exceptions it is required by law to land all catches. Consequently, no minimum landing size is in force. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place (see below).

Within this system individual boat owners have substantial flexibility in exchanging quota, both among vessels within individual company as well as among different companies. The latter can be done via temporary or permanent transfer of quota. In addition, some flexibility is allowed by individual boats with regard to transfer allowable catch of one species to another. These measures, which can be acted on more or less instantaneously, are likely to result in lesser initiative to discards and misreporting than can be expected if individual boats are restricted by strict TAC measures alone. They may however result in fishing pressures of individual species to be different than intended under the single species TAC allocation.

7.5.2 Mesh size regulations

With the extension of the fisheries jurisdiction to 200 miles in 1975, Iceland introduced new measures to protect juvenile fish. The mesh size in trawls was increased from 120 mm to 155 mm in 1977. Mesh size of 135 mm was only allowed in the fisheries for redfish in certain areas. Since 1998 a minimum mesh size of 135 is allowed in the codend in all trawl fisheries not using "Polish cover" and in the Danish seine fisheries. For the gillnet fishery both minimum and maximum mesh-sizes are restricted. Since autumn 2004 the maximum allowed mesh-size in the gillnet fishery is 8 inches. The objective of this measure is to decrease the effort directed towards bigger spawners.

7.5.3 Area closures

REAL TIME AREA CLOSURE: A quick closure system has been in force since 1976 with the objective to protect juvenile fish. Fishing is prohibited for at least two weeks in areas where the number of small fish in the catches has been observed by inspectors to exceed certain percentage (25% or more of <55 cm cod and saithe, 25% or more of <45 cm haddock and 20% or more of <33 cm redfish). If, in a given area, there are several consecutive quick closures the Minister of Fisheries can with regulations close the area for longer time forcing the fleet to operate in other areas. Inspectors from the

Directorate of Fisheries supervise these closures in collaboration with the Marine Research Institute. In 2008, 93 such closures took place

PERMANENT AREA CLOSURES: In addition to allocating quotas on each species, there are other measures in place to protect fish stocks. Based on knowledge on the biology of various stocks, many areas have been closed temporarily or permanently aiming at protect juveniles. Figure 7.5.1. shows map of such legislation that was in force in 2008. Some of them are temporarily, but others have been closed for fishery for decades.

TEMPORARY AREA CLOSURES: The major spawning grounds of cod, plaice and wolfish are closed during the main spawning period of these species. The general objectives of these measures, which were in part initiated by the fishermen, are to reduce fishing during the spawning activity of these species.

7.5.4 Discards

Discarding measurements have been carried out in Icelandic fisheries since 2001, based on extensive data collection and length based analysis of the data (Pálsson 2003). The data collection is mainly directed towards main fisheries for cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) and towards saithe (*Pollachius virens*) and golden redfish (*Sebastes marinus*) fisheries in demersal trawl and plaice in Danish seine. Sampling for other species is not sufficient to warrant a satisfactory estimation of discarding. The discard rate for cod has been less than 1-2% of the reported landings over the time investigated (Figure 7.5.2.). The discard estimates for haddock are somewhat higher ranging between 2-6% annually. Discarding of saithe and golden redfish has been negligible over time period of investigation. Estimates of discards of cod and haddock in 2008 by individual fleets are given in table 7.2. These relatively low discard rates compared to what is generally assumed to be a side effect of a TAC system may be a result of the various measures, including the flexibility within the Icelandic ITQ system (see above). Since the time series of discards is relatively short it is not included in the assessments.

All catch that is brought ashore must by law be weighted by a licensed body. The monitoring and enforcement is under the realm of the Directorate of Fisheries. Under the TAC system there are known incentives for misreporting, both with regards to the actual landings statistics as well as with regards to the species recorded. This results in bias in the landings data but detailed quantitative estimates of how large the bias may be, is not available to the NWWG. Unpulished reports from the Directorate of Fisheries, partly based on investigation comparing export from fish processing plants with the amount of fish weighted in the landing process indicate that this bias may be of the order of single digit percentages and not in double digits.

7.6 Mixed fisheries, capacity and effort

A number of species caught in Icelandic waters are caught in fisheries targeting only one species, with very little bycatch. These include the pelagic fisheries on herring, capelin and blue whiting (see however below), the Greenland halibut fishery in the west and southeast of Iceland and the *S. mentella* fishery. Advice given for these stocks should thus not influence the advice of other stocks.

Other fisheries, particularly demersal fisheries may be classified as more mixed, where a target species of e.g. cod, haddock, saithe or S. marinus may be caught in a mixture with other species in the same haul/setting (Figure 7.6.1.). Fishermen can however have a relatively good control of the relative catch composition of the different species. E.g. the saithe fishery along the shelf edge is often in the same areas as the redfish fisheries: Fleets are often targeting at redfish during daytime and saithe during nights. Therefore the fishery for one of those species is relatively free of by-catch of the other species even though they take place in the same area. Small differences in the location of setting are also known to affect the catch composition. This has for example been documented in the long line fisheries in Faxabay, where in adjacent areas cod catches and wolfish catches are known to consistently dominate the catches in individual setting. There are however numerous species in Icelandic waters that can be classified as "bycatch species" in some fisheries. E.g. in the bottom trawl fisheries 75 % of the annual plaice yield is caught in hauls where plaice is minority of the catches. In a proper fisheries based advice taking mixed fisheries issues into account, such stocks may have a greater influence on the advice on the main stocks that are currently assessed by ICES than fisheries linkage among the latter.

In the pelagic fisheries catch other than the targeted species is considered rare. In some cases juveniles of other species are caught in significant numbers. When observers are on board or when fishermen themselves provide voluntary information, the fishing areas have in such cases been closed for fishing, temporarily or permanently. By catch of adults of other species in the blue whiting fishery have been estimated (Pálsson 2005).

7.7 References

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Table 7.1 Overview of the 2007 landings of fish and shrimp caught in Icelandic waters by the Icelandic fleet categorized by gear type. The fishery for capelin, blue whiting and herring are fished in both pelagic trawls and purse seine, but those gears are combined. Based on landing statistics from the Directorate of Fisheries. Landings are given in t.

Species	Bottom trawl	Danish seine	Dredge	Gillnets	Jiggers	Long line	Neprops trawl	Pelagic trawl	Pot	Purse seine	Shrimp trawl	Total
Atlantic mackerel	0	0	0	0	0	0	0	36518	0	0	0	36518
Atlantic wolffish	7819	1551	0	88	6	6645	45	21	0	0	0	16175
Black scabbard fish	1	0	0	0	0	0	0	0	0	0	0	1
Blue whiting	0	0	0	0	0	0	0	237854	0	0	0	237854
Blueling, European ling	1483	44	0	33	0	374	55	6	0	0	0	1995
Capelin	0	0	0	0	0	0	0	50529	0	257176	0	307705
Cod	77080	8633	0	23584	4228	58927	735	829	53	75	141	174285
European/Common whelk	3	0	0	0	0	0	0	0	551	0	0	554
Dab	22	780	0	5	0	7	0	0	0	0	0	814
Deep water prawn	10	0	0	0	0	0	0	0	0	0	2016	2026
Dogfish	2	3	0	4	0	35	0	0	0	0	0	44
Greater argentine	4108	0	0	0	0	0	0	119	0	0	0	4227
Greater forkbeard	0	0	0	0	0	1	0	0	0	0	0	1
Greenland halibut	8985	2	0	166	0	20	0	420	0	0	3	9596
Greenland shark	1	0	0	0	0	1	0	0	0	0	0	2
Haddock	57235	12846	0	1035	45	37192	211	714	2	8	43	109331
Halibut	171	39	0	19	1	187	10	5	0	0	0	432
Herring	0	0	0	0	0	0	0	368	0	142891	0	143259
Herring (Atl.-scand)	5	0	0	0	0	0	0	166813	0	9808	0	176626
Lemon sole	1441	1191	0	8	1	0	14	9	0	0	0	2664
Ling	1396	238	0	671	6	4042	243	5	0	0	0	6601
Long rough dab	82	271	0	2	0	9	1	0	0	0	0	365
Lumpsucker, lumpfish	2	2	0	18	0	0	0	2	0	0	0	24
Megrim	43	120	0	0	0	0	25	0	0	0	0	188
Monkfish	558	385	0	1484	1	52	311	0	0	0	0	2791
Norway haddock	24	0	0	0	0	0	0	0	0	0	0	24
Norway lobster	1	0	0	0	0	0	2006	0	0	0	0	2007
Ocean quahog	0	0	4620	0	0	0	0	0	0	0	0	4620
Other	21	1	0	0	0	0	0	0	0	1	0	23
Other	45	4	0	1	0	1	1	0	0	0	0	52
Plaice	2223	3306	0	140	2	124	1	13	0	1	0	5810
Rabbitfish (rat fish)	1	0	0	0	0	0	0	0	0	0	0	1
Rauðmagi	2	4	0	36	0	0	0	0	0	0	0	42
Redfish (demersal S.mentella)	12823	0	0	0	0	0	0	1735	0	0	0	14558
Redfish (pelagic S.mentella)	3629	0	0	0	0	0	0	16338	0	0	0	19967
Redfish (S. Marinus)	37418	546	0	175	55	1151	362	1203	0	0	0	40910
Roughhead grenadier	2	0	0	0	0	0	0	0	0	0	0	2
Roundnose grenadier,	11	0	0	0	0	0	0	1	0	0	0	12
Sailray	0	0	0	0	0	7	0	0	0	0	0	7
Saithe	54500	1197	0	4029	1736	945	40	1790	0	6	0	64243
Sea urchins	0	0	134	0	0	0	0	0	0	0	0	134
Shagreen ray	1	1	0	0	0	16	0	0	0	0	0	18
Skate	43	21	0	16	0	39	4	0	0	0	0	123
Spotted wolffish, leopardfish	1296	15	0	5	1	1391	1	15	0	0	0	2724
Starry ray, thorny skate	45	113	0	9	0	329	0	2	0	0	0	498
Tusk, torsk, cusk	95	0	0	40	9	5833	9	0	0	0	0	5986
Whiting	741	71	0	22	5	394	22	4	0	0	0	1259
Witch	113	1531	0	2	0	0	159	0	0	0	0	1805
Total	273481	32915	4754	31592	6096	117722	4255	515313	606	409966	2203	1398903

Table 7.2. Estimates of discard of cod and haddock in the Icelandic fisheries in 2006. Source: Ólafur K. Pálsson, Eyþór Björnsson, Guðmundur Jóhannesson, Ari Arason, og Þórhallur Ottesen 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series (manuscript for printing). NOT UPDATED

		Landings	Discards		
		(tonnes)	Numbers (thous.)	Weight(Tonnes)	% Weight
COD	Long line	71033	931	588	0.83
	Gill net	23371	184	418	1.79
	Hand line	5729	108	118	2.05
	Danish Seine	10358	52	36	0.35
	Bottom trawl	80096	821	899	1.12
	Total	**190587**	**2096**	**2059**	**1.08**
HADDOCK	Long line	36216	1256	791	2.18
	Danish Seine	12700	360	166	1.30
	Botnvarpa	45495	2536	1495	3.29
	Total	**94411**	**4152**	**2452**	**2.60**

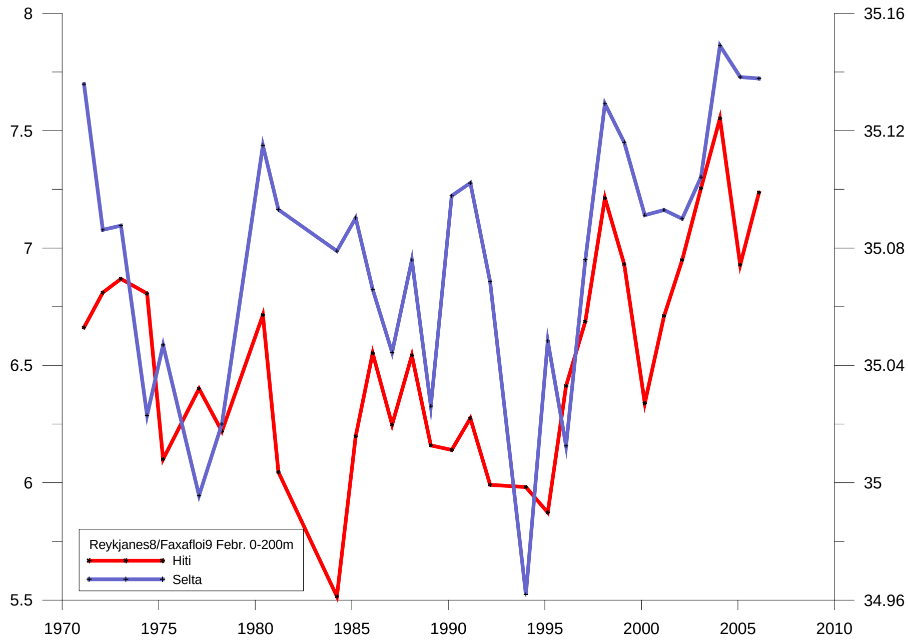

Figure 7.3.1. Changes of temperature and salinity west of Iceland 1970-2006. NOT UPDATED

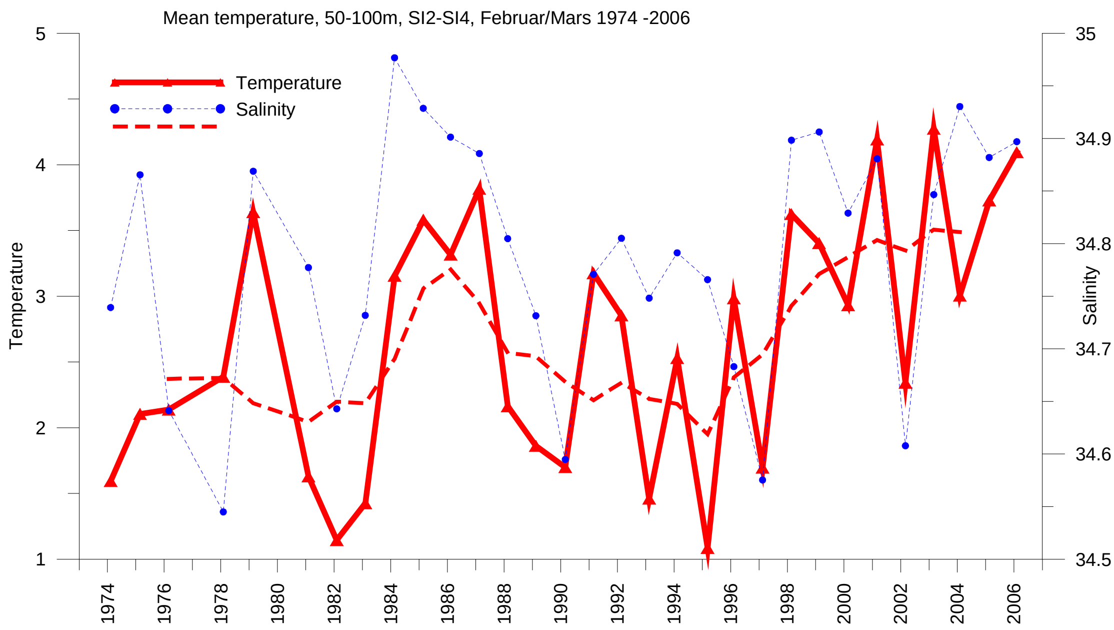

Figure 7.3.2. Changes of temperature and salinity off central North-Iceland 1970-2006. NOT UPDATED

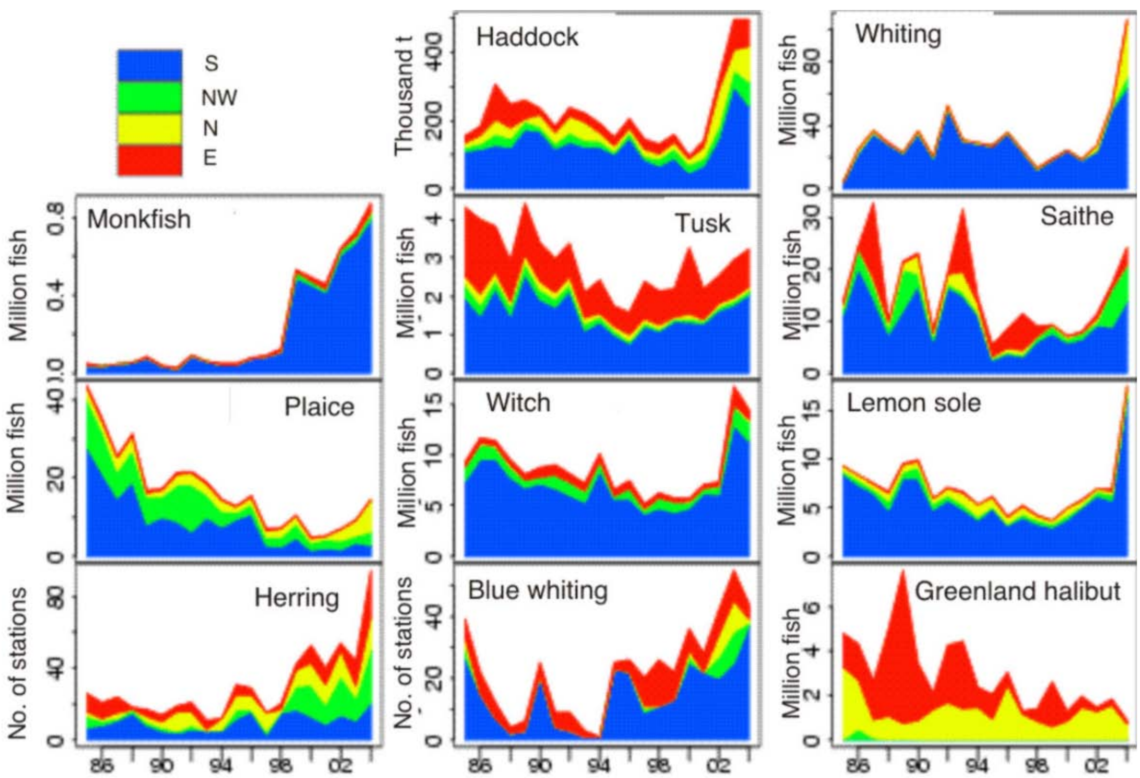

Figure 7.3.3. Changes of indices of abundance and geographical distribution of several fish stocks in Icelandic waters, 1985 – 2005 (based on the spring groundfish survey). The denotations S, NW, N and E beside the color code shown in the top left corner stand for South-, Northwest-, North- and East-Iceland in that order NOT UPDATED.

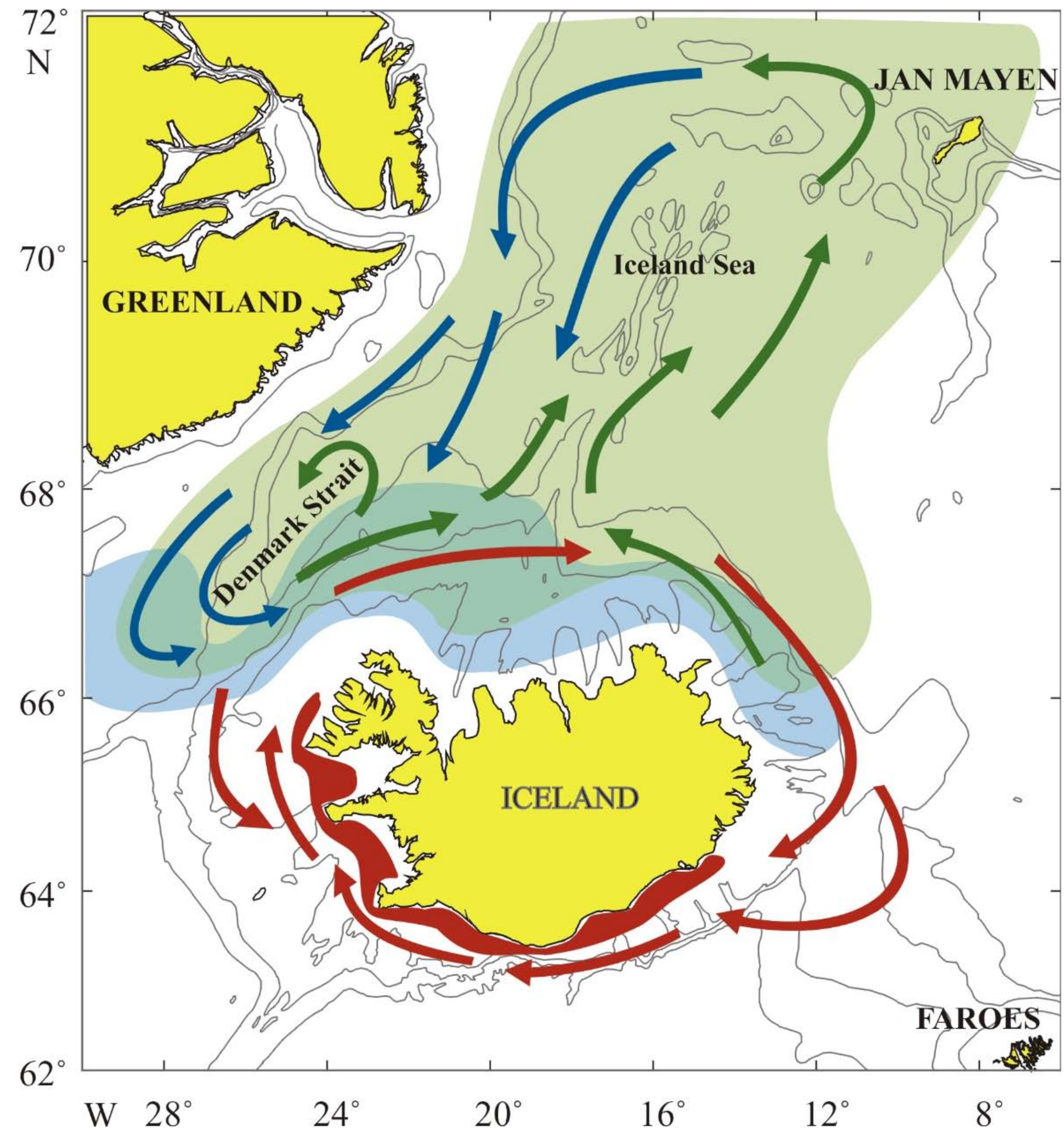

Figure 7.3.4. Distribution and migrations of capelin in the Iceland/East-Greenland/Jan Mayen area before 2001. Red: Spawning grounds; Green: Adult feeding area; Blue: Distribution and feeding area of juveniles; Green arrows: Adult feeding migrations; Blue arrows: Return migrations; Red arrows: Spawning migrations; Depth contours are 200, 500 and 1000 m (Vilhjalmsson 2002)

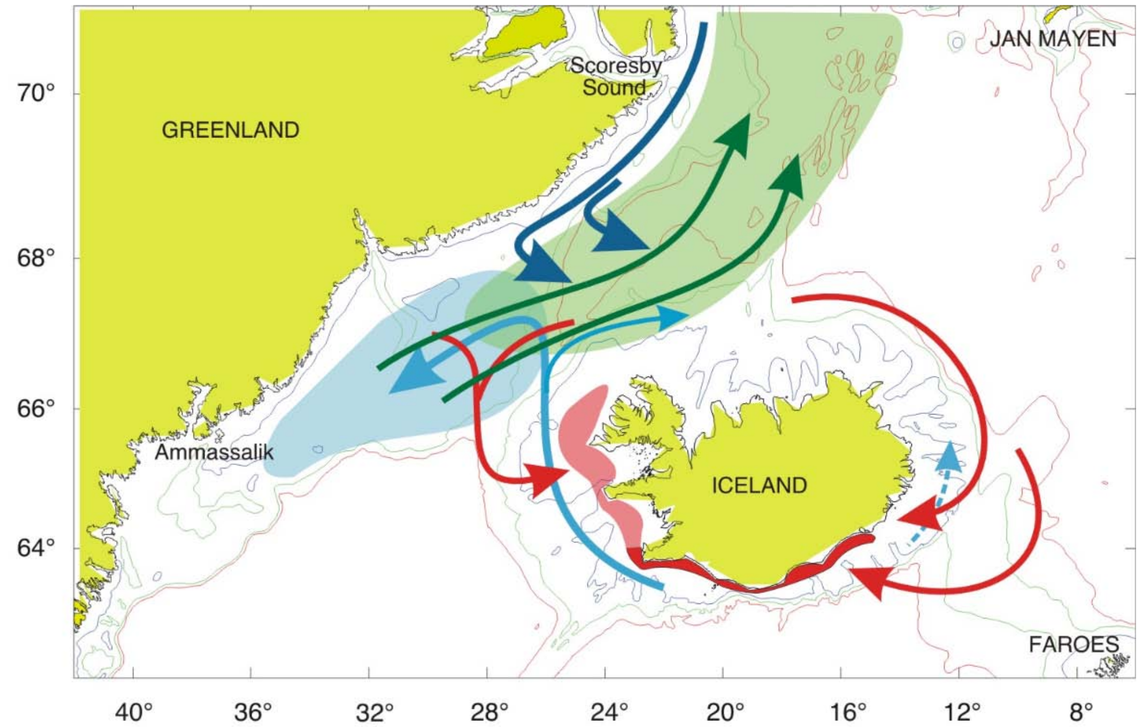

Figure 7.3.5. Likely changes of distribution and migration routes of capelin in the Iceland/Greenland/Jan Mayen area in the last 3-4 years. Green: Feeding area; Light blue: Juvenile area; Red area: Main spawning grounds; Lighter red colour: Lesser importance of W-Iceland spawning areas; Light blue arrows: Larval drift; Dark green arrows: Feeding migrations; Dark blue arrows: Return migrations; Red arrows: Spawning migrations. Depth contours are 200, 500 and 1000 m.

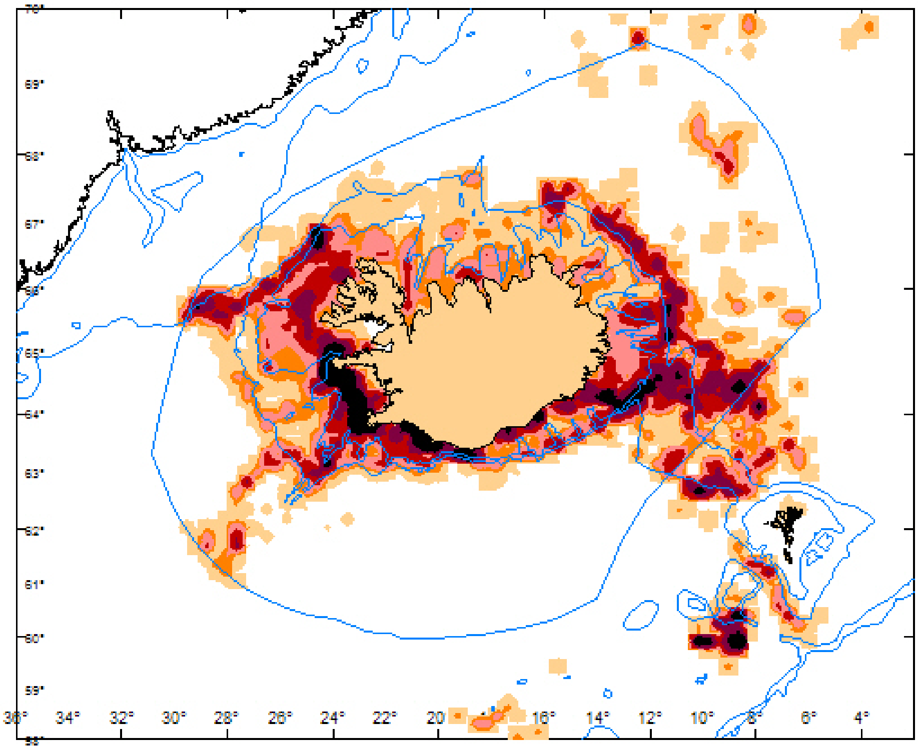

Figure 7.4.1. Distribution of total catch of all species by the Icelandic fishing fleet in Icelandic EEZ and adjacent waters in 2007. The Icelandic EEZ is shown as a blue, contour lines indicate 500 and 1000 m depth.

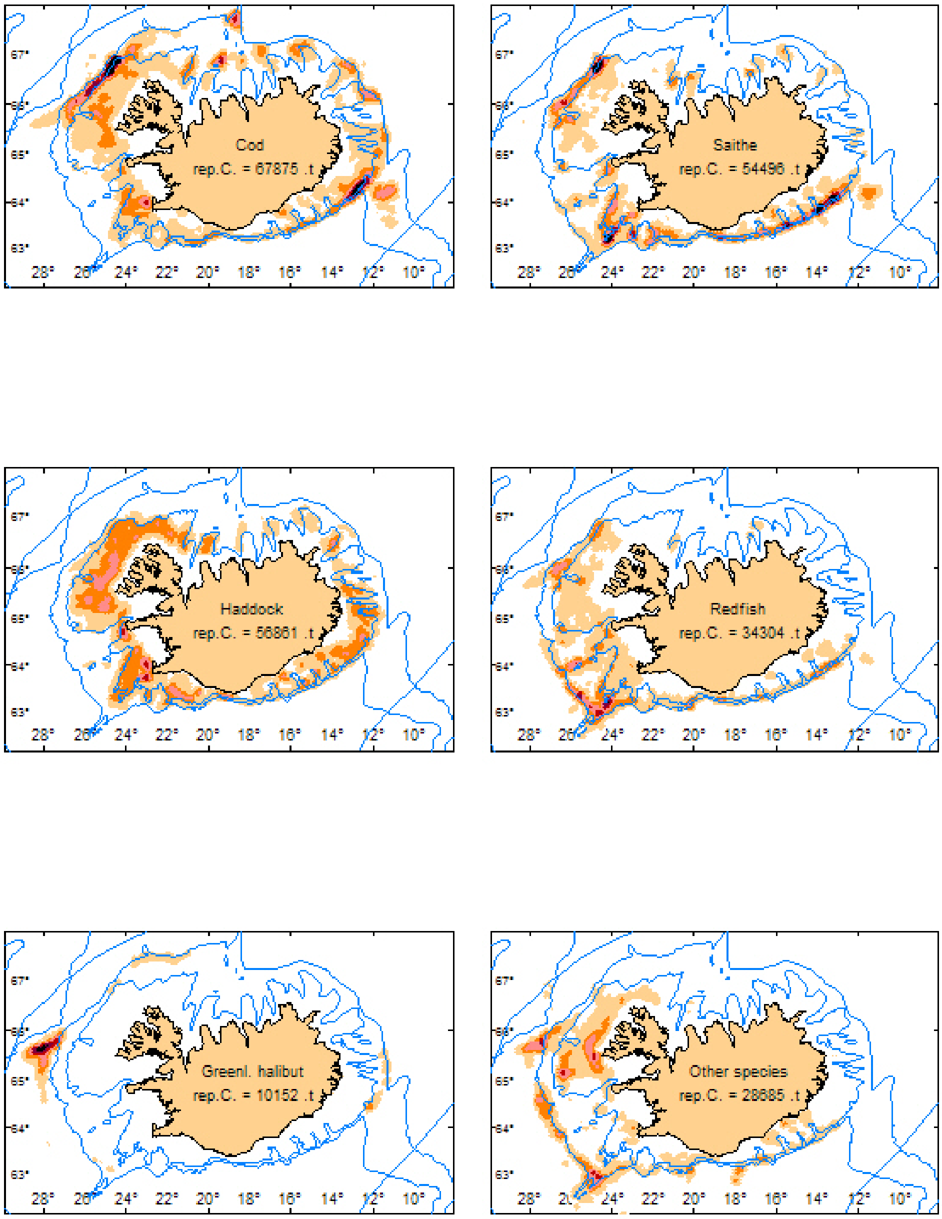

Figure 7.4.2. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with bottom trawl 2007.

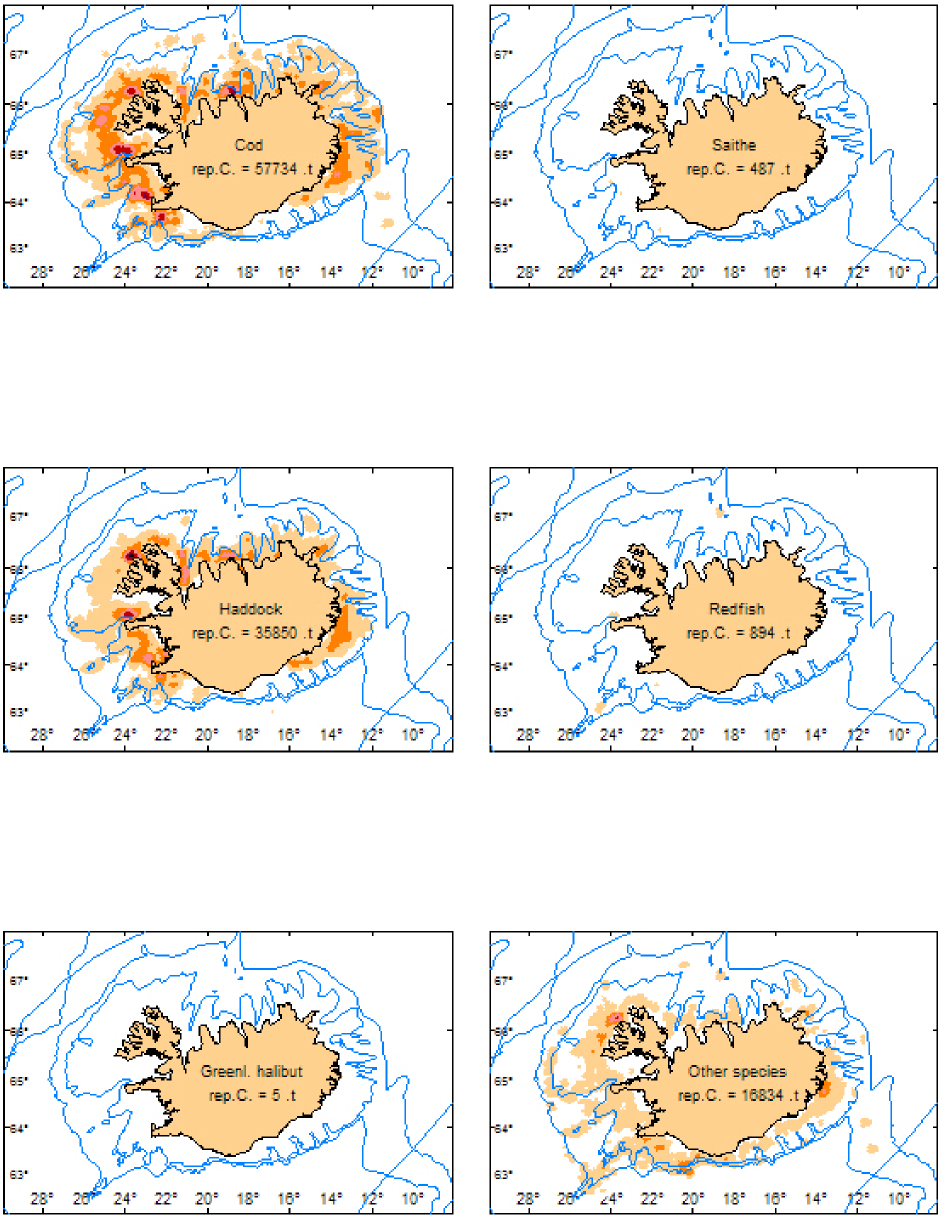

Figure 7.4.3. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with long-line in 2007.

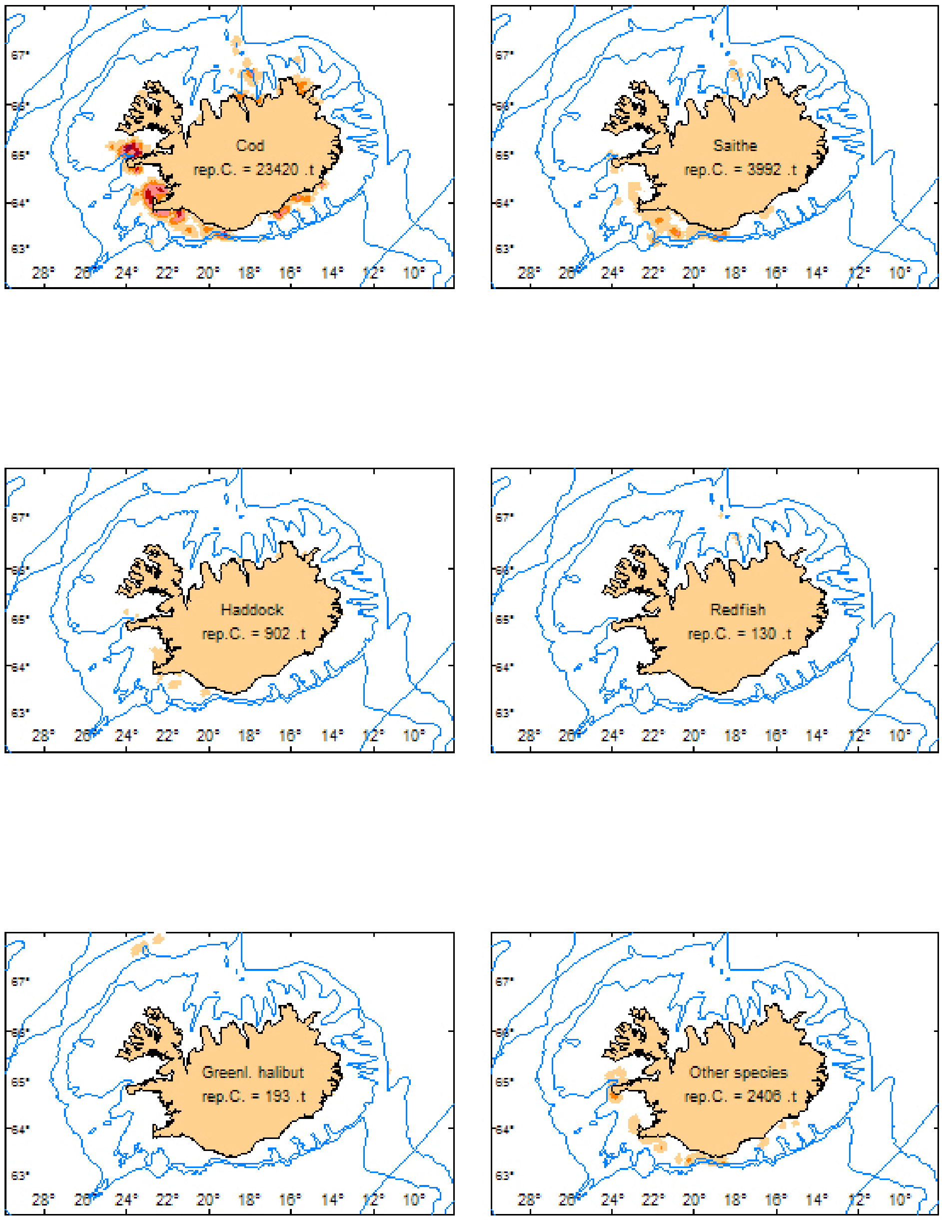

Figure 7.4.4. Location of catches of cod, saithe, haddock, redfish, Greenland halibut and others caught with gillnets in 2007.

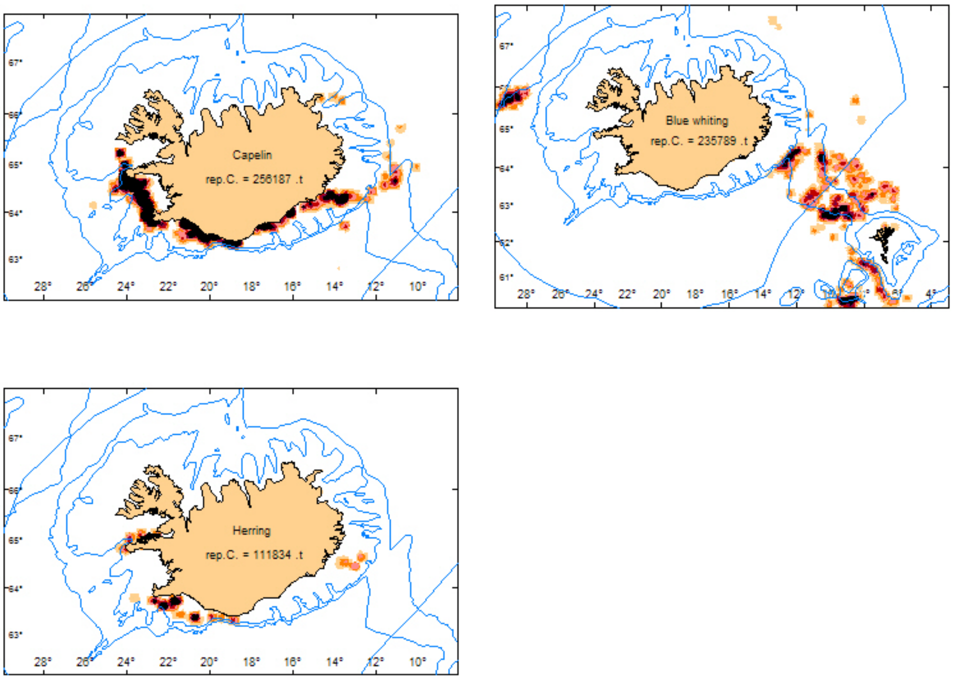

Figure 7.4.5. Location of catches of capelin, Icelandic summer spawning herring and blue whiting with purse seine and pelagic trawls in 2007.

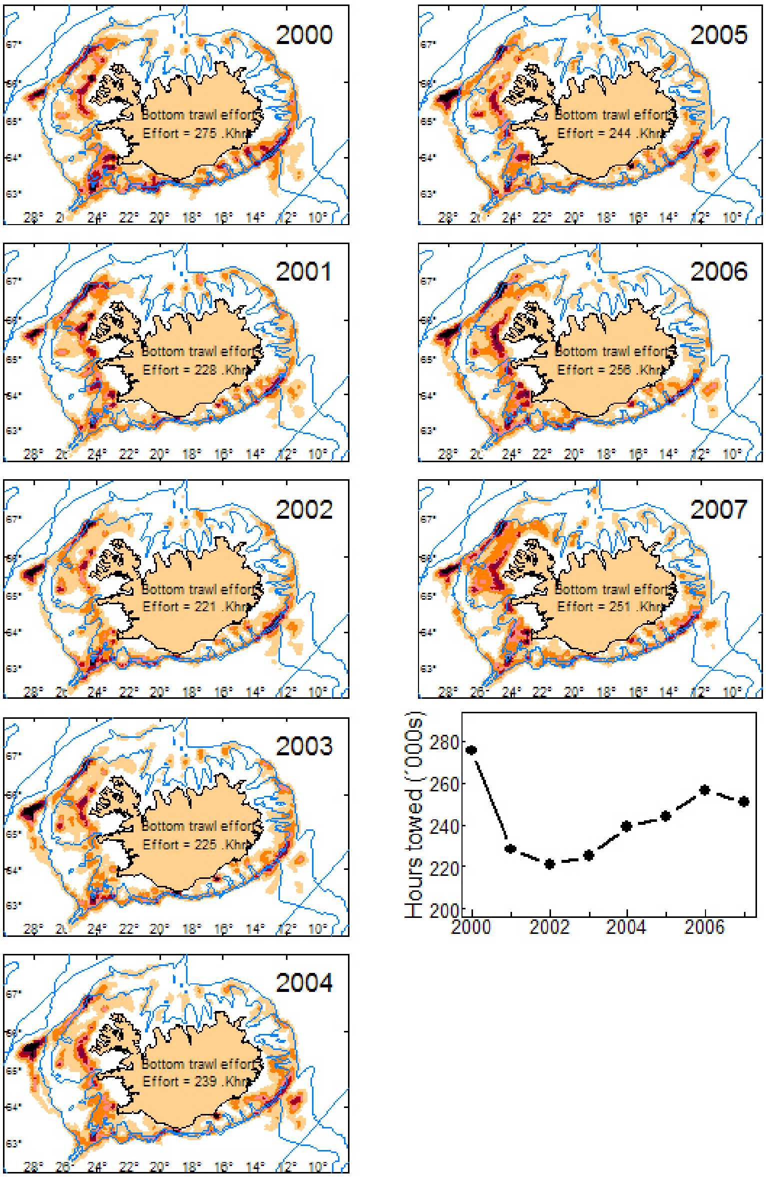

Figure 7.4.6 Spatial distribution of the trawler fleet effort (in hours trawled) in 2000-2007.

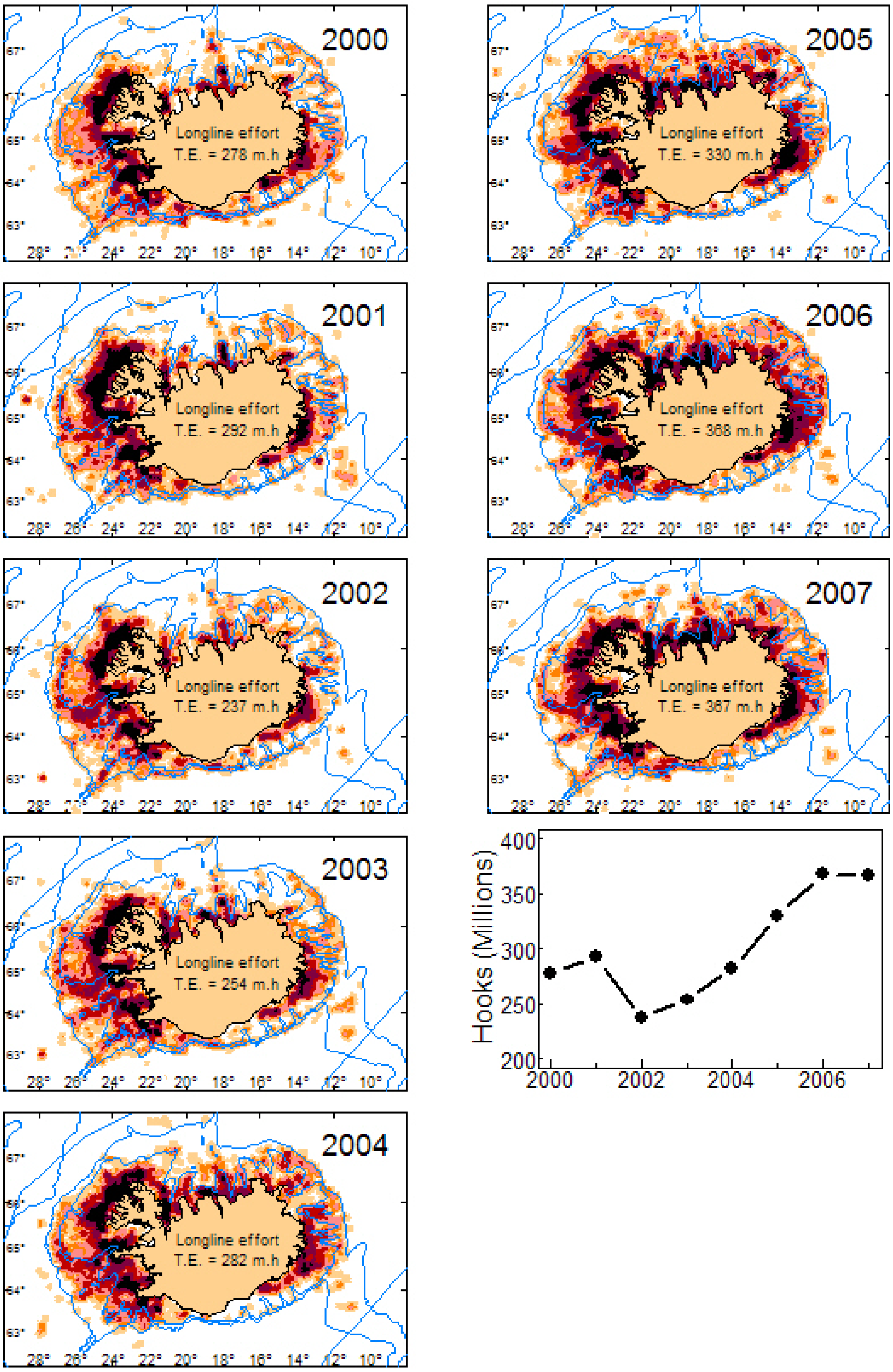

Figure 7.4.7. Spatial distribution of the longlinefleet effort (in number of hooks) in 2000-2007. The main targeted species for longline fishing are cod, haddock, catfish and tusk.

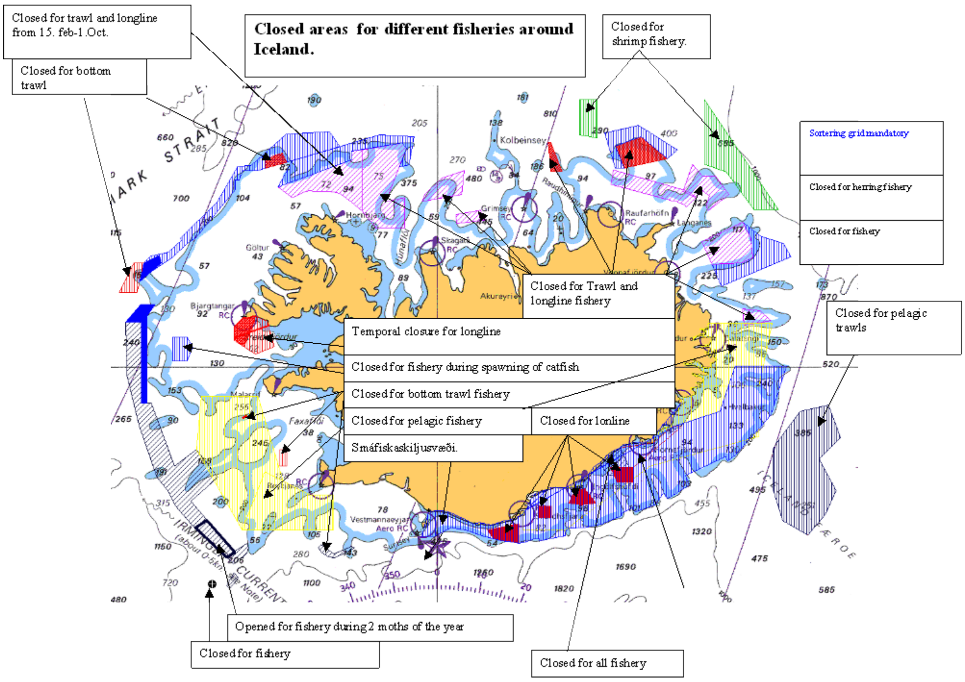

Figure 7.5.1. Overview of closed areas around Iceland. The boxes are of different nature and can be closed for different time period and gear type. NOT UPDATED

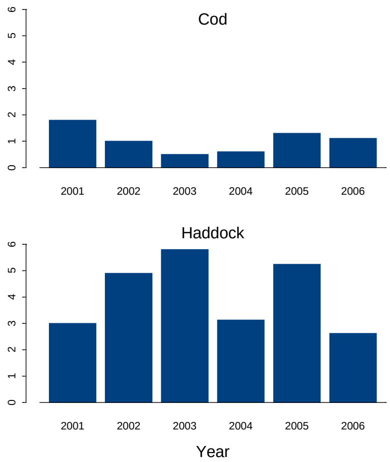

Figure 7.5.2. Estimates of discard percentage by weight, all gears combined for cod and haddock. Source: Ólafur K. Pálsson, Eyþór Björnsson, Guðmundur Jóhannesson, Ari Arason, og Þórhallur Ottesen 2007. Discards in demersal Icelandic fisheries 2006. Marine Research Institute, report series (manuscript for printing). NOT UPDATED

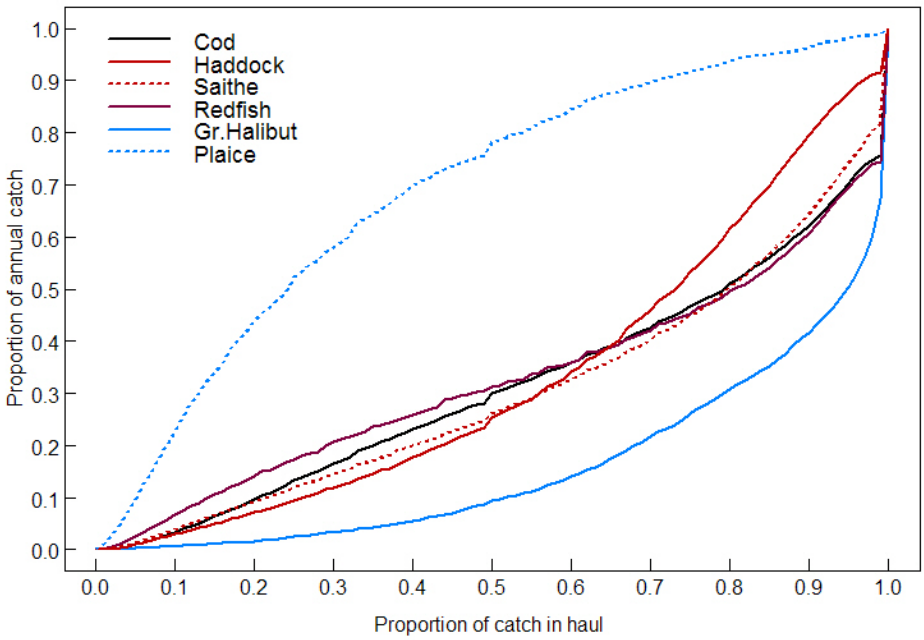

Figure 7.6.1. Cumulative plot for bottom trawl in 2007. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 60% of the total catch while only 4% of the catch of greenland halibut comes from hauls where it is less than 50% of the total catch. 75 % of the plaice is on the other hand caught in hauls where plaice is minority of the catches. The figures also shows that 70% of the catch of greenland halibut comes from hauls where nothing else is caught but only 10% of the haddock. Of the species shown in the figure plaice is the one with largest proportion as bycatch while greenland halibut is the one with largest proportion caught in mixed fisheries.

8 Saithe in Icelandic waters

8.1 Summary

- This assessment is a SPALY (Same Procedure As Last Year) assessment using the same input data with addition of one year and the same model with the same parameter settings as last year. The assessment results are very much in line with that of last year.
- The stock size (B4+ and SSB) is around the long term average but fishing mortality is high in most recent year. Relatively strong recruitment is now being replaced by much lower average recruitment. A SPALY advice, based on the short term prediction provided would imply very harsh measures if the stock is to be maintained above Bpa, following the advisory year.
- The major issue in the development of the saithe stock, are low mean weight at age for most ages in recent years and recent changes in fishing pattern, with increasing mortality on younger fish. In addition weight at age of the older age groups, in the early part of the time series seem to be abnormally high. If they are artificially high, the dynamic range of historical SSB is much narrower than what has been used in past assessments. All the above points have implications with regards to the appropriateness of using the current reference points as the basis of the advice.
- Recommendations are made for the Benchmark Workshop in January 2009 (where the Icelandic saithe will be on the agenda), with regards to further issues to explore, both in terms of assessment inputs and reference points. However, for next year's advice the WG suggests interim reference F values to be used as the basis of the advice. The approach used is similar as has been done for Icelandic haddock, in part due to similar issues.

8.1 Stock description and management units

Description of the stock and management units is provided in NWWG 2008 report.

8.2 Fisheries dependent data

8.2.1 Landings, advice and TAC

Landings of saithe in Icelandic waters in 2008 are estimated to have been 70,189 tonnes (Table 8.1 and Figure 8.1). Landings of ~65-75 kt have now been taken since 2004 or 5 year running. Domestic landings in the quota year 2007/2008 amounted to 66718, 13500 tonnes short of the 75Kt TAC issued (Figure 8.2).

The domestic advice of 50 kt in the current fishing year differed from that of ICES advice (22 kt) for 2009 where the latter based the advice on maintaining SSB above Bpa in the year following the advisory year. ICES however noted in the Management considerations last year the following: "Recent information on stock dynamics and growth rate of saithe suggests that the biomass reference points defined in 1998 would need to be re-evaluated. Fishing at Fpa, and thereby ignoring the Bpa threshold, would correspond to landings of 50 000 t which is expected to decrease SSB to 124 000 t (10% decrease in SSB compared to 2009)." The TAC for the current fishing year was however set by the managers to 65 kt.

The gear used for catching saithe is mainly bottom trawl (~85% in 2006-2008), gillnet, jiggers and Danish seine taking the majority of the rest (Figure 8.1). The gillnet fleet has in the past taken a considerable part of the total catches especially when large year classes have reached age 5 or 6 and its proportion of the domestic landings has now increased from 5% to almost 10%.

8.2.2 Landings by age

Catch in numbers by age based on landings are shown in table 8.2. Discarding is not considered to be a problem in the Icelandic saithe fisheries for which monitoring programmes have been in place (Pálsson 2003). Comparison of sea and harbour samples indicate that discard was small in the last two years, as it has been in most years since 2000. The sea-samples constitute about 60-70% of the length samples used in the calculation of the catch in number. Since the amount of discard is likely to be small, not taking discards into account in the total catches and catch in numbers is not considered to have major effect on the stock dynamics estimated.

The sampling program and sampling intensity in 2008 as well as the approach used for calculating catch in numbers is the same as has been done in preceding years. What follows in the rest of this subsection are some details of how samples are taken and how the numbers are calculated. Data from samples from catch of most gear types, collected systematically over the year (SÝNÓ-system and Icelandic discards monitoring programme) and representative of the distribution of the fishery, were used to calculate catch in numbers at age in total landings in 2008, with the sampling level indicated in the text table below:

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	3914	8	370	20	1900
Jiggers	1733	2	78	11	899
Danish seine	1197	2	100	13	2364
Bottom trawl	54308	125	6198	326	49561
Other gear	2853	-	-	-	-
Foreign landings	425	-	-	-	-
Total	64430	137	6746	370	54724

Gillnet catches were split according to a gear-specific age-length key, the rest of the catches were split according to a key based on all samples from commercial gear except those from gill nets. The length weight relationship used ($W = 0.02498 * L^{2.75674}$) was applied to length distributions from both fleets.

Estimated by-catch of saithe in the blue whiting fishery in the Icelandic EEZ was added to catch in numbers in 2003-2005. The by-catch was split on age groups according to samples from landings as length distributions of saithe in the by-catch samples were similar to that in landings. The estimates indicate that the by-catch is an insignificant part of the total catch (~1%). The sampling program from the blue whiting catches has continued, but very little saithe have been observed in recent years (Ólafur K. Pálsson, pers. comm.), so no pelagic saithe by-catch estimate has been included in the 2006-2008 catch at age.

8.2.3 Mean Weight and maturity at age

Mean weights at age in landings are computed on the basis of samples of otoliths and lengths along with length distributions and length-weight relationships. Weight at age in recent years have been below average and remains so in (Table 8.3 and Figure 8.3). Weight at age in the landings is also used as weight at age in the stock. It is of note that the weights at age in the first 4 years of the time series are constant and abnormally high in the older age classes. This issue is discussed further in section 8.6 on Reference points.

Predicted weights (2009 and beyond, Table 8.3 and Table 8.11) and Figure 8.3) are as in last year assessment based on the average of the three terminal years (2006-2008).

Annual maturity estimates are poor and highly variable and and a fixed maturity ogive has been used since 2004 (Table 8.4). This is also used in the predictions (Table 8.11).

8.2.4 Log book data

The main fishing grounds of the bottom trawl fishery are southwest of Reykjanes and off the south east coast and in recent years an area NW of Iceland has become increasingly important. The gillnet fishery is concentrated on spawning grounds south and southwest of Iceland.

Simple CPUE indices i.e. mean and median CPUE in trawl hauls where saithe was recorded, as either more or less than 50% of the reported catch in each haul are shown in Figure 8.4. The indices increased sharply from 2000-2004 but have decreased since then, how much varies between indices. The CPUE did not change much from 2007 to 2008 and is above the level from 1988 to 2000.

8.3 Scientific surveys

Saithe is among the most difficult demersal fishes to get reliable information on from bottom trawl surveys. In the March survey which has 500-600 stations large proportion of the saithe is caught in relatively few hauls and there seems to be considerable inter-annual variability in the number of these hauls.

The survey indices indicate that biomass indices were high in the beginning of the period, low in the period 1995-2001, high in the period around 2005, but declining to a low level in the most recent years (Figure 8.5)

Internal consistency in the surveys measured by the correlation of the indices for the same year class in 2 adjacent surveys is bad with R2 close to 0.3 for the best defined age groups much lower for some other. Despite these poor diagnostic the retrospective pattern are surprisingly good, when using these noisy data spring survey data (Figure 8.7). This may be a pure coincidence or it may have origin in that the inter-annual variability is higher in the period prior to 1999 as is apparent in the high variability in the biomass estimator in Figure 8.7.

Small saithe tends to live very close to shore, near piers so survey indices for ages 1 and 2 are non surprisingly not good measures of recruitment and the number of those saithe caught in the survey is very low.

8.4 Assessment methods

The data used for the analytical assessment are as last year the spring survey abundance indices at age (ages 3-10, year 1985-2009) and catch at age (ages 3-14, years 1974-2008) and catch weight at age. Maturity is poorly estimated and a fixed maturity ogive has been used since 2004. The model (ADCAM) is a statistical catch at age model. No changes in the setting of the model were done since from the run last year. An assessment using a Time Series Model (Guðmundur Guðmundsson, NWWG 2009 WD # xx) is as usual also run

The *AD*CAM model settings for saithe are the same as last year and are as follows:

- Nonparametric fishing mortality. Random walk model of fishing mortality with light weight.
- Catch at age data from 1974 to 2008, survey data 1985 – 2009, age 2-10.
- Ricker SSB-recruitment relationship first recruitment guess. Autocorrelation in residuals modelled.
- Correlation of residuals of age groups in survey estimated.
- CV of residuals in the catch and the survey estimated. The pattern in each set is given but one multiplier estimated.
- Linear relationship for all age groups.
- 5 Migrations estimated (the same as in TSA)

THE ADCAM MODEL RESULTS: The CV in the catch by age is low, the CV in the survey quite high (Figure 8.6). The lowest survey CV is observed in age groups 5 to 7 (just under 0.4). Residuals (ln-observed vs. ln-predicted) from the survey are shown in table 8.7 and the catch residuals from the assessment are shown in table 8.6. The survey residuals are largely positive in 2004-2006 and negative in 2007-2009 (Figure 8.6 and 8.7) indicating, as in the more distant past, that the model does understandably not follow the information in survey indices exactly. The results of the principal stock parameters (Table 8.10 and Figure 8.9) are in line with that estimated last year (Figure 8.8). The details of the fishing mortality and stock in numbers by re presented in Tables 8.8 and 8.9. These point estimator values estimated using the ADCAM model were, as last year used as "the final run".

THE TSA MODEL RESULTS: What follows is an excerpt of the summary (Table 8.13) made by the developer of the method (Guðmundur Guðmundsson, see WD #11 NWWG 2009 for details of the method and mathematical notation,):

> "Estimation of saithe was carried out with catch-at-age 1985-2008, ages 4-11, and March survey index 1985-2009, ages 2-6.
>
> The survey indices for saithe are considerably less informative than for cod or haddock. Accordingly estimated standard deviations are higher, especially in the recruitment ages, but also in total biomass and average F.
>
> Selectivity is considerably more variable in this stock than in Icelandic cod and haddock. This is expressed both by large variances of residuals in the model for f_{at} and also by permanent and transitory variations expressed by $\Gamma_{f,2,a}\ \zeta_{2,,t-1}$ and $\Gamma_{f,3,a}\ \zeta_{3,t-1}$. There has been a shift towards younger fish in recent years.
>
> Stock dependence was not apparent so that $\phi_a \equiv 1$.
>
> Estimation of the natural mortality rate requires fairly good data for both catch-at-age and CPUE index. The present data are insufficient for this so m_0 is fixed at log(0.2). The likelihood function was maximised with no variation

in natural mortality. Experiments with some variations included had negligible effect on the stock estimates and the present estimates are obtained by constant m_{at}. The data are also inadequate for separate estimation of variations in f_{at} and measurement errors in catch-at-age, but the likelihood function clearly prefers variations in f_{at}.

There are fairly large discrepancies in the retrospective analyses and less correspondence between the retrospective patterns of biomass and average F than is commonly observed. This is associated with the large variations in selectivity and possibly also the fact that the parameter controlling the magnitude of permanent variations in selectivity was much lower in the earlier than the latest estimates."

The principal reference estimates of B4+ and F4-9 in the terminal years are very similar in the TSA and ADCAM framework.

8.5 Reference points

Reference points for Icelandic saithe were defined in 1998. Blim was then defined as Bloss or 100 000 tonnes. The Bpa base were the low SSB values in 1978 – 1997 or 150 000 tonnes. Fpa was set as the fishing mortality sustained for 3 decades or 0.3.

The reference points for Icelandic saithe were based on data from 1962 - 1998. Bloss of 90 000 tonnes was suggested as candidate for Blim. When the reference points were set it was noted that no SSB-recruitment relationship had been observed. Or as was put into a more understandable language by SGPRP in 2003 "the breakpoint of the segmented regression was not significantly different from Bloss".

The dynamic range of the long data series (1962 onwards), used at the time the reference points were set in 1998 and revisited in 2003 (SGPRP 2003), show the spawning stock ranging from 90 000 tonnes in 1998 to 400 000 tonnes in 1969-1971 (data not shown in this report, see NWWG2009 WD #13 for some detail plots of parameters discussed in this section). Comparison of landings data and sum of products for the period around 1970 indicates that mean weight in the catches might be overestimated by 40%. This observation resulted in the data series being cut to period after 1974 in 2006 assessment and in consequent years. The discrepancy in the landings and sum of products however applies to all years before 1981 although the overestimate of weight in the late seventies is closer to 20%. As has been mentioned in section 8.3.3 the weights at age in the older age groups of the first four years (1975-1989) of the current data series are constant and abnormally high (Figure 8.3). If the catch in numbers are correct and if the weights are abnormally high the large spawning stock in the beginning of the current time series are likely also an overestimate (Figure 8.9).

Although a thorough, and thus presentable analysis on the long time series was not possible before and during the present meeting, exploratory analysis indicate that the high value values of the spawning stock around 1970 will more likely be on the order of 250 thousand tonnes rather than 400 thousand tonnes. Similarly, the spawning stock in 1975 to 1979 is likely to be lower than the 200 to 280 thousand tonnes presented here (Figure 8.9). The values around the period 1969-1978 would however still be the highest value of SSB in the long series. This is caused by series of good year classes from 1960-1968 but average size of those Year classes at age 3 is 70 million. Year class larger than 70 million has only been seen once since Year class 1968, the 1984 Year class. Investigation of catch in numbers from before 1975 indicates that migration into Icelandic waters might play an important role. The catch data are though noisy due to limited otolith sampling in that time period, making reasonable estimates of the size of immigration from catch at age data in that period difficult.

The only years with reliable data to compile the spawning stock are therefore from 1981 onwards In that period the spawning stock ranges from 90 to 190 000 tonnes. The period is characterized by good recruitments from Year classes 1981-1985, poor from 1986 - 1996 and good from 1998-2002. As in the work done by SGPRP in 2003 no relationship between spawning stock and recruitment is noted but the autocorrelation of residuals is estimated high, probably caused by the long period of poor (typical) recruitment from Year classes 1986-1996. It is also clear that with so much autocorrelation the data series is rather short.

Following the periods of good recruitment the spawning stock usually exceeds Bpa but has dropped relatively fast due to too higher fishing mortality when stock is decreasing and in recent years also due to low mean weight at age. The reduction in weight has been considerable so now the weight at age of a number of age groups is nearly "one year behind" compared to the mean of last 30 years. Low mean weight at age has been seen in this stock before, especially in large Year classes and sometimes been linked to migrations.

This reduction in mean weight at age means that both fishing mortality and biomass reference points need to be revised, as already noted last year. Also the large autocorrelation of residuals in the SSB-recruitment relationship would call for reduction of the presently set fishing mortality and biomass reference points. Another issue is that in recent years is the tendency of the fleet to target small saithe. This change in selection pattern leads to smaller spawning stock per recruit for a given fishing mortality. To see the effect changes in mean weight at age and selection the stock was simulated for number of years with the recruitment pattern observed in 1981 - 2009 repeated cyclically but 4 different combinations of selection pattern and mean weight at age (see Figure 8.11):

- Selection pattern 2002-2008, weights 2008
- Selection pattern 2002-2008, weights 1981-2008
- Selection pattern 1991-2007, weights 2008
- Selection pattern 1981-2007, weights 1981-2008

Fishing mortality was assumed to be followed exactly which is of course not realistic considering the relatively imprecise stock estimate.

Figure 8.11 shows a cumulative probability distribution of the spawning stock when fishing at F_{4-9} = Fpa = 0.3. The effect of the change in selection pattern seems to be of the same order as the effect of changes in mean weight at age. The probability of being below Blim is negligible for the run with the long term selection pattern and weights but in the range of 10-20 % in the other settings. The probability of being below Bpa is between 40 and 90% so in over half of the cases the advice will not be based on Fpa but on getting the stock above Bpa in the year following the advisory year. If uncertainty in the assessment is included the probability that advice becomes based on the biomass reference points rather than Fpa=0.3 is even higher. For a relatively long lived species like saithe the biomass reference points should not affect the advice when the stock is fished at Fpa is as upper bound of Ftarget. Effectively Ftarget if a harvest control rule is set in place needs to be set well below the current Fpa value if the current weight at age and selection pattern persist. These investigations do therefore indicate that the both the biomass and fishing mortality reference points need to be lowered and both linked to mean weight at age. The effect of changes in selection pattern does also need to be addressed.

Weight at age is now nearly one year behind the spawning stock biomass. The predicted spawning stock biomass in 2010-2011 would be 20% higher if the mean weights from 1981-2008 were used instead of the current weights (average 2006-2008). As has already been done for Icelandic haddock, the relationship between F_{3-8} and F_{4-9} can be used to approximate the effect of weight reduction on current reference F. The ratio between the long term average F_{3-8} and F_{4-9} is 0.8. Weight at age for ages 4-9 now is approximately 0.75 years behind. Taking this reduction into account leads to F_{4-9} = 0.3*(0.8^0.75) = 0.25. The Fpa should thus be reduced to that number. Taking the change in selection into account the Fpa should further be reduced to around 0.22. This value of reference F is suggested as a temporary solution with a better solution postponed for the planned benchmark of Icelandic saithe in a workshop in January 2009.

Figure 8.12 shows the cumulative profile of spawning stock if F_{4-9}=0.22 was followed. There seems to be little risk of the stock going below current Blim irrespective of weight and selection scenario. The stock would on the other hand often be close to 150 and with Bpa of 150 kt and rather imprecise assessment the Bpa point would exaggerate the inter-annual changes in Tac caused by those oscillations. Looking at plots of spawning stock, fishing mortality and recruitment since 1981 no major trends can be seen (Figure 8.9). The mean fishing mortality during that period has been 0.32 and there has been a tendency to have higher mortality in periods of reduced stock size. To summarize the points mentioned here before the NWWG makes the following recommendations to the January meeting:

1) Linking target fishing effort to weight at age and make it more independent of selection than using fishing mortality of age 4 to 9 is.
2) Considering general lowering of Ftarget to take into account long periods without good recruitment.
3) Lowering biomass reference points, so the advice in "normal" situation is calculated from Ftarget rather than biomass reference points. Let the points follow stock weights.

For the calendar year 2010 the NWWG recommends that advice is based on F4-9 = 0.22 which is the Fpa of 0.3 corrected for effect of lower mean weight and changed selection in recent years.

8.6 State of the stock

The spawning stock in the beginning of 2009 is estimated to be 137, 000, which is close to the long term mean but below Bpa=150 000. Fishing mortality in 2008 is 0.38, which is higher than Fpa=0.2. It has been increasing in recent years. Year classes 1998-2000 and 2002 are strong but the year classes after 2003 considerably smaller, fluctuating around the long term geometric mean.

8.7 Short term forecast

The input for the short term forecast, the basis which is the same as last year, is shown in Table 8.11. The mean projected weights, the selection pattern are the average of the years 2006-08, the maturity ogive the fixed pattern used for recent years. Stock in numbers for age groups 3-14 in 2009 were those estimated in the ADCAM model. The assumed recruitment of 15 million fish for year classes 2007 onward is the same as used last year. A "TAC-constraint" of 55 kt landings is applied in the assessment year based on best estimates of catches in 2009. This results in a fishing mortality that is very close to the terminal value (F09=0.36 compared with F08=0.38).

Results from short term prediction are shown in Table 8.12. They indicate that the SSB in 2011 will be below 150 000 tons if fished at Fpa =0.3 in 2010. Even applying a zero fishing mortality will not bring the SSB above the current Bpa in 2010. However, has been noted above the low weight at age imply that the SSB is around 20% lower than under average conditions.

As For the calendar year 2010 the NWWG recommends that advice is based on F4-9 = 0.22 which is the Fpa of 0.3 corrected for effect of lower mean weight and changed selection in recent years. This advice will most likely lead to little change in spawning stock from 2010 to 2011.

8.8 Uncertainties in assessment and forecast

The assessment of Icelandic saithe is relatively uncertain due to lack of good tuning data. The internal consistency in the survey that is used for the assessment is very low. These things are not surprising considering the nature of the species that is partly pelagic, schooling and relatively widely migrating. The retrospective pattern is however surprisingly good, giving credence for using the survey data rather than just the catch at age matrix.

Landings in last 3 years have shown more than expected of young fish and less of older fish than expected. Some of it is due changes in selection and some can be due to less than predicted of older age groups or changes in behaviour of the older fish. How much is caused by each of those is on the other hand not known.

8.9 Comparison with previous assessment and forecast

The estimated SSB in 2009 is the same as estimated in by NWWG2008 (137 vs 139). Same applies to the fishing mortality estimates in 2007 0.33 vs 0.32). No major revision has been in the recruitment estimates this year, which is different from the past few where there were some significant changes between assessment years.

8.10 Ecosystem considerations

Changes in the distribution of the large pelagic stocks (blue whiting, Norwegian spring spawning herring) may affect the propensity of saithe to migrate off shelf and between management units. This is poorly documented but well .known. The evidence from the tagging experiments shows that there is some traffic along the Faroe-Iceland Ridge and also to some extent onto the East Greenland shelf, but to which extent, the larger saithe, some of which went missing in the last 2 assessments (especially the 2000 year class) are out of reach from the fishery is not know. A hypotheses of a descending right limb on the selection curve for saithe might have some merit, the saithe might thereby show resilience to fishing given that enough saithe 'escape' from the fishery onto the niche where the large pelagic stocks are available.

8.11 Changes in fishing technology and fishing patterns

There are indications that the fleet may be increasingly targeting younger fish in recent years.

The proportion of saithe landings taken in gillnets increased slightly in recent years (from 5% in 2005 to 10% in 2008) in spite of the fact that in recent years the total effort of gillnetters has gone down around Iceland. This fleet might be able pick up saithe from the large year classes of 2000 and 2002 if they show up again.

Table 8.1 Nominal catch (tonnes) of SAITHE in Division Va by countries, 1997-2008, as officially reported to ICES with working group estimates.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Faroe Islands	716	997	700	228	128	366	143	214	322	415	392	196
Germany	-	3	2	1	14	6	56	157	224	33		
Iceland	36548	30531	30583	32914	31854	41687	51857	62614	67283	75197	64005	69,991*
Norway	-	-	6	1	44	3	164	1	2	2	3	2
UK (E/W/NI)	-	-	1	2	23	7	...	105				
UK (Scotland)	-	-	1	-	-	2	...					
United Kingdom						35		312	16	30		
Total	37264	31531	31293	33146	32063	42071	52091	63091	68143	75663	64430	70189*
WG es.	37264	31531	31293	33146	32063	42106	52494	64791	69143	75663	64430	70189

Table 8.2. Saithe in division Va. Catch in numbers (thousands) 1974--2008.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1974	1.269	3.404	2.348	3.164	3.452	3.384	1.303	0.824	0.351	0.141	0.043	0.013
1975	0.526	2.997	2.479	1.829	3.496	2.994	1.434	0.710	0.325	0.176	0.100	0.036
1976	0.329	3.234	3.045	2.530	2.154	2.367	1.530	1.064	0.295	0.191	0.094	0.068
1977	0.059	2.099	2.858	1.801	1.036	1.068	1.528	0.958	0.538	0.166	0.071	0.012
1978	0.548	1.145	2.435	1.556	1.275	0.961	0.537	0.575	0.476	0.279	0.139	0.091
1979	0.480	3.764	1.991	3.616	1.566	0.718	0.292	0.669	0.589	0.489	0.150	0.072
1980	0.275	2.540	5.214	2.596	2.169	1.341	0.387	0.262	0.155	0.112	0.064	0.033
1981	0.203	1.325	3.503	5.404	1.457	1.415	0.578	0.242	0.061	0.154	0.135	0.128
1982	0.508	1.092	2.804	4.845	4.293	1.215	0.975	0.306	0.059	0.035	0.048	0.046
1983	0.107	1.750	1.065	2.455	4.454	2.311	0.501	0.251	0.038	0.012	0.002	0.004
1984	0.053	0.657	0.800	1.825	2.184	3.610	0.844	0.376	0.291	0.135	0.185	0.226
1985	0.376	4.014	3.366	1.958	1.536	1.172	0.747	0.479	0.074	0.023	0.072	0.071
1986	3.108	1.400	4.170	2.665	1.550	1.116	0.628	1.549	0.216	0.051	0.030	0.014
1987	0.956	5.135	4.428	5.409	2.915	1.348	0.661	0.496	0.498	0.058	0.027	0.048
1988	1.318	5.067	6.619	3.678	2.859	1.775	0.845	0.226	0.270	0.107	0.024	0.001
1989	0.315	4.313	8.471	7.309	1.794	1.928	0.848	0.270	0.191	0.135	0.076	0.010
1990	0.143	1.692	5.471	10.112	6.174	1.816	1.087	0.380	0.151	0.055	0.076	0.037
1991	0.198	0.874	3.613	6.844	10.772	3.223	0.858	0.838	0.228	0.040	0.006	0.005
1992	0.242	2.928	3.844	4.355	3.884	4.046	1.290	0.350	0.196	0.056	0.054	0.015
1993	0.657	1.083	2.841	2.252	2.247	2.314	3.671	0.830	0.223	0.188	0.081	0.012
1994	0.702	2.955	1.770	2.603	1.377	1.243	1.263	2.009	0.454	0.158	0.188	0.082
1995	1.573	1.853	2.661	1.807	2.370	0.905	0.574	0.482	0.521	0.106	0.035	0.013
1996	1.102	2.608	1.868	1.649	0.835	1.233	0.385	0.267	0.210	0.232	0.141	0.074
1997	0.603	2.960	2.766	1.651	1.178	0.599	0.454	0.125	0.095	0.114	0.077	0.043
1998	0.183	1.289	1.767	1.545	1.114	0.658	0.351	0.265	0.120	0.081	0.085	0.085
1999	0.989	0.732	1.564	2.176	1.934	0.669	0.324	0.140	0.072	0.025	0.028	0.022
2000	0.850	2.383	0.896	1.511	1.612	1.806	0.335	0.173	0.057	0.033	0.017	0.007
2001	1.223	2.619	2.184	0.591	0.977	0.943	0.819	0.186	0.094	0.028	0.028	0.013
2002	1.187	4.190	3.147	2.970	0.519	0.820	0.570	0.309	0.101	0.027	0.015	0.011
2003	2.262	4.320	5.973	2.448	1.924	0.282	0.434	0.287	0.195	0.027	0.029	0.015
2004	0.952	7.841	7.195	5.363	1.563	1.057	0.211	0.224	0.157	0.074	0.039	0.011
2005	2.607	3.089	7.333	6.876	3.592	0.978	0.642	0.119	0.149	0.089	0.046	0.012
2006	1.380	10.051	2.616	5.840	4.514	1.989	0.667	0.485	0.118	0.112	0.086	0.031
2007	1.244	6.552	8.751	2.124	2.935	1.817	0.964	0.395	0.190	0.043	0.036	0.020
2008	1.432	3.602	5.874	6.706	1.155	1.894	1.248	0.803	0.262	0.176	0.087	0.044

Table 8.3 Saithe in Division Va. Mean weight at age in the catches and in the spawning stock 1974-2008 with predicted weights for 2009-2011 (as the average of 2006-2008).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1974	1.120	1.760	2.730	4.290	5.540	7.270	8.420	9.410	10.000	10.560	11.870	13.120
1975	1.120	1.760	2.730	4.290	5.540	7.270	8.420	9.410	10.000	10.560	11.870	13.120
1976	1.120	1.760	2.730	4.290	5.540	7.270	8.420	9.410	10.000	10.560	11.870	13.120
1977	1.120	1.760	2.730	4.290	5.540	7.270	8.420	9.410	10.000	10.560	11.870	13.120
1978	1.120	1.760	2.730	4.290	5.540	7.270	8.420	9.410	10.000	10.560	11.870	13.120
1979	1.116	1.760	2.731	4.294	5.539	7.268	8.415	9.410	10.001	10.563	11.873	13.115
1980	1.428	1.983	2.667	3.689	5.409	6.321	7.213	8.565	9.147	9.617	10.066	11.041
1981	1.585	2.037	2.696	3.525	4.541	6.247	6.991	8.202	9.537	9.089	9.351	10.225
1982	1.547	2.194	3.015	3.183	5.114	6.202	7.256	7.922	8.924	10.134	9.447	10.535
1983	1.530	2.221	3.171	4.270	4.107	5.984	7.565	8.673	8.801	9.039	11.138	9.818
1984	1.653	2.432	3.330	4.681	5.466	4.973	7.407	8.179	8.770	8.831	11.010	11.127
1985	1.609	2.172	3.169	3.922	4.697	6.411	6.492	8.346	9.401	10.335	11.027	10.644
1986	1.450	2.190	2.959	4.402	5.488	6.406	7.570	6.487	9.616	10.462	11.747	11.902
1987	1.516	1.715	2.670	3.839	5.081	6.185	7.330	8.025	7.974	9.615	12.246	11.656
1988	1.261	2.017	2.513	3.476	4.719	5.932	7.523	8.439	8.748	9.559	10.824	14.099
1989	1.403	2.021	2.194	3.047	4.505	5.889	7.172	8.852	10.170	10.392	12.522	11.923
1990	1.647	1.983	2.566	3.021	4.077	5.744	7.038	7.564	8.854	10.645	11.674	11.431
1991	1.224	1.939	2.432	3.160	3.634	4.967	6.629	7.704	9.061	9.117	10.922	11.342
1992	1.269	1.909	2.578	3.288	4.150	4.865	6.168	7.926	8.349	9.029	11.574	9.466
1993	1.381	2.143	2.742	3.636	4.398	5.421	5.319	7.006	8.070	10.048	9.106	11.591
1994	1.444	1.836	2.649	3.512	4.906	5.539	6.818	6.374	8.341	9.770	10.528	11.257
1995	1.370	1.977	2.769	3.722	4.621	5.854	6.416	7.356	6.815	8.312	9.119	11.910
1996	1.229	1.755	2.670	3.802	4.902	5.681	7.182	7.734	9.256	8.322	10.501	11.894
1997	1.325	1.936	2.409	3.906	5.032	6.171	7.202	7.883	8.856	9.649	9.621	10.877
1998	1.347	1.972	2.943	3.419	4.850	5.962	6.933	7.781	8.695	9.564	10.164	10.379
1999	1.279	2.106	2.752	3.497	3.831	5.819	7.072	8.078	8.865	10.550	10.823	11.300
2000	1.367	1.929	2.751	3.274	4.171	4.447	6.790	8.216	9.369	9.817	10.932	12.204
2001	1.280	1.882	2.599	3.697	4.420	5.538	5.639	7.985	9.059	9.942	10.632	10.988
2002	1.308	1.946	2.569	3.266	4.872	5.365	6.830	7.067	9.240	9.659	10.088	11.632
2003	1.310	1.908	2.545	3.336	4.069	5.792	7.156	8.131	8.051	10.186	10.948	11.780
2004	1.467	1.847	2.181	2.918	4.017	5.135	7.125	7.732	8.420	8.927	10.420	10.622
2005	1.287	1.888	2.307	2.619	3.516	5.080	6.060	8.052	8.292	8.342	8.567	10.256
2006	1.164	1.722	2.369	2.808	3.235	4.361	6.007	7.166	8.459	9.324	9.902	9.636
2007	1.140	1.578	2.122	2.719	3.495	4.114	5.402	6.995	7.792	9.331	9.970	10.738
2008	1.306	1.805	2.295	2.749	3.515	4.530	5.132	6.394	7.694	9.170	9.594	11.258
2009	1.201	1.700	2.259	2.755	3.411	4.329	5.507	6.843	7.972	9.263	9.810	10.531
2010	1.202	1.700	2.260	2.757	3.412	4.331	5.509	6.846	7.975	9.267	9.813	10.535
2011	1.203	1.701	2.261	2.758	3.414	4.334	5.512	6.850	7.980	9.272	9.819	10.541

Table 8.4. Saithe in Division Va. Sexual maturity at age used to calculate SSB. Fixed ogive for 1974-1979, smoothed maturity at age for 1980-2003, fixed ogive for 2004-2011 at predicted values for 2004. The maturity model is based on samples from landings, in recent year insufficient to update model.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1974	0.000	0.060	0.270	0.630	0.810	0.970	1.000	1.000	1.000	1.000	1.000	1.000
1975	0.000	0.060	0.270	0.630	0.810	0.970	1.000	1.000	1.000	1.000	1.000	1.000
1976	0.000	0.060	0.270	0.630	0.810	0.970	1.000	1.000	1.000	1.000	1.000	1.000
1977	0.000	0.060	0.270	0.630	0.810	0.970	1.000	1.000	1.000	1.000	1.000	1.000
1978	0.000	0.060	0.270	0.630	0.810	0.970	1.000	1.000	1.000	1.000	1.000	1.000
1979	0.000	0.060	0.270	0.630	0.810	0.970	1.000	1.000	1.000	1.000	1.000	1.000
1980	0.150	0.240	0.390	0.650	0.780	0.890	0.950	1.000	1.000	1.000	1.000	1.000
1981	0.160	0.270	0.400	0.580	0.800	0.890	0.950	1.000	1.000	1.000	1.000	1.000
1982	0.160	0.290	0.450	0.590	0.740	0.900	0.940	1.000	1.000	1.000	1.000	1.000
1983	0.140	0.310	0.510	0.640	0.740	0.850	0.960	1.000	1.000	1.000	1.000	1.000
1984	0.110	0.260	0.490	0.690	0.800	0.860	0.920	1.000	1.000	1.000	1.000	1.000
1985	0.140	0.200	0.430	0.680	0.830	0.900	0.930	1.000	1.000	1.000	1.000	1.000
1986	0.080	0.260	0.360	0.630	0.820	0.910	0.950	1.000	1.000	1.000	1.000	1.000
1987	0.040	0.150	0.430	0.550	0.780	0.910	0.960	1.000	1.000	1.000	1.000	1.000
1988	0.100	0.090	0.280	0.620	0.720	0.890	0.960	1.000	1.000	1.000	1.000	1.000
1989	0.140	0.200	0.170	0.460	0.780	0.850	0.940	1.000	1.000	1.000	1.000	1.000
1990	0.170	0.270	0.350	0.310	0.650	0.890	0.930	1.000	1.000	1.000	1.000	1.000
1991	0.140	0.310	0.440	0.540	0.500	0.800	0.940	1.000	1.000	1.000	1.000	1.000
1992	0.190	0.270	0.500	0.630	0.720	0.680	0.900	1.000	1.000	1.000	1.000	1.000
1993	0.180	0.340	0.440	0.680	0.790	0.850	0.820	1.000	1.000	1.000	1.000	1.000
1994	0.190	0.330	0.530	0.630	0.820	0.890	0.920	1.000	1.000	1.000	1.000	1.000
1995	0.140	0.330	0.510	0.710	0.790	0.910	0.950	1.000	1.000	1.000	1.000	1.000
1996	0.160	0.270	0.520	0.700	0.840	0.890	0.960	1.000	1.000	1.000	1.000	1.000
1997	0.190	0.300	0.440	0.700	0.830	0.920	0.950	1.000	1.000	1.000	1.000	1.000
1998	0.220	0.340	0.480	0.630	0.840	0.920	0.960	1.000	1.000	1.000	1.000	1.000
1999	0.160	0.380	0.520	0.660	0.790	0.920	0.960	1.000	1.000	1.000	1.000	1.000
2000	0.150	0.290	0.570	0.710	0.810	0.890	0.960	1.000	1.000	1.000	1.000	1.000
2001	0.130	0.270	0.470	0.740	0.840	0.900	0.950	1.000	1.000	1.000	1.000	1.000
2002	0.110	0.240	0.450	0.660	0.860	0.920	0.950	1.000	1.000	1.000	1.000	1.000
2003	0.040	0.200	0.410	0.640	0.810	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2004	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2005	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2006	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2007	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2008	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2009	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2010	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000
2011	0.080	0.220	0.430	0.650	0.840	0.930	0.960	1.000	1.000	1.000	1.000	1.000

Table 8.5. Saithe in Division Va. IGFS indices of numbers at age 1985-2009 used for tuning in ADCAM and TSA

year\age	1	2	3	4	5	6	7	8	9	10
1985	0.05	0.61	0.58	3.06	5.18	1.73	1.03	0.47	1.32	0.13
1986	0.02	2.33	2.44	2.10	2.10	1.41	0.60	0.26	0.16	0.29
1987	0.10	0.39	11.54	12.94	6.31	3.71	2.89	0.74	0.34	0.24
1988	0.69	0.31	0.48	2.69	2.72	1.62	0.88	0.35	0.06	0.06
1989	0.20	1.43	3.96	4.98	6.46	2.42	1.74	0.89	0.39	0.00
1990	0.01	0.35	1.69	4.83	6.20	11.95	3.17	1.13	0.57	0.10
1991	0.01	0.22	1.40	1.69	2.15	1.08	2.38	0.28	0.02	0.02
1992	0.01	0.14	0.89	5.68	5.45	2.76	2.62	1.86	0.26	0.05
1993	0.00	1.27	11.04	2.00	6.79	2.40	2.24	1.02	4.00	0.64
1994	0.04	0.82	0.73	1.89	1.73	1.94	0.52	0.83	1.00	3.59
1995	0.06	0.48	1.97	1.09	0.50	0.28	0.33	0.09	0.14	0.15
1996	0.03	0.13	0.51	3.71	1.11	0.99	0.57	0.94	0.05	0.09
1997	0.23	0.32	0.90	4.66	3.90	0.94	0.39	0.15	0.10	0.05
1998	0.01	0.11	1.64	2.30	2.50	1.23	0.69	0.29	0.08	0.07
1999	0.57	0.75	3.70	0.92	1.23	1.64	0.56	0.16	0.02	0.02
2000	0.00	0.38	2.01	2.51	0.60	0.84	0.52	0.44	0.07	0.03
2001	0.00	0.89	1.90	2.60	1.58	0.20	0.22	0.38	0.13	0.07
2002	0.02	1.05	2.22	2.93	3.04	2.14	0.41	0.46	0.31	0.22
2003	0.01	0.05	9.60	4.99	2.90	1.34	0.75	0.20	0.05	0.10
2004	0.01	0.91	1.38	8.98	5.80	4.19	1.44	0.80	0.17	0.16
2005	0.00	0.23	4.32	2.32	6.85	4.27	2.17	0.85	0.43	0.12
2006	0.01	0.00	2.18	6.62	1.92	8.58	3.37	1.16	0.28	0.25
2007	0.00	0.05	0.30	1.70	3.07	0.74	1.47	0.64	0.27	0.15
2008	0.01	0.08	2.25	1.77	2.73	3.73	0.55	0.70	0.31	0.14
2009	0.01	0.21	2.42	1.79	0.65	0.84	0.75	0.11	0.25	0.14

Table 8.6. Saithe in Division Va. Log catch residuals from SPALY ADCAM run.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1974			0.13	0.00	-0.03	-0.03	-0.03	0.02	0.06	0.04	0.07	-0.08	-0.18	-0.00
1975			-0.01	-0.01	0.01	-0.07	0.02	-0.00	-0.08	-0.05	-0.05	0.05	-0.02	0.48
1976			0.02	0.02	0.01	0.12	0.06	-0.01	-0.03	0.04	-0.12	0.00	-0.03	0.39
1977			-0.36	-0.02	0.01	-0.00	-0.08	-0.09	0.14	-0.00	0.08	-0.12	-0.30	-1.22
1978			0.07	-0.02	-0.03	-0.11	0.03	0.10	-0.10	-0.26	-0.04	-0.01	0.25	0.48
1979			-0.01	-0.02	-0.02	0.01	-0.02	-0.13	-0.17	0.32	0.30	0.43	0.08	0.28
1980			-0.01	-0.01	0.04	0.02	0.00	0.10	-0.01	-0.01	-0.10	-0.52	-0.56	-0.62
1981			-0.05	-0.01	-0.05	0.02	-0.05	-0.07	0.02	-0.02	-0.31	0.43	0.20	0.54
1982			0.15	-0.01	0.06	-0.03	0.02	0.03	0.17	0.03	-0.27	-0.31	-0.11	-0.23
1983			-0.14	0.08	-0.02	-0.01	0.03	-0.02	-0.01	-0.34	-0.95	-1.27	-2.78	-1.98
1984			-0.63	-0.17	-0.14	-0.04	-0.07	0.08	-0.01	0.23	0.51	0.81	1.31	2.11
1985			0.02	0.13	0.08	0.00	-0.01	-0.15	-0.20	-0.10	-0.38	-0.94	0.27	1.10
1986			0.13	-0.06	-0.00	-0.08	-0.04	0.00	-0.06	0.15	0.02	0.25	-0.52	-0.46
1987			-0.12	0.01	0.02	0.07	0.02	0.03	0.09	0.12	-0.06	-0.12	-0.05	0.59
1988			0.09	-0.03	-0.01	-0.02	0.01	-0.00	0.16	-0.19	0.21	-0.33	-0.50	-2.64
1989			-0.03	0.05	-0.01	0.03	-0.13	-0.05	-0.07	-0.08	0.16	0.61	-0.15	-0.85
1990			-0.05	-0.02	0.02	-0.05	0.08	0.02	-0.03	-0.13	-0.07	0.05	0.69	-0.42
1991			-0.07	-0.06	-0.06	0.06	-0.00	0.06	-0.01	0.26	0.05	-0.33	-1.54	-1.43
1992			0.01	0.06	0.06	0.04	0.01	-0.08	-0.08	-0.23	-0.25	-0.41	0.30	-0.23
1993			0.01	-0.04	-0.08	-0.03	-0.03	0.05	0.04	0.05	0.05	0.31	0.17	-0.66
1994			-0.01	-0.01	0.01	-0.10	-0.05	-0.06	0.08	0.08	0.24	0.38	0.61	0.73
1995			0.03	-0.00	0.03	0.09	0.06	0.03	-0.06	-0.06	-0.19	-0.26	-0.54	-1.07
1996			0.00	-0.04	-0.00	-0.03	-0.06	0.01	0.03	-0.01	0.02	-0.18	0.38	0.81
1997			0.02	0.04	0.00	0.08	0.02	0.00	-0.10	-0.23	-0.19	0.14	-0.69	0.04
1998			-0.08	-0.02	-0.05	-0.12	-0.01	-0.03	0.14	0.10	0.43	0.33	0.41	-0.09
1999			0.03	0.00	0.02	0.03	0.04	-0.02	-0.05	0.01	-0.34	-0.26	-0.10	-0.28
2000			-0.00	-0.02	0.03	0.03	-0.01	0.09	-0.02	0.03	-0.09	-0.28	-0.14	-0.85
2001			0.00	0.01	-0.04	-0.08	-0.02	-0.07	0.05	0.10	0.12	0.07	-0.05	0.18
2002			-0.04	0.00	-0.01	0.05	-0.00	0.09	-0.01	-0.13	0.11	-0.18	-0.22	-0.36
2003			0.01	-0.02	0.03	-0.05	0.03	-0.11	0.01	0.01	-0.05	-0.27	0.12	0.40
2004			0.02	-0.02	0.02	0.03	-0.07	0.01	-0.00	-0.02	-0.06	-0.18	0.29	-0.15
2005			-0.00	0.01	-0.04	0.04	0.03	-0.04	-0.03	-0.05	0.05	0.03	-0.40	-0.12
2006			-0.03	-0.02	0.01	-0.10	0.07	0.07	0.03	0.09	0.41	0.31	0.28	-0.08
2007			0.05	0.03	0.03	0.02	-0.11	-0.02	-0.07	-0.08	-0.21	-0.04	-0.43	-0.31
2008			-0.02	-0.01	0.02	0.00	0.04	-0.03	0.02	0.05	0.07	0.10	0.86	0.54

Table 8.7. Saithe in Division Va. Log survey residuals from SPALY ADCAM run.

Year/age	1	2	3	4	5	6	7	8	9	10
1985			-0.94	-0.34	0.43	0.11	0.19	-0.12	0.81	-0.09
1986			-0.53	-0.43	-0.58	-0.36	-0.28	-0.29	-0.26	-0.18
1987			0.58	0.62	0.58	0.24	0.69	0.25	0.20	0.17
1988			-1.39	-1.15	-0.73	-0.23	-0.45	-0.43	-0.42	-0.13
1989			0.57	-0.03	-0.33	-0.48	0.31	0.01	0.06	-0.33
1990			0.17	0.38	0.24	0.60	0.30	0.36	0.13	-0.17
1991			-0.19	-0.17	-0.26	-0.83	-0.41	-0.91	-0.71	-0.52
1992			-0.02	0.65	0.89	0.32	0.43	0.04	-0.44	-0.31
1993			1.87	0.27	0.91	0.57	0.73	0.17	1.02	0.48
1994			-0.26	0.00	0.23	0.16	-0.07	0.40	0.63	1.49
1995			0.14	-0.29	-0.71	-0.52	-0.59	-0.41	-0.15	-0.06
1996			-0.73	0.38	-0.17	0.03	0.19	0.57	-0.20	-0.02
1997			-0.13	0.60	0.53	0.01	-0.15	-0.15	-0.18	-0.03
1998			0.71	0.27	0.16	-0.09	0.20	0.05	-0.07	-0.04
1999			0.57	0.07	-0.15	0.10	-0.27	-0.22	-0.30	-0.09
2000			0.04	-0.10	-0.13	-0.14	-0.32	-0.22	-0.16	-0.10
2001			-0.50	-0.08	-0.39	-0.37	-0.56	-0.11	-0.34	0.00
2002			-0.51	-0.51	0.14	0.13	0.15	0.13	0.11	0.13
2003			0.72	-0.19	-0.44	-0.19	-0.24	0.03	-0.36	-0.08
2004			-0.02	0.30	0.02	0.24	0.30	0.19	0.14	0.11
2005			0.01	0.09	0.18	0.12	0.17	0.25	0.10	0.15
2006			-0.02	0.06	0.08	0.79	0.46	0.10	-0.12	0.08
2007			-0.67	-0.53	-0.43	-0.25	-0.27	-0.42	-0.45	-0.12
2008			0.21	0.14	0.09	0.19	-0.03	-0.42	-0.48	-0.39
2009			0.04	-0.25	-0.31	-0.30	-0.54	-0.43	-0.64	-0.46

Table 8.8. Saithe in Division Va. Fishing mortality from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1974			0.05	0.23	0.18	0.20	0.28	0.44	0.41	0.50	0.45	0.41	0.58	0.58
1975			0.02	0.20	0.25	0.22	0.33	0.40	0.37	0.47	0.42	0.44	0.54	0.54
1976			0.01	0.18	0.32	0.39	0.38	0.40	0.38	0.46	0.40	0.43	0.50	0.50
1977			0.00	0.10	0.25	0.32	0.34	0.39	0.40	0.43	0.42	0.41	0.41	0.41
1978			0.01	0.07	0.16	0.24	0.38	0.49	0.35	0.41	0.41	0.45	0.44	0.44
1979			0.01	0.11	0.18	0.35	0.36	0.45	0.36	0.53	0.46	0.50	0.42	0.42
1980			0.01	0.07	0.21	0.35	0.37	0.51	0.41	0.53	0.36	0.37	0.33	0.33
1981			0.01	0.07	0.14	0.35	0.37	0.49	0.48	0.50	0.31	0.38	0.38	0.38
1982			0.02	0.08	0.18	0.28	0.51	0.55	0.54	0.50	0.29	0.29	0.35	0.35
1983			0.00	0.11	0.10	0.26	0.43	0.62	0.49	0.48	0.30	0.25	0.33	0.33
1984			0.00	0.03	0.08	0.27	0.42	0.69	0.47	0.61	0.46	0.31	0.52	0.52
1985			0.01	0.11	0.18	0.25	0.36	0.46	0.41	0.62	0.47	0.28	0.51	0.51
1986			0.04	0.06	0.18	0.25	0.33	0.48	0.42	0.66	0.55	0.31	0.40	0.40
1987			0.01	0.11	0.24	0.35	0.41	0.49	0.52	0.55	0.60	0.32	0.39	0.39
1988			0.02	0.08	0.20	0.34	0.34	0.49	0.56	0.48	0.59	0.33	0.33	0.33
1989			0.01	0.11	0.17	0.33	0.31	0.44	0.50	0.47	0.59	0.40	0.33	0.33
1990			0.01	0.08	0.21	0.33	0.48	0.49	0.46	0.47	0.52	0.38	0.37	0.37
1991			0.01	0.06	0.24	0.41	0.57	0.51	0.48	0.53	0.47	0.34	0.36	0.36
1992			0.02	0.14	0.35	0.45	0.46	0.47	0.47	0.48	0.40	0.33	0.44	0.44
1993			0.04	0.11	0.23	0.41	0.48	0.52	0.56	0.54	0.44	0.40	0.49	0.49
1994			0.05	0.23	0.26	0.36	0.48	0.57	0.58	0.65	0.50	0.43	0.59	0.59
1995			0.07	0.16	0.32	0.41	0.52	0.60	0.57	0.56	0.47	0.37	0.45	0.45
1996			0.05	0.16	0.24	0.36	0.40	0.61	0.57	0.53	0.46	0.39	0.48	0.48
1997			0.04	0.17	0.24	0.32	0.43	0.52	0.54	0.50	0.45	0.42	0.40	0.40
1998			0.03	0.11	0.16	0.24	0.42	0.50	0.55	0.54	0.49	0.43	0.44	0.44
1999			0.04	0.12	0.19	0.28	0.43	0.49	0.50	0.52	0.46	0.40	0.44	0.44
2000			0.03	0.12	0.21	0.27	0.37	0.52	0.48	0.50	0.47	0.37	0.44	0.44
2001			0.02	0.13	0.16	0.24	0.30	0.41	0.49	0.47	0.49	0.37	0.47	0.47
2002			0.02	0.11	0.23	0.30	0.31	0.39	0.44	0.43	0.50	0.36	0.50	0.50
2003			0.04	0.10	0.22	0.29	0.33	0.31	0.40	0.41	0.48	0.37	0.55	0.55
2004			0.05	0.17	0.23	0.32	0.31	0.32	0.36	0.38	0.44	0.39	0.59	0.59
2005			0.04	0.21	0.25	0.35	0.36	0.31	0.34	0.37	0.43	0.43	0.60	0.60
2006			0.05	0.24	0.28	0.35	0.39	0.34	0.34	0.40	0.42	0.48	0.69	0.69
2007			0.08	0.29	0.32	0.38	0.30	0.30	0.32	0.39	0.39	0.46	0.71	0.71
2008			0.06	0.37	0.46	0.45	0.36	0.29	0.33	0.41	0.41	0.49	0.89	0.89
2009			0.06	0.31	0.36	0.41	0.36	0.32	0.34	0.42	0.42	0.50	0.79	0.79
2010			0.05	0.26	0.31	0.35	0.31	0.28	0.29	0.36	0.36	0.43	0.67	0.67
2011			0.05	0.26	0.31	0.35	0.31	0.28	0.29	0.36	0.36	0.43	0.67	0.67

Table 8.9. Saithe in Division Va. Stock in numbers from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1974	47	32	23	18	16	20	16	10	4	2.2	1.0	0.5	0.1	0.0
1975	33	38	26	18	12	11	13	10	5	2.2	1.1	0.5	0.3	0.1
1976	74	27	31	21	12	8	7	8	5	3.1	1.1	0.6	0.3	0.1
1977	75	61	22	25	14	7	4	4	4	3.0	1.6	0.6	0.3	0.1
1978	42	61	50	18	19	9	4	2	2	2.4	1.6	0.9	0.3	0.2
1979	30	35	50	40	14	13	6	2	1	1.3	1.3	0.9	0.4	0.2
1980	33	24	28	41	30	9	8	3	1	0.7	0.6	0.7	0.4	0.2
1981	49	27	20	23	31	20	5	4	2	0.7	0.3	0.4	0.4	0.3
1982	68	40	22	16	18	22	11	3	2	0.8	0.3	0.2	0.2	0.2
1983	53	56	33	18	12	12	14	6	1	1.0	0.4	0.2	0.1	0.1
1984	106	43	46	27	13	9	8	7	2	0.7	0.5	0.2	0.1	0.1
1985	147	87	36	37	21	10	6	4	3	1.3	0.3	0.3	0.1	0.1
1986	80	120	71	29	27	14	6	3	2	3.0	0.5	0.2	0.2	0.1
1987	48	66	98	56	22	19	9	4	2	1.1	1.3	0.3	0.1	0.1
1988	32	39	54	80	41	14	11	5	2	0.8	0.5	0.6	0.2	0.1
1989	42	26	32	43	60	28	8	6	3	0.9	0.4	0.2	0.3	0.1
1990	22	34	21	26	32	42	16	5	3	1.3	0.4	0.2	0.1	0.2
1991	30	18	28	17	20	21	27	8	2	1.7	0.6	0.2	0.1	0.1
1992	26	25	15	23	13	13	11	13	4	1.3	0.8	0.3	0.1	0.1
1993	39	21	20	12	16	8	7	6	9	2.1	0.6	0.5	0.2	0.1
1994	38	32	17	16	9	11	4	3	3	4.3	1.0	0.3	0.3	0.1
1995	26	31	26	14	10	5	6	2	2	1.3	1.8	0.5	0.2	0.1
1996	13	21	25	20	9	6	3	3	1	0.7	0.6	0.9	0.3	0.1
1997	44	11	17	20	14	6	4	2	1	0.4	0.3	0.3	0.5	0.1
1998	45	36	9	14	14	9	4	2	1	0.6	0.2	0.2	0.2	0.3
1999	82	37	30	7	10	9	6	2	1	0.4	0.3	0.1	0.1	0.1
2000	95	67	30	23	5	7	6	4	1	0.5	0.2	0.2	0.1	0.1
2001	104	78	55	24	17	3	4	3	2	0.5	0.2	0.1	0.1	0.0
2002	34	85	64	44	17	12	2	3	2	1.1	0.3	0.1	0.1	0.0
2003	101	28	70	51	32	11	7	1	1	0.9	0.6	0.1	0.1	0.0
2004	53	82	23	55	38	21	7	4	1	0.8	0.5	0.3	0.1	0.0
2005	25	43	67	18	38	25	12	4	3	0.4	0.4	0.3	0.2	0.0
2006	41	21	36	53	12	24	14	7	2	1.5	0.2	0.2	0.1	0.1
2007	55	34	17	28	34	7	14	8	4	1.4	0.8	0.1	0.1	0.1
2008	32	45	27	13	17	20	4	8	5	2.5	0.8	0.4	0.1	0.0
2009	38	26	37	21	7	9	11	2	5	2.8	1.3	0.4	0.2	0.0
2010	44	31	22	28	13	4	5	6	1	3.0	1.5	0.7	0.2	0.1
2011	50	36	25	17	18	8	2	3	4	0.8	1.7	0.9	0.4	0.1

Table 8.10 Saithe in Division Va. Main population estimates from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009.

	Recruits Age 3	Totalbio	TotalSpbio	Landings	Yield/SSB	Fbar 4-9
1974	23474	422768	283498	97568	0.344	0.289
1975	25940	373624	257009	87954	0.342	0.297
1976	31431	331679	216605	82003	0.379	0.341
1977	22087	284910	173177	62026	0.358	0.299
1978	49933	292501	149783	49672	0.332	0.280
1979	50341	323785	145842	63504	0.435	0.303
1980	28252	331304	163460	58347	0.357	0.322
1981	19781	312215	164020	58986	0.360	0.316
1982	21967	300738	171477	68615	0.400	0.360
1983	32654	295413	168419	58266	0.346	0.335
1984	45798	335882	170989	62719	0.367	0.327
1985	35598	333916	161070	57102	0.355	0.293
1986	71330	411523	185520	64868	0.350	0.287
1987	98386	481932	178269	80531	0.452	0.354
1988	53899	495509	176818	77247	0.437	0.334
1989	31972	461077	182391	82425	0.452	0.309
1990	21248	431407	197091	98127	0.498	0.340
1991	28159	362067	193208	102316	0.530	0.377
1992	14527	294174	179345	79597	0.444	0.392
1993	20336	261494	168593	71648	0.425	0.386
1994	17432	215092	143413	64339	0.449	0.412
1995	26225	191242	114850	48629	0.423	0.430
1996	25197	176166	100754	40101	0.398	0.389
1997	17336	171955	96427	37264	0.386	0.372
1998	8677	156530	93724	31531	0.336	0.329
1999	29729	162187	91059	31293	0.344	0.334
2000	30114	181457	95044	33146	0.349	0.329
2001	54635	228747	103194	32063	0.311	0.288
2002	63721	299852	120555	42071	0.349	0.295
2003	69567	368957	135672	52494	0.387	0.276
2004	22561	347059	163023	64791	0.397	0.285
2005	67399	362958	175901	69143	0.393	0.305
2006	35527	336290	177805	75663	0.426	0.322
2007	17021	277909	166954	64430	0.386	0.318
2008	27430	257889	159200	70189	0.441	0.377
2009	36852	231599	137458			
Arith. Mean	35459	308439	160045	63448	0.392	0.331
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 8.11. Saithe in Division Va. Input values for the short term predictions.

Mean weights in the stock and the catch

age\year	2008	2009	2010	2011	2012
3	1.306	1.201	1.202	1.203	1.203
4	1.805	1.700	1.700	1.701	1.702
5	2.295	2.259	2.260	2.261	2.262
6	2.749	2.755	2.757	2.758	2.759
7	3.515	3.411	3.412	3.414	3.415
8	4.530	4.329	4.331	4.334	4.335
9	5.132	5.507	5.509	5.512	5.513
10	6.394	6.843	6.846	6.850	6.851
11	7.694	7.972	7.975	7.980	7.981
12	9.170	9.263	9.267	9.272	9.274
13	9.594	9.810	9.813	9.819	9.821
14	11.258	10.531	10.535	10.541	10.543

Mean weights in the SSB

age\year	2008	2009	2010	2011	2012
3	1.306	1.201	1.202	1.203	1.203
4	1.805	1.700	1.700	1.701	1.702
5	2.295	2.259	2.260	2.261	2.262
6	2.749	2.755	2.757	2.758	2.759
7	3.515	3.411	3.412	3.414	3.415
8	4.530	4.329	4.331	4.334	4.335
9	5.132	5.507	5.509	5.512	5.513
10	6.394	6.843	6.846	6.850	6.851
11	7.694	7.972	7.975	7.980	7.981
12	9.170	9.263	9.267	9.272	9.274
13	9.594	9.810	9.813	9.819	9.821
14	11.258	10.531	10.535	10.541	10.543

Sexual maturity at spawning time:

age\year	2008	2009	2010	2011	2012
3	0.08	0.08	0.08	0.08	0.08
4	0.22	0.22	0.22	0.22	0.22
5	0.43	0.43	0.43	0.43	0.43
6	0.65	0.65	0.65	0.65	0.65
7	0.84	0.84	0.84	0.84	0.84
8	0.93	0.93	0.93	0.93	0.93
9	0.96	0.96	0.96	0.96	0.96
10	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00

Selection pattern

age\year	2008	2009	2010	2011	2012
3	0.158	0.173	0.173	0.173	0.173
4	0.962	0.840	0.840	0.840	0.840
5	1.203	0.994	0.994	0.994	0.994
6	1.177	1.105	1.105	1.105	1.105
7	0.929	0.982	0.982	0.982	0.982
8	0.762	0.870	0.870	0.870	0.870
9	0.856	0.921	0.921	0.921	0.921
10	1.073	1.128	1.128	1.128	1.128
11	1.055	1.693	1.693	1.693	1.693
12	1.287	1.693	1.693	1.693	1.693
13	2.308	1.693	1.693	1.693	1.693
14	2.308	1.693	1.693	1.693	1.693

Natural Mortality

age\year	2008	2009	2010	2011	2012
3	0.20	0.20	0.20	0.20	0.20
4	0.20	0.20	0.20	0.20	0.20
5	0.20	0.20	0.20	0.20	0.20
6	0.20	0.20	0.20	0.20	0.20
7	0.20	0.20	0.20	0.20	0.20
8	0.20	0.20	0.20	0.20	0.20
9	0.20	0.20	0.20	0.20	0.20
10	0.20	0.20	0.20	0.20	0.20
11	0.20	0.20	0.20	0.20	0.20
12	0.20	0.20	0.20	0.20	0.20
13	0.20	0.20	0.20	0.20	0.20
14	0.20	0.20	0.20	0.20	0.20

Stock numbers

age\year	2008	2009	2010	2011	2012
3	27.430	36.852	15.76	15.76	15.76
4	12.873	21.134			
5	17.074	7.284			
6	20.181	8.807			
7	4.045	10.512			
8	8.449	2.318			
9	4.771	5.162			
10	2.476	2.812			
11	0.801	1.343			
12	0.446	0.437			
13	0.068	0.223			
14	0.047	0.023			

Prop. mort. before spawning

age\year	F	M
3	0.000	0.000
4	0.000	0.000
5	0.000	0.000
6	0.000	0.000
7	0.000	0.000
8	0.000	0.000
9	0.000	0.000
10	0.000	0.000
11	0.000	0.000
12	0.000	0.000
13	0.000	0.000
14	0.000	0.000

Table 8.12 Saithe in Division Va. Output of the short term predictions.

2009 B4+	Fbar	SSB	Landings
187	0.36	137	55

2010 B4+	Fmult	Fbar	SSB2010	Landings	2011 B4+	SSB	%SSB change[1)]	% TAC change[2)]
181	0.000	0.000	119	0	205	146	22%	-100%
	0.070	0.025	119	4	201	142	19%	-97%
	0.139	0.050	119	8	196	138	16%	-95%
	0.209	0.075	119	12	192	135	13%	-92%
	0.279	0.100	119	16	187	132	10%	-90%
	0.349	0.125	119	20	183	128	8%	-87%
	0.418	0.150	119	24	179	125	5%	-85%
	0.488	0.175	119	28	175	122	2%	-83%
	0.558	0.200	119	31	171	119	0%	-81%
	0.627	0.225	119	35	167	116	-3%	-78%
	0.697	0.250	119	38	163	113	-5%	-76%
	0.767	0.275	119	41	160	110	-7%	-74%
	0.837	0.300	119	44	156	108	-10%	-72%
	0.906	0.325	119	48	153	105	-12%	-70%
	0.976	0.350	119	51	150	103	-14%	-68%
	1.046	0.375	119	54	146	100	-16%	-67%
	1.115	0.400	119	56	143	98	-18%	-65%
	1.185	0.425	119	59	140	95	-20%	-63%

1) SSB 2011 relative to SSB 2010
2) TAC 2010 relative to TAC 2009

Table 8.13. Saithe in Division Va. Output from TSA run tuned with IGFS index for age groups 2-6.

Icelandic saithe

Standardized residuals

Catch-at-age

	4	5	6	7	8	9	10	11
1987	2.12	2.47	1.90	1.11	1.06	1.00	0.41	-0.07
1988	-0.04	0.16	0.38	-1.21	0.10	1.32	-1.75	0.06
1989	2.13	1.39	0.86	-2.40	-0.77	-0.25	-0.34	0.58
1990	-1.13	1.22	1.31	0.91	0.97	0.01	-0.55	0.25
1991	-1.76	0.90	1.46	1.12	-0.19	0.26	2.01	0.01
1992	1.16	2.52	0.80	-0.10	-1.18	-1.37	-1.19	-1.17
1993	-0.73	-0.97	-1.27	-1.01	0.37	0.63	0.51	0.38
1994	0.28	0.41	-1.61	-2.31	-1.31	0.72	1.07	0.87
1995	0.30	-0.50	-0.02	0.02	-0.76	-1.13	-0.78	-2.08
1996	-0.33	-0.89	-1.17	-1.40	-0.17	-1.23	-0.76	-0.57
1997	0.85	-0.62	-0.22	-0.26	0.54	-1.12	-2.27	-1.42
1998	-0.81	-2.33	-2.31	-0.44	-0.52	1.24	0.54	1.49
1999	-2.18	-0.48	0.03	-0.08	-0.04	-0.63	-0.24	-2.06
2000	0.61	-0.91	-0.23	-0.16	0.87	-0.43	-0.17	-0.66
2001	0.33	-1.18	-2.01	-1.11	-0.73	-0.29	0.04	0.23
2002	1.28	0.01	0.97	-0.16	1.33	0.40	-1.31	0.19
2003	0.65	1.41	-0.68	-0.29	-1.36	0.56	0.13	-0.23
2004	0.24	1.66	0.82	-0.56	-0.12	0.70	0.15	-0.10
2005	1.15	-0.34	1.03	0.34	-0.13	0.37	0.56	0.60
2006	1.15	-0.36	-0.14	0.46	-0.35	0.64	1.36	2.29
2007	0.60	0.38	0.30	-1.46	-1.79	-1.40	0.08	-1.02
2008	1.10	1.13	1.11	0.33	0.14	0.18	0.87	0.76
2009	-0.02	0.03	0.04	0.00	0.00	-0.01	-0.02	0.00

ra = 0.48;   rt = 0.04; rcoh = 0.04;   ?1 = -0.93; ?2 = -0.68

STANDARDISED SURVEY RESIDUALS

	2	3	4	5	6
1987	0.26	1.40	1.87	1.30	0.55
1988	0.08	-1.39	-1.48	-1.32	-0.36
1989	1.26	0.63	1.49	0.51	-0.59
1990	0.17	-0.45	0.36	1.10	1.78
1991	-0.19	-0.41	-0.96	-0.31	-1.66
1992	-0.54	-0.75	1.09	1.83	0.50
1993	1.17	1.95	-0.28	1.24	0.60
1994	0.83	-1.17	-1.22	0.15	-0.30
1995	0.42	-0.33	-1.03	-2.98	-2.41
1996	-0.60	-1.52	0.07	-0.90	-0.33
1997	0.10	-0.74	1.16	0.69	-0.06
1998	-0.73	-0.26	0.03	-0.06	-0.24
1999	0.76	0.92	-1.78	-0.46	0.33
2000	0.24	-0.05	-0.14	-1.19	-0.45
2001	0.90	-0.06	-0.31	-1.05	-1.92
2002	1.02	-0.10	0.08	0.09	0.60
2003	-1.34	1.38	0.51	-0.23	-0.39
2004	0.91	0.25	0.36	0.87	0.87
2005	-0.15	0.62	0.50	0.20	0.59
2006	-2.05	0.26	0.46	-0.12	1.60
2007	-1.34	-1.28	-1.12	-0.97	-0.76
2008	-0.97	0.49	0.58	0.16	0.53
2009	-0.22	0.62	-0.66	-1.14	-1.12

ra = 0.58;   rt = -0.14; rcoh = -0.01;   ?1 = -1.62; ?2 = 0.07

Stock (million fish)

	biom.	2	3	4	5	6	7	8	9	10	11
1985	288.	57.2	27.5	37.5	20.8	9.83	5.86	4.38	5.22	1.33	0.20
1986	307.	70.5	57.2	27.5	27.4	14.11	6.28	3.34	2.43	3.56	0.63
1987	332.	43.5	70.5	57.2	21.3	18.67	9.07	3.72	1.72	1.41	1.55
1988	401.	24.5	43.5	70.5	42.2	13.52	10.55	4.84	1.87	0.83	0.72
1989	392.	16.5	24.5	43.5	53.7	28.67	7.74	6.03	2.37	0.79	0.48
1990	371.	21.8	16.5	24.5	32.0	36.46	16.88	4.68	3.19	1.17	0.40
1991	319.	11.8	21.8	16.5	18.5	21.29	27.56	8.36	2.22	1.64	0.62
1992	262.	15.8	11.8	21.8	12.7	11.97	11.36	13.00	3.95	1.05	0.62
1993	217.	14.2	15.8	11.8	15.4	7.24	6.05	5.81	8.71	2.08	0.55
1994	175.	24.0	14.2	15.8	8.7	10.15	4.06	3.00	2.69	3.86	0.96
1995	146.	20.2	24.0	14.2	10.6	5.61	6.03	2.14	1.40	1.14	1.53
1996	141.	14.3	20.2	24.0	10.0	6.37	3.01	2.87	0.97	0.65	0.51
1997	151.	6.9	14.3	20.2	17.3	6.49	3.72	1.70	1.27	0.46	0.30
1998	153.	23.8	6.9	14.3	13.9	11.69	3.84	2.00	0.87	0.64	0.26
1999	135.	23.5	23.8	6.9	10.5	9.79	8.34	2.14	1.04	0.40	0.29
2000	146.	44.8	23.5	23.8	5.0	7.21	6.05	5.11	1.15	0.56	0.20
2001	164.	50.9	44.8	23.5	17.4	3.34	4.55	3.51	2.59	0.64	0.31
2002	224.	48.8	50.9	44.8	16.9	12.27	2.20	2.87	2.03	1.38	0.36

Table 8.13 (ctd).

2003	285.	17.5	48.8	50.9	33.2	11.01	7.40	1.34	1.65	1.17	0.87
2004	306.	53.6	17.5	48.8	38.2	21.82	6.78	4.33	0.86	0.98	0.71
2005	267.	30.0	53.6	17.5	33.1	24.90	13.12	4.19	2.64	0.53	0.61
2006	286.	13.2	30.0	53.6	11.6	20.49	14.27	7.55	2.59	1.62	0.34
2007	255.	22.5	13.2	30.0	34.9	7.13	11.69	7.74	4.41	1.53	0.90
2008	217.	20.6	22.5	13.2	18.7	20.69	3.93	6.89	4.68	2.73	0.89
2009	184.	20.1	20.6	22.5	7.7	10.14	11.04	2.19	3.95	2.72	1.52

Kalman filter estimation of standard deviation of biomass and log-stock

2008	30.	0.419	0.310	0.187	0.159	0.160	0.173	0.193	0.218	0.228	0.250
2009	33.	0.511	0.419	0.310	0.251	0.226	0.234	0.246	0.270	0.303	0.327

Adjusted for errors in parameter estimates

	(35)	0.516	0.423	0.319	0.271	0.246	0.253	0.270	0.302	0.340	0.365

Migration
(million fish, standard deviation in parentheses)

7 years 1991	4300	(2000)
9 years 1993	2500	(1000)
7 years 1999	2000	(1000)
8 years 2000	1000	(600)

Icelandic saithe
Fishing mortality rates

	F 4-9	4	5	6	7	8	9	10	11
1985	0.247	0.113	0.186	0.248	0.360	0.390	0.183	0.544	0.526
1986	0.269	0.059	0.184	0.241	0.325	0.467	0.340	0.634	0.468
1987	0.362	0.103	0.252	0.371	0.428	0.487	0.530	0.476	0.433
1988	0.361	0.083	0.191	0.358	0.359	0.516	0.662	0.354	0.531
1989	0.313	0.116	0.191	0.330	0.302	0.438	0.504	0.470	0.573
1990	0.361	0.079	0.208	0.362	0.505	0.545	0.467	0.443	0.527
1991	0.396	0.061	0.239	0.428	0.552	0.550	0.546	0.772	0.514
1992	0.395	0.157	0.383	0.496	0.471	0.418	0.442	0.451	0.423
1993	0.411	0.107	0.230	0.418	0.523	0.570	0.615	0.573	0.586
1994	0.427	0.222	0.250	0.331	0.466	0.597	0.696	0.795	0.703
1995	0.440	0.154	0.315	0.428	0.549	0.608	0.586	0.612	0.469
1996	0.377	0.128	0.231	0.338	0.370	0.627	0.570	0.597	0.591
1997	0.348	0.174	0.195	0.324	0.420	0.479	0.496	0.360	0.437
1998	0.305	0.106	0.151	0.155	0.386	0.452	0.582	0.603	0.673
1999	0.286	0.124	0.179	0.281	0.295	0.421	0.417	0.484	0.318
2000	0.300	0.116	0.215	0.261	0.344	0.479	0.382	0.409	0.372
2001	0.258	0.132	0.151	0.218	0.269	0.351	0.428	0.382	0.409
2002	0.279	0.108	0.227	0.306	0.299	0.369	0.363	0.279	0.366
2003	0.260	0.100	0.223	0.286	0.342	0.264	0.342	0.313	0.281
2004	0.274	0.193	0.231	0.311	0.290	0.308	0.310	0.287	0.274
2005	0.301	0.215	0.279	0.357	0.355	0.294	0.308	0.279	0.308
2006	0.328	0.228	0.285	0.370	0.417	0.339	0.329	0.393	0.468
2007	0.317	0.274	0.324	0.395	0.329	0.304	0.279	0.336	0.266
2008	0.379	0.348	0.413	0.429	0.386	0.357	0.344	0.383	0.382

Kalman filter estimates of standard deviation of F 4-9 and logF

2007	0.043	0.136	0.134	0.142	0.167	0.192	0.202	0.208	0.248
2008	0.061	0.213	0.185	0.190	0.205	0.229	0.258	0.269	0.294

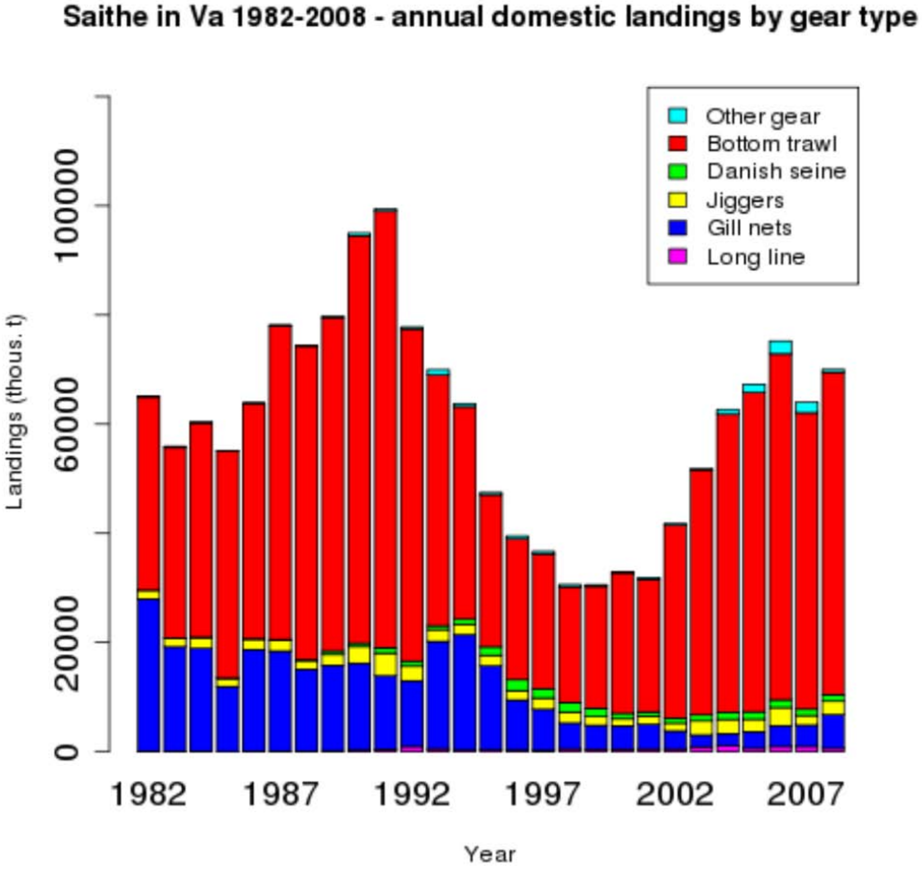

Figure 8.1 Saithe in Division Va. Total landings by gear from 1982 – 2008

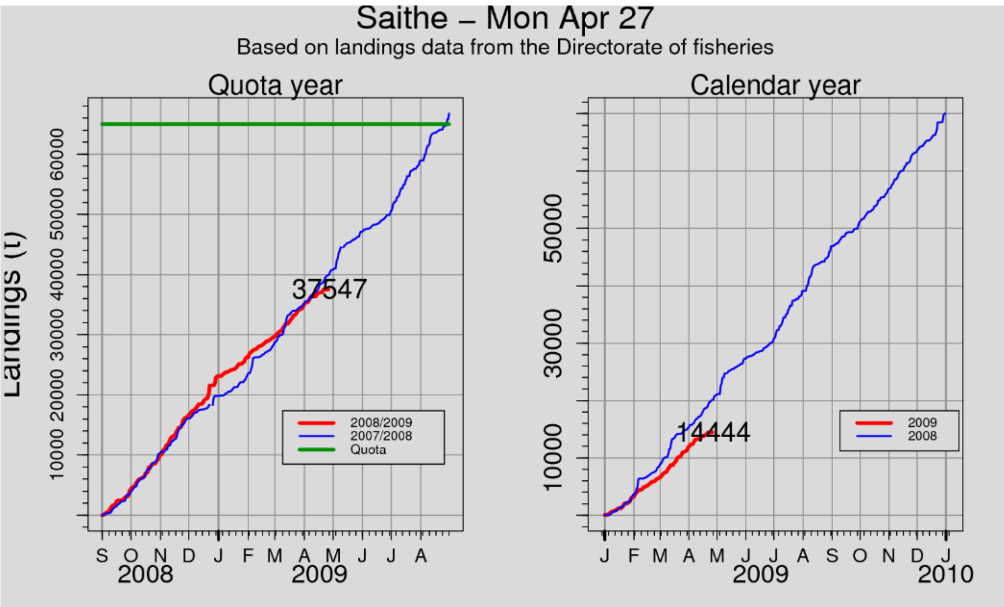

Figure 8.2 Saithe in Division Va. Cumulative landings in the last two fishing years (left) and calendar years (right). The vertical (green line) in the left figure shows the 65 kt quota for the current fishing year (2008/2009), the quota for the fishing 2007/2008 having been set at 75 kt.

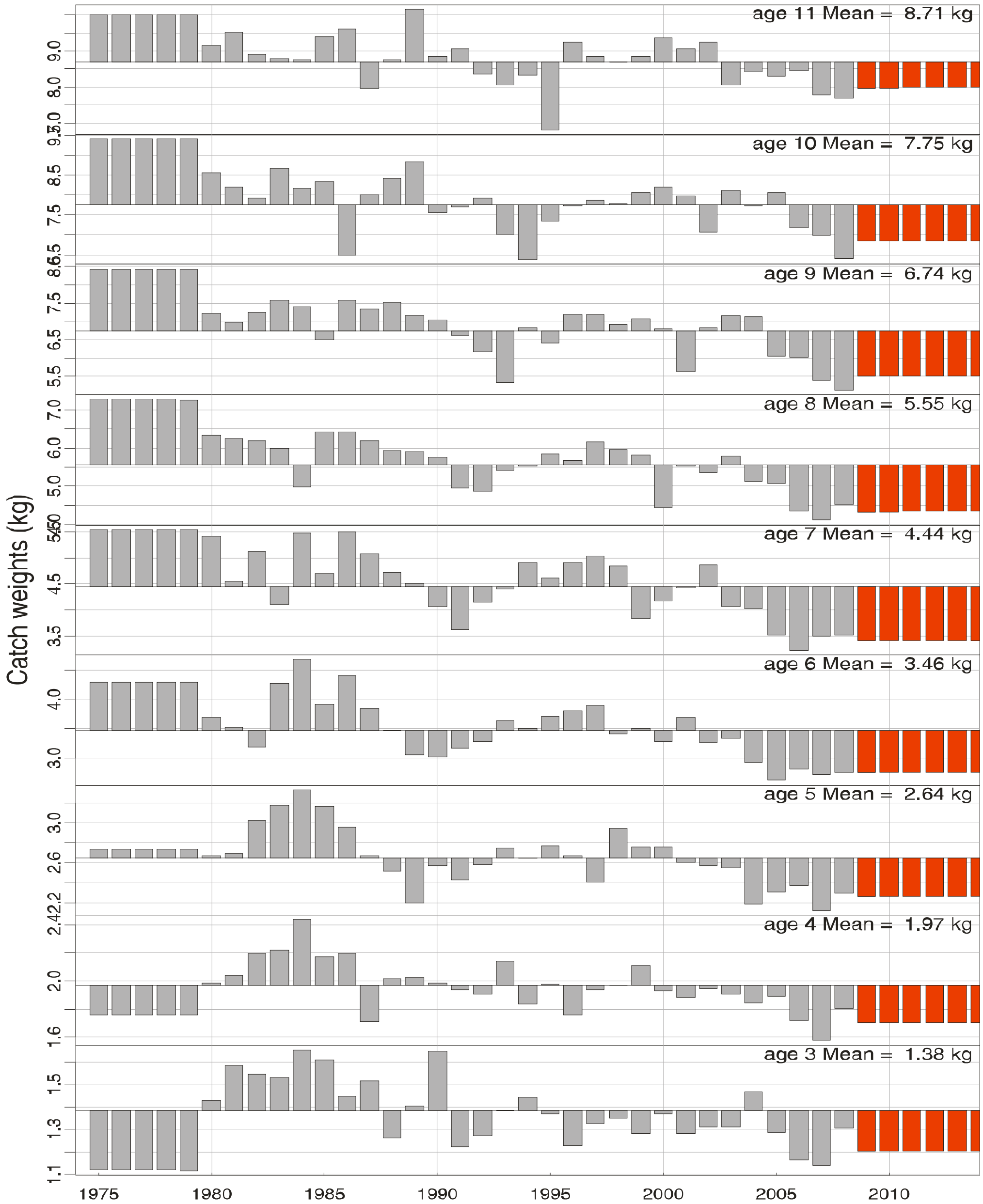

Figure 8.3 Saithe in Division Va. Weight at age in the catches. The reference line shows the mean weight for the period 1980-2008. The red bars show the weight at age used in the predictions (average of 2006-2008).

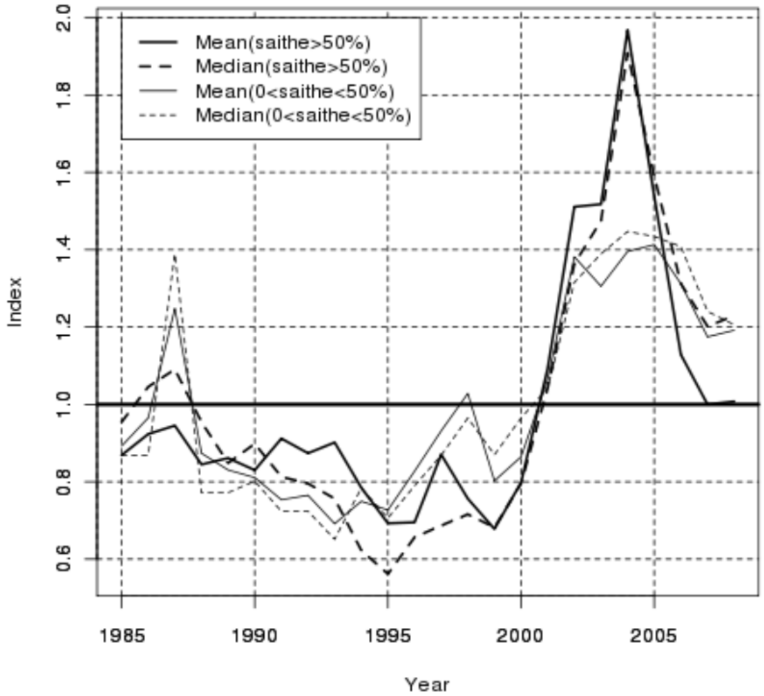

Figure 8.4 Saithe in Division Va. Catch per unit effort where saithe is larger than 50% and smaller than 50% of the catches in each tow. Shown are mean and median values and the long term mean. The numbers are scaled to the mean of the time series.

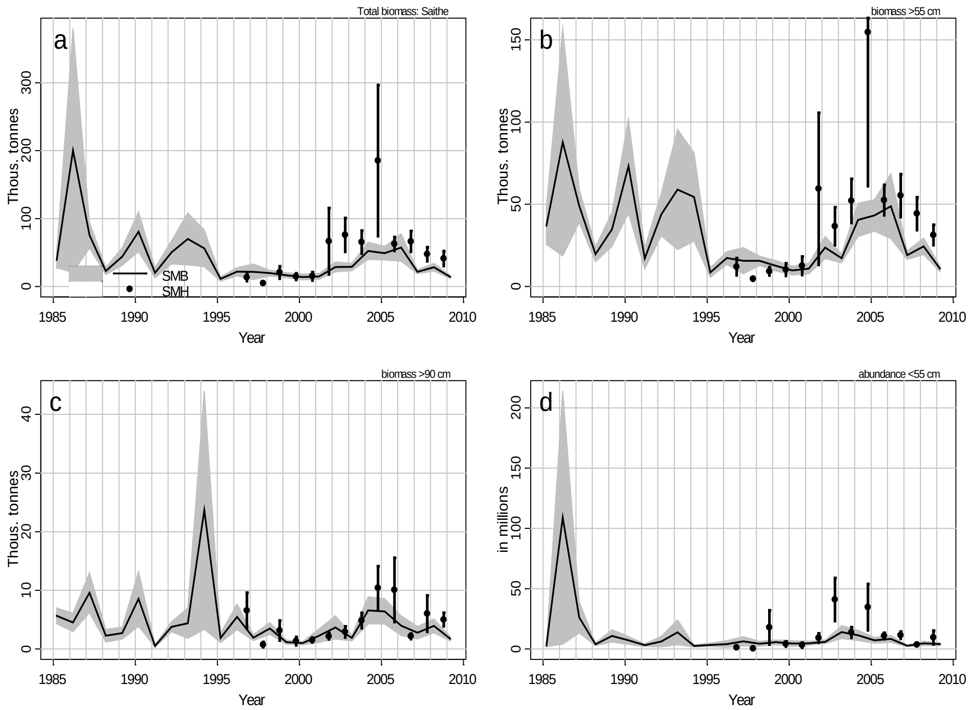

Figure 8.5 Saithe in Division Va. Shown are a) total biomass indices, b) biomass indices larger than 55 cm, biomass indices smaller than 90 cm and d) abundance indices smaller than 55 cm. The lines with the shades show the spring survey indices from 1985 (SMB) and the points with the vertical line she fall survey indices from 1997. The shades and the vertical lines indicate +/- 1 standard error.

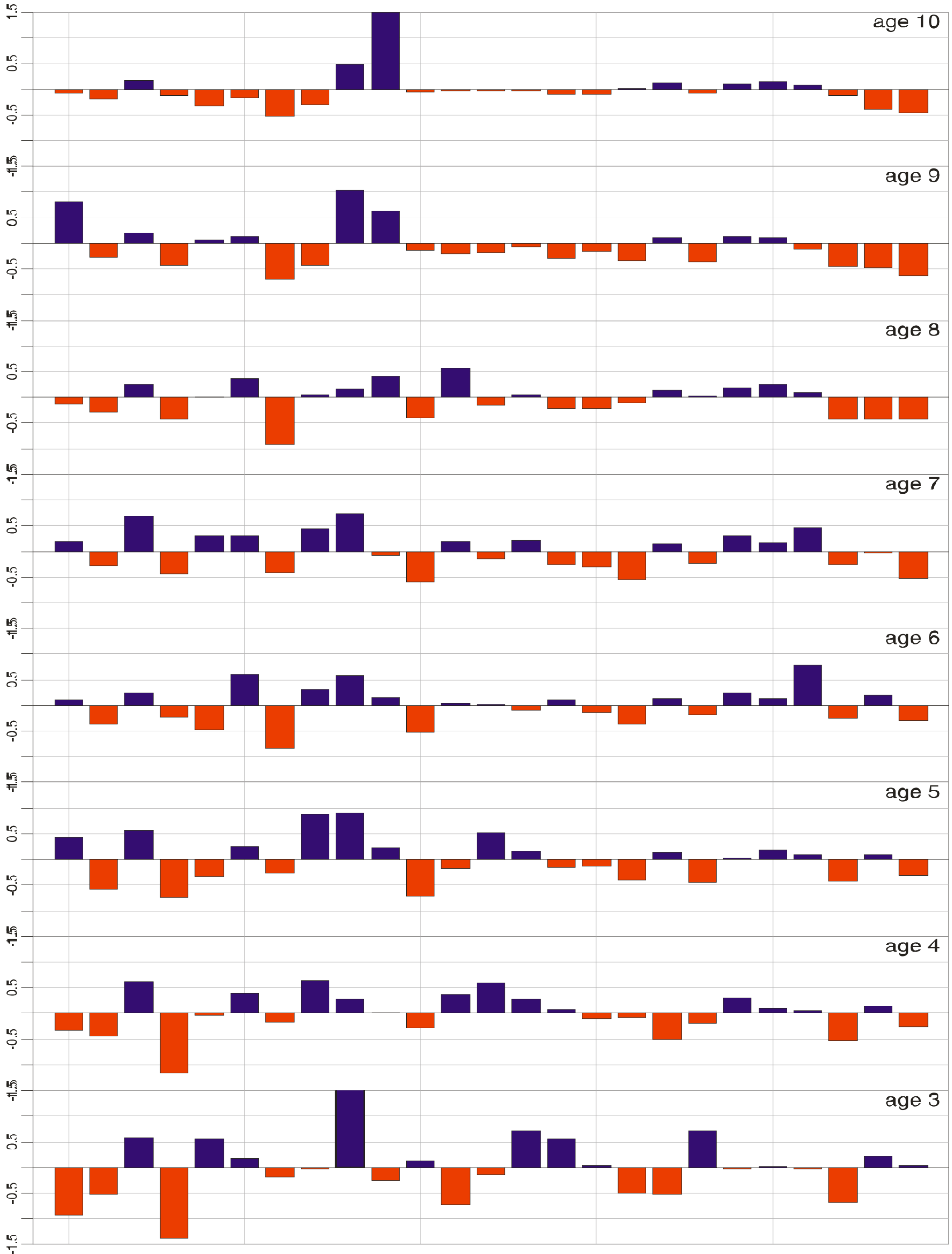

Figure 8.6. Saithe in Division Va. Survey residuals at age from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009. The vertical line indicates the zero line.

Figure 8.7. Saithe in Division Va. Observed and predicted survey indices (sum of age groups 3-10) from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009.

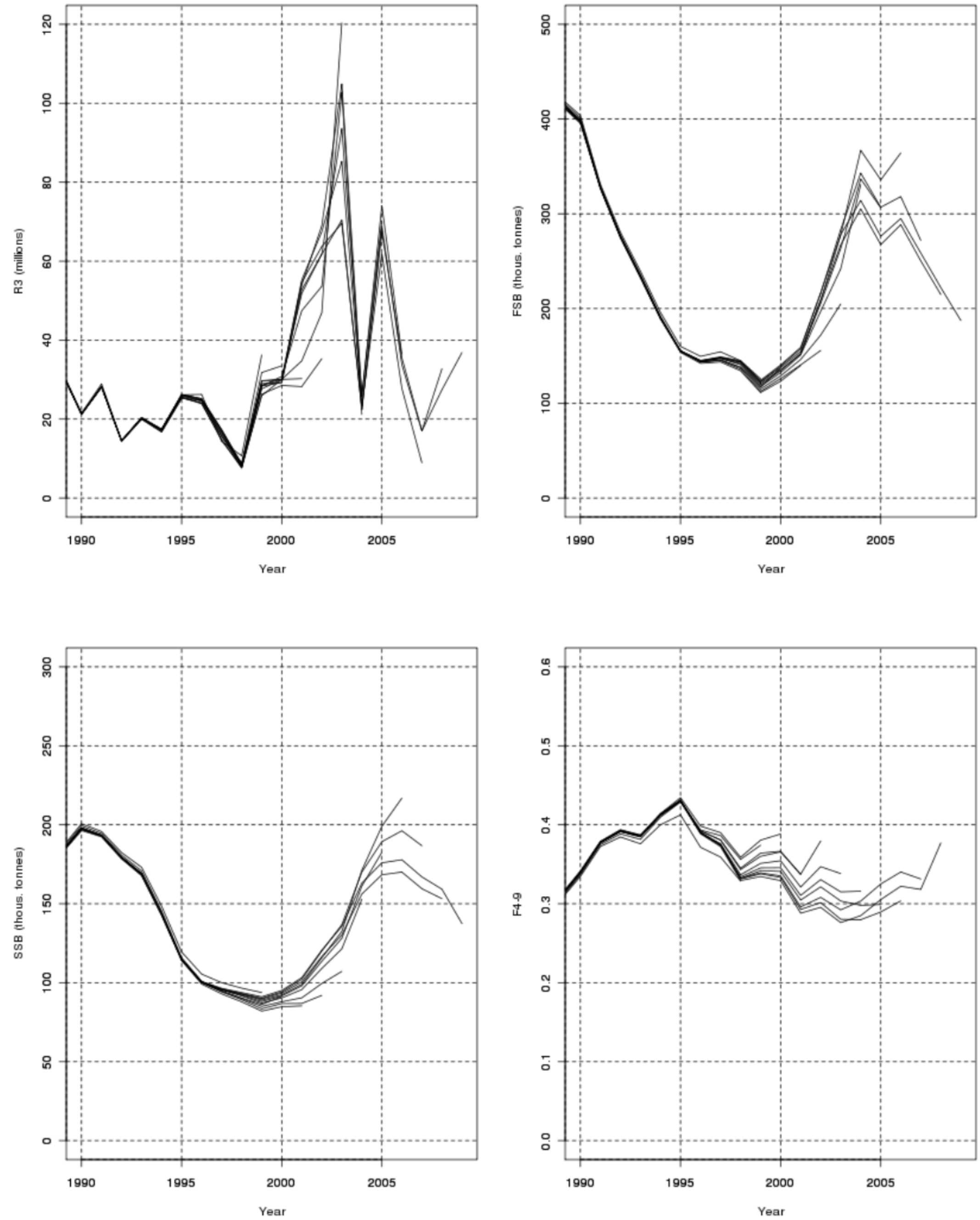

Figure 8.8: Saithe in Division Va. Retrospective pattern from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009 (the most recent three trajectories represent the final adopted assessment results adopted in 2007, 2008 and 2009).

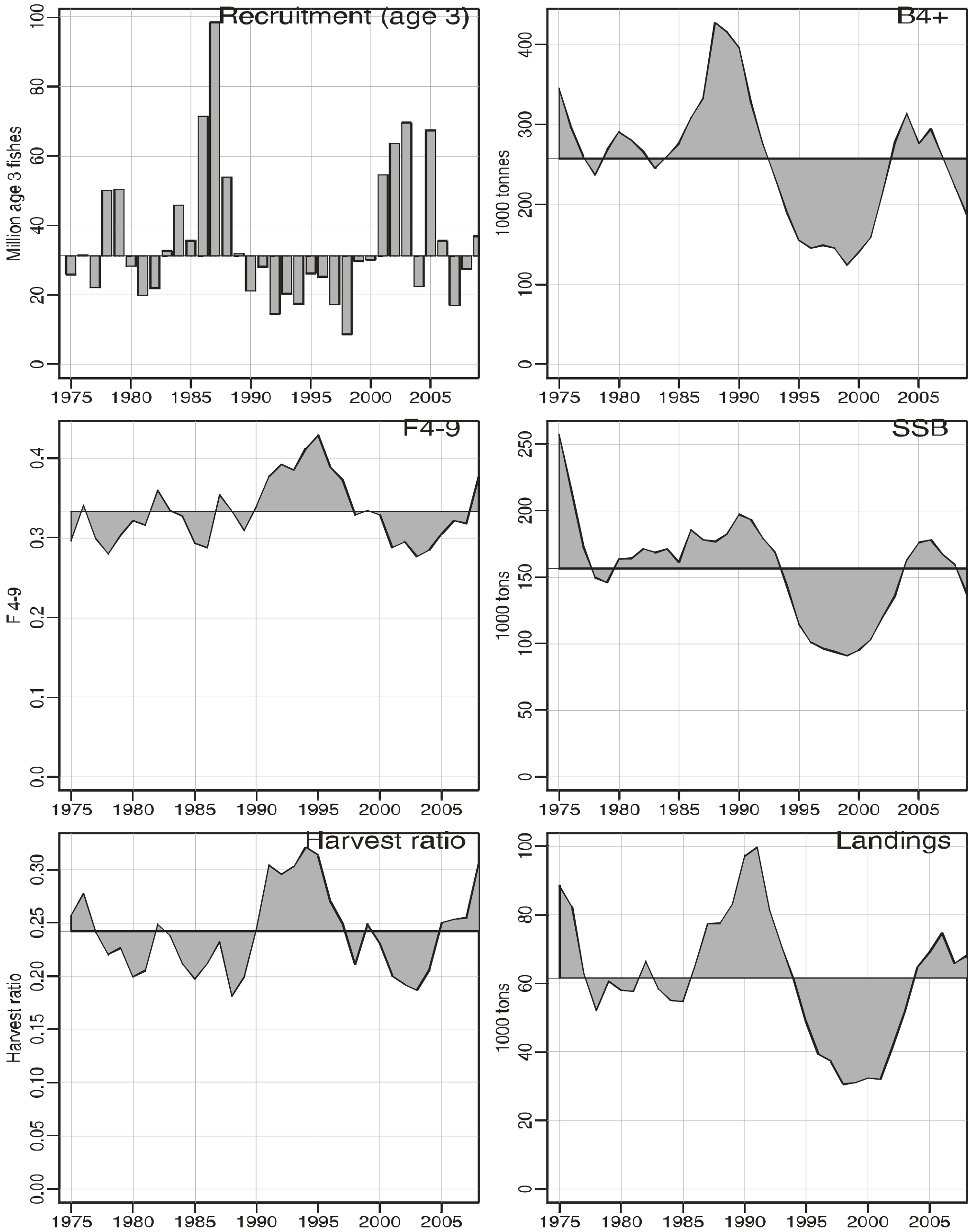

Figure 8.9 Saithe in Division Va. Main population estimates from SPALY ADCAM run, a statistical catch at age model calibrated with IGFS survey age disaggregated indices 1985-2009. The mean value for each parameter is plotted as the horizontal reference line.

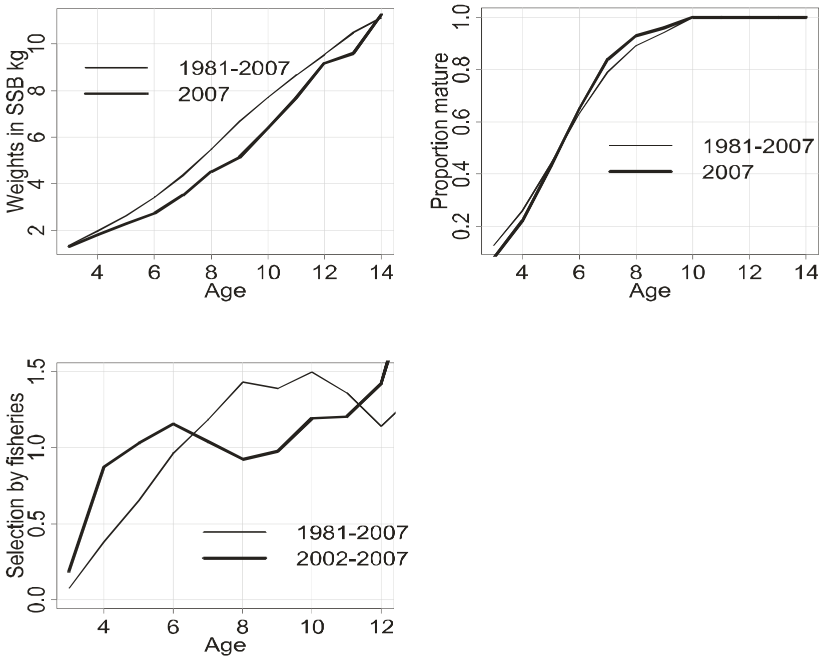

Figure 8.10. Saithe in Division Va. Input parameters in the simulation.

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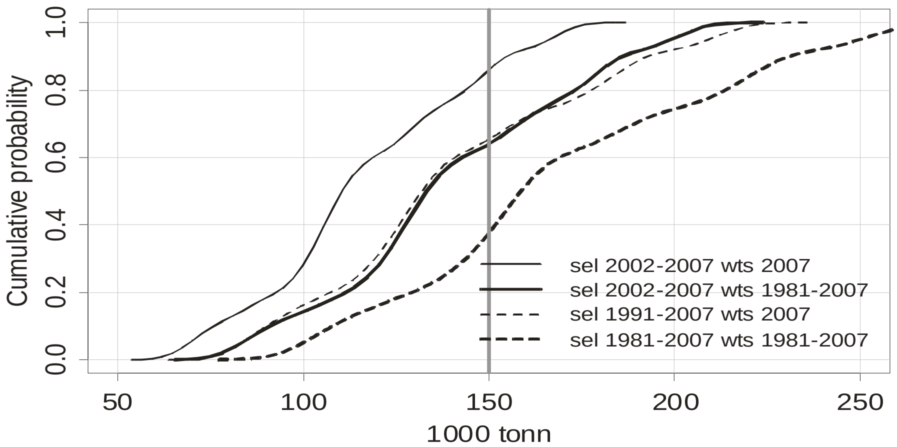

Figure 8.11. Saithe in Division Va. Probability distribution of the SSB when fishing at 0.3 (original Fpa) using 4 input scenarios of weight and selection patterns

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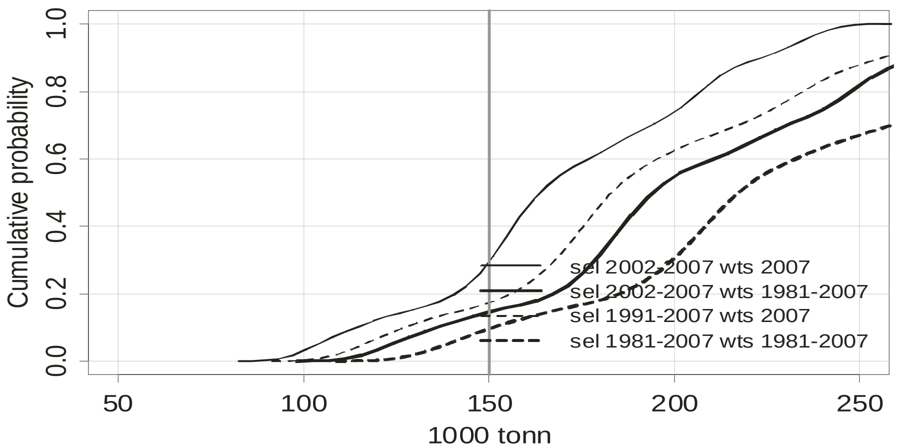

Figure 8.12 Saithe in Division Va. . Probability distribution of the SSB when fishing at 0.22 (provisional Fpa) using 4 input scenarios of weight and selection

9 Icelandic cod

Summary

INPUT DATA: The total reported landings in 2008 were 147 kt. Total landings in the last 4 fishing year have been relatively close to the set TAC for the Icelandic fleet. The TAC for the current fishing year is set to 160 kt.

Mean weight at age in landings have been declining in the last 6-7 years and are in 2008 about 9 to 12 % (20 % for the small 2001 year class) below the long term average in age groups 4 to 9. Weights at age in the spring survey have also been declining over the same period and are generally very low in the 2009 survey.

Abundance indices by age from the spring and the fall surveys show that the year classes from 2001 onward are on average smaller than the ones from 1997 to 2000. The first measurement of the 2008 year class indicates that it may be above average. That year class will however not contribute significantly to the fisheries until 2013.

ASSESSMENT MODELS: Several assessment models were applied as in recent years, all giving similar results. The results from the AD-Model builder statistical Catch at Age Model (ADCAM) based on the spring survey, were as in previous years, adopted as a point estimate for forward projections. The survey indices were revised to take into account measurements from Iceland-Faeroe ridge (Rósagarðurinn).

COMPARISON WITH 2008 ASSESSMENT: The estimates of reference fishing mortality in 2007 is now 0.52 compared with 0.55 estimated last year. The SSB in 2008 is now estimated to have been 253 kt compared with 230 kt estimate last year. Half of this difference is caused by inclusion of the Iceland-Faeroe ridge in the survey area. The retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicates a minor but constantly downward revision of year classes 2002 and younger. Since these revisions are on pre-recruits that have not entered the fishery they have minor effect on the estimates of the post-recruit metrics.

STATE OF THE STOCK: The spawning stock has been relatively small in the last 40 year compared with the time before that. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 220 kt at present. In spite of major drawback around the year 2000 exploitation rate and fishing mortality have on the been lower after the implementation of the catch rule in 1995 compared with period 1980-1993. Fishing mortality has declined significantly in recent years, the present estimate of about 0.4 not seen since the early 1960's. Year classes from 2001 to 2007 are estimated to be below the long-term average . First measurement of the 2008 year class indicate that it may above medium size or even large . The low recruitment in recent years in addition to very low mean weight at age means that the productivity of the stock at present is very low.

9.1 Stock description and management units

The Icelandic cod stock is distributed all around Iceland and in the assessment it is assumed to be a single homogenous unit. Spawning takes place in late winter mainly off the southwest coast but smaller, variable regional spawning components have also been observed all around Iceland. The pelagic eggs and larvae from the main spawning grounds drift clockwise around the island to the main nursery grounds off the north coast. A larval drift to Greenland waters has been recorded in some years and substantial immigrations of mature cod from Greenland which are considered to be of Icelandic origin have been observed in some years. The latest of such migration was from the 1984 year class in 1990, the number estimated around 30 millions. Extensive tagging experiments spanning with some hiatuses over the last 100 year show no indication of significant emigration from Iceland to other areas. In recent years it has been observed that cod tagged in Iceland has been recaptured inside Faroes waters close to the EEZ line separating Iceland and the Faroes islands.

The management unit of the Icelandic cod is limited the Icelandic EEZ zone.

9.2 Scientific data

The scientific data used for assessing Icelandic cod are the same as for most other species in Icelandic waters. The sampling programs i.e log books, surveys, sampling from landings etc. have been described in previous reports but have not yet been summarized in a form of a stock annex.

9.2.1 Catch: Landings, discards and misreporting

Landings of Icelandic cod in 2008 are estimated to have been 147 kt which are the lowest post-war landings (Table and Figure 9.2.1). Of the total landings 144 kt were taken by Icelandic fleet but 3 kt by other nations. The latter includes 1.8 kt of cod taken by the Faroese bottom trawl fleet inside the Faroese EEZ close to the line separating the Icelandic and Faroese EEZ. Allocations of those catches are based on analysis of tagging, described in detail in section 4.1.

Historically the landings of bottom trawlers constituted a larger portion of the total catches than today, in some years prior to 1990 reaching 60% of the total landings. In the 1990's the landings from bottom trawlers declined significantly, and have been just above 40% of the total landings in the last decade. (Figure 9.2.1). The share of long line has tripled over the last 20 years and is now on par with bottom trawl. The share of gill net has over the same time period declined and is now only half of what it was in the 1980's. Since the size of cod caught by the gillnet fleet is generally much larger than caught by other fleet, this change in fishing pattern is likely to have caused a significant reduction in the fishing mortality of older fish.

The trend in landings in recent years is largely a reflection of the set TAC (Figure 9.2.2) that is set for the fishing year (starting 1. September and ending 31 august) The TAC for the fishing year 2008/2009 was set at 160 kt and the TAC for the fishing year 2009-2010 is estimated to be around 150kt. Based on these numbers the landings for the 2009 calendar year are estimated to be around 160 kt.

Estimates of annual cod discards (Pálsson et al 2006, Pálsson et al 2009, in press) since 2001 are in the range of 1.4-4.3% of numbers landed and 0.4-1.8% of weight landed. Mean annual discard of cod over the period 2001-2008 was around 2 kt,or just over 1% of landings. In 2008 estimates of cod discards amounted to 1.1 kt, 0.8% of landings, the third lowest value int the period 2001-2008. The method used for deriving these estimates assumes that discarding only occurs as high grading but larger fish is usually higher priced.

In recent years misreporting has not been regarded as a major problem in the fishery of this stock. No study is though available to support that general perspective. Production figures from processing plants do though seem to be in "good" agreement with landings figures according to the Fisheries Directorate (personal communication).

9.2.2 Landings and weight by age

SAMPLING INTENSITY: Current sampling protocol for estimating the age composition of the cod has been in effect since 1991 and have been described previous reports. The sampling intensity in 2008 is similar as it has been in previous years.

LANDINGS IN NUMBERS BY AGE: The total landings-at-age (Table 9.2.2) show that in the past three decades age groups 7 and younger have been more than 90% of the landings in numbers. In 2008 the number of 4 year old in the catches is low, confirming the prior estimates from the survey that the 2004 year class is small. The small 2001 year class is however lasting longer in the catches than the medium sized year class from 2000. This phenomenon has been observed before with small year classes, possibly indicating that they recruit later to the fisheries than larger year classes. The catch at age matrix is reasonably consistent, with CV estimated to be approximately 0.2 for age groups 4-10 based on a Shepherd-Nicholson model (Shepherd and Nicholson 1991).

MEAN WEIGHT AT AGE IN THE LANDINGS: The mean weight age in the landings (Table 9.2.3 and Figure 9.2.4) delclined from 2001 to 2007, reaching then a historical low in many age groups. The weight at age in the landings in 2008 increased from that of 2007, but are still below the long term average. The decline in weight at age in the catches is in part a reflection of the decline in weight in the stock as seen in the measurements from the spring survey (Figure 9.2.5) but also change in fishing pattern. In recent years gillnet fisheries in the south have decreased but longline fishery in the north increased(section 9.2.1). Mean weights at age of cod caught by longlines is usually lower than of cod caught by gillnets. In addition mean weight at age is higher in the south than in the north.

Last year the estimates of mean weights in the landings of age groups 3-9 in 2008 were based on a prediction from the spring survey measurements in 2008 using the relationship between survey and landings weights in 2007. This gave slight underestimate of the weight at age in the catches in 2008. The reference biomass upon which the TAC is set based is derived from population numbers and catch weights. The biomass estimates for the start of 2008 was last year estimated being 590 kt based on the predicted 2008 catch weights but would have been 613kt based on the observed 2008 catch weights.

The same approach was used this year for predicting weight at age in the catches for 2009. The catch weights in 2009 were estimated from the weights in the spring survey 2009 using the relationship between survey and landings weight in 2008. Since the survey weights are low for some age groups in 2009 compared with 2008 (Figure 9.2.5), mean weights at age in the catches are predicted to decrease from 2008 to 2009 (Figure 9.2.4). The reference biomass of age groups four and older (B4+) in 2009 is based on those predicted weights.

9.2.3 Surveys

BIOMASS INDICES: The total biomass indices from the spring survey (Figure 9.2.6) indicate that the decline in total stock size observed in recent years has halted with the most recent observations indicating an increase in stock size. Indices of large fish are relatively high but indices of small fish relatively low, as would be expected in a situation where recruitment is poor and fishing mortality relatively low, as is considered to be the case for Icelandic cod.

In recent years the survey information used for tuning have not included the Iceland – Faeroe ridge. The proportion of the total survey index in this area varied from 3 – 10% in the years 1985-1995 when a decision was made not to survey this area. In 2004 it was noted that large part of the trawler fleet was in this area so a decision was made to start surveying in this area again. Since then 8-12 percent of the total survey biomass have been from this area. The cod in the area is typically large.

AGE BASED INDICES: Abundance indices by age from the spring and the fall surveys (Tables 9.2.6 and 9.2.7) show that the year classes from 2001 onward are significantly smaller than the ones from 1997 to 2000. However the first estimate of year class 2008, based on measurement from the 2009 spring survey indicate that is may be above average. That year class will not affect the landings and spawning stock until 2013. .

A residual plot of the spring survey indices by age and year ($U_{a,y}$) from consecutive years based on the model:

$$U_{a+1,y+1} = a + bU_{a,y} + \varepsilon$$

shows that in recent years later observed values (ages 1 vs 2 and ages 2 vs 3) of the incoming year classes are smaller than expected on average (Figure 9.2.7). Although the difference is relatively small it is persistent, resulting in some revision in the size of the incoming recruits to the fishery (age 3) in the assessments in recent year The difference would be even larger if the estimates of *a* and *b* in the equation above were only based on data until the year *y*. .

9.3 Information from the fishing industry

Unstandardised CPUE and effort indices, based on log book records where cod constitutes more than 70% of the catch, show a increase in CPUE in all gears in the early 1990's (Figure 9.3.1), coinciding with the time of the adoption of the HCR.. CPUE decreased from 1998-2001 but has increased since then and is now high for all gear type. The perception from logbook data is that effort towards cod has decreased in recent years but a proper method to calculate effort has not yet been implemented

The changes in cpue are to some extent a reflection of the dynamics in the stock although but they are confounded by other factors like abundance of other species caught with cod in mixed fisheries but this abundance affects the arbitrary selection criteria applied (cod >70% of catch). Haddock has probably the largest effect in this respect but the ration between landings of haddock and cod has been highly variable in the last 10 years.

9.4 Methods

INTRODUCTION: In recent years "the final assessment" of the Icelandic cod has been based on a statistical catch at age model (ADCAM, developed by Höskuldur Björnsson) tuned with the spring survey indices (SMB). The NWWG 2009 point estimators for the short term predictions as well as for the medium term projections (5 years) are based on the same script (ADCAM) as used last year, here after sometimes referred to as the SPALY (Same Procedure As Last Year) run. The model settings were identical to last years but the tuning data changed by addition of the Iceland-Faeroe ridge to the survey area (see section on the surveys). The Iceland – Faeroe ridge was not surveyed in 1996 – 2003 and to cover that gap the mean proportion of agegroup found in the area in 1994 – 1995 was used for the years 1996-2003. The proportion of the codstock in this area low in 1994-1995.

Icelandic cod has annually been assessed using a Time Series Analysis developed and run by Guðmundur Guðmundsson (199x, model description and details of numerous runs are given in WD xx, NWWG 2009). Models where the catch/fishing mortality is not modelled (XSA, ADAPT) were also run. A significant difference in the model setup of all but XSA is that correlation between the residuals of different age groups in the survey is not modelled. In addition all the assessment models were run using autumn groundfish survey (SMH conducted since 1996) for calibration. The results from the autumn survey 2009 were not available before the meeting..

The WG concluded that there was no basis to change model configuration applied last year. What follows is thus only done for the matter of completeness and includes a description of the method applied as well as the major conclusions from the assessment work carried out this year using the ADCAM (SPALY) framework. Analysis and conclusions using the TSA framework is also presented for comparison, since it contains analysis related to potential model misspecifications..

THE ADCAM (SPALY) MODEL:

Input data: The model used catch data from 1955 to 2008 and spring survey data from 1985 – 2009. Age groups included are 1-10 in the survey and 3 – 14 in the catches.

Parameter estimates and assumptions used:

- Fishing mortality is estimated for every year and age. Fishing mortality of each age group was constrained with a random walk term with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variability in F) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to be larger for the older age groups.
- Catchability in the survey was dependent on stock size for ages 1-5.
- CV's of the commercial catch and of survey indices as function of age are estimated. The CV of both catch and survey residuals are estimated. For the catches the CV is a parabola with 2 numbers estimated but for the catches the pattern with age is obtained from an Adapt run and a common multiplier estimated.
- Correlation of residuals of different age groups in the survey was estimated as a 1st order AR model. This is to take into account "year effects" in the survey.
- Migrations for specified years (y) in specified ages (a) are estimated (y=c(1958, 1959, 1960, 1962, 1964, 1969, 1970, 1972, 1980, 1981, 1990),a=(9, 9, 10, 9, 10, 8, 8, 9, 7, 8, 6)). The basis for allowing migration in these years and ages are anomalies in the catch and weight matrix.

The recruitment model, weight and maturity model (used for medium term projections):

- Recruitment was assumed to be lognormally distributed around a Ricker curve with the CV of the lognormal distribution estimated. Time trend in Rmax of the Ricker curve was allowed and CV of the residuals in the SSB-recruitment relationship depend on stock size.

Estimated Rmax decreases by 0.9% per year from 1955 to 1995 so predicted recruitment in 1995 is expected to be 67% of what it was in 1955 for the same spawning size of the spawning stock.

- The average weight at age in the catches and the spawning stock was assumed to be of the same as used for deterministic short term prediction. Deviations in weights at age were assumed to be lognormal with CV 0.1 and autocorrelation 0.35. The same deviations were applied to all age groups in the same year. Sexual maturity is fixed to that observed in the short term prediction with no CV modelled.

DIAGNOSTIC OF THE SPALY RUN: The diagnostic from the SPALY run are shown in Table and Figure 9.4.1 and 9.4.2. The log residuals from the spring survey are generally small but with apparent year effects. Of notice is the largely positive residual blocks for ages 1 and 2 in the most recent years. This is because more recent survey estimates of pre-recruits are smaller than expected (section 9.2.3). The "corrections" of the final year class size are largely between the first, second and third measurements as is apparent in the relatively good diagnostics seen in the retrospective plot on the recruitment at age 3 (Figure 9.4.2). Retrospective bias in the estimate of the reference biomass (Biomass of age 4 and older, B4+) is in the order of ±10%, with little indication of a persistent pattern in the last decade. The effect of the downward revision in pre-recruits in the recent years does not affect the accuracy of the the advice which is based on the B4+ in the assessment year. It does on the other hand affect short-medium term prediction if this pattern will persist as the estimated size of year classes 2007 and 2008, that are now age 2 and 1 will be reduced. Overall, the addition of one more year of data indicate relatively little changes in the perception of the state of the stock compared with last year (Table 9.4.7).

The relationship between the survey indices and estimated stock in numbers for age groups 1-9 for the SPALY run are shown in Figure 9.4.3. The regression line is only fitted to the period 1985-2005, the period were the stock in number estimates are not likely to change with addition of new data. Relatively high correlation is observed for most age groups indicating a good consistency between the catch at age and the survey data. The crosshair shows the SPALY estimates of population numbers in 2009 and the spring survey measurements in 2009. The estimated stock size is generally very close to that predicted from the survey measurements in 2009. Of significance with respect to reference biomass estimates is the somewhat larger stock size estimate of 4 year olds compared with that measured in the survey. Estimates based on the 2009 survey measurement point only would give a 20kt (<5%) lower biomass estimate than the final run indicate.

The fishing mortalities and stock in numbers by age are from the SPALY run are presented in Tables 9.4.3 and 9.4.4.

Working document 11 describes the results and diagnostics of the TSA model. The results of TSA calibrated with the March survey are similar to the Adcam results. The estimated recruitment is though lower but the amount of older fish is estimated to be higher and the fishing mortality of old fish therefore lower. The model differences causing these changes are most likely the parametric selection curves used in TSA and that transient changes in M on recruiting age groups are allowed in TSA.

The standardized residuals and model results for the spring survey are presented in Table 9.4.5 and Figure 9.4.1

COMPARISONS OF PRINCIPAL METRICS

Comparison of the principal assessment metrics for all the models run is shown in Table 9.4.7. The difference between models is relatively small with reference biomass in 2009 ranging from 651-790?? in models calibrated with the March survey and 740-850 ? in models calibrated with the autumn survey. In short the autumn survey indicates better state of the stock than the March survey.

The March survey is a longer time series with higher density of stations than the autumn survey. It has therefore been used as base in the assessment in recent years. The estimated standard deviation of the reference biomass 2009 from TSA is 41 kt when tuned with the March survey but 64 kt when tuned with the autumn survey. The most recent autumn survey has also been considered as an outlier as can for example be seen in Figure 9.2.6. The choice of survey used in the assessment is further discussed in section 9.9 on uncertainty in the assessment.

9.5 Reference points THIS WILL BE EXPANDED

No limit reference points have been defined for this stock by ICES, because the harvest rule (see section 9.11) was implemented prior to ICES defining such reference points on a larger scale. ICES considered the 1995 harvest control rule to be consistent with the precautionary approach provided the implementation error is minimal.

The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested a candidate for Blim "somewhere in the range of 400kt". Due to a change in the method used to calculate the spawning stock biomass (implemented in 2005) from using catch weight and maturity from the catches to using estimated stock weights and stock maturity at age the historical spawning stock estimates presently used are lower than the ones that SGPRP 2003 based their suggestion on. Based on the present estimates on SSB and recruitment relationship presented in fig. x.x.x the size of SSB where recruitment becomes impaired seems to in the range of 210-230 kt which about the size of the SSB at present. In this report a Blim candidate of 220 kt is used to evaluate the results of medium term simulations.

9.6 State of the stock

The spawning stock has been relatively small in the last 40 year compared with the time before that. It reached a historical low in 1993 (120 kt) but has since then increased and is estimated to be about 220 kt at present. In spite of major drawback around the year 2000 explotation rate and fishing mortality have on the been lower after the implementation of the catch rule in 1995 compared with period 1980-1993. Fishing mortality has declined significantly in recent years, the present estimate of about 0.4 not seen since the early 1960's. Year classes from 2001 to 2007 are estimated to be below the long-term average . First measurement of the 2008 year class indicate that it may above medium size or even large . The low recruitment in recent years in addition to very low mean weight at age means that the productivity of the stock at present is very low.

9.7 Short term forecast

INPUT: The basis for the prediction for the weight in the catch in 2009, which are also used in the weight of the reference biomass (B_{4+}) were described in section 9.2.2. Weights in the catch and B_{4+} for 2010 onwards were assumed to be the same as those predicted for 2009. Weights and proportion mature in the spawning stock 2010 and onwards were assumed to be the same as measured in the mature fish in the spring survey in 2009 (Tables 9.2.4 and 9.2.5). The fishing pattern used is the average of the years 2006-2008.

The estimated landings for the calendar year 2009 are 160kt as discussed in section 9.2.1. Using an Fsq constraint where F09=F08 would give the same landing predictions. Details of the inputs values used are shown in Table 9.7.1.

The catch in the next fishing year calculated as 20% of reference biomass in 2009 is 140 kt (Table 9.7.2). A buffer where the TAC in the current fishing year of 160 kt has a 50% weight results in a TAC of 150 kt. In predictions based on fishing year (ADCAM) 150 is used as the TAC in next fishing year.

OUTPUT: Fishing mortality is expected to decline further from a point estimate of 0.42 in 2008 and 2009, to 0.34-0.36, respectively in 2010. The reference biomass and the spawning stock are predicted to increase from 2009 to 2011. An advice based on Fmax =0.32, as was used by ICES last year would give 136 kt.

9.8 Medium term forecasts

The ADCAM script was used for medium term () simulation, the assumption and input being described in the method section (section 9.4). The projected landings removed were based on the following scenario:

$$Y_{y/y+1} = \frac{0.2B_{4+,y} + TAC_{y-1/y}}{2}$$

where the Y stands yield in the fishing year (y/y+1), TAC stands for the set TAC in the previous fishing year (y-1/y) and $B_{4+,y}$ is the estimated biomass in the assessment year. This scenario is in accordance with that advised domestically in 2007 as a medium term strategy and has now been informally adopted by Icelandic authorities as a part of a potential long term management plan The simulations start with a TAC of 150 kt for the fishing year 2009/2010 as described in last section.

The simulation is carried forward using as time horizon the year 2015 (in agreement with the Johannesburg Declaration). Median recruitment estimates (Figure 9.8.1) are projected to be low relative to the long term, this being based on the assumptions that Rmax has declined over the time period from 1955 to 1995 (described in the method section 9.4).

To investigate the effect of problem with recruitment estimates an alternative scenario was run where M of agegroups 1 and 2 was fixed at 0.2 before 1999 but estimated 1999 and later (the same value for all the years).

The results (Figures 9.8.1 and 9.8.2) indicate that there is a high probability that the spawning stock biomass (SSB) in 2015 will be above the potential Blim candidate and present estimate of 220 kt. The medium terms simulations also indicate the probability of SBB<Blim(candidate) in 2013 is less than 5%.. probability The reference biomass (B_{4+}) and catches will most likely increase from the present to 2015 The reference biomass is more dependent of the Ricker function applied for predicting recruitment than the other metrics i.e catch and SSB. The reason is that the younger age groups of the reference biomass do not contribute to the spawning stock and catches and, TAC in the prediction year is the mean of the TAC in the previous year and 20% of the reference biomass in the previous year. .

Estimating M of ages 1 and 2 1999 and later gives M of 0.3-0.35. The estimates are correlated so estimating 1 number would have been enough. The results give more pessimistic view of the stock but indicate that the probability of the spawning stock being below Blim in 2015 is less than 5%. (Figure 9.8.2)

9.9 Uncertainties in assessment and forecast

HISTORICAL ASSESSMENT UNCERTAINTIES: Relative to most southern gadoid stocks assessed by ICES the assessment of the Icelandic cod is likely to be a candidate that could be classified as precise, although the accuracy is unknown. The former is partly because three survey measurements (age 1 to 3) for each year class are available to assess year class strength before they actually enter the reference stock and the fisheries. Compared with last year assessment, the additional measurements have resulted in abundance estimates of incoming year classes being revised downwards, year class 2007 by 18% and year class 2006 by 4%. Since neither of these year classes have yet entered the reference stock (B_{4+}), and since fishing mortality estimates (F_{5-10}) are more or less in line with that predicted last year, those latter metrics are more or less the same as estimated last year.

As discussed in section 9.4 and shown in Table 9.4.7 there is considerable difference between results of assessment models calibrated with the autumn survey and those calibrated with the March survey. The estimated reference biomass in 2009 is 14% higher from TSA tuned with the autumn survey instead of the March survey.

According to the assessment models the standard deviation of stock estimates is considerably higher when calibrated with the autumn survey instead of the March survey (64kt vs 41 kt for the reference biomass 2009). That does not tell all the story as there are two potential problems with the March survey.

- Retrospective pattern in the recruitment estimates described before.
- Negative trend of close to 1% estimated with TSA. The trend is not significant but the P value is still uncomfortably high.

Neither of these patterns is observed in the autumn survey but the series is shorter and not as easy to detect those kind of problems. Allowing catchability trends in other assessment models than TSA like Adapt does give similar negative trend, increasing estimated stock size.

The causes of the trend are not clear. Tests on generated data using Adapt indicate that stock assessment based on too high M on data with negative trend in fishing mortality leads to negative trend in catchability being estimated. This could be an indication that M on the age groups in the catches is lower than 0.2??

SHORT TERM FORCAST: Uncertainties in the short term forecast have not been formally quantified, but are by nature larger current and historical stock estimates. Assessment models that are used for prediction show well how the uncertainty in the assessment increases, especially if a TAC constraint is used for the next few years. That is probably the most realistic scenario as fishing mortality is not known. With a TAC constraint the CV of the reference biomass in 2011 is 13% but only 6.3% on the reference biomass in 2009 (Spaly run). This is an underestimate of the "real uncertainty" as a number of factors is not included in the model.

Uncertainty in prediction of weights is something that is not covered by standard assessment models. Mean weight at age reduced from 1998-2004 and were always overestimated in that period. Since then the weights have stabilized and the prediction of weight has at the same time improved but the model used for predicting weights is not very complicated, use the same weights as last year.

Looking at performance of historical assessments the estimates of the B4+ in the assessment year, which now is the basis for determining TAC in the advisory year, during the assessment period from 1991 to 2005 have on average been 12% higher relative to the current estimates.

In summary the assessment and prediction are reasonably precise but have tendency to overestimate.

MEDIUM TERM FORECAST: Sources of uncertainty are the same as in the short term forecast but uncertainty is larger as considerable changes can occur in the ecosystem. Here prediction with fixed TAC is not feasible so the catches have to be calculated as some proportion of the biomass and assessment error therefore included.

The main uncertainty seen today is due to the overestimate of recruitment from indices of ages 1 and 2 seen in recent year. Taking that into account by allowing natural morality of ages 1 and 2 to be different after 1999 predicts considerably slower increase of the stock in coming years.

9.10 Comparison with previous assessment and forecast

The reference stock in 2008 is now estimated to be 654 kt compared to 589 kt last year. 20 kt of the difference is caused by higher than predicted mean weight at age in the catches, 30 kt by inclusion of the Iceland-Faeroe ridge in the survey data and the rest by changes in stock numbers.

Fishing mortality in 2007 is now estimated 0.52 compared to 0.55 last year.

Estimate of year classes 2005 – 2007 is lower than in 2008, 18% lower for year class 2007 but 4% for year classes 2006 and 2005

9.11 Management plans and evaluations

THE 1995 HARVEST CONTROL RULE:

A formal Harvest Control Rule was implemented for this stock in 1995. The TAC for a fishing year (y/y+1) was set as a fraction (25%) of the "available biomass" which was computed as average of the biomass of age 4 and older fish B(4+) in the assessment year (y) and advisory year (y+1). In mathematical terms the 1995 catch rule was:

$$TAC_{y/y+1} = 0.25\frac{B_y + B_{y+1}}{2}$$

The rule followed work of a group set up by the minister of fisheries. The suggestions of the working group (xxx 1994) were somewhat different from what was implemented or

$$TAC_{y/y+1} = \frac{TAC_{y-1/y} + 0.22B_y}{2}$$

The HCR has since its introduction undergone a number of changes and for a number of years the catches exceeded the TAC. The main reason was that part of the small boat fleet was in an effort based system and there was to will to predict the landings of this fleet correctly.

The most recent version of the HCR is similar to the original proposed HCR except the proportion is 0.2 instead of 0.22. This HCR was implemented for the first time in 2007/2008 without a buffer reducing landings to 130kt. The TAC for the fishing year 2009/2010 was in the beginning set to 130kt according to the HCR. The TAC was then increased to 160 kt in December 2008. The basis for that increase is unclear but it did not include any longterm considerations. The situation today is relatively unclear but the government plans to follow the 2007 year class of the catch rule but use 160kt as buffer when the TAC for the fishing year 2009/2010 is calculated.

Ices advice last year was: However, taking into account 1) two amendments in the catch rule that resulted at the time they were set in less stringent action in limiting catches in the next fishing year than would have been the case with the original rule, 2) experienced implementation problems and, 3) the assessment errors and biases in recent 10 years, ICES suggested in 2007 that the original plan should be re-evaluated. Furthermore, ICES advised last year that "Given the relatively high proportions of younger fish in the fishable as well as in the spawning-stock biomass, the relatively weak incoming year classes, and low capelin abundance, lower fishing mortalities than those obtained by the Harvest Control Rule should be considered. In order to ensure a high probability of the SSB increasing in the next 5 years, the exploitation rate must be reduced to no more than 20%."

9.12 Management considerations

Prior to allocating the ITQ catches to the Icelandic fishing fleet, the managers should ensure subtracting all expected catches from other sources, including likely catches of the foreign fleets, likely catches of Faroese inside their own EEZ and "research landings". The amount is not known in advance but is likely to be of the similar order of magnitude as last year.

Cod and haddock are often caught in the same fishing operation. The TAC constraint on cod expected to result in significant reduction in fishing mortalities. This reduction is not in line with current fishing mortality trends in haddock. Anecdotal information from the fisheries indicates that the restrictions on the landings of cod are presently changing the behaviour of the fishing fleet, fishermen trying to avoid catching cod but targeting haddock. A lower exploitation rate of the haddock is thus advisable, in particular to avoid potential increase in discarding and misreporting of cod.

9.13 Ecosystem considerations

In Icelandic waters there are a number of areas closed to fishing activities. Although relatively small at present, such no-take zones areas are likely to be important for protection biological communities and species diversity. Findings from a recent study show that closed areas can benefit several fish species such as cod. Recent practices of reducing the size of some of the areas where no fishing activity has taken place for numerous years are counter to prevalent thinking of the importance of no-take zones as well as counter to the ecosystem based approach to fisheries management. The pressure to open closed areas could be an indication that fishing effort was too high

During the last few years the capelin stock has been low. This low abundance as well as anecdotal information about the low abundance of sandeel may have caused an increase in natural mortality in seabird populations around Iceland. It is possible that some of these changes are climate-driven but the effects of fishery induced mortality on the capelin cannot be ruled out.

9.14 Regulations and their effects

Exploitation rate and fishing mortality have been lower after the implementation of the catch rule in 1995 compared with the past.

A quick closure system has been in force since 1976, aimed at protecting juvenile fish. Fishing is prohibited, for at least two weeks, in areas where the number of small cod (< 55 cm) in the catches has been observed by inspectors to exceed 25%. A preliminary evaluation of the effectiveness of the system indicates that the relatively small areas closed for a short time do most likely not contribute much to the protection of juveniles. On the other hand, several consecutive quick closures often lead to closures of larger areas for a longer time and force the fleet to operate in other areas. The effect of these longer closures has not been evaluated analytically.

Since 1995, spawning areas have been closed for 2-3 weeks during the spawning season for all fisheries. The intent of this measure was to protect spawning fish. In 2005, the maximum allowed mesh size in gillnets was decreased to 8 inches in order to protect the largest spawners.

The mesh size in the codend in the trawling fishery was increased from 120 mm to 155 mm in 1977. Since 1998 the minimum codend mesh size allowed is 135 mm, provided that a so-called Polish cover is not used. Numerous areas are closed temporarily or permanently for all fisheries or specific gears for protecting juveniles and habitat, or for socio-political reasons. The effects of these measures have not been evaluated.

9.15 Changes in fishing technology and fishing patterns

Changes in the importance of the various gears used to catch cod are described in section 9.3. The decline in the gill net fishery and the increase in the long line fishery are likely to have resulted in shift in the fishing pattern to smaller fish. The increase in the long line fishery in the north is partly the reason for the decline in the observed mean weight at age in the catches.

Anecdotal information from the fishing industry in recent months indicate that to minimize cod catches in relative to other species (due to restrictive TAC),the fleet has shifted to somewhat shallower water. It has been hypothesised that this may lead to increased targeting of small cod. This hypothesis has not been supported with data.

9.16 Changes in the environment

An increased inflow of Atlantic water has been observed in Icelandic waters since 1997, resulting in higher temperature and higher salinity in the Icelandic waters. At present no relationships have been demonstrated between these environmental indicators and cod recruitment. A northward shift in distribution of immature capelin may be linked to these hydrographical changes, resulting in lower availability of capelin as fodder for cod.

In the past, weights-at-age of the cod have been clearly related to the biomass of capelin. The recent reduced mean weights-at-age are likely to be linked to the low abundance of capelin from the feeding areas for cod. These low weights were also used in forecasts, because estimates of the capelin biomass indicate that it will remain low.

In years of high recruitment a larval drift to Greenland is sometimes observed, resulting in a large year class at Greenland. In some other years an immigration of adult cod from Greenland has taken place, which has been taken into account in the assessment. Based on the present status of cod stocks in Greenland, no substantial immigration to Iceland can be expected in the near future. It is, however possible that the relatively moderate 2003 year class presently found in Greenland waters is of Icelandic origin.

9.17 References

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Table 9.2.1. Icelandic cod in division Va. Nominal catches (tonnes) by countries 1973-2008 as officially reported to ICES and WG best estimates of landings.

Year	Belgium	Faeroe Islands	France	Germany	Germany, Fed. Rep	Greenland	Iceland	Norway	Poland	UK - Eng+Wales+N	UK - England & Wa	UK - Scotland	UK	Sum	WG estimates	Difference
1973	1110	14207	-	.	6839	-	235184	268	-	.	121320	957		379885	369205	-10680
1974	1128	12125	203	.	5554	-	238066	171	1	.	115395	2144		374787	368133	-6654
1975	1269	9440	23	.	2266	-	264975	144	-	.	91000	1897		371014	364754	-6260
1976	956	8772	-	.	2970	-	280831	514	-	.	53534	786		348363	346253	-2110
1977	1408	7261	-	.	1598	-	329676	108	-	.	-	-		340051	340086	35
1978	1314	7069	-	.	-	-	319648	189	-	.	-	-		328220	329602	1382
1979	1485	6163	-	.	-	-	360077	288	-	.	-	-		368013	366462	-1551
1980	840	4802	-	.	-	-	429044	358	-	.	-	-		435044	432237	-2807
1981	1321	6183	-	.	-	-	461038	559	-	.	-	-		469101	465032	-4069
1982	236	5297	-	.	-	-	382297	557	-	.	-	-		388387	380068	-8319
1983	188	5626	-	.	-	-	293890	109	-	.	-	-		299813	298049	-1764
1984	254	2041	-	.	-	-	281481	90	-	.	2	-		283868	282022	-1846
1985	207	2203	-	.	-	-	322810	46	-	.	1	-		325267	323428	-1839
1986	226	2554	-	.	-	-	365852	1	-	.	-	-		368633	364797	-3836
1987	597	1848	-	.	-	-	389808	4	-	.	-	-		392257	389915	-2342
1988	365	1966	-	.	-	-	375741	4	-	.	-	-		378076	377554	-522
1989	309	2012	-	.	-	-	353985	3	-	-	.	-		356309	363125	6816
1990	260	1782	-	.	-	-	333348	-	-	-	.	-		335390	335316	-74
1991	548	1323	-	-	.	-	306697	-	-	-	.	-		308568	307759	-809
1992	222	883	-	-	.	-	266662	-	-	-	.	-		267767	264834	-2933
1993	145	664	-	-	.	-	251170	-	-	<0.5	.	-		251979	250704	-1275
1994	136	754	-	-	.	-	177919	-	-	-	.	-		178809	178138	-671
1995	-	739	-	-	.	-	168685	-	-	-	.	-		169424	168592	-832
1996	-	599	-	<0.5	.	-	181052	7	-	-	.	-		181658	180701	-957
1997	-	408	-	-	.	-	202745	-	-	-	.	-		203153	203112	-41
1998	-	1078	-	9	.	-	241545	-	-	-	.	-		242632	243987	1355
1999	-	1247	.	21	.	25	258658	85	-	12	.	4		260052	260147	95
2000	-	.	-	15	.	-	234362	60	-	10	.	<0.5		234447	235092	645
2001	-	1143	-	11	.	-	233875	65	-	15	.	5		235114	234229	-885
2002	-	1175	-	15	.	-	206987	73	-	19	.	13		208282	208487	205
2003	-	2118	-	88	.	-	200327	56	-	104	.	42		202735	207543	4808
2004	-	2737	-	113	.	-	220020	90	-	310	.	102		223372	226762	3390
2005	-	2310	.	177	.	.	206343	77	-	224	.	220		209351	213403	4052
2006	-	1665	-	38	.	.	193425	78	-	15	.	5		195226	196276	1050
2007	-	1760	-	-	-	-	-	110	-	-	-	-	11	1880.6	170622	168741
2008															148000	

Table 9.2.2. Icelandic cod in Division Va. Observed catch in numbers by year and age in millions of fish in 1955-2008. The 2009 catches are estimates based on a landing estimates of 160 kt, the 2010 and beyond estimates are based on prediction from the adopted model applying a 20% catch rule with a buffer.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	4.790	25.164	46.566	28.287	10.541	5.224	2.467	25.182	2.101	1.202	1.668	0.665
1956	6.709	17.265	31.030	27.793	14.389	4.261	3.429	2.128	16.820	1.552	1.522	1.545
1957	13.240	21.278	17.515	24.569	17.634	12.296	3.568	2.169	1.171	6.822	0.512	1.089
1958	25.237	30.742	14.298	10.859	15.997	15.822	12.021	2.003	2.125	0.771	3.508	0.723
1959	18.394	37.650	23.901	7.682	5.883	8.791	13.003	7.683	0.914	0.990	0.218	1.287
1960	14.830	28.642	27.968	14.120	8.387	6.089	6.393	11.600	3.526	0.692	0.183	0.510
1961	16.507	21.808	19.488	15.034	7.900	6.925	3.969	3.211	6.756	1.202	0.089	0.425
1962	13.514	28.526	18.924	14.650	12.045	4.276	8.809	2.664	1.883	2.988	0.405	0.324
1963	18.507	28.466	19.664	11.314	15.682	7.704	2.724	6.508	1.657	1.030	1.372	0.246
1964	19.287	28.845	18.712	11.620	7.936	18.032	5.040	1.437	2.670	0.655	0.370	1.025
1965	21.658	29.586	24.783	11.706	9.334	6.394	11.122	1.477	0.823	0.489	0.118	0.489
1966	17.910	30.649	20.006	13.872	5.942	7.586	2.320	5.583	0.407	0.363	0.299	0.311
1967	25.945	27.941	24.322	11.320	8.751	2.595	5.490	1.392	1.998	0.109	0.030	0.106
1968	11.933	47.311	22.344	16.277	15.590	7.059	1.571	2.506	0.512	0.659	0.047	0.098
1969	11.149	23.925	45.445	17.397	12.559	14.811	1.590	0.475	0.340	0.064	0.024	0.021
1970	9.876	47.210	23.607	25.451	15.196	12.261	14.469	0.567	0.207	0.147	0.035	0.050
1971	13.060	35.856	45.577	21.135	17.340	10.924	6.001	4.210	0.237	0.069	0.038	0.020
1972	8.973	29.574	30.918	22.855	11.097	9.784	10.538	3.938	1.242	0.119	0.031	0.001
1973	36.538	25.542	27.391	17.045	12.721	3.685	4.718	5.809	1.134	0.282	0.007	0.001
1974	14.846	61.826	21.824	14.413	8.974	6.216	1.647	2.530	1.765	0.334	0.062	0.028
1975	29.301	29.489	44.138	12.088	9.628	3.691	2.051	0.752	0.891	0.416	0.060	0.046
1976	23.578	39.790	21.092	24.395	5.803	5.343	1.297	0.633	0.205	0.155	0.065	0.029
1977	2.614	42.659	32.465	12.162	13.017	2.809	1.773	0.421	0.086	0.024	0.006	0.002
1978	5.999	16.287	43.931	17.626	8.729	4.119	0.978	0.348	0.119	0.048	0.015	0.027
1979	7.186	28.427	13.772	34.443	14.130	4.426	1.432	0.350	0.168	0.043	0.024	0.004
1980	4.348	28.530	32.500	15.119	27.090	7.847	2.228	0.646	0.246	0.099	0.025	0.004
1981	2.118	13.297	39.195	23.247	12.710	26.455	4.804	1.677	0.582	0.228	0.053	0.068
1982	3.285	20.812	24.462	28.351	14.012	7.666	11.517	1.912	0.327	0.094	0.043	0.011
1983	3.554	10.910	24.305	18.944	17.382	8.381	2.054	2.733	0.514	0.215	0.064	0.037
1984	6.750	31.553	19.420	15.326	8.082	7.336	2.680	0.512	0.538	0.195	0.090	0.036
1985	6.457	24.552	35.392	18.267	8.711	4.201	2.264	1.063	0.217	0.233	0.102	0.038
1986	20.642	20.330	26.644	30.839	11.413	4.441	1.771	0.805	0.392	0.103	0.076	0.044
1987	11.002	62.130	27.192	15.127	15.695	4.159	1.463	0.592	0.253	0.142	0.046	0.058
1988	6.713	39.323	55.895	18.663	6.399	5.877	1.345	0.455	0.305	0.157	0.114	0.025
1989	2.605	27.983	50.059	31.455	6.010	1.915	0.881	0.225	0.107	0.086	0.038	0.005
1990	5.785	12.313	27.179	44.534	17.037	2.573	0.609	0.322	0.118	0.050	0.015	0.020
1991	8.554	25.131	15.491	21.514	25.038	6.364	0.903	0.243	0.125	0.063	0.011	0.012
1992	12.217	21.708	26.524	11.413	10.073	8.304	2.006	0.257	0.046	0.032	0.009	0.008
1993	20.500	33.078	15.195	13.281	3.583	2.785	2.707	1.181	0.180	0.034	0.011	0.013
1994	6.160	24.142	19.666	6.968	4.393	1.257	0.599	0.508	0.283	0.049	0.018	0.006
1995	10.770	9.103	16.829	13.066	4.115	1.596	0.313	0.184	0.156	0.141	0.029	0.008
1996	5.356	14.886	7.372	12.307	9.429	2.157	0.837	0.208	0.076	0.065	0.055	0.005
1997	1.722	16.442	17.298	6.711	7.379	5.958	1.147	0.493	0.126	0.028	0.037	0.021
1998	3.458	7.707	25.394	20.167	5.893	3.856	2.951	0.500	0.196	0.055	0.033	0.013
1999	2.525	19.554	15.226	24.622	12.966	2.795	1.489	0.748	0.140	0.046	0.010	0.005
2000	10.493	6.581	29.080	11.227	11.390	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.338	25.040	9.311	19.471	5.620	3.929	2.017	0.452	0.202	0.118	0.013	0.009
2002	5.934	18.482	24.297	6.874	8.943	2.227	1.353	0.689	0.123	0.040	0.041	0.002
2003	3.950	16.160	21.874	18.145	5.063	4.419	1.124	0.401	0.172	0.034	0.020	0.015
2004	1.778	19.184	25.003	17.384	9.926	2.734	2.023	0.481	0.126	0.062	0.014	0.005
2005	5.102	5.125	26.749	16.980	8.339	4.682	1.292	0.913	0.203	0.089	0.025	0.002
2006	3.258	12.884	8.438	22.041	10.418	4.523	2.194	0.497	0.336	0.067	0.027	0.002
2007	2.074	11.961	15.948	8.280	9.593	5.428	2.205	1.229	0.366	0.198	0.053	0.010
2008	2.616	4.850	12.585	11.973	5.238	4.582	2.040	0.831	0.308	0.053	0.037	0.004
2009	2.152	8.654	8.215	13.407	10.532	2.462	2.802	1.119	0.340	0.120	0.013	0.009
2010	1.980	6.538	11.834	7.294	8.357	5.581	1.271	1.413	0.488	0.149	0.048	0.005
2011	3.210	6.265	9.399	11.185	4.895	4.800	3.138	0.702	0.680	0.236	0.066	0.021
2012	1.953	10.389	9.271	9.224	7.853	2.955	2.846	1.837	0.360	0.351	0.112	0.030
2013	2.109	7.183	17.491	10.371	7.406	5.432	2.009	1.911	1.082	0.213	0.192	0.059

Table 9.2.3. Icelandic cod in Division Va. Observed mean weight at age in the landings (kg) in period the 1955-2008. The weights for age groups 3 to 9 in 2009 are based on predictions from the 2009 survey measurements, weight for 2010 onwards are set equal to those in 2009. The weights in the catches are used to calculate the reference biomass (B4+).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.827	1.307	2.157	3.617	4.638	5.657	6.635	6.168	8.746	8.829	10.086	14.584
1956	1.080	1.600	2.190	3.280	4.650	5.630	6.180	6.970	6.830	9.290	10.965	12.954
1957	1.140	1.710	2.520	3.200	4.560	5.960	7.170	7.260	8.300	8.290	10.350	13.174
1958	1.210	1.810	3.120	4.510	5.000	5.940	6.640	8.290	8.510	8.840	9.360	13.097
1959	1.110	1.950	2.930	4.520	5.520	6.170	6.610	7.130	8.510	8.670	9.980	11.276
1960	1.060	1.720	2.920	4.640	5.660	6.550	6.910	7.140	7.970	10.240	10.100	12.871
1961	1.020	1.670	2.700	4.330	5.530	6.310	6.930	7.310	7.500	8.510	9.840	14.550
1962	0.990	1.610	2.610	3.900	5.720	6.660	6.750	7.060	7.540	8.280	10.900	12.826
1963	1.250	1.650	2.640	3.800	5.110	6.920	7.840	7.610	8.230	9.100	9.920	11.553
1964	1.210	1.750	2.640	4.020	5.450	6.460	8.000	9.940	9.210	10.940	12.670	15.900
1965	1.020	1.530	2.570	4.090	5.410	6.400	7.120	8.600	12.310	10.460	10.190	17.220
1966	1.170	1.680	2.590	4.180	5.730	6.900	7.830	8.580	9.090	14.230	14.090	17.924
1967	1.120	1.820	2.660	4.067	5.560	7.790	7.840	8.430	9.090	10.090	14.240	16.412
1968	1.170	1.590	2.680	3.930	5.040	5.910	7.510	8.480	10.750	11.580	14.640	16.011
1969	1.100	1.810	2.480	3.770	5.040	5.860	7.000	8.350	8.720	10.080	11.430	13.144
1970	0.990	1.450	2.440	3.770	4.860	5.590	6.260	8.370	10.490	12.310	14.590	21.777
1971	1.090	1.570	2.310	2.980	4.930	5.150	5.580	6.300	8.530	11.240	14.740	17.130
1972	0.980	1.460	2.210	3.250	4.330	5.610	6.040	6.100	6.870	8.950	11.720	16.000
1973	1.030	1.420	2.470	3.600	4.900	6.110	6.670	6.750	7.430	7.950	10.170	17.000
1974	1.050	1.710	2.430	3.820	5.240	6.660	7.150	7.760	8.190	9.780	12.380	14.700
1975	1.100	1.770	2.780	3.760	5.450	6.690	7.570	8.580	8.810	9.780	10.090	11.000
1976	1.350	1.780	2.650	4.100	5.070	6.730	8.250	9.610	11.540	11.430	14.060	16.180
1977	1.259	1.911	2.856	4.069	5.777	6.636	7.685	9.730	11.703	14.394	17.456	24.116
1978	1.289	1.833	2.929	3.955	5.726	6.806	9.041	10.865	13.068	11.982	19.062	21.284
1979	1.408	1.956	2.642	3.999	5.548	6.754	8.299	9.312	13.130	13.418	13.540	20.072
1980	1.392	1.862	2.733	3.768	5.259	6.981	8.037	10.731	12.301	17.281	14.893	19.069
1981	1.180	1.651	2.260	3.293	4.483	5.821	7.739	9.422	11.374	12.784	12.514	19.069
1982	1.006	1.550	2.246	3.104	4.258	5.386	6.682	9.141	11.963	14.226	17.287	16.590
1983	1.095	1.599	2.275	3.021	4.096	5.481	7.049	8.128	11.009	13.972	15.882	18.498
1984	1.288	1.725	2.596	3.581	4.371	5.798	7.456	9.851	11.052	14.338	15.273	16.660
1985	1.407	1.971	2.576	3.650	4.976	6.372	8.207	10.320	12.197	14.683	16.175	19.050
1986	1.459	1.961	2.844	3.593	4.635	6.155	7.503	9.084	10.356	15.283	14.540	15.017
1987	1.316	1.956	2.686	3.894	4.716	6.257	7.368	9.243	10.697	10.622	15.894	12.592
1988	1.438	1.805	2.576	3.519	4.930	6.001	7.144	8.822	9.977	11.732	14.156	13.042
1989	1.186	1.813	2.590	3.915	5.210	6.892	8.035	9.831	11.986	10.003	12.611	16.045
1990	1.290	1.704	2.383	3.034	4.624	6.521	8.888	10.592	10.993	14.570	15.732	17.290
1991	1.309	1.899	2.475	3.159	3.792	5.680	7.242	9.804	9.754	14.344	14.172	20.200
1992	1.289	1.768	2.469	3.292	4.394	5.582	6.830	8.127	12.679	13.410	15.715	11.267
1993	1.392	1.887	2.772	3.762	4.930	6.054	7.450	8.641	10.901	12.517	14.742	16.874
1994	1.443	2.063	2.562	3.659	5.117	6.262	7.719	8.896	10.847	12.874	14.742	17.470
1995	1.348	1.959	2.920	3.625	5.176	6.416	7.916	10.273	11.022	11.407	13.098	15.182
1996	1.457	1.930	3.132	4.141	4.922	6.009	7.406	9.772	10.539	13.503	13.689	16.194
1997	1.484	1.877	2.878	4.028	5.402	6.386	7.344	8.537	10.797	11.533	10.428	12.788
1998	1.230	1.750	2.458	3.559	5.213	7.737	7.837	9.304	10.759	14.903	16.651	18.666
1999	1.241	1.716	2.426	3.443	4.720	6.352	8.730	9.946	11.088	12.535	14.995	15.151
2000	1.308	1.782	2.330	3.252	4.690	5.894	7.809	9.203	10.240	11.172	13.172	17.442
2001	1.499	2.050	2.649	3.413	4.766	6.508	7.520	9.055	8.769	9.526	11.210	13.874
2002	1.294	1.926	2.656	3.680	4.720	6.369	7.808	9.002	10.422	13.402	9.008	16.893
2003	1.265	1.790	2.424	3.505	4.455	5.037	5.980	7.819	8.802	10.712	12.152	13.797
2004	1.257	1.771	2.323	3.312	4.269	5.394	5.872	7.397	10.808	11.569	13.767	12.955
2005	1.194	1.712	2.374	3.435	4.392	5.201	6.200	5.495	7.211	9.909	12.944	18.151
2006	1.070	1.614	2.185	3.052	4.347	5.177	5.382	5.769	6.258	5.688	7.301	15.412
2007	1.083	1.556	2.144	2.754	3.920	5.255	6.272	6.481	7.142	6.530	9.724	10.143
2008	1.162	1.627	2.318	3.120	3.846	5.367	6.771	7.648	8.282	11.181	14.266	17.320
2009	1.115	1.515	2.217	3.160	4.122	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2010	1.115	1.515	2.217	3.160	4.122	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2011	1.115	1.515	2.217	3.160	4.122	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2012	1.115	1.515	2.217	3.160	4.122	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2013	1.115	1.515	2.217	3.160	4.122	5.073	6.091	7.648	8.282	11.181	14.266	17.320

Table 9.2.4. Icelandic cod in Division Va. Estimated weight at age in the spawning stock (kg) in period the 1955-2009. The weights for the period 2010 onward are set equal to those in 2009. These weights are used to calculate the spawning stock biomass (SSB).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.645	1.019	1.833	3.183	4.128	5.657	6.635	6.168	8.746	8.829	10.086	14.584
1956	0.645	1.248	1.862	2.886	4.138	5.630	6.180	6.970	6.830	9.290	10.965	12.954
1957	0.645	1.334	2.142	2.816	4.058	5.960	7.170	7.260	8.300	8.290	10.350	13.174
1958	0.645	1.412	2.652	3.969	4.450	5.940	6.640	8.290	8.510	8.840	9.360	13.097
1959	0.645	1.521	2.490	3.978	4.913	6.170	6.610	7.130	8.510	8.670	9.980	11.276
1960	0.645	1.342	2.482	4.083	5.037	6.550	6.910	7.140	7.970	10.240	10.100	12.871
1961	0.645	1.303	2.295	3.810	4.922	6.310	6.930	7.310	0.750	8.510	9.840	14.550
1962	0.645	1.256	2.218	3.432	5.091	6.660	6.750	7.060	7.540	8.280	10.900	12.826
1963	0.645	1.287	2.244	3.344	4.548	6.920	7.840	7.610	8.230	9.100	9.920	11.553
1964	0.645	1.365	2.244	3.538	4.850	6.460	8.000	9.940	9.210	10.940	12.670	15.900
1965	0.645	1.193	2.184	3.599	4.815	6.400	7.120	8.600	12.310	10.460	10.190	17.220
1966	0.645	1.310	2.202	3.678	5.100	6.900	7.830	8.580	9.090	14.230	14.090	17.924
1967	0.645	1.420	2.261	3.579	4.948	7.790	7.840	8.430	9.090	10.090	14.240	16.412
1968	0.645	1.240	2.278	3.458	4.486	5.910	7.510	8.480	10.750	11.580	14.640	16.011
1969	0.645	1.412	2.108	3.318	4.486	5.860	7.000	8.350	8.720	10.080	11.430	13.144
1970	0.645	1.131	2.074	3.318	4.325	5.590	6.260	8.370	10.490	12.310	14.590	21.777
1971	0.645	1.225	1.964	2.622	4.388	5.150	5.580	6.300	8.530	11.240	14.740	17.130
1972	0.645	1.139	1.878	2.860	3.854	5.610	6.040	6.100	6.870	8.950	11.720	16.000
1973	0.645	1.108	2.100	3.168	4.361	6.110	6.670	6.750	7.430	7.950	10.170	17.000
1974	0.645	1.334	2.066	3.362	4.664	6.660	7.150	7.760	8.190	9.780	12.380	14.700
1975	0.645	1.381	2.363	3.309	4.850	6.690	7.570	8.580	8.810	9.780	10.090	11.000
1976	0.645	1.388	2.252	3.608	4.512	6.730	8.250	9.610	11.540	11.430	14.060	16.180
1977	0.645	1.491	2.428	3.581	5.142	6.636	7.685	9.730	11.703	14.394	17.456	24.116
1978	0.645	1.430	2.490	3.480	5.096	6.806	9.041	10.865	13.068	11.982	19.062	21.284
1979	0.645	1.526	2.246	3.519	4.938	6.754	8.299	9.312	13.130	13.418	13.540	20.072
1980	0.645	1.452	2.323	3.316	4.681	6.981	8.037	10.731	12.301	17.281	14.893	19.069
1981	0.645	1.288	1.921	2.898	3.990	5.821	7.739	9.422	11.374	12.784	12.514	19.069
1982	0.645	1.209	1.909	2.732	3.790	5.386	6.682	9.141	11.963	14.226	17.287	16.590
1983	0.645	1.247	1.934	2.658	3.645	5.481	7.049	8.128	11.009	13.972	15.882	18.498
1984	0.645	1.346	2.207	3.151	3.890	5.798	7.456	9.851	11.052	14.338	15.273	16.660
1985	0.485	1.375	1.750	2.709	3.454	6.372	8.207	10.320	12.197	14.683	16.175	19.050
1986	0.758	1.597	2.882	3.246	4.581	6.155	7.503	9.084	10.356	15.283	14.540	15.017
1987	0.576	1.584	2.423	3.522	4.905	6.257	7.368	9.243	10.697	10.622	15.894	12.592
1988	0.610	1.475	2.261	3.277	4.398	6.001	7.144	8.822	9.977	11.732	14.156	13.042
1989	0.673	1.494	2.338	3.429	4.686	6.892	8.035	9.831	11.986	10.003	12.611	16.045
1990	0.563	1.035	2.170	2.798	4.422	6.521	8.888	10.592	10.993	14.570	15.732	17.290
1991	0.686	1.283	2.039	2.747	3.397	5.680	7.242	9.804	9.754	14.344	14.172	20.200
1992	0.619	1.336	2.094	3.029	3.753	5.582	6.830	8.127	12.679	13.410	15.715	11.267
1993	0.708	1.363	2.309	3.235	4.109	6.054	7.450	8.641	10.901	12.517	14.742	16.874
1994	0.847	1.728	2.254	3.340	4.514	6.262	7.719	8.896	10.847	12.874	14.742	17.470
1995	0.745	1.635	2.345	3.186	4.489	6.416	7.916	10.273	11.022	11.407	13.098	15.182
1996	0.678	1.753	2.490	3.531	4.273	6.009	7.406	9.772	10.539	13.503	13.689	16.194
1997	0.670	1.347	2.267	3.746	5.245	6.386	7.344	8.537	10.797	11.533	10.428	12.788
1998	0.599	1.516	2.261	3.263	4.474	7.737	7.837	9.304	10.759	14.903	16.651	18.666
1999	0.711	1.467	1.932	2.996	3.961	6.352	8.730	9.946	11.088	12.535	14.995	15.151
2000	0.600	1.355	1.915	2.881	4.319	5.894	7.809	9.203	10.240	11.172	13.172	17.442
2001	0.661	1.550	2.071	2.694	4.131	6.508	7.520	9.055	8.769	9.526	11.210	13.874
2002	0.630	1.590	2.259	3.120	3.984	6.369	7.808	9.002	10.422	13.402	9.008	16.893
2003	0.900	1.338	2.215	2.988	4.169	5.037	5.980	7.819	8.802	10.712	12.152	13.797
2004	0.900	1.453	2.099	3.057	3.757	5.394	5.872	7.397	10.808	11.569	13.767	12.955
2005	0.900	1.119	1.897	2.963	3.874	5.201	6.200	5.495	7.211	9.909	12.944	18.151
2006	0.900	1.383	1.998	2.905	4.385	5.177	5.382	5.769	6.258	5.688	7.301	15.412
2007	0.900	1.264	2.022	2.580	4.078	5.255	6.272	6.481	7.142	6.530	9.724	10.143
2008	1.017	1.841	2.227	2.924	3.920	5.367	6.771	7.648	8.282	11.181	14.266	17.320
2009	1.017	1.440	2.027	2.871	3.909	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2010	1.017	1.440	2.027	2.871	3.909	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2011	1.017	1.440	2.027	2.871	3.909	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2012	1.017	1.440	2.027	2.871	3.909	5.073	6.091	7.648	8.282	11.181	14.266	17.320
2013	1.017	1.440	2.027	2.871	3.909	5.073	6.091	7.648	8.282	11.181	14.266	17.320

Table 9.2.5. Icelandic cod in Division Va. Estimated maturity at age in period the 1955-2009. The maturity for the period 2010 onward are set equal to those in 2009.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.019	0.022	0.033	0.181	0.577	0.782	0.834	0.960	1.000	1.000	1.000	1.000
1956	0.019	0.025	0.033	0.111	0.577	0.782	0.818	0.980	0.980	1.000	1.000	1.000
1957	0.019	0.026	0.043	0.100	0.549	0.801	0.842	0.990	1.000	1.000	1.000	1.000
1958	0.019	0.028	0.086	0.520	0.682	0.801	0.834	1.000	1.000	1.000	1.000	1.000
1959	0.019	0.029	0.070	0.535	0.772	0.818	0.834	0.990	1.000	1.000	1.000	1.000
1960	0.019	0.026	0.066	0.577	0.782	0.826	0.834	0.990	1.000	1.000	1.000	1.000
1961	0.019	0.025	0.053	0.450	0.772	0.818	0.834	0.990	0.990	1.000	1.000	1.000
1962	0.019	0.025	0.048	0.281	0.791	0.834	0.834	0.990	0.990	1.000	1.000	1.000
1963	0.019	0.025	0.048	0.237	0.706	0.834	0.849	1.000	1.000	1.000	1.000	1.000
1964	0.019	0.026	0.048	0.329	0.762	0.826	0.849	1.000	1.000	1.000	1.000	1.000
1965	0.019	0.025	0.045	0.354	0.751	0.826	0.842	1.000	1.000	1.000	1.000	1.000
1966	0.019	0.026	0.045	0.394	0.791	0.849	0.849	1.000	1.000	1.000	1.000	1.000
1967	0.019	0.028	0.051	0.341	0.772	0.842	0.849	1.000	1.000	1.000	1.000	1.000
1968	0.019	0.025	0.051	0.292	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1969	0.019	0.028	0.043	0.227	0.682	0.801	0.842	1.000	1.000	1.000	1.000	1.000
1970	0.019	0.023	0.041	0.227	0.644	0.772	0.818	1.000	1.000	1.000	1.000	1.000
1971	0.019	0.025	0.037	0.074	0.657	0.706	0.772	0.979	0.994	0.982	0.993	1.000
1972	0.019	0.023	0.035	0.106	0.450	0.772	0.809	0.979	0.994	0.982	0.993	1.000
1973	0.022	0.028	0.163	0.382	0.697	0.801	0.834	0.996	0.996	1.000	1.000	1.000
1974	0.020	0.031	0.085	0.346	0.636	0.790	0.818	0.989	1.000	1.000	1.000	1.000
1975	0.020	0.035	0.118	0.287	0.715	0.809	0.839	1.000	1.000	1.000	1.000	1.000
1976	0.025	0.026	0.086	0.253	0.406	0.797	0.841	1.000	1.000	1.000	1.000	1.000
1977	0.019	0.024	0.060	0.382	0.742	0.817	0.842	1.000	1.000	1.000	1.000	1.000
1978	0.025	0.025	0.052	0.192	0.737	0.820	0.836	1.000	1.000	1.000	1.000	1.000
1979	0.019	0.021	0.053	0.282	0.635	0.790	0.836	0.919	1.000	1.000	1.000	1.000
1980	0.026	0.021	0.047	0.225	0.653	0.777	0.834	0.977	1.000	0.964	1.000	1.000
1981	0.019	0.022	0.030	0.090	0.448	0.751	0.811	0.962	0.988	1.000	1.000	1.000
1982	0.021	0.025	0.038	0.065	0.297	0.705	0.815	0.967	1.000	1.000	1.000	1.000
1983	0.019	0.030	0.047	0.116	0.264	0.530	0.715	0.979	0.985	1.000	1.000	1.000
1984	0.019	0.024	0.053	0.169	0.444	0.620	0.716	0.949	0.969	0.948	1.000	1.000
1985	0.000	0.021	0.185	0.412	0.495	0.735	0.572	1.000	1.000	1.000	1.000	1.000
1986	0.001	0.023	0.149	0.395	0.682	0.734	0.941	0.962	0.988	1.000	1.000	1.000
1987	0.002	0.033	0.093	0.360	0.490	0.885	0.782	1.000	0.979	1.000	1.000	1.000
1988	0.006	0.029	0.225	0.511	0.448	0.683	0.937	0.946	0.974	0.821	1.000	1.000
1989	0.008	0.025	0.142	0.372	0.645	0.652	0.634	0.991	1.000	0.903	0.859	1.000
1990	0.006	0.012	0.155	0.437	0.581	0.796	0.814	0.986	1.000	1.000	1.000	1.000
1991	0.000	0.055	0.149	0.369	0.637	0.790	0.682	0.842	1.000	1.000	1.000	1.000
1992	0.002	0.062	0.265	0.402	0.813	0.917	0.894	1.000	1.000	1.000	1.000	1.000
1993	0.006	0.085	0.267	0.464	0.693	0.801	0.843	0.968	1.000	1.000	1.000	1.000
1994	0.008	0.110	0.339	0.591	0.702	0.917	0.698	0.852	0.985	1.000	1.000	1.000
1995	0.005	0.109	0.384	0.528	0.752	0.787	0.859	1.000	1.000	1.000	1.000	1.000
1996	0.002	0.031	0.186	0.499	0.650	0.733	0.812	1.000	1.000	0.986	0.971	1.000
1997	0.006	0.037	0.246	0.424	0.685	0.787	0.804	0.932	1.000	0.913	1.000	1.000
1998	0.000	0.061	0.209	0.491	0.782	0.814	0.810	0.925	0.998	1.000	1.000	1.000
1999	0.012	0.044	0.239	0.516	0.649	0.835	0.687	0.988	1.000	1.000	1.000	1.000
2000	0.001	0.065	0.248	0.512	0.611	0.867	0.998	0.980	1.000	1.000	1.000	1.000
2001	0.004	0.043	0.261	0.589	0.750	0.742	0.862	0.987	1.000	1.000	1.000	1.000
2002	0.008	0.086	0.322	0.656	0.759	0.920	0.550	0.979	1.000	1.000	1.000	1.000
2003	0.005	0.046	0.218	0.524	0.870	0.798	0.860	0.998	1.000	1.000	1.000	1.000
2004	0.000	0.038	0.246	0.549	0.626	0.843	0.816	0.990	1.000	1.000	1.000	1.000
2005	0.006	0.109	0.282	0.495	0.791	0.814	0.951	0.990	1.000	1.000	1.000	1.000
2006	0.002	0.023	0.294	0.448	0.751	0.869	0.743	1.000	1.000	1.000	1.000	1.000
2007	0.012	0.032	0.159	0.500	0.693	0.795	0.862	0.960	0.924	1.000	1.000	1.000
2008	0.001	0.041	0.275	0.550	0.730	0.826	0.846	0.954	0.736	1.000	1.000	1.000
2009	0.002	0.015	0.132	0.455	0.688	0.883	0.741	0.631	0.892	1.000	1.000	1.000
2010	0.002	0.015	0.132	0.455	0.688	0.883	0.741	0.631	0.892	1.000	1.000	1.000
2011	0.002	0.015	0.132	0.455	0.688	0.883	0.741	0.631	0.892	1.000	1.000	1.000
2012	0.002	0.015	0.132	0.455	0.688	0.883	0.741	0.631	0.892	1.000	1.000	1.000
2013	0.002	0.015	0.132	0.455	0.688	0.883	0.741	0.631	0.892	1.000	1.000	1.000

Table 9.2.6. Icelandic cod in Division Va. Survey indices of the spring bottom trawl survey (SMB).

year\age	1	2	3	4	5	6	7	8	9	10
1985	16.54	111.11	34.86	48.14	64.74	22.94	15.28	5.04	3.39	1.60
1986	15.10	60.90	95.61	22.47	21.52	27.46	7.18	2.80	0.93	0.82
1987	3.65	28.92	103.80	82.71	21.43	12.78	12.95	2.80	0.99	0.43
1988	3.45	7.45	72.11	103.77	69.71	8.39	6.41	6.94	0.68	0.28
1989	4.04	16.47	22.06	79.80	74.16	39.11	4.85	1.72	1.42	0.27
1990	5.56	11.80	26.17	14.18	27.83	35.22	16.74	1.76	0.59	0.48
1991	3.95	16.29	17.94	30.24	15.49	18.94	22.45	4.90	0.94	0.34
1992	0.72	17.24	33.32	18.94	16.58	6.87	6.35	5.76	1.48	0.23
1993	3.57	4.84	30.85	36.71	13.55	10.64	2.43	2.04	1.40	0.38
1994	14.40	15.03	9.00	26.91	22.43	6.09	3.96	0.80	0.54	0.49
1995	1.18	29.21	24.82	9.07	24.53	18.44	4.02	1.87	0.38	0.20
1996	3.72	5.52	42.74	29.71	13.17	15.34	15.09	4.20	1.16	0.22
1997	1.21	22.47	13.60	56.69	29.80	9.94	9.41	7.29	0.62	0.42
1998	8.07	5.58	30.05	16.21	63.36	29.72	7.02	5.73	3.37	0.76
1999	7.40	33.10	7.03	42.66	13.35	24.82	12.01	2.60	1.48	0.79
2000	18.84	28.02	54.90	7.00	30.79	8.69	8.83	4.58	0.56	0.35
2001	12.32	23.53	36.94	37.94	5.04	15.99	3.59	2.17	0.87	0.27
2002	0.92	38.85	41.36	40.70	37.16	7.45	9.01	1.67	0.82	0.35
2003	11.18	4.54	46.29	36.95	29.18	17.72	4.11	4.72	1.13	0.24
2004	7.01	26.61	8.16	64.43	38.37	27.79	15.92	3.03	3.21	0.51
2005	2.69	17.89	42.07	10.00	46.25	24.97	12.14	6.36	1.01	0.93
2006	9.11	7.59	24.94	40.60	11.75	31.57	11.63	4.07	1.62	0.25
2007	5.61	19.14	8.99	22.94	30.15	10.14	11.43	6.05	2.38	0.77
2008	6.75	12.41	23.02	9.86	22.38	22.99	9.46	7.97	3.05	0.78
2009	21.97	12.60	16.57	22.76	15.68	26.06	16.72	4.86	3.15	1.15

Table 9.2.7 Icelandic cod in Division Va. Survey indices of the fall bottom trawl survey (SMH).

year\age	1	2	3	4	5	6	7	8	9	10
1996	6.69	3.57	20.00	13.98	5.40	7.44	6.26	1.60	0.31	0.09
1997	0.67	16.89	6.83	29.57	15.76	4.09	3.62	2.36	0.25	0.17
1998	5.92	2.63	15.62	7.36	16.01	16.03	5.20	2.24	1.27	0.20
1999	8.61	14.54	5.68	23.38	7.42	9.94	4.05	0.59	0.34	0.36
2000	4.60	13.17	15.25	3.71	11.15	3.49	2.61	1.11	0.34	0.28
2001	7.11	11.51	19.53	21.13	3.30	6.73	1.60	0.76	0.17	0.03
2002	0.92	13.72	16.11	23.39	15.94	5.41	4.77	1.11	0.61	0.08
2003	5.16	2.68	25.66	16.98	13.22	8.99	1.89	2.55	0.38	0.10
2004	3.67	16.28	6.92	29.86	18.85	11.73	7.38	1.88	1.65	0.23
2005	2.15	9.03	20.37	6.82	25.62	10.88	3.86	1.91	0.29	0.31
2006	4.51	4.52	16.28	23.04	7.67	13.93	6.12	2.05	1.02	0.16
2007	3.73	9.82	4.93	11.73	15.68	6.34	5.91	3.14	0.76	0.50
2008	5.30	11.88	15.19	7.68	17.54	18.51	5.67	5.61	1.50	0.79

Table 9.4.1. Icelandic cod in Division Va. Catch at age residuals from the ADCAM model tuned with the spring groundfish survey (SMB).

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			-0.12	-0.21	0.08	0.11	0.21	-0.12	-0.16	0.13	-0.10	-0.45	-0.21	-0.00
1956			-0.03	-0.05	0.03	-0.01	-0.13	-0.20	-0.01	0.01	0.17	0.09	0.23	0.22
1957			0.09	0.02	-0.02	0.17	-0.13	0.09	0.06	-0.15	-0.10	-0.12	-0.38	0.52
1958			0.15	0.18	-0.27	-0.07	0.06	0.08	0.13	-0.23	0.23	0.00	-0.23	0.39
1959			-0.21	0.21	0.26	-0.24	-0.22	-0.06	-0.07	0.28	-0.26	0.38	-0.23	-0.41
1960			0.10	-0.36	0.14	0.19	0.06	0.07	-0.03	-0.11	-0.04	0.03	-0.64	0.90
1961			0.05	0.04	-0.40	0.12	-0.02	0.27	0.20	-0.14	0.09	-0.19	-0.97	0.83
1962			0.09	-0.01	0.13	-0.24	0.12	-0.30	0.09	0.26	-0.06	0.03	-0.40	0.70
1963			-0.06	0.30	-0.17	0.01	-0.03	-0.07	-0.38	0.21	0.35	0.06	0.07	-0.62
1964			-0.13	-0.02	0.13	-0.25	-0.12	0.38	-0.10	-0.46	-0.01	0.27	-0.16	0.01
1965			-0.03	-0.11	0.08	0.16	-0.13	0.05	0.47	-0.48	-0.06	-0.51	-0.36	0.64
1966			-0.04	-0.04	-0.18	0.10	-0.07	0.12	-0.35	0.59	-0.83	0.28	0.01	1.06
1967			0.19	-0.13	0.02	-0.20	0.02	-0.37	0.49	0.05	0.67	-0.73	-0.84	-0.18
1968			0.04	-0.02	-0.27	-0.12	0.23	0.16	-0.42	0.37	-0.12	0.60	-0.66	0.66
1969			-0.09	-0.03	0.15	-0.01	0.05	-0.15	-0.33	-0.25	-0.04	-0.26	-0.81	-0.14
1970			-0.10	0.14	-0.05	-0.14	0.05	-0.16	0.48	-0.58	-0.12	0.24	0.29	0.45
1971			-0.10	0.07	0.09	0.18	-0.18	0.28	-0.17	0.05	-0.45	-0.02	0.12	0.36
1972			-0.17	-0.13	0.07	-0.03	0.12	-0.05	-0.10	0.29	-0.07	0.17	0.52	-2.76
1973			0.27	-0.02	-0.10	0.03	-0.00	-0.24	0.09	0.17	0.16	-0.20	-1.26	-2.09
1974			-0.16	0.21	-0.02	-0.18	-0.01	-0.00	-0.22	0.29	0.01	0.18	-0.44	0.81
1975			0.19	-0.07	0.04	-0.05	0.03	-0.15	-0.21	-0.01	0.41	-0.02	-0.12	0.10
1976			0.10	0.00	-0.17	0.08	-0.09	0.25	-0.16	-0.15	0.06	0.27	-0.23	0.25
1977			-0.40	-0.06	0.05	-0.09	0.13	0.05	0.31	0.03	-0.70	-0.48	-1.23	-2.48
1978			0.08	-0.01	0.04	-0.10	0.04	-0.21	0.12	-0.19	0.02	-0.05	0.53	1.21
1979			0.15	0.10	-0.22	0.10	-0.05	0.03	-0.31	-0.08	0.05	-0.15	0.40	-0.20
1980			0.21	0.01	0.08	0.06	-0.01	-0.09	0.12	-0.49	0.30	0.09	0.15	-1.08
1981			-0.30	-0.20	0.08	-0.13	0.07	0.09	0.02	0.33	-0.07	0.60	-0.03	1.17
1982			0.01	0.15	0.07	-0.06	-0.22	0.19	0.17	0.14	-0.23	-0.87	0.04	-0.85
1983			-0.32	-0.36	0.11	0.14	0.04	0.01	-0.04	-0.03	0.01	0.37	-0.20	0.60
1984			0.35	0.03	-0.06	-0.05	-0.10	-0.01	0.05	-0.13	-0.35	0.16	0.71	0.11
1985			0.05	0.18	-0.10	0.12	-0.10	-0.02	-0.15	0.14	0.04	-0.34	0.47	0.48
1986			0.14	-0.11	0.02	-0.02	0.17	-0.05	0.11	-0.21	0.09	0.06	-0.60	0.20
1987			-0.15	0.11	0.03	-0.16	0.06	0.03	-0.04	0.11	-0.38	-0.11	0.12	-0.28
1988			-0.08	-0.07	-0.06	0.15	-0.09	0.07	0.15	0.03	0.49	0.02	0.55	0.15
1989			-0.20	0.05	0.14	-0.08	0.00	-0.16	-0.33	-0.10	-0.02	0.52	-0.03	-1.38
1990			-0.00	-0.12	-0.09	0.01	0.03	0.10	-0.10	-0.24	0.29	0.11	-0.22	0.10
1991			0.09	0.04	-0.10	-0.06	0.09	-0.09	0.11	-0.09	-0.32	0.39	-0.58	0.15
1992			-0.22	0.10	0.05	0.05	0.10	-0.01	-0.06	-0.06	-0.75	-0.78	-0.58	-0.12
1993			0.25	0.05	-0.17	-0.05	-0.07	-0.13	0.06	0.48	0.52	-0.21	-0.97	0.48
1994			0.05	0.23	-0.12	-0.17	-0.05	0.07	-0.20	-0.14	0.44	0.54	0.54	-0.32
1995			0.27	-0.02	0.08	-0.03	-0.03	-0.13	-0.13	-0.30	-0.20	0.73	1.14	0.68
1996			0.01	-0.06	-0.15	0.07	0.05	0.04	0.11	0.16	-0.38	-0.41	0.60	0.01
1997			-0.14	0.02	-0.03	-0.10	-0.11	0.23	0.18	0.22	0.40	-0.76	-0.25	0.20
1998			-0.18	-0.15	0.08	0.07	0.03	-0.17	0.24	0.04	0.06	0.24	0.12	-0.70
1999			-0.09	0.02	0.07	0.04	0.09	-0.02	-0.26	-0.17	-0.23	-0.42	-0.47	-0.84
2000			0.15	-0.23	0.11	-0.01	0.00	0.11	0.03	-0.13	0.04	0.19	-0.11	0.04
2001			0.20	0.16	-0.14	-0.02	0.03	-0.19	0.06	0.27	-0.03	0.19	-0.43	0.13
2002			-0.04	0.09	0.01	-0.07	-0.04	0.01	-0.21	0.22	0.26	-0.35	0.45	-0.95
2003			-0.23	-0.01	0.01	-0.06	0.18	0.01	0.21	-0.38	-0.01	0.10	0.14	0.62
2004			-0.15	0.07	0.06	-0.07	-0.09	0.27	0.01	0.22	-0.55	-0.11	0.20	-0.29
2005			0.20	-0.24	0.11	-0.08	-0.13	-0.09	0.34	0.09	0.35	0.02	-0.01	-0.76
2006			-0.02	-0.03	-0.09	0.04	0.00	-0.05	-0.09	0.19	0.02	0.12	-0.20	-1.59
2007			-0.02	0.08	-0.07	0.17	-0.15	0.07	-0.09	-0.03	0.54	0.10	0.51	-0.58
2008			0.03	-0.06	0.04	-0.05	0.12	-0.09	-0.00	-0.03	-0.08	0.17	0.12	-0.13

Table 9.4.2. Icelandic cod in Division Va. Spring survey (SMB) at age residuals from the ADCAM model.

Year/age	1	2	3	4	5	6	7	8	9	10
1985	-0.39	0.07	0.17	0.41	0.15	0.27	0.43	0.22	0.34	0.54
1986	0.39	-0.06	-0.43	-0.25	-0.10	0.02	-0.14	-0.25	-0.22	-0.05
1987	0.41	0.01	0.08	-0.42	-0.03	-0.06	0.07	-0.06	-0.06	0.01
1988	-0.36	0.02	0.45	0.17	-0.09	-0.32	0.11	0.48	-0.08	-0.11
1989	0.18	0.02	0.48	0.55	0.25	0.20	-0.09	-0.08	0.24	0.10
1990	-0.52	0.09	0.01	0.01	-0.15	-0.13	0.10	-0.12	-0.01	0.15
1991	-0.34	-0.44	0.05	0.12	0.23	0.06	0.16	-0.13	0.25	0.25
1992	-0.49	-0.01	-0.23	0.09	-0.12	-0.11	-0.12	-0.12	-0.09	-0.00
1993	-0.64	-0.07	0.11	-0.05	0.04	-0.02	-0.18	-0.13	-0.19	-0.27
1994	0.44	-0.29	-0.03	0.06	-0.19	-0.29	-0.15	-0.20	-0.15	-0.10
1995	-0.41	0.10	-0.29	-0.10	0.14	0.01	-0.18	-0.08	-0.04	-0.21
1996	-0.74	-0.14	0.04	-0.15	0.18	-0.03	0.30	0.44	0.23	0.07
1997	-0.06	-0.08	0.09	0.26	-0.04	-0.02	-0.02	0.30	-0.30	0.07
1998	-0.22	0.10	-0.24	0.09	0.51	0.30	0.13	0.22	0.49	0.52
1999	-0.10	0.11	-0.09	0.02	-0.05	0.09	0.05	0.02	0.01	0.12
2000	0.73	0.13	0.19	-0.22	-0.09	-0.18	-0.18	0.01	-0.22	-0.22
2001	0.13	-0.05	-0.02	-0.16	-0.48	-0.20	-0.33	-0.55	-0.35	0.06
2002	-0.28	0.22	0.04	0.06	0.02	-0.12	-0.15	-0.24	-0.40	-0.17
2003	0.35	-0.04	-0.02	-0.10	-0.10	-0.21	-0.15	-0.04	0.20	-0.54
2004	0.18	0.15	-0.04	0.25	0.07	0.25	0.21	0.20	0.46	0.29
2005	0.27	0.03	0.15	-0.05	0.09	0.10	0.04	0.05	0.08	0.17
2006	0.45	0.11	-0.10	0.05	0.01	0.19	-0.08	-0.27	-0.32	-0.27
2007	0.29	0.11	-0.14	-0.27	-0.15	-0.06	-0.24	-0.03	0.07	-0.16
2008	0.36	-0.00	-0.15	-0.24	-0.27	-0.07	0.25	0.02	0.14	-0.09
2009	0.28	-0.07	-0.19	-0.27	0.03	0.11	-0.03	0.18	-0.13	-0.11

Table 9.4.3. Icelandic cod in Division Va. Estimates of fishing mortality 1955-2008 based on ACAM using catch at age and spring bottom survey indices. Estimates for 2009 are based on catch constraint; the prediction for 2010 is based on the 20% catch rule.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955			0.04	0.17	0.25	0.27	0.30	0.30	0.28	0.32	0.32	0.31	0.32	0.32
1956			0.05	0.18	0.25	0.26	0.29	0.30	0.29	0.34	0.36	0.33	0.33	0.33
1957			0.08	0.21	0.27	0.27	0.30	0.33	0.33	0.36	0.36	0.33	0.30	0.30
1958			0.11	0.25	0.30	0.29	0.32	0.37	0.40	0.44	0.44	0.39	0.32	0.32
1959			0.09	0.23	0.28	0.26	0.30	0.34	0.35	0.40	0.38	0.32	0.23	0.23
1960			0.10	0.23	0.29	0.29	0.34	0.40	0.43	0.48	0.48	0.39	0.27	0.27
1961			0.09	0.23	0.26	0.26	0.33	0.40	0.42	0.46	0.44	0.35	0.23	0.23
1962			0.11	0.25	0.28	0.26	0.35	0.42	0.47	0.51	0.49	0.38	0.24	0.24
1963			0.13	0.28	0.33	0.31	0.38	0.49	0.59	0.65	0.63	0.46	0.29	0.29
1964			0.13	0.29	0.37	0.36	0.43	0.57	0.74	0.81	0.84	0.61	0.39	0.39
1965			0.12	0.28	0.38	0.40	0.47	0.60	0.74	0.85	0.88	0.66	0.43	0.43
1966			0.09	0.25	0.34	0.38	0.49	0.62	0.78	0.92	1.01	0.79	0.53	0.53
1967			0.08	0.23	0.30	0.34	0.48	0.61	0.75	0.88	0.93	0.73	0.46	0.46
1968			0.08	0.25	0.34	0.41	0.58	0.77	1.04	1.20	1.36	1.08	0.74	0.74
1969			0.06	0.23	0.32	0.35	0.50	0.61	0.72	0.84	0.87	0.72	0.45	0.45
1970			0.07	0.27	0.39	0.43	0.55	0.65	0.76	0.89	0.95	0.80	0.52	0.52
1971			0.09	0.31	0.48	0.53	0.62	0.72	0.80	0.96	1.04	0.89	0.59	0.59
1972			0.09	0.30	0.48	0.55	0.65	0.73	0.79	0.96	1.06	0.92	0.61	0.61
1973			0.12	0.32	0.49	0.56	0.67	0.75	0.80	0.95	1.04	0.91	0.60	0.60
1974			0.11	0.32	0.50	0.58	0.70	0.83	0.92	1.06	1.18	1.04	0.71	0.71
1975			0.11	0.31	0.50	0.60	0.72	0.89	1.02	1.13	1.26	1.11	0.79	0.79
1976			0.07	0.26	0.43	0.55	0.70	0.85	0.95	1.01	1.07	0.96	0.67	0.67
1977			0.03	0.20	0.33	0.43	0.61	0.72	0.73	0.74	0.70	0.64	0.42	0.42
1978			0.03	0.17	0.28	0.35	0.53	0.60	0.55	0.55	0.49	0.45	0.29	0.29
1979			0.03	0.17	0.27	0.34	0.50	0.57	0.50	0.49	0.42	0.40	0.25	0.25
1980			0.03	0.17	0.31	0.39	0.54	0.62	0.56	0.55	0.47	0.45	0.30	0.30
1981			0.02	0.18	0.35	0.49	0.65	0.82	0.85	0.82	0.76	0.70	0.53	0.53
1982			0.03	0.19	0.39	0.56	0.70	0.90	0.96	0.88	0.75	0.68	0.53	0.53
1983			0.02	0.18	0.38	0.55	0.71	0.88	0.92	0.86	0.74	0.69	0.54	0.54
1984			0.04	0.20	0.38	0.53	0.67	0.81	0.76	0.71	0.60	0.57	0.45	0.45
1985			0.05	0.23	0.42	0.58	0.71	0.83	0.77	0.71	0.60	0.58	0.46	0.46
1986			0.06	0.26	0.52	0.71	0.82	0.95	0.88	0.78	0.67	0.63	0.51	0.51
1987			0.06	0.27	0.55	0.81	0.91	1.06	1.00	0.86	0.75	0.72	0.60	0.60
1988			0.05	0.26	0.52	0.79	0.92	1.10	1.09	0.95	0.88	0.85	0.76	0.76
1989			0.04	0.24	0.46	0.65	0.79	0.89	0.80	0.73	0.65	0.65	0.54	0.54
1990			0.05	0.25	0.47	0.66	0.79	0.86	0.75	0.69	0.62	0.62	0.52	0.52
1991			0.09	0.30	0.56	0.80	0.88	0.95	0.85	0.78	0.72	0.71	0.62	0.62
1992			0.10	0.32	0.59	0.86	0.92	1.00	0.90	0.81	0.75	0.74	0.65	0.65
1993			0.14	0.31	0.55	0.79	0.89	1.03	1.03	0.94	0.91	0.89	0.82	0.82
1994			0.09	0.24	0.38	0.53	0.68	0.76	0.72	0.70	0.65	0.66	0.58	0.58
1995			0.06	0.20	0.32	0.42	0.57	0.62	0.56	0.57	0.52	0.54	0.47	0.47
1996			0.04	0.16	0.28	0.41	0.56	0.62	0.57	0.60	0.55	0.56	0.50	0.50
1997			0.03	0.15	0.27	0.42	0.59	0.66	0.66	0.68	0.65	0.65	0.59	0.59
1998			0.03	0.15	0.33	0.52	0.67	0.77	0.83	0.84	0.83	0.83	0.79	0.79
1999			0.04	0.18	0.39	0.64	0.74	0.85	0.93	0.92	0.90	0.90	0.88	0.88
2000			0.06	0.18	0.39	0.62	0.74	0.86	0.96	0.97	0.96	0.97	0.97	0.97
2001			0.07	0.19	0.38	0.58	0.70	0.83	0.97	1.00	1.01	1.02	1.04	1.04
2002			0.04	0.17	0.34	0.49	0.60	0.70	0.81	0.87	0.86	0.88	0.88	0.88
2003			0.03	0.15	0.33	0.50	0.58	0.65	0.71	0.77	0.75	0.78	0.77	0.77
2004			0.03	0.15	0.34	0.52	0.59	0.65	0.71	0.76	0.75	0.78	0.77	0.77
2005			0.03	0.13	0.30	0.48	0.56	0.62	0.67	0.74	0.73	0.77	0.76	0.76
2006			0.03	0.13	0.28	0.48	0.55	0.61	0.67	0.74	0.74	0.79	0.78	0.78
2007			0.03	0.12	0.24	0.36	0.50	0.58	0.74	0.96	1.17	1.29	1.47	1.47
2008			0.02	0.09	0.19	0.28	0.44	0.45	0.49	0.65	0.73	0.85	0.90	0.90
2009			0.02	0.09	0.21	0.33	0.40	0.44	0.49	0.56	0.59	0.63	0.65	0.65
2010			0.02	0.08	0.18	0.28	0.35	0.38	0.42	0.49	0.51	0.55	0.57	0.57
2011			0.02	0.07	0.16	0.26	0.31	0.34	0.38	0.44	0.46	0.50	0.51	0.51
2012			0.02	0.07	0.15	0.23	0.29	0.31	0.35	0.40	0.42	0.46	0.47	0.47
2013			0.02	0.07	0.15	0.25	0.30	0.33	0.37	0.42	0.44	0.48	0.49	0.49

Table 9.4.4. Icelandic cod in Division Va. Estimates of numbers at age in the stock 1955-2009 based on ACAM using catch at age and spring bottom survey indices. Estimates for 2010 are based on catch constraint for the year 2009; the predictions are based on the 20% catch rule.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955	255	187	152	218	212	115	36	25	13	87.7	9.2	7.8	8.1	2.6
1956	329	208	153	120	150	135	72	22	15	8.0	51.9	5.5	4.7	4.8
1957	431	270	171	119	82	96	85	44	13	9.1	4.6	29.8	3.2	2.8
1958	230	353	221	129	79	51	60	52	35	7.8	5.2	2.6	17.5	1.9
1959	288	188	289	161	82	48	31	35	51	19.3	4.1	2.7	1.5	10.4
1960	192	236	154	216	105	51	30	19	21	37.5	10.6	2.3	1.6	1.0
1961	265	157	193	114	140	64	31	18	10	11.0	19.0	5.4	1.3	1.0
1962	304	217	129	144	75	89	40	18	24	5.6	5.7	10.0	3.1	0.8
1963	323	249	178	94	92	46	56	23	10	12.1	2.7	2.9	5.6	2.0
1964	342	264	204	128	58	54	28	31	12	4.4	5.2	1.2	1.5	3.5
1965	478	280	216	147	78	33	31	15	14	4.5	1.6	1.8	0.5	0.8
1966	256	391	229	157	91	44	18	16	7	5.6	1.6	0.5	0.8	0.3
1967	369	210	320	171	100	53	24	9	7	2.5	1.8	0.5	0.2	0.4
1968	269	302	172	243	111	60	31	12	4	2.7	0.8	0.6	0.2	0.1
1969	281	220	248	130	155	65	33	41	5	1.2	0.7	0.2	0.2	0.1
1970	208	230	180	192	85	92	37	33	18	1.9	0.4	0.2	0.1	0.1
1971	407	170	189	138	120	47	49	18	14	7.0	0.6	0.1	0.1	0.0
1972	267	334	139	141	83	61	23	22	23	5.2	2.2	0.2	0.0	0.0
1973	389	219	273	104	86	42	29	10	9	8.6	1.6	0.6	0.1	0.0
1974	549	319	179	199	62	43	20	12	4	3.2	2.7	0.5	0.2	0.0
1975	214	449	261	131	118	31	20	8	4	1.2	0.9	0.7	0.1	0.1
1976	338	175	368	192	79	58	14	8	3	1.3	0.3	0.2	0.2	0.1
1977	364	277	143	282	121	42	27	6	3	0.9	0.4	0.1	0.1	0.1
1978	208	298	227	114	190	71	22	12	2	1.1	0.3	0.2	0.0	0.0
1979	210	171	244	181	78	117	41	11	5	1.1	0.5	0.2	0.1	0.0
1980	197	172	140	194	125	49	72	20	5	2.7	0.5	0.3	0.1	0.1
1981	348	161	141	111	134	75	27	47	9	2.4	1.3	0.3	0.1	0.1
1982	207	285	132	113	76	77	38	12	17	3.1	0.8	0.5	0.1	0.1
1983	207	170	233	105	76	42	36	15	4	5.3	1.1	0.3	0.2	0.1
1984	496	169	139	186	72	43	20	15	5	1.3	1.8	0.4	0.1	0.1
1985	392	406	139	109	125	40	21	8	5	2.0	0.5	0.8	0.2	0.1
1986	260	321	332	108	71	67	19	8	3	2.0	0.8	0.2	0.4	0.1
1987	131	213	263	256	68	35	27	7	3	1.0	0.8	0.3	0.1	0.2
1988	194	107	174	203	160	32	13	9	2	0.8	0.3	0.3	0.1	0.0
1989	156	159	87	136	129	78	12	4	2	0.5	0.2	0.1	0.1	0.1
1990	258	128	130	69	87	100	33	4	1	0.9	0.2	0.1	0.1	0.0
1991	204	211	105	101	44	45	43	12	2	0.5	0.4	0.1	0.0	0.0
1992	114	167	173	79	61	20	16	14	4	0.5	0.2	0.1	0.0	0.0
1993	226	93	137	128	47	28	7	5	4	1.3	0.2	0.1	0.1	0.0
1994	247	185	76	97	76	22	10	2	2	1.3	0.4	0.1	0.0	0.0
1995	129	202	152	57	63	43	11	4	1	0.6	0.5	0.2	0.0	0.0
1996	242	105	166	117	39	37	23	5	2	0.4	0.3	0.2	0.1	0.0
1997	104	198	86	131	81	24	20	11	2	0.9	0.2	0.1	0.1	0.0
1998	262	85	162	69	93	51	13	9	4	0.9	0.4	0.1	0.1	0.1
1999	238	214	70	129	48	55	25	5	3	1.6	0.3	0.1	0.0	0.0
2000	244	195	176	54	89	27	24	10	2	1.1	0.5	0.1	0.0	0.0
2001	267	200	160	136	37	49	12	9	3	0.6	0.4	0.2	0.0	0.0
2002	108	219	163	122	92	21	23	5	3	1.0	0.2	0.1	0.0	0.0
2003	230	88	179	128	85	54	10	10	2	1.2	0.4	0.1	0.0	0.0
2004	201	188	72	142	90	50	27	5	4	0.8	0.5	0.1	0.0	0.0
2005	122	165	154	57	100	53	24	12	2	1.7	0.3	0.2	0.1	0.0
2006	199	100	135	122	41	61	27	11	5	0.9	0.7	0.1	0.1	0.0
2007	171	163	82	107	88	25	31	13	5	2.2	0.3	0.3	0.0	0.0
2008	181	140	133	65	78	57	14	15	6	2.0	0.7	0.1	0.1	0.0
2009	325	148	115	107	49	53	35	8	8	2.9	0.8	0.3	0.0	0.0
2010	215	266	121	92	80	32	31	19	4	4.0	1.3	0.4	0.1	0.0
2011	222	176	218	98	70	55	20	18	11	2.2	2.0	0.7	0.2	0.1
2012	230	182	144	176	74	48	35	12	11	6.1	1.1	1.0	0.3	0.1
2013	237	188	149	116	134	52	31	21	7	6.1	3.3	0.6	0.5	0.2

Table 9.4.5. Icelandic cod in division Va. Standardized catch and survey residuals from the TSA run based on tuning with the spring survey Estimation with a time series model of F

STANDARDISED CATCH RESIDUALS

	4	5	6	7	8	9	10	11
1987	1.17	1.06	-0.83	0.92	0.30	0.02	0.06	-0.34
1988	-1.23	0.39	0.89	-0.32	0.45	0.15	-0.05	1.11
1989	-1.24	-0.28	-0.54	-0.44	-0.56	-2.59	-2.40	-0.68
1990	-1.03	-2.05	0.23	0.80	0.97	-0.78	-1.89	0.10
1991	1.59	0.06	0.28	1.07	-0.53	-0.43	-0.18	-0.56
1992	1.19	0.61	0.08	-0.09	-0.88	-0.44	-0.89	-1.49
1993	0.91	-1.96	-0.79	-1.59	-1.00	0.33	2.10	1.45
1994	1.07	-0.49	-0.81	-0.69	1.31	-0.73	-0.50	0.96
1995	-0.53	-1.46	-0.83	0.32	-1.57	-2.98	-1.17	-0.77
1996	-0.47	-1.31	-0.61	1.34	0.73	0.62	0.86	-0.56
1997	-0.84	0.34	0.16	0.09	1.55	0.47	0.78	0.61
1998	-0.32	0.53	2.05	2.06	0.09	0.41	0.15	0.03
1999	1.61	2.20	0.44	0.70	-0.20	-0.95	-2.29	-1.18
2000	-0.68	0.80	0.47	-0.54	0.44	-0.20	-0.72	-0.85
2001	0.25	0.38	-0.74	-0.23	-1.05	-0.35	0.29	-0.36
2002	-0.73	-1.42	0.38	-0.54	0.28	0.22	0.28	-0.15
2003	-0.78	-0.57	-0.82	1.73	1.06	1.90	-0.44	-0.62
2004	-0.22	0.49	-0.31	0.00	1.63	0.83	0.39	-0.92
2005	-1.36	-0.01	-0.91	-1.38	-0.04	0.60	0.18	-0.15
2006	-0.85	0.56	-0.17	-0.17	0.45	0.09	-0.39	-0.37
2007	0.38	-1.32	0.34	-2.62	0.22	0.48	0.96	1.05
2008	-0.43	0.17	-0.53	0.74	0.58	-0.24	0.18	-0.53

$r_a = 0.38$; $r_t = 0.11$; $r_{coh} = 0.11$; $\gamma_1 = -2.39$; $\gamma_2 = 1.03$

STANDARDISED SURVEY RESIDUALS

	1	2	3	4	5	6	7	8	9
1987	-0.31	-0.52	1.53	-0.16	0.26	-0.43	0.37	-0.15	0.17
1988	-0.37	-1.59	2.11	1.08	1.02	-1.48	0.92	1.86	-0.48
1989	-0.19	1.02	1.60	1.39	0.89	0.74	0.02	0.63	0.38
1990	0.16	-0.24	0.22	-1.57	-2.11	-1.21	0.63	0.27	0.78
1991	-0.22	-0.14	-0.61	0.47	0.07	-0.36	0.02	-0.61	0.95
1992	-2.12	0.87	0.89	-0.22	-1.44	-1.01	-1.10	-0.93	0.00
1993	-0.33	0.92	0.62	0.71	-0.57	-0.06	-0.78	-0.13	-0.29
1994	1.23	0.81	-0.03	-0.40	-0.54	-0.89	-0.80	-0.39	-0.18
1995	-1.57	-0.37	0.26	-0.62	0.14	0.63	0.29	0.06	-0.26
1996	-0.29	0.07	-0.20	0.55	1.56	-0.09	1.93	2.63	1.61
1997	-1.54	1.82	0.93	1.16	1.04	1.01	-0.15	0.57	-1.81
1998	0.58	0.34	-0.05	0.45	1.84	1.44	1.09	0.85	0.43
1999	0.48	1.31	-1.78	1.25	-0.25	-1.34	-0.99	-0.56	-0.41
2000	1.53	1.03	0.88	-1.24	-0.44	-0.70	-1.42	-0.24	-1.29
2001	1.05	-1.65	-0.15	-0.99	-1.72	-1.54	-1.29	-1.85	-1.72
2002	-1.84	0.76	0.22	0.43	0.14	1.74	0.31	0.38	-0.04
2003	0.94	0.17	-0.51	-0.30	-0.25	-0.88	0.83	1.44	2.12
2004	0.42	-0.20	-0.48	1.36	0.73	1.10	1.57	1.69	2.51
2005	-0.65	-0.41	0.12	-0.14	0.28	-0.08	0.02	0.93	0.01
2006	0.71	-0.83	-0.71	-0.08	0.75	-0.48	-0.82	-0.60	-0.91
2007	0.17	-0.70	-2.05	-0.72	-0.75	0.20	-1.92	0.14	0.64
2008	0.38	-1.06	-1.42	-0.98	-0.45	-0.14	1.09	0.98	0.44
2009	1.70	-1.53	-1.42	-0.78	1.25	0.88	0.49	0.28	-0.14

$r_a = 0.47$; $r_t = 0.17$; $r_{coh} = 0.13$; $\gamma_1 = 1.21$; $\gamma_2 = -1.06$

Table 9.4.6. Icelandic cod in division Va. The estimate of fishing mortality, stock numbers and biomass from the TSA based on tuning with the spring survey. "Biom" refers to biomass of fish 4 years and older. Note that the numbers at age 1, 2 and 3 are unconventional, showing the 1st, 2nd and 3rd estimates of the size of the year class at age 4.

STOCK

	Biom	1	2	3	4	5	6	7	8	9	10	11
1985	903.	171.0	252.7	114.3	117.5	121.18	42.95	17.37	8.38	4.23	2.15	0.44
1986	841.	147.8	194.7	230.9	104.6	74.63	65.21	20.50	7.69	3.20	1.62	0.80
1987	990.	84.6	146.5	220.7	237.1	69.06	32.96	28.03	7.23	2.59	1.08	0.52
1988	1048.	93.5	76.8	171.1	224.6	148.82	33.30	11.54	9.97	2.16	0.75	0.34
1989	1097.	88.9	98.5	81.7	167.5	149.93	73.02	11.76	3.74	2.87	0.64	0.24
1990	850.	105.8	87.5	101.8	73.3	92.12	97.61	33.57	4.83	1.32	0.85	0.22
1991	700.	98.5	107.6	83.9	103.7	44.76	44.13	44.05	11.65	1.74	0.46	0.28
1992	559.	52.2	105.4	115.9	83.0	61.76	21.20	17.00	14.77	3.82	0.56	0.14
1993	563.	91.7	55.2	110.1	122.2	44.53	27.64	6.60	4.85	4.08	1.28	0.17
1994	583.	143.1	96.9	54.6	112.7	72.00	19.40	10.63	2.54	1.36	1.16	0.41
1995	569.	61.8	140.6	100.6	53.9	72.16	41.65	10.61	4.38	1.03	0.53	0.45
1996	654.	101.3	63.7	142.0	104.1	36.29	39.13	24.71	5.51	2.05	0.48	0.24
1997	806.	58.4	112.9	65.6	147.2	77.15	21.95	19.66	13.25	2.46	0.96	0.23
1998	751.	128.9	58.0	115.8	62.9	106.80	51.85	12.78	8.51	6.10	1.04	0.42
1999	754.	120.0	143.1	49.1	129.5	46.50	59.06	26.13	5.67	3.33	2.29	0.42
2000	592.	144.5	126.2	151.6	44.9	92.96	26.24	23.58	10.81	2.13	1.22	0.80
2001	718.	143.6	129.7	126.8	154.9	30.66	50.02	11.86	7.96	3.87	0.78	0.42
2002	766.	53.6	149.6	130.3	131.1	101.02	19.60	21.98	4.89	2.85	1.42	0.29
2003	772.	132.1	54.1	146.8	131.5	89.57	52.90	11.83	10.31	2.46	1.15	0.60
2004	843.	110.1	131.4	52.1	156.4	93.45	50.97	24.81	6.09	4.75	1.17	0.47
2005	742.	73.9	105.4	132.3	50.7	115.29	54.60	22.88	11.54	2.90	2.12	0.52
2006	733.	114.8	67.1	99.0	129.6	39.39	70.84	27.61	11.17	5.46	1.37	0.98
2007	661.	97.5	108.3	57.8	99.2	86.93	27.85	29.46	13.88	5.39	2.60	0.65
2008	636.	105.1	90.3	97.6	55.8	71.94	50.54	17.38	14.56	6.74	2.63	1.22
2009	651.	173.1	96.0	82.9	90.8	44.26	49.70	29.59	9.91	7.77	3.51	1.42

KALMAN FILTER ESTIMATION OF STANDARD DEVIATION OF BIOMASS AND LOG-STOCK

2008	34.	0.072	0.057	0.056	0.070	0.070	0.074	0.070	0.084	0.099	0.131	0.164
2009	41.	0.090	0.065	0.061	0.077	0.085	0.089	0.104	0.102	0.119	0.153	0.174

ADJUSTED FOR ERRORS IN PARAMETER ESTIMATES

2009	(42)	0.097	0.067	0.064	0.080	0.086	0.091	0.108	0.108	0.125	0.158	0.178

Standard deviation of prediction of stock at 4 years

2009	0.190	0.151	0.116

FISHING MORTALITY RATES

	F 5-10	4	5	6	7	8	9	10	11
1985	0.673	0.262	0.397	0.603	0.719	0.768	0.779	0.770	0.771
1986	0.816	0.243	0.526	0.704	0.893	0.935	0.919	0.921	0.922
1987	0.870	0.323	0.549	0.741	0.904	1.002	1.016	1.007	1.011
1988	0.890	0.216	0.527	0.889	0.937	1.014	0.997	0.975	0.985
1989	0.747	0.227	0.460	0.632	0.779	0.863	0.880	0.865	0.876
1990	0.757	0.222	0.430	0.672	0.830	0.877	0.865	0.868	0.874
1991	0.842	0.313	0.502	0.765	0.934	0.940	0.948	0.962	0.956
1992	0.932	0.350	0.623	0.914	1.042	1.031	0.981	1.001	0.999
1993	0.849	0.347	0.499	0.744	0.850	0.985	1.013	1.006	1.006
1994	0.608	0.261	0.354	0.480	0.624	0.742	0.720	0.727	0.732
1995	0.488	0.202	0.311	0.408	0.524	0.554	0.556	0.574	0.571
1996	0.487	0.164	0.257	0.432	0.506	0.568	0.577	0.581	0.577
1997	0.522	0.131	0.272	0.397	0.551	0.626	0.643	0.642	0.641
1998	0.608	0.143	0.317	0.532	0.664	0.696	0.725	0.713	0.713
1999	0.682	0.172	0.413	0.621	0.731	0.778	0.779	0.771	0.776
2000	0.713	0.173	0.411	0.610	0.777	0.830	0.823	0.825	0.824
2001	0.659	0.191	0.363	0.555	0.702	0.768	0.782	0.785	0.780
2002	0.536	0.163	0.311	0.429	0.561	0.609	0.658	0.649	0.647
2003	0.524	0.140	0.308	0.470	0.562	0.595	0.607	0.603	0.602
2004	0.519	0.134	0.325	0.469	0.549	0.595	0.588	0.591	0.587
2005	0.464	0.109	0.276	0.404	0.485	0.534	0.545	0.540	0.539
2006	0.457	0.114	0.238	0.434	0.491	0.529	0.526	0.522	0.524
2007	0.411	0.129	0.216	0.338	0.415	0.492	0.499	0.504	0.503
2008	0.328	0.089	0.189	0.276	0.353	0.382	0.382	0.386	0.384

ESTIMATED STANDARD DEVIATION OF LOG(F)

2007	0.029	0.070	0.066	0.058	0.066	0.075	0.087	0.088	0.088
2008	0.027	0.077	0.075	0.076	0.077	0.089	0.100	0.100	0.100

Table 9.4.7. Icelandic cod in division Va. Comparison of estimates of key metrics using various methodological approaches. All results shown are based on tuning with the spring survey (SMB) except TSA SMH and ADCAM SMH, where the fall survey is used. 2008 estimate refers to the estimates from the result from the ADCAM framework that was the basis for advice last year.

Estimated fishing mortality rate in 2008:

Age	Estimated in 2008	ADCAM SMB	TSA SMB	ADAPT	XSA	ADCAM SMH	TSA SMH	ADCAM09 vs 2008
3	0.02	0.02		0.02	0.02	0.02		17.3%
4	0.10	0.09	0.09	0.08	0.08	0.10	0.09	-6.9%
5	0.21	0.19	0.19	0.20	0.20	0.19	0.18	-10.6%
6	0.33	0.28	0.28	0.25	0.23	0.28	0.27	-15.2%
7	0.37	0.44	0.35	0.44	0.46	0.40	0.35	17.9%
8	0.42	0.45	0.38	0.38	0.31	0.40	0.39	6.5%
9	0.46	0.49	0.38	0.47	0.37	0.38	0.39	7.5%
10	0.51	0.65	0.39	0.58	0.33	0.45	0.39	26.7%
11	0.52	0.73	0.38	0.64	0.59	0.42	0.39	40.1%
12	0.56	0.85		3.79	1.25	0.47		51.4%
13	0.56	0.90		0.11	1.67	0.42		60.3%
14	0.56	0.90		0.54	1.00	0.42		60.3%
F(5-10)	**0.38**	**0.42**	**0.33**	**0.39**	**0.31**	**0.35**	**0.33**	8.3%

a)

Estimated stock in numbers (millions) in 2009:

Age	Estimated in 2008	ADCAM SMB	TSA	ADAPT	XSA	ADCAM SMH	TSA SMH	ADCAM09 vs 2008
1	207	337	315	340	323	225	137	62.6%
2	170	151	143	152	151	188	134	-11.2%
3	116	98	101	117	116	143	142	-15.3%
4	110	96	91	109	110	113	116	-13.1%
5	46	48	44	50	52	47	47	3.3%
6	46	53	50	51	53	53	58	14.4%
7	30	35	30	39	42	36	35	17.2%
8	7	8	10	9	8	9	11	9.2%
9	8.0	8.0	7.8	9.0	11.2	9.2	9.0	-0.1%
10	3.0	2.9	3.5	3.1	4.2	3.8	3.9	-4.6%
11	1.1	0.8	1.4	0.9	1.9	1.4	1.8	-23.6%
12	0.4	0.3		0.3	0.3	0.6		-30.6%
13	0.1	0.0		0.0	0.0	0.1		
14	0.0	0.0		0.3	0.0	0.1		

b)

Recruitment (N3 abundance):

Yearcl.	Estimated in 2008	ADCAM SMB	TSA	ADAPT	XSA	ADCAM SMH	TSA SMH	ADCAM09 vs 2008
2002	147	154	158	159	167	156		4.8%
2003	122	134	121	133	137	135		10.1%
2004	79	80	68	83	86	79		1.5%
2005	137	120	111	137	138	141	141	-12.7%
2006	116	98	101	117	116	143	142	-15.3%
2007	139	98	110	124	124	154	134	-29.6%
2008		154	211	228	217		137	

c)

Estimated stock size (B4+, Thous. tonnes) in 1991-2010

Year	Estimated in 2008	ADCAM SMB	TSA	ADAPT	XSA	ADCAM SMH	TSA SMH	ADCAM09 vs 2008
1993	590	590	563	588	588	605		0.0%
1994	574	574	583	585	585	581		0.0%
1995	553	553	569	563	563	560	570	0.0%
1996	668	668	654	688	688	681	716	0.0%
1997	783	782	806	805	805	783	789	-0.1%
1998	718	718	751	740	739	718	727	0.0%
1999	731	731	754	755	751	735	760	-0.1%
2000	591	591	592	610	606	603	615	-0.1%
2001	698	696	718	706	702	702	721	-0.4%
2002	735	732	766	737	741	735	820	-0.4%
2003	748	746	772	752	763	751	815	-0.2%
2004	805	805	843	818	842	811	898	0.0%
2005	705	714	742	728	753	731	815	1.3%
2006	668	687	733	710	745	711	812	2.8%
2007	629	663	661	684	726	696	719	5.5%
2008	590	663	636	690	740	695	708	12.4%
2009	647	702	651	735	785	740	774	8.6%

d)

Table 9.6.1. Icelandic cod in Division Va. Landings (thousand tonnes, average fishing mortality of age groups 5 to 10, recruitment to the fisheries at age 3 (millions), reference fishing biomass (B4+, thousand tonnes), spawning stock biomass (thousand tonnes) at spawning time and harvest ration. Shaded areas are predictions based on 20% harvest strategy.

Year	Landings	F5-10	SSB	N3	B4+	Hratio
1955	538	0.29	943	152	2362	0.24
1956	481	0.29	796	153	2086	0.24
1957	452	0.31	776	171	1882	0.24
1958	509	0.35	875	221	1868	0.28
1959	453	0.32	853	289	1829	0.25
1960	465	0.37	709	154	1754	0.29
1961	375	0.36	467	193	1497	0.25
1962	387	0.38	569	129	1493	0.28
1963	410	0.46	508	178	1316	0.32
1964	434	0.55	451	204	1219	0.39
1965	394	0.58	318	216	1023	0.38
1966	357	0.59	277	229	1031	0.33
1967	345	0.56	256	320	1103	0.30
1968	381	0.72	222	172	1223	0.30
1969	406	0.56	314	248	1326	0.31
1970	471	0.61	331	180	1337	0.39
1971	453	0.68	242	189	1098	0.43
1972	399	0.69	222	139	997	0.43
1973	383	0.70	245	273	843	0.44
1974	375	0.76	187	179	918	0.41
1975	371	0.81	168	261	895	0.40
1976	348	0.75	138	368	955	0.31
1977	340	0.59	198	143	1289	0.26
1978	330	0.48	212	227	1297	0.25
1979	368	0.45	304	244	1396	0.26
1980	434	0.49	356	140	1489	0.32
1981	469	0.66	263	141	1241	0.42
1982	388	0.73	166	132	970	0.44
1983	300	0.72	129	233	791	0.35
1984	284	0.64	140	139	913	0.31
1985	325	0.67	172	139	927	0.37
1986	369	0.78	197	332	851	0.39
1987	392	0.86	149	263	1031	0.38
1988	378	0.89	172	174	1036	0.37
1989	356	0.72	172	87	1005	0.39
1990	335	0.70	214	130	839	0.44
1991	309	0.80	161	105	696	0.50
1992	268	0.85	152	173	547	0.47
1993	252	0.87	123	137	590	0.43
1994	179	0.63	153	76	574	0.32
1995	169	0.51	178	152	553	0.28
1996	182	0.51	158	166	668	0.25
1997	203	0.55	189	86	782	0.27
1998	243	0.66	211	162	718	0.33
1999	260	0.74	185	70	731	0.39
2000	236	0.76	168	176	591	0.37
2001	235	0.74	164	160	696	0.33
2002	209	0.63	198	163	732	0.28
2003	208	0.59	187	179	746	0.27
2004	227	0.59	202	72	805	0.30
2005	214	0.56	231	154	714	0.30
2006	196	0.56	217	135	687	0.29
2007	170	0.56	194	82	663	0.26
2008	146	0.42	253	133	663	0.21
2009	162	0.40	223	115	702	0.23
2010	149	0.35	240	121	719	0.20
2011	148	0.32	261	218	759	0.18
2012	155	0.29	284	144	925	0.16
2013	185	0.30	327	149	1012	0.18

Table 9.7.1. Icelandic cod in Division Va. Inputs in the short term predictions

Mean weights in the stock and the catch

age\year	2008	2009	2010	2011	2012
3	1.162	1.115	1.115	1.115	1.115
4	1.627	1.515	1.515	1.515	1.515
5	2.318	2.217	2.217	2.217	2.217
6	3.120	3.160	3.160	3.160	3.160
7	3.846	4.122	4.122	4.122	4.122
8	5.367	5.073	5.073	5.073	5.073
9	6.771	6.091	6.091	6.091	6.091
10	7.648	7.648	7.648	7.648	7.648
11	8.282	8.282	8.282	8.282	8.282
12	11.181	11.181	11.181	11.181	11.181
13	14.266	14.266	14.266	14.266	14.266
14	17.320	17.320	17.320	17.320	17.320

Mean weights in the SSB

age\year	2008	2009	2010	2011
3	1.017	1.017	1.017	1.017
4	1.841	1.440	1.440	1.440
5	2.227	2.027	2.027	2.027
6	2.924	2.871	2.871	2.871
7	3.920	3.909	3.909	3.909
8	5.367	5.073	5.073	5.073
9	6.771	6.091	6.091	6.091
10	7.648	7.648	7.648	7.648
11	8.282	8.282	8.282	8.282
12	11.181	11.181	11.181	11.181
13	14.266	14.266	14.266	14.266
14	17.320	17.320	17.320	17.320

Sexual maturity at spawning time:

age\year	2008	2009	2010	2011	2012
3	0.00	0.00	0.00	0.00	0.00
4	0.04	0.02	0.02	0.02	0.02
5	0.28	0.13	0.13	0.13	0.13
6	0.55	0.46	0.46	0.46	0.46
7	0.73	0.69	0.69	0.69	0.69
8	0.83	0.88	0.88	0.88	0.88
9	0.85	0.74	0.74	0.74	0.74
10	0.95	0.63	0.63	0.63	0.63
11	0.74	0.89	0.89	0.89	0.89
12	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00

Selection pattern

age\year	2008	2009	2010	2011
3	0.051	0.050	0.050	0.050
4	0.219	0.220	0.220	0.220
5	0.448	0.462	0.462	0.462
6	0.673	0.729	0.729	0.729
7	1.052	0.972	0.972	0.972
8	1.078	1.069	1.069	1.069
9	1.192	1.243	1.243	1.243
10	1.557	1.524	1.524	1.524
11	1.754	1.928	1.928	1.928
12	2.039	1.928	1.928	1.928
13	2.157	1.928	1.928	1.928
14	2.157	1.928	1.928	1.928

Natural Mortality

age\year	2008	2009	2010	2011	2012
3	0.20	0.20	0.20	0.20	0.20
4	0.20	0.20	0.20	0.20	0.20
5	0.20	0.20	0.20	0.20	0.20
6	0.20	0.20	0.20	0.20	0.20
7	0.20	0.20	0.20	0.20	0.20
8	0.20	0.20	0.20	0.20	0.20
9	0.20	0.20	0.20	0.20	0.20
10	0.20	0.20	0.20	0.20	0.20
11	0.20	0.20	0.20	0.20	0.20
12	0.20	0.20	0.20	0.20	0.20
13	0.20	0.20	0.20	0.20	0.20
14	0.20	0.20	0.20	0.20	0.20

Stock numbers

age\year	2008	2009	2010	2011
3	133.243	114.940	121.32	217.93
4	65.1791	106.802		
5	77.9885	48.724		
6	56.8477	53.005		
7	14.4244	35.202		
8	15.2352	7.630		
9	5.72593	7.971		
10	1.95675	2.858		
11	0.70361	0.839		
12	0.08477	0.278		
13	0.06043	0.030		
14	0.00838	0.020		

Prop. mort. before spawning

age\year	F	M
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	0.477	0.250

Table 9.7.2a. Icelandic cod in Division Va. Output of the short term predictions, domestic format

Prognosis - Summary table

2009				2010				2011				2012			
TAC	4+ stofn 4+ stock	Hr. stofn Sp. stock	F (5-10)	TAC	4+ stofn 4+ stock	Hr. stofn Sp. stock	F (5-10)	TAC	4+ stofn 4+ stock	Hr. stofn Sp. stock	F (5-10)	TAC	4+ stofn 4+ stock	Hr. stofn Sp. stock	F (5-10)
160	702	222	0.410	100	722	252	0.228	100	819	307	0.188	100	1043	368	0.150
				140	722	241	0.335	144	773	267	0.309	155	944	292	0.287
				150	722	239	0.362	147	762	260	0.323	151	929	284	0.287
				178	722	231	0.443	187	730	230	0.459	215	850	222	0.509
				200	722	225	0.512	200	705	212	0.529	200	808	203	0.513

```
Opt 1: Fixed 100 kt landings
Opt 2: 20% of B4+, no buffer
Opt 3: 20% of B4+, buffer
Opt 4: 1996 catch rule
Opt 5: Fixed 200 kt landings
```

Table 9.7.2b. Icelandic cod in Division Va. Output of the short term predictions, ICES format

2009 B4+	SSB	Landings	Fbar
702	222	160	0.410

2010 B4+	Fmult	Fbar	SSB2010	Landings	2011 B4+	SSB
722	0.000	0.000	277	0	934	406
	0.025	0.025	274	12	921	392
	0.050	0.050	271	24	907	380
	0.075	0.075	269	35	894	367
	0.100	0.100	266	46	881	356
	0.125	0.125	263	57	868	344
	0.150	0.150	260	68	856	333
	0.175	0.175	258	79	844	323
	0.200	0.200	255	89	832	313
	0.225	0.225	252	99	821	303
	0.250	0.250	250	109	809	294
	0.275	0.275	247	118	798	285
	0.300	0.300	245	128	788	276
	0.325	0.325	242	137	777	268
	0.350	0.350	240	146	767	259
	0.375	0.375	237	155	757	252
	0.400	0.400	235	163	747	244
	0.425	0.425	233	172	737	237
	0.450	0.450	230	180	727	230
	0.475	0.475	228	188	718	223
	0.500	0.500	226	196	709	217

Table 9.7.2b. Icelandic cod in Division Va. Output of the short term predictions, ICES format

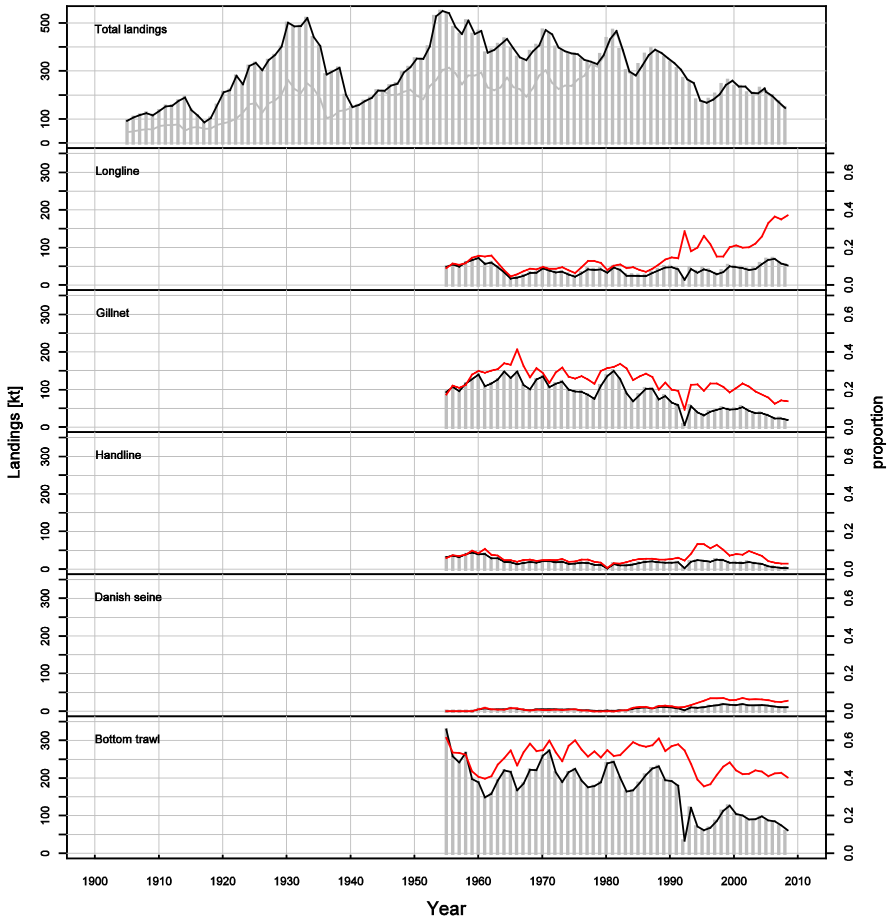


Figure 9.2.1 Icelandic cod division Va. Total landings from 1905 to 2008 and landings by principal gear from 1955 to 2008. The proportion of landings by each gear are shown by the red line.

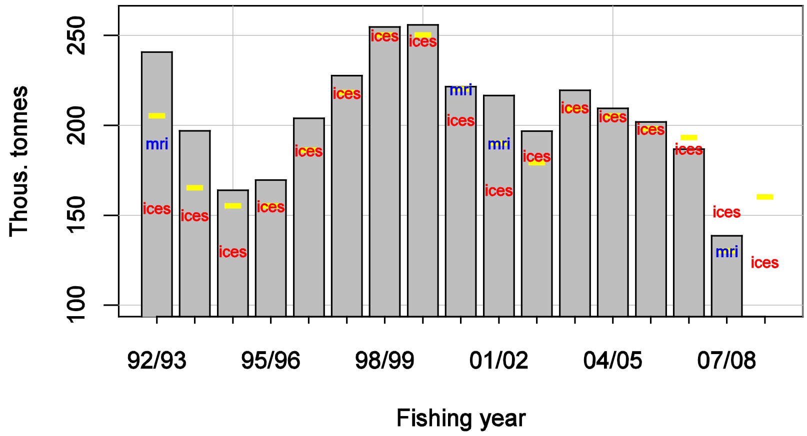


Figure 9.2.3. Icelandic cod division Va. ICES advice (ices), domestic advice (mri) if different from ICES advice and set TAC (yellow bar) and reported landings (grey bar) for the fishing year (September through August).

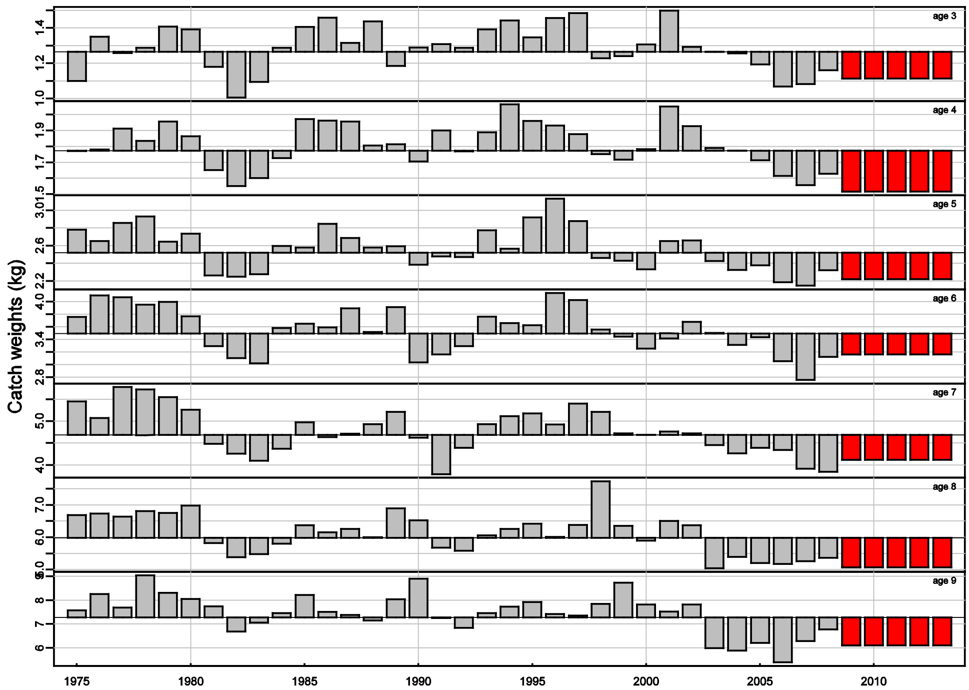


Figure 9.2.4. Icelandic cod division Va. Mean observed weight at age (numbers indicate age classes) in the catches 1974-2008, with predicted and assumed mean weight at age for 2009 and beyond.

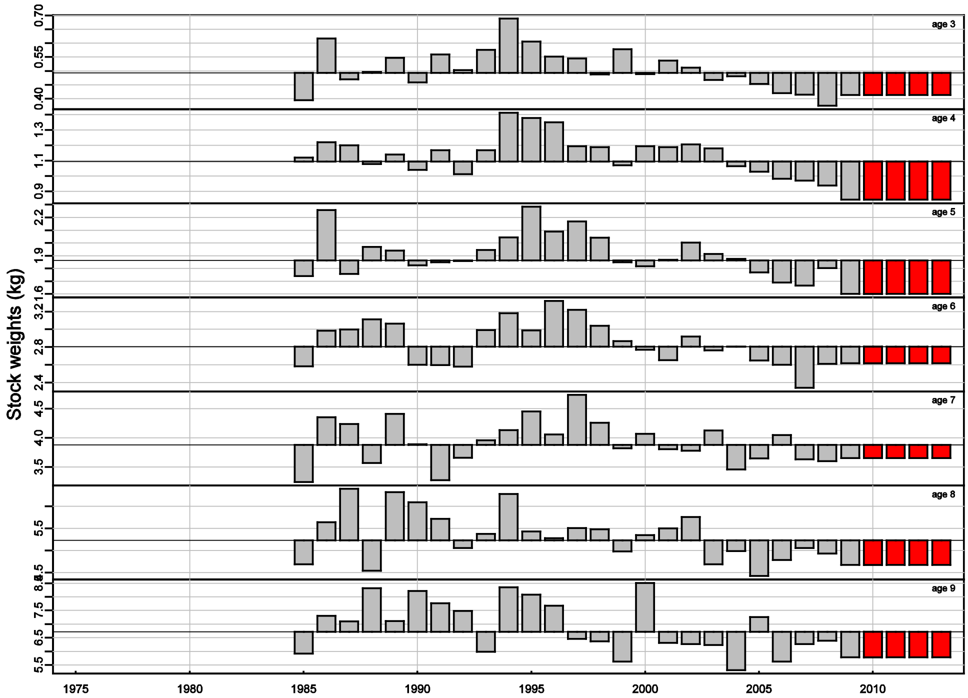


Figure 9.2.5. Icelandic cod division Va. Mean observed weight at age (numbers indicate age classes) in the March groundfish survey 1985-2009.

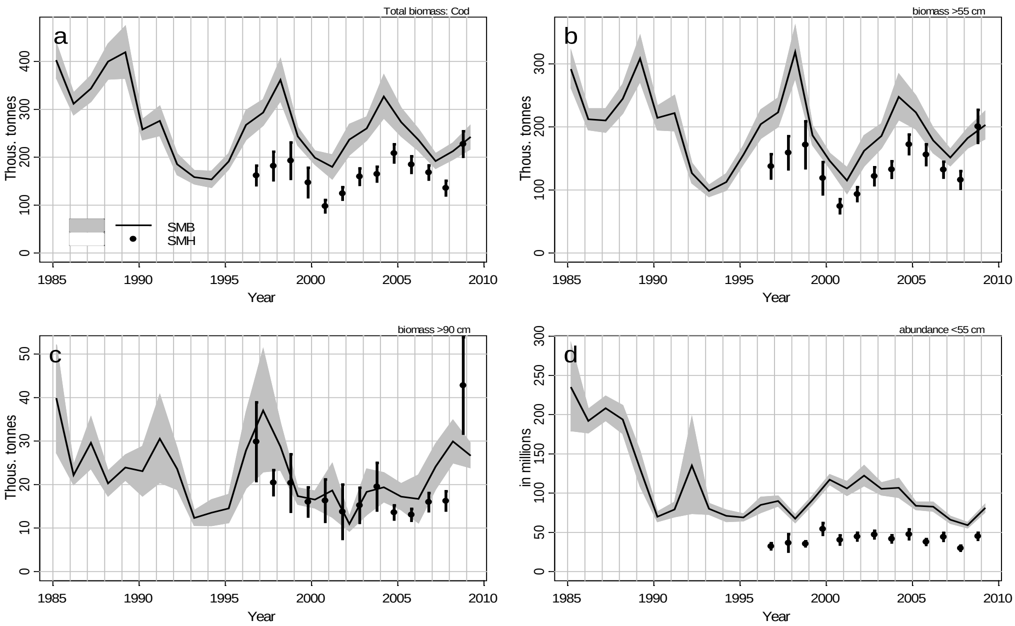


Figure 9.2.6. Icelandic cod division Va. Abundance indices of cod in the groundfish survey in March 1985-2009 (SMB, line, shaded area) and October 1996-2008 (SMH, points, vertical lines). a) Total biomass index, b) Biomass index of 55 cm and larger, c) Biomass index 90 cm and larger, d) Abundance index of < 55 cm. The shaded area and the vertical bar show ± 1 standard error of the estimate.

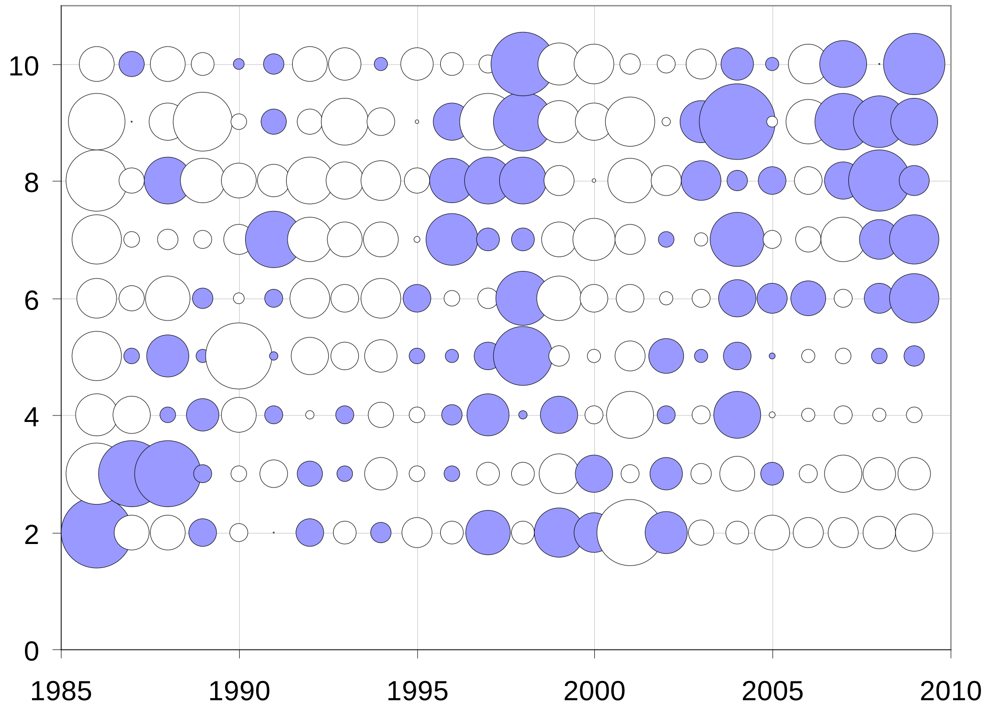


Figure 9.2.7. Icelandic cod division Va. Residual pattern of the observed vs. predicted spring survey indices by age and year from consecutive years. For further explanation see section 9.2.3.

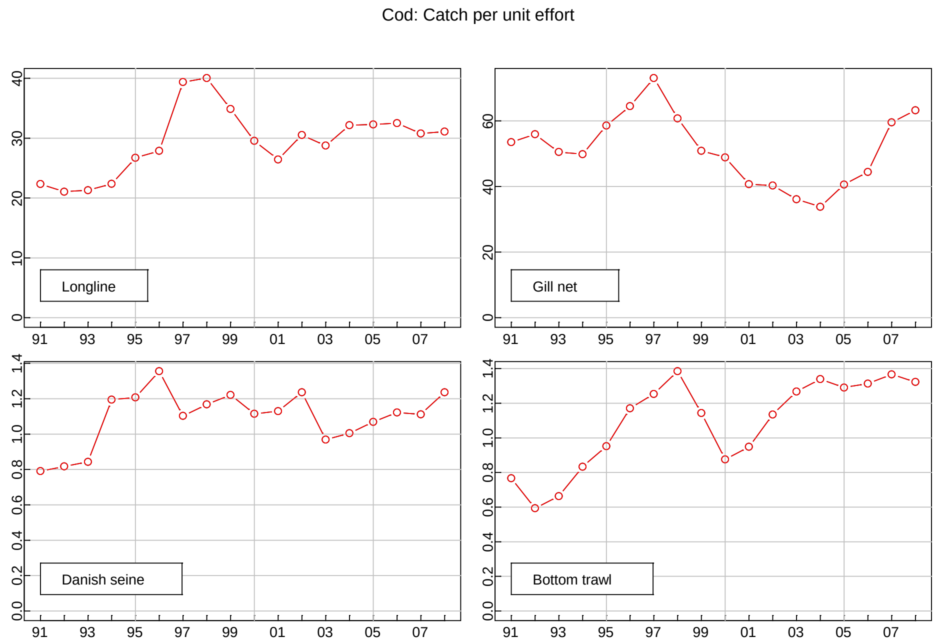


Figure 9.3.1. Icelandic cod division Va. Unstandardized index of catch per unit effort based on log book records where the proportion of cod in the catch is greater than 70%.

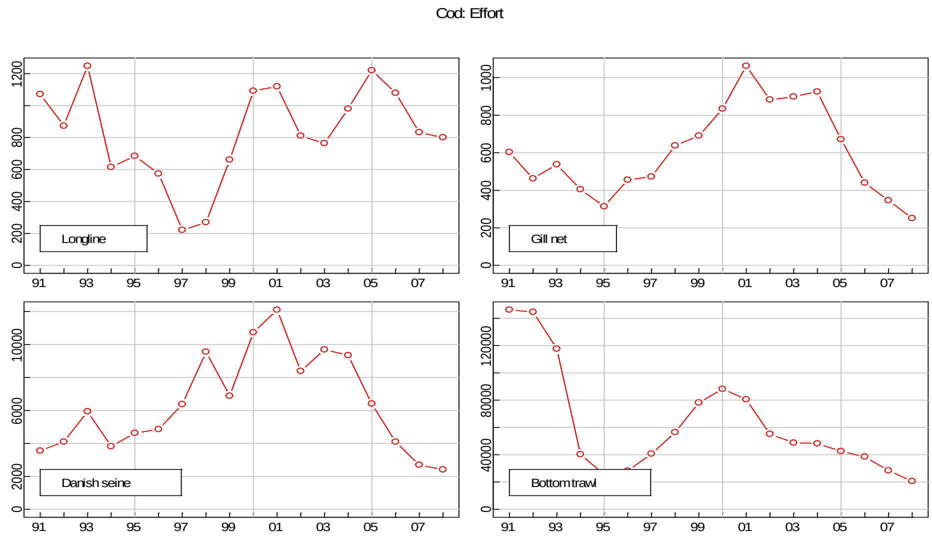


Figure 9.3.2. Icelandic cod division Va. Unstandardized index of effort based on log book records where the proportion of cod in the catch is greater than 70%.

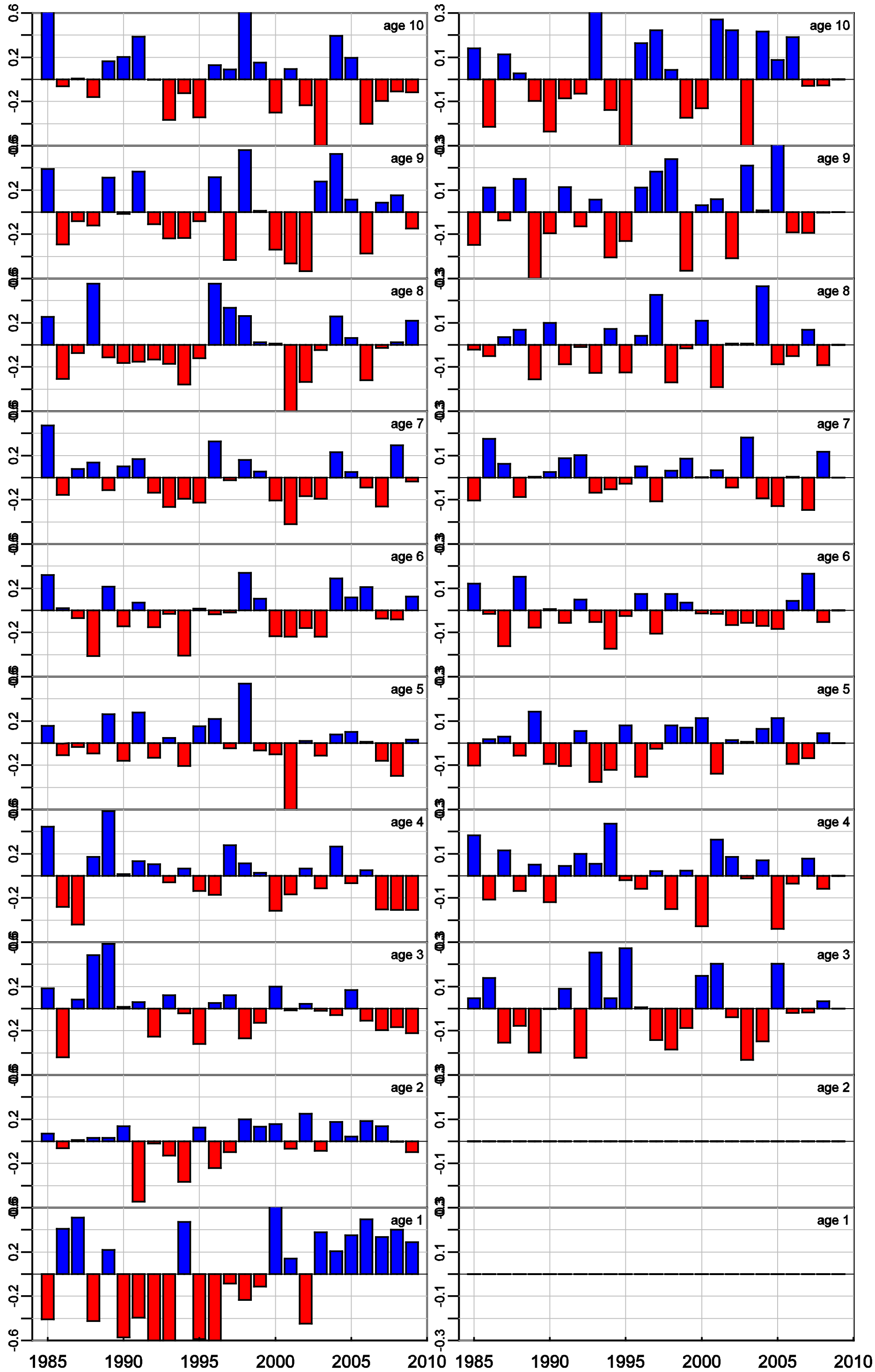


Figure 9.4.1.a Survey residuals (left) and catch residuals (right) by year and age from the ADCAM run.

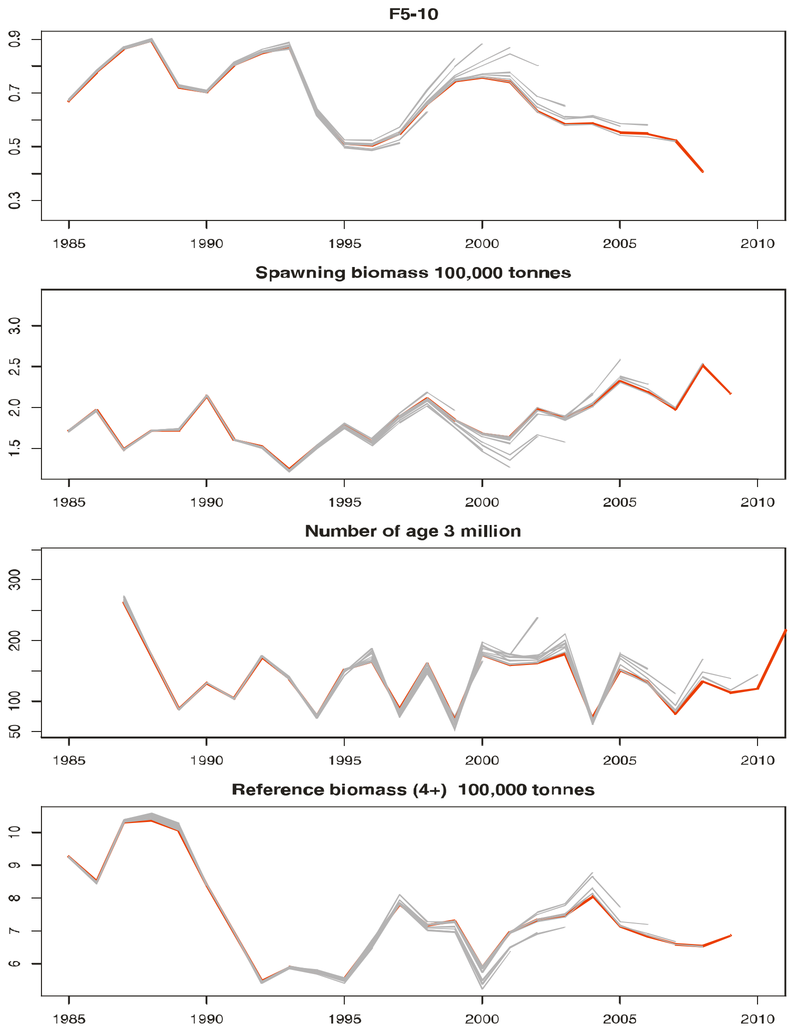


Figure 9.4.2. Icelandic cod in division Va. Retrospective pattern from the ADCAM SPALY fit with the spring survey. Note that the intercept of the y-axis on the x-axis is not set to zero and that the estimates of B4+ is shown, not the conventional SSB (which constitutes older portion of the stock).

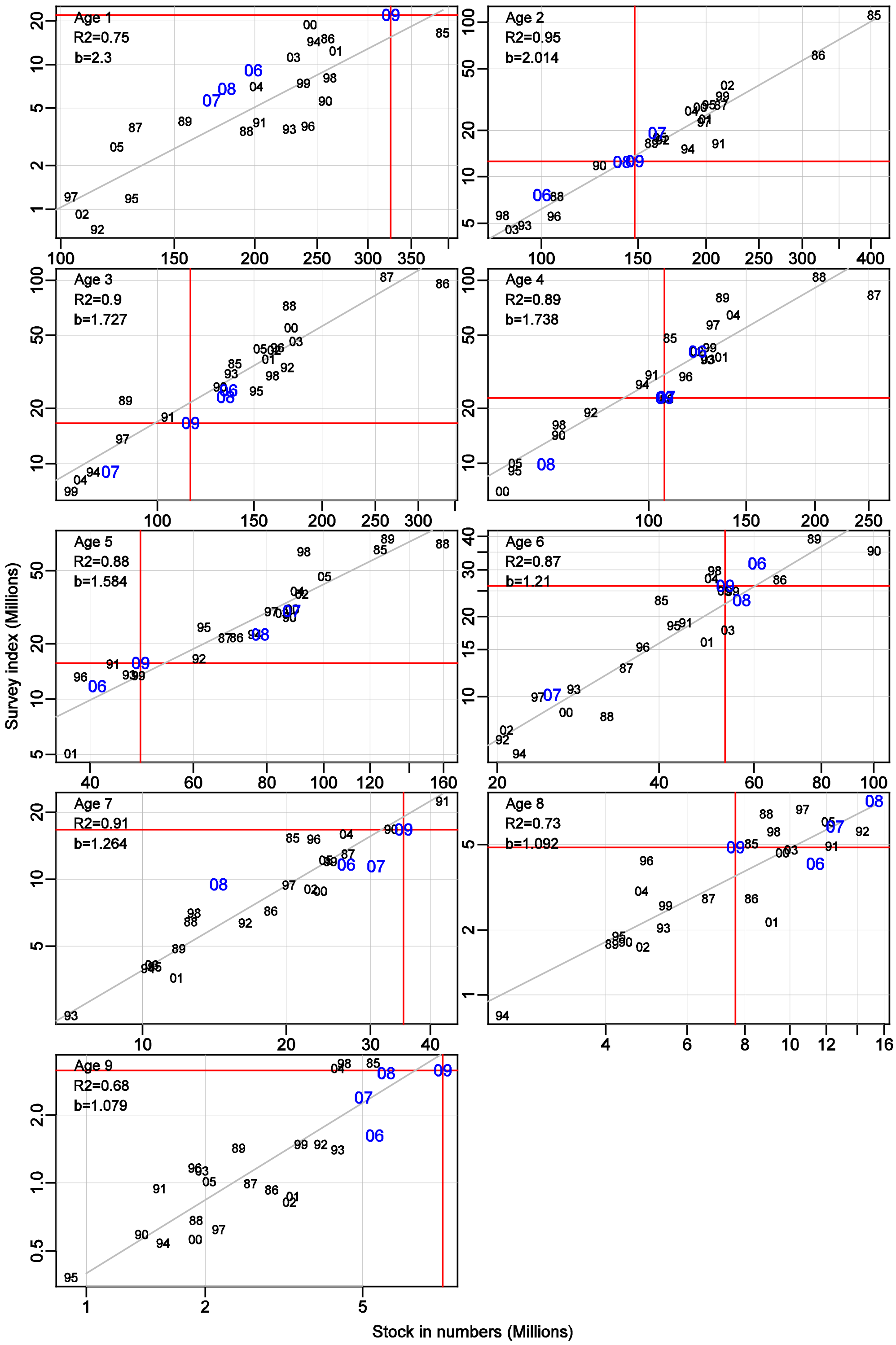


Figure 9.4.3. Icelandic cod in division Va. Log Indices from the spring groundfish survey vs. log number in stock. Line fitted on log scale (power curve) using data from 1985 to 2004. The red lines indicate the stock estimates in 2009 (Na,2009) from the ADCAM SPALY run and the corresponding spring survey measurement (Ua,2009).

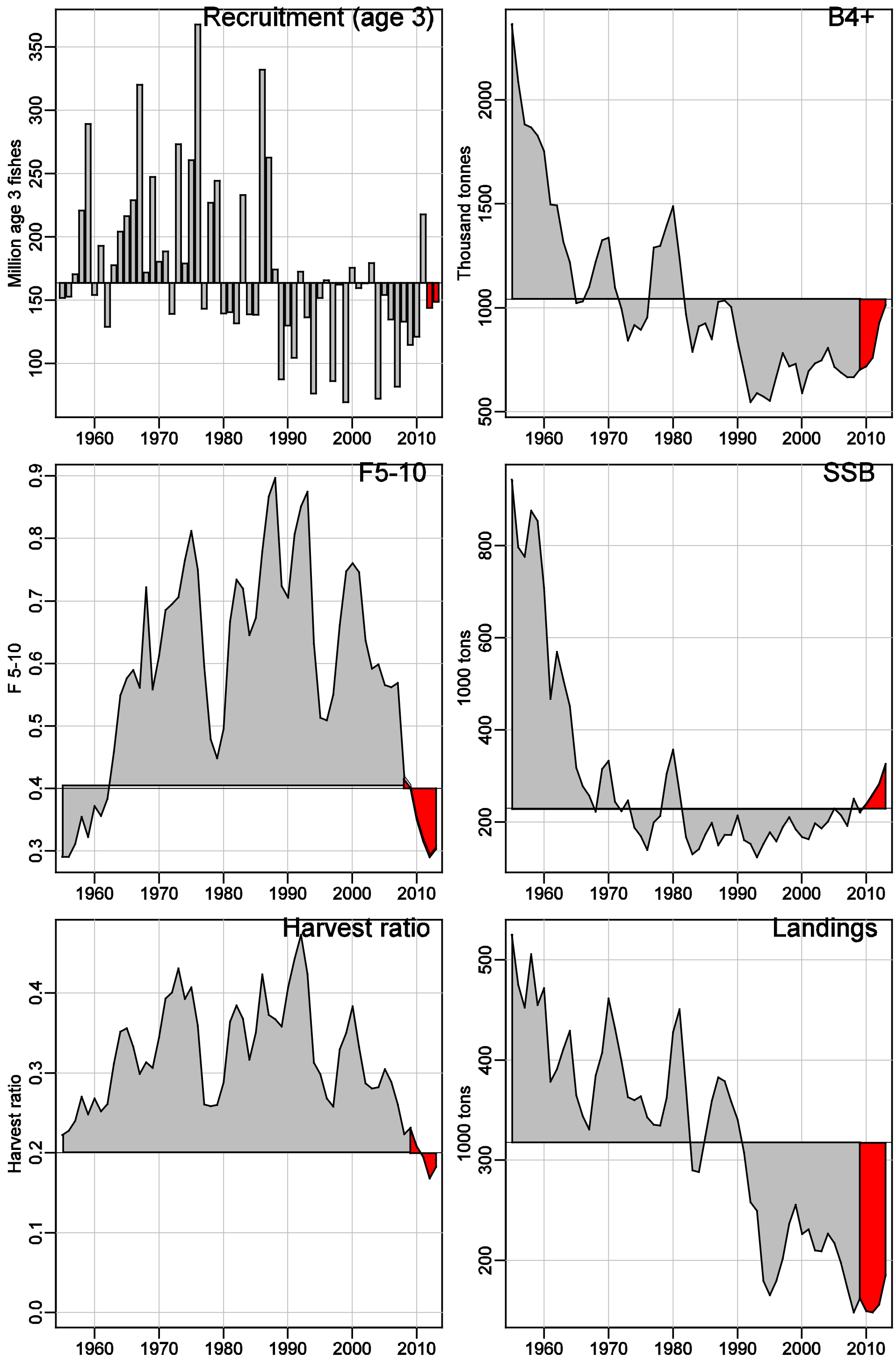


Figure 9.6.1. Icelandic cod in division Va. Summary plot. The x-axis on the recruitment plot refers to year class.

Figure 9.8.1. Icelandic cod in division Va. Medium term projections based showing 95% confidence interval.

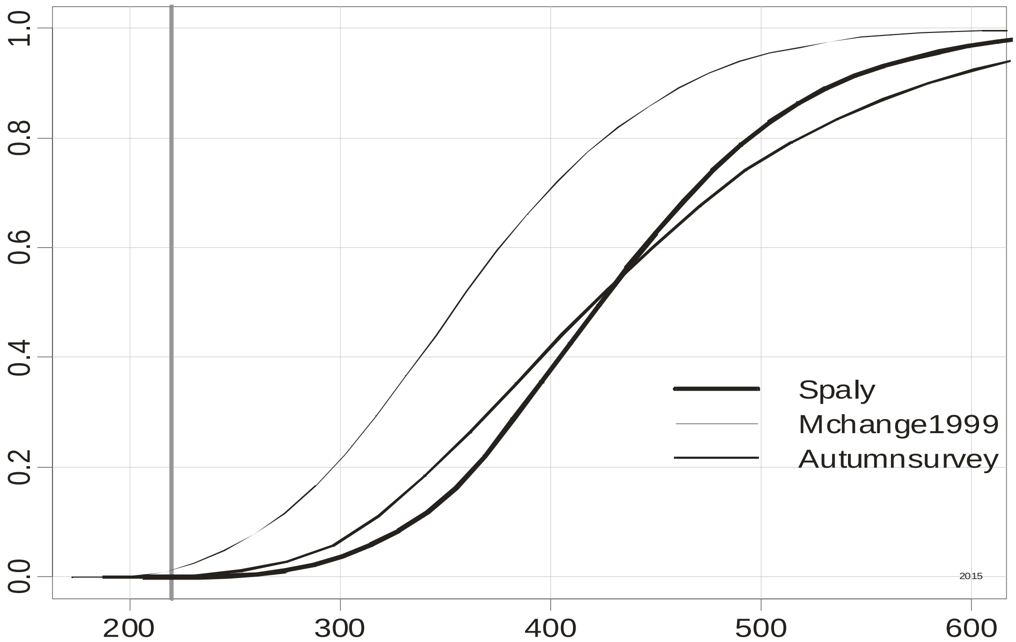


Figure 9.8.2. Icelandic cod in division Va. Cumulative probability distribution of the spawning stock in 2015

10 Icelandic haddock

The main points in this section are.

- Same assessment procedure as last year (SPALY). Adapt type model tuned with both the surveys.
- Year classes entering the fishable stock much smaller than those disappearing so the stock is rapidly decreasing.
- Slow growth. Selection size based so year classes recruit late to the fishery. Prediction of growth the main problem. Still no indications of improved growth in spite of smaller year classes.
- Low mean weight at age means that same age based fishing mortality means higher fishing effort. Propose lowering the target F from 0.47 to 0.35 as last year.
- Problems with to high TAC of haddock compared to cod. Too high effort towards haddock.

10.1 Stock description and management units

Icelandic haddock (*Melanogrammus aeglefinus*) is mostly limited to the Icelandic continental shelf but 0-group and juveniles from the stock are occasionally found in E Greenland waters. Apart from this larval drifts links with other areas have not been found. The species is found all around the Icelandic coast, principally in the relatively warm waters off the west and south coast, in fairly shallow waters (50-200 m depth). Haddock is also found off the North coast and in warm periods a large part of the immature fish can be found north of Iceland.

10.2 Scientific data

The scientific data used for assessing Icelandic haddock are the similar as for most other demersal species in Icelandic waters. The sampling programs i.e log books, surveys, sampling from landings etc. are described in section xx.

10.2.1 Landings

Landings of Icelandic haddock in 2008 are estimated to have been 102,490 tonnes , see Figure 10.2.1 and Table 10.2.1 Of the landings 101 650 tonnes are by Iceland but 840 tonnes by other nations. For comparison the landings in 2007 were 108, 000 tonnes the highest for over 40 years. The share of different gear in the haddock catches have been varying with time, with the share of longlines and Danish seine increasing in recent year while the proportion of haddock caught in gillnets is now very small. (Figure 10.2.2) . The main change from 2007 to 2008 was substantial increase in the percent caught by Danish seine.

10.2.2 Landings by age

Catch in numbers by age are shown in Table 10.2.2 and Figure 10.2.4. Discards are not included in the total catch in tonnes but partly in the samples used for compiling catch in numbers that are a somewhat variable mixture of harbour and sea samples.

Discard is a larger problem in the Icelandic haddock fisheries than in other demersal fisheries in Icelandic waters. The discards have been estimated to be up to 40% of number landed and 22% of landings in 1997 (Pálsson 2003). Comparison of sea and harbour samples indicate that discard was small in 2008 (Figure 10.2.6) as it has been in most years since 2000. Not including discards with catch in numbers has probably some effect on recruitment estimates as the recruitment in the years with most discards is underestimated. It must though be born in mind that length measurements taken at sea have usually been 60-70% of the length measurements used for calculating catch in numbers. Raising of the landings has though not been done. Discards might also be an index of hidden mortality caused by the fisheries. Figure 10.2.5 shows the catch in numbers plotted on log scale with lines corresponding to Z=1 shown for reference. The line indicates that total mortality of Icelandic haddock has usually been high.

10.2.3 Surveys

Haddock is one of the most abundant fishes in the Icelandic groundfish surveys in March and October, being caught in large number at age 1 and becoming fully recruited at age 2 or 3.

The index of total biomass from the groundfish surveys in March and October is shown in Figure 10.2.7. Both surveys show much increase between 2002 and 2005 but the most recent surveys show considerable decrease. The index of total biomass from the groundfish survey in March 2009 is the lowest since 2002 but still high compared to the period 1985 – 2002.

Age disaggregated indices from the March survey are given in Table 10.2 3 and Figure 10.2.8 and indices from the autumn survey in Table 10.2.4. They indicate that most of year classes 1998 – 2003 are large with the 2003 year class much larger than any other year class. In 2009 the abundance of year classes 2003 and earlier is substantially reduced. Later year classes are much smaller but year class 2007 seems to be the largest of those and well above mean. Year class 2008 seems to be small. Figure 10.2.9 shows indices from the March survey on log scale indicating that total mortality has usually been high or closed to 1.

Figures 10.2.12 and 10.2.13 show the abundance of the same year class in the surveys two adjacent years, indicating a reasonably good consistency for the most important age groups. At age 6 the abundance of the large 2003 year class looks normal compared to what it was at age 5 (Figure 10.2.12). As the point furthest to the right it can have much effect on the regression line. Skipping it in the regression does not change the line very much so the drop of the year class from age 5 to 6 seems near average. This might indicate average fishing mortality of age 5 in 2008 pointing to relatively high effort as weight at age is low.??????? . The abundance of older age groups seems to be similar to or little higher than expected, indicating that the mortality of those agegroups in 2008 was similar to the average for the period 1985-2007.

10.2.4 Mean Weight and maturity at age

Mean weight at age in the catch is shown in Table 10.2.6 and Figure 10.2.16.

Mean weight at age in the stock for 1985–2008 is given in Table 10.2.5 and Figure 10.2.15. Those data are obtained from the groundfish survey in March. Weights for 1985–1992 were calculated using a length-weight relationship which is the mean from the years 1993–2009. Weights from 1993 onwards are based on weighting of fish in the groundfish survey each year. Stock weights prior to 1985 have been taken to be the mean of 1985-2002 weights.

Both stock and catch weights have been relatively low since 1990 compared to the eighties. From 1990 to 2004 the weights did not show any apparent trend but it seems like the large year classes (1990 and 1995) and sometimes the following year classes grow slower than other year classes. In recent years the weights at age have reduced much and are in 2009 at or near historic low. From history increased growth should be expected when the stock size reduces and smaller year classes enter the stock. Improved growth has though not been observed yet. The catch weights show similar trends as the stock weights.

Maturity at age data are given in Table 10.2.7 and Figure 10.2.17. Those data are obtained from the groundfish survey in March. Maturity at age increased in the nineties compared to the eighties at the same time as mean weight at age decreased. In recent years maturity at age has been decreasing at the same time as mean weight at age has been decreasing. Maturity by size has though not changed much in recent years.

10.3 Information from the fishing industry

Catch and/or landings in numbers are described in 10.2 and will not be described further here.

Since 2000 all vessels fishing in Icelandic waters have been required to fill out logbooks where they list information about the location, catch and a number of other things for each tow (setting). Vessels larger than 12 tonnes have been required to return logbooks since 1991 and some trawlers started returning logbooks in the seventies.

The logbook data have been used to compile catch per unit effort. Interpretation of those data have often been difficult for it is not always clear when haddock is being targeted but haddock has traditionally been caught in mixed fisheries with cod and some other species. Most often "haddock records" have been selected by choosing records where haddock exceeds certain percent of the total catch (often 50%). The effect of this selection criterion with rapidly increasing haddock catch contemporary with rapidly diminishing cod catch as in recent years is not clear.

Figure 10.3.1 shows the CPUE from the 4 most important fishing gear targeting haddock. The CPUE in longlines, Danish seine and bottom trawl based on settings where haddock exceeds 50 % of the total catch has been reducing in recent years but is still at relatively high level. The CPUE based on all settings where haddock is recorded does not show this decrease. This discrepancy is not unexpected having in mind the increase in haddock landings and expansion of the fisheries (Figures 10.2.3 and 10.2.11). The rapid decrease seen in the surveys recently (Figure 10.2.7) has not yet been seen in the CPUE. The total biomass of the stock has been reducing but at the same time the size distribution of haddock has become more suitable for the commercial fisheries (older fish). CPUE in gillnets is at relatively low level and the share of gillnets in the haddock fisheries is now very small (Figure 10.2.2).

10.4 Methods

In 2007 and 2008 the final assessment was based on an Adapt type model calibrated with indices from both the groundfish surveys in March and October. Before that statistical catch at age model calibrated with indices from the March survey was used.

In recent years assessment of Icelandic haddock has been done with a number of different age based models, both VPA and statistical catch at age models. This year assessment was done with 4 different models i.e XSA, TSA, Adapt type model and Adcam. In recent years the same models have been used. XSA has always indicated that the stock is somewhat larger than the other models do. Examination of the models has shown that the most important explanation of this difference is that XSA does not model correlation between residuals of different age groups in the surveys in the same year. For Icelandic haddock this correlation is quite high (especially in the March survey) so it can nearly be described as a year factor.

Assessment in recent years has shown some difference between different models but more difference between different data sources i.e the March and the October surveys. Models calibrated with the October survey have indicated smaller stock although both surveys have indicated that the stock is very large. There have been indications that "catchability" of haddock in the March survey might have been on the higher side so since 2007 the assessment was based on both the surveys.

The SPALY method used this year was the same as in last year i.e Adapt type model tuned with both the surveys. As before this was not done without reference to results from the other models and it can therefore be stated that the assessment was based on 4 different models (TSA, XSA, Adcam and Adapt) or 4 little different models as all are age disaggregated models assuming M=0.2 using more or less the same data.

10.5 Reference points

In the year 2000 the working group proposed provisional F_{pa} set to the F_{med} value of 0.47 and this value has been used as F_{target} since then. At that time $F_{4\text{-}7}$ = 0.47 looked like a reasonable fishing mortality, forgetting the F_{med} approach that does probably not hold water. Since 1984 $F_{4\text{–}7}$ has only 3 times been below F_{pa} and 7 times since 1960.

In recent years the mean weight at age has been reducing considerably, especially for the huge 2003 year class and at the moment mean weight at age is one year behind what has been normal. This has affected the selection pattern of the fisheries but also meshed up the reference F as $F_{4\text{-}7}$ should now be compared to $F_{3\text{-}6}$ in earlier years. Those factors were considered last year and the advice based on $F_{4\text{-}7}$ = 0.35 that was considered to lead to similar fishing mortality for the same size of fish as $F_{4\text{-}7}$=0.47 would have done 1985-2000.

The SGPRP proposed B_{loss} as candidate for B_{pa} at its meeting in February 2003. The working group did not discuss this matter further.

10.6 State of the stock

All assessment models run indicate that the stock is still relatively large but rapidly decreasing because younger year classes are much smaller than those that are now in the fisheries so the stock will decrease in coming years. As last year the final assessment was based on an Adapt type model using both the March and the October survey for tuning

Figures 10.6.1 shows the development of recruitment, biomass, survey biomass and fishing mortality but Figures 10.6.2 and 10.6.3 residuals from the fit to the survey data. The residuals in the most recent March survey are negative indicating that the model does not follow the drop in survey indices seen in the most recent survey. This could be an indication that the current assessment was an overestimate and the retrospective pattern (Figure 10.6.5) shows that adding one year from last year's assessment leads to downward revision of the stock size.

Figure 10.6.4 shows the estimated “catchability” and CV as function of age for the surveys showing that estimated CV is lower in the autumn survey for ages 2 to 7. Therefore the autumn survey gets more weight for those age groups. The figure also indicates that estimated CV and “catchability” have not changed much since last year.

The table below show estimated fishing mortality in 2008 and biomass in 2009 from a number of models. It shows that models based only on the March survey indicate larger stock than models tuned with the autumn survey or both the surveys. The difference between model results has decreased from assessment in recent years.

Model and data	*F4-7 2008*	*Bio 3+ 2009*
XSA March survey	*0.515*	*226*
Adcam March survey	*0.51*	*196*
TSA March survey	*0.50*	*181*
Adapt autumn survey	*0.59*	*169*
Adapt both surveys	*0.54*	*191*

10.7 Short term forecast

Prediction of weight at age in the stock, weight at age in the catches, maturity at age and selection is described in working paper #19 in 2006. To summarize the findings of working paper #19 the stock weights are predicted forward in time starting with the weights from the March survey 2009. Growth is predicted as a function of weight at age multiplied by a year effect.

$$\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$$

Model including year class effect did not fit the data as well for the low mean weight at age of large year classes can already be seen at age 2.

Figure 10.7.1 shows the estimated year effect indicating slow growth in 3 years. Last year the year factor for the year 2007 was used as basis for prediction of growth in 2008 and 2009, leading to reasonably correct estimation of stock weight at age in 2009 as growth in 2008 is estimated to be similar than in 2007 (Figure 10.7.1) . This year the procedure is repeated i.e the very slow 2008 growth was used for the years 2009 and later. As discussed earlier this might a pessimistic assumption as slow growth is possibly a density dependent phenomena and density of haddock is predicted to decrease in coming years.

Mean weight at age in the catches is predicted from mean weight at age in the stock the same year by an equation of the form

$$\log Wc_{a,t} = \alpha + \beta \log W_{a,t}$$

Figure 10.7.2 shows the data and the fitted relationship. The fitted relationship predicts that catch weights will be below stock weights when the latter are above 3100g but there are no indications in the near future that the mean weight of any age group will reach that value.

Maturity at age was predicted from mean weight at age in the stock by an equation of the form

$$\log it(P_{a,t}) = \alpha + \beta \log W_{a,t}$$

The fitting is done separately for the period 1985 – 2000 and 2001 – 2008 with the latter relationship used for prediction.

Haddock fisheries in Icelandic waters tend to avoid small haddock so when growth is slower the year classes recruit slower to the fisheries. Figure 10.7.2 shows the relationship between mean weight at age in the stock and selection at age of the fisheries with a curve fitted to the data. The selection at age is flat when mean weight at age in the stock exceeds approximately 2 kg.

Stock numbers in the year 2008 and recruitment in 2008 – 2009 were obtained from the Adapt type model calibrated both the surveys and the same model was used for prediction as for assessment.

$F_{4\text{-}7}$ = 0.35 was used as basis for advice but as described in working paper #19 2006 and in the section on reference point (section 10.7.2). This value corresponds to $F_{4\text{-}7}$ = 0.47 in the period that the reference point was based on.

A TAC constraint of 85 000 tonnes was used for the year 2009. The estimate was the sum of the TAC for the fishing year starting September 1st 2008 that was remaining in the beginning of 2009 and 33% of the estimated TAC for the fishing year 2009-2010

The result of short term prediction is shown in Table 10.7.1 and Figure 10.6.1. They show that both stock size and landings will decrease rapidly in coming years when the large year classes disappear, how rapidly depends on fishing mortality and growth. Prediction based on F4-7=0.35 lead to landings of 57000 tonnes in 2010.

10.8 Medium term forecasts

Last year medium term forecasts were not done. This year there was a request to look at the probability distribution of the spawning stock in 2015 with regard to refrence points. This turned out to be rather difficult as no such points had been defined. In the meeting of SGPRP in 2003 (Ices 2003a) B_{loss} (40 000 tons) was suggested at candidate for B_{pa}. The stock of haddock is predicted to decrease in coming years and its status in 2015 with regards to B_{loss} was investigated.

The premises in the stochastic prognosis were.

1. Mean weight at age same as in 2009. Random error lognormal with CV = 0.15 and autocorrelation = 0.35 added to the weight.
2. Assessment error lognormal with CV = 0.15.
3. Size of year classes 2009 and later lognormal with mean and CV estimated from historical data. Lognormal does though not describe well the probability distribution of recruitment of Icelandic haddock.
4. Fishing mortality of ages 4 – 7 was assumed to be 0.35.

Figure 10.8.1 shows the cumulative probability distribution of the spawning stock in 2010. There about 10% probability being below B_{pa}. This is rather high probability considering that B_{pa} is Bl_{oss} and has only been reached once in 30 years and for most of those 30 years fishing mortality was much higher than in the simulations. Low mean weight at age used in the simulations is probably the reason that the probability of the SSB going below 40 000 tonnes is not negligible. Growth is likely to improve somewhat when stock size reduces. Mean weight at age does on the other hand show trend and had already reduced much before the drop after 2004.

Mean F of 0.3 will lead to less than 5% probability of the spawning stock in 2015 being below B_{loss}. Lowering of F to 0.3 might lead to better balance between the effort towards cod and haddock as well as leading to the large year class from 2003 to last longer in the fisheries.

10.9 Uncertainties in assessment and forecast

The state of the stock today is reasonably well known but there is considerable uncertainty in prediction of growth and therefore in the short term forecast. Currently mean weight of all age groups are at historical minimum. Growth is predicted to be very slow in coming years but growth is modelled as function of size instead of age so the old relatively small fishes of the 2003 year class are expected to continue to grow at the same rate as 1-2 years younger fish of the same size. This assumption might be correct but growth might also be reduced to age or maturity effects. On the other side growth of haddock is to some degree density dependent and is expected to improve with reduced stock size.

10.10 Comparison with previous assessment and forecast

Figure 10.10.1 shows a comparison of this years and last year's assessment. The weights compare reasonably well but there is some downward revision of stock numbers. Comparison with last year's assessment may also be seen in figure 10.6.1 where last years assessment is shown as dashed lines.

Even though the assessment is doing reasonably well in terms of stock in numbers the most recent residuals are negative (Figures 10.6.1 and 10.6.2). This indicates that the model does not follow the recent drop in survey indices. Perhaps a signal that numbers might reduce further in next year's assessment.

Looking at the last 6 years prediction of numbers in stock has succeeded reasonably well but mean weight at was overestimated leading to much lower than predicted landings from the large year classes 2002 and 2003. The problem of growth prediction was tackled in 2006 leading to somewhat better prediction of growth since then, some underestimation of 2006 growth, overestimation for 2007 and correct estimate for 2008.

10.11 Management plans and evaluations

Could just be a reference to the year when the plan was agreed/evaluated. Include proposed/agreed management plan.

10.12 Management considerations

Hidden mortality of young haddock is potentially a major problem (Björnsson and Jónsson 2004). The problem is most pronounced when there is much overlap in the spatial distribution of the recruits and of the fisheries. Also the problem tends to be worse when larger haddock are lacking and when fishing mortality is high. The problem tends to be aliased with the discard problem but also includes fish that escapes from the fishing gear below the surface. In recent years share of longliners have increased, possibly changing the hidden mortality but longlines do not affect fish that does not take the bait.

In 2008 most fishermen claimed that fishing their haddock quotas was difficult because of by catch of cod. This might be an indication that haddock quotas in Icelandic waters are too high and the current assessment confirms that fishing mortality is increasing when fishing mortality of cod is being reduced. **Fishing mortality by age is still not high compared to what it has usually been but fishing mortality by size is relatively higher and that is what matters.** Reasonable balance in fishing mortality of species coexisting in mixed fisheries is very important for management of the fisheries.

10.13 Ecosystem considerations

Known/new impacts of the fisheries on the ecosystem

10.14 Regulations and their effects

For a number of years reference landing size of haddock has been 45 cm and areas where more than 25% of the catch was below this size were closed temporarily. In 2007 large part of the very large 2003 year class was below reference landing size but younger year classes are much smaller so nearly all haddock close to the reference landing size was of the 2003 year class. Keeping the reference landing size unchanged meant trying to take the largest individuals of the same year class so it was decided to change the reference landings size to follow the size of the 2003 year class. The reference landings size was changed back to 45 cm in 2009 when most of the 2003 year class had reached that size.

10.15 Changes in fishing technology and fishing patterns

In recent years increased proportion of haddock has been caught by longliners (figure 10.2.2). This might have affected the hidden mortality of haddock.

10.16 Changes in the environment.

Table 10.2.1 Haddock in Division Va Landings by nation.

Table 1.1. Icelandic haddock. Landings by nation.

Country	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	1010	1144	673	377	268	359	391	257
Faroe Islands	2161	2029	1839	1982	1783	707	987	1289
Iceland	52152	47916	61033	67038	63889	47216	49553	47317
Norway	11	23	15	28	3	3	+	
€UK								
Total	55334	51112	63560	69425	65943	48285	50933	48863

HADDOCK Va

Country	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	238	352	483	595	485	361	458	248
Faroe Islands	1043	797	606	603	773	757	754	911
Iceland	39479	53085	61792	66004	53516	46098	46932	58408
Norway	1	+						1
UK								
Total	40761	54234	62881	67202	53774	47216	48144	59567

HADDOCK Va

Country	1995	1996	1997	1998	1999	2000	2001	2002
Belgium								
Faroe Islands	758	664	340	639	624	968	609	878
Iceland	60061	56223	43245	40795	44557	41199	39038	49591
Norway	+	4						
UK								
Total	60819	56891	43585	41434	45481	42167	39647	50469

Country	2003	2004	2005	2006	2007	2008
Belgium						
Faroe Islands	833	1035	1372	1499	1780	828
Iceland	59970	83791	95859	96115	108175	101651
Norway	30	9			11	11
UK	51					
Total	60884	84835	97231	97614	109966	102490

Table 10.2.2 Haddock in division Va. Catch in number by year and age.

Year/age	2	3	4	5	6	7	8	9
1979	161	2066	4074	6559	9769	1887	474	61
1980	595	1384	11476	4296	3796	3730	544	91
1981	10	516	4929	16961	6021	2835	1810	169
1982	50	286	2698	10703	14115	2288	1167	816
1983	10	705	1498	4645	10301	8808	874	241
1984	60	755	4970	1176	4875	3772	4446	171
1985	427	1773	4981	6058	837	1564	2475	2212
1986	196	3681	3822	4933	5761	493	852	898
1987	2237	7559	7500	2696	2249	1194	151	208
1988	133	10068	15927	5598	1260	1009	577	58
1989	78	2603	23077	9703	3118	541	507	144
1990	446	2603	7994	23803	6654	857	167	71
1991	2461	1282	3942	6711	13650	2956	398	52
1992	2726	7343	4181	4158	3989	5936	1314	132
1993	218	11617	12642	3167	1786	1504	2263	379
1994	280	3030	27025	10722	1550	756	404	700
1995	2357	6327	5667	23357	5605	610	263	210
1996	1467	8982	7076	4751	13963	2446	228	87
1997	1375	3690	11127	4885	2540	4981	692	52
1998	207	8109	5984	8390	2420	1502	1884	207
1999	1077	1455	16897	4844	4982	942	588	514
2000	2351	6496	2335	13817	2052	1789	364	197
2001	2212	11298	7124	1497	6212	698	484	104
2002	1020	10603	16192	5128	1126	3126	245	175
2003	279	6396	16355	12695	2866	766	1314	85
2004	1356	4154	17937	19402	8801	1957	539	538
2005	1577	9580	7169	25996	14108	4841	837	250
2006	157	9930	20900	6688	19218	7806	2257	316
2007	745	3730	41648	22995	3445	10445	2902	538
2008	2244	4443	9710	52866	10995	1721	3040	816

Table 10.2.3 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in March

Year/ age	1	2	3	4	5	6	7	8	9	10
1985	28.15	32.72	18.34	23.65	26.54	3.73	10.98	4.88	5.64	0.51
1986	123.95	108.51	59.07	12.8	16.38	13.2	0.98	2.77	1.26	2.32
1987	22.22	296.28	163.63	57.08	13.17	11.17	8.09	0.58	1.28	0.84
1988	15.77	40.71	184.77	88.86	22.86	1.36	2.25	1.87	0.18	0.28
1989	10.58	23.35	41.53	146.71	44.9	12.74	0.85	0.84	0.41	0.28
1990	70.48	31.86	27.25	39.06	91.79	30.87	3.44	0.9	0.23	0
1991	89.73	145.95	41.55	17.83	20.27	32.55	7.67	0.3	0.1	0.11
1992	18.15	211.43	138.4	35.54	16.56	13.14	15.93	2.21	0.18	0.07
1993	29.99	37.65	245.06	87.3	11.15	3.86	1.66	4.46	0.88	0
1994	58.54	61.34	39.83	142.62	42.41	6.93	2.89	1.42	4.07	0
1995	35.89	82.53	48.09	19.74	68.41	7.66	1.31	0.11	0.34	0
1996	95.25	66.3	121	36.93	19.11	39.77	5.84	0.62	0.13	0.12
1997	8.57	119.13	50.88	52.99	10.86	7.28	10.58	1.37	0.06	0.03
1998	23.12	18.07	108.27	28.25	23.32	4.64	3.47	4.57	0.33	0
1999	80.73	86.21	25.8	98.18	12.9	9.6	1.42	1.7	1.03	0.03
2000	60.58	90.44	45.03	8.54	24.63	2.94	1.62	0.41	0.15	0.45
2001	81.33	148.06	115.04	22.16	4.09	10.56	0.93	0.57	0	0.1
2002	21.14	298.28	201	112.78	23.25	3.52	7	0.31	0.34	0.11
2003	111.96	97.85	282.83	244.83	112.28	18.05	2.58	4.43	0.48	0.85
2004	325.9	291.97	70.85	208.84	109.26	33.86	6.88	1.08	0.86	0
2005	58.37	693.04	288.21	44.97	156.93	57.32	15.75	3.34	0.32	0.27
2006	38.39	90.06	575.79	179.18	18.92	62.94	16.24	6.74	0.7	0.29
2007	34.01	66.06	88.56	436.14	85.73	7.78	21.61	4.74	2.06	34.01
2008	88.53	68.49	71.90	75.17	222.62	29.91	3.53	7.47	1.67	0.27
2009	10.52	111.32	54.16	41.45	41.94	105.19	12.98	2.24	3.17	10.52

Table 10.2.4 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in October

Year/age	0	1	2	3	4	5	6	7	8	9
1995	93.95	162.64	184.92	51.4	24.27	42.47	5.74	0.56	0	0.07
1996	12.45	347.52	93.69	77.33	16.52	6.35	15.27	1.28	0	0
1997	49.84	29.63	200.21	59.25	39.34	7.12	5.79	6.35	0.29	0
1998	183.18	79.7	33.41	138.33	19.47	13.6	4.52	4.36	1.68	0
1999	204.63	343.81	57.78	26.55	96.25	10.51	8.97	0.45	1.49	0.31
2000	56.59	157.27	240.32	41.42	7.05	26.77	1.8	2.73	0.07	0.21
2001	50.18	331.24	253.85	155.73	31.35	3.53	12.14	0.64	0.95	0
2002	137.95	76.53	213.48	171.33	84.46	16.88	2.49	2.14	0.85	0.09
2003	313.08	337.83	139.25	223.58	144.16	48.03	8.24	1.89	0.55	0
2004	197.06	716.82	323.19	48.18	142.49	62.11	14.93	3.2	0.67	0.4
2005	98.52	73.87	530.9	171.08	24.38	81.16	23.04	9.29	1.68	0
2006	82.97	109.08	108.39	456.13	96.72	11.78	32.52	8.25	2.91	0.97
2007	197.81	94.74	70.83	85.36	302.15	50.55	7.39	10.39	3.35	0.5
2008		212.68	93.03	63.48	75.96	164.57	13.5	2.29	3.1	

Table 10.2.5 Haddock in division Va Weight at age in the stock. Predicted values are shaded.

Year/ age	1	2	3	4	5	6	7	8	9
1985	35	244	567	1187	1673	2372	2768	3199	3334
1986	35	239	671	1134	1944	2400	3192	3295	3731
1987	31	162	550	1216	1825	2605	3031	3644	3838
1988	37	176	456	974	1831	2697	3104	3483	3321
1989	26	182	440	886	1510	2382	3011	3502	3198
1990	29	184	456	839	1234	1966	2677	3055	3269
1991	31	176	500	1002	1406	1885	2498	3757	3656
1992	28	157	503	894	1365	1892	2326	2938	3684
1993	41	169	384	879	1487	1766	2548	2538	3227
1994	33	179	401	696	1242	1683	1641	2693	1991
1995	37	164	444	763	1071	1856	2667	5312	1313
1996	41	174	447	806	1072	1474	2160	2407	4803
1997	50	173	423	818	1224	1426	1917	2397	3694
1998	41	202	404	742	1232	1738	2015	2333	3081
1999	34	205	479	719	1198	1967	2381	2798	2929
2000	29	179	552	888	1167	1777	2620	2924	3155
2001	36	188	487	1052	1433	1502	2165	2758	
2002	63	172	474	891	1465	1955	2143	1998	3662
2003	40	230	412	801	1268	1873	3139	2343	3301
2004	34	176	556	807	1282	1690	2454	3236	2942
2005	40	153	448	920	1188	1564	2128	2808	2550
2006	33	127	333	736	1145	1512	1944	2232	3272
2007	48	170	350	615	1053	1514	1786	2073	2198
2008	27	179	382	595	868	1295	1828	2201	2340
2009	29	139	442	687	882	1141	1495	1920	2574
2010	29	140	345	731	996	1193	1440	1755	2103
2011	29	140	345	731	996	1193	1440	1755	2103

Table 10.2.6 Haddock in division Va Weight at age in the catches. Predicted values are shaded.

Year/age	2	3	4	5	6	7	8	9
1982	330	819	1365	1649	2329	3012	3384	3965
1983	655	958	1436	1827	2355	2834	3569	4308
1984	980	1041	1476	2105	2460	3028	3014	3807
1985	599	1002	1783	2201	2727	3431	3783	4070
1986	867	1187	1755	2377	2710	3591	3760	4135
1987	446	1048	1629	2373	2984	3550	4483	4667
1988	468	808	1474	2230	2934	3545	3769	4574
1989	745	856	1170	2010	2879	4109	4035	4706
1990	357	716	1039	1542	2403	3458	4186	4969
1991	409	868	1111	1546	2035	2849	3464	4642
1992	320	856	1253	1597	2088	2529	3133	4022
1993	420	756	1372	1870	2360	2888	2975	3442
1994	568	720	1058	1742	2380	2785	3447	3156
1995	457	874	1145	1366	2079	2853	3251	3899
1996	387	841	1189	1528	1816	2641	3499	3526
1997	450	829	1192	1663	1934	2360	3059	3010
1998	689	777	1166	1692	2312	2379	2882	3417
1999	616	866	1096	1638	2205	2681	2863	3229
2000	518	951	1314	1461	2096	2679	3181	3438
2001	542	933	1451	1759	1836	2309	2966	3123
2002	573	918	1256	1741	2192	2224	2844	3392
2003	559	908	1266	1700	2297	2699	2626	2897
2004	575	979	1235	1574	2048	2799	3167	3082
2005	398	848	1212	1469	1898	2271	2952	3141
2006	429	723	1087	1496	1754	2167	2591	2923
2007	500	716	970	1326	1815	2048	2361	2572
2008	380	633	856	1124	1573	2147	2411	2800
2009	389	842	1129	1334	1583	1897	2241	2724
2010	391	714	1177	1446	1631	1849	2109	2380
2011	391	714	1177	1446	1631	1849	2109	2380

Table 10.2.7 Haddock in division Va Sexual maturity at age in the stock. (from the March survey). Predicted values are shaded.

Year/ age	2	3	4	5	6	7	8	9
1985	1.6	14.4	53.6	57.7	76.5	76.6	96.1	93.4
1986	2.1	20.5	41.3	67.3	84.5	88.4	95.2	98.6
1987	2.2	13.7	42.6	53.5	77.8	77.6	100	96.9
1988	1.3	22.1	39.4	76.7	79.3	92.8	91.4	100
1989	4.1	20.2	53.2	72.7	81.8	99.8	100	100
1990	11.4	33.4	63.4	81.4	84.3	91.8	88.2	100
1991	6.3	22.4	59.2	73.9	81.7	89.4	49.5	100
1992	5	22.7	41.9	79.9	90.1	90.1	85.8	100
1993	12.4	36.2	48.1	67	90.4	97.7	90.8	86.7
1994	24.8	31.2	57.3	76.2	84.6	100	90.7	100
1995	12.4	47.9	38.2	75	75.3	60.6	98.5	100
1996	19.1	36.2	59	64.8	78.7	73.9	94.9	90.8
1997	9.3	43.6	58.7	68.3	75	78.3	88	100
1998	2.6	45.4	66.8	77	73.3	84.9	89.9	100
1999	5	39.7	68.3	72.4	74.9	89.2	76.1	92
2000	10.7	26.1	63.2	80.8	86.8	87.3	100	78
2001	9.1	37.7	52.2	75.3	89.5	91.6	91.8	100
2002	4.7	28.6	63.3	80	93.4	92.8	100	100
2003	6.2	34.7	68.5	86.7	92.2	94.6	100	100
2004	3.7	36.1	57	83.1	91	100	100	100
2005	2.4	23	56.2	75.3	92.7	93.6	96.8	100
2006	2.7	11.7	46.2	62.1	73.9	91.8	100	100
2007	7.8	20.8	41.8	68	77	87.5	95.9	100
2008	2.7	26.3	41.8	62.1	82.8	87	90.4	97.5
2009	1.7	30.1	47	57.6	84.7	89.1	100	96.8
2010	2.3	16.4	53.6	70.5	78.6	85.1	90.1	93.3
2011	2.3	16.5	43.7	72.7	81.9	86.1	89.5	92.3

Table 10.6.1 Haddock in division Va. Summary table from the SPALY run using the March survey for tuning.

year	Recruitment million at age 2	Biomass 3+ tons	SSB tons	Landings 1000 tons	Yield/SSB	F_{4-7}
1979	83747	167578	98406	59190	0.601	0.573
1980	36665	197955	119118	50902	0.427	0.384
1981	9758	214309	146537	63491	0.433	0.513
1982	42214	188330	143248	68533	0.478	0.453
1983	30201	154238	117733	64698	0.55	0.477
1984	19949	118839	88032	48121	0.547	0.503
1985	41798	106663	70380	50261	0.714	0.52
1986	89077	94221	57384	47272	0.824	0.787
1987	167335	103846	43116	40132	0.931	0.638
1988	47697	153934	67084	53871	0.803	0.654
1989	26693	170414	100484	62712	0.624	0.656
1990	22368	146847	112274	67038	0.597	0.577
1991	80259	121903	90147	54694	0.607	0.6
1992	170419	105951	67993	47026	0.692	0.695
1993	37566	129982	70863	48737	0.688	0.676
1994	41320	126354	81798	59007	0.721	0.669
1995	70923	121294	82588	60111	0.728	0.653
1996	35111	107765	69556	56716	0.815	0.709
1997	102257	86960	58342	44006	0.754	0.619
1998	18123	97724	64460	41374	0.642	0.654
1999	50366	90819	64065	45231	0.706	0.706
2000	118498	89534	62090	41870	0.674	0.668
2001	158193	114278	69108	39530	0.572	0.504
2002	191065	168719	98821	50294	0.509	0.453
2003	48900	221524	148022	60598	0.409	0.394
2004	151751	254912	182675	84405	0.462	0.481
2005	391077	260309	177910	96655	0.543	0.537
2006	74593	300188	142837	97366	0.682	0.59
2007	51719	294917	162004	109813	0.678	0.593
2008	50083	246628	155677	102003	0.655	0.54
20009	109931	191344	139976	84994	0.607	0.434
Mean 79-08	81991	158564	100425	60522	0.636	0.583

Table 10.6.2 Haddock in division Va. Number in stock from the SPALY run using both the surveys. Shaded cells are input to prediction

Year/age	1	2	3	4	5	6	7	8	9
1979	44.78	83.75	123.74	28.11	20.7	21.49	3.32	0.77	0.1
1980	11.92	36.67	68.42	99.44	19.33	11.01	8.76	1.01	0.21
1981	51.56	9.76	29.48	54.77	71.03	11.94	5.58	3.8	0.34
1982	36.89	42.21	7.98	23.67	40.38	42.81	4.32	2	1.47
1983	24.37	30.2	34.52	6.27	16.94	23.37	22.28	1.47	0.58
1984	51.05	19.95	24.72	27.62	3.78	9.66	9.82	10.27	0.41
1985	108.8	41.8	16.28	19.55	18.12	2.03	3.5	4.62	4.39
1986	204.38	89.08	33.83	11.72	11.5	9.35	0.91	1.45	1.55
1987	58.26	167.34	72.75	24.37	6.14	4.95	2.44	0.3	0.42
1988	32.6	47.7	134.98	52.72	13.17	2.59	2.02	0.92	0.11
1989	27.32	26.69	38.93	101.4	28.76	5.71	0.98	0.74	0.23
1990	98.03	22.37	21.78	29.52	62.14	14.76	1.86	0.31	0.15
1991	208.15	80.26	17.91	15.48	16.93	29.34	6.07	0.75	0.1
1992	45.88	170.42	63.48	13.5	9.11	7.79	11.67	2.29	0.25
1993	50.47	37.57	137.06	45.33	7.27	3.69	2.77	4.18	0.69
1994	86.63	41.32	30.56	101.7	25.68	3.09	1.41	0.91	1.38
1995	42.88	70.92	33.58	22.28	58.82	11.32	1.13	0.47	0.38
1996	124.9	35.11	55.93	21.77	13.11	27.02	4.2	0.37	0.15
1997	22.14	102.26	27.42	37.67	11.42	6.44	9.49	1.22	0.1
1998	61.52	18.12	82.48	19.11	20.77	4.93	2.97	3.26	0.37
1999	144.73	50.37	14.65	60.19	10.23	9.41	1.84	1.07	0.97
2000	193.22	118.5	40.26	10.68	33.99	3.99	3.2	0.66	0.35
2001	233.37	158.19	94.89	27.09	6.63	15.33	1.41	1	0.21
2002	59.73	191.06	127.52	67.47	15.73	4.07	6.93	0.53	0.38
2003	185.35	48.9	155.51	94.81	40.59	8.24	2.32	2.84	0.21
2004	477.66	151.75	39.78	121.53	62.82	21.74	4.15	1.2	1.14
2005	91.11	391.08	123.02	28.81	83.27	33.88	9.84	1.63	0.5
2006	63.17	74.59	318.76	92.05	17.1	44.65	14.97	3.67	0.58
2007	61.17	51.72	60.93	251.99	56.45	7.95	19.17	5.2	0.97
2008	134.27	50.08	41.67	46.51	168.63	25.41	3.39	6.24	1.63
2009	21.93	109.93	38.97	30.1	29.29	90.23	10.86	1.22	2.36
2010	71.02	17.96	89.39	28.72	19.24	16.72	45.19	4.71	0.46
2011	71.02	58.14	14.62	69.93	19.05	11.4	9.23	23.09	2.21
2012	71.02	58.14	47.36	11.44	48.93	11.13	6.1	4.68	11.04
2013	71.02	58.14	47.36	37.04	8	29.9	5.86	3	2.21

Table 10.6.3 Haddock in division Va. Fishing mortality from the SPALY run using the March survey.

Year/age	2	3	4	5	6	7	8	9
1979	0.002	0.019	0.175	0.431	0.698	0.989	1.127	1.013
1980	0.018	0.023	0.136	0.282	0.48	0.636	0.902	0.661
1981	0.001	0.02	0.105	0.306	0.815	0.824	0.749	0.793
1982	0.001	0.04	0.135	0.347	0.453	0.879	1.032	0.925
1983	0	0.023	0.306	0.361	0.668	0.574	1.07	0.599
1984	0.003	0.034	0.222	0.421	0.815	0.553	0.651	0.602
1985	0.011	0.128	0.331	0.461	0.607	0.68	0.895	0.797
1986	0.002	0.128	0.447	0.642	1.142	0.919	1.046	0.995
1987	0.015	0.122	0.416	0.664	0.697	0.776	0.829	0.782
1988	0.003	0.086	0.406	0.635	0.772	0.803	1.18	0.906
1989	0.003	0.077	0.29	0.467	0.924	0.944	1.409	1.119
1990	0.022	0.142	0.356	0.551	0.689	0.713	0.897	0.737
1991	0.034	0.082	0.331	0.576	0.722	0.773	0.892	0.786
1992	0.018	0.137	0.419	0.702	0.834	0.826	1.004	0.853
1993	0.006	0.098	0.368	0.656	0.764	0.916	0.911	0.913
1994	0.008	0.116	0.348	0.619	0.809	0.9	0.678	0.807
1995	0.037	0.234	0.33	0.578	0.792	0.913	0.968	0.929
1996	0.047	0.195	0.445	0.512	0.847	1.033	1.143	1.042
1997	0.015	0.161	0.395	0.64	0.573	0.868	0.982	0.88
1998	0.013	0.115	0.425	0.591	0.783	0.818	1.018	0.917
1999	0.024	0.116	0.371	0.741	0.879	0.831	0.93	0.866
2000	0.022	0.196	0.277	0.596	0.839	0.962	0.945	0.959
2001	0.016	0.141	0.343	0.287	0.594	0.789	0.764	0.779
2002	0.006	0.096	0.308	0.447	0.365	0.691	0.724	0.693
2003	0.006	0.047	0.212	0.424	0.485	0.455	0.715	0.59
2004	0.01	0.123	0.178	0.418	0.593	0.736	0.683	0.724
2005	0.004	0.09	0.322	0.423	0.617	0.785	0.839	0.792
2006	0.002	0.035	0.289	0.566	0.646	0.858	1.136	0.907
2007	0.016	0.07	0.202	0.598	0.652	0.922	0.961	0.93
2008	0.051	0.125	0.262	0.425	0.65	0.822	0.772	0.79
2009	0.007	0.105	0.248	0.36	0.491	0.635	0.778	0.804
2010	0.005	0.045	0.211	0.323	0.395	0.471	0.556	0.617
2011	0.005	0.045	0.157	0.337	0.426	0.48	0.538	0.604
2012	0.005	0.046	0.158	0.293	0.441	0.508	0.55	0.596
2013	0.005	0.046	0.158	0.293	0.441	0.508	0.55	0.596

Table 10.7.1. Output from short term prediction.

$F_{4\text{-}7}$ 2008 = 0.54

2009				
Bio 3+	SSB	Fmult	F4-7	Landings
191	140	0.803	0.434	85

		2010			***2011***	
Fmult	***F4-7***	***Bio 3+***	***SSB***	***Landings***	***Bio 3+***	***SSB***
0.1	***0.054***	***165***	***109***	***10***	***185***	***132***
0.2	***0.108***	***165***	***109***	***20***	***177***	***126***
0.3	***0.162***	***165***	***109***	***29***	***170***	***119***
0.4	***0.216***	***165***	***109***	***37***	***163***	***113***
0.5	***0.27***	***165***	***109***	***46***	***156***	***108***
0.6	***0.324***	***165***	***109***	***53***	***150***	***103***
0.7	***0.378***	***165***	***109***	***60***	***144***	***98***
0.8	***0.432***	***165***	***109***	***67***	***139***	***93***
0.9	***0.486***	***165***	***109***	***73***	***134***	***89***
1	***0.54***	***165***	***109***	***79***	***129***	***85***
1.1	***0.594***	***165***	***109***	***85***	***124***	***81***
1.2	***0.648***	***165***	***109***	***90***	***120***	***78***
1.3	***0.702***	***165***	***109***	***96***	***116***	***74***
1.4	***0.756***	***165***	***109***	***100***	***112***	***71***
1.5	***0.81***	***165***	***109***	***105***	***108***	***68***
1.6	***0.864***	***165***	***109***	***109***	***105***	***65***
1.7	***0.918***	***165***	***109***	***113***	***102***	***63***
1.8	***0.972***	***165***	***109***	***117***	***99***	***60***
1.9	***1.026***	***165***	***109***	***121***	***96***	***58***
2	***1.08***	***165***	***109***	***124***	***93***	***56***

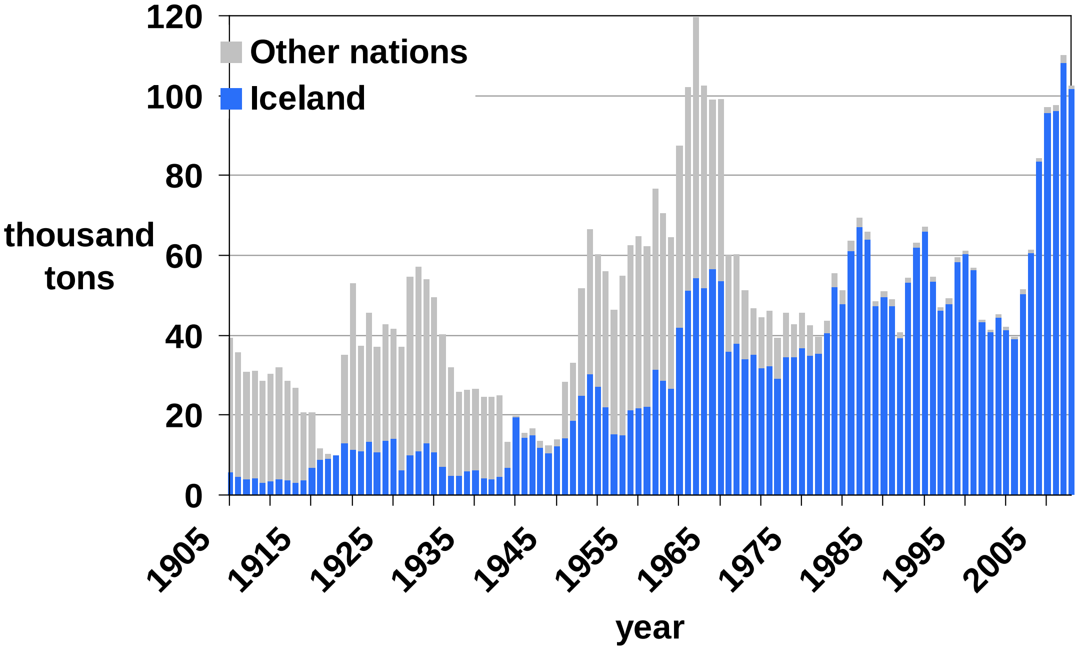


Figure 10.2.1 Haddock in division Va. Landings 1905 – 2005.

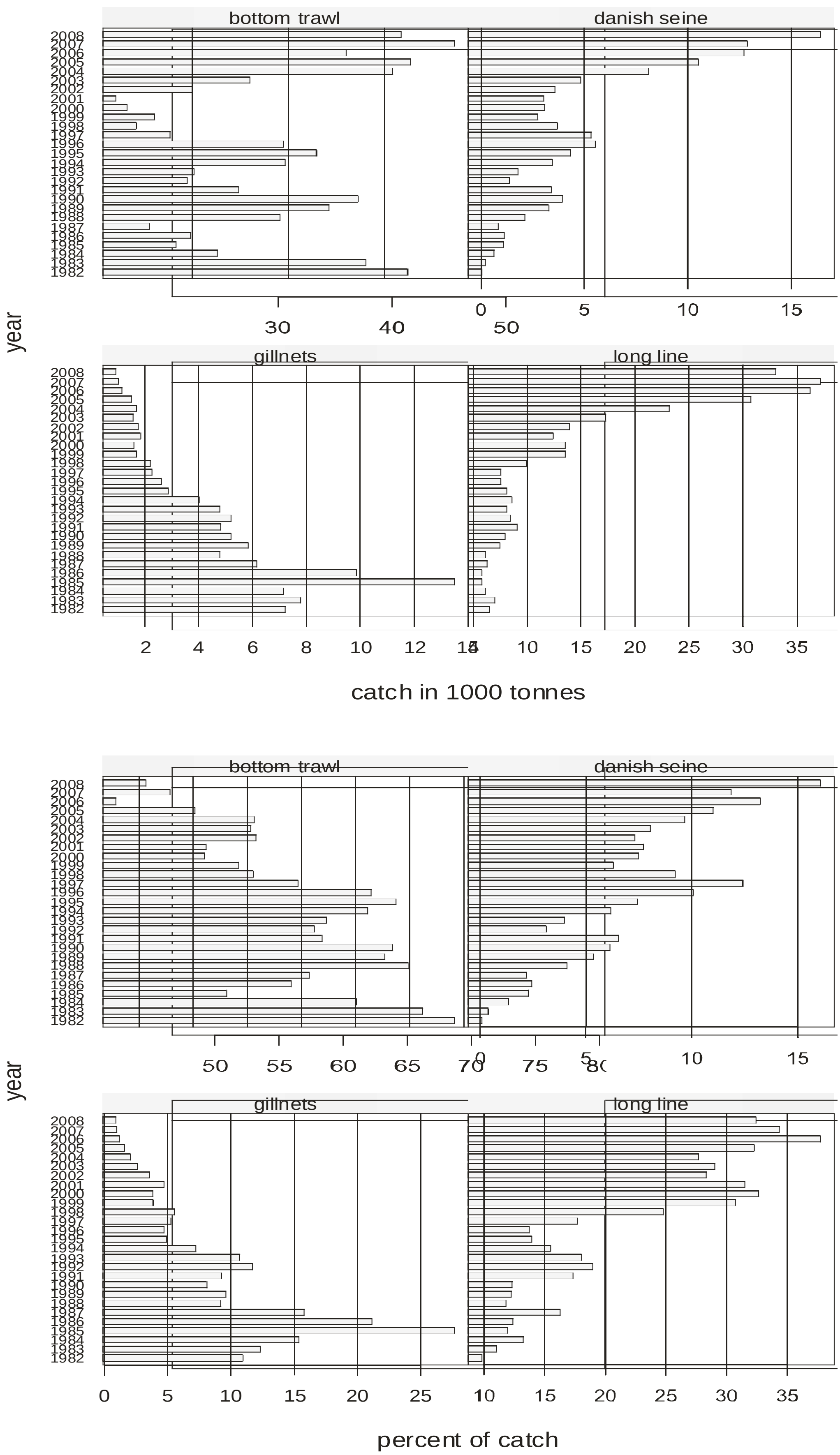


Figure 10.2.2 Haddock Division VA. Landings in tons and percent of total by gear and year.

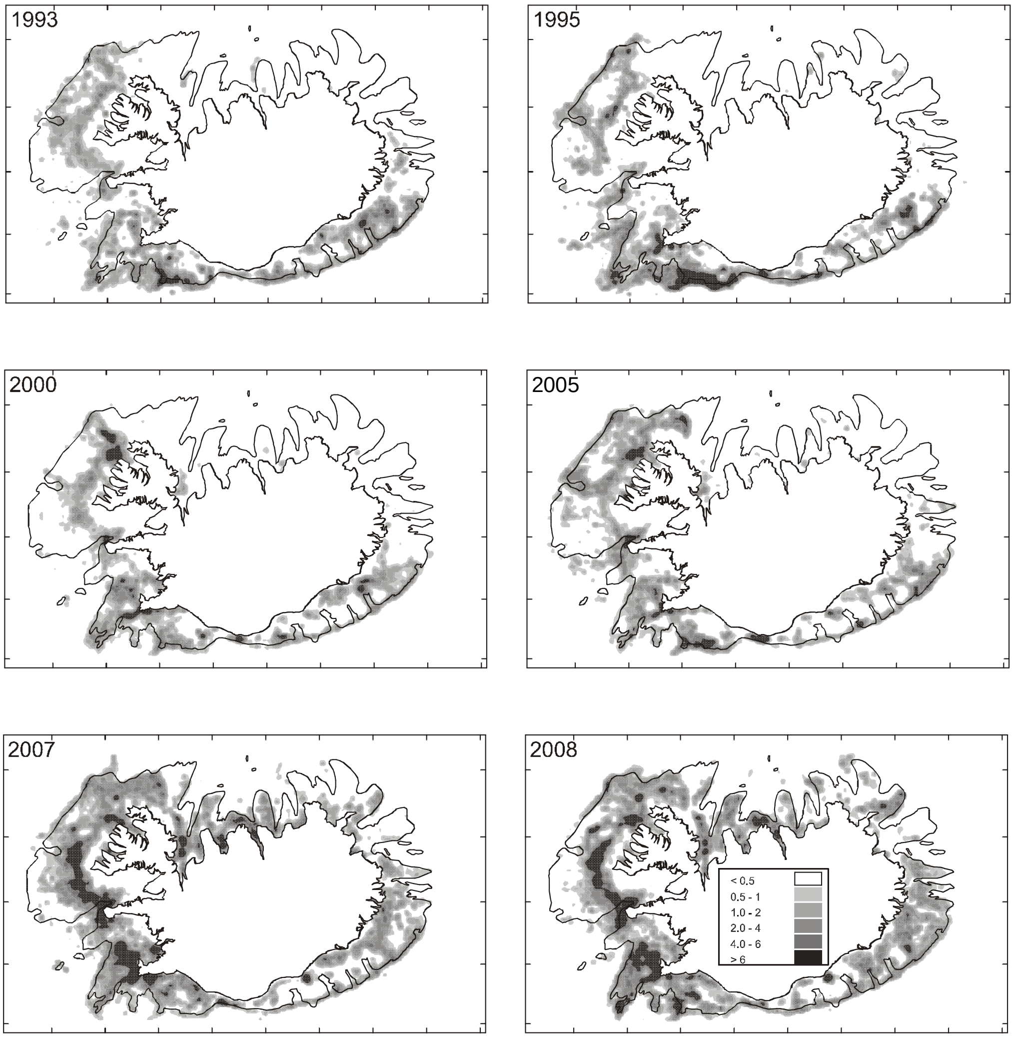


Figure 10.2.3 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile.

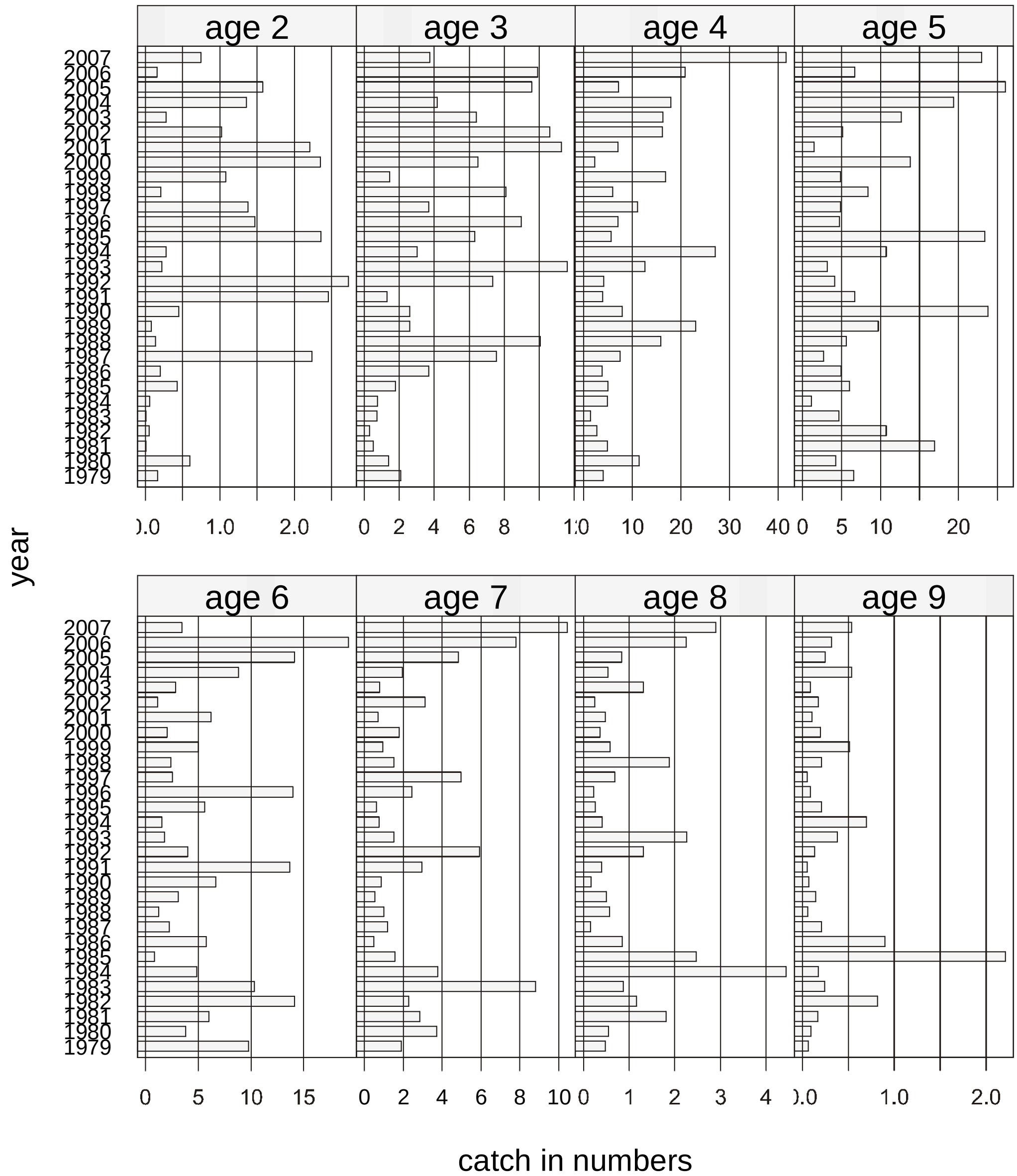


Figure 10.2.4 Haddock in division Va. Age disaggregated catch in numbers.

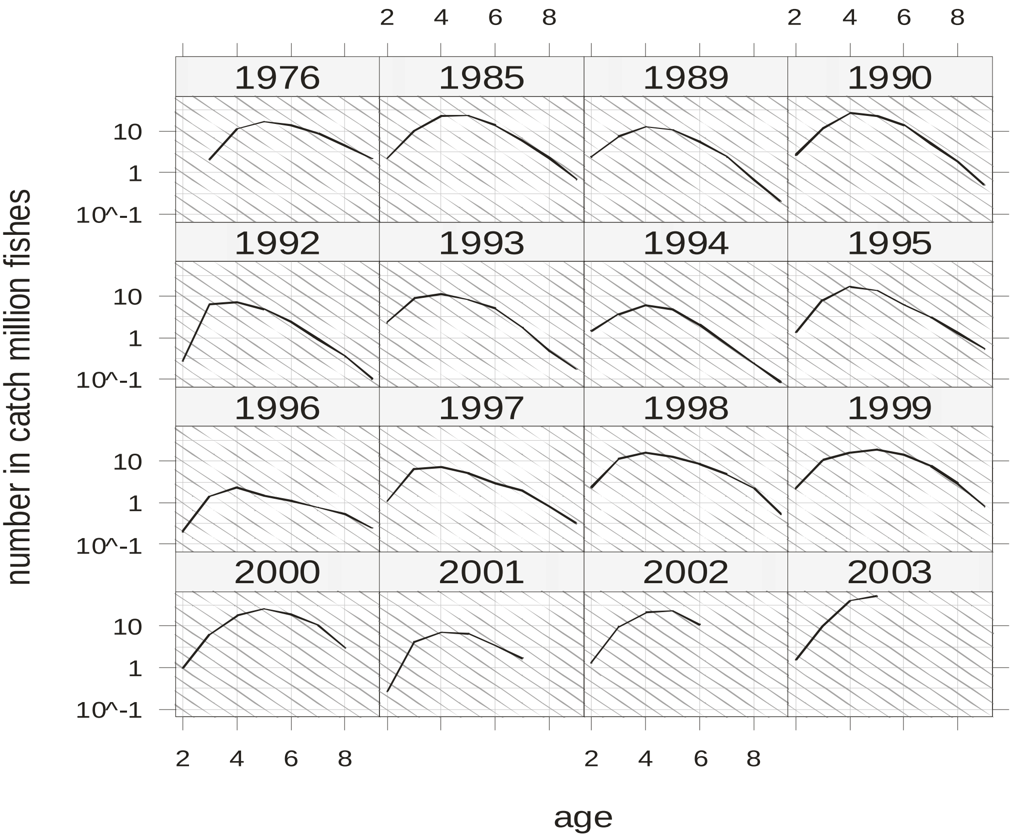


Figure 10.2.5. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

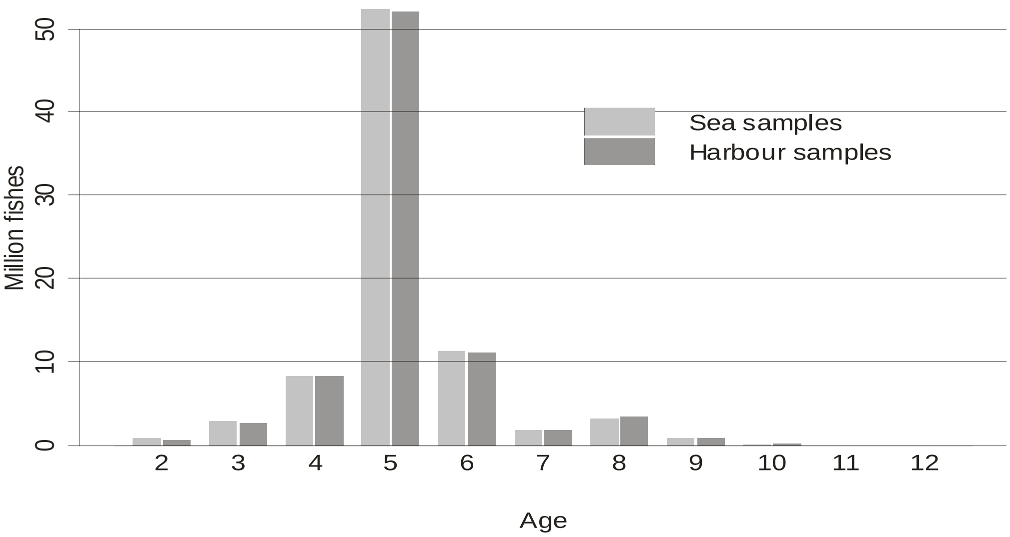


Figure 10.2.6 Comparison of catch in numers in 2008 based on port samples and shore samples.

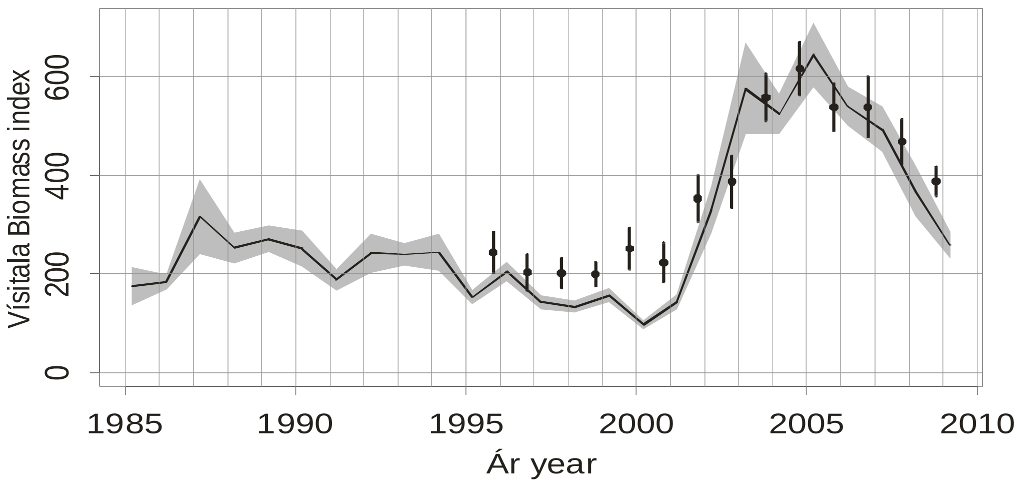


Figure 10.2.7 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

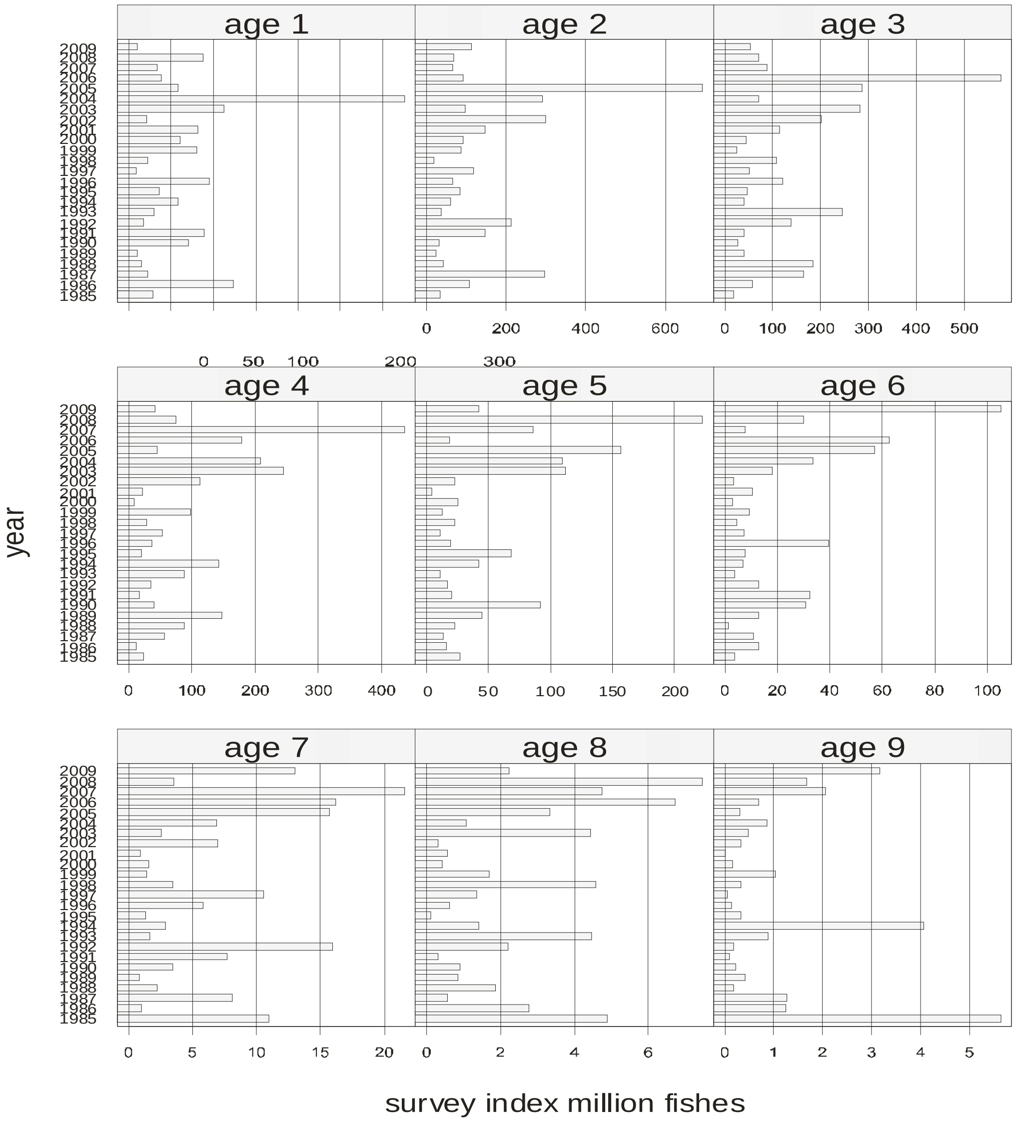


Figure 10.2.8. Age disaggregated indices from the groundfish survey in March.

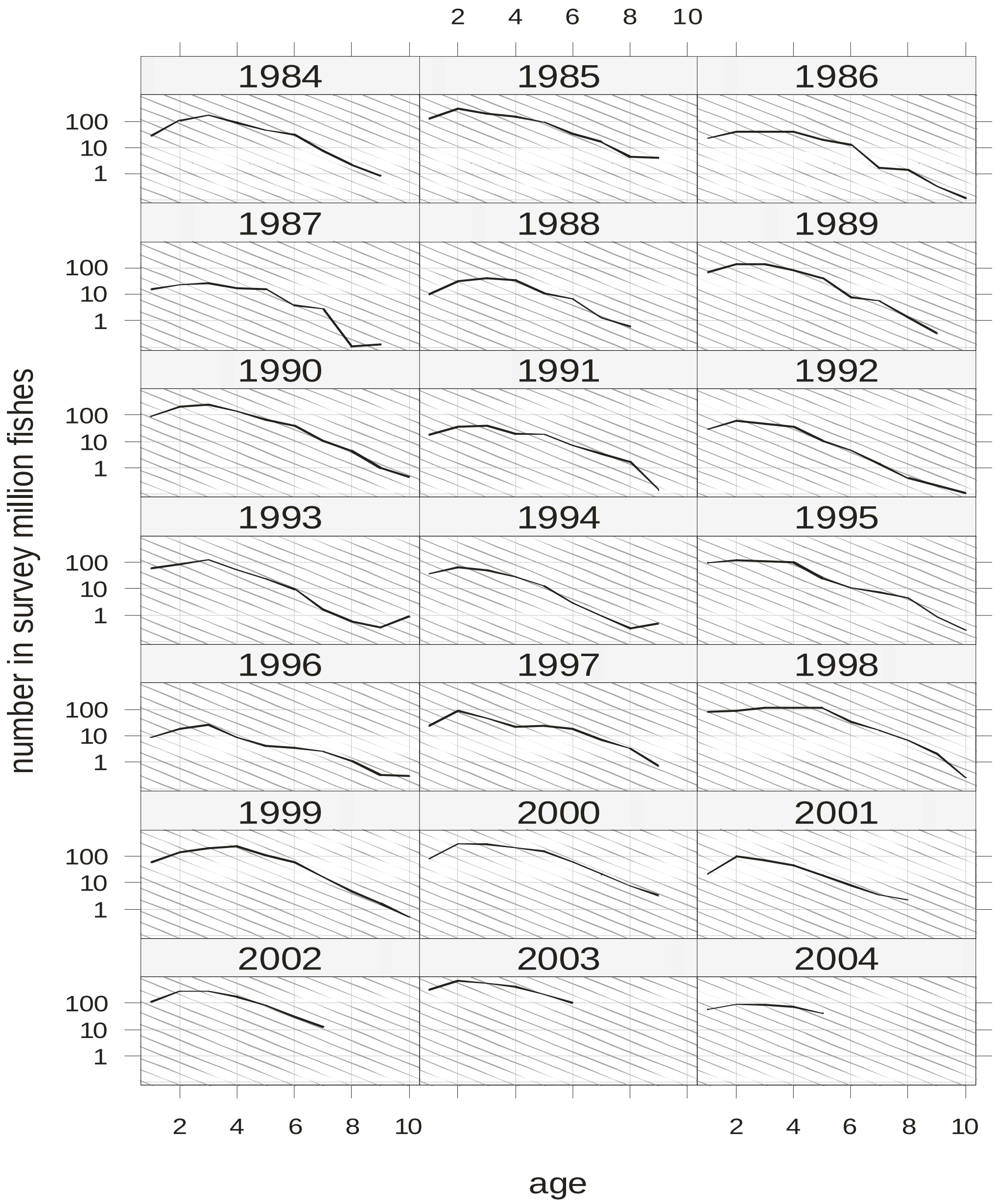


Figure 10.2.9. Age disaggregated indices from the groundfish survey in March plotted on logscale . Grey lines show Z=1.

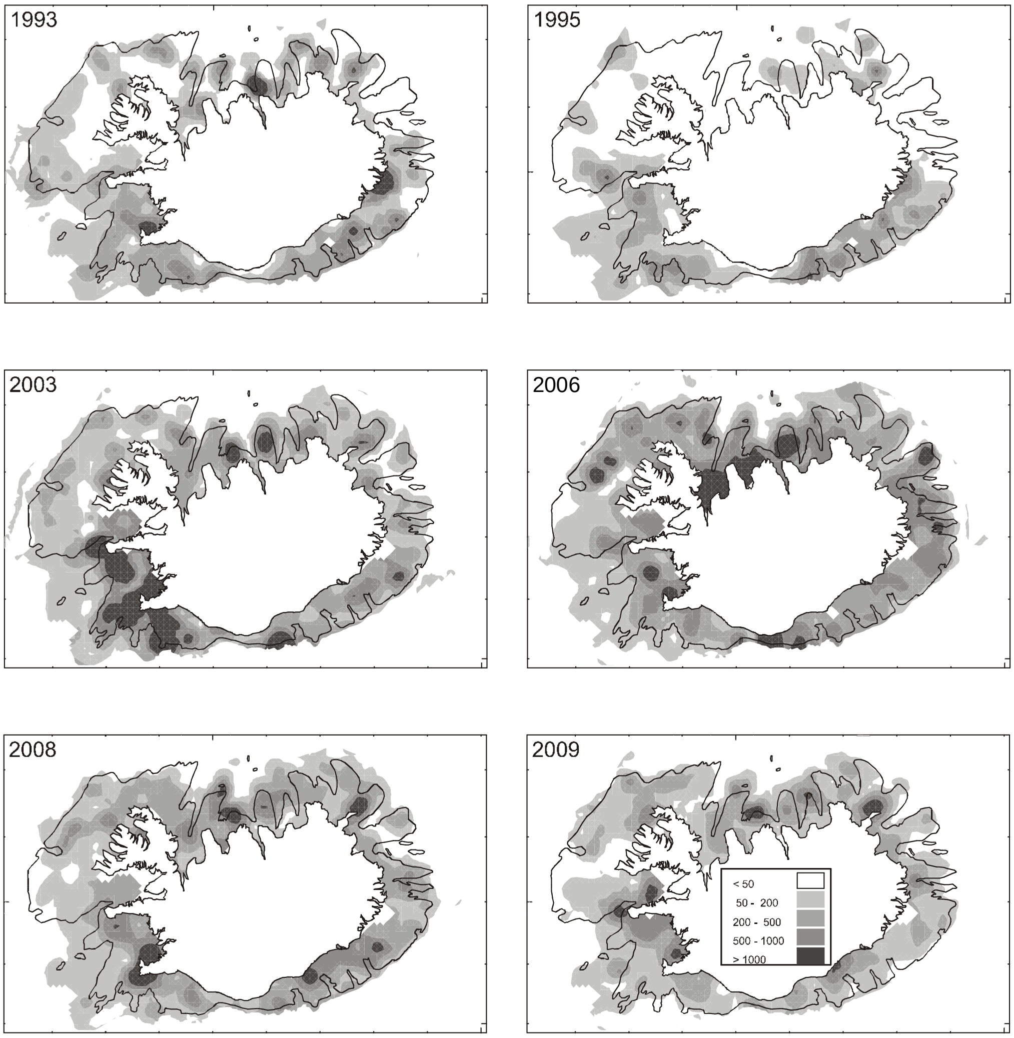


Figure 10.2.10. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.

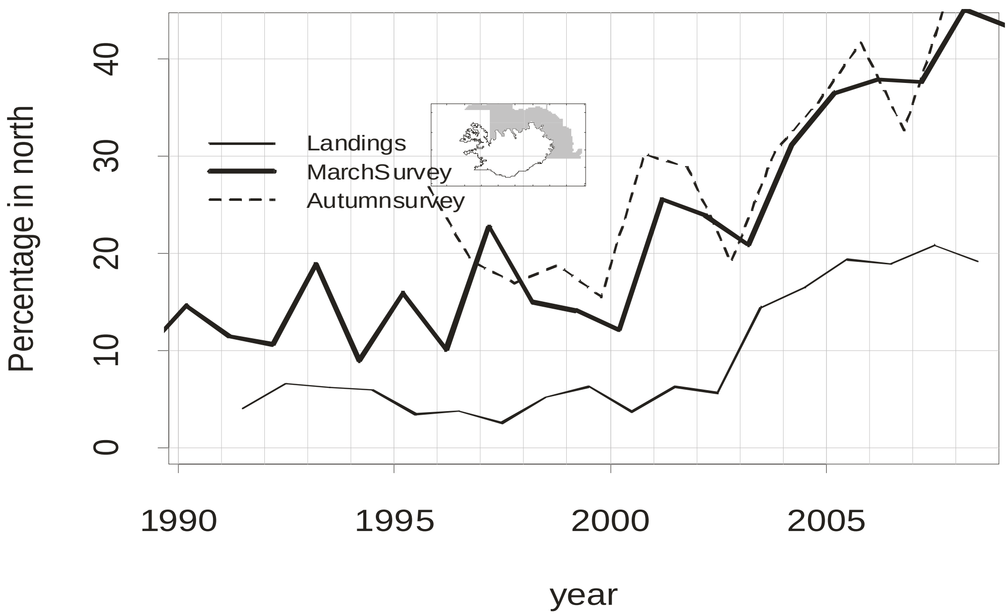


Figure 10.2.11. Proportion of the landings and the biomass of 42cm and older haddock that is in the north area. The small figure shows the northern area

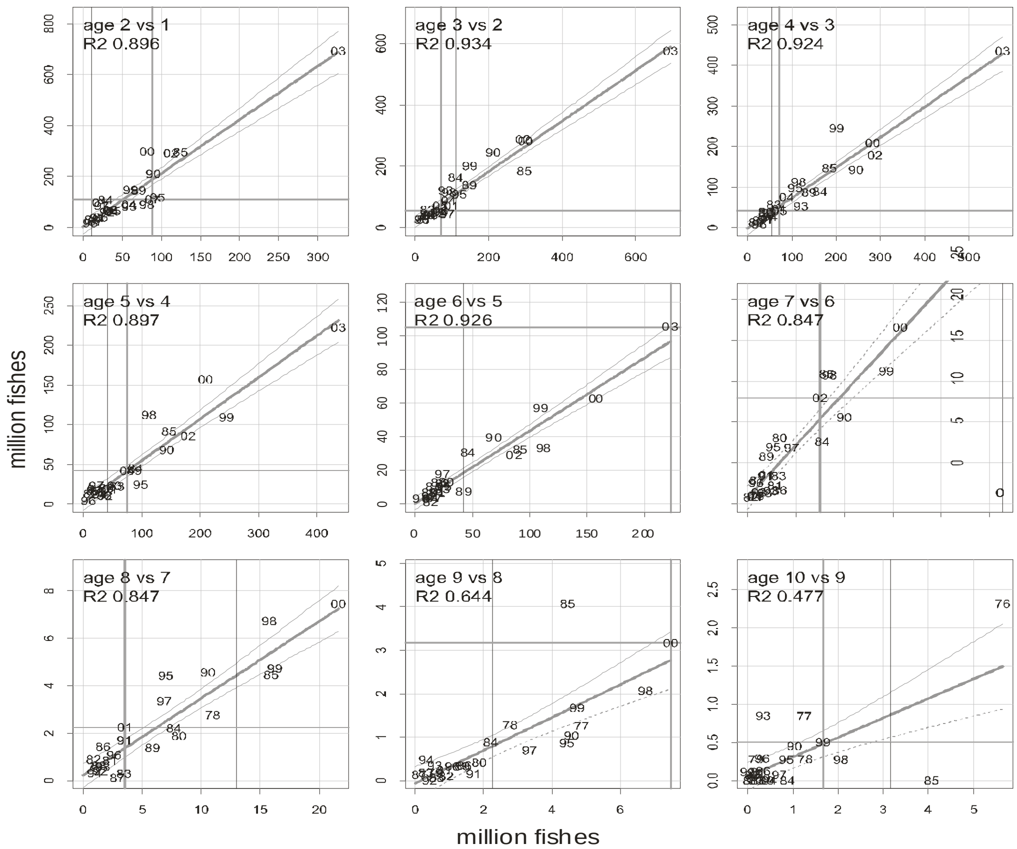


Figure 10.2.12. Haddock in division Va. Indices from March survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.

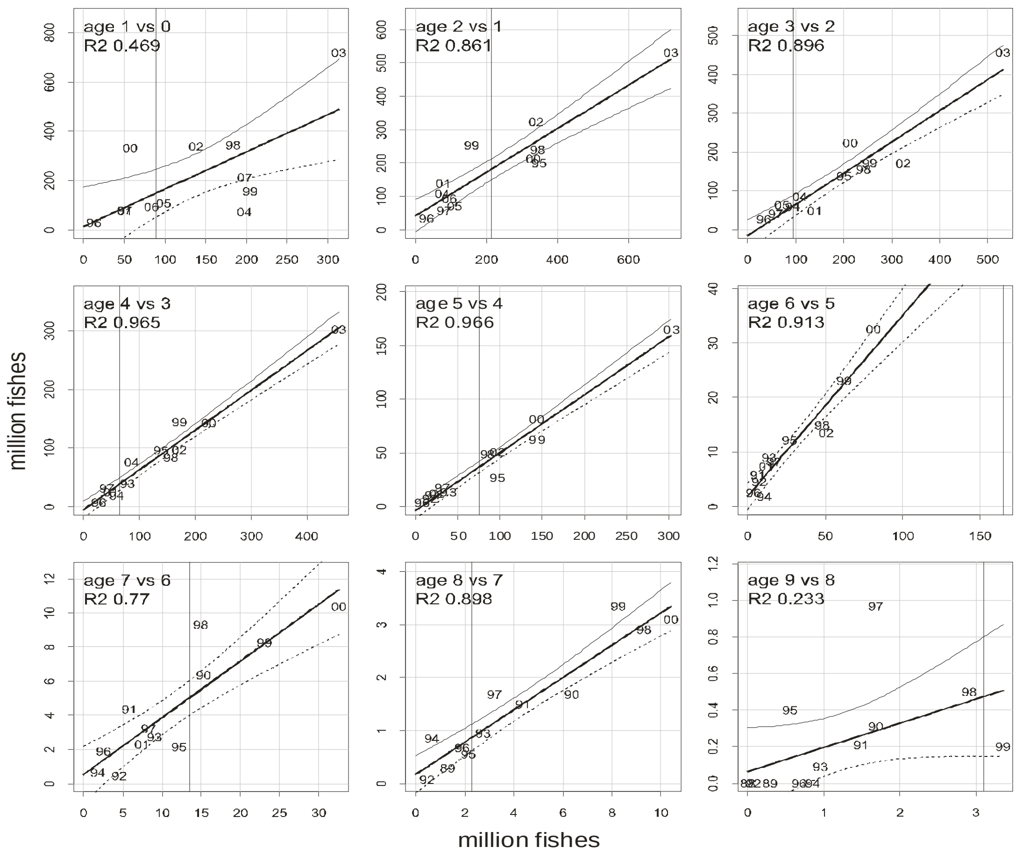


Figure 10.2.13. Indices from October survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values and the intersection of the gray lines the most recent pair.

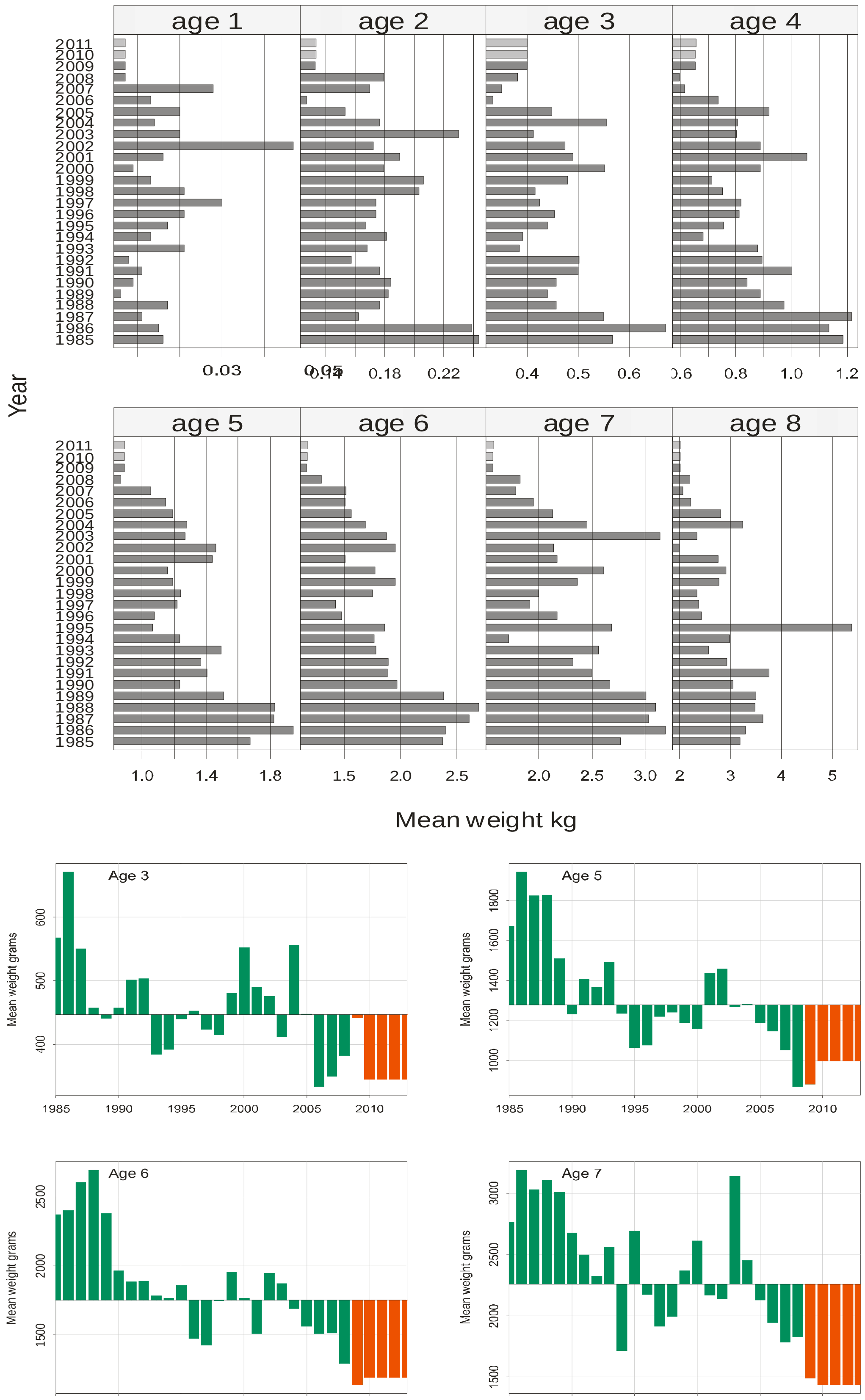


Figure 10.2.15 Haddock in division Va. Mean weight at age in the survey. Predictions are shown as light grey. The values shown are used as weight at age in the stock and spawning stock.

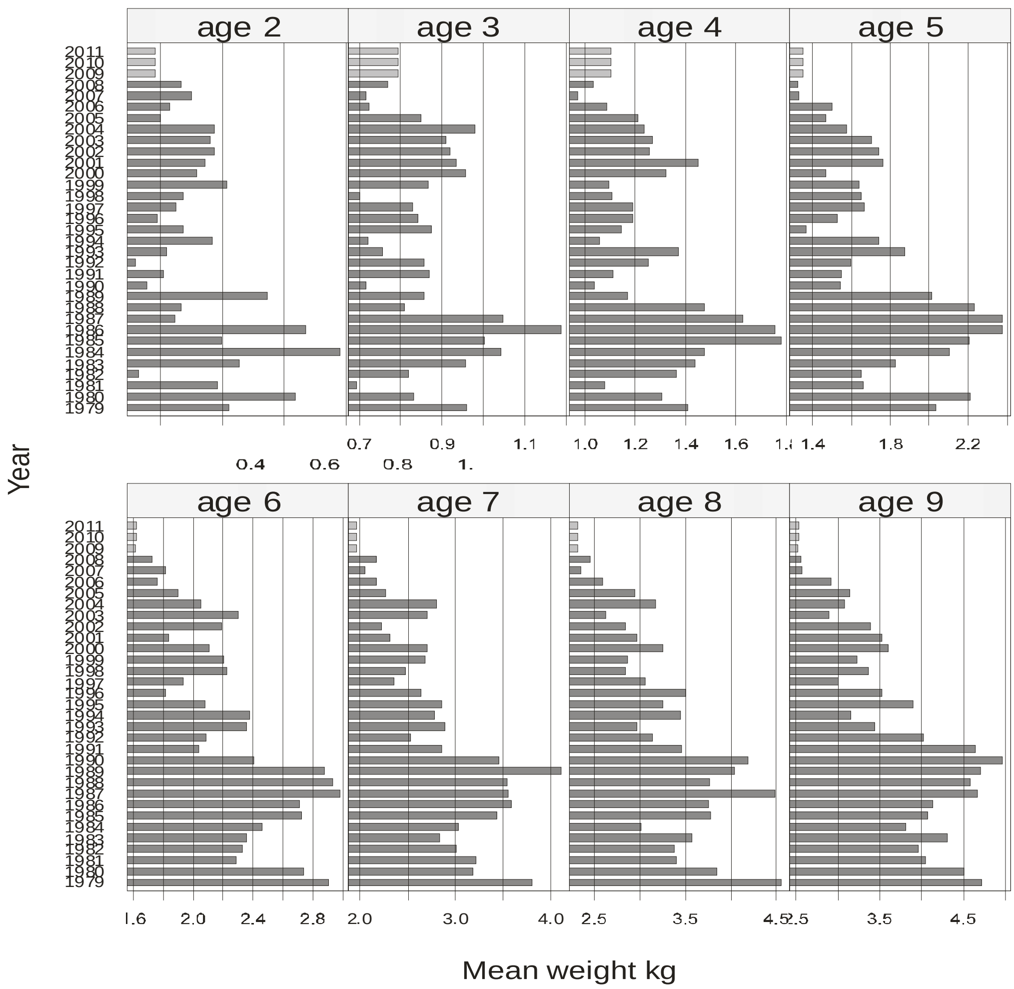


Figure 10.2.16 Haddock in division Va. Mean weight at age in the catches. Perdictions are shown as light grey.

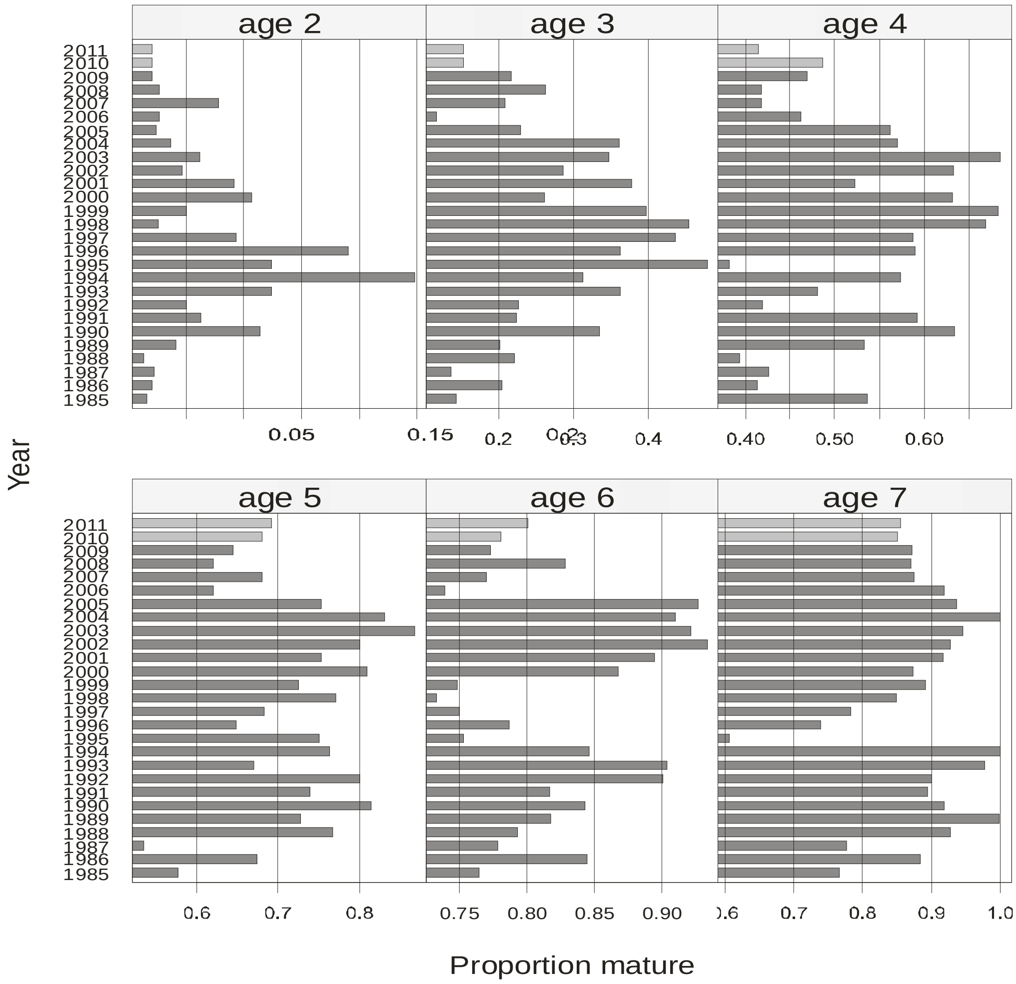


Figure 10.2.17 Haddock in division Va. Maturity at age in the survey. The light grey bars indicate prediction. The values are used to calculate the spawning stock.

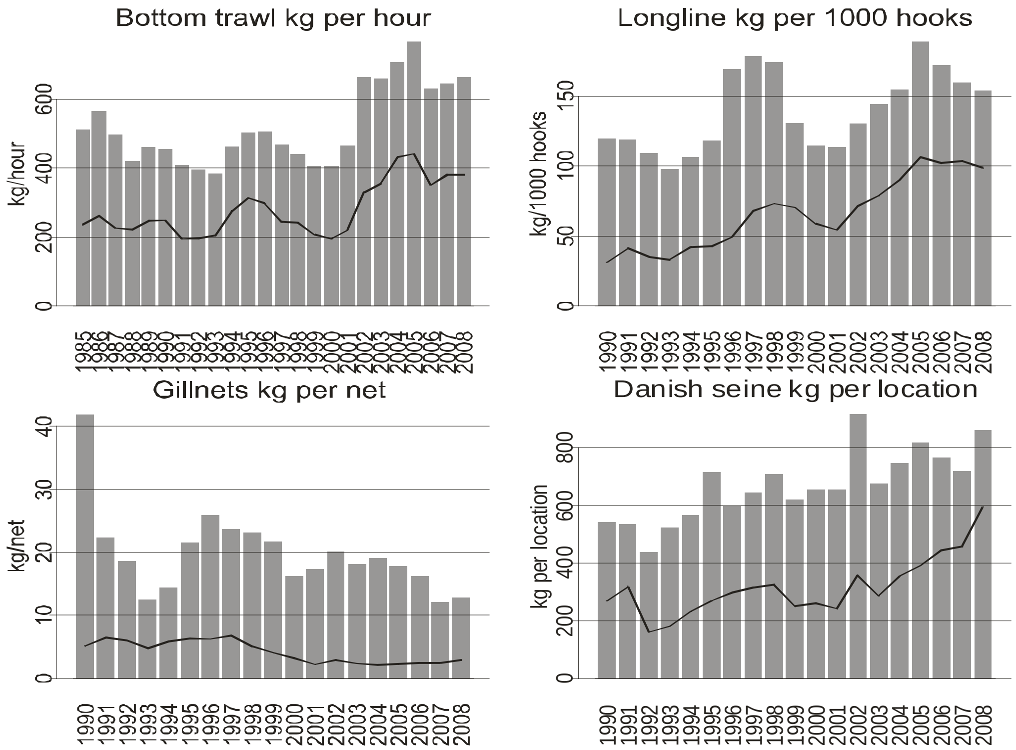


Figure 10.3.1. Catch per unit effort in the most important gear types. The bars are based on locations where more than 50% of the catch is haddock and the lines on all records where haddock is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

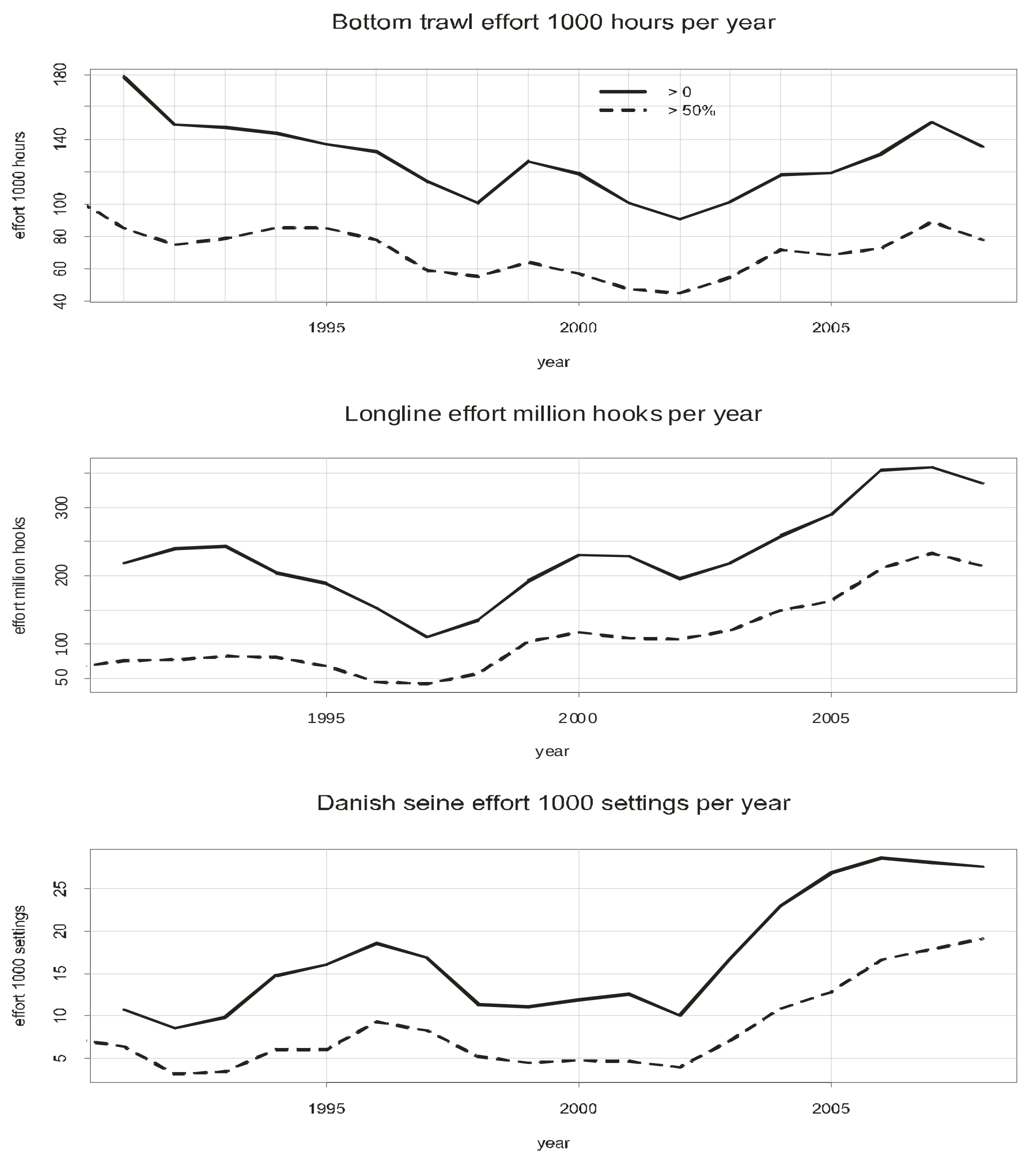


Figure 10.3.2. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch

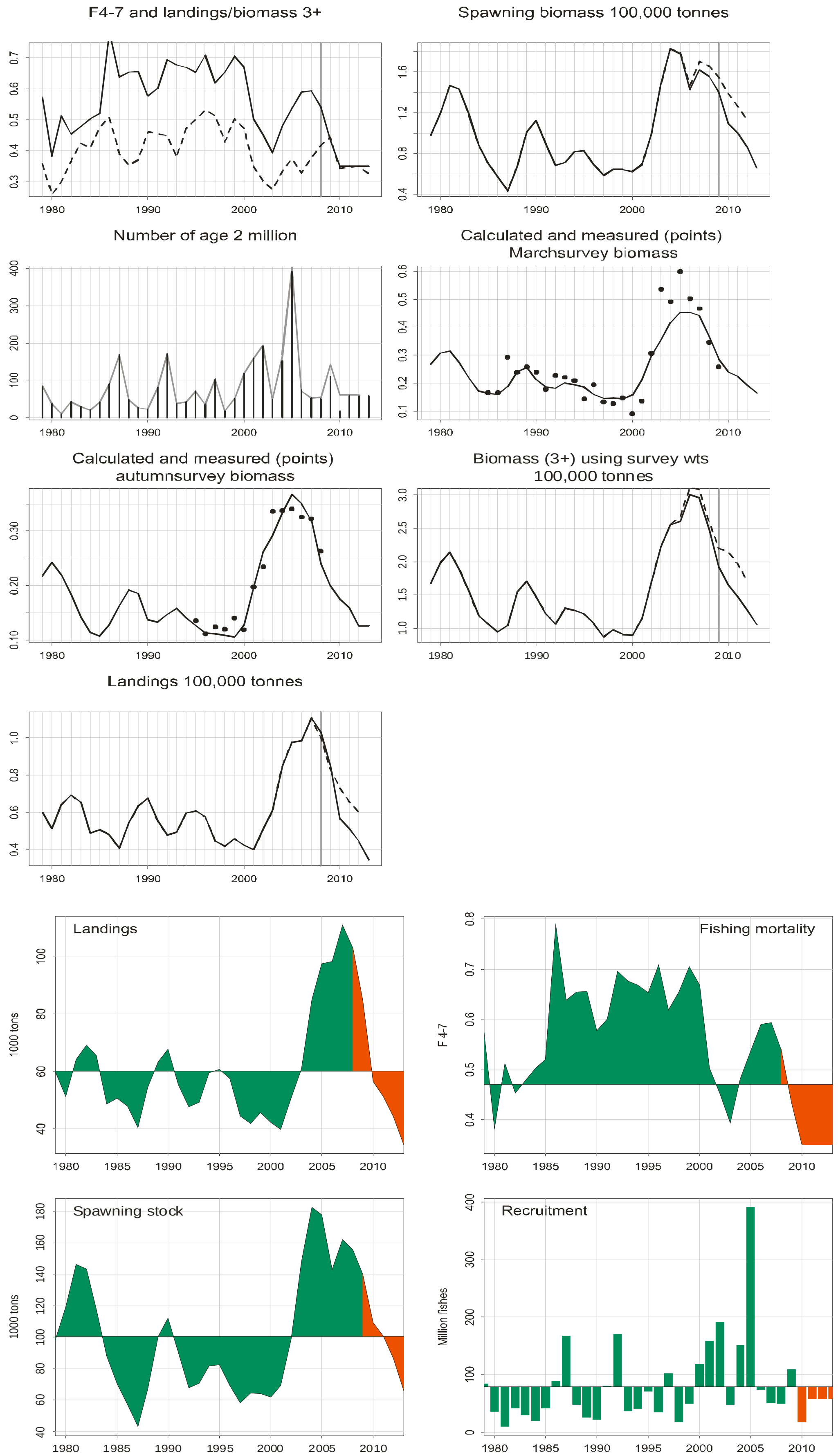


Figure 10.6.1. Haddock in division Va. Summary plots from the SPALY run using the March survey. The dashed lines in the figure of SSB and Biomass(3+) show last years results.

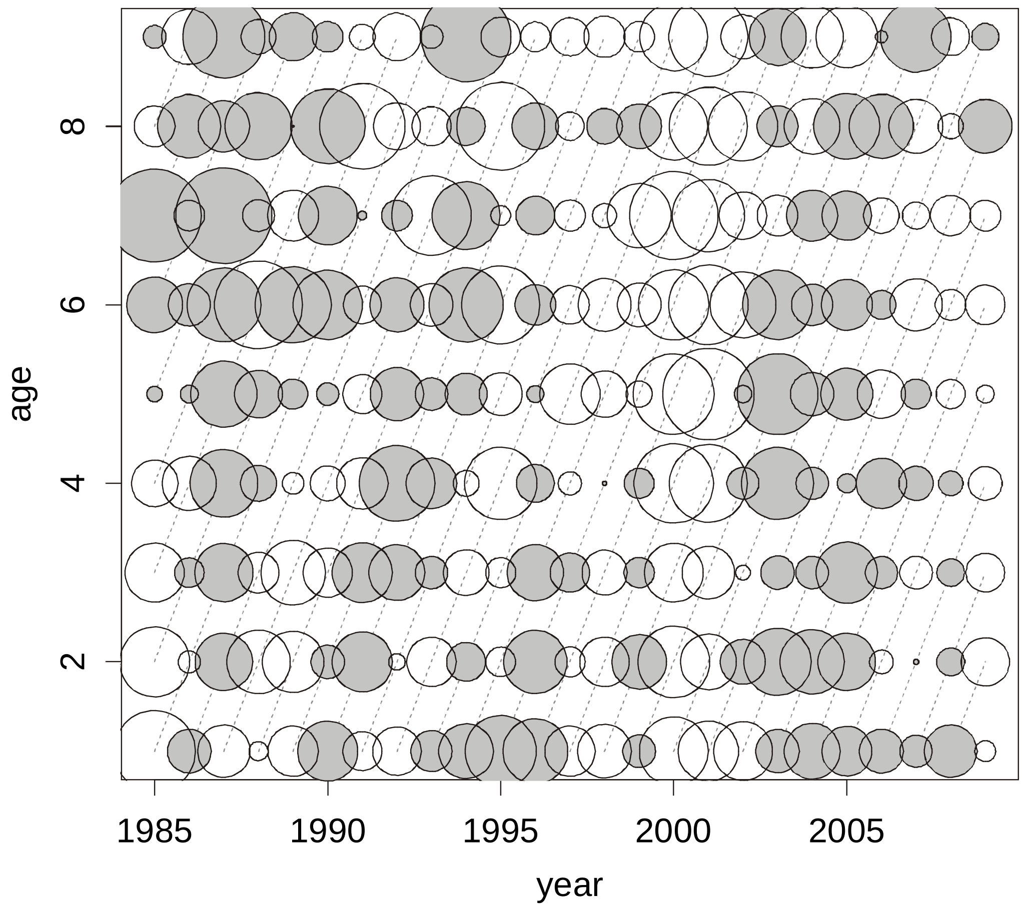


Figure 10.6.2. Haddock in division Va. Residuals from the fit to March survey data . from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.87. Residuals are proportional to the area of the circles.

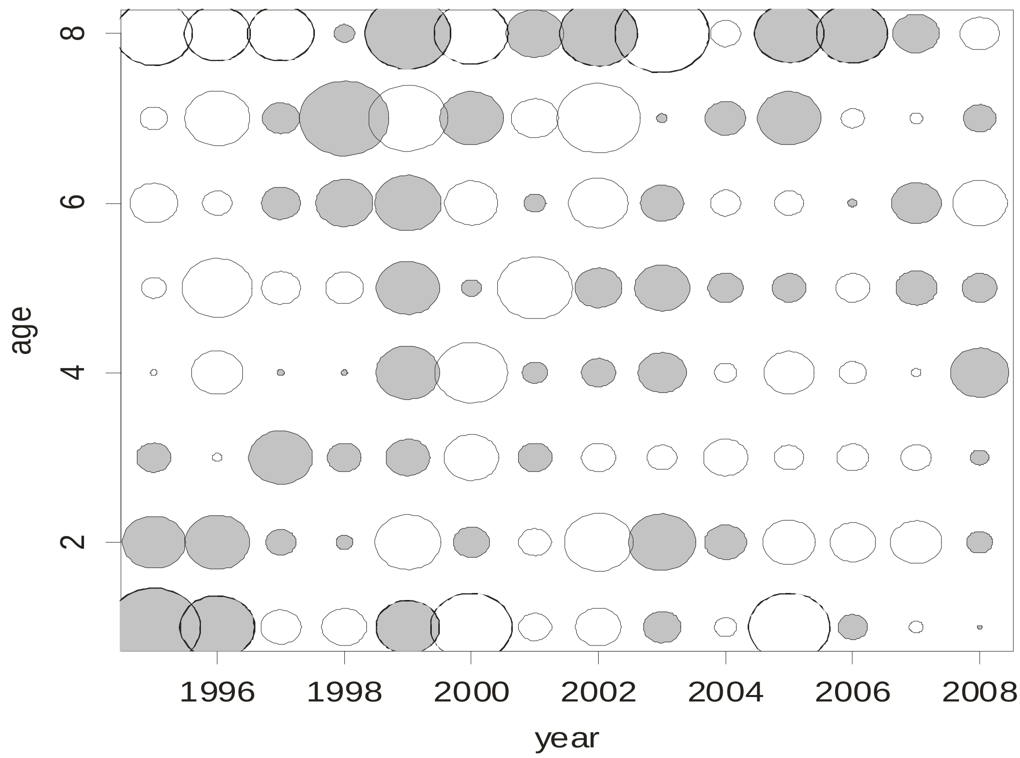


Figure 10.6.3. Haddock in division Va. Residuals from the fit to October survey data from Adapt run based on the both the surveys. Coloured circles indicate positive residuals (observed > modelled). The largest circle for corresponds to a value of 0.89. residuals are proportional to the area of the circles.

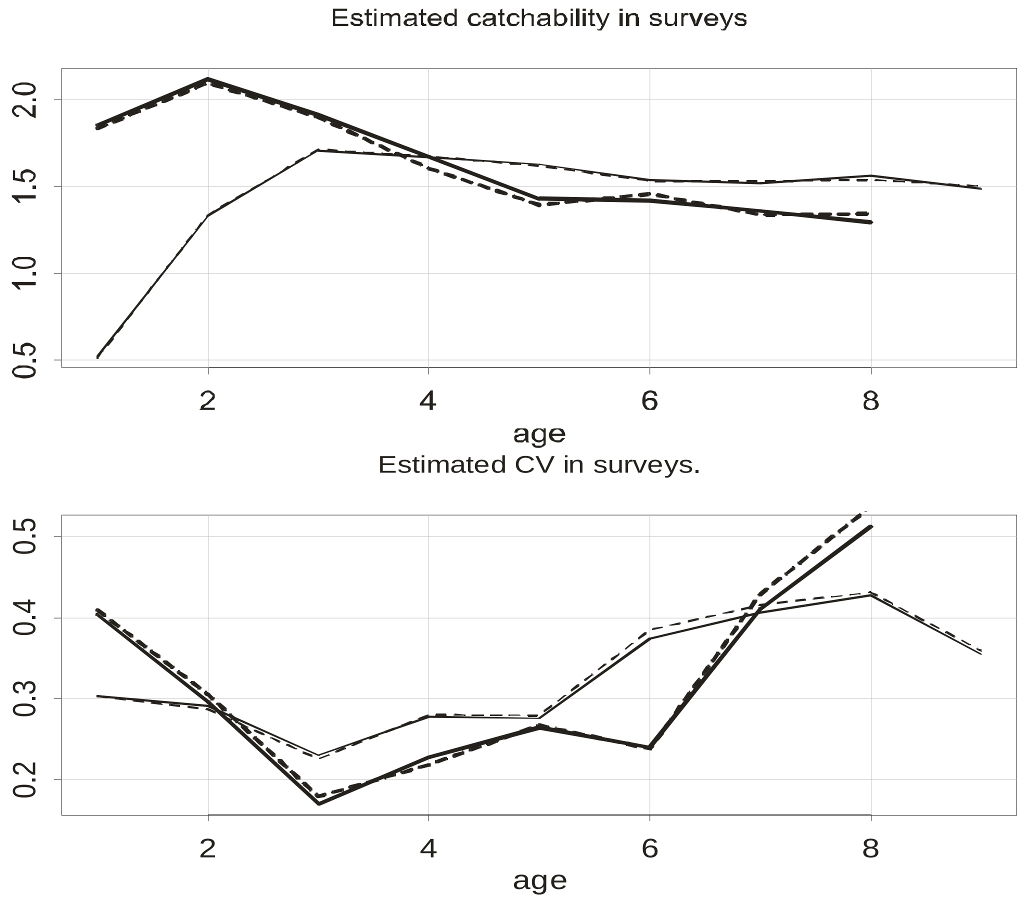


Figure 10.6.4. Haddock in division Va . Results from the spaly run. Catchability and CV from the autumn survey (wide lines) and March survey (thinner lines) . Last years estimates shown dashed.

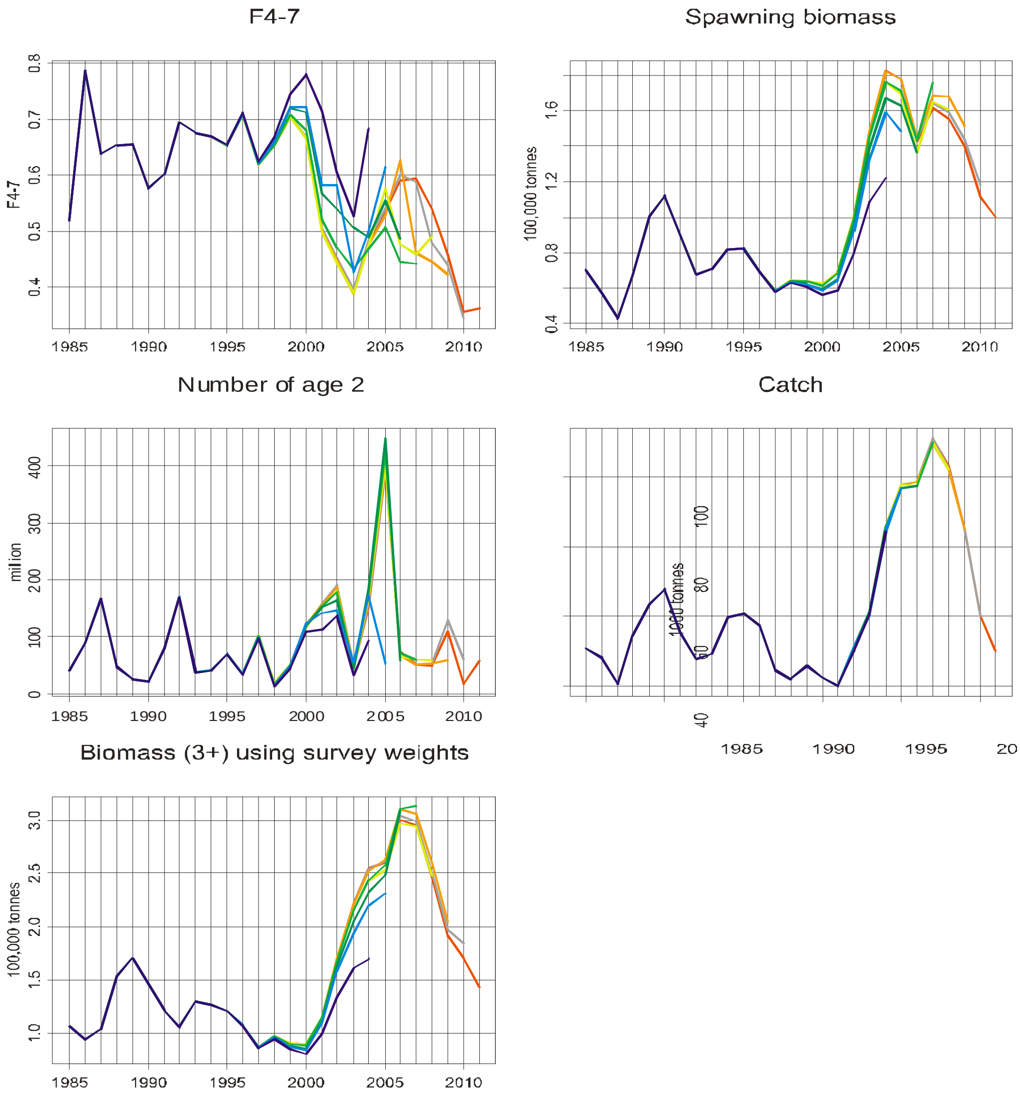


Figure 10.6.5. Haddock in division Va . Retrospective pattern from the SPALY run.

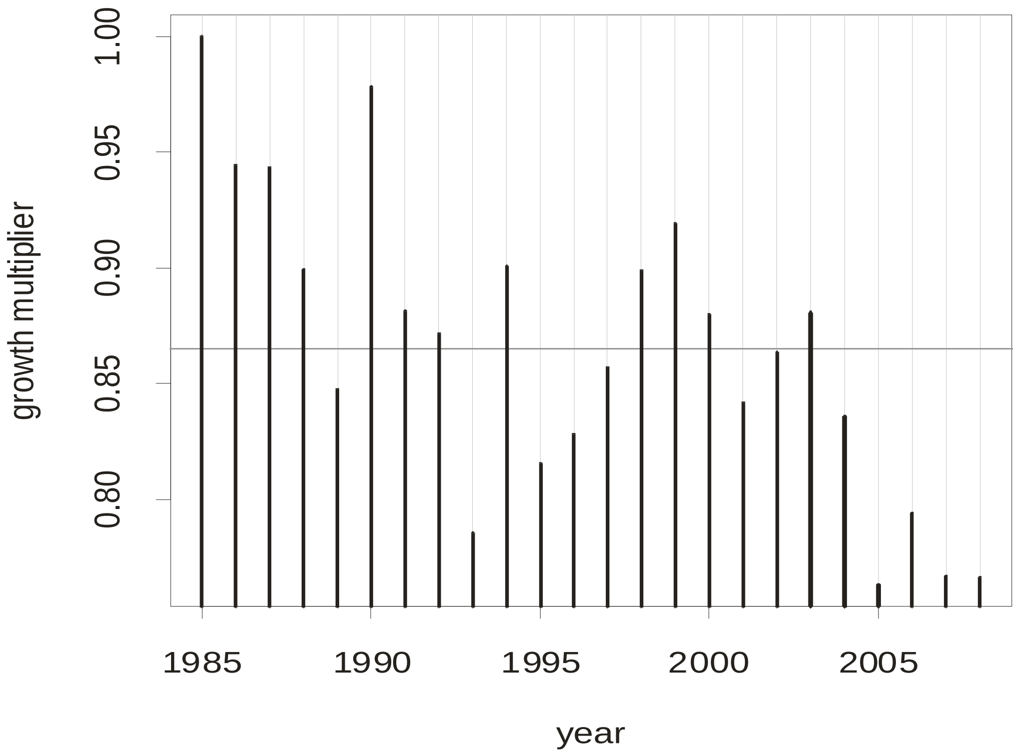


Figure 10.7.1. Haddock in division Va. Exponential of the yearfactor (growth multiplier) in the equation $\log \frac{W_{a+1,t+1}}{W_{a,t}} = \alpha + \beta \log W_{a,t} + \delta_{year}$

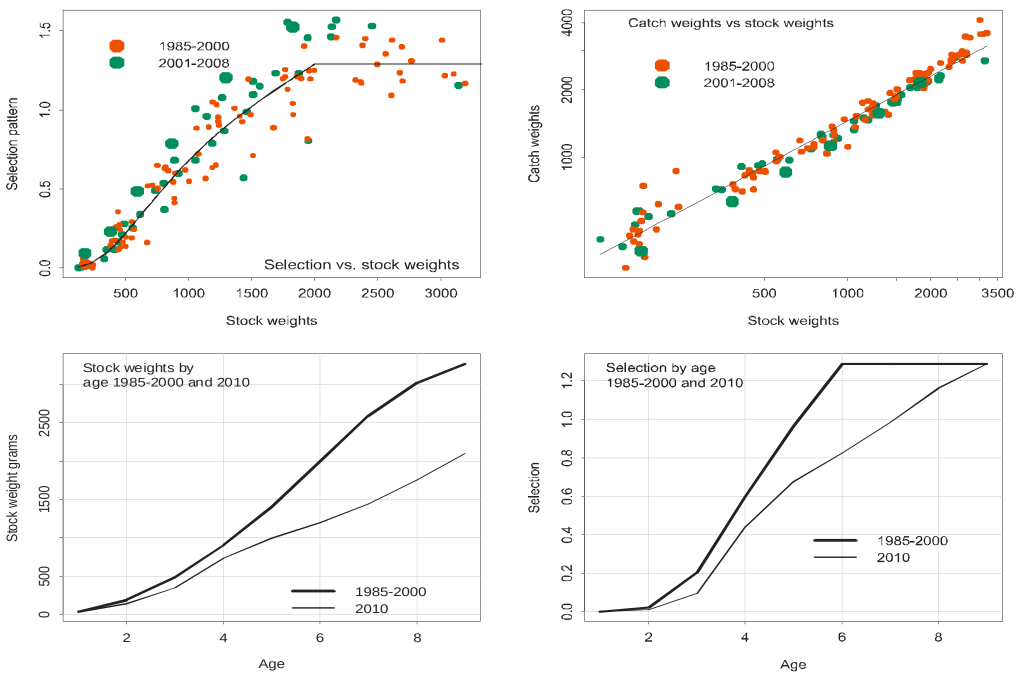
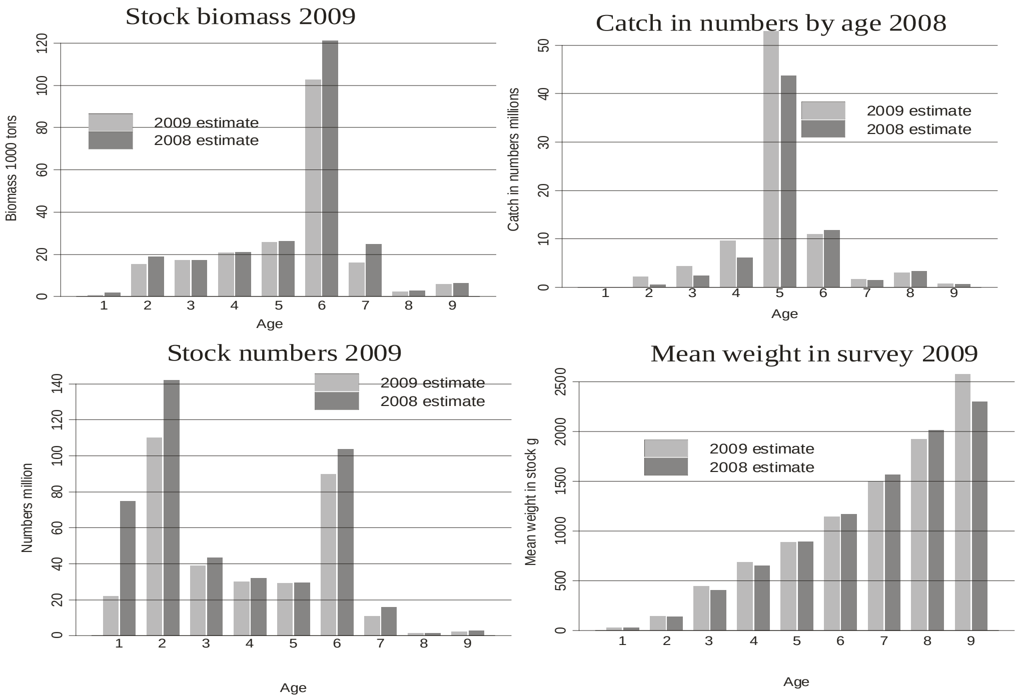


Figure 10.7.2 Haddock in division Va. Input data to prediction.



10.10.1 Haddock in division Va. Comparison of some of the results of the 2008 and 2007 assessment.

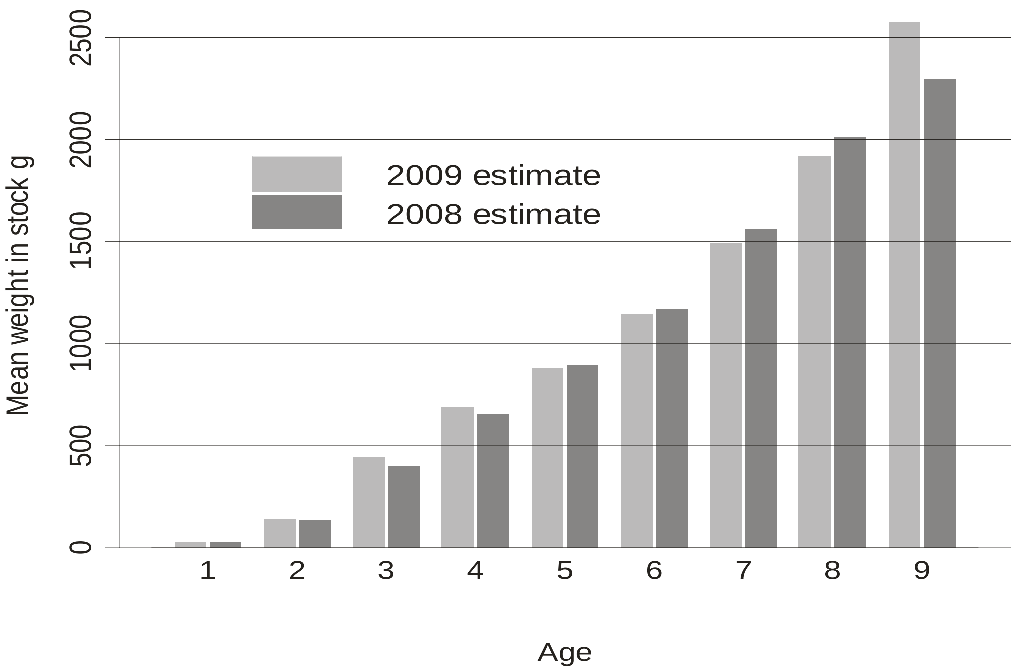


Figure 10.10.2 Mean weight at age in the stock in 2009 as predicted in 2009 and measured in 2009.

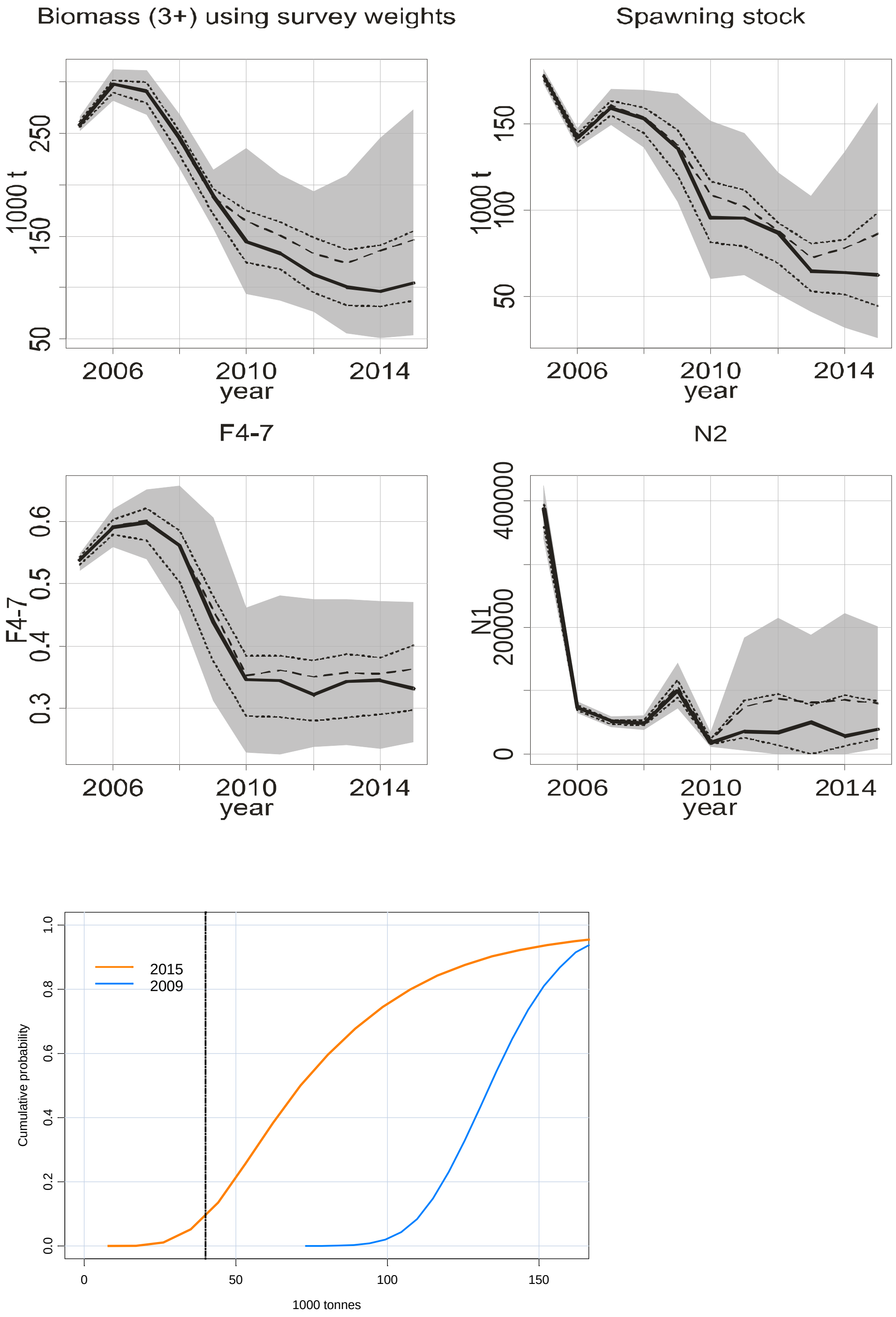


Figure 10.8.1 Haddock in division Va. Stochastic simulations. Cumulative distribution of spawning stock in 2009 and 2015. The dashed line shows B_{pa} (40 000 tonnes)

11 Icelandic summer spawning herring

Summary

Input data

- The total reported landings in 2008/09 were 152 kt, the recommended TAC was 130 kt, while the TAC was 150 kt.
- Around 137 kt of the catch in 2008/09 was taken in a relatively small area in Breidafjörður, in W Iceland, similar to the preceding fishing season.
- The total estimate of the adult stock (age 4+) in the herring acoustic surveys in January 2009 was 560 kt, or 220 kt less than in the December 2007 survey.
- In November 2008, the herring stock was found to be seriously infected by Ichthyophonus. Around 32.2% of the fishing stock, as estimated in the January survey 2009, will die in the winter/spring 2009 because of the infections, which corresponds to Minfection=0.39.
- Resurrect herring juvenile survey indicates that the 2007 year class (age 1 in 2008) is not seriously infected by Ichthyophonus and it could become of average size, while herring at age 2 (2006 year class) is poorly accessible to the survey and its strength remains uncertain.

Assessment

- The final analytical assessment model, NFT-Adapt, indicate that the biomass of age 3+ is 628 kt and SSB is 542 kt in the beginning of year 2009. Accounting for the observed *Ichthyophonus* infection (32.2%) in that period gives estimates of surviving fish, or 426 kt of age 3+ and SSB of 367 kt.
- Around 17% of the SSB in the beginning of year 2009 consists of the 1999 year class, 16% of the 2002 year class and 15% of the 2004 year class.

Predictions

- Fishing at $\mathbf{F}_{0.1}$= 0.22 in the fishing season 2009/10 will give at catch of 75 kt, where 17% derives from the 1999 year class. This prediction is under the premises that no further *Ichthyophonus* infection occurs, which is considered unlikely because similar outbreaks in other herring stocks often last for two years. It will be verified in a survey in July 2009.

Comments

- The massive *Ichthyophonus* infection in the stock has been investigated adequately since it was discovered in the autumn 2008 and its effects on the stock's development are considered in the assessment as justifiable.
- Due to the uncertainty regarding the development of the *Ichthyophonus* infection in the spring 2009, the WG consider it necessary to postpone a recommendation of TAC until the results of a survey in July 2009 on the spawning grounds becomes available and the recommended TAC should then be limited to $\mathbf{F}_{0.1}$= 0.22 and/or leave behind SSB of at least 300 kt=B_{pa} in 2010/2011, depending on the infection rate.

General description of the stock's definition, the stock's life-history and the management unit is given in the stock annex (Her-Vasu).

11.1 Scientific data

The scientific data used for assessment of the Icelandic summer-spawning herring stock are based on annual acoustic surveys, which have been ongoing since 1974 (Table 11.1.1). These surveys have been conducted in October-December or January. The surveyed area each year is decided based on all available information on the distribution of the stock in recent years, including information from the fishery. Thus, the survey area varies spatially as the survey is focused on the adult and incoming year classes.

The acoustic estimate for 2008/09 is based on four acoustic surveys. During December 5-17, the research vessel Dröfn searched the inshore areas off the west coast from Keflavík north to Ísafjarðardjúp (Fig. 11.1.1), which included Breiðafjörður where most of the stock was found. During January 18-21, Breiðafjörður was resurveyed by RV Dröfn and those acoustic measurements corresponded well to the previous measurements a month earlier. RV Bjarni Sæmundsson searched the offshore areas off the west and inshore areas off the southwest coast in December, while RV Árni Friðriksson measured herring off the east and south-east during a capelin survey in January 2009. Different from recent years, the nursery grounds of the stock were covered this winter on RV Dröfn. The western part of the nursery areas were covered in the December survey and the northern part during January 21-31 (Fig. 11.1.1). The objective was to get an acoustic estimate of juveniles and estimate their prevalence of *Ichthyophonus* infection, that was first discovered in November 2008 (see Óskarsson *et al.* 2009b). The acoustic measurements introduced here incorporate the infection rate results as relevant and as is stated in the text.

The fishery was still ongoing when the surveys took place. The highest abundance of the adult stock (age 4+) was in Kiðeyjarsund and nearby areas in southern Breiðafjörður (Fig. 11.1.1), a total of 456 kt. Near Hrolllaugseyjar (i.e. off the SE coast) were 71 kt measured, 14 kt in Ísafjarðardjúp, 9 kt near Hafnarfjörður (considered to be the same schools as fished from in Keflavik in December), 8 kt in Papagrunn (off the east coast), and around 2 kt near Vestmannaeyjar off the south coast. The total estimate of the adult stock was therefore 560 thousands tons. Figure 11.1.2 shows the total estimated biomass of age 4+ in the acoustic survey since 1973, and how the eastern part of the stock has been decreasing in size and the western part increasing since 1995.

The 2002 and 2004 year classes were most numerous in the survey or 20% and 18%, respectively, of the total number of herring (Table 11.1.1). The measurements indicate that the 2004 year class is at least of average size and confines measurements from acoustic surveys in the last two years. The number of fish at age 3 indicate that the 2005 year class (9%) is also of average size.

The results of the juvenile acoustic measurements account for the *Ichthyophonus* infection. The total estimates of the 2007 and 2006 year classes west and north of Iceland, were 516×10^6 and 41×10^6 individuals, respectively, when fish infected by *Ichthyophonus* has been subtracted (see Óskarsson *et al.* 2009b). The year class strength of two year old herring (2006 year class here) has been found to be poorly determined by acoustical measurements of the stock (Gudmundsdottir *et al.* 2007), while acoustic estimates of one year old herring provide a reliable estimate of year class strength. Considering Gudmundsdottir *et al.* (2007) finding and using their obtained relationship between acoustic measurements of one year old and number of individuals at age 2 in the stock according to analytical stock assessments, the predicted number at age 2 is 547×10^6. It means that the 2007 year class is near average size. Most of the

2007 year class, or around 81%, derives from the bay Skjalfandi (Fig. 11.1.1) where no *Ichthyophonus* infection was observed (Óskarsson et al. 2009b).

The length composition of the adult part of the stock in the acoustic estimation in 2008/09 is based on total 11 samples, 5 taken in Breiðafjörður and 6 taken in other areas (total 2292 herring), while the composition of the juvenile part was based on total 7 samples. The age composition was then derived from length-at key from a total of 29 samples (Table 11.1.2). The total number of aged scales from these samples was 1448.

The vessels used in the acoustic surveys this year, as well as previous years, were equated with EK500 operated at 38 kHz, and all the acoustic data were processed in Echoview software. The threshold of -69 to -72 dB were used in the data processing. The threshold target strength (TS) for individual fish (*TS-threshold/40logR)* was set at -60 dB. The survey tracks were often irregular so the whole survey area was divided into cells at different size and the mean TS values calculated for each cell (with the script Echoabundance.sh within Generic Mapping Tools). The TS-length (L) relationship applied was the following: TS=20 log L-72 dB. As normally practiced in acoustic surveys, trawl samples were used to get information about the schools species- and length composition. Furthermore, because of problems regarding sampling in bottom trawl on RV Dröfn in Breiðafjörður (see Óskarsson *et al.* 2009b), catch samples from purse seiners, taken the same day as the acoustic measurements, were used additionally to obtain information about the length composition.

11.2 Information from the fishing industry

The total landings in 2008/2009 season were about 152 thousand tonnes with no discards reported (Table 11.2.1 and in Figure 11.2.1). The quality of the herring landing data regarding discards and misreporting is consider to be adequate as implied in a general summary in section 7 and in the Her-Vasu stock annex. The fishery started in the beginning of October and lasted till February, with the highest intensity in November and December. The geographical distribution of the fishery in the last two years differed from earlier seasons (Fig. 11.2.2; Óskarsson *et al.* 2009a). This season around 90% of the catch was taken in a small area in southern Breiðafjörður off west Iceland, while only 6 kt were taken off the east and southeast coast, 2.5 kt near Vestmannaeyjar, 4 kt near Keflavik and 2 kt in Ísafjarðardjúp.

Different from the fishing seasons in 2004/05, 2005/06 and 2006/07, no Norwegian spring spawning herring was found to mixed with the Icelandic summer spawning herring stock in the catch in the last two seasons. This is probably because the mixing has been almost exclusively connected to the areas east of Iceland where almost no fishery took place this season. However, 1.8 kt of the total catch of Norwegian spring-spawning herring off the east coast in the summer 2008 were allocated to Icelandic summer-spawning herring, which was added to the total catch in the 2008/09 fishing season.

11.2.1 Fleets and fishing grounds

The herring fishing season has taken minor changes in last three decades. Until 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2008 the autumn fishery extended into January or early February of the following year, and has started in September since 1994. In 2003 the season was further extended to the end of April and in the summers of 2002 and 2003 an experimental fishery for spawning herring with a catch of about 5 kt each year was conducted at the south coast. All seasonal restricted landings, catches and recommended TACs since 1984 are given in thousands tonnes (kt) in Table 11.2.1.

Almost all of the catch in 2008/09 was taken with purse-seines and only around 5.2 kt were taken with pelagic trawls, which is amongst the lowest proportion in pelagic trawls since 1995/96 (see Figure 11.2.1.1). A part of the catches since the fishing season 1998/99 has been taken west off Iceland (opposite to the traditional east coast fishery) or ranging from about 15% (in 2004/05) to 55% (in 2002/03). The fishery in this season (2008/09) was different where only around 1.7% was taken of the east coast, 4% off the south coast, 3% in SW Iceland (Keflavik), 1.5% in Isafjarðardjúp and the remaining off the west coast in Breidafjörður. Such large catches have not been taken from the west coast in recent years (Guðmundsdóttir and Sigurðsson 2004; Previous stock's assessment reports), except for the last season, which resemble this season very much. Apart from that, we need to go back to 1948 to see some similarities or the fishery in Hvalfjörður in the winter 1947/48 with total catch of 180 kt (Jakobsson 1980).

To protect juveniles herring (27 cm and smaller) in the fishery, area closures are enforced based on a regulation of the herring fishery set by the Icelandic Ministry of Fisheries (no. 376, 8. October 1992). Like in last fishing season, only two closures were enforced in 2008/09 and they were also both off the south coast (near Þrídrangar and east off Vestmannaeyjar).

11.2.2 Catch in numbers, weight at age and maturity

Procedure for catch at age estimation:

The annual estimations in the catch at age matrix are based on dividing the annual landings into cells according to the fishing gear, geographical location and month of fishing. The annual number of cells depends then on number of factors, including the spatial and temporal distribution of the fishing and the gear used and the sampling intensity. The number of weight-at-length relationships and length-at-age relationships applied differ between years and are on the range of 1-2 in both cases. Since 1990 to present, all available length measurements are used for the estimations in the cells, while length of aged fish was only used in earlier estimations. Length measurements done by fishery inspectors are though usually omitted as inspectors tend to focus on catches that are suspected to consist of small herring. Including these measurements would therefore give biased estimates of length distributions in the calculations as a whole.

Catch at age in 2009:

Data from samples taken from purse seiners and pelagic trawlers (at the harbours by the research personnel or at sea by the fishermen) were used to calculate catch in numbers at age for total landings in this fishing season (2008/09) in a traditional manner (Table 11.2.2.1). The calculations were accomplished by dividing the total catch into 9 cells confined by area (six areas), and months (in Breiðafjörður), as the catch- and sample sizes allowed. Three weight-at-length relationships were used that were derived from the length and weight measurements of the catch samples and one length-at-age relations. The catches of the Icelandic summer spawners in numbers at age for this fishing season as well as back to 1982 are given in Table 11.2.2.2. The geographical location of the sampling is shown on Figure 11.2.2.1.

Weight at age:

The mean weight at age of the stock is derived from the same catch samples (Table 11.3.2.3) by fitting the equation: ln(whole body weight) = a + b • ln(total length), and link the weights to age-at-length key derived from the same data. The total number of fish weighed from the catch in 2008/09 was 6057 and 3730 of them were aged from their fish scales. This unusual high number of measured fish is due to increased sampling effort to get a good estimation of the *Ichthyophonus* infection (Óskarsson *et al.* 2009b).

Proportion mature:

The proportion mature at age has traditionally been estimated annually from the catch data alone for the stock, until in the assessment in 2006 where the proportion mature was fixed (Table 11.2.2.4). The reason for the changes in 2006 was the belief that the large variation of the maturity values over the years was more related to imprecision of the estimations than variation in the stock (Óskarsson and Guðmundsdóttir 2006). In this years assessment we apply the same fixed maturity ogives, where proportion mature at age 3 is set 20% and 85% for fish at age 4, while all older fish is considered mature.

Observed versus predictions of catch composition:

The year class from 2002 dominated in the total catch weight (21%; Figure 11.2.2.2) as well as in number (20%). The contribution of the year classes from 2004, 2003, 2001, 2000, and 1999 to the total catch biomass was then at similar level or from 12-14% (10-17% by number). The main difference in the catch composition from what was proposed from last year's assessment (Figure 11.2.2.2), is that the 1999 year class was expected to provide much more to the catch biomass. This relates to how strong the 1999 year class has been measured in the acoustic measurements. On the opposite, this is the third season that the 2002 year class dominates the catch and in all cases, the total weight of the year class was higher than predicted.

There is no indication that the fishery in 2008/09 was concentrated more on certain year classes than others, like observed in some fishing season (see previous Assessment reports). It could be related to the fact that the herring in Breiðafjörður was very assessable to the fleet and fishing elsewhere was more related to search for less or uninfected herring. It was only herring near Hrolllaugseyjar in January, that had significantly less infection than herring in Breiðafjörður. The low infection rate there was considered to be because of mortality of infected herring had taken place or it got separated from the more healthy herring (Óskarsson *et al.* 2009b).

11.3 Analytical assessment

11.3.1 Analysis of input data

Examination of catch curves for the year classes from 1973 to 2004 (Figure 11.3.1.1) indicates, in general, that the total mortality signal (Z) in the fully recruited age groups is around 0.4. It is under the assumption that the effort has been the same the whole time. Further examination indicates that the 1987 year class and those that follows are fully recruited to the fishery at younger ages (around age 3 to 4) than the earlier year classes (age 5 to 6). There are obvious indications that the fishing effort in some year classes has varied, for example there is a jump in the curves for the two last points in year classes 1997 to 2000. This can be explained by high fishing effort in relative young herring off the south coast in the fishing season 2006/07 (had difficulties to find larger herring), but concentrated on older fish the next two seasons thereafter in Breiðafjörður.

Catch curves were also plotted using the age disaggregated survey indices for each year class from 1973-2004 (Figure 11.3.1.2). Even if the total mortalities look at bit noisy in general, they seem to be fairly close to 0.4. There is an indication that the fish is fully assessable to the survey at age 3, but apparently a year later occasionally. Further exploration of the survey data include a linear fitting of number at age x against number at age x+1 (Figure 11.3.1.3) for different age groups. The slope of the regression lines for the most abundant age classes (age 3 to 7) varied non-systematically from 0.5 to 0.9, which corresponds to 50% and 10%, respectively, mortality between adjoining age classes. The results imply that those age classes (age 3 to 7) are applicable for tuning in the analytical models.

The conclusion from the above is that both the catch- and the survey data are showing similar trend in Z, even if the survey data are noisier than the catch data.

The year class strength was evaluated independently from the catch data, by sum the total catch of each year class (Figure 11.3.1.4). The 1999 year class is apparently the largest in the time series, but according to cumulative fishing of the year classes from 1978-1996 (Figure 11.3.1.5), around 92% can be expected to be already fished of that year class. The 2002 year class is still getting stronger in the estimations (Figure 11.3.1.4), and it can be expected that around 35% of it remains to be fished (Figure 11.3.1.5), under normal circumstances.

11.3.2 Exploration of different assessment models

In order to explore the data this year, two assessments tools were used, namely NFT-ADAPT (VPA/ADPAT version 2.8.0 NOAA Fisheries Toolbox) and a new version of TSA (older version see Gudmundsson, G. 1994). NFT-Adapt used catch data from 1986/87-2008/09 and survey data from 1987/88-2008/09, while TSA used three years less catch data, 1989/90-2008/09. Natural mortality is M=0.1 for all age groups, proportion of M before spawning is set to 0.5 and proportion of F before spawning is set to 0.

<u>NFT-Adapt:</u>

In NFT Adapt the estimated parameters are the stock in numbers. The parameters are output by the Levenburg-Marquardt Non-Linear Least Squares minimization algorithm (see VPA/ADAPT Version 2.0, Reference Manual). Corresponding to previous assessment, the estimated parameters were stock numbers for ages 4 to 10 in 2008, but stock numbers at age 3 were set to the geometric mean from 1986-2004.

In NFT Adapt there are three options (classic, average and Heincke) to calculate the value of fully-recruited fishing mortality in the terminal year. It was decided to set the *input partial recruitment* to 1 for ages 4 and older and after testing different options the classic one was chosen on the basis of residuals of sum of squares (RSS). It must be noted though, that RSS was at a similar level in all cases.

The catchability at age in the survey, as estimated by the NFT Adapt, and the CV is shown in Figure 11.3.2.1. Like in the two last year assessments (2006 and 2007) the final Adapt run was done with age groups 3-9 (i.e. age in autumns) and without the years 1997 and 2001 in the tuning series.

The output and model settings of the NFT-Adapt run (the adopted final assessment model; see below) are shown in Table 11.3.2.1. Stock numbers and fishing mortalities derived from the run are shown in Table 11.3.2.2 and Table 11.3.2.3, respectively, and summarized in Table 11.3.2.4 and Figure 11.3.2.2.

Residuals of the model fit are shown in Figure 11.3.2.3 and Table 11.3.2.5. The highest values are in the years 1997 to 2003 (i.e. moved to 1st January winter). In this period both the year classes from 1994 and 1996 are seen greater in the survey each year than estimated in the model (i.e. positive residuals). Another cohort effect seen is for the year class 1999, where the model estimates it smaller than seen in the survey, for all age groups, except for the last one (in this year survey). Year effects are also observed where 1988 was a general negative year for all age groups (smaller in the survey than estimated in the model) and 1997 and 2003 were positive years.

Retrospective analysis (Figure 11.3.2.4) shows that the estimate of SSB is lower for 2003-2007 when the 2008 data are included (referring to the end of the year), even if the estimates for the last five years are in harmony, particularly for SSB. This pattern indicates improvements from the last assessment. Before that, the bias is consistent in overestimating the spawning stock and underestimating the fishing mortalities. Thus, there is an indication that this bias is becoming weaker in the last years.

TSA:

One TSA run was made in 2009 (Figure 11.3.2.2), with a fixed natural mortality (M=0.1) and allowing the catchability of surveys to change (Guðmundsson 2009 [ICES 2009, NWWG, WD 16]). Estimated standard deviations and the retrospective analysis indicate poor accuracy and the specification was rather uncertain. There was little evidence of permanent variations in catchability. This year TSA run differs from the last years analyses by leaving out 1987-1988, which is considered to be the main reason for now little indication of variations in survey catchability.

Comparisons of models:

The estimations of recruitment, spawning stock biomass, and N weighed average $F_{5\text{-}10}$ from the two models (NFT-Adapt and TSA) were compared (Figure 11.3.2.2). There is clear indication that the stock estimates of TSA are lower from around 2003 to present. Similar observations was made in last years assessment (ICES 2008) and it was explained by that TSA estimates the 1999 and 2000 year classes weaker than NFT Adapt did, and it is also apparent now (Figure 11.3.2.2). The estimated 3+ biomass in the beginning of year 2009 is 476 kt from TSA and 628 kt from NFT Adapt.

As in previous years there is a retrospective pattern in the results from all the models. The retrospective analysis from TSA indicates poor accuracy in the most recent year compared with that observed in the NFT-Adapt retrospective pattern. Based on this in addition to that the NFT-Adapt approach is a more familiar framework for the principal assessor of this stock, the WG adopted the results from that method as point estimator for the prediction and thus the basis for the advice.

11.3.3 Final assessment

The model settings and outputs of the adopted final model (NFT-Adapt run in 2009) are shown in Table 11.3.2.1 to Table 11.3.2.4 and Figure 11.3.2.2.

The assessment (Table 11.3.2.4 and Figure 11.3.2.2) indicates that the fishing mortality (weighed average) was high during 1986 to 2003 and fluctuated between 0.25 and 0.45, which is above F_{pa}=0.22. During 2004-2006 F declined below F_{pa} but has been above F_{pa} in 2007 and 2008, which is related to higher agreed TAC (150 kt in both years) than recommended by MRI (130 kt in both years). F_{lim} is not defined for the stock. The spawning stock reached maximum in 2006 but is decreasing. The 1999 year class (age 3 in 2002) is the largest one in the whole series and the 2000 and 2002 year class are also large, but the 2002 year class had the highest value ever in the acoustic surveys as one year old in 2003.

The results of the final model include the *Ichthyophonus* infected part of the stock, which is assumed to die in the first few months of the year 2009. When the infected part is subtracted from the stock estimates according to the estimated infection rate (32.2%; Óskarsson et al. 2009b), the surviving biomass of age 3+ is 426 kt and SSB 367 kt in the beginning of year 2009.

11.4 Reference points

The Working Group has pointed out that managing this stock at an exploitation rate at or above $\mathbf{F}_{0.1}$ has been successful in the past, despite biased assessments. Thus, as stated in the Annex for this stock, the Northern Pelagic and Blue Whiting Fisheries Working Group agreed in 1998 with the SGPAFM on using $\mathbf{F}_{pa} = \mathbf{F}_{0.1} = 0.22$, $\mathbf{B}_{pa} = \mathbf{B}_{lim} * e^{1.645\sigma} = 300\,000$ t where $\mathbf{B}_{lim} = 200\,000$ t. The Study Group on Precautionary Reference Points for Advice on Fishery Management met in February 2003 and concluded that it was not considered relevant to change the $\mathbf{B}_{lim}$ from 200 000 t. The WG have not dealt with this issue.

The fishing mortality has since 1990 been on the average 0.304 or approximately 40% higher than the intended target of $F_{0.1}=0.22$. This is despite the fact that the managers have followed the scientific advice and restricted quotas with the aim of fishing at the intended target. During this time period the SSB has remained above B_{lim}. As there is an agreed management strategy that have been applied since the fishery was re-opened after it collapsed in late 1960's, it is proposed to use $F_{0.1} = \mathbf{F}_{pa}$ as F_{target}.

11.5 State of the stock

The state of the stock can be considered healthy despite some uncertainty in the assessment because the stock level has been above, and is still around, any known historical level reaching back to 1948 (Jakobsson and Stefansson, 1999; Table 11.3.2.4). The health of the stock is both manifested from the acoustic surveys (section 11.3.3) and the analytical assessment (section 11.3.4). However, there are concerns about stock's development in next years because of the *Ichthyophonus* infection (see in sections 11.8.2, 11.12 and Óskarsson *et al.* 2009b).

11.6 Short term forecast

11.6.1 The input data

A prognosis was done for the final adopted model, NFT-Adapt, which gave the number at age on January 1st, 2009. Because of the *Ichthyophonus* infection in the stock of 32.2% (Óskarsson *et al.* 2009b), the number at age values from the NFT-Adapt model output were reduced accordingly in the input data. The reason for the approach is that all of the infected herring observed in 2008/09 will die in the first 1-3 months of the year (Óskarsson *et al.* 2009b). All input values for the prognosis are given in Table 11.6.1.1. The weights estimates used in the prognoses were the mean weight at age from the catch during the last three fishing seasons (2006/07-2008/09) (Figure 11.6.1.1). The selection pattern used in the prognosis was determined from the fishing mortality at age ($F_{age\ i}/WF_{age\ 5\text{-}10}$), averaged over 2003 to 2008 from the final run (the years 2005 and 2006 were omitted for age 3 and 4 because of atypical effort those years). As traditionally, M was set 0.1, proportion M before spawning was set 0.5 and proportion F before spawning was set 0. The numbers of recruits in the prognosis were determined as follows:

The 2005 year class: There is no estimation available of the strength of the year class, except the fishery in the season 2008/09. We use therefore the estimated number at age 4 on January 1st 2009 in the prognosis and accounts for the observed 32.2% *Ichthyophonus* infection, but there was no length/age effect in the prevalence of the infection in the fishable stock (Óskarsson *et al.* 2009b).

The 2006 year class: There is no estimate available for the 2006 year class because it is poorly determined at age 2 in juvenile surveys (Gudmundsdottir *et al.* 2007) and therefore not measureable in the 2008/09 juvenile survey (Óskarsson *et al.* 2009b). Thus, the year class size was, as traditionally, set to the geometrical mean for age-3 over 1986-2008, which give 578 millions from the NFT-Adapt run in 2009 but becomes 391 millions when the observed infection rate of 32.2% has been accounted for. Reliable estimation of the infection rate in the year class is not available (Óskarsson *et al.* 2009b) so it was set equal to the adult part of the stock.

The 2007 year class: The number at age 3 in 2010 was set to the geometrical mean for age-3 over 1986-2008, which give 578 millions. There are indications from a juvenile survey in December 2008/January 2009 that the year class is of average size (Óskarsson *et al.* 2009b), thus geometric mean is the most reasonable estimate.

11.6.2 Prognosis results

The results of the prognosis from the final NFT-Adapt run are shown in Table 11.6.2.1 for five different scenarios for possible infection rate in July 2009 (see further in section 11.8.2). Fishing at 0.22 (= $F_{0.1}$; the stock is managed at F=0.22) would correspond to TAC in 2009/10 of 75 kt if the *Ichthyophonus* infection rate in July 2009 turns out to be 0% and 68 kt if the rate is 10%. If the infection will be above 10%, F must be decreased accordingly to secure that SSB in 2010/2011 does not fall below B_{pa}=300 kt. Thus, 20% infection would give TAC of 30 kt (F=0.10) and >28% infection rate will mean TAC=0. The proposed composition of the catch and SSB in the season 2009/10 is shown in Figure 11.6.2.1 as estimated under scenarios 1-3. Like in recent assessments, the NFT-Adapt model results still gives relative high value to the 1999 year class, and that is reflected in the prognosis. The 1999 year class has always been seen stronger in surveys than in the analytical assessments, except for the 2009 survey (see residuals in Figure 11.3.2.3 and Table 11.3.2.5).

11.7 Medium term predictions

No medium term predictions were performed.

11.8 Uncertainties in assessment and forecast

11.8.1 Assessment

There are several things that could lead to uncertainty in the assessment. The main factor that distinct between the results of the NFT-Adapt and TSA is the estimated strength of the 1999 and 2000 year classes (Fig. 11.3.2.2). The 1999 year class has been observed stronger in the surveys than it appears in the catch for all years except for now (2008/09; Figure 11.3.2.3 and Table 11.3.2.5). This discrepancy that has been explained by different spatial distribution of the fleet and the year class in previous assessment reports, is certainly adding uncertainty to the assessment.

The reinstate of the juvenile survey in the winter 2008/09 (the last one was in 2003) is seen as a very positive step in reducing uncertainty in determining year class strength of recruits. However, since the age 2 herring (i.e. the 2006 year class) is poorly determined in the survey, an uncertainty regarding its strength remains. It is important that these juvenile surveys will take place every year as they provide a reliable estimate of year class strength of one year old herring (Gudmundsdottir *et al.* 2007).

Uncertainty related to the obtained survey indices in 2008/09 are not considered to be of significance in this year's assessment. The distribution areas are considered to have been covered adequately by research vessels both in herring and capelin surveys (off the east and west coast) and by the herring fleet that were looking for new schools throughout the season that possibly had less *Ichthyophonus* infection.

11.8.2 Forecast

Uncertainties in the forecast, in addition to those related to the analytical assessment, are related to the *Ichthyophonus* infection. The observed infection during the winter 2008/09 was considered in the prognosis procedure, but there is a reason to belief that more herring will be infected during the feeding seasons in the 2009 (prior and following spawning in July). It is impossible to predict if and then how much herring will be infected during that period or even the year after. The herring gets probably only infected via oral intake of resting spores of *Ichthyophonus* so the period of getting infected is only restricted to the feeding seasons. It is known for other herring stocks that such epidemics last around two years (see Óskarsson *et al.* 2009b). Because of this huge uncertainty related to the development of the infection in the coming months, the WG consider it necessary to postpone giving a final recommendation of TAC until the results of the July 2009 survey on the spawning grounds becomes available (around middle of July), where the prevalence of the infection will be determined along with acoustic measurements. The recommended TAC should then reflect the infection rate in line with the results of scenarios 1 to 5 in Table 11.6.2.1. Selected catch option that takes the stock below its precautionary reference point for biomass (B_{pa}) is not consistent with a precautionary approach to fishery management. Thus, the final recommended TAC for 2009/2010 as will be given around middle of July 2009 should be based on as follows: (i) re-running the prognosis (see section 11.6) with same input values except that the number-at-age are multiplied with a survival rate (=1-infection rate in July); (ii) the TAC in 2009/2010 should be limited to catch that gives $\mathbf{F}_{0.1}$= 0.22, but must also be set at a level that gives SSB in the beginning of year 2010 not below B_{pa} of 300 kt.

11.8.3 Assessment quality

In previous years there has been concerns regarding the assessment because of retrospective patterns of the models. No assessment was provided in the 2005 due to data and model problems and in the two next consecutive years, ACFM rejected the assessment due to the retrospective pattern. In the last three year assessments (2007, 2008 and 2009) there was observed an improvement in the pattern from NFT-Adapt, which has continued in this year assessment for the last five years in the series. Considering this improved behavior, stock estimations from the assessment models and the acoustic surveys in 2006 to 2008, the WG consider that the state of the stock is good, and the assessment quality acceptable. The indication of decreasing stock size according to the acoustic survey in January 2009, and the observation of high percentage of *Ichthyophonus* infection add an uncertainty to this year assessment and particularly to the forecast.

11.9 Comparison with previous assessment and forecast

This year assessment is in line with the last year assessment, apart from the effects of *Ichthyophonus* infection on the stock development. The ACFM advice of TAC in 2008 was 131 kt, which was based on projections from an analytical assessment. In the prognosis from this year assessment, $F_{0.22}$ gives 75 kt.

11.10 Management plans and evaluations

It was agreed in 1998 in the Northern Pelagic and Blue Whiting Fisheries Working Group to use $\mathbf{F}_{pa}= \mathbf{F}_{0.1}= 0.22$, $\mathbf{B}_{pa}= \mathbf{B}_{lim} * e^{1.645\sigma}= 300\,000$ t where $\mathbf{B}_{lim}= 200\,000$ tons for the Icelandic summer-spawning herring. That is the main management plan in action. As there is an agreed management strategy that have been applied since the fishery was reopened after it collapsed in late 1960's, it is proposed to use $F_{0.1} = \mathbf{F}_{pa}$ as F_{target}. Evaluation of the management plan has not taken place.

11.11 Management consideration

There are several points to address:

The assessment has suffered from a retrospective pattern in recent years, which is now diminishing in the fourth year in a row, and the last five years in the assessment harmonize in a retrospective sense.

There are no evidence available supporting that significant mortality related to the *Ichthyophonus* infection had taken place in the stock prior to the winter 2008/09 (i.e. during the spring to early autumn 2008). Therefore, M was set 0.1 for that period as traditionally for the stock. Lack of evidence for this possible mortality does however, not mean that it can be fully rejected. In the approach taken in this assessment, all the observed infection (from Nov.-Feb.) is considered to cause mortality in the spring 2009, which is supported by observations (Óskarsson *et al.* 2009b). It is obvious that in future analytical assessments of the stock, M must be set at least to 0.49 in 2009, or in line whit what is done in the prognosis now to reflect the infection rate. Further information about the infection that will be collected in July 2009 and in autumn 2009 should also be considered when determining M in 2009 for the stock.

No specific issues were raised in the technical minutes in the 2008 assessment report by the Review Group (ICES 2008), and all general issues (i.e. retrospective pattern and necessity of a juvenile survey) have been addressed here.

11.12 Ecosystem considerations

The reason for the outbreak of *Ichthyophonus* infection in the herring stock is not known but is probably the effect of interaction between environmental factors and distribution of the stock (Óskarsson *et al.* 2009b). It includes that outbreak of *Ichthyophonus* spores in the environment, which infect the herring via oral intake, could be linked to the observed increased temperature off the southwest coast. Further researches on the causes of such an outbreak are needed and how the herring get infected, i.e. through intake of free floating spores or through zooplankton that contain spores.

The WG does not have any information of direct evidence of environmental effects of the stock but emphasize that increased sea temperature is considered to have generally positive effects on the stock (Jakobsson and Stefansson, 1999). It is manifest in higher number of recruits per SSB during warm years (Jakobsson and Stefansson, 1999; Óskarsson, 2005). Furthermore, the stock occupies colder water around Iceland than other herring stocks in the N-Atlantic and is therefore on edge of the distribution towards cold water, where warming will generally have a positive impacts on the stock development. The increased temperature in Icelandic waters since 1998 (MRI, 2008), has therefore probably positive effects on the stock.

11.13 Regulations and their effects

The fishery of the Icelandic summer-spawning herring is limited to the period 1 September to 1 May each season, according to regulations set by the Icelandic Fishery Ministry (no. 770, 8. September 2006). Several other regulations are enforced by the Ministry that effect the herring fishery. They involve protections of juveniles herring (27 cm and smaller) in the fishery where area closures are enforced if the proportion of juveniles exceeds 25% in number (no. 376, 8. October 1992). Another regulation deals with the quantity of bycatch allowed. Then there are regulations that prohibit use of pelagic trawls within the 12 nm fishing zone (no. 770, 8. September 2006), which are enforced to limit bycatch of juveniles of other fish species.

11.14 Changes in fishing technology and fishing patterns

The catches of Icelandic summer-spawning herring increased rapidly in the early 1960s due to the development of the purse seine fishery off the south coast of Iceland. This resulted in a rapidly increasing exploitation rate until the stock collapsed in the late 1960s. A fishing ban was enforced during 1972–1975. The catches have since increased gradually to over 100 000 t. In earlier times, the fleet consisted of multi-purpose vessels, mostly under 300 GRT, operating purse-seines and driftnets. In recent 20 years, larger vessels (up to 1500 GRT) have been entering the fishery, and today they represent the whole herring fishing fleet. These are a combination of purse-seiners and pelagic trawlers operating in the herring, capelin, and blue whiting fisheries. Since the 1997/1998 fishing season, there has been a fishery for herring both to the west and east of Iceland, which is unusual compared to earlier years when the fishable stock was only found south and east of Iceland. Pelagic trawl fisheries were introduced in 1997/98 and contributed to around 20–60% of the catches for several years, but to less than 5% in last two fishing seasons (Fig. 11.2.1.1)

There are no recent changes in fishing technology which may lead to different catch compositions. The fishing pattern in 2008/09 was similar to the last season’s pattern, which was different from previous season because most of the catch in two the recent seasons were taken from a small area off the west coast. It is emphasized that the fishing pattern does varies annually as noted in section 11.2 and is related to variation in distribution and catchability of the different age classes of the stock. This variation in distribution and catchability can have consequences for the catch composition but it is impossible to forecast anything about this variation.

11.15 Comments on the PA reference points

The WG have not dealt with this issue recently.

11.16 Comments on the assessment

In 2005 there was a large uncertainty regarding the assessment of the stock and no assessment was considered reliable enough by ACFM. The same happened in the 2006 and 2007 assessments. Assessments use to be consistently biased in overestimating the spawning stock for some years. Several reasons have been mentioned to account for this overestimation problem, including: (1) discrepancies in the catch and survey; (2) a possible higher natural mortality because of much more widespread spatial distribution of the stock since 1997, which means more accessibility for predators; (3) higher mortality related to the fishery with the pelagic trawl, but from 1997 to 2006 around 20-60% of the catch was taken by pelagic trawl; (4) the reduction of the part of the stock that was acoustically measured east of Iceland.

The 2008 assessment was, however, accepted by ACFM because of better retrospective pattern that is more consistent for the last years, high survey coverage and similarity between the assessment models results. The retrospective pattern that persisted for years continues to diminishing in the adopted 2009 assessment, and the last five years in the assessment harmonize in a retrospective sense.

The cautious allowed TAC in recent years that is based on $F_{0.22}$, has probably facilitated continuous increase in stock size in the last decade.

11.17 References

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Table 11.1.1. Icelandic summer-spawning herring. Acoustic estimates (in millions) in the seasons 1973/74-2008/09 (age refers to the former year, i.e. autumns).

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1973/74	154.000	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	154
1974/75	5.000	137.000	19.000	21.000	2.000	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	186
1975/76	136.000	20.000	133.000	17.000	10.000	3.000	3.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	322
1976/77**	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
1977/78	212.000	424.000	46.000	19.000	139.000	18.000	18.000	10.000	0.000	0.000	0.000	0.000	0.000	0.000	886
1978/79	158.000	334.000	215.000	49.000	20.000	111.000	30.000	30.000	20.000	0.000	0.000	0.000	0.000	0.000	967
1979/80	19.000	177.000	360.000	253.000	51.000	41.000	93.000	10.000	0.000	0.000	0.000	0.000	0.000	0.000	1004
1980/81	361.000	462.000	85.000	170.000	182.000	33.000	29.000	58.000	10.000	0.000	0.000	0.000	0.000	0.000	1390
1981/82	17.000	75.000	159.000	42.000	123.000	162.000	24.000	8.000	46.000	10.000	0.000	0.000	0.000	0.000	666
1982/83**	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
1983/84	171.000	310.000	724.000	80.000	39.000	15.000	27.000	26.000	10.000	5.000	12.000	0.000	0.000	0.000	1419
1984/85	28.000	67.000	56.000	360.000	65.000	32.000	16.000	17.000	18.000	9.000	7.000	4.000	5.000	5.000	689
1985/86	652.000	208.000	110.000	86.000	425.000	67.000	41.000	17.000	27.000	26.000	16.000	6.000	6.000	1.000	1688
1986/87**	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
1987/88	115.544	401.246	858.012	308.065	57.103	32.532	70.426	36.713	23.586	18.401	24.278	10.127	3.926	4.858	1965
1988/89	635.675	201.284	232.808	381.417	188.456	46.448	25.798	32.819	17.439	10.373	9.081	5.419	3.128	5.007	1795
1989/90	138.780	655.361	179.364	278.836	592.982	179.665	22.182	21.768	13.080	9.941	1.989	0.000	0.000	0.000	2094
1990/91	403.661	132.235	258.591	94.373	191.054	514.403	79.353	37.618	9.394	12.636	0.000	0.000	0.000	0.000	1733
1991/92	598.157	1049.990	354.521	319.866	89.825	138.333	256.921	21.290	9.866	0.000	9.327	0.000	0.000	1.494	2850
1992/93	267.862	830.608	729.556	158.778	130.781	54.156	96.330	96.649	24.542	1.130	1.130	3.390	0.000	0.000	2395
1993/94	302.075	505.279	882.868	496.297	66.963	58.295	106.172	48.874	36.201	0.000	4.224	18.080	0.000	0.000	2525
1994/95**	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
1995/96	216.991	133.810	761.581	277.893	385.027	176.906	98.150	48.503	16.226	29.390	47.945	4.476	0.000	0.000	2197
1996/97	33.363	270.706	133.667	468.678	269.888	325.664	217.421	92.979	55.494	39.048	30.028	53.216	18.838	12.612	2022
1997/98*	291.884	601.783	81.055	57.366	287.046	155.998	203.382	105.730	35.469	27.373	14.234	36.500	14.235	11.570	1924
1998/99	100.426	255.937	1081.504	103.344	51.786	135.246	70.514	101.626	53.935	17.414	13.636	2.642	4.209	8.775	2001
1999/00	516.153	839.491	239.064	605.858	88.214	43.353	165.716	89.916	121.345	77.600	21.542	3.740	11.149	0.000	2823
2000/01	190.281	966.960	1316.413	191.001	482.418	34.377	15.727	37.940	14.320	15.413	14.668	1.705	3.259	0.000	3284
2001/02*	1047.643	287.004	217.441	260.497	161.049	345.852	62.451	57.105	38.405	46.044	38.114	21.062	3.663	0.000	2586
2002/03	1731.809	1919.368	553.149	205.656	262.362	153.037	276.199	99.206	47.621	55.126	18.798	24.419	24.112	1.377	5372
2003/04	1115.255	1434.976	2058.222	330.800	109.146	100.785	38.693	45.582	7.039	6.362	7.509	10.894	0.000	2.289	5268
2004/05	2417.128	713.730	1022.326	1046.657	171.326	62.429	44.313	10.947	23.942	12.669	0.000	1.948	11.088	0.000	5539
2005/06	469.532	443.877	344.983	818.738	1220.902	281.448	122.183	129.588	73.339	65.287	10.115	9.205	3.548	12.417	4005
2006/07	109.959	608.205	1059.597	410.145	424.525	693.423	95.997	123.748	48.773	0.955	0.000	0.000	0.000	0.480	3576
2007/08	90.231	456.773	289.260	541.585	309.443	402.889	702.708	221.626	244.772	13.997	22.113	68.105	10.136	2.800	3376
2008/09	149.466	196.127	416.862	288.156	457.659	266.975	225.747	168.960	29.922	26.281	17.790	9.881	0.974	3.195	2258

*** The estimates from the fishing season 1997/98 and 2001/02 were omitted from the tuning procedure in the assessment 2007 because of incomplete coverage of the surveys due to weather condition and time limitations (ICES, 2006). ** No survey**

Table 11.1.2. Icelandic summers-spawning herring. Number of scales by ages and number of samples taken in the annual acoustic surveys in the seasons 1987/88-2008/09 (age refers to the former year, i.e. autumns). In 2000 seven samples were used from the fishery. No survey was conducted in 1994/95.

	Number of scales															Number of samples		
Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Total	West	East
1987/88	11	59	246	156	37	28	58	33	22	16	23	10	5	8	712	8	1	7
1988/89	229	78	181	424	178	69	50	77	42	29	23	13	7	12	1412	18	5	10
1989/90	38	245	96	132	225	35	2	2	3	3	2	0	0	0	783	8		8
1990/91	418	229	303	90	131	257	28	6	3	8	0	0	0	0	1473	15		15
1991/92	414	439	127	127	33	48	84	5	3	0	2	0	0	1	1283	15		15
1992/93	122	513	289	68	73	28	38	34	6	2	2	6	0	0	1181	12		12
1993/94	63	285	343	129	13	15	7	14	11	0	1	3	0	0	884	9		9
1994/95*																		
1995/96	183	90	471	162	209	107	38	18	8	14	18	2	0	0	1320	14	9	5
1996/97	24	150	88	351	141	137	87	32	15	10	7	14	4	2	1062	11	4	7
1997/98	101	249	50	36	159	95	122	62	21	13	8	15	8	5	944	14	7	7
1998/99	130	216	777	72	31	65	59	86	37	22	17	5	6	11	1534	17	10	7
1999/00	116	227	72	144	17	13	26	26	27	10	8	2	1	0	689	7	3	4
2000/01	116	249	332	87	166	10	7	21	8	14	11	3	1	0	1025	14	10	4
2001/02	61	56	130	114	62	136	25	24	17	21	17	10	3	0	676	9	4	5
2002/03	520	705	258	104	130	74	128	46	26	25	13	15	10	1	2055	22	12	10
2003/04	126	301	415	88	35	32	15	17	3	4	4	6	1	1	1048	13	8	5
2004/05	304	159	284	326	70	29	17	5	8	4	0	3	3	0	1212	13	4	9
2005/06	217	312	190	420	501	110	40	38	26	18	5	5	5	7	1894	22	14	8
2006/07	19	77	134	64	71	88	22	4	2	2	0	0	0	1	484	6	4	2
2007/08	58	288	180	264	85	80	104	19	15	2	2	6	1	3	1107	17	13	4
2008/09	274	208	213	136	204	123	125	97	18	13	9	7	4	17	1448	29	19	10

*** No survey**

Table 11.2.1. Icelandic summer spawners. Landings, catches, recommended TACs, and set National TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs	National TACs
1972	0.31	0.31		
1973	0.254	0.254		
1974	1.275	1.275		
1975	13.28	13.28		
1976	17.168	17.168		
1977	28.925	28.925		
1978	37.333	37.333		
1979	45.072	45.072		
1980	53.268	53.268		
1981	39.544	39.544		
1982	56.528	56.528		
1983	58.867	58.867		
1984	50.304	50.304		
1985	49.368	49.368	50	50
1986	65.5	65.5	65	65
1987	75	75	70	73
1988	92.8	92.8	90	90
1989	97.3	101	90	90
1990/1991	101.6	105.1	80	110
1991/1992	98.5	109.5	80	110
1992/1993	106.7	108.5	90	110
1993/1994	101.5	102.7	90	100
1994/1995	132	134	120	120
1995/1996	125	125.9	110	110
1996/1997	95.9	95.9	100	100
1997/1998	64.7	64.7	100	100
1998/1999**	87	87	90	70
1999/2000	92.9	92.9	100	100
2000/2001	100.3	100.3	110	110
2001/2002	95.7	95.7	125	125
2002/2003*	96.1	96.1	105	105
2003/2004*	130.7	130.7	110	110
2004/2005	114.2	114.2	110	110
2005/2006	103	103	110	110
2006/2007	135	135	130	130
2007/2008	158.9	158.9	130	150
2008/2009	151.8	151.8	130	150

***Summer fishery in 2002 and 2003 included**

**** TAC was decided 70 thous. tonnes but because of transfers from the previous quota year the national TAC became 90 thous. tonnes.**

Table 11.2.2.1. Overview of the catch data for Icelandic summer-spawning herring 2008/09.

	BREIÐAFJÖRÐUR	OTHER AREAS	TOTAL
Total catch (thousands tonnes)	137.043	14.737	151.780
Number of samplings for ageing	59	19	78
Number of aged fish	2805	925	3730
Number of weighed fish	4627	1430	6057
Number of fish taken for *Ichthyophonus* infection estimate	4627	1430	6057
Number of samplings for length determinations	95	28	123
Number of fish length measured	4639	1582	6221

Table 11.2.2.2. Icelandic summer-spawning herring. Catch in numbers (millions) and total catch in weight (thous. tonnes) (1981 refers to season 1981/1982 etc).

Year\Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Catch
1975	1.518	2.049	31.975	6.493	7.905	0.863	0.442	0.345	0.114	0.004	0.001	0.001	0.001	0.001	13.280
1976	0.614	9.848	3.908	34.144	7.009	5.481	1.045	0.438	0.296	0.134	0.092	0.001	0.001	0.001	17.168
1977	0.705	18.853	24.152	10.404	46.357	6.735	5.421	1.395	0.524	0.362	0.027	0.128	0.001	0.001	28.925
1978	2.634	22.551	50.995	13.846	8.738	39.492	7.253	6.354	1.616	0.926	0.4	0.017	0.025	0.051	37.333
1979	0.929	15.098	47.561	69.735	16.451	8.003	26.04	3.05	1.869	0.494	0.439	0.032	0.054	0.006	45.072
1980	3.147	14.347	20.761	60.727	65.328	11.541	9.285	19.442	1.796	1.464	0.698	0.001	0.11	0.079	53.268
1981	2.283	4.629	16.771	12.126	36.871	41.917	7.299	4.863	13.416	1.032	0.884	0.760	0.101	0.062	39.544
1982	0.454	19.187	28.109	38.280	16.623	38.308	43.770	6.813	6.633	10.457	2.354	0.594	0.075	0.211	56.528
1983	1.475	22.499	151.718	30.285	21.599	8.667	14.065	13.713	3.728	2.381	3.436	0.554	0.100	0.003	58.867
1984	0.421	18.015	32.244	141.354	17.043	7.113	3.916	4.113	4.517	1.828	0.202	0.255	0.260	0.003	50.304
1985	0.112	12.872	24.659	21.656	85.210	11.903	5.740	2.336	4.363	4.053	2.773	0.975	0.480	0.581	49.368
1986	0.100	8.172	33.938	23.452	20.681	77.629	18.252	10.986	8.594	9.675	7.183	3.682	2.918	1.788	65.500
1987	0.029	3.144	44.590	60.285	20.622	19.751	46.240	15.232	13.963	10.179	13.216	6.224	4.723	2.280	75.439
1988	0.879	4.757	41.331	99.366	69.331	22.955	20.131	32.201	12.349	10.250	7.378	7.284	4.807	1.957	92.828
1989	3.974	22.628	26.649	77.824	188.654	43.114	8.116	5.897	7.292	4.780	3.449	1.410	0.844	0.348	101.000
1990	12.567	14.884	56.995	35.593	79.757	157.225	30.248	8.187	4.372	3.379	1.786	0.715	0.446	0.565	105.097
1991	37.085	88.683	49.081	86.292	34.793	55.228	110.132	10.079	4.155	2.735	2.003	0.519	0.339	0.416	109.489
1992	16.144	94.86	122.626	38.381	58.605	27.921	38.42	53.114	11.592	1.727	1.757	0.153	0.376	0.001	108.504
1993	2.467	51.153	177.78	92.68	20.791	28.56	13.313	19.617	15.266	4.254	0.797	0.254	0.001	0.001	102.741
1994	5.738	134.616	113.29	142.876	87.207	24.913	20.303	16.301	15.695	14.68	2.936	1.435	0.244	0.195	134.003
1995	4.555	20.991	137.232	86.864	109.14	76.78	21.361	15.225	8.541	9.617	7.034	2.291	0.621	0.235	125.851
1996	0.717	15.969	40.311	86.187	68.927	84.66	39.664	14.746	8.419	5.836	3.152	5.18	1.996	0.574	95.882
1997	2.008	39.24	30.141	26.307	36.738	33.705	31.022	22.277	8.531	3.383	1.141	10.296	0.947	2.524	64.682
1998	23.655	45.39	175.529	22.691	8.613	40.898	25.944	32.046	14.647	2.122	2.754	2.15	1.07	1.011	86.998
1999	5.306	56.315	54.779	140.913	16.093	13.506	31.467	19.845	22.031	12.609	2.673	2.746	1.416	2.514	92.896
2000	17.286	57.282	136.278	49.289	76.614	11.546	8.294	16.367	9.874	11.332	6.744	2.975	1.539	1.104	100.332
2001	27.486	42.304	86.422	93.597	30.336	54.491	10.375	8.762	12.244	9.907	8.259	6.088	1.491	1.259	95.675
2002	11.698	80.863	70.801	45.607	54.202	21.211	42.199	9.888	4.707	6.52	9.108	9.355	3.994	5.697	96.128
2003	24.477	211.495	286.017	58.120	27.979	25.592	14.203	10.944	2.230	3.424	4.225	2.562	1.575	1.370	130.741
2004	23.144	63.355	139.543	182.45	40.489	13.727	9.342	5.769	7.021	3.136	1.861	3.871	0.994	1.855	114.237
2005	6.088	26.091	42.116	117.91	133.437	27.565	12.074	9.203	5.172	5.116	1.045	1.706	2.11	0.757	103.043
2006	52.567	118.526	217.672	54.800	48.312	57.241	13.603	5.994	4.299	0.898	1.626	1.213	0.849	0.933	135.303
2007	10.817	94.250	83.631	163.294	61.207	87.541	92.126	23.238	11.728	7.319	2.593	4.961	2.302	1.420	158.917
2008	10.427	38.830	90.932	79.745	107.644	59.656	62.194	54.345	18.130	8.240	5.157	2.680	2.630	1.178	151.780

Table 11.2.2.3. Icelandic summer-spawning herring. The mean weight (g) at age from the commercial catch (1981 refers to season 1981/1982 etc).

YEAR\AGE	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1975	110	179	241	291	319	339	365	364	407	389	430	416	416	416
1976	103	189	243	281	305	335	351	355	395	363	396	396	396	396
1977	84	157	217	261	285	313	326	347	364	362	358	355	400	420
1978	73	128	196	247	295	314	339	359	360	376	380	425	425	425
1979	75	145	182	231	285	316	334	350	367	368	371	350	350	450
1980	69	115	202	232	269	317	352	360	380	383	393	390	390	390
1981	61	141	190	246	269	298	330	356	368	405	382	400	400	400
1982	65	141	186	217	274	293	323	354	385	389	400	394	390	420
1983	59	132	180	218	260	309	329	356	370	407	437	459	430	472
1984	49	131	189	217	245	277	315	322	351	334	362	446	417	392
1985	53	146	219	266	285	315	335	365	388	400	453	469	433	447
1986	60	140	200	252	282	298	320	334	373	380	394	408	405	439
1987	60	168	200	240	278	304	325	339	356	378	400	404	424	430
1988	75	157	221	239	271	298	319	334	354	352	371	390	408	437
1989	63	130	206	246	261	290	331	338	352	369	389	380	434	409
1990	80	127	197	245	272	285	305	324	336	362	370	382	375	378
1991	74	135	188	232	267	289	304	323	340	352	369	402	406	388
1992	68	148	190	235	273	312	329	339	355	382	405	377	398	398
1993	66	145	211	246	292	324	350	362	376	386	419	389	389	389
1994	66	134	201	247	272	303	333	366	378	389	390	412	418	383
1995	68	130	183	240	277	298	325	358	378	397	409	431	430	467
1996	75	139	168	212	258	289	308	325	353	353	377	404	395	410
1997	63	131	191	233	269	300	324	341	355	362	367	393	398	411
1998	52	134	185	238	264	288	324	340	348	375	406	391	426	456
1999	74	137	204	233	268	294	311	339	353	362	378	385	411	422
2000	62	159	217	268	289	325	342	363	378	393	407	425	436	430
2001	74	139	214	244	286	296	324	347	354	385	403	421	421	433
2002	85	161	211	258	280	319	332	354	405	396	416	433	463	460
2003	72	156	189	229	260	283	309	336	336	369	394	378	412	423
2004	84	149	213	248	280	315	331	349	355	379	388	412	419	425
2005	106	170	224	262	275	298	324	335	335	356	372	394	405	413
2006	107	189	234	263	290	304	339	349	369	416	402	413	413	467
2007	93	158	221	245	261	277	287	311	339	334	346	356	384	390
2008	105	174	232	275	292	307	315	327	345	366	377	372	403	434

Table 11.2.2.4. Icelandic summer-spawning herring. Proportion mature at age (1981 refers to season 1981/1982 etc).

Year\age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1975	0	0.27	0.97	1	1	1	1	1	1	1	1	1	1	1
1976	0	0.13	0.9	1	1	1	1	1	1	1	1	1	1	1
1977	0	0.02	0.87	1	1	1	1	1	1	1	1	1	1	1
1978	0	0.04	0.78	1	1	1	1	1	1	1	1	1	1	1
1979	0	0.07	0.65	0.98	1	1	1	1	1	1	1	1	1	1
1980	0	0.05	0.92	1	1	1	1	1	1	1	1	1	1	1
1981	0	0.03	0.65	0.99	1	1	1	1	1	1	1	1	1	1
1982	0.02	0.05	0.85	1	1	1	1	1	1	1	1	1	1	1
1983	0	0	0.64	1	1	1	1	1	1	1	1	1	1	1
1984	0	0.01	0.82	1	1	1	1	1	1	1	1	1	1	1
1985	0	0	0.9	1	1	1	1	1	1	1	1	1	1	1
1986	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1987	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1988	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1989	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1990	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1991	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1992	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1993	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1994	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1995	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1996	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1997	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1998	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
1999	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2000	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2001	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2002	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2003	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2004	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2005	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2006	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2007	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1
2008	0	0.2	0.85	1	1	1	1	1	1	1	1	1	1	1

Table 11.3.2.1. Model settings and results of model parameters from the NFT-Adapt run in 2009 for Icelandic summer spawning herring.

```
VPA    Version       2.8.0

Model  ID:    Run 1 in 2009 Data from 2008/09 added to last year's run.
Input  File:  C:\ASTA\NFT\VPA\2009\RUN1\RUN1_2009.DAT
Date of Run:  12.mar.09     Time of Run:  15:53
       Levenburg-Marquardt  Algorithm     Completed     6      Iterations

       Residual      Sum    of     Squares       =      28.5379
       Number of     Residuals     =      133
       Number of     Parameters    =      7
       Degrees       of     Freedom       =      126
       Mean   Squared       Residual      =      0.226492
       Standard      Deviation     =      0.475911
       Number of     Years  =      23
       Number of     Ages   =      10
       First  Year          =      1986
       Youngest      Age    =      3
       Oldest TRUE   Age    =      11

       Number of Survey Indices Available =      7
       Number of Survey Indices Used      in Estimate   =      7

       VPA    Classic Method – Auto Estimated    Q's

       Stock  Numbers Predicted in Terminal Year Plus One-2009
       Age    Stock  Predicted     Std.   Error  CV
       4      170640.34       8.36E+04   4.90E-01
       5      299457.016      1.15E+05   3.83E-01
       6      202777.276      7.18E+04   3.54E-01
       7      286491.747      9.84E+04   3.44E-01
       8      165960.9        5.25E+04   3.16E-01
       9      201629.588      6.05E+04   3.00E-01
       10     267182.324      7.51E+04   2.81E-01

       Catchability Values for Each Survey Used in Estimate
       INDEX  Catchability  Std.   Error  CV
       1      1.15E+00      1.16E-01      1.01E-01
       2      1.41E+00      1.53E-01      1.09E-01
       3      1.30E+00      1.07E-01      8.26E-02
       4      1.28E+00      1.08E-01      8.50E-02
       5      1.33E+00      1.35E-01      1.01E-01
       6      1.54E+00      1.99E-01      1.29E-01
       7      1.70E+00      2.43E-01      1.43E-01

--     Non-Linear    Least  Squares       Fit    --

       Default       Tolerances    Used
       Scaled Gradient Tolerance   =      6.06E-06
       Scaled Step   Tolerance     =      3.67E-11
       Relative Function Tolerance =      3.67E-11
       Absolute Function Tolerance =      4.93E-32

       VPA Method Options
       -Catchability Values Estimated as an Analytic Function of N
       -Pope  Approximation Used in Cohort Solution
       -Plus Group   Forward Calculation Method Used
       -Arithmetic   Average Used in F-Oldest Calculation
       -F-Oldest Calculation in Years Prior to Terminal Year Uses Fishing Mortality in
               Ages 8 to 10
       -Calculation of Population of Age 3 In Year 2009=
            Geometric Mean of First Age Populations
```

Table 11.3.2.1.,continues:

Year Range Applied = 1986 to 2005

Stock Estimates

Age 4

Age 5

Age 6

Age 7

Age 8

Age 9

Age 10

Full F in Terminal Year = 0.2676

F in Oldest TRUE Age in Terminal Year = 0.2339

Full F Calculated Using Classic Method

F in Oldest TRUE Age in Terminal Year has been Calculated in Same Manner as in all Other Years

Age	Input Partial Recruitment	Calc Partial Mortality	Fishing Full F	Used In Comments	Recruitment			
3	0.7	0.617	0.1959	NO	Stock	Estimate	in	T+1
4	1	0.798	0.2537	YES	Stock	Estimate	in	T+1
5	1	1	0.3178	YES	Stock	Estimate	in	T+1
6	1	0.962	0.3056	YES	Stock	Estimate	in	T+1
7	1	0.925	0.2941	YES	Stock	Estimate	in	T+1
8	1	0.81	0.2573	YES	Stock	Estimate	in	T+1
9	1	0.557	0.1769	YES	Stock	Estimate	in	T+1
10	1	0.842	0.2676	NO	Input	PR	*	Full F
11	1	0.736	0.2339	F-Oldest				

Table 11.3.2.2. Icelandic summer spawners stock estimates (from NFT-Adapt in 2009) in numbers (thousands) during 1986-2009.

Age\Year	1986	1987	1988	1989	1990	1991	1992	1993
3	1124616	549005	282609	435317	293084	836906	1050011	629976
4	378909	1009821	493770	251190	372367	251035	672906	859856
5	118145	310568	871309	407466	201937	282716	180459	492225
6	97892	84594	223669	693873	294662	148863	173729	126777
7	200210	68904	56927	136434	448389	190754	101601	101450
8	72151	107315	43559	29674	82440	256162	120067	65373
9	52356	47923	53118	20265	19130	45822	127024	72095
10	38699	36923	28873	17432	12727	9522	31874	64413
11	42223	26842	20128	14379	8837	7357	4664	17814
12+	67954	75743	58136	40840	39690	37373	34771	31873
Total	2193155	2317639	2132098	2046872	1773263	2066511	2497104	2461850

Age\Year	1994	1995	1996	1997	1998	1999	2000	2001
3	684768	210178	200029	784017	319187	579438	429942	533551
4	521367	491553	170210	165804	672082	245636	470729	334539
5	608920	363988	314237	115667	121354	441157	170153	296301
6	357224	415066	246722	202350	79636	88222	265134	107076
7	94935	240276	271750	157678	148147	63865	64518	167026
8	64628	62203	144375	165358	110612	95146	44940	47395
9	46488	39165	35964	92906	120113	75407	56159	32774
10	46574	26558	20956	18515	62875	78200	49354	35246
11	43761	27212	15906	10953	8638	42959	49802	35265
12+	39922	57244	57646	50679	38429	33946	48769	66716
Total	2508589	1933443	1477795	1763928	1681074	1743974	1649500	1655890

Age\Year	2002	2003	2004	2005	2006	2007	2008	2009
3	1734797	1220132	643285	1065883	596227	569906	229408	577678
4	442537	1492790	902841	521803	939632	426743	426545	170640
5	220496	333076	1078665	684187	432085	643158	307937	299457
6	179072	156131	246094	802464	506918	338840	429785	202777
7	68030	110473	114658	184161	599171	412723	246130	286492
8	99298	41379	75616	90690	140415	487703	288218	165961
9	33016	49708	23931	59534	70574	114113	352413	201630
10	21320	20469	34567	16166	45114	58157	80974	267182
11	20245	14814	16399	24599	9708	36732	41436	56068
12+	66669	45824	42385	42072	50136	48904	59808	71608
Total	2885481	3484795	3178442	3491558	3389981	3136978	2462654	2299493

Table 11.3.2.3. Estimated fishing mortality at age of Icelandic summer-spawning herring (from NFT-Adapt in 2009) during 1986-2008 and weighed average F by numbers (WF 5-10 and WF 4-8).

Age\Year	1986	1987	1988	1989	1990	1991	1992	1993
3	0.008	0.006	0.018	0.056	0.055	0.118	0.100	0.089
4	0.099	0.048	0.092	0.118	0.175	0.230	0.213	0.245
5	0.234	0.228	0.128	0.224	0.205	0.387	0.253	0.221
6	0.251	0.296	0.394	0.337	0.335	0.282	0.438	0.189
7	0.524	0.359	0.552	0.404	0.460	0.363	0.341	0.351
8	0.309	0.603	0.665	0.339	0.487	0.601	0.410	0.241
9	0.249	0.407	1.014	0.365	0.598	0.263	0.579	0.337
10	0.266	0.507	0.597	0.579	0.448	0.614	0.482	0.287
11	0.275	0.506	0.759	0.428	0.511	0.493	0.490	0.288
12+	0.275	0.455	0.487	0.169	0.098	0.097	0.072	0.035
WF 5-10	0.388	0.387	0.414	0.325	0.406	0.448	0.425	0.255
WF 4-8	0.347	0.297	0.276	0.303	0.364	0.420	0.303	0.244

Age\Year	1994	1995	1996	1997	1998	1999	2000	2001
3	0.232	0.111	0.088	0.054	0.162	0.108	0.151	0.087
4	0.259	0.347	0.286	0.212	0.321	0.267	0.363	0.317
5	0.283	0.289	0.340	0.273	0.219	0.409	0.363	0.404
6	0.297	0.324	0.348	0.212	0.121	0.213	0.362	0.354
7	0.323	0.409	0.397	0.255	0.343	0.251	0.208	0.420
8	0.401	0.448	0.341	0.220	0.283	0.427	0.216	0.262
9	0.460	0.525	0.564	0.291	0.329	0.324	0.366	0.330
10	0.437	0.413	0.549	0.662	0.281	0.351	0.236	0.454
11	0.433	0.462	0.485	0.391	0.298	0.367	0.273	0.349
12+	0.135	0.207	0.221	0.368	0.212	0.341	0.309	0.313
WF 5-10	0.315	0.355	0.375	0.268	0.290	0.378	0.338	0.393
WF 4-8	0.288	0.346	0.350	0.233	0.306	0.361	0.352	0.369

Age\Year	2002	2003	2004	2005	2006	2007	2008
3	0.050	0.201	0.109	0.026	0.234	0.190	0.196
4	0.184	0.225	0.177	0.089	0.279	0.226	0.254
5	0.245	0.203	0.196	0.200	0.143	0.303	0.318
6	0.383	0.209	0.190	0.192	0.106	0.220	0.306
7	0.397	0.279	0.135	0.171	0.106	0.259	0.294
8	0.592	0.448	0.139	0.151	0.107	0.225	0.257
9	0.378	0.263	0.292	0.177	0.094	0.243	0.177
10	0.264	0.122	0.240	0.410	0.106	0.239	0.268
11	0.411	0.278	0.224	0.246	0.102	0.236	0.234
12+	0.583	0.252	0.239	0.151	0.102	0.277	0.228
WF 5-10	0.396	0.246	0.193	0.195	0.117	0.261	0.278
WF 4-8	0.335	0.232	0.185	0.179	0.207	0.256	0.287

Table 11.3.2.4. Summary table from NFT-Adapt run in 2009 for Icelandic summer spawning herring.

Year	Recruits age 3 (millions)	Biomass age 3+ (kt)	SSB (kt)	Landings age 3+ (kt)	Yield/SSB	WF 5-10
1986	1125	449	296	66	0.221	0.388
1987	549	519	394	75	0.191	0.387
1988	283	511	437	93	0.212	0.414
1989	435	473	400	101	0.252	0.325
1990	293	422	362	104	0.288	0.406
1991	837	433	319	107	0.334	0.448
1992	1050	514	353	107	0.304	0.425
1993	630	557	434	103	0.236	0.255
1994	685	562	450	134	0.297	0.315
1995	210	470	414	125	0.303	0.355
1996	200	357	314	96	0.305	0.375
1997	784	379	278	65	0.233	0.268
1998	319	377	309	86	0.279	0.290
1999	579	386	300	93	0.308	0.378
2000	430	408	322	100	0.311	0.338
2001	534	378	293	94	0.319	0.393
2002	1735	592	337	96	0.285	0.396
2003	1220	681	462	129	0.279	0.246
2004	643	730	594	112	0.189	0.193
2005	1066	833	638	102	0.161	0.195
2006	596	889	729	130	0.178	0.117
2007	570	769	650	158	0.243	0.261
2008	229	697	618	151	0.244	0.278
2009	578	628	542			

Table 11.3.2.5. The residuals from survey observations and NFT-Adapt 2009 results for Icelandic summer spawning herring (no surveys in 1994, 1997, and 2001) on 1st January.

Year\Age	4	5	6	7	8	9	10
1988	-0.35	-0.36	0.06	-0.24	-0.58	-0.15	-0.29
1989	-0.36	-0.90	-0.86	0.08	0.16	-0.19	0.10
1990	0.43	-0.46	-0.32	0.04	0.49	-0.29	0.01
1991	-0.78	-0.43	-0.72	-0.24	0.41	0.12	0.85
1992	0.31	0.33	0.35	-0.37	-0.15	0.27	-0.93
1993	-0.17	0.05	-0.04	0.01	-0.47	-0.15	-0.12
1994	-0.17	0.03	0.07	-0.59	-0.39	0.39	-0.48
1995							
1996	-0.38	0.54	-0.14	0.11	-0.08	0.57	0.31
1997	0.35	-0.20	0.58	0.29	0.39	0.42	1.09
1998							
1999	-0.10	0.55	-0.10	-0.45	0.07	-0.50	-0.27
2000	0.44	0.00	0.56	0.07	-0.32	0.65	0.07
2001	0.92	1.15	0.32	0.82	-0.61	-1.17	-0.46
2002							
2003	0.11	0.16	0.01	0.62	1.02	1.28	1.05
2004	0.32	0.30	0.03	-0.29	0.00	0.05	-0.25
2005	0.17	0.06	0.00	-0.32	-0.66	-0.73	-0.92
2006	-0.89	-0.57	0.22	0.47	0.41	0.11	0.53
2007	0.22	0.16	-0.07	-0.22	0.07	-0.61	0.23
2008	-0.07	-0.41	-0.03	-0.01	0.05	0.26	0.48
2009	0.00	-0.01	0.09	0.23	0.19	-0.32	-0.99

Table 11.6.1.1. The input data used for prognosis of the Icelandic summer-spawning herring. The mean weights are based on last three years (2006-08), M is set 0.1 (as usually), proportion of M before spawning is set 0.5, number at age derives from NFT-Adapt run but are reduced according to the estimated *Ichthyophonus* infection rate in the stock in January 2009 of 32.2%, and the geometric mean of number at age 3 on Jan. 1st from 1986-2008, reduced because of the infection, was used as the number of recruits (but see scenario 2 in section 11.7.1 regarding the 2006 year class).

Age	Mean weights (kg)	M	Maturity ogive	Selection pattern	Mortality prop. before spawn. F	M	Number at age Jan. 1st 2009
3	0.173	0.1	0.2	0.7	0	0.5	391.12
4	0.229	0.1	0.85	0.9	0	0.5	115.53
5	0.261	0.1	1	1	0	0.5	202.75
6	0.281	0.1	1	1	0	0.5	137.29
7	0.296	0.1	1	1	0	0.5	193.97
8	0.314	0.1	1	1	0	0.5	112.37
9	0.329	0.1	1	1	0	0.5	136.51
10	0.351	0.1	1	1	0	0.5	180.90
11	0.372	0.1	1	1	0	0.5	37.96
12+	0.390	0.1	1	1	0	0.5	48.48

Table 11.6.2.1. The prognosis of the Icelandic summer spawning herring for 2009/2010 fishing season from the final NFT-Adapt run in 2009 with five different scenarios where the possible infection rate in July 2009 varies from 0% (Scenario 1) to 40% (Scenario 5). The TAC is determined from F=0.22, but limited to leave at least SSB of 300 kt in the season 2010/2011. The biomasses of 3+ and the spawning stock are in the beginning of the fishing season and are in thousands tons.

	2009/2010					2010/2011	
	Possible infection rate in July 2009 (%)	3+ stock*	Sp. Stock*	TAC	F (5-10)	3+ stock	Sp. Stock
Scenario 1	0	420	344	75	0.22	443	335
Scenario 2	10	378	310	68	0.22	408	303
Scenario 3	20	336	275	30	0.10	405	301
Scenario 4	30	294	241	0	0.00	395	291
Scenario 5	40	252	206	0	0.00	352	252

*** On Sept. 1st 2009 or at the beginning of the fishing season 2009/2010.**

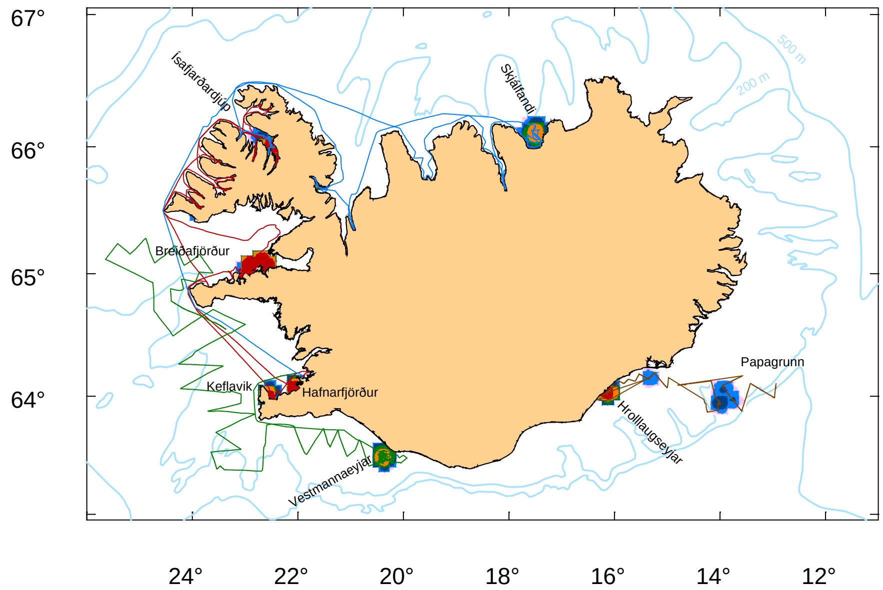

Figure 11.1.1. Distribution of Icelandic summer-spawning herring according to acoustic surveys in December 2008 and January 2009 (total 540 thousands tonnes). The purple cruise tracks off the SE coast represent combined capelin and herring surveys. The locations indicated refer to the text.

Figure 11.1.2 Total biomass index for Icelandic summer-spawning herring from the acoustic surveys for ages 4+ in the areas east and west of 18°W and then combined. The years in the plot (1973-2008) refer to the autumn of the fishing seasons.

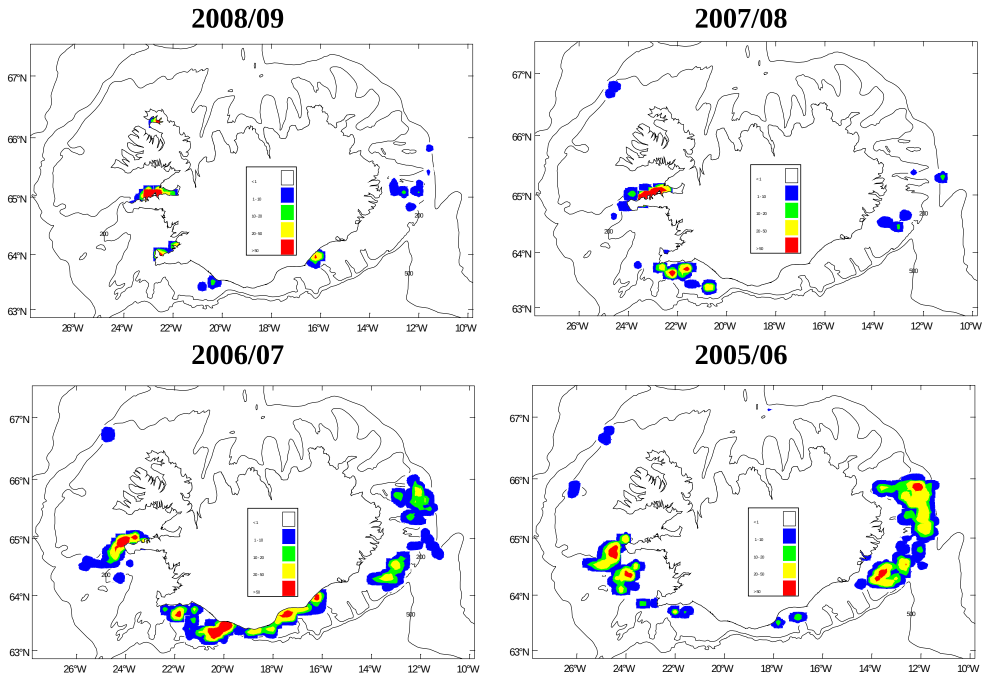

Figure 11.2.1. The distribution of the fishery of Icelandic summer spawning herring during the fishing season 2008/09 in comparison to previous three seasons.

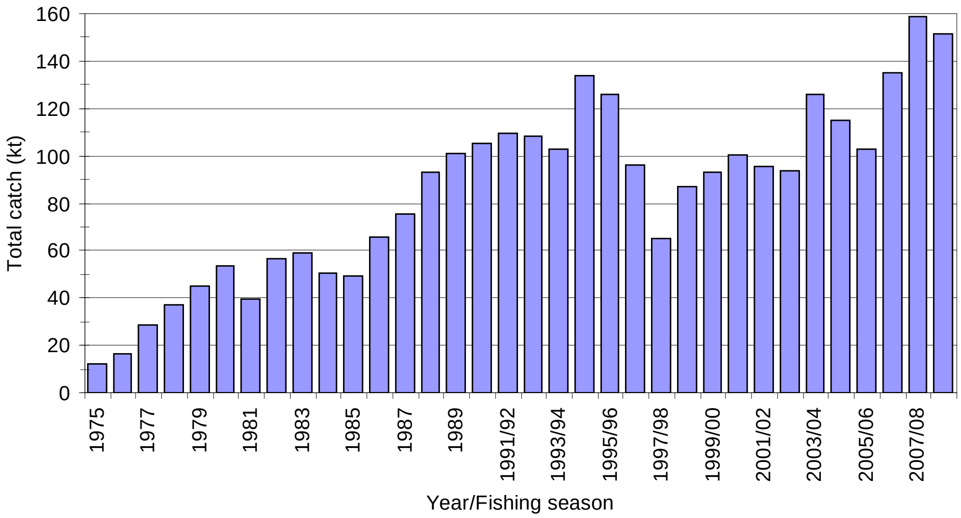

Figure 11.2.2. Icelandic summer spawning herring. Total catch (in thousand tonnes) in 1975-2008/09.

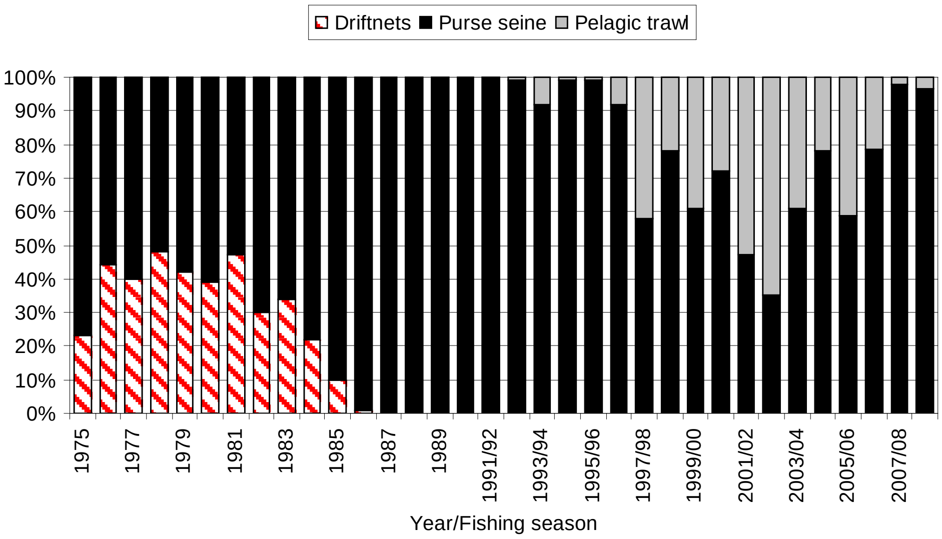

Figure 11.2.1.1. Icelandic summer spawning herring. Proportion of the total catches of the Icelandic summer-spawning herring in 1975/76-2008/09 taken by different gears.

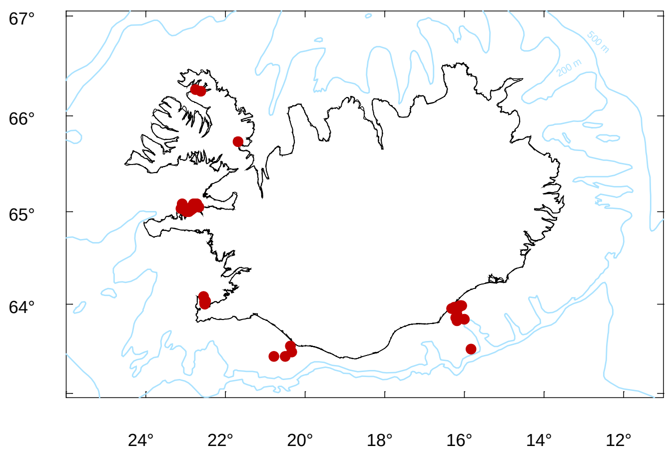

Figure 11.2.2.1. The locations of the Icelandic summer-spawning herring catch samples in 2008/09.

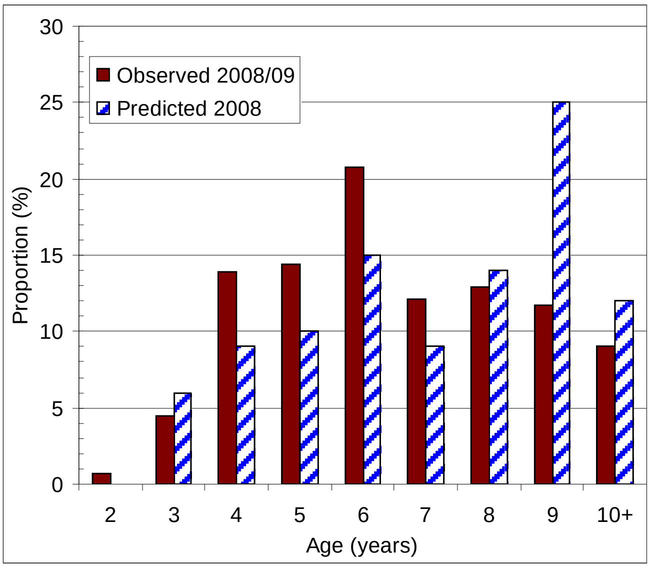

Figure 11.2.2.2. Icelandic summer spawning herring. Predicted catch in weight (%) in the assessment 2008 and observed catch in the season 2008/09.

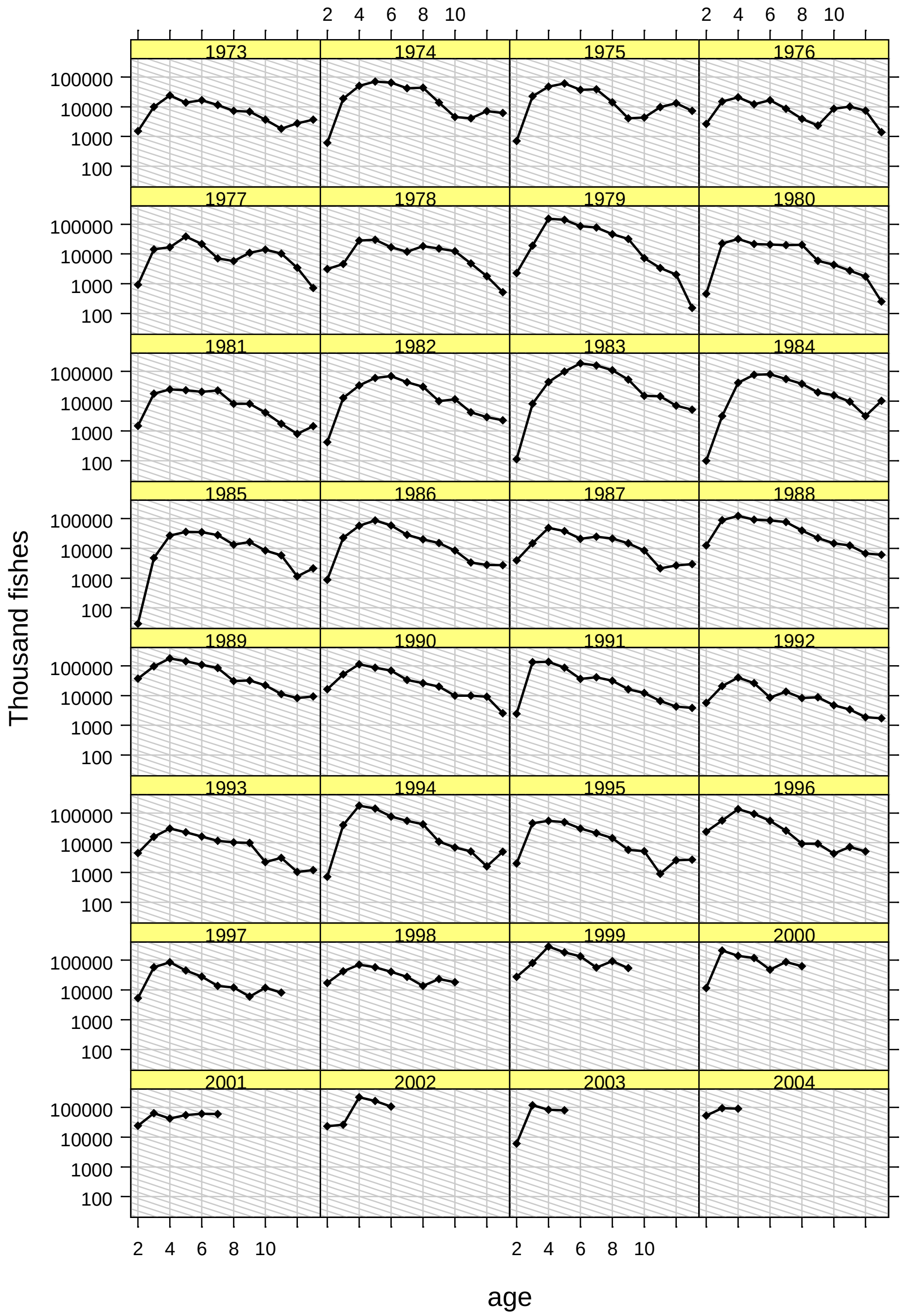

Figure 11.3.1.1. Icelandic summer-spawning herring. Catch curves by year classes 1973-2004. Grey lines correspond to Z=0.4.

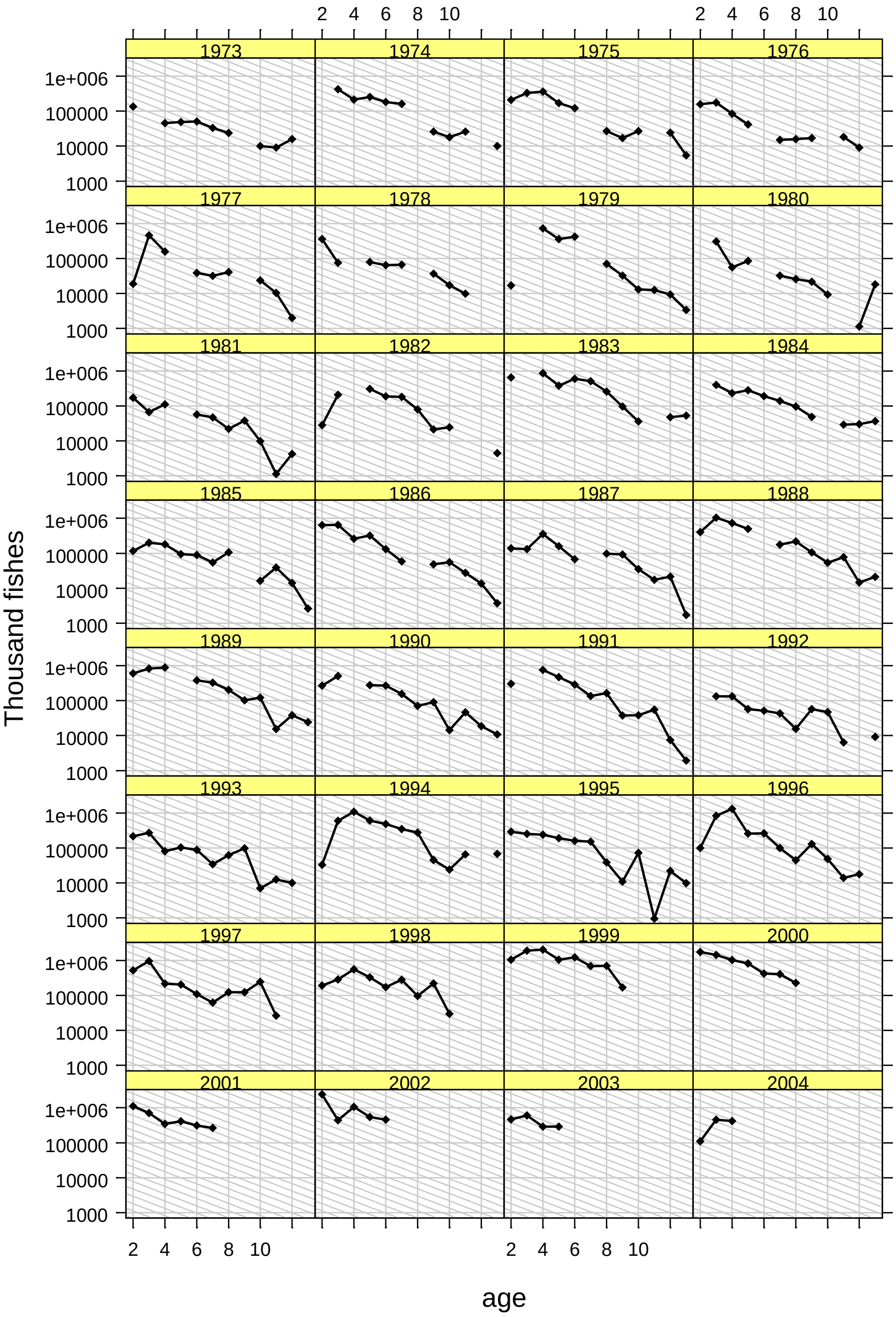

Figure 11.3.1.2. Icelandic summer spawning herring. Catch curves from survey data by year classes 1973-2004. Grey lines correspond to Z=0.4.

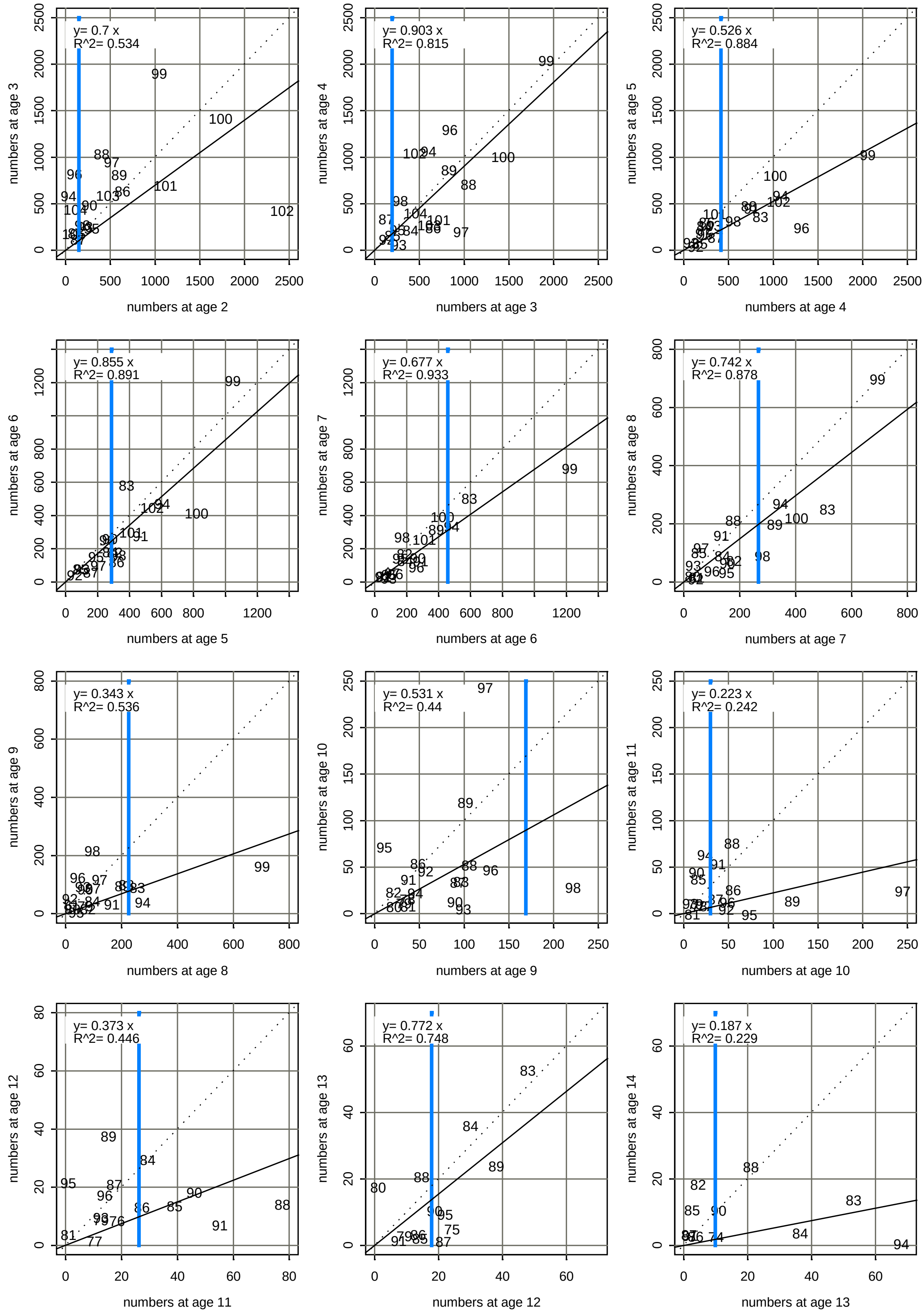

Figure 11.3.1.3. The relationship between acoustic survey indices for age groups 2 to 13 and the same year classes (indicate on graphs) a year later for Icelandic summer-spawning herring. The bolded vertical line represent the acoustic indices in December 2008.

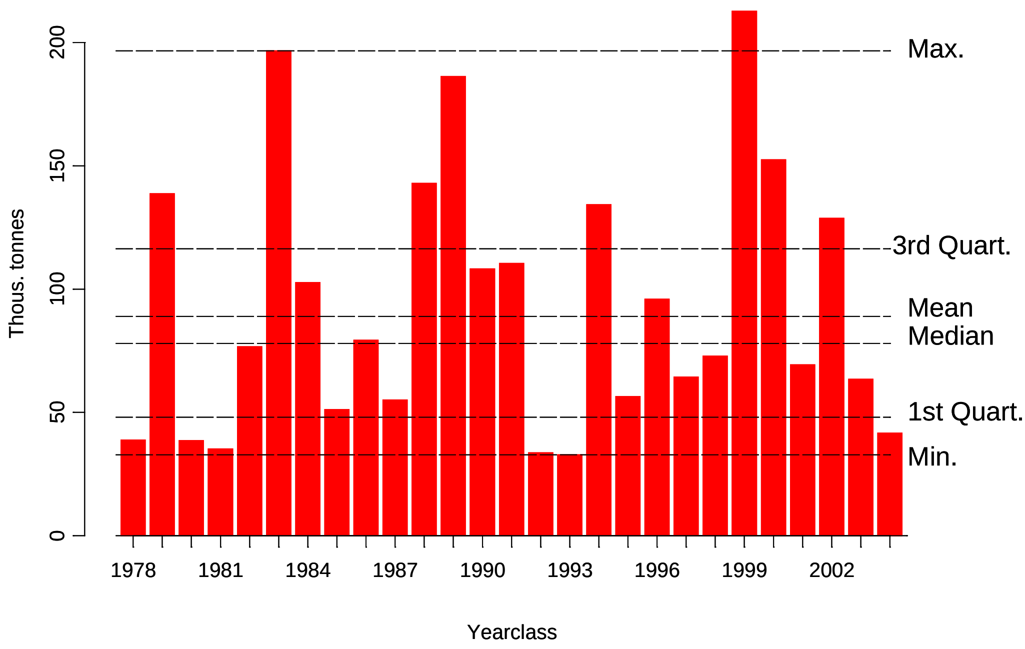

Figure 11.3.1.4. The sum of total catch of each year class of Icelandic summer-spawning herring during 1971 to 2008/09. The provided summary statistic is based on yearclasses from 1978 to 1997.

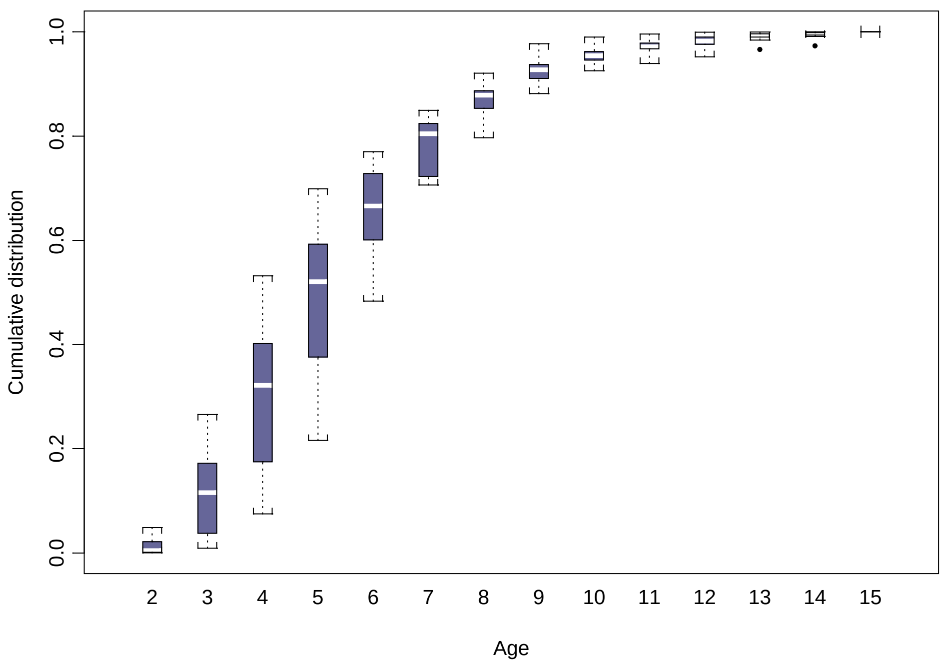

Figure 11.3.1.5. The cumulative total biomass in the catch (in proportion) of Icelandic summer-spawning herring for different age group for the year classes 1978 to 1996.

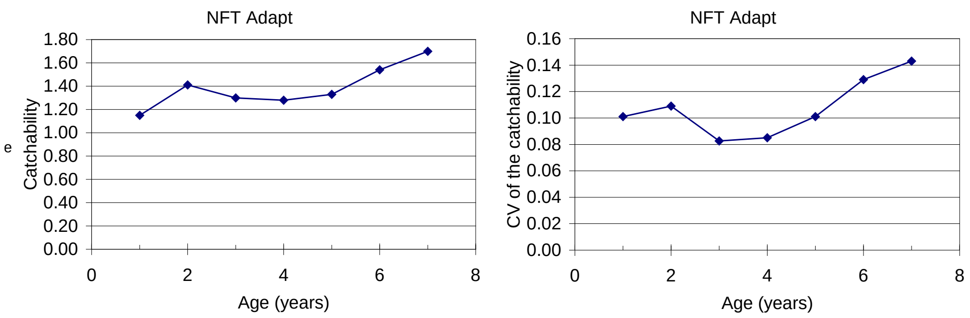

Figure 11.3.2.1. Icelandic summer-spawning herring. The catchability and its CV for the acoustic surveys used in the final Adapt run in 2009.

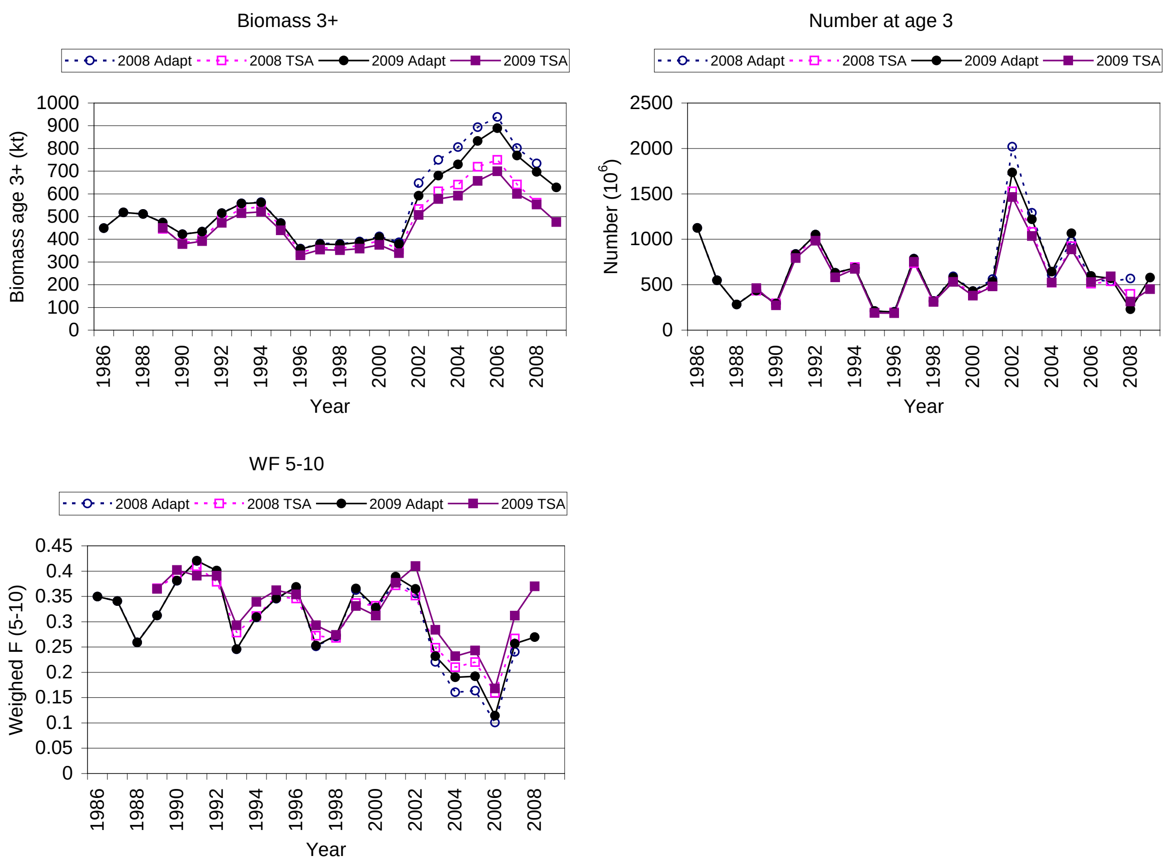

Figure 11.3.2.2. Icelandic summer-spawning herring. Comparisons of NFT-Adapt and TSA runs in 2008 and in 2009.

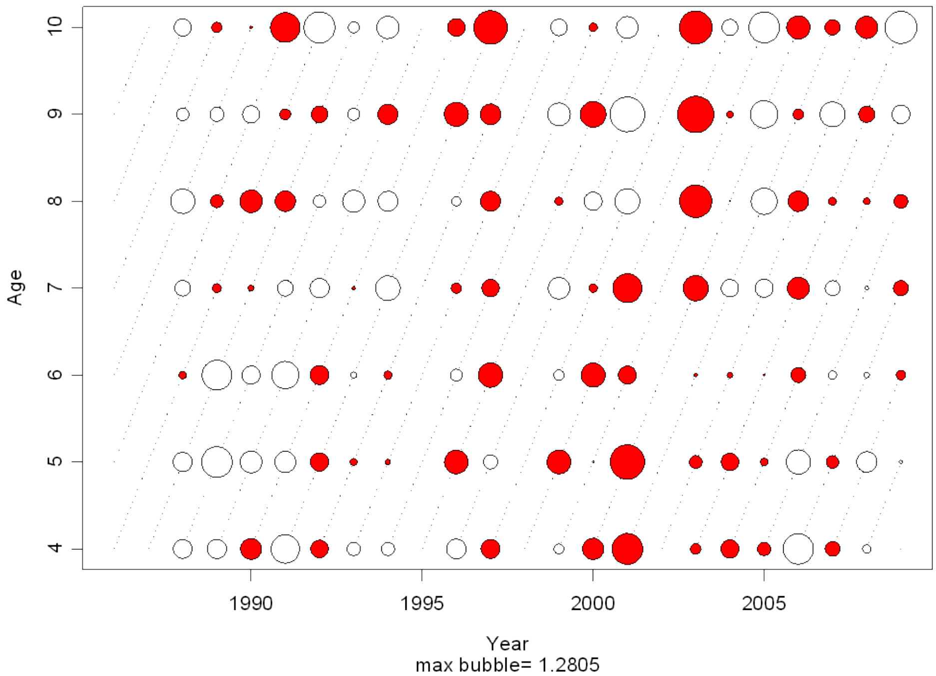

Figure 11.3.2.3. Icelandic summer spawning herring. Residuals of NFT-Adapt run in 2009 from survey observations (moved to 1st January). Filled bubbles are positive and open negative. Max bubble = 1.28.

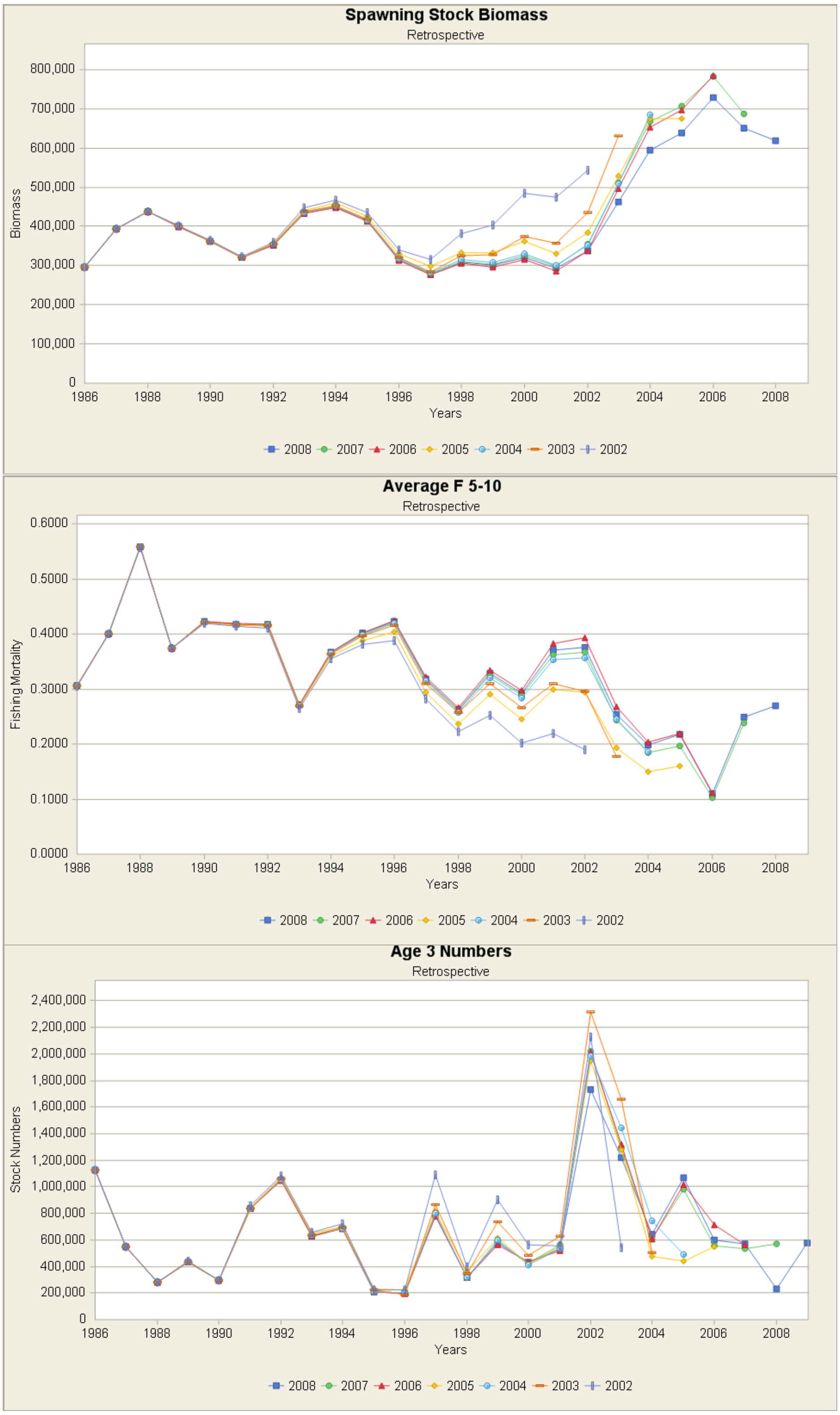

Figure 11.3.2.4. Icelandic summer spawning herring. Retrospective pattern in spawning stock biomass, N weighted F and recruitment (N at age 3) from NFT-Adapt in 2009.

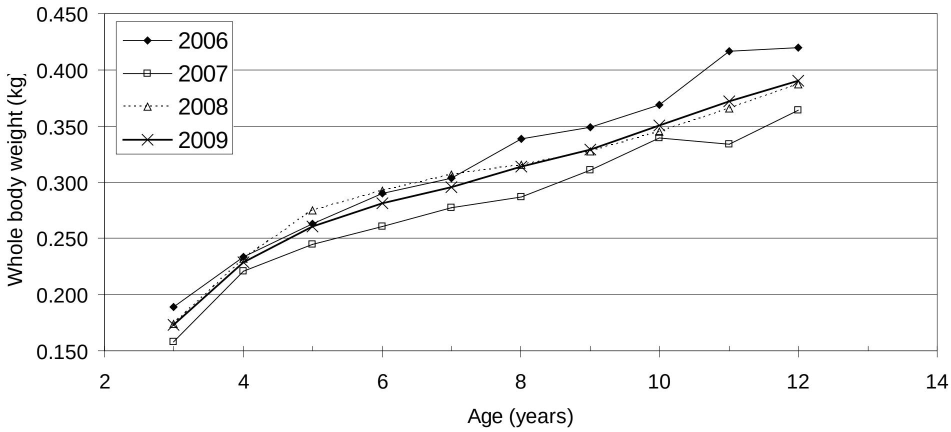

Figure 11.6.1.1. Icelandic summer spawning herring. The mean weight at age for age groups 3 to 12 (+ group) during 2006 to 2008 and the average across the three years that represents 2009 in the stock prognosis.

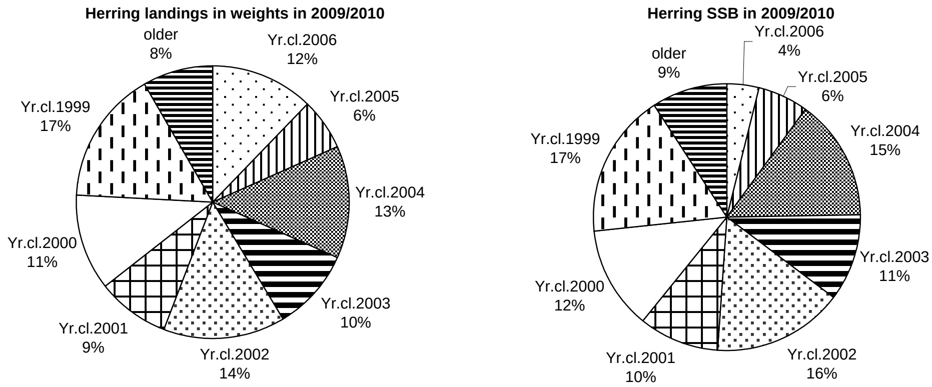

Figure 11.6.2.1. The expected catch composition (to left; weights in %) and expected SSB composition (to right; in %) of different year classes of Icelandic summer spawning herring in the fishing season 2009/10 as estimated from NFT adapt.

12 Capelin in the Iceland-East Greenland-Jan Mayen area

Summary

- Last year (2008) no starting quota was issued.
- There was no official fishery because the acoustic measurements prior to the spawning gave only SSB of 320 000 t. The only catch was 15 000 t that was allocated to scouting vessels in February. The stock has been at low levels the last 4 years.
- Only very low abundance of 1 year old capelin was measured in November-December 2008.
- The advice is therefore not to open the fishery in the season 2009/10 until acoustic assessment surveys have verified that a catch can be allowed with the usual prerequisite of a remaining spawning stock of 400 000 t in March 2010 after accounting for the natural mortality.

12.1 Stock description and management units

The capelin is a small pelagic shooling fish. It is a cold water species that occurs widely in the northern hemisphere. The capelin in the Iceland-East Greenland-Jan Mayen area is considered to be a separate stock. The spawning grounds are in shallow waters (10-150 m) off the south-east, south and west coast of Iceland. Spawning peaks in March. Capelin spawn mainly at the age 3-4 years and the males and most of the females die after spawning. Capelin is a migratory fish. Changes in distribution and migrations of both the adult and juvenile parts of the stock around 2002 are discussed in section 7 (see Figure 7.3.4 and Figure 7.3.5. Capelin is a very important forage species for several commercial fish species and especially cod.

The fishing is shared between Iceland, Norway, Faroe Islands and Greenland by a special agreement, but by far the largest quantities are fished by Iceland.

12.2 Scientific data

Surveys

Several surveys aimed at different age groups of capelin have been conducted through the years. The purpose of the surveys on young capelin is to locate and estimate the abundance of young capelin. The results from these surveys are used to predict a starting quota for the fishing season starting in the year after the surveys are conducted. The surveys aimed at the fishable part of the stock are conducted in the fishing season, either in autumn or in winter. The purpose of these surveys is to assess the size of the fishable stock and on its basis to set a final TAC for the season.

0-group and 1-group surveys in August

The distribution and abundance of 0-group capelin in the Iceland-East Greenland-Jan Mayen area has not been recorded in August since 2003 as the survey was discontinued in 2004. The abundance indices for the 0-group in the years 1970-2003 are given in Table 12.2.1. Age 1 capelin was recorded during these 0-group surveys in the years 1983-2001. The estimated numbers, mean length and weight of age 1 capelin are given in Table 12.2.2. The results from these surveys did not prove to be useful for predicting starting quota.

Surveys on immature 1 and 2 capelin in autumn

The surveys, aimed at young capelin in October to December, have been the basis for the starting quota in many years. But in the years 2001 to 2005 and 2007 these surveys failed to locate the juveniles and therefore a starting quota could not be set on the basis of their results.

In November 2006 survey recorded immature capelin, mostly in the Denmark Strait and north of the Vestfirdir peninsula but also in more scattered condition off the Icelandic north coast. The total estimate came to about 45 billion age 1 capelin, which is roughly half that indicating an average-to-large year class. The numbers of age 2 immature capelin were very low, which is in tune with the low contribution of age group 4 to the spawning stock in the last few years. Although juvenile capelin were not registered in large numbers, their distribution pattern had become quite similar to that experienced prior to 2002.

In November-December 2008 the survey located the young capelin only in small numbers (Table 12.2.3 and Figure 12.2.1). The abundance of one year old capelin measured was only $12.5*10^9$ where almost all capelin larger than 12.5 cm were mature and preparing spawning. Thus, only about $7*10^9$ of one year old immature capelin were measured in the survey, indicating that preliminary quota cannot be set for the fishing season 2009/10.

In November-December 2008, 0-group capelin was observed in large number, in historical perspective, over the Greenland and Iceland shelf all the way to East Iceland. No estimate of numbers are available but it is concluded that the spawning success of the capelin stock in 2008 was very high. The relative acoustic density distribution (Sa-values) of the 0-group is shown in Figure 12.2.2.

Oceanography/ecology survey in summer

In July 2006 a multidisciplinary project began (oceanography/ecology) covering the area from Ammassalik in the west to about 10°W east of Iceland as well as the Iceland Sea north to 71-72°N. One of the main purposes of this project is to study the distribution, behaviour and feeding habits of all age groups of capelin in spring and summer.

With regard to capelin, the survey in 2006 was not very successful since ice still covered large areas of the Greenland plateau. Capelin was encountered fairly widely in the survey area but in low abundance.

In August 2007 two year old capelin was found along the continental slope at East Greenland between 68° -70°30′N but the abundance was very low.

In August 2008 the stock had a more southerly distribution in the Denmark Strait and over the Greenland shelf but still the abundance was very low.

Surveys on the adult fishable stock

The acoustic surveys on the maturing, fishable stock have been carried out in October-December and/or in January/February in the fishing season. In the last 9 years it has not succeeded to acoustically measure the fishable stock before New Year and final catch quotas have therefore often been set late in the fishing season. This fishing season 2008/09 was an exception, as a survey in November-December seems to have covered most if not all of the very few adult capelin which came in for spawning in 2009. The survey resulted in total biomass of 370 000 t. The spawning stock biomass was estimated as 320 000 t (Table 12.2.3 and Figure 12.2.1). The resulting biomass estimate was however too low to recommend a quota.

In January four acoustic assessments of the stock were made off NE and E-Iceland. The first two surveys were conducted by one research vessel (r/v Arni Fridriksson) and three scouting vessel, which had the same equipments as the research vessel. The size of the migration was estimated as 140 000 t total biomass by the research vessel and 215 000 tonnes by the scouting vessel. The distribution of the SA-values in the research vessel survey is shown in Figure 12.2.3. The two latter surveys made in January were conducted by the r/v Arni Fridriksson. The research vessel sailed against the capelin migration during the survey 21-29 January. The total biomass was estimated as 392 000 t, but the spawning biomass as 383 000 t. During the survey 29 January – 2 February the research vessel followed the capelin migration. Some of the capelin recordings were close to the surface above the transducer and therefore not included in the assessment. The total biomass was estimated 334 000 t and the spawning stock biomass 330 000 t. The distribution of the SA-values for these two surveys are shown in Figure 12.2.4. The two acoustic assessments made at the end of January are considered to be fairly consistent. The mean of the two surveys is taken as the final estimate of the size of the capelin spawning migration east off Iceland at the end of January (Table 12.2.4). The total biomass thus estimated was 363 000 t and the spawning stock biomass as 357 000 t.

As a consequence of the low abundance in all the surveys in January the Marine Research Institute (MRI) did not recommend a capelin quota to the Ministry of Fisheries.

During February, more attempts of assessing the stock were made as the spawning migration moved inshore at the southeast, south and southwest Iceland but all attempts to locate more capelin failed. Furthermore, an extensive scouting program was instigated in deeper waters off the east and south coast as well as off the north and west coast with the participation of both research and fishing vessels but to no avail and there were no indications of a western migration this year. All attempts to locate any further migrations were finally abandoned in the beginning of March and no catch quotas were set for the fishing season 2008/09 apart for a quota of 15 000 tonnes allocated to the scouting vessels.

Good consistency is between the survey made in November and the two latter ones in January. The mean of the two surveys conducted 21 January-2 February is considered as a final assessment for the fishing season 2008/09 (Table 12.2.4)

12.3 Information from the fishing industry

The fishery is primarily based on maturing capelin of each year class which spawns at age 3 as well as those fish at age 4, that did not mature and spawn at age 3.

A starting quota for a fishing season is allocated to Iceland, Norway, Faroe Islands and Greenland by an existing agreement between the nations. No direct fishery was allowed in the season 2008/09 as surveys failed to record enough capelin to start the fishery according to the catch rule in effect. Usually the first spawning migration enters the warm Atlantic water off the southeast coast at the beginning of the second week of February. From there they migrate fairly fast westward in near-shore areas. This was the case in February 2009. As said earlier only a scouting quota of about 15 000 tonnes was caught in the latter half of February- beginning of March and it was all frozen for human consumption and roe processing. This limited fishery took place off South Iceland and in Faxaflói (Fig 12.3.1).

The total annual catch of capelin in the Iceland-East Greenland-Jan Mayen area since 1964 is given by weight, season, and fleet in Table 12.3.1 and Figure 12.3.2.

No summer fishery took place in 2006, 2007 and 2008 but the total catches in numbers by age during the summer/autumn 1985–2005 are given in Table 12.3.2 and Figure 12.3.2.

The catch in number by length groups at age for the winter season 2009 are given in Table 12.3.3. and the total catches in numbers by age during the winter seasons 1986–2009 are in Table 12.3.4.

Preliminary and recommended TAC as well as landings for the fishing seasons 1994/95 – 2008/09 are given in Table 12.3.5.

12.4 Methods

Stock projections

To calculate the stock numbers at age on the 1 January one has to take into account both the results from the final acoustic survey and how much has been taken by the fishery. Let us assume that the final assessment survey was in winter and only winter fishery took place. The calculations are simple back-projections of stock numbers. Let $I_{a.}$=abundance at age a (a=3 and 4) in the survey and C_a=the total number caught at age a prior to the survey. Assuming that there is no survival of spawners, we are practically calculating the number of mature capelin at age 3 and 4.

The stock number N_a at age a on the 1 January is $N_a = I_a\, e^{iM} + C_a\, e^{i1/2M}$, where i=the number of months between 1 January and the acoustic survey and M=0.035 (a monthly natural mortality).

Further details can be found in Gudmundsdottir, A., and Vilhjálmsson, H. 2002.

Stock prognosis

The fishable stock consists primarily of only two year classes, i.e. age classes 2 and 3 in autumn, spawning at age 3 and 4 at the end of the fishing season. Therefore one needs to know how many mature capelin will be at age 2 and 3 in autumn, to be able to predict a quota.

There exists a linear relationship between the abundance of 1 year old capelin in year y and the number of 2 years old mature capelin in year y+1. A similar relationship exists between the total number of 2 years old in year y and 3 years old mature ones in year y+1. Therefore one can for example predict the number of 2 and 3 years old in autumn 2009 if one has the abundance of 1 and 2 year old in autumn 2008.

An account is taken of some things in the stock prognosis, such as the mean weight being inversely related to the total adult stock in numbers, weight gain from autumn to winter and that 400 000 t have to be left to spawn. Detailed description is given in Gudmundsdottir, A., and Vilhjálmsson, H. 2002.

12.5 Reference points

Reference points have not been defined for this stock. The proposal is to use B_{lim}=400 000 t, which is the targeted remaining spawning stock for capelin in the Iceland-East Greenland-Jan Mayen area since 1979.

The definition of other precautionary reference points is even more problematic.

12.6 State of the stock

The state of the stock is very uncertain. The SSB is highly variable because it is dependent on only two age groups. It is estimated that 328 000 t were left for spawning in spring 2009 (Table 12.6.1). It is clear that the stock has been at low level the last four fishing seasons. Only few 1 year old capelin were measured in autumn 2008 and immature 2 year old were hardly seen, both of which should be in the SSB in spring 2010.

The number of 4 years old capelin in the catches have been declining since the fishing season 1986/87 and were at very low level in the fishing seasons 2005/06-2007/08. This seams to follow the year class size at age 3 in the stock, so it might indicate that the stock has been at low levels in the years 2005/06-2007/08. In 2009 the percentage proportion of 4 year old capelin in the spawning stock increased again but this can be explained by the fact that the stock numbers of other age groups are very low.

The historical estimates of stock abundance are based on the "best" acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys, the "best" in each case being defined as that estimate on which the final decision of TAC was based. Taking account of the catch in number and a monthly natural mortality rate of M = 0.035 (ICES 1991/Assess:17), abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are not known, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight at age for mature and immature capelin in the Iceland-East Greenland-Jan Mayen area has been calculated with reference to 1 January of the following year for the 1978/79–2008/09 seasons. The results are shown in Table 12.6.1 and also the remaining spawning stock by number and biomass in March/April 1979–2009.

An overview of stock development during 1978–2009 is given in Table 12.6.2.

12.7 Short term forecast

To predict the abundance of the fishable stock in the 2009/10 season knowledge of the amount of immature capelin at age 1 and 2 from the autumn 2008 are needed. As the measurement of 1 year old capelin is so low (corresponding to a SSB of less than 100 000 t) and the numbers of immature capelin at age 2 were very low then a starting quota cannot be given for the fishing season 2009/10. There should be no fishery until new information on stock size becomes available predicting SSB of at least 400 000 t in March 2010 in addition to a sizeable amount for fishing.

12.8 (Medium term forecasts)

12.9 Uncertainties in assessment and forecast

The stock was acoustically assessed in deep waters off East-Iceland and survey conditions were good. This year several acoustic surveys were also conducted in shallow water south of Iceland. The latter surveys gave in all instances smaller spawning stock biomass than the assessments off the east coast. Comparisons between acoustic biomass assessments in deep and shallow water do not exist. It is known that it is more difficult to separate other species and the bottom from the targeted species in shallow water when the shoal is very dense and surface schooling may sometimes be a problem.

The practice of increasing searching time when the acoustic measurements of capelin are low, as the tendency has been in recent years, should be considered more carefully as they may result in a biased assessment of stock size.

12.10 Comparison with previous assessment and forecast

Last year there was no predicted quota (for 1 November 2008) and the state of the stock was considered uncertain. This assessment gives a spawning stock biomass of about 328 000 t which is below the management target. No final TAC was set for the fishing season 2008/09. Like last year no starting quota can be set for the fishing season 2009/10 due to low abundance of juvenile capelin.

12.11 Management plans and evaluations

The fishery is managed according to a two-step management plan which requires a minimum spawning-stock biomass of 400 000 t by the end of the fishing season. The first step in this plan is to set a preliminary TAC based on the results of an acoustic survey carried out to evaluate the immature (age 1 and most of age 2) part of the capelin stock about a year before it enters the fishable stock. The initial quota is set at 2/3 of the preliminary TAC, calculated on the condition that 400 000 t of the SSB should be left for spawning. The second step is based on the results of another survey conducted during the fishing season for the same year classes. This result is used to revise the TAC, still based on the condition that 400 000 t should be left for spawning.

ICES has not evaluated the management plan with respect to its conformity to the precautionary approach.

12.12 Management considerations

In recent years, the fishery due to small TAC has changed from being mostly an industrial fishery to being mostly for human consumption.

12.13 Ecosystem considerations

Capelin is an important forage fish and declines in stock may be expected to have implications on the productivity of their predators, see further in section 7.3.

12.14 Regulations and their effects

Over the years the fishery has been closed during April - late June and the season has started in July/August or later, depending on the state of the stock. Due to very low stock abundance there was a fishing ban lasting from December 1981 to November 1983. There was also a ban on capelin fishing during the summer/autumn seasons in 2005, 2006 and 2007 due to lack of information on the state of the stock. In addition, areas with high abundances of juvenile age 1 and 2 capelin (on the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

Discards are allowed when catches are beyond the carrying capacity of the vessel. Methods of transferring catches from the purse seine of one vessel to another vessel were developed long ago, and since skippers of purse-seine vessels generally operate in groups due to the behaviour of the fish, discards are practically zero. In the pelagic trawl fishery, such large catches of capelin rarely occur.

A regulation calling for immediate, temporary area closures when high abundance of juveniles are measured in the catch (more than 20% of the catch composed of fish less than 13 cm) is enforced, using on-board observers.

12.15 Changes in fishing technology and fishing patterns

Until 1975 only winter fishery took place (January-March), even only in February-March the first 8 years (1965-1973). Summer fishery began in 1976 in deep water north of Iceland. The fishery then soon became multinational. When the fishery started in mid 1960 it was exclusively purse seine fishery, but in mid 1990s the pelagic trawl was introduced to the capelin fishery. Variable amount of the catches have been taken with pelagic trawl through the fishing seasons. Only small part was taken with the pelagic trawl in the fishing season 2007/08. Since 2005 only winter fishery has taken place.

12.16 Changes in the environment

Icelandic waters are characterized by highly variable hydrographical conditions, with temperatures and salinities depending on the strength of Atlantic inflow through the Denmark Strait and the variable flow of polar water from the north. Since 1996 the quarterly monitoring of environmental conditions of Icelandic waters shows a rise in sea temperatures north and east of Iceland, which probably also reaches farther north and northwest. The temperature increase is so great that it may have led to displacements of the juvenile part of the capelin stock. More detailed description is in section 7.3.

References

Gudmundsdottir, A., and Vilhjálmsson, H. 2002. Predicting total allowable catches for Icelandic capelin, 1978–2001. – ICES Journal of Marine Science, 59: 1105–1115.

Table 12.2.1 Abundance indices of 0-group capelin 1970-2003 and their division by areas. No surveys after 2003.

Year	NW-Irminger Sea	West Iceland	North Iceland	East Iceland	Total
1970*	1	8	2	-	11
1971*	+	7	12	+	19
1972	+	30	52	7	89
1973	14	39	46	17	116
1974	26	44	57	7	134
1975	3	37	46	3	89
1976	2	5	10	15	32
1977	2	19	19	3	43
1978	+	2	29	+	31
1979	4	19	25	1	49
1980	3	18	19	+	40
1981	10	13	6	-	29
1982	+	8	5	+	13
1983	+	3	18	1	22
1984	+	2	17	9	28
1985	1	8	19	3	31
1986	+	16	17	4	37
1987	1	6	6	1	14
1988	3	22	26	1	52
1989	1	13	24	2	40
1990	+	7	12	2	21
1991	8	2	43	1	54
1992	3	11	20	+	34
1993	2	21	13	15	51
1994	3	12	69	10	94
1995	+	6	10	8	24
1996	2	17	57	6	82
1997	5	14	30	12	61
1998	+	7	34	5	46
1999	NA	25	51	7	83
2000	NA	1	7	4	12
2001	NA	25	53	4	82
2002	NA	17	8	1	26
2003**	+	+	4	+	5

*** These data are considered less reliable since the distribution area could not be covered adequately.**

**** No surveys after 2003**

Table 12.2.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys for 1983–2001.

Year	Number (10^9)	Mean length (cm)	Mean weight (g)
1983	155	10.4	4.2
1984	286	9.7	3.6
1985	31	10.2	3.8
1986	71	9.5	3.3
1987	101	9.1	3
1988	147	8.8	2.6
1989	111	10.1	3.4
1990	36	10.4	4
1991	50	10.7	5.1
1992	87	9.7	3.4
1993	33	9.4	3
1994	85	9	2.8
1995	189	9.8	3.4
1996	138	9.3	2.9
1997	143	9.3	2.8
1998	87	9	2.9
1999	55	9.5	3.2
2000	94	9.5	3.1
2001	99	10	3.7

*** No surveys after 2001**

Table 12.2.3 Assessment of young capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson 17/11-12/12 2008. (Numbers in billions, biomass in thousand tonnes)

		Age/Year class					
Length (cm)	Mean weight (g)	1 2007	2 2006	3 2005	Numbers (10^9)	Biomass (10^3 t)	Total
9	2.4	0.082	0.000	0.000	0.082	0.197	
9.5	2.5	0.054	0.000	0.000	0.054	0.136	
10	3.4	0.354	0.000	0.000	0.354	1.202	
10.5	4.1	0.890	0.000	0.000	0.890	3.645	
11	4.73	1.018	0.000	0.000	1.018	4.817	
11.5	6.86	1.344	0.347	0.000	1.691	11.608	
12	6.63	1.754	0.000	0.000	1.754	11.632	
12.5	7.74	1.980	0.082	0.000	2.062	15.951	
13	8.96	1.708	0.041	0.000	1.749	15.674	
13.5	10.64	1.553	0.487	0.000	2.040	21.700	
14	11.96	0.627	0.486	0.059	1.172	14.016	
14.5	13.25	0.940	0.640	0.003	1.582	20.960	
15	15.15	0.170	2.608	0.041	2.819	42.698	
15.5	17.51	0.047	2.170	0.365	2.582	45.216	
16	19.39	0.018	1.859	0.337	2.215	42.934	
16.5	22.31	0.006	1.743	0.169	1.917	42.782	
17	24.98	0.000	1.355	0.351	1.706	42.630	
17.5	27.64	0.000	0.651	0.295	0.946	26.148	
18	30.22	0.000	0.018	0.146	0.164	4.968	
18.5	32.4	0.000	0.000	0.018	0.018	0.582	
TSN (10^9)		12.544	12.487	1.785	26.815		
TSB (10^3)		101.820	227.673	40.007		369.500	
Mean weight (g)		8.1	18.2	22.4			13.8
Mean length (cm)		12.4	15.6	16.5			14.2
% N		46.8	46.6	6.7			100
SSN (10^9)		5.069	12.140	1.785	18.993		
SSB (10^3)		55.648	225.286	40.008		320.942	

Table 12.2.4 Capelin. Final assessment of capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson January 2009. (Numbers in billions, biomass in thousand tonnes)

		Age/Year class						
Length (cm)	Mean weight (g)	2 2007	3 2006	4 2005	5 2004	Numbers (10^9)	Biomass (10^3 t)	Total
10	4.00	0.000	0.007	0.000	0.000	0.007	0.029	
10.5								
11								
11.5	6.17	0.099	0.000	0.000	0.000	0.099	0.612	
12	6.90	0.160	0.000	0.000	0.000	0.160	1.106	
12.5	8.35	0.300	0.000	0.000	0.000	0.300	2.500	
13	11.91	0.334	0.076	0.000	0.000	0.411	4.891	
13.5	10.66	0.574	0.365	0.000	0.000	0.939	10.012	
14	12.82	0.637	0.407	0.000	0.000	1.044	13.378	
14.5	14.04	0.572	1.387	0.003	0.000	1.962	27.536	
15	16.12	0.266	2.189	0.132	0.000	2.587	41.687	
15.5	17.87	0.184	2.407	0.209	0.000	2.800	50.027	
16	20.76	0.035	2.522	0.255	0.000	2.812	58.383	
16.5	22.47	0.181	2.363	0.421	0.029	2.994	67.264	
17	25.62	0.000	1.429	0.837	0.000	2.266	58.048	
17.5	28.10	0.000	0.250	0.397	0.000	0.647	18.173	
18	30.77	0.000	0.105	0.164	0.000	0.269	8.266	
18.5	30.10	0.000	0.000	0.032	0.000	0.032	0.972	
TSN (10^9)		3.342	13.506	2.449	0.029	19.327		
TSB (10^3)		42.877	260.097	59.256	0.653		362.883	
Mean weight (g)		12.8	19.3	24.2	22.5			18.8
Mean length (cm)		13.9	15.7	16.5	16.5			15.5
% N		17.3	69.9	12.7	0.2			100.0
SSN (10^9)		2.808	13.414	2.449	0.029	18.700		
SSB (10^3)		38.842	259.172	59.256	0.653		357.270	

Table 12.3.1 The international capelin catch 1964–2009 (thousand tonnes).

	Winter season					Summer and autumn season						
Year	Iceland	Nor-way	Faroes	Green-land	Season total	Iceland	Nor-way	Faroes	Green-land	EU	Season total	Total
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5	-	298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2	-	611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1	-	324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2	-	205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1,561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0	-	102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1,095.4
2001	767.2	-	10.0	29.0	806.2	150.0	106.0	12.0	9.0	17.0	294.0	1,061.2
2002	901.0	-	28.0	26.0	955.0	180.0	118.7	-	13.0	28.0	339.7	1,294.7
2003	585.0	-	40.0	23.0	648.0	96.5	78.0	3.5	2.5	18.0	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9	46.0	34.0	-	12.0		92.0	634.9
2005	594.1	69.0	19.0	10.0	692.0	9.0	-	-	-	-	9.0	701.1
2006	193.0	8.0	30.0	7.0	238.0	-	-	-	-		-	238.0
2007	307.0	38.0	19.0	12.8	376.8	-	-	-	-	-	-	376.8
2008	149.0	37.6	10.1	6.7	203.4	-	-	-	-	-	-	203.4
2009*	15.1	-	-	-	15.1							

*** preliminary**

Table 12.3.2 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the autumn season (August-December) 1985–2005.

Year	age 1	age 2	age 3	age 4	Total number	Total weight
1985	0.8	25.6	15.4	0.2	42	919.7
1986	+	10	23.3	0.5	33.8	772.9
1987	+	27.7	6.7	+	34.4	458.6
1988	0.3	13.6	5.4	+	19.3	371.4
1989	1.7	6	1.5	+	9.2	121
1990	0.8	5.9	1	+	7.7	111.2
1991	0.3	2.7	0.4	+	3.4	56
1992	1.7	14	2.1	+	17.8	298.1
1993	0.2	24.9	5.4	0.2	30.7	611.6
1994	0.6	15	2.8	+	18.4	324.1
1995	1.5	9.7	1.1	+	12.3	205.7
1996	0.2	25.2	12.7	0.2	38.4	773.7
1997	1.8	33.4	10.2	0.4	45.8	763.6
1998	0.9	25.1	2.9	+	28.9	440.5
1999	0.3	4.7	0.7	+	5.7	102.4
2000	0.2	12.9	3.3	0.1	16.5	265.1
2001	+	17.6	1.2	+	18.8	294
2002	+	18.3	2.5	+	20.8	339.7
2003	0.3	11.8	1	+	14.3	199.5
2004	+	5.3	0.5	-	5.8	92
2005*	-	0.4	+	-	0.4	9

*** No catch in summer since 2005.**

Table 12.3.3 The total international catch in numbers (billions) of capelin in the Iceland-East Greenland-Jan Mayen area in the winter season of 2009 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 2	Age 3	Age 4	Total	Percentage
13.5	0.000	0.005	0.000	0.005	0.8
14	0.007	0.004	0.000	0.011	1.5
14.5	0.011	0.020	0.000	0.030	4.3
15	0.005	0.077	0.005	0.087	12.3
15.5	0.005	0.103	0.011	0.120	16.8
16	0.012	0.105	0.020	0.137	19.3
16.5	0.014	0.093	0.014	0.121	17.0
17	0.000	0.077	0.014	0.091	12.8
17.5	0.002	0.066	0.012	0.080	11.3
18	0.000	0.012	0.004	0.016	2.3
18.5	0.000	0.004	0.007	0.011	1.5
19	0.000	0.002	0.000	0.002	0.3
Total number	0.057	0.567	0.087	0.712	100.0
Percentage	8.0	79.7	12.3	100.0	
Total weight	1.0	12.1	2.0	15.1	

Table 12.3.4 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the winter season (January-March) 1986–2009.

Year	age 2	age 3	age 4	age 5	Total number	Total weight
1986	0.1	9.8	6.9	0.2	17	391.8
1987	+	6.9	15.5	-	22.4	560.5
1988	+	23.4	7.2	0.3	30.9	657.2
1989	0.1	22.9	7.8	+	30.8	665.1
1990	1.4	24.8	9.6	0.1	35.9	686.8
1991	0.5	7.4	1.5	+	9.4	202.4
1992	2.7	29.4	2.8	+	34.9	621.1
1993	0.2	20.1	2.5	+	22.8	489.6
1994	0.6	22.7	3.9	+	27.2	567.1
1995	1.3	17.6	5.9	+	24.8	539.8
1996	0.6	27.4	7.7	+	35.7	723.6
1997	0.9	29.1	11	+	41	797.6
1998	0.3	20.4	5.4	+	26.1	481.3
1999	0.5	31.2	7.5	+	39.2	658.9
2000	0.3	36.3	5.4	+	42	830.3
2001	0.4	27.9	6.7	+	35	787.2
2002	0.1	33.1	4.2	+	37.4	955.0
2003	0.1	32.2	1.9	+	34.4	648.0
2004	0.6	24.6	3	+	28.3	542.9
2005	0.1	31.5	3.1	-	34.7	692.0
2006	0.1	10.4	0.3	-	10.8	230.0
2007	0.3	19.5	0.5	-	20.3	376.8
2008	0.5	10.6	0.4	-	11.5	202.4
2009	0.1	0.6	0.1	-	0.7	15.1

Table12.3.5 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season and landings (000 tonnes) in the 1994/95–2008/09 seasons.

Season	Preliminary TAC	Recommended TAC	Landings
1994/95	950	850	842
1995/96	800	1390	930
1996/97	1100	1600	1571
1997/98	850	1265	1245
1998/99	950	1200	1100
1999/00	866	1000	934
2000/01	975	1090	1065
2001/02	1050	1325	1249
2002/03	1040	1000	988
2003/04	835	875	741
2004/05	335	987	783
2005/06	235	235	238
2006/07	180	385	377
2007/08	205	207	202
2008/09*	0	0	15

*** landings from scouting vessels**

Table 12.4.1 Capelin. The data used in comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for calculations of preliminary TACs.

Year class	Age 1 - Acoustics (Measured Autumn)	Back-calculated age 2 mature (August)	Back-calculated total age 2(August)	Back-calculated age 3 mature (August)
1980	23.7	17.1	32.1	9.8
1981	68	53.7	96.2	27.9
1982	44.1	40.7	81.6	27
1983	73.8	64.6	164.6	65.8
1984	33.8	35.6	65	20.1
1985	58.6	65.4	102.6	24.5
1986	70.2	70.3	94.8	15.8
1987	43.9	42.8	58.6	6.8
1988	29.2	31.9	42	6.7
1989	39.2[1)]	67.7	77.4	6.4
1990	60	70.7	87.3	10.9
1991	104.6	86.9	107	13.2
1992	100.4	59.8	95	23
1993	119	102.2	147.3	29.6
1994	165	100.7	129.4	19
1995	111.9	90.3	125.5	23.2
1996	128.5	89.5	108.7	12.6
1997	121	85.9	110.3	16
1998	89.8	65.7	90.7	16.9
1999	103	86.7	95.7	5.9
2000	100.3	68	91.9	15.7
2001	74.4[2)]	82.1	93.5	7.5
2002	86.4	86.6	89.3	2.3
2003	*	37.2	38.9	1.1
2004	*	62.5	63.8	0.8
2005	44.7	38.7	43.4	3.1
2006	5	17.2		
2007	7.5			

1) invalid due to ice conditions

2) Calculated from acoustic estimate in April 2003

***) No information available**

Table 12.6.1 The estimated number (billions) of capelin on 1 January 1979–2008 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight (March) are also given.

Year	Age 2 juven-ile	Age 3 immat	Age 3 mature	Age 4 mature	Age 5 mature	Number immat.		Weight immat.		Number Spawn. stock	Weight Spawn. stock
						immat.	mature	immat.	mature		
1979	137.6	12.8	51.8	14.8	0.3	150.4	66.9	1028	1358	29	600
1980	50.6	13.8	53.4	3.6	0.2	64.4	57.2	502	980	17.5	300
1981	55.3	3.5	16.3	4.9	+	58.8	21.2	527	471	7.7	170
1982	41.2	3	8	0.5	+	44.2	8.5	292	171	6.8	140
1983	123.7	12.6	14.3	2	+	136.3	16.3	685	315	13.5	260
1984	105	35.7	39.8	7.6	0.1	140.7	47.5	984	966	21.6	440
1985	211.6	34.3	25.2	15.6	0.3	245.9	41.1	1467	913	20.7	460
1986	83.2	83.9	34.5	10.5	0.2	167.1	45.2	1414	1059	19.6	460
1987	131.9	25.6	22.1	37	0.2	157.5	59.1	1003	1355	18.3	420
1988	120.5	31.2	34.1	11.7	+	151.3	45.8	1083	993	18.5	400
1989	67.8	20.1	48.8	16	0.3	87.9	64.8	434	1298	22	440
1990	53.9	8.6	31.2	12.1	+	62.5	43.3	291	904	5.5	115
1991	98.9	8.6	22.3	4.5	+	107.5	26.8	501	544	16.3	330
1992	111.6	8.1	54.8	5.3	+	119.7	60.1	487	1106	25.8	475
1993	124.6	13.9	46.5	3.5	+	138.5	50	622	1017	23.6	499
1994	121.3	16.9	50.5	4.6	+	138.2	55.1	573	1063	24.8	460
1995	188.1	29.5	35.1	8.7	+	217.6	43.8	696	914	19.2	420
1996	165.2	37.9	75.5	20.1	+	203.1	95.6	800	1820	42.8	830
1997	160	24.1	72.4	24.8	+	184.1	97.2	672	1881	21.8	430
1998	138.8	29.5	50.1	7.9	+	168.3	58	621	1106	27.6	492
1999	140.9	16.1	53.2	16	+	157	69.3	585	1171	29.5	500
2000	115.8	20.5	68.2	10	+	136.3	78.2	535	1485	34.2	650
2001	122.2	21	46.3	10.5	+	161.2	56.8	655	1197	21.3	450
2002	117.3	7.6	59.3	10.5	+	126.6	69.8	510	1445	22.9	475
2003	109.4	9.4	58.4	2.9		105.1	61.3	487	1214	20.7	410
2004	134.6	11.4	54.2	6.2	+	143.5	60.4	597	1204	28.2	535
2005	48	2.9	86.6	7.5	+	50.9	72.5	214	1450	36.3	602
2006	103.8	2.2	29.4	1.9		106.0	31.3	960	639	18.8	400
2007	88.4	1.5	52.5	1.4		89.9	53.9	814	997	19.1	410
2008	23.0*	14.6*	32.5	0.7		37.6*	33.2	382*	619	22.2	406
2009	7.2*	0.3*	14.5	2.6	+	7.6*	17.1	69*	343	17.3	328

*** preliminary**

Table 12.6.2 Capelin in the Iceland-East Greenland-Jan Mayen area 1978-2009. Recruitment of 1 year old fish (unit 10^9) are given for 1 August Spawning stock biomass ('000 t) is given at the time of spawning (March next year). Landings ('000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated and ending in March of the following year.

Season Summer/winter	Recruitment	Landings	Spawning stock biomass
1978/79	164	1195	600
1979/80	60	980	300
1980/81	66	684	170
1981/82	49	626	140
1982/83	146	0	260
1983/84	124	573	440
1984/85	251	897	460
1985/86	99	1312	460
1986/87	156	1333	420
1987/88	144	1116	400
1988/89	81	1037	440
1989/90	64	808	115
1990/91	118	314	330
1991/92	133	677	475
1992/93	163	788	499
1993/94	144	1179	460
1994/95	224	864	420
1995/96	197	929	830
1996/97	191	1571	430
1997/98	165	1245	492
1998/99	168	1100	500
1999/00	138	933	650
2000/01	146	1071	450
2001/02	140	1249	475
2002/03	142	988	410
2003/04	132	741	535
2004/05	57	783	602
2005/06	124	238	400
2006/07	105*	377	410
2007/08	27*	202	406
2008/09	9*	15	328

*** preliminary**

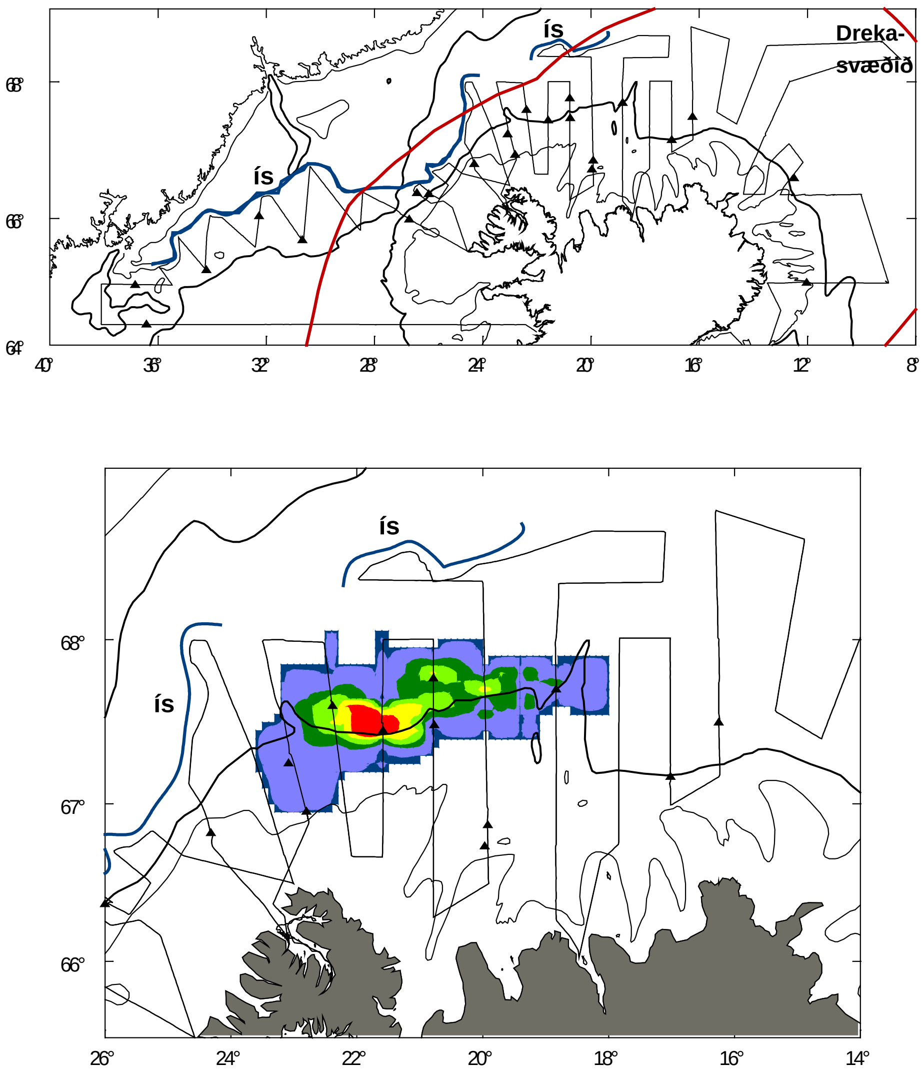

Figure 12.2.1. Capelin. Cruise tracks and trawl stations (upper figure), distribution of 1-3 year old capelin (lower figure) and the ice edge during an acoustic survey by r/v Arni Fridriksson in November/December 2008.

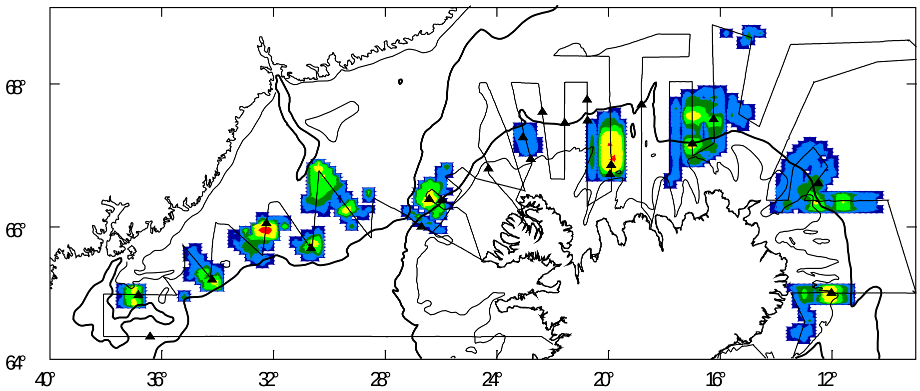

Figure 12.2.2. Capelin. The distribution of 0-group capelin in an acoustic survey carried out with the r/v Arni Fridriksson in November-December 2008.

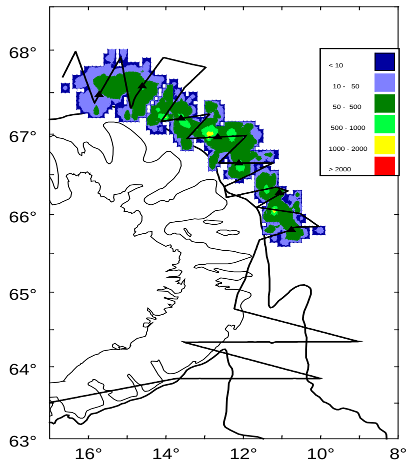

Figure 12.2.3. Capelin. The distribution of SA-values from an assessment survey carried out with r/v Arni Fridriksson in January 7-10, 2009.

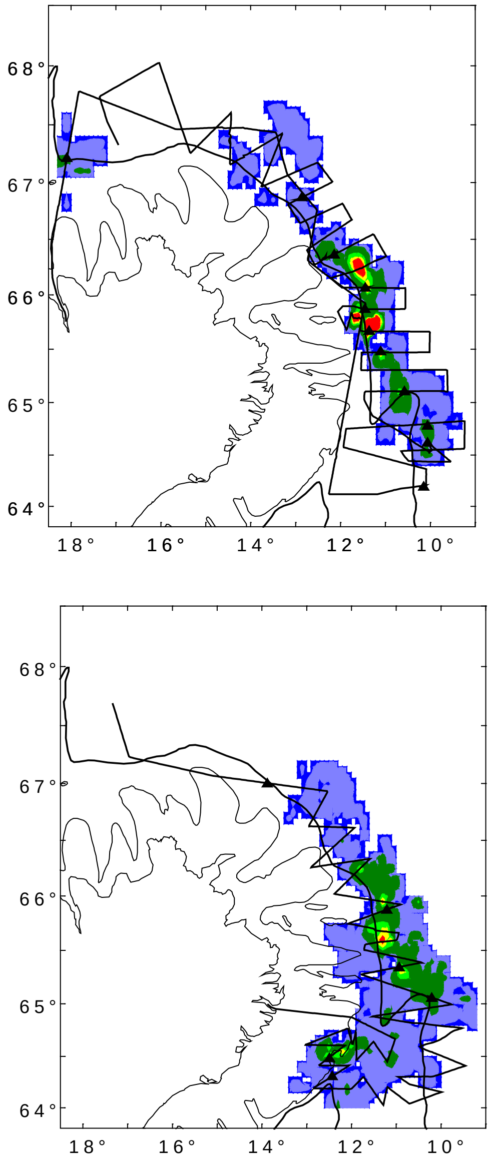

Figure 12.2.4 Capelin. The distribution of SA-values, cruiselines and trawl stations from an assessment survey carried out with r/v Arni Fridriksson NE- and E off Iceland in January 21-29, 2009 (upper figure) and 29 January – 2 February (lower figure).

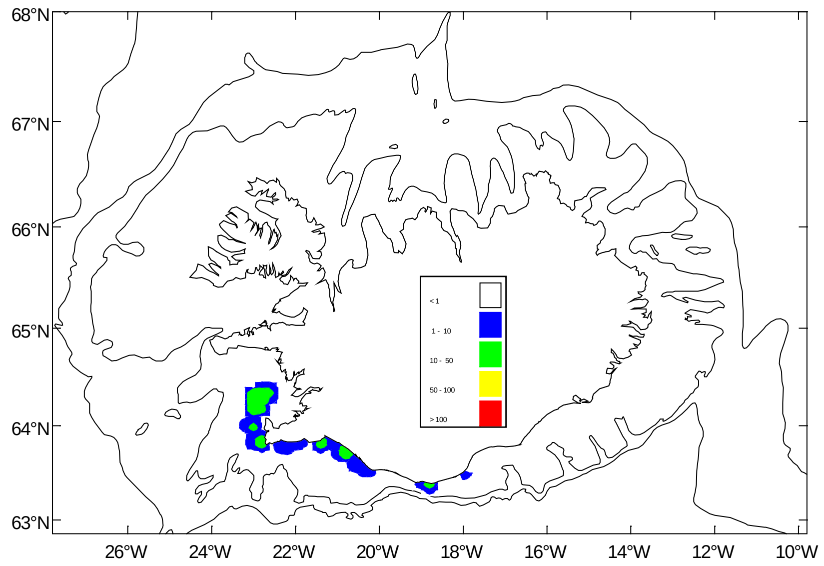

Figure 12.3.1. Distribution of the catches of the Icelandic capelin in the fishing season 2008/09 based on data from logbooks.

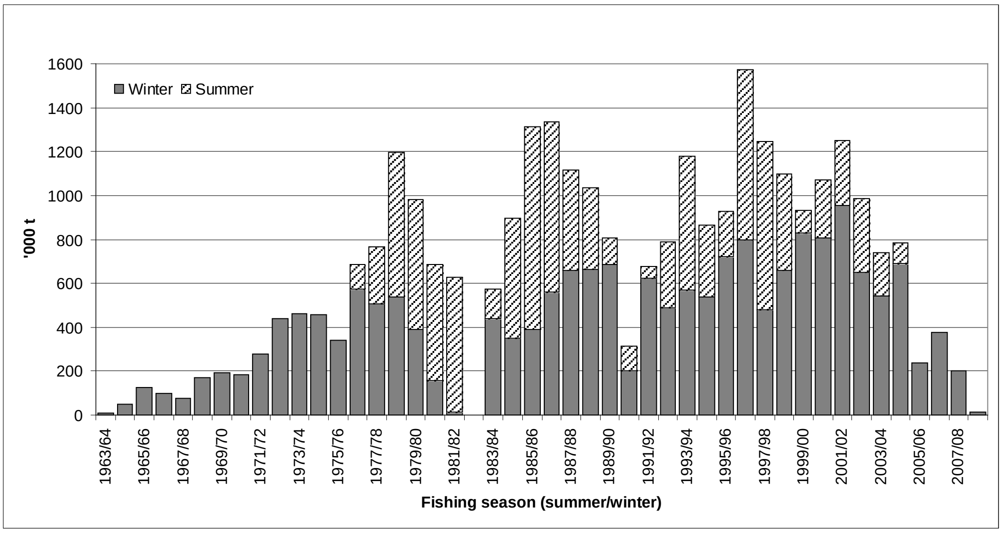

Figure 12.3.2. Total catch (in thousand tonnes) of the Icelandic capelin in 1963/64-2008/09.

13 Overview on ecosystem, fisheries and their management in Greenland waters.

13.1 Ecosystem considerations

The marine ecosystem around Greenland is located from arctic regions to subarctic regions. The watermasses in East Greenland are composed of the polar *East Greenland Current* and the warm and saline *Irminger Current*. As the currents rounds Cape Farewell at Southernmost Greenland the Irminger water subducts the polar water and mix extensively and forms the relatively warm *West Greenland Current*. The Irminger Current play a key role in the transport of larval and juvenile fish from spawning grounds south and west of Iceland to nursery areas, not only off N- and E-Iceland but also across to E- and then W-Greenland. In recent years spawning cod has been observed on the banks of East Greenland, eggs and larvae from these cod are also being transported with the current to West Greenland. The spawning takes place in spring (April-May) and shortly after a peak in primary production occurs (Figure 1).

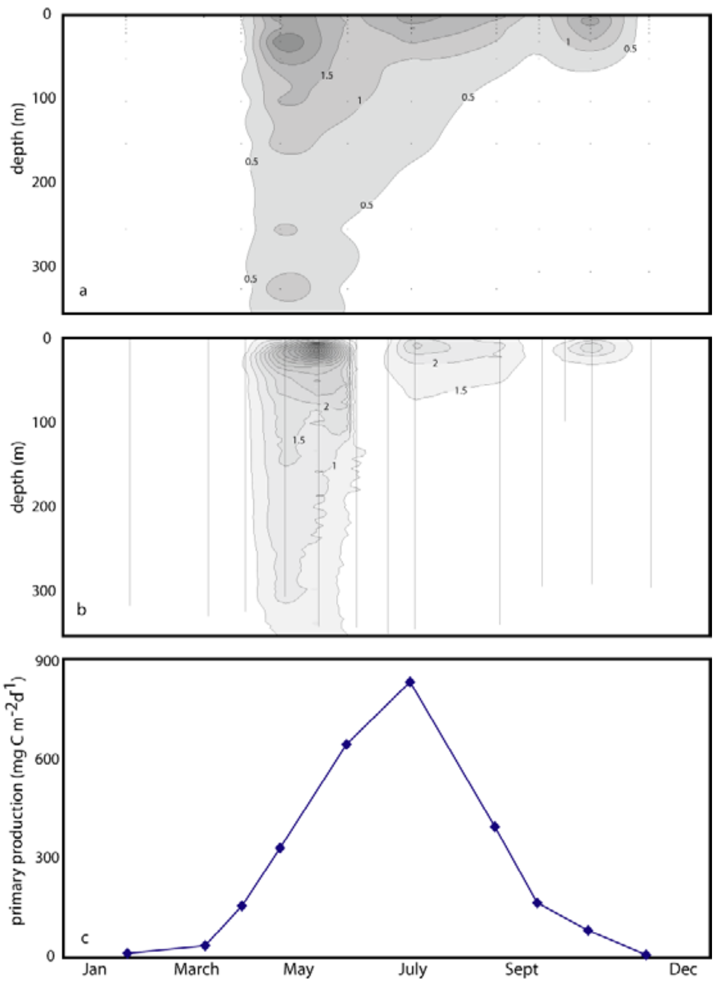

Figure 1. Annual variation in algal biomass and productivity at the inlet of Nuuk Fjord. a: chlorophyll (µg l^{-1}), b: fluorescence, c: primary production (mg C m^{-2} d^{-1}). Dots represent sampling points. From Mikkelsen et al. (2008).

Depending of the relative strength of the two East Greenland currents, The Polar Current and the Irminger Current, the marine environment experience extensive variability with respect to temperature and speed of the West Greenland Current. The general effects of such changes have been increased bioproduction during warm periods as compared to cold ones, and resulted in extensive distribution and productivity changes of many commercial stocks. Historically, cod is the most prominent example of such a change.

In recent years temperature have increased significant in Greenland water to about 2°C above the average for the historic average, with historic high temperatures registered in 2005 (50 years time series, fig. 2). Recently increased growth rates for some fish stocks as indicated from the surveys might be a response of the stock to such favourable environmental conditions. As has been observed with the Icelandic cod stock an important interaction between cod and shrimp exist and with a historic large shrimp biomass in West Greenland water in present time feeding conditions would be optimal for fish predators such as cod (Hvingel & Kingsley 2006).

In recent years more southerly distributed species such as monk fish, lemon sole, saithe and whiting has been observed on surveys in offshore West and East Greenland and inshore West Greenland.

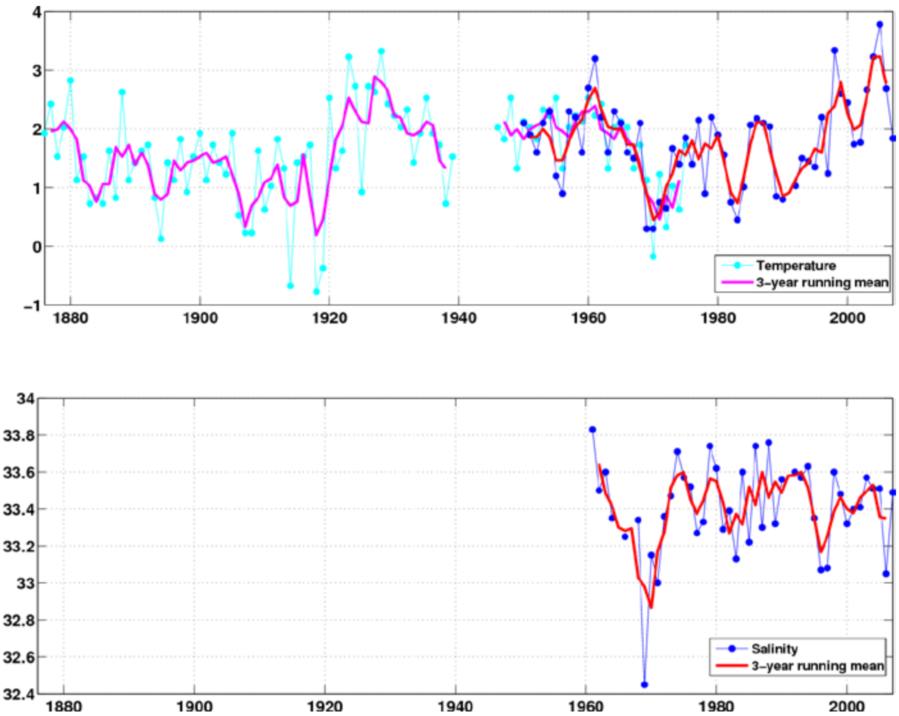

Figure 2. Timeseries of mean temperature (top) and mean salinity (bottom) on top of Fylla Bank (located outside Nuuk Fjord) (0–40 m) in the middle of June for the period 1950–2007. The red curve is the 3 year running mean value. From Ribergaard et al. (2008).

13.2 Description of the fisheries

Fisheries targeting marine resources off Greenland can be divided into inshore and offshore fleets. The Greenland fleet has been built up through the 60s and is today comprised of 450 ships with an inside motor and a large fleet of small boats. It is estimated that around 1700 small boats are dissipating in some sort of artisinal fishery mainly for private use or in the pound net fishery.

Active fishing fleet reported to Greenland statistic by GRT in 1996 – no later number are available.

All fleet (N)	<5	6-10	11-20	21-80	>80
441	31%	34%	2%	9%	6%

There is a large difference between the fleet in the northern and southern part of Greenland. In south, were the cod fishery was a major resource the average vessel age is 22 years, in north only 9 years.

13.2.1 Inshore fleets;

The fleet are constituted by a variety of different platforms from dog sledges used for ice fishing, to small multi purpose boats engaged in whaling or deploying mainly passive gears like gill nets, pound nets, traps, dredges and long lines. West Greenland water is ice free all years up to Sisimiut at 67 ºN.

In the northern areas from the Disko Bay at 72ºN and north to Upernavik at 74º30N, dog sledge are the platforms in winter and small open vessels the units in summer, both fishing with longlines to target Greenland halibut in the icefjords. The main by-catch from this fishery is redfish, Greenland shark, roughhead grenadier and in recent years cod in Disko Bay.

The inshore shrimp fisheries are departed along most of the West coast from 61-72ºN. The main by-catch with the inshore shrimp trawlers is juvenile redfish, cod and Greenland halibut. An inshore shrimp fishery is conducted mainly in Disko Bay but also occasional in fjords at southwest Greenland. Most of the small inshore shrimp trawlers have dispensation for using sorting grid, which is mandatory in the shrimp fishery.

Cod is targeted all year, but with a peak time in June – July, and pound net and gill net are main gear types. By-catches are mainly the Greenland cod (*Gadus ogac*) and wolffish.

In the recent years there has been an increasing exploitation rate for lumpfish. Fishing season is rather short, around April and along most of the West coast the roe is landed. By-catch is mainly comprised of seabirds (eiders).

The scallop fishery is conducted with dredges at the West coast from 64-72 ºN, with the main landings at 66ºN. By-catch in this fishery is considered insignificant.

Fishery for snow crab is presently the fourth largest fishery in Greenland waters measured by economic value. The snow crabs are caught in traps in areas 62-70ºN. Problems with by-catch are at present unknown.

A small salmon fishery with drifting nets and gillnets are conducted in August to October, regulated by a TAC.

Management of the inshore fleets is regulated by licenses, TAC and closed areas for the snow crab, scallops, salmon and shrimp. Fishery for Greenland cod, Atlantic cod and lumpfish are unregulated.

13.2.2 Offshore fleets

Apart from the Greenland fleet resources are exploited by several nations mainly EU, Iceland, Norway and Russia. Recently, Greenland halibut and redfish were targeted using demersal otter board trawls with a minimum mesh size of 140 mm since 1985.

Cod fishing has ceased since 1992 in the West Greenland offshore waters. In East Greenland the fishery has been increasing in recent years due to a small longline fishery and limited commercial "experimental fisheries" using trawl. The Greenland offshore shrimp fleet consist of 15 freezer trawlers. They exclusively target shrimp stocks off West and East Greenland landing around 135 000 and 12 500 t, respectively. The shrimp fleet is close to or above 80 BT and 75% of the fleet process the shrimps onboard. They use shrimp trawls with a minimum mesh size of 44 mm and a mandatory sorting grid (22 mm) to avoid by-catch of juvenile fish. The 3 most economically interesting species, redfish, cod and Greenland halibut are only found in relatively small proportions of the by-catch.

The longliners are operating on the East coast with Greenland halibut and cod as targeted species. By-catches for the longliners fishing for Greenland halibut are roundnose grenadier, roughhead grenadier, tusk and Atlantic halibut, and Greenland shark (Gordon et al. 2003). Some segments of the longline fleet target Atlantic halibut.

At the East coast an offshore pelagic fleet, are conducting a fishery on capelin (106 000t landed in 2003 by EU, Norway and Iceland). The capelin fishery is considered a rather clean fishery, without any significant by-catches. Since 2004 this fishery has ceased due to the low capelin biomass. Also the pelagic red fish fishery is a clean fishery conducted in the Irminger Sea and extending south of Greenland into NAFO area. The demersal and pelagic offshore fishing is managed by TAC, minimum landing sizes, gear specifications and irregularly closed areas.

13.3 Overview of resources

In the last century the main target species of the various fisheries in Greenland waters have changed. A large international fleet landed in the 50s and 60s, large catches of cod reaching historic high in 1962 with about 450 000t. The offshore stock collapsed in the late 60s early 70s due to heavy exploitation and possible due to environmental condition. Since then the stock remained depended on occasional Icelandic larval cod transported. From 1992 to 2004 the biomass of offshore cod at West Greenland has been negligible. In 1969 the offshore shrimp fishery started and has been increasing ever since reaching a historic high of close to 150 000 t in 2003. Recent catches however indicate a decline in the shrimp fishery.

13.3.1 Shrimp

The shrimp *Pandalus borealis* stock in Greenland waters is considered in moderately good condition although a decrease in estimated biomass of the West Greenland has been observed over the last four years. The stock in East Greenland is considered stable based on available information. The 2003 West Greenland biomass (690 000 tonnes) was the highest in the time series but has since then decreased (2004; 640 000 tonnes, 2005; 550 000 tonnes and in 2007; 400 200 tonnes) but biomass-levels are still regarded as moderately high.

13.3.2 Snow crab

The biomass of snow crab in West Greenland waters has decreased substantially since 2001. Snow crab has been exploited inshore since the mid 90s and offshore since 1999. Total landings have been reported to amount to 3 305t in 2006 down from 15 139t in 2001. After several years of decreasing CPUE it now appears to have stabilized at low levels in the majority of areas.

13.3.3 Scallops

The status of scallops in Greenland is unknown. From the mid 80s to the start 90s landings were between 4-600 t yearly. Since then landings have increased to around 2000 t. The fishery is based on license and is exclusively at the west coast between 20-60m. The growth rate is considered very low reaching the minimum landing size on 65mm on 10 years.

13.3.4 Squids

The status of squids in Greenland water is unknown.

13.3.5 Cod

In 2007, total landings of cod were reported as 16500 t where 4800 t were reported from the offshore areas. Although the landings are the highest in a 10-years period it is still only a fraction (16%) of the landings caught in 1990. Recruitment has been negligible since the 1984 and 1985 year class was observed, but the 2003 year class is estimated to be 25% of the strength of the 1984 year class in 2007. The information on spawning offshore is limited as the survey takes place well after the spawning period. However offshore spawning has been inferred of East Greenland since 2004 and in spring 2007 dense concentrations of unusual large cod were actively spawning off East Greenland. The inshore fishery is not regulated and the offshore fishery is managed with license and minimum size. As a response to the favourable environmental conditions (large shrimp stock, high temperatures and spawning cod in East Greenland) cod could re-colonise the offshore areas and therefore a recovery plan is urgently required to rebuild the stock.

13.3.6 Redfish

Advice on demersal stocks under mixed fisheries consideration.

13.3.7 Greenland halibut

Greenland halibut in the Greenland area consist of at least two stocks and more components; the status of the inshore component is not known but the components have sustained catches of 15-20 000 t annually. The offshore stock component in NAFO SA 0+1 has remained stable in the last decade, sustaining a fishery of about 10 000 t annually. The East Greenland stock is a part of a complex distributed to Iceland and Faroe Islands. The long time perspective the stock is at a low level.

13.3.8 Lump sucker

The status of the lumpfish is unknown. The landing of lumpfish has increased the last couple of years reaching close to 9 000 t in 2003. Catches have remained at that level since. Local depletion will likely occur due to a heavy exploitation.

13.3.9 Capelin

Advice on demersal stocks under mixed fisheries consideration.

13.4 Advice on demersal fisheries

ICES recommends a zero catch for cod in Greenland for all offshore areas. It is especially important to give the spawning stock of East Greenland the maximum protection to secure the spawning potential that may be able to utilize the favourable environmental conditions (large shrimp stock and high temperatures). A recovery plan is recommended to ensure a sustainable increase in SSB and recruitment. Such plan must include appropriate measures to avoid any cod by-catch in other fisheries deploying mobile gears capable of catching cod. Observers must monitor functionalism of measures.

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14 Cod Stocks in the Greenland Area (NAFO Area 1 and ICES Subdivision XIVB)

14.1 Stock definition

The cod found in Greenland is derived from three separate "stocks" that each is labelled by their spawning areas: I) offshore cod spawning of East and West Greenland waters; II) cod spawning in West Greenland fiords cod and III) Icelandic spawning where the offspring occasionally are transported in significant quantities with the Irminger current to Greenland water (Fig. 14.1). The Stock Annex provides more details on the stock identities including the references to primary works. Some recent/ongoing activities on spawning and migrations are included below.

14.2 Information from the fisheries

14.2.1 The emergence and collapse of the Greenland cod fisheries

The inshore Greenland commercial cod fishery in West Greenland started in 1911 by opening the cod trading at localities where cod seemed to occur regularly, but there are historical information's on earlier fisheries. The West Greenland offshore fishery took off in 1924 when Norwegian fishers discovered dense concentrations of cod on Fylla Bank. The fishery gradually developed culminating with catch levels above 400,000 tons annually in the 1960s. The East Greenland offshore cod fishery started in the 1950's. Due to over fishing and deteriorating environmental conditions the stock size declined and the fishery completely collapsed in the early 1990's (Fig 14.2).

The 1990s stock collapse was followed by a decade of very limited fishing, with inshore catches falling below 1000t annually and with no directed offshore fisheries taking place (Table 14.3). From 2000 the inshore catches has gradually increased from less than 1000 t to 12,000 in 2007. From 2002 limited offshore quotas have been allotted to Faeroese and Norwegian vessels and in 2005-2006 Greenland trawlers were allowed limited quotas for experimental cod fishery. In 2007 small quotas were given to Greenland, EU, Norway and the Faeroe Islands with catches reaching 5000 tons, mainly taken off East Greenland. Officially reported catches for East and West Greenland are provided in Tables 14.1 and 14.2

14.2.2 The Fishery in 2008

The catch statistics differentiates between a *coastal fleet* (smaller vessels mainly, but not exclusively fishing inshore) and an international *offshore fleet*, mainly large trawlers (cf. stock annex). The coastal fleet almost exclusively takes its catch in West Greenland.

In 2008 the catches from the coastal fleet amounted to 12,270 including 6 tons taken in East Greenland, which is 5% above lasts years catches (Table 14.4). Relative to 2007 catches increased by 44% in the northern divisions 1ABCD and declined by 36% in the southern divisions of 1EF. The coastal fleets catches peaks during summer where the dominant pound net fishery takes place. Catches in Div. 1F includes catches from the offshore area taken by coastal vessels.

In 2008 the offshores area north of the 63^{o} parallel was closed for directed cod fisheries and the 2008 offshore catches was therefore found exclusively off south Greenland (71% in NAFO 1F; 26% in ICES XIVb). The long liners caught 1,339 tons, the trawlers caught 11,582 tons. EU, Norway and Faeroe Islands took their quotas. Of the Greenland quotas of 11,500 tons only 8,370 tons was taken; this undershooting is caused by discussions over the legal status for some of the quota allotments.

14.2.3 Length and age distributions, catch in weight at age in 2008

There limited landing sample information from the 1990's were the cod fishery was very low. For that period length frequency information is generally lacking for the offshore fisheries where cod was taken as a by-catch only. For the inshore fisheries length frequency information is lacking for 1997-1998 and 2000-2001. Sampling intensities have been considerably increased in the later years, although sampling is often impeded by the logistic difficulties found in Greenland (see Stock Anex).

Catch-at-age and weight-at-age is not used in assessment and is not provided in this report. The time series presented in last years report need to be recompiled as the data until 2005 only covers the catches from the coastal fleet.

In 2008 the Greenland inshore length frequencies were measured from 44 inshore samples (8,400 cod measured.) with the majority (31 samples) covering the pound net fishery. Gaps in sampling of the jig fisheries in the winter periods have been filled using available length frequency data from GINR experimental jigging. The 2008 Greenland offshore samples amounts to 5 samples (500 cod measured) all from NAFO Div. 1F. Length frequency info was available from the offshore Long-liners were available by an arrangement with a Norwegian Skipper. Length and age information from the EU trawl fisheries is supplied from a German observer samplings program.

The pound net are operated on shallow depth (0-20m) with catches dominated of small cod ~ 40-50 cm. The 2004 YC dominates in the coastal fishery, although in 1F with a considerable number from YCs 2003 and 2005 (Fig. 14.3 and 14.5). The length of cod in the offshore fisheries were considerable larger (40-70 cm, Fig 14.6) and dominated by the 2003 year class (Fig. 14.4).

14.2.4 Information on spawning

Offshore Spawning.

The recent offshore fishery has shown dense concentrations of large spawning cod off East Greenland at least since 2004. In 2007 GINR carried out an observer program onboard two Greenland trawler to document that spawning takes place off East Greenland. 14,000 cod were measured and 1000 examined for maturity/spawning The average length was 70 cm. Cod was maturity staged according to Tomkiewicz et al, (2002). All maturity stages were recorded (non-mature 27%; maturing 23%; active spawning 36% and spent 14% spent).

An ongoing Icelandic survey (April-Mai 2009) along the East Greenland shelf, finds that spawning in full swing. Spawning cod is found between "Kleine Banke" (64°30') and down to "Skjoldungen" (62°30') where a further southward extension was impeded by the ice situation. The spawning cod is of length 45-120cm.

In 2007, the East Greenland offshore cod reached 50% maturity at a length of 58 cm (ICES, 2008)

Inshore spawning

Inshore spawning has been documented since 1926 and spawning is known to have occurred in several Greenland fiords. An ongoing program attempts to map the the extension of spawning. Based on the criteria that a spawning ground is documented when actively spawning females occur spawning areas has been located off Ilulissat (Disko Bay, Div. 1A), Aasiat (Northern Div. 1B) and in several of the Fjords around Nuuk (Div. 1D). Samplings in 2009, just prior to the actual spawning time, indicate that spawning most likely occur also in Fiskenæsset (southern Div. 1D). The cod reached 50% maturity at a length of 45 cm (ICES, 2008)

Tagging experiments

Tagging of cod has been resumed in 2007. Inshore tagged cod in NAFO Div. 1BDF totaled 1370 fish. Offshore tagged off both West and East Greenland totaled, 2280 and 1900, respectively.

A preliminary compilation indicates that all inshore-tagged cod have been recorded in inshore areas with the majority taken in the same area where they were tagged (Table 14.5). Most tag recoveries of offshore-tagged cod were similarly found in the vicinity of the tagging area, including 4 fish that were taken in the adjacent inshore zone. 5 cod tagged off East Greenland has been caught in Icelandic waters (Table 14.6).

The interpretation of the tag-return pattern need to take into account the 2008 closure of the areas north of the 63º parallel.

14.3 Surveys

At present, the surveys - two offshore trawl surveys and an inshore gill-net surveys- provide the core information relevant for stock assessment purposes. Considering the importance of the surveys for the assessment the NWWG used considerable effort to discuss present weaknesses and ways to improve the survey interpretations..

Issues addressed and clarified

1) In 2005 the Greenland trawl-survey covering West Greenland changed the trawl gear to improve the ability to cover shrimp areas with difficult bottoms. The calibration hauls with the old and new trawl caught few cod. An analysis of the relative efficiencies indicated that the new trawl was about 1.5 times as efficient as the old trawl (the analysis is documented in the NWWG working doc. 19, 2008). Given the strength of the survey signal in 2005 the effect of the trawl change appears limited (Tables 14.12-14.13). Thus, although the gear change may impeded finer comparisons there is no doubt that the survey reflects the profound changes occurring in 2005, *inter alia* the appearance of the strong 2003 YC.

2) The West Greenland survey data was previously analysed after using a re-stratification that biased stock estimates. This issue was addressed last year (ICES, 2008; NWWG WD 19, 2008). Estimates back to 2005 are now analysed using the stratification scheme actually used and the subsequent tabulations of results by NAFO divisions is only provided to facilitate readability. A recalculation of the entire time series back to 1992 is possible but complicated by a change in the data base system. Given that the 1992-

2004 period is characterized by an almost lack of cod in the West Greenland area such a reanalysis is given a low priority.

3) In the analysis of the results from the German survey strata with less than five hauls has previous not been reported. This procedure is now changed so that all strata's fished, throughout the entire time series, is now included in the calculation and are reported (Tables 14.7-14.10).

4) The twine thickness of some of the mesh-sizes used in the inshore gill-net survey has been changed, as the original net materials were no longer commercial available. This implies a potential change in the fishing power of the gear. The effect of twine thickness on the nets fishing power in the Greenland inshore survey is well documented and the power change has now been quantified. The effect is estimated as limited. Detailed in the Stock Annex.

Major survey issues outstanding

The NWWG identified a number of outstanding survey issues that could not be properly treated within the time available.

1) East Greenland is characterised by huge non-trawlable areas whereas the fishing is by and large restricted to the eastern slope areas only (Fig. 14.7 and 14.8). For the survey this implies that the fish density experienced in the shelf area is applied to the vast areas between the slope and the Greenland coast. It is uncertain whether the stock density found at the shelf is representative for the entire area. The East Greenland area encompasses a frontal zone separating the warmer Irminger current water from the East Greenla polar current and preliminary echo sounder tracings may indicate that echo density differs between the shelf and bank areas. Although the surveys are interpreted on a relative scale the area sizes used for the east Greenland strata will have a profound effect on the stock distribution between West and East Greenland. The NWWG discussed to use strata sizes that would in some way reflect the size of the trawlable shelf areas but refrained for this solution as i) actual delimitations may be arbitrary and 2) implies the density of fish outside such areas as being implicit set at zero. In this years report the size of the “”historical “ bathymetric based areas have therefore been maintained.

2) For a number of year tough weather conditions have meant that the German survey have not been able to fish all strata, implying that the survey biomass and abundance estimates in those years only relates to part of the total area. The NWWG whish to evaluate robust schemes that may provide corrections for that bias.

3) In a number of years the survey biomass and abundance is heavily influenced by a few “high leverage” hauls. E.g.. in 2008 a single haul accounts for about half the biomass and abundance in the German survey. The NWWG whish to explore ways that may reduce the importance of those leverage tows, as e.g. various data transformations.

The NWWG recommend that these issues be analysed further on a designated survey workshop, encompassing scientist from the countries represented in the group. The objective should be to explore/develop more suitable indicators for the stock development from the available survey time series.

Despite the outstanding difficulties described and the fact that the surveys have different focuses they also complement each other. The German survey being designed for cod research have covered the main cod grounds off both South East and West Greenland since 1982, i.e. stretching the period where cod were abundant and later very scarce. The Greenland survey target shrimp off West Greenland between 60° and 72° N. Lat down to 600 m and hereby extending the coverage into the adjacent areas where large cod concentrations is not expected. Although most of the effort is allocated for shrimp the high number of hauls (ca. 260) and a recent addition of extra "cod" stations implies a fair coverage of the areas were cod exist. In 2008 the Greenland survey was extended to cove East Greenland (52 hauls)

14.3.1 Results of the German groundfish survey off West and East Greenland

Both abundance and biomass indices increased relative to last year (Table14.7). However, the results are heavily dependent on one large haul (stratum 6.1 in East Greenland) that accounted for about 56 % and 42 % of the total biomass and abundance, respectively. This, of course, is reflected in the survey confident interval that is in 2008 is found at 92% and 122% for abundance and biomass, respectively.

The 2008 survey results confirmed previous findings indicating a strong year class of 2003 that is the strongest year class since year class 1985 (Table 14.8 -14.10). At age 5 the survey indicates that year class strength of 2003 is about 41 % of that of 1984 (omitting the high leverage hauls at 21%). These values are s consistent with the ratio of 25%, and 32 %, measured at age 4 and 3 respectively. The highest abundances of the 2003 YC are found in East Greenland (Table 14.11). The second most abundant year class is that of 2005 witch is found almost exclusively on West Greenland. This year class is estimated as considerable smaller than the 2003 year class. The 2006 Year class is estimated as weak. A fist estimate of the 2007 year class, based at age 1 abundance indicates a size of ca 10 % of the 2003 year class. Older cod (year classes 1999-2002) are almost exclusively taken in East Greenland (Table 14.11 ; Fig 14.9).

The historical survey time series show the pronounced increase in cod abundance and biomass from 1987 to 1989 caused by the good recruitment of the 1984 and 1985 year classes (Fig 14.10 and Table 14.7). From 1989, stock abundance and biomass plummeted by 99% to only 5 million fish and 6 000t in 1993. Biomass and abundance remained at these very low levels during the next decade. Due to the recruitment of the 2003 year class abundance increased considerable in 2005. Although the later year classes is estimated considerable smaller than the 2003 year class they are, except for the 2006 year class, well above the year classes observed in 1986-2000.

The survey CPUE, that provide a measure not influenced by ambiguities in the East Greenland strata sizes, have increased since 2005, particularly off East Greenland (Fig. 14.11).

The mean length for Age groups 3–10 years off East Greenland were found to be in average 15% larger than those off West Greenland (Figures 14.12 and 14.13). Off West Greenland mean length for the age groups 1–5 declined in 1986–87 and remained at low levels until 1991. Since then a slight increase have occurred notably for the older ages in the most recent years. At East Greenland length at age have been more constant, although fluctuating somewhat between years.

14.3.2 Results of the 2008 Greenland surveys in West Greenland

The 2008 West Greenland survey biomass was estimated at 28 Kt and the survey abundance at 53 million individuals. Both values are similar to those estimated last year (Tables 14.12 and 14.13). The effort was 258 hauls, however, a considerable part thereof exerted in northern areas where cod is scarce. Abundance per Km2 and Biomass per Km2 is shown in Figs. 14.14 and 14.15 respectively.

The stock in West Greenland was dominated by the 2003 and 2005 year classes that accounts for 30% and 39% of the total abundance respectively (Table 14.14). The 2003 YC is the largest observed in the survey since the commencement of the time series in 1992. The size of the 2005 YC is estimated at 34% and 49% of the 2003 YC, based on comparing survey abundance as age 2 and age 3, respectively. The 2008 survey confirmed that the 2006 YC is very small. A first assessment of the size of the 2007 YC indicates a year class size below that of the 2005 YC.

The survey has consistently found the 2003 YC concentrated in southern West Greenland and in 2008 95 % of the survey catches of that year class was taken in Div. 1F (Table 14.15 and Figs. 14.16 and 14.18). The 2005 YC has throughout its life span been distributed more northerly, and is in 2008 dispersed over Div. 1BCDEF. The 2007 YC show a distribution pattern similar to the 2005 YC.

14.3.3 Results of the 2008 Greenland surveys in East Greenland

In 2008 the trawl survey was extended to cover the east Greenland area with 52 hauls (Fig. 14.14). The difficult bottom conditions implied that three small shallow water strata (1.4% of the survey area) could not be fished and had to be covered by the density found in the adjacent 200-400 m strata.

The survey stock biomass was estimated at 47 Kt and the abundance at 31 million individuals. Cod of the year classes 2002-2005 was found abundant, with the 2003 YC concentrated in the Cape Farewell area (Q6) and the 2005 YC concentrated in the Kleine Bank area (Q3). Considerable number of older cod are found in the northern areas (Q1-Q3) ~ the area between Kleine Bank and Dohrn Bank (Table 14.15, Fig. 14.18). The length distribution by strata is shown in Fig. 14.17.

As the two Greenland surveys are carried out in succession and uses the same trawl the Greenland survey now provides an estimate of the total stock distribution. The overall pattern estimated from the Greenland surveys are that the abundance is found in West Greenland and the biomass in East Greenland. This covers that: a) Old and large cod are found off East Greenland b) that the 2003 year class is concentrated on both sides of Cape Farewell and that c) fish of the 2005 YC and mainly distributed off West Greenland and in the Q3 area off East Greenland. This pattern is reflected in the distribution of the Spawning Stock that is found in South and particularly East Greenland (Fig. 14.19).

14.3.4 West Greenland young cod survey

The inshore survey provides information on mainly pre recruit abundance in inshore areas. Gangs of nets with different mesh-sizes are used, as the inshore areas are not trawlable. The change of the nets fishing power associated with a change in the twine thickness for some mesh-sizes in 2004 is estimated as limited (Stock Anex.). The survey has been conducted since 1985

The 2008 catches in Div. 1D was dominated by the 2004 year class hereby confirming that this year class is one of the largest seen in the Nuuk area (Table 14.16). The size of the 2005 year class is also estimated as strong but the 2006 year class is found very weak. In south Greenland (Div. 1F) catches was dominated by the 2005 year class.

Due to the breakdown of R/V Adolf Jensen no survey was carried out in Div 1B in 2008.

Seen over its entire 1985-2008 history, the survey demonstrates considerable differences between the three areas (Fig. 14.20, Table 14.16). For south Greenland (Div. 1F) high recruitment indices are found only for year classes that have been estimated as strong by the offshore surveys, i.e.1984, 1985, 2003 and 2005. However, after the 1988-1995 period with practically no catches of young cod (3-4 per day), the southern coverage was dropped in many years. For the central Nuuk area (Div. 1D) recruitment is high for the 1984-1991 year classes ; low for the 1992-2002 year classes and increasing again for the later year classes. The northern area (Div. 1B) is in contrast characterised by stability with high recruitment throughout the period.

14.3.5 State of the stock

The two survey abundance indices both indicate that the cod stock is presently significantly above the very depressed state that was experienced in the 1990's.

Since ca. 2000, and following a decade of no cod fishing, the cod stock, particular off East Greenland has been building up. In east Greenland the stock is composed of a row of older year classless ~ the 2003 YC and older. Spawning has been inferred since 2004 and was documented by a designated observer program in 2007. An Icelandic survey off East Greenland, conducted concurrently with this NWWG meeting, confirmed the existence of shoals of mixed sizes of cod now spawning on the East Greenland shelf area.

The surveys indicate an improvement in recruitment with all year classes since 2002 (except the 2006 YC) estimated at sizes above the very small year classes seen in the 1990s.

The 2003 year class shows the characteristics usually associated with a year class of Icelandic origin – i.e. a southern distribution and with a concurrent occurrence of haddock of the same year class (ICES 2008).

Knowledge on the stock size changes of the local fiord spawning cod population is limited. The historical tag-return pattern indicates that inshore cod predominately remains in the tagging area, which is not contradicted by the recaptures in the last two years. The inshore gill-net survey has in recent years shown better recruitment than in the 1990's. The inshore survey, however, show pronounced area differences; relative stable recruitment northerly in Div. 1B, a more fluctuating recruitment in 1D and with good recruitment in the southern Div.1F area being restricted to year classes that are also abundant offshore.

14.4 Implemented management measures for 2009

The offshore quota for the total international fishery is sat at 10,000 tons for 2009. The quota for 2008 was 15,000 tons. An area closure of the offshore area north of the 62° parallel off East Greenland and the offshore area north of the 61° parallel off West Greenland have been closed for all directed cod fisheries in 2009.

For the coastal fisheries a TAC, sat at 10,000 tons, has been introduced for the coastal fleets for 2009. Until and including 2008 the coastal fleets have had a free access fishery.

14.5 Management considerations.

No sustainable offshore cod fishery at Greenland can be based on the infrequent inflow of cod from Iceland waters. The main management objective should therefore be to establish a robust offshore spawning stock that may improve the likelihood of future good recruitment.

All management effort should therefore be given to secure the rebuilding of the indigenous Greenland offshore cod stock. This implies that no offshore fishery should take place in 2010.

The present area closures are considered a second-best option proving a partial protection of the spawning stock. The ban of fishing north of 62 on East Greenland provides protection of the areas where most, but not all, of the spawning stock is found. The ban on West Greenland fisheries north of the and north of 61 similarly provide some protection of the main areas of the 2005 YC that enters the SSB in 2010-2012.

The inshore stocks have until 2009 not been subjected to catch constraints and is expected to yield far les that their maximum sustainable yield. The catch is predominantly taken at shallow water (pound net) and is dominated by 0.6-1 kg cod impeding a full utilisation of the cods growth potential. An increase in the minimum landing size (presently at 40 cm) and low catch ceilings is expected to increase stock size and landings in the medium term.

Table 14.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2008 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993
Faroe Islands	-	-	51	1	-	-
Germany	6.574	12.892	7.515	96	-	-
Greenland	52.135	92.152	58.816	20.238	5.723	1.924
Japan	10	-	-	-	-	-
Norway	7	2	948	-	-	-
UK	927	3780	1.631	-	-	-
Total	59.653	108.826	68.961	20.335	5.723	1.924
WG estimate	62.653 [2]	111.567 [3]	98.474 [4]	-	-	-

Country	1994	1995	1996	1997	1998	1999
Faroe Islands	-	-	-	-		
Germany	-	-	-	-		
Greenland	2.115	1.710	948	904	319	622
Japan	-	-	-	-		
Norway	-	-	-	-		
UK	-	-	-	-		
Togo	2.115	1.710				
Total	-	-	948	904	319	622
WG estimate			-	-	-	-

Country	2000	2001	2002[1]	2003[1]	2004[1]	2005
Faroe Islands						
Germany						
Greenland	764	1680	3698	3989	4948	
Japan						
Norway				693 [5]		
UK						
Togo				533 [5]		
Total	764	1680	3698	5215		
WG estimate	-	-				6118

Country	2006	2007	2008
Faroe Islands			
Germany			
Greenland			
Japan			
Norway			
UK			
Togo			
Total			
WG estimate	7769	13313	21921

[1]) Provisional data reported by Greenland authorities

[2]) Includes 3,000 t reported to be caught in ICES Sub-area XIV

[3]) Includes 2,741 t reported to be caught in ICES Sub-area XIV

[4]) Includes 29,513 t caught inshore

[5]) Transshipment from local inshore fishers

Table 14.2 Nominal catch (t) of cod in ICES Sub-area XIV, 1988-2008 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993
Faroe Islands	12	40	-	-	-	-
Germany	12.049	10.613	26.419	8.434	5.893	164
Greenland	345	3.715	4.442	6.677	1.283	241
Iceland	9	-	-	-	22	-
Norway	-	-	17	828	1.032	122
Russia		-	-	-	126	
UK (Engl. and Wales)	-	1.158	2.365	5.333	2.532	-
UK (Scotland)	-	135	93	528	463	163
United Kingdom	-	-	-	-	-	46
Total	12.415	15.661	33.336	21.800	11.351	-
WG estimate	9.457 [1]	14.669 [2]	33.513 [3]	21.818 [4]	-	736

Country	1994	1995	1996	1997	1998	1999
Faroe Islands	1	-	-	-	-	6
Germany	24	22	5	39	128	13
Greenland	73	29	5	32	37 [5]	+ [5]
Iceland	-	1	-	-		-
Norway	14	+	1	-	+	2
Portugal					31	-
UK (E/W/NI)	-	232	181	284	149	95
United Kingdom	296					
Total	408	284	192	355	345	116
WG estimate	-	-	-	-	-	-

Country	2000	2001	2002[5]	2003[5]	2004	2005
Faroe Islands					329	205
Germany	3	92	5	1		
Greenland		4	232	78	23	1
Iceland	-	210				
Norway	- [5]	43	13		5	507
Portugal	-	278				
UK (E/W/NI)	149	129				55
United Kingdom			34			
Total	152	756	284	79	357	
WG estimate	-		448[6]	294[7]		836[8]

[1]) Excluding 3,000t assumed to be from NAFO Division 1F and including 42t taken by Japan

[2]) Excluding 2,74 t assumed to be from NAFO Division 1F and including 1,500t reported from other areas assumed to be from Sub-area XIV and including 94t by Japan and 155t by Greenland (Horsted, 1994)

[3]) Includes 129t by Japan and 48 t additional catches by Greenland (Horsted, 1994)

[4]) Includes 18t by Japan

[5]) Provisional data

[6]) Includes 164t from Faroe Islands

[7]) Includes 215t from Faroe Islands

[8]) Includes 68t from Norway

Table 14.2 Cont. Nominal catch (t) of cod in ICES Sub-area XIV.

Country	2006	2007	2008
Faroe Islands		305	
Germany	775	772	
Greenland			
Iceland			
Norway	479	613	
Portugal			
UK (E/W/NI)			
United Kingdom		180	
Total			
WG estimate	1981	3221	2997

Table 14.3. Cod off Greenland (inshore and offshore components). Catches (t) from 1924 – 2008 as used by the Working Group, inshore and offshore by NAFO division 1B and 1D, offshore divided into East and West Greenland. Until 1995, based on Horsted (1994, 2000). * indicates preliminary results.

Cod		Offshore			Total
Year	Total inshore	East	West	Total offshore	Greenland
1924	843		200	200	1043
1925	1024		1871	1871	2895
1926	2224		4452	4452	6676
1927	3570		4427	4427	7997
1928	4163		5871	5871	10034
1929	7080		22304	22304	29384
1930	9658		94722	94722	104380
1931	9054		120858	120858	129912
1932	9232		87273	87273	96505
1933	8238		54351	54351	62589
1934	9468		88122	88122	97590
1935	7526		65846	65846	73372
1936	7174		125972	125972	133146
1937	6961		90296	90296	97257
1938	5492		90042	90042	95534
1939	7161		89807	89807	96968
1940	8026		43122	43122	51148
1941	8622		35000	35000	43622
1942	12027		40814	40814	52841
1943	13026		47400	47400	60426
1944	13385		51627	51627	65012
1945	14289		45800	45800	60089
1946	15262		44395	44395	59657
1947	18029		63458	63458	81487
1948	18675		109058	109058	127733
1949	17050		156015	156015	173065
1950	21173		179398	179398	200571
1951	18200		222340	222340	240540
1952	16726		317545	317545	334271
1953	22651		225017	225017	247668
1954	18698	4321	286120	290441	309139
1955	19787	5135	247931	253066	272853
1956	21028	12887	302617	315504	336532
1957	24593	10453	246042	256495	281088
1958	25802	10915	294119	305034	330836
1959	27577	19178	207665	226843	254420
1960	27099	23914	215737	239651	266750
1961	33965	19690	313626	333316	367281
1962	35380	17315	425278	442593	477973
1963	23269	23057	405441	428498	451767
1964	21986	35577	327752	363329	385315
1965	24322	17497	342395	359892	384214
1966	29076	12870	339130	352000	381076
1967	27524	24732	401955	426687	454211
1968	20587	15701	373013	388714	409301
1969	21492	17771	193163	210934	232426

Table 14.3 *continued*. Cod off Greenland (inshore and offshore components). Catches (t) from 1924 – 2007 as used by the Working Group, inshore and offshore by NAFO division 1B and 1D, offshore divided into East and West Greenland. Until 1995, based on Horsted (1994, 2000). * indicates preliminary results.

Cod		Offshore			Total
Year	Total inshore	East	West	Total offshore	Greenland
1970	15613	20907	97891	118798	134411
1971	13506	32616	107674	140290	153796
1972	14645	26629	95974	122603	137248
1973	9622	11752	53320	65072	74694
1974	8638	6553	39396	45949	54587
1975	6557	5925	41352	47277	53834
1976	5174	13027	28114	41141	46315
1977	13999	8775	23997	32772	46771
1978	19679	7827	18852	26679	46358
1979	35590	8974	12315	21289	56879
1980	38571	11244	8291	19535	58106
1981	39703	10381	13753	24134	63837
1982	26664	20929	30342	51271	77935
1983	28652	13378	27825	41203	69855
1984	19958	8914	13458	22372	42330
1985	8441	2112	6437	8549	16990
1986	5302	4755	1301	6056	11358
1987	18486	6909	3937	10846	29332
1988	18791	12457	36824	49281	68072
1989	38529	15910	70295	86205	124734
1990	28799	33508	40162	73670	102469
1991	18311	21596	2024	23620	41931
1992	5723	11349	4	11353	17076
1993	1924	1135	0	1135	3059
1994	2115	437	0	437	2552
1995	1710	284	0	284	1994
1996	948	192	0	192	1140
1997	1186	370	0	370	1556
1998	323	346	0	346	669
1999	622	112	0	112	734
2000	764	100	0	100	864
2001	1680	221	0	221	1901
2002	3698*	448	0	448	4146
2003	5215*	286	7	293	5508
2004	4948*	369	27	396*	5344
2005	6043	773	75	847*	6890*
2006	7388*	1981	408	2389	9777*
2007	11693	3221	1620	4841	16533
2008	12270	2997	9651	12648	24918

Table 14.4. Cod catches (t) divided to NAFO –divisions, caught by the coastal fleets (Horsted 2000, Statistic Greenland 2007, Greenland Fisheries License Control). [1]Including 1258t transhipped from local inshore fishers to foreign vessels.[2] Including landings fished in unknown waters.

	NAFO Division						
Year	1A	1B	1C	1D	1E	1F	Total
1984	175	3,908	1,889	5,414	1,149	1,333	19,958
1985	149	2,936	957	1,976	1,178	1,245	8,441
1986	76	1,038	255	1,209	1,456	1,268	5,302
1987	97	2,995	536	8,110	4,560	1,678	18,486
1988	333	6,294	1,342	2,992	3,346	4,484	18,791
1989	634	8,491	5,671	8,212	10,845	4,676	38,529
1990	476	9,857	1,482	9,826	1,917	5,241	28799
1991	876	8,641	917	2,782	1,089	4,007	18,311
1992	695	2,710	563	1,070	239	450	5,723
1993	333	323	173	968	18	109	1,924
1994	209	332	589	914	11	62	2,115
1995	53	521	710	332	4	81	1,710
1996	41	211	471	164	11	46	948
1997	18	446	198	99	13	130	1,186
1998	9	118	79	78	0	38	319
1999	68	142	55	336	8	4	622
2000	154	266	0	332	0	12	764
2001	117	1,183	245	54	0	81	1,680
2002	263	1,803	505	214	24	813	3,622
2003	1,109	1,522	334	274	3	479	5,215 [1]
2004	535	1,316	242	116	47	84	4,948 [1]
2005	650	2,351	1,137	1,162	278	382	6,043 [1]
2006	922	1,682	577	943	630	1,461	7,388 [1]
2007	417	2,547	1,197	1,843	660	4,988	11,693 [2]
2008	870	3,067	1,538	3,171	224	3,395	12,270 [2]

Table 14.5 Recoveries from cod inshore tagging in 2007-2008.

Inshore Taggings

	NAFO Div.					Rec. Info limited
Tag area	1B	1C	1D	1E	1F	
Div. 1B	12					
Div. 1D		2	34			
Div. 1F				1	82	13

Rec. With poor info : 1 taken in Div. 1F (inshore/offshore not known)
12 fish taken inshore - division presumably 1F

Table 14.6 Recoveries from cod offshor tagging in 2007-2008.

	Recapture area - Inshore returns in (brackets)								Rec. Info limited
Tag Area	Div 1D	Div. 1E	Div. 1F	ICES Q6	ICES Q5	ICES Q4	ICES Q3	ICES Va	
Div. 1E	3	5+(1)	1						1
Div. 1F			11+(3)	1					
ICES Q6			1	1					
ICES Q5					2	1		3	
ICES Q4					2			1	
ICES Q3							1	1	

Return with poor info taken offshore at south Greenland by long-liner

Table 14.7 German survey. Cod off Greenland. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2008. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling. Spawning stock numbers (SSN, x1000) and biomass indices (SSB, tons) based on survey indices, 1982-2008, and historical maturity data from Horsted et al, 1984.

	Abundance					Biomass				
Year	West	East	Total	CI	SSN	West	East	Total	CI	SSB
1982	100553	12214	112767	40	16661	145419	32552	177971	35	47868
1983	55453	9819	65272	34	14392	93296	40103	133399	29	48114
1984	18540	7822	26362	41	6255	28496	23610	52106	38	21463
1985	58531	12014	70545	35	9191	38012	32464	70476	47	29168
1986	130176	22838	153014	33	9499	77830	38246	116076	28	40878
1987	778042	43992	822034	47	23131	633071	55087	688158	48	55727
1988	652220	25133	677353	51	30004	646733	56815	703548	49	48997
1989	422763	101758	524521	52	60244	404602	259793	664395	44	127083
1990	41358	33473	74831	38	20654	42167	83753	125920	29	35871
1991	5874	11592	17466	26	8100	6809	35970	42779	29	19400
1992	2298	937	3235	42	123	723	1425	2148	51	685
1993	1798	4112	5910	38	103	440	6385	6825	42	2560
1994	578	1103	1681	27	191	137	3674	3811	62	1009
1995	339	7600	7939	75	29	85	17375	17460	92	6761
1996	851	1578	2429	34	155	388	3860	4248	45	1237
1997	301	5559	5860	57	114	275	16073	16348	67	3485
1998	1799	1722	3521	39	76	141	4450	4591	69	1674
1999	1014	3201	4215	43	121	290	4728	5018	55	1747
2000	2133	5255	7388	60	62	638	5154	5792	41	2208
2001	7990	8608	16598	48	356	2602	16328	18930	38	3879
2002	4724	10952	15676	50	150	2446	22318	24764	59	8049
2003	6539	20111	26650	44	3052	2576	51701	54277	71	9279
2004	32572	19607	52179	54	3932	6588	36276	42864	32	12311
2005	67543	91915	159458	34	7163	27191	124417	151608	33	36932
2006	248920	153196	402116	99	8773	162125	145796	307921	67	34020
2007	173095	38803	211898	90	12037	173178	89971	263149	72	37369
2008	46714	142034	188748	92	37561	41113	427304	468417	122	181490

Table 14.8 ***German survey*****, West Greenland. Age disaggregate abundance indices), 1982-2008, ('1000).**

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	884	33470	11368	32504	9528	2622	578	939	91	90	92250
*1983	0	0	1469	2815	26619	4960	10969	1882	992	317	168	13	50204
1984	205	6	42	2359	1702	10736	986	2178	106	185	30	.	18535
1985	828	37494	1401	895	6243	2793	7673	426	737	18	25	.	58533
1986	.	9151	102390	4823	837	6767	1932	3726	108	386	22	.	130142
1987	.	296	55472	670795	29299	6249	10404	1517	3619	.	337	28	778016
1988	.	266	3225	103181	535793	5785	698	1184	699	1315	32	.	652178
1989	-24	339	2718	8921	201787	205439	3172	.	228	37	141	.	422758
1990	137	62	1227	3339	1589	26427	8494	50	0	0	.	.	41325
1991	.	252	237	493	1319	175	2845	504	8	.	.	.	5833
1992	.	196	1644	264	52	87	.	54	.	.	.	.	2297
1993	.	15	1061	651	26	44	.	.	.	.	.	.	1797
1994	.	290	46	196	36	5	.	5	.	.	.	.	578
1995	.	.	274	14	51	.	.	.	.	.	.	.	339
1996	.	154	12	665	9	.	10	.	.	.	.	.	850
1997	.	11	25	13	250	.	.	.	.	.	.	.	299
1998	49	1712	.	6	6	25	.	.	.	.	.	.	1798
1999	29	405	460	107	7	.	6	.	.	.	.	.	1014
2000	.	182	1108	696	140	.	.	.	.	.	.	.	2126
2001	.	663	5992	1118	140	41	.	.	.	.	.	.	7954
2002	12	13	1166	3441	82	.	.	.	.	.	.	.	4714
2003	96	3768	430	1263	849	102	28	.	.	.	.	.	6536
2004	823	24172	5290	814	641	636	171	11	.	.	.	.	32558
2005	236	1108	57596	6760	464	628	509	41	27	.	.	.	67369
2006	477	4587	18549	206716	13749	656	2483	1325	116	.	.	.	248658
2007	370	564	22211	12739	127222	9210	542	167	70	.	.	.	173095
2008	53	2806	4796	15385	4792	18232	533	22	87	0	0	0	46706

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.9 ***German survey*, East Greenland. Age disaggregate abundance indices 1982-2008, (1000),. *). () incomplete sampling. In 2007, stratum 5.1 was not completely sampled.**

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	0	239	841	1764	1999	1227	379	130	1392	73	72	8116
*1983	0	0	411	605	1008	1187	2125	1287	302	265	703	101	7994
-1984	.	29	136	1786	701	1468	931	1887	498	219	26	.	7681
1985	209	1864	543	120	2492	1959	1772	738	1907	275	54	82	12015
1986	.	5119	7987	2184	574	2131	1006	1834	467	1275	87	100	22764
1987	.	8	13367	19261	4635	1186	1909	458	1641	200	1111	113	43889
1988	12	27	196	7378	11417	2385	551	1705	166	693	95	477	25102
1989	.	9	252	776	20785	68832	3188	334	5026	419	1647	446	101714
1990	.	41	113	798	702	6589	24034	347	44	253	.	379	33300
1991	.	132	462	446	767	170	3952	5482	98	44	12	.	11565
-1992	.	.	73	111	80	54	106	64	79	.	.	.	567
1993	.	18	53	2487	455	306	306	98	279	100	.	.	4102
-1994	.	153	.	37	377	182	103	177	.	36	.	.	1065
1995	.	7	2514	1133	398	1922	508	163	525	42	248	.	7460
1996	.	.	.	574	273	310	275	67	82	.	.	.	1581
1997	.	.	60	84	2577	1793	602	248	149	.	.	.	5513
1998	93	246	192	22	46	467	449	156	42	.	.	.	1713
1999	259	631	773	490	146	372	230	223	.	45	30	.	3199
2000	.	889	1174	1458	871	170	311	77	148	128	33	.	5259
2001	.	402	1205	1723	2473	1449	742	213	195	73	39	.	8514
2002	106	9	466	2052	2296	2367	2206	1001	265	93	40	.	10901
2003	1426	426	149	989	4361	4354	4652	2452	1086	185	.	.	20080
2004	361	4606	2256	797	1140	4416	2836	2145	822	141	52	.	19572
2005	155	3677	53513	14918	2855	6866	6544	2300	607	111	.	.	91546
-2006	.	372	4863	124917	14430	2882	3242	1964	307	91	24	.	153092
-2007	182	300	913	1344	23104	9193	1147	1278	1211	122	.	.	38794
2008	38	355	296	2853	9104	94922	24954	3989	2039	2050	929		141529

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.10 ***German survey*****. Greenland (total). Age disaggregate abundance indices (1000), 1982-2005. () incomplete sampling. Minor differences between previous tables due to rounding.**

YEAR	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11+	TOTAL
1982	0	176	1123	34311	13132	34503	10755	3001	708	2331	164	162	100366
*1983	0	0	1880	3420	27627	6147	13094	3169	1294	582	871	114	58198
-1984		35	178	4145	2403	12204	1917	4065	604	404	56	0	26216
1985	1037	39358	1944	1015	8735	4752	9445	1164	2644	293	79	0	70548
1986		14270	110377	7007	1411	8898	2938	5560	575	1661	109	0	152906
1987		304	68839	690056	33934	7435	12313	1975	5260	0	1448	141	821905
1988		293	3421	110559	547210	8170	1249	2889	865	2008	127	0	677280
1989		348	2970	9697	222572	274271	6360	0	5254	456	1788	0	524472
1990		103	1340	4137	2291	33016	32528	397	44	253	0	0	74625
1991		384	699	939	2086	345	6797	5986	106	0	0	0	17398
-1992			1717	375	132	141	0	118	0	0	0	0	2864
1993		33	1114	3138	481	350	0	0	0	0	0	0	5899
-1994		443		233	413	187	0	182	0	0	0	0	1643
1995			2788	1147	449	0	0	0	0	0	0	0	7799
1996				1239	282	0	285	0	0	0	0	0	2431
1997			85	97	2827	0	0	0	0	0	0	0	5812
1998	142	1958		28	52	492	0	0	0	0	0	0	3511
1999	288	1036	1233	597	153	0	236	0	0	0	0	0	4213
2000		1071	2282	2154	1011	0	0	0	0	0	0	0	7385
2001		1065	7197	2841	2613	1490	0	0	0	0	0	0	16468
2002	118	22	1632	5493	2378	0	0	0	0	0	0	0	15615
2003	1522	4194	579	2252	5210	4456	4680	0	0	0	0	0	26616
2004	1184	28778	7546	1611	1781	5052	3007	2156	0	0	0	0	52130
2005	391	4785	111109	21678	3319	7494	7053	2341	634	0	0	0	158915
-2006		4959	23412	331633	28179	3538	5725	3289	423	0	0	0	401750
-2007	552	864	23124	14083	150326	18403	1689	1445	1281	0	0	0	211889
2008	91	3161	5092	18238	13896	113154	25487	4011	2126	2050	929	0	188235

***) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES, 1984).**

Table 14.11 . ***German survey*****. Age-disaggregated abundance estimates by stratum 2008 ('000). Strata shown in fig. 14.7.**

year	stratum	age0	age1	age2	age3	age4	age5	age6	age7	age8	age9	age10	age11	total
2008	1.2	.	.	.	.	.	.	.	.	.	.	.	.	.
2008	1.1	11	702	1005	3058	259	297	0	0	0	.	.	.	5332
2008	2.1	16	519	417	841	35	5	0	0	0	.	.	.	1833
2008	2.2	3	624	314	801	51	29	0	0	0	.	.	.	1822
2008	3.1	3	450	2331	4675	164	137	52	0	6	.	.	.	7818
2008	3.2	5	188	288	693	21	36	1	0	0	.	.	.	1232
2008	4.1	15	315	344	5096	4225	17553	459	5	81	.	.	.	28093
2008	4.2	0	8	97	221	37	175	21	17	0	.	.	.	576
2008	5.1	0	318	130	474	687	4168	603	46	4	3	0	.	6433
2008	5.2	0	0	111	1316	1757	6891	1178	103	13	7	0	.	11376
2008	6.1	0	0	23	711	5081	64505	16086	2818	1641	1620	851	.	93336
2008	6.2	38	37	21	239	1266	14870	4186	543	182	234	56	.	21672
2008	7.2	0	0	11	113	313	4488	2901	479	199	186	22	.	8712

Table 14.12 Cod abundance indices ('000) from the West Greenland Shrimp and Fish survey by year and NAFO divisions. The survey gear was changed in 2005. The new gear is estimated as ca. 50% more efficient than the old gear.

Year	0A	1A	1B	1C	1D	1E	1F	Total	CV
1992		4	53	243	345	0	8	653	49
1993		2	16	54	135	286	18	512	68
1994		10	41	87	0	6	0	144	47
1995		0	51	380	44	62	39	578	55
1996		0	0	46	68	87	107	308	55
1997		0	7	31	0	0	0	38	68
1998		0	4	0	26	26	3	59	54
1999		32	136	16	23	6	0	213	29
2000		585	437	71	58	9	189	1349	23
2001		26	305	110	448	305	313	1508	26
2002		13	203	78	3294	114	457	4158	50
2003		492	1395	351	727	214	211	3391	22
2004		197	152	379	2630	1538	1610	6507	29
New Survey Gear Introduced									
2005	145	205	820	1846	4643	7051	93608	108317	52
2006	454	429	4091	2702	11039	8792	40261	67769	29
2007	737	1267	3179	7424	3798	2857	33256	52517	37
2008	1209	886	4129	4107	9521	11905	21651	53408	23

Table 14.13. Cod biomass indices (tons) from the West Greenland Shrimp and Fish survey by year and NAFO divisions. The survey gear was changed in 2005. The new gear is estimated as ca. 50% more efficient compared to the old gear.

	0A	1A	1B	1C	1D	1E	1F	Total	CV
1992		23	54	75	118	0	2	251	45
1993		2	5	25	39	124	5	200	70
1994		3	9	38	0	1	0	51	46
1995		5	6	120	23	3	4	155	63
1996		0	0	15	23	27	49	113	51
1997		0	2	53	0	0	0	55	76
1998		1	1	0	47	50	3	101	56
1999		29	28	1	17	1	0	53	47
2000		226	130	21	9	2	46	357	23
2001		140	155	56	178	98	100	603	23
2002		67	128	41	1489	42	150	1863	46
2003		444	323	264	453	118	46	1332	26
2004		542	53	176	680	685	305	2394	28
New Survey Gear Introduced									
2005	38	71	349	406	1226	1316	60546	63952	70
2006	114	77	640	481	3148	2855	17197	24514	33
2007	247	386	826	1554	620	899	23957	28488	45
2008	421	372	2012	923	1730	3321	19702	28481	37

Table 14.14 : Abundance indices ('000) by age from the West Greenland Shrimp and Fish survey. The survey gear was changed in 2005. The new gear is estimated as ca. 50% more efficient compared to the old gear.

Year/age	0	1	2	3	4	5	6	7	8+
1992		0	221	126	123	63	10	3	1
1993		0	39	170	73	16	7	1	2
1994		0	10	126	22	8	1	0	0
1995		19	345	101	157	40	0	0	0
1996		0	14	203	78	3	0	0	0
1997		0	0	10	3	24	8	1	0
1998		0	17	25	20	0	0	0	0
1999		7	144	66	23	6	1	1	1
2000		90	711	363	92	13	52	0	0
2001		97	540	546	376	0	0	0	0
2002		0	603	2323	1078	245	0	4	0
2003		81	1416	1037	433	135	18	0	0
2004		1215	2812	1205	786	382	71	33	4
New Survey gear Introduced									
2005	3284	1348	38177	44685	10490	5595	4596	113	30
2006	244	6804	5826	42612	9722	1956	532	72	0
2007	224	295	12835	6348	29856	2708	166	69	16
2008	35	3516	2880	20921	8337	16047	1530	150	0

Table 14.15: Greenland Survey. The 2008 abundance indices ('000) by year class/age . The areas are shown in fig. 14.14.

Age	0	1	2	3	4	5	6	7	8	9	10+
Year-class	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	<1999
Div. 0A	0	492	54	438	135	88	0	0	0	0	0
Div. 1A	0	27	253	386	219	0	0	0	0	0	0
Div. 1B	0	575	229	1133	1569	522	79	29	0	0	0
Div. 1C	35	884	604	1604	979	0	0	0	0	0	0
Div. 1D	0	944	1042	7106	417	11	0	0	0	0	0
Div. 1E	0	553	615	7997	2454	236	39	15	0	0	0
Div. 1F	0	40	83	2257	2563	15189	1412	106	0	0	0
ICES Q6	86	60	172	732	1577	3530	1242	184	108	10	5
ICES Q5	0	14	219	177	207	538	422	34	11	8	3
ICES Q4	384	55	492	250	283	274	182	0	0	0	51
ICES Q3	1251	0	45	4330	2396	1175	1265	943	417	573	644
ICES Q2	770	26	0	0	0	25	140	186	54	130	35
ICES Q1	1712	179	219	269	235	499	766	548	111	359	0

Table 14.16 : NAFO Div. 1B. Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the West Greenland inshore gill-net survey.

NAFO division 1B

	Age								
Year	1	2	3	4	5	6	7	8	All
1985	26	23	0	6	0	0	0	0	54
1986	4	245	16	8	2	2	0	0	278
1987	0	122	233	25	1	0	0	0	381
1988	0	33	130	111	2	0	0	0	276
1989	1	110	83	57	32	1	0	0	283
1990	0	109	108	62	53	12	0	0	344
1991	0	3	131	53	11	3	0	0	202
1992	0	43	10	18	3	0	0	0	74
1993	0	22	22	2	1	0	0	0	47
1994	4	8	19	12	0	0	0	0	43
1995	2	115	19	7	1	0	0	0	143
1996	0	28	40	7	1	0	0	0	77
1997	0	14	8	3	1	0	0	0	26
1998	2	7	4	6	3	0	0	0	23
1999	na	na	na	na	na	na	na	na	na
2000	na	na	na	na	na	na	na	na	na
2001	na	na	na	na	na	na	na	na	na
2002	31	207	72	21	9	1	0	0	340
2003	1	68	69	21	3	0	0	0	163
2004	32	28	29	9	5	0		0	102
2005	47	123	35	7	5	1	3	0	221
2006	32	148	60	24	1	1	0	0	170
2007	7	170	82	15	1	0	0	0	275
2008	na	na	na	na	na	na	na	na	na

Table 14.16, *continued* : NAFO Div. 1D. Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the West Greenland inshore gill-net survey

NAFO division 1D

	Age								
Year	1	2	3	4	5	6	7	8	All
1985	68	77	0	3	3	3	0	1	155
1986	0	96	15	0	0	1	2	0	114
1987	1	16	68	5	0	0	0	0	90
1988	0	20	48	30	1	0	0	0	99
1989	0	78	47	13	13	0	0	0	152
1990	0	14	35	4	4	3	0	0	60
1991	124	3	17	6	2	1	0	0	154
1992	0	61	22	10	7	1	0	0	100
1993	0	4	57	20	2	0	0	0	83
1994	0	0	6	5	1	0	0	0	12
1995	0	3	2	4	4	0	0	0	12
1996	0	1	1	0	2	0	0	0	4
1997	3	3	1	0	0	1	0	0	8
1998	0	10	17	1	0	0	0	0	28
1999	0	0	1	3	0	0	0	0	5
2000	0	2	2	1	1	0	0	0	6
2001	na	na	na	na	na	na	na	na	na
2002	0	7	4	3	0	0	0	0	14
2003	0	6	4	2	1	0	0	0	13
2004	3	43	6	3	1	1	0	0	57
2005	9	27	7	2	0	0	0	0	45
2006	2	114	37	13	4	0	0	0	170
2007	na	na	na	na	na	na	na	na	na
2008	4	4	47	63	7	0	0	0	124

Table 14.16, *continued* : NAFO Div. 1F. Cod abundance indices (numbers of cod caught per 100 hours net settings) by age in the West Greenland inshore gill-net survey. The strong (and only) year classes of any importance offshore are indicated with yellow.

NAFO division 1F

	Age								
Year	1	2	3	4	5	6	7	8+	All
1985	204	8	1	1	1	1	1	0	217
1986	17	112	5	0	2	0	0	0	136
1987	0	143	147	1	0	0	0	0	291
1988	0	1	83	6	0	0	0	0	89
1989	0	5	2	19	2	0	0	0	29
1990	0	0	3	2	13	1	0	0	18
1991	2	2	0	2	0	1	0	0	7
1992	0	3	1	0	1	0	1	0	6
1993	0	5	2	1	0	0	0	0	8
1994	0	0	1	1	0	0	0	0	3
1995	0	0	0	0	0	0	0	0	0
1996	na	na	na	na	na	na	na	na	na
1997	na	na	na	na	na	na	na	na	na
1998	0	4	12	0	0	0	0	0	17
1999	na	na	na	na	na	na	na	na	na
2000	0	14	8	0	2	0	1	0	24
2001	na	na	na	na	na	na	na	na	na
2002	na	na	na	na	na	na	na	na	na
2003	na	na	na	na	na	na	na	na	na
2004	na	na	na	na	na	na	na	na	na
2005	na	na	na	na	na	na	na	na	na
2006	na	na	na	na	na	na	na	na	na
2007	6	90	9	21	1	0	0	0	108
2008	8	17	30	4	2	0	0	0	62

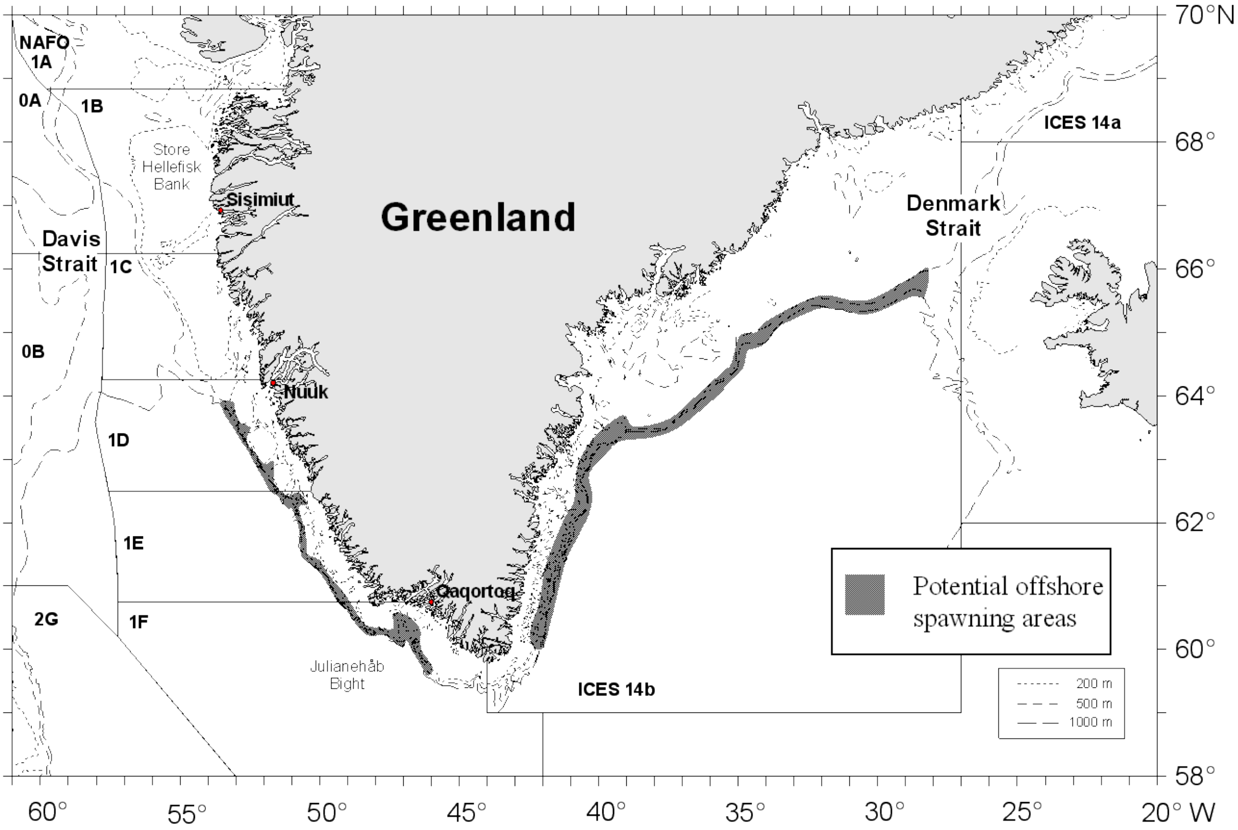


Figure. 14.1 Historical offshore spawning areas of cod in Greenland.

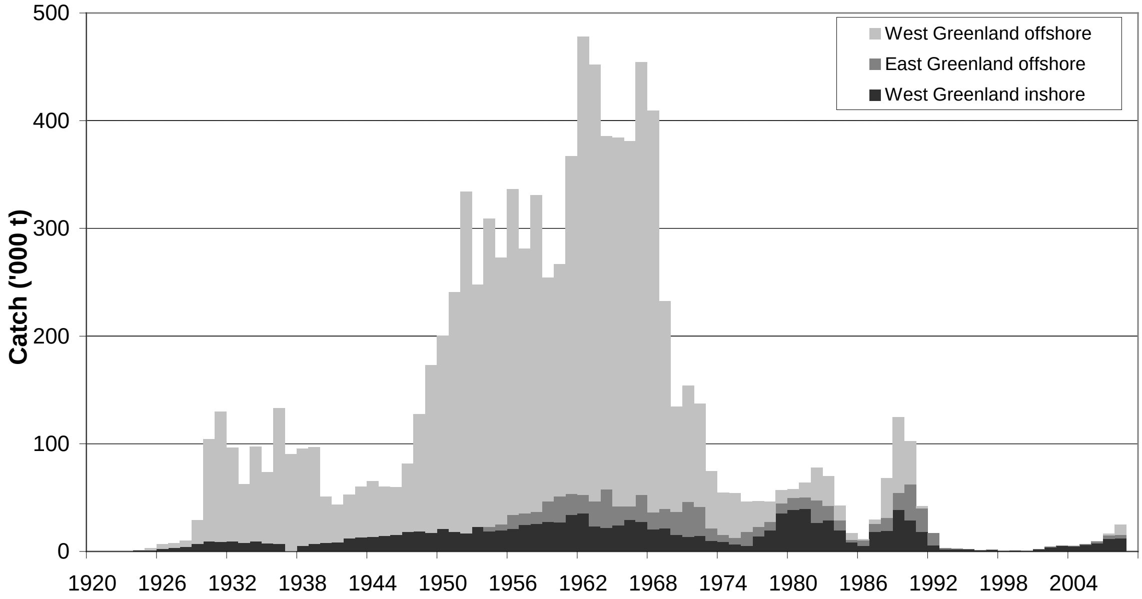


Figure 14.2.. Cod off Greenland. Catches 1920-2008 as used by the Working Group, inshore and offshore by West and offshore by East Greenland (Horsted 1994,2000). Columns are stacked.

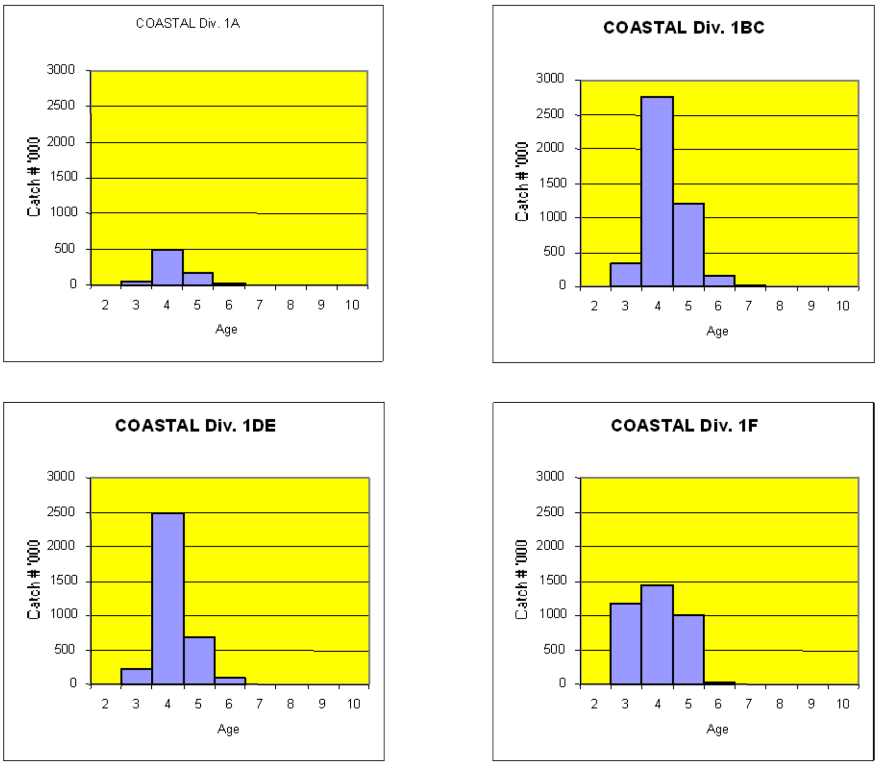


Figure14.3 : Estimated 2008 catch in numbers by area and age from the coastal fleets.

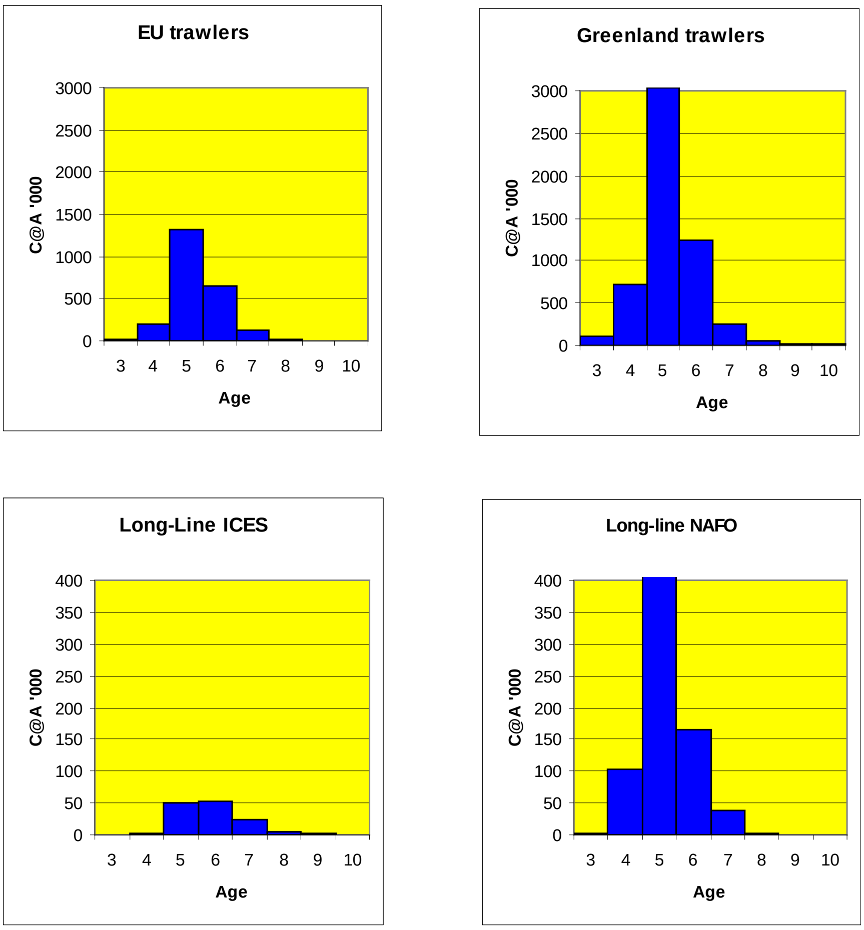


Figure:14.4 Estimated 2008 catch in numbers by age for the offshore vessels.

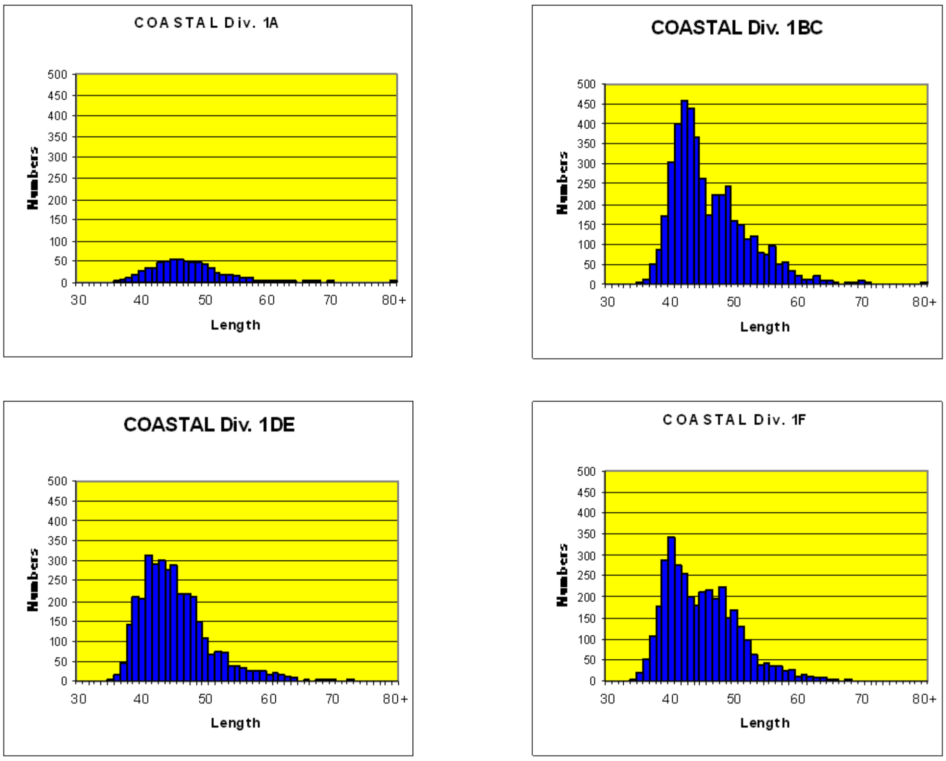


Figure 14.5 Estimated LFQ distribution from the Coastal vessels, 2008

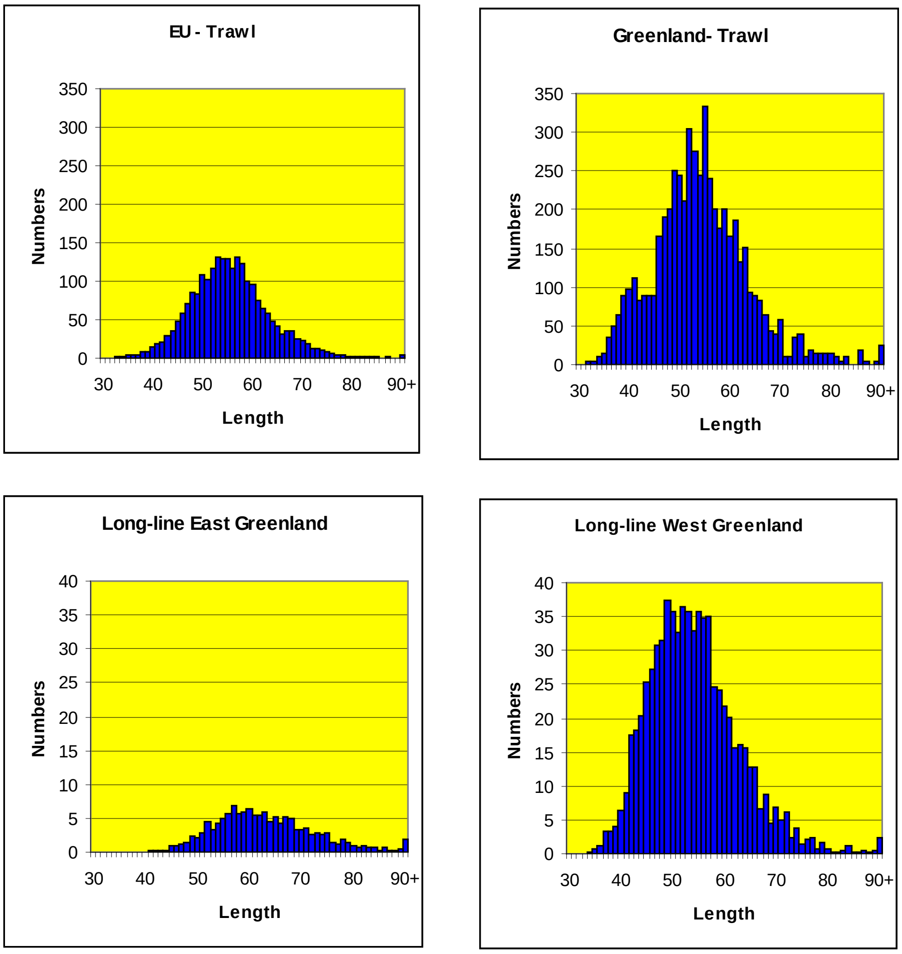


Figure 14.6 Estimated LFQ distribution from the offshore vessels, 2008

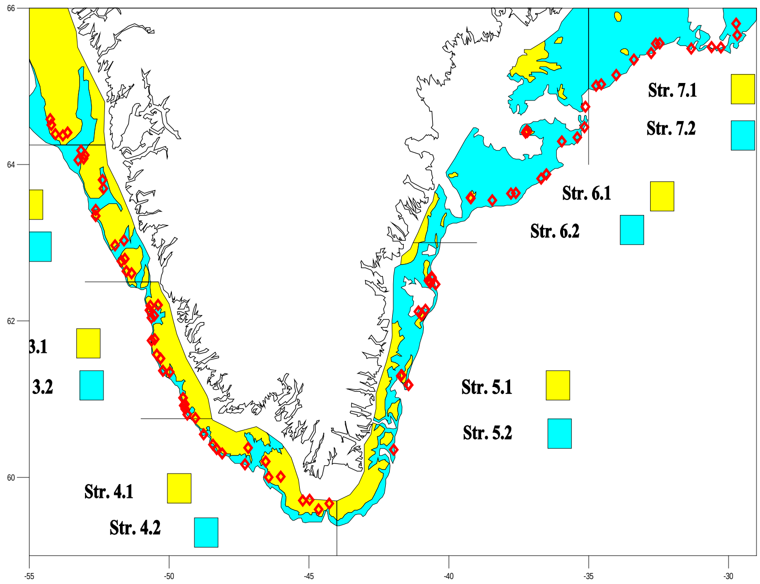


Figure 14.7 German survey, 2008. Strata and haul positions. At East Greenland hauls generally restricted to the shelf area.

Figure 14.8 Grenland survey, 2008. Strata and haul positions. Hauls are generally restricted to the shelf area.

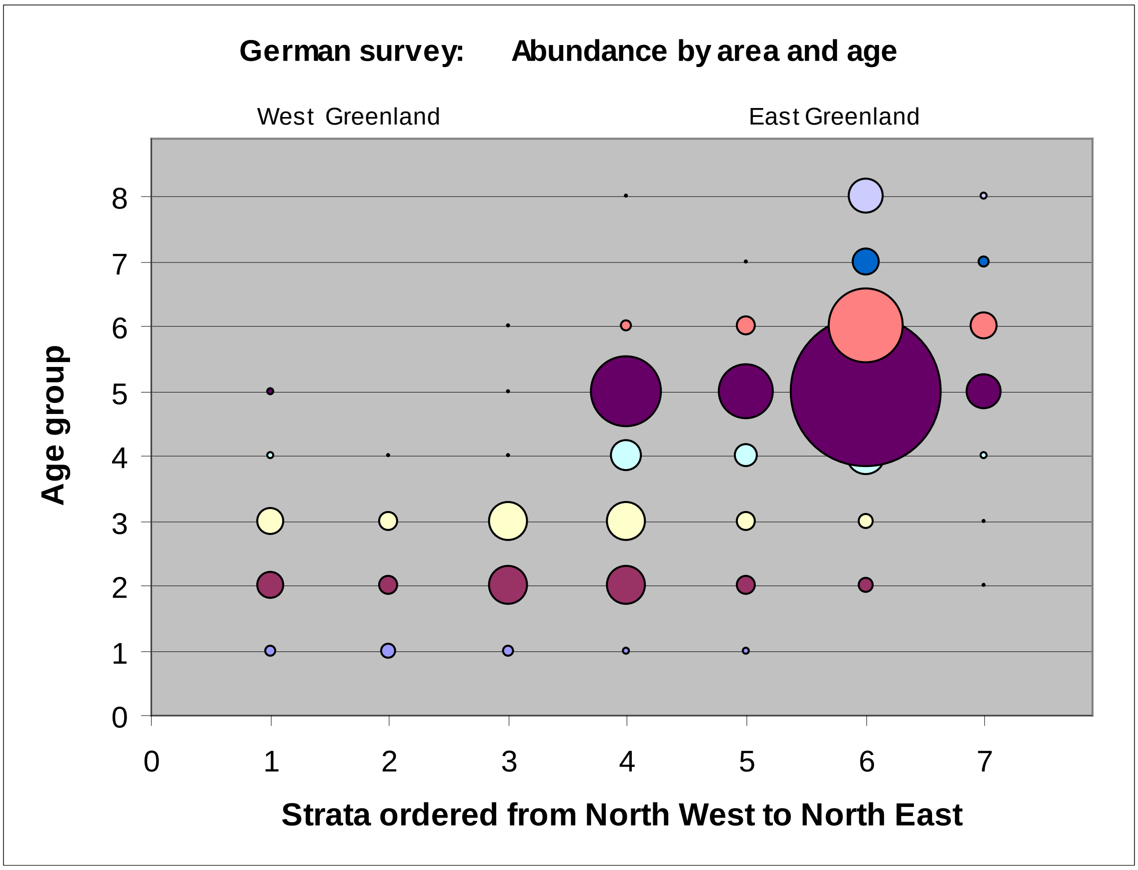


Figure 14.9 German survey, Abundance per age group and strata. Strata 1 –4 is West Greenland from north to south; strata 5-7 is East Greenland from south to north.

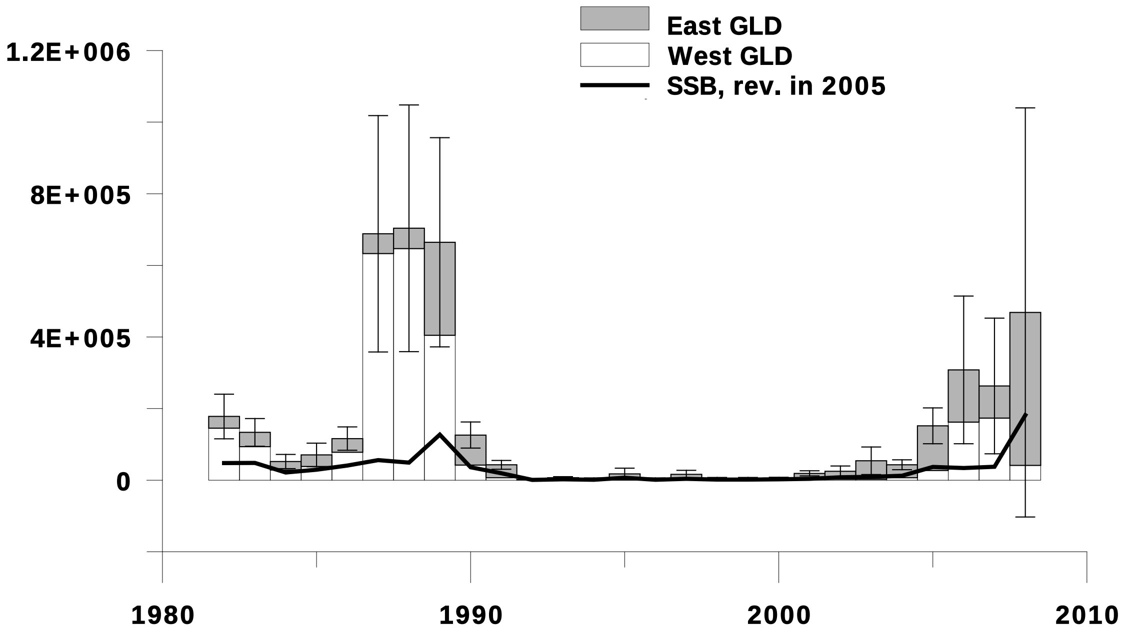


Figure 14.10 German survey, Cod off Greenland. Aggregated survey biomass indices for West and East Greenland and revised spawning stock biomass, 1982-2008. Error bars indicate 95% confidence intervals on the total biomass. Incomplete survey coverage in 1984, 1992, 1994, 2006 and 2007.

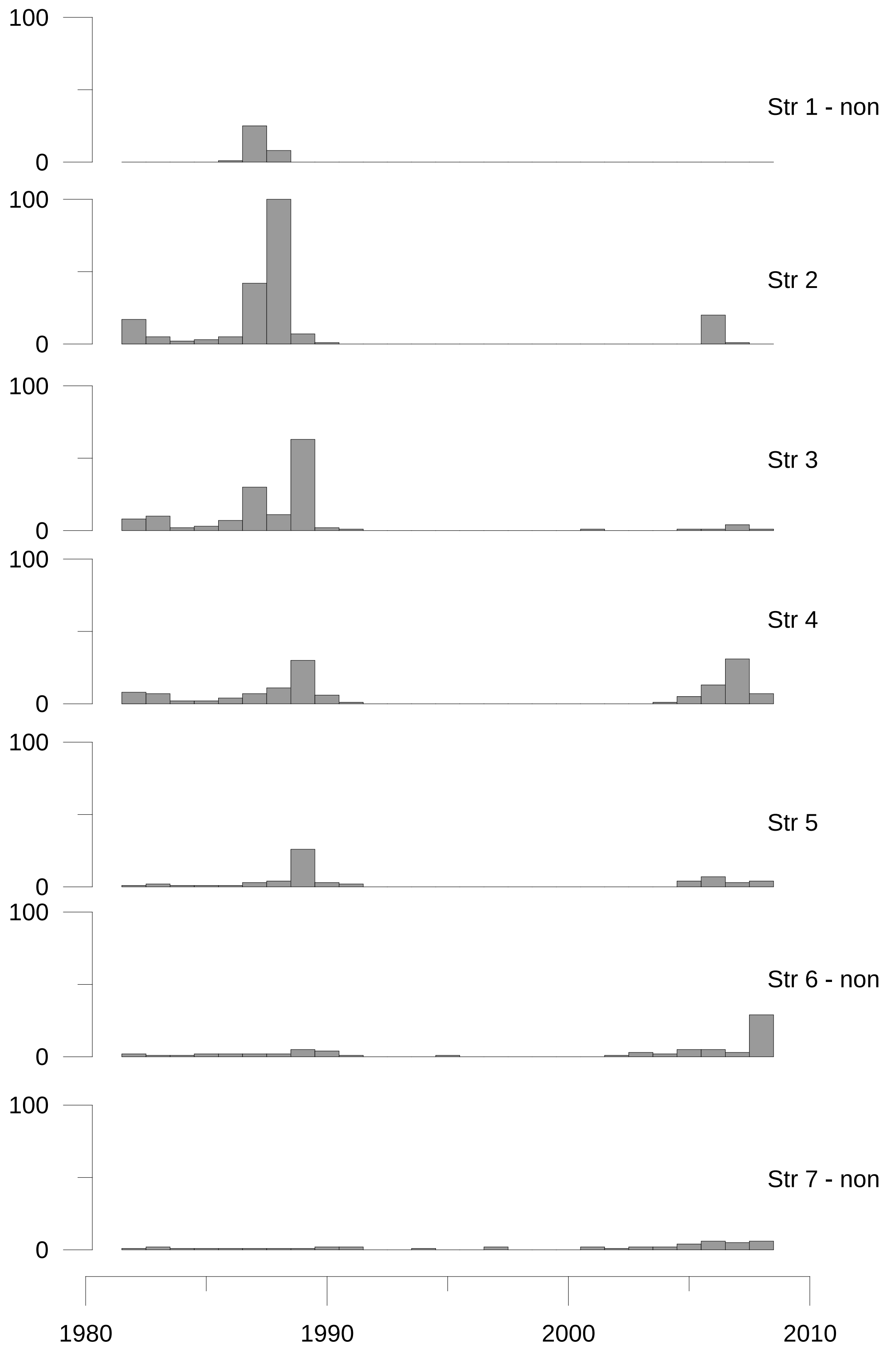


Figure 14.11 German survey. CPUEs in weight by stratum. CPUEs standardized to maximum=100 in stratum 2, 1988. The high value in stratum 6 in 2008 driven by one exceptional large haul.

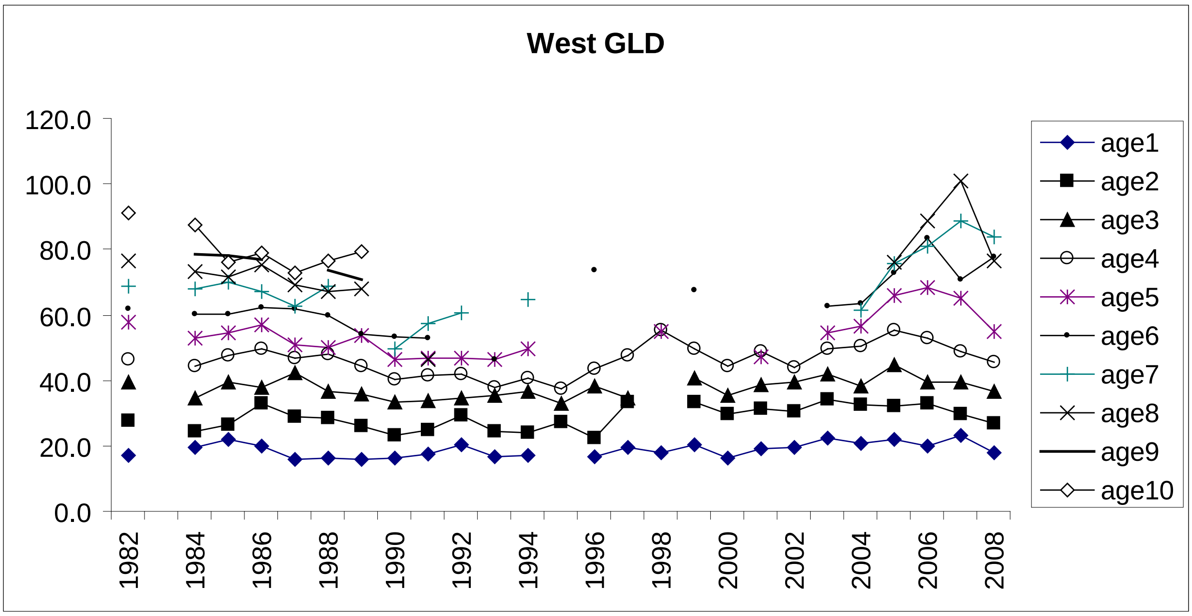


Figure 14:12 Mean length at age 1-10 years 1982, 1984-2008 sampled in West Greenland. Data derived from German survey.

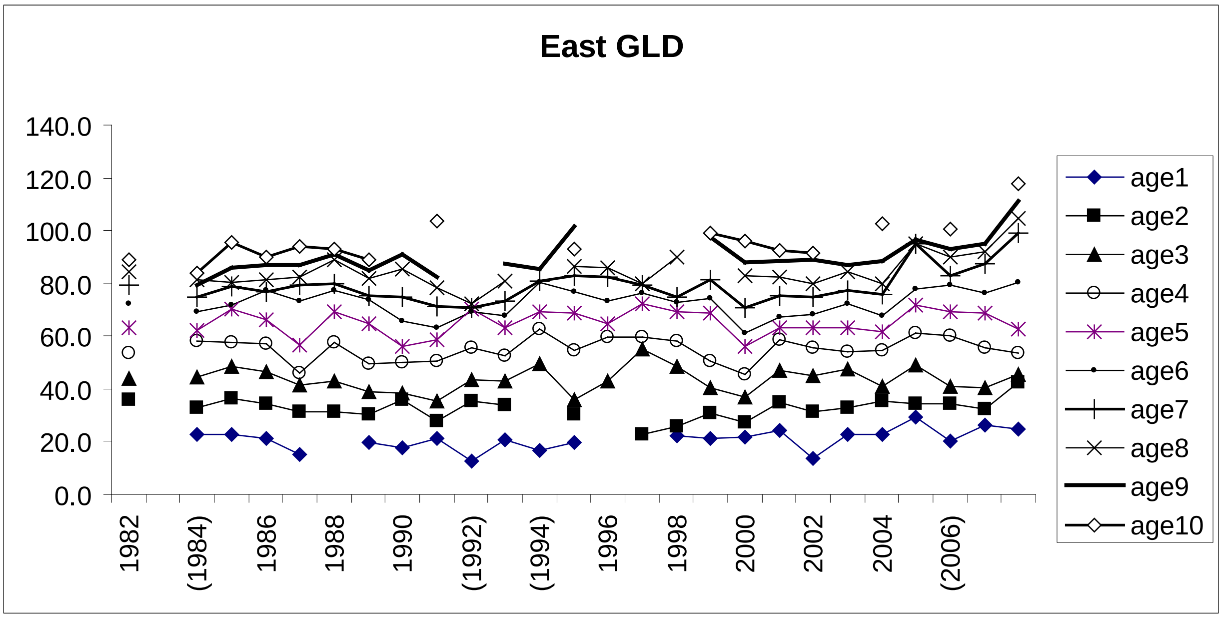


Figure 14 :13 mean length at age 1-10 years 1982, 1984-2008 sampled in East Greenland. Data derived from German survey.

Figure14.14. Greenland survey 2008. Abundance per Km^2

Figure 14.15 Greenland survey. Catch weight per Km²

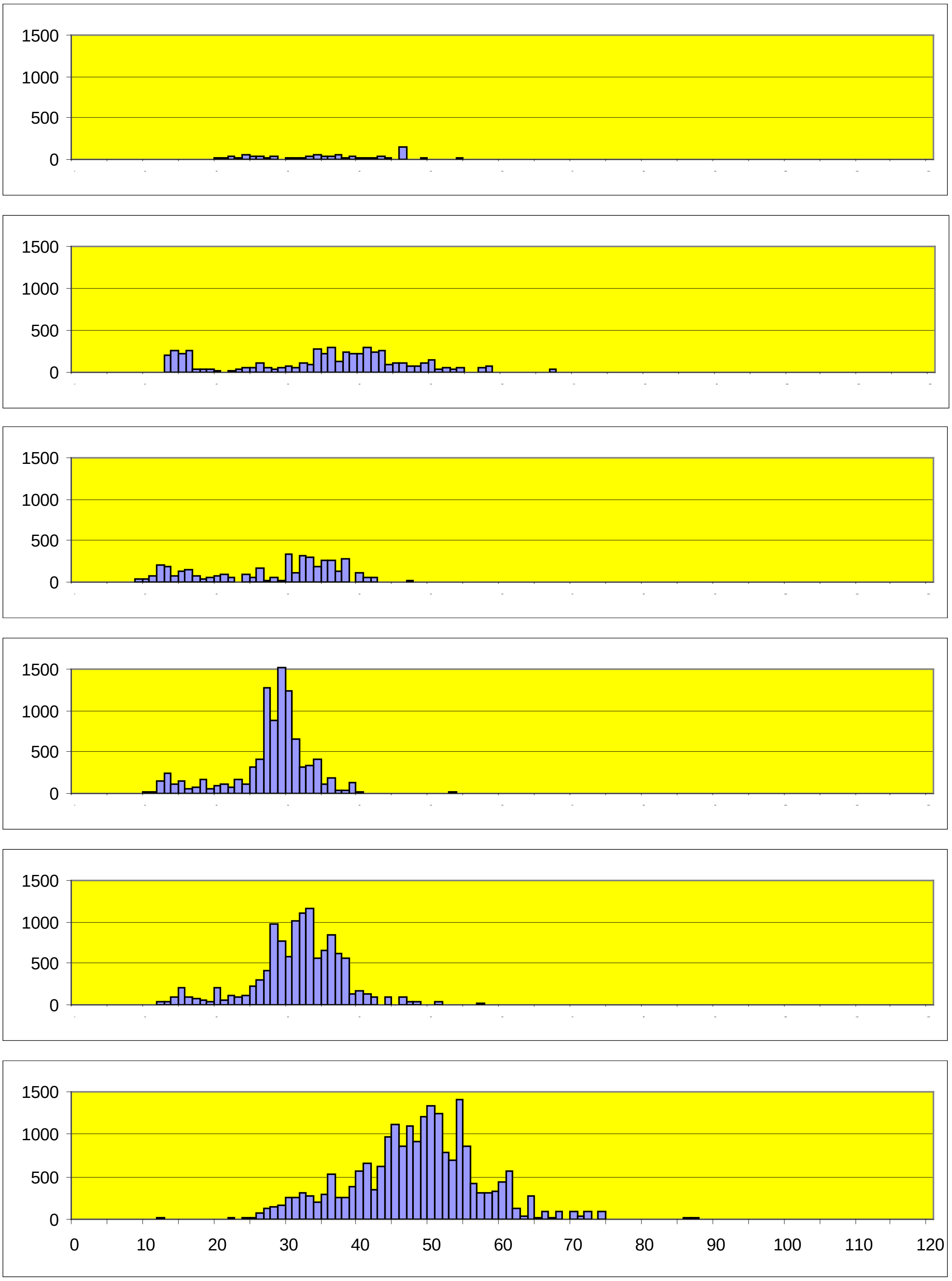


Figure 14.16 : Greenland survey 2008 West Greenland. Length distribution from NAFO Div. 1A (top) to 1F (bottom).

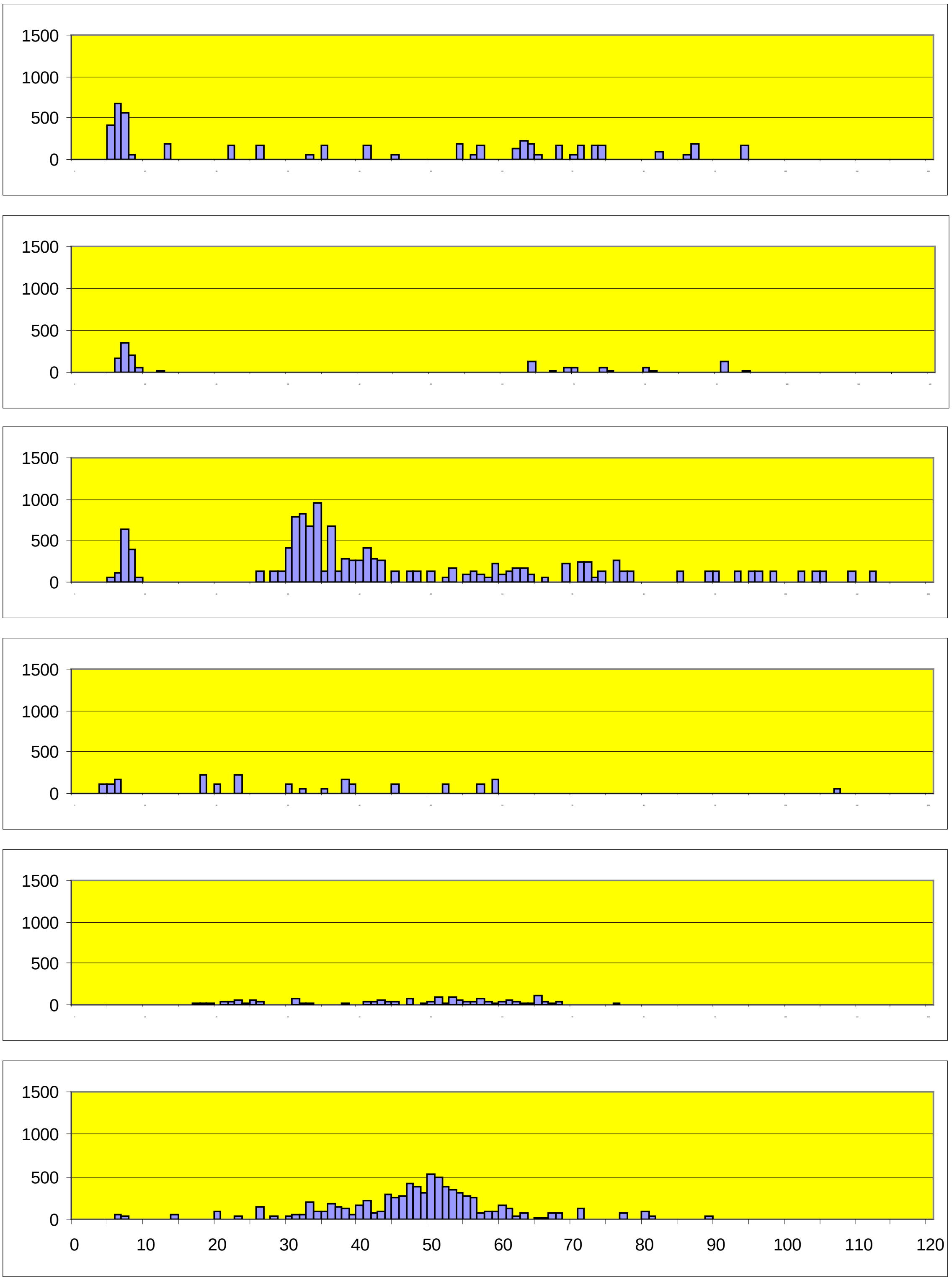


Figure 14.17 : Greenland survey 2008 East Greenland. Length distribution from the northern area Q1 (top) to the southernmost area Q6 (bottom).Areas shown in fig. 14

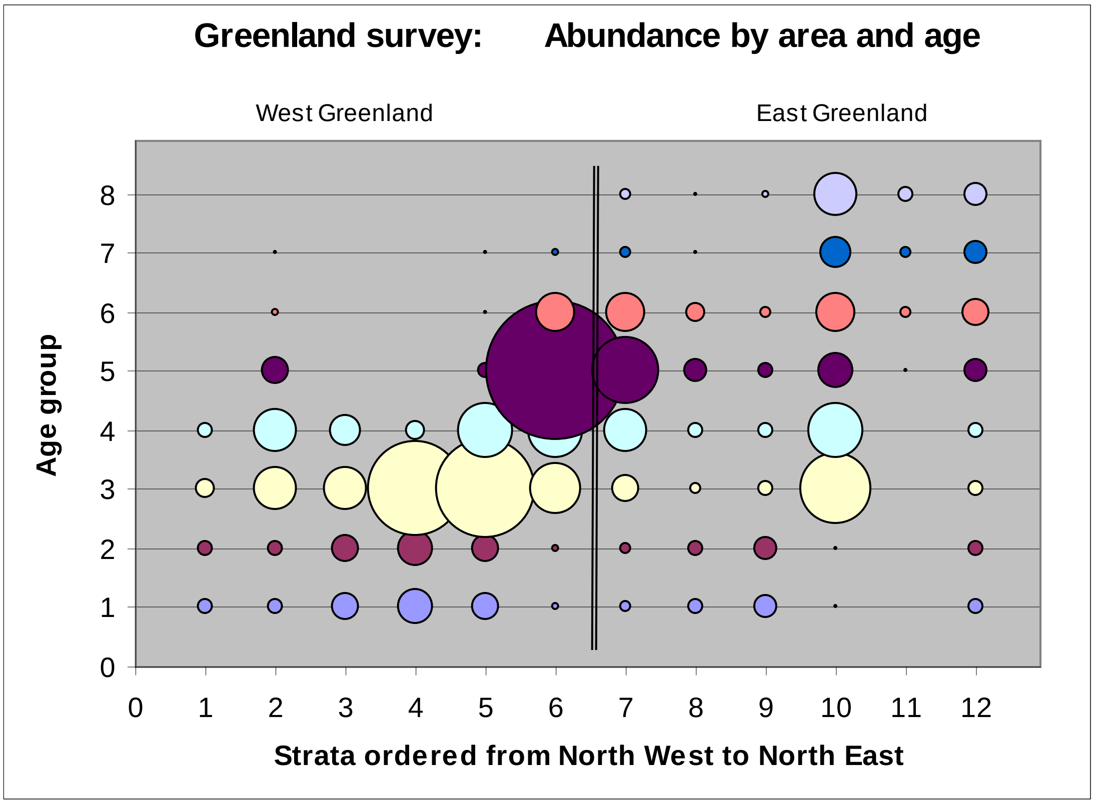


Figure 14.18 Abundance indices from the Greenland Survey, by strata and age. Strata's from NAFO Div. 1A, numbered=1 (left) to the East Greenland northernmost strata Q1 numbered 12 (right). The separation between West and East Greenland at Cape Farewell is indicated by the line between strata no. 6 and 7.

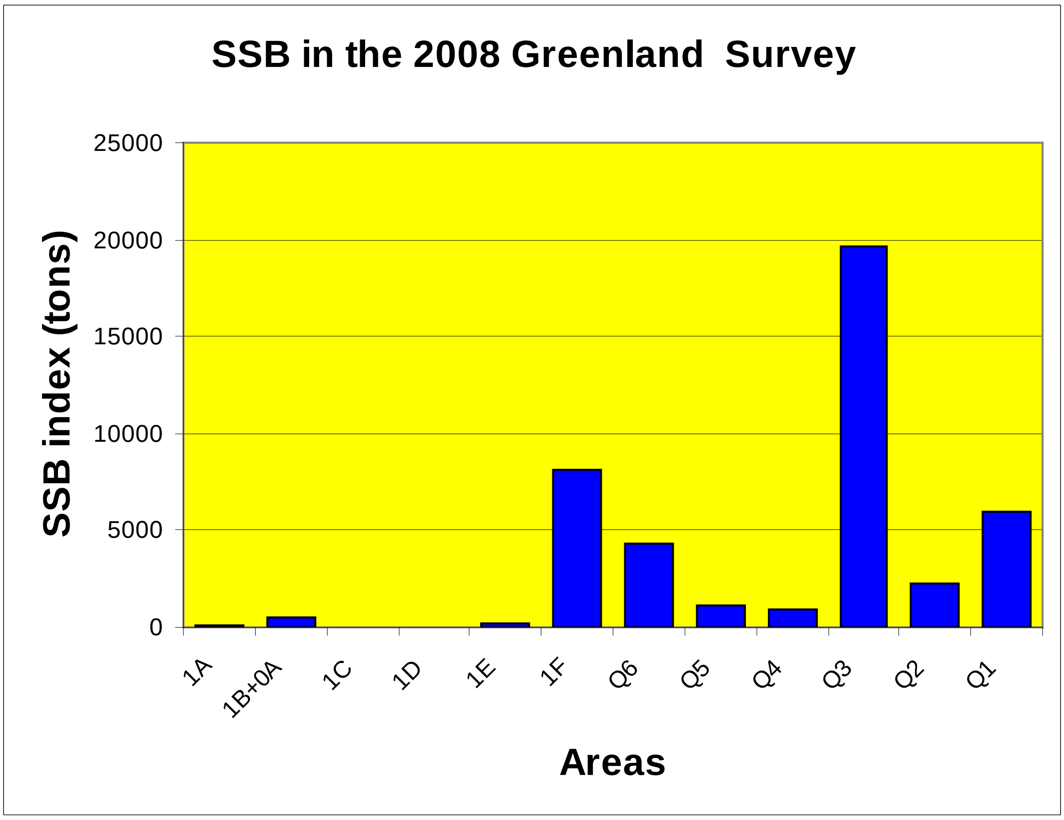


Figure 14.19 The Spawning stock biomass from the Greenland surveys, 2008. Maturity taken from proportion mature by length as recorded on observer trips off East Greenland in 2007.

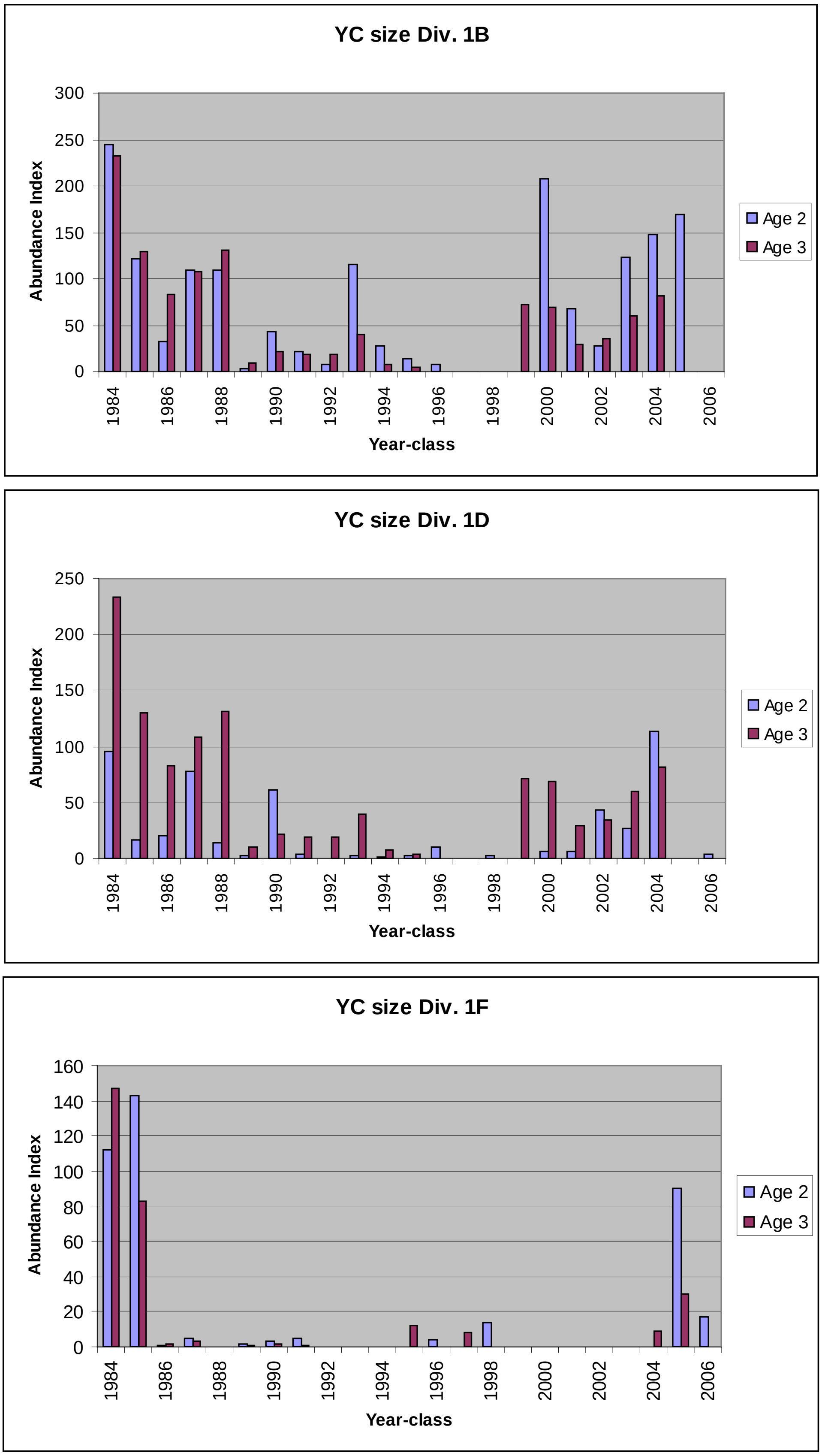


Figure 14.20. Abundance indices from the inshore Gill-net survey, by Year class and area. Indices given for age 2 and age 3. Year classes without bars reflect no sampling in particular years.

15 Greenland Halibut in Subareas V, VI, XII, and XIV

Greenland halibut in ICES Subareas V, VI, XII and XIV are assessed as one stock unit although precise stock associations are not known.

15.1 Executive summary

Input data to the assessment: current surveys have continued and sampling intensity and coverage remains also unchanged. Logbooks from the fishery are available as haul by haul data. Since 2001 no age readings of otoliths were available from the main fishing areas.

From 2007 a logistic production model in a Bayesian framework was used to assess stock status and for making predictions. The model includes an extended catch series going back to the beginning of the fishery in 1961.

Estimated stock biomass showed and overall decline throughout most of the time series. Since 2004 the stock has been stable at relative low levels well below Bmsy and fishing mortality exceeds the value that maximizes yield (F_{msy}).

Stock status 2008–2009

- Stock size:
  - Stock biomass $0.4B_{msy}$ (median)
  - 100% probability of being below B_{msy}
  - 4-18% risk of being below B_{lim} (30%B_{msy})
- Stock production:
  - MSY = 21 – 36 ktons (inter-quartile range)
  - Actual ≈ 0.6MSY (median)
- Exploitation:
  - 23-20 ktons
  - $2F_{msy}$ (median)
  - ≈65% risk of exceeding F_{lim}

Predictions 2010 onwards

- Risk of exceeding Blim (B<30%Bmsy)
  - As the stock is estimated to be near B_{lim} and slow growing, the projected risk of exceeding this reference point will be relatively high at any catch level.
- Catch option of 10 ktons/yr
  - Stock biomass is projected to increase slowly to about $0.5B_{msy}$ within a decade.
  - F is projected to decrease below F_{msy}.

- Catch option of 5 ktons/yr
  - Stock biomass is likely to increase slowly to about $0.7B_{msy}$ within a decade.
  - Fishing mortality is projected to decrease below $0.5F_{msy}$.
- Moratorium
  - In the order of 10 years or more to rebuild to B_{msy}

15.2 Landings, Fisheries, Fleet and Stock Perception

Landings

Total annual landings in Divisions Va, Vb, and Subareas VI, XII and XIV are presented for the years 1981–2008 in Tables 15.2.1–15.2.6 and since 1961 in Figure 15.2.1. Catches taken within the Icelandic EEZ in Division XIVb have historically been registrated in Division Va. Landings during the decade prior to the extension of the EEZ to 200 nm by coastal nations in 1976 were in the order of 20-35 000 t. From 1976 landings increased from a low of 5 000 t to a record high of about 61 000 t in 1989. Since then landings have decreased markedly to a low of 20 000 t in 1998-99, followed by an increase to about 30 000 t in 2003. From 2003 landings have continually decreased to about 23 000 t in 2008.

Landings in Icelandic waters have historically predominated the total landings in areas V+XIV. In the year 1989 with record high total landings Iceland took 97%. Since then fisheries have developed in Division XIVb and Vb and these areas have gradually increased their share of the total landings to about 30% - 50% in the past decade. However, in 2008 landings in Va increased about 15% (to 12 000 t.), while landings in XIV decreased about 10% (to 9 100 t). Division Vb has in 2005 – 2007 experienced low landings at about 1000 t but in 2008 landings increased to 1800 t.

Fisheries and fleets

In 2008 quotas in Greenland EEZ were utilised by most of the principal fleets except for Norway (90%) and Greenland (50%). Within the Iceland EEZ, quotas in the fishing year 2007/2008 were fully utilized as in the preceding three fishing years. In the Faroe EEZ the fishery is regulated by a fixed numbers of licenses and technical measures like by-catch regulations for the trawlers and depth and gear restrictions for the gillnetters.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed trawl fishery, and only minor catches in Va by Iceland, and in XIVb by Germany and the UK comes partly from a redfish fishery.

Spatial distribution of 2008 fishery and historic effort and catch in the trawl fishery in XIV and V is provided in Figures 15.2.2-5. Fishery in the entire area had previously occurred in a more or less continuous belt on the continental slope from the slope of the Faroe plateau to southeast of Iceland extending north and west of Iceland and further south to southeast Greenland. Fishing depth ranges from 350-500 m southeast, east and north of Iceland to about 1500 m at East Greenland. In 2008 and recent years the distribution of the fishery is limited mostly to western Icelandic fishing grounds and along the east Greenland slopes. A gillnet fishery developed in 2002 north of Iceland with approx. 10% of the catches in Div. Va. This fishery has now ceased.

Since 1996 Greenland halibut has been taken as by-catch in the Spanish trawl fishery in the Hatton Bank area of Division VIb. Further a Norwegian longline fishery has been developing in the deeper waters of the western continental slope of the same area since 2000 (deeper than 1 000 m) also stretching into Div. XIIb. Landings in Divisions XII and VIb in Tables 15.2.5-15.2.6 derive from the Hatton Bank area.

By-catch and discard

The Greenland halibut trawl fishery is generally a clean fishery with respect to by-catches. By-catches are mainly redfish, sharks and cod. Southeast of Iceland the cod fishery and the minor Greenland halibut fishery are coinciding spatially.

The mandatory use of sorting grids in Va and XIVb in the shrimp fishery operated since November 2002 are observed to have reduced by-catches considerably. Based on sampling from three trips (93 hauls) in 2006 and 2007, scientific staff observed by-catches of Greenland halibut to be less than 1% by weight (2 g or 0.04 specimens per 1 kg shrimp) compared to about 50% by weight (0.48 kg and 0.81 individuals of Greenland halibut were caught per 1 kg shrimp) observed before the implementation of sorting grids (in 2002) (Sünksen 2007, WD # 18). No information have since been available.

Only little information is presently available on discard in the Greenland halibut fishery, but records from fishery in XIVb (from logbooks) suggest discard less than 1%.

15.3 Trends in Effort and CPUE

Division Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2008 (Table 15.3.1, Figures 15.3.1-3.) were estimated from a GLM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month, and year effects. All hauls with Greenland halibut exceeding 50% of the total catch were included in the CPUE estimation. The CPUE indices from the trawling fleets in Divisions Va, as well as in Vb and XIVb were used to estimate the total effort for each year (y) for each of the divisions according to:

$E_{y,div} = Y_{y,div} / CPUE_{y,div}$

where E is the total effort and Y is the total reported landings (Table 15.3.1).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1996 (Figure 15.3.1). Since 1996 catch rates peaked in 2000-2001 and has in recent years been record low. The tendency over time is the same for all fishing grounds in Va (Figure 15.3.2), although the less important fishing grounds in north, east and southeast show a more optimistic view since 2006. The derived effort has decreased from a high in 2003-2004 to a level similar to that in 1999-2000. The observed effort from logbook information, suggest a higher effort prior to 1998 (Figure 15.3.3).

Division Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2008 (Table 15.3.1, Figure 15.3.4.-5.). The location of the bulk of fishery has changed from the eastern side of the islands in 1995-1998, to the south-western side since 2000. Only hauls where Greenland halibut consisted of more than 50% of the catches and conducted on depths more than 450 meters were selected for the analyses. The standardisation procedure for the logbooks was similar to that of the Va fleet. CPUE decreased drastically in the early period by more than 50 % coinciding with a significant increase in effort. Since 1994 CPUE has been slightly decreasing.

Division XIVb

For Division XIVb, logbook data was available from both Greenland and foreign fleets. In the time series a variable proportion of all logbooks have been available for analysis (on average 40%, since 2006 more than 90%). Hauls where targeted species was Greenland halibut and where catch weight exceeds 100 kg were selected, as no information on other species caught was available. CPUE from logbooks in the years 1991–2008 were standardised in the same way as described for fleets in Va and so was effort (Table 15.3.1, Figure 15.3.6). Since 2005 catch rates have maintained a high level above the average. The fishery in XIVb started in the late 1980'ies and annual catches have increased from below 500 tons before 1991 to 10 000 t in 2004 and 2005. The fishery was therefore assumed to be in the process of learning in the beginning of the CPUE series. A breakdown of the CPUE series into subdivisions, trace the 2005 CPUE increase to the southernmost areas (Figure. 15.3.7). Derived effort decreased by approx 15% in 2008.

The trend in CPUE series from Divisions Va, Vb and XIVb do not cohere in the period where time series are comparable. This might indicate different population developments in the areas, but could also be artefacts, i.e. due to different behaviour of the fleets, fish migration between areas or difference in availability to the fishery.

Divisions VI and XIIb

Since 2001 a fishery developed in divisions VIb and XIIb in the Hatton Bank area but catches up to 2007 are insignificant. In 2008 Lithuania caught 968 t and also France and Russia has developed a fishery in this area resulting in total 2008 catches of 1200 t. Limited fleet information is available (ICES WGDEEP). Norway has been targeting Greenland halibut in the Hatton Bank area using longlines since 2000 (Hareide et al 2002). Catches are reported in both VIb and XIIb. Unstandardised catch rates based on available logbooks do not show any consistent patterns. Greenland halibut has been reported as by-catch from the Spanish fleet since 1998. In addition to the fishery in the Hatton bank area Greenland halibut has also previously been caught in the Reykjanes Ridge area within Subarea XII. (Tables 15.2.5-15.2.6).

15.4 Catch composition

Otoliths have been sampled from the Icelandic fishery in 2006 but as ageing have not been conducted in Iceland since 2001, no readings were available for the WG. Thus, the only available aged otoliths in the entire area were from the Greenland survey in East Greenland. As this survey mainly catches younger fish than the commercial fishery, i.e. below age 8-9 and as length composition by age in the survey is expected to differ from the commercial fishery, attempts were not made to establish catch-at-age for the total catches. Since 2000 no age-disaggregated assessment has been conducted for Greenland halibut and the lack of a catch-at-age matrix do thus prevent an update of any analytical stock assessment approaches.

Length compositions of catches from the commercial trawl fishery in Div. Va are rather stable from year to year. In Figure 15.4.1 length distributions are shown since 2000 and compared to average 1985-2008 from the western area of Iceland, comprising the most important fishing grounds. In most years catches are composed of fish smaller than long-term average, while 1985 consist of larger fish than the long-term average. Figure 15.4.2 shows a comparison of length compositions of 2008 catches in XIVb, Va and Vb. In 2008 largest fish size were obtained in Va while the smallest were recorded in Vb.

15.5 Survey information

The total surveyed area in 2008 for Greenland halibut in Divisions Va, Vb and XIVb is provided in Figure 15.5.1. Most of the areas where commercial fishing takes place (Figure 15.2.1-2.) are covered by the surveys, although a few areas are not that intensively surveyed.

Division Va

Since 2001 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) has decreased significantly in Icelandic waters (Figures 15.5.2), but stabilised at a low level since 2004 (Figures 15.5.3. – 15.5.4.).

Division Vb

Data from the combined survey/exploratory fishery in Vb were not available for 2008. The catch rates from the available time series of the exploratory fisheries survey (1995-2007) shows a continuous downward trend since the beginning of the survey (Figure 15.5.5).

Division XIVb

Total biomass in the Greenlandic survey (Figure 15.5.6) in 2008 was estimated at 10700 tons which is a more than 50% reduction from 2006 (Figure 15.5.7) and a new record low as 2007 also were. A GLM analysis performed on the survey catch rates, taking into account different coverage of area and depth between years did show a similar development in catch rates (Figure 15.5.8.).

Survey /Division	No. hauls in 2008 (planned hauls)	Depth range (m)	Coverage (km^2)
Va	219 (219)	400-1500	130 000
XIVb	46 (70)	400-1500	29 000

See the stock annex for more extensive descriptions of the surveys and trends.

15.6 Stock Assessment

15.6.1 Summary of the various observation data

A number of indices from surveys and from the commercial fishery are available as indicators for the biomass development.

The surveys in Va and XIV are considered to cover the adult stock distribution in the two divisions adequately, while the survey/exploratory fishery in Vb is not considered a good biomass indicator due to its design.

The main fishing grounds are covered well by the logbook data in Va and XIV, while in Vb the logbook information does not include the second principal fleet, gill netters, that covers other areas within Vb. The fleet behaviour is likely influenced by a number of factors, such as weather conditions and sea ice especially in the north-western areas. Over the years also technological development of the fishing gear has probably increased catchability. Therefore CPUE series is considered less qualified as biomass indicators than surveys.

Div. Va: Fishery and survey indices from Va show similar trends although of varying magnitude. The fall groundfish survey in Va (1996-2008) indicate a recovery from a low level in the last five years for all sizes of fish and in all surveyed areas. Within the same period as the Greenland survey in XIVb is conducted (1998-2008) the Icelandic survey increased catch rates until 2001 followed by a decline until 2004. Icelandic trawl CPUE in 1993-2008 are less than half that observed in 1985-1989. CPUE declined since 2001 to a low in 2004 and have since increased slowly. In 2008 CPUE are 1/4 of that in 1985. Effort has increased since the late 1980s, and had a recent low in 1998-00. Effort lowered again from 2004 to 2008 and is now about the low 1998-00 effort.

Div. Vb: The Faroese survey/exploratory fishery decreases within the entire available time series 1994-2007

Div. XIVb: The Greenland survey in XIV has stable biomass index (GLM) in the early period 1998-2000, but has since 2002 decreased to 2008. Trawl CPUE's from the various fleets in XIVb have maintained three distinct periods, a period from 1994-1998 with high and stable CPUE following a decrease in 1998-2000, to a stable period with lower CPUE in 2000-2004. In 2005 to 2008 CPUEs was markedly higher but below the high 1994-98 CPUE.

15.6.2 A model based assessment

Assessment and management advice was derived using a stochastic version of the logistic production model and Bayesian inference (Hvingel et al. 2008 WD #4). The biomass dynamic process equation of this model is similar to the one used in the previous assessment methods (ASPIC) and a continuation of that work.

15.6.2.1 Modelling framework

The model was built in a state-space framework (Hvingel and Kingsley 2006, Schnute 1994) with a set of parameters (θ) defining the dynamics of the stock. The posterior distribution for the parameters of the model, $p(\theta|data)$, given a joint prior distribution, $p(\theta)$, and the likelihood of the data, $p(data|\theta)$, was determined using Bayes' (1763) theorem:

$$(1) \qquad p(\theta \mid data) \propto p(data \mid \theta)\, p(\theta)$$

The posterior was derived by Monte-Carlo-Markov-Chain (MCMC) sampling methods using WinBUGS v.1.4.3 (Spiegelhalter et al. 2004).

The equation describing the state transition from time t to t+1 was a discrete form of the logistic model of population growth including fishing mortality (e.g. Schaefer (1954), and parameterised in terms of MSY (Maximum Sustainable Yield) rather than r (intrinsic growth rate) (cf. Fletcher 1978):

$$(2) \qquad B_{t+1} = B_t - C_t + 4MSY\frac{B_t}{K}\left(1 - \frac{B_t}{K}\right)$$

K is the carrying capacity, or the equilibrium stock size in the absence of fishing; B_t is the stock biomass; C_t is the catch taken by the fishery.

To reduce the uncertainty introduced by the "catchabilities" (the parameters that scales biomass indices to real biomass) equation (2) was divided throughout by B_{MSY}

(Hvingel and Kingsley 2006). Finally a term for the process error was applied and the state equation took the form:

(3) $$P_{t+1} = \left(P_t - \frac{C_t}{B_{MSY}} + \frac{2\,MSY\,P_t}{B_{MSY}} \left(1 - \frac{P_t}{2} \right) \right) \cdot \exp(\nu_t)$$

where P_t is the stock biomass relative to biomass at MSY ($P_t=B_t/B_{MSY}$) in year t. This frames the range of stock biomass (P) on a relative scale where $P_{MSY}=1$ and $K=2$. The 'process errors', v, are normally, independently and identically distributed with mean 0 and variance σ_v^2 .

15.6.2.2 Input data

The model synthesized information from input priors and three independent series of Greenland halibut biomasses and one series of catches by the fishery (Table 15.6.1). The three series of biomass indices were: a standardised series of annual commercial-vessel catch rates for 1985–2008, $CPUE_t$,; and two trawl-survey biomass index for 1996–2008, Ice_t, and 1998-2008, $Green_t$. These indices were scaled to true biomass by catchability parameters, q_{cpue}, q_{Ice} and q_{Green} and lognormal observation errors , ω, κ and ε were applied, giving:

(4) $$\begin{aligned} CPUE_t &= q_{cpue} B_{MSY} P_t \exp(\omega_t) \\ Ice_t &= q_{Ice} B_{MSY} P_t \exp(\kappa_t) \\ Green_t &= q_{Green} B_{MSY} P_t \exp(\varepsilon_t) \end{aligned}$$

The error terms, ω, κ and ε are normally, independently and identically distributed with mean 0 and variance σ^2_{cpue} , σ^2_{Ice} and σ^2_{Green} .

Total reported catch in ICES Subareas V, VI, XII and XIV 1961-2008 was used as yield data (Table 15.6.1, Figure. 15.2.1). Total catches were revised several times under the WG meeting and therefore 2008 catch used as input for the model does not exactly equal the final catch as stated in Table 15.2.1. A post run of the model with correct 2008 catch figures (22 949 t instead of 22 69 t) did not change the output to any detectable degree. The fishery being without major discarding problems or variable misreporting, reported catches were entered into the model as error-free.

Two additional biomass series were available. However, for unknown reasons the Greenland CPUE series showed trends conflicting with those of the other biomass indices – even if restricted to data just opposite the midline next to the Icelandic fishery and were therefore not included. The Faeroese survey covered areas contributing less than 4% of the total catches and was due to design not considered to reflect stock dynamics. This survey was therefore not included either.

15.6.2.3 Input priors

The distributions of priors are given in Table 15.6.2. Initial stock size: We did not have any information on the size of the stock in 1985 when the stock index series start and an informative prior for the biomass in that year could not be constructed. However, the fishery started i 1961 (Table 15.2.1 and Figure 15.2.1) and it was therefore likely that the stock was close to K in 1960. To provide this information to the model we made it simulate stock development from 1960 and on giving P1960 a normal prior with a mean of 2 (K=2) and a standard error of 0.071 (Table 15.6.2, Figure 15.6.1). As we had no observations on stock size until 1985 we ran the model for the 1960-1984 period without the process error in order not to blow up the uncertainty and avoid unrealistically large values of the P1985-estimate due to the long period of 'prediction' (1960 to 1985 = 25 years). The resulting effective prior for P1985 had a median of 1.52 and an inter-quartile range of 1.43 to 1.60 (Table 15.6.3, Figure. 15.6.1)

The prior distributions for the error terms associated with the biomass indices (the observation errors) were assigned inverse gamma distributions (the gamma distribution, G(r,μ), is defined by: μrxr-1e-μx/Γ(r); x>0) as error standard deviations typically follow this kind of distribution. Their standard deviations were given inverse gamma distributions with 95% of their values between 0.06 and 0.26, corresponding to CVs ranging from 7 to 26% , which is considered to represent a typical range for such data.

The catchabilities qIce , qGreen and qcpue was given reference priors uniform on a log scale (cf. Gelman et al. 1995, Punt and Hilborn 1997, McAllister and Kirkwood 1998, Hvingel and Kingsley 2006). For all these catchabilities the distributions were truncated at -10 and 1 (log scale) – the range chosen large enough as not to interfere with the posteriors.

To provide the model with information on the order of magnitude of K, its prior was constructed as follows: mean biomass densities recorded by the two surveys are around 0.5 tons/km2. If we assume that the surveys 'sees' around 1/3 of the biomass and that K is in the area of 3-4 times larger than this 1996-2008 level we end up around 5 tons/km2 corresponding to 750 ktons in the total area. The prior for K was therefore given a normal prior with a mean of 750 ktons and standard error of 300 supposed to account for our prior uncertainty and provide a reasonable range of what K might be (Hvingel et al. 2009 WD #4). The sensitivity of model results to changes in this prior was investigated (see section 15.6.2.4).

Low-information or reference priors were given to *MSY*, and σ_v as we had little or no information on what their probability distributions might look like. *MSY* was given a uniform prior between 1 and 300 ktons. The upper limit was chosen high enough not to truncate the posterior distribution (Figure. 15.6.1).

15.6.2.4 Model performance

Inference were made from samples from the converged part of the MCMC samples as identified by appropriate statistics (Hvingel et al. 2009 WD #4). The model was able to produce a reasonable simulation of the observed data (Figure. 15.6.2). The probabilities of getting more extreme observations than the realised ones given in the data series on stock size were in the range of 0.05 to 0.95 i.e. the observations did not lie in the extreme tails of their posterior distributions (Table 15.6.4). The CPUE series was generally better estimated than the survey series. No major problems in capturing the variability of the data were detected.

The data could not be expected to carry much information on the parameter P_{1960} – the stock size 25 years prior to when the series of stock biomass series start – and the posterior resembled the prior (Figure.15.6.1). The prior for K was somewhat updated to slightly higher values. However, the posterior still had a wide distribution. If the information in the prior for K was relaxed or restricted to lower values changes in the central parameters MSY and P_{2008} was small. Overall, the model was robust to changes in the priors for the process and observation errors. Further, the model estimates of stock sizes were relatively insensitive to additions of new data points (Figure. 15.6.3).

The priors for *MSY* was significantly updated (Figure. 15.6.1). As mentioned above *MSY* was relatively insensitive to changes in prior distributions. The posterior *K* had an inter-quartile range of 807-1146 ktons (Table 15.6.3).

15.6.2.5 Assessment results

The time series of estimated median biomass-ratios starts in 1960 as a virgin stock at K (Figure. 15.6.4 -5). The fishery starts in 1961. While experiencing increasing fishing mortality the stock then declined until the mid 1990s to levels below the optimum, B_{msy}. Some rebuilding towards B_{msy} was then seen but in 2001 the stock started to decline again reaching its lowest level in 2004. Since then the stock has been stable at relative low levels. The risk of the biomass being below B_{msy} in 2008 is 100% and 5% of being below B_{lim} (Table 15.6.5). The median fishing mortality ratio (*F-ratio*) has exceeded F_{msy} since the 1990s (Figure. 15.6.4 and 15.6.6). This parameter can only be estimated with relatively large uncertainty and the posteriors therefore also include values below F_{msy}. However, the probability that the *F* has exceeded F_{msy} is high for most of the series.

The posterior for *MSY* was positively skewed with upper and lower quartiles at 21 ktons and 36 ktons (Table 15.6.3). As mentioned above MSY was relatively insensitive to changes in prior distributions.

Within a one-year perspective the sensitivity of the stock biomass to alternative catch options seems rather low. This is due to the inertia of the model used (see WD #4) and the low growth rate of the population. Risk associated with five optional catch levels for 2010 are given in Table 15.6.5.

The risk trajectory associated with ten-year projections of stock development assuming a maintained annual catch in the entire period ranging from 0 to 30 ktons were investigated (Figure. 15.6.7). The calculated risk is a result of the projected development of the stock and the increase in uncertainty as projections are carried forward. It most be noted that a catch scenario of a maintained constant catch over a decade without considering arrival of new biological information and advice is highly unrealistic.

Catches around 15 ktons are likely to maintain stock size around its current level, while larger catches have a higher probability of causing further reductions in stock size.

A catch of 5 ktons will likely result in stock increase. Taking 20 and higher ktons/yr will increase risk of going below B_{lim} to more than 35% within a 3-year period (Fig 15.6.7).

The length distributions from the Icelandic survey are in agreement with the model predictions, i.e. there is no sign of above 1996-2006 average recruitment entering the fishable stock in the near future (Figure. 15.6.8).

15.6.2.6 Conclusions

Stock status 2007–2008

Stock size:

- Stock biomass $0.4B_{msy}$ (median)
- 100% probability of being below B_{msy}
- 5-18% risk of being below B_{lim}

Stock production:

- MSY = 21 – 36 ktons (inter-quartile range)
- Actual ≈ 0.6MSY (median)

Exploitation:

- 20-23 ktons
- 2F_{msy} (median)
- ≈65% risk of exceeding F_{lim}

Predictions

Risk of exceeding Blim

- As the stock is estimated to be near B_{lim} and slow growing, the projected risk of exceeding this reference point will be relatively high at any catch level.

Catch option of 15 ktons/yr

- Stock biomass is projected to remain near the current low level. There is a high risk going below B_{lim}. F is not projected to decrease towards Fmsy.

Catch option of 5 ktons/yr

Stock biomass is likely to increase slowly to about 0.7B_{msy} within a decade.

– Median fishing mortality is projected to decrease below F_{msy}.

15.6.3 Precautionary reference points

In 2001-2003 when the stock was assessed by a model of similar structure (ASPIC-framework, (Prager 1994) a F_{pa} reference point (precautionary fishing mortality supposed to act as a buffer for F_{lim} by taking into account uncertainties in the point estimates of F) was introduced in the advice (ACFM 2001). The F_{pa} was set to 0.67F_{msy}.

Other reference points were not explicitly defined. However, this Fpa corresponds to a Bpa = 1.33Bmsy (see calculations at the end of this section). By the standard ICES approach $B_{lim} = B_{pa} \cdot \exp(-1.645\sigma)$, where $\sigma = 0.3$. The set Fpa thus infer the following set of references:

$B_{lim} = 0.81B_{msy}$; $B_{pa} = 1.33B_{msy}$; $F_{lim} = 1.19F_{msy}$; $F_{pa} = 0.67F_{msy}$

Setting reference points that imply a B_{lim} close to B_{msy} does in any circumstances not seem appropriate. Further, as the probability of transgressing reference points is calculated directly in this assessment and uncertainty in model estimates therefore explicitly accounted for "buffer reference points" are no longer needed. The WG therefore reiterate its proposal from 2008 to introduce a new set of limit reference points as B_{lim}=0.3B_{msy} and F_{lim}=1.7Fmsy based on the following considerations:

Blim

The Schaefer production curve fitted by the assessment model is the estimated stock-recruitment relation of the stock. The slope of this curve is decreasing linearly (Figure. 15.6.8) i.e. there is not a distinct "change-point" where recruitment starts to decline rapidly as the stock is reduced, which could provide a candidate for a Blim reference.

A Blim could instead be set in relation to the time it takes for the stock to recover from this point (cf. Cadrin 1999). The time needed to rebuild an overfished stock from Blim back to Bmsy depends on the stock size at Blim, the rate of growth and fishing mortality.

At 30%Bmsy production is reduced to 50% of its maximum (Figure. 15.6.9). This is equivalent to the SSB-level (spawning stock biomass) at 50% Rmax (maximum recruitment). Greenland halibut is believed to be a slow growing species i.e. with relative low r (intrinsic rate of increase) (Figure. 15.6.10 left). This means that even without fishery it would take some 10 years to rebuild the stock from 30%Bmsy to Bmsy (calculated by setting r=0.21, the 75th percentile) – but likely longer (Figure. 15.6.10 right).

Once fished down to low levels the stock will, due to the predicted slow recovery potential, spend proportionally longer time at low levels once a recovery plan is implemented and fishing pressure is relaxed. Longer time at low levels means higher risk of "bad things" happening which could destabilise the stock. We therefore propose that the Blim be set no lower than 30% Bmsy.

Flim

An F-ratio (F/Fmsy) corresponding to a yield of 50%MSY (50%Rmax) at a stock biomass of 30%Bmsy (suggested Blim) may be derived from equation 3 as follows:

$$\frac{production}{B_{MSY}} = \frac{2\ MSY\ P_t}{B_{MSY}}\left(1 - \frac{P_t}{2}\right),$$

at equilibrium: $C = production$ and

$$F = \frac{C}{B} = \frac{C}{B_{MSY}}\frac{B_{MSY}}{B} \Rightarrow$$

$$F = \frac{2\ MSY\ P_t}{B_{MSY}}\left(1 - \frac{P_t}{2}\right)\frac{1}{P}, \quad \text{as } F_{MSY} = \frac{MSY}{B_{MSY}} \Rightarrow$$

$$\frac{F}{F_{MSY}} = Fratio = 2 - P$$

if Blim is 30%Bmsy (P=0.3) then the corresponding Fratio is 1.7 (Figure. 15.6.9). The proposed Flim at 1.7Fmsy is the fishing mortality that will drive the stock biomass to Blim.

15.7 Management Considerations

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in XIV and V belong to the same entity and do mix. Historic information on tag-recapture experiments in Iceland have shown that Greenland halibut migrate around Iceland. Similar information from Greenland suggests some mix, both between West Greenland and Iceland but also between East Greenland and Iceland. Therefore, management of the stock needs to be in accordance for the present three distinct management areas, XIV, Va and Vb. At present no formal agreement on the management of the Greenland halibut exists among the three coastal states, Greenland, Iceland, and the Faroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of TAC's advised by ICES.

15.8 Data consideration

The Icelandic CPUE series has for a decade in the 1990s been used as a biomass indicator in the assessment of the stock. However, with the appearance of the new fisheries and surveys in XIV and Vb, indices for those areas were compiled. The commercial CPUE indices are based on haul by haul data from logbooks, and the fisheries for Greenland halibut in the entire area are clean fishery with minor by-catches indices. Thus the quality of these sources is considered good. Despite these qualities, it cannot be out ruled that they are poor biomass indicators due to an assumed scattered distribution of Greenland halibut. Also poor knowledge of stock structure and distribution of the life stages in the area prevent interpretation of the indices and also their use in any model framework. Thus, for the present model framework, a stock production model, that requires cpue indices, it was necessary to reject the Greenland cpue series of commercial catches due to a contrasting signal to the other indices, although the quality of the Greenland commercial data is considered similar to the series included in the model.

15.8.1 Assessment quality

The assessment relies on a number of indices from surveys and the commercial fishery in absence of material to age-disaggregate the catches. As the stock dynamics as well as stock structure in the entire distribution area is not fully understood, any stock index are not easily selected to describe the entire stock development. Among many, one possibility to improve the quality of the assessment of the stock, age-disaggregation of catches must therefore be recommenced. This will require that the main labs must continue sampling otoliths from Greenland halibut and put higher priority to age-reading work. Work is ongoing on age interpretation from otoliths. Preliminary results suggests that Greenland halibut grow slower than previously thought,

The precision of the survey estimates in XIVb and in Va is equal with cv's within the range 15-20%.

15.9 Communication with RG, ACOM

The Review Group on North Western stocks had in its report of 9-10 May 2008 a number of comments on the assessment and report structure. Their main issues are commented by NWWG as follows:

- *RG would like to see a description of the differences between this new approach and the old (ASPIC) approach.*

  The ASPIC approach is described in previous NWWG report as well as in Prager (Prager, 2005). Both models are based on the Schafer production model, and the main difference is the inclusion of an error term in the Bayesian approach. This makes the Bayesian approach more dynamic in its predicted estimates of the input series. An exploratory ASPIC run is presented in Figure 15.6.11 for comparison with the Bayesian model. The two models shows same TS and F trends over the time series and 2008 status is approximately the same.

- *Report needs to start with an overview of the stock characteristics.*

  The WG has moved the section of stock structure and biology into the stock annex after a recommendation by ICES.

- *The projections need further explanation: what is the meaning of the risk % in forecasts (is this the risk of falling below Bmsy once in the period or separate for each year ?).*

  The projections (Fig 15.6.7) are continuous and should be read continuous, i.e. maintaining catches of 20kt in the future will result in a 40% risk that B<30%Bmsy in 2013; maintaining these catches until 2019 will increase the risk to 55% that B<30%Bmsy at that time.

Table 15.2.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-areas V, VI, XII and XIV 1981-2008, as officially reported to ICES and estimated by WG

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	767	1 532	1 146	2 502	1 052	853	1 096	1 378	2 319
France	8	27	236	489	845	52	19	25	-
Germany	3 007	2 581	1 142	936	863	858	565	637	493
Greenland	+	1	5	15	81	177	154	37	11
Iceland	15 457	28 300	28 360	30 080	29 231	31 044	44 780	49 040	58 330
Norway	-	-	2	2	3	+	2	1	3
Russia	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	19 239	32 441	30 891	34 024	32 075	32 984	46 622	51 118	61 156
Working Group estimate	-	-	-	-	-	-	-	-	61 396

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	-	
Faroe Islands	1 803	1 566	2 128	4 405	6 241	3 763	6 148	4 971	3 817
France	-	-	3	2	-	-	29	11	8
Germany	336	303	382	415	648	811	3 368	3 342	3 056
Greenland	40	66	437	288	867	533	1 162	1 129	747
Iceland	36 557	34 883	31 955	33 987	27 778	27 383	22 055	18 569	10 728
Norway	50	34	221	846	1 173 [1]	1 810	2 164	1 939	1 367
Russia	-	-	5	-	-	10	424	37	52
Spain									89
UK (Engl. and Wales)	27	38	109	811	513	1 436	386	218	190
UK (Scotland)	-	-	19	26	84	232	25	26	43
United Kingdom									
Total	38 813	36 890	35 259	40 780	37 305	36 006	35 762	30 242	20 360
Working Group estimate	39 326	37 950	35 423	40 817	36 958	36 300	35 825	30 309	20 382

Country	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark		-	-	-	-	-	-	-	-
Estonia		-	-	8	-	-	5	3	-
Faroe Islands	3 884	-	121	334	458	338	1 150	855	1 141
France	-	2	32	290	177	157	-	62	17
Germany	3 082	3 265	2 800	2 050	2 948	5 169	5 150	4 299	4 930
Greenland	200	1 740	1 553	1 887	1 459	-	-	-	-
Iceland	11 180	14 537	16 590	19 224	20 366	15 478	13 023	11 798	-
Ireland		-	56	-	-	-	-	-	-
Lithuania		-	-	-	2	1	-	2	3
Norway	1 187	1 750	2 243	1 998	1 074	1 233	1 124	1 097	692
Poland		-	2	16	93	207	-	-	-
Portugal		-	6	130	-	-	-	1 094	-
Russia	138	183	187	44	-	262	-	552	501
Spain		779	1 698	1 395	3 075	4 721	506	33	-
UK (Engl. and Wales)	261	370	227	71	40	49	10	1	-
UK (Scotland)	69	121	130	181	367	367	391	1	-
United Kingdom	-	166	252	255	841	1 304	220	93	17
Total	20 001	22 913	25 897	27 883	30 900	29 286	21 579	19 890	7 301
Working Group estimate	20 371	26 644	27 291	29 158	30 891	27 102	24 978	21 466	21 873

Country	2008 [1]
Denmark	-
Estonia	-
Faroe Islands	-
France	114
Germany	4 846
Greenland	-
Iceland	-
Ireland	-
Lithuania	2
Norway	639
Poland	1 354
Portugal	-
Russia	799
Spain	-
UK (Engl. and Wales)	-
UK (Scotland)	-
United Kingdom	422
Total	8 212
Working Group estimate	22 949

1) Provisional data

Table 15.2.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Va 1981-2008, as officially reported to ICES and estimated by WG.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	325	669	33	46			15	379	719
Germany									
Greenland									
Iceland	15 455	28 300	28 359	30 078	29 195	31 027	44 644	49 000	58 330
Norway			+	+	2				
Total	15 780	28 969	28 392	30 124	29 197	31 027	44 659	49 379	59 049
Working Group estimate									59 272 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Faroe Islands	739	273	23	166	910	13	14	26	6
Germany					1	2	4		9
Greenland					1				[1]
Iceland	36 557	34 883	31 955	33 968	27 696	27 376	22 055	16 766	10 580
Norway								[1]	[1]
Total	37 296	35 156	31 978	34 134	28 608	27 391	22 073	16 792	10 595
Working Group estimate	37 308 [2]	35 413 [2]							

Country	1999	2000	2001	2002	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2 007
Faroe Islands	9		15	7	34	29	77	16	25
Germany	13	22	50	31	23	10	6	1	228
Greenland									
Iceland	11 087	14 507	2 310 [4]	2 277 [4]	20 360	15 478	13 023	11 798	
Norway							100		691
Russia									
UK (E/W/I)	26	73	50	21	16	8	8	1	
UK Scottland	3	5	12	16	5	2	27	1	
UK									1
Total	11 138	14 607	2 437	2 352	20 438	15 527	13 241	11 817	945
Working Group estimate		14 607	16 752	19 714	20 415	15 477	13 172	11 817	10 525

Country	2008
Faroe Islands	
Germany	4
Greenland	
Iceland	
Norway	
Russia	4
UK (E/W/I)	
UK Scottland	
UK	179
Total	187
Working Group estimate	11 859

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 12 t catch by Norway.

4) fished in Icelandic EEZ, but allocated to XIVb

Table 15.2.3 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Vb 1981-2008 as officially reported to ICES and estimated by WG.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	442	863	1 112	2 456	1 052	775	907	901	1 513
France	8	27	236	489	845	52	19	25	...
Germany	114	142	86	118	227	113	109	42	73
Greenland	-	-	-	-	-	-	-	-	-
Norway	2	+	2	2	2	+	2	1	3
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	566	1 032	1 436	3 065	2 126	940	1 043	969	1 589
Working Group estimate	-	-	-	-	-	-	-	-	1 606

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	-	-	
Faroe Islands	1 064	1 293	2 105	4 058	5 163	3 603	6 004	4750	3660
France [6]	...	...	3 [1]	2	1	28	29	11	8
Germany	43	24	71	24	8	1	21	41	
Greenland	-	-	-	-	-	-	-	-	
Norway	42	16	25	335	53	142	281	42 [1]	114
UK (Engl. and Wales)	-	-	1	15	-	31	122		
UK (Scotland)	-	-	1	-	-	27	12	26	43
United Kingdom	-	-	-	-	-				
Total	1 149	1 333	2 206	4 434	5 225	3 832	6 469	4 870	3825
Working Group estimate	1 282 [2]	1 662 [2]	2 269 [2]	-	-		-	-	-

Country	1999	2000 [1]	2001 [1]	2002 [1]	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark									
Faroe Islands	3873		106	13	58	35	887	817	1116
France		1	32	4	8	17		40	9
Germany	22								
Iceland									
Ireland									
Norway	87	1	2	1	1		1		1
UK (Engl. and Wales)	9	35	77	50	24	41	2		
UK (Scotland)	66	116	118	141	174	87	204		
United Kingdom								19	1
Total	4057	153	335	209	265	180	1 094	876	1 127
Working Group estimate	2694 [2]	5079	3 951	2 694	2 459	1 771	892	873	1060

Country	2008
Denmark	
Faroe Islands	
France	36
Germany	
Iceland	
Ireland	
Norway	1
UK (Engl. and Wales)	
UK (Scotland)	
United Kingdom	32
Total	69
Working Group estimate	1759

1) Provisional data
2) WG estimate includes additional catches as described in Working Group reports for each year and in the report from 2001.

Table 15.2.4 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-area XIV 1981-2008, as officially reported to ICES and estimated by WG.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-	78	74	98	87
Germany	2 893	2 439	1 054	818	636	745	456	595	420
Greenland	+	1	5	15	81	177	154	37	11
Iceland	-	-	1	2	36	17	136	40	+
Norway	-	-	-	+	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	+
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	2 893	2 440	1 060	835	753	1 017	820	770	518
Working Group estimate	-	-	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	+	+
Faroe Islands	-	-	-	181	168	147	130	148	151
Germany	293	279	311	391	639	808	3 343	3 301	3 399
Greenland	40	66	437	288	866	533	1 162	1 129	747 [1,7]
Iceland	-	-	-	19	82	7	-	1 803	148
Norway	8	18	196	511	1 120	1 668	1 881	1 897 [1]	1 253 [1]
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	108	796	513	1405	264	218	190
UK (Scotland)	-	-	18	26	84	205	13		
United Kingdom	-	-	-	-	-	-	-		
Total	368	401	1 075	2 212	3 472	4 783	7 218	8 533	5940
Working Group estimate	736 [2]	875 [3]	1 176 [4]	2 249 [5]	3 125 [6]	5 077 [7]	7 283 [8]	8 558 [9]	

Country	1999	2000	2001 [1]	2002 [1]	2003 [1]	2004 [1]	2005 [1]	2006 [1]	2007 [1]
Denmark									
Faroe Islands	2			274	366	274	186	22	
Germany	3047	3243	2 750	2 019	2 925	5 159	5 144	4 298	4 702
Greenland	200 [1,4]	1740	1 553	1 887	1 459				
Iceland	93	30	14 280	16 947	6				
Ireland			7						
Norway	1100	1161	1 424	1 660	846	1 114	1 023	1 094	
Poland						205			
Portugal			6	130				1 094	
Russia	138	183	186	44		261		505	500
Spain		8	10		2 131	3 406	2		
UK (Engl. and Wales)	226	262	100						
UK (Scotland)				24	188	278	160		
United Kingdom				178	799	1 294			
Total	4806	6627	20 316	23 163	8 720	11 991	6 515	7 013	5 202
Working Group estimate	5376 [11]	6958	6 588 [6]	6 750 [6]	8 017	9 854	10 185	8 589	10 261

Country	2008 [1]
Denmark	
Faroe Islands	
Germany	4 842
Greenland	
Iceland	
Ireland	
Norway	637
Poland	1 354
Portugal	
Russia	763
Spain	
UK (Engl. and Wales)	
UK (Scotland)	
United Kingdom	131
Total	7 727
Working Group estimate	9 102

1) Provisional data
2)WG estimate includes additional catches as described in working Group reports for each year and in the report from 2001.
3) Includes 125 t by Faroe Islands and 206 t by Greenland.
4) Excluding 4732 t reported as area unknown.
5) Includes 1523 t by Norway, 102 t by Faroe Islands, 3343 t by Germany, 1910 t by Greenland, 180 t by Russia, as reported to Greenland authorities.
6) Does not include most of the Icelandic catch as those are included in WG estimate of Va.
7) Excluding 138 t reported as area unknown.

Table 15.2.5 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area XII, as officially reported to the ICES and estimated by WG

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]
Faroe Islands		47					40		
France					1			4	30
Ireland						49			
Lithuania								2	1
Poland						2		2	1
Spain [2]	2	42	67	137	751	1338	28	730	1145
UK					7	5			
Russia									
Norway	2				553	500	316	201	119
Estonia									
Total	4	89	67	137	1 312	1 894	384	939	1 296
WG estimate									

Country	2005 [1]	2006 [1]	2007 [1]	2008 [1]
Faroe Islands				
France				
Ireland				
Lithuania		2	3	1
Poland				
Spain [2]	501			
UK	3			
Russia		46	1	
Norway				
Estonia		2		
Total	504	50	4	1
WG estimate				

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 15.2.6 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Sub-area VI, as officially reported to the ICES and estimated by WG.

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]
Estonia							8		
Faroe Islands									
France							286	165	110
Poland							16	91	1
Spain [2]			22	88	20	350	1367	214	170
UK					159	247	77	42	10
Russia						1			1
Norway					35	317	21	26	
Total	0	0	22	88	214	915	1775	538	292
WG estimate									

Country	2005 [1]	2006 [1]	2007 [1]	2008 [1]
Estonia	5	1		
Faroe Islands				
France		22	8	114
Poland				
Spain [2]	3	33		
UK	217	74	15	80
Russia		1		32
Norway		3		1
Lithuania				1
Total	225	134	23	228
WG estimate				

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 15.3.1. CPUE indices oftrawl fleets in Div Va, Vb and XIVb as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	relative derived effort	% change in effort between years
Iceland Va	1985	1.00		29,197	100	
	1986	1.01	1	31,027	105	5
	1987	1.08	7	44,659	135	28
	1988	1.09	1	49,379	110	-19
	1989	1.04	-5	59,049	125	14
	1990	0.71	-32	37,308	92	-26
	1991	0.68	-4	35,413	98	6
	1992	0.60	-12	31,978	103	5
	1993	0.47	-21	34,134	136	32
	1994	0.39	-18	28,608	102	-25
	1995	0.31	-20	27,391	120	18
	1996	0.26	-16	22,073	96	-20
	1997	0.28	7	16,792	71	-26
	1998	0.43	57	10,595	40	-44
	1999	0.50	15	11,138	91	127
	2000	0.57	14	14,607	115	26
	2001	0.60	4	16,755	110	-4
	2002	0.49	-18	19,714	143	30
	2003	0.32	-34	20,415	157	9
	2004	0.22	-31	15,477	110	-30
	2005	0.24	8	13,015	78	-29
	2006	0.24	2	11,817	89	14
	2007	0.28	15	10,525	77	-14
	2008	0.27	-5	9,580	96	25
Greenland, XIVb	1991	1.00		875	100	0
	1992	0.93	-7	1,176	145	45
	1993	2.59	179	2,249	68	-53
	1994	3.29	27	3,125	110	60
	1995	3.42	4	5,077	156	43
	1996	3.40	0	7,283	144	-8
	1997	3.54	4	8,558	113	-22
	1998	3.39	-4	5,940	73	-36
	1999	2.65	-22	5,376	116	60
	2000	2.21	-16	6,958	155	34
	2001	2.18	-1	7,216	105	-32
	2002	2.33	7	6,750	88	-17
	2003	2.37	2	8,017	117	33
	2004	2.27	-4	9,854	128	10
	2005	3.11	37	10,185	75	-41
	2006	3.21	3	8589	82	8
	2007	3.00	-7	10261	128	57
	2008	3.10	3	8,952	84	-34
Faroe Islands, Vb	1991	1.00		1,662	100	33
	1992	1.11	11	2,269	123	23
	1993	0.84	-25	4,434	260	112
	1994	0.57	-31	5,225	172	-34
	1995	0.54	-6	3,832	78	-54
	1996	0.58	8	6,469	156	99
	1997	0.59	2	4,870	74	-53
	1998	0.46	-22	3,825	101	37
	1999	0.47	2	4,265	109	8
	2000	0.60	28	5,079	93	-15
	2001	0.48	-20	3,245	80	-13
	2002	0.46	-5	2,694	87	8
	2003	0.61	33	2,426	68	-22
	2004	0.43	-29	1,771	103	52
	2005	0.39	-9	892	55	-47
	2006	0.52	33	873	73	33
	2007	0.42	-20	1,060	151	106
	2008	0.53	-20	1759	100	-34

Table 15.6.1. Model input data series: Catch by the fishery; three indices of stock biomass – a standardized catch rate index based on fishery data (CPUE) from the Iceland EEZ, a Icelandic (Ice) and a Greenlandic (Green) research survey index.

Year	Catch (ktons)	CPUE (index)	Survey Ice (ktons)	Survey Green (ktons)
1960	0	-	-	-
1961	0.029	-	-	-
1962	3.071	-	-	-
1963	4.275	-	-	-
1964	4.748	-	-	-
1965	7.421	-	-	-
1966	8.030	-	-	-
1967	9.597	-	-	-
1968	8.337	-	-	-
1969	26.200	-	-	-
1970	33.823	-	-	-
1971	28.973	-	-	-
1972	26.473	-	-	-
1973	20.463	-	-	-
1974	36.280	-	-	-
1975	23.494	-	-	-
1976	6.045	-	-	-
1977	16.578	-	-	-
1978	14.349	-	-	-
1979	23.622	-	-	-
1980	31.157	-	-	-
1981	19.239	-	-	-
1982	32.441	-	-	-
1983	30.891	-	-	-
1984	34.024	-	-	-
1985	32.075	1.76	-	-
1986	32.984	1.78	-	-
1987	46.622	1.90	-	-
1988	51.118	1.92	-	-
1989	61.396	1.83	-	-
1990	39.326	1.25	-	-
1991	37.950	1.20	-	-
1992	35.487	1.06	-	-
1993	41.247	0.83	-	-
1994	37.190	0.69	-	-
1995	36.288	0.55	-	-
1996	35.932	0.46	34.44	-
1997	30.309	0.49	42.01	-
1998	20.382	0.77	42.01	49.40
1999	20.371	0.88	52.37	37.90
2000	26.644	1.01	39.63	47.93
2001	27.291	1.05	55.73	-
2002	29.158	0.86	47.15	58.11
2003	30.891	0.57	24.41	34.95
2004	27.102	0.39	16.01	25.31
2005	24.249	0.42	22.31	35.24
2006	21.432	0.43	18.46	42.21
2007	20.957	0.50	21.05	26.98
2008	22.169*	0.47	30.15	18.92
2009	20.000**	-	-	-

*total catch in 2008 has been revised since this estimate and appears in Table 15.2.

**estimated

Table 15.6.2. Priors used in the assessment model. ~ means "distributed as..", dunif = uniform-, dlnorm = lognormal-, dnorm= normal- and dgamma = gammadistributed. Symbols as in text.

Parameter		Prior	
Name	Symbol	Type	Distribution
Maximal Suatainable Yield	MSY	reference	dunif(1,300)
Carrying capacity	K	low informative	dnorm(750,300)
Catchability Iceland survey	q_{Ice}	reference	$\ln(q_{Ice})$~dunif(-3,1)
Catchability Greenland survey	q_{Green}	reference	$\ln(q_{Green})$~dunif(-3,1)
Catchability Iceland CPUE	q_{cpue}	reference	$\ln(q_{cpue})$~dunif(-10,1)
Initial biomass ratio	P_1	informative	dnorm(2,0.071)
Precision Iceland survey	$1/\sigma_{Ice}^2$	low informative	dgamma(2.5,0.03)
Precision Greenland survey	$1/\sigma_{Green}^2$	low informative	dgamma(2.5,0.03)
Precision Iceland CPUE	$1/\sigma_{cpue}^2$	low informative	dgamma(2.5,0.03)
Precision model	$1/\sigma_P^2$	reference	dgamma(0.01,0.01)

Table 15.6.3. Summary of parameter estimates: mean, standard deviation (sd) and 25, 50, and 75 percentiles of the posterior distribution of selected parameters (symbols as in the text).

	Mean	sd	25%	Median	75%
MSY (ktons)	29	12	21	28	36
K (ktons)	981	241	807	975	1146
r	0.13	0.06	0.08	0.12	0.16
q_{cpue}	3E-03	8E-04	2E-03	2E-03	3E-03
q_{Ice}	0.13	0.04	0.10	0.12	0.16
q_{Green}	0.16	0.05	0.12	0.15	0.18
P_{1985}	1.52	0.15	1.42	1.53	1.62
P_{2008}	0.40	0.06	0.36	0.40	0.44
σ_{Ice}	0.23	0.05	0.20	0.23	0.26
σ_{cpue}	0.10	0.02	0.08	0.10	0.11
σ_{Green}	0.20	0.04	0.17	0.19	0.22
σ_P	0.20	0.04	0.18	0.20	0.22

Table 15.6.4. Model diagnostics: residuals (% of observed value), probability of getting a more extreme observation (p.extreame; see text for explanation).

	CPUE		Survey Ice		Survey Green	
Year	resid (%)	Pr	resid (%)	Pr	resid (%)	Pr
1985	-0.28	0.51	-	-	-	-
1986	0.61	0.48	-	-	-	-
1987	-0.86	0.52	-	-	-	-
1988	-1.89	0.55	-	-	-	-
1989	-5.09	0.65	-	-	-	-
1990	3.57	0.39	-	-	-	-
1991	-1.04	0.53	-	-	-	-
1992	-2.26	0.57	-	-	-	-
1993	0.81	0.47	-	-	-	-
1994	0.06	0.50	-	-	-	-
1995	3.44	0.40	-	-	-	-
1996	12.02	0.18	-22.56	0.85	-	-
1997	14.12	0.14	-33.84	0.94	-	-
1998	-2.17	0.57	-5.26	0.59	-7.44	0.62
1999	-3.25	0.60	-15.06	0.76	32.14	0.10
2000	-8.82	0.75	21.24	0.16	16.75	0.25
2001	-5.09	0.64	-5.83	0.60	0.05	-
2002	-2.46	0.58	-5.88	0.60	-12.02	0.68
2003	-2.41	0.58	18.71	0.19	-2.36	0.54
2004	3.21	0.40	28.81	0.09	-2.20	0.53
2005	3.20	0.40	2.76	0.45	-27.60	0.86
2006	2.64	0.42	23.70	0.13	-44.16	0.96
2007	-7.11	0.71	16.04	0.23	5.06	0.42
2008	-2.49	0.57	-21.69	0.84	39.70	0.06

Table 15.6.5. Upper: stock status for 2008 and predicted to the end of 2009. Lower: predictions for 2010 given catch options ranging from 0 to 30 ktons.

Status	2008	2009*
Risk of falling below B_{lim} ($0.3B_{MSY}$)	5%	18%
Risk of falling below B_{MSY}	100%	100%
Risk of exceeding F_{MSY}	100%	90%
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	68%	60%
Stock size (B/Bmsy), median	0.40	0.39
Fishing mortality (F/Fmsy),	2.14	1.99
Productivity (% of MSY)	64%	63%

*Predicted catch = 20ktons

Catch option 2010 (ktons)	0	5	10	15	20	30
Risk of falling below B_{lim} ($0.3B_{MSY}$)	17%	19%	22%	25%	26%	36%
Risk of falling below B_{MSY}	100%	100%	100%	100%	100%	100%
Risk of exceeding F_{MSY}	-	15%	45%	72%	86%	97%
Risk of exceeding F_{lim} ($1.7F_{MSY}$)	-	7%	22%	41%	60%	83%
Stock size (B/Bmsy), median	0.42	0.41	0.40	0.39	0.38	0.38
Fishing mortality (F/Fmsy),	0.00	0.44	0.92	1.46	2.05	3.18
Productivity (% of MSY)	66%	65%	64%	63%	62%	62%

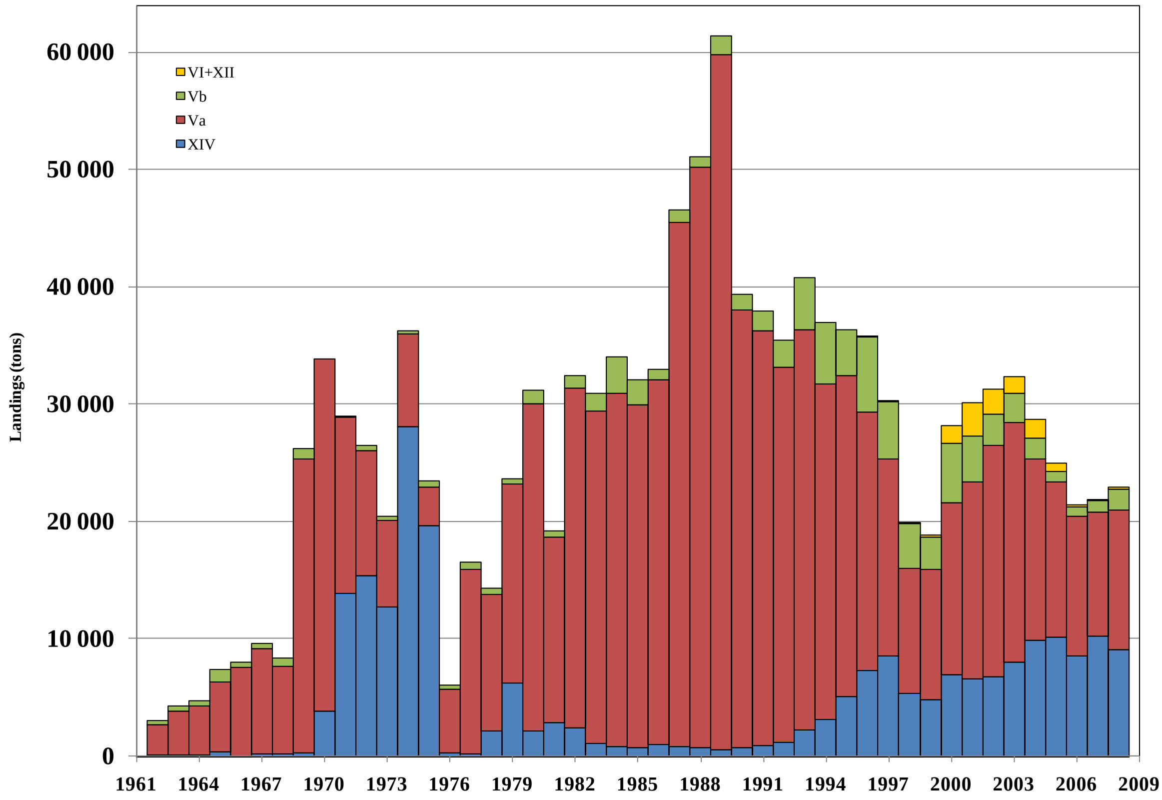


Figure 15.2.1. Landings of Greenland halibut in Divisions V, XI and XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

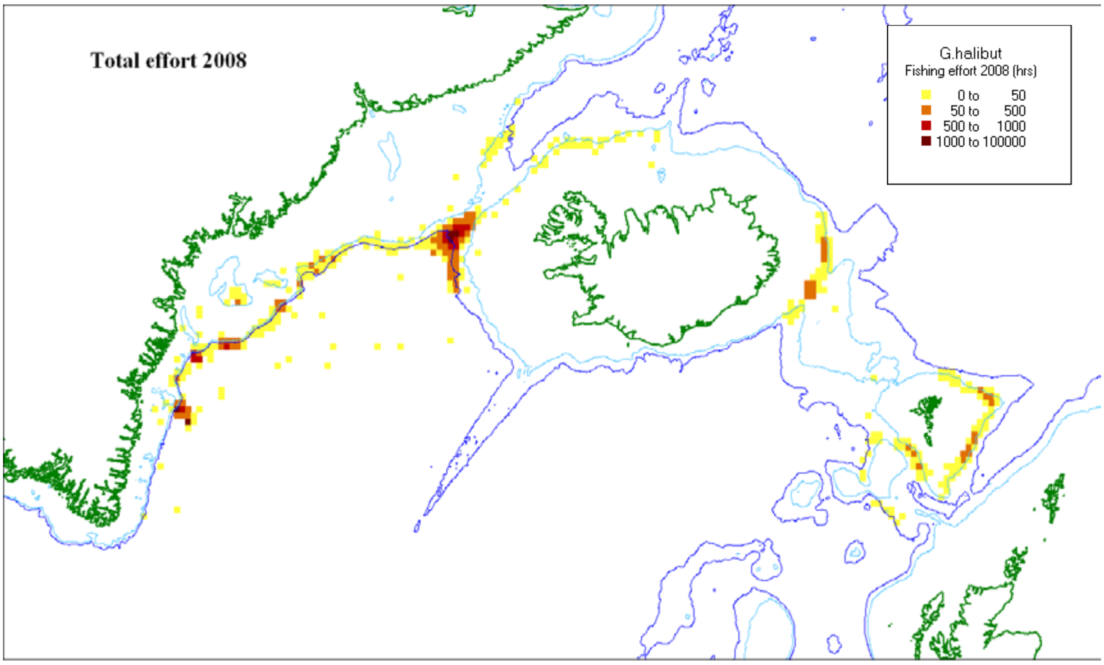


Figure. 15.2.2 Greenland halibut V+XIV. Distribution of fishing effort 2008. 500m and 1000 m depth contours are shown.

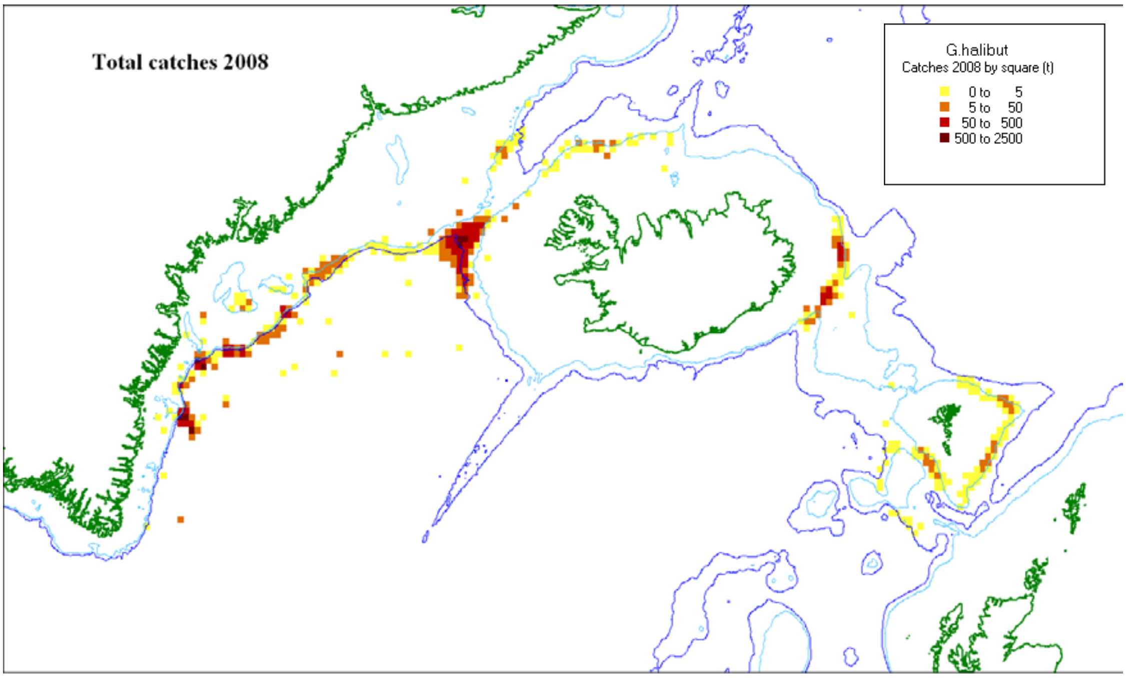


Figure 15.2.3. Greenland halibut V+XIV. Distribution of catches in the fishery in 2008. 500m and 1000 m depth contours are shown

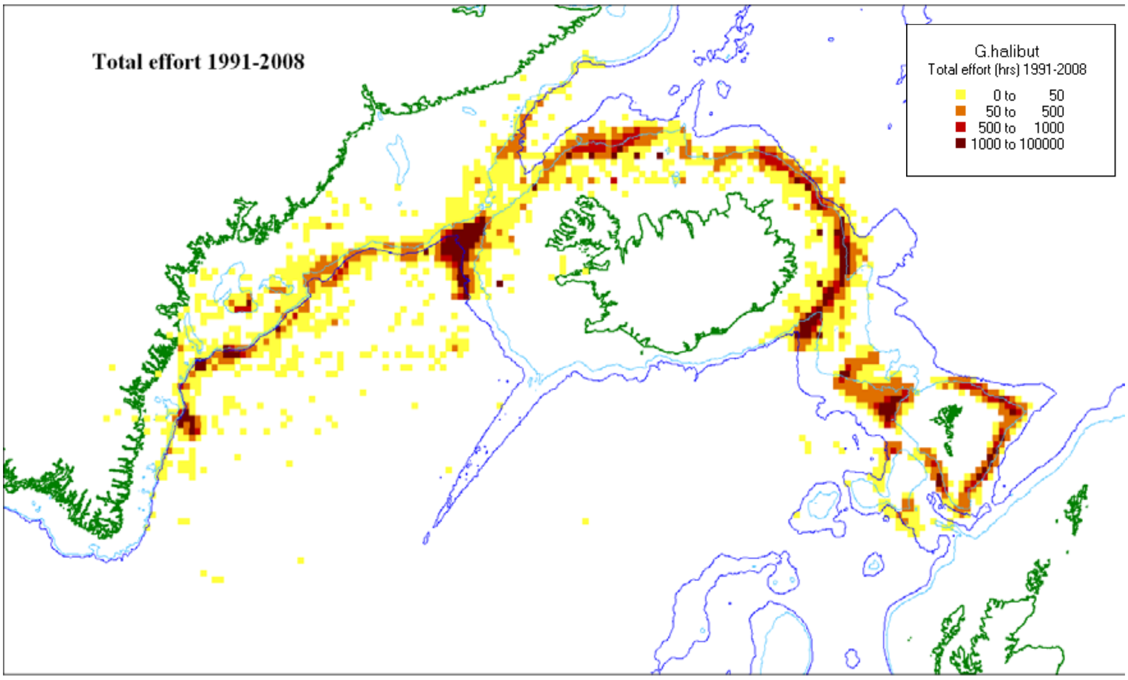


Figure 15.2.4. Greenland halibut V+XIV. Distribution of total fishing effort 1991-2008. The 500m and 1000 m depth contours are shown.

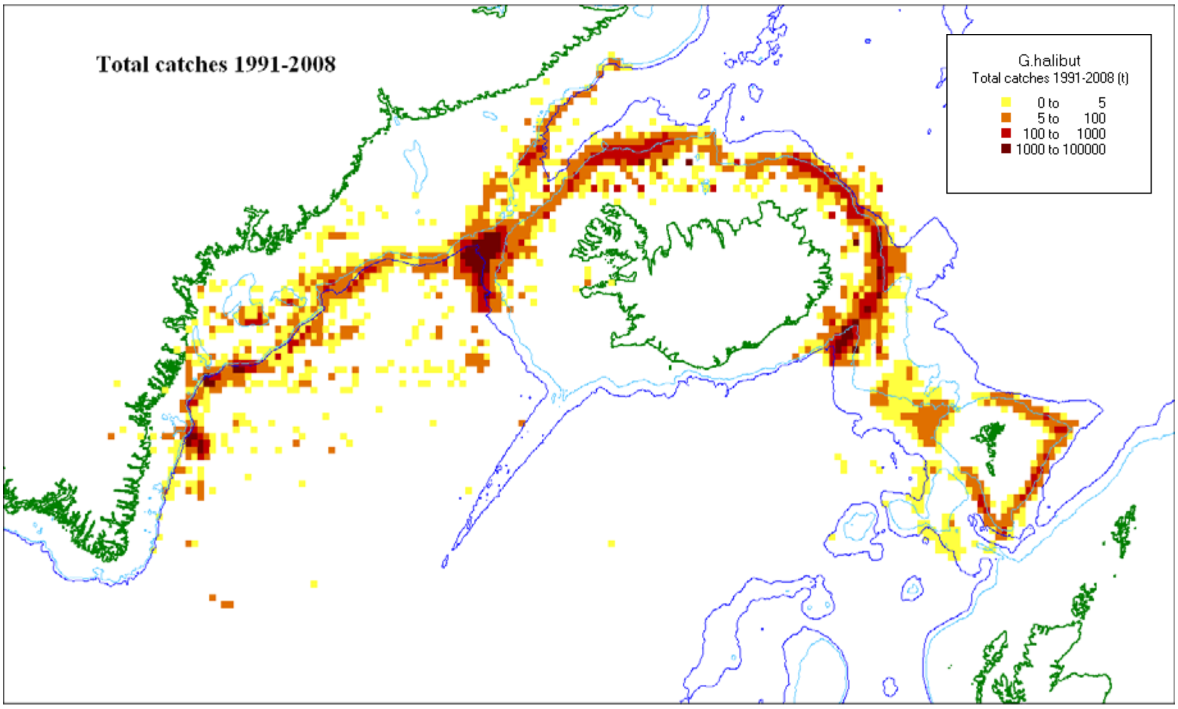


Figure 15.2.5. Greenland halibut V+XIV. Distribution of total catches in the fishery 1991-2008. 500m and 1000 m depth contours are shown.

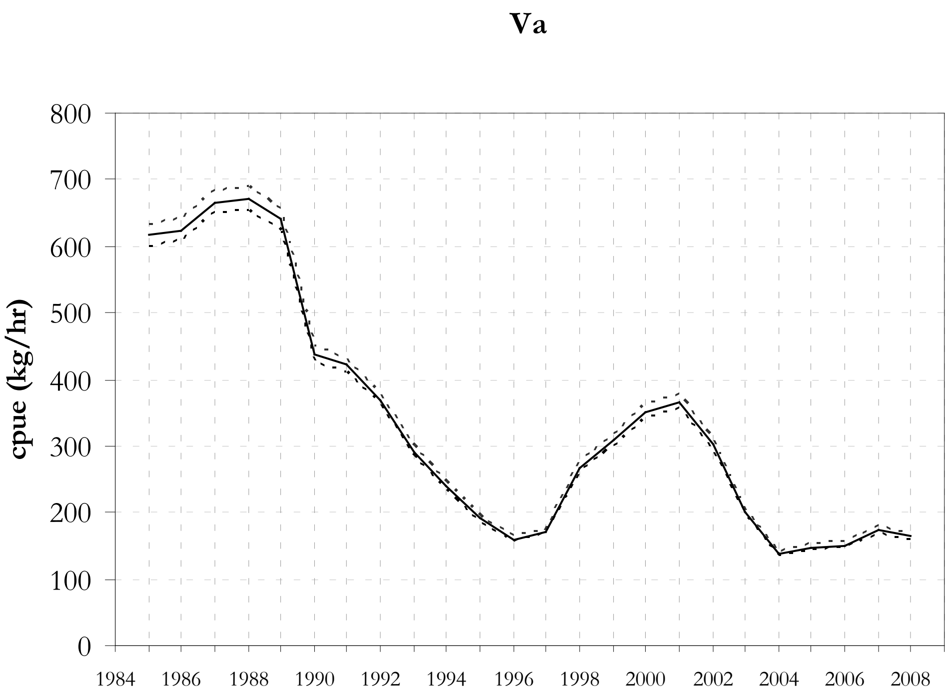


Figure 15.3.1. Standardised CPUE from the Icelandic trawler fleet in Va. 95% CI indicated.

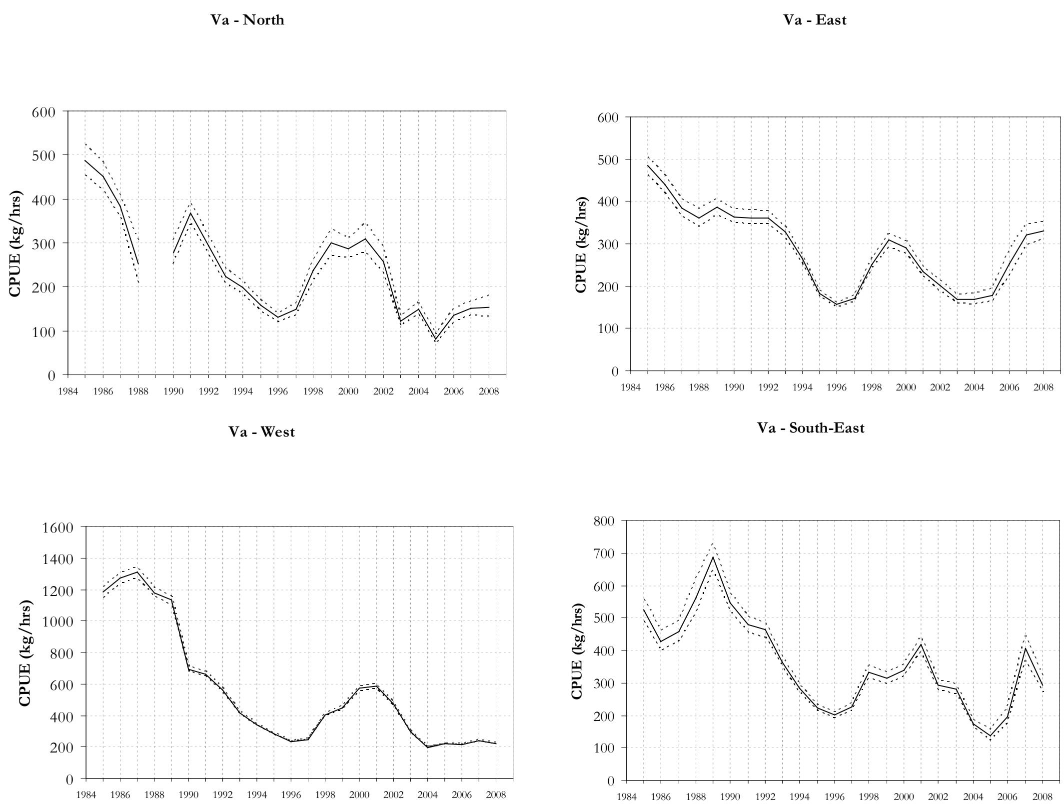


Figure 15.3.2 Standardised CPUE from the Icelandic trawler fleet in Va by four main fishing areas in Va. 95% CI indicated.

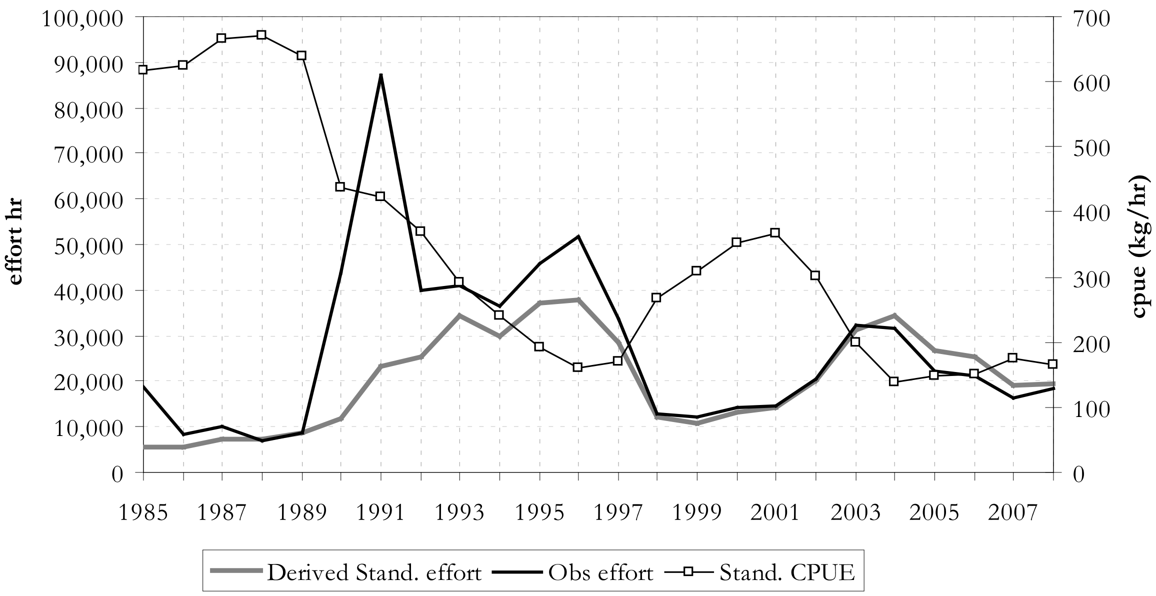


Figure 15.3.3. CPUE, observed and derived effort from Icelandic trawl fishery.

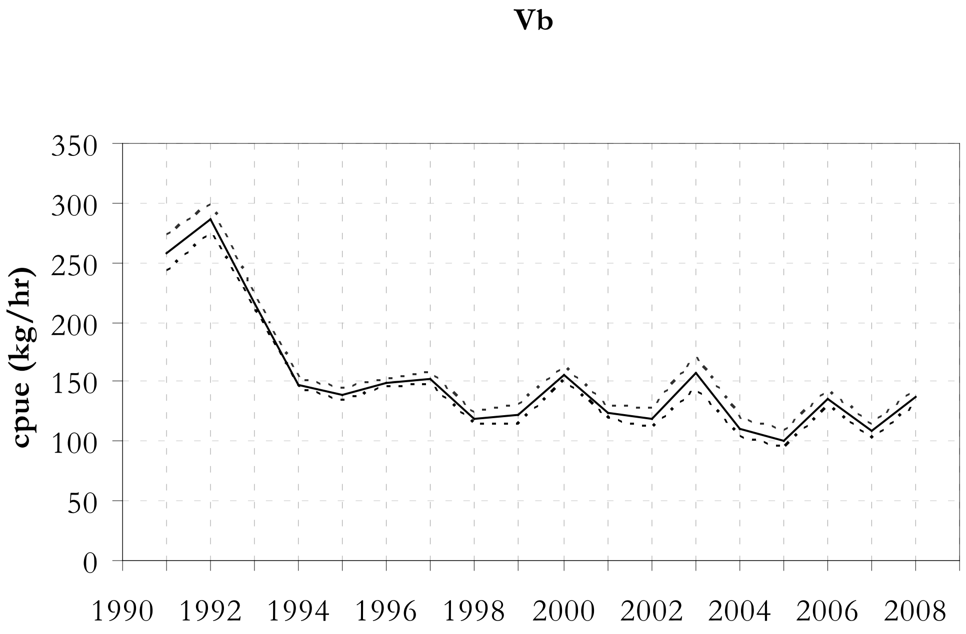


Figure 15.3.4.. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated

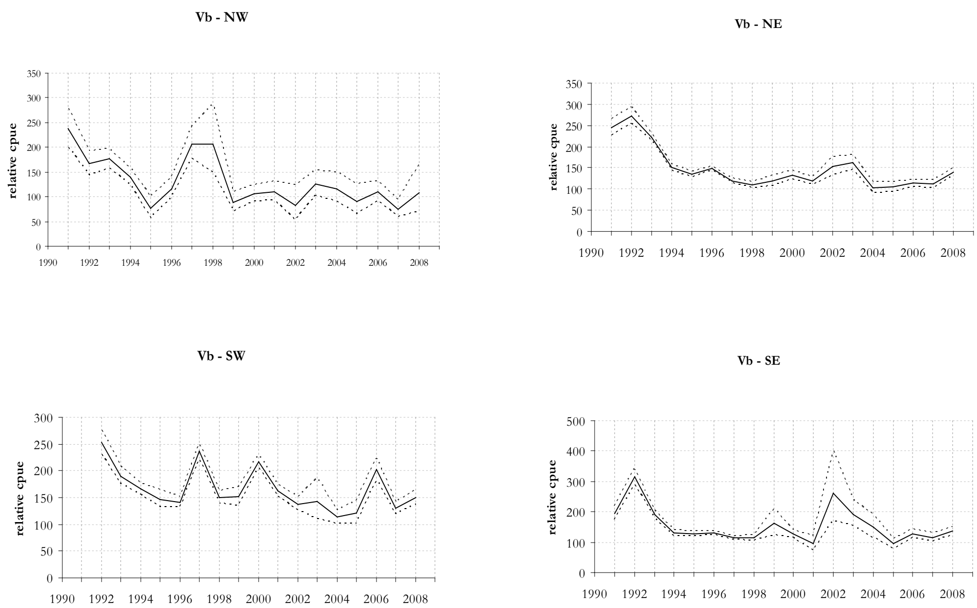


Figure 15.3.5. Standardised CPUE from the Faroese trawler fleet by four fishing areas as indicated on map. 95% CI indicated.

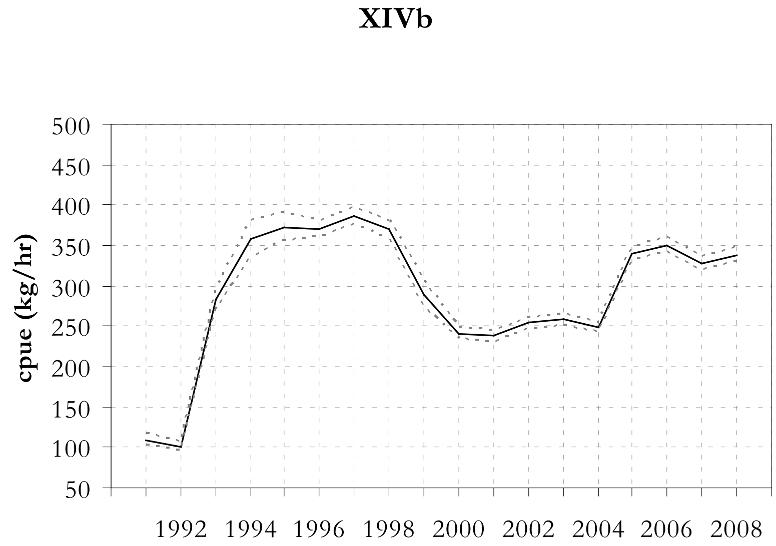


Figure 15.3.6. Standardised CPUE from trawler fleets in XIVb. 95% CI indicated

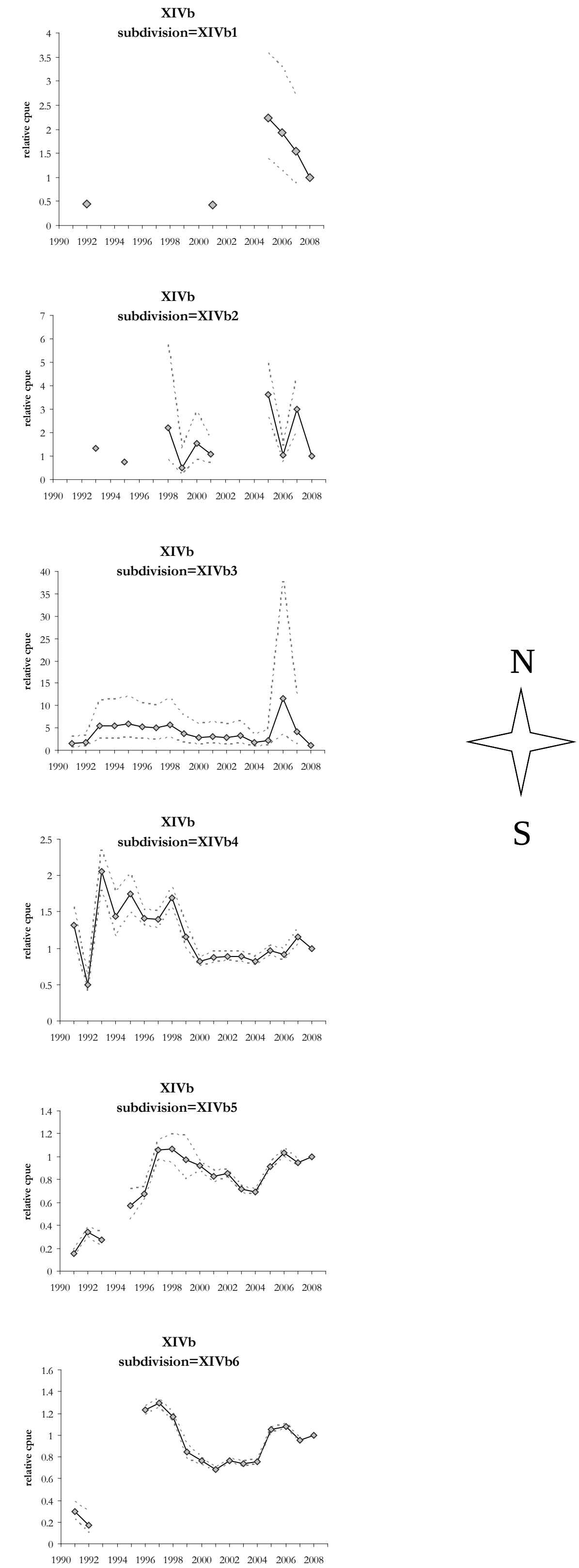


Figure 15.3.7. Standardised CPUE from trawler fleets in XIVb shown by subdivisions in XIVb in a north-south orientation. 95% CI indicated.

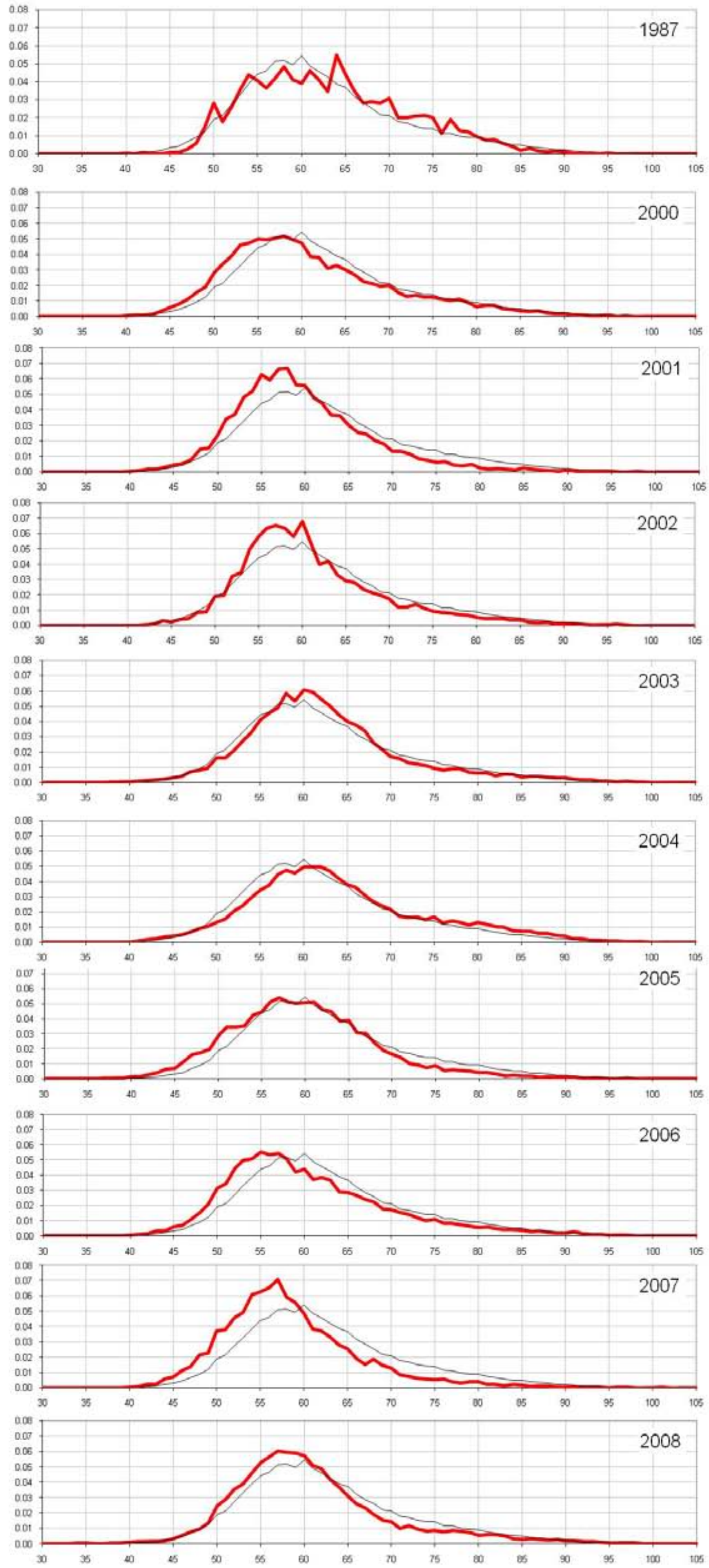


Figure 15.4.1. Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 1985 and 2000 – 2008. The thin solid line is average of 1985-20087 and the thick red solid line is annual distribution.

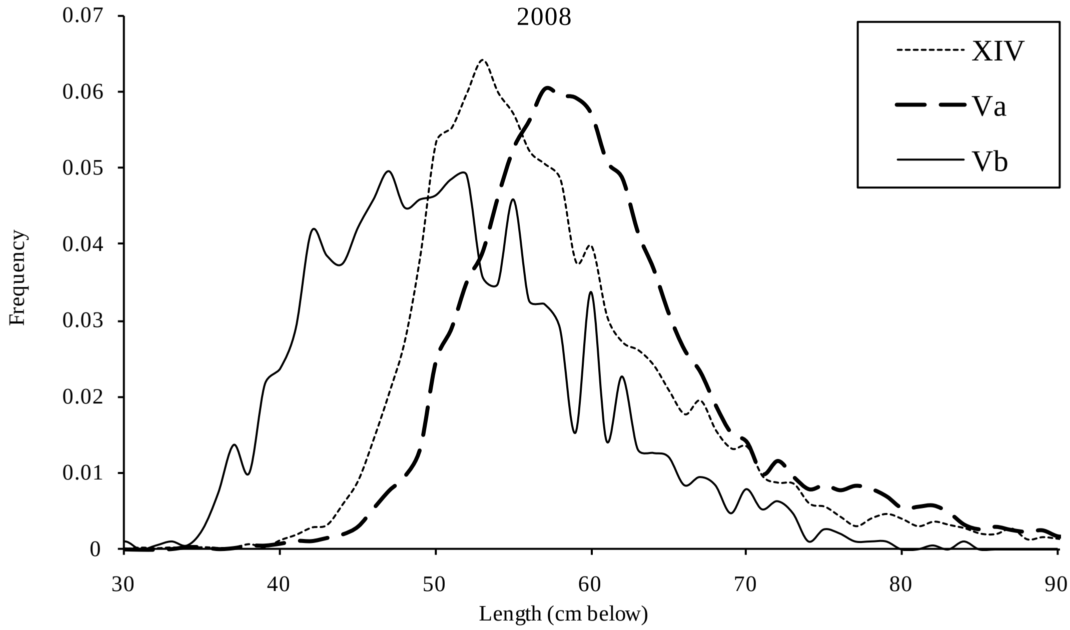


Figure 15.4.2. Length distributions of Greenland halibut caught in the commercial fishery in ICES Va, Vb and XIV in 2008.

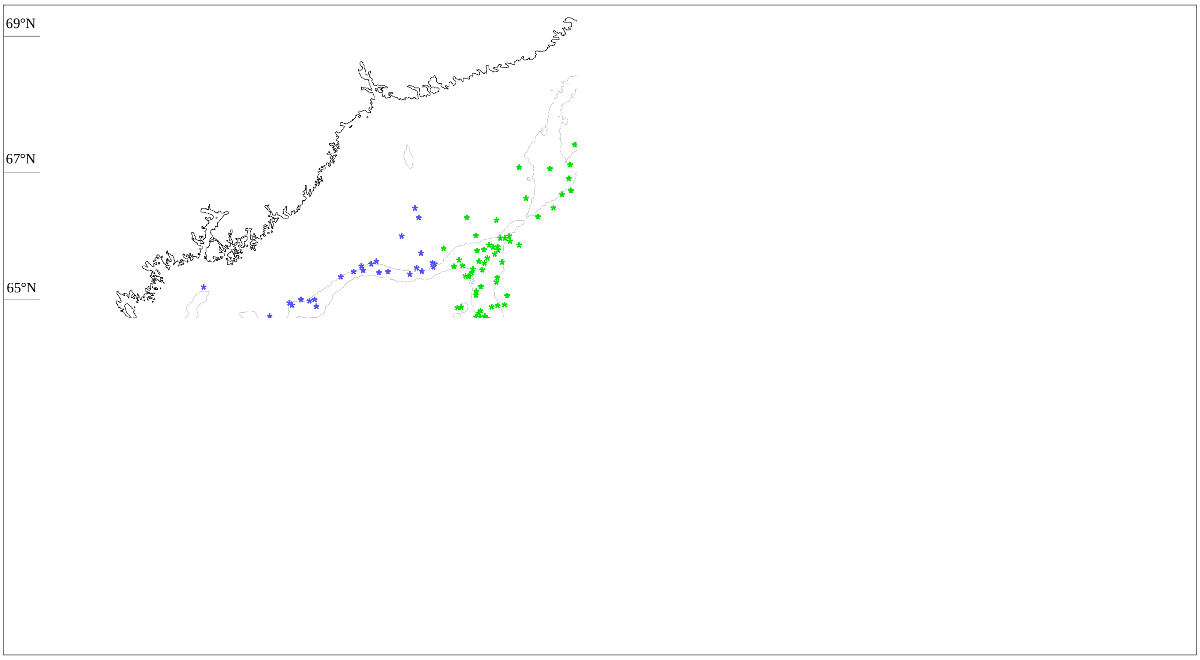


Figure 15.5.1. Surveyed area in XIV+V indicated as station positions in 2008 by the Greenland (n=46), Iceland (n=219) and Faroese surveys (n=42).

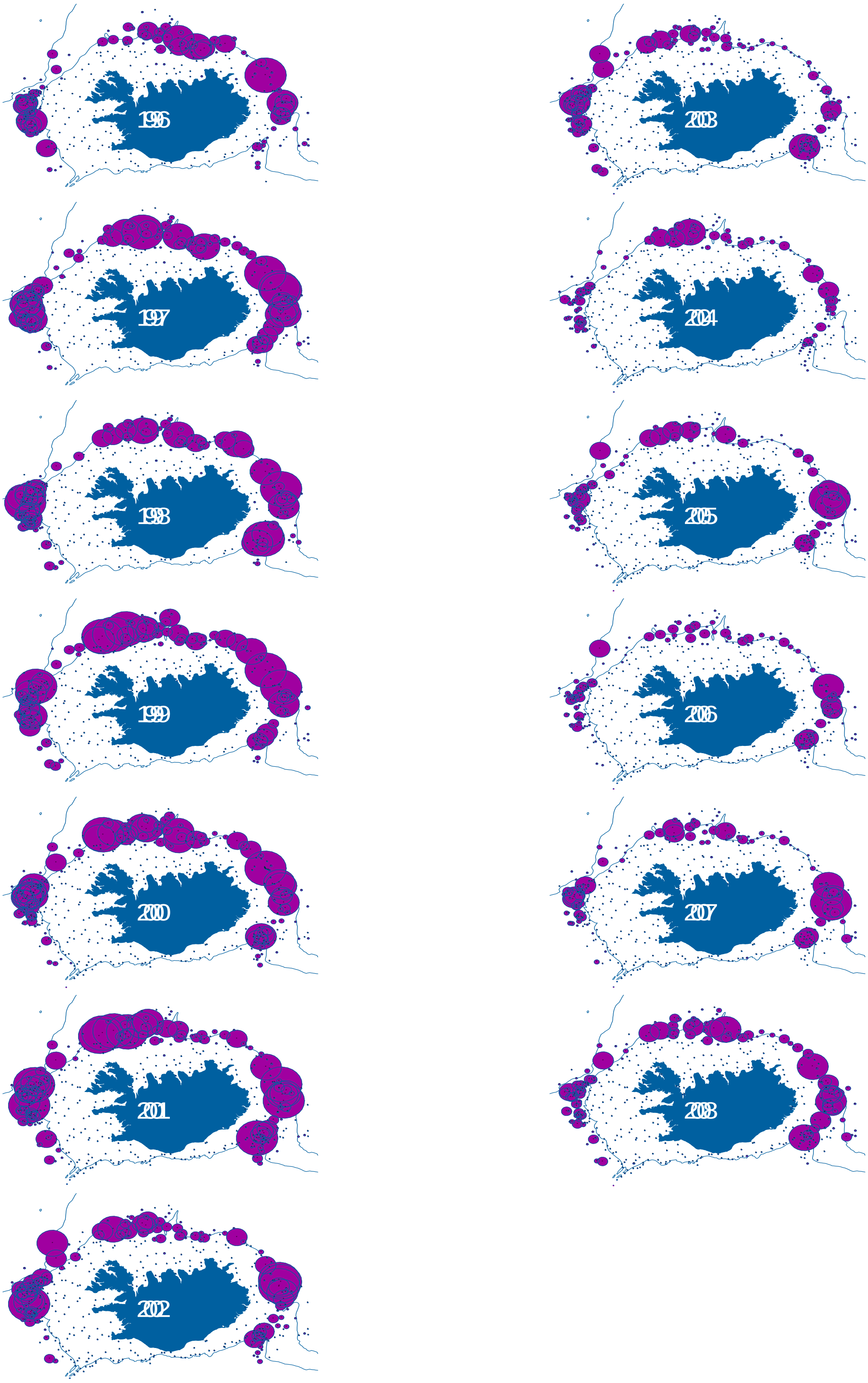


Figure 15.5.2. Distribution of catches from the Icelandic fall survey 1996-2008.

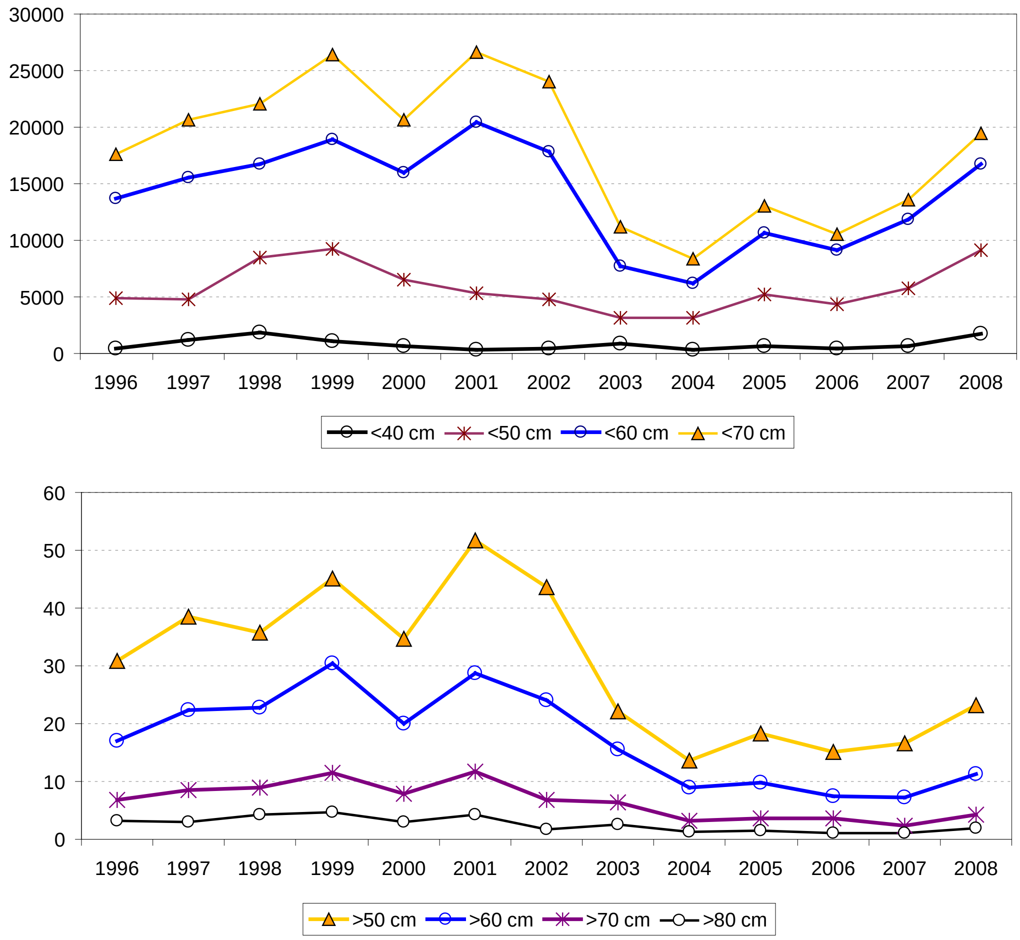


Figure 15.5.3. Greenland halibut in Icelandic fall groundfish survey; UPPER: biomass indices of lengths larger than indicated and, LOWER: abundance indices by length smaller than indicated.

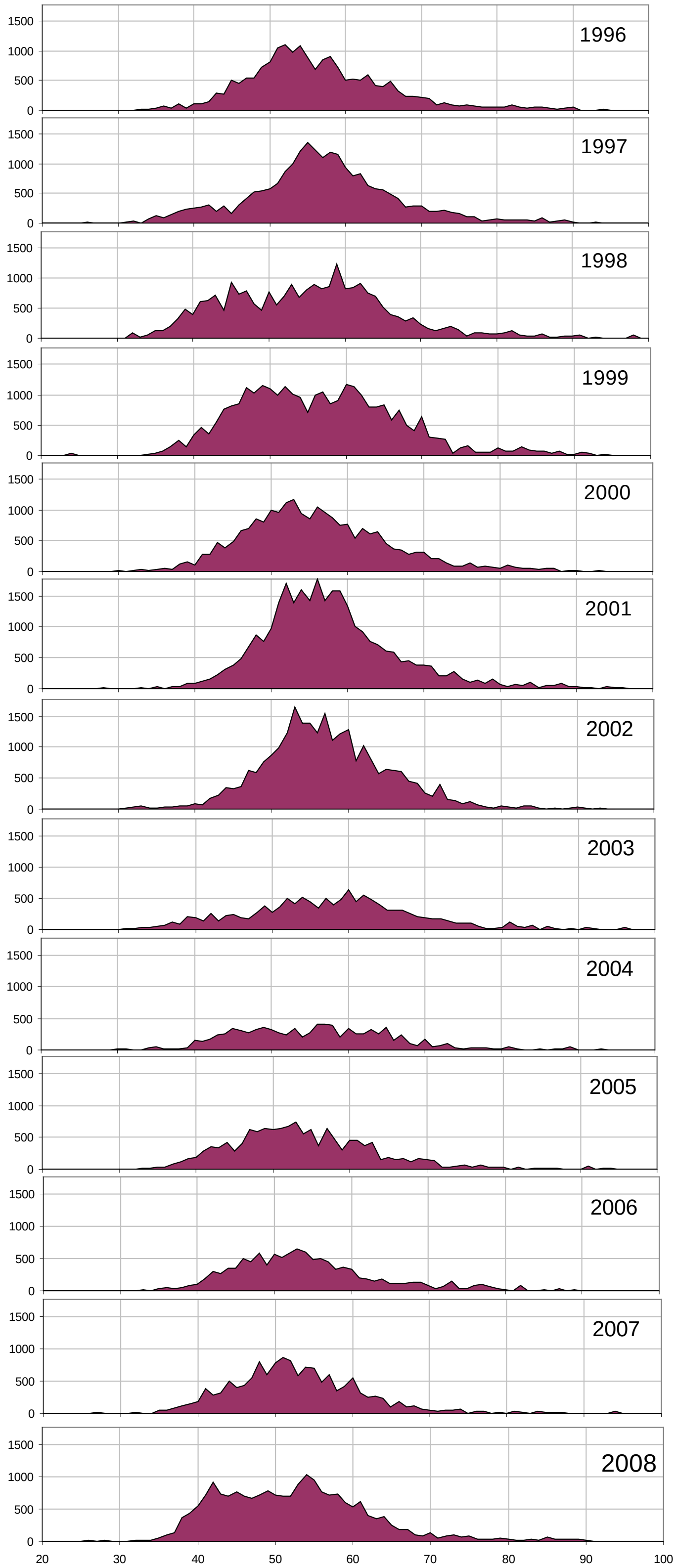
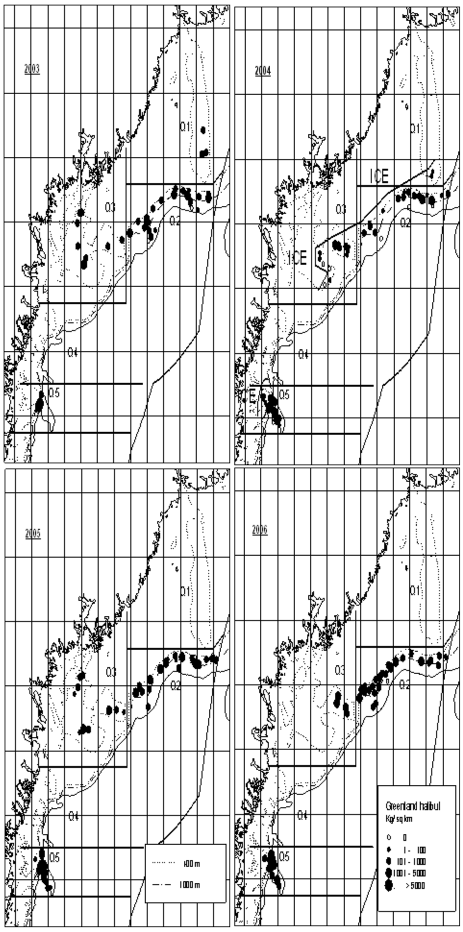
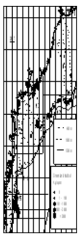


Figure 15.5.4. Abundance indices by length for the Icelandic fall survey 1996-2007.

Figure 15.5.5. Catch rates from a combined survey/fishermans survey in Vb.





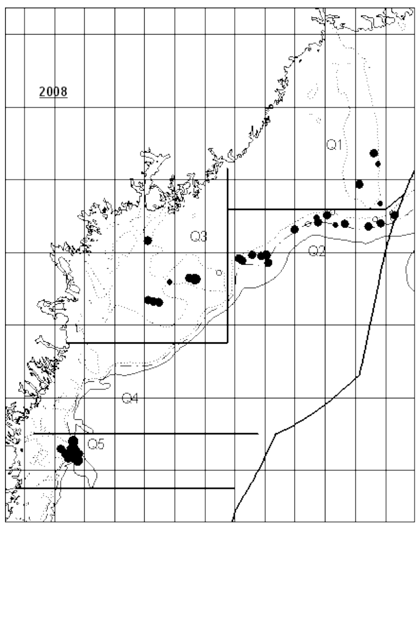


Figure 15.5.6. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2008 in the Greenland deep-water survey.

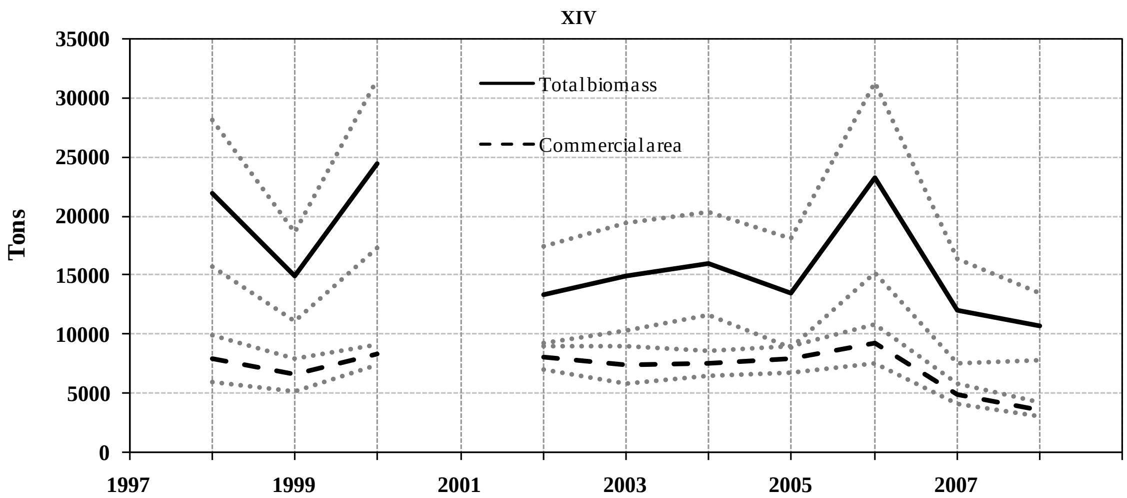


Figure 15.5.7. Estimated Biomass (t) in div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.Biomass Tot is is swept area estimates for the entire survey area, Biomass Com.is swept area estimates for strata Q2 and Q5 covered all years.

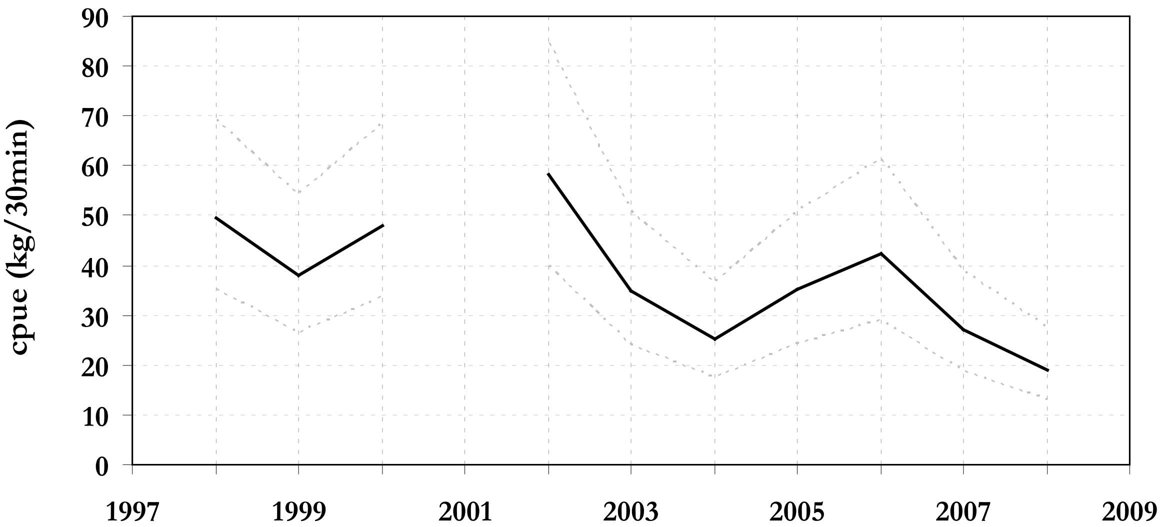


Figure 15.5.8. Standardised catch rates from the Greenland survey.(95% CI indicated.)

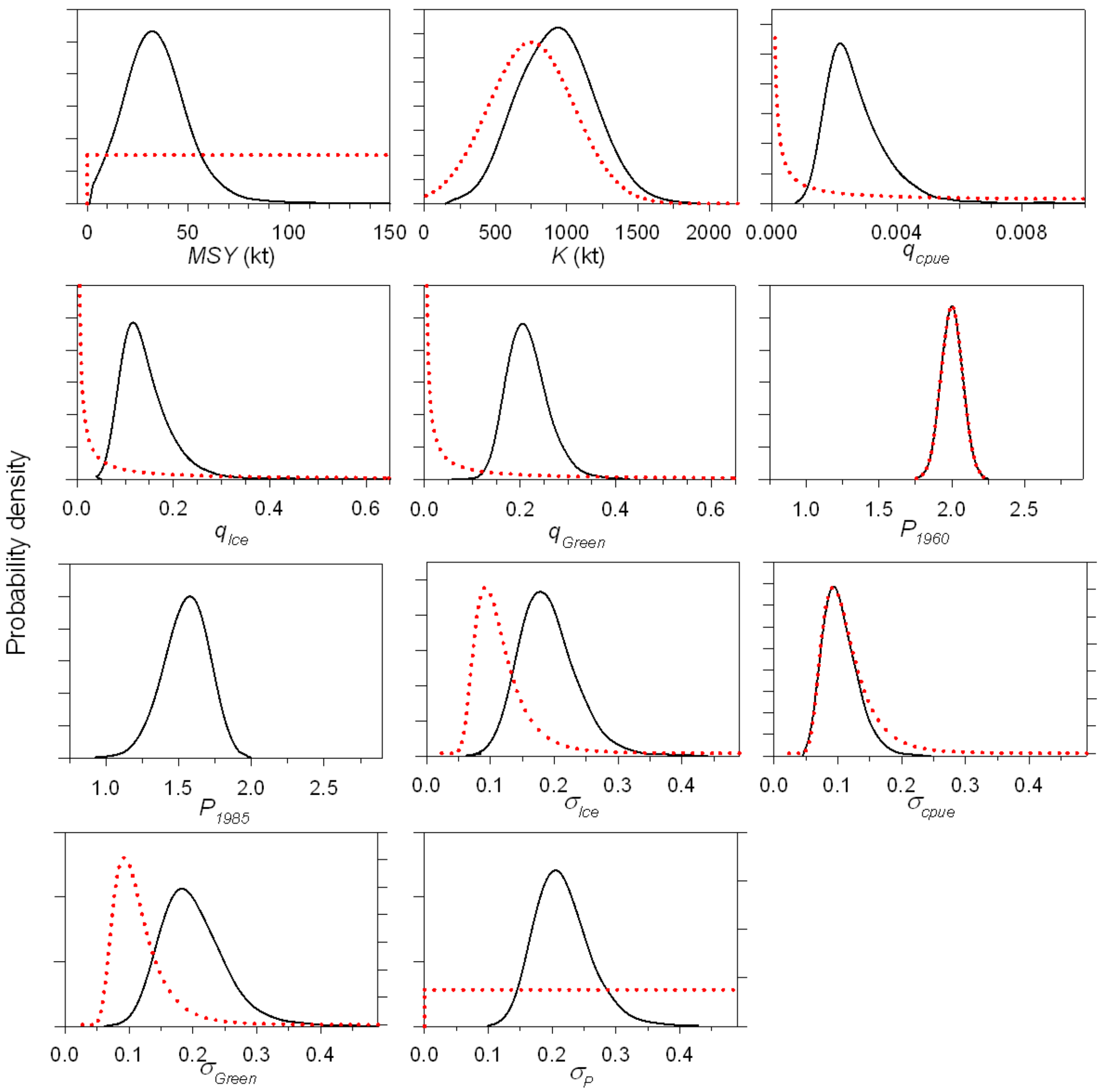


Figure 15.6.1. Probability density distributions of model parameters: estimated posterior (solid line) and prior (broken line) distributions.

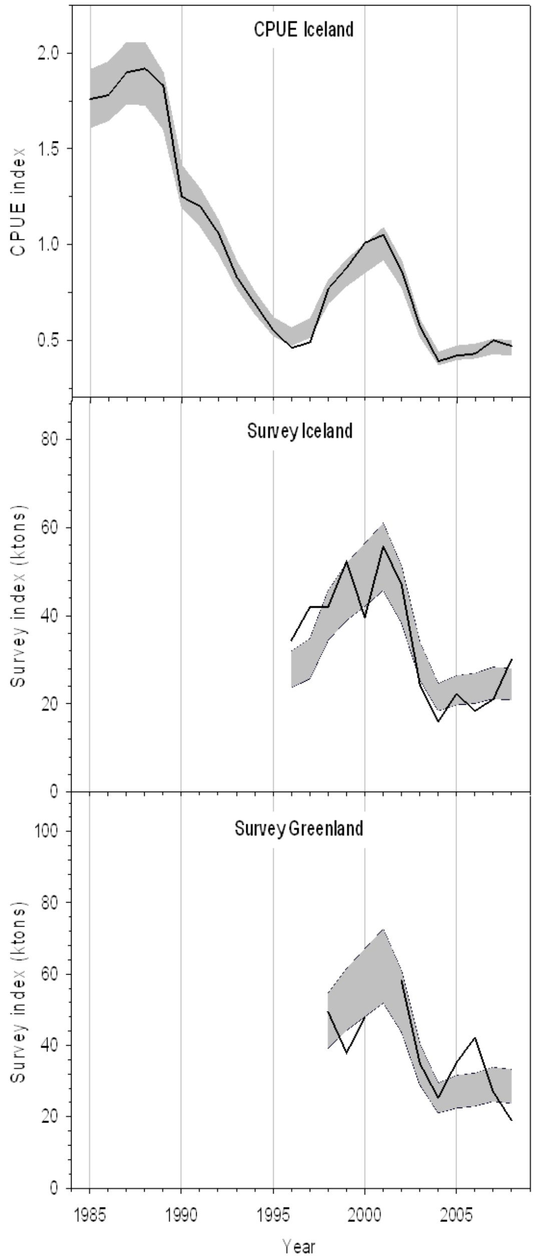


Figure 15.6.2. Observed (solid line) and predicted (shaded) series of the biomass indices used as input to the model. Gray shaded areas are inter-quartile range of the posteriors.

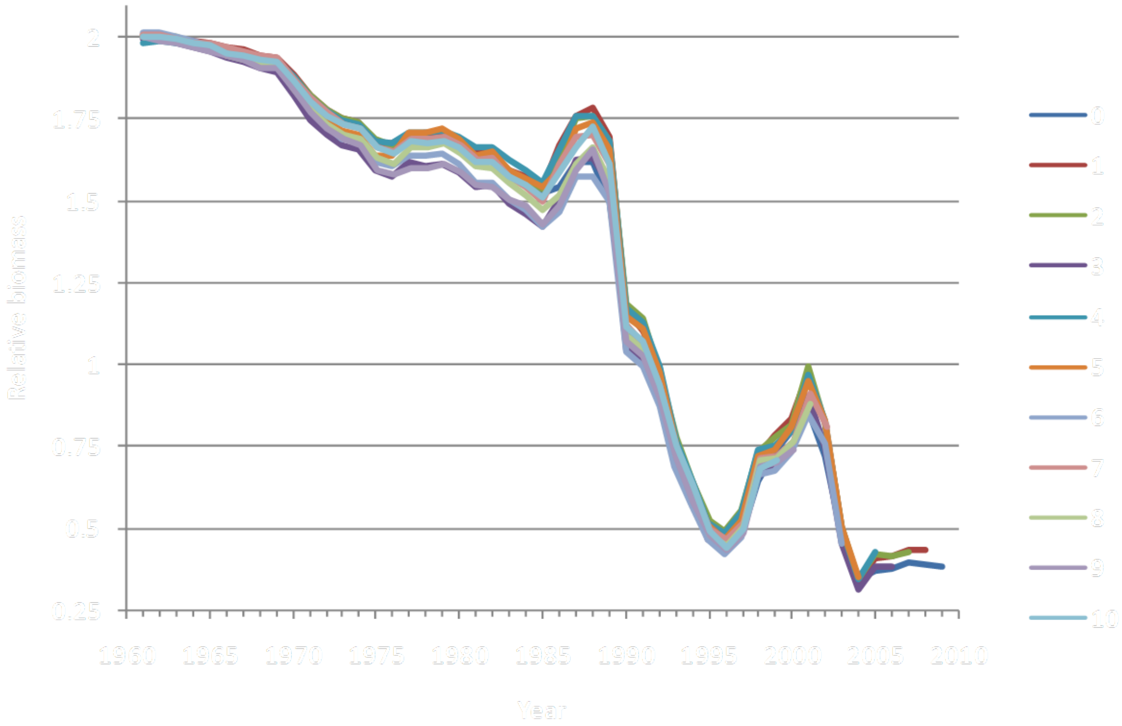


Figure 15.6.3. Retrospective plot of median relative biomass (*B*/*B*$_{msy}$). Relative biomass series are estimated by consecutively leaving out from 0 to 9 years of data.

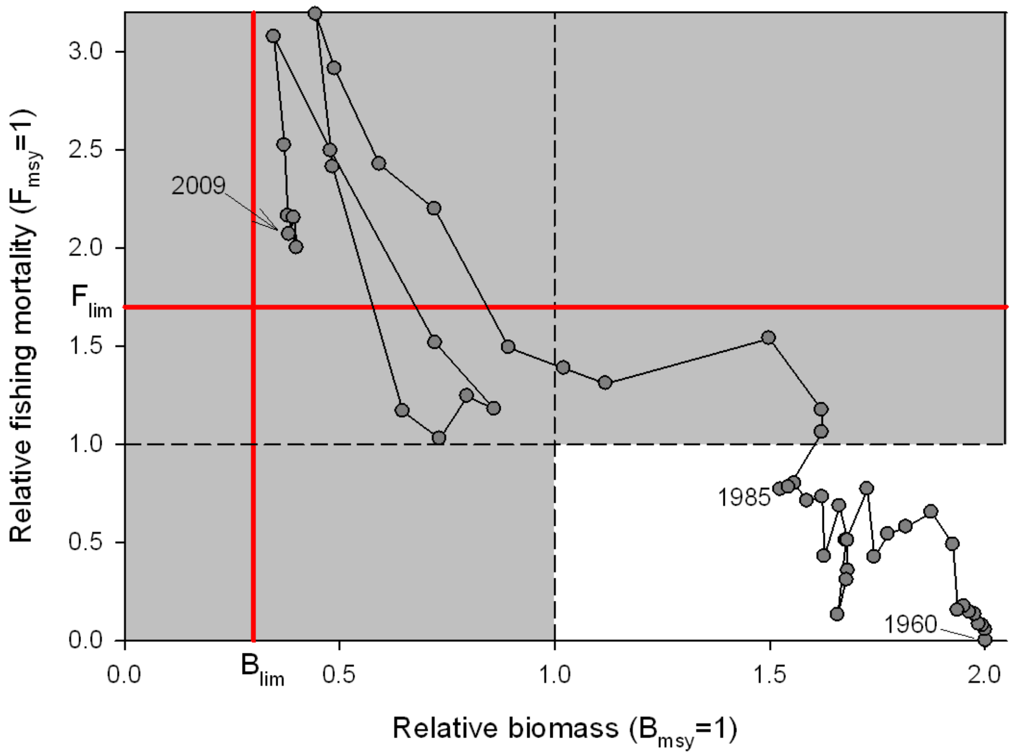


Figure 15.6.4. Estimated annual median biomass-ratio (*B*/*B_{MSY}*) and fishing mortality-ratio (*F*/*F_{MSY}*) 1985-2009. Suggested reference points for stock biomass, *B_{lim}*, and fishing mortality, *F_{lim}*, are indicated by red lines.

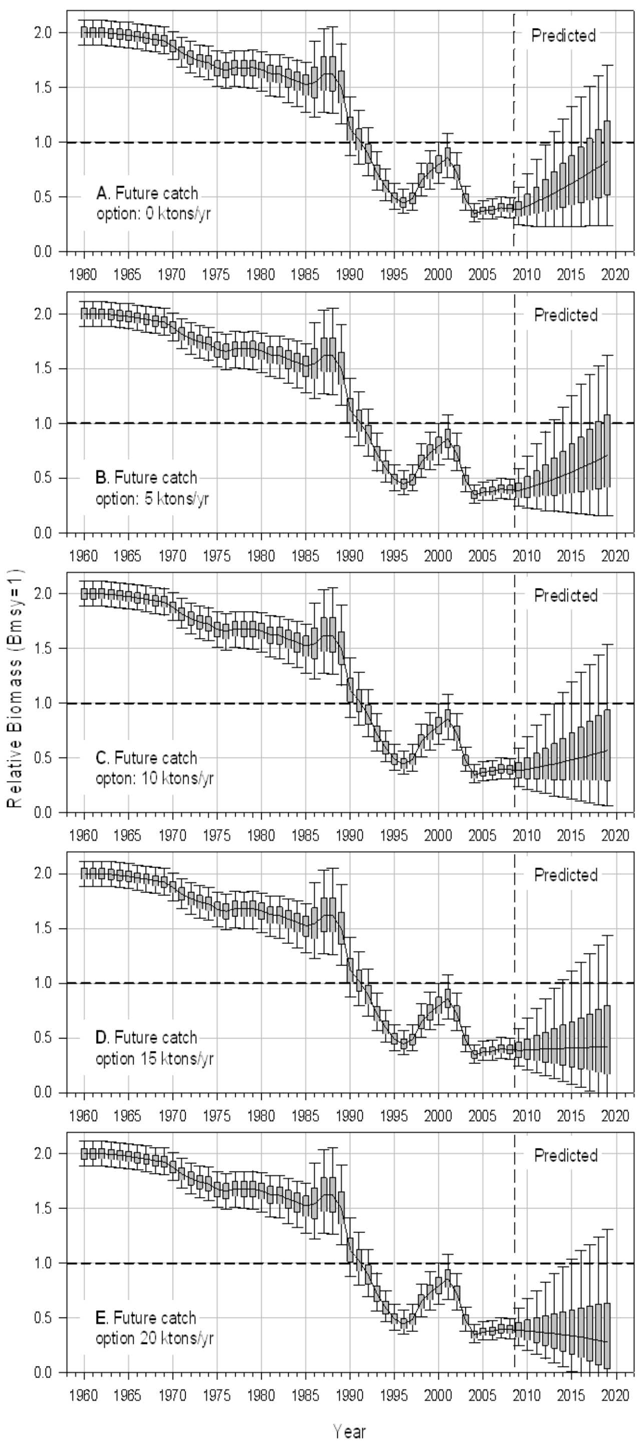


Figure 15.6.5. Estimated time series of relative biomass (B_t/B_{msy}). Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95 per cent of the distribution. The vertical black line marks proposed B_{lim} ($0.3B_{msy}$).

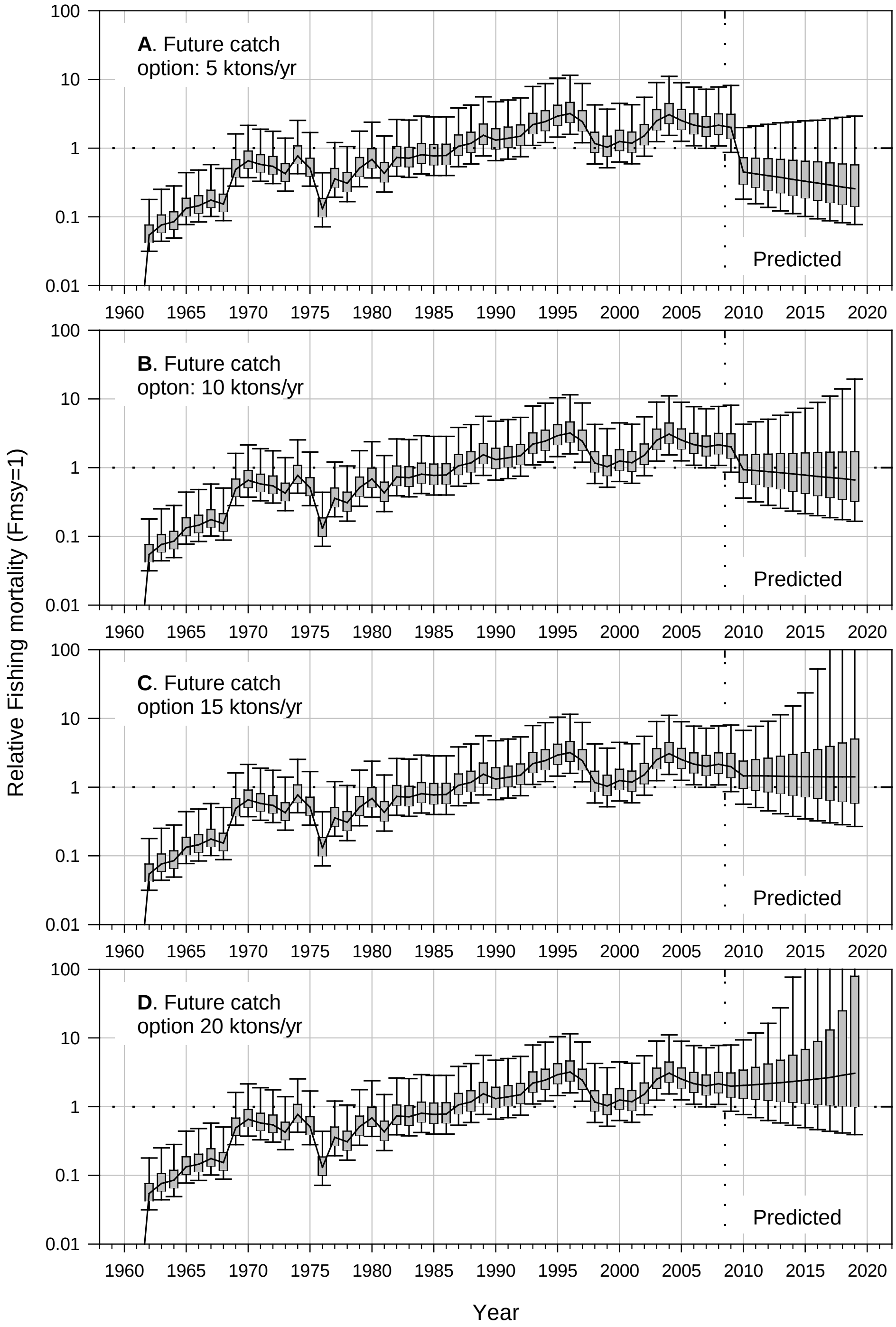


Figure 15.6.6. Estimated time series of relative fishing mortality (F_t/F_{msy}). Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95 per cent of the distribution. The vertical black line marks proposed F_{lim} ($1.7F_{msy}$).

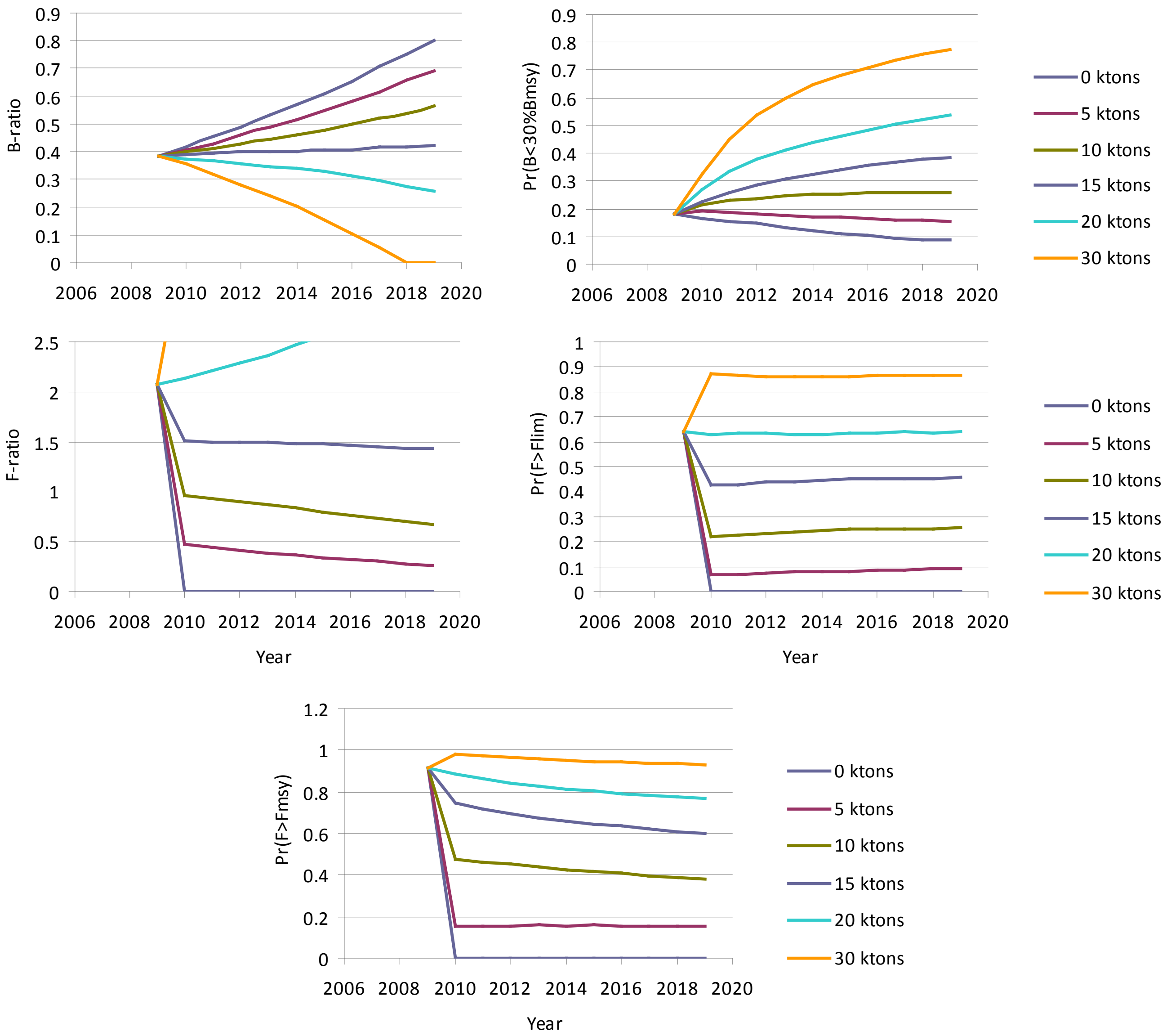


Figure 15.6.7. Projections: Medians of estimated posterior biomass- and fishing mortality ratios; estimated risk of exceeding F_{msy} and F_{lim} (1.7F_{msy}) or going below and B_{lim} given catches at 0, 5,10, 15, 20 and 30 ktons.

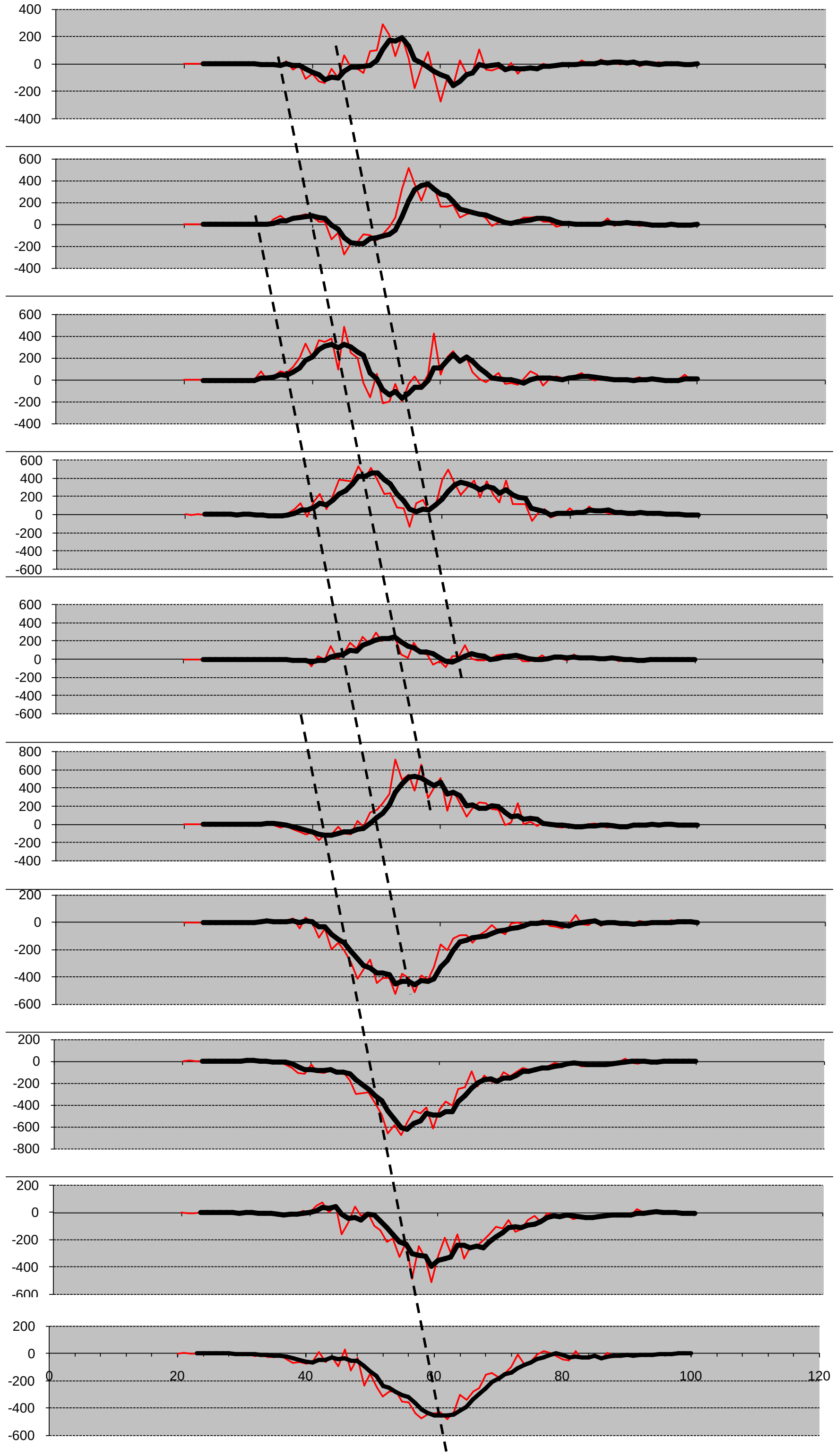


Figure 15.6.8. Length frequencies of GHL from the Icelandic survey 1996 (*top*)-2005(*bottom*) shown as deviations from the mean. Dotted lines indicate traceable recruitment modes consisting of several yearclasses

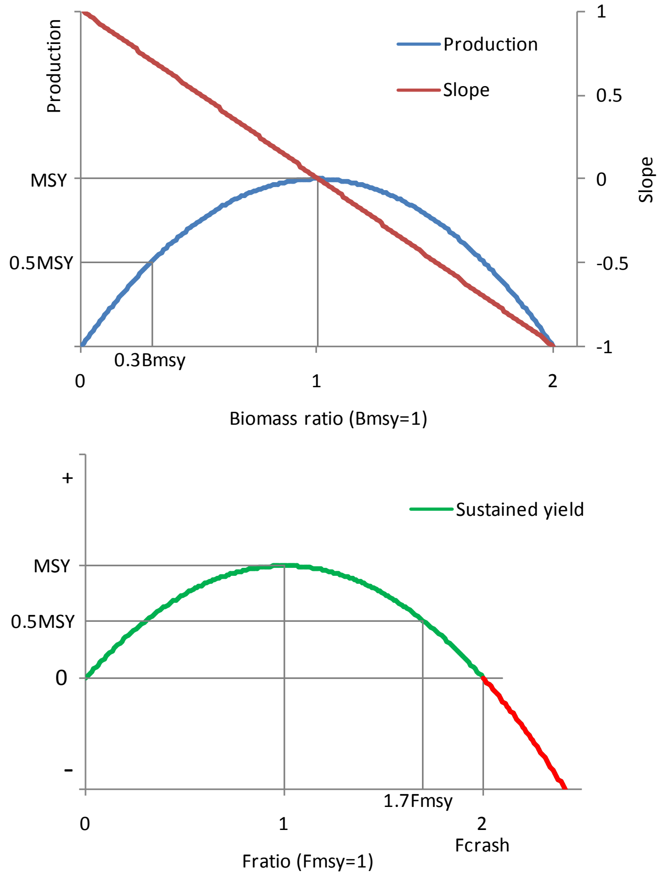


Figure 15.6.9. The logistic production curve in relation to stock biomass (B/Bmsy) (*upper*) and fishing mortality (F/Fmsy) (l*ower*). *Upper*: points of maximum sustainable yield (MSY) and corresponding stock size are shown as well as the slope (red line) of the production curve (blue line); *lower*: points of MSY and corresponding fishing mortality and Fcrash (≥Fcrash do not have st a-ble equilibriums and will drive the stock to zero).

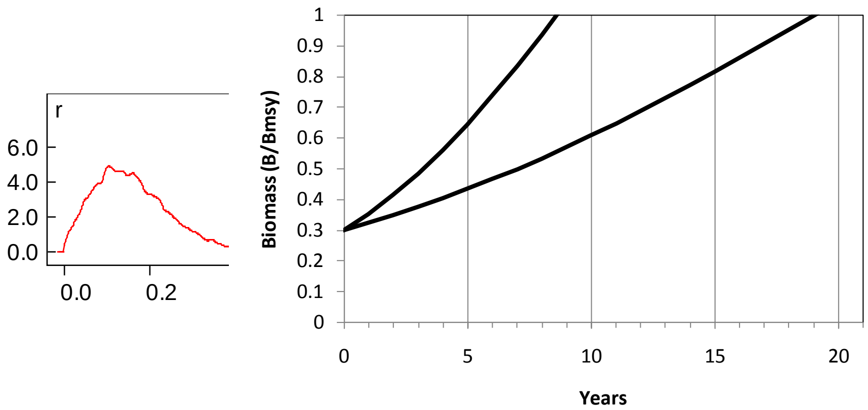


Figure 15.6.10. ***Left*:The posterior probability density distribution of *r*, the intrinsic rate of growth. Right: estimated recovery time from Blim (0.3Bmsy) to Bmsy (relative biomass = 1) given *r*-values ranging within the 95% conf. lim. of the posterior (left figure) and no fishing mortality.**

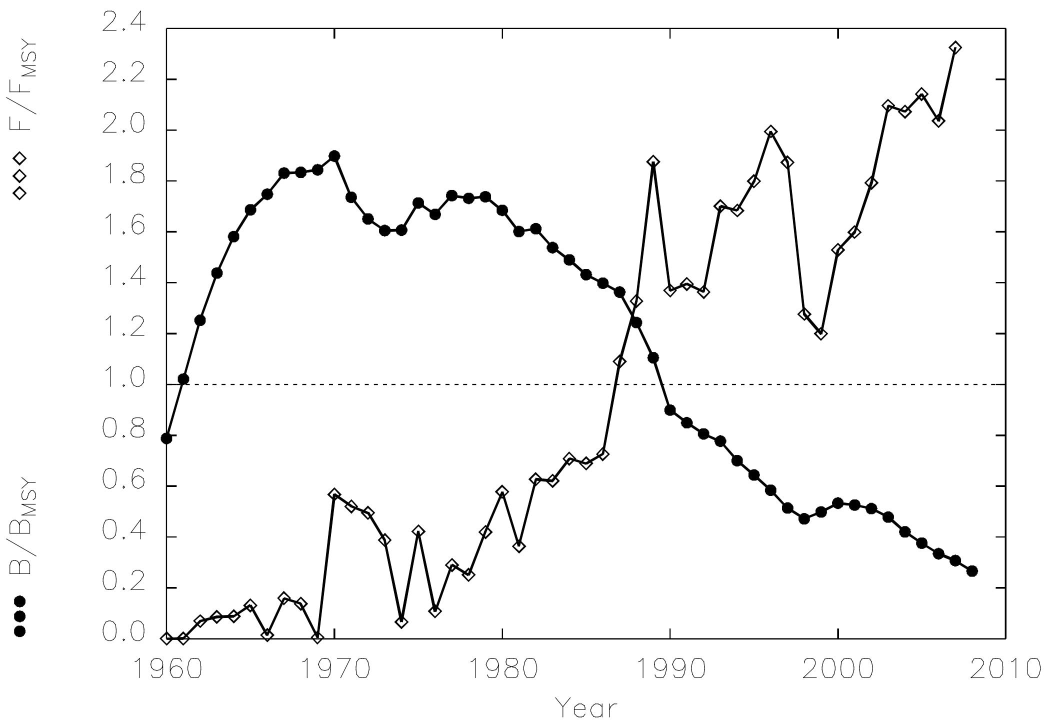


Figure 15.6.11. Relative biomass and fishing mortality from an exploratory ASPIC run with same input series as used in the Bayesian model.

16 Redfish in Subareas V, VI, XII and XIV

This chapter deals with redfish of the genus *Sebastes* in general, therefore the Group provides information on the redfish fisheries in Subarea V, VI, XII and XIV (chapter 16.4), the abundance and distribution of juveniles (chapter 16.2.1), discards and by-catches (chapter 16.5.1).

The "Workshop on Redfish Stock Structure" (WKREDS, 22-23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *Sebastes mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that there are three biological stocks of *S. mentella* in the Irminger Sea and adjacent waters:

- a 'Deep Pelagic' stock (NAFO 1–2, ICES V, XII, XIV >500 m) – primarily pelagic habitats, and includes demersal habitats west of the Faeroe Islands;
- a 'Shallow Pelagic' stock (NAFO 1–2, ICES V, XII, XIV <500 m) – extends to ICES I and II, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;
- an 'Icelandic Slope' stock (ICES Va, XIV) – primarily demersal habitats.

This conclusion is primarily based on genetic information, i.e. microsattellite information, and supported by analysis of allozymes, fatty acids and other biological information on stock structure, such as some parasite patterns.

The East-Greenland shelf is most likely a common nursery area for the three biological stocks.

ICES past advice for *S. mentella* fisheries was provided for two distinct management units, i.e. a demersal unit on the continental shelves and slopes and pelagic unit in the Irminger Sea and adjacent waters. However, based on this new stock identification information, ICES recommends three potential management units that are geographic proxies for biological stocks that were partly defined by depth and whose boundaries are based on spatial pattern of the fishery to minimize mixed stock catches (see Figure 16.1.1):

- Management Unit in the northeast Irminger Sea: ICES Areas Va, XII, and XIV.
- Management Unit in the southwest Irminger Sea: NAFO Areas 1 and 2, ICES areas Vb, XII and XIV.
- Management Unit on the Icelandic slope: ICES Areas Va and XIV, and to the north and east of the boundary proposed in the MU in the northeast Irming Sea.

The pelagic fishery in the Irminger Sea and adjacent waters shows clear distinction between two widely separated grounds fished at different seasons and depths. Spatial analysis of pelagic fishery catch and effort by depth, inside and outside the boundaries proposed for the management units in the northeast Irminger Sea, indicate that the boundaries effectively delineate the pelagic fishery in the northeast Irminger Sea from the pelagic fishery in the southwest Irminger Sea, with a small portion of mixed-stock catches. The northeastern fisheries on the pelagic *S. mentella* occur at the start of the fishing season at depths below 500 m and overlap to some extent with demersal fisheries on the continental slopes of Iceland (Sigurdsson et al., 2006).

A schematic illustration of the relationship between the management units and biological stocks is given in Figure 16.1.2.

For the abovementioned reasons, the Group now provides fishery and survey information for the two pelagic *S. mentella* units in the Irminger Sea and adjacent waters (chapter 19), and a separated advise for the demersal *S. mentella* on the Icelandic slope (chapter 18). Histiorically, the *S. mentella* on the Greenland shelf has been included in the demersal catches. However, this area is not included in the three recommended management units. As an interim measure until the affinity of adult *S. mentella* in this region has been clarified, the catches from this fishery will be accounted separately in this chapter.

The *S. marinus* on the continental shelves of ICES Divisions Va, Vb and Subarea VI and XIV is dealt with in Chapter 17.

16.1 Environmental and ecosystem information

Species of the genus *Sebastes* are common and widely distributed in the North Atlantic. They are found off the coast of Great Britain, along Norway and Spitzbergen, in the Barents Sea, off the Faroe Islands, Iceland, East and West Greenland, and along the east coast of North America from Baffin Island to Cape Cod. All *Sebastes* species are viviparous. The extrusion of the larvae takes place in late winter–late spring/early summer, but copulation occurs in autumn–early winter. Little is known about the copulation areas.

The Group is tasked with evaluating the stock status of redfish in ICES Subarea V, VI, XII, and XIV, including pelagic redfish in NAFO Subarea 1 and 2. Information on the ecosystems around the Faeroe Islands, Iceland and Greenland is given in chapters 2, 7 and 13 respectively.

16.2 Environmental drivers of productivity

16.2.1 Abundance and distribution of 0-group and juvenile redfish

Available data on the distribution of juvenile *S. marinus* indicate that the nursery grounds are located in Icelandic and Greenland waters. No nursery grounds have been found in Faroese waters. Studies indicate that considerable amounts of juvenile *S. marinus* off East Greenland are mixed with juvenile *S. mentella* (Magnússon *et al.* 1988; 1990, ICES CM 1998/G:3). The 1983 Redfish Study Group report (ICES CM 1983/G:3) and Magnússon and Jóhannesson (1997) describe the distribution of 0-group *S. marinus* off East Greenland. The nursery areas for *S. marinus* in Icelandic waters are found all around Iceland, but are mainly located west and north of the island at depths between 50 and 350 m (ICES CM 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As they grow, the juveniles migrate along the north coast towards the most important fishing areas off the west coast.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970–1995. Thereafter, the survey was discontinued. Above average year class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

There are very few juvenile demersal *S. mentella* in Icelandic waters (see chapter 18), and the main nursery area for this species is located off East Greenland (Magnússon et al. 1988, Saborido-Rey et al. 2004). Abundance and biomass indices of redfish smaller than 17 cm from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, show that juveniles were abundant in 1993 and 1995-1998 (Figure 16.2.1). In 2008, the lowest survey index was recorded since 1982. Juvenile redfish were only classified to the genus *Sebastes* spp., as species identification of small specimens is difficult due to very similar morphological features. The 1999-2008 survey results indicate low abundance and are similar to those observed in the late 1980s. Observations on length distributions of *S. mentella* fished deeper than 400 m indicate that a part of the juvenile *S. mentella* on the East Greenland shelf migrates into deeper shelf areas (WD12 of NWWG 2006, WD 03 of NWWG 2007) and into the pelagic zone in the Irminger Sea and adjacent waters (WD12 of NWWG 2006, Stransky 2000), with unknown shares.

16.3 Ecosystem considerations (General)

Information on the ecosystems around the Faroe Islands, Iceland and Greenland is given in chapters 2, 7 and 13.

16.4 Description of fisheries

There are three species of redfish commercially exploited in ICES Subarea V, VI, XII, and XIV, *S. marinus*, *S. mentella* and *S. viviparus*. The last one has only been of a minor commercial value in Icelandic waters and is exploited in two small areas south of Iceland at depths of 150-250 m. The landings of *S. viviparus* decreased from 1160 t in 1997 to 2-9 t in 2003-2006 (Table 16.4.1) due to decreased commercial interest in this species. The landings in 2008 amounted to 15 t, 9 t less than in 2007.

The Group has in the past included the fraction of *S. mentella* that are caught with pelagic trawls above the western, south-western and southern continental slope of Iceland as part of the landing statistics of the demersal *S. mentella*. This practice has been in accordance with Icelandic legislation, where captains are obligated to report their *S. mentella* catch as either "pelagic redfish" or as "demersal redfish" depending in which fishing area they fish. According to this legislation, all catch outside the Icelandic EEZ and west of the 'redfish line' (red line shown in Figure 16.1.1, which is drawn approximately over the 1000-m isoclines within the Icelandic EEZ) shall be reported as pelagic *S. mentella*. All fish caught east of the 'redfish line' shall be reported as demersal *S. mentella*. Most of the catches since 1991 have been taken by bottom trawlers along the shelf west, southwest, and southeast of Iceland at depths between 500 and 800 m. The Group accepts this praxis as pragmatic management measure, but notes that there is no biological information that could support this catch allocation.

As the Review Group in 2005 noted that this issue needed more elaboration, detailed portrayals of the geographical, vertical and seasonal distribution of the demersal *S. mentella* fisheries with different gears are presented here, as done last year (see below). Quantitative information on the fractions of the pelagic catches of demersal *S. mentella* is given in chapter 18. The proportion of the total demersal *S. mentella* catches taken by pelagic trawls has varied since 1991 between 0% and 44% (Table 18.3.2), and was on average 25%. No demersal *S. mentella* was caught by pelagic trawls in 2004-2006 and in 2008. The geographic distribution of the Icelandic fishery for *S. mentella* since 1991 was in general close to the redfish line, off South Iceland, and has expanded into the NAFO Convention Area since 2003 (Figure 16.4.1). The pelagic catches of demersal *S. mentella* were taken in similar areas and depths as the bottom trawl catches (Figure 16.4.2). The vertical and horizontal distribution of the pelagic catches was, however, focusing on smaller areas and depth layers as the bottom trawl catches. The seasonal distribution by depth (Figure 16.4.3) shows that the pelagic catches of demersal *S. mentella* were in general taken during autumn, and only in 2003 and 2007, overlapped with the traditional pelagic fishery during June. The bottom trawl catches of the demersal *S. mentella* were mainly taken in the first quarter of the year and during autumn/winter. The length distributions of the demersal *S. mentella* catches by gear and area are given in Figure 16.4.4. During 1994-1999 and in 2003, the fish taken with pelagic trawls were considerably larger than the fish caught in bottom trawls, and were of similar length during 2000-2002. The fish caught in the north-eastern area were on average about 5 cm larger than those caught in the south-western area.

16.5 Demersal *S. mentella* in Vb, VI, and XIV

16.5.1 Demersal *S. mentella* in Vb

16.5.1.1 Surveys

The Faroese spring and summer surveys in Division Vb are mainly designed for species inhabiting depths down to 500 m and do not cover the vertical distribution of demersal *S. mentella* fully. Therefore, the surveys will not be used in order to evaluate the status of the stock.

16.5.1.2 Fisheries

In Division Vb, landings gradually decreased from 15,000 t in 1986 to about 5,000 t in 2001 (Table 16.5.1). Since then the landings have varied between 1,400 and 4,000 t. The landings in 2008 were only about 750 t which are 700 t less than in 2007 and the lowest since 1978.

Length distributions from the landings in 2001-2008 indicate that the fish caught in Vb are on average larger than the fish caught in Va and are slightly larger than 40 cm (Figure 16.5.1).

Non-standardized CPUE indices in Division Vb were obtained from the Faroese otterboard (OB) trawlers (> 1000 HP) towing deeper than 450 m and where demersal *S. mentella* composed at least 70% of the total catch in each tow. The OB trawlers have in recent years landed about 50% of the total demersal *S. mentella* landings from Vb. CPUE decreased from 500 kg/hour in 1991 to 300 kg/hour in 1993 and remained at that level until 2004 (Figure 16.5.1). In 2005, the CPUE decreased to the lowest level in the time series and has since then been close to the Upa level.

Fishing effort has decreased since the beginning of the time series and was in 2008 the lowest in the time series.

16.5.2 Demersal *S. mentella* in VI

16.5.2.1 Fisheries

In Subarea VI, the annual landings varied between 200 t and 1 100 t in 1978-2000 (Table 16.5.1). The landings from VI in 2004 were negligible (6 t), the lowest recorded since 1978. They increased again to 111 t in 2005 and 179 t in 2006. The reported landings in 2008 were 50 t.

16.5.3 Dermsal *S. mentella* in XIV

16.5.3.1 Surveys

The German survey conducted on the continental shelf of West and East Greenland since 1982 cover nursery grounds in addition to part of the adult distribution (0-400 m). The results indicate that juveniles (<17 cm) were most abundant off East Greenland in the mid 1990's, while a negligible part of juveniles is distributed off West Greenland. In 2008, a record low for juvenile redfish was found. The low abundance of juveniles coincided with a low abundance of younger S. mentella of pre-fishery size (< 30 cm), while since 2004 redfish of fishable size (> 30 cm) has become abundant (Figure 16.5.3*c*).

Survey biomass for *S. mentella* > 30 cm decreased in 2008 after an increase in 2007 (Figure 16.5.3). Figure 16.5.4 shows that the abundance is dominated by a strong year class recorded for the first time in 1997 at a mean length of 22 cm. The juveniles observed at East and West Greenland will probably recruit to some extent to the demersal stock on the shelves of Greenland, Iceland and Faeroe Islands and partly to the pelagic stock as well (Stransky 2000). Juvenile demersal *S. mentella* are not observed in the spring and autumn surveys in Icelandic waters and in the surveys conducted in Faroese waters.

The Greenland halibut survey is a random stratified bottom trawl survey, conducted on the continental shelf and slope of East Greenland 1998-2008 (no survey was conducted in 2001) and covers depths from 400 m down to 1,500 m. Catch rates have been variable with high catch rates in 2007 and 2008 (Figure 16.5.5). The length distributions in 2005-2008 are dominated by 20-25 cm fish.

16.5.3.2 Fisheries

In Subarea XIV, the annual demersal *S. mentella* landings have decreased drastically (Table 16.5.1). In 1980-1994, landings varied between 2,000 and 19,000 t with the lowest landings in 1989 and the highest in 1994. In the following three years, the annual landings were less than 1,000 t and the redfish was mainly caught as bycatch in the shrimp fishery. In 1998, Germany started a directed fishery for redfish with annual landings around 1,000 t in 1998-2001, and landings increased to 1,900 t in 2002. Samples taken from the German fleet indicated that substantial quantities of the redfish caught, especially in 2002, were juveniles, i.e. fish less than 30 cm. There was very little demersal *S. mentella* fishery in XIV 2003-2005 (less than 400 t). Annual landings in 2006-2008 were between 10-20 t.

Non-standardized CPUE data from Division XIV were available from 1998 to 2002 when the German fleet fished for *S. mentella* along the continental slope of East Greenland. CPUE decreased between 1998 and 1999, but increased since then annually. No CPUE and effort data were available from Subarea XIV in 2003-2007, as there was no effort exerted by the German fleet.

16.6 Regulations (TAC, effort control, area closure, mesh size etc.)

Management of redfish differs between stock units and is given in sections 17.14 for *S. marinus*, section 18.7 for demersal *S. mentella* and section 19.10 for pelagic *S. mentella*.

The allocation of Icelandic *S. mentella* catches to the pelagic and demersal management unit has been based on the "redfish line" (see section 16.4).

16.6.1 Discards and by-catches

An offshore shrimp fishery with small meshed trawl (44 mm in the codend) began in the early 1970s off West Greenland. This fishery expanded to East Greenland in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery Licence Control showed that redfish is by-catch in the shrimp fishery off Greenland. Since 1st October 2000, sorting grids with 22 mm bar spacing have been mandatory to reduce the by-catches. New information on the effect of sorting grids was presented in WD 18, showing by-catch rates of redfish in the shrimp fishery of 0.5% by weight in 2006-2007.

In late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the by-catch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a by-catch in the fishery, but also juveniles of other species. Since the large year classes of *S. marinus* disappeared out of the shrimp fishing area in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery.

16.7 Mixed fisheries, capacity and effort

The official statistics reported to ICES do not divide catch by species/stocks, and since the Review Group in 2005 recommended that "multispecies catch tables are not relevant to management of redfish resources", these data are not given here and the best estimates on the landings by species/stock unit are given in the relevant chapters. Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data, especially with respect to pelagic *S. mentella* (see chapter 19.11). Detailed descriptions of the fisheries are given in the respective chapters: *S. marinus* in chapter 17.3, demersal *S. mentella* in chapter 18.3 and pelagic *S. mentella* in chapter 19.3.

Information from various sources is used to split demersal landings into two redfish species, *S. marinus* and *S. mentella* (see WD22 of the NWWG 2006). In Division Va, if no direct information is available on the catches for a given vessel, the landings are allocated based on logbooks and samples from the fishery. According to the proportion of biological samples from each cell (one fourth of ICES statistical square), the unknown catches within that cell are split accordingly and raised to the landings of a given vessel. For other areas, samples from the landings are used as basis for dividing the demersal redfish catches between *S. marinus* and *S. mentella*.

16.8 Special comment by Sergey Melnikov

In the course of the ICES Study Group on Redfish Stock Structure (WKREDS) held on 22-23 January 2009 there was no consensus reached between the participants of that group concerning the development of the scientific advice in accordance with ToRs of that SG. Some experts supported the hypothesis about the occurrence of two biological stocks of *Sebastes mentella* in the pelagic Irminger Sea and adjacent waters and recommended two pelagic management units. Based on recommendations of WKREDS the ICES prepared the response to the special request of the client Commission, NEAFC.

Russian scientists strongly disagreed to that in developing a scientific advice on the management of the Irminger Sea redfish stock in ICES only part of the available scientific evidence was used for decision. As for the response of ICES to NEAFC, the main element to which Russian scientists cannot agree is the identification of two pelagic *S. mentella* stocks in the Irminger Sea on the basis of one study method only, i.e. the genetic method, when all other methods and numerous data on biology, ecology, life cycle, and distribution of this species in the North Atlantic do not support this division. The analysis of the genetic data on which the advice of WKREDS is based indicates that the current approach to *S. mentella* fishery based on single population hypothesis is the most reasonable from the biological point of view. The phenotypical differences found between "oceanic" and "deep-sea" phenotypes are adaptive, putatively dependent on age and it is rather difficult to define clear criteria of discrimination between these two morphotypes. No statistically significant differences were found between the samples from continental slope and deep-sea samples from the Irminger Sea. Thus there is no evidence of separate Icelandic Slope stock existence. As regards the division of the Irminger Sea redfish into two biological stocks and two management units, correspondingly, the scheme suggested by WKREDS is not at least obvious and requires additional investigations and examinations. The mode of collecting samples for microsatellite analysis used in most investigations seems to be incorrect as all the samples from north-eastern part of the Irminger Sea are from depths below 500 m whereas all shallow samples have south-western origin. Any conclusions will be more reliable if there is opportunity to compare samples from the same geographical position and different depths and/or vice versa.

The analysis of Russian non-standardised CPUE for two fishing areas give the grounds to state about synchronization of CPUE decrease since 2004 in the southwest (the NAFO zone) and its rise since 2005 in the northeastern Irminger Sea (the ICES Subarea XIV). The same variations of the non-standardised CPUE by areas have been shown by the data from the international fleet. Revealed relationship in variations of redfish fishing efficiency in the two areas has proved the assumption, which was made before, on forming dense concentrations in the NAFO zone owing to redistribution of concentrations from the conventional area in the Irminger Sea because of the alteration of hydrographic conditions. This spatial redistribution of redfish concentrations is cyclic and depends on strengthening or weakening of the Atlantic water advection by the Irminger Current that, as a result, causes the back shift of concentrations from the NAFO area and the mixing of them with those ones in the Irminger Sea. This is fully corroborated by the stability and reduction in water temperature positive anomalies in the upper layer that has been noticed recently.

According to the data from the international surveys the effect of oceanic processes led to redistribution of the part of concentrations in upper 500 m layer from the open part of the Irminger and Labrador Seas to the 200 mile zone of the Greenland. The alteration in the pattern of the redfish feeding migrations caused earlier periods of the beginning of fishery (two week shift) and its termination (one month shift) in the NAFO area in recent 3 years as compared to the early 2000s.

Fishery pattern has significantly changed also in the northeast of the Irminger Sea. If, in the previous years, redfish fishery started along the both sides of the 200 mile zone in the Icelandic EEZ, at 63ºN, in April, in 2009, in the second half of April, Russian vessels successfully fished the redfish much more southward, at 59ºN. Also, in recent three years, in the northeast of the sea, within the depth range of 400-600 m, the portion of Russian catch increased from 1 to 17% that indicated the redfish redistribution, but already along the vertical. At the same time, this process was obviously connected with the decrease in water temperature in the surface layer, in this area.

Thus, the fishery pattern for *S. mentella* based on singling out two units to manage established in the beginning of the 2000s, at present, has changed significantly in both the northeastern and southwestern areas of fishery by the following basic indications including the alteration of the periods of the beginning and termination of fishery; the spatial redistribution of commercial concentrations of the redfish; the change of redfish catch percentage at different depths. The statement about the distinction of the two areas of redfish pelagic fishery and using the boundaries between them as an efficient measure to single out the two management units (WKREDS Report, 2009) is inconclusive and scientifically groundless, as it ignores the effect of a number of environmental factors on year-to-year dynamics of distribution and fisheries of redfish in the pelagic Irminger Sea and adjacent waters.

Table 16.4.1. Landings of *S. viviparus* in Division Va.

Year	Landings (t)
1996	22
1997	1159
1998	994
1999	498
2000	227
2001	21
2002	20
2003	3
2004	2
2005	4
2006	9
2007	24
2008	15

Table 16.5.1. Nominal landings (tonnes) of demersal *S. mentella* 1978-2008 by ICES Divisions.

	ICES Division			
Year	Vb	VI	XII	XIV
1978	7 767	18	0	5 403
1979	7 869	819	0	5 131
1980	5 119	1 109	0	10 406
1981	4 607	1 008	0	19 391
1982	7 631	626	0	12 140
1983	5 990	396	0	15 207
1984	7 704	609	0	9 126
1985	10 560	247	0	9 376
1986	15 176	242	0	12 138
1987	11 395	478	0	6 407
1988	10 488	590	0	6 065
1989	10 928	424	0	2 284
1990	9 330	348	0	6 097
1991	12 897	273	0	7 057
1992	12 533	134	0	7 022
1993	7 801	346	0	14 828
1994	6 899	642	0	19 305
1995	5 670	536	0	819
1996	5 337	1 048	0	730
1997	4 558	419	0	199
1998	4 089	298	3	1 376
1999	5 294	243	0	865
2000	4 841	885	0	986
2001	4 696	36	0	927
2002	2 552	20	0	1 903
2003	2 114	197	0	376
2004	3 931	6	0	389
2005	1 593	111	0	120
2006	3 421	179	0	12
2007	1 376	1	0	23
2008[1)]	750	50	0	10

[1)] **Provisional**

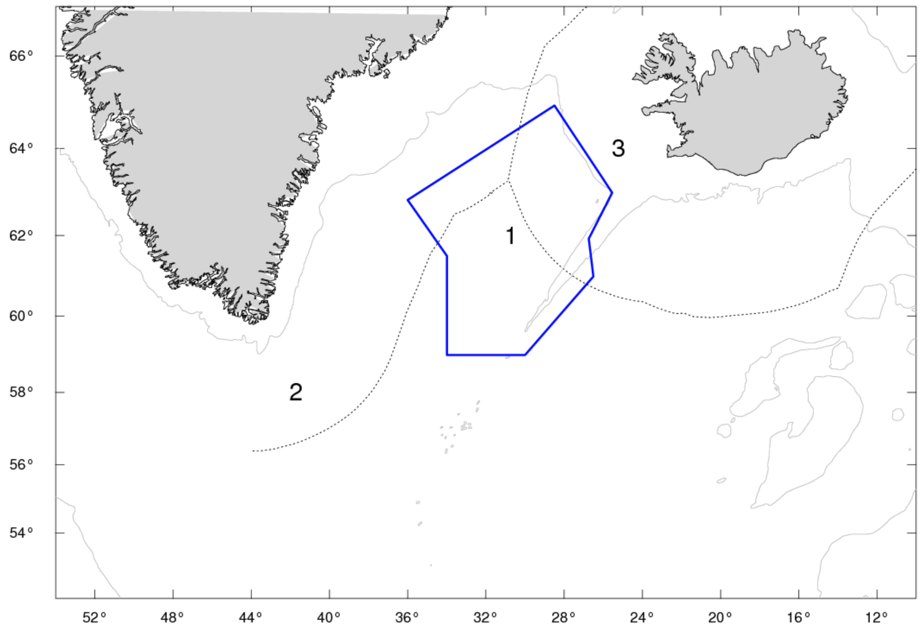


Figure 16.1.1 Potential management unit boundaries. The polygon bounded by blue lines, i.e. 1, indicates the region for the 'deep pelagic' management unit in the northwest Irminger Sea, 2 is the "shallow pelagic" management unit in the southwest Irminger Sea, and 3 is the Icelandic slope management unit.

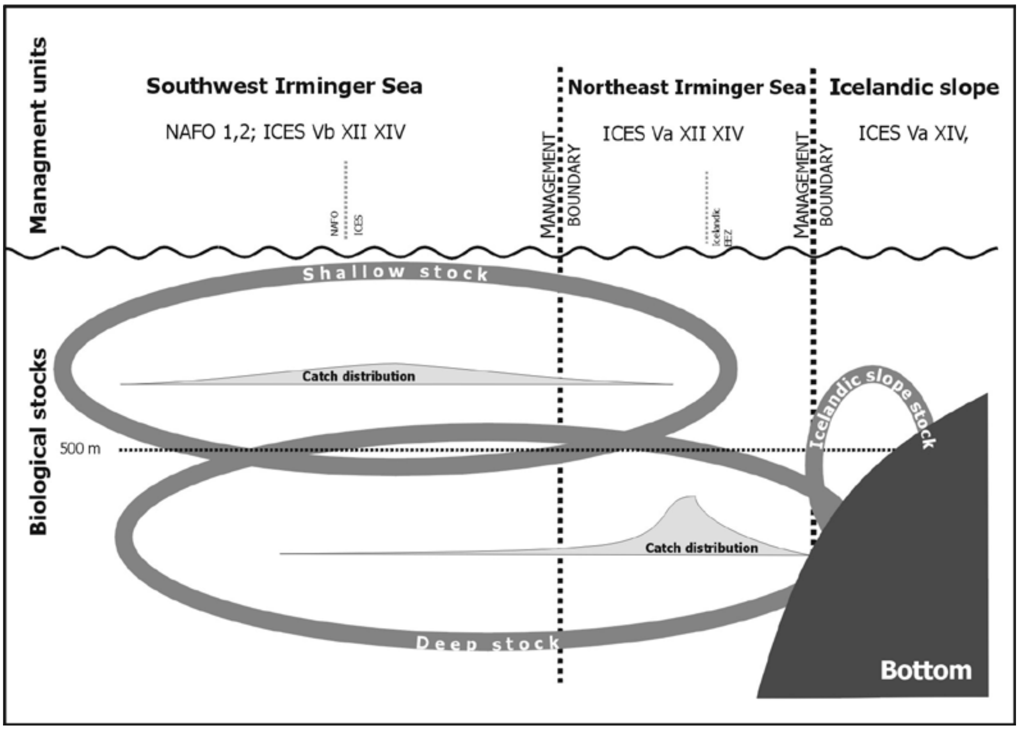


Figure 16.1.2 Schematic representation of biological stocks and potential management units of *S. mentella* in the Irminger Sea and adjacent waters. The the management units are shown in Figure 16.1.1. Included is a schematic representation of the geographical catch distribution in recent years. Note that the shallow pelagic stock includes demersal *S. mentella* east of the Faroe Islands and the deep pelagic stock includes demersal *S. mentella* west of the Faroe Islands.

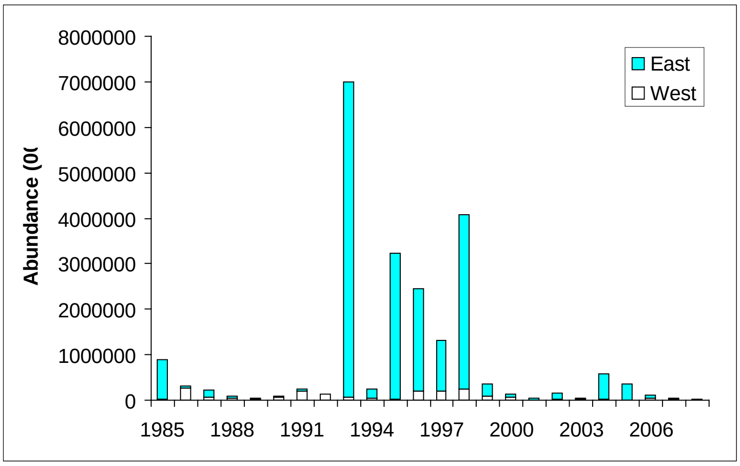


Figure 16.2.1 Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985-2008.

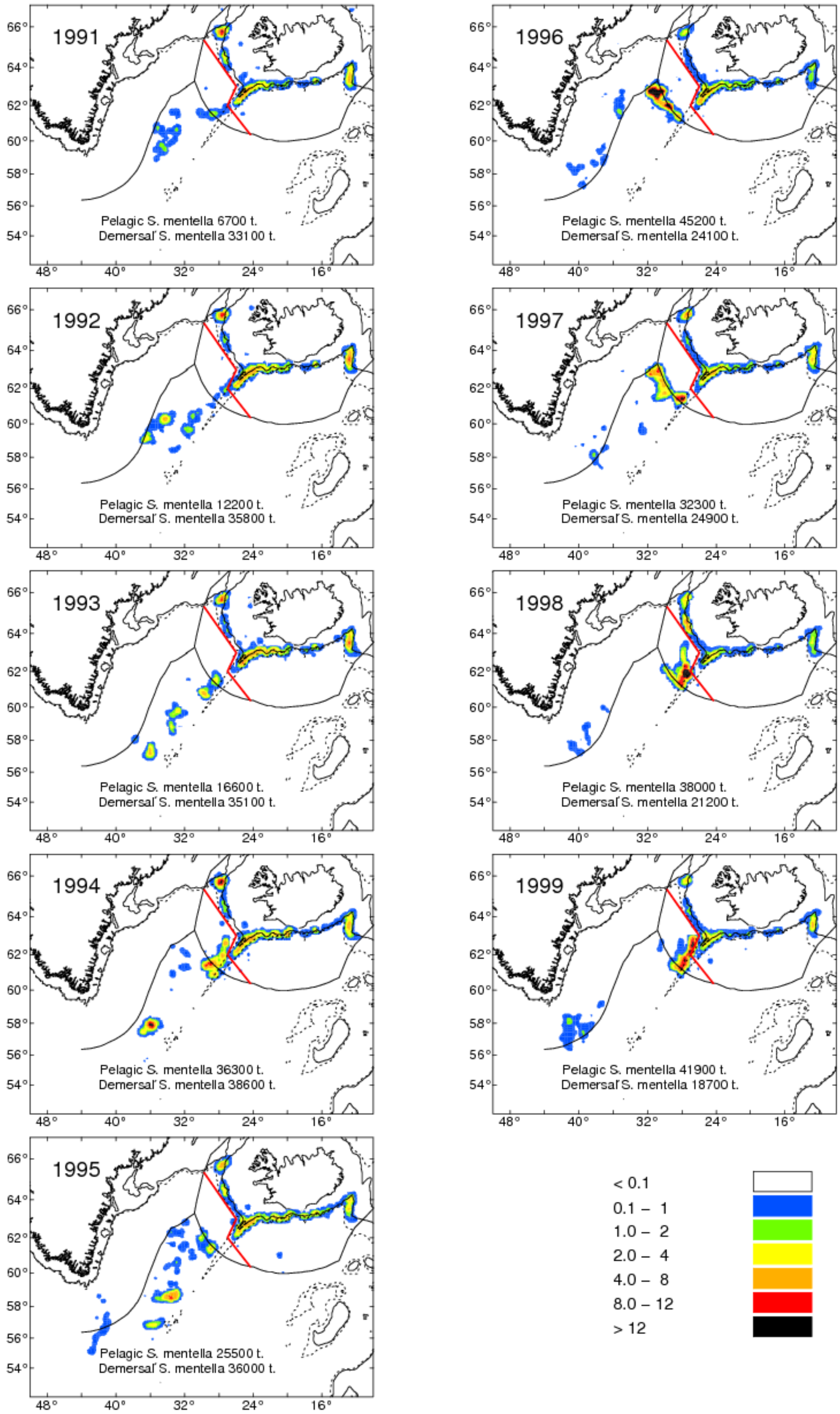


Figure 16.4.1 Geographical distribution of the Icelandic catches of *S. mentella* 1991-1999. The colour scale indicates catches (tonnes per NM²).

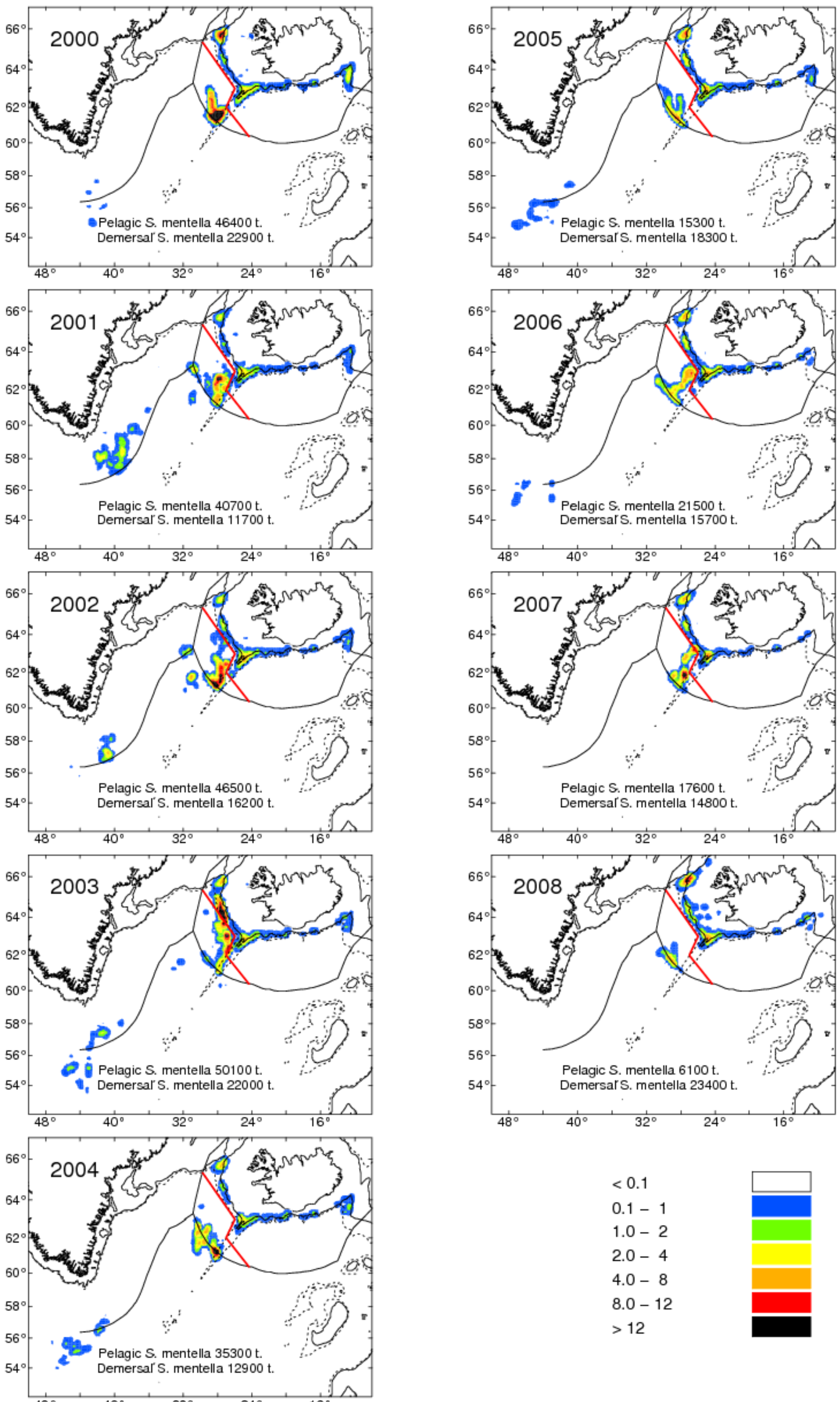


Figure 16.4.1 (Cont'd) Geographical distribution of the Icelandic catches of *S. mentella* 2000-2008. The colour scale indicates catches (tonnes per NM²).

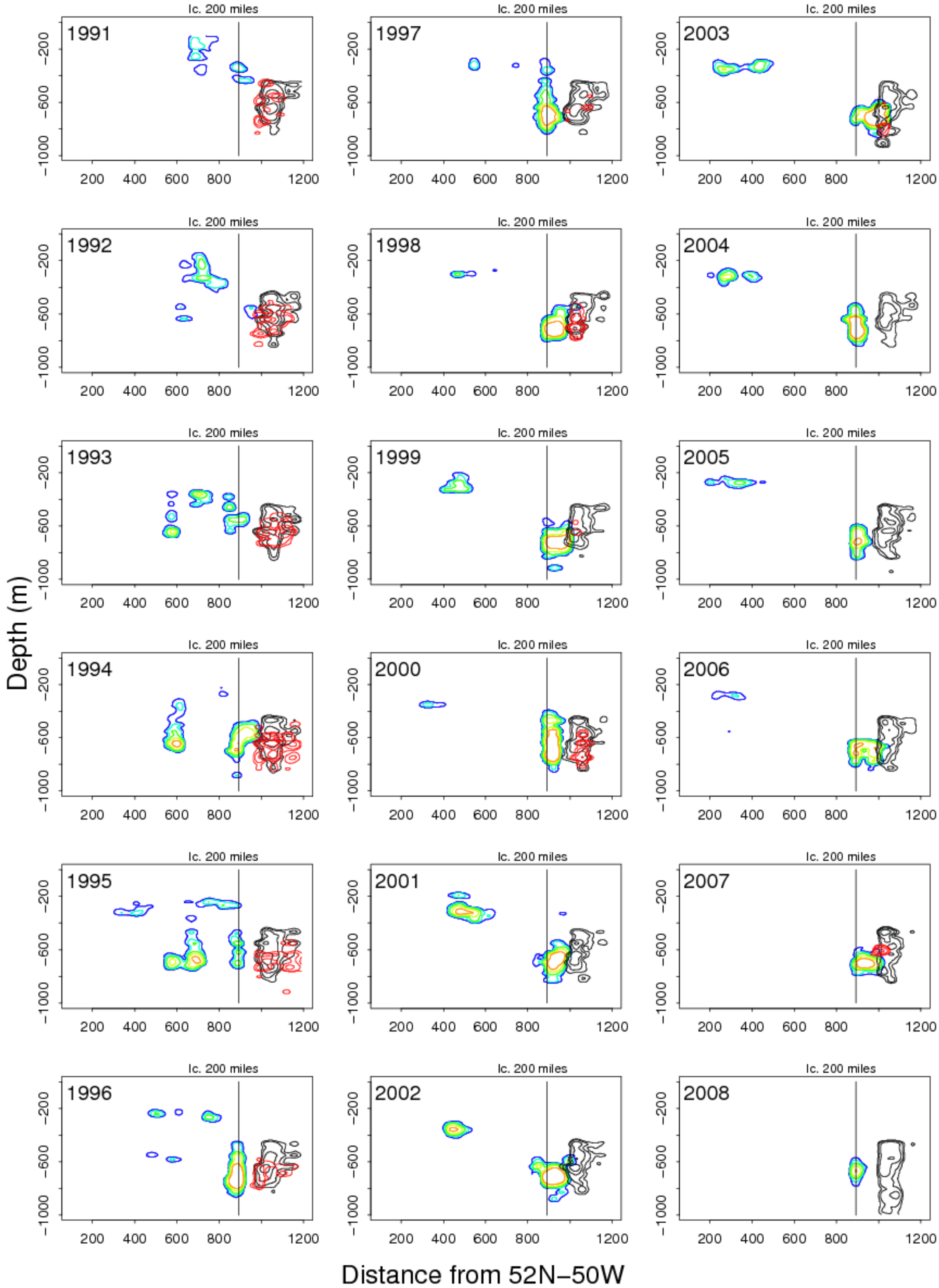


Figure 16.4.2 Distance-depth plot for Icelandic *S. mentella* catches, where distance (in NM) from a fixed position (52°N 50°W) is given. The contour lines indicate catches in a given area and distance. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

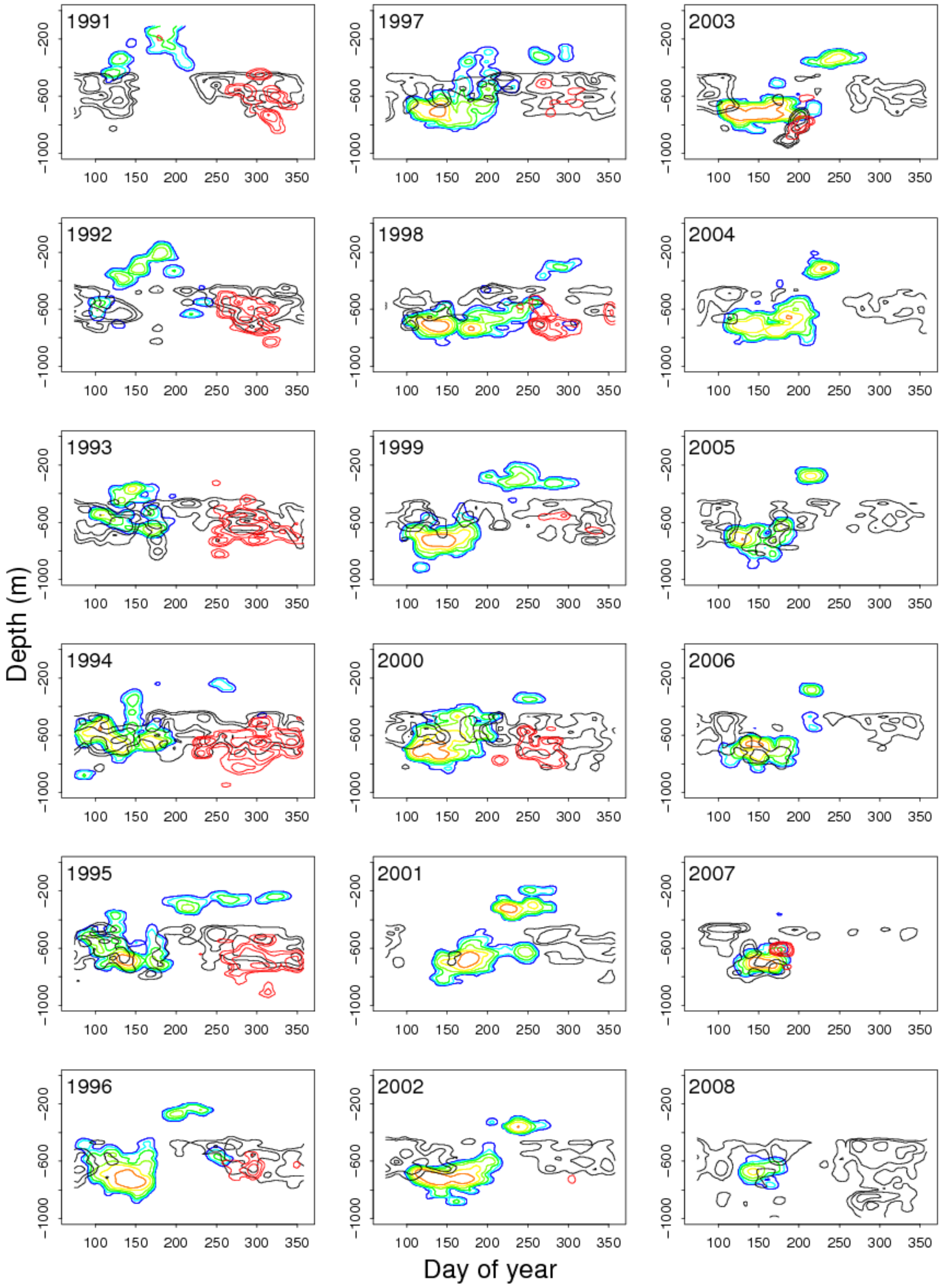


Figure 16.4.3 Depth-time plot for Icelandic *S. mentella* catches, where the y-axis is depth, the x-axis is day of the year and the colour indicates the catches. The coloured contours represent the fishery on pelagic *S. mentella*, the black contours indicate bottom trawl catches of demersal *S. mentella*, and the red contours represent catches of demersal *S. mentella* taken with pelagic trawls.

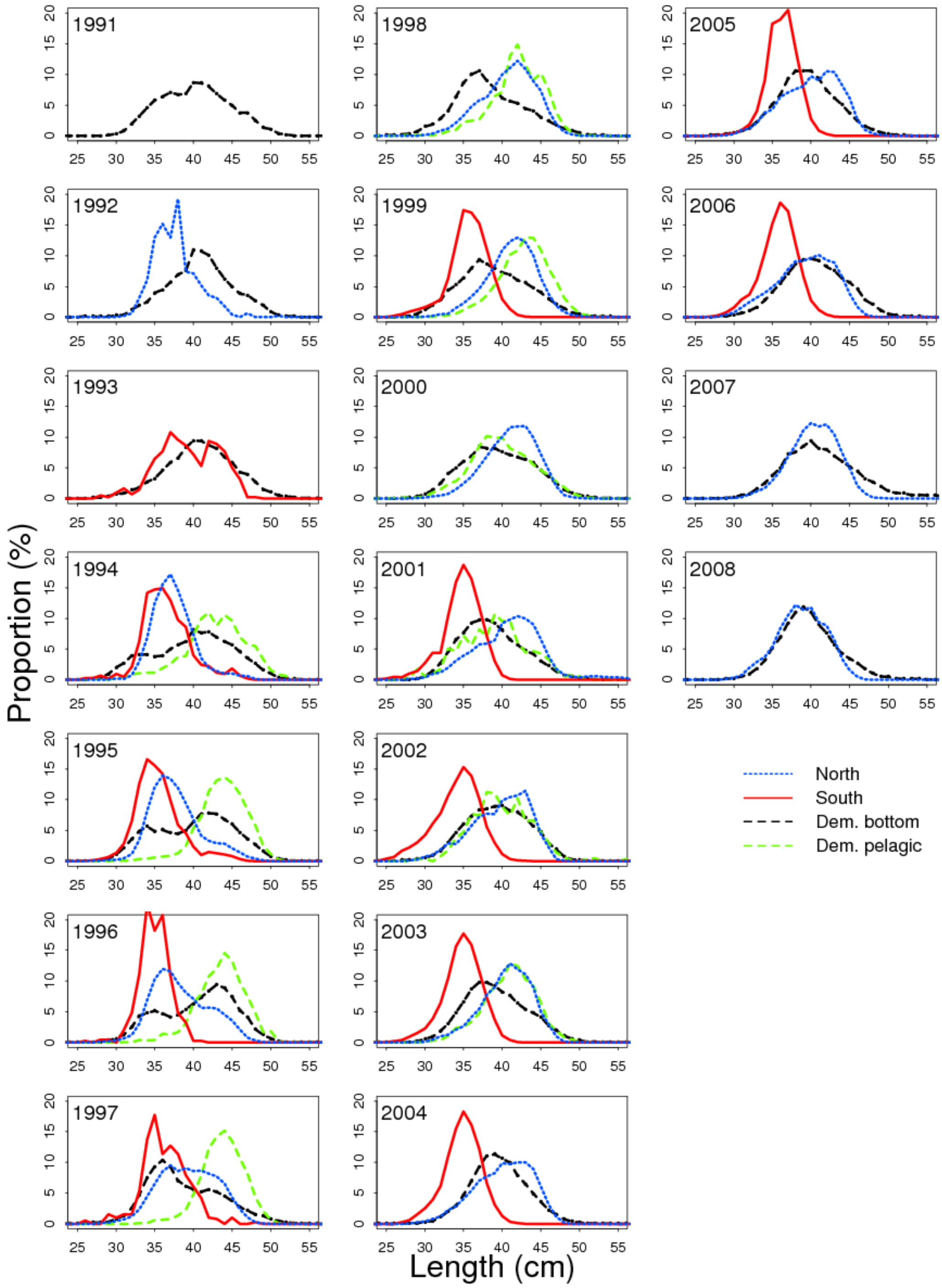


Figure 16.4.4 Length distributions from different Icelandic *S. mentella* fisheries. The blue lines represent the fishery on pelagic *S. mentella* in the northeastern area, the red lines the pelagic fishery in the southwestern area, the black lines indicate bottom trawl catches of demersal *S. mentella*, and the green lines represent catches of demersal *S. mentella* taken with pelagic trawls.

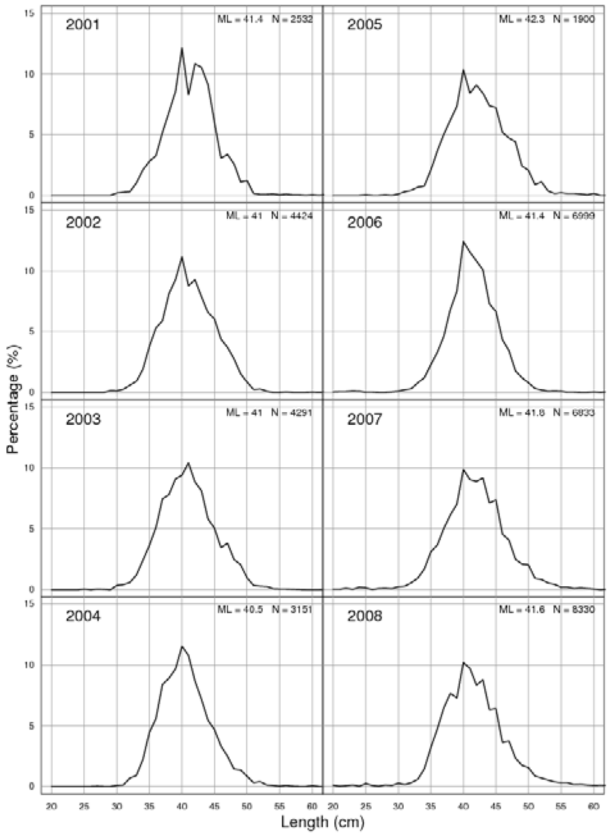


Figure 16.5.1 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2008.

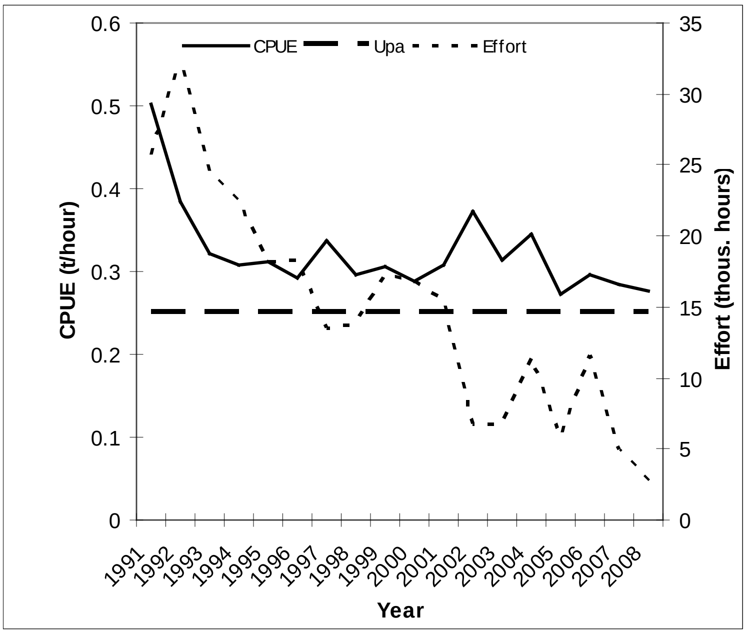


Figure 16.5.2 Demersal S. mentella.. CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991-2008 and where 70% of the total catch was demersal *S. mentella*.

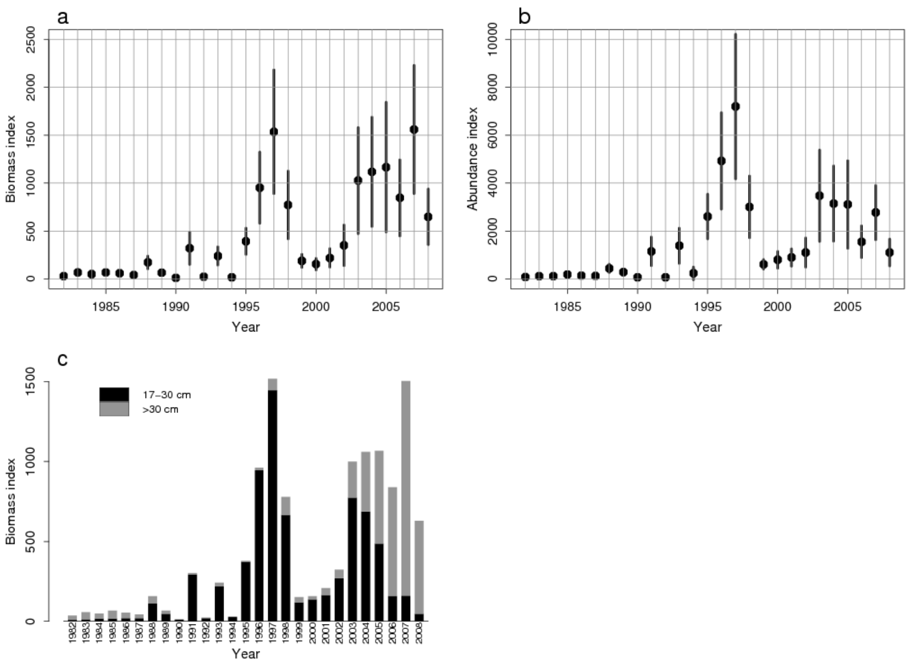


Figure 16.5.3 Demersal *S. mentella* (>=17 cm) survey indices on the continental shelf of East and West Greenland derived from the German groundfish survey 1982–2007. a) Total biomass index, b) total abundance index, c) biomass index divided to size classes (17-30 cm and > 30 cm).

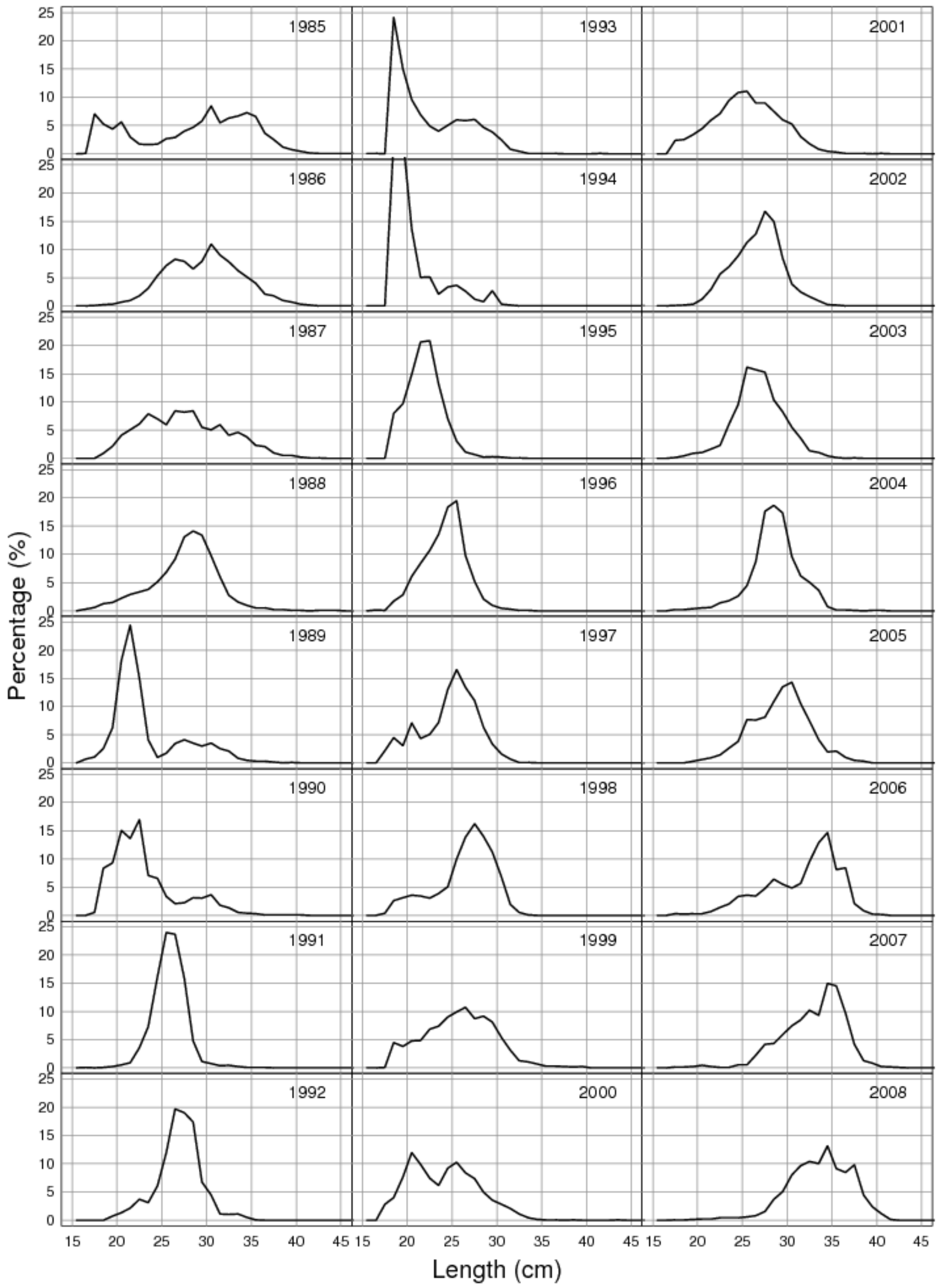


Figure 16.5.4 Demersal *S. mentella* on the continental shelves off East-Greenland. Length composition off Greenland is derived from the German groundfish survey 1985-2008.

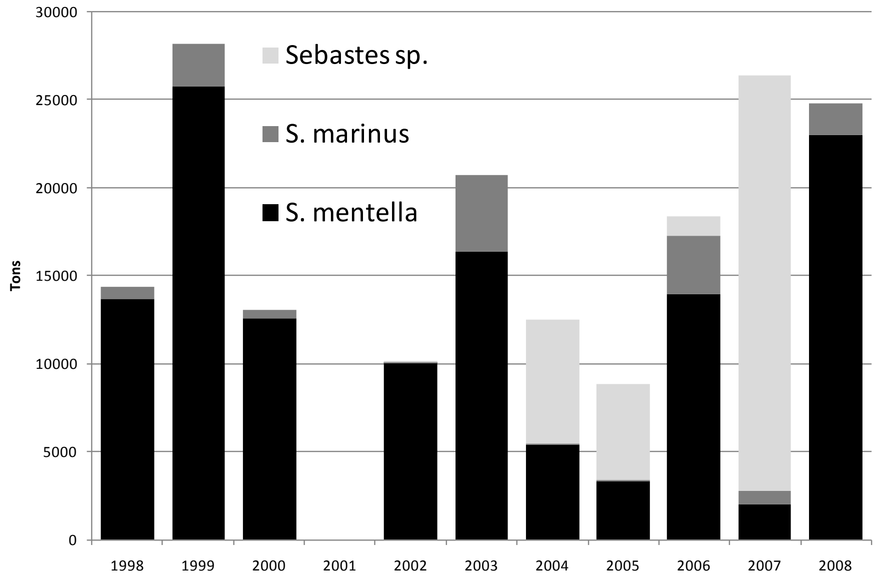


Figure 16.5.5 Biomass of redfish (*Sebastes*) from the Greenland halibut bottom trawl survey of East Greenland (ICES Division XIV). No survey was conducted in 2001. In 2004, 2005 and 2007, a large proportion of the redfish were not determined to species and only reported as "*Sebastes* sp".

17 Golden redfish (*Sebastes marinus*) in Subareas V, VI and XIV

Summary

- Total landings in 2008 were about 45,000 t, about 5,000 t more than in 2007. About 99% of the catches were taken in Division Va.
- The basis for advice and the relative state of the stock is based on projection derived from the analytical GADGET model and survey index series. The GADGET model used only catches and survey indices from Va.
- Catch-at-age data from Va shows that the catch is dominated by two strong year classes from 1985 and 1990. It is expected that the 1990 year class will be important in the catches in the next few years but the 1985 year class is disappearing.
- Survey indices of the fishable stock in Va decreased in recent years but increased in 2008 and was in the vicinity of safe biological limits (Bpa). The fishable stock situation in Vb remains at low level, but has improved in XIV.
- Recruitment in Va has been low since 1993 compared to the big 1985- and 1990 year classes, but there is an indication of improving new year classes observed as 9-11 years old fish in the October survey in 2008. There are signs of improved recruitment in XIV as well.
- The GADGET model predicts that catches in Va below 30 000 t would provide a fishable stock size above current biomass level for the next 5 year.

17.1 Stock description and management units

Golden redfish (*Sebastes marinus*) in ICES Subareas V and XIV have been considered as one management unit.

Catches in VI have traditionally been included in this report and the Group continues to do so.

17.2 Scientific data

This chapter describes results from various surveys conducted annually on the continental shelves and slopes of Subareas V and XIV.

17.2.1 Division Va

Figure 17.2.1 shows the total biomass index from the Icelandic spring and autumn groundfish surveys with ±1 standard deviation in the estimate (68% confidence interval). The figure shows a large measurement error in some years in both the March and October surveys, which is caused by relatively few tows accounting for a large part of the total amount of fish caught. This is also reflected in rapid changes of the indices from one year to another.

To get a more stable index, the index of fishable biomass was calculated from the March survey for the area from 0–400 m depth and based on a selection curve (Figure 17.2.2) rising sharply from 34-36 cm (L_{50} = 35 cm). The survey extends down to 500 m depth but the stations between 400 and 500 m are few and show the largest CV´s. Figure 17.2.3 shows this index of fishable biomass. The index indicates a decrease in the fishable biomass from 1985-1995, and an increasing trend since then. The lowest index was in 1995, only about 30% of the maximum in 1987. The values in 2004-2008 have on average been at 60% of the highest observed value. The index of the fishable biomass decreased gradually from 2003 to 2008 but increased again in 2009 to 2% below the Upa level (Figure 17.2.3). In comparison the total biomass index in both surveys has shown great variability, especially in recent years, without any clear trend (Figure 17.2.3). It is difficult to use such indices that are driven by few but large hauls, to interpret trends in stock size. The total indices were used in the GADGET model (see below).

The estimate of the fishable biomass can be used as a proxy for the SSB. Figure 17.2.4 shows the proportion of mature *S. marinus* in the commercial catches 1995-2004 as a function of length. The estimated length at which 50% fish became mature (L_{50}) was estimated 33.2 cm, which is about 2 cm lower than the L_{50} of the selection pattern.

Length distributions from the Icelandic groundfish surveys show that the peaks, which can be seen first in 1987 and then in 1991-1992, reached the fishable stock approximately 10 years later (Figure 17.2.5). The increase in the survey index since 1995, therefore, reflects the recruitment of a relatively strong year classes (1985-year class and then the 1990-year class). This has been confirmed by age readings (Figure 17.2.6). There is an indication of considerable recruitment (fish less than 12 cm) observed in both groundfish surveys in 1998-2000 (Figure 17.2.1*d*) and can be seen as 8-10 years old fish in the 2006 autumn survey (Figure 17.2.6). This recruitment is, however, not as large as observed in the 1987 and 1992 March surveys. A large amount of fish between 25 and 30 cm was observed in the 2005 survey, but not observed previously as smaller fish or in the 2006 survey. This could therefore be recruiting fish coming from East Greenland (Figures 17.2.8 and 17.2.9).

17.2.2 Division Vb

In Division Vb, CPUE of *S. marinus* were available from the Faeroes spring groundfish survey from 1994-2009 and the summer survey 1996-2008. Both surveys show similar trends in the indices from 1998 onwards with a sharp declines between 1998-1999 (Figure 17.2.7). After an increase in the mid 1990s, CPUE decreased drastically. CPUE in the spring survey has since 2000 been stable at low level whereas CPUE in the summer survey has gradually decreased to the lowest recorded level in 2008.

17.2.3 Subarea XIV – not updated

Relative abundance and biomass indices from the German groundfish survey from 1982 to 2008 for *S. marinus* (fish >17 cm) are illustrated in Figures 17.2.8. After a severe depletion of the *S. marinus* stock on the traditional fishing grounds around East Greenland in the early 1990's, the survey estimates showed a significant increase in both abundance and biomass with a maximum in 2007. The survey index decreased considerable in 2008 even if it is the second highest value observed in the time series. It should be noted that the CV for the indices are high and the increase is driven by few very large hauls. During the recent period of increase, both the fishable biomass (> 30 cm) and the biomass of pre-fishery recruits (17-30 cm) has increased considerable (Figures 17.2.8*c* and 17.2.9).

17.3 Information from the fishing industry

17.3.1 Landings

Total landings gradually decreased by more than 70% from about 130,000 t in 1982 to about 43,000 t in 1994 (Table 17.3.1 and Figure 17.3.1). Since then, the total annual landings have varied between 33,500 and 51,000 t. The total landings in 2008 were 45,000 t, which was 5,000 t higher than in 2007. The majority of the golden redfish catch is taken in ICES Division Va and in recent years contributes to about 98% of the total landings.

Landings of golden redfish of the main fishing ground in Division Va declined from about 98,000 t in 1982 to 39,000 t in 1994 (Table 17.3.1). Since then, landings have varied between 32,000 and 49,000 t. The landings in 2008 were about 44,300 t, about 5 000 t more than in 2007. Between 90-95% of the golden redfish catch is taken by bottom trawlers targeting redfish (both fresh fish and factory trawlers; vessel length 48-65 m). The remaining catches are partly caught as by-catch in gillnet and long-line fishery. In 2008, as in previous years, most of the catches were taken along the shelf W, SW, and SE of Iceland, mostly between 12°W and 27°W (Figure 17.3.2).

In Division Vb, landings dropped gradually from 1985 to 1999 from 9,000 t to 1,500 t and varied between 1,500 and 2,500 t from 1999-2005 (Table 17.3.1). In 2006-2008 annual landings were less than 1,000 t which has not been observed before in the time series. The majority of the golden redfish caught in Division Vb is taken by pair and single trawlers (vessels larger than 1000 HP).

Annual landings from Subarea VI increased from 1978 to 1987 followed by a gradual decrease to 1992 (Table 17.3.1). In the 1995-2004 period, annual landings have ranged between 400 and 800 t, but decreased to 137 t in 2005. No landings of golden redfish were reported from Subarea VI in 2006 and 2007 but were 64 t in 2008.

Annual landings from Subarea XIV have been more variable than in the other areas (Table 17.3.1). After the landings reached a record high of 31,000 t in 1982, the golden redfish fishery drastically reduced within the next three years (the landings from XIV were about 2,000 t in 1985). During the period 1985-1994, the annual landings from Subarea XIV varied between 600 and 4,200 t, but since 1995, there has been little or no direct fishery for golden redfish. In recent years, landings have been 200 t or less and are mainly taken as by-catch in the shrimp fishery. With the opening of the cod fishery off East Greenland in 2007, it is expected that by-catches of golden redfish will increase in Subarea XIV.

17.3.2 Discard

Although no direct measurements are available on discards, it is believed that there are no significant discards of golden redfish in the Icelandic redfish fishery due to area closures of important nursery grounds west off Iceland. Discard of redfish in bottom trawl fisheries directed towards other species are considered negligible (Palsson et al 2008).

Discard of redfish species in the shrimp fishery is described in Chapter 16 as the redfish is not split into species.

17.3.3 Biological data from the commercial fishery

The table below shows the fishery related sampling by gear type and Divisions in 2008. No sampling of the commercial catch from sub-divisions VI and XIV was carried out.

Area	Nation	Gear	Landings	Samples	No. length measured	No. Age read
Va	Iceland	Bottom trawl	44.308	326	49.834	1.675
Vb	Faeroe	Bottom trawl and gillnets	470	72	2687	

17.3.4 Landings by length and age

The length distributions from the Icelandic commercial trawler fleet in 1989-2008 show that the majority of the fish caught is between 30 and 45 cm (Figure 17.3.3). The modes of the length distributions range between 35-37 cm.

Catch-at-age data from the Icelandic fishery in Division Va shows that the 1985-year class dominated the catches from 1995-2002 (Figure 17.3.4 and Table 17.3.2) and in 2002 this year class still contributed to about 25% of the total catch in weight. The strong 1990-year class dominated the catch in 2003-2007 contributing between 25-30% of the total catch in weight. This year class contributed about 18% of the total catch in 2008 and the 1985-year class about 9%. The 1996-1998 year classes contributed in total about 30% of the total catch in 2008.

The average total mortality (Z), estimated from the 11-year series of catch-at-age data (Figure 17.3.5) is about 0.23 for age groups 15+, and about 0.20 for age groups 20+.

Length distribution from the Faeroes commercial catches for 2001-2008 indicates that the fish caught are on average larger than 40 cm with modes between 40 cm and 45 cm (Figure 17.3.6).

No length data from the catches have been available for several years in Subareas XIV and VI.

17.3.5 CPUE

Data used to estimate CPUE for golden redfish in Division Va 1986-2008 were obtained from log-books of the Icelandic bottom trawl fleet. Only hauls taken above 450 m depth and comprising of at least 50% golden redfish were assumed to be the direct fishery. Non-standardized CPUE for each year (y) was calculated and used to derive total fishing effort for each year (Ey) according to:

$E_y = Y_y / CPUE_y$,

were Y is the total reported landings (Table 17.3.1).

CPUE indices were also estimated from this data set using a GLM multiplicative model (generalized linear models). This model takes into account changes in vessels over time, area (ICES statistical square), month and year effects. The outcome of the model run is given in Table 17.3.3 and the model residuals in Figure 17.3.8.

The CPUE index increased considerably in 2001 after being at low level 1993-1999 and was until 2006 high but stable (Figure 17.3.7). In 2006, the CPUE index decreased by 12% compared to the previous year but increased again in 2007 and 2008. The unstandardized CPUE index was in 2008 the highest in the time series. Effort towards golden redfish gradually decreased from 1986 until 2004, increased in 2005 and 2006, but has decreased again (Figure 17.3.7).

Un-standardized CPUE of the Faroese otterboard (OB) trawlers 1991-2008 gradually declined to a record low in 1997 and increased till 2004 being about 80% of the 1991 value. CPUE has decreased again over the most recent years (Figure 17.3.9). OB trawlers conduct a mixed fishery and direct their fishery to some extent towards golden redfish. Un-standardised CPUE from the Faeroese CUBA pair-trawler fleet, where golden redfish is mainly caught as by-catch in the saithe fishery, has been fairly stable since 1991 (Figure 17.3.9). Effort has in recent years fluctuated both for the CUBA and OB trawlers.

17.4 Methods

The BORMICON (**BOR**eal **M**igration and **CON**sumption model) has been used for assessment of *S.marinus* stock in Va since 1999 (Björnsson and Sigurdsson 2003). Since then the model has been developed further and is now referred as Gadget (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see www.hafro.is/gadget). The main settings and structure of the Gadget model for red-fish are similar to what has been used in the BORMICON model (Björnsson and Sigurdsson (2003).

The Gadget model is an age-length based cohort model, where all the selection curves depend on the length of the fish and information on age is not a prerequisite but can be utilized if available. The commercial catch is modelled as one fleet with a fixed selection pattern described by a logistic function and total catch in tonnes specified for each time period.

Data used for tuning are:

- Length disaggregated survey indices (2 cm length increments, 4 cm for 5-8 cm fish) from the Icelandic groundfish survey in March 1985-2008.
- Length distribution from the Icelandic commercial catch since 1970. The sampling effort was though relatively limited until the 1990's.
- Landings data by 6 month period.
- Age-length keys and mean length at age from the Icelandic groundfish survey in October 1996-2008.
- Age-length keys and mean length at age from the Icelandic commercial catch 1995-2008.

The simulation period is from 1970 to 2015 using data until 2009 for estimation. Two time steps are used each year. Natural mortality is set to 0.20 for the youngest age, decreasing gradually to 0.05 for age 5 and older. The ages used were 1 to 30 years, where the oldest age is treated as a plus group (fish 30 years and older). Recruitment was set at age 1. Length at recruitment was estimated separately prior to and after 1989.

Estimated parameters are:

- Number of fishes when the simulation starts (8 parameters).
- Recruitment each year (32 parameters).
- Length at recruitment (2 parameters).
- Parameters in the growth equation; (2 parameters).
- Parameter β of the beta-binomial distribution controlling the spread of the length distribution.
- Selection pattern of the commercial fleet (2 parameters).

Five alternative settings of the Gadget model were run this year. The settings of the base case will not be described in detail, only how the alternatives differ from the base case. The alternatives differ from the base case as follows:

- Alternative 1. Power curve in the relationship between number in stock and abundance index for 10 cm and smaller fish.
- Alternative 2. Much more weight was set on age length keys.
- Alternative 3. No age data.
- Alternative 4. Tows from the March survey that had catches larger than 2000 kg were set to 2000 kg.

17.4.1 Results

Estimated model parameters were used in simulations to determine the value of $\mathbf{F_{max}}$ and $\mathbf{F_{0.1}}$. A year class was started in 1970 and caught using fixed fishing mortality and the estimated selection pattern. The simulation was done for 45 years. The total yield from the year class was then calculated as function of fishing mortality. The results gave $\mathbf{F_{max}}$=0.15, $\mathbf{F_{0.1}}$=0.09 and maximum yield was estimated to be 225 g/recruit (1 year) (Figure 17.4.1). Maximum yield was estimated by the BORMICON model in 2000 giving 250 g/recruit. The reason for reduction is not clear but most of the aging data available are sampled after 2000 and the estimated selection pattern assumed fixed in the model has changed since then. Here, F is not fishing mortality, but close to it when small time steps are used, or when mortality is small. It is also the mortality of a fish where the selection is 1. The estimated values of $\mathbf{F_{max}}$ and $\mathbf{F_{0.1}}$ are more conservative than corresponding estimates from catch at age models and $\mathbf{F}_{max}$ could be a candidate for $\mathbf{F_{target}}$.

Figure 17.4.2 shows estimated recruitment, selection pattern, the mean length at age and harvestable and total biomass from the model. The figure indicates that the 1985 and 1990 year classes are the most abundant in the series.

Figure 17.4.3 shows development of the harvestable biomass (biomass multiplied by the selection pattern) for different catch options after 2009. The results indicate that landings in excess of 30,000 tonnes will lead to substantial reduction of the stock in coming years.

Figure 17.4.4 shows residuals from the model fit to the survey data, demonstrating substantial negative blocks in small fish for some of the small year classes. This could mean that recruitment is partly coming from other areas. Also observed are positive blocks around 30 cm in recent years that might be caused by measurement errors, but CV is quite high in recent years. Those positive blocks in recent years could also be caused by year classes that did not show up in the survey when they were small. That leads back to the earlier mentioned problem that the survey might not cover the nursery area of the stock. Part of the explanation for the positive blocks could also be the lack of 40 cm and larger redfish in recent years but high abundance of 30-38 cm fish 5-6 years ago should have contributed to that part of the stock.

Figure 17.4.5 shows survey indices vs. number in stock. There are some indications of nonlinear relationship for the smallest length groups but for the intermediate length groups (13-24 cm) the fit is reasonable and the relationship is linear. The same applies to the largest redfish, (45+) where the fit is good. The dynamic range of the data is quite large for this part of the stock seems is severely depleted. For the intermediate fish (27-38 cm) the range of stock size is relatively small and the noise in the data substantial but those are the length groups responsible for the large redfish hauls that are so common in the groundfish survey. These are also the sizes accounting for a large part of the stock biomass.

Figure 17.4.6 shows the observed and modelled survey biomass indices. From this figure the model does not seems to follow the observed pattern, especially in recent years.

17.5 Reference points

The biological reference points are given in Table 17.5.1.

As described earlier F_{max} and $F_{0.1}$ were calculated by following one year class of million fishes for 45 years through the fisheries calculating total yield from the year class as function of fishing mortality of fully recruited fish. From the plot of yield vs. fishing mortality F_{max} and $F_{0.1}$ were estimated. In the model, the selection of the fisheries is length based so only the largest individuals of recruiting year classes are caught reducing mean weight of the survivors, more as fishing mortality is increased. This is to be contrasted with age based yield per recruit where the same weights at age are assumed in the landings independent of the fishing mortality even when the catch weights are much higher as the mean weight in the stock. Those effects can be seen in Figure 17.4.1.

The group was asked for suggestions for reference points based on the Gadget model. As length of the data series is short compared to the live span of the fish all considerations about SSB-Recruitment or recruitment pattern are impossible. There are though indications that recruitment is uneven and that long period between good year classes should lead to more careful harvesting of the stock. The only reference points that are possible to get from the gadget run is the lowest value of SSB or SSB in 1990 when the last good year class was generated, the former as B_{lim} and the latter as B_{pa}. Reference points should not be taken at face value but rather defined in a relative sense. This precaution is taken as the level of the stock can change in future runs as the model is now based on 25 years of survey data and the year class seen in the 2nd March survey is still abundant in the fishery. The biological reference points based on the Gadget model were, however, not fully evaluated by the Group

Looking at possible ways to formulate advice the model indicates that catches around 30,000 t in the next 5 years will keep the SSB similar. However, because of relatively poorer recruitment than in 1985 and 1990, the total biomass is expected to decrease at this catch level.

Golden redfish is mainly caught in Division Va, and the relative state of the stock can be assessed through survey index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max} /5$ and $U_{pa} = 60\%$ of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been close but below U_{pa} during the last three years (Figure 17.2.3). The survey index series is only available from 1985.

17.6 State of the stock

Golden redfish is mainly caught in ICES Division Va, contributing 90-95% of the total landings from Va, Vb, and XIV. The GADGET model and available survey information from Division Va show that the golden redfish stock decreased considerably from 1985 to the lowest recorded biomass in 1995. An improvement in the fishable biomass has, however, been seen in the most recent years due to improved recruitment. During the last few years, the 1985-year class has contributed significantly to the fishable stock but is slowly diminishing. The 1990-year class has also contributed significantly to the fishable biomass and landings in the last decade. It is expected that the 1990 year class will be important in the catches in the next few years but the 1985 year class is disappearing. There is an indication of relatively good classes that are observed as 9-11 year-old fish (about 30 cm) in the October survey. The GADGET model estimated an exploitation rate of F=0.26 in 2009.

In Vb, survey indices are stable at low level and do not indicate an improved situation in the area. In Subarea XIV, the biomass of the fishable stock has increased in recent years and there are also signs of improved recruitment, as has been seen in Icelandic waters. No information is available on exploitation rates in Divisions Vb and XIV.

In summary, the Icelandic groundfish survey shows a considerable decline in the fishable biomass of golden redfish during the period from 1986 to 1994. The stock has since the mid 1990s increased, and is now inside defined safe biological limits (U_{pa}). A large proportion of the catches in Va in recent years are caught from only two year classes but there is an indication that relatively good year classes are coming into the fishery. The fishable stock situation remains at low level Vb, but has improved in XIV.

17.7 Short term forecast

Results from the short term prediction are given in Table 17.7.1 and Figure 17.4.3. Based on the Gadget model, a decrease in the fishable biomass in Va is expected for all catch options above 30,000 t (the fishable biomass is used here as a proxy for SSB). This is due to the poor recruitment after the 1990-year class. The estimated average year class since 1992 is about 110 millions at age 1 (the average from 1979-2008 is about 145 millions) and maximum yield-per-recruit is estimated to about 225 g. There are though indications that recruitment is being underestimated.

17.8 Medium term forecast

No medium term forecast was carried out.

17.9 Uncertainties in assessment and forecast

The basis for advice and the relative state of the stock is based on projection derived from the analytical GADGET model and survey index series.

The estimate of the harvestable biomass (SSB) in the beginning or 2009 is 150,000 t compared to 170,000 t when estimated last year. The changes are due to addition of new biological data and more catches in 2008 than anticipated.

The model indicates that the year classes after the 1990 have been much smaller than the 1985- and 1990 year classes. Those estimates are based on the groundfish survey in March (Figure 17.2.7). In current assessment the combined 1996-1998 year classes are estimated to be larger than either the 1985 or the 1990 year classes. On the contrary, the indices shown in Figure 17.2.7 indicate that combined they are less than 1/3 of each of the two big year classes.

This could be an indication of recruitment from other areas, for example East-Greenland. The spatial distribution of the 1985- and 1990 year classes is also different from the 1996-1998 year classes. The earlier year classes were mostly found in the north while the latter year classes were mostly found west of Iceland. Much higher contrast in recruitment indices than stock abundance estimates is common and the traditional way of dealing with that problem is to use power curves. There are more than on possible explanation of the power curves but they do not help if a major shift in the proportion of recruits within the survey area occurs.

Another factor that could explain part of this discrepancy in estimation of year classes strengths is discarding of juvenile redfish in the deep water shrimp fishery north of Iceland in the late 1980s and early 1990s. Small redfish was abundant in the deep water shrimp survey in 1986-1988 and in 1991-1995 and scaling the survey estimate with the effort by the shrimp fleet indicates that about 20% of the 1985- and 1990 year classes might have been discarded in the shrimp fishery. Since 1995 sorting grids have been used in the shrimp fishery but at the same time spatial distribution of redfish recruitment has changed.

The final factor that might partly explain this discrepancy is area closure of large area west and southwest of Iceland in order to protect juvenile redfish.

In conclusion, there are signs that the model, based on the March survey, has been underestimating recruitment in recent years.

As shown in Figure 17.4.4 the model has not followed the most important age groups in terms of biomass (30-38 cm) for the last 6 years. One reason is older recruitment estimates. Another explanation could be that no recovery has been seen in the indices of 40 cm and larger fish (Figure 17.2.1). The index of this size class decreased rapidly from 1985-1990 and has since then been stable at low level. With the growth curve shown in Figure 17.4.1 the 1985- and 1990 year classes should have contributed to this size group but has not. The only way to obtain such results from the model, i.e. no increase in 40 cm and larger fish, is to reduce the number of smaller fish and increase estimated fishing effort.

As the model is set up, responses to changes in the tuning data are relatively slow as both M and F are low. The first year class seen in the survey is the 1985 year class. This year class is still abundant in the stock, so the catchability in the survey is not well defined and changes in the estimate of the catchability and, therefore, stock size could be expected. Variations in growth could also be causing different perception of the stock but the model is based on fixed growth throughout the period.

Survey indices are disaggregated by length but 2 cm length increments (4cm for 5-8cm) are used instead of 1cm in the older runs. The size of length increments is always a question but the smaller the length groups the higher is the correlation between residuals and that correlation is not modelled. One option would be to used the total index or split in few groups by length. What needs to be done is to investigate the sensitivity of the model results to how the likelihood function is set up but the current work does not do extensive work in this context.

Another indication of the stock size of golden redfish is obtained by looking at age disagggreged catch in numbers and age disaggregated indices from the autumn survey (Figure 17.4.10). The data indicate that total mortality of the 1985 and 1990 year classes has been close to 0.2 in recent years, both according to survey and catch in numbers. This is considerably lower than the GADGET estimate that is around 0.27. Time series analysis (TSA) was run on those data indicating much larger stock and lower mortality than the Gadget runs (Working Doc # 11) . The precision of the estimates is though very low due to short time series (1996-2008) but the model results follow the biomass trends in the autumn survey better than the Gadget model does. As discussed earlier the Gadget results are to a large extent driven by comparison with abundance of large and small redfish in the years 1985 – 1992 before the autumn survey commenced.

There are only available data on nursery grounds of golden redfish in Icelandic and Greenland waters but no nursery grounds are known in the Faeroese waters. In Icelandic waters, nursery areas are found mostly West and North of Iceland at depths between 50 m and approximately 350 m, but also in the South and East (ICES C.M. 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). Other nursery areas might be on the continental shelf off East Greenland. As length (age) increases, migration of young golden redfish is anticlockwise from the North coast to the West coast and further to the Southeast fishing areas and to Faeroese fishing grounds in Vb. The largest specimens are found in Division Vb and therefore the 1985 and 1990 year classes might still not have entered into that area. This might explain the inconsistency between different indicators on the status of the stock.

17.10 Comparison with previous assessment and forecast

In Figure 17.4.7, the development of the available biomass according to the five Gadget runs described here is compared to the Gadget run from last year (real time retro). In Figure 17.4.8, the estimated recruitment is compared for the same runs. As can seen from the model is that estimates from the 2009 runs are somewhat lower than the 2008 run.

Figure 17.4.9 shows analytical retro of the GADGET model. The comparison between 2008 and 2009 is better than in the real time retro. The reason is not clear but it is possible that when the model was run last year not all the data were available for early 2007, this applies especially to the age data that are usually behind. The analytical retro shows that recruitment has been underestimated.

The different Gadget runs show on the average similar recruitment although considerable difference may be noticed for some year classes, especially the small ones (Figure 17.4.8).

17.11 Management plans and evaluation

17.12 Management consideration

Based on the model results, a TAC below 30,000 t in Va in the next 5 years would provide a fishable stock size around current biomass level at the end of that period, but the total biomass would decrease because of low recruitment since 1991 (Table 17.7.1). A large proportion of the catch will be from the 1985- and 1990-year classes. Therefore, after these two strong year classes have passed the fishery, higher yield than about 20-25,000 t cannot be expected after 2012. The approximate **F** from the model would decrease from the current level and be close to $\mathbf{F_{max}}$.

Analytical retrospective pattern from the GADGET model indicates that recruitment has been underestimated in recent years. Recruitment is based on survey indices from Va in March which has been very low since 1993 compared to the 1985 and 1990 year classes. Results from age reading in recent years indicate that some of the year classes are larger than estimated by use of the survey indices. This could indicate that part of the recruitment comes from other areas. Total mortality according to the GADGET model results is also considerably higher than observed by looking directly at survey indices (0.27 vs. 0.2) indicating that the stock might be underestimated.

The GADGET model uses only catches from Va and predicts that catches below 30,000 t would provide a fishable stock size above current biomass level for the next 5 year. Including total catches for the whole area (Division V and XIV) is only a matter of scaling as there are no surveys data available from Vb and XIV. On average, about 10% of the total catches 1985-2008 are taken in Vb and XIV and adding proportion to the catch predicted by the GADGET model would give 33,000 t for the whole area.

ACFM recommended in 2008 that the total allowable catch in Division V should be less than 30,000 t. However, the total annual catches in 2005-2007 were around 40,000-45,000 t. The Icelandic authorities give a joint quota for golden redfish and demersal *S. mentella* (see Chapter 18.7), which causes this difference. Joint quota also impedes direct management of golden redfish. TAC allocated to demersal *Sebastes* fishery should be given separately for each of the fish stocks.

The biomass of the fishable stock of *S. marinus* in Subarea XIV has increased in recent years and was in 2008 high although it was considerable lower than in 2007.

The present advice allow for a potential increase in the redfish fishery in Subarea XIVb. Here redfish and cod are found in the same areas and depths and historically these species have been taken in the same fisheries. An increased redfish fishery may therefore affect cod. ICES presently advise that no fishery should take place on off-shore cod in Greenland waters. ICES therefore recommends measures that will keep effort on cod low in a potential redfish fishery.

Greenland have opened for an offshore cod fishery with a TAC of 15 000 t in 2008. To protect spawning aggregations of cod present management measures in Greenland EEZ prohibits trawl fishery for cod north of 63°N latitude. Restrictions on cod by-catch in fisheries directed towards other demersal fish (i.e. redfish and Greenland halibut) provide some protection of cod, but additional measures such as a closure of potential redfish fisheries north of 63°N could be considered.

Subarea XIV is an important nursery area for the entire resource. Measures to protect juvenile in Subarea XIV should be continued (sorting grids in the shrimp fishery).

No formal agreement on the management of *S. marinus* exists among the three coastal states, Greenland, Iceland and the Faeroe Islands. In Greenland and Iceland the fishery is regulated by a TAC and in the Faeroe Islands by effort limitation. The regulation schemes of those states have previously resulted in catches well in excess of TACs advised by ICES.

17.13 Ecosystem consideration

Not evaluated.

17.14 Regulation and their effects

There is no minimum landing size of golden redfish in Va. However, if more than 20% of a catch observed onboard is below 33 cm a small area can be closed temporarily. A large area west and southwest of Iceland is closed for fishing in order to protect young golden redfish.

There is no regulation of the golden redfish in Vb.

Since 2002 it has been mandatory in the shrimp fishery in Subarea XIV to use sorting grids in order to reduce by-catches of juvenile redfish in the shrimp fishery.

17.15 Changes in fishing technology and fishing patterns

There have been no changes in the fishing technology and the fishing pattern of golden redfish in Subareas V and XIV.

17.16 Changes in the environment

See chapters 2, 7, and 13.

Table 17.2.1 Index on fishable stock of golden redfish in the Icelandic groundfish survey 1985-2009 divided by depth intervals.

	Depth Intervals					
Year	< 100m	100-200m	200-400m	400-500m	0 - 400m	Total
1985	7.0	91.1	145.2	23.6	243.2	266.8
1986	2.0	86.1	179.9	12.1	268.0	280.1
1987	2.0	123.8	150.2	10.0	276.0	286.0
1988	1.1	94.6	110.1	4.0	205.8	209.7
1989	1.1	101.4	117.8	10.9	220.2	231.1
1990	2.3	67.9	81.0	22.2	151.2	173.4
1991	1.7	75.9	52.6	8.3	130.3	138.6
1992	1.2	62.2	58.5	9.4	121.9	131.3
1993	0.7	47.5	50.2	16.6	98.4	115.0
1994	0.5	57.7	51.4	1.3	109.6	110.9
1995	0.3	36.0	44.6	11.2	81.0	92.1
1996	0.8	44.3	76.5	21.1	121.5	142.6
1997	1.0	60.3	71.5	33.6	132.7	166.4
1998	1.6	56.9	71.2	2.7	129.7	132.4
1999	0.7	55.5	107.3	44.4	163.6	207.9
2000	2.0	46.7	68.5	8.1	117.2	125.4
2001	1.6	33.1	66.6	5.8	101.2	107.0
2002	1.8	64.0	74.2	11.4	140.1	151.4
2003	8.7	60.2	107.5	28.8	176.4	205.2
2004	7.9	48.8	91.6	102.3	148.4	250.6
2005	9.4	42.3	112.3	37.6	164.1	201.7
2006	6.0	52.6	95.7	17.0	154.4	171.4
2007	4.9	51.1	76.5	77.4	132.6	209.9
2008	5.5	38.5	85.1	33.1	129.1	162.2
2009	4.3	41.8	100.7	272.4	146.8	419.2

Table 17.3.1 Official landings (in tonnes) of golden redfish, by area, 1978-2008 as officially reported to ICES. Landings statistics for 2008 are provisional.

	Area				
Year	Va	Vb	VI	XIV	Total
1978	31,300	2,039	313	15,477	49,129
1979	56,616	4,805	6	15,787	77,214
1980	62,052	4,920	2	22,203	89,177
1981	75,828	2,538	3	23,608	101,977
1982	97,899	1,810	28	30,692	130,429
1983	87,412	3,394	60	15,636	106,502
1984	84,766	6,228	86	5,040	96,120
1985	67,312	9,194	245	2,117	78,868
1986	67,772	6,300	288	2,988	77,348
1987	69,212	6,143	576	1,196	77,127
1988	80,472	5,020	533	3,964	89,989
1989	51,852	4,140	373	685	57,050
1990	63,156	2,407	382	687	66,632
1991	49,677	2,140	292	4,255	56,364
1992	51,464	3,460	40	746	55,710
1993	45,890	2,621	101	1,738	50,350
1994	38,669	2,274	129	1,443	42,515
1995	41,516	2,581	606	62	44,765
1996	33,558	2,316	664	59	36,597
1997	36,342	2,839	542	37	39,761
1998	36,771	2,565	379	109	39,825
1999	39,824	1,436	773	7	42,040
2000	41,187	1,498	776	89	43,550
2001	35,067	1,631	535	93	37,326
2002	48,570	1,941	392	189	51,092
2003	36,577	1,459	968	215	39,220
2004	31,686	1,139	519	107	33,451
2005	42,593	2,484	137	115	45,329
2006	41,521	656	0	34	42,211
2007	39,058	689	0	83	39,830
2008[1)]	44,308	569	64	80	45,021

1) Provisional

Table 17.3.2 Golden redfish in Va. Observed catch in weight (tonnes) by age and years in 1995-2008. Highlighted are the 1985- and 1990-year classes. It should be noted that the catch-at-age results for 1996 are only based on three samples, which explains that there are no specimens older than 23 years.

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
7	62	0	**33**	24	7	40	122	130	201	227	236	187	139	471
8	374	360	230	**285**	350	65	138	910	211	849	782	1,063	461	1,224
9	1,596	825	482	596	**1,623**	852	395	767	1,366	499	1,925	2,221	1,793	2,175
10	**9,436**	3,701	1,039	1,211	1,259	**4,308**	1,623	841	1,120	2,109	1,526	3,724	2,527	5,042
11	2,719	**9,127**	2,702	1,132	1,855	1,894	**7,763**	3,188	1,197	795	3,139	2,145	3,425	3,877
12	1,319	2,102	**11,583**	3,252	2,528	2,277	1,807	**11,065**	3,952	982	1,919	2,841	1,963	4,555
13	3,534	1,317	2,828	**12,532**	2,450	1,703	1,983	3,095	**9,788**	2,035	1,378	1,641	3,145	2,221
14	5,671	1,477	1,373	2,085	**15,566**	2,375	1,252	2,630	2,361	**8,661**	3,027	1,302	1,078	2,770
15	5,971	4,347	3,142	2,039	1,244	**14,878**	839	1,856	1,978	2,158	**11,920**	2,849	986	1,450
16	1,730	5,456	3,666	2,413	1,276	1,777	**11,686**	3,029	1,218	1,723	2,138	**10,226**	2,257	1,043
17	852	934	3,035	3,416	1,823	1,184	523	**12,046**	2,267	826	1,472	2,112	**9,676**	1,761
18	368	379	900	2,051	2,665	1,624	787	2,097	**6,427**	1,401	1,333	1,186	1,389	**8,030**
19	1,134	259	642	1,018	2,228	2,427	1,068	1,174	761	**5,342**	1,315	684	768	1,476
20	1,144	340	925	729	1,271	2,191	1,801	663	410	1,120	**6,797**	958	791	927
21	503	1,157	449	523	479	544	970	1,411	604	336	412	**5,658**	925	512
22	677	988	520	391	217	447	420	1,028	791	491	466	644	**5,075**	847
23	1,427	791	681	427	341	270	437	743	755	620	868	235	768	**4,086**
24	664	0	587	665	218	64	169	363	379	600	636	384	116	364
25	762	0	749	516	930	393	130	294	303	284	446	485	653	251
26	365	0	271	401	279	340	126	185	75	106	97	73	337	412
27	350	0	136	427	649	193	293	83	83	180	324	269	353	339
28	725	0	192	360	228	528	204	297	27	153	215	202	224	164
29	0	0	149	54	105	371	153	500	106	138	31	174	36	212
30	133	0	30	226	231	441	375	174	197	161	227	274	76	82
Total	41,516	33,560	36,344	36,773	39,822	41,186	35,064	48,569	36,577	31,796	42,629	41,537	38,961	44,291

Table 17.3.3 Results of the GLM model to calculate standardized CPUE for Icelandic golden redfish fishery in Va. Note that the residuals are shown in Fig. 8.2.2.

Call: glm(formula = lcatch ~ ltowtime + factor(year) + factor(month) + factor(ship) + factor(area), family = gaussian(), data = tmp)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-6.35701	-0.4790798	0.03187228	0.5153328	5.610659

Coefficients:

	Value	Std. Error	t value
(Intercept)	-1.628812335	0.899026015	-1.8117522
ltowtime	1.132087910	0.004487607	252.2698323
factor(year)1987	0.051883877	0.037324010	1.3900939
factor(year)1988	-0.004580606	0.038093012	-0.1202479
factor(year)1989	0.022204585	0.038475806	0.5771051
factor(year)1990	0.045178644	0.038427898	1.1756730
factor(year)1991	0.032114700	0.031918873	1.0061352
factor(year)1992	-0.161870797	0.032229339	-5.0224671
factor(year)1993	-0.289688438	0.031897643	-9.0818132
factor(year)1994	-0.309276426	0.032924520	-9.3934983
factor(year)1995	-0.287565970	0.033274038	-8.6423526
factor(year)1996	-0.275106719	0.033813516	-8.1359986
factor(year)1997	-0.284073740	0.033958894	-8.3652235
factor(year)1998	-0.211091438	0.034346638	-6.1459128
factor(year)1999	-0.267324098	0.033731082	-7.9251562
factor(year)2000	-0.119401085	0.033835502	-3.5288699
factor(year)2001	0.028109646	0.035080201	0.8012966
factor(year)2002	0.066768891	0.034621877	1.9285173
factor(year)2003	0.082772635	0.035962052	2.3016661
factor(year)2004	0.136103357	0.037109424	3.6676225
factor(year)2005	0.088719303	0.035433317	2.5038385
factor(year)2006	-0.054278618	0.034584412	-1.5694533
factor(year)2007	-0.012277019	0.035780486	-0.3431205
factor(year)2008	-0.01565832	0.03625593	-0.431883

Analysis of Deviance Table

Gaussian model

Response: log(afli)

Terms added sequentially (first to last)

	Df	Dev. Resid.	Df Resid.	Dev	F Value	Pr(F)
NULL			44069	112235.9		
ltowtime	1	65586.69	44068	46649.2	85463.89	0
factor(year)	22	1388.06	44046	45261.2	82.22	0
factor(month)	11	1096.28	44035	44164.9	129.87	0
factor(ship)	199	8134.46	43836	36030.4	53.27	0
factor(area)	**149**	**2504.17**	**43687**	**33526.3**	**21.90**	**0**

Table 17.5.1 Biological reference points for golden redfish in Division Va.

PARAMETERS	ESTIMATION
F_{max}	0.15
$F_{0.1}$	0.09
B_{pa}	125 000 t
Yield per recruit	225 g

Table 17.7.1 Golden redfish in Division Va. Output from short term prediction using results from the BORMICON model, where the annual landings after 2008 is set to 30 000 t. The table gives the SSB (the same as the catchable biomass), total biomass and landings in thousands tonnes F_{20} is the fishing mortality at age 20.

YEAR	SSB	F_{20}	TOTAL BIOMASS	LANDINGS
2008	158		272	44.5
2009	150		252	30
2010	156		247	30
2011	159		241	30
2012	159		234	30
2013	156		224	30
2014	150		213	30
2005	142		201	30

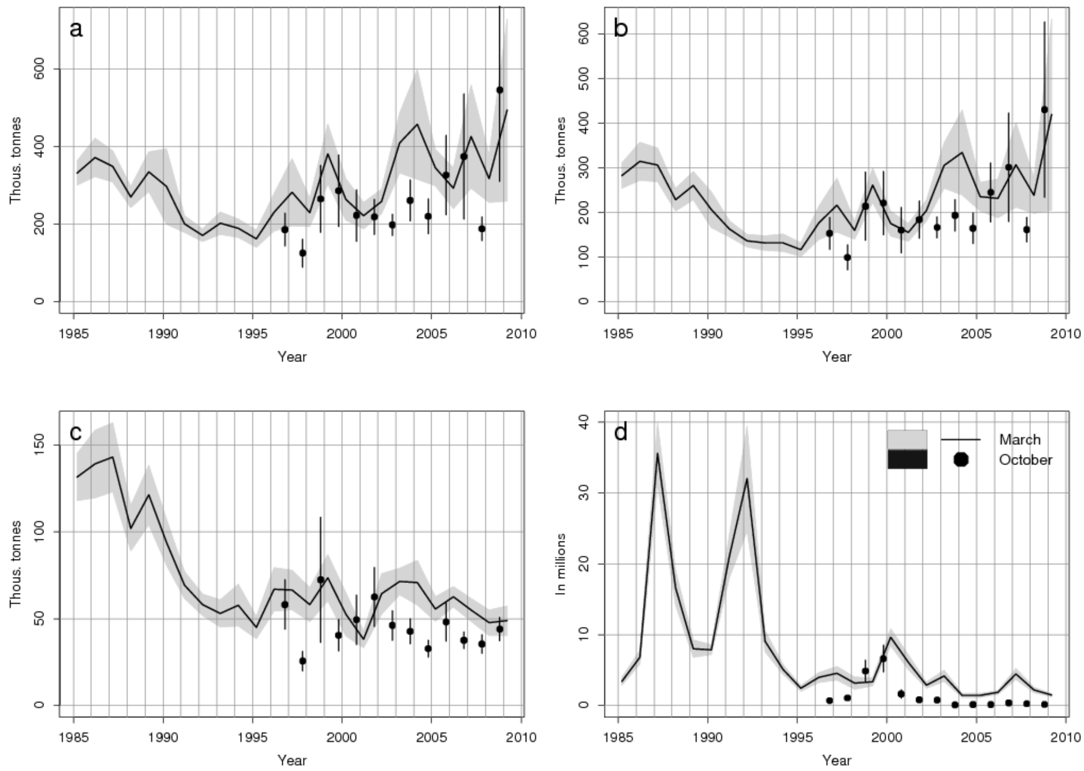


Figure 17.2.1 Indices of golden redfish from the groundfish surveys in March 1985-2009 (line, shaded area) and October 1996-2008 (points, vertical lines). a) Total biomass; b) biomass of fish larger than 32 cm; c) biomass of fish larger than 40 cm; d) indices of juvenile golden redfish (4-11) cm in millions. The shaded area and the vertical bar show ±1 standard error of the estimate.

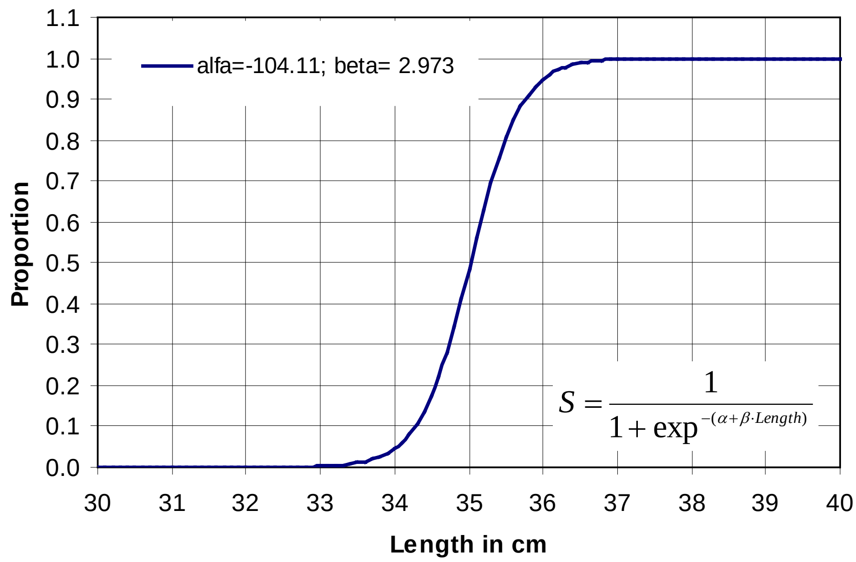


Figure 17.2.2 Selection pattern of golden redfish from the commercial fishery used to estimate the abundance of the fishable stock abundance. L_{50} = 35 cm.

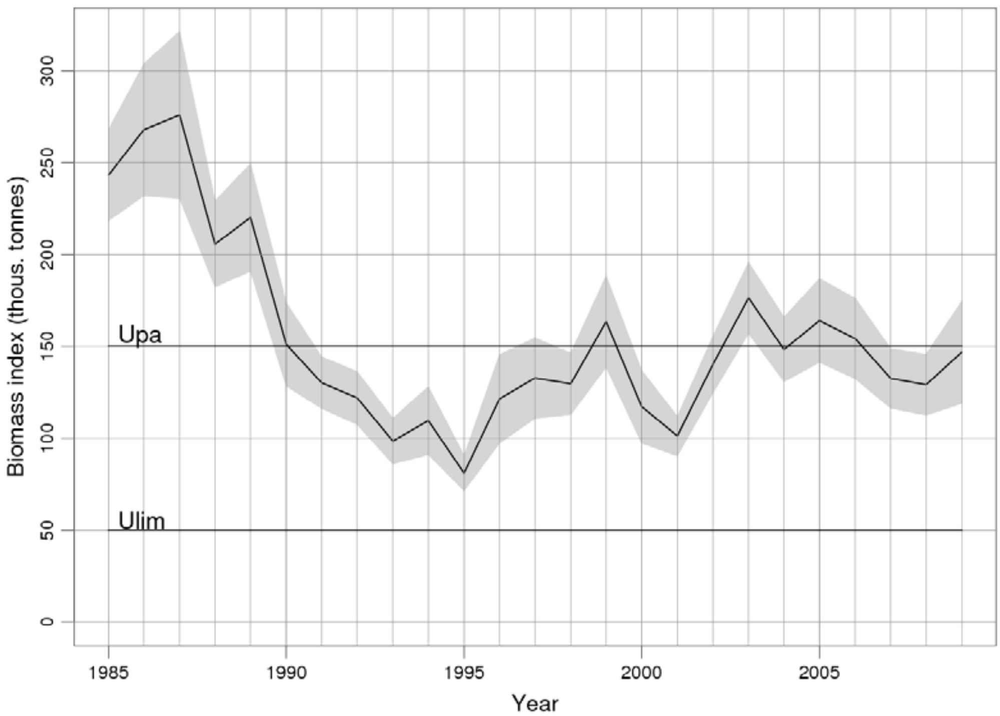


Figure 17.2.3 Index on fishable stock of golden redfish from Icelandic groundfish survey in March 1985-2009. The shaded area and the vertical bar show ±1 standard error of the estimate.

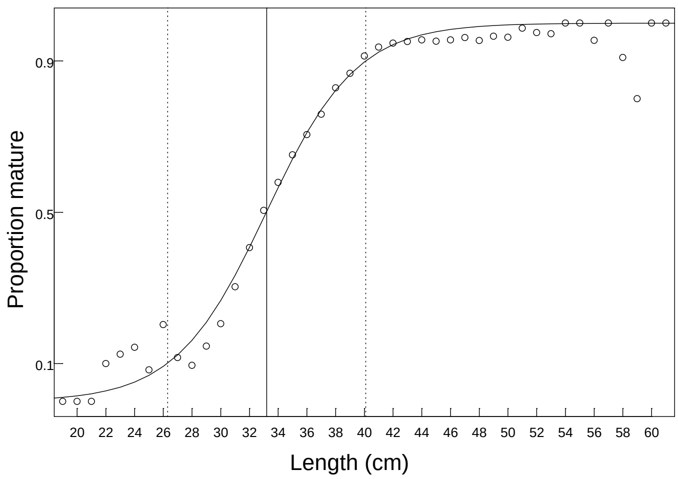


Figure 17.2.4 The proportion of mature golden redfish as a function of length from the commercial catch in Va 1995-2004 (all data pooled). The data points show the observed proportion mature and the lines the fitted maturity. The solid vertical line indicates the point where 50% of the fish mature and the two dotted lines indicate the 10% and 90% probability of being mature.

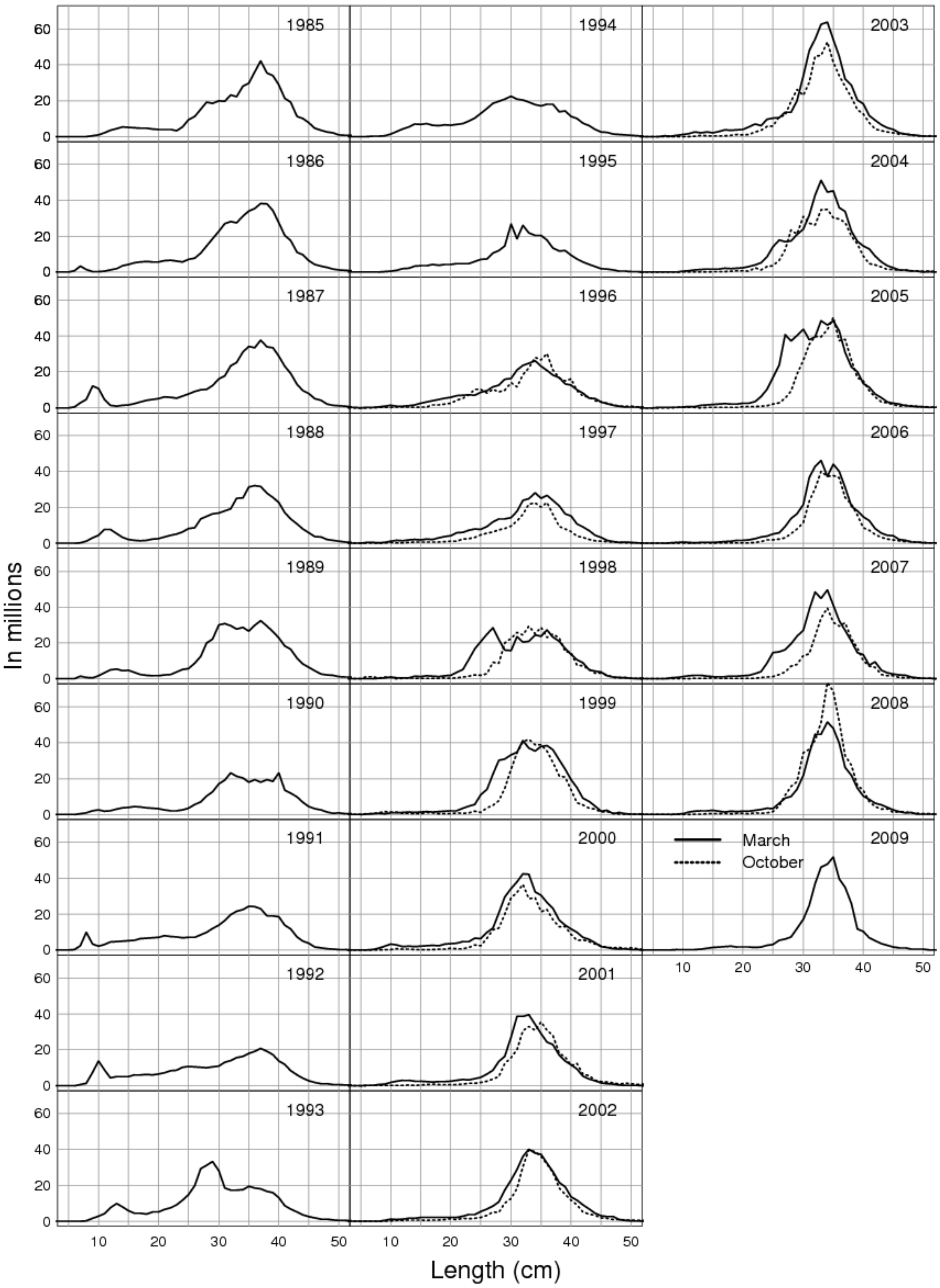


Figure 17.2.5 Length distribution of golden redfish in the bottom trawl surveys in March 1985-2009 (solid line) and in October 1996-2008 (broken lines) conducted in Icelandic waters.

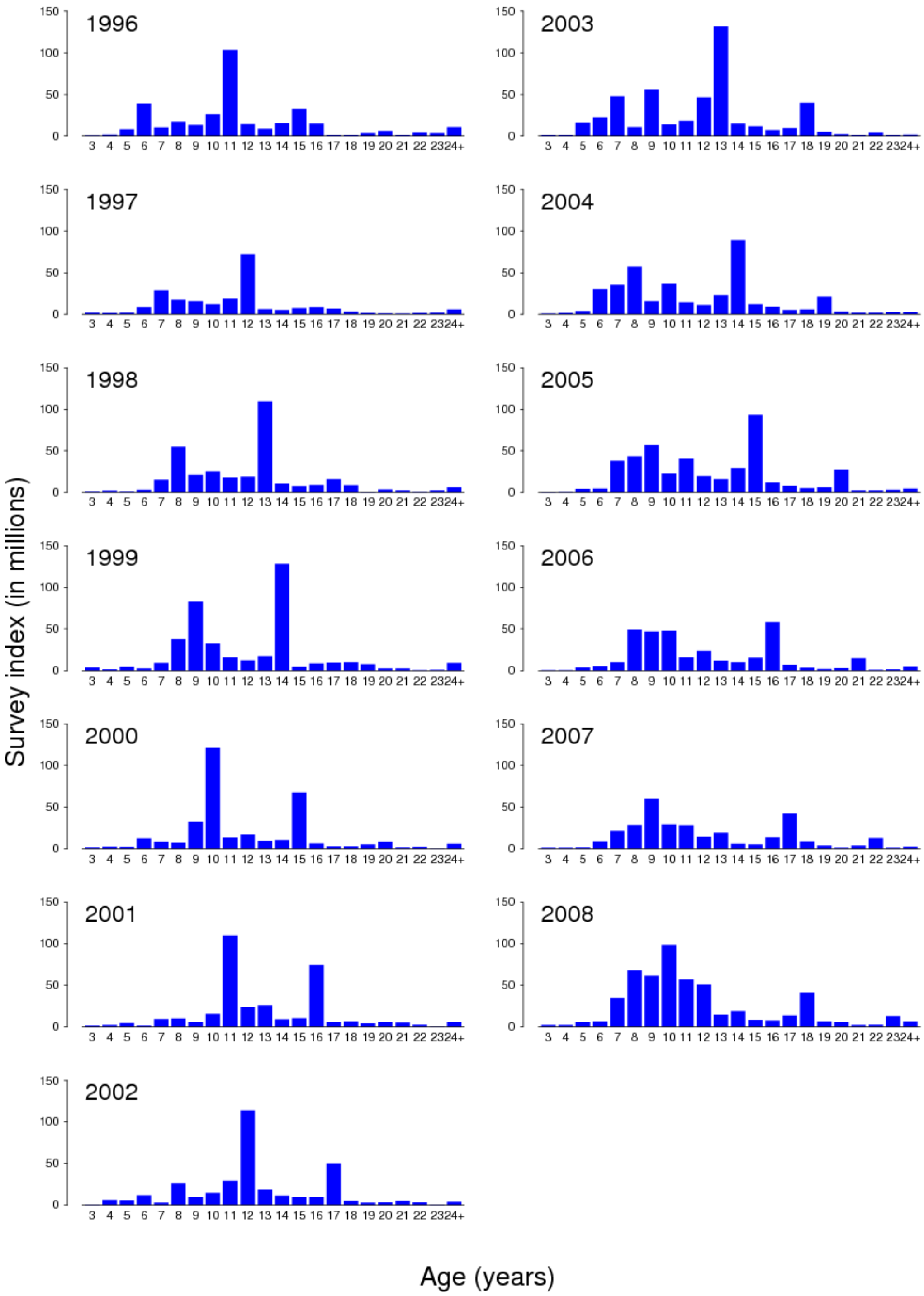


Figure 17.2.6 Age distribution of golden redfish in the bottom trawl survey in October conducted in Icelandic waters 1996-2008.

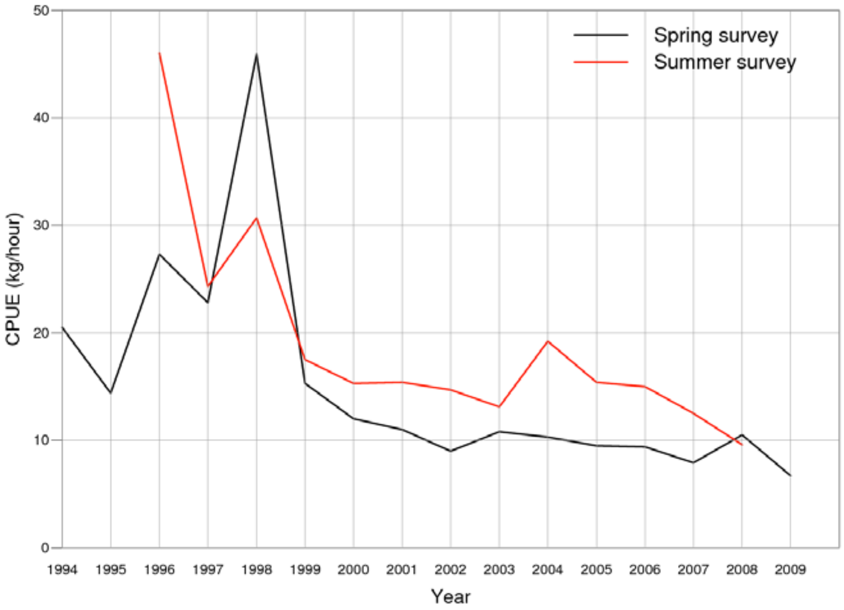


Figure 17.2.7 CPUE of golden redfish in the Faeroes spring groundfish survey 1994-2009 and the summer groundfish survey 1996-2008 in ICES Division Vb.

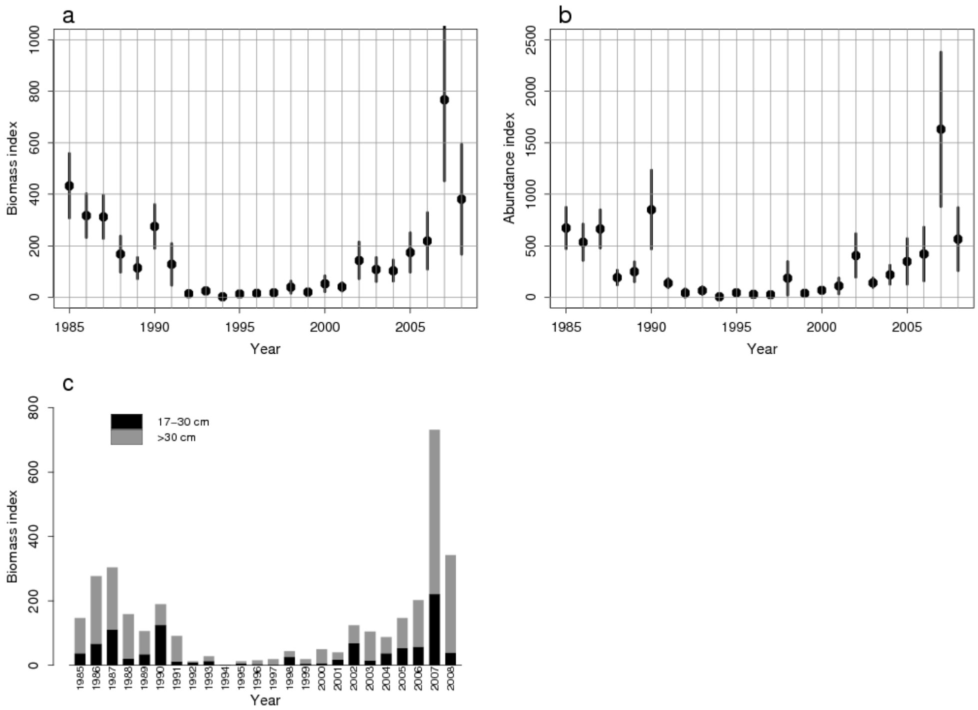


Figure 17.2.8 Golden redfish (≥17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1985-2008. a) Total biomass index, b) total abundance index, c) biomass index divided by size classes (17-30 cm and > 30 cm).

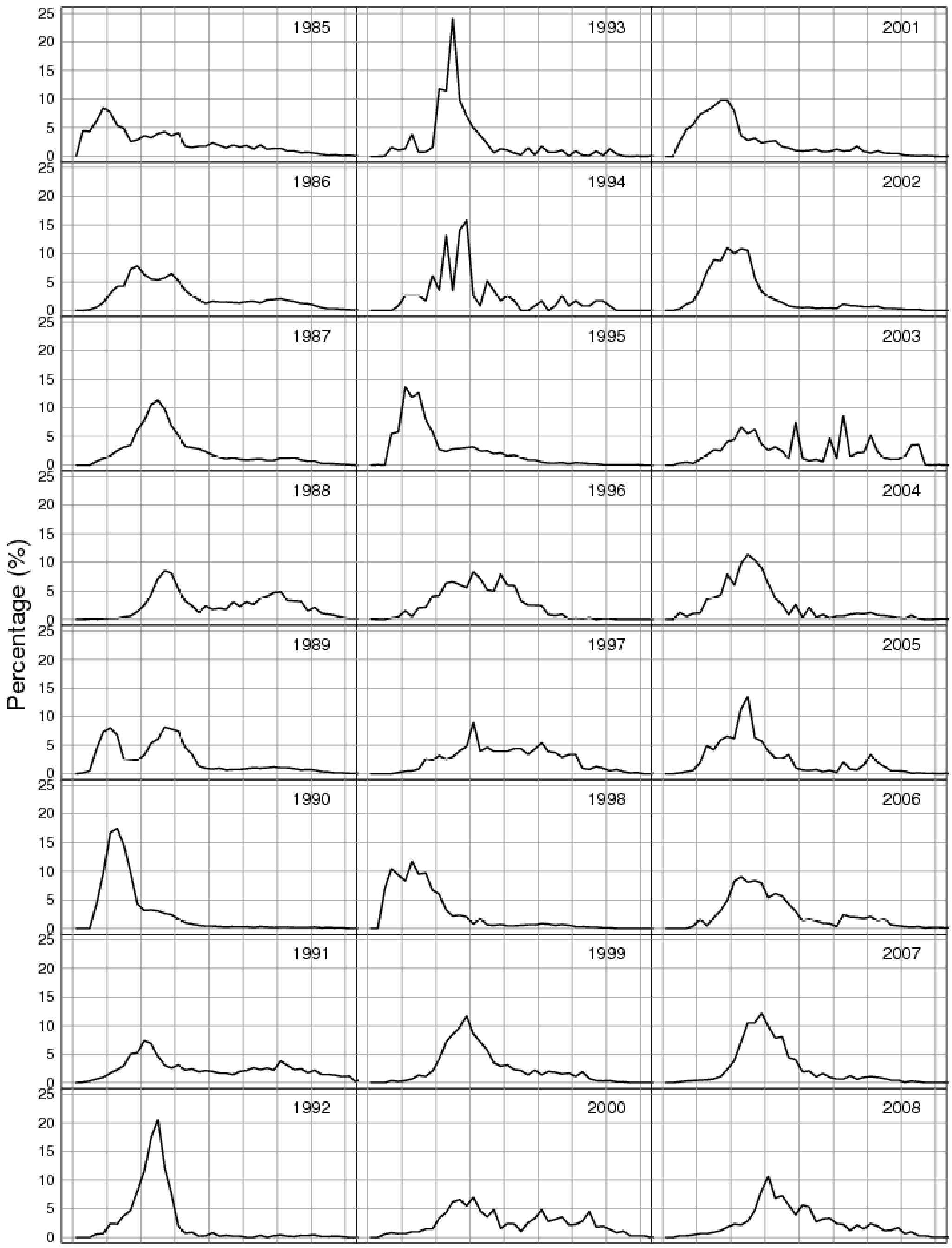


Figure 17.2.9 Golden redfish (>17 cm). Length frequencies for East and West Greenland 1985-2008.

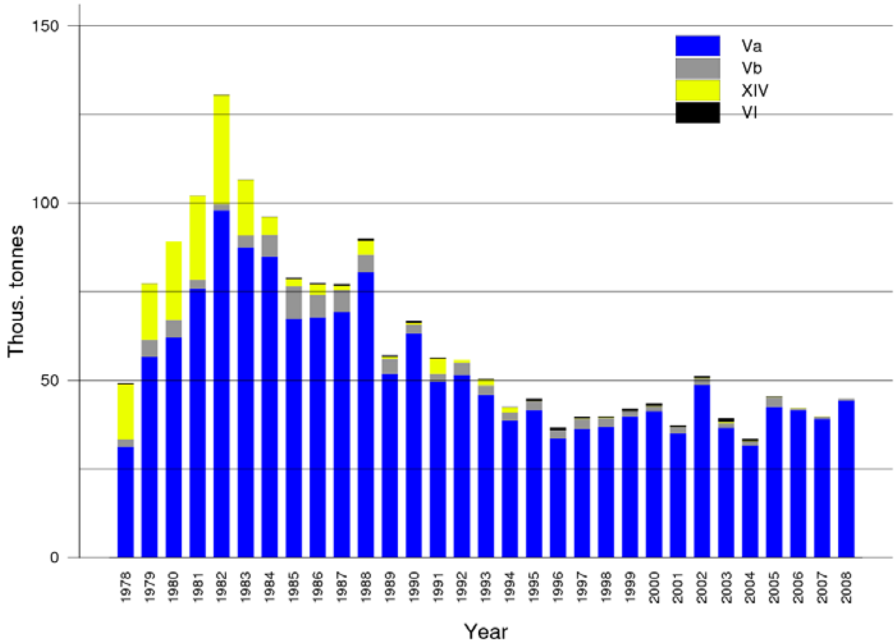


Figure 17.3.1 Nominal landings of golden redfish in tonnes by ICES Divisions 1978-2008. Landings statistics for 2008 are provisional.

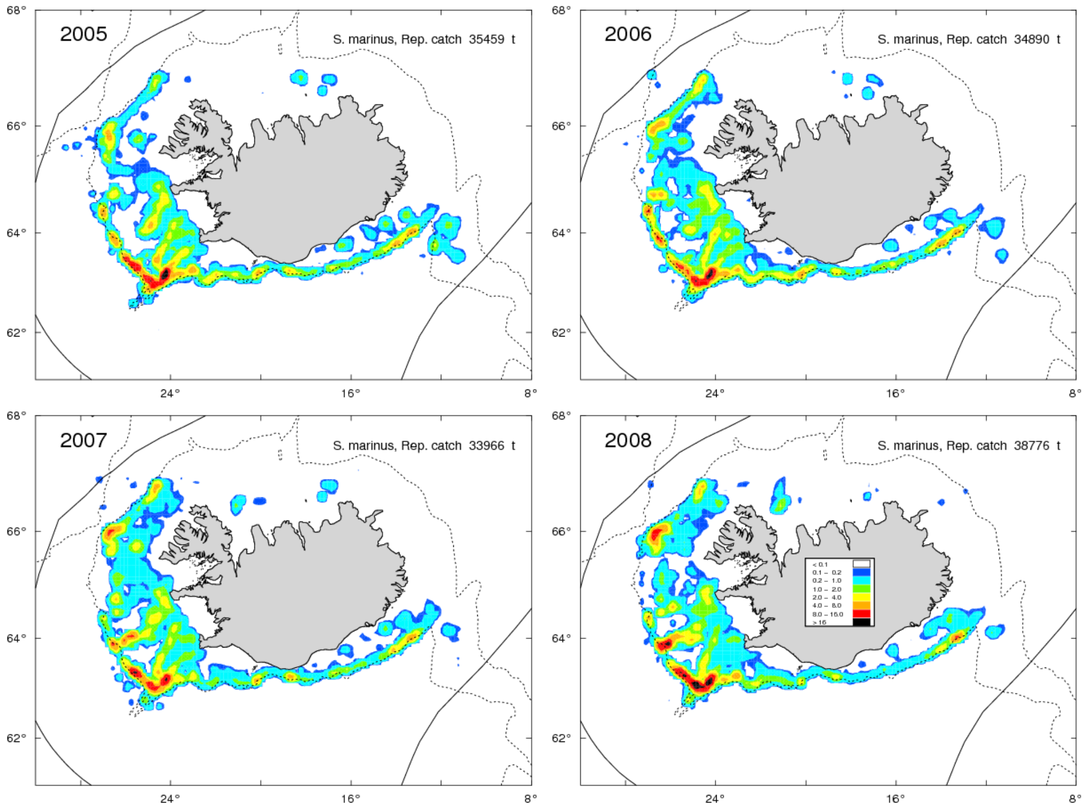


Figure 17.3.2 Geographical distribution of golden redfish bottom trawl catches in Division Va 2005-2008.

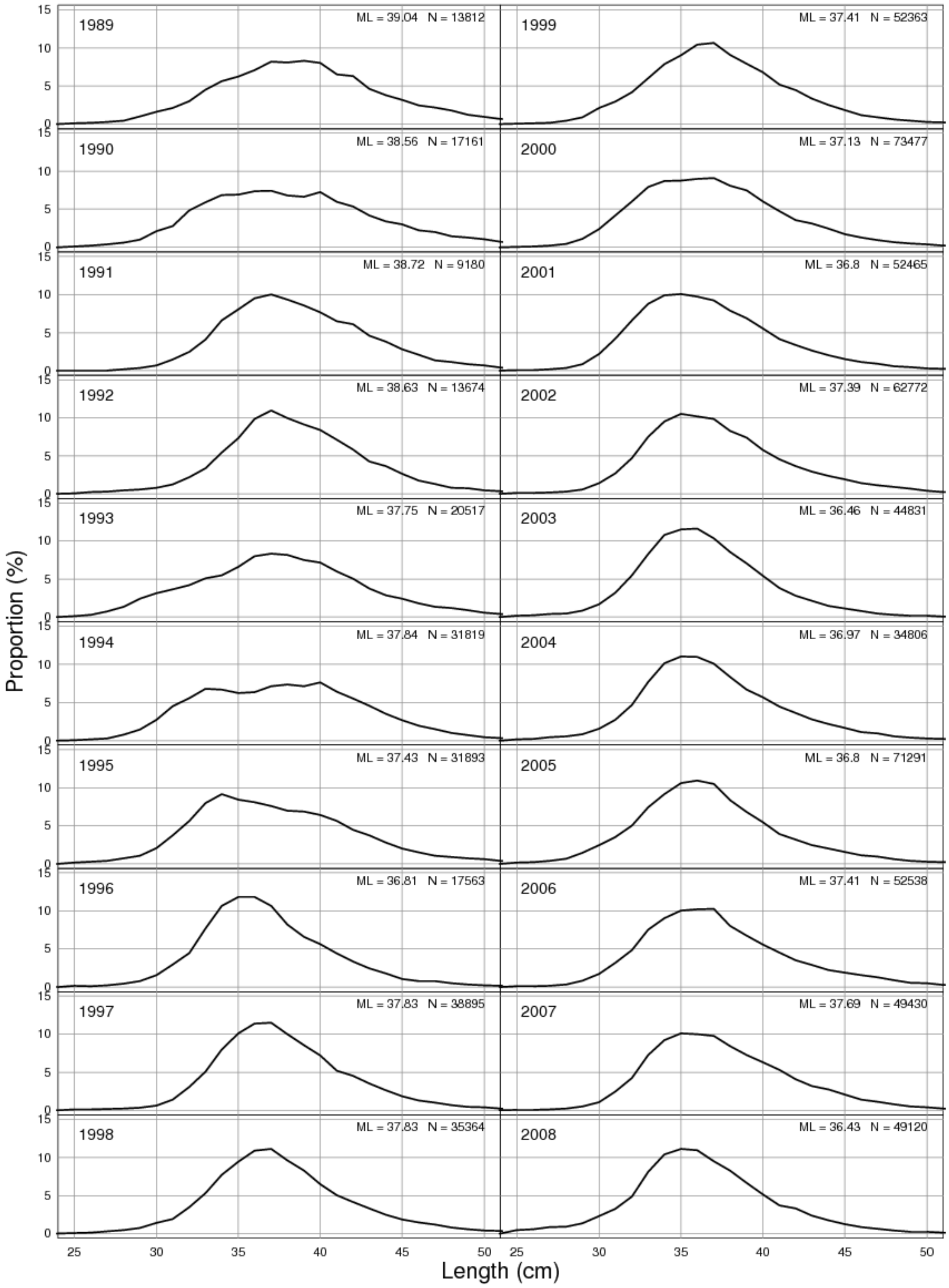


Figure 17.3.3 Length distribution of golden redfish in the commercial landings of the Icelandic bottom trawl fleet 1989-2008.

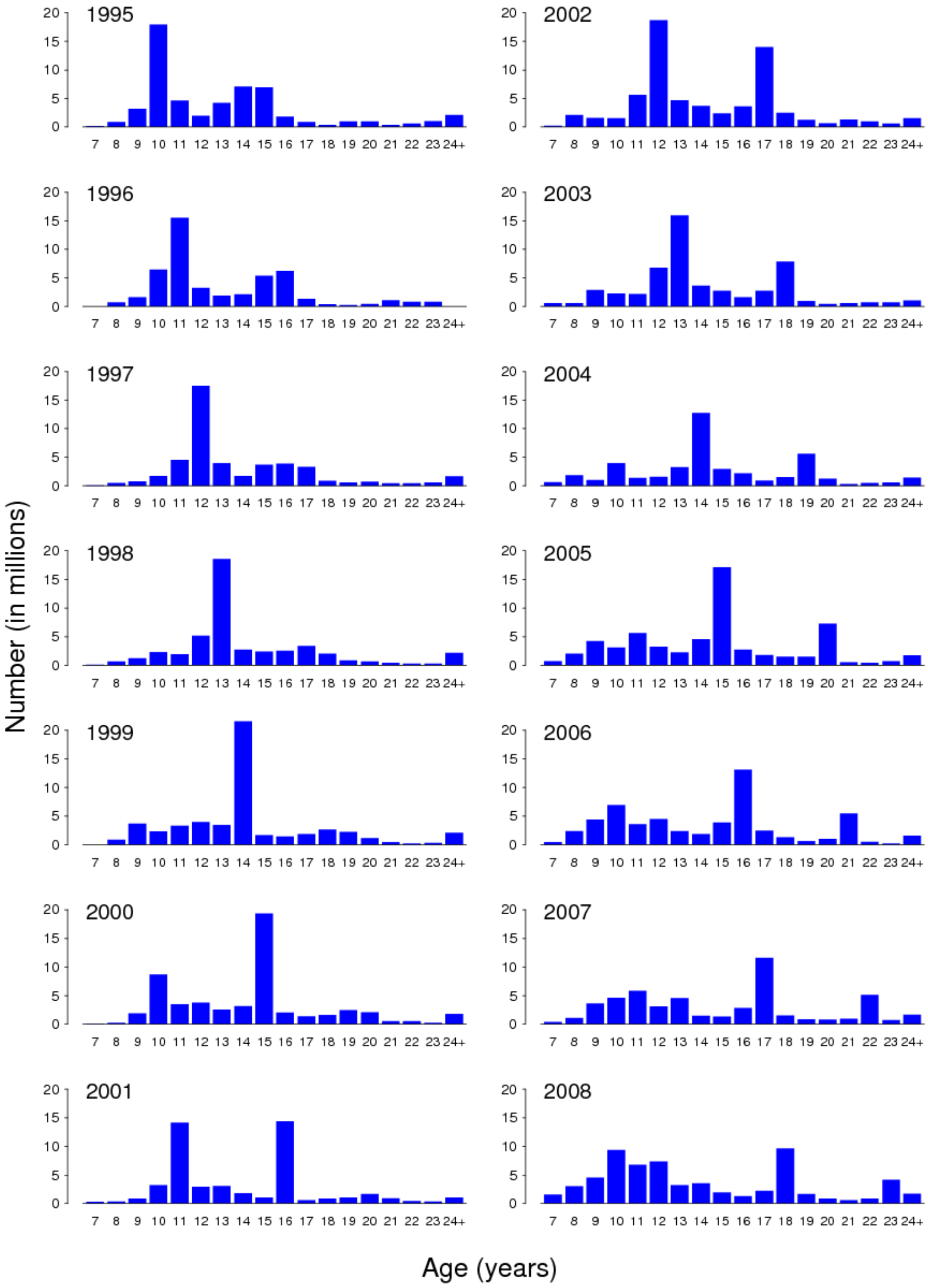


Figure 17.3.4 Catch-at-age of golden redfish in numbers in ICES Subdivision Va 1995-2008.

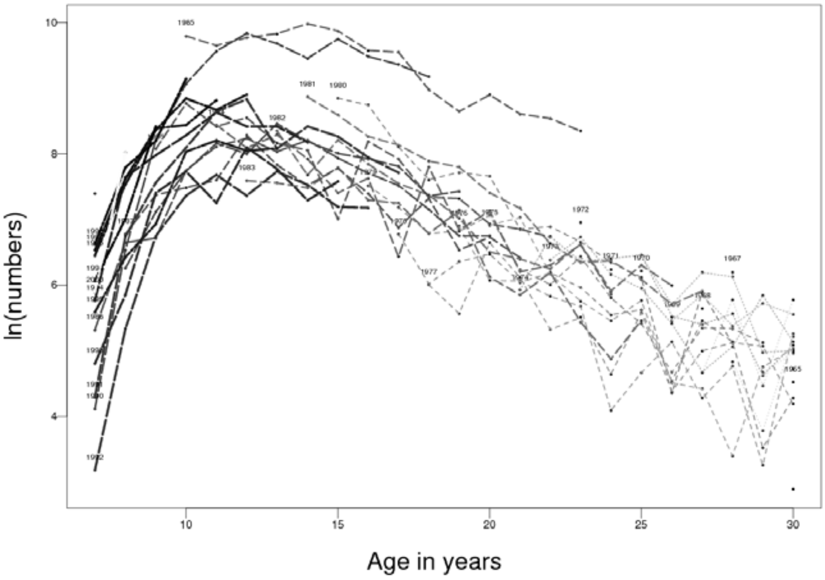


Figure 17.3.5 Catch curve of golden redfish based on the catch-at-age data in ICES Division Va 1995-2008.

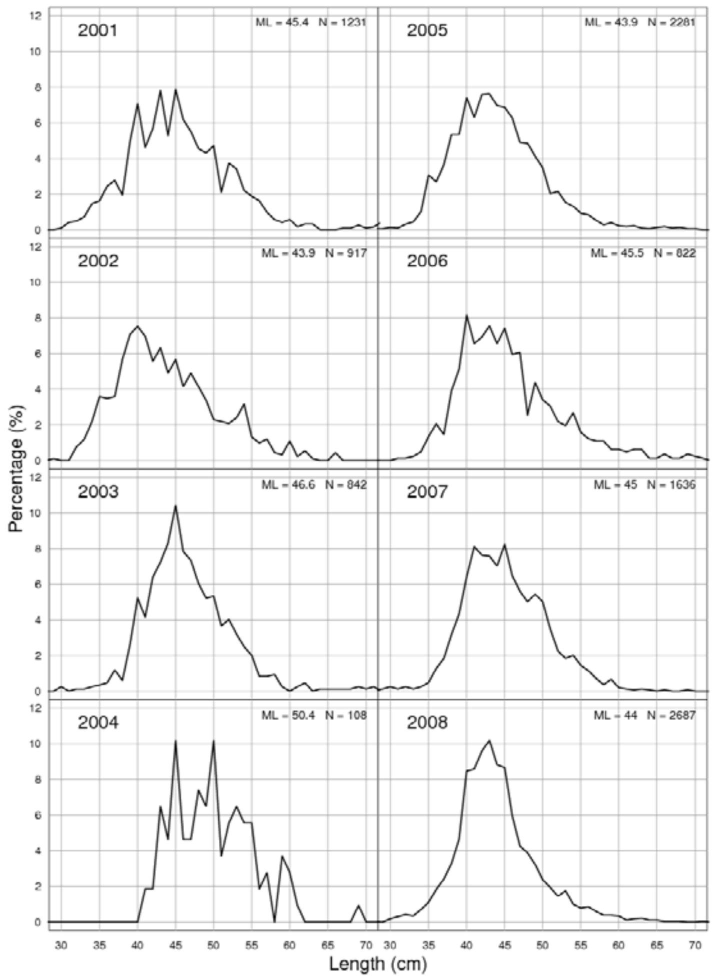


Figure 17.3.6 Length distribution of golden redfish from Faroese catches in 2001-2008.

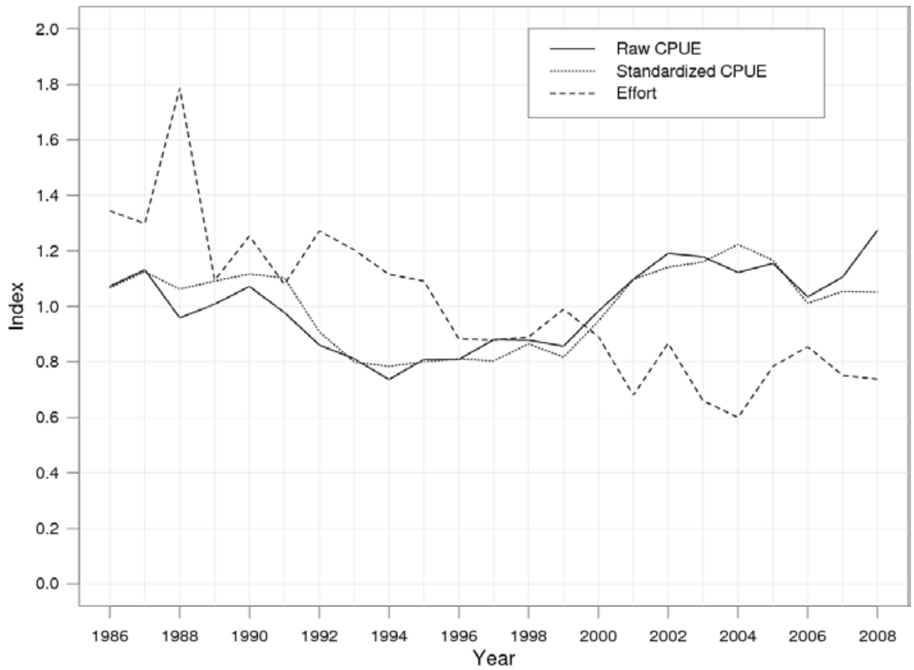


Figure 17.3.7 CPUE of golden redfish from Icelandic trawlers based on results from the GLM model 1985-2008 where golden redfish catch composed at least 50% of the total catch in each haul. The figure shows the raw CPUE index (sum(yield)/sum(effort)), standardized CPUE index estimated using a generalized linear model, and effort.

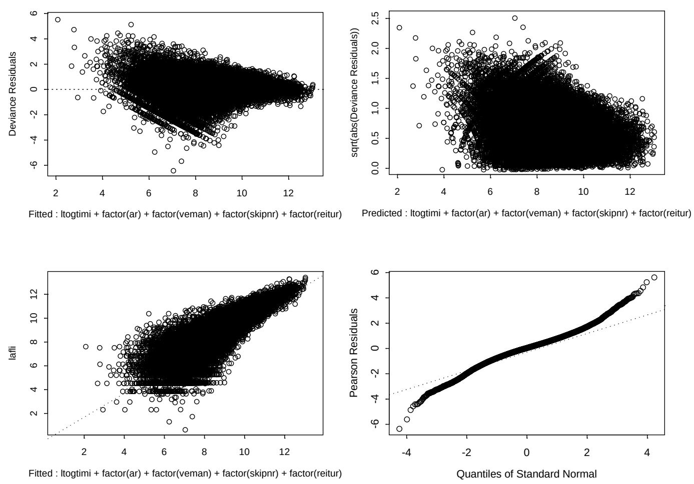


Figure 17.3.8 Results from the GLM modle (section 8.2.1) for the CPUE series of golden redfish in Va. From left to right, top to bottom: Residuals against fitted values; square root of the absolute value of residuals against predicted values; response against fitted values; normal QQplot of standardized residuals.

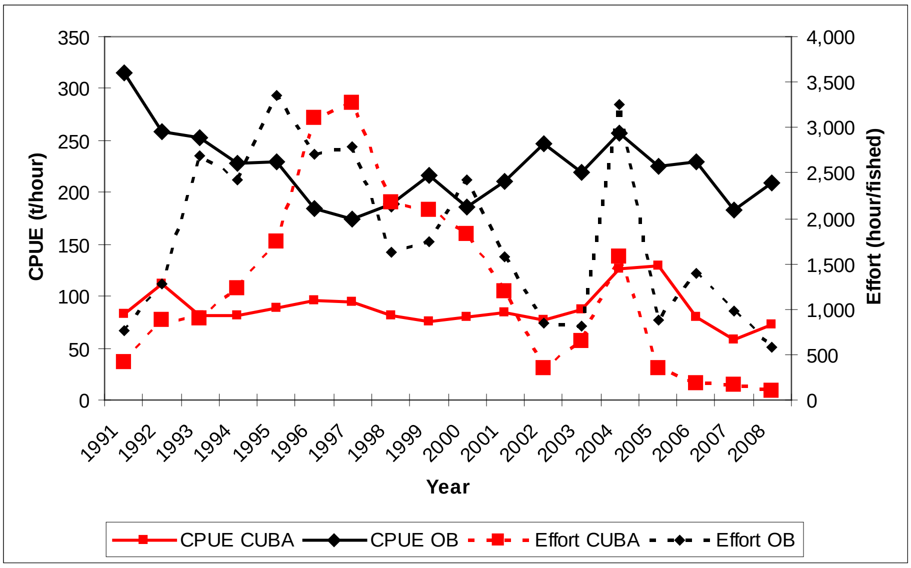


Figure 17.3.9 CPUE (solid lines) and effort (dotted lines) for golden redfish from the Faroese CUBA pair-trawlers (grey) and otterboard trawlers (black) in ICES Division Vb 1991-2008.

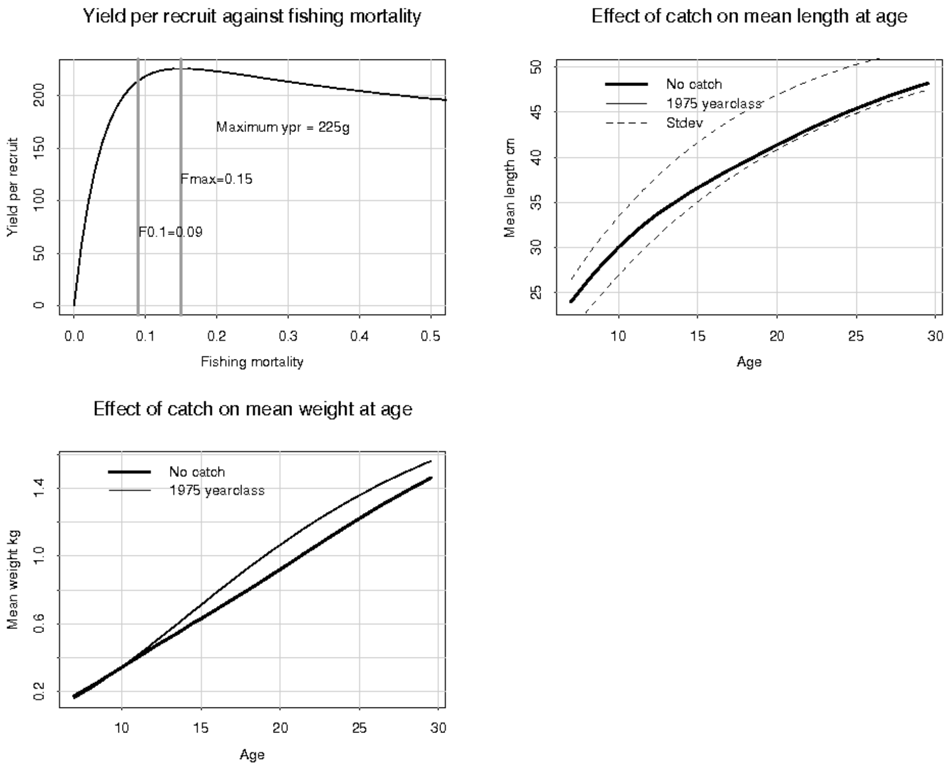


Figure 17.4.1 Results from the Gadget model for golden redfish using catch data from ICES Division Va. a) Yield-per-recruit, b) Mean length at age and effect of catch on length at age, c) Mean weight at age and effect of catch on weight at age.

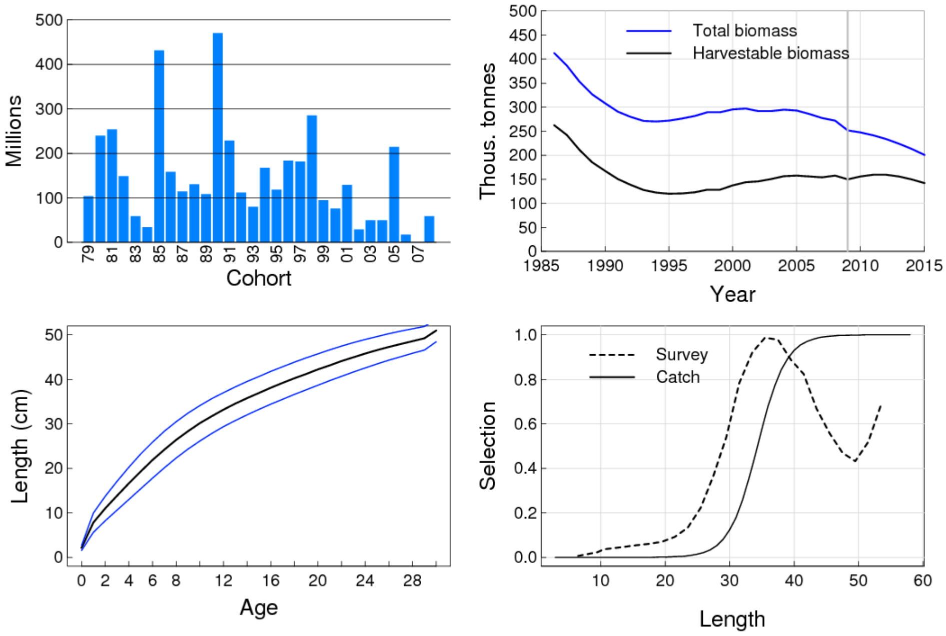


Figure 17.4.2 Results from the Gadget model for golden redfish using catch data from ICES Division Va. a) Estimated recruitment at age 1. b) Total and harvestable biomass using 30 000 tonnes after 2009. c) Mean length at age. d) Estimated selection pattern of the commercial fleeit and the survey.

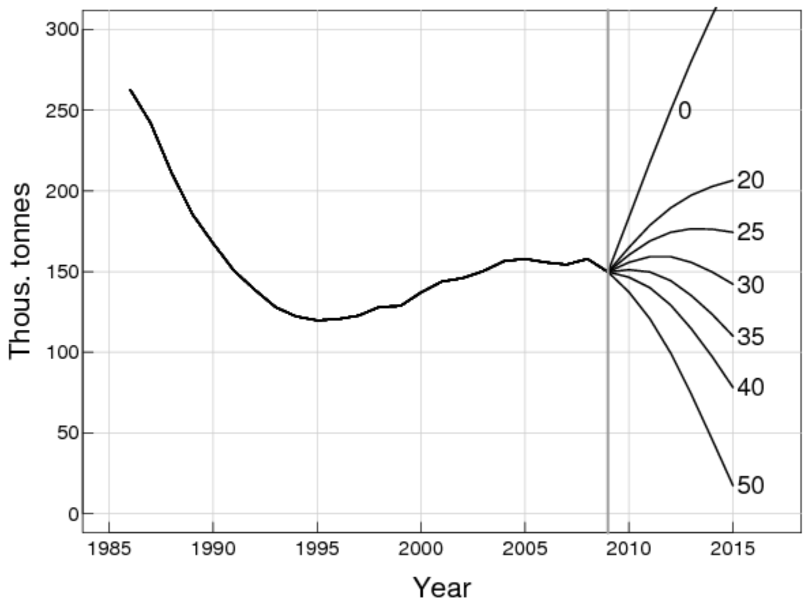


Figure 17.4.3 Development of catchable biomass of golden redfish using different catch options (0-50 000 t) after 2009.

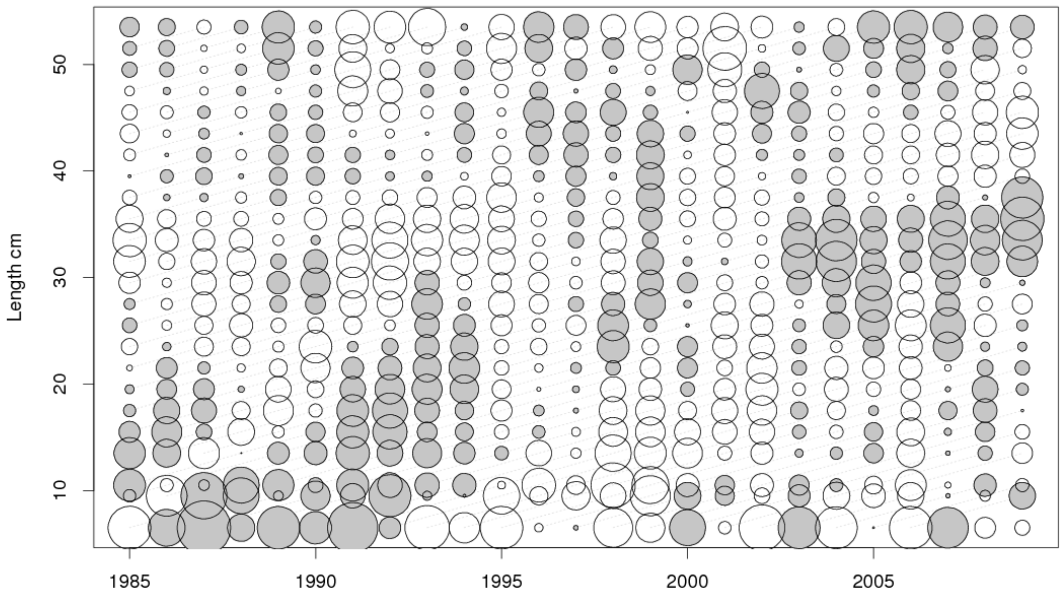


Figure 17.4.4 Residuals from the fit between model and survey indices. The shaded circles indicate positive residuals (survey results exceed model prediction). Largest residuals correspond to log(obs/mod) = 1.

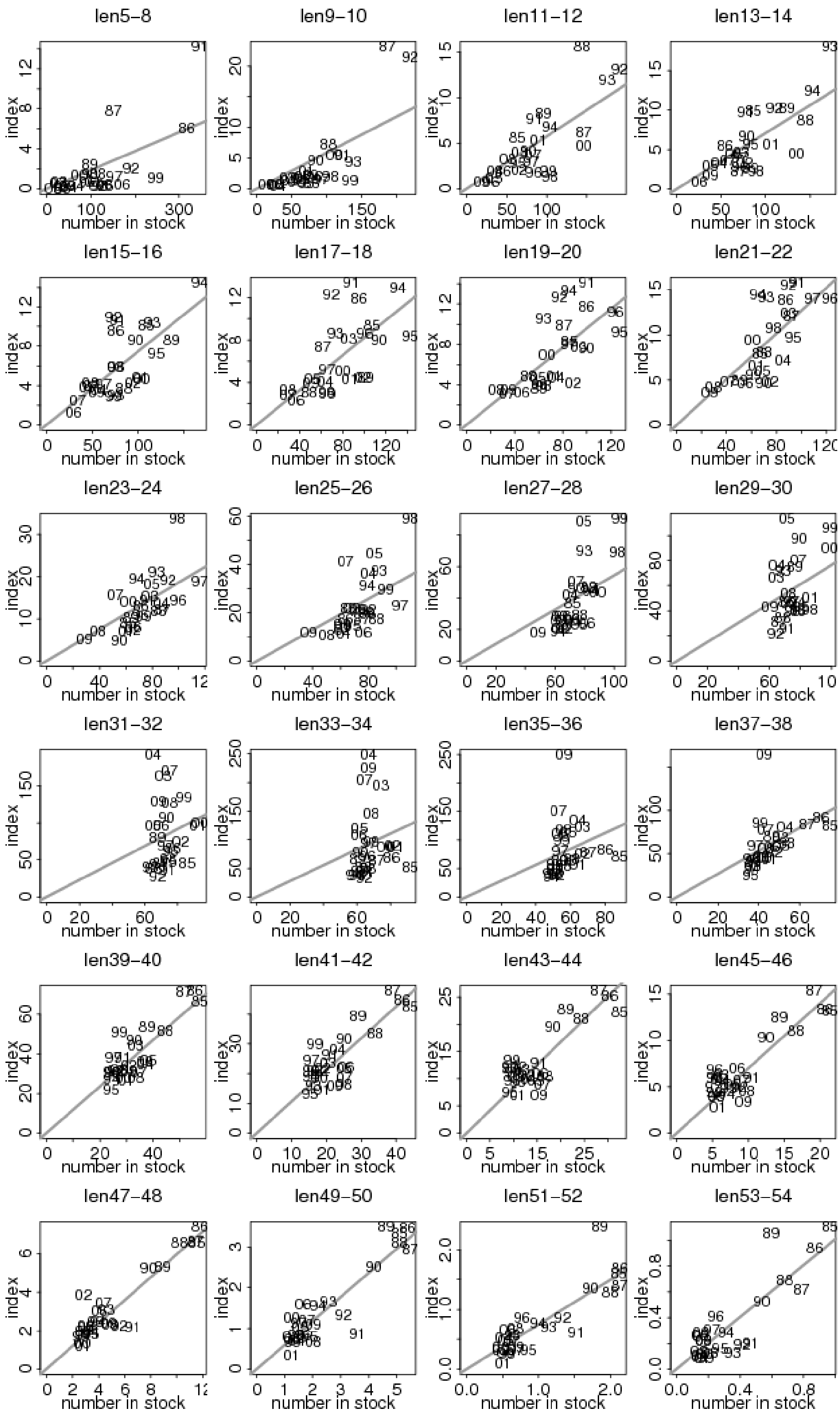


Figure 17.4.5 Survey indices for each length group plotted against the estimated number in stock from the model. The line shown is fitted on original scale but the model fit is on log scale. °

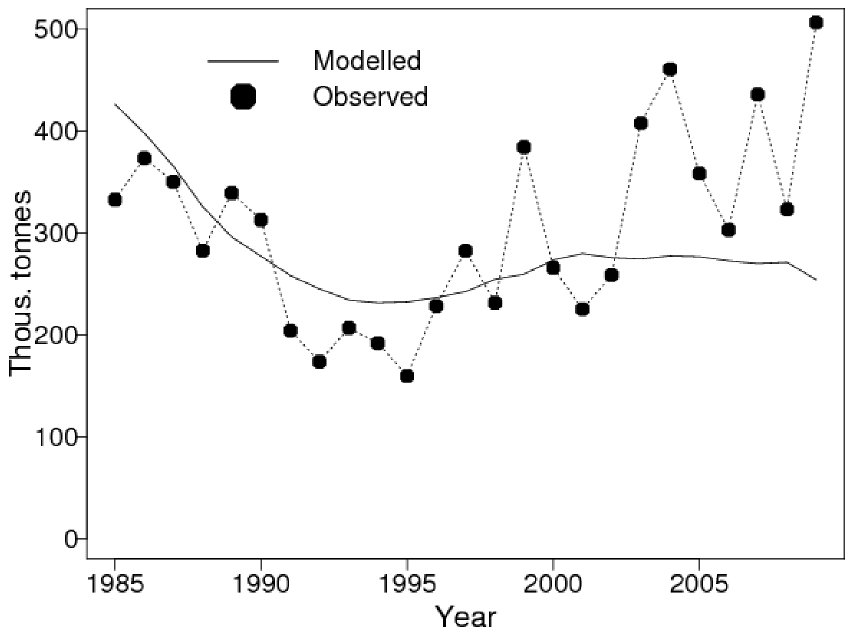


Figure 17.4.6 Results from the Gadget run, using only catch data from ICES Division Va. The Figure shows comparison of observed and modelled survey biomass (total biomass) 1985-2009.

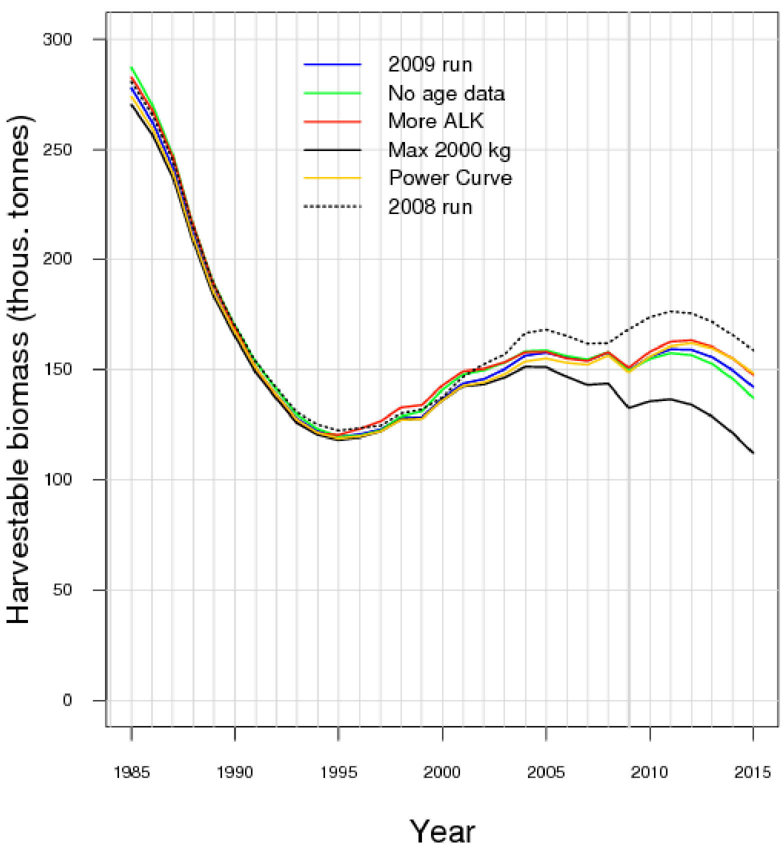


Figure 17.4.7 Comparison of the development of the available biomass in Va according to the GADGET runs this year and GADGET run last year. Prognosis is don with TAC constraints of 30 kt.

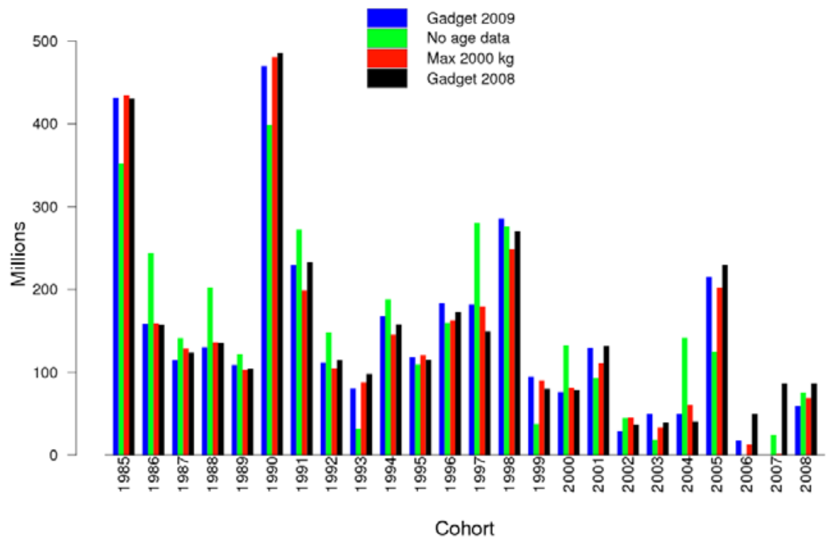


Figure 17.4.8 Comparison of the estimated recruitment according to the GADGET runs this year and GADGET run last year.

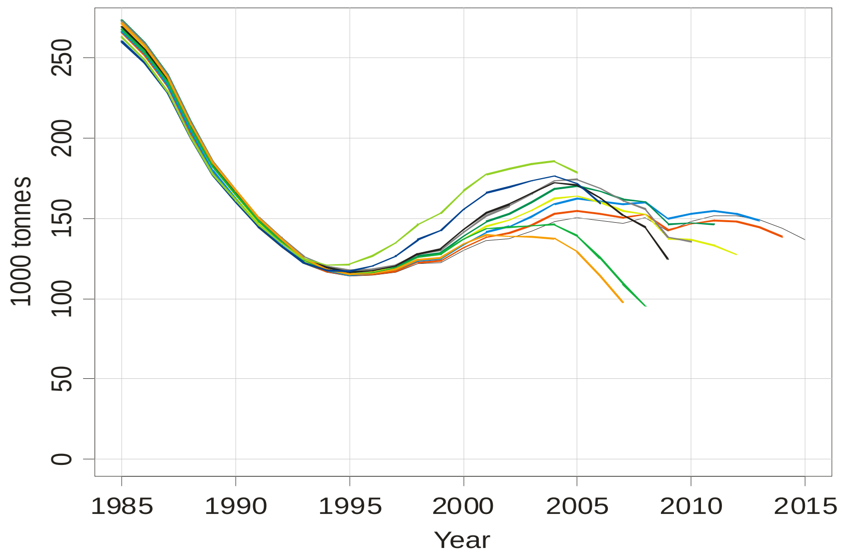


Figure 17.4.9 Retrospective pattern of the harvestable biomass of golden redfish in ICES Division Va. The retrospective patterns (1999-2008) show prognosis 6 years after the assessment year so the last retro ends in 2015.

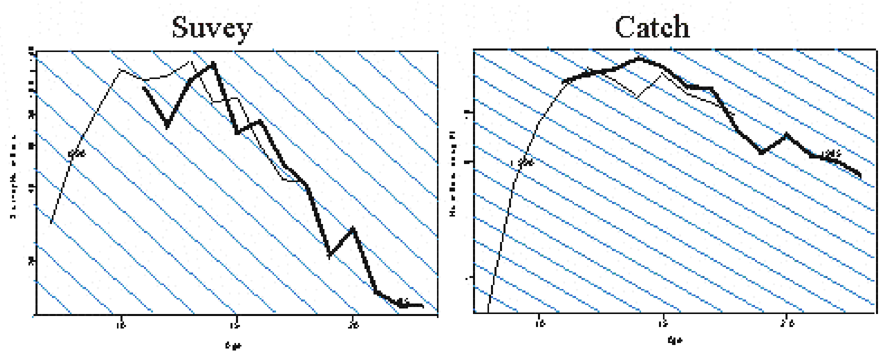


Figure 17.4.10 Autum survey indices and number caught for year classes 1985 and 1995 of golden redfish. Lines correspond to Z=0.2.

18 Icelandic slope *Sebastes mentella* in Va and XIV

Executive summary

- ICES concluded in February 2009 that demersal *S. mentella* is to be divided to three biological stocks and that the *S. mentella* on the continental shelf and slope should be treated as separate biological stock and management unit. This chapter therefore deals only with the Icelandic Slope stock.
- Total landings of demersal *S. mentella* in Icelandic waters in 2008 were about 25 500 t, about 8 500 t more than in 2007.
- No formal assessment was conducted and there are no biological reference points for the species. Survey indices are used as basis for advice.
- Available survey biomass indices show that in Division Va the biomass has been low but stable in the last 6 years.
- In recent years, good recruitment has been observed on the East-Greenland shelf which is assumed to contribute to the three stocks at unknown shares.

18.1 Stock description and management units

In February 2009 ICES concluded that there are three biological stocks of *Sebastes mentella* in the Irminger Sea and adjacent waters and should be managed as such: deep-pelagic (see Chapter 19) shallow-pelagic (see Chapter 19) and Icelandic Slope. The demersal *S. mentella* on continental shelves and slopes off East Greenland (XIV), Iceland (Va and XIV), and around the Faeroe Islands (Vb) has traditionally been treated as one stock but is now divided to these three stocks. The Icelandic shelf and slope component, i.e. in ICES divisions Va and XIV within the Icelandic 200 mile EEZ, will now be treated as separate biological stock and management unit.

The demersal habitat west of the Faeroe Islands is to be included with the deep pelagic component whereas demersal habitat east of the Faeroe Islands is to be included with the shallow pelagic component. For the time being the fishery of *S. mentella* from ICES Division Vb is described in Chapter 16.5.

Adult redfish on the East-Greenland shelf and slopes have been attributed to several stocks and is not included the three recommended management units. The *S. mentella* in Greenland waters is described in Chapter 16.5.

The East-Greenland shelf is most likely a common nursery area for the three biological stocks.

18.2 Scientific data

The Icelandic autumn survey on the continental shelf and slope in Va 2000-2008, covering depths down to 1,200 m, shows that the fishable biomass index (fish > 30 cm) of demersal *S. mentella* was highest in 2001, decreased in 2002 and has since then remained relatively stable (Figure 18.2.1*a* and *b*). The biomass index of fish larger than 45 cm was at lowest level in 2007 but increased again in 2008 and was similar to the 2005 value (Figure 18.2.1*c*). The abundance index of fish smaller than 30 cm (Figure 18.2.1*d*) was in 2008 at lowest level. The length of the demersal *S. mentella* in the autumn survey is between 30 and 47 cm with modes ranging from 36-39 cm (Figure 18.2.2).

18.3 Information from the fishing industry

18.3.1 Landings

Total annual landings of demersal *S. mentella* from Divisions Va from 1978-2008 are presented in Table 18.3.1 and in Figure 18.3.1. Annual landings gradually decreased from a record high of 57 000 t in 1994 to 17 000 t in 2001 t. Landings in 2003 increased to 28 500 t but fluctuated between 16 000 t and 21 000 in 2004-2007. The landings in 2008 were about 24 500 t, an increase of about 8 500 t from the previous year. This increase is because of increased landings in the last quarter of the year.

18.3.2 Fisheries and fleets

Most of the fishery for demersal *S. mentella* in Va is a directed trawl fishery taken by bottom trawlers along the shelf and slope west, southwest, and southeast of Iceland at depths between 500 and 800 m (Figure 18.3.2). The proportion of demersal *S. mentella* catches taken by pelagic trawls 1991-2000 varied between 10 and 44% (Table 18.3.2). In 2001-2006 and 2008, no pelagic fishery occurred or it was negligible, except in 2003 and 2007 (see below). In general, the pelagic fishery of demersal *S. mentella* has mainly been in the same areas as the bottom trawl fishery (Figure 18.3.3), but usually in later months of the year (Figure 18.3.4). The catches in the third and fourth quarter of the year decreased considerable in 2001-2007 compared with earlier years, mainly due to decreased pelagic fishery (Figure 18.3.4). The increased landings in 2008 is mainly due to increased bottom trawl fishery in September-November, which is unusual compared to other years (Figure 18.3.4). These catches were mainly taken in a fishing area northwest of Iceland (Figure (18.3.2).

The catch pattern was different in 2003 and in 2007 than in prior to 2003 and in 2004-2006. The catches peaked in July in 2003 and in June 2007, which was unusual compared with other years (Figure 18.3.4). This pattern is probably associated with the pelagic *S. mentella* fishery within the Icelandic EEZ (see Figure 16.1.1). The pelagic *S. mentella* fishery has in recent years moved more northwards, and in 2003 and 2007 it merged with the demersal *S. mentella* fishery on the redfish line in July (Figure 16.1.3). When the pelagic *S. mentella* crossed the redfish line to the east, it was recorded as demersal *S. mentella* and caught either with pelagic or bottom trawls resulting in increased landings in 2003 (Figures 18.3.2-18.3.3 and 16.1.1).

A notable change in the catch pattern is that catches taken in the southeast fishing area has been gradually decreasing since 2000 and in recent years very little demersal *S. mentella* was taken on these fishing grounds (Figure 18.3.2). This area has historically been an important fishing area for demersal *S. mentella*.

18.3.3 Sampling from the commercial fishery

The table below shows the 2008 biological sampling from the catch and landings of demersal *S. mentella* in Icelandic waters (Va).

Area	Nation	Gear	Landings (t)	No. samples	No. length measured
Va	Iceland	Bottom trawl	25 430	193	32 312

18.3.4 Length distribution from the commercial catch

Length distributions of demersal *S. mentella* in Va from the bottom trawl fishery show an increase in the number of small fish in the catch in 1994 compared to previous years (Figure 18.3.5). The peak of about 32 cm in 1994 can be followed by approximately 1 cm annual growth in 1996-2002. The fish caught in 2004-2008 peaked around 37-39 cm and were on average bigger than in 2003. The length distribution of demersal *S. mentella* from the pelagic fishery, where available, showed that in most years the fish was on average bigger than taken in the bottom trawl fishery (Figure 18.3.5).

18.3.5 Catch per unit effort

Data used to estimate CPUE for demersal *S. mentella* in Division Va 1986-2007 were obtained from log-books of the Icelandic bottom trawl fleet. Only those hauls were used that were taken below 450 m depth and that were comprised of at least 50% demersal *S. mentella*. Non-standardized CPUE for each year (y) was calculated and from which total fishing effort for each year (y) was estimated according to:

$$E_y = Y_y / CPUE_y,$$

where E is the total fishing effort and Y is the total reported landings (Table 18.3.1).

CPUE indices were also estimated from this data set using a GLM multiplicative model (generalized linear models). This model takes into account changes in vessels over time, area (ICES statistical square), month and year effects. The output of the model is given in Table 18.3.3 and the model residuals in Figure 18.3.8.

Trends in CPUE and effort are shown in Figure 18.3.7. CPUE gradually decreased from 1986 to a record low in 1994, but increased slightly annually to 2000. From 2000 to 2007 the CPUE was stable but increased in 2008. From 1991 to 1994, when CPUE decreased, the fishing effort increased drastically. Since then, effort decreased and is now at similar level as in the beginning of the series. Effort has not decreased as much annually in recent years as in 1995-2001, when the decrease was between 10% and 20% annually.

18.4 Methods

No formal assessment was conducted on this stock

18.5 Reference points

There are no biological reference points for the species. Previous reference points established were based upon commercial CPUE indices, but are now considered to be unreliable indicators of stock size. ICES has withdrawn these reference points.

18.6 State of the stock

The Group concludes that the state of the stock is stable on a low level. With the information at hand, current exploitation rates can not be evaluated for the demersal *S. mentella* in Division Va.

The fishable biomass index of demersal *S. mentella* in Va from the Icelandic autumn survey shows that the biomass index for 2002-2008 has been relatively stable on a lower level than in earlier years. Standardised CPUE indices show a reduction from highs in the late 1980s, but there is an indication that the stock has started a slow recovery since the middle of 1990s, when CPUE was close to 50% of the maximum. The CPUE index has been increasing since 1995.

Recently, good recruitment has been observed on the East Greenland shelf (growth of about 2cm/yr) which is assumed to contribute to both the demersal and pelagic stock at unknown shares.

18.7 Management considerations

S. mentella is a slow growing, late maturing deep-sea species and is therefore considered vulnerable to overexploitation and advice has to be conservative.

The CPUE has been stable on a low level during recent years. It is, however, not known to what extent CPUE series reflect change in stock status of demersal *S. mentella*. The nature of the redfish fishery is targeting schools of fish using advancing technology. The effect of technological advances is to increase CPUE, but is unlikely to reflect biomass increase.

The advice for 2008 was that a management plan to be developed and implemented which takes into account the uncertainties in science and the properties of the fisheries. ICES suggested that catches of *S. mentella* are set no higher than 10 000 t as a starting point for the adaptive part of the management plan.

The demersal *S. mentella* fishery southeast of Iceland has gradually ceased since 2000 and in 2008 very little fishing occurred in this area. This fishing area was prior to 2000 very important fishing area for demersal *S. mentella*.

The landings increased in Division Va between 2002 and 2003 by about 10,000 t when the fishery of pelagic *S. mentella* merged with the demersal fishery at the redfish line. Those two fisheries merged again in 2007.

Icelandic authorities give a joint quota for golden redfish and demersal *S. mentella* in Icelandic waters. In late 2008, the Ministry of Fisheries in Iceland established a committee with the objective to review and recommend on how to separate quotas for the two species. Consensus was within the committee that quota for those two species should be given separately and it is expected to be implemented in the next fishing year which starts September 1 2009.

Table 18.3.1 Nominal landings (tonnes) of demersal *S. mentella* 1978-2008 ICES Division Va.

Year	Iceland	Others	Total
1978	3 693	209	3 902
1979	7 448	246	7 694
1980	9 849	348	10 197
1981	19 242	447	19 689
1982	18 279	213	18 492
1983	36 585	530	37 115
1984	24 271	222	24 493
1985	24 580	188	24 768
1986	18 750	148	18 898
1987	19 132	161	19 293
1988	14 177	113	14 290
1989	40 013	256	40 269
1990	28 214	215	28 429
1991	47 378	273	47 651
1992	43 414	0	43 414
1993	51 221	0	51 221
1994	56 674	46	56 720
1995	48 479	229	48 708
1996	34 508	233	34 741
1997	37 876	0	37 876
1998	32 841	284	33 125
1999	27 475	1 115	28 590
2000	30 185	1 208	31 393
2001	15 415	1 815	17 230
2002	17 870	1 175	19 045
2003	26 295	2 183	28 478
2004	16 226	1 338	17 564
2005	19 109	1 454	20 563
2006	16 339	869	17 208
2007	16 495	369	16 864
2008[1)]	25 430	0	25 430

1) Provisional

Table 18.3.2 Proportion of the landings of demersal *S. mentella* taken in Va by pelagic and bottom trawls 1991-2008.

Year	Pelagic trawl	Bottom trawl
1991	22%	78%
1992	27%	73%
1993	32%	68%
1994	44%	56%
1995	36%	64%
1996	31%	69%
1997	11%	89%
1998	37%	63%
1999	10%	90%
2000	24%	76%
2001	3%	97%
2002	3%	97%
2003	28%	72%
2004	0%	100%
2005	0%	100%
2006	0%	100%
2007	17%	83%
2008	0%	100%

Table 18.3.3 Results of the GLM model to calculate standardized CPUE for Icelandic demersal redfish fishery in Va. Note that the residuals are shown in Fig..

```
Call: glm(formula = lafli ~ ltogtimi + factor(ar) + factor(veman) + factor(skipnr) +
factor(reitur)  family =
        gaussian()  data = tmp)

Deviance Residuals:
       Min         1Q     Median       3Q      Max

  -5.016804 -0.3243327 0.01429249 0.3445513 4.716284


                  Value  StdError t.value ar  index  lower  upper
factor(year)1986  0.000      0.000   0.000 1986 1.000 1.000 1.000
factor(year)1987  0.064      0.043   1.477 1987 1.066 1.021 1.113
factor(year)1988  0.001      0.042   0.024 1988 1.001 0.959 1.044
factor(year)1989 -0.040      0.042  -0.967 1989 0.960 0.921 1.001
factor(year)1990 -0.100      0.039  -2.550 1990 0.904 0.870 0.941
factor(year)1991 -0.059      0.035  -1.677 1991 0.943 0.910 0.977
factor(year)1992 -0.310      0.035  -8.896 1992 0.734 0.709 0.760
factor(year)1993 -0.410      0.035 -11.763 1993 0.664 0.641 0.687
factor(year)1994 -0.518      0.035 -14.825 1994 0.596 0.575 0.617
factor(year)1995 -0.482      0.035 -13.646 1995 0.618 0.596 0.640
factor(year)1996 -0.467      0.036 -12.947 1996 0.627 0.605 0.650
factor(year)1997 -0.415      0.036 -11.579 1997 0.660 0.637 0.684
factor(year)1998 -0.423      0.038 -11.197 1998 0.655 0.631 0.681
factor(year)1999 -0.370      0.037 -10.019 1999 0.691 0.666 0.717
factor(year)2000 -0.314      0.038  -8.366 2000 0.731 0.704 0.759
factor(year)2001 -0.326      0.039  -8.265 2001 0.722 0.694 0.751
factor(year)2002 -0.357      0.038  -9.443 2002 0.700 0.674 0.727
factor(year)2003 -0.285      0.038  -7.502 2003 0.752 0.724 0.781
factor(year)2004 -0.359      0.039  -9.281 2004 0.698 0.672 0.726
factor(year)2005 -0.347      0.037  -9.262 2005 0.707 0.681 0.734
factor(year)2006 -0.358      0.038  -9.331 2006 0.699 0.673 0.726
factor(year)2007 -0.355      0.041  -8.604 2007 0.701 0.673 0.731
factor(year)2008 -0.265      0.039  -6.815 2008 0.767 0.738 0.798

Analysis of Deviance Table

Gaussian model

Response: log(catch)

Terms added sequentially (first to last)
                Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
NULL                  25826   48432
NULL                  26920   50772
Log(towingtime)   1   36489   26919   14282   92735.68     0
factor(year)     22     842   26897   13440      97.25     0
factor(month)    11     236   26886   13205      54.50     0
factor(ship)    150    1837   26736   11367      31.13     0
factor(area)    148     905   26588   10462      15.55     0
```

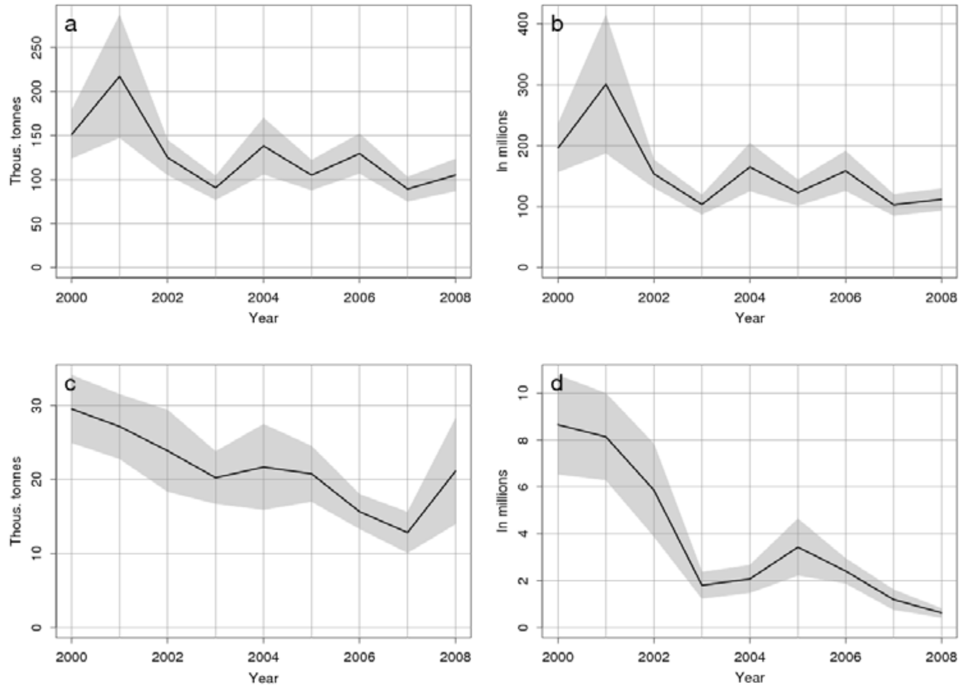


Figure 18.2.1 Survey indices of the Icelandic demersal *S. mentella* in the autumn survey in Division Va 2003-2008. a) Total biomass index b) fishable biomass index (> 30 cm) c) biomass index of fish larger than 45 cm d) abundance index of fish smaller than 30 cm.

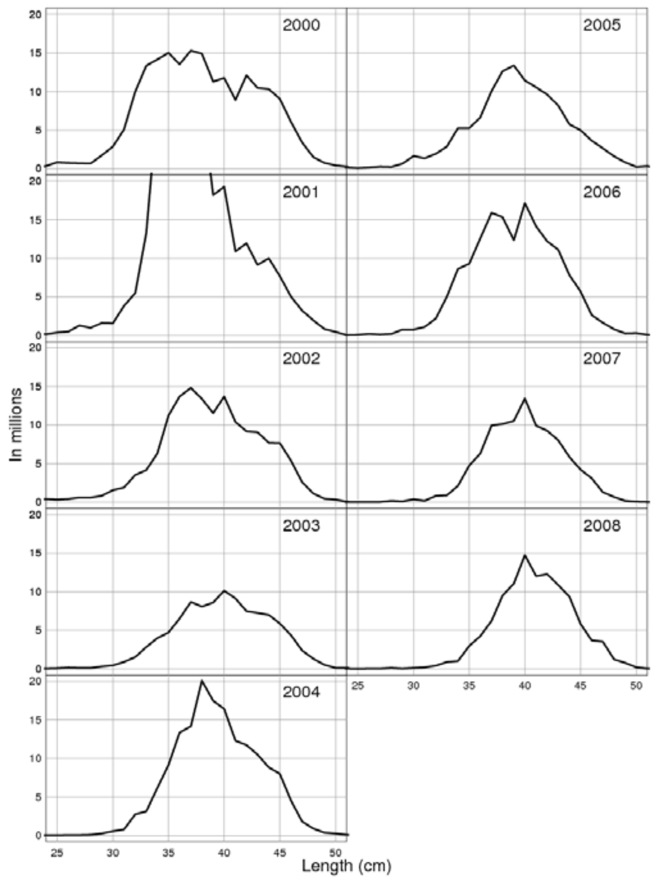


Figure 18.2.2 Length distribution of demersal *S. mentella* in the bottom trawl surveys in October 2000-2008 in ICES Division Va.

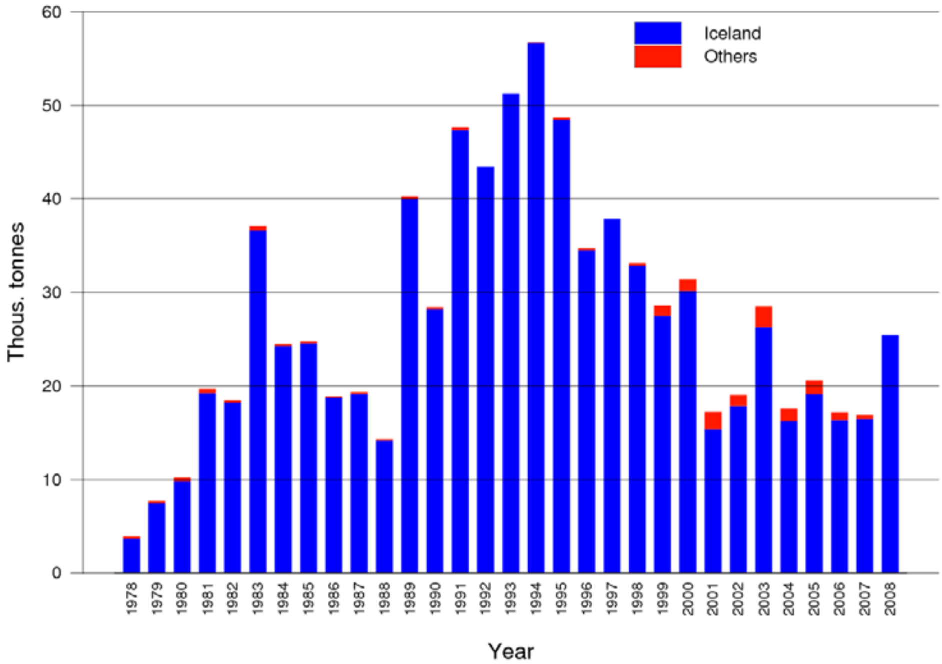


Figure 18.3.1 Nominal landings of demersal *S. mentella* (in tonnes) from ICES Divisions Va 1978-2008.

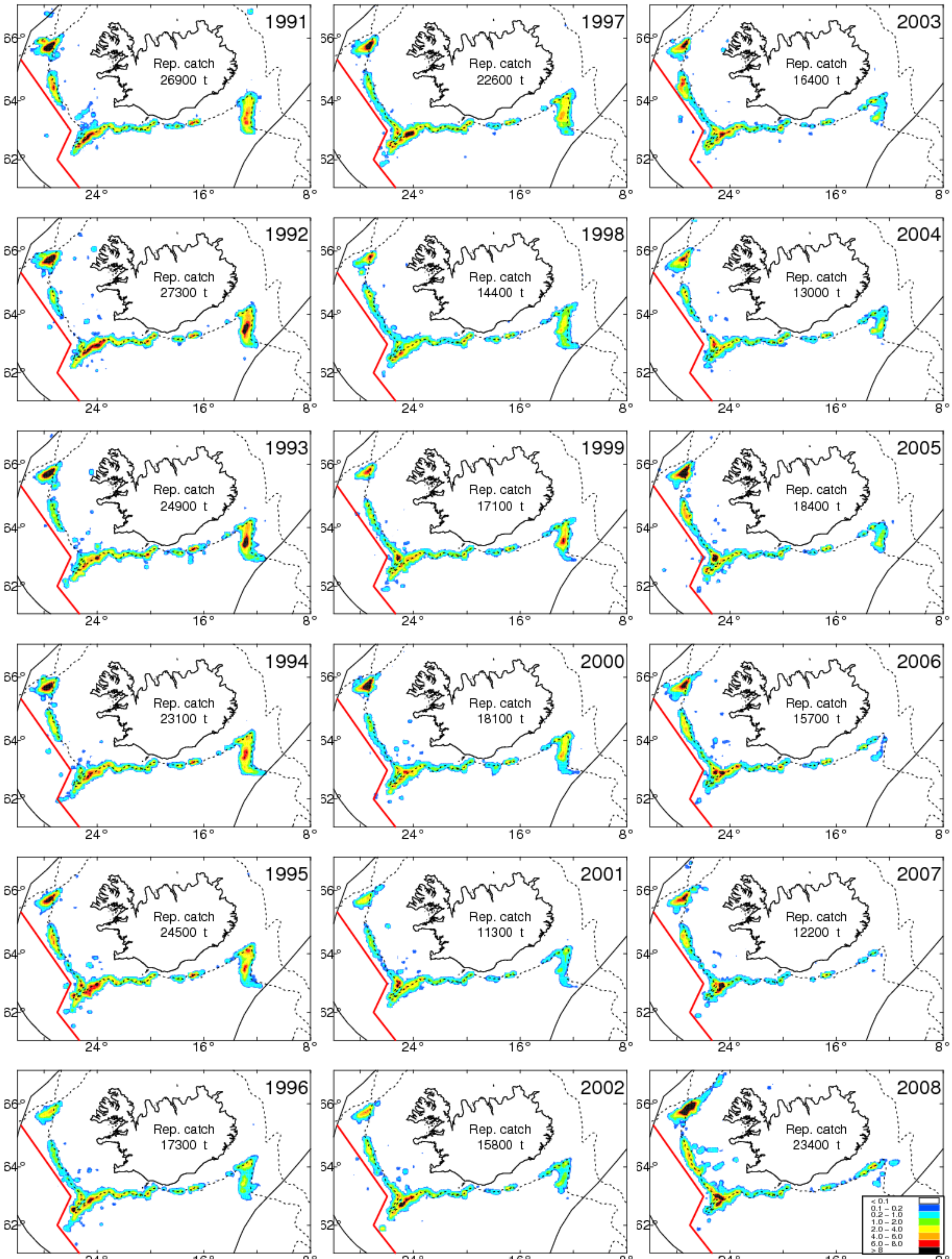


Figure 18.3.2 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2008 as reported in log-books of the Icelandic fleet using bottom trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

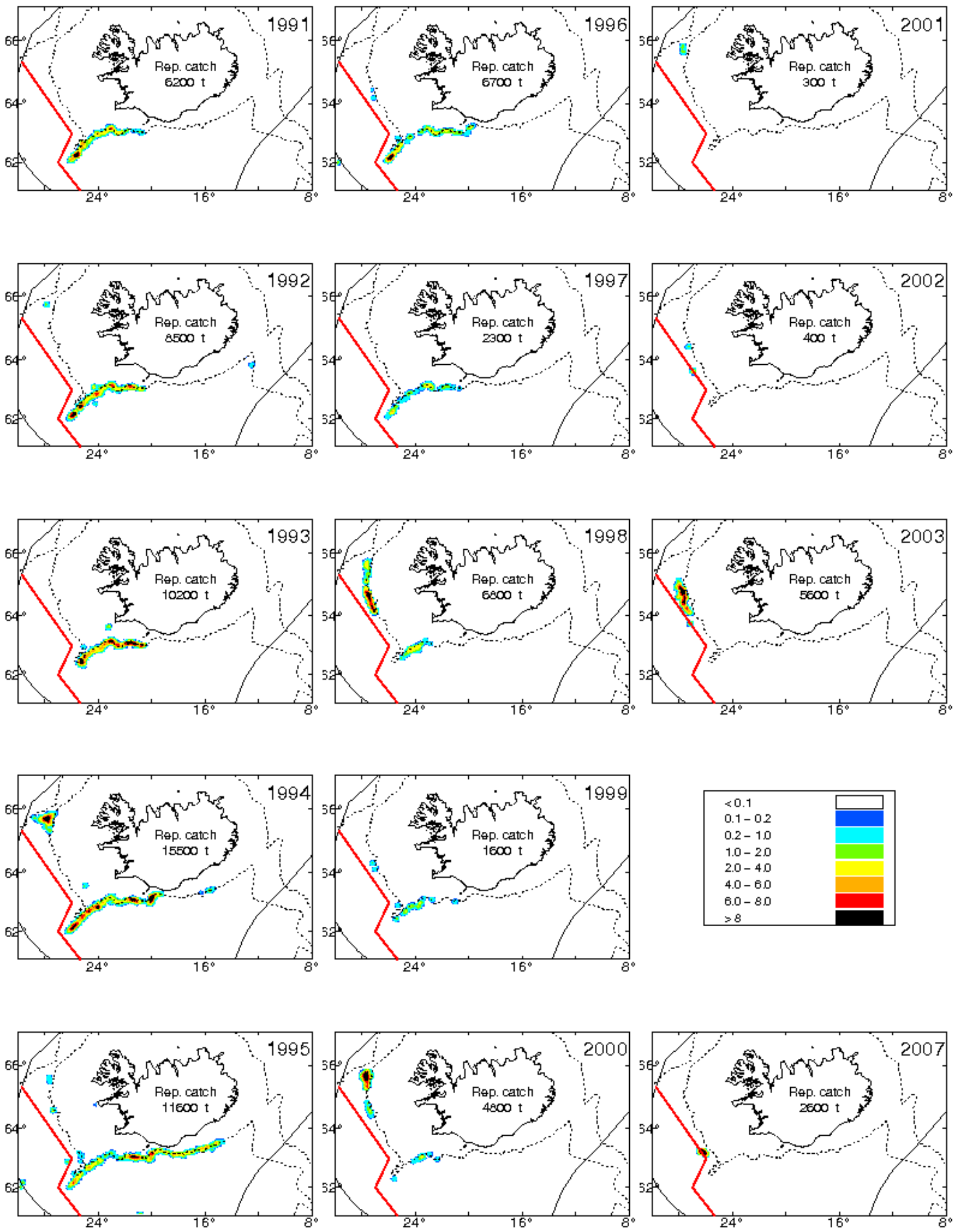


Figure 18.3.3 Geographical location of the demersal *S. mentella* catches in Icelandic waters 1991-2003 and 2007 as reported in log-books of the Icelandic fleet using pelagic trawl. The red line is the redfish line and the dotted line represents the 500 m isobaths.

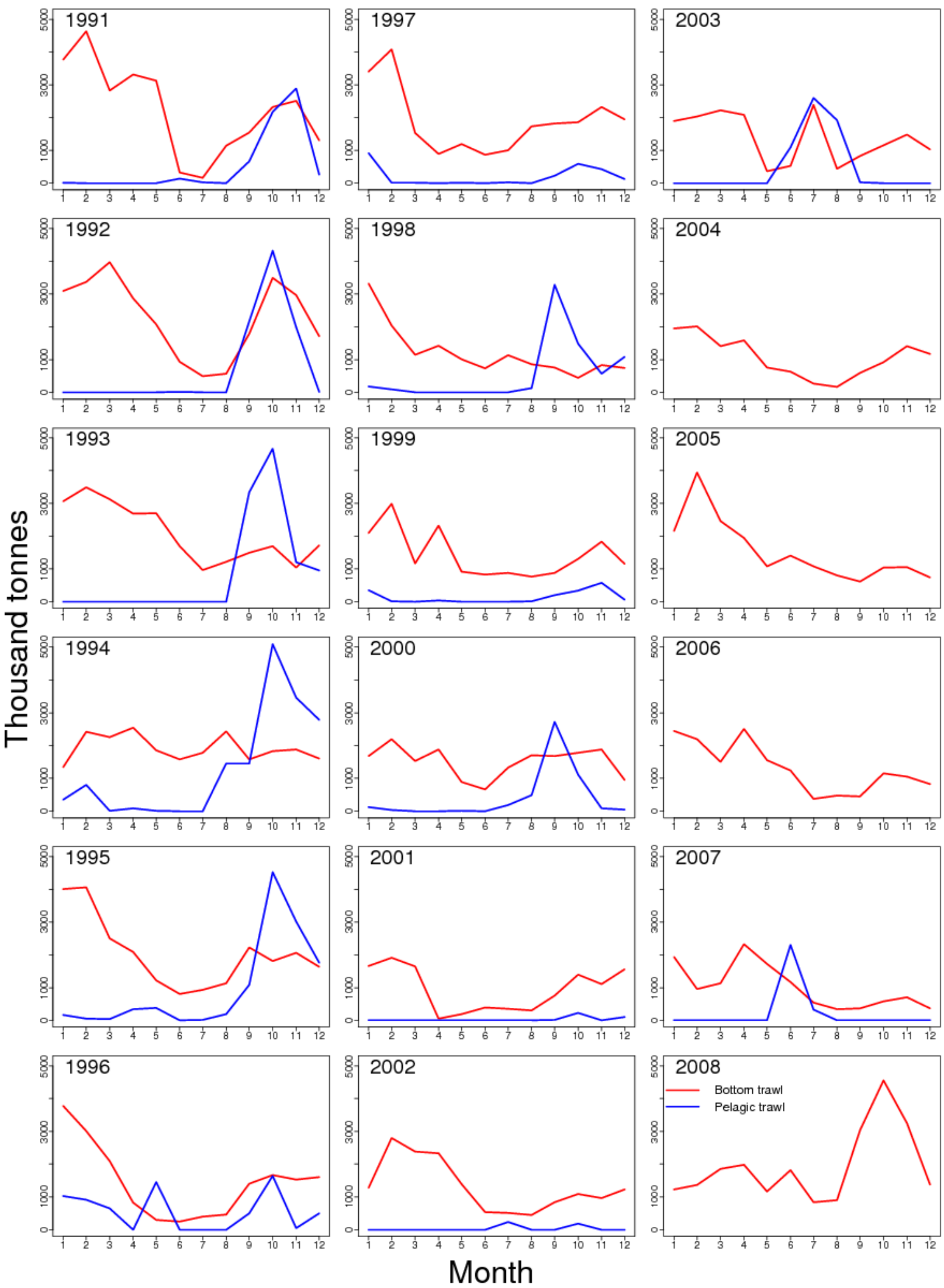


Figure 18.3.4 Nominal landings of demersal *S. mentella* (in tonnes) in Icelandic waters (ICES Division Va) of the Icelandic fleet using either bottom trawl (red line) or pelagic trawl (blue line) 1991-2008 divided by month.

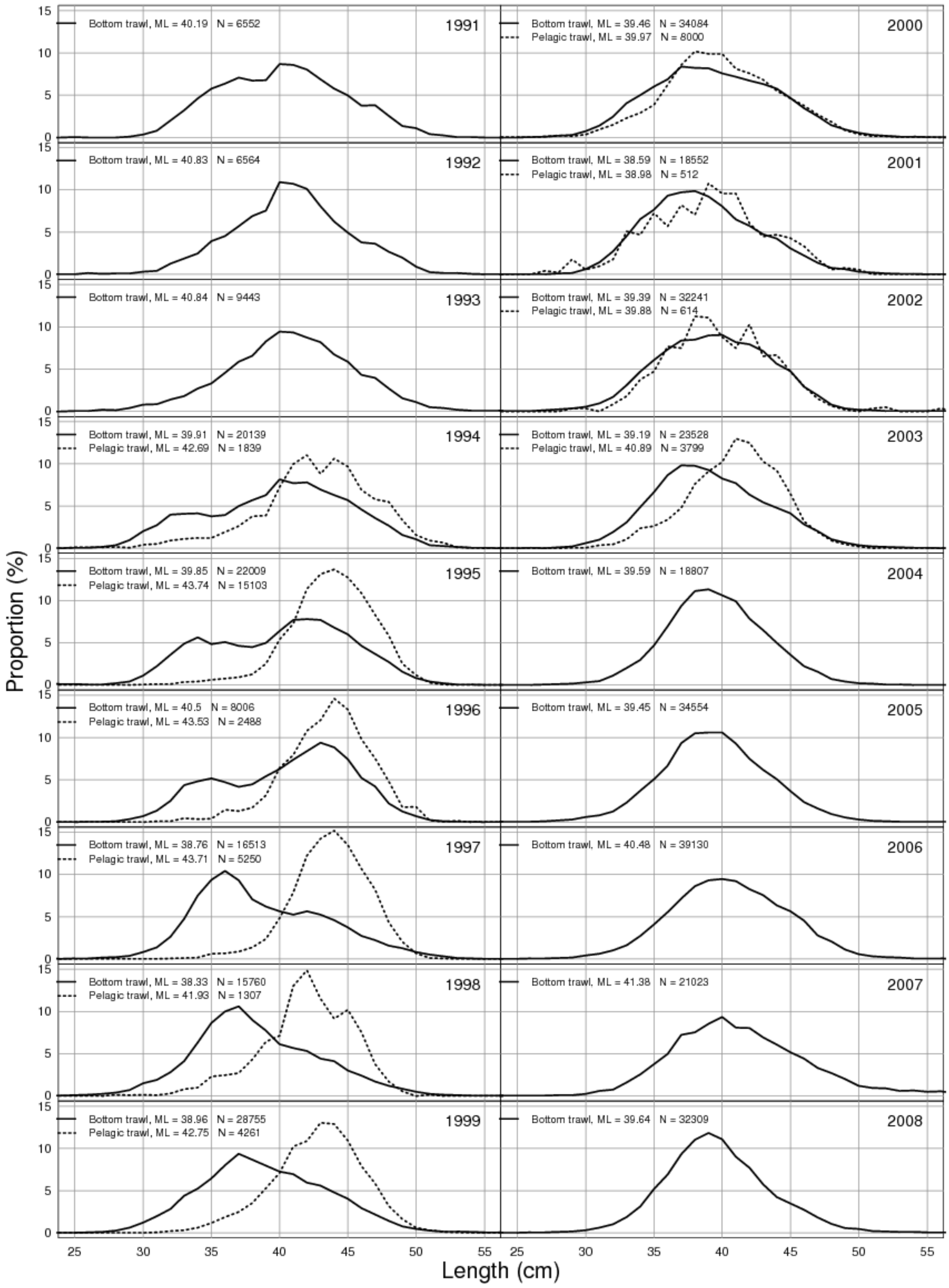


Figure 18.3.5 Length distributions of demersal *S. mentella* from the Icelandic landings taken with bottom trawl (solid line) and pelagic trawl (dotted line) in Division Va 1991-2008.

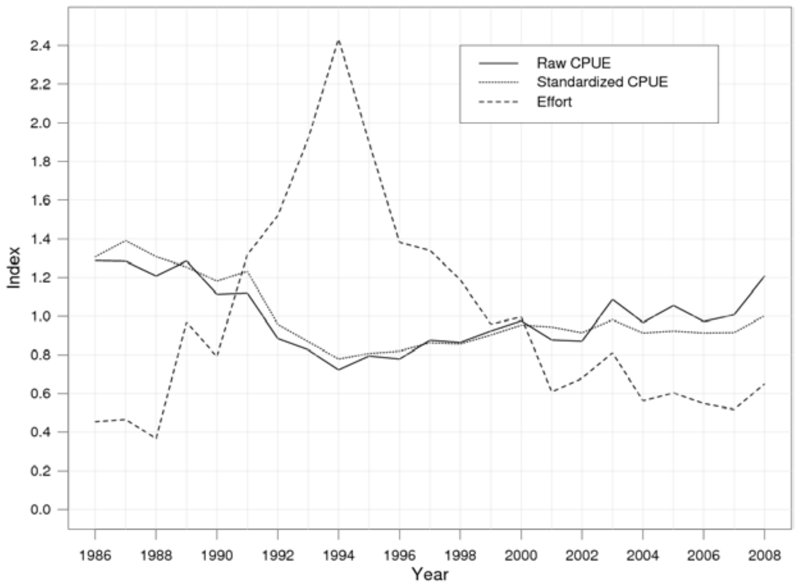


Figure 18.3.7 CPUE relative to 1986 of demersal *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model based on data from log-books and where at least 50% of the total catch in each tow was demersal *S. mentella*. Also shown is fishing effort (hours fished in thousands).

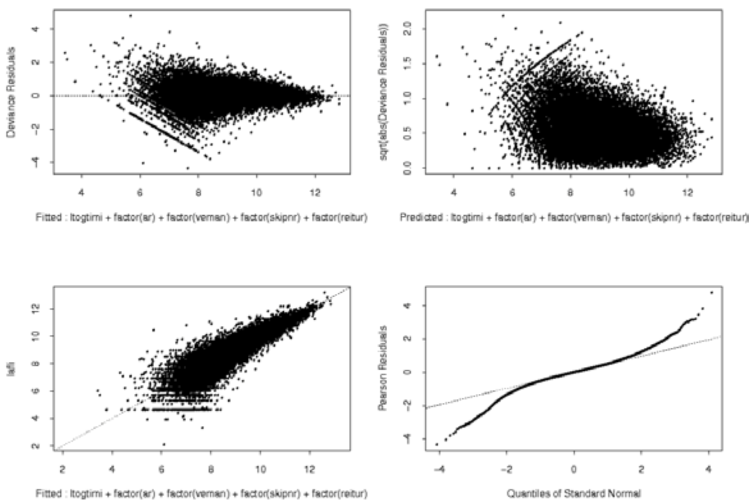


Figure 18.3.8 Residual of the GLM model (section 9.2.1) for the CPUE series of demersal *S. mentella.*

19 Shallow Pelagic and Deep Pelagic *Sebastes mentella*

19.1 Stock description and management units

The "Workshop on Redfish Stock Structure" (WKREDS, 22-23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *Sebastes mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that the pelagic *S. mentella* in the Irminger Sea and adjacent waters should be divided into two biological stocks:

- a 'Deep Pelagic' stock (NAFO 1–2, ICES V, XII, XIV >500 m) – primarily pelagic habitats, and includes demersal habitats west of the Faeroe Islands;
- a 'Shallow Pelagic' stock (NAFO 1–2, ICES V, XII, XIV <500 m) – extends to ICES I and II, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;

This section therefore divides the information on the pelagic fishery for pelagic *S. mentella* in the Irminger Sea and adjacent areas (parts of Division Va, Subareas XII and XIV; eastern parts of NAFO Divisions 1F, 2H and 2J) into these two biological stocks were possible (Chapter 19.3 and 19.4 on shallow and deep pelagic *S. mentella* respectively). However, time did not allow the group to evaluate the data. The state of the two stocks was, therefore, not evaluated by the NWWG 2009. The state of the stocks will be evaluated after the survey and publication of relevant report in the autumn of 2009.

The following text table summarises the available information from fishing fleets in the Irminger Sea and adjacent waters in 2008:

Faroes	3 factory trawlers
Iceland	12 factory trawlers
Norway	1 factory trawler
Poland	1 factory trawler
Portugal	6 factory trawlers
Russia	17 factory trawlers
Spain	6 factory trawlers

19.2 Splitting the catches between shallow pelagic and deep pelagic *S. mentella*

This work is based on the work done at the NWWG meeting in Bergen, Norway in September 2004.

For the period 1982-1991, all landings are from the oceanic *S. mentella* because the main fishing area was in the central Irminger Sea from 58° to 61°N and between 28° and 36°W, the ICES Divisions XII and XIV beyond Greenland and Icelandic national jurisdictions at depths between 75 and 400 m.

In the period 1992-1996, the fishery gradually shifted towards trawling at greater depths and developing a clear seasonal pattern in the fishery. Both the fishing areas and the depth of trawling changed systematically as the season progressed. By the end of this period, all fleets were fishing in the NE part of the Irminger Sea on the deep pelagic *S. mentella* in the beginning of the season until around mid June, when all fleets moved southwest to the central Irminger Sea to fish on the shallow pelagic *S. mentella*. For this period, landings have been assigned to stocks based on different criteria such as landings by ICES statistical areas, ICES Divisions, landings by nation, logbook data. If data was lacking for some nations, the average from other nations where data was available was assigned to that nation. The landing figures by stock for this period are considered the most unreliable one and therefore to be regarded as the WG's best estimates (guestimates).

From 1997 onwards, following persistent fishing pattern have developed: During the first months of the fishing season (April), the fishery is conducted in an area east of 32°W and north of 61°N. In May and June, the fishery is conducted more or less at the same areas, but in July and August, the fleets moved to areas south of 60°N and west of about 32°W, where the fishery continues until October. There are very little fishing activities in the period from November until late March or early April when the next fishing season starts. For the period from 1997 onwards, logbook data from Russia, Iceland, Faroe Islands, Norway and Germany have been used to calculate landings by stock within each ICES Division. Catches by other nations are assumed based on the same proportions as calculated here.

The depth range of the fisheries of various nations in 2008 is given in Table 19.2.1. This table has not been updated for the previous years and therefore the numbers are given for above and below 600 m.

The WG acknowledges information on trawling depths as provided by some nations, but recommends that all nations should report depth information in accordance with the NEAFC logbook format.

The depth range for the Russian fleet is shown in Figure 19.2.1. Note that the depth range is divided into 0-400 m, 400-600 m and 600 m and deeper.

The splitting of the catches between shallow and deep pelagic *S. mentella* will be re-evaluated as it is expected that individual nations will provide better resolution of the catches in respect of depth.

19.3 Shallow pelagic *S. mentella*

19.3.1 Biological sampling from the fishery

The biological sampling from catches of shallow pelagic *S. mentella* in each Subarea/Division in 2008 is shown in the text table below.

COUNTRY	AREA	LANDINGS (T)	NO. OF SAMPLES	NO. OF FISH MEASURED
Portugal	XIV		5	480
Russia	NAFO 1F	1,580	NA	3,347
Spain	XIV	36	2	331

19.3.2 Summary of the development of the fishery

A summary of the catches by ICES Divisions/NAFO regulatory area as estimated by the Working Group is given in Table 19.3.1 and shown in Figure 19.3.1. Russian trawlers started fishing pelagic *S. mentella* in 1982 and covered wide areas of the Irminger Sea (Figure 19.2.4). Vessels from Bulgaria, the former GDR and Poland joined those from in 1984. The annual landing 1982-1995 ranged between 60,000 t and 100,000 except for the period 1989-1991 when the annual landings was around 30,000

t. In 1996, annual landing decreased by about 60,000 t to 41,000 t and varied between 25,000 and 40,000 t between 1996-2005. This is probably an underestimate due to incomplete reporting of catches (see section 19.5.3). Since then, annual landings have decreased considerable and only about 2,000 t were landed from this stock in 2008, mainly from NAFO Convention area 1F (Figure 19.2.3).

Since 2000, significant catches were taken in NAFO Divisions 1F and 2J, up to 32 000 t (20% of total catches) in 2003. In 2007, however, only 1 500 t (5% of the total catches) were taken in the NAFO area.

In the period 1982-1992, the fishery was carried out mainly from April to August but since then the fishery has been carried from July-October.

The fleets participating in this fishery have continued to develop their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80-150 m.

The WG acknowledges information on trawling depths as provided by some nations, but recommends that all nations should report depth information in accordance with the NEAFC logbook format.

The historic development of the fisheries by nation can be found in the 2007 NWWG Report.

A summary of the catches by nation as estimated by the Working Group is given in Table 19.3.2.

Non-standardised CPUE series for the largest fleets (representing about 80% of landings) are given in Figure 19.3.2. Since 1995, there is a decreasing trend in CPUE.

19.3.3 Biological information

The length distributions by ICES and NAFO areas are given in Figures 19.2.5 and 19.2.5 for 2000-2007. The data for those years have not been made available to the NWWG in order to analyse them separately for the shallow pelagic stock.

Length distribution of shallow pelagic *S. mentella* from the catches in 2008 is given in Figure 19.3.3.

The peak length in ICES Subarea XIV was usually 41-42 cm, whereas it was around 35 cm in ICES Subarea XII and NAFO Division 1F and 2J. This mostly reflects the general pattern of a fishery in deeper layers in Subarea XIV and shallower layers in Subarea XII and NAFO 1F and 2J. In 2001, the German catches in Subarea XIV were taken in shallower depths, resulting in markedly smaller fish landed (Figure 19.2.5). In 2005, a considerable decrease in mean length was observed, especially in Subareas XII and XIV (Figures 19.2.5). In 2006 and 2007, however, the mean lengths generally increased again to values observed in 2003 and earlier.

Biological samples from the catches in recent years, and also from the acoustic survey in 1999, suggested that new cohorts are entering into the fishable stock of pelagic redfish on an irregular basis (Stransky, 2000).

19.3.4 Discards

Discard is at present not considered to be significant for those both fisheries. This is based on available measurements from various institutes.

19.3.5 Illegal Unregulated and Unreported Fishing (IUU)

The Group had again difficulties in obtaining catch estimates from the various fleets. Furthermore, landings data were missing from some nations. The Group requests NEAFC and NAFO to provide ICES in time with all information that supports the Group with regard to more reliable catch statistics.

19.3.6 Surveys

No new survey data were available to the group since the last international trawl-acoustic survey was in 2007. The next survey will be carried out in June/July 2009.

The international trawl-acoustic surveys on pelagic redfish have been conducted in international collaboration with Germany, Iceland, Norway (in 1994 and 2001) and Russia at 2-3 years intervals (Table 19.2.2). In addition, several national surveys have been carried out. During the last decade, the horizontal and vertical coverage of the survey changed as the fishery explored new fishing grounds in southwesterly direction and deeper layers. Vertical coverage of the hydro-acoustic recording of redfish varied among years in relation to the upper boundary of the deep scattering layer (DSL), in which redfish echoes are difficult to identify. Since 2001, the varying depth layers within and deeper than the DSL were covered by standard trawl hauls to account for the incompletely covered vertical depth distribution of the pelagic redfish.

The most recent survey was carried out during June/July 2007 (ICES CM 2007/RMC:12).

19.3.6.1 Survey acoustic data

Since 1994, the results of the acoustic estimate show a drastic decreasing trend from 2.2 mio t to 0.6 mio t in 1999 and have fluctuated between 100 000-700 000 t in 2001-2007 (Table 19.2.2). The 2003 estimate, however, was considered as inconsistent with the time series due to a shift in the timing of the survey.

The most recent trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Iceland and Russia from mid-June to mid-July 2007. Approximately 350 000 NM^2 were covered. A total biomass of 372 000 t was estimated acoustically in the layer shallower than the DSL. The highest concentrations of redfish in this layer were found in Division XIVb within the Greenlandic EEZ and in NAFO Div. 1F, 2H and 2J (Fig. 19.2.8). Biological samples from identification trawls in these depths showed a mean length of 34.7 cm. Figure 19.2.10 (upper panel) shows the length distribution.

19.3.6.2 Survey trawl estimates

In addition to the acoustic measurements, redfish were estimated within and below the DSL by correlating catches and acoustic values at depths shallower than the DSL (Figure 19.2.7). The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance. For that purpose, standardised trawl hauls were carried out at different depth intervals (four depth intervals in hauls ≥DSL and two depth intervals hauls <DSL), evenly distributed over the survey area (Figure 19.2.9). As the correlation between the catch and acoustic values is based on few data points only (Figure 19.2.7), the abundance estimation obtained from this exercise makes the method questionable and also the assumption that the catchability of the trawl is the same, regardless of the trawling depth. The quality of the trawl method cannot be verified as the data series is very short. Such evaluation on the consistency of the method can therefore not be done until more data points are available.

Therefore, the abundance estimation by the trawl method must only be considered as a rough attempt to measure the abundance within and deeper than the DSL.

Biological samples from the trawls within and deeper than the DSL showed a mean length of 37.1 cm. Figure 19.2.10 (lower panel) shows the corresponding length distribution.

19.3.7 Methods

The assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data. See sections 19.2, 19.3 and 19.6 for details.

19.3.8 Reference points

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is being carried out due to data uncertainties and the lack of reliable age data. Thus, no reference points can be derived.

19.3.9 State of the stock

19.3.10 Short term forecast

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is being carried out due to data uncertainties and the lack of reliable age data. Thus, no short-term forecasts can be derived.

19.3.11 Uncertainties in assessment and forecast

19.3.11.1 Data considerations

Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data. The Group has during the last years identified problems with unreported catches of pelagic redfish. Current data available to the Group indicate that the reported effort (and consequently landings) could represent only around 80% of the real effort.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries were given.

The Group started to collate an international database with length distributions from the sampling of the fisheries on a spatially disaggregated level. Once complete, the horizontal and vertical differences in mean length by fishing areas can be illustrated as alternative to the portrayals by ICES/NAFO Divisions.

19.3.11.2 Assessment quality

The results of the international trawl-acoustic survey are given in sections 19.6.1 and 19.6.2. Given the high variability in the correlation between trawl and acoustic estimates as well as the assumptions that need to be made about constant catchability with depth and areas, the uncertainty of these estimates is very high.

The reduction in biomass observed in the surveys in the hydroacoustic layer (about 2 mio. t in the last decade) cannot be explained by the reported removal by the fisheries (about about 500,000 t in the entire depth range in 1995-2007) alone. A decreasing trend in the relative biomass indices in the acoustic layer, however, is visible since 1991.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*. The fishery is focusing on aggregations. Therefore, CPUE series might not indicate or reflect actual trends in stock size.

19.3.12 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

19.3.13 Management considerations

The Group had again difficulties in obtaining catch estimates from the various fleets, and new information available indicates that unreported catches might be substantial. Furthermore, landings data were missing from some nations. The Group requests NEAFC and NAFO to provide ICES with all information that supports the Group with regard to more reliable catch statistics.

As mentioned in Chapter 19.1 the "Workshop on Redfish Stock Structure" (WKREDS, 22-23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *Sebastes mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that the pelagic *S. mentella* in the Irminger Sea and adjacent waters should be divided into two biological stocks:

- a 'Deep Pelagic' stock (NAFO 1–2, ICES V, XII, XIV >500 m) – primarily pelagic habitats, and includes demersal habitats west of the Faeroe Islands;
- a 'Shallow Pelagic' stock (NAFO 1–2, ICES V, XII, XIV <500 m) – extends to ICES I and II, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;

ICES past advice for *S. mentella* fisheries was provided for one pelagic unit in the Irminger Sea and adjacent waters. However, based on this new stock identification information, ICES recommends two potential management units that are geographic proxies for biological stocks that were partly defined by depth and whose boundaries are based on spatial pattern of the fishery to minimize mixed stock catches (see Figure 16.1.1):

- Management Unit in the northeast Irminger Sea: ICES Areas Va, XII, and XIV.
- Management Unit in the southwest Irminger Sea: NAFO Areas 1 and 2, ICES areas Vb, XII and XIV.

The pelagic fishery in the Irminger Sea and adjacent waters shows clear distinction between two widely separated grounds fished at different seasons and depths. Spatial analysis of pelagic fishery catch and effort by depth, inside and outside the boundaries proposed for the management units in the northeast Irminger Sea, indicate that the boundaries effectively delineate the pelagic fishery in the northeast Irminger Sea from the pelagic fishery in the southwest Irminger Sea, with a small portion of mixed-stock catches. The northeastern fisheries on the pelagic *S. mentella* occur at the start of the fishing season at depths below 500 m and overlap to some extent with demersal fisheries on the continental slopes of Iceland (Sigurdsson et al., 2006).

19.3.14 Ecosystem considerations

The fisheries on pelagic redfish in the Irminger Sea and adjacent waters is generally regarded as having negligible impact on other fish or invertebrate species due to very low by-catch and discard rates. As this fishery uses pelagic nets, the impact on the habitat is also regarded as negligible.

19.3.15 Changes in the environment

Analysis of the oceanographic situation during the 2007 international survey and long-term data including 2003, allows the following conclusions:

Strong positive anomalies of temperature observed in the upper layer of the Irminger Sea with a maximum in 1998 are related to an overall warming of water in the Irminger Sea and adjacent areas in 1994-2003. These changes were also observed in the Irminger Current above the Reykjanes Ridge (Pedchenko, 2000), off Iceland (Malmberg *et al*., 2001) and in the Labrador Sea water (Mortensen and Valdimarsson, 1999). Thus an increase in temperature and salinity has been found in the Irminger Current since 1997 to higher values than for decades, as well as a withdrawal of the Labrador Sea water due to a slow-down of its formation by winter convection since the extreme year 1988 (ICES, 2001).

The results of the survey in 2003 were confirmed by the high temperature anomalies of the 0-200 m layer in the Irminger Sea and adjacent waters. In 200-500 m depth and deeper, positive anomalies in most parts of the observation area were observed, but increasing temperature as compared to the survey in June-July 2001 was obtained only north of 60° N in the flow of the Irminger Current above the Reykjanes Ridge and the northwestern part of the Irminger Sea. These changes in oceanographic conditions might have an effect on the seasonal distribution of redfish and its aggregations in the layer shallower than 500 m in the survey area (ICES, 2003b).

In June/July 2005, the temperature of the water in the shallower layer (0-500 m) of the Irminger Sea was higher than normal (ICES, 2005b). As in the surveys 1999-2003, the redfish were aggregating in the southwestern part of the survey area, partly influenced by these hydrographic conditions. Favourable conditions for aggregation of redfish in an acoustic layer have been marked only in the southwestern part of the survey area with temperatures between 3.6-4.5°C. In June/July 2007, again a higher temperature in the shallower layer was observed, as seen since 1996.

19.4 Deep pelagic *S. mentella*

19.4.1 Biological sampling from the fishery

The biological sampling from catches of deep pelagic *S. mentella* in each Subarea/Division in 2008 is shown in the text table below.

COUNTRY	AREA	LANDINGS (T)	NO. OF SAMPLES	NO. OF FISH MEASURED
Iceland	XIV	6,721	37	4,782
Poland	XIV	219	16	3,549
Portugal	XIV	1,733	29	3,697
Russia	XIV	15,106	NA	34,751
Spain	XIV	1,179	45	7,417

19.4.2 Summary of the development of the fishery

A summary of the catches by ICES Divisions/NAFO regulatory area as estimated by the Working Group is given in Table 19.4.1 and shown in 19.4.1. Fishing from this stock started in 1992. The landings gradually increased to about estimated 140,000 t in 1996. In 1997-2004 the annual landings varied between 85,000 t and 105,000 t. This is probably an underestimate due to incomplete reporting of catches (see section 19.5.3). Since then the catches have gradually decreased and 30,000 t were landed from this stock in 2008 which is the lowest annual landing since the 1993. Most of the catches in recent years have been taken in ICES Divisions Va and XIV close to the Icelandic and Greenland EEZ and within the Icelandic EEZ (Figure 19.2.3). The fishery has mainly been carried out from April to July.

The fleets participating in this fishery have continued to develop their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80-150 m.

A summary of the catches by nation as estimated by the Working Group is given in Table 19.4.2.

The WG acknowledges information on trawling depths as provided by some nations, but recommends that all nations should report depth information in accordance with the NEAFC logbook format.

The historic development of the fisheries by nation can be found in the 2007 NWWG Report.

Non-standardised CPUE series for the largest fleets (representing about 80% of landings) are given in Figure 19.4.2. Since 1995, there is a slight decreasing trend in CPUE for the most nations.

19.4.3 Biological information

The length distributions by ICES and NAFO areas are given in Figures 19.2.5 and 19.2.6 for 2000-2007. The data for those years have not been made available to the NWWG in order to analyse them separately for the deep pelagic stock.

Length distribution of deep pelagic *S. mentella* from the catches in 2008 is given in Figure 19.4.3.

The peak length in ICES Subarea XIV was usually 41-42 cm, whereas it was around 35 cm in ICES Subarea XII and NAFO Division 1F and 2J. This mostly reflects the general pattern of a fishery in deeper layers in Subarea XIV and shallower layers in Subarea XII and NAFO 1F and 2J. In 2002, the German catches in Subarea XIV were taken in shallower depths, resulting in markedly smaller fish landed (Figure 19.2.5). In 2005, a considerable decrease in mean length was observed, especially in Subareas XII and XIV (Figures 19.2.5 and 19.2.6). In 2006 and 2007, however, the mean lengths generally increased again to values observed in 2003 and earlier.

Biological samples from the catches in recent years, and also from the acoustic survey in 1999, suggested that new cohorts are entering into the fishable stock of pelagic redfish on an irregular basis (Stransky, 2000).

19.4.4 Discards

Discard is at present not considered to be significant for those both fisheries. This is based on available measurements from various institutes.

19.4.5 Illegal Unregulated and Unreported Fishing (IUU)

The Group had again difficulties in obtaining catch estimates from the various fleets. Furthermore, landings data were missing from some nations. The Group requests NEAFC to provide ICES in time with all information that supports the Group with regard to more reliable catch statistics.

Observations in June 2002, 2003 and 2004 indicated that the effort could have been 15-33% higher than reported to NEAFC (WD27 of NWWG2005). The latest information (Indregard 2006, Lemoine et al. 2006) confirms this order of magnitude with regard to IUU fisheries, as only 71 and 81% of the vessels visible in the VDS reported to the Vessel Monitoring System (VMS) in 2005 and 2006, respectively. Data from the 2007 campaign were not fully available to the Group, but preliminary information indicates that the unaccounted effort in 2007 was in the same range as 2006.

19.4.6 Surveys

No new survey data were available to the group since the last international trawl-acoustic survey was in 2007. The next survey will be carried out in June/July 2009.

The international trawl-acoustic surveys on pelagic redfish have been conducted in international collaboration with Germany, Iceland, Norway (in 1994 and 2001) and Russia at 2-3 years intervals (Table 19.2.2.). In addition, several national surveys have been carried out. During the last decade, the horizontal and vertical coverage of the survey changed as the fishery explored new fishing grounds in southwesterly direction and deeper layers. Vertical coverage of the hydro-acoustic recording of redfish varied among years in relation to the upper boundary of the deep scattering layer (DSL), in which redfish echoes are difficult to identify. Since 2001, the varying depth layers within and deeper than the DSL were covered by standard trawl hauls to account for the incompletely covered vertical depth distribution of the pelagic redfish. These survey hauls were converted into hydro-acoustic measurement units (s_A values) by means of regression (Figure 19.2.7). The stock abundance estimates in these depths are considered highly uncertain. The most recent survey was carried out during June/July 2007 (ICES CM 2007/RMC:12).

19.4.6.1 Survey trawl estimates

In addition to the acoustic measurements, redfish were estimated within and below the DSL by correlating catches and acoustic values at depths shallower than the DSL (Figure 19.2.7). The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance. For that purpose, standardised trawl hauls were carried out at different depth intervals (four depth intervals in hauls ≥DSL and two depth intervals hauls <DSL), evenly distributed over the survey area (Figure 19.2.9). As the correlation between the catch and acoustic values is based on few data points only (Figure 19.2.7), the abundance estimation obtained from this exercise makes the method questionable and also the assumption that the catchability of the trawl is the same, regardless of the trawling depth. The quality of the trawl method cannot be verified as the data series is very short. Such evaluation on the consistency of the method can therefore not be done until more data points are available. Therefore, the abundance estimation by the trawl method must only be considered as a rough attempt to measure the abundance within and deeper than the DSL.

The short time series from 1999-2007 (Table 19.2.2.) does not show a clear trend in biomass estimates deeper than 500 m (within and deeper than the DSL since 2005).

Biological samples from the trawls within and deeper than the DSL showed a mean length of 37.1 cm. Figure 19.2.10 (lower panel) shows the corresponding length distribution.

19.4.7 Methods

The assessment of pelagic redfish in the Irminger Sea and adjacent waters is based on survey indices, catches, CPUE and biological data. See sections 19.2, 19.3 and 19.6 for details.

19.4.8 Reference points

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is being carried out due to data uncertainties and the lack of reliable age data. Thus, no reference points can be derived.

19.4.9 State of the stock

19.4.10 Short term forecast

For pelagic redfish in the Irminger Sea and adjacent waters, no analytical assessment is being carried out due to data uncertainties and the lack of reliable age data. Thus, no short-term forecasts can be derived.

19.4.11 Uncertainties in assessment and forecast

19.4.11.1 Data considerations

Preliminary official landings data were provided by the ICES Secretariat, NEAFC and NAFO, and various national data were reported to the Group. The Group, however, repeatedly faced problems in obtaining catch data. The Group has during the last years identified problems with unreported catches of pelagic redfish. Current data available to the Group indicate that the reported effort (and consequently landings) could represent only around 80% of the real effort.

As in previous years, detailed descriptions on the horizontal, vertical and seasonal distribution of the fisheries were given.

The Group started to collate an international database with length distributions from the sampling of the fisheries on a spatially disaggregated level. Once complete, the horizontal and vertical differences in mean length by fishing areas can be illustrated as alternative to the portrayals by ICES/NAFO Divisions.

19.4.11.2 Assessment quality

The results of the international trawl-acoustic survey are given in sections 19.6.1 and 19.6.2. Given the high variability in the correlation between trawl and acoustic estimates as well as the assumptions that need to be made about constant catchability with depth and areas, the uncertainty of these estimates is very high.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*. The fishery is focusing on aggregations. Therefore, CPUE series might not indicate or reflect actual trends in stock size.

19.4.12 Comparison with previous assessment and forecast

The data available for evaluating the stock status are similar to last year.

19.4.13 Management considerations

The Group had again difficulties in obtaining catch estimates from the various fleets, and new information available indicates that unreported catches might be substantial. Furthermore, landings data were missing from some nations. The Group requests NEAFC and NAFO to provide ICES with all information that supports the Group with regard to more reliable catch statistics.

As mentioned in Chapter 19.1 the "Workshop on Redfish Stock Structure" (WKREDS, 22-23 January 2009, Copenhagen, Denmark; ICES 2009) reviewed the stock structure of *Sebastes mentella* in the Irminger Sea and adjacent waters. ACOM concluded, based on the outcome of the WKREDS meeting, that the pelagic *S. mentella* in the Irminger Sea and adjacent waters should be divided into two biological stocks:

- a 'Deep Pelagic' stock (NAFO 1–2, ICES V, XII, XIV >500 m) – primarily pelagic habitats, and includes demersal habitats west of the Faeroe Islands;
- a 'Shallow Pelagic' stock (NAFO 1–2, ICES V, XII, XIV <500 m) – extends to ICES I and II, but primarily pelagic habitats, and includes demersal habitats east of the Faeroe Islands;

ICES past advice for *S. mentella* fisheries was provided for one pelagic unit in the Irminger Sea and adjacent waters. However, based on this new stock identification information, ICES recommends two potential management units that are geographic proxies for biological stocks that were partly defined by depth and whose boundaries are based on spatial pattern of the fishery to minimize mixed stock catches (see Figure 16.1.1):

- Management Unit in the northeast Irminger Sea: ICES Areas Va, XII, and XIV.
- Management Unit in the southwest Irminger Sea: NAFO Areas 1 and 2, ICES areas Vb, XII and XIV.

The pelagic fishery in the Irminger Sea and adjacent waters shows clear distinction between two widely separated grounds fished at different seasons and depths. Spatial analysis of pelagic fishery catch and effort by depth, inside and outside the boundaries proposed for the management units in the northeast Irminger Sea, indicate that the boundaries effectively delineate the pelagic fishery in the northeast Irminger Sea from the pelagic fishery in the southwest Irminger Sea, with a small portion of mixed-stock catches. The northeastern fisheries on the pelagic *S. mentella* occur at the start of the fishing season at depths below 500 m and overlap to some extent with demersal fisheries on the continental slopes of Iceland (Sigurdsson et al., 2006).

19.4.14 Ecosystem considerations

The fisheries on pelagic redfish in the Irminger Sea and adjacent waters is generally regarded as having negligible impact on other fish or invertebrate species due to very low by-catch and discard rates. As this fishery uses pelagic nets, the impact on the habitat is also regarded as negligible.

Table 19.2.1 Pelagic *S. mentella* catches (in tonnes) in 2008 by countries and depth (A), and in 1996-2007 by depth (B). Note that in table B the catches are split into above and below 600 m. (Working Group figures and/or as reported to NEAFC).

A.	Catch	Not splitted	Shallower than 500 m	Deeper than 500 m
Faroes	2,951	0.8%	10.0%	89.2%
Greenland	1,170	100%		
Iceland	6,785		0.9%	99.1%
Lithuania	757	100%		
Norway	571	100%		
Poland	219	100%		
Portugal	1,733	100%		
Russia	16,703		10%	90%
Spain	1,215		3%	97%
Total	32,104	14%	6%	80%

B.	Total	Not splitted	Shallower than 600 m	Deeper than 600 m
1996	180,322	18 %	20 %	62 %
1997	122,825	7 %	24 %	69 %
1998	116,968	0 %	21 %	79 %
1999	109,665	5 %	20 %	75 %
2000	126,313	23 %	28 %	49 %
2001	128,818	23 %	27 %	50 %
2002	146,344	26 %	19 %	55 %
2003	160,984	10 %	25 %	65 %
2004	125,905	10 %	23 %	67 %
2005	73,715	14 %	32 %	53 %
2006	82,925	17 %	16 %	67 %
2007	64,004	19 %	17 %	64 %

Table 19.2.2 Pelagic *S. mentella*. Time series of survey results, areas covered, hydro-acoustic abundance and biomass estimates shallower and deeper than 500 m (based on standardized trawl catches converted into hydro-acoustic estimates derived from linear regression models). [1]within and deeper than the deep-scattering layer (DSL) in 2005 and 2007. *international surveys.

Year	Area covered (1000 NM²)	Acoustic estimates < 500 m (10^6 ind.)	Acoustic estimates < 500 m (1000 t)	Trawl estimates < 500 m (10^6 ind.)	Trawl estimates < 500 m (1000 t)	Trawl estimates > 500 m (10^6 ind.)[1]	Trawl estimates > 500 m (1000 t)[1]
1991	105	3498	2235				
1992*	190	3404	2165				
1993	121	4186	2556				
1994*	190	3496	2190				
1995	168	4091	2481				
1996*	253	2594	1576				
1997	158	2380	1225				
1999*	296	1165	614			638	497
2001*	420	1370	716	1955	1075	1446	1057
2003*	405	160	89	175	92	960	678
2005*	386	940	551			1083	674
2007*	349	731	372			1423	854

Table 19.2.3 Pelagic *S. mentella*. Results of the acoustic abundance and biomass estimation shallower than the DSL from the survey in June/July 2007.

Subarea	A	B	C	D	E	F	Total
Area (NM²)	129,614	106,594	8,464	33,855	62,623	8,052	349,201
No. fishes ('000)	172,365	192,306	0	91,683	269,661	4,594	730,608
Biomass (t)	79,750	94,471	0	53,329	141,703	2,649	371,902

Table 19.2.4. Pelagic *S. mentella*. Results of the trawl estimation within and deeper than the DSL from the survey in June/July 2007.

	A	B	C	D	E	F	Total
Area (NM²)	129,614	106,594	8,464	33,855	62,623	8,052	349,201
No. fishes ('000)	504,662	474,062	4,490	57,098	346,360	36,666	1,423,337
Biomass (t)	345,061	283,404	2,268	32,453	171,869	19,309	854,364
Lower CL	245,878	199,844	1,694	24,249	125,255	14,427	611,346
Upper CL	444,244	366,964	2,841	40,658	218,483	24,190	1,097,381

Table 19.3.1 Shallow Pelagic *S. mentella* (stock unit above 500 m). Catches (in tonnes) by area as used by the Working Group.

YEAR	VA	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	TOTAL
1982		39,783	20,798				60,581
1983		60,079	155				60,234
1984		60,643	4,189				64,832
1985		17,300	54,371				71,671
1986		24,131	80,976				105,107
1987		2,948	88,221				91,169
1988		9,772	81,647				91,419
1989		17,233	21,551				38,784
1990		7,039	24,477	385			31,901
1991		9,689	17,048	458			27,195
1992	1,662	22,976	38,709				63,346
1993	1,200	66,458	32,500				100,158
1994	1,031	77,174	18,679				96,884
1995	653	78,895	17,895				97,443
1996	257	22,474	18,566				41,297
1997	1,204	18,212	8,245				27,661
1998	589	21,976	1,598				24,163
1999	529	23,659	827	534			25,550
2000	3,700	17,491	687	11,052			32,930
2001	287	32,164	1,151	5,290	8	1,751	40,652
2002	117	24,004	222	15,702		3,143	43,189
2003	80	24,211	134	26,594	325	5,377	56,721
2004	103	7,669	1,051	20,336		4,778	33,937
2005	0	6,784	281	16,260	5	4,899	28,229
2006	0	2,088	94	12,693	260	593	15,727
2007	76	378	99	2,843	175	2,561	6,132
2008	44	25	354	1,580			2,004

1982-1991	All pelagic catches assumed to be of the shallow pelagic stock
1992-1996	Guestimates based on different sources (see text)
1997-2008	Catches from calculations based on jointed catch database and total landings

Table 19.3.2 Shallow pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, Subareas XII, XIV and NAFO Div. 1F, 2H and 2J by countries used by the Working Group. * Prior to 1991, the figures for Russia included Estonian, Latvian and Lithuanian catches.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
1982														581		60,000				60,581
1983						155										60,079				60,234
1984	2,961					989								239		60,643				64,832
1985	5,825					5,438								135		60,273				71,671
1986	11,385			5		8,574								149		84,994				105,107
1987	12,270			382		7,023								25		71,469				91,169
1988	8,455			1,090		16,848										65,026				91,419
1989	4,546			226		6,797	567	3,816						112		22,720				38,784
1990	2,690					7,957		4,537					7,085			9,632				31,901
1991			2,195	115		201		8,740					6,197			9,747				27,195
1992	628		1,810	3,765	2	6,447	9	12,862		780	6,656		14,654			15,733				63,346
1993	3,216		6,365	6,812		16,677	710	9,553		6,803	7,899		14,112			25,229			2,782	100,158
1994	3,600		17,875	2,896	606	15,133		5,911		13,205	7,404		6,834		1,510	16,349			5,561	96,884
1995	2,660	421	11,798	3,667	158	10,714	277	8,435	841	3,502	16,025	9	4,288		2,170	28,314	1,934		2,230	97,443
1996	1,846	343	3,741	2,523		5,696	1,866	5,288	219	572	5,618		1,681		476	9,348	1,671	137	273	41,297
1997		102	3,405	3,510		9,276		4,361	28				330	776	367	3,693	1,812			27,661
1998			3,892	2,990		9,679	1,161	1,995	30		1,734		701	12	60	89	1,819			24,163
1999			2,055	1,190		8,271	998	3,700					2,098	6	62	6,538	447	183		25,550
2000			4,218	486		5,672	956	3,479			430		2,124		37	14,373	1,154			32,930
2001			9	4,364		4,755	1,083	13,571			8,269		947		256	5,964	1,433			40,652
2002			0	719		5,354	657	5,203		1,841	12,052		1,094	428	878	13,958	1,005			43,189
2003				1,955		3,579	1,047	4,306		1,269	21,629		3,214	917	1,926	15,418	1,461			56,721
2004				777		1,126	750	5,714		1,114	3,698		2,721	1,018	2,133	13,208	1,679			33,937
2005				210		1,152		3,086		919	1,169		624	1,170	2,780	15,562	1,557			28,229
2006				334		994		1,287		1,803	466		280	663	1,372	4,953	3,576			15,727
2007			209	98				77		186	467			189	529	4,037	339			6,132
2008				298				64			8					1,597	36			2,004

Table 19.4.1 Deep Pelagic *S. mentella* (stock unit below 500 m). Catches (in tonnes) by area as used by the Working Group.

YEAR	VA	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	TOTAL
1982		0	0				0
1983		0	0				0
1984		0	0				0
1985		0	0				0
1986		0	0				0
1987		0	0				0
1988		0	0				0
1989		0	0				0
1990		0	0	0			0
1991		2	41	0			43
1992	306	273	2,036				2,615
1993	1,403	6,072	8,203				15,678
1994	14,441	17,015	20,350				51,805
1995	890	53,145	24,365				78,399
1996	4,487	20,129	114,409				139,025
1997	14,097	1,614	79,453				95,164
1998	40,024	470	52,312				92,805
1999	35,995	426	47,695	0			84,115
2000	40,977	0	52,422	0			93,399
2001	27,861	0	60,305	0	0	0	88,166
2002	37,162	22	65,971	0		0	103,155
2003	46,596	21	57,646	0	0	0	104,263
2004	14,353	0	77,615	0		0	91,968
2005	11,726	0	33,759	0	0	0	45,485
2006	16,452	58	50,531	253	0	0	67,294
2007	17,764	0	40,746	0	0	0	58,511
2008	4,626	0	25,474	0			30,100

1982-1991	All pelagic catches assumed to be of the shallow pelagic stock
1992-1996	Guestimates based on different sources (see text)
1997-2008	Catches from calculations based on jointed catch database and total landings

Table 19.4.2 Deep pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, Subareas XII, XIV and NAFO Div. 1F, 2H and 2J by countries used by the Working Group. * Prior to 1991, the figures for Russia included Estonian, Latvian and Lithuanian catches.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Russia*	Spain	UK	Ukraine	Total
1982																				
1983																				
1984																				
1985																				
1986																				
1987																				
1988																				
1989																				
1990																				
1991								43												43
1992								2,615												2,615
1993				310		1,135		13,354					878							15,678
1994						2,019		47,421					523		377	1,465				51,805
1995	1,140	181	5,056	1,572	68	8,271	1,579	26,197	396	1,501	6,868	4	3,169		2,955	15,868	2,620		956	78,399
1996	1,654	307	3,351	3,748		15,549	1,671	57,616	196	512	5,031		5,161		1,903	36,400	5,558	123	245	139,025
1997		9	315	435		11,200		36,915	3				2,849		3,307	33,237	6,895			95,164
1998			76	4,484		8,368	302	46,524	1		34		438		4,073	25,748	2,758			92,805
1999			53	3,466		8,218	3,271	40,223					3,337		4,240	11,419	9,885	5		84,115
2000			7,733	2,367		6,827	3,327	41,753			0		3,108		3,694	14,851	9,740			93,399
2001			878	3,377		5,914	2,360	28,901			7,515		4,275		2,488	23,810	8,649			88,166
2002			15	3,664		7,858	3,442	39,289			9,771		4,197		2,208	25,309	7,402			103,155
2003				3,938		7,028	3,403	44,588					5,185		2,109	28,638	9,374			104,263
2004				4,670		2,251	2,419	31,112					6,277	1,889	2,286	31,067	9,996			91,968
2005				1,800		1,836	1,431	12,919			1,027		3,950	1,240	1,088	16,323	3,871			45,485
2006				3,498		1,830	744	20,948			1,294		5,968	1,356	1,313	23,670	6,673			67,294
2007				2,902		1,110	1,961	18,091		575	1,394		4,628	636	2,067	21,337	3,810			58,511
2008				2,653			1,170	6,721			749		571	219	1,733	15,106	1,179			30,100

Table 19.6d.4 Pelagic *S. mentella*. Survey biomass estimates 1999-2007 and area splitting between NAFO and NEAFC Convention areas by depth. *acoustically measured

	NAFO (000 T)	NAFO %	NEAFC (000 T)	NEAFC %	SUM (000 T)
1999 < 500 m*	282	46	332	54	614
1999 > 500 m	58	12	439	88	497
1999 Sum	340	31	771	69	1111
2001 < 500 m*	377	53	338	47	716
2001 > 500 m	165	16	892	84	1057
2001 Sum	542	31	1230	69	1773
2003 < 500 m*	11	12	78	88	89
2003 > 500 m	41	6	637	94	678
2003 Sum	52	7	715	93	767
2005 < DSL*	308	56	244	44	551
2005 ≥ DSL	237	35	437	65	674
2005 Sum	545	44	681	56	1225
2007 < DSL*	198	53	174	47	372
2007 ≥ DSL	224	26	631	74	854
2007 Sum	422	34	805	66	1226

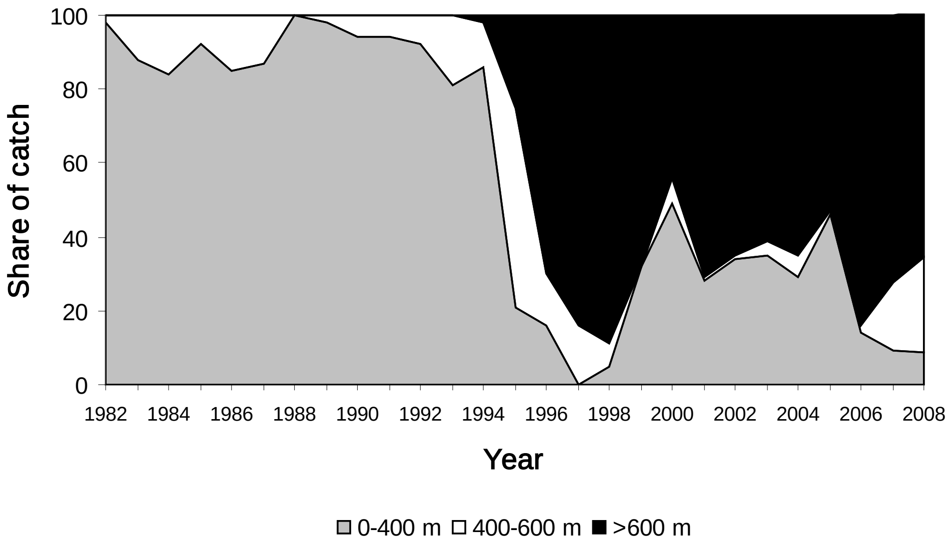


Figure 19.2.1 Percentage of the catch of *S. mentella* by Russian vessels by depth in the Irminger Sea in 1982-2008.

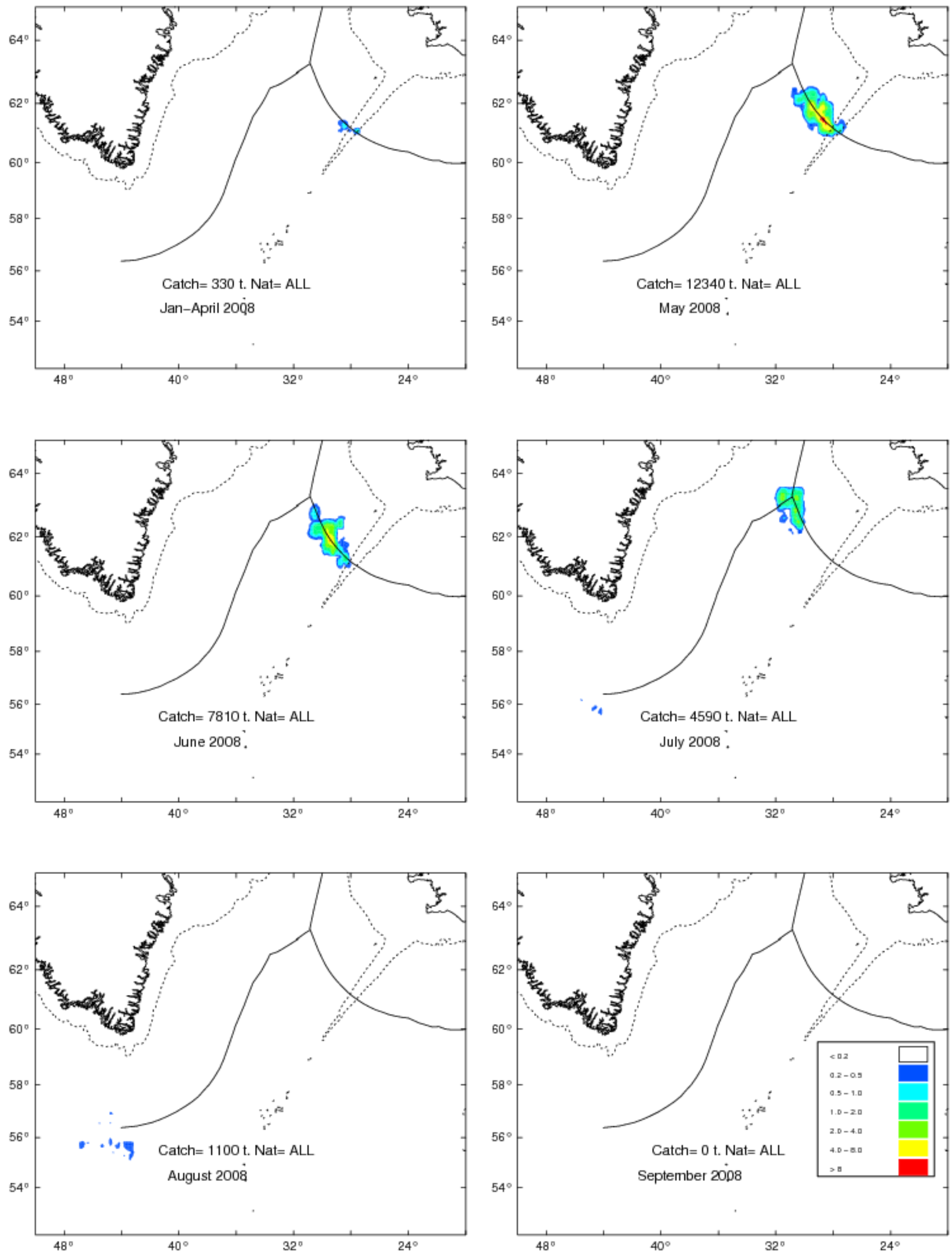


Figure 19.2.2 Fishing areas and total catch of pelagic redfish (*S. mentella*) by month(s) in 2008, derived from catch statistics provided by the Faroe Islands, Germany, Iceland, Norway and Russia. The catches in the legend are given as tonnes per square nautical mile.

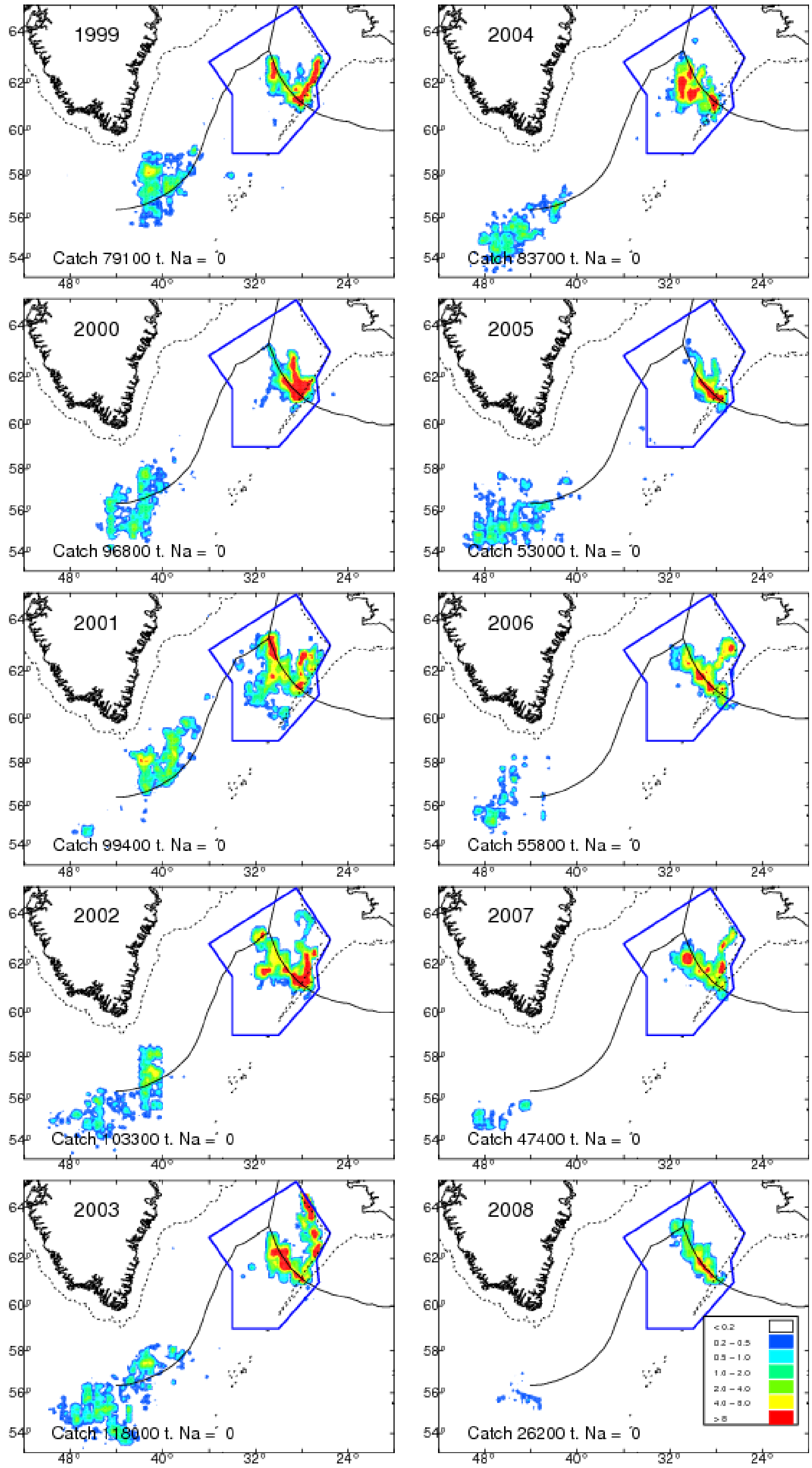


Figure 19.2.3 Fishing areas and total catch of pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1999-2008. Data are from the Faroe Islands (1995-2008), Germany (1995-2007), Greenland (1999-2003), Iceland (1995-2008), Norway (1995-2003 and 2008) and Russia (1997-2008). The catches in the legend are given as tonnes per square nautical mile. The blue box represents the proposed management unit of the northern area.

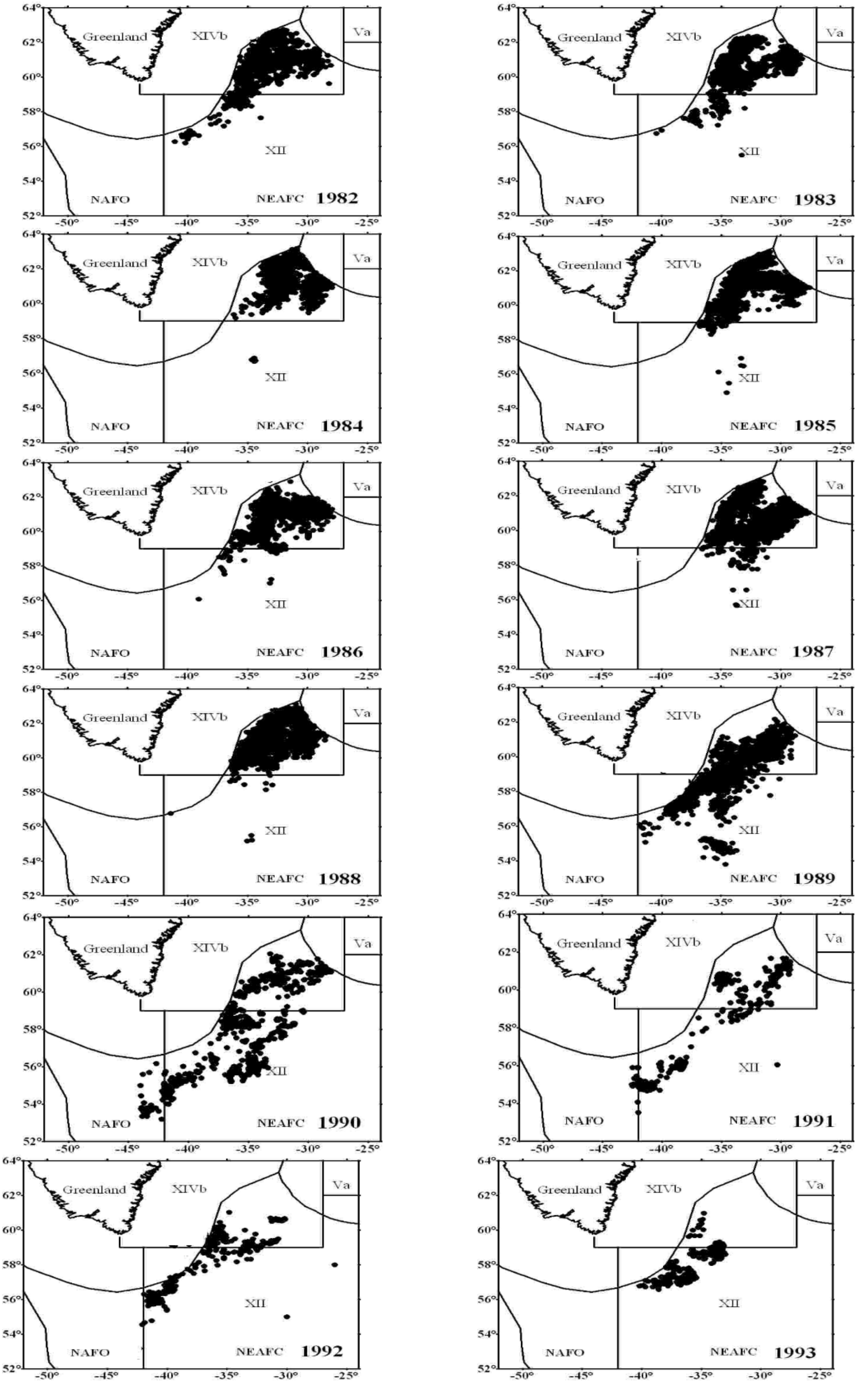


Figure 19.2.4 Location of the Russian fleet during fishery for *S. mentella* in the Irminger Sea in 1982-1993.

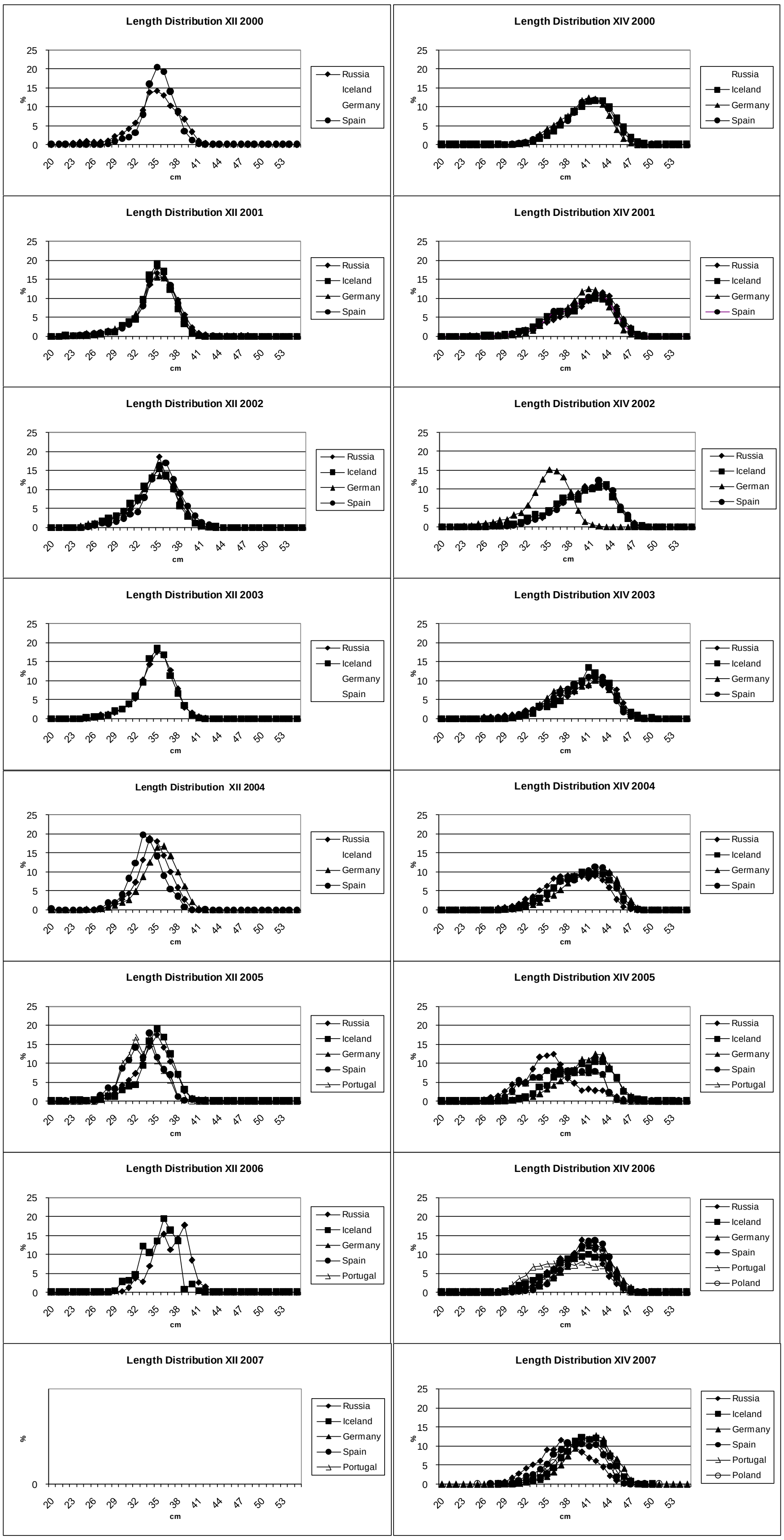


Figure 19.2.5 Length distributions from landings of pelagic *S. mentella* by ICES Subareas XII and XIV and country in 2000-2007.

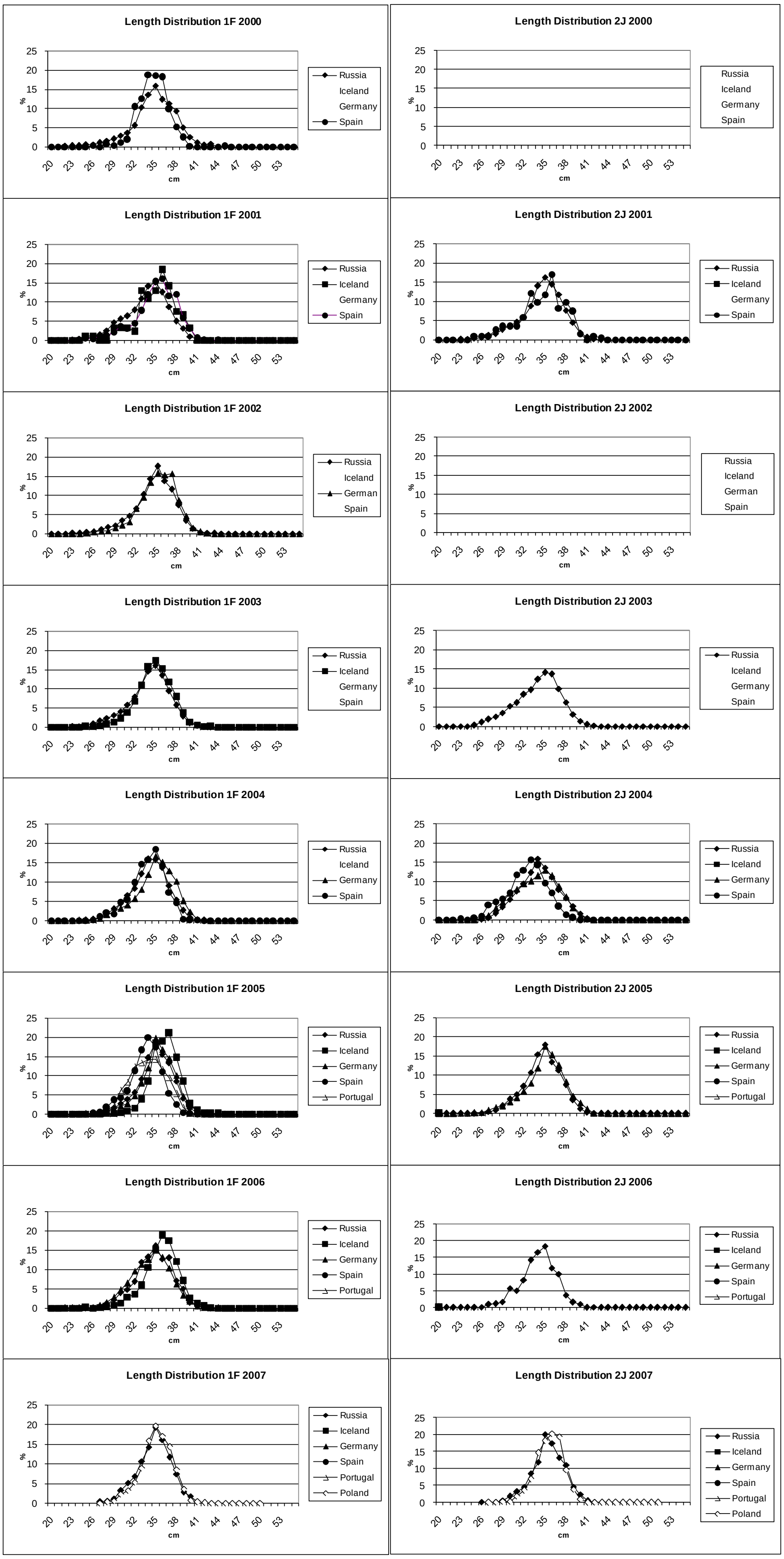


Figure 19.2.6 Length distributions from landings of pelagic *S. mentella* by NAFO Divisions 1F and 2J and country in 2000-2007.

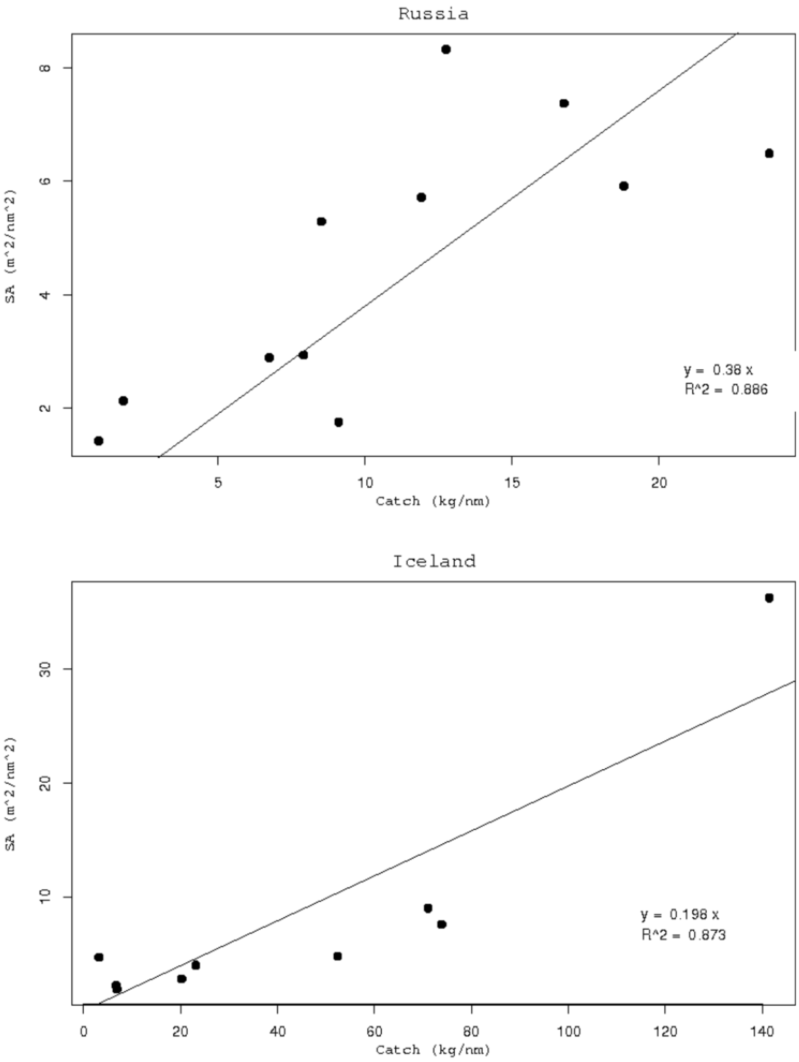


Figure 19.2.7. Regressions between catches and observed hydroacoustic s_A values, observed on the Russian and Icelandic vessel on the joint trawl-acoustic survey in June/July 2007 shallower than the DSL and used in the biomass calculations.

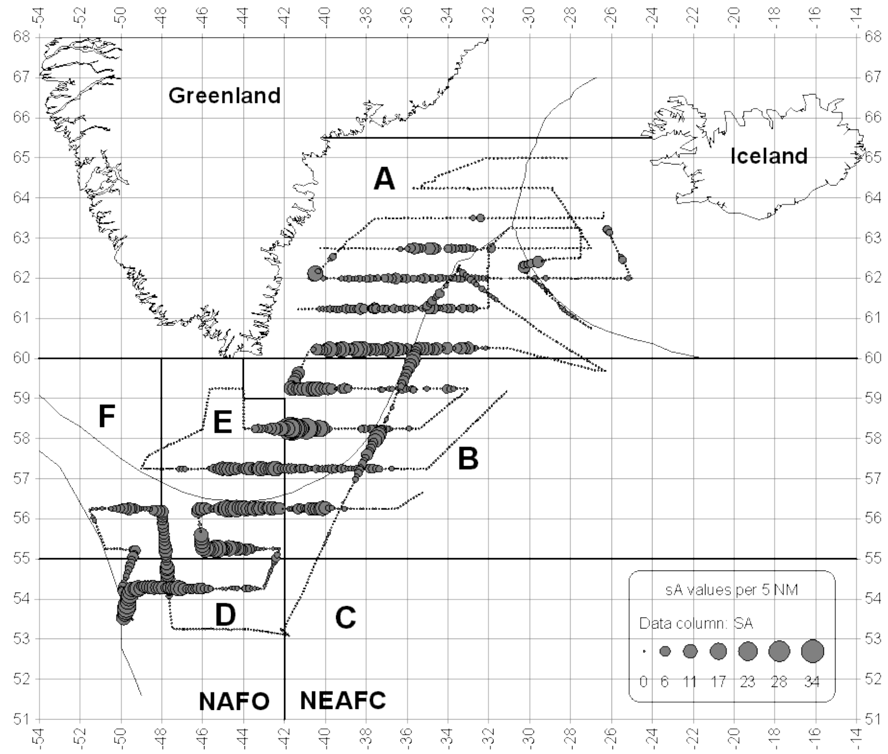


Figure 19.2.8 Pelagic *S. mentella*. Acoustic estimates (average sA values by 5 NM sailed) shallower than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2007.

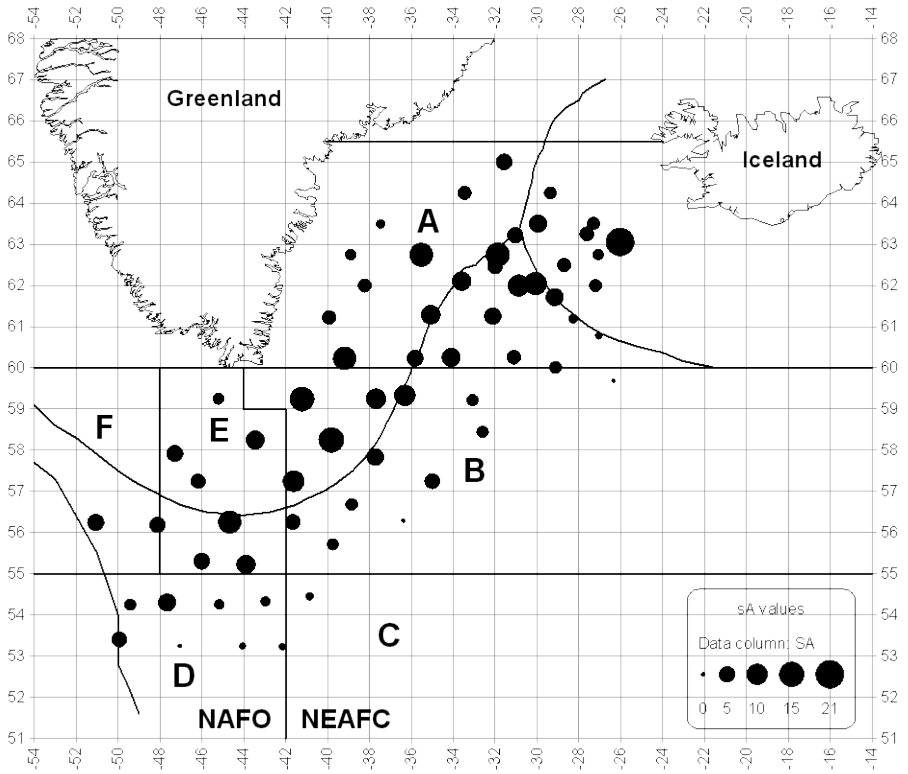


Figure 19.2.9 Pelagic *S. mentella*. Trawl estimates (sA values calculated from trawls; ICES CM 2007/RMC:12) within and deeper than the deep-scattering layer (DSL) from the joint trawl-acoustic survey in June/July 2007.

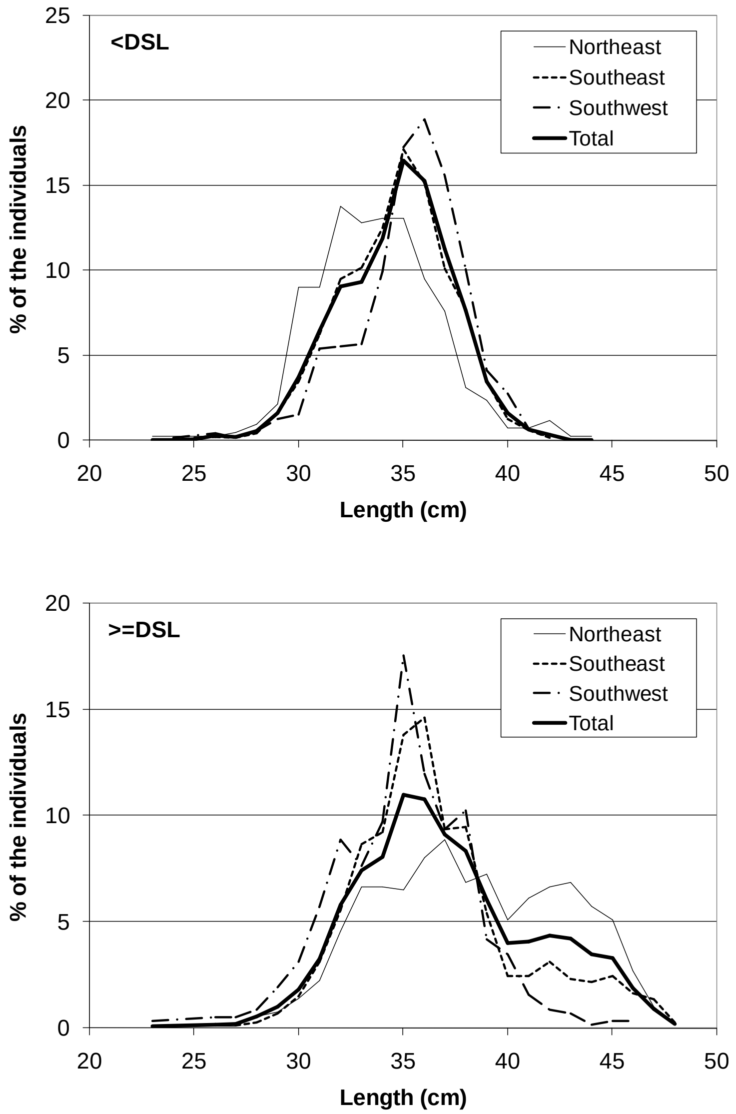


Figure 19.2.10 Length distribution of pelagic *S. mentella* redfish in the trawls, by geographical areas (ICES CM 2007/RMC:12) and total, shallower than the DSL, and within and deeper than the DSL from the joint trawl-acoustic survey in June/July 2007.

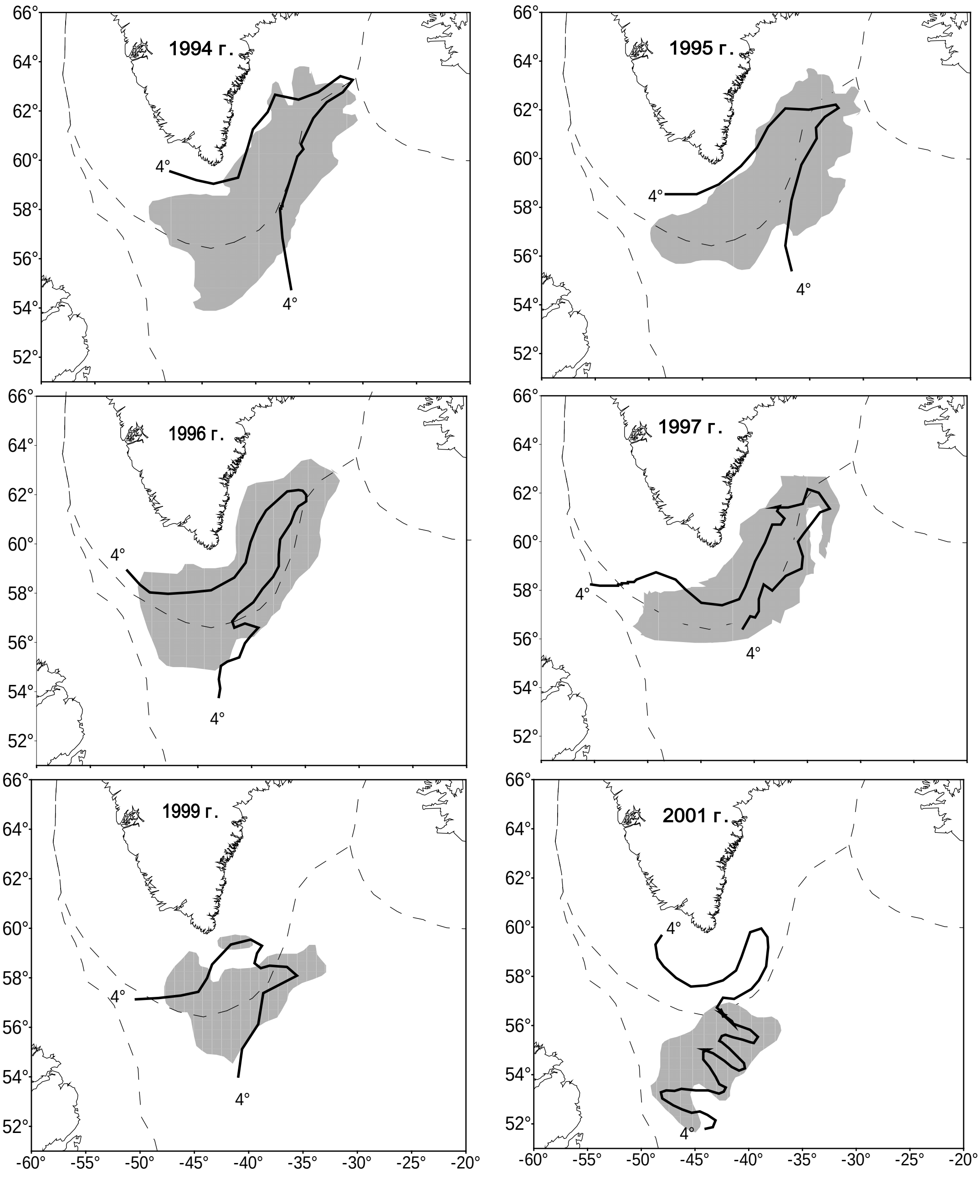


Figure 19.2.11 Temperature distribution (black 4°C line) on 200 m depth and main redfish stock distribution (shaded areas) derived from international and Russian redfish surveys in 1994-2001.

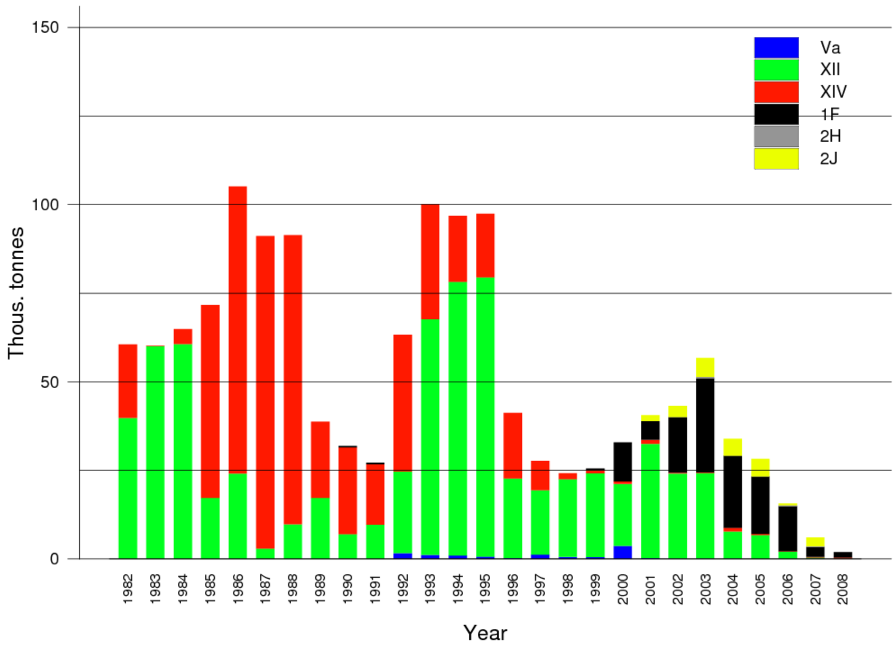


Figure 19.3.1 Landings of shallow pelagic *S. mentella* (Working Group estimates, see Table 19.1.1).

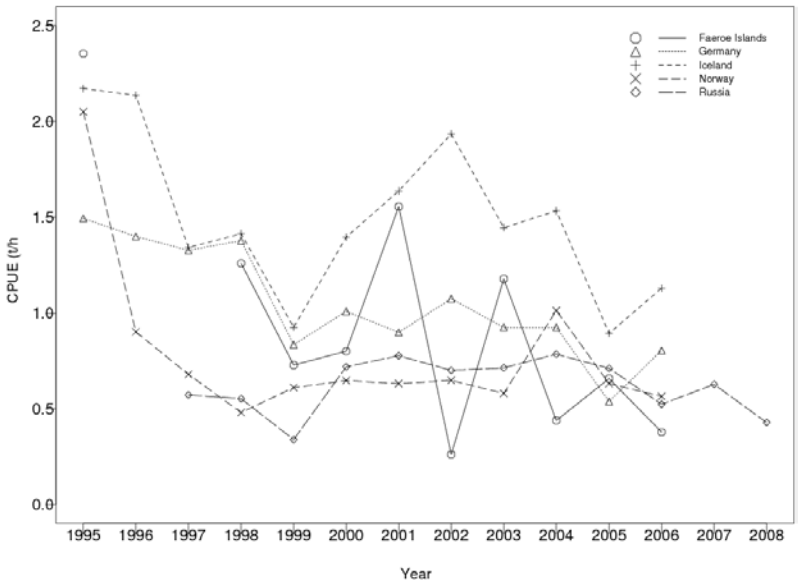


Figure 19.3.2 Trends in national non-standardised CPUE of the shallow pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book statistics in the joint international database.

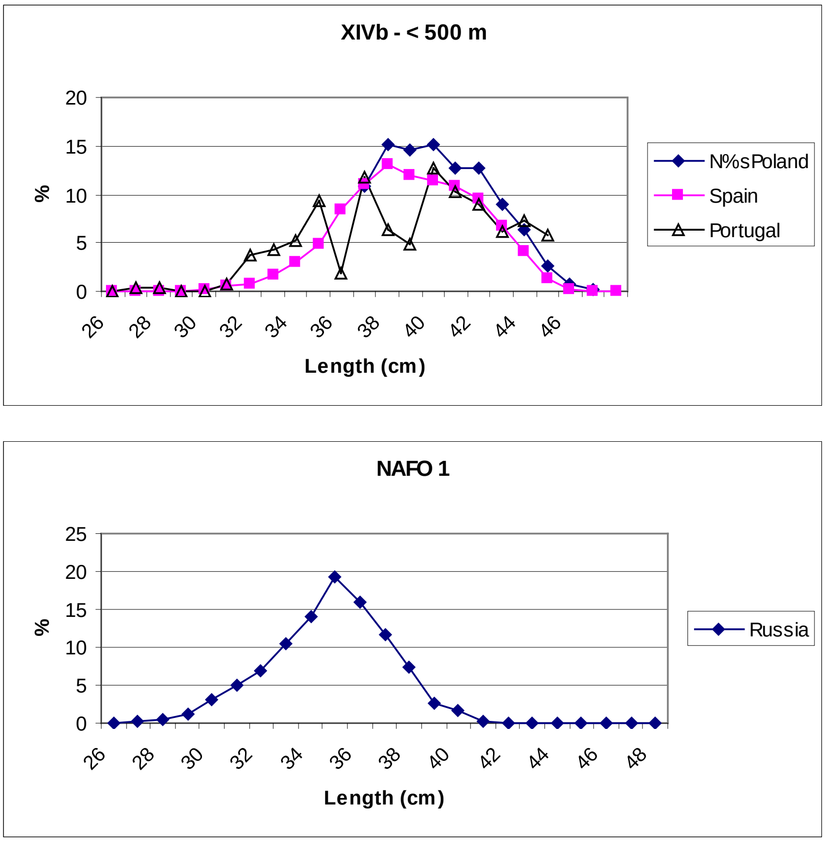


Figure 19.3.3 Length distribution from landings of shallow pelagic *S. mentella* by ICES Division XIV and NAFO Divisions 1F in 2008.

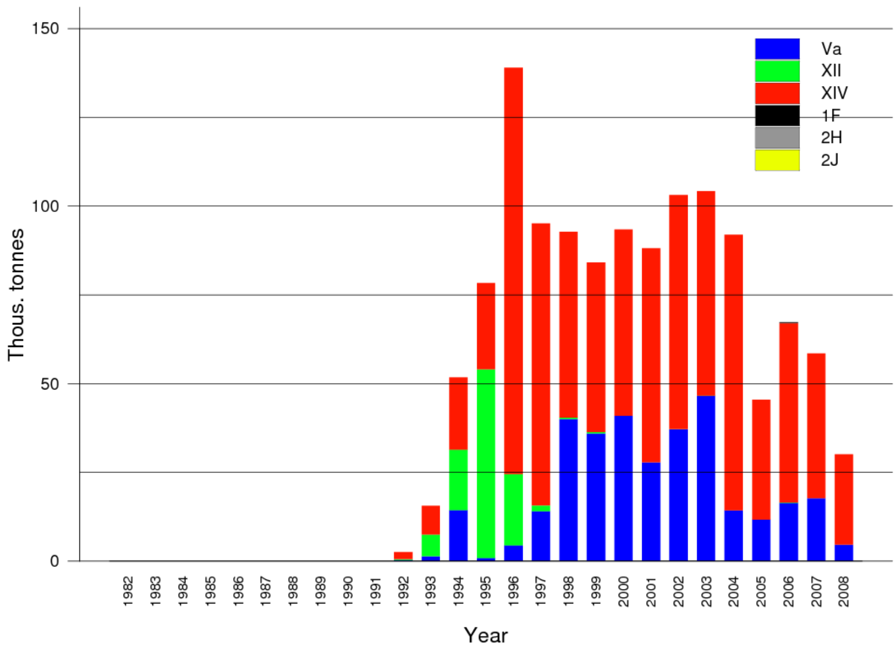


Figure 19.4.1 Landings of deep pelagic *S. mentella* (Working Group estimates, see Table 19.1.1).

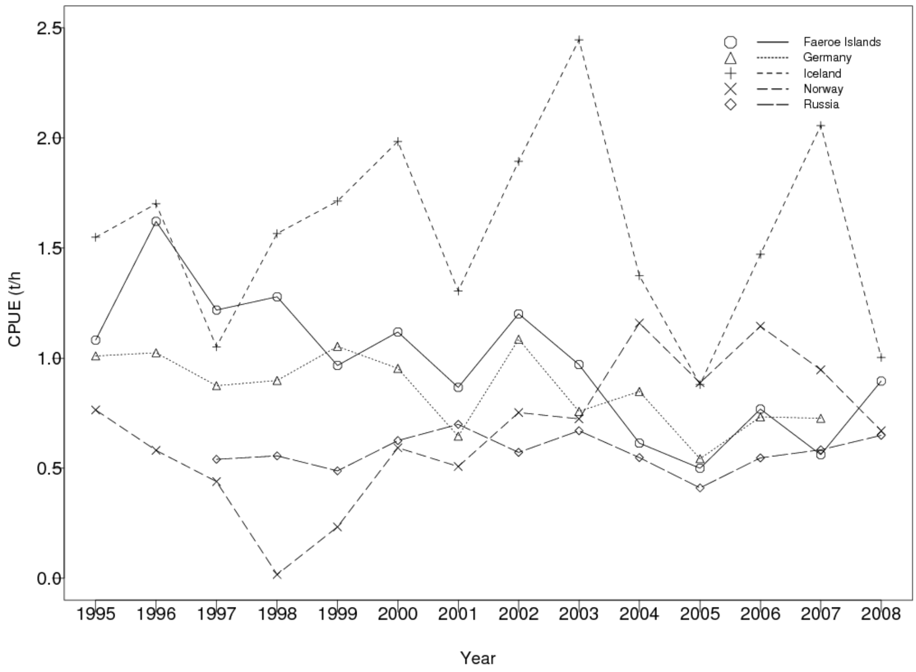


Figure 19.4.2 Trends in national non-standardised CPUE of the deep pelagic *S. mentella* fishery in the Irminger Sea and adjacent waters, based on log-book statistics in the joint international database.

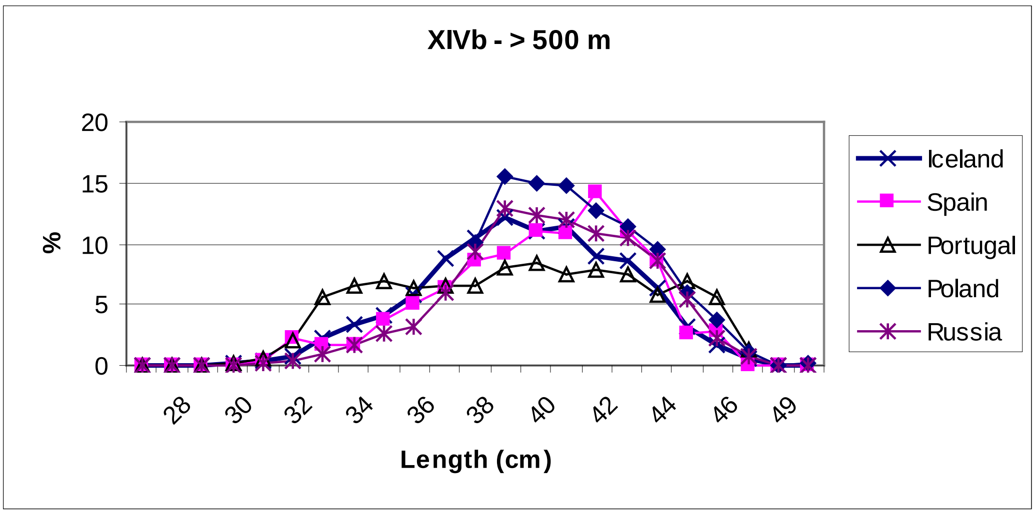


Figure 19.4.3 Length distribution from landings of deep pelagic *S. mentella* by ICES Division XIV in 2008.

Annex 1 – List of Participants

North-Western Working Group

29 April – 5 May 2009

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Annex 2 –Technical Minutes of a review of the ICES North Western Working Group (NWWG) Report 2009 (by correspondence)

8-20 May 2009.

Reviewers:	Frans van Beek (chair)
	Joachim Gröger
	Evgeny Shamray
	Krzysztof Radtke
Chair WG:	Jesper Boye
Secretariat:	Mette Bertlesen

Audience to write for: advice drafting group, ACOM, benchmark groups and next years EG.

General

The Review Group considered the following stocks:

- Cod in Subdivision Vb2 (Faroe Bank)
- Cod in Subdivision Vb1 (Faroe Plateau)
- Cod in Division Va (Icelandic cod)
- Greenland halibut in Subareas V, VI, XII and XIV
- Haddock in Division Vb
- Haddock in Division Va (Icelandic haddock)
- Herring in Division Va (Icelandic summer-spawners)
- Saithe in Division Vb (Faroe Saithe)
- Saithe in Division Va (Icelandic saithe)
- Beaked Redfish (Sebastes mentella) in Division Va and Subarea XIV (Icelandic Slope stock)
- Beaked Redfish (Sebastes mentella) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Shallow Pelagic stock<500 m)
- Beaked Redfish (Sebastes mentella) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Deep Pelagic stock>500 m)
- Golden Redfish (Sebastes marinus) in Subareas V, VI, XII and XI

And the following special requests:

- none

The RG acknowledges the intense effort expended by the working group to produce the report. The report is traditionally structured and information is in general, but not always easy to find. The stocks listed above were all updates and were reviewed by the group. The reviewers met by correspondence and had limited contact through e-mail and share-point. For the purpose of evaluation the chair of the review group split the stocks between the reviewers. There is no quality handbook or guidelines describing the procedures to be followed at when an update assessment is carried. In this case the present assessments were compared with those of last year. Given the time pressure where this has been done, no attention is given to the other chapters of the report. Also no draft stock summaries were considered by the review group.

FishStock	Name	Asstype in WG ToR	1st reviewer
cap-icel	Capelin in Subareas V, XIV and Division IIa west of 5°W (Iceland-East Greenland-Jan Mayen area)	Update	ES
cod-ewgr	Cod in ICES Subarea XIV and NAFO Subarea 1 (Greenland cod)	Update	KR
cod-farb	Cod in Subdivision Vb2 (Faroe Bank)	Same Advice saly	JG
cod-farp	Cod in Subdivision Vb1 (Faroe Plateau)	Update	JG
cod-iceg	Cod in Division Va (Icelandic cod)	Update	ES
ghl-grn	Greenland halibut in Subareas V, VI, XII and XIV	Update	KR
had-faro	Haddock in Division Vb	Update	ES
had-iceg	Haddock in Division Va (Icelandic haddock)	Update	JG
her-vasu	Herring in Division Va (Icelandic summer-spawners)	Update	FvB
sai-faro	Saithe in Division Vb (Faroe Saithe)	Update	KR
sai-icel	Saithe in Division Va (Icelandic saithe)	Update	JG
smn-con	Beaked Redfish (*Sebastes mentella*) in Division Va and Subarea XIV (Icelandic Slope stock)	Update	ES
Smn-sp	Beaked Redfish (*Sebastes mentella*) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Shallow Pelagic stock<500 m)	Update	KR
Smn-dp	Beaked Redfish (*Sebastes mentella*) in Subareas V, XII, XIV and NAFO Subareas 1+2 (Deep Pelagic stock>500 m)	Update	KR
smr-5614	Golden Redfish (*Sebastes marinus*) in Subareas V, VI, XII and XIV	Update	FvB

A general point to the Faroese stocks. These stocks are managed by effort control. It is important that effort data are presented for those fleets which are subject to effort management. These data should allow to identify the applied effort, the permitted effort and the advised effort. From these data it would become clear what effort parameters are managed. Also from these data a table could be constructed in the stock summary with effort information, comparable to those stocks which are managed by TAC (ICES advised TAC, agreed TAC and catch).

Stock: Faroe Bank Cod (report section 03)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment** There is no analytical assessment for Cod in Subdivision Vb_2 (Faroe Bank)
3) **Forecast**: not presented
4) **Assessment model**: descriptive – survey based (summer + spring survey)
5) **Consistency**: The advice for the fishery in 2010 is consistent with that of last year, i.e. it is the same as the advice given in 2008 for the 2009 fishery: no fishing – closure until the recovery of the stock is confirmed
6) **Stock status**: Survey indices indicate that the stock is severely depleted. Catches have declined steeply in the last four years while exploitation ratios (proxy for fishing mortality) remains higher than average. Biological reference points have not been defined
7) **Man. Plan.**: No Management Plan agreed

General comments

Given the poor data and assessment situation this was a fairly short section; within these limitations it was anyway well documented, well ordered and considered section in the report. The text in the report is an update from last year's report containing only a limited number of tables and figures that appeared to be also updated.

Technical comments

- a comparison with last year's report was made: the procedures used were the same as last year
- the assessment is purely based on two survey indices where the catch rates (kg/hr) are used as an index for indicating stock trends; the reason is that no analytic assessment such as a catch-at-age analysis using for instance XSA can be performed as the sampling for age composition is poor particularly for trawl landings; it would be good to improve this situation in the near future to allow performing an analytic assessment; the WG however is aware of this; it should be checked if alternative procedures such as SURBA would allow an assessment
- the data have been used as specified in the stock annex
- the assessment has been applied as specified in the stock annex
- there is no **major** reason to deviate from the standard procedure for this stock
- the update assessment gives a valid basis for advice
- the main conclusions are in accordance with the WG report
- the draft advice sheet is incomplete; it does include all paragraphs necessary that also have been presented in 2008: the paragraphs entitled "state of the stock" (the overview table), "management objectives", "reference points", "Management considerations", "Factors affecting the fisheries and the stock" and "Scientific basis" were completely missing.

- although this year's draft advice sheets contain the same figures as last year, this time some of the specific legends necessary to tell the details (e.g. summer/spring survey) are missing; this should be changed in figures 4.4.2.2 and 4.4.2.3
- also, all figure titles should be below the figures – need to be changed.

Conclusions

There was no better way to go given the data situation and that the assessment was purely descriptive. There would be some need for a benchmark assessment. However, a benchmark assessment could only be recommended if more/other data become available and/or new assessment methodology based on survey data. The information given is sufficient to provide advice; it should be checked if alternative procedures such as SURBA would allow an assessment

Stock: Faroe Plateau Cod - Cod in Subdivision Vb1 (report section 04)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: a short-term prediction until year 2011 carried out with MFDP by using a management option table and yield per recruit routines gives landings dependent on Fbar; the initial stock size was taken from XSA for all ages (2-10+). No medium term projection was performed. However, a long-term prediction was performed instead using MFYPR indicating the development of Y/R dependent on Fbar
4) **Assessment model**: XSA based on commercial catch-at-age data for period 1961-2008 and ages 2-10+ plus two tuning fleets (1 summer survey for period 1996-2008 and ages 2-8, 1 spring survey for period 1994-2009 and ages 2-9)
5) **Consistency**: The advice for the fishery in 2010 is consistent with that of last year, i.e. it is the same as the advice given in 2008 for the 2009 fishery: no fishing
6) **Stock status**: Based on the most recent estimates of SSB (in 2009) and fishing mortality (in 2008), the stock is classified as suffering reduced reproductive capacity and as being harvested unsustainably. The reference points for this stock are: Bpa = 40kt, Blim = 21kt, Fpa = 0.35 and Flim = 0.68. The current fishing mortality estimated as 0.76, and the average F for 1997-2008 = 0.60, is above rates that would support an optimal yield and low risk of stock depletion ($F_{0.1}$ and F_{max}). The stock is expected to remain at B_{lim} in the short term. Therefore a closure of the fishery has been recommended by the WG
7) **Man. Plan.**: An effort management system was implemented in the Faroese demersal fisheries in Division Vb in 1996 to achieve sustainable fisheries. The aim of the effort management system was to harvest on average 33% (in numbers) of the exploitable stock of cod. However, as the present management has led to fishing mortalities that do not appear sustainable the WG recommends a rebuilding plan. A rebuilding plan should offer maximum protection to the cod, recognizing that it is caught in a mixed-fishery with haddock and saithe.

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with relative little changes.

Technical comments

- the review was restricted to a check whether the assessment was carried in the same way as last year. This was the case. No deviations were spotted.
- the data have been used as specified in the stock annex
- the assessment and forecast model has been applied as specified in the stock annex
- there is no reason to deviate from the standard procedure for this stock
- the main conclusions are in accordance with the WG report
- tables and figures have been updated and are correct except that in the advice sheet for Table 4.4.1.3. the title is missing

Conclusions

- The assessment has been performed correctly.
- The information given by the assessments is sufficient to provide advice.

Stock: Haddock in Division Vb (Faroe haddock) (section 05)

1) **Assessment type**: update/SPALY
2) **Assessment:** analytical
3) **Forecast:** analytical short- and long-term forecasts are presented
4) **Assessment model**: XSA using 2 tuning fleets (2 surveys); maturity data are from survey; M is estimated equally and without additional data; no additional models were used. SSB calculated at Jan 1st. The ADAPT component of the assessment was not made this year, however some comparisons with the F and SSB's from 2008 are presented.
5) **Consistency**: The assessment is in line with that from 2008. Only changes are minor revisions of recent landings according to revised data and corresponding revisions of the catch at age data. It can be seen, that recruitment and biomass has been overestimated while fishing mortality has been underestimated last year, but the differences are relatively small.
6) **Stock status**: The assessment showing a declining SSB mainly due to poor recruitment and estimated just below B_{pa} and is predicted to be close to B_{lim} in 2010 and 2011 with status quo fishing mortality. Fishing mortality in 2008 is estimated at 0.22, i.e. less them F_{pa} = 0.25. Reference points were set in 1998 and have been revised in 2007 (B_{lim}=22 000 t, B_{pa}=35 000 t)
7) **Man. Plan.**: A management system based on number of fishing days, closed areas and other technical measures was introduced in 1996.

General comments

The report is well done and the text is an update from last years report with relative changes.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year.
- Total landings in 2008 have to be presented more correctly. In the Executive summary - "only 7 500 t", however, chapter 5.2.1 - "about 7 600 t", tables 5.1 and 5.12 gives 7 582 t.
- No any explanation why the medium-term forecasts not presented in this year report.

Remarks by the reviewer

- Maturity at age 3 (figure 5.6) for the years 1987-1989 looks strange. Suggested to revised data.
- WG mentioned that "The ban on discarding as stated in the law on fisheries should also – in theory – keep the discarding at a low level". However, nothing about minimum landing size. In practice, strong restrictions concerning minimum landing size and market price very influence for the discarding. Suggested to investigate this issue.

Conclusions

The assessment has been performed correctly. The information given by the assessments is sufficient to provide advice. Management of fisheries on haddock needs to take into account measures for cod and saithe.

Stock: Saithe in Division Vb (Faroe saithe) (report section 6)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: analytical forecast presented (F_{sq}=$F_{(2006\text{-}2008)}$, unscaled to F_{2008}),
4) **Assessment model**: XSA
5) **Consistency**: The assessment is consistent with previous results. 2006-2009 assessments were rejected due to retrospective pattern which is believed to be the result of decreased size at age. 2009 assessment was used to illustrate historical trends only.
6) **Stock status**: SSB is below the ICES B_{pa} and F is higher than F_{target} and F_{pa}. With status quo fishing mortality SSB will increase but still below B_{pa}.
7) **Man. Plan.**: There is no management plan. Fishery is managed with annual TAC and technical measures. The probability that F_{bar} is at or less than the target F=0.45 is low. Stock is harvested unsustainably. Current measures are probably insufficient to meet the target F.

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last year's report with relative little changes. The outcome of the current assessment gives the same perception of the stock and fishery as last year's assessments. The report clearly states about the problems related to the quality of the data used in the assessment, making finally the assessment not accepted.

Technical comments

- The review was restricted to a check whether the procedures described in the stock annex were applied. This was the case. No deviations were spotted.
- Also a comparison with last years report was made. The procedures used were the same as last year. Assessment results and the conclusions of last year report were very similar.
- Tables and figures are correctly ordered and numbered in line with the text of the report. Tables and figures are correctly labeled and the units of measure always presented.
- In Figure 6.4.3 (Retrospective analysis) recruitment reaches some unrealistic high value (last data point).

Remarks by the reviewer

- There is in fact no improvement in the current year assessment as compared with the last year. The SSB seems to be continuously underestimated while fishing mortality tends to be overestimated.
- The observed decline in weight-at-age since mid-1990s seems to lead to lower catchabilities implying the stock size underestimated. It is also likely that that recent year classes are underestimated due to changes in catchabilities.
- As there is high fishing pressure on the stock and it seems to be evident that there is no relationship between the number of fishing days and fishing mortality therefore area restrictions shall be considered as an alternative regulatory measure.
- In 2009 two new pairs of trawlers were used to extend the tuning series which provide almost twice higher CPUE than the existing pairs.
- Fishing mortality reference points need to be further investigated. The highest recruitment was observed at the lowest SSB.

Conclusions

The assessment has been performed correctly. There is a need for revision of biological reference points. The assessment does not provide solid basis for the formulation of the advice.

Stock: Saithe in Icelandic waters - Saithe in Division Va (report section 8)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: analytical forecast presented; ($F_{sq}=F_{(2006\text{-}2008)scaled}$)
4) **Assessment model**: ADCAM using 1 tuning fleet; maturity at age based on survey samples and natural mortality are set constant in time; additional models presented were.
5) **Consistency**: Last years assessment was accepted and used as a basis for advice. This years assessment is consistent with last year.
6) **Stock status**: Increased risk of reduced productivity and unsustainable harvest. Fsq>Fpa and Blim<SSBsq<Bpa. Recruitment is around average. Reference points have not been revised since 1998.
7) **Man. Plan.**: no agreed management plan

General comments

In general, this was an ordered and well considered section. However, some information could be given more detailed and results could be presented in a better way. The assessments give the perception of a decreasing SSB as a result of lower weight at age and lower recruitment compared to former time periods. This is accompanied by an increase of fishing mortality above Fpa.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year. This was the case. No deviations were spotted. For a detailed review of the method not enough information is provided regarding model settings. Only little attention has been given to the additional models by the reviewer. The results of the assessment are in line with last year's assessment.
- No comparison between different settings (e.g., catch only vs. catch+ survey vs. catch+ scientific surveys+ commercial tuning series) in ADCAM were carried out. Since survey estimates are considered to be highly uncertain, such comparisons are needed to evaluate the robustness of assessment outcomes.
- Exploratory analyses on consistency between different surveys were not carried out. Also internal consistency was only analysed for the spring survey but not for the other available indices.
- There seems to be a tendency to overestimate F and underestimate SSB in the retrospective pattern. Recruitment estimates are in general highly uncertain.
- The assessment indicates that the decrease in SSB is caused by an increase in F combined with a decrease in weight at age and average recruitment (above average in former time periods).

- Although the ADCAM is the standard method, TSA was run as an alternative. The results of ADCAM and TSA seem to be similar in the most recent years. However, description of the comparison is too short and some figures would help.
- Results could be presented in a better way. In especially, bubble plots would help to visualize residuals. Survey consistency plots would also help. Uncertainties in historic and future SSB and F trajectories estimated by ADCAM would be interesting and not only point estimates should be presented.

Remarks by the reviewer

- Uncertain survey indices are a major concern for this assessment and exploratory data analyses are not carried out to the extent needed. Commercial tuning data are not analyzed at all. Also different settings for the model are not tested. This should be done during the benchmark meeting. However, the model is mainly driven by catch data. Since discard seems to be no problem for this fishery and landings data are of good quality, the assessment is certain enough to give advice.
- I am not sure whether a stock annex exists for this stock. If not, it should be created during the benchmark meeting.
- The group suggests a change in reference points for the advice this year. This is not appropriate to my opinion. Such things should be done during the benchmark meeting. In addition, a change in reference points would not change the perception of the status of the stock. Fsq is above Fpa in all circumstances. For advice, I would suggest something like: No TAC should be set leading to a further reduction in SSB. This implies a TAC of 31.000 tonnes at maximum.
- There is no management plan for this stock. Since it seems that formerly sustainable harvest rates and management strategies are no longer appropriate, a management plan is needed.

Conclusions

- The assessment has been performed correctly, although it is uncertain due to the survey indices used. There is an urgent need for a benchmark in the short time. The present management has led to an increase in F and a decrease in SSB below Bpa. A management plan is needed that ensures sustainable harvest rates (e.g., MSY) in the future.
- The information given by the assessments is sufficient to provide advice

Stock: Icelandic cod (section 09)

1) **Assessment type**: update/SPALY

2) **Assessment:** analytical

3) Forecast: short- and medium-term forecasts are presented

4) **Assessment model**: ADCAM tuned with the spring survey indices. In 2009 the model settings were identical to last years but the tuning data changed by addition of the Iceland-Faeroe ridge to the survey area. Analysis and conclusions using the Time Series Analysis is also presented and the results are similar to the ADCAM. XSA, ADAPT were also run. Total biomass indices and weight at age are available from the spring survey and autumn ground fish survey. M fixed for ages 1 and 2 before 1999 and estimated after.

5) **Consistency:** The assessment is in line with that from 2008. Reference fishing mortality in 2007 is now 0.52 compared with 0.55 estimated last year. The SSB in 2008 estimated to have been 253 kt compared with 230 kt. Seems that is due by inclusion of the catches from the Faroese EEZ and data from the Iceland-Faeroe ridge in the survey area. A minor constantly downward revision of year classes 2002 and younger.

6) **Stock status:** The spawning stock is relatively small and is estimated to be about 225 kt. The year classes from 2001 to 2007 are below average. The preliminary estimates of the 2008 year class indicate it may be above average or strong. The productivity of the stock at present is very low. Fishing mortality has declined in 2008 and is estimated around 0.4. Biological reference points have not been defined.

7) **Man. Plan.**: A formal Harvest Control Rule was implemented for this stock in 1995. The TAC for a fishing year was set as 25% of the "available biomass", computed as the biomass of age 4+ over intermediate and projection years. ICES has considered that this HCR is consistent with the precautionary approach provided that the implementation error is minimal. For the fishing year 2008/2009 the exploitation rate was reduced to 20%, TAC of 130 000 t being set prior to the fishing season. However, the TAC was set 160 000 t in January 2009, which implies a fishing mortality of 0.4.

General comments

The report is well in general and the text is an update from last years with relative changes. However, the report was not finalized before review. A lot of marked and uncompleted text and data still.

Technical comments

- The review was restricted to a check whether the assessment was carried in the same way as last year.
- Chapter 9.2.1. Landings of cod mentioned as 147 kt, however in table 9.2.1. - 148 and table 9.7.1 – 146.
- Table 9.2.1. Missing landings data for Iceland I don't understood. Have to be put or explained.
- Table 9.2.6. Data for the age 1 in 2009 is very high – almost highest from 1985. Is it cannot be overestimated?

- Figure 9.2.7. Seems that residuals for some ages and years are very high. It's difficult to analyse because cannot to see exact value.

Remarks by the reviewer

- The WG suggested to set a Blim candidate of 220 kt that estimated this year (see chapter 9.5). I agree that "somewhere in the range of 400kt" is not so clear. However, no detail description or enough evidences for new Blim are presented in the report that was available to the reviewers. From my point of view it is cannot be accepted now. Such things should be done during the benchmark meeting. Especially, if based on SGPRP have to be conclude that "the stock is outside safe biological limits and very overfished because SSB= ½ Blim(candidate)". If we accepted a new Blim (candidate), that means opposite "the stock is outside safe biological limits but not so overfished because SSB around Blim(candidate)".
- Chapter 9.12. First paragraph look strange. Because it means that "authorities don't have catch date from foreign fleets and research vessels and from Faroe EEZ". As for the cod/haddock fisheries, nothing anecdotal. If the ITQ for cod is too small or market price not like, the fishermen will try to avoid big catches of cod practically of formally (discards). Same for the chapter 9.15.
- Chapter 9.13. No fully understood correlation between "During the last few years the capelin stock has been low. This low abundance as well as anecdotal information about the low abundance of sandeel may have caused an increase in natural mortality in seabird populations around Iceland. It is possible that some of these changes are climate-driven but the effects of fishery induced mortality on the capelin cannot be ruled out." and state of the cod stock. Have to be write more clearly.

Conclusions

The assessment has been performed correctly, although it is uncertain. The information given by the assessments is sufficient to provide advice. There is an urgent need for a benchmark and define agreed reference point in the short time. The present management is not sustainable. A formal Harvest Control Rule have to be revised as soon as possible.

Stock: Icelandic haddock - Haddock in Division Va (report section 10)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY - same input data with addition of one year, same model, same parameter settings
2) **Assessment**: analytical
3) **Forecast**: a short-term prediction has been carried out that gives expected future landings dependent on Fbar; these forecasts indicate that stock size and landings will decrease rapidly in coming years when the large year classes disappear
4) **Assessment model**: ADAPT type model; the assessment is based on age-disaggregated landings from 1979 to 2008; the model is tuned with survey data from the March survey 1985–2009 and the October survey 1995–2008; the assessment does not include discards
5) **Consistency**: The estimates for biomass and fishing mortality are consistent with that of 2008; the basis for the advice is the same as in 2008; however, the WG recommends to lower the target F from 0.47 to 0.35 to keep the effort comparable to what 0.47 led to earlier; given this the predicted catch proposed reduces from <83 in 2008 to <57 in 2009
6) **Stock status**: No reference points are defined; given this the state of the stock cannot be evaluated; however, the recent spawning stock size has decreased and is predicted to decrease rapidly next years when strong year classes disappear from the stock and average year classes replace them; recent recruitment has been around the long-term average since year class 2004; growth has reduced considerably and at the beginning of 2009 the mean weight of most age groups was near a historic low; the large 2003 year class grows especially slowly
7) **Man. Plan.**: There are no explicit management objectives and no management plan defined for this stock; however, the WG recommends the application of a lower fishing mortality than before as under the current conditions a fishing mortality of $F_{4\text{–}7} = 0.35$ is seen to lead to similar results as in case of $F_{4\text{–}7} = 0.47$ in previous years (1985–2000)

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last years report with a few changes. The result of the assessment gives the same perception of the stock and fishery as last year's assessment.

Technical comments

- the review was restricted to a check whether the assessment was carried in the same way as last year. This was the case. No deviations were spotted
- the data have been used as specified in the stock annex
- the assessment, recruitment and forecast model has been applied as specified in the stock annex
- no comparison between different settings of ADAPT were carried out, at least the results were not given or discussed; however, the effect of includ-

ing the one or the other or both of the two surveys was tested by additionally also using different methods (XSA, ADCAM, TSA); dependent on the type of model and the survey(s) selected the results varied somewhat: while the estimates appeared relatively similar re F4-7 (2008) ranging from 0.50 to 0.59 (15% max deviation), the estimates for Bio3+ (2009) varied somewhat more ranging between 169 to 226 (25% max deviation); under inclusion of both groundfish surveys from March and October ADAPT led to median results why it has been obviously chosen; nevertheless, the most recent residuals all appear negative (indicating some kind of bias); although in principle the WG is aware of this it should be looked more carefully at the reasons for it (model settings, method itself, survey results, commercial data?)

- re both the short term forecast and the assessment there is an issue with the uncertainty in growth strongly influencing the outcome; in short term predictions growth is predicted as a function of weight at age multiplied by a year effect; although the WG is aware of it in principle, it seems necessary to look more closely at the reasons for it (looking for alternative growth functions, appropriateness of age class spectrum used, are there any obvious other factors influencing this that need to be included such as climate, temperature, density dependence, food availability, …)
- the main conclusions are in accordance with the WG report
- tables and figures have been updated and are correct

Conclusions

- the assessment has been performed correctly
- the update assessment gives a valid basis for advice
- there is no reason to deviate from the standard procedure for this stock

Stock: Icelandic summer spawning herring (section 11)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: NFT-ADAPT and TSA using survey indices from 1 survey
5) **Consistency**: consistent with last year; previously bias but this is less since last year
6) **Stock status**: unknown. The assessment indicates the stock in SBL but an outburst of *Ichthyophonus* infection was observed and will have reduces the stock in 2009.
7) **Man. Plan.**: There is no formal management plan but there is a ‘tradition’ to set TAC based on F=0.22

General comments

Non standard approach but the same as last year. Apart from the sections dealing with the assessment and the elaborations on *Ichthyophonus* the text is the same as last year. There is a lot information but because of the structure of the report, difficult to find if you are not familiar with this stock.

Technical comments

- There is an Annex according the text, but this was not available during the review. It could also not be found on the share-point. The assessment was compared to last years.
- This is an update assessment. Comparison of the tables shows that there were no revisions in last year's data. Only the year 2008 has been added to the table.
- Last year, 3 assessment models were tested. This year, there were 2 models. The XSA has not been carried out this year. Compared with last year, both new assessments have been carried out with new versions of software.
- The surveys are been carried out in an unusual way (non standard area), but apparently this has been done so for a long time and is an Icelandic tradition. No further comments. It is not clear whether the survey is used as and absolute index or relative. Table 11.3.2.1.says that there are 7 indices. This is probably not correct. There is one time series with 7 age groups.
- The 2 year olds were considered not well estimated by the survey, while the 1 year old and older were. This age group (2 year olds) was estimated from the 1-year olds estimate of the assessment. It is not clear where this has been done (before the tuning?) and whether this has been done last year in the same way.
- The text in the paragraph 'scientific data' is difficult to read. There are numbers, year classes, ages, estimates, corrected estimates. It is also not always clear to which age the number belong. Better present estimates in a text table and describe what has been done.
- SSB in the beginning 2009 is estimated at 542 kt. Accounting for mortality because of the Ichthyophonus infection, a fixed mortality percentage of 32.2% has been applied to the stock in SSB. SSB in 2009 becomes than 376 kt. The percentage has been applied to all age groups except age 1 (year class 2007). This year class is assumed not to be infected. This corrected stock was the basis for the analytical prediction.
- The calculation of fishing mortality used in the prediction is different from last year. Last year the average 2001-2006 was used. This year the average 2003-2008 excluding 2005 and 2006 was used. However Table 11.6.1. shows a flat topped selection pattern after age 4, the same for all ages. The approach seems to be very non standard.
- The fact that proportion of M before spawning is set at 0.5 (summer spawners) is used in the prediction. Does this means that the SSB after the predicted TAC's have been taken is at spawning time? The standard summary table suggests that the SSB result of the assessment is at 1st January. If that is the case the SSB in the prediction cannot be compared with the assessment.

- Surveys, later in 2009 may give better estimates of infection mortality. A revised estimate of SSE and a new prediction may become later this year. The present outburst has been detected in August 2008 in the survey. The infection rate differed at different places. It is noted that Ichthyophonus infections usually can maintain for 2 years. The mortality assumed can therefore be an underestimate.
- In section input data for the forecast words are used 'there is no estimate available' of 'there is no estimation available' for recruitment of certain year classes. Is there a difference here? The surveys should give estimates!

Remarks by the reviewer

- This stock mixes with Norwegian Spring Spawning herring during part of the year in east Icelandic waters. Is it possible that the infection can be transferred to this stock?
- The catches are generally in line with TAC and advice. In some years, pending of the location of the fishery, catches mixed with NSSH can occur.
- The herring fishing season has taken minor changes in last three decades. Until 1990, the herring fishery took place during the last three months of the calendar year. Almost all of the catch in 2008/09 was taken with purse-seines
- At the presently assumed rate of infection, the TAC should be 0 if previous management practice is maintained because the stock is expected to be reduced below Bpa.

Conclusions

The assessment has been performed almost the same way as last year and only data were updated. In several places the approaches in this assessment and forecast are non standard. A lot of questions remain, but these would also apply on last year's assessment. Also, in order to improve readability (in particular for finding information) the structure of the text could be more standardized. This assessment is therefore a candidate for a bench mark.

The advice will depend on the severity of the *Ichthyophonus* infection. The magnitude of that will become clear later in the year. In consultation with the client, the advice should be postponed to later in the year, when the magnitude of the infection is clearer.

Stock: Capelin in the Iceland-East Greenland-Jan Mayen area (section 12)

1) **Assessment type**: update/SPALY
2) **Assessment**: analytical (acoustic measurements)
3) **Forecast:** not presented
4) Assessment model: The calculations are simple back-projections of stock numbers. The stock numbers at age are calculated on the January 1st with take into account the results from the acoustic surveys and catch taken by the fishery. The TAC for the next season is calculated from the prognosis on fishable stock take into account monthly natural mortality and a linear relationship between the abundance of one years old capelin (1 January) and the number of 2 years old mature capelin in the autumn, and the same method for the 3 years old mature ones. An account is taken mean weight that gain from autumn to winter and that the number have to be left to spawn.
5) Consistency: The current assessment was using the same methodology. Last year there was no starting quota was issued and the state of the stock was considered uncertain. There was no official fishery. The only 15 000 t was allocated to scouting vessels.
6) Stock status: The state of the stock is very uncertain. The SSB is highly variable because it is dependent on only two age groups. The stock been at low levels the last 4 years. Reference points have not been defined. The proposal is to use B_{lim}=400 000 t, which is the targeted remaining spawning stock since 1979. Last estimations gives only 328 000 t were left for spawning in spring 2009. It is clear that the stock is at very low level and the advice is therefore not to open the fishery in the season 2009/10 until new assessment will be available.
7) Man. Plan.: The fishery is managed according to a minimum spawning-stock biomass of 400 000 t by the end of the fishing season. The initial quota is set at 2/3 of the preliminary TAC. Later based on the results of another survey conducted during the fishing season the initial quota is revised still based on the condition that 400 000 t should be left for spawning. ICES has not evaluated the management plan with respect to its conformity to the precautionary approach.

General comments

This was a well documented, well ordered and considered section. It was easy to follow and to interpret. The Quality Handbook was revised.

Technical comments

- Table 12.2.3. The weight for the length 12 cm have to be check because lower then for length 11.5 cm.
- Table 12.2.4. The weight for the length 13.5 cm have to be check because lower then for length 13 cm.

Remarks by the reviewer

- Seems that in future the report regarding Capelin in the Iceland-East Greenland-Jan Mayen area "will be reviewed optionally". It is impossible to review the acoustic results because not presented enough.

Conclusions

The assessment has been performed correctly. The state of the stock is very uncertain, however, it can be say that the stock is outside safe biological limits. The information given by the report is sufficient to advice not to open the capelin fishery until new acoustic surveys measurement will be done in late 2009 and eary 2010.

Stock: Cod in ICES Sub-area XVI and NAFO Sub-area 1 (Greenland cod) (report section 14)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update, no advice
2) **Assessment**: trends
3) **Forecast**: not presented
4) **Assessment model**: descriptive, trawl and gill-net survey abundance indices used to estimate SSB index; CANUM and WECA not used in the assessment
5) **Consistency**: Update assessment.
6) **Stock status**: Two survey abundance indices indicate that the cod stock is presently considerably above the very depressed state observed in the 1990's. However, the stock is well below historical levels. The surveys indicate an improvement in recruitment with all year-classes since 2002.
7) **Man. Plan.**: No management plan developed. There is a need to establish multi-annual plan to ensure the TAC are set at low levels until a substantial increase in biomass and recruitment is evident. TAC quota set separately for coastal and offshore fisheries. The NWWG proposes no offshore fishery in 2010 in order to rebuilt Greenland offshore cod stock as it is considered that no sustainable offshore cod fishery at Greenland can rely on the infrequent inflow of Icelandic cod.

General comments

This was a well documented, well ordered and considered section. The text was relevant to tables and figures presented, and the text was also easy to follow. The assessment (trends) is consistent with last year's assessment.

Technical comments

- Technical annex was not available to Review Group.
- The report provides very thorough information on surveys both in terms of their weakness and advantages.
- Tables and figures are correctly ordered and numbered in line with the text of the report. Tables and figures are correctly labeled and the units of measure always presented.

Remarks by the reviewer

- East Greenland offshore area is to large extent non-trawlable fishing ground, except for eastern shelf slope only. This implies that the fish density occurred in the survey may be not representative for the whole area. The Working Group tried to resolve that problem by using strata sizes that would reflect the size of the trawlable shelf areas but refrained for that solution.
- Another issue is poor area coverage due to stormy weather conditions observed in number of years. This again reflects that survey biomass and abundance estimates correspond to only a part of the whole area.
- There is also a question on how to proceed with large hauls that may represent large part of the abundance and biomass.
- The above items are planned to be investigated during designated survey workshop.

Conclusions

The assessment has been performed correctly. Surveys provide the core information relevant for stock assessment purposes. The information given by the assessments is sufficient to provide advice.

Stock: Greenland halibut in Sub-areas V, VI, XII and XIV (Greenland halibut) (report section 15)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: logistic production model in a Bayesian framework
3) **Forecast**: logistic production model in a Bayesian framework
4) **Assessment model**: the assessment was performed using difference version of the Schaffer model in Bayesian framework. Three tuning series were used, one commercial CPUE and two surveys.
5) **Consistency**: in 2007 the stock production model was presented in a Bayesian framework and accepted by the NWWG. This approach was rejected by the review group based on some technicalities. The comments of the 2007 reviewers have been taken into account in the 2008 assessment that was accepted. The present estimates were compared with those from previously applied ASPIC model. There are some differences in estimates (e.g. present approach shows much sharper increase in stock size near 2000, and biomass from ASPIC at the beginning of time series is close to B_{msy}, while in the present approach it is close to carrying capacity).
6) **Stock status**: Stock size: stock biomass $0.4B_{msy}$ (median), 100% probability of being below B_{msy}, 5-18% risk of being below B_{lim}. Exploitation: $2F_{msy}$ (median), approx. 65% risk of exceeding F_{lim}.
7) **Man. Plan.**: At present no formal agreement on the management of the Greenland halibut exists among the three coastal states Greenland, Iceland

and the Faroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of TAC's advised by ICES.

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last year's report with relative little changes.

Technical comments

- The review was restricted to a check whether the procedures described in the stock annex were applied. This was the case. No deviations were spotted.
- Tables and figures are correctly ordered and numbered in line with the text of the report. Tables and figures are correctly labeled and the units of measure always presented.

Remarks by the reviewer

- Included tuning series are consistent, showing similar trends.
- For some parameters informative priors were used. Sensitivity of the results to choice of priors was investigated and appeared to be rather low. Residuals from the fitted values do not show specific patterns.
- Retrospective analysis was performed and produced consistent estimates of stock biomass.
- The estimates were compared with those from previously applied ASPIC model. There are some differences in estimates, which could be closer inspected (e.g. present approach shows much sharper increase in stock size near 2000, and biomass from ASPIC at the beginning of time series is close to B_{msy}, while in the present approach it is close to carrying capacity).

Conclusions

The assessment has been performed correctly. The assessment provides basis for the formulation of the advice.

Stock Golden Redfish (Sebastes marinus) in Subareas V, VI and XIV (section 17)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: Gadget using survey and cpue data
5) **Consistency**: consistent with last year
6) **Stock status**: survey cpue is below Upa, but there is a lot of conflicting information which suggest otherwise.
7) **Man. Plan.**: There is no management plan.

General comments

This is an update assessment. See further conclusions.

Technical comments

- There is no mention of reference to a bench mark assessment. The procedures followed by the WG and results were compared with the assessment in last year's report..
- This is an update assessment. Comparison of the tables shows that there were only revisions in last year's (2007) data. The data for 2008 has been added to the table.
- The reviewer had no experience with Gadget. It is checked that the model and the configuration of the model is the same as last year. This was the case. It is unclear why the Gadget model would give better answers than a VPA model and why the utilities for taken account for immigration have not been used. Also, why is F not estimated.?
- It is irrelevant to put attention minor changes in the text on for instance fishable biomass and cpue given the stdev.
- The large increase in the total survey index in Iceland waters (Va) in 2009 comes from the 400-500m depth zone and from fish between 32 and 40 cm. This index (table 17.2.1) in about 2.5 times higher than the previous highest. Given the slow growth of Sebastes, it would be possible to predict such an increase from previous surveys because the responsible year class would be present in the survey for a number of years as smaller fish. This is not the case. The increase can be also be explained by immigration from other areas but there is no additional information to support this. Also an increase in catchability could be the case.
- Note there are also large peaks in abundance given by the surveys in single years, especially in the past. This puts doubt on the quality of the surveys as indicators especially as point estimators and can be misleading when describing trends.
- Note there is increase in last year in as well small as large fish in Greenland waters which can only be explained by immigration, but from where? We have a problem in seeing more fish in survey not knowing

where it comes from. This points to lack of understanding of the stock dynamics and doubt on the quality of our observations to predict. There is something going here but we don't understand it. Time for a bench mark

- survey CPUE is available for 3 areas but cannot be compared easily. It would be very helpful, if the cpue's in the different area were presented in the same way (comparable). In Va there is a spit in 4 size categories. For Vb nothing is indicated. In XIV there are 2 categories.
- The results of the alternative configuration of the model are shown but not used in the interpretation.
- The bending of the tails of the QQplot points to different distributions between the X-axis and Y-axis and may be a cause for concern.
- The units for the cpue in Division Vb in figure 17.3.9 must be wrong. They indicate several hundred tonnes per hour. The total catches in this Division are only a few hundred tonnes.

Remarks by the reviewer

- The stock occurs in several areas but the catches are almost entirely from area Va.
- There in information on the trends in the stock for the separate areas.
- The GADGET model predicts that catches in Va below 30 000 t would provide a fishable stock size above current biomass level for the next 5 year.

Conclusions

The assessment has been performed almost the same way as last year and only data were updated. Based on the analyses by the WG and the basis of the advice by ACOM last year, the advice would have been the same.

In several places the approaches in this assessment and forecast are non standard. There are indications for a positive development in the Sebastes marinus abundance, but the present analyses are difficult to interpret. The large variation in data, suggests either problems with quality of the data or the stock identity. This assessment is therefore an urgent candidate for a bench mark with expertise from outside included. Based on the present assessment the advice of last year could be maintained.

Stock: Icelandic slope Sebastes mentella in Va and XIV (section 18)

1) **Assessment type**: not relevant
2) **Assessment:** no formal assessment
3) **Forecast:** not presented (not possible)
4) **Assessment model**: no formal model
5) **Consistency**: The stock has been evaluated by ICES in 2009. Previously demersal S. mentella has been treated as one stock (see chapter 18.1) but is now divided on three stocks. The Icelandic autumn survey in Va gives the biomass index and biological data. CPUE and sampling from the commercial fishery also available.
6) **Stock status**: The state of the stock is on a low level. The fishable biomass index from the Icelandic autumn survey shows that the biomass index for 2002-2008 has been on a lower level than in earlier years. Good recruitment

has been observed on the East Greenland shelf but their contribution to the demersal stock is at unknown. There are no biological reference points. Previous reference points established were based upon commercial CPUE indices, but are now considered to be unreliable indicators.

7) Man. Plan.: There is no management plan. The advice for 2008 was that catches of *S. mentella* are set no higher than 10 000 t as a starting point for the adaptive part of the management plan. However, the total landings in 2008 were about 25 000 t that higher about 8 500 t than in 2007. A joint quota for golden redfish and demersal *S. mentella* is set in Icelandic waters. The Ministry of Fisheries in Iceland established a committee with the objective to review and recommend on how to separate quotas for the two species. The new regulation is expected in September 2009.

General comments

The poor data and the lack of long time series indices of abundance prevent analytical assessment and the situation cannot be fully evaluated. However, it was well documented, well ordered and considered section in the report.

Technical comments

- Chapter 18.2. "The length of the demersal S. mentella in the autumn survey is between 30 and 47 cm with modes ranging from 36-39 cm (Figure 18.2.2)." However, figure 18.2.2. gives range between 25 and more them 50 cm and another modes.
- Chapter 18.3.1 "The landings in 2008 were about 24 500 t, an increase of about 8 500 t from the previous year. This increase is because of increased landings in the last quarter of the year." Some misunderstanding. Is it very important that increasing was in last quarter? Better, for example, "is because the quota was increased …. ". However, nothing said about TAC or quota in the report.
- Chapter 18.3.3. Have to be mentioned enough or not the sampling data from the commercial fishery.
- Chapter 18.3.4. "The length distribution of demersal *S. mentella* from the pelagic fishery, …, showed that in most years the fish was on average bigger than taken in the bottom trawl fishery". Any suggestion to explanation? Different stocks, fishing time or mesh size?
- Figure 18.2.1b. In the text "b) fishable biomass index (> 30 cm)", but on the picture we can see "in millions", and the picture b very same as picture a. Strongly recommends to revise.

Remarks by the reviewer

- From my point of view the stock is outside biological limits, harvested unsustainable and very overfished.
- Very poor description about management. How this fishery is managed? No any data about minimum landing size, TAC, ITQ closed area, restricted seasons, gears ect.
- Nothing said about misreporting catches or discards.
- From the biological view the "redfish line" is something strange and cannot be accepted. Because this artificial line cannot split two live stocks that migrated and so on. This gives possibility to misreporting (or incorrect) da-

ta for different fisheries and stocks. As evidence see Chapter 18.3.2, paragraph 2 – "This pattern is probably associated with the pelagic S. mentella fishery within the Icelandic EEZ (see Figure 16.1.1). The pelagic S. mentella fishery has in recent years moved more northwards, and in 2003 and 2007 it merged with the demersal S. mentella fishery on the redfish line in July (Figure 16.1.3). When the pelagic S. mentella crossed the redfish line to the east, it was recorded as demersal S. mentella and caught either with pelagic or bottom trawls resulting in increased landings in 2003 (Figures 18.3.2-18.3.3 and 16.1.1)."

Conclusions

There are a number of uncertainties in the assessment of the demersal *Sebastes mentella* on the Icelandic slope. However, it can be concluded that this stock is under overexploitation. The present management is not sustainable. The development of a management plan and define agreed reference point are needs. Last year ICES advises that that catches to be set no higher than 10 000 t as a starting point for the adaptive part of the management plan. There are no indications that there are changes in the stock status or advice.

Stock: Beaked Redfish (*Sebastes mentella*) in Division V, XII, XIV and NAFO Sub-areas 1+2 (Shallow Pelagic stock<500 m) (report section 19)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: trends, assessment and advice will be provided in the autumn 2009 based on a scheduled acoustic-trawl survey in June 2009
3) **Forecast**: not presented
4) **Assessment model**: descriptive, trawl-acoustic survey indices+CPUE, last survey was carried out in 2007
5) **Consistency**: the data available for evaluating the stock status are similar to last year
6) **Stock status**: due to data uncertainties and the lack of reliable data no analytical assessment was carried out and in consequence no ref. points can be derived. Trawl pelagic estimate of the stock size in 2007 (854 000 t) is the second in row of 5 recent estimates.
7) **Man. Plan.**: There is no management plan established.

General comments

- This was a well documented, well ordered and considered section. The text in the report is an update from last years report with relative little changes. Stock size is provided on the basis of pelagic trawl estimates.

Technical comments

- There is a very good environmental background provided in the report.
- The report provides very useful maps of fishing distribution.

- Tables and figures are correctly ordered and numbered in line with the text. Tables and figures are correctly labeled and the units of measure always presented.

Remarks by the reviewer

- In a Special comment provided in 2009 to NWWG by S.P. Melnikov there is expressed strong Russian scientists disagreement to "developing scientific advice on the management of the Irminger Sea redfish stock in ICES only part of the available scientific evidence was used for decision" on identification of two pelagic stocks of *Sebastes mentella*. The statement presented in the special comment was not commented by the Group.
- Not all nations provide landings information in association with the depth of trawling, which is essential to split the landings by two distinguished *Sebastes mentella* stocks. This makes the planned assessment less reliable.
- Quality of some countries catches (including discards) is very low, in particular in the period 1992-1996. For that reason landings figure is in fact WG's best guestimate. In general credibility of landing statistics is questionable. There are indications suggesting that unreported catches might be substantial. There is also lack of reliable age data.
- High variability in the correlation between trawl and acoustic estimates and also the assumptions made about constant catchability with depths and areas makes the uncertainty of these estimates very high.

Conclusions

There are a number of uncertainties regarding the data quality and the methodology described in the report which gives in general the impression that the perception of the stock size is very imprecise. The Group has pointed out all the weaknesses in the data and the methodology very explicitly. All that, gives also the impression that separate assessment for two recently distinguished *Sebastes mentella* stocks is ambitious.

Stock: Beaked Redfish (*Sebastes mentella*) in Division V, XII, XIV and NAFO Sub-areas 1+2 (Deep Pelagic stock>500 m) (report section 19)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SPALY
2) **Assessment**: trends, assessment and advice will be provided in the autumn 2009 based on a scheduled acoustic-trawl survey in June 2009
3) **Forecast**: not presented
4) **Assessment model**: descriptive, trawl-acoustic survey indices+CPUE, last survey was carried out in 2007
5) **Consistency**: the data available for evaluating the stock status are similar to last year
6) **Stock status**: due to data uncertainties and the lack of reliable data no analytical assessment was carried out and in consequence no ref. points can be

derived. Trawl pelagic estimate of the stock size in 2007 (854 000 t) is the second in row of 5 recent estimates.

7) **Man. Plan.**: There is no management plan established.

General comments

- This was a well documented, well ordered and considered section. The text in the report is an update from last year's report with relative little changes. Stock size is provided on the basis of pelagic trawl estimates.

Technical comments

- There is a very good environmental background provided in the report.
- The report provides very useful maps of fishing distribution.
- Tables and figures are correctly ordered and numbered in line with the text. Tables and figures are correctly labeled and the units of measure always presented.

Remarks by the reviewer

- In a Special comment provided in 2009 to NWWG by S.P. Melnikov there is expressed strong Russian scientists disagreement to "developing scientific advice on the management of the Irminger Sea redfish stock in ICES only part of the available scientific evidence was used for decision" on identification of two pelagic stocks of *Sebastes mentella*. The statement presented in the special comment was not commented by the Group.
- Not all nations provide landings information in association with the depth of trawling, which is essential to split the landings by two distinguished *Sebastes mentella* stocks. This makes the planned assessment less reliable.
- Quality of some countries catches (including discards) is very low, in particular in the period 1992-1996. For that reason landings figure is in fact WG's best guestimate. In general credibility of landing statistics is questionable. There are indications suggesting that unreported catches might be substantial. There is also lack of reliable age data.
- High variability in the correlation between trawl and acoustic estimates and also the assumptions made about constant catchability with depths and areas makes the uncertainty of these estimates very high.

Conclusions

There are a number of uncertainties regarding the data quality and the methodology described in the report which gives in general the impression that the perception of the stock size is very imprecise. The Group has pointed out all the weaknesses in the data and the methodology very explicitly. All that, gives also the impression that separate assessment for two recently distinguished *Sebastes mentella* stocks is ambitious.

Annex 3 – Stock Annexes

Quality Handbook **Stock Annex: Faroe Bank Cod**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	**Faroe Bank Cod**
Working Group:	**North Western Working Group**
Date:	**May 2009**
Revised by	………..

A. General

A.1. Stock definition

The Faroe Bank is located approximately 75 km Southwest of the Faroe Islands (60º15′ S, 61º30′ N,9º 40′W,7º40′ E)(Eyðfinn, 2002). The Faroe Bank cod is under ICES management unit Vb2. Inside the 200 m depth contour, the Faroe Bank covers an area of about 45 × 90 km and its shallowest part is less than 100 m deep. The Faroe Bank cod is distributed mainly in the shallow waters of the Bank within the 200 m depth contour. The cod stock on the Bank is regarded as an independent stock displaying a higher growth rate than that of cod on the Plateau. Tagging experiments have shown that exchanges between the two cod stocks are negligible. The stock spawns from March to May with the main spawning in the first-half of April in the shallow waters of the Bank (<200 m). The eggs and larvae are kept on the Bank by an anti-cyclonic circulation. The juveniles descend to the bottom of the Bank proper in July. No distinct nursery areas have been found on the Bank. It is expected that the juveniles are widely distributed on the Bank, finding shelter in areas difficult to access by fishing gear (Jákupsstovu, 1999).

A.2. Fishery

Due to the decreasing trend in cod landings the Bank was closed to all fishing in 1990. This advice was followed for depths shallower than 200 meters. In 1992 and 1993 longliners and jiggers were allowed to participate in an experimental fishery inside the 200-meter depth contour. The new management regime with fishing days was introduced on 1 June 1996 allowing longliners and jiggers to fish in depths below 200 m while trawlers are allowed to fish in waters deeper than 200 m.

A total fishing ban during the spawning period (1 March to 1 May) has been enforced since 2005.

A.3. Ecosystem aspects

The Faroe Bank is a geographically well-defined and self-contained ecosystem surrounded by an oceanic environment (Eyðfinn, 2002) in which cod spawns from March to May with the main spawning in the first-half of April in the shallow waters of the Bank (<200 m). The eggs and larvae are contained in the anti-cyclonic circulation on the Bank. The juveniles descend to the bottom of the Bank proper in July. No distinct nursery areas have been found on the Bank. It is anticipated that the juveniles are widely distributed on the Bank, finding shelter in areas difficult to access by fishing gear (Jákupsstovu, 1999).

Growth

Cod in the Faroe Bank is the fastest growing cod stock in the North Atlantic. For comparison the average size of 1-year old cod in the Bank is approximately 60 cm while the Faroe Plateau cod is slightly below 20 cm (Figure 1.)

Maturity

The majority of cod in the Faroe Bank mature at age three with usually all mature by age four.

Diet

The diet of cod in the Bank varies with the size of the fish and season. Adult cod feeds mainly of fish preys like sandeel and crustaceans specially crabs, shrimps, munida and galathea while whelks and worms may contribute to a lesser extent to its diet.

B. Data

B.1. Commercial catch

Faroese commercial catch in tonnes by month, area and gear are provided by the Faroese Statistical Office (Hagstova). Data on catch in tonnes from other countries are taken from ICES official statistics and/or from Coastal Guard reports.

The landing estimates are uncertain because since 1996 vessels are allowed to fish both on the Plateau and on Faroe Bank during the same trip, rendering landings from both areas uncertain. Given the relative size of the two fisheries, this is a bigger problem for Faroe Bank cod than for Faroe Plateau cod.

No discards are reported or accounted for in the assessment..

The following table gives the source of landings data for Faroe Bank cod:

Kind of data

Country	Caton (catch in weight)
Faroe Islands	x
Norway[1]	x
UK (E/W/NI) [1]	x
UK (Scotland) [1]	x

[1] As reported to Faroese authorities

B.2. Biological

Biological samples have been taken from commercial landings since 1974 and from the groundfish survey since 1983.

B.3. Surveys

Two research vessel survey series for cod in Vb2 were available to the Working Group in 2008.

- Faroese spring groundfish survey (FGFS1): years 1983–2003, 2006–2008 (discontinued in 2004 and 2005)
- Faroese fall groundfish survey (FGFS2): years 1996–2008.

The design for both bottom-trawl surveys is depth stratified with randomised stations. The number of stations is 29 and effort is recorded in terms of minutes towed (~60 min)

Plots of the spatial distribution of the fall (2000-2004) and spring (2006-2008) faroese groundfish surveys mean catch rates are given in Figure 2 and 3.

B.4. Commercial CPUE

A commercial cpue series from longliners is available but has never been used in the final assessment by the WG.

B.5. Other relevant data

The number of fishing days by the longline fleet is provided by the Faroese Coastal Guard and consist of realised days at sea.

C. Historical Stock Development

In 2000, an attempt was made to assess the stock using XSA with catch at age for 1992-1999, using the spring groundfish survey as a tuning series (1995-1999) but the WG and ACFM concluded that it could only be taken as indicative due to scarce catch-at-age data. No attempt was made to update the XSA in subsequent years given the poor sampling for age composition particularly for trawl landings. Since then several tools have been used to assess the status of the stock including a surplus production model and statistical catch at age all providing unrealistic estimates of fishing mortalities and stock size. Therefore the WG has agreed to use the survey catch rates (kg/hr) as indicative to follow stock trends.

D. Uncertainties in assessment and forecast

The landing estimates are uncertain because since 1996 vessels are allowed to fish both on the Plateau and on Faroe Bank during the same trip, rendering landings from both areas uncertain. Given the relative size of the two fisheries, this is a bigger problem for Faroe Bank cod than for Faroe Plateau cod, but the magnitude remains unquantified for both.

The catches of cod on Faroe Bank are sometimes reported on the landing slips and only the vessels larger than 15 GRT are obliged to have logbooks. The Faroes Coastal Guard is splitting the landings into Vb1 and Vb2 on the basis of landing slips and logbooks. Since small boats do not fill out logbooks and may not sell their catch, the catch figures on the Faroe Bank are actually estimates rather than absolute figures. The error in the catches of Faroe Bank cod may be in the order of some hundred tonnes, not thousand tonnes.

E. Short-Term Projection

None

F. Medium-Term Projections

None

G. Long-Term Projections

None

H. Biological Reference Points

There are not analytical basis to suggest reference points based on XSA, general production and statistical catch at age analysis.

J. Other Issues

None

K. References

Eyðfinn, 2002. Demersal fish assemblages of Faroe Bank: species composition, distribution, biomass spectrum and diversity

Jákupsstovu, 1999. The Fisheries in Faroese waters. Fleets, Activities, distribution and potential conflicts of interest with an offshore oil industry.

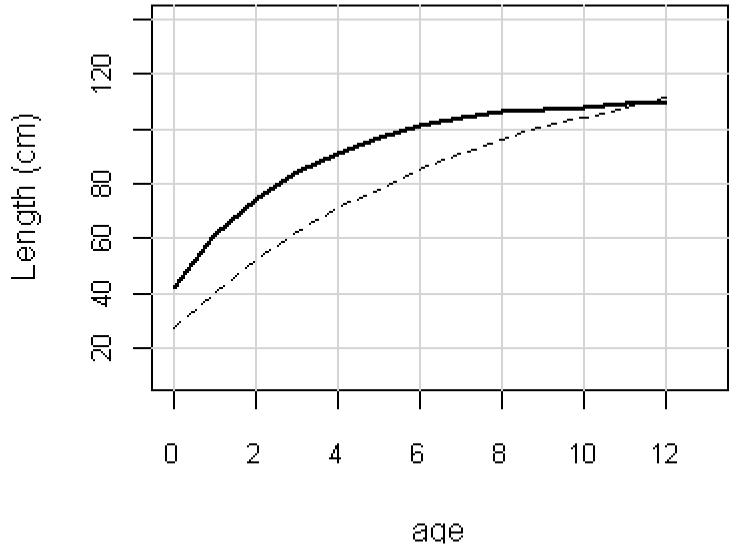

Figure 1. Von Bertalanfy growth equation for the Faroe Bank (thick line) and Faroe Plateau (dash line) cod stocks.

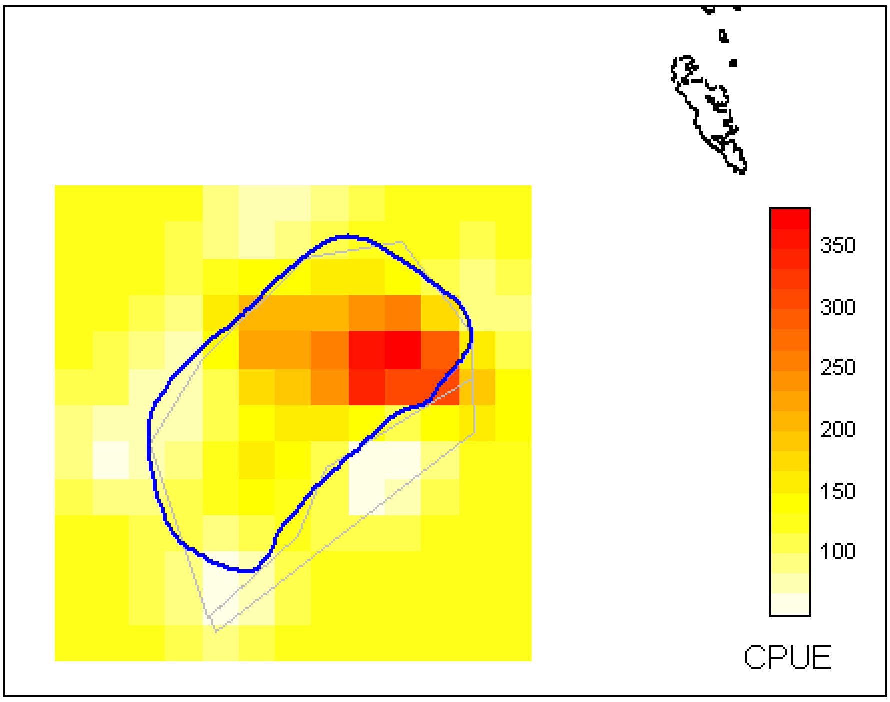

Figure 2. Cod in Division Vb2. Catch per unit of effort (CPUE) from the faroese summer ground-fish survey 2000-2004.

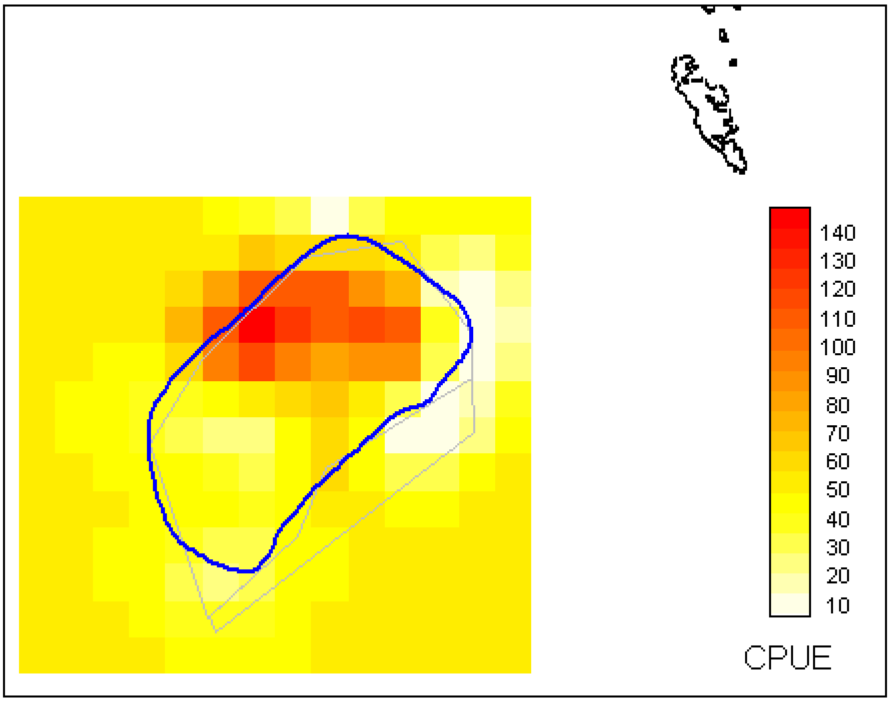

Figure 3. Cod in Division Vb2. Catch per unit of effort (CPUE) from the faroese spring groundfish survey 2006-2008.

Quality Handbook Stock Annex: Faroe Plateau Cod (Division Vb1)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Faroe Plateau cod (Division Vb1)
Working Group:	North-Western Working Group
Last updated:	May 2009
Revised by	………..

A. General

A.1. Stock definition.

Extensive tagging experiments on the Faroe Plateau (Strubberg, 1916; 1933; Tåning, 1940; Joensen *et al*., 2005; unpublished data) during a century strongly suggest that the cod stock on the Faroe Plateau is isolated from other cod stocks, e.g., from cod on the Faroe Bank and cod at Iceland. Only around 0.1% of recaptured tagged cod are recaptured in other areas than the Faroe Plateau (Joensen *et al*., 2005). The immigration rate from Iceland is even lower. During 1948-86, around 90,000 cod were tagged at Iceland and 11,000 recaptured. Of these, five cod were recaptured in Faroese waters and only three of them on the Faroe Plateau (Jónsson, 1996). Of cod tagged in the North Sea, one specimen has been recaptured at the Faroes (Bedford, 1966).

Icelandic and Faroese tagging experiments suggest that the cod population on the Faroe-Icelandic ridge mainly belongs to the Icelandic cod stock. Faroese Fisheries Laboratory tagged about 29 000 cod in Faroese waters during 1997-2009 and about 8 500 have been recaptured to March 2009. Of these, one individual was caught on the Icelandic shelf and one on the Faroe-Icelandic ridge. In 2002, 168 individuals were tagged on the Faroe-Icelandic Ridge (Midbank). Twelve have been recaptured so far, 6 at Iceland, 3 on the Faroe-Icelandic Ridge and 0 on the Faroe Plateau (3 had unknown recapture position). The Marine Research Institute in Iceland tagged 25572 cod in Icelandic waters during 1997-2004 and 3708 were recaptured to April 2006. Of these, only 13 individuals were recaptured on the Faroe-Icelandic ridge and none on the Faroe Plateau.

Genetic investigations indicate that Icelandic cod might be composed by two components (Pampoulie *et al*., 2006): a western component and an eastern component, which, genetically, is indistinguishable from the Faroe Plateau cod stock (Pampoulie *et al*., 2008). While Faroe Plateau cod is dominated by the Pan I^A allele (above 0.8), the frequency is much lower (between 0.2 and 0.8) for Icelandic populations (Case *et al*., 2005), especially on the Faroe-Icelandic Ridge (0.2). The cod populations in the North Sea are dominated by the Pan I^A allele (as the populations on the Faroe Plateau and the Faroe Bank) but they have a higher frequency of the HbI(1) hemoglobin allele (Sick, 1965). Hence, Faroe Plateau cod have a rather special combination of genetic traits, as they mainly possess the 'coldwater' hemoglobine allele (Hb-I(2)) and the 'warmwater' PanI^A allele.

Cod spawn in February-March at two main spawning grounds north and west of the islands at depths around 90-120 m. The larvae hatch in April and are carried by the

Faroe Shelf residual current (Hansen, 1992) that flows clockwise around the Faroe plateau within the 100-130 m isobath (Gaard *et al*. 1998; Larsen *et al*., 2002). The fry settle in July-August and occupy the near shore areas, which normally are covered by dense algae vegetation. In autumn the following year (*i.e.* as 1 group), the juvenile cod begin to migrate to deeper waters (usually within the 200 m contour), thus entering the feeding areas of adult cod. They seem to be fully recruited to the fishing grounds as 3 year olds. Faroe plateau cod mature as 3-4 year old. The spawning migration seems to start in January and ends in May. Cod move gradually to deeper waters when they are growing older. The diet in shallow water (< 200 m) is dominated by sandeels and benthic crustaceans, whereas the diet in deeper water mainly consists of Norway pout, Blue whiting and a few species of benthic crustaceans.

A.2. Fishery

The cod fishery on the Faroe Plateau was dominated by British trawlers during the 1950s and 1960s. Faroese vessels took an increasing part of the share during the 1960s. In 1977, the EEZ was extended to 200 nautical miles, excluding most foreign fishing vessels from Faroese fishing grounds. In the 1980s, closed areas (mostly during the spawning time) were introduced and these were extended in the 1990s. Longliners and jiggers fished in shallow (< 150 m) waters, targeting cod and haddock, whereas trawlers exploited the deeper waters, targeting saithe. Small trawlers were allowed to exploit the shallow fishing grounds for flatfish during the summertime. After the collapse in the fishery in the beginning of the 1990s, which contributed to a serious national economic crisis in the Faroes, a quota system was introduced in 1994. It was in charge during 1994-1995, but was replaced by the effort management system in June 1996. The cod stock had by then recovered rapidly, which was in contrast with the scientific expectations.

A.3. Ecosystem aspects

The rapid recovery of the cod stock in the mid 1990s strongly indicated that 'strange things' had happened in the environment. It became clear that the productivity of the ecosystem affected both cod and haddock recruitment and growth (Gaard *et al*., 2002), a feature outlined in Steingrund and Gaard (2005). The primary production on the Faroe Shelf (< 130 m depth), which took place during May-June, varied interannually by a factor of five, giving rise to low- or high-productive periods of 2-5 years duration (Steingrund and Gaard, 2005). The productivity over the outer areas seems to be negatively correlated with the strength of the Subpolar Gyre (Hátún *et al*., 2005; Hátún *et al*., 2009; Steingrund *et al*., submitted), which may reglulate the abundance of saithe in Faroese waters (Steingrund and Hátún, 2008).

B. Data

B.1. Commercial catch

When calculating the catch-at-age, the sampling strategy is to have length, length-age, and length-weight samples from all major gears during three periods: January-April, May-August and September-December. In the period 1985-1995, the year was split into four periods: January-March, April-June, July-September, and October-December. The reason for this change was that the three-period splitup was considered to be in better agreement with biological cycles (the spawning period ends in April). When sampling was insufficient, length-age and length-weight samples were borrowed from similar fleets in the same time period. Length measurements were, if possible, not borrowed. The number of samples in 2005 and 2007-2008 was not sufficient to allow the traditional three period splitup for all the fleets, and a two period splitup (January-June and July-December) was adopted for those fleets.

The landing figures were obtained from the Fisheries Ministry and Statistics Faroe Islands. The catches on the Faroe-Iceland ridge were not included in the catch-at-age calculations, a practice introduced in the 2005 WG. Catch-at-age for the fleets covered by the sampling scheme were calculated from the age composition in each fleet category and raised by their respective landings. The catch-at-age by fleet was summed across all fleets and scaled to the correct catch.

Mean weight-at-age data were calculated using the length/weight relationship based on individual length/weight measurements of samples from the landings.

B.2. Biological

B.3. Surveys

The spring groundfish surveys in Faroese waters with the research vessel Magnus Heinason were initiated in 1983. Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the period was shortened by dropping the first cruise and one third of the 1991-stations were used as fixed stations. Since 1993 all stations are fixed stations. The standard abundance estimates is the stratified mean catch per hour in numbers at age calculated using smoothed age/length keys. In last years assessment, the same strata were used as in the summer survey and calculated in the same way (see below). All cod less than 25 cm were set to 1 year old.

In 1996, a summer (August-September) groundfish survey was initiated, having 200 fixed stations distributed within the 500 m contour of the Faroe Plateau. Half of the stations were the same as in the spring survey.

The abundance index was calculated as the stratified mean number of cod at age. The age length key was based on otolith samples pooled for all stations. Due to incomplete otolith samples for the youngest age groups, all cod less than 15 cm were considered being 0 years and between 15-34 cm 1 year (15-26 cm for 2005 because of abnormally small 2 year old fish). Since the age length key was the same for all strata, a mean length distribution was calculated by stratum and the overall length distribution was calculated as the mean length distribution for all strata weighted by stratum area. Having this length distribution and the age length key, the number of fish at age per station was calculated, and scaled up to 200 stations.

The proportion mature was obtained from the spring survey, where all aged individuals were pooled, i.e., from all stations, being in the spawning areas or not. The average maturity at age for 1983 to 1996 was used in years prior to 1983. Some of the 1983-1996 values were revised in 2003 but not the maturities for the 1961-1982 period.

B.4. Commercial CPUE

Two commercial cpue series (longliners and Cuba trawlers) are updated every year, but the WG decided in the benchmark assessment in 2004 not to use them in the tuning of the VPA. The cpue for the longliners was shown to be highly dependent upon environmental conditions whereas the cpue for the pair trawlers could be influenced by other factors than stock size, for example the price differential between cod and saithe. These two cpue series are presented in the report although they were not used as tuning series.

B.5. Other relevant data

C. Historical Stock Development

An XSA has been performed during a number of years. The use of tuning indices has, however, varied quite a lot since the mid 1990s. The Faroese spring groundfish survey was excluded as a tuning series in the mid 1990s because the catch-curves in the survey showed an anormal pattern. Two commercial tuning series (single trawlers 400-1000 HP and longliners > 100 GRT) were used during 1996-1998 where the effort was in number of days. In 1999, the tuning series constituted the pairtrawlers > 1000 HP (effort in the number of trawl hours) and the longliners > 100 GRT (effort in the number of hooks set). In 2002, the Faroese Summer Groundfish survey was used as the only tuning series, as was the case in 2003. A benchmark assessment was performed in the 2004 NWWG, where the Faroese Spring Grounfish Survey was reintroduced, albeit with a modified stratification, i.e., the two surveys were used as the only tuning series. All assessments since then have been update assessments where only minor changes in settings have been made.

Model used: Extended Survivors Analysis.

Software used: Virtual Population Analysis, version 3.2, beta: Windows 95. Copyright: MAFF Directorate of Fisheries Research. License number: DFRVPA31M.DFR.

Model Options chosen:

Time series weights : Tapered time weighting not applied. 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 5 oldest ages. S.E. of the mean to which the estimates are shrunk = 2.000. Minimum standard error for population estimates derived from each fleet = .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	1961-2008		Yes
Canum	Catch at age in numbers	1961-2008	2-10+	Yes
Weca	Weight at age in the commercial catch	1961-2008	2-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1961-2008	2-10+	Yes, the same data as for the commercial catch
Mprop	Proportion of natural mortality before spawning	1961-2008	2-10+	No, set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1961-2008	2-10+	No, so to 0 for all ages in all years
Matprop	Proportion mature at age	1983-2009	2-10+	Yes, but constant values used prior to 1983, i.e., average maturities during 1983-1996
Natmor	Natural mortality	1961-2008	2-10+	No, set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Summer Survey	1996-2008	2-8
Tuning fleet 2	Spring Survey	1994-2009	2-9

D. Short-Term Projection

Model used: Age structured.

Software used: MFDP prediction with management option table and yield per recruit routines.

Initial stock size. Taken from XSA for all ages (2-10+).

Natural mortality: Set to 0.2 for all ages in all years.

Maturity: The values observed in the spring survey 2009 are used for 2009 while average maturities 2007-2009 are used in 2010 and 2011.

F and M before spawning: Set to 0 for all ages in all years.

Weight at age in the stock: The same values as weight-at-age in the catch.

Weight at age in the catch: For each age, a regression was performed between the weight-at-age during the whole year and 1) the weight-at-age during January-February or 2) the weight-at-age in the spring survey 1994-2008. The relationship with the higher coefficient of correlation was used as a basis to predict the weight-at-age in 2009. The values for 2010-2011 was set to the 2009 value.

Exploitation pattern: Average for the three last years.

Intermediate year assumptions: average for the three last years, i.e., not rescaled to the terminal year.

Stock recruitment model used: none.

Procedures used for splitting projected catches: none.

E. Medium-Term Projections

Not performed.

F. Long-Term Projections

Model used: Yield and biomass per recruit over a range of F-values.

Software used: MFYPR version 1.

Maturity: Average for 1983-2009.

F and M before spawning: Set to 0 for all ages and years.

Weight at age in the stock: Same as the weights in the catch.

Weight at age in the catch: Average for 1978-2008 in order exclude the high values in former times.

Exploitation pattern: Average for 2000-2008 (not rescaled to the terminal year) in order to reflect a recent fishing pattern.

Procedures used for splitting projected catches: none.

G. Biological Reference Points

The reference points are dealt with in the general section of Faroese stocks. The reference points for Faroe Plateau cod are the following: B_{pa} = 40kt, B_{lim} = 21kt, F_{pa} = 0.35 and F_{lim} = 0.68.

H. Other Issues

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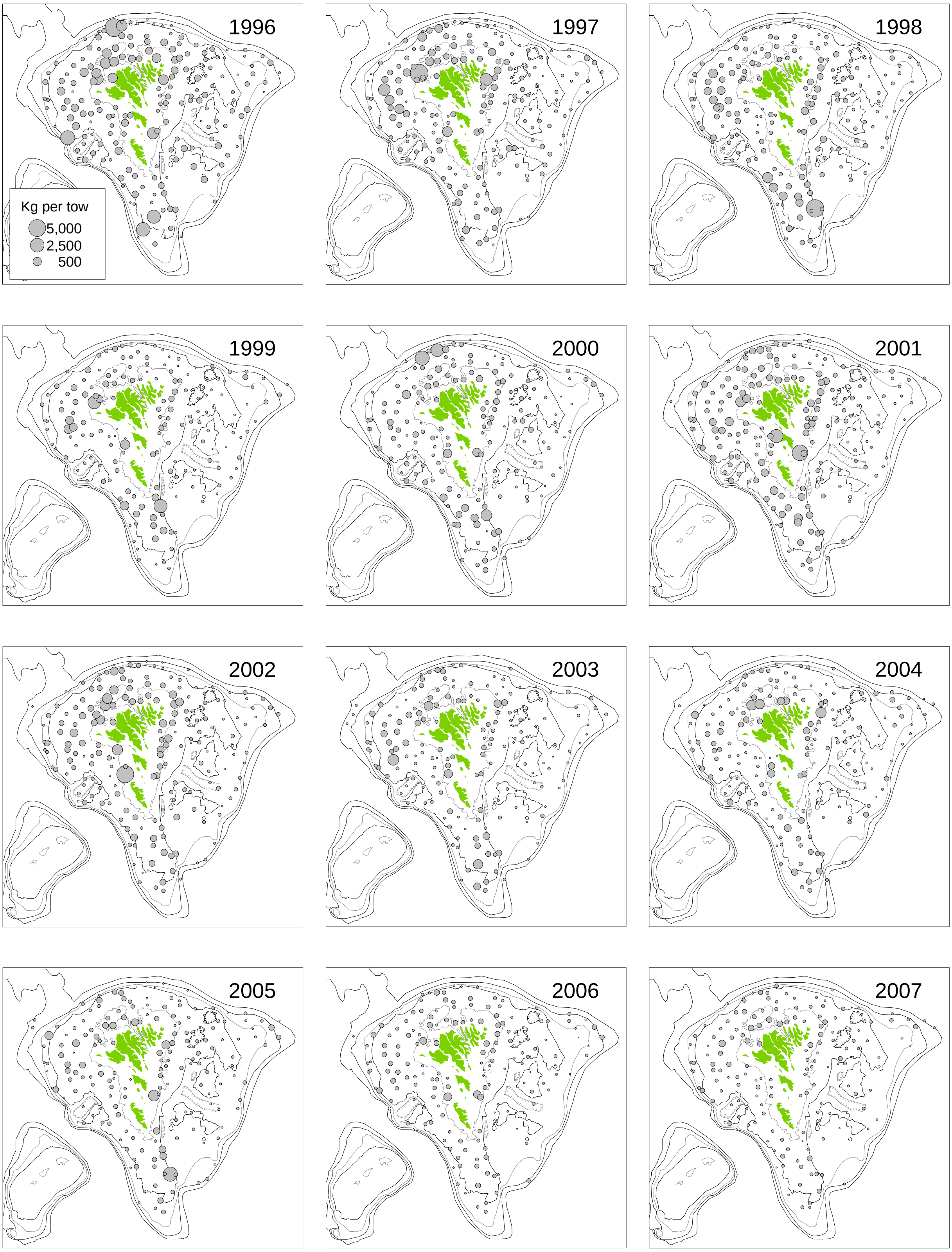
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Kg per tow
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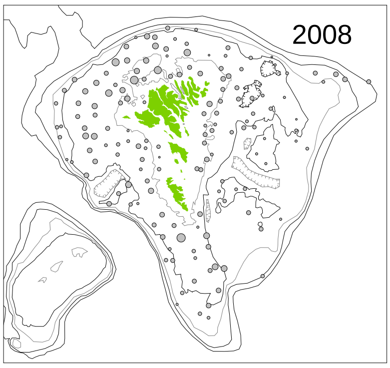
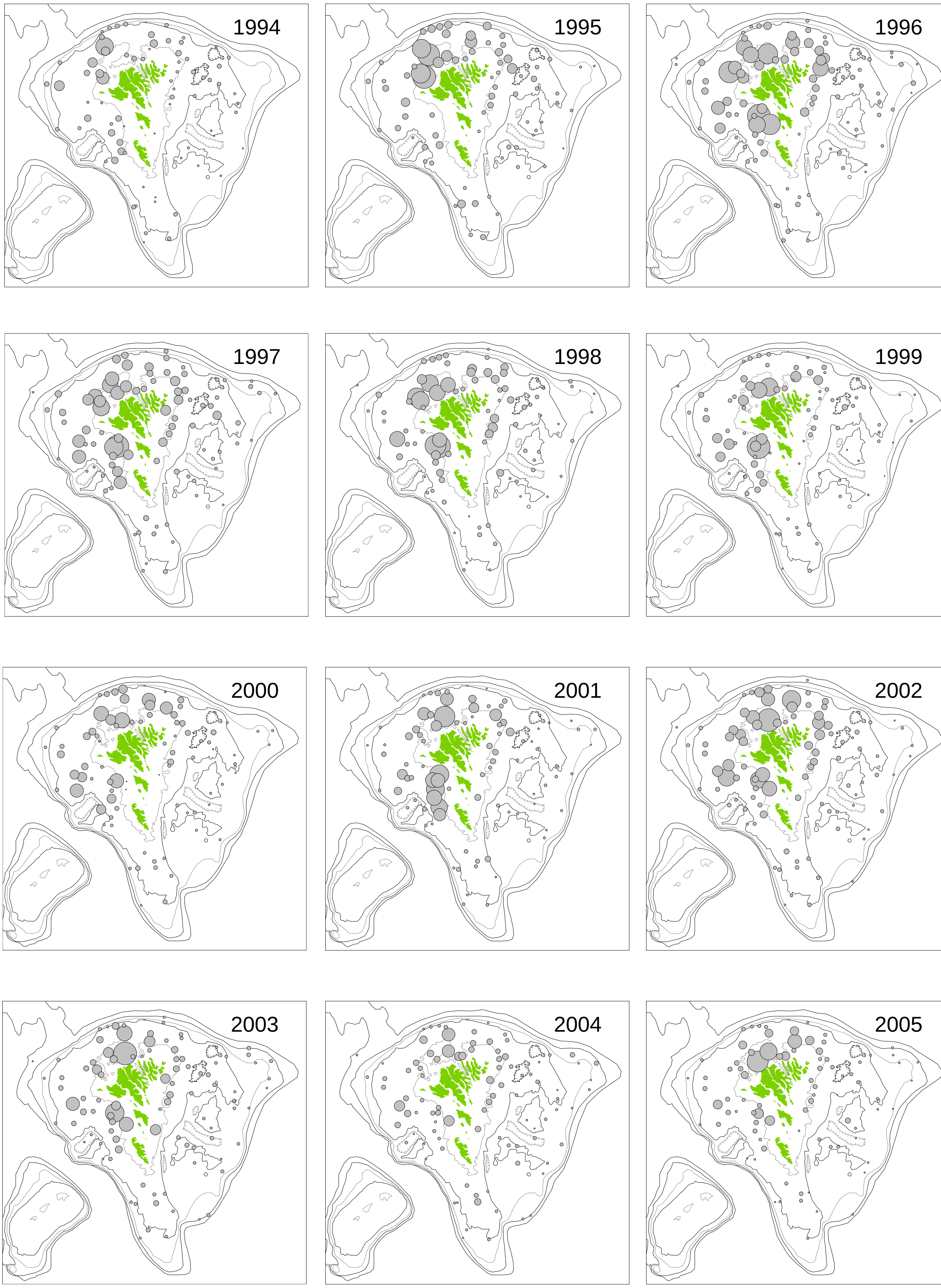


Figure 1. Cod in Division Vb1. The spatial distribution of cod according to the Summer survey on the Faroe Plateau (kg per tow, the size of the bubbles is on a logaritmic scale). 100 to 500 m depth contours are shown. The figure is continued on the following page.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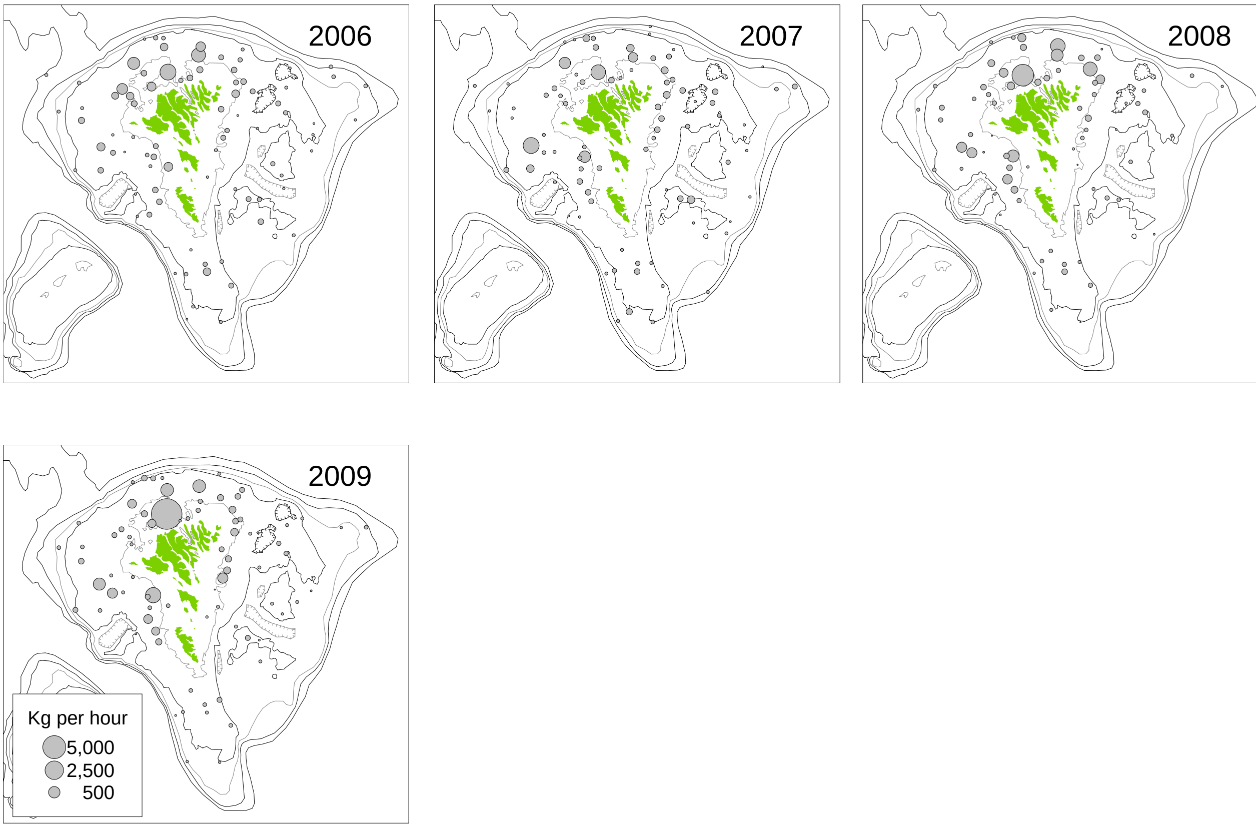

Figure 2. Cod in Division Vb1. The spatial distribution of cod according to the spring survey on the Faroe Plateau (kg per tow, the size of the bubbles is on a logaritmic scale). 100 to 500 m depth contours are shown. The figure is continued on the following pages.

Quality Handbook **Stock Annex: Faroe Saithe (Division Vb)**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Faroe saithe (Division Vb)
Working Group:	North-Western Working Group
Date:	May 2009
Revised by	………..

A. General

A.1. Stock definition

Saithe is widely distributed around the Faroes, from shallow inshore waters to depths of 500 m. The main spawning areas are found at 150-250 meters depth east and north of the Faroes. Spawning takes place from January to April, with the main spawning in the second half of February. The pelagic eggs and larvae drift with the clockwise current around the islands until May/June, when the juveniles, at lengths of 2.5-3.5 cm, migrate inshore. The nursery areas during the first two years of life are in very shallow waters in the littoral zone. Young saithe are also distributed in shallow depths, but at increasing depths with increasing age. Saithe enter the adult stock at the age of 3 or 4 years (Jákupsstovu 1999).

Saithe in Division Vb is regarded as a management unit although tagging experiments have demonstrated migrations between the Faroes, Iceland, Norway, west of Scotland and the North Sea (Jákupsstovu 1999).

A.2. Fishery

Since the introduction of the 200 miles EEZ in 1977, the saithe fishery has been prosecuted mostly by Faroese vessels. The principal fleet consists of large pair trawlers (>1000 HP), which have a directed fishery for saithe, about 50 - 60% of the reported landings in since 1992. The smaller pair trawlers (<1000 HP) and larger single trawlers have a more mixed fishery and they have accounted for about 10-20% of the total landings of saithe since 1997. The share of landings by the jigger fleet accounts for less than 4% of the total landings since 2000.

Nominal landings of saithe in Division Vb have varied cyclically between 10 000 t and 68 000 t since 1960.

Catches used in the assessment include foreign catches that have been reported to the Faroese Authorities but not officially reported to ICES. Catches in Subdivision IIa, which lies immediately north of the Faroes, have also been included. Little discarding is thought to occur in this fishery.

A.3. Ecosystem aspects

The rapid recovery of the cod stock in the mid 1990s strongly indicated that 'strange things' had happened in the environment. It became clear that the productivity of the ecosystem affected both cod and haddock recruitment and growth (Gaard *et al.*, 2002), a feature outlined in Steingrund and Gaard (2005). The primary production on the Faroe Shelf (< 130 m depth), which took place during May-June, varied interannually by a factor of five, giving rise to low- or high-productive periods of 2-5 years duration (Steingrund and Gaard, 2005). The productivity over the outer areas seems to be negatively correlated with the strength of the Subpolar Gyre (Hátún *et al*., 2005; Hátún *et al*., 2009; Steingrund *et al*., submitted), which may regulate the abundance of saithe in Faroese waters (Steingrund and Hátún, 2008). When comparing a gyre index (GI) to saithe in Faroese waters there was a marked positive relationship between annual variations in GI and the total biomass of saithe lagged 4 years.

There is a negative relationship between mean weight-at-age and the stock size of saithe in Faroese waters. This could be due to simple density-dependence, where there is a competition for limited food resources. Stomach content data show that the food of saithe is dominated by blue whiting, Norway pout, and krill, and the annual variations in the stomach fullness are mainly attributable to variations in the feeding on blue whiting. There seemed to be no relationship between the way stomach fullness is related to weights-at-age (í Homrum *et al*. 2009).

B. Data

B.1. Commercial catch

In order to compile catch-at-age data, the sampling strategy is to have length, length-age, and length-weight samples from all major gears (jiggers, single trawlers > 1000 HP, pair trawlers < 1000 HP, pair trawlers > 1000 HP and others) during three periods: January-April, May-August and September-December. When sampling was insufficient, length-age and length-weight samples were used from similar fleets in the same time period while avoiding if possible the use of length measurements. Landings were obtained from the Fisheries Ministry and Statistics of Faroe Islands. Catch-at-age for fleets covered by the sampling scheme were calculated from the age composition in each fleet category and raised by their respective landings. Fleet based catch-at-age data was summed across all fleets and scaled to the correct catch.

Mean weight-at-age data were calculated using the length/weight relationship based on individual length/weight measurements of landing samples.

B.2. Biological

B.3. Surveys

The spring groundfish surveys in Faroese waters were initiated in 1983 with the research vessel Magnus Heinason. Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the first cruise was not conducted and one third of the stations used up to 1991 were fixed. Since 1993 all stations are fixed.

The summer (August-September) groundfish survey was initiated in 1996 and consists of a bottom-trawl depth stratified with 200 fixed stations distributed within the 500 m contour of the Faroe Plateau. Effort for both surveys is recorded in terms of minutes towed (~60 min). Survey series for Faroe saithe are available to the WG from the spring- (since 1994) and summer- (since 1996) surveys. The usual way was to calculate the index as the stratified mean number of saithe at age. The age length key was based on otolith samples pooled for all stations. Due to incomplete otolith samples for the youngest age groups, all saithe less than 20 cm were considered being 0 years and between 20-40 cm 1 year. Since the age length key was the same for all strata, a mean length distribution was calculated by stratum and the overall length distribution was calculated as the mean length distribution for all strata weighted by stratum area. Having this length distribution and the age length key, the number of fish at age per station was calculated, and scaled up to 200 stations in the summer survey.

Two survey indices conducted in the spring and the summer time are available to the Working Group. However the survey series have not been used due to high CVs. In order to address this issue, a data-driven post-stratification analysis was applied in 2008. The analysis suggested that the optimal number of strata to estimate relative stock abundances should be between 5 and 7 for both surveys. The new stratification results in less variable survey estimates while improving year class consistency from one year to the next (Ridao Cruz, L. 2008, WD 5). The NWWG agreed this approach should be explored further. The survey data were not used in the 2008 SPALY (Same Procedure as Last Year) XSA assessment but they were used in an exploratory XSA using FLR, in NFT ADAPT and in TSA

Maturity at age data from the spring survey is available since 1983. Some of the 1983-1996 values were revised in 2003 but not the maturities for the 1961-1982 period. (Steingrund, 2003). The proportion mature was obtained from the spring survey, where all aged individuals were pooled, i.e., from all stations, being in the spawning areas or not. Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. The working group examined various smoothers in previous meetings and decided to use a three years running average to predict the maturity at age; this was repeated since 1983. For 1961 to 1982, the average maturity at age for 1983 to 1996 was used.

B.4. Commercial CPUE

The CPUE series from pair trawlers that has been used in the assessment since 2000 was introduced in 1998 (ICES C.M. 1998/ACFM:19), and consists of saithe catch at age and effort in hours, referred to as the pair trawler series. All vessels use 135mm mesh size, the catch is stored on ice on board and landed as fresh fish. The vessels are greater than 1000 HP and have specialized in fishing on saithe and account for 5 000-20 000 t of saithe each year. The data on which the tuning series are based originally from all available logbooks by 4-10 trawlers since 1995. Data are stored in the database at the Faroe Marine Research Institute in Torshavn where they are controlled and corrected if necessary. Effort is estimated as the number of fishing (trawling) hours, i.e. from the time the trawl meets the bottom until hauling starts. It is not possible to determine effort in fishing days because day and time of fishing trips are not recorded on the logbooks. The CPUE series were compiled based on hauls where saithe contributed to more than 50% of the total catch. The effort distribution of the pair trawlersfleet covers most of the fishing areas.

During 2002-2005 four pairs of these trawlers left the fleet. In 2004 and 2005 two new pairs of trawlers (>1000 HP) were introduced in the tuning series; one pair had been fishing saithe since 1986 and the other since 1995. These two new pairs showed approximately the same trends as the other pair trawlers in the series during 1999-2003. In 2009 two new pair of trawlers were used to extend the tuning series. These trawlers were build in 2003 and 2004 and they show the same CPUE trends as the others, but higher in absolute numbers.

B.5. Other relevant data

C. Historical Stock Development

An XSA has been performed during a number of years. The use of tuning indices has varied. The CPUE series that has been used in the assessment since 2000 was introduced in 1998 (ICES C.M. 1998/ACFM:19), and consists of saithe catch at age and effort in hours, referred to as the pair trawler series. The last benchmark assessment was performed in the 2005 NWWG, where the different surveys and settings of XSA were inspected. The adopted assessment was the XSA using the pair trawler as a tuning fleet and since then it has been updated on a year basis.

Model used: Extended Survivors Analysis (XSA)

Software used: Virtual Population Analysis (VPA), version 3.1

Model Options chosen:

Time series weights: Tapered time weighting not applied.

Catchability analysis: Catchability independent of stock size for all ages, catchability independent of age for ages ≥ 8.

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 = 2.000. Minimum standard error for population estimates derived from each fleet = .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	1961-last data year	3 – 11+	Yes
Canum	Catch at age in numbers	1961-last data year	3 – 11+	Yes
Weca	Weight at age in the commercial catch	1961-last data year	3 – 11+	Yes
West	Weight at age of the spawning stock at spawning time.	1961-last data year	3 – 11+	Yes, assumed to be the same data as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1961-last data year	3 – 11+	No, set to 0 for all ages and years
Fprop	Proportion of fishing mortality before spawning	1961-last data year	3 – 11+	No, set to 0 for all ages and years
Matprop	Proportion mature at age	1983- last data year + 1 (2009)	3 – 11+	Yes, three years running average. Data prior to 1983 is average of 1983-1996 values.
Natmor	Natural mortality	1961-last data year	3 – 11+	No, set to 0.2 for all ages and years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Pair trawlers	1995- last data year	3-11

D. Short-Term Projection

Model used: Age structured

Software used: Multi Fleet Deterministic projection (MFDP1a), prediction with management option table

Initial stock size: Taken from the final VPA run (table 10). Recruitment at age 3 is geometric mean of 1980- last data year.

Natural mortality: Set to 0.2 for all ages in all years.

Maturity: First year (2009) is average of the last data year (2008) and last data year +1 (2009). The two next years (2010-2011) is average of three latest years (2007-2009)

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 value as weight at age in the catch.

Weight at age in the catch: The same value as in the last data year.

Exploitation pattern: Average exploitation pattern in the final VPA for the last three years, not rescaled.

Intermediate year assumptions: None

Stock recruitment model used: None

Procedures used for splitting projected catches: None

E. Medium-Term Projections

Not performed.

F. Long-Term Projections

Model used: Yield and biomass per recruit over a range of F-values.

Software used: Multi Fleet Yield Per Recruit (MFYPR2a).

Maturity: Average for 1983 to last data year +1 (2009).

F and M before spawning: Set to 0 for 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: Average weights from 1961 to last data year.

Exploitation pattern: Average exploitation pattern of the last five years

Procedures used for splitting projected catches: None.

G. Biological Reference Points

Biological reference points for saithe in Division Vb are as follows:

B_{lim} = 60 000 t

B_{pa} = 85 000 t

F_{lim} = 0.40

F_{pa} = 0.28

For Faroe saithe, the highest recruitment has been observed at or near the lowest SSB. The NWWG in 2007 therefore suggested that Bloss should be used as Bpa, not Blim. The working group recommended that Bpa for saithe be set at Bloss = 60 000 t and that Blim be set at an arbitrarily lower value (45-50 000t) until more stock and recruitment data pairs are observed below Bloss. NWWG 2009 reiterates those recommendations. Fishing mortality reference points need to be further considered.

H. Other Issues

I. References

Gaard, E., Hansen, B., Olsen, B., and Reinert, J. 2002. Ecological features and recent trends in physical environment, plankton, fish and sea birds in the Faroe plateau ecosystem. In Large Marine Ecosystem of the North Atlantic (eds K. Sherman, and H.-R. Skjoldal), pp. 245-265. Elsevier. 449 pp.

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Steingrund, P., and Hátún, H. 2008. Relationship between the North Atlantic Subpolar Gyre and fluctuations of the saithe stock in Faroese waters. WD 20, NWWG 2008. 7 pp.

Quality Handbook **Stock Annex: Icelandic summer-spawning herring**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Icelandic summer-spawning herring (Her-Va)
Working Group:	NWWG
Date:	22.04.2009
Revised by	Guðmundur J. Óskarsson and Asta Gudmundsdottir

A. General

A.1. Stock definition

The Icelandic summer-spawning herring is constrained to Icelandic waters throughout its lifespan. Results from various researches including, tagging experiments around middle of last century, studies on larval transport, and studies on migration pattern and distribution, all suggest that the stock is local to Icelandic waters. No genetic studies have taken place to distinct the stock from the two other herring stocks around Iceland (Icelandic spring-spawning herring and Norwegian spring-spawning herring). The stocks are distinguished on the basis of their spawning time and spawning area, which are both represented by their naming.

A.2. Fishery

Since at least the year 2000, the herring fishery has been conducted by big vessels that in most cases have onboard both purse seines and mid-water-trawls that are used as needed in the fishery. Usually, most of the catch is taken by purse seine (ICES 2008). Bycatch in the herring fishery is normally insignificant as the fishing season is during the over-wintering period when the herring is in large dense schools.

A2.1. 1980 onwards

Until the autumn 1990, the herring fishery took place during the last three months of the calendar year. During 1990-2008 the autumn fishery continued until January or early February of the following year, and has started in September/October since 1994. In 2003 the season was further extended to the end of April and in the summers of 2002 and 2003 an experimental fishery for spawning herring with a catch of about 5 000 t each year was conducted at the south coast.

The number of vessels participating in the fishery has shown decreasing trend in the 2000s from around 30 down to 20 in 2007.

A2.2. Fishery regulations

The fishery of the summer-spawning herring is currently regulated by regulations set by the Icelandic Ministry of Fisheries in 2006 (no. 770, 8. September 2006). According to it, fishery of juveniles herring (27 cm and smaller) is prohibited and to prevent such a fishery, area closures are enforced.

The fishery can take place from 1st September to 31st May each fishing season (1st September-31st August) in nets, purse seines and mid-water trawls. The mid-water trawling is only allowed outside of the 12 nautical miles zones with some additional areal restrictions. Use of sorting grids in the mid-water trawls can be required in some areas, if necessary to avoid bycatch.

If nets are used in the herring fishery, the minimum mesh size (stretched) is 63 mm.

The annual total allowable catch is decided by the Ministry of Fisheries. Since 1985, the decision has more or less been based on the advices given by the Marine Research Institute, with very small discrepancy (ICES 2008).

A.3. Ecosystem aspects

A3.1. Geographic location and timing of spawning

The spawning of the stock takes place around July off the SE, S and SW coast (Jakobsson and Stefansson, 1999; Oskarsson 2005). The nursery grounds are mainly in coastal areas off the NW and N coast, but occasionally also in coastal areas off the E, SE, and SW and W Iceland (Gudmundsdottir et al. 2007). The location of the overwintering of the mature and fishable stock has varied during the last 30 years (Óskarsson et al. 2009a). Prior to 1998 it was mainly off the SE and E Iceland but from 1998 to 2006, the overwintering took place both off the east and west coast, with increasing proportion being in the western part. Since then (winters 2006/07 to 2008/09), most of the stock has been located in high density in coastal waters in northern part of Breidafjördur in western Iceland.

A3.2. Fecundity

A fixed maturity ogive has been used in the assessment since 2006, because of problems in estimating it annually from available data (Óskarsson and Guðmundsdóttir 2006). It was estimated that around 20% of the stock becomes mature at age 3, 85% is mature at age 4, and all older fish is mature. The fecundity is length dependent (Fecundity [$\times 10^3$] = 15.9 × Length [cm] - 382.2) where herring at average length in the catch (32 cm) spawns around 127 thousands eggs in as season and release all the eggs at once (Óskarsson and Taggart 2006).

A3.3. Diet

The variation in the diet composition of the Icelandic summer-spawning herring is poorly known due to limited examinations. The main prey is probably Calanoids (e.g. *Calanus finmarchicus*) but other zooplankton groups and species, and fish eggs and larvae could also be significant part of the diet according to preliminary research made by MRI in a small area in 2008.

A3.4. Predators

Adult herring is food resource for various animals in Icelandic waters according to various researches. The animals include mink whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), several sea bird species, cod (*Gadus mor-*

hua) and pollack (*Pollachius virens*), but the annual consumption of herring by the different predators is relatively unknown.

B. Data

B.1. Commercial catch

B1.1. Landings

Information about landings of the fishery fleet are collected by the Icelandic Directorate of Fisheries. They have an access to both landings in the harbours (the official landing) and the registered catch in the digital logbook kept by all the vessels. The logbooks keep information about timing (day and time), location (latitude and longitude), fishing gear, catch size, and species composition in the catch of each fishing operation for each vessel.

Biological samples from the catch are taken at sea by the fishermen or in the harbours by people from MRI and/or inspectors from the Directorate of Fisheries and then analysed by MRI (record at least the fish length, weight, age (from scales), sex, maturation, and weight of sexual organs). The information from the samples are then used along with the total landing data and the logbook data to estimate the composition of the total landings. It includes estimating Caton (catch-in-weight), Canum (catch-at-age-in numbers), Weca (weight-at-age-in-the-catch), and length composition in the catch.

The annual estimations of the composition of the total landings (e.g. the catch at age matrix) are based on dividing the annual landings into cells according to the fishing gear, geographical location and month of fishing. The annual number of cells depends then on number of factors, including the spatial and temporal distribution of the fishing and the gear used and the sampling intensity. The number of weight-at-length relationships and length-at-age relationships applied differ between years and are on the range of 1-2 in both cases. Since 1990 to present, all available length measurements are used for the estimations in the cells, while length of aged fish was only used in earlier estimations. Length measurements done by inspectors of the Directorate of Fisheries are though usually omitted as inspectors tend to focus on catches that are suspected to consist of small herring and give therefore often biased length distributions.

A planed re-aging of herring from the catch samples in the fishing seasons 1994/95 through 1997/98 was not finished in February 2009 but is ongoing at the Marine Research Institute. When the re-aging is accomplished the number at age in the catch will be re-estimated. Previous work suggests though that only a small changes can be expected.

B1.2. Discards

Discards is illegal in Icelandic waters. Normally, discards is considered to be insignificant in the fishery of Icelandic summer-spawning herring. There are few exceptions in the past 35 years where discards was estimated to be significant (1990-95; ICES 2008). These exceptions are related to large year classes being entering the fishery and juveniles have been numerous in the catch. Surveillance by inspectors from the Directorate of Fisheries during each fishing season is considered adequate in verifying if a discard is ongoing.

B.2. Biological

Natural mortality is assumed to be constant, M=0.1, for the whole range of ages and years. There are no direct estimates of M but the estimate of M=0.1 has been verified numerically by Jakobsson *et al.* (1993). They concluded, through comparison of acoustical- and VPA based stock size estimations that the assessed level of M ranged from 0.1 to 0.15.

Like mentioned above, the maturity-at-age has been assumed to be constant from 2006 and onwards (Óskarsson and Guðmundsdóttir 2006) as follows:

Age	<3	3	4	5+
Proportion mature	**0.00**	**0.20**	**0.85**	**1.00**

Prior to 2006, the maturity-at-age was estimated from catch samples (ICES 2008).

B.3. Surveys

One survey is available and applied for assessment of the Icelandic summer-spawning herring stock. It is an acoustic research survey, which have been ongoing annually since 1974 except for the winters 1976/77, 1982/83, 1986/87, and 1994/95. These surveys have been conducted in October-December and/or January. The survey area varies spatially as the survey is focused on the adult and incoming year classes. The surveyed area is decided based on all available information on the distribution of the stock, including information from the fishery. As normally practiced in acoustic surveys, trawl samples were used to get information about the schools species- and length composition.

In addition to this acoustic survey aimed at the fishable part of the stock, there have been occasionally acoustic surveys off the NW, N, and NE coast of Iceland aimed to estimate the year class strength of the juveniles. This survey has not taken place since 2003, but was partly resurrected in January 2009. The results of these measurements were normally not used in the assessment directly even if the year class indices derived from the survey have shown a significant relationship to recruitment of the stock (Gudmundsdóttir *et al.* 2007).

B.4. Commercial CPUE

Not considered relevant to the assessment because of the nature of the fishery and the continuous development the vessels and the equipment used in the fishery.

B.5. Other relevant data

None

C. Historical Stock Development

The summer-spawning herring stock collapsed in late 1960s due to overfishing and environmental changes (Jakobsson *et al.* 1993). The spawning stock has increased from about 10 thous. tonnes in 1972 to about 700 thous. tonnes around the middle of the 2000s.

During the recovery period, the assessments were based on acoustic surveys. These surveys, during the early and mid-1970s, were considered very uncertain. During late 1980s and early 1990s the assessment tool used was a homemade Adapt type of VPA. The stock was consistently overestimated during the late 1980s and the early 1990s. The difference between the acoustic values and those obtained from VPA was about 30%. The most likely cause of this error was considered to be the use of too low target strength (TS) values in the acoustic surveys (Jakobsson *et al.*, 1993). The TS value was raised about 30% or to similar value as used for other herring stocks in the NE Atlantic and the old acoustic values in the tuning file corrected. Until 2002 the homemade Adapt-type of VPA was used for the final assessment of the Icelandic summer-spawning herring stock. Assessment tools like XSA and AMCI were run along as well for some years. In 2003-2004, AMCI runs were accepted as the final assessment. NFT-Adapt, which was first applied in the 2004 assessment, has been the main assessment tool since 2005, even if it was first in 2008 accepted as the final assessment. Both TSA (Gudmundsson, 1994) and XSA have been run along with NFT-Adapt for comparisona as alternative tools. In all these assessments, one sided retrospective pattern is seen, especially in the years 2002-2005, but it has diminished in the last years. The reasoning for this pattern is not known.

A benchmark assessment has not taken place but detailed examination has taken place during some working group meetings.

Model used: Age structured

Software used: NFT-ADAPT (VPA/ADPAT version 2.3.2 NOAA Fisheries Toolbox), XSA (Version 3.1, Lowestoft) and a new version of TSA (older version see Gudmundsson 1994).

Model Options chosen: The model options differ slightly between years, but are given in tables or text in the WG assessment reports (e.g. ICES 2008).

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1947-last data year	2-15+	Yes
Canum	Catch at age in numbers	1947-last data year	2-15+	Yes
Weca	Weight at age in the commercial catch	1947-last data year	2-15+	Yes
West	Weight at age of the stock .	1947-last data year	2-15+	Yes
Mprop	Proportion of natural mortality before spawning	1947-last data year	2-15+	No –set to 0.5 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1947-last data year	2-15+	No –set to 0 for all ages in all years
Matprop	Proportion mature at age	1947-last data year	2-15+	No- since 2005 set 0.2 for age-3 and 0.85 for age-4
Natmor	Natural mortality	1947-last data year	2-15+	No – set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Acoustic survey	1974-last data year	2-15+
Tuning fleet 2			
Tuning fleet 3			
….			

D. Short-Term Projection

Model used: Age structured

Software used: An Excel spreadsheet prepared in MRI, which has been compared to results from a Fortran script used at MRI for years for herring and other species, and they have giving identical results.

Initial stock size: Taken from NFT-Adapt in most recent years. The number of the youngest age-classes in the projection (age-3) is set as the geometrical mean for age-3 over the last 20 years, because no estimate exits.

Maturity: The same ogive as in the assessment for the year 2006 to present.

Natural mortality: Set to 0.1 for all ages in all years

F and M before spawning: Set to 0 for F and to 0.5 for M.

Weight at age in the stock: Normally based on simple three years means but sometimes on last year weights (e.g. ICES 2008), following an examination.

Weight at age in the catch: Same as used for the stock

Exploitation pattern: Average of five last years for age-3 and 4, but set 1.0 for age-5+.

Intermediate year assumptions: Not relevant

Stock recruitment model used: Geometrical mean for age-3 is used to determine the recruitment

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Medium-term projection has not been completed in recent assessments for this stock. The reliance of the fishery on intermittent large year-classes, and the fluid nature of the fishery and related assessment, make the usefulness of medium-term projections questionable.

F. Long-Term Projections

It has not been completed in recent assessments.

G. Biological Reference Points

The Working Group have pointed out that managing this stock at an exploitation rate at or above $\mathbf{F}_{0.1}$ has been successful in the past, despite biased assessments (ICES

2008). The Northern Pelagic and Blue Whiting Fisheries Working Group agreed in 1998 with the SGPAFM on using $\mathbf{F}_{pa}= \mathbf{F}_{0.1}= 0.22$, $\mathbf{B}_{pa}= \mathbf{B}_{lim} * e^{1.645\sigma}= 300\,000$ t where $\mathbf{B}_{lim}= 200\,000$ t. The Study Group on Precautionary Reference Points for Advice on Fishery Management met in February 2003 and concluded that it was not considered relevant to change the $\mathbf{B}_{lim}$ from 200 000 t. The WG have not dealt with this issue now in February 2009.

The fishing mortality during 1990 to 2007 has been on the average 0.308 (ICES 2008) or approximately 40% higher than the intended target of $F_{0.1}$=0.22. This is despite the fact that the managers have followed the scientific advice and restricted quotas with the aim of fishing at the intended target. During this time period the SSB has remained above B_{lim}. As there is an agreed management strategy that have been applied since the fishery was reopened after it collapsed in late 1960's, it is proposed to use $F_{0.1}$ **=** $\mathbf{F}_{pa}$ as F_{target}.

H. Other Issues

In November 2008, an *Ichthyophonus hoferi* infection was observed in the Icelandic summer-spawning herring. A massive research program was launched immediately to quantify the infection rate and the results indicated that this was a massive outbreak (Óskarsson *et al.* 2009b). Around 32% of the adult stock was estimated to be infected, which is all believed to die because of it within few months. Infection was also observed in juveniles (year classes 2006 and 2007) at the main nursery grounds west and north of Iceland, except for the visited location furthest east (Skjálfandi) where most of the 2007 year class was found.

There is a large uncertainty regarding the development of the infection and if it will continue to infect the stock in the spring and summer 2009. The literature implies that *Ichthyophonus* outbreaks in herring last often for two years, so further infection can be expected in the stock at some unknown proportion. It will be examined as needed.

Another source of uncertainty regarding the infection relates to the period prior to the autumn 2008. Information given by fishermen in the autumn 2008, indicates that they had started to observe infected herring already in the winter 2007/08. MRI did not have any information about it at that time and were not running a program to determine *Ichthyophonus* infection. Thus, the magnitude of infection prior to the autumn 2008 is unknown and thereby the additional natural mortality rate related to the infection.

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Quality Handbook **Stock Annex: Faroe Haddock**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Faroe Haddock
Working Group:	North-Western Working Group
Date:	day.month.year of last revision
Revised by	………..

A. General

A.1. Stock definition

Haddock in Faroese Waters, i.e. ICES Subdivisions Vb1 and Vb2 and in the southern part of ICES Division IIa, close to the border of Sub-Division Vb1, are generally believed to belong to the same stock and are treated as one management unit named Faroe haddock. Haddock is distributed all over the Faroe Plateau and the Faroe Bank from shallow water down to more than 450 m. Spawning takes place from late March to the beginning of May with a peak in the middle of April and occurs in several areas on the Faroe Plateau and on the Faroe Bank. Haddock does not form as dense spawning aggregations as cod and saithe, nor does it perform ordinary spawning migrations. After spawning, eggs and fry are pelagic for about 4 months over the Plateau and Bank and settling starts in August. This is a prolonged process and pelagic juveniles can be found at least until September. Also during the first years of life they can be pelagic and this vertical distribution seems to be connected to year class strength, with some individuals from large year classes staying pelagic for a longer time period. No special nursery areas can be found, because young haddock are distributed all over the Plateau and Bank. After settling the haddock is considered very stationary as seen in tagging experiments

A.2. Fishery

Landings statistics are available since 1903. During the first half of this century, foreign nations dominated the landings, especially England and Scotland, but since the early 1950s, the Faroese landings have increased considerably. After the introduction of the 200 nm EEZ in 1977, almost all landings have been by Faroese vessels.

Nominal landings of Faroe haddock have in recent years increased very rapidly from only 4 000 t in 1993 to 27 000 t in 2003; they have declined since and amounted in 2008 to about 7 600 t. Most of the landings are taken from the Faroe Plateau; the landings from the Faroe Bank (Sub-Division Vb2) in 2008 were about 360 t (Tables 5.1 and 5.2). Faroese vessels have taken almost the entire catch since the late 1970s. The longliners have taken most of the catches in recent years followed by the trawlers; the proportions in 2008 were: longliners 81% and trawlers 19%.

A.3. Ecosystem aspects

The waters around the Faroe Islands are in the upper 500 m dominated by the North Atlantic current, which to the north of the islands meets the East Icelandic current.

Clockwise current systems create retention areas on the Faroe Plateau (Faroe shelf) and on the Faroe Bank. In deeper waters to the north and east and in the Faroe Bank channel is deep Norwegian Sea water, and to the south and west is Atlantic water. From the late 1980s the intensity of the North Atlantic current passing the Faroe area decreased, but it has increased again in the most recent years. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. This applies also to the recruitment of many fish stocks, and the growth of the fish was poor as well. From 1992 onwards the conditions have returned to more normal values which also is reflected in the fish landings. There has been observed a very clear relationship, from primary production to the higher trophic levels (including fish and seabirds), in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Gaard, E. et al. 2002). There is a positive relationship between primary production and the cod and haddock individual fish growth and recruitment 1-2 years later. The primary production indices have been below average since 2002 except for 2004 and 2008 when it was above average. The estimate of primary production in 2009 will not be available until July, but preliminary estimates suggest it to be at the same level as in 2008. It will have little effect on the spawning stock size in the short term, but recruitment and total stock biomass will likely be improved. Potential positive effect on the recruitment will not influence the fishery before 2-3 years.

There seems to be a link between the primary production and growth of haddock. The primary production seems to be negatively correlated with the catchability of longlines, suggesting that haddock attack longline baits more when natural food abundance is low. Since longliners usually take tha majority of the haddock catch, the total fishing mortality fluctuates in the same way as the long line catchability and thus there is a negative relationship between primary production and fishing mortality. It is, however, important to note that the relationship between the productivity of the ecosystem and the catchability of long lines depends on the age of the fish. For young haddock there apparently is no such relationship between productivity and catchability.

B. Data

B.1. Commercial catch

For the Faroese landings, catch-at-age data are provided for fish taken from the Faroe Plateau and the Faroe Bank. The sampling intensity in 2008 was somewhat lower than in recent years. The main reasons for this are illness, small catches and difficulties to get access to some of the landings.

Due to the low sampling level in 2008, the normal practise to disaggregate samples from each fleet category by season (Jan-Apr, May-Aug and Sep-Dec) and then raise them by the corresponding catch proportions to give the annual catch-at-age in numbers for each fleet, had to be replaced by using 2 seasons only (Jan-Jun, Jul-Dec. Catches of some minor fleets have been included under the "Others" heading. No catch-at-age data were available from other nations fishing in Faroese waters. Therefore, catches by trawlers from France, Russia and UKwere assumed to have the same age composition as Faroese otter board trawlers larger than 1 000 HP. The Norwegian longliners were assumed to have the same age distribution as the Faroese longliners greater than 100 GRT.

In general the catch-at-age matrix in recent years appears consistent although from time to time a few small year classes are disturbing this consistency, both in numbers and mean weights at age. Also there are some problems with what ages should be included in the plus group; there are some periods where only a few fishes are older than 9 years, and other period with a quite substantial plus group (10+). These problems have been addressed in former reports of this WG and will not be further dealt with here. No estimates of discards of haddock are available. However, since almost no quotas are used in the management of the fisheries on this stock, the incentive to discard in order to high grade the catches should be low. The landings statistics is therefore regarded as being adequate for assessment purposes. The ban on discarding as stated in the law on fisheries should also – in theory – keep the discarding at a low level.

B.2. Biological

Mean weight-at-age data are provided for the Faroese fishery. In the period 1957-1976, constant weights have been applied, but from 1977 onwards they have been estimated each year. During the period, weights have shown cyclical changes, and have decreased during the most recent years to very low values in 2006; in 2007 and 2008, mean weights for ages up to 5 years included show a small increase, age 6 show a small increase in 2008 while older fish continue to decline. The mean weight at age in the stock are assumed equal to those in the landings.

Maturity-at-age data is available from the Faroese Spring Groundfish Surveys 1982–2009. The survey is carried out in February-March, so the maturity-at-age is determined just prior to the spawning of haddock in Faroese waters and the determinations of the different maturity stages is relatively easy. In order to reduce eventual year-to-year effects due to possible inadequate sampling and at the same time allow for trends in the series, the routine by the NWWG has been to use a 3-year running average in the assessment. For the years prior to 1982, average maturity-at-age from the surveys 1982–1995 was adopted

B.3. Surveys

Two annual groundfish surveys are available on the Faroe Plateau, one carried out in February-March since 1982 (100 stations per year down to 500 m depth), and the other in August-September since 1996 (200 stations per year down to 500 m depth). Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the period was shortened by dropping the first cruise and one third of the 1991-stations were used as fixed stations. Since 1993 all stations are fixed stations. The surveyed area is divided into 15 strata defined by depth and environmental conditions. The standard abundance estimates is the stratified mean catch per hour in numbers at age calculated using smoothed age/length keys. Due to discrete length distributions for the younger haddock, in the spring survey all fish less than 18 cm are set to age 1 and haddock 18-27 cm set to age 2. In the summer survey, all haddock less than 16 cm are set to age 0, haddock 16-24 cm set to age 1 and haddock 25-35 cm to age 2. Age disaggregated data are available for the whole summer series, but due to problems with the database (see earlier North-Western Working Group reports), age disaggregated data for the spring survey are only available since 1994.

B.4. Commercial CPUE

Several commercial catch per unit effort series are updated every year, but as discussed in previous reports of the NWWG they are not used directly for tuning of the VPA due to changes in catchability caused by e.g. productivity variations in the area (see Ecosystem aspects), a different behaviour of the fleets after the introduction of the effort management system with large areas closed for trawlers, and in years when haddock prices are low as compared to cod the fleets apparently try to avoid grounds with high abundances of haddock, especially the younger age groups areas. The opposite may also happen if prices of haddock become high as compared to other species. The data are based on logbooks. These are mixed fisheries and not directly targeting haddock

B.5. Other relevant data

C. Historical Stock Development

Model used: Several different models have been applied to this stock but the basic method has for many years been the Extended Survivors Analysis.

Software used: Virtual Population Analysis, version 3.2, beta: Windows 95. Copyright: MAFF Directorate of Fisheries Research. License number: DFRVPA31M.DFR.

Model Options chosen: The assessment for this stock has been an update for several years including the one in 2009. Consequently the same options have been used in 2009 as in the recent years:

```
Lowestoft VPA Version 3.1

   23/04/2009  17:32

 Extended Survivors Analysis

 FAROE HADDOCK (ICES DIVISION Vb)                HAD_IND

 CPUE data from file D:\vpa\vpa2009\vpa\input-files\comb-survey-spaly-09-jr.txt

 Catch data for  52 years. 1957 to 2008. Ages  0 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2008,   1,     8,   .600,   .700
 SPRING SURVEY SHIFTE,   1993, 2008,   0,     6,   .950,  1.000

 Time series weights :
      Tapered time weighting not applied

 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   5 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   42 iterations

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

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1957-2008		Yes
Canum	Catch at age in numbers	1957-2008	0-10+	Yes
Weca	Weight at age in the commercial catch	1957-2008	0-10+	Yes
West	Weight at age of the spawning stock at spawning time.	1957-2008	0-10+	Yes
Mprop	Proportion of natural mortality before spawning	1957-2008	0-10+	No
Fprop	Proportion of fishing mortality before spawning	1957-2008	0-10+	No
Matprop	Proportion mature at age	1957-2009	0-10+	Yes
Natmor	Natural mortality	1957-2008	0-10+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Summer survey	1996-2008	1-8
Tuning fleet 2	Spring survey	1994-2009	0-6
Tuning fleet 3			
….			

D. Short-Term Projection

Since this is an update assessment, the same procedure as last year has been used in 2009 and the input and assumptions are exemplified with the 2009 ones.

Model used: Multi Fleet Deterministic Projection

Software used: MFDP version 1

Initial stock size: The stock in numbers 2009 is taken directly from the 2009 XSA. The year class 2008 at age 2 (in 2010) is estimated from the 2009 XSA age 1 applying a natural mortality of 0.2 in foreword calculation of the number using the standard VPA equation. The year class 2009 at age 2 (in 2011) is estimated as the geomean of the year classes since 1980.

Maturity: The proportion mature at age in 2009 is estimated as the average of the observed data in 2008 and 2009. For 2010 and 2011, the average for 2007 to 2009 is used.

F and M before spawning: Zero

Weight at age in the stock: Stock weights at age 2009-2011 were estimated as the average weights at age in the catch 2007-2009 and kept constant for all years.

Weight at age in the catch: Catch weights at age 2009-2011 were estimated as the average weights at age in the catch 2007-2009 and kept constant for all years.

Exploitation pattern: The exploitation pattern is estimated as the average fishing mortality matrix in 2006-2008 from the final VPA in 2009, re-scaled to 2008, and kept constant for all 3 years. Justification for changing procedures from last year, when the 3-years average was used un-scaled is, that there has been a declining trend in fishing mortality for many years.

Intermediate year assumptions: Status quo fishing mortality.

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: Multi Fleet Yield Per Recruit.

Software used: MFYPR version 1.

Maturity: Average for the whole time series: 1982-2008

F and M before spawning: Zero

Weight at age in the stock: Average for the whole time series: 1977-2008

Weight at age in the catch: Average for the whole time series: 1977-2008

Exploitation pattern: The same as in the short term projection: The exploitation pattern is estimated as the average fishing mortality matrix in 2006-2008 from the final VPA in 2009, re-scaled to 2008, and kept constant for all 3 years. Justification for changing procedures from last year, when the 3-years average was used un-scaled is, that there has been a declining trend in fishing mortality for many years.

Procedures used for splitting projected catches:

G. Biological Reference Points

$\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were in 2009 calculated at 0.28 and 1.45, respectively. F_{max} was estimated at 0.61, and $F_{0.1}$ at 0.18.

The precautionary reference fishing mortalities were set in 1998 by ACFM with F_{pa} as the $\mathbf{F}_{med}$ value of 0.25 and F_{lim} two standard deviations above $\mathbf{F}_{pa}$ equal to 0.40. The precautionary reference spawning stock biomass levels were changed by ACFM in 2007. B_{lim} was set at 22 000 t (B_{loss}) and B_{pa} at 35 000 t based on the formula B_{pa} = $B_{lim}e^{1.645\sigma}$, assuming a σ of about 0.3 to account for the uncertainties in the assessment.

H. Other Issues

I. References

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ICES C.M. 2009/ACOM:04. Report of the North-Western Working Group, 29 April – 5 May 2009.

Quality Handbook **Stock Annex: Capelin in the Iceland-East Greenland-Jan Mayen ecosystem**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Capelin in the Iceland-East Greenland-Jan Mayen ecosystem
Working Group:	NWWG
Date:	21.4.2009
Revised by	Asta Gudmundsdottir and Sveinn Sveinbjörnsson

A. General

A.1. Stock definition

Capelin in the Iceland-East Greenland-Jan Mayen area spawn in March in shallow water off the southeast, south and west coast of Iceland. Most juveniles grow on or close to the continental shelf off northwest, north and northeast Iceland, and on the East Greenland plateau, west of the Denmark Strait. A large proportion of each year class matures and spawns at age 3 and dies thereafter. The remainder of the year class spawns at age 4 and dies. Maturing capelin usually undertakes extensive feeding migrations in spring and summer northwards into the Iceland Sea and the Denmark Strait. They return in September and October. By November the adults have assembled near the shelf edge, usually off northwest Iceland, but also off north and northeast Iceland. The spawning migration starts in December/January southward along the shelf break off the east coast and on entering the mixed waters off the Southeast coast they move into shallow waters and follow the coast westwards on their spawning migration. The main spawning migration usually reaches the west coast and spawns there but late arrivals spawn further east at the southeast and south coast.

A.2. Fishery

In the mid 1960s purse seine fishery began on capelin. It soon became a large-scale fishery. During its first eight years, the fishery was conducted in February and March on schools of prespawning fish on or close to the spawning grounds south and west of Iceland. In January 1973 a successful capelin fishery began in deep water near the shelf break east of Iceland. In July 1976 a summer capelin fishery began in the Iceland Sea. This fishery became multinational with vessels from Iceland, Norway, Faroes and Denmark. The fishery is conducted all years in July-March except in periods of low stock size. Over the years the fishery has been closed during April-late June and the season has started in late June/August or later, depending on the state of the stock.

A regulation calling for immediate, temporary area closures when high abundance of juveniles are measured in the catch (more than 20% of the catch composed of fish less than 13 cm) is enforced, using on-board observers.

In recent years, the fishery has changed from being mostly an industrial fishery to being mostly for human consumption. This is largely because of the low abundance and low TACs.

A.3. Ecosystem aspects

A3.1 Geographic location and timing of spawning

The spawning takes place in March-April. The main spawning grounds are shallow waters on the sea bed off the south and west coasts. Some minor spawning may take place elsewhere.

A3.2 Fecundity

The main part of each year class matures and spawns at age 3. The remainder of the year class spawns at age 4. Only few spawns at age 2 and very few at age 5. Spawning mortality is considered very high.

A3.3 Diet

The main food of larval and juvenile and small capelin are copepod species such as *Calanus finmarchicus*, *Oithona* spp, *Temora* spp, *Acartia* spp, *Oncaea borealis* and *Pseudocalanus elongatus*. The importance of each species differs according to areas and size of the capelin. Later in the season there is a shift from smaller to larger food items. *C. finmarchicus*, *C. hyperboreus* and euphausids (mainly *Thysanoessa inermis*) become increasingly important in the stomachs of larger capelin

A3.4 Predators

The capelin plays a key role in the marine ecosystem in this area and is by far the most important pelagic fish stock in Icelandic waters. They are the main single item in the diet of Icelandic cod. They are prey to several species of marine mammals and seabirds and are also important as food for several other commercial fish species.

B. Data

B.1. Commercial catch

The fishing is shared between Iceland, Norway, Faroe Islands and Greenland by a special agreement, but by far the largest quantities are fished by Iceland.

B1.1 Landings

Information about landings in the fishery are collected by the Icelandic Directorate of Fisheries which has access to both landing figures in the ports (the official landing) and the recorded catch in the digital logbook kept by all the vessels. The logbooks keep information about timing (day and time), location (latitude and longitude), fishing gear, duration (minutes), catch size, and species composition in the catch of each fishing operation for each vessel.

Biological samples from the catch are taken at sea by the fishermen or in the ports by people from MRI and/or inspectors from the Directorate of Fisheries and then analysed by MRI (record at least the fish length, weight, age (from otoliths), sex, maturation, and weight of sexual organs). The information from the samples are then used along with the total landing data and the logbook data to estimate the age and length composition and numbers of fish by age of the total landings.

Landings are provided by Norway, Faroe Island and Greenland as catches-in-numbers-at-age. They are added to the Icelandic catches-in-numbers-at-age to get the annual landings-at-age.

B1.2 Discards

Discards are allowed when catches are beyond the carrying capacity of the vessel. Methods of transferring catches from the purse seine of one vessel to another vessel were developed long ago, and since skippers of purse-seine vessels generally operate in groups due to the behaviour of the fish, discards are practically zero. In the pelagic trawl fishery, such large catches of capelin rarely occur.

B.2. Biological

Natural mortality rates of Icelandic capelin were derived from 8 successive acoustic estimates of spawning stock abundance and catch in November 1978 to January 1989. It is estimated as 0.035/Month with SD=0.011.

B.3. Surveys

Several acoustic surveys aimed at different age groups of capelin have been conducted through the years. The purpose of the surveys on young capelin is to locate and estimate the abundance of young capelin. These surveys have been conducted in November since 1978 and the survey area is the nursery area on the shelf west, north and northeast of Iceland. Trawl samples are taken to get the species- and length composition. All ages, sex and maturity stage are recorded. The results from these surveys are used to predict an initial quota for the fishing season starting in the year after the surveys are conducted.

The surveys aimed at the fishable part of the stock are conducted in the fishing season, either in autumn, in conjunction with the survey of the juveniles, and/or in January –March on the spawning migration. The purpose of these surveys is to assess the size of the fishable stock and on its basis to set a final TAC for the season. These acoustic surveys on the adult component of the stock have been ongoing since 1979. The survey area varies spatially and is often influenced by drift ice conditions in the Denmark Strait-East-Greenland-NW-Iceland area in autumn. In January-March the main survey area is along the spawning migration route off NE-, E- and S-Iceland as well as off W- and NW Iceland in late February-early March. Trawl samples are taken to get the age and length structure as well as sex and maturity stage of the fishable stock. The results from these surveys are used to set a final quota for the ongoing fishing season.

B.4. Commercial CPUE

Is not relevant for this stock.

B.5. Other relevant data

None.

C. Historical Stock Development

The main objectivity of the management rule for the capelin is to leave 400 000 t for spawning in March each year. This goal has not been reached all years. In the fishing seasons 1979/1980-1982/83, 1989/90-1990/91 and 2008/09 the spawning stock biomass was below the target biomass. The stock has been at a low level the last 4 years.

A benchmark assessment has not been made, but is scheduled at the end of August this year.

Model used: Age structured.

Software used: The stock projections used are described in Gudmundsdottir, A., and Vilhjalmsson, H. 2002. It exists in versions both in Splus and in Excel.

Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Canum	Catch at age in numbers	1985 – last data year	2-4	yes
West	Weight at age of the stock.	1985 - last data year	2-4	Yes
Matprop	Proportion mature at age		2-4	No survival of spawners is assumed.
Natmor	Natural mortality		2-4	No – fixed 0.035/month

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Acoustic fleet	1979 – last data year	2-4

D. Short-Term Projection

Model used: Age structured.

Software used: The model for the stock prognosis used is described in Gudmundsdottir, A., and Vilhjalmsson, H. 2002. There exist versions both in Splus and in Excel.

Initial stock size: Acoustic measurements in numbers at age 1 and 2 from autumn surveys.

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

As the capelin is a short lived species this is not considered relevant. (Most capelin die at age 3).

F. Long-Term Projections

G. Biological Reference Points

Reference points have not been defined for this stock. The proposal is to use Blim=400 000 t. It corresponds to the targeted remaining spawning stock for capelin since 1979.

H. Other Issues

I. References

Gudmundsdottir, A., and Vilhjálmsson, H. 2002. Predicting total allowable catches for Icelandic capelin, 1978-2001. ICES Journal of Marine Science, 59: 1105-1115.

Vilhjálmsson, H. and Carscadden, J.E. 2002. Assessment surveys for capelin in the Iceland-East Greenland-Jan Mayen area, 1978-2001. ICES Journal of marine Science, 59: 1069-1104.

Vilhjálmsson, H. 2002. Capelin (*Mallotus villosus)* in the Iceland-East Greenland-Jan Mayen ecosystem. ICES Journal of Marine Science, 59: 870-883.

Quality Handbook Stock Annex: Greenland Halibut in V, VI XII and XIV

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Greenland halibut in V, VI XII and XIV

Working Group: North Western Working Group

Date: 5 May 2009

A. General

A.1. Stock definition

Greenland halibut in ICES Subareas V, VI, XII and XIV are assessed as one stock unit although precise stock associations are not known.

Available biological information and information on distribution of the fisheries suggest that Greenland halibut in XIV and V belong to the same entity and do mix. Historic information on tag-recapture experiments in Iceland have shown that Greenland halibut migrate around Iceland. Similar information from Greenland suggests some mix, both between West Greenland and Iceland but also between East Greenland and Iceland.

The scientific basis for the assumption on spawning grounds located west of Iceland is weak and based only on a few observed spawning fish and on distribution of eggs and larvae. 0-group surveys suggest that recruits are supplied to East Greenland and might also drift to West Greenland. Nursery grounds have not been found in the entire assessment area. Tag-recapture experiments have shown migrations of adult fish from Greenland to Iceland and also a mix within Icelandic waters, which supports a drift of larvae from west of Iceland to both Greenland and to north of Iceland. Tagging also suggest occasional migrations of adult fish from east Greenland and Iceland to Faroe Islands.

No major new information has been presented in recent years to contribute to the clarification of stock structure of Greenland halibut. However, compilation of fishery information (Section on Fisheries and Fleets) provides an overview of the geographical distribution of the fishery over time (Fig. 15.2.2-5.). Fishery in East Greenland and Iceland occurs continuously along the continental slopes at depth of 500-1000 m, which suggest that Greenland halibut in those areas belong to the same stock entity. A more detailed description of the present perception on stock structure is provided in the NWWG report 2006 (ICES 2006).

A.2. Fishery

The major fishing grounds in Icelandic waters are located west of Iceland (64º30-66ºN, 27º-29ºW), where approximately 95% of the annual trawl catch in Icelandic waters has been taken in recent years. The Icelandic trawlers moved to deeper waters around 1988, but the average depth of fishing on the western grounds has remained at approximately 900 meters since 1990. A minor fishery also occurred north of Iceland (67º-68ºN, 19º-24ºW, at approximately 500 m), and along the narrow continental slope northeast and east of Iceland (63º30-66ºN, 11º–16ºW, between 400 and 700 meter depth). The main fishing season in Division Va formerly occurred during the spawning season in spring, but in recent years, the fishing season has expanded and the present fishery is conducted in late winter to early summer, with the bulk of the catches taken in spring.

The trawlers (single trawlers > 1000 Hp) fishing in Division Vb operate on relatively shallow parts of the continental slope, mainly in summer. The gillnet fishery in Division Vb started in 1993, and since then the fishing grounds have expanded. This fishery is carried out during the whole year with a peak activity in the spring, and has been the main Greenland halibut fishery in Vb in recent years. Since 2006, however, their catch has decreased considerable, mainly due to an allocation of effort towards monkfish and in some cases to longline fisheries for cod, ling and tusk. .

The fishing grounds in Division XIVb are found on the continental slopes from southeast Greenland to the Icelandic EEZ east of Ammasalik (61ºN-65ºN, 36º-41ºW). Trawling was formerly concentrated in a narrow belt of the continental slope at depths of 500–1000 meters in the north-easternmost area of XIVb, but since 1997 expanded to a southerly area between 61°40-62°30N, 40°00-40°30W at depths of 1000–1400 meters, where longliners are also fishing. In 2005 the fishery entered an unexploited area north of 67° N just north of the Icelandic EEZ with catches of about 1 200 t. The fishery began as an exploratory fishery in September 2005 by a Greenlandic vessel, which was followed by 3-4 foreign vessels that operated in the area through October and November. This fishery continued in 2006 and 2007, but only with total catches of approx. 250 t annually taken in July-September. The fishery in 2007 is distributed almost continuously along the continental shelf at depths of 500-1300 m from 30°W to 41°W, and has since 2005, when the area north of 67°N were explored, been the most widespread fishery recorded since 1991. It should be noted that in 2006 and 2007 also the most comprehensive information (91% and 93% respectively) from the fishery is available as logbook data. The main fishing season in XIV has expanded and is in recent years from March to November with the bulk of the catches taken in the 2nd quarter. Both freezer trawlers and fresh fish trawlers operate in the area.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

EU, Norway, The Faroe Islands and Greenland collects biological information (lengths, weights, otoliths) from commercial fisheries which is used for stock assessment. Landings data are supplied annually by the relevant nations..Data files are available from ICES.

B.2. Biological

Considerable ageing problems are still unsolved, it seems that present ageing underestimates the current age of fish more than a few years old (Albert 2007). Therefore since 2001 no age readings of otoliths were available from the main fishing areas. Otoliths are still being sampled in hope that this problem will be solved in the future.

B.3. Surveys

Three surveys are being conducted, separately in Va, Vb and XIV.

Icelandic survey in Va

An October groundfish survey in Icelandic waters, covering the distributional area of Greenland halibut within the Icelandic EEZ, was started in 1996. The survey is a fixed station stratified random survey consisting of approx. 300 stations on the continental shelf and slope down to a depth of 1300 m. 176 stations of the stations in the survey are on depths between 400 and 1500 meters. Since 2001 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) has decreased significantly, but stabilised at a low level since 2004.

Faroese survey in Vb

Since 1995, a Faroese Greenland halibut survey has been carried out on the southern and eastern slope on the Faroe Plateau at depths of 400-600 m. The survey is designed as an exploratory fishery where the skipper decides haul location; due to the design of the survey with a mix of fixed stations in combination with an exploratory part, and in addition to a shift on area coverage over time, it has been considered inappropriate as a biomass indicator at present time.

Greenlandic halibut survey in XIVb

Since 1998, a Greenland survey for Greenland halibut has been carried out in East Greenland waters from 60°N to 67°N at the main commercial fishing grounds at depths of 400-1500 m in late June/early July (Fig. 15.5.4.). No survey took place in 2001. Total biomass in 2008 was estimated at 11000 tons which is a 50% reduction from 2006 (Fig. 15.5.5). Compared to the period 1999-2001, total biomass estimates for the period 2002-2006 is somewhat lower, while the 2008 estimate is record low and replacing the previous lowest index in 2007. In September 2006 an extension of the Greenland survey was conducted north (67°N - 72°N) of the area annually surveyed in East Greenland waters. The survey found poor concentrations of Greenland halibut and of 44 hauls were Greenland halibut only found in 18 hauls and only with one haul having a catch higher than 50 kg (30 min hauls).

The survey is documented in a WD to the WG each year.

Calibration of surveys in Va and XIVb

As a part of the 2006 surveys the Icelandic and the Greenlandic research vessels "Arni Fridriksson" and "Paamiut", respectively, met in Icelandic waters in October to conduct parallel trawling experiments. A total of 11 parallel hauls were made. The original plan called for more hauls but due to problems onboard Paamiut the experiment had to be halted. Because of the small number of hauls it was impossible to get good estimates of the relative trawling efficiency of the two vessels. However the average catch of Greenland halibut standardized to number or weight per km^2, was highest for Paamiut but there was no statistical difference (95% level) in the catches between the two vessels.

B.4. Commercial CPUE

Haul by haul logbooks are available from Va, Vb and XIV.

B.5. Other relevant data

None.

C. Historical Stock Development

D. Short-Term Projection

E. Medium-Term Projections

F. Long-Term Projections

G. Biological Reference Points

H. Other Issues

History of assessment methods used.

In the 1990's a VPA was conducted to assess the state of the stock. Only the Icelandic trawler fleet was available for calibration of the VPA. Due to diagnostic problems with the VPA and a strong retrospective pattern in the estimation of F and SSB this approach was rejected in 2000. Also ageing problems caused the rejection of an age based assessment model. At the same time age reading ceased in the main fishing lab dealing with assessment of the stock. This still prevents the reversion to an age based assessment. In 2001 – 2004 a stock production model was used as basis for the advice (ASPIC). In 2004 the ASPIC were not able to track the indices (Icelandic survey and CPUE) and thus rejected as an assessment approach. State of the stock in 2004-2006 was entirely based on indices from surveys and the commercial fishery. In 2007 the stock production model was presented in a Bayesian framework and accepted by the NWWG. This approach was, however, rejected by the review group based on some technicalities. The comments of the 2007 reviewers have been taken into account in the 2008 assessment that was accepted.

Quality Handbook **Stock Annex: NWWG - SMR**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	*Sebastes marinus* in ICES Subareas V and XIV
Working Group:	North-Western Working Group
Date:	13.05.2009

A. General

A.1. Stock definition

Golden redfish (*Sebastes marinus*) on the continental shelves of East- and West-Greenland, Iceland and Faeroe Islands (ICES Subareas V and XIV) is considered one stock. *S. marinus* is most abundant in Icelandic waters where most of the commercial catches are taken. *S. marinus* in Icelandic water is found all around Iceland, but is most common West-, Southwest-, South- and Southeast of Iceland at depth of 100-400 m. The main nursery areas are off East-Greenland and Iceland. No nursery grounds are known for *S. marinus* in the Faeroese waters. In Icelandic waters, nursery areas are found all around Iceland, but are mainly located west and north of the island at depths between 50 m and 350 m (ICES C.M. 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson et al. 1997). As they grow, the juveniles migrate along the north coast towards the most important fishing areas the west and southwest coast and further to the Southeast fishing areas and to Faeroese fishing grounds in Vb.

A.2. Fishery

Iceland

The fishery for *S. marinus* in Icelandic waters is predominantly conducted by the Icelandic bottom trawl fleet directed towards the species, and which accounts for more than 90% of the total catch. The remains are partly caught as by-catch in gillnet and long-line fishery. The most important fishing grounds are southwest and west of Iceland at depths from 200-400 m.

The minimum legal catch size of *S. marinus* in Icelandic waters is 33 cm for all fleets, with allowance to have up to 20% undersized (i.e. less than 33 cm) specimens of *S. marinus* (in numbers) in each haul. If the number of redfish smaller than 33 cm in a haul is more than 20% fishing is prohibited for at least two weeks in those areas (see Chapter 7.5.3 for further details about the quick closure system). Very few quick closures have been on small redfish since 2001.

Since 1991, large areas west and southwest of Iceland are closed permanently or temporarily for trawling to protect juvenile *S. marinus* (Figure 1). These areas were closed partly because of frequent quick closures on redfish fisheries in 1991-1994 (Schopka 2007).

Although no direct measurements are available on discards, it is believed that there are no significant discards of *S. marinus* in the Icelandic redfish fishery due to area closures of important nursery grounds west of Iceland. Discard of redfish in bottom trawl fisheries directed towards other species are considered negligible (Palsson et al 2008).

In late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the by-catch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a by-catch in the fishery, but also juveniles of other species. Since the large year classes of S. marinus disappeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery.

Greenland

Since 1995, there has been little or no directed fishery for golden redfish in Greenland waters. Landings have been 200 t or less and are mainly taken as by-catch in the shrimp fishery.

Faeroe Islands

The majority of the golden redfish caught in Division Vb is taken by pair and single trawlers (vessels larger than 1000 HP).

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The text table below shows which data from landings is supplied from each area.

	Kind of data				
Country/area	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
Iceland (Va)	x	x	x		x
Faeroe Islands (Vb)	x				x
Greenland (XIV)	x				

The landing statistics used by the North-Western Working Group (NWWG) are those officially reported to ICES.

Iceland

Icelandic commercial catch in tonnes by month, area and gear are obtained from Statistical Iceland and Directorate of Fisheries. The distribution of catches is obtained from log-book statistic where location of each haul, effort, depth of trawling and total catch of *S. marinus* is given.

Icelandic authorities give annually a joint quota for *S. marinus* and demersal *S. mentella* in ICES Division Va. Icelandic fishermen are, therefore, not required to divide the redfish catch into species. The redfish catch of the freezer trawler is usually divided into species in the log-books and considered reliable. Data were available from 1993 to 2007. The redfish catch of the fresh fish trawlers are on other hand not always split into species. To split the redfish catches into species, the catches for each year are divided into strata and scaled to the total un-split catch of the two species for each rectangle. The biological samples taken from the commercial catch are then used to split the catch in each stratum into species. In this step, the average species composition in the samples in each stratum is found and then applied to the total catch of the fleet in that stratum.

Biological data from the commercial catch were collected from landings by scientists and technicians of the Marine Research Institute (MRI) in Iceland and directly on board on the commercial vessels (mainly length samples) during trips by personnel of the Diroctorate of Fisheries in Iceland. The biological data collected are length (to the nearest cm), sex, maturity stage and otoliths for age reading. Most of the fish that otoliths were collected from were also weighted.

The general process of the sampling strategy is to take one sample of *S. marinus* for every 500 tonnes landed. Each sample consists of 200 fishes: otoliths are extracted from 30 fishes which are also length measured, weighed, and sex and maturity determined; 70 fishes are length measured, weighted, sex and maturity determined; the remaining 100 are length measured and sex and maturity determined. Annually, about 1700 *S. marinus* are age read.

The data is stored in a data base at the Marine Research Institute. The data is used for age-length key (ALK) and as input data for the GADGET model.

B.2. Biological

The total catch-at-age data in Va back to 1995 is based on Icelandic otolith readings.

B.3. Surveys

Five surveys are conducted annually in Va, Vb and XIV.

Icelandic surveys in Va

Two bottom trawl survey series in Va (Icelandic waters) have been evaluated by the NWWG. The surveys cover the distribution of *S. marinus* in Va.

1. Annual bottom trawl survey in March from 1985-2009 at depths of 50-500 m. About 550 stations taken annually. Data are available on length 1985-2009 and weight, sex and maturity for the years 1998-2009.

2. Annual bottom trawl survey in October 1996-2008 at depths of 50-1500 m. About 380 stations are taken annually. Data are available on length, age, weight, sex, and maturity.

From those surveys biomass and abundance indices are developed. The data is used in the assessment (GADGET model).

Faeroese surveys in Vb

Two research vessel survey series from Faeroese waters (Vb) are available to the Working group.

1. The Faeroese groundfish spring survey conducted in February-March from 1994-2009. Each year 100 stations are taken down to 500 m depth.

2. The Faeroese groundfish summery survey conducted in August-September from 1996-2008. Each year 200 stations are taken down to 500 m depth.

Surveys in Greenland waters.

One research vessel series from Greenland waters are available to the Working Group.

1. The German groundfish survey 1982-2008 conducted in the autumn. Primarily designed for cod but covers the entire groundfish faun down to 400 m (Rätz 1999). The survey is designed as a stratified random survey, the hauls are allocated to the strata off West and East Greenland both according to the area and the mean historical cod abundance at equal weights. Towing time is 30 min at 4.5 kn.

B.4. Commercial CPUE

Commercial CPUE series for *S. marinus* were available from the Icelandic and Faeroese bottom trawl fleet.

Iceland: Data used to estimate CPUE for *S. marinus* in Division Va since 1986 were obtained from log-books of the Icelandic bottom trawl fleet. Only those hauls were used that were taken above 450 m depth and that were comprised of at least 50% golden redfish (assumed to be the directed fishery towards the species). Non-standardized CPUE and effort is calculated for each year. CPUE indices were also estimated from this data set using a GLM multiplicative model (generalized linear models). This model takes into account changes in vessels over time, area (ICES statistical square), month and year effects.

Faeroe Islands: Un-standardized CPUE is estimated for the Faroese otterboard (OB) trawlers since 1991. OB trawlers conduct a mixed fishery and direct their fishery to some extent towards golden redfish. Un-standardised CPUE is also estimated from the Faeroese CUBA pair-trawler fleet, where *S. marinus* is mainly caught as by-catch in the saithe fishery.

B.5. Other relevant data

C. Historical Stock Development

The development of the stock has annually been discussed and evaluated based on the research survey series and information from the fishery.

D. Short-Term Projection

E. Medium-Term Projections

F. Long-Term Projections

G. Biological Reference Points

H. Other Issues

Since 1999, analytical assessment have been conducted on *S. marinus* in Icelandic waters have been conducted using GADGET. Data from Greenland and Faeroe Islands have not been used in the assessment. This approach has, however, been rejected by the review group.

I. References

Rätz, H.-J. 1999: Structures and Changes of the Demersal Fish Assemblage off Greenland, 1982–96. *NAFO Sci. Coun. Studies*, 32: 1-15.

Schopka, S. A. 2007. Area closures in Icelandic waters and the real-time closure system. A historical review. Marine Research Institute. Report series nr. 133. 86 pp.

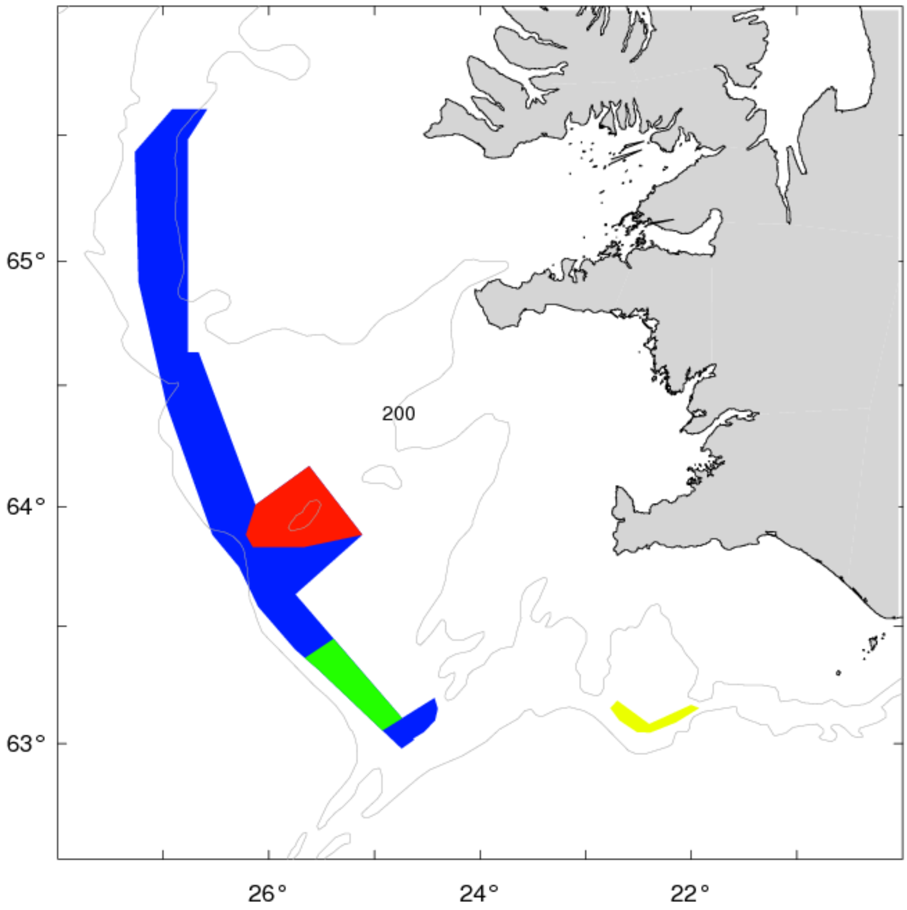

Figure 1. Overview of closed areas for protection of juvenile *S. marinus*. These areas are either closed permanently or temporarily and during closure bottom trawling is prohibited. The blue area is closed all year long; the red area is only open during the night or from 20:00-08:00 from October 1 to April 1 to allow fishing for saithe; the green area is open for bottom trawling February 1 to April 15; the yellow area is closed for bottom trawl fishery from June 1 to October 31.

Annex 4 Recommendations

The North-Western Working Group recommends the establishment of a Workshop on the use of survey information in ICES XIVb and NAFO area 1 [WKSXIV] (contact person Holger Hovgård, Greenland) to be established and to meet in Reykjavik during spring 2010 (prior to 2010 NWWG meeting - date to be decided) to:

- Explore/develop suitable indicators for stock development using available survey time series information in the areas.
- Develop robust procedures to enable corrections in biomass/abundance indices for years when parts of the survey area are not covered.
- Evaluate the usefulness of potential approaches, as e.g. transformations, to deal with high "leverage" hauls in the surveys.
- Evaluate the appropriate strata sizes of the East Greenland bank areas in lieu of available knowledge. Recommend supplementary research approaches if needed.
- Apply and test the approaches developed on the relevant survey time series

WKSXIV will report by April 2010 for the attention of the NWWG and ACOM.

Supporting Information

Priority:	High. Surveys presently provide the essential information for assessing the the stocks in ICES area XIV/NAFO Subarea 1.
Scientific justification and relation to action plan:	The NWWG has identified of number of potential approaches that may enhance the usefulness of existing suvey information for stock assessment purposes. The development of improved stock indicators requires intersesional work the that need be carried out in a joint NWWG workshop.
Resource requirements:	No specific resource requirements beyond the need for members to prepare for and participate in the workshop.
Participants:	These would include the NWWG experts working with relevant surveys and assessments.
Secretariat facilities:	This group is likely to have limited demand on the ICES Secretariat.
Financial:	None specific.
Linkages to advisory committees:	ACON
Linkages to other committees or groups:	
Linkages to other organizations:	NAFO Scientific Council.
Secretariat marginal cost share:	