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INTRODUCTION

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Terms of Reference

At its October 2003 meeting ACFM decided the following:

The **Arctic Fisheries Working Group** [AFWG] (Chair: Y. Kovalev, Russia) will meet at ICES Headquarters from 4–13 May 2004 to:

a) assess the status of and provide catch options for the year 2005 for the stocks of cod, haddock, saithe, Greenland halibut, and redfish in Subareas I and II, taking into account interactions with other species and attempting alternative assessment methods where applicable;
b) evaluate the agreed management strategy for cod and haddock, with special attention to the reference points for spawning stock biomass and fishing mortality;
c) provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation, including inadequacies in available software. The consequences of these deficiencies for the assessment of the status of the stocks and for the projection should be clarified;
d) comment on this meeting's assessments compared to the last assessment of the same stock, for stocks for which a full or update assessment is presented;
e) document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done.

AFWG will report by 17 May 2004 for the attention of ACFM.

General comment

Because Barents Sea shrimp assessment will be dealt with by a joint NAFO-ICES pandalus working group, its section is deleted from the AFWG report from this year.

Management strategy for NEA cod and haddock

At the 31st session of The Joint Norwegian-Russian Fishery Commission the Parties agreed on a new harvesting strategy for Northeast Arctic cod and haddock. An evaluation of this harvesting strategy is ToR b) for the working group. Two working documents considering the evaluation of this rule for cod were presented (WD3 and WD18). The evaluation of the harvest control rule is given in Section 3.12. The evaluation of the harvesting strategy for haddock was postponed.

Unreported landings

ICES received an official letter from the Norwegian ICES delegate with information about unreported landings of cod in the Barents Sea and Svalbard areas. Quoting from this letter:

"The Norwegian Directorate of Fisheries has with assistance from the Norwegian Coast Guard conducted comprehensive investigations to estimate the total catch of North-East Arctic Cod in the Barents Sea since 2002.

Based on the information available, it seems that the total catch of North-East Arctic Cod in 2002 is about 80.000-100.000 tonnes higher than the officially reported catch quantities. The estimate for 2003 is not yet completed, but available information indicates that the extent of over-fishing is about the same quantity as in 2002."

Other inadequacies in the data and possible deficiencies in the assessments

At recent AFWG meetings it has been recognized that there is growing evidence of both substantial discarding and mis-/un-reporting of catches throughout the Barents Sea for most groundfish stocks in recent years (ICES CM 2002/ACFM:18, ICES CM 2001/ACFM:02, ICES CM 2001/ACFM:19, Dingsør WD 13 2002 WG, Hareide and Garnes WD 14 2002 WG, Nakken WD 10 2001 WG, Nakken WD8 2000 WG, Schöne WD4 1999 WG, Sokolov, WD 9 2003 WG). During the present meeting, in addition to the Norwegian report on unreported landings in 2002 and 2003, a working document (Sokolov, WD 7) estimating cod discard in the Russian bottom trawl fishery in the Barents Sea in 1983-2002 was presented. The discard was found to be highly variable over time and affected mainly age groups 3 and 4, and on average over the time period, 6 million individuals, mostly age groups 3 and 4 (30-45 cm), were annually discarded. On average, this composes about 6% of the total number of cod caught. Ajiad et al. (WD 24) presents preliminary results on the total cod by-catch in the Norwegian shrimp fishery during 1983-2002 based on data from the Norwegian commercial shrimp landing statistics, data from the Norwegian fishery surveillance agency and the scientific shrimp surveys. The working group was informed about the focus on discards in Norway recently, which resulted in a report to the Norwegian Ministry of Fisheries about possible actions to quantify and reduce the problem. The total effect of the discarding is still very unclear and requires more work before it can be included in the assessments.

Inaccuracies in the catch statistics continue to represent one of the most serious errors in stock assessments. The 32nd Russian-Norwegian Fisheries Commission declared at its meeting in November 2003 that 2004 should be the "Year of control". The Commission has asked the Permanent Russian-Norwegian Committee on Fisheries Management and Control to work out and present a joint report by 1 July 2004 on how to stop unreported landings. To secure that the official landing statistics become reliable, it is important that the responsible authorities intensify their control and estimate the catches and landings by independent methods on a regular basis.

While the area coverage of the winter surveys was incomplete in 1997 and 1998, the coverage was normal for these surveys in 1999-2002. In the autumn 2002 and winter 2003, however, surveys have again been incomplete due to lack of access to both the Norwegian and Russian Economic Zones. This affects the reliability of some of the most important survey time series for cod and haddock and consequently also the quality of the assessments. In some years, the permission to work in the Norwegian and Russian Economic Zones, respectively, has been received so late that the work has been severely hampered, e.g., the Russian survey in autumn 2003. There is no acceptable way around this problem except asking the Norwegian and Russian authorities to give each other's research vessels full access to the respective economical zones when assessing the joint resources, as, e.g., was the case for the Norwegian survey in winter 2004.

In 1992, PINRO, Murmansk and IMR, Bergen began a routine exchange program of cod otoliths in order to validate age readings and ensure consistency in age interpretations (Nedreaas and Yaragina, WD 11 2003 WG). Later, a similar exchange program was established for haddock otoliths. Once a year the age readers come together and evaluate discrepancies, which are seldom more than 1 year, and the results show an improvement over the time period from 30% to 15% discrepancies for cod. The discrepancies are discussed and a final agreement on the exchanged otoliths is at present achieved for all otoliths except ca. 2%. A similar positive development is also seen for haddock age readings.

Inadequacies in available software

The AFWG have found that the prediction program in use lack some important options. The stocks on the observation list require various methods to examine forecast options. The MFDP program would improve if F multiplier could be typed in for each year in the short term prediction.

Regarding the MFYPR program, useful improvements could be to have additional options for some parameters. These are:

- Scenario for different weight in catch at age for each year in the forecast.
- Scenario for different weight in stock at age for each year in the forecast.
- Scenario for different natural mortality in stock at age for each year in the forecast, due to e.g., cannibalism that may be predicted to vary from year to year.
- Scenario for different maturity at age for each year in the forecast.

As example, for doing the predictions of NeA cod in this year's assessment all the above listed parameter options were needed. It is preferred that the MFYPR program has the option to permit files to input these numbers in addition to the option to type the numbers from the keyboard.

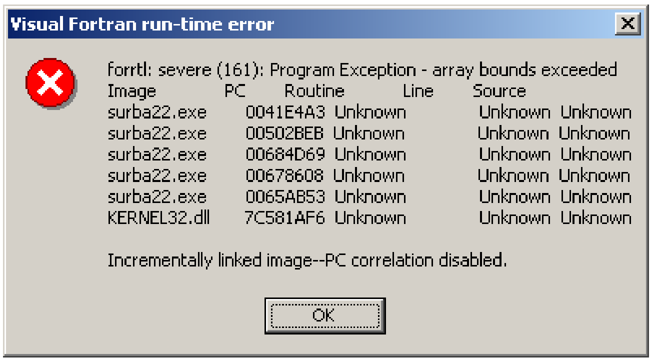
During the AFWG-meeting, the survey-based assessments program SURBA (Needle 2003, 2004) was presented to the group, and useful runs were made with this program to explore the survey data and as a supplement to the adopted assessment procedures. However, when using SURBA some shortcomings were discovered. Below are listed some desired improvements/further developments.

The AFWG have used SURBA 2.1 version and SURBA version 2.2. Some fleets could be analyzed in SURBA 2.1 but give error handling problem in the newer version. An example is the single tuning series used in NeA cod assessment. Two tuning series could be analyzed in SURBA 2.2 and all four in the older version.

The following surveys and commercial CPUE data series was used for <u>initial tuning runs</u> by single fleets:

	Name	Place	Season	Age	Years
Fleet 17	Russian bottom trawl surv.	Total area	Oct-Dec	3-8	1982-2003
Fleet 09	Russian trawl CPUE	Total area	All year	9-12	1985-2003
Fleet 15	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2004
Fleet 16	Joint acoustic survey	Barents Sea + Lofoten	Feb-Mar	3-11	1985-2004 (Table A16)

Running SURBA 2.2 with the shaded tuning fleets, give the error message:



FishFrame, an international web based database and data warehouse for biological information of commercial catches, was presented to the AFWG. The working group considered this software very useful for standardizing and quality assurance of the compilation of assessment input data. It will also provide important historical records of the assessment input data, the possibility to post-stratify data, to facilitate an easy access and overview to all data existing internationally, and to provide basis for additional analysis across countries and areas. The software including a dummy, but complete data set, should be made available to members of assessment working groups for further evaluation in order to do evaluations of FishFrame before eventually being adopted as a standard tool.

Use of age- and length structured models in assessment (Fleksibest)

The development of a new assessment model for Northeast Arctic cod – Fleksibest – started at IMR, Bergen, in 1997. A description of the model is given in Frøysa et al. (2002). The model is age- and length-structured, and the biological processes growth, maturation, mortality, fishing and cannibalism are modelled as length-structured processes. Fleksibest is a forward simulation model based on the Gadget (formerly BORMICON, Stefánsson and Pálsson 1997, 1998, Anon., 2001, 2002) framework within which different formulations of biological processes can be tested and compared. Fleksibest is an extension of the type of age-structured assessment models where catches are modelled, sometimes termed CAGEAN or 'statistical catch at age analysis' (Fournier and Archibald, 1982, Deriso et al., 1985).

For NEA cod, Fleksibest has been used as a supplementary model to XSA for some years. Fleksibest is now a complete assessment model which provides the same kind of output (assessment, retrospective analysis, prognosis, diagnostics) as e.g. XSA. Although questions concerning choice of likelihood functions and appropriate aggregation level for model/data comparisons need further study, it may be time to give the results from Fleksibest more weight. The use of several assessment models for the same stock is increasingly common in several assessment working groups. A comprehensive analysis of the performance of XSA and Fleksibest should be presented to the 2005 AFWG meeting.

A project is currently underway to construct a multi-area, multi-species (cod, capelin, herring, minke whale) model for the Barents Sea using the Gadget modelling framework (see http://www.hafro.is/gadget), with the Fleksibest cod model as the starting point. This model will also build upon the MULTSPEC model (Bogstad et al., 1997). The ability to model the length-dependent interactions between species is critical to this work, which forms part of the new EU project BECAUSE. The move (with this model and elsewhere) towards biologically realistic multi-species models represents one possible route to a goal of more inclusive ecosystem-based management.

Adding length structure makes it easier to include biological realism by modelling growth, maturity, fecundity, recruitment, fishing mortality and natural mortality (e.g. cannibalism) as processes depending on fish length/weight, temperature, prey abundance and other factors. The current NEA cod Fleksibest model has been extended to contain four population groups (EggsandLarvae, 0-group, immature fish and mature fish) in order to model the closed life-cycle for cod as well as to include more biological realism. Results of extending the model down to age 1+ (without closed life-cycle) are discussed in this year's report. Results of the closed life-cycle model will be presented in a paper to the 2004 ICES ASC. With such an extension Fleksibest can be used to model the abundance of all age groups in the stock. Splitting immature and mature fish by sex in order to take sex differences in maturity, growth and natural mortality into account could further extend this approach. Such an extension will also make it possible to include fecundity/length/weight relationships in more appropriate way.

Age-length structured models such as Fleksibest were studied at the ICES Study Group on Age-Length Structured Assessment Models (SGASAM) in Bergen in June 2003 (ICES CM 2003/D:07). The meeting reviewed current status for age-length-structured and length-structured population models. Age-based models make an implicit assumption that processes are either age-dependant, or that age can be used as a proxy for the controlling factor (typically length). There is thus a need to consider length-structured or age-length-structured models where this assumption fails, or where age data is sparse or unreliable. Maturation, growth, cannibalism, predation and fishing mortalities were all presented as processes where age-structured modelling alone may prove insufficient. Examples of some attempts to resolve these issues with different model were presented, and the meeting compared age-length-structured models constructed for several different areas (Celtic Sea cod, whiting and blue whiting, NE Arctic cod, New Zealand snapper), and a length-structured model (Northern Shelf anglerfish). Length based modelling may also be useful in a situation where stock demographics (e.g. length-at-age, maturity-at-age) show changes over time. Such changes occur on an inter-annual basis, and may also show longer-term trends in response to fishing pressure or environmental changes.

A second meeting of SGASAM will be held in December 2004. In addition to reviewing ongoing developments in age-length-structured models, this meeting will examine incorporating process-based developments from the SGGROMAT meeting (ICES CM 2004/D:02) into age-length-structured models. The meeting also intends to examine comparisons between age-structured and age-length-structured models.

ICES Quality Handbook

Following the guidelines as adopted by ACFM in October 2002, a stock specific template was filled out for all AFWG stocks, describing how the annual assessment calculations and projections are performed, as well as the biological stock dynamic, ecosystem aspect, and the fisheries relevant for fisheries management. These templates are presented as appendices to the working group report, and the report has been re-structured accordingly.

Scientific Presentations

WD 1 (presented by J.E. Stiansen) describes the present oceanographic conditions, the role of zooplankton and some relations between climate and fish population parameters. A forecast for sea temperature in the Barents Sea is given.

WD2 (presented by B. Bogstad) gives a prognosis for the development of the Barents Sea capelin stock. The capelin stock is predicted to be 410 thousand tonnes at 1 January 2004 and 1420 thousand tonnes at 1 January 2005. The predictions are given with uncertainty. The prediction method has now been integrated into the capelin assessment software. It is planned to carry out a review of the prediction method before the capelin assessment meeting in October 2004.

WD3 (presented by B. Bogstad) describes the status of joint Norwegian-Russian work on evaluation of the proposed harvest control rule for Northeast Arctic cod. A biologically detailed population model for cod to be used in the evaluation is described. In this model, recruitment is modelled using a segmented regression approach, as well as a periodic term and a term including the mean weight of spawning fish. Growth and maturation is modelled as density dependent, and cod cannibalism can also be included. Assessment error and uncertainty in the stock/recruitment relationship is included. It is outlined, which harvest control rules should be explored and how they could be evaluated.

WD6 (presented by B. Bogstad) presents data on length, weight and growth at age for Northeast Arctic cod from surveys and commercial catches as well as data on cod stomach content. The condition factor has declined during the last year. Also, the amount of capelin in cod stomachs during the period January-March decreased by about 50% from 2003 to 2004 for most age groups, but did not reach historic low levels. The 1-year prediction of weight at age in the stock and in the catch made by AFWG last year was fairly accurate, with errors < 12% for all age groups 3-10 both for catch weights and stock weights. This document gives relevant information for predicting growth and maturation of cod.

WD9 (presented by Y. Kovalev) concludes that incorporation of the North-East Arctic cod cannibalism data into the VPA model improves the overall quality of its assessment but only when the entire time-series is considered (1985-2002). This is achieved by better consistency between survey abundance indices and VPA estimates for juvenile cod. In addition, variability in model estimates is also reduced according to retrospective analysis. The improvement is most apparent for estimates of recruitment at age 3, which enhances confidence in predicting recruitment. However, when examining XSA diagnostics for the most recent years the improvement in the quality of the assessment is not quite so clear.

WD10 (presented by Y. Kovalev) demonstrates the low quality of predicting cod natural mortality caused by cannibalism with the method currently used by AFWG. Examining the feasible predictors of cod natural mortality from cannibalism, such as abundance/biomass of cannibals, prey abundance and capelin biomass, a parameter was chosen having the closest relationship with the mortality level – the biomass of cod spawning stock with minus 3-year lag. In spite of the fact that the mechanism of the cod SSB influence on the level of natural mortality of young cod 3-4 years later is unclear, the strength of the statistical relationship between these quantities and some advantages compared to all other discussed methods of prognostication, may recommend this as the predictor for use at AFWG.

WD14 (presented by B. Bogstad) presents extensions and changes of the Fleksibest model from 2003 to 2004. Fleksibest has now been extended to cover age 1-12+ (previously 3-12+ was used). Catch is now modelled by modelling effort, while previously it was modelled using fishing mortalities. Similarly, cod cannibalism is modelled as predation, not as mortality. The length selectivity is now described by logistic curves for all surveys.

WD16 (presented by A. Filin) describes results of simulation of year-to-year abundance dynamic of krill in the Barents Sea. The prognostic model is constructed on the basis of multiple linear regressions incorporating along with environmental factors (water temperature, NAO indices, sea level and ice coverage) and biomass of capelin. The model was tuned by data for the period 1977-2000. According to the model it is expected that in 2004-2005 euphausiid abundance will increase compared to 2003-2004 to above average (similar to 1987 and 1995), and subsequently decrease in 2005-2006 down to the level of 1989 and 1994.

WD17 (presented by A. Filin) describes results of monitoring of abundance and distribution of krill (euphausiids) in the Barents Sea, conducted by PINRO since 1952. From these monitoring data, it is seen that the abundance of euphausiids, as well as the peculiarities of their distribution, and that the specific composition is characterized by significant year-to-year dynamics, influence the fish feeding conditions . In autumn-winter 2003/04 the mean annual indices of euphausiid abundance was approximately 50% higher than the long-term mean. However, a reduction of these indices compared to the previous year was noticed. In the samples, *Thysanoessa raschii* prevailed and made up

53%. The relative abundance of *T. inermis* was 24%, of *Meganyctiphanes norvegica* – 18% and of *T. longicaudata* – 4%.

WD 18 (presented by T. Bulgakova) proposes a simulation model, which is intended for testing and comparison of various management regimes for their feasibility and suitability for the NEA cod stock. The model is realized in the environment of EXCEL + VBA and works on a long retrospective period. This is a cod population model with recruitment depending on population fecundity index, on established inflow index of Atlantic waters, and on the SSB as cannibalism factor. The model comprises the management rule and stochastic modules, too. Three versions of harvest rule adopted by The Joint Russian-Norwegian Fisheries Commission are tested. The best of them (judged from the perspective to get high average multiannual catch and low risk probability to cross limit reference points) gives that the risk probability to fall below B_{lim} is 5% during the simulation period, and the risk probability to come above the F_{lim} level is equal to 10%. The increase of this allowable limit to 15% gave a zero probability of $SSB<B_{lim}$ and of $F>F_{lim}$. . Further increase of the percentage catch changes from year to year did not influence the cod population dynamics.

WD20 (presented by A. Filin) describes results of cod growth rate in the Barents Sea, performed by the STOCOBAR model. Model parameters were estimated by historical data for 1984-2002. The prognosis of cod growth rate is done for a three-year period, from 2003 to 2005. In the prognosis the forecasts of mean annual temperature in the Kola Section for 2003-2005 was used as input data, together with the prognosis of capelin biomass. According to model calculations, on the whole, the mean weight of fish is expected to be decreasing from 2003 to 2005 due to the predicted reduction in water temperature and capelin stock in the Barents Sea. The most pronounced reduction in growth rate is expected for fish from the younger age groups, 3-5 years. Significant changes of fish mean weight at the beginning of 2006, compared with 2005, are not predicted. As a whole, the mean weight of fish in 2004-2006 is expected to be lower than the long-term mean level (1984-2003).

WD 24 (presented by A. Aglen). The aim of this work is to establish a bycatch database for cod and other commercially important species in the shrimp fishery in the Barents Sea. The present WD estimates cod bycatch in numbers and weight by length groups on quarterly and yearly basis during 1983-2002 by tracing both in space and time the commercial shrimp catch and cod bycatch. Data available for this estimation include the official shrimp landing statistics, log-book data from shrimp trawlers, fishery surveillance data from the Directorate of Fisheries, and data from shrimp surveys and demersal fish surveys using Campelen shrimp trawl. The annual bycatch of young cod in the Norwegian shrimp fishery has been up to 60 mill. individuals, but has in recent years due to effective regulation measures decreased to 10-12 mill. specimens. By adding similar bycatch estimates from other countries' shrimp fisheries, an implementation of cod bycatch as additional fishing mortality to cod stock assessment and management procedures should be considered.

WD 25 (presented by A. Aglen) a time series of total catch numbers at age of cod in the Norwegian trawl fishery was used to estimate partial Fs for this fleet. From effort data F per effort was calculated for the period 1977-2003. An increasing trend in F per effort was observed for the period after 1990 for age 7 and older. For age 5 and younger it has decreased again since 1993. These changes in F per effort make Catch per effort a biased indicator of stock size. (Calculations updated with the new vpa-assessment are presented in Figure 3.16 in the wg-report).WD 26 (presented by A. Aglen) a method for using catch at age analysis to calibrate survey estimates was presented. This is indicate to give more robust estimates of stock size than when using survey estimates to calibrate catch at age analysis (like xsa). The method was applied for the cod estimates in the Joint bottom trawl winter survey and compared to xsa-results from AFWG. Survey based predictions for 2004 were given.WD 27 (presented by V. Borisov) a retrospective analysis of percentage variations in the cod fishable stock in year "i" relative to year "i-1" for the period 1946-2002 was made. It was shown that in 35 cases in the period of 54 years the stock varied more than ± 10% from one year to the other; in 17 cases deviations exceeded ± 20%, and in 6 cases they constituted from 30 to 61%. TAC, which does not take into account fluctuations of the stock in neighboring years, can lead to overfishing in years of its decrease and also to underfishing in years of the stock growth. Adequacy of the relative yearly variation of TAC to the variation of the fishable stock should be included into the main elements of the fisheries management.

Two confidential reports (for 2002 and 2003) from the Norwegian Directorate of Fisheries, including spreadsheet examples of the estimation procedure, were circulated and presented by K. Nedreaas to the AFWG. Over the recent years there has been a growing concern that trans-shipping of fish from the Barents Sea may to some extent utilize loop-holes in international control systems (and regulations) and thereby lead to trading of fish not counted against quotas. This topic was of high priority for the coordinated Norwegian-Russian activities on Fisheries Control in 2002, and was initiated by growing concern by Russia due to the sudden new development of trans-shipping fish in the open sea, and by Norway due to sudden decrease of landings in Norwegian harbours. It is therefore believed that the magnitude of the unreported landings increased sharply in 2002 and has continued since then. Various sources of information has been used to quantify the amount of cod landed, e.g., observations/inspections by the Norwegian coast guard (both trans-shipping vessels and fishing vessels), satellite tracking (VMS) of trans-shipping vessels and fishing vessels, detailed information on landings in Norway and supplementary and supporting information on landings in Russia, EU and

Canada. Also direct and indirect information from trans-shipping companies and information on quotas and catches by several fishing companies have been available. Out of ca. 400 active trawlers fishing cod in the Barents Sea, and systematically controlled by airplanes and coastguard, about 190 vessels got special attention.

Time of Next Meeting

The Working Group proposes the dates of April 20 – 29, 2005 for it's next meeting.

1 ECOSYSTEM INFLUENCES ON BARENTS SEA FISH STOCKS

The population dynamics of all commercial fish stocks are determined by fisheries effects and by environmental effects on growth, recruitment and natural mortality. The goal of this chapter is to describe the implications of interannual variation in the climate and trophic interactions for fish stocks in the Barents Sea ecosystem. Forecasts for the upcoming year are made for several variables. The consequences for growth, recruitment and natural mortality are also discussed.

1.1 Climate considerations in the Barents Sea

1.1.1 Temperature and ice conditions (Figures 1.1-1.2)

The Barents Sea is characterised by large year-to-year fluctuations in heat content and ice coverage caused by variations in the influx of Atlantic water from the Norwegian Sea. Temperatures in the Barents Sea have been relatively high during most of the 1990s, and with a continuous warm period from 1989-1995. During 1996-1997, the temperature was just below the long-term average before it turned warm again at the end of the decade, and has remained warm until present. Even though the whole decade was warm; it was only the third warmest decade in the 20th century (Bochkov, 1982, Ingvaldsen *et al.* 2002).

In January 2003 the temperature was just above the long-term average in the whole Barents Sea, but then the temperature increased quickly until March when it was 0.7°C above the long-term mean. From April and the rest of the year, the temperature was 0.5°C above the long-term average. In January and March 2004 the temperature was still 0.5°C above the average. (Figs. 1.1 and 1.2, Stiansen *et al.,* WD1).

The variability in the ice coverage is closely linked to the temperature of the inflowing Atlantic water. The ice has a relatively short response time on temperature changes in the ocean, but usually the sea ice distribution in the eastern Barents Sea responds a bit later than in the western part. 2003 had a negative ice index, which means more ice than average. This was very surprising since the sea temperature was high. There were two reasons for this. Firstly the really ice melt did not start before mid June, which is about one month later that usual. Secondly, the ice melt during summer was extremely low, most likely due to atmospheric forcing. In 2004 the ice coverage is expected to be the same as in 2003, but the ice index will depend on the ice melting in the summer 2004 (Stiansen *et al.,* WD1).

1.1.2 Inflow of Atlantic water

Transport of Atlantic water to the Barents Sea has been measured since August 1997. The flow of Atlantic water is very variable. Most of the time there is a net inflow of Atlantic water to the Barents Sea, but in some periods large outflows are observed. High outflows occurred around April in 1998, 1999 and 2001. In 2000 there was strong outflow in January while in 2002 and 2003 strong outflow was observed in August/September. In the first half of 2003 the inflow was continuously high, which may explain the rapid temperature increase between January and March. The intensity of the flow was reduced during spring and summer. Results from a wind driven model shows similar results (Stiansen *et al*., WD1). Except for January, it is a good fit with the observations. The model results indicate that the variations in the local atmospheric pressure field may be important for the inflow of Atlantic water to the Barents Sea (Ådlandsvik and Loeng, 1991, Ingvaldsen et al., 2002, Stiansen *et al.,* WD1).

1.1.3 Predicting Barents Sea temperature (Figure 1.2)

Prediction of Barents Sea temperature is complicated since the variation is governed by processes of both external and local origin that operate on different time scales (Stiansen *et al*, WD1). The volume flux and temperature of inflowing Atlantic water masses, as well as heat exchange with the atmosphere, is important in determining the temperature of the Barents Sea. Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered. The major changes in Barents Sea climate take place during the winter months. The variability in the amount of heat flowing in with Atlantic water masses from the south is particularly high during this season. Furthermore, variability in low-pressure passages and cloud cover has a strong influence on the winter atmosphere-ocean heat exchange.

This seasonal difference is reflected in the merit of simple six-month forecasts (Ottersen et al., 2000) of Kola-section temperature (Bochkov, 1982) based on linear regression models. The tendency is that persistence across the spring and summer months are higher than for other seasons, allowing for reasonably reliable forecasts from spring until autumn. Data available until March 2004 allow for a six-month forecast until September 2004 (Stiansen et al., WD1). The predictions indicates that the temperatures in the southern Barents Sea will be close to average from April to June, followed by a warm (0.4°C above average) period from July to September (Fig. 1. 2).

1.1.4 Climatic effects on plankton (phyto,- zoo- and ichtyoplankton)

Variation in climate factors can have strong impact on the lower trophic levels in the ecosystem. Plankton is always subject to the surrounding physical environment. Limited self-motion compared to surrounding currents sets strong limitations on the ability to avoid or seek better climate condition. This is especially the case for climatic factors, which vary slowly and/or over large scale in space and time (e.g. temperature in the open waters). However, many plankton organisms have mechanisms allowing some kind of vertical motion and may thereby move to more profitable vertical layers. The influences on plankton from climatic factors with strong vertical gradients (e.g. turbulence and light) are therefore also dependent on the individual's behaviour. Different climatic factors may also affect individual plankton differently at different stages of its life cycle, and for fish also in nekton stages. Climate variation also affects the trophic interactions on different scales in time and space. The total effect of climate variation on plankton (and also nekton) is therefore a complicated matter.

The identification of which factors are most important in different processes is a major task in this field of research. For assessment purposes it is not possible to take all such factors and mechanisms into account. Still it is important to recognise that climate play a major effect on plankton.

A promising approach for implementing climate effects into the assessment is through the use of climate indicators. One such indicator is the North Atlantic Oscillation index (NAO), which is an overall indicator of the climate in the North Atlantic, Nordic Seas and the Barents Sea. Another climate indicator is the mean temperature in the Kola Section (Bochkov, 1982), which is a more local indicator of the temperature in the southern Barents Sea.

Based on such indicators the effect of climate on recruitment of cod has been estimated to account for as much as 50-70% of the variation in survival (AFWG 2003). Also, a high correlation is found between the NAO index and the zooplankton biomass in the Norwegian Sea the following year (Melle and Holst, 2001). Both these examples illustrate the necessity of taking climate conditions into account when considering the ecosystem.

Conclusions section 1.1:

- 2003 was warmer than average. The temperature in the beginning of the year was just above average, followed by an strong increase in the spring and remaining warm for the rest of the year. In January and March 2004 the temperature was still 0.5°C above the average.
- The inflow of Atlantic water was high in the first half of the year, but with normal variation for the rest of 2003.
- The temperature in 2004 is expected to be normal for spring/early summer and warm for late summer/autumn in most of the Barents Sea.
- Climate conditions are predicted to be at the average long-term level, showing a slight trend towards warming. This will have a positive effect on zooplankton development and survival of fish at their early life stages.

1.2 Zooplankton

1.2.1 Sampling and abundance (Figure 1.3-1.4)

Zooplankton sampling on a regular basis IMR began in the Barents Sea in 1979, and since 1986 zooplankton abundance has been monitored at annual surveys during joint Norwegian/Russian 0-group and capelin surveys in August-October. In addition, the standard sections Bjørnøya-Fugløya and Vardø-N (since 1991) are covered on average 6 and 4 times a year, respectively. Regular macroplankton surveys have been conducted by PINRO in the Barents Sea since 1952. Surveys involve annual monitoring of the total abundance and distribution of euphausiids (krill) in autumn-winter trawl-acoustic survey for demersal fishes. In 2002 PINRO also joined the collection of samples of zooplankton during August-October.

Plankton samples in August/October IMR were obtained by using WP2 (IMR, PINRO), MOCNESS (Multiple Opening Closing Net and Environmental Sensing System) plankton net (IMR) and Juday net (PINRO). In the PINRO macroplankton survey the trawl net was attached to the upper headline of the bottom trawl. During winter crustaceans are concentrated in the near-bottom layer and have no pronounced daily migrations and the consumption by fish is minimal. Therefore sampling of euphausiids during autumn-winter survey can be used to estimate year-to-year dynamics of their abundance in the Barents Sea. Annually 200-300 samples of macroplankton are collected during these surveys. Species and size composition of the euphausiids in the samples are determined.

In autumn-winter most of the production has taken place and the zooplankton biomass can be expressed as the overwintering population of zooplankton. According to the data from August/October survey there was a marked increase in zooplankton biomass during the period 1991-1994. Though the biomass has decreased from 1994 to present, the average biomass values during 1995 to 2003 are still higher than in the 1988-1992 period. In 2003 the zooplankton biomass was at an average level, with a slight decrease from 2002 to 2003 (Stiansen et al., WD1).

Possible reasons for the large year-to-year variations are the differences in advective transport and predation pressure. Figure 1.3 shows the total biomass of zooplankton together with capelin stock size (million tonnes). There seems to be an inverse relationship between capelin stock size and zooplankton biomass, indicating capelin to exercise strong feedback control on the system through its predation pressure on zooplankton.

The results from long-term investigations of macroplankton in autumn-winter indicate that the abundance of euphausiids (Fig.1.4), as well as the distribution and specific composition, is affected by interannual dynamics. This leads to changes in the feeding conditions of fish (cod in particular). According to Ponomarenko (1973, 1984) interannual changes of euphausiid abundance determined the survival rate of cod yearlings. Adult cod feeding on euphausiids in summer influences seasonal dynamics of their fatness (Orlova *et al*., 1998). The role of euphausiids for cod feeding increases in the years when capelin stock is at a low level (Ponomarenko and Yaragina, 1990).

The Barents Sea community of euphausiids is represented by four abundant species: neritic shelf boreal *Meganyctiphanes norvegica* (M.Sars), oceanic arcto-boreal *Thysanoessa longicaudata* (Krøyer), neritic shelf arcto-boreal *Th. inermis* (Krøyer) and neritic coastal arcto-boreal *Th. raschii* (M.Sars) (Drobysheva, 1994). According to the data from the long-term observations (Drobysheva, 1994; Drobysheva and Nesterova, 1996) *Th. inermis* and *Th. raschii* make up 80-98% of the total euphausiid abundance. Species ratio in the Barents Sea euphausiid community is characterized by year-to-year variability probably due to climatic variation as a main factor (Drobysheva, 1994).

In 2003/04, the samples of macroplankton were collected during cruises by three Russian and one Norwegian vessel (Zhukova et al., WD 17). In all, 373 macroplankton samples were collected.

In autumn-winter 2003/04 the mean annual indices of euphausiid abundance were about 50% higher than the long-term mean, both in the northwest and southern areas (Fig. 1.4). However, a reduction of these indices as compared to the previous year was noticed. In the samples *Th. raschii* prevailed and made up 53%. The relative abundance of *Th. inermis* was 24%, of *Meganyctiphanes norvegica* – 18% and of *Thysanoessa longicaudata* – 4%.

1.2.2 Prediction of year-to-year dynamic of krill abundance (Figure 1.5)

The main reasons for the year-to-year variations in abundance of krill in the Barents Sea are the differences in advective transport and predation pressure. A multiple regression model for the abundance indices of euphausids in the Barents Sea is presented in Nikiforov (WD16). The model is based on capelin biomass along with environmental factors, and gives a two-year prognosis.

The model was tuned by data for the period 1977-2000. For the period from 1977 to 2000 the relationship between the mean water temperature in the Kola Section (averaged for three years with time lag of two years) and abundance indices of euphausids showed a correlation coefficient of 0.55. Analysis of the relationship between euphausiid abundance indices and NAO indices showed that the closest inverse relationship ($r = -0.64$) was observed in August with a time lag of one year.

The analysis showed that when using synchronous series, the closest relationship between variations in the sea level and abundance indices of euphausiids occurred in April with a correlation coefficient of 0.43. The relationship between ice coverage in the Barents Sea (time lag of one year) and euphausiid biomass was also fairly high ($r=0.42$).

Thus during 1977-2000, the effect of temperature and NAO indices on variations of euphausiid abundance was characterized by a negative relationship, while the sea level and ice coverage displayed positive relationship.

A trial run using dependent material as well as independent data for the period 2001-2003 showed that the model described up to 73% of year-to-year variability of abundance indices of euphausiids in the southern Barents Sea (Fig. 1.5). According to the model it is expected that in 2004-2005 euphausiid abundance will increase to above average, compared to 2003-2004 (similar to 1987 and 1995) Further, it is expected to be a decrease in 2005-2006 down to the level of 1989 and 1994.

Conclusion section 1.2:

- An overwintering zooplankton biomass moderately above the average in 2003/2004 will create the basis for an average zooplankton production in 2004. This will give average feeding conditions for capelin and other pelagic fish and juvenile demersal species in the Barents Sea in 2004.

1.3 Trophic interactions

1.3.1 Predicting capelin biomass (Tables 1.1-1.2)

Capelin is the most important prey species for Northeast Arctic cod, and the development of the capelin stock may have a strong effect on growth and maturation of cod, as well as cod cannibalism.

The biomass of capelin (1+) decreased from 2.2 million tonnes in 2002 to 0.5 million tonnes in 2003 (Anon., 2003). This is considerably lower than the prediction for 2003 made by AFWG last year (2.0 million tonnes). The prediction method used in Anon. (2003), which is essentially the same as previously used, predicts the biomass of 1+ capelin in October 2004 to be 1.71 million tonnes (90% confidence interval: 0.86-2.87). Of this 0.13 million tonnes (90% confidence interval: 0.001-0.439) are predicted to be mature capelin (Gjøsæter and Bogstad, WD2). The stock history for capelin from 1984 onwards is given in Table 1.1 together with the estimated biomass of capelin removed from the stock by natural mortality.

A 1-year prognosis has been presented to AFWG since 1999. A review of the prognoses made during this period is given in Table 1.2. The prognoses seem to be overestimates in most cases. The prediction methodology is still under development. Before the assessment meeting for Barents Sea capelin in October 2004, it is planned to carry out an analysis of the how the current prediction method performs on historical data.

1.3.2 Predation by cod (Table 1.3-1.6, Figure 1.6)

The consumption by cod of various prey species for the period 1984-2003 is given in Table 1.3, using the same method as described by Bogstad and Mehl (1997). Dolgov (WD 4, Table 1.4) also calculated the consumption by cod based on the same data, using a somewhat different methodology.

As usual, capelin was the most important prey for cod. Table 1.3 shows that the proportion of capelin in the diet of cod was about 50% both in 2002 and 2003, but the total consumption of capelin by cod increased from 2002 to 2003 due to an increase of the cod stock. These results are somewhat surprising in view of the decline in the capelin stock. The consumption by cod of herring, polar cod, haddock, shrimp, krill and amphipods) increased from 2002 to 2003, while the consumption of cod and blue whiting decreased from 2002 to 2003. The calculation of consumption of cod and haddock by cod using this method are used in the assessment of cod and haddock (Sections 3 and 4).

The consumption by prey species from the two calculation methods for 2003 and the changes from 2002 to 2003 are fairly similar. The main difference is that the calculations in Table 1.3 give an increase in the consumption of capelin from 2002 to 2003, while the calculations in Table 1.4 show a decrease. Also, the consumption of haddock by cod in 2003 given in Table 1.4 is much higher than the figures given in Table 1.3, and there are notable differences in the time series of number at age of cod and haddock consumed by cod. It should be noted that the calculations in Table 1.3 are based on the number at age of cod from the VPA given in this year's report, while the calculations in Table 1.4 are based on the VPA from the 2003 AFWG meeting. The difference between the methodologies is less than shown in last year's report, as the same stomach evacuation rate model is now used in both methods. However, there are still inconsistencies between the methods, in that the consumption per cod is fairly equal for all age groups (Table 1.5 and 1.6) while the total consumption differs substantially for some prey items (Table 1.3 and 1.4). Steps will be taken to investigate possible reasons for these differences and reconcile them.

Preliminary data from the Joint winter survey in 2004 show that the amount of capelin in cod stomachs during January-March 2004 was about 50% of the level observed during the same period in 2003, but still well above the lowest level observed (Bogstad, WD6).

The annual consumption for each age group of cod (kg/year), based on the consumption calculations shown in Tables 1.3 and 1.4 are given in Tables 1.5 and 1.6, respectively. Table 1.5 shows that the consumption per cod increased somewhat from 2002 to 2003 for most age groups, while Table 1.6 shows a slight decrease for most age groups. Both tables show that the consumption per cod in 2003 is close to the long-term average. The discrepancies in consumption per cod by age group are fairly small.

The consumption estimates in Tables 1.3 and 1.4 do not include the consumption by mature cod in the period when it is outside the Barents Sea (assumed to be 3 months during the first half of the year). During this period it may consume significant amounts of adult herring (Bogstad and Mehl 1997).

Johansen *et al*. (2004) describe a new method for calculating the consumption by cod, and applies this to calculate the consumption of herring by cod in the period 1992-1997. Their consumption estimates are comparable to the estimates given in Table 1.3, except for 1994, when they obtained a much higher estimate (494 vs. 147 thousand tonnes).

As in previous years, the consumption of cod and haddock by cod (Section 3 and 4), which is taken into account in the assessment of these species, was calculated using the method described by Bogstad and Mehl (1997).

The calculations of annual cod consumption of capelin, krill and young cod in the Barents Sea in 1984-2005 using the STOCOBAR model (Filin, WD20) are presented in Figure 1.6. In general there is a good agreement between the model calculations and calculations based on methods described by Bogstad and Mehl (1997) and Dolgov (WD 4, Table 1.4), except for 1992. This year the capelin stock was large, and according to the STOCOBAR model the consumption by cod must also have been high. Concerning cod consumption of their juveniles, the results from STOCOBAR exceed the figures obtained by Bogstad and Dolgov for 1984-1996, but show good agreement for the recent years. Model results of consumption of krill by cod were in general between calculations by Bogstad and Dolgov. A comparison of the STOCOBAR model with results from Bogstad and Dolgov is shown in Figure 1.6.

1.3.3 Predation by other fish species

Dolgov *et al*. (WD 11, AFWG 2002) investigated the diet of blue whiting in the Barents Sea in the period 1998-2001. They concluded that predation by blue whiting will not have a significant impact on the recruitment of cod, haddock and redfish. However, food competition between blue whiting and juveniles of other commercial fish stocks due to blue whiting grazing zooplankton in the areas of larval drift may occur. The diet of saithe in the period 1998-2001 was investigated by Dolgov (WD12, AFWG 2002). The diet of saithe > 40 cm is dominated by capelin, with herring and euphausiids being next in order of importance. In some areas there are significant amounts of blue whiting and haddock juveniles. For saithe < 40cm, the diet is dominated by euphausiids.

1.3.4 Predation by mammals (Table 1.7)

The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 1.7. These consumption estimates are based on stock size estimates of 85 000 minke whales in the Barents Sea and Norwegian coastal waters (Schweder *et al*., 1997) and of 2 223 000 harp seals in the Barents Sea (ICES 1999/ACFM:7). The consumption by harp seal is calculated both for situations with high and low capelin stock, while the consumption by minke whale is calculated for a situation with a high herring stock and a low capelin stock. Food consumption by harp seals and minke whales combined is at about the same level as the food consumption by cod, and the predation by these two species needs to be considered when calculating the mortality of capelin and young herring in the Barents Sea.

In the period 1992-1999, the mean annual consumption of immature herring by minke whales in the southern Barents Sea varied considerably (640 t –118 000 t) (Lindstrøm *et al.* 2002). The major part of the consumed herring belonged to the strong 1991 and 1992 year classes and there was a substantial reduction in the dietary importance of herring to whales after 1995, when a major part of both the 1991 and 1992 year classes migrated out of the Barents Sea. In 1992-1997, minke whales may have consumed 230 000 t and 74 000 t, corresponding to 14.6 billion and 2.8 billion individuals of the herring year classes of 1991 and 1992, respectively. The dietary importance of herring to whales appeared to increase in a non-linear relation with herring abundance.

<u>*Conclusions section 1.3:*</u>

- The capelin biomass is expected to increase from 2003 to 2004, but the mature stock is expected to remain at a low level also in 2004.

- The consumption of capelin by cod increased from 2002 to 2003, according to Norwegian consumption calculations, but decreased according to the Russian calculations.

- The consumption of herring, polar cod, haddock, shrimp, krill and amphipods by cod increased from 2002 to 2003, while the consumption of blue whiting and cod decreased from 2002 to 2003. The consumption per cod is close to the long-term average.

1.4 Ecosystem data for potential use in the stock assessment and projections

1.4.1 Recruitment

1.4.1.1 Recruitment models (Table 1.8, Figure 1.7)

Predictions of the recruitment in fish stocks are essential for future harvesting of the fish stocks. Traditionally prediction methods have not included effects of climate variability. Multiple linear regression models can be used to incorporate both climate and fish parameters. Especially interesting are the cases where there exists a time lag between the predictor and response variables as this gives the opportunity to make a prediction.

Models (Stiansen *et al.*, WD1), based on climate and fish stock parameters, for prediction of recruitment have been given for the 0-group index (with 2-year prognoses) and the number of three-year-old fish for North East Arctic Cod (with 3-year prognoses), for the number of one-year-old fish for Barents Sea capelin (with 1-year prognoses) and for the number of three-year old fish for Norwegian spring spawning herring (with 3-year prognoses) (Tab. 1.8). The models are encouraging, and the models might at present prove useful as background information for stock assessment, and may in the future be incorporated as recruitment models in the assessments.

Borisov and Bulgakova (2002) give another approach. A new stock-recruitment model is developed, which includes an index of Atlantic inflow (Bulgakova, 2003). This model together with a new management scheme, are incorporated in a simulation model for NEA cod. This simulation model allows for a three-year prediction of recruits of age 3 (Tab. 1.8) up to 2006 (WD 15).

Models by Titov (1999, 2001, WD8) estimate the recruitment of the Barents Sea capelin at age 1 and NEA cod at age 3, with prognostic probabilities of 1-2 and 1-4 years respectively. The model uses aggregated ecosystem indices, which incorporates both biological and climate parameters (further details can be found in Titov, WD8). The predictions for cod at age 3 are shown in Table 1.8 for comparison with the other models.

The recruitment estimates from XSA/RCT3 and from Fleksibest are also given in Tab. 1.8. The various models are compared graphically in Fig. 1.7. There is relative good correspondence between the various methods concerning recruitment in 2005 and 2006, while there are large discrepancies for 2004 It was decided to use the ‘traditional’ RCT3 estimates in the predictions of cod recruitment.

Conclusions sections 1.4.1:

- The 0-group index of NEA cod is expected to increase to a medium strong level in 2004 and 2005.

- Six out of eight recruitment models give a prognosis for the number of recruits (age 3) in 2004 below average. For 2005 and 2006 the corresponding fractions are three out of six and three out of four, which may indicate that the prospects for recruitment in near future is average or below average. The RCT3 method was used to predict recruitment also in this year’s assessment.

- The number of recruits (age 1) of Barents Sea capelin is expected to be at a medium high level in 2004.

1.4.2 Growth

1.4.2.1 Prediction of NEA cod growth rate (Table 1.9)

The Northeast arctic cod is characterized by significant year-to-year variations in the growth rate. In different years the mean weight of fish at the same age may differ 2-3 times. This should be taken into consideration when forecasting stock dynamics. Among the factors influencing cod growth are water temperature, food supply and cod population abundance. A prognosis of cod growth in the Barents Sea was performed by the STOCOBAR model (Filin, WD20). The model is used to calculate mean weight of fish at age 2-10 in the beginning of the year based on input data on food supply, temperature and size of cod abundance.

Model parameters were estimated based on historical data for 1984-2002, using stomach data from the Russian-Norwegian database, mean annual temperature data in the Kola Section, estimated biomass of capelin and data on abundance and mean weight-at-age from the AFWG 2003 assessment.

The forecast of cod growth rate was made for 2003-2005 with 2002 taken as a starting year. Observed data from the start of 2002 were used in the forecast of mean weight at age. The mean weight of a cod aged 1 for 2004 and 2005 was calculated as a mean over the 3 previous years. In the prognosis the forecasts of mean annual temperature in the Kola Section for 2004-2005 was used as input data, together with the prognosis of capelin biomass in 2004 and 2005 (Gjøsæter and Bogstad, WD2).

The results of forecasting the growth rate of cod aged 3-8 are presented in Table 1.9. The modeled weight of fish at the beginning of 2003 is shown as compared to the actual data. The greatest discrepancy of modeled and actual fish individual weight values was noticed for 3 and 4-year-old age groups. The modeled weight at age in the beginning of 2004 is slightly below the observed values for age groups 2-9.

In general, model calculations showed that the mean weight of fish is expected to be decreasing from 2003 to 2005, due to the predicted reduction in water temperature and capelin stock in the Barents Sea. The most pronounced reduction in growth rate is expected for fish from the younger age groups (age 3-5). For 2004-2006 the mean weight of fish is in general expected to be lower than the long-term mean average (1984-2003).

1.4.2.2 Effects of capelin and temperature on maturation of cod (Table 1.10, Figure 1.8-1.11)

The decrease in capelin stock biomass potentially impacts the maturation dynamics of Northeast Arctic cod by delaying the onset of maturation and/or increasing the incidence of skipped spawning. From the perspective of incorporating this knowledge into a predictive model which could be used in the assessment there must be some degree of similarity between the data that are produced by the assessment and the variables included in the model. One approach to investigating the links between food availability and maturation is to examine the correlation between weight- and maturity-at-age. Bivariate plots of these two variables for Northeast Arctic cod show that there is a clear distinction between the 1946-1979 and 1985-2001 time periods (Fig. 1.8). In the earlier time period cod were maturing more slowly for their weight-at-age. Norwegian and Russian estimates of weight- and maturity-at-age (i.e., the time series that are used to estimate the stock weight- and maturity-at-age) confirm that the two time periods are distinct. Because the distinction is evident in two independent databases there is little likelihood that it is a result of changes in data quality.

Weight- and maturity-at-age data in Figure 1.8 were converted to weight- and maturity-at-length using age/length keys described by Marshall et al. (in press). The relationship between weight- and length-at-age shows that for a given length weight-at-length is positively correlated with proportion mature-at-length for the 1985-2001 time period (Fig. 1.9). Furthermore, the recent time period has distinctly higher values of weight-at-length than the earlier time period. This indicates that fish mature earlier when they are heavier at length. These results are consistent with bioenergetic studies that show feeding rates impact the onset of cod maturation (Lehmann et al. 1991) and with field observations showing condition to have a significant effect on the proportion of mature cod (Marteinsdottir and Begg 2002).

Estimates of weight-at-length were multiplied by the Russian liver condition index at length (Yaragina and Marshall 2000) to derive estimates of liver weight in grams for cod at a standard length (see Marshall et al. in press for details of this calculation). This analysis indicated that for the 1985-2001 there is a consistently significant, positive relationship between liver weight and proportion mature (Fig. 1.10). For two length classes (midpoints 72.5 and 82.5 cm) there are significant correlations between liver weight and proportion mature for the earlier time period as well. This result confirms that the magnitude of stored energy is positively correlated with proportion mature. Furthermore, these derived estimates of liver weight are, positively correlated with capelin stock biomass over the entire 1946-2001 time period (Fig. 1.11) ($n = 54$, $r^2 = 0.44$, $p < 0.001$ Marshall et al. in press). Thus, capelin stock biomass impacts cod maturation by influencing the magnitude of stored energy reserves.

To investigate whether temperature had any effect on the relationship between liver weights and proportion mature average temperature values for July through December were calculated using the Kola section time series. The mean temperature of the last six months in the preceding year was did not explain a significant amount of variability in the proportion mature-at-length in models that use liver weight to represent the bioenergetic status (Table 1.10). Thus, variability in temperature does not appear to impact the proportion mature of cod.

This analysis also serves to illustrate the usefulness of converting age-based assessment data to length-based. There was no relationship between weight-at-age and maturity-at-age for the 1985-2001 time period (Fig. 1.8) but when converted to length the data showed statistically significant relationships between weight and proportion mature (Fig. 1.9) as well as between liver weight and proportion mature (Fig. 1.10). Thus, age/length keys are an essential requirement for modelling the maturity dynamics of cod for projection purposes. Results obtained using age-based data are highly likely to obscure important trends. A modelling approach to implement this knowledge in the assessment could be developed intersessionally.

Conclusions section 1.4.2:

- Mean weight of cod is expected to decrease from 2003 to 2005. The most pronounced reduction in growth rate is expected for fish from the younger age groups (age 3-5). For 2004-2006 the mean weight of fish is in general expected to be lower than the long-term mean average (1984-2003).

- Cod weight-at-length is uncorrelated with capelin stock biomass, whereas liver weights show a positive correlation. Thus, assessing the degree of inter-annual variation in condition requires routine monitoring of liver weights, such as has been done by PINRO since 1927.

- There is a significant, positive relationship between liver weight and proportion mature (for the period 1985-2001). Thus, the magnitude of stored energy is positively correlated with proportion mature.

- For a given length weight-at-length is positively correlated with proportion mature-at-length for the 1985-2001 time period. This was illustrated by converting age-based assessment data to length-based, age/length keys are an essential requirement for modelling the maturity dynamics of cod for projection purposes.

1.4.3 Natural mortality

1.4.3.1 Cannibalism mortality for cod (Table 1.11)

An alternative approach for prediction of NEA cod cannibalism based on the linear relationship between the natural mortality of cod at ages 3-5 and the biomass of cod spawning stock with minus 3-year lag was proposed (WD10). Using this approach the predicted natural mortality coefficient for cod including cannibalism seems to be higher compared to "the standard" prediction sec. 3.3.8

For age 3 the level of natural mortality tend to increase from 0.3 in 2004 to 0.54 in 2007 and for age 4 from 0.23 to 0.31. Values for the years 2004 to 2006 are given in the text table below:

	M2 age 3	M2 age 4
	by regression	
2004	0.30	0.23
2005	0.40	0.26
2006	0.45	0.28
	values used in assessment	
2004-2006	0.2655	0.2134

Because the mechanism of the cod SSB influence on the level of own young natural mortality in 3-4 years is unclear the WG decided not to use this approach for prediction before it will be further tested.

Table 1.11 shows the proportion of cod in the cod diet, by predator age and year. This proportion increases by predator age.

Table 1.1. Capelin stock history from 1984 and prognosis for capelin biomass in 2004. M output biomass is the estimated biomass of the capelin removed from the stock by natural mortality.

Year	Total stock number, billions (Oct. 1)	Total stock biomass in 1000 tonnes (Oct. 1)	M output biomass (MOB) during year (1000 tonnes)
1984	393	2964	3151
1985	109	860	1975
1986	14	120	681
1987	39	101	200
1988	50	428	80
1989	209	864	537
1990	894	5831	415
1991	1016	7287	3307
1992	678	5150	7745
1993	75	796	4631
1994	28	199	982
1995	17	194	163
1996	96	503	261
1997	140	909	828
1998	263	2056	915
1999	285	2775	2070
2000	595	4373	2464
2001	364	3630	3906
2002	201	2210	2666
2003	104	533	2018
2004*		1710	

* Estimate, includes the 2003 year class, which size is estimated from a regression on an 0-group index

Table 1.2. Capelin one-year prognoses compared with survey estimates (in million tonnes).

Year	Prognosis (1+ capelin biomass) Available at AFWG in this year	Survey estimate (1+ capelin biomass)
1999	4.0	2.8
2000	3.8	4.3
2001	4.1	3.6
2002	3.4	2.2
2003	2.0	0.5

Table 1.3 The North-east arctic COD stock's consumption of various prey species in 1984-2003 (1000 tonnes),based on Norwegian consumption calculations.

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Total
1984	506	27	112	436	722	78	15	22	50	364	0	0	2332
1985	1157	169	57	155	1619	183	3	32	47	225	0	1	3649
1986	665	1223	108	142	835	133	141	83	110	313	0	0	3754
1987	680	1084	67	191	229	32	205	25	4	324	1	0	2843
1988	407	1236	317	129	339	8	92	9	3	223	0	4	2767
1989	725	800	241	132	580	3	32	8	10	232	0	0	2765
1990	1447	136	83	194	1593	7	6	19	15	243	0	85	3829
1991	1076	65	75	188	2902	8	12	26	20	312	7	10	4702
1992	1014	102	157	373	2455	331	97	54	106	189	20	2	4900
1993	782	252	713	315	3041	164	278	285	71	100	2	2	6004
1994	668	561	702	516	1084	147	581	225	49	79	0	1	4613
1995	854	980	514	362	627	115	253	392	116	194	1	0	4408
1996	640	633	1160	341	536	47	104	534	68	96	0	10	4171
1997	438	391	529	311	906	5	112	340	41	36	0	55	3164
1998	428	365	466	325	714	88	151	153	32	9	0	13	2743
1999	387	148	275	256	1747	133	226	62	26	16	1	31	3308
2000	409	170	463	459	1767	54	198	76	52	7	0	38	3693
2001	744	181	403	288	1776	73	257	65	50	6	1	155	3998
2002	425	133	438	247	2074	81	292	124	131	1	0	245	4191
2003	485	323	505	285	2632	143	395	86	165	3	0	110	5132

Table 1.4. The North-east arctic COD stock's consumption of various prey species in 1984-2003 (1000 tonnes), based on Russian consumption calculations.

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Total
1984	614	31	94	355	599	34	17	13	50	197	0	5	2011
1985	762	436	30	204	1000	25	0	99	35	98	0	18	2708
1986	591	854	59	143	794	46	156	28	104	158	1	4	2938
1987	480	510	70	202	163	8	106	27	2	119	0	10	1696
1988	504	170	211	119	294	19	0	20	93	128	0	0	1558
1989	510	293	168	105	685	4	34	34	2	159	0	0	1995
1990	367	30	105	274	1270	65	8	22	17	235	0	40	2431
1991	344	84	55	289	3320	28	44	53	23	145	6	7	4396
1992	838	38	214	265	2035	378	191	84	38	122	1	0	4204
1993	606	174	185	220	2763	176	169	145	152	41	5	4	4640
1994	473	286	350	443	1263	101	461	361	69	55	0	1	3864
1995	535	432	373	517	654	185	181	521	124	109	2	0	3634
1996	697	345	930	189	454	74	72	434	57	69	0	8	3330
1997	530	85	386	207	488	48	107	409	33	37	2	3	2334
1998	295	185	616	241	797	65	119	124	21	15	0	23	2500
1999	173	75	444	240	1387	74	163	46	14	13	0	24	2654
2000	243	111	424	368	1668	48	155	54	28	4	0	26	3130
2001	398	76	416	311	1455	88	144	56	49	4	2	139	3139
2002	263	54	437	208	2467	57	308	100	81	2	0	111	4087
2003	331	217	479	256	1494	79	308	96	297	2	0	42	3601

Table 1.5 Consumption per cod by cod age group (kg/year), based on Norwegian consumption calculations.

Year/Age	1	2	3	4	5	6	7	8	9	1011+	
1984	0.247	0.814	1.686	2.527	3.953	5.213	8.037	8.554	9.213	9.947	10.019
1985	0.304	0.761	1.833	3.111	4.678	7.364	11.305	12.033	12.562	13.822	13.936
1986	0.161	0.489	1.349	3.168	5.628	6.834	11.062	11.978	12.787	13.553	13.785
1987	0.219	0.601	1.275	2.055	3.538	5.466	7.044	8.112	8.923	9.344	9.296
1988	0.164	0.703	1.149	2.149	3.745	5.880	10.103	11.226	12.579	13.131	13.355
1989	0.223	0.716	1.611	2.720	3.987	5.621	7.706	8.527	9.630	10.231	10.678
1990	0.397	1.058	2.072	3.697	4.954	5.837	8.572	9.516	10.538	10.802	11.399
1991	0.293	0.974	2.185	3.565	5.346	7.113	9.531	10.303	11.364	12.417	12.059
1992	0.216	0.662	2.103	3.137	4.142	5.094	7.898	9.071	9.440	9.943	10.212
1993	0.112	0.526	1.544	3.045	4.810	6.289	9.424	11.287	11.814	12.303	11.959
1994	0.130	0.407	0.922	2.520	3.512	4.540	6.412	8.923	9.731	10.038	10.238
1995	0.103	0.297	0.922	1.802	3.362	5.272	7.734	10.459	12.411	12.816	13.264
1996	0.108	0.355	0.931	1.849	3.055	4.437	7.426	11.255	15.010	15.207	15.588
1997	0.138	0.311	0.935	1.768	2.694	3.539	5.242	8.222	12.757	13.667	13.281
1998	0.117	0.398	0.985	1.940	2.924	4.189	5.749	8.078	11.573	12.099	12.157
1999	0.163	0.505	1.093	2.717	3.721	5.162	6.987	9.125	11.234	12.079	12.138
2000	0.157	0.501	1.238	2.467	4.262	5.651	7.711	9.391	12.695	13.683	13.616
2001	0.171	0.444	1.310	2.435	3.683	5.304	7.537	11.310	13.624	14.446	14.760
2002	0.192	0.557	1.180	2.406	3.411	4.720	6.113	8.939	10.427	11.101	11.122
2003	0.221	0.668	1.348	2.409	3.960	6.289	8.548	10.790	13.300	14.246	14.381

Table 1.6 Consumption per cod by cod age group (kg/year), based on Russian consumption calculations.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	1213+	
1984	0.262	0.893	1.612	2.748	3.848	5.486	6.990	8.563	10.574	13.166	12.437	14.282	15.272
1985	0.295	0.752	1.656	2.683	4.264	6.601	8.242	9.743	10.975	14.447	16.499	16.061	17.343
1986	0.179	0.515	1.461	3.467	4.956	5.913	6.477	8.156	9.766	11.455	12.500	13.577	14.772
1987	0.145	0.431	0.844	1.561	3.078	4.346	7.279	9.683	12.703	14.482	15.014	15.115	16.377
1988	0.183	0.704	1.075	1.627	2.392	4.387	8.208	9.978	10.867	16.536	14.352	15.765	12.361
1989	0.282	0.910	1.468	2.207	3.244	4.799	6.581	8.725	11.134	15.799	15.950	17.909	14.023
1990	0.288	1.007	1.696	2.694	3.278	3.833	5.584	6.871	10.716	11.428	12.660	15.053	16.064
1991	0.241	0.936	2.670	4.473	6.038	7.846	9.590	11.542	14.970	19.294	17.509	20.109	22.109
1992	0.178	0.969	2.475	2.866	3.995	5.138	6.724	7.414	8.754	12.304	13.518	13.744	14.908
1993	0.133	0.476	1.512	2.865	3.944	5.108	7.372	8.945	10.343	11.600	14.067	14.893	15.922
1994	0.180	0.512	1.212	2.402	3.517	5.359	7.560	10.001	11.818	12.896	13.554	15.902	16.806
1995	0.194	0.497	0.962	1.819	3.204	4.847	7.332	9.688	13.835	15.247	15.892	17.306	18.290
1996	0.170	0.498	1.028	1.916	3.075	4.189	6.987	10.212	12.185	13.426	13.669	14.968	15.738
1997	0.119	0.341	0.992	1.908	2.668	3.503	4.954	7.980	12.174	21.523	19.738	20.974	23.744
1998	0.232	0.528	1.081	2.016	2.823	4.089	5.469	7.346	9.586	13.012	13.570	14.540	15.762
1999	0.261	0.431	1.128	2.490	3.676	5.222	6.398	8.220	9.194	13.364	14.327	15.918	17.109
2000	0.186	0.545	1.288	2.551	4.384	6.557	8.813	10.483	11.495	15.101	16.026	18.770	20.330
2001	0.150	0.413	1.163	2.109	3.425	5.562	6.825	10.214	12.371	14.997	16.773	17.473	19.788
2002	0.252	0.687	1.345	2.617	3.877	5.635	7.778	10.894	13.129	15.751	17.365	18.424	20.291
2003	0.234	0.641	1.351	2.191	3.791	5.259	7.190	9.855	13.126	15.417	16.988	18.037	19.847

Table 1.7. Consumption by minke whale and harp seal (thousand tonnes). The figures for minke whales are based on data from 1992-1995, while the figures for harp seals are based on data for 1990-1996.

Prey	Minke whale consumption	Harp seal consumption (low capelin stock)	Harp seal consumption (high capelin stock)
Capelin	142	23	812
Herring	633	394	213
Cod	256	298	101
Haddock	128	47	[1]
Krill	602	550	605
Amphipods	0	304	313 [2]
Shrimp	0	[1]	[1]
Polar cod	[1]	880	608
Other fish	55	622	406
Other crustaceans	0	356	312
Total	1817	3491	3371

[1] the prey species is included in the relevant ‘other’ group for this predator.
[2] only Parathemisto

Table 1.8. Overview of recruitment models prognoses together with the 2004 assessment estimates. Models A-C is from WD1, model D from WD8, model E from WD15 and model F from WD1. The models G and H are similar to model D, with the exception that for the survey index for age 2 and age 3 are used instead of age 1. The last rows show the NEA cod recruitment estimates from the assessments by XSA in 2003 and 2004 and for Fleksibest in 2004 (Section 3.5.2 and 3.10.4). The given month in the fifth column indicate when the prognoses can be extended for another year.

	Species	Variable	Prognoses year	Prognoses available	2004 Prognoses	2005 Prognoses	2006 Prognoses
A	NEA cod	0-group, log (age 0)	2	November	1.47	1.65	X
B	Barents Sea capelin	Recruits (age 1)	1	November	$315*10^9$	X	X
C	Norwegian spring spawning herring	Recruits (age 3)	3	November	$3.0*10^9$	$9.0*10^9$	$12.1*10^9$
D	NEA cod	Recruits (age 3)	4	Before assessment	$384*10^6$	$626*10^6$	$494*10^6$
E	NEA cod	Recruits (age 3)	3	Before assessment	$667*10^6$	$565*10^6$	$689*10^6$
F	NEA cod	Recruits (age 3)	2 (3 [1])	November (March [1])	$679*10^6$	$747*10^6$	$459*10^6$ [1]
G	NEA cod	Recruits (age 3)	1 (2 [1])	November (March [1])	$539*10^6$	$486*10^6$ [1]	X
H	NEA cod	Recruits (age 3)	0 (1 [1])	November (March [1])	$553*10^6$ [1]	X	X
XSA/RCT3 Assessment 2003	NEA cod	Recruits (age 3)	3	At assessment	$308*10^6$	$664*10^6$	X
XSA/RCT3 Assessment 2004	NEA cod	Recruits (age 3)	3	At assessment	$276*10^6$	$604*10^6$	$455*10^6$
Fleksibest Assessment 2004	NEA cod	Recruits (age 3)	1	At assessment	$131*10^6$	X	X

[1] For the prognosis of NEA cod recruitment in model F-G a prognosis of mature capelin biomass for 2004 (129 000 tonnes) is used (Section 1.3.1), thereby allowing for an additional year.

Table 1.9 Prognoses of mean weight at age of NEA cod at the beginning of the year by the STOCOBAR model, together with the observations in 2003 and 2004.

Age	Observed 2003	Model 2003	Observed 2004	Model 2004	Model 2005	Model 2006
2	0.063	0.079	0.055	0.068	0.058	0.066
3	0.290	0.233	0.241	0.250	0.208	0.206
4	0.510	0.618	0.480	0.518	0.524	0.492
5	1.210	1.288	1.112	1.194	1.112	1.101
6	2.260	2.055	2.054	2.138	2.044	1.893
7	3.280	3.290	2.972	3.016	3.160	2.976
8	4.970	5.084	4.567	4.699	4.357	4.534
9	6.160	6.473	6.601	6.934	6.834	6.209
10	9.100	9.074	8.761	7.933	8.542	8.362

Table 1.10. Significance levels of temperature and interaction terms in the model: $M_l = LW_l + Temp + LW_l \times Temp$ where M_l is the proportion mature at length, LW_l is liver weight at length and Temp is the average temperature from July through December in the previous year. The pre time period is 1946 to 1979 and the post time period is 1985 to 2001.

Time period	Length	r^2	pLW_l	p(Temp)	p(LW_l X Temp)
post	72.5	0.47	0.394	0.336	0.29
pre	72.5	0.27	0.283	0.441	0.393
post	82.5	0.43	0.448	0.583	0.579
pre	82.5	0.13	0.852	0.99	0.972
post	92.5	0.54	0.199	0.291	0.296
pre	92.5	0.07	0.868	0.875	0.78
post	102.5	0.62	0.062	0.119	0.107
pre	102.5	0.14	0.847	0.949	0.758

Table 1.11 Proportion of cod in the diet of cod

Cod (predator) age **Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1984	0.0000	0.0000	0.0032	0.0000	0.0437	0.0263	0.0326	0.0356	0.0364	0.0387	0.0371
1985	0.0015	0.0009	0.0014	0.0017	0.0313	0.0076	0.0818	0.0824	0.0832	0.0837	0.0842
1986	0.0000	0.0022	0.0015	0.0004	0.0129	0.1761	0.1757	0.1755	0.1751	0.1746	0.1735
1987	0.0000	0.0000	0.0007	0.0051	0.0103	0.0246	0.0377	0.0400	0.0418	0.0405	0.0435
1988	0.0000	0.0000	0.0000	0.0002	0.0058	0.0014	0.0038	0.0036	0.0032	0.0038	0.0036
1989	0.0000	0.0006	0.0016	0.0019	0.0027	0.0040	0.0034	0.0035	0.0038	0.0038	0.0041
1990	0.0000	0.0000	0.0000	0.0007	0.0010	0.0010	0.0172	0.0178	0.0185	0.0186	0.0182
1991	0.0000	0.0005	0.0000	0.0003	0.0032	0.0020	0.0219	0.0227	0.0232	0.0235	0.0237
1992	0.0000	0.0021	0.0037	0.0128	0.0249	0.0475	0.0117	0.0157	0.0230	0.0230	0.0228
1993	0.0000	0.0412	0.0368	0.0515	0.0536	0.1129	0.0498	0.0796	0.0798	0.0798	0.0816
1994	0.0000	0.0038	0.0918	0.0347	0.0284	0.0778	0.1244	0.1311	0.2641	0.2655	0.2624
1995	0.0069	0.0811	0.0744	0.1103	0.0925	0.1115	0.1382	0.2500	0.2516	0.2521	0.2536
1996	0.0000	0.1491	0.2547	0.2059	0.1321	0.1265	0.1834	0.2025	0.2287	0.2288	0.2286
1997	0.0000	0.0718	0.0767	0.1140	0.1588	0.1559	0.2336	0.2247	0.2768	0.2677	0.2718
1998	0.0000	0.0133	0.0272	0.0417	0.1039	0.0975	0.1085	0.1487	0.2577	0.2581	0.2585
1999	0.0000	0.0000	0.0049	0.0137	0.0147	0.0347	0.0618	0.1111	0.1965	0.1940	0.1848
2000	0.0000	0.0000	0.0286	0.0148	0.0134	0.0266	0.0493	0.0560	0.2710	0.2714	0.2727
2001	0.0000	0.0155	0.0116	0.0082	0.0131	0.0241	0.0498	0.0364	0.2837	0.2817	0.2827
2002	0.0000	0.0372	0.0597	0.0151	0.0187	0.0274	0.0626	0.0632	0.1581	0.1573	0.1564
2003	0.0000	0.0233	0.0122	0.0052	0.0174	0.0158	0.0370	0.0564	0.1139	0.1140	0.1128
Average	**0.0004**	**0.0221**	**0.0345**	**0.0319**	**0.0391**	**0.0550**	**0.0742**	**0.0878**	**0.1395**	**0.1390**	**0.1388**

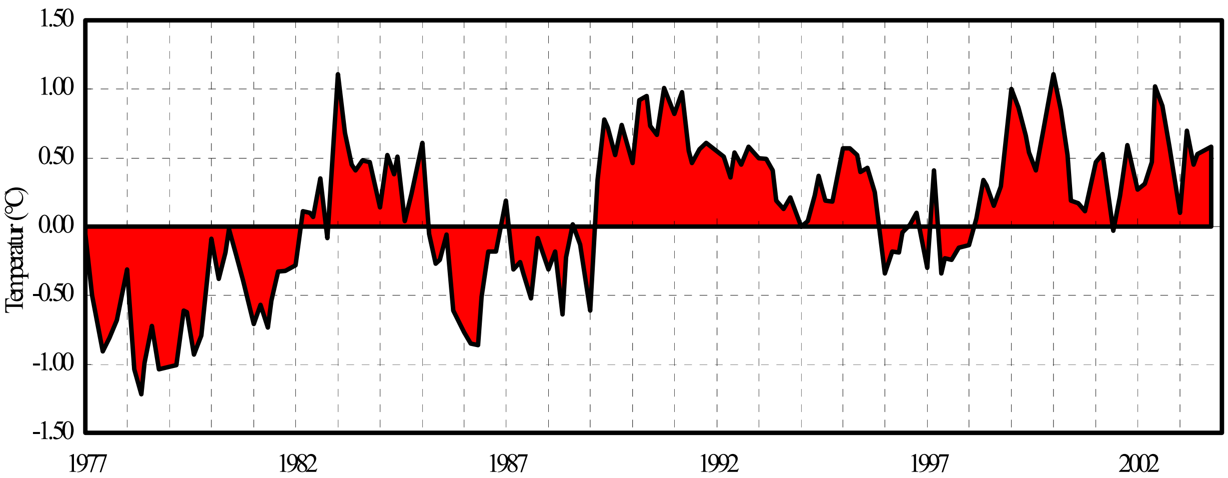


Figure 1.1 Temperature anomalies in the section Fugløya – Bear Island (Sjøtun, 2004).

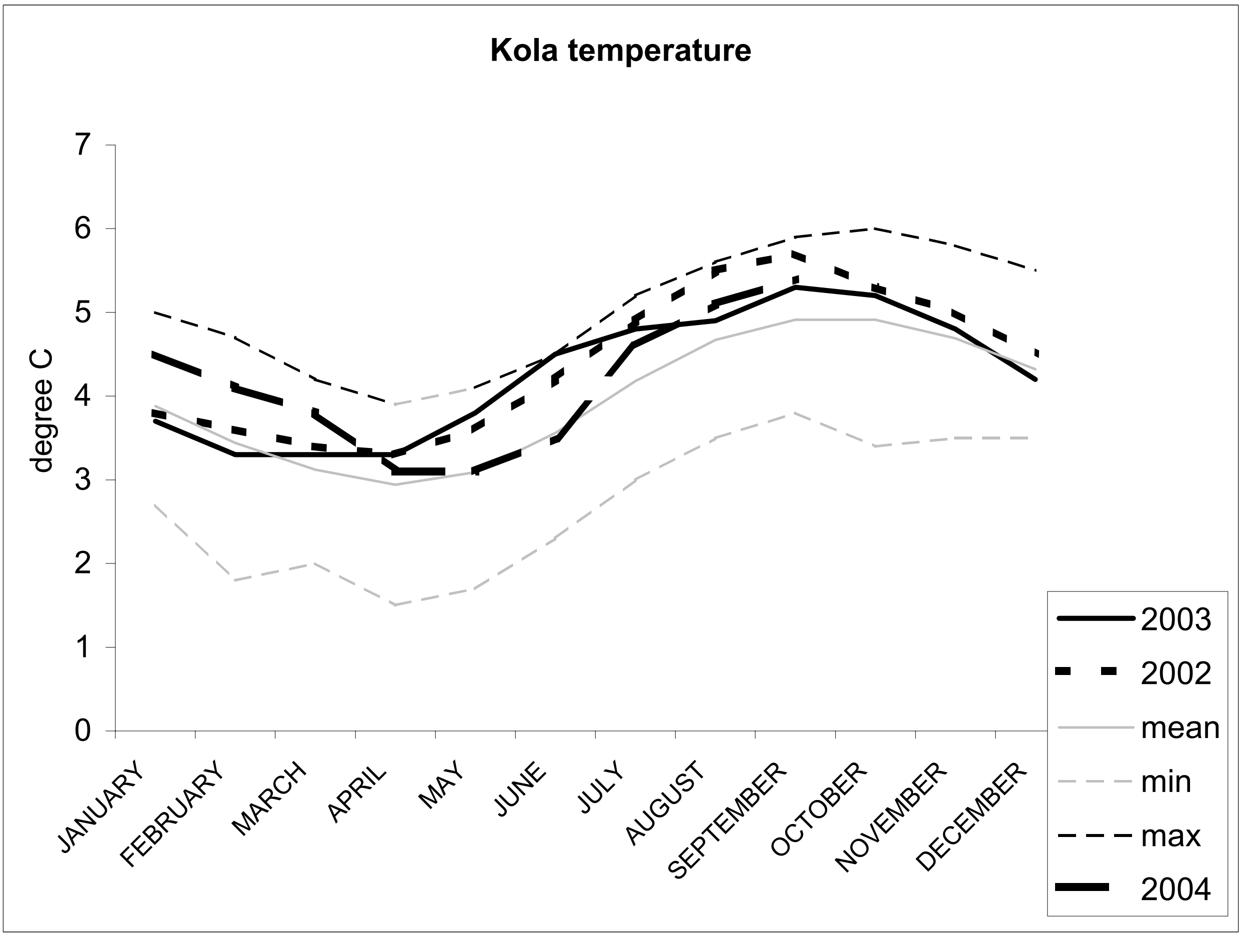


Figure 1.2 Temperature in the Kola section. Seasonal temperatures are shown for the minimum, maximum and average for the period 1921-1999), together with the years 2002-2004. For 2004 the values are a combination of observations (January-March) and six-month prognosis (April-September).

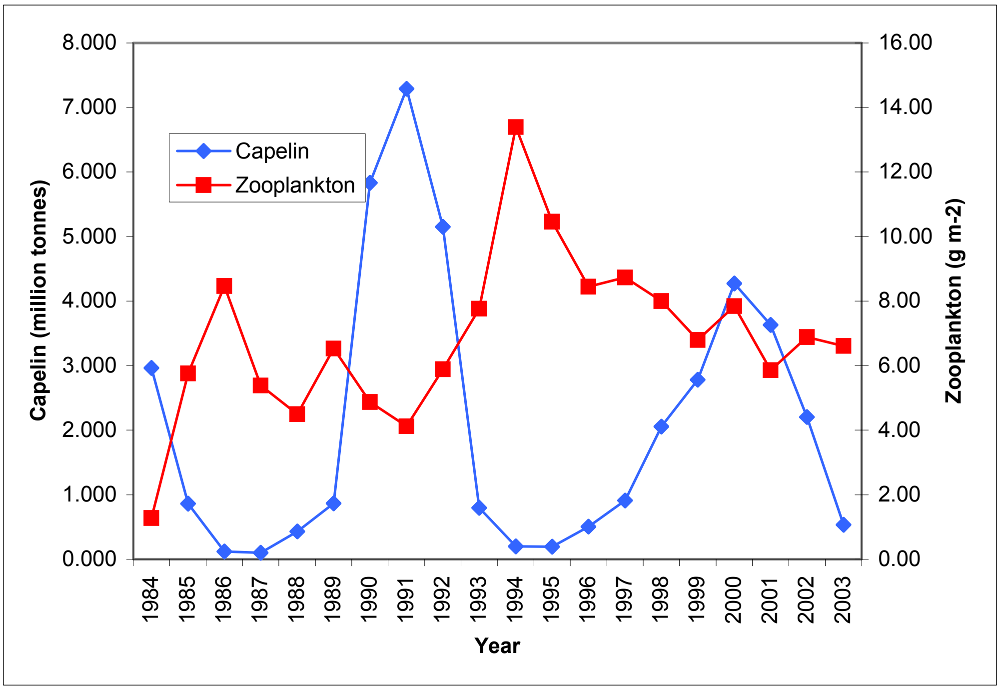


Figure 1.3. Average zooplankton biomass (g m^{-2}) together with biomass of one year old and older capelin (million tonnes) during 1984 – 2003, in the Barents Sea (from Dalpadado *et al.* 2002, updated with data for 2001-2003).

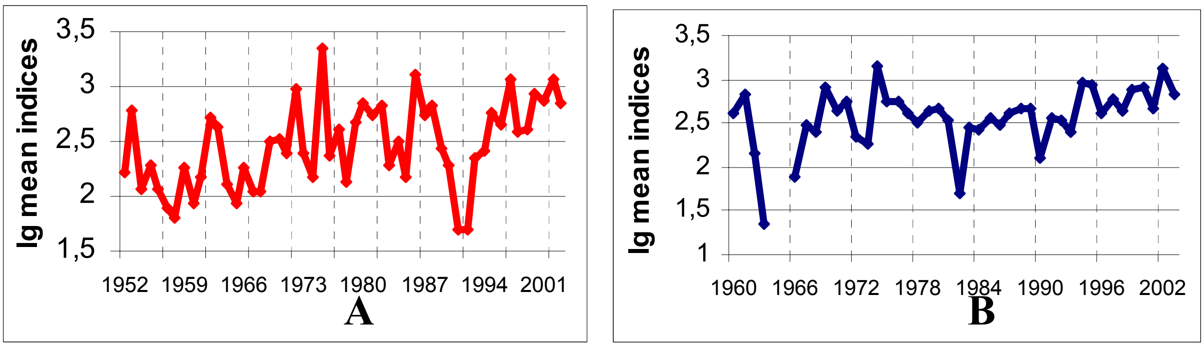


Figure 1.4. Krill abundance indices from the Russian macroplankton survey in the southern (A) and in the northwestern sea (B)

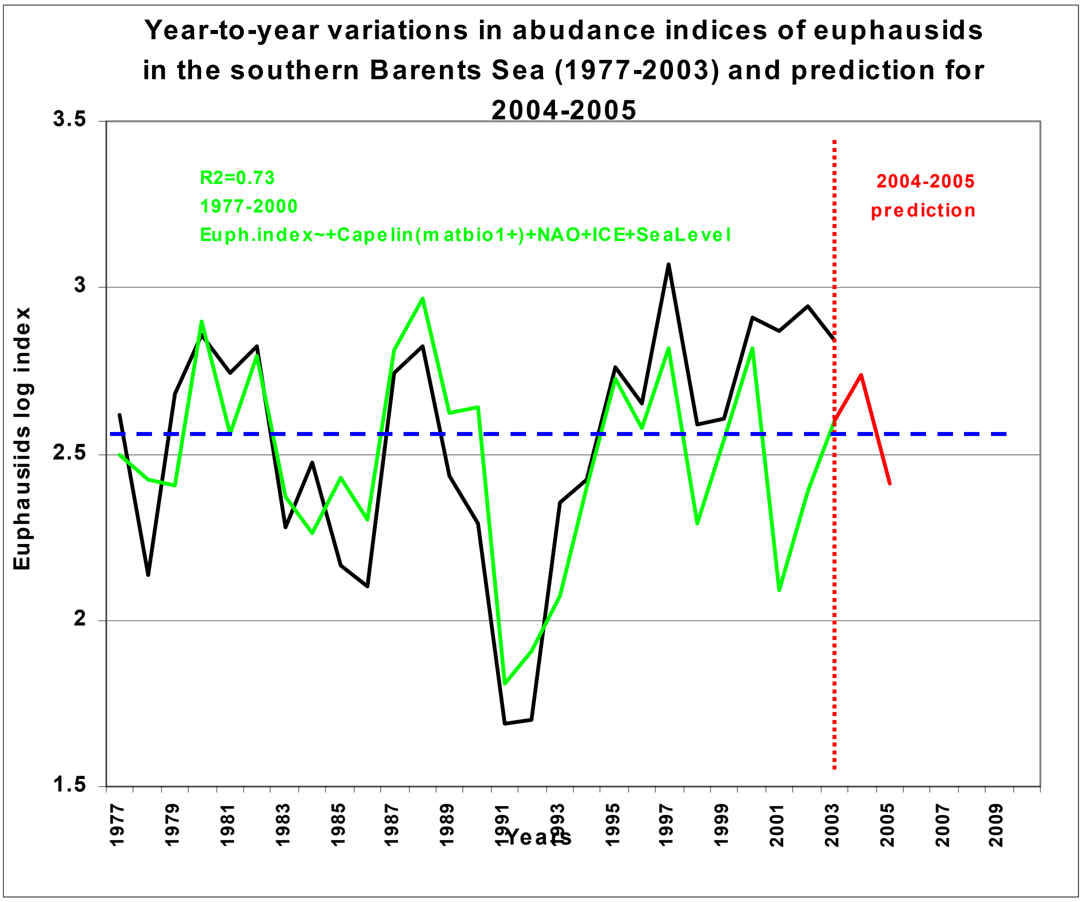


Figure 1.5 Consistency between observed (black) and modelled (green) krill abundance indices, together with prediction (red) for 2004-2005.

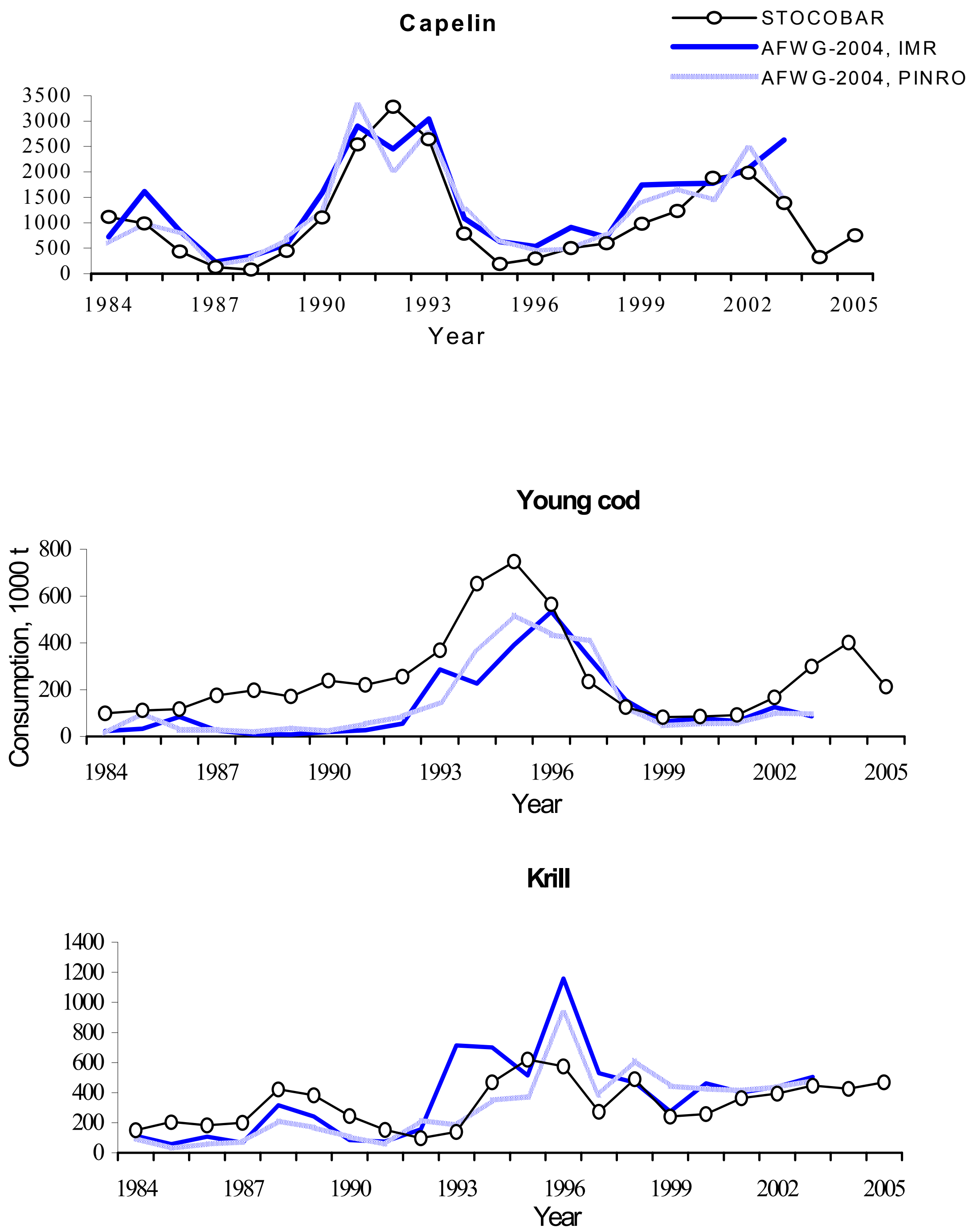


Figure 1.6. Annual consumption of capelin, krill and young cod by cod calculated by the STOCOBAR model in comparison with the data from the AFWG assessment.

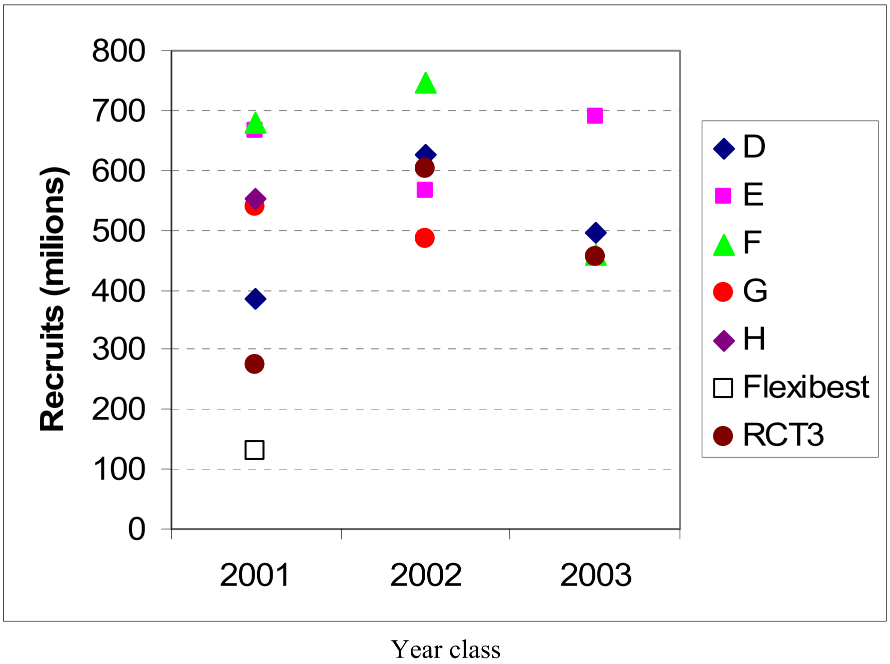


Figure 1.7. Comparison of the various recruitment models for cod.

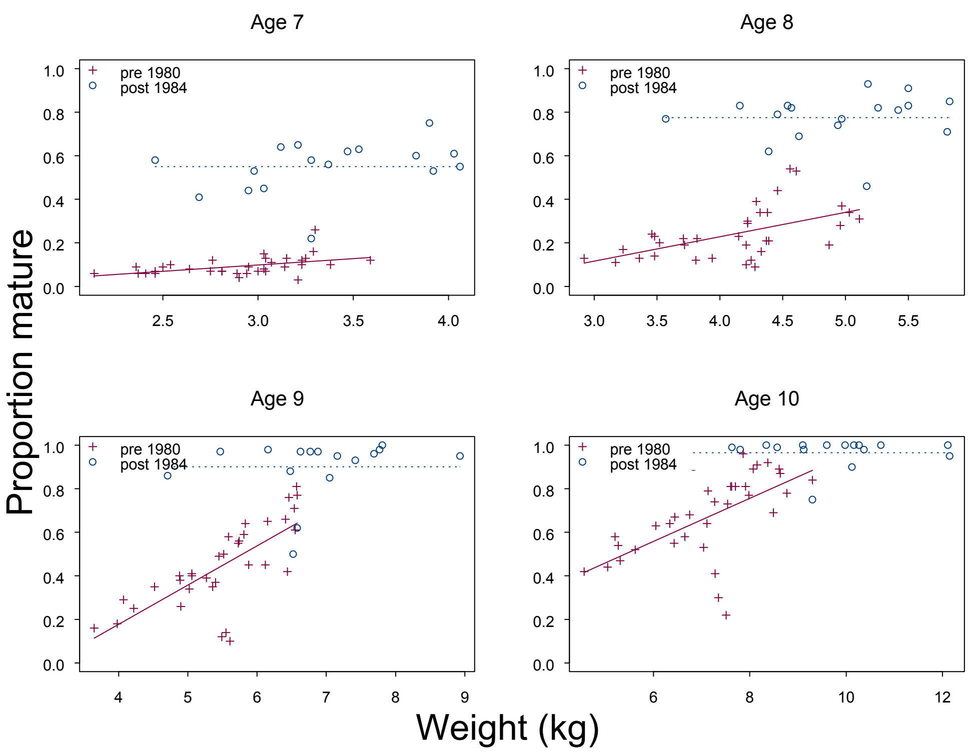


Figure 1.8. Bivariate relationships between cod weight at age (kg) and proportion of mature fish in two time periods (1946-1979 and 1984-2001).

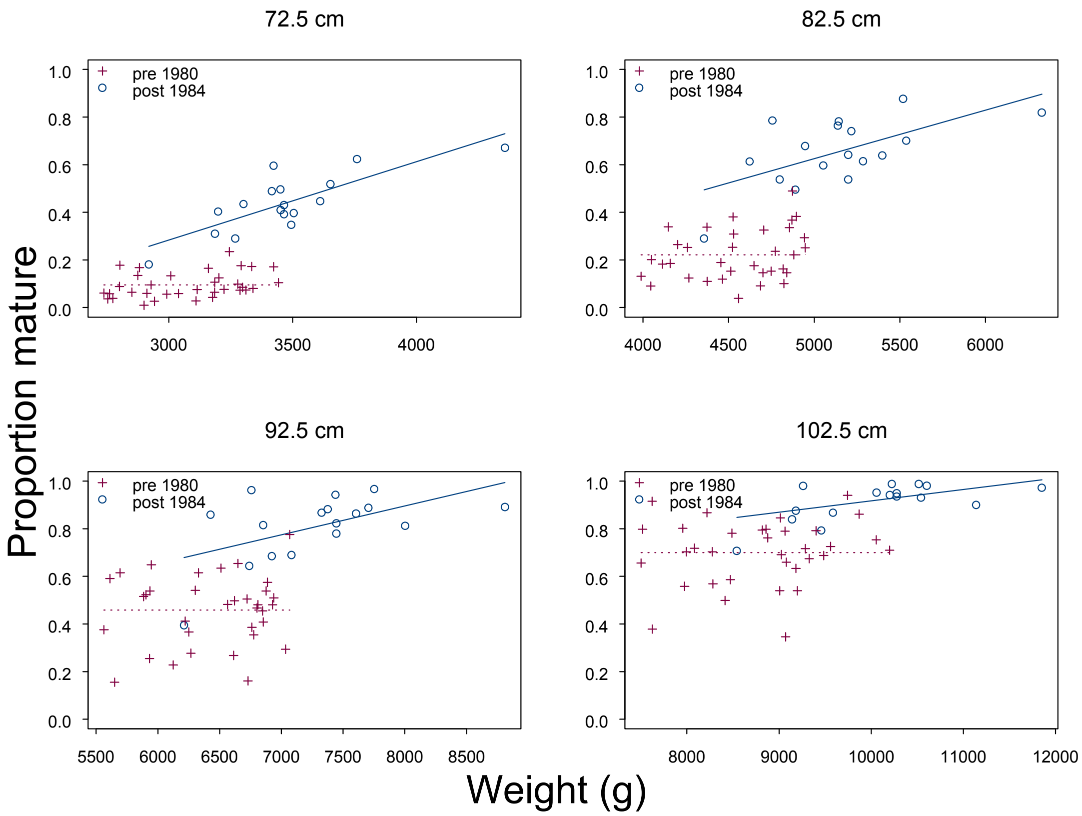


Figure 1.9. Bivariate relationships between cod weight (g) at 4 different lengths and proportion of mature fish in two time periods (1946-1979 and 1984-2001).

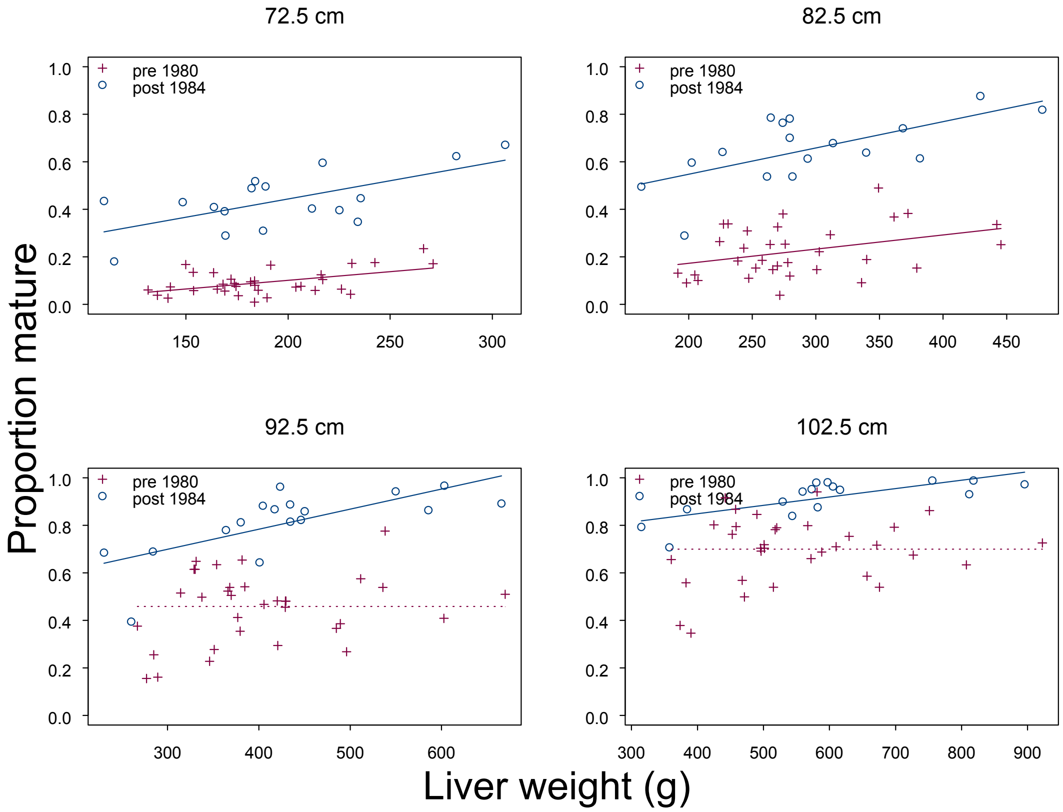


Figure 1.10. Bivariate relationships between cod liver weight at 4 different lengths and proportion of mature fish in two time periods (1946-1979 and 1984-2001).

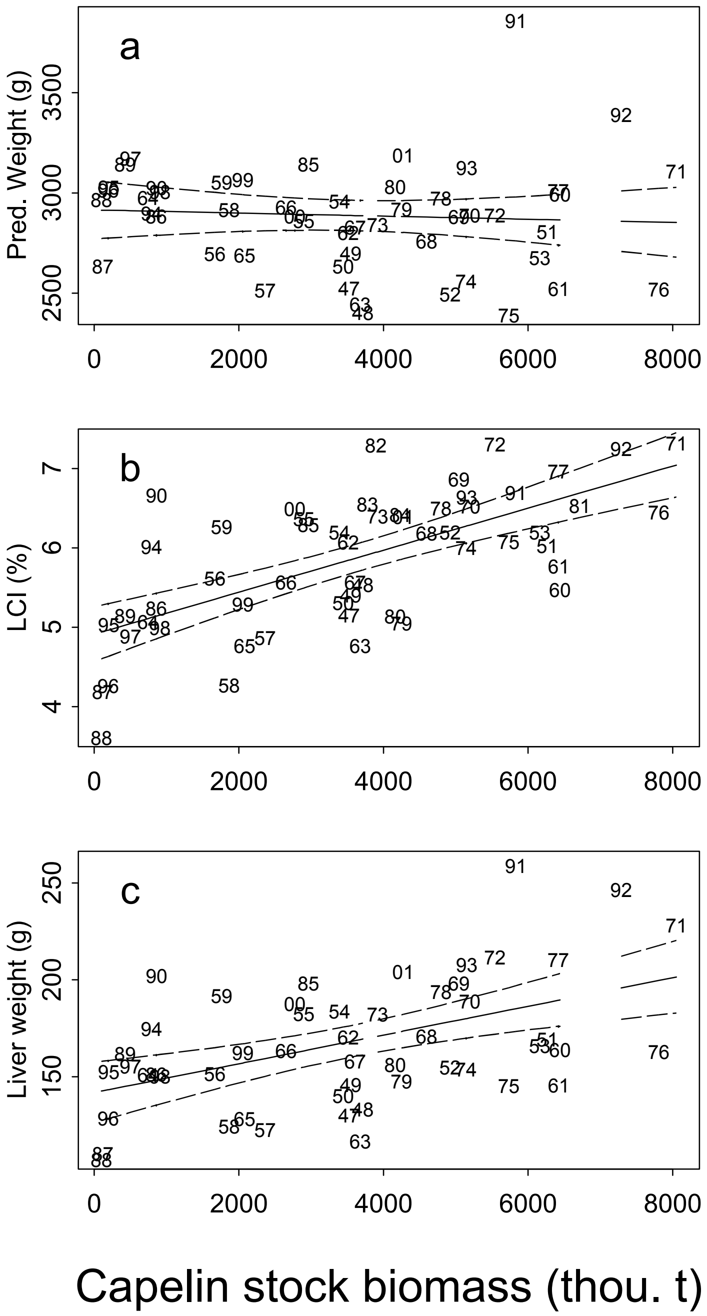


Figure 1.11. Bivariate relationships between capelin stock biomass (thousand t) and a) predicted weight of cod at 70 cm (g); b) liver condition index of the 61-70 cm length class of cod (%); and c) estimated liver weight of cod at 70 cm (g). Observations are denoted by year. Solid line indicates the least squares model fit and dashed lines indicate approximate 95% confidence intervals for the estimate.

2 NORWEGIAN COASTAL COD IN SUB-AREAS I AND II

2.1 Status of the Fisheries

2.1.1 Landings prior to 2003 (Tables 2.9, 2.19, Figure 2.2)

The catches of Norwegian Coastal cod (NCC) have been calculated back to 1984. During this period the catches have been between 25,000 and 75,000 t. The estimated landings of NCC in 2002 reported to the Working Group is 40,994 t and the provisional figure for 2003 is 34,635 t (Tables 2.9, 2.19, Figure 2.2). The landings in 2003 decreased compared with 2002. However, the landings were higher than expected. In the Lofoten area and in the southern part (statistical area 06 and 07) the landings were at the same level as in 2002 while the landings in the northernmost region decreased. In this region the availability of Northeast Arctic cod was high on the fishing banks near the coast and a major part of the smaller vessels quotas consisted therefore of Northeast Arctic cod. The catches inside the 12 n.mile zone was separated to type of cod by the structure of the otoliths (ref. Quality Control Handbook, Coastal cod). A total of 12,437 were collected from the commercial catches (Table 2.1.A) separated into quarter of catch and fishing gear. Approximately 25 % of the otoliths were classified as coastal cod.

2.1.2 Expected landings in 2004 (Figure 2.5)

The quota for Norwegian coastal cod was reduced from 40,000 t. in 2003 to 20,000 t. in 2004. To achieve a reduction in landings of coastal cod new technical regulations were adopted in 2004 in Norway. In the new regulations lines are drawn along the shore to close several fjords for direct cod fishing with vessels larger than 15 meter (Figure 2.5). These regulations are supposed to turn the traditional coastal fishery over from catching coastal cod in the fjords to catch more cod outside the fjords where the proportion of Northeast Arctic cod is higher. However, these new regulations did not become operative before the beginning of May. At this time many of the small coastal vessels had already fished most of their cod quotas and the new regulations might therefore only to some extent influence the landings of coastal cod.

During winter/spring the amount of Northeast Arctic cod at spawning migration near the Norwegian coast was large (Mehl et al., WD 12) and hence the accessibility for the fishermen, and most of the smaller coastal vessel quotas were therefore taken before May. The amount of Northeast Arctic cod spawning inside the Lofoten area was small, and hence a major part of the landings in this region is expected to consist of coastal cod. I addition, the remaining part of the quotas for the coastal vessels that will be taken after May will consists of a high proportion coastal cod. This makes it difficult to estimate the landings in 2004 accurate. The working group therefore assume a status quo fishing mortality in 2004, which will result in landings of 21,847 tonnes using the same exploitation pattern as in the period 2001-2003, scaled to the 2003 level.

2.2 Status of Research

2.2.1 Survey results (Tables 2.1.B, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7)

A new trawl-acoustic survey was conducted along the Norwegian coast from Varanger to Stadt in October-November 2003 using RV Jan Mayen and RV Johan Hjort. This is a combined survey covering the distribution of coastal cod and Northeast Arctic saithe and replaces two other surveys (saithe survey and coastal survey). In 2003 the survey covered a larger area than the coastal surveys in 1995-2002. However, the survey indices are calculated the same way as previous years using the same covering area as for previous surveys. The survey indices will not be recalculated before the time series from the new survey is extended.

The trawl-acoustic coastal survey in 2003 estimated a total survey biomass of NCC of about 32,000 t (19 million fish) from Varanger to Stadt at 62^{o} N (Tables 2.1.B, 2.2, 2.7). The spawning biomass accounted for 16,000 t (4 million fish) of the total (Tables 2.3, 2.4). More than eighty percent of the total coastal biomass was distributed from the Russian border to 67^{o} N and less than 20% south of 67^{o} N (Norwegian statistical areas 06 and 07). The bulk of the biomass was comprised of ages 3-8 (Table 2.2).

The data indicated a higher proportion of NCC in the fjords and to the south compared with the northern and outer areas. In the Norwegian statistical areas 06 and 07 (south of 67^{o} N) nearly all otoliths collected were of the NCC type, which is similar to the results of the 1995-2002 surveys.

The numbers of NCC per age groups from all the coastal surveys is given in Table 2.7. The total numbers decreased in 2003 compared with the 2002 survey. For age groups 2-5 the biomass and numbers decreased considerably from 2002 to 2003. The numbers decreased most in the southernmost region (area 07) (Table 2.1.B).

The Norwegian 2004 coastal survey (October-November) will be conducted in a similar way as the previous one (2003) to further extend the time series for NCC over its distribution area.

2.2.2 Age reading and stock separation

Age readings of the cod both from the surveys and from the catches, are done the same way as for the NEAC. A total of 3133 cod otoliths were sampled during the 2003 survey, and separated into NCC type (2593) and NEAC (540). The precision and accuracy of the separation method is under investigation by comparison of different otolith readers and results from genetic investigation of cod. Preliminary results indicate more than 95 % accuracy in the estimates.

As in previous years, NCC was found throughout the survey area. The 2003 survey data shows the same pattern as the 1995-2002 surveys. The proportion of the NCC increases going from north to south along the Norwegian coast. The NCC type otoliths dominate south of 67^{o} N (Norwegian statistical areas 06 and 07). Although the proportion is lower, there is significant biomass of NCC north of 67^{o} N. It must be emphasised that the Norwegian coastal surveys have been conducted in August-November, and there may be more NEAC in the southern area at other times of the year, especially during the spawning season in the wintertime.

2.2.3 Weight-at-age (Tables 2,5 2.11)

There is a general tendency for cod to have higher weight-at-age when caught further south along the coast (Tables 2.5, 2.11). The same tendency was found for the surveys in 1995-2002. The number of cod estimated in the southernmost area decreased substantially from 2002 to 2003. This is probably the main reason why the weight-at-age (weighted average) from the trawl-acoustic survey in 2003 was lower for all ages (except for age 8) compared with the 2002 survey. The difference in weight at age between 2003 and 2002 increased with age. The weight-at-age for NCC is however, well above the present level for NEAC.

2.2.4 Maturity-at-age (Tables 2.6, 2.12)

The maturity-at-age is estimated from the data collected at the Norwegian coastal survey. The age at 50% maturity (M_{50}) for the NCC was estimated to be close to 6 year on average for the surveyed area in 2003 (Tables 2.6, 2.12). There are some variations between the different areas. The 2003 data show that the average M_{50} is at a higher age as that found in the 2002 survey. The main reason for the higher age at maturation might be the substantial reduction in number of cod estimated in the southern area, where cod is growing faster and reaches M_{50} at younger age. However, the survey is conducted in the period October/November. In this period the maturity ogive can be difficult to define exactly and might influence the estimation of maturity-at-age and hence the estimation of SSB. In addition, the average M_{50} for the NEAC in 2003 is close to 7 years.

2.3 Data Used in the Assessment

2.3.1 Catch-at-age (Table 2.9)

The catches of coastal cod are calculated splitting the total catches of cod caught inside the 12 n.mile zone into coastal cod and Northeast Arctic cod based on samples from commercial catches. The proportion coastal cod is estimated by inspection of the otoliths (see chapter 2.2.2).

The catch-at-age (2-10+) for the period 1984-2003 is given in Table 2.9. The exploitation pattern in 2003 was similar to that observed last year.

2.3.2 Weight-at-age (Table 2.10, 2.11)

The weight-at-age in the stock, used in the assessment, is obtained from the Norwegian coastal survey (Table 2.11). The survey is covering the distribution area of the stock. Weight-at-age from this survey is therefore assumed to reflect the weight-at-age in the stock. Weight-at-age in 2003 was slightly lower for all ages (except for age 8) compared with 2002 (see 2.2.3). The weight-at-age in the catch is given in Table 2.10. Weight at age in the catch increased from 2002 to 2003 caused by a relative higher proportion cod caught in the southernmost area where weight at age is somewhat higher compared with further north.

2.3.3 Natural mortality

A fixed natural mortality of 0.2 was used.

2.3.4 Maturity-at-age (Tables 2.6, 2.12)

The maturity ogive data in 2003 is obtained from the Norwegian coastal survey (Tables 2.6, 2.12). The proportion mature at age has decreased the latest years for ages 3-6 (ref. chapter 2.2.4) (Table 2.12).

2.3.5 Tuning data (Table 2.7)

In previous assessments (until 2002) the acoustic indices (age 2-10+) from the Norwegian coastal survey conducted late autumn (1995-2001) have been used in the tuning (Table 2.7). ACFM proposed in 2002 to exclude age group 9 from the tuning fleet due to high S.E. (log q) for this age group. The S.E. (log q) was slightly lower for several ages when excluding age 9, and the WG in 2003 therefore decided to exclude it in the tuning in last year's assessment. The same age groups are used in this year's assessment.

2.3.6 Prediction data (Tables 2.20, 2.21, 2.22)

The input data to the short-term prediction with management option table (2004-2006) are given in Table 2.21. Weight at age in the stock has decreased and the age-at-maturation (M_{50}) increased because the proportion of cod in southernmost area has decreased the latest years. Cod in this area grows faster and has lower M_{50} than further north. For 2004-2006 the weight-at-age in stock and maturity-at-age were therefore set to the level in 2003. Weight at age in catch was set to the level in 2002 because the proportion of cod caught in the southernmost area is supposed to decrease in 2004-2006 compared with 2003.

The recruitment (age 2) in 2004 was estimated using RCT3 with C regression and without shrinkage towards the mean since SSB has been steadily declining and is present at the lowest observed level. Shrinkage towards the mean would therefore probably overestimate the recruitment radically. A run using P-regression was also tried. However, this gave also recruitment at the same level as using shrinkage and well above the two latest observed year classes (year classes 2000 and 2001). Since the SSB has been declining substantially since 1999 the recruitment in 2004-2006 is supposed to be lower than the last estimated by the XSA (4.1 million). However, the recruiting year classes will not influence the SSB in 2005 and 2006 since hardly any of these are mature in 2006. Estimated number at age 1 from the Norwegian coastal survey was used as recruitment index, and the index in the 2003 survey was therefore used to estimate the 2002 year class (age 2 in 2004). The recruitment in 2004 was estimated to 2.7 million in 2004 and set to the same level in 2005 and 2006 (Table 2.20). It must be emphasized that the regression diagnosis is not very good (R^2=0.27). The reason for the bad R^2 is mainly caused by the 1994 year class. As 1-year old in the survey this year class was observed as very weak.

The exploitation pattern is calculated using the average fishing mortality (age 4-7) from 2001 to 2003 scaled to the fishing mortality (age 4-7) in 2003. The scaling was used since there has been a trend towards fishing at older ages in recent years.

2.4 Methods Used in the Assessment

2.4.1 VPA and tuning (Table 2.8)

Tuning of the VPA was carried out using Extended Survival Analysis (XSA), using the default settings for the XSA with the following exceptions:

1. Catchability was set to be stock size independent for all ages. When examining the diagnostics from several exploratory runs in 2003 the regression statistics showed a slope not significant different from one when catchability was set to be stock size independent for all ages.

2. Catchability was set to be age dependent for ages 8 and older. This setting were obtained after examining the diagnostics of the mean log catchabilities from several exploratory XSA-runs in 2003 when changing this setting with one age at the time.

3. The survivors estimate was shrunk towards the mean F of the final 2 years since the exploitation pattern has changed the last few years. The 4 oldest ages are used in the shrinkage to stabilize fluctuations in historical F-values for ages 8 and above.

4. The standard error of the mean to which the survivor estimates are shrunk was set to 1.0 (Table 2.8). It was set above the default level because the coastal survey has shown a steadily decline in the latest years. The WG assumes the survey is reflecting the development of the stock and more weight is therefore assigned to the survey.

The XSA converged after 125 iterations. The log catchability residuals were positive for most of the ages in 2003, while they were negative for all ages below 8 for the 2002 survey. The Norwegian coastal survey in 2003 covered a larger area than the coastal surveys in 1995-2002. However, the survey indices are calculated the same way as previous years using the same covering area as in the previous surveys. The survey index in 2003 might still suffer from this and from comparing bottom trawl indices the index might be an overestimation. At next WG a bottom trawl index based on fixed trawl stations extending back to 1995 will be presented. The mean log catchabilities has slightly increased for ages 7 and 8, and decreased for ages 6 and younger in this years assessment. This is probably the main reason to the observed retrospective pattern in fishing mortality.

2.5 Results of the Assessment

2.5.1 Fishing mortality and VPA (Tables 2.13-2.19, Figure 2.2)

The average ages 4-7 fishing mortality in 2003 were estimated to be 0.62 (Table 2.13). This is the highest observed level (except for 1984) and well above the level in 2002 (0.46). Fishing mortalities tend to be overestimated while SSB tends to be underestimated in the assessment year as illustrated by the retrospective plots in Figure 2.3. If the retrospective pattern is continued the estimated F_{4-7} in 2003 is supposed to somewhat to high. However, the fishing mortality has increased substantially since 2000.

In 1990 and 1991 the lowest F-values was estimated (0.18 and 0.16). The fishing mortality was quite stable in the period 1996-2001 at a level of about 0.40, but has for the last two years increased. The total biomass of the stock in the period from 1984-2003 has been between 69,000 t and 314,000 t (Tables 2.17, 2.19). In 2003 the biomass was estimated to be the lowest observed and about half the biomass in 2002. The spawning stock biomass has been between 38,000 t and 197,000 t (Tables 2.18, 2.19, Figure 2.2). As for the total stock biomass, the lowest observed SSB was estimated in 2003. The SSB has declined steadily from 1996 to present. The SSB in 2003 was only about half of the SSB in 2002. The decline both in the total stock biomass and the SSB has been accelerating, and will continue to decline unless the fishing mortality is substantially reduced.

A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1984 is given in Table 2.19 and Figure 2.2.

2.5.2 Recruitment (Tables 2.7, 2.15, 2.19, 2.20)

Both the survey estimates of abundance in 2003 (age 1-4, Table 2.7), the XSA-estimate (age 2 and 3, Tables 2.15, 2.19) and result from the RCT3 (Table 2.20) indicate lower than average year classes from 1997-2002. These seven year classes are the lowest seven observed in the time series. The 2001 year class is the lowest observed in the time series, and the RCT estimate of the 2002 year class is even lower than the 2001 year class. Since 2001 the SSB has decreased further with approximately 50 % and the probability of weak year classes the next few years is assumed to be high.

2.6 Catch Options for 2005 and Management Scenarios (Tables 2.22-2.23, Figure 2.2)

The total stock biomass and the SSB were further reduced during 2003 (respectively 17% and close to 27%). The management option table (2.22) shows that the expected catch of 21,847 t in 2004 (assuming F status quo) will give an unchanged fishing mortality (F_{2004}=0.62). The total stock biomass and the SSB will however be further reduced (35,000 t. and 24,000 t.). The status quo catch in 2005 is 14,373 t, and leads to a further decrease of the total stock biomass. In 2006 the total stock biomass and the SSB will be 25,000 t. and the 16,000 t., which is far less than half of the level in 2003. The SSB will not be rebuilt to the 2004 level even if the fishing mortality in 2004 is set to zero (Table 2.22). A catch of 5,000 t (F=0.18) brings the SSB up to the level in 2005 (Table 2.22, Figure 2.2).

2.7 Biological reference points

2.7.1 Biomass reference points (Figure 2.4)

In the report of the study group on Precautionary Reference Points (February, 2003), the SG stated that the most recent recruitment values are very influential in the segmented regression, since recruitment is at age 2. The analysis should therefore not include the final 2 data pairs since the assessment is still unstable. The time series is now extended with two more years and both the SSB and recruitment have further decreased.

The recruitment is clearly impaired at this low SSB level. When examining the retrospective pattern in SSB there is a trend towards underestimating the SSB in the assessment year (Figure 2.3). The retrospective pattern in recruitment is better and the estimated recruits have been quite stable since 2000.

During this years meeting the WG has calculated potential candidates for $\mathbf{B}_{\mathrm{lim}}$ using segmented regression. Two different input data sets were examined. In the first data set, the last two year classes estimated in the XSA were excluded while in the second they were not (see table below). When excluding the latest two year classes the calculated $\mathbf{B}_{\mathrm{lim}}$ was approximately 125,000 tonnes, while including them gave a $\mathbf{B}_{\mathrm{lim}}$ of approximately 140,000 tonnes (see table below and figure 2.4). The sensitivity plots show that removing one more year (1999 year class) reduce the changepoint to about 110,000 t. Removing subsequently 8 further points makes no change in the changepoint. The conclusion is that reasonable $\mathbf{B}_{\mathrm{lim}}$ will be in the range 110-140,000 t.

However, there is a time-trend in the SSB/R plot (Figure 2.4). The year classes 1986-1990 were all above average and originated from SSB below 140,000 t, while the year class 1997 originated from a SSB of more than 150,000 t. was well below average. The year classes 1986-1990 tends to reduce $\mathbf{B}_{\mathrm{lim}}$, while for instance the year classes 1997 and onwards tends to increase the estimated $\mathbf{B}_{\mathrm{lim}}$. In addition to SSB, environmental conditions or influence from other fish species might contribute these unexpected time trends of recruitment. However, the highest observed level of recruitment is only about twice average, while the lowest observed is about 1/10 of the average.

The WG has examined potential candidates for $\mathbf{B}_{\mathrm{lim}}$, but will at the time being not propose a specific $\mathbf{B}_{\mathrm{lim}}$ because there seems to be a time trend in the data.

Input year classes	Model	Resid df	RSS	F-Statistics	B-lim value (tonnes)	Bootstrap p-value
1984-1999	Changepoint	15 (n-1)	3.104376	2.821350	125,493	0.0990
1984-2001	Changepoint	17 (n-1)	5.981249	7.613725	139,588	0.0099

2.8 Comments to the Assessment

2.8.1 A comparison of the assessment results and the survey results (Figure 2.1)

Both the assessment and the surveys from 1995-2003 show a steeply declining stock. For ages 2-8 the survey indices and the XSA estimates are well correlated (Figure 2.1). It therefore seems like the survey and the XSA assessment reflect the changes in the stock number quite well. There is a general trend towards decreasing catchability with increasing age.

2.8.2 Comparison of this years assessment with last years assessment (Figure 2.3)

Fishing mortalities tend to be overestimated while SSB tends to be underestimated in the assessment year as illustrated by the retrospective plots in Figure 2.3. The retrospective pattern for the recruitment is better, especially from 2000 and onwards. The calculated fishing mortality $F_{4\text{-}7}$ and SSB in 2002 is lower (23%) and SSB higher (4%) in this years assessment compared with last years assessment (see below). The recruitment in 2002 (2000 year-class) is lower (19%) in last years assessment compared with this year's assessment.

Assessment year	$F_{4\text{-}7}$ year 2002	SSB year 2002	Total stock biomass 2002	Recruits age 2 year 2001
2003	0.60	76,443	121,818	6,055
2004	0.46	79,799	130,047	7,190

2.8.3 Uncertainties in the assessment

- The Norwegian coastal survey is the only survey covering the distribution area of the stock. The survey is conducted in the period October/November. In this period the maturity ogive can be difficult to define exactly and might influence the estimation of maturity-at-age and hence the estimation of SSB.
- The catches and survey indices are estimated by separating between coastal cod and Northeast Arctic cod by inspection of the otoliths. The precision and accuracy of the method is under investigation by comparison of different otolith readers and results from genetic investigation of the same otoliths. Preliminary results indicate more than 95 % accuracy in the estimates.
- The retrospective pattern shows an overestimation of the F-values in the assessment year. The stock has been steadily declining for several years now. However, the catches are quite high which tends to push the historical stock upwards and the fishing mortality downwards. The accuracy of the estimated number might therefore be uncertain in the assessment year.
- The Norwegian coastal survey in 2003 covered a larger area than the coastal surveys in 1995-2002. However, the survey indices are calculated the same way as previous years using the same covering area as in the previous surveys. The survey index in 2003 might still suffer from this and from comparing bottom trawl indices the index might be an overestimation.

2.8.4 Management considerations

New regulations for coastal cod became operative in May 2004 (see chapter 2.1.2). In accordance with the precautionary approach and the state of the stock, the new regulations should be closely evaluated. In case the fishing mortality is not substantially reduced further action needs to be taken.

Recruitment from SSB below 100,000 t is clearly impaired. The SSB is present the lowest observed and only 1/3 of this level and at the beginning of 2005 will be 24,000 t assuming F status quo in 2004. In that sense, SSB in 2004 will be well below any $\mathbf{B}_{\mathrm{lim}}$ candidate, and the probability of further recruitment failure is likely to be very high. This being the case, the SSB should be rebuilt to a level where recruitment is not impaired before fishing is resumed.

2.9 Response to ACFM technical minutes

The review committee last year had some comments to the assessment;

- The values of the input tables are now checked for errors.
- More detailed explanations regarding the model inputs (e.g. RCT3 and XSA) are included in the text (2.3.6 and 2.4.1).
- More detailed explanations regarding diagnostics are included in the text (2.3.6 and 2.8.3).
- The XSA model showed a strong year effect in 2003 F estimates. This is further examined and discussed in the text (2.5.1), and a retrospective analysis of the XSA is included in this years report (2.8.2).
- A justification for the heavy reliance on the survey data for tuning the XSA model is included in the text (2.4.1).
- Uncertainties in the assessment is described in more detail in chapter 2.8.3.

Table 2.1.A Number of otoliths sampled from commercial catches in the period 1985-2003. CC=coastal cod, NEAC=Northeast Arctic cod.

Year	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Total		
Year	CC	NEAC	CC	NEAC	CC	NEAC	CC	NEAC	CC	NEAC	% CC
1985	1 451	3 852	777	1 540	1 277	1 767	1 966	730	5 471	7 889	41
1986	940	1 594	1 656	2 579	0	0	669	966	3 265	5 139	39
1987	1 195	2 322	937	3 051	638	1 108	1 122	1 137	3 892	7 618	34
1988	257	546	160	619	87	135	55	44	559	1 344	29
1989	556	1 387	72	374	65	501	97	663	790	2 925	21
1990	731	2 974	61	689	252	97	265	674	1 309	4 434	23
1991	285	1 168	92	561	77	96	279	718	733	2 543	22
1992	152	619	281	788	79	82	272	672	784	2 161	27
1993	314	1 098	172	1 046	0	0	310	541	796	2 685	23
1994	317	1 605	179	923	21	31	126	674	643	3 233	17
1995	188	1 591	232	1 682	2 095	1 057	752	1 330	3 267	5 660	37
1996	861	5 486	591	1 958	1 784	1 076	958	2 256	4 194	10 776	28
1997	1 106	5 429	367	2 494	1 940	894	1 690	1 755	5 103	10 572	33
1998	608	4 930	552	1 342	489	1 094	2 999	2 217	4 648	9 583	33
1999	1 277	4 702	493	2 379	202	717	961	1 987	2 933	9 785	23
2000	1 283	4 918	365	2 112	386	1 295	472	1 668	2 506	9 993	20
2001	1 102	5 091	352	2 295	126	786	432	983	2 012	9 155	18
2002	823	5 818	321	1 656	503	831	897	1 355	2 544	9 660	21
2003	821	4 197	445	2 850	790	936	1 112	1 286	3 168	9 269	25

Table 2.1.B Estimated survey number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2003.

Area	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
03 East Finnmark	1096	613	1078	991	765	490	198	97	35	3	5366
04 West Finnmark/Tromsø	771	963	1410	1427	942	748	475	280	152	65	7233
05 Lofoten/Vesterålen	36	64	155	226	104	146	36	5	102	3	877
00 Vestfjord	106	255	224	665	347	642	210	86	45	8	2588
06 Nordland	75	246	671	492	603	328	211	111	26	0	2763
07 Møre	0	3	7	79	27	35	14	10	4	0	179
Total	2084	2145	3545	3880	2788	2389	1144	589	364	80	19008

Table 2.2 Estimated survey biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2003.

Area	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
03 East Finnmark	52	159	640	1007	1302	1301	732	403	164	22	5782
04 West Finnmark/Troms	61	332	966	1924	2065	2261	1782	1166	759	964	12280
05 Lofoten/Vesterålen	2	47	180	407	311	423	109	20	1174	32	2705
00 Vestfjord	4	224	229	1175	838	2071	935	813	498	118	6905
06 Nordland	6	112	546	548	1182	810	588	315	58	0	4165
07 Møre	.	2	8	177	91	130	56	37	20	0	521
Total	125	876	2569	5238	5788	6995	4201	2754	2674	1136	32356

Table 2.3 Estimated survey spawning stock number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2003.

Area	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
03 East Finnmark	0	0	0	10	161	289	176	91	34	3	764
04 West Finnmark/Troms	0	0	0	43	292	404	423	272	137	65	1635
05 Lofoten/Vesterålen	0	0	14	36	59	124	34	5	102	3	377
00 Vestfjord	0	0	0	0	125	83	197	86	45	8	545
06 Nordland	0	0	0	103	151	253	194	111	26	0	838
07 Møre	0	0	0	0	14	22	8	10	4	0	58
Total	0	0	14	192	801	1175	1032	574	347	79	4216

Table 2.4 Estimated survey spawning stock biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2003.

Area	Age										
	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	0	0	0	10	273	768	651	379	157	22	2261
04 West Finnmark/Troms	0	0	0	58	640	1221	1586	1131	683	964	6283
05 Lofoten/Vesterålen	0	0	16	65	177	360	102	18	1174	32	1945
00 Vestfjord	0	0	0	0	302	269	879	813	498	118	2879
06 Nordland	0	0	0	115	296	624	541	315	58	0	1948
07 Møre	0	0	0	0	46	82	32	37	20	0	216
Total	0	0	16	248	1734	3323	3792	2693	2591	1136	15532

Table 2.5 Weight (gram)-at-age (year) for Norwegian Coastal cod from the Norwegian coastal survey during the autumn 2003.

	Age									
Area	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	45	258	606	1084	1889	3214	4404	5848	4691	12700
04 West Finnmark/Troms	84	324	686	1365	2197	3132	3984	4499	5521	9809
05 Lofoten/Vesterålen	83	372	897	1688	2724	2575	2871	3618	11327	10298
00 Vestfjord	54	885	952	1675	2286	3336	4431	7963		11213
06 Nordland	85	421	948	1140	2091	2551	3022	2730	2028	
07 Møre		583	962	2156	4665	4055	8441	6518	10683	
Weighted average	62	384	736	1309	2099	3044	3878	4810	6075	9954

Table 2.6 Percent mature at age for Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2003.

	Age									
Area	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	0	0	0	1	21	59	89	94	96	100
04 West Finnmark/Troms	0	0	0	3	31	54	89	97	90	100
05 Lofoten/Vesterålen	0	0	9	16	57	85	94	91	100	100
00 Vestfjord	0	0	0	0	36	13	94	100	100	100
06 Nordland	0	0	0	21	25	77	92	100	100	100
07 Møre	0	0	0	0	50	63	57	100	100	100
Weighted average	0	0	0	5	29	49	90	98	96	100

Table 2.7 Estimated survey numbers at age (x1000) of Norwegian Coastal cod from the coastal surveys from 1995-2003.

	Age										
YEAR	1	2	3	4	5	6	7	8	9	10+	TOTAL
1995	28707	20191	13633	15636	16219	9550	3174	1158	781	579	109628
1996	1756	17378	22815	12382	12514	6817	3180	754	242	5	77843
1997	30694	18827	28913	17334	12379	10612	3928	1515	26	663	124891
1998	14455	13659	15003	13239	7415	3137	1578	315	169	128	69098
1999	6850	11309	12171	10123	7197	3052	850	242	112	54	51960
2000	9587	11528	11612	8974	7984	5451	1365	488	85	97	57171
2001	8366	6729	7994	7578	4751	2567	1493	487	189	116	40270
2002	1329	2990	4103	4940	3617	2593	1470	408	29	128	21607
2003	2084	2145	3545	3880	2788	2389	1144	589	364	80	19008

Table 2.8

```
Lowestoft VPA Version 3.1

   5/05/2004  10:19

 Extended Survivors Analysis

 Norwegian Coastal Cod,COMBSEX,PLUSGROUP

 CPUE data from file c:\VPA\DATA\2004\COASt-9.TUN

 Catch data for  20 years. 1984 to 2003. Ages  2 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                      ,    year, year,  age ,  age
 Norw. Coast. survey ,   1995, 2003,   0,     8,   .750,   .850


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    8


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   2 years or the   4 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.000

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

      Prior weighting not applied


 Tuning converged after  125 iterations


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


 Fishing mortalities
    Age,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003

      2,  .026,  .034,  .045,  .021,  .014,  .011,  .004,  .030,  .022
      3,  .047,  .099,  .128,  .127,  .065,  .067,  .043,  .115,  .241
      4,  .136,  .177,  .185,  .265,  .148,  .256,  .174,  .288,  .429
      5,  .257,  .467,  .243,  .382,  .401,  .382,  .342,  .439,  .576
      6,  .316,  .387,  .458,  .412,  .497,  .474,  .354,  .614,  .725
      7,  .465,  .416,  .670,  .581,  .578,  .376,  .496,  .509,  .731
      8,  .359,  .617,  .695,  .778,  .630,  .216,  .319,  .711,  .379
      9,  .351,  .394,  .655,  .448,  .940,  .209,  .185,  .323,  .442


XSA population numbers (Thousands)

                                  AGE
 YEAR ,           2,         3,         4,         5,         6,         7,         8,         9,

 1995 ,    3.48E+04, 2.16E+04, 2.04E+04, 2.53E+04, 2.26E+04, 9.71E+03, 5.33E+03, 2.08E+03,
 1996 ,    3.98E+04, 2.78E+04, 1.69E+04, 1.46E+04, 1.60E+04, 1.35E+04, 4.99E+03, 3.05E+03,
 1997 ,    3.33E+04, 3.15E+04, 2.06E+04, 1.16E+04, 7.49E+03, 8.91E+03, 7.31E+03, 2.21E+03,
 1998 ,    2.91E+04, 2.61E+04, 2.27E+04, 1.40E+04, 7.44E+03, 3.88E+03, 3.73E+03, 2.98E+03,
 1999 ,    2.06E+04, 2.34E+04, 1.88E+04, 1.43E+04, 7.82E+03, 4.04E+03, 1.78E+03, 1.40E+03,
 2000 ,    1.62E+04, 1.66E+04, 1.79E+04, 1.33E+04, 7.82E+03, 3.90E+03, 1.85E+03, 7.74E+02,
 2001 ,    1.12E+04, 1.31E+04, 1.27E+04, 1.14E+04, 7.41E+03, 3.98E+03, 2.19E+03, 1.22E+03,
 2002 ,    7.19E+03, 9.09E+03, 1.03E+04, 8.77E+03, 6.61E+03, 4.26E+03, 1.99E+03, 1.30E+03,
 2003 ,    4.12E+03, 5.71E+03, 6.64E+03, 6.32E+03, 4.63E+03, 2.93E+03, 2.10E+03, 7.98E+02,
```

Table 2.8 (continued)

Estimated population abundance at 1st Jan 2004

, 0.00E+00, 3.30E+03, 3.68E+03, 3.54E+03, 2.91E+03, 1.84E+03, 1.15E+03, 1.18E+03,

Taper weighted geometric mean of the VPA populations:

, 2.16E+04, 2.10E+04, 1.87E+04, 1.47E+04, 9.78E+03, 5.96E+03, 3.16E+03, 1.56E+03,

Standard error of the weighted Log(VPA populations) :

, .7856, .6141, .4975, .4541, .4623, .5017, .5187, .6029,

Log catchability residuals.

Fleet : Norw. Coast. survey

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	.09	-.19	.08	-.13	.02	.28	.11	-.24	-.02
3	-.05	.26	.39	-.07	-.22	.07	-.08	-.35	.09
4	.15	.14	.29	-.02	-.19	-.18	-.07	-.17	.11
5	.02	.48	.52	-.07	-.10	.06	-.34	-.37	-.10
6	-.25	-.19	1.07	-.18	-.19	.38	-.42	-.50	.28
7	-.02	-.39	.44	.29	-.37	-.02	.14	-.45	.37
8	.05	-.10	.28	-.56	-.19	.13	.05	.00	.33

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	-.4516	-.2179	-.1490	-.0992	-.1985	-.5652	-1.1348
S.E(Log q)	.1652	.2304	.1733	.3108	.4959	.3433	.2678

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.98	.189	.59	.96	9	.17	-.45
3	.87	.997	1.42	.91	9	.20	-.22
4	.97	.184	.43	.86	9	.18	-.15
5	.81	.767	1.89	.71	9	.26	-.10
6	1.33	-.620	-2.76	.34	9	.69	-.20
7	1.15	-.504	-.60	.65	9	.41	-.57
8	1.00	-.013	1.12	.80	9	.29	-1.13

Terminal year survivor and F summaries :

Age 2 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
Norw. Coast. survey	3223.	.300	.000	.00	1	.916	.022
F shrinkage mean	4226.	1.00				.084	.017

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3297.	.29	.08	2	.274	.022

Table 2.8 (continued)

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

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      3429.,   .212,       .165,    .78,   2,  .945,     .256

  F shrinkage mean  ,     12127.,   1.00,,,,                         .055,     .079

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3676.,       .21,      .24,    3,   1.146,   .241


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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      3416.,   .174,       .152,    .88,   3,  .953,     .441

  F shrinkage mean  ,      7263.,   1.00,,,,                         .047,     .232

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3540.,       .17,      .15,    4,    .895,   .429


Age  5   Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      2837.,   .155,       .099,    .64,   4,  .949,     .587

  F shrinkage mean  ,      4707.,   1.00,,,,                         .051,     .393

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2911.,       .16,      .10,    5,    .649,   .576


Age  6   Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      1762.,   .152,       .102,    .67,   5,  .928,     .746

  F shrinkage mean  ,      3109.,   1.00,,,,                         .072,     .487

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1836.,       .16,      .11,    6,    .702,   .725
```

Table 2.8 (continued)

```
Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      1103.,   .159,       .140,    .88,   6,  .915,     .755

  F shrinkage mean  ,      1886.,   1.00,,,,                         .085,     .506

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1155.,       .17,      .14,    7,    .819,   .731


Age  8   Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,      1201.,   .152,       .125,    .82,   7,  .949,     .372

  F shrinkage mean  ,       794.,   1.00,,,,                         .051,     .520

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1176.,       .15,      .12,    8,    .769,   .379


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

Year class = 1994

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
Norw. Coast. survey ,       443.,   .161,       .062,    .39,   7,  .887,     .423

  F shrinkage mean  ,       279.,   1.00,,,,                         .113,     .608

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      420.,       .18,      .08,    8,    .438,   .442
```

Table 2.9

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	829,	396,	4095,	170,	110,	41,	7,	125,	40,	4,
3,	3478,	7848,	4095,	940,	1921,	1159,	349,	607,	665,	369,
4,	6954,	7367,	12662,	8236,	3343,	1434,	1233,	1452,	3160,	1706,
5,	7278,	8699,	8906,	12430,	6451,	2299,	1330,	3114,	4422,	2343,
6,	6004,	7085,	5750,	4427,	6626,	5197,	1129,	1873,	2992,	2684,
7,	4964,	3066,	3868,	2649,	4687,	2720,	3456,	1297,	1945,	3072,
8,	2161,	705,	1270,	1127,	1461,	949,	773,	873,	898,	1871,
9,	819,	433,	342,	313,	497,	236,	141,	132,	837,	627,
+gp,	624,	264,	407,	149,	333,	86,	73,	94,	279,	690,
TOTALNUM,	33111,	35863,	41395,	30441,	25429,	14121,	8491,	9567,	15238,	13366,
TONSLAND,	74824,	75451,	68905,	60972,	59294,	40285,	28127,	24822,	41690,	52557,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Table 2.9 (continued)

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
2,	332,	810,	1193,	1326,	554,	252,	156,	44,	192,	81,
3,	573,	896,	2376,	3438,	2819,	1322,	971,	505,	893,	1107,
4,	1693,	2345,	2480,	3150,	4786,	2346,	3664,	1837,	2331,	2094,
5,	4302,	5188,	4930,	2258,	4023,	4263,	3807,	2974,	2822,	2506,
6,	2467,	5546,	4647,	2490,	2272,	2773,	2671,	1998,	2742,	2158,
7,	3337,	3270,	4160,	3935,	1546,	1602,	1104,	1409,	1538,	1374,
8,	1514,	1455,	2082,	3312,	1826,	751,	326,	542,	915,	598,
9,	777,	557,	898,	959,	975,	774,	132,	187,	325,	258,
+gp,	798,	433,	543,	684,	343,	320,	152,	119,	377,	99,
TOTALNUM,	15793,	20500,	23309,	21552,	19144,	14403,	12983,	9615,	12135,	10275,
TONSLAND,	54562,	57207,	61776,	63319,	51572,	40732,	36715,	29699,	40994,	34635,
SOPCOF %,	100,	100,	100,	100,	99,	100,	100,	100,	102,	97,

Table 2.10

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Table 2 Catch weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	.2480,	.2140,	.2270,	.3310,	.2460,	.3000,	.3450,	.1640,	.1680,	.2410,
3,	.6190,	.7120,	.5250,	.6730,	.6340,	.6610,	1.1740,	.9220,	.5560,	.6450,
4,	1.1490,	1.4150,	1.0800,	1.1200,	1.1700,	1.8360,	1.5150,	1.6080,	1.3590,	1.7100,
5,	1.7340,	2.0360,	1.7060,	1.6930,	1.7270,	2.1700,	1.6780,	2.1080,	2.2670,	2.5910,
6,	2.3250,	2.7370,	2.2560,	2.3590,	2.3280,	2.4480,	2.7080,	2.5070,	2.9570,	3.5880,
7,	3.4860,	4.0120,	3.3530,	3.7430,	3.2560,	4.3910,	3.8980,	3.4690,	3.9030,	4.3660,
8,	4.8450,	6.1160,	4.8380,	5.3260,	4.7000,	4.8990,	6.5150,	4.9760,	5.3170,	5.8990,
9,	5.6080,	6.4600,	5.8380,	6.1290,	5.4500,	6.6610,	7.2990,	5.7340,	4.5580,	6.4940,
+gp,	8.8400,	10.7550,	7.0530,	11.6230,	8.2020,	11.6080,	13.9240,	11.0590,	7.0320,	7.5090,
SOPCOFAC,	1.0002,	1.0000,	1.0001,	1.0001,	1.0001,	1.0000,	1.0002,	1.0003,	1.0001,	1.0000,

Table 2.10 (continued)

Table 2 Catch weights at age (kg)

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
2,	.2540,	.3020,	.2740,	.2770,	.3760,	.4670,	.5150,	.1640,	.4910,	.7640,
3,	.8050,	.7100,	.9210,	.9700,	.9780,	1.1550,	1.3050,	.9520,	1.1790,	1.5040,
4,	1.4760,	1.3350,	1.4640,	1.5540,	1.5180,	1.6330,	2.2720,	1.6370,	1.8000,	2.4050,
5,	2.0970,	1.8420,	1.9790,	1.9700,	2.2810,	2.1710,	2.5550,	2.8810,	2.4850,	3.0340,
6,	3.2870,	2.4670,	2.5160,	2.8970,	3.1250,	3.2490,	3.2830,	3.4240,	3.8600,	4.0750,
7,	4.0950,	4.1910,	3.4610,	3.7160,	3.9000,	4.0950,	4.5040,	4.0380,	4.7600,	4.9290,
8,	5.5920,	5.7780,	4.8660,	4.8290,	5.5200,	5.0130,	5.4000,	5.3970,	5.1950,	5.2900,
9,	7.2170,	6.3760,	5.3910,	6.3490,	6.3330,	6.0180,	6.3790,	7.2080,	5.5070,	6.7400,
+gp,	8.3310,	9.9030,	8.8540,	9.2670,	9.3370,	6.2550,	6.4200,	6.8810,	9.1830,	10.3300,
SOPCOFAC,	1.0000,	1.0001,	1.0001,	1.0003,	.9919,	1.0002,	.9999,	1.0004,	1.0181,	.9659,

Table 2.11

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Table 3 Stock weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,
3,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,
4,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,
5,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,
6,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,
7,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,
8,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,
9,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,
+gp,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,

Table 3 Stock weights at age (kg)

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
2,	.3210,	.3900,	.2520,	.2400,	.3720,	.3230,	.3650,	.3960,	.4280,	.3840,
3,	.7580,	.7910,	.7240,	.6830,	.8830,	.8410,	.8090,	.9660,	.8950,	.7360,
4,	1.4790,	1.5250,	1.4330,	1.3640,	1.4560,	1.6750,	1.5540,	1.5240,	1.7410,	1.3090,
5,	2.1370,	2.2220,	2.0530,	1.8930,	2.1070,	2.1920,	2.5390,	2.3140,	2.4330,	2.0990,
6,	2.8140,	2.8810,	2.7480,	2.8160,	2.9500,	2.8570,	3.0490,	3.3200,	3.1330,	3.0440,
7,	4.7220,	4.6650,	4.7220,	4.4260,	4.3190,	4.5400,	4.3520,	3.6950,	4.2730,	3.8780,
8,	6.6850,	6.9790,	6.6850,	6.4060,	5.6250,	6.5790,	6.2030,	6.1440,	4.3970,	4.8100,
9,	6.9800,	6.7590,	6.9320,	7.8050,	8.3230,	9.4540,	8.5270,	8.7680,	7.7590,	6.0750,
+gp,	9.7230,	9.8970,	9.7230,	10.8270,	12.4680,	12.9020,	12.0660,	12.4680,	12.9920,	9.9540,

Table 2.12

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Table 5 Proportion mature at age

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
2,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
3,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
4,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,
5,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,
6,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,
7,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,
8,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,
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

YEAR, AGE	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
2,	.0100,	.0000,	.0000,	.0000,	.0000,	.0100,	.0100,	.0000,	.0000,	.0000,
3,	.0600,	.0100,	.0300,	.0600,	.0600,	.0300,	.0600,	.0000,	.0200,	.0000,
4,	.2400,	.2000,	.2400,	.2900,	.2500,	.2100,	.2400,	.0700,	.0200,	.0500,
5,	.4900,	.4700,	.5600,	.4500,	.5300,	.4400,	.4900,	.3700,	.2600,	.2900,
6,	.7200,	.6700,	.8000,	.7600,	.7400,	.6500,	.7200,	.7900,	.8800,	.4900,
7,	.8800,	.8500,	.9200,	.9700,	.8700,	.7700,	.8800,	.9700,	.9300,	.9000,
8,	.9500,	.8600,	.9900,	1.0000,	.8900,	1.0000,	.9500,	.9800,	.9000,	.9800,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9800,	.9700,	.9600,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.13

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
2,	.0105,	.0059,	.1344,	.0050,	.0030,	.0010,	.0002,	.0022,	.0009,	.0001,
3,	.0744,	.1297,	.0770,	.0412,	.0721,	.0395,	.0103,	.0191,	.0144,	.0101,
4,	.2168,	.2228,	.3187,	.2190,	.2016,	.0706,	.0537,	.0539,	.1311,	.0465,
5,	.3336,	.4620,	.4597,	.5980,	.2668,	.2077,	.0865,	.1866,	.2306,	.1357,
6,	.6282,	.6364,	.6425,	.4374,	.7612,	.3580,	.1491,	.1689,	.2754,	.2135,
7,	1.3093,	.7881,	.8996,	.7076,	1.2363,	.8486,	.4302,	.2556,	.2658,	.5069,
8,	1.0722,	.6330,	.9332,	.7320,	1.1816,	.9266,	.6234,	.1814,	.2828,	.4429,
9,	.8446,	.6355,	.7409,	.6242,	.8706,	.5903,	.3242,	.1990,	.2651,	.3267,
+gp,	.8446,	.6355,	.7409,	.6242,	.8706,	.5903,	.3242,	.1990,	.2651,	.3267,
FBAR 4- 7,	.6220,	.5273,	.5801,	.4905,	.6165,	.3712,	.1799,	.1663,	.2257,	.2256,

Table 8 Fishing mortality (F) at age

YEAR, AGE	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR 01-03
2,	.0138,	.0261,	.0337,	.0450,	.0212,	.0136,	.0107,	.0044,	.0300,	.0220,	.0188,
3,	.0251,	.0469,	.0994,	.1284,	.1273,	.0646,	.0667,	.0434,	.1149,	.2410,	.1331,
4,	.0588,	.1358,	.1771,	.1853,	.2652,	.1485,	.2561,	.1736,	.2878,	.4287,	.2967,
5,	.1586,	.2571,	.4674,	.2427,	.3821,	.4011,	.3817,	.3416,	.4395,	.5760,	.4524,
6,	.2068,	.3157,	.3867,	.4582,	.4118,	.4972,	.4742,	.3537,	.6136,	.7245,	.5640,
7,	.4486,	.4652,	.4156,	.6699,	.5811,	.5776,	.3758,	.4958,	.5091,	.7308,	.5786,
8,	.5064,	.3588,	.6174,	.6952,	.7781,	.6303,	.2161,	.3195,	.7114,	.3786,	.4699,
9,	.3321,	.3514,	.3935,	.6549,	.4479,	.9404,	.2089,	.1851,	.3225,	.4418,	.3165,
+gp,	.3321,	.3514,	.3935,	.6549,	.4479,	.9404,	.2089,	.1851,	.3225,	.4418,	
FBAR 4- 7,	.2182,	.2934,	.3617,	.3890,	.4100,	.4061,	.3719,	.3412,	.4625,	.6150,	

Table 2.14

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
2,	.0168,	.0111,	.2317,	.0103,	.0049,	.0026,	.0010,	.0132,	.0040,	.0006,
3,	.1196,	.2460,	.1328,	.0839,	.1170,	.1063,	.0571,	.1151,	.0638,	.0449,
4,	.3486,	.4225,	.5494,	.4464,	.3270,	.1902,	.2986,	.3241,	.5807,	.2062,
5,	.5363,	.8761,	.7924,	1.2192,	.4328,	.5596,	.4810,	1.1223,	1.0215,	.6012,
6,	1.0100,	1.2069,	1.1076,	.8918,	1.2348,	.9643,	.8287,	1.0161,	1.2201,	.9463,
7,	2.1051,	1.4945,	1.5506,	1.4426,	2.0054,	2.2859,	2.3917,	1.5375,	1.1777,	2.2464,
8,	1.7239,	1.2004,	1.6085,	1.4924,	1.9168,	2.4960,	3.4657,	1.0908,	1.2527,	1.9627,
9,	1.3579,	1.2052,	1.2771,	1.2727,	1.4123,	1.5900,	1.8026,	1.1970,	1.1742,	1.4478,
+gp,	1.3579,	1.2052,	1.2771,	1.2727,	1.4123,	1.5900,	1.8026,	1.1970,	1.1742,	1.4478,
REFMEAN,	.6220,	.5273,	.5801,	.4905,	.6165,	.3712,	.1799,	.1663,	.2257,	.2256,

Table 2.14 (continued)

Table 9 Relative F at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	MEAN 01-03
AGE											
2,	.0632,	.0888,	.0931,	.1157,	.0518,	.0335,	.0287,	.0128,	.0648,	.0357,	.0378,
3,	.1149,	.1598,	.2747,	.3301,	.3105,	.1591,	.1793,	.1272,	.2484,	.3918,	.2558,
4,	.2695,	.4627,	.4897,	.4764,	.6468,	.3656,	.6886,	.5087,	.6223,	.6970,	.6093,
5,	.7270,	.8761,	1.2922,	.6238,	.9318,	.9876,	1.0262,	1.0014,	.9502,	.9366,	.9627,
6,	.9479,	1.0758,	1.0691,	1.1778,	1.0042,	1.2244,	1.2749,	1.0367,	1.3268,	1.1781,	1.1805,
7,	2.0557,	1.5855,	1.1490,	1.7221,	1.4172,	1.4224,	1.0103,	1.4532,	1.1007,	1.1883,	1.2474,
8,	2.3209,	1.2227,	1.7070,	1.7872,	1.8976,	1.5520,	.5809,	.9365,	1.5382,	.6157,	1.0301,
9,	1.5221,	1.1976,	1.0881,	1.6836,	1.0924,	2.3156,	.5616,	.5426,	.6974,	.7183,	.6528,
+gp,	1.5221,	1.1976,	1.0881,	1.6836,	1.0924,	2.3156,	.5616,	.5426,	.6974,	.7183,	
REFMEAN,	.2182,	.2934,	.3617,	.3890,	.4100,	.4061,	.3719,	.3412,	.4625,	.6150,	

Table 2.15

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	88000,	75014,	35987,	37460,	40558,	46151,	43231,	62905,	49423,	31235,
3,	53634,	71298,	61058,	25758,	30516,	33107,	37748,	35388,	51389,	40428,
4,	39426,	40765,	51273,	46284,	20238,	23246,	26057,	30590,	28424,	41472,
5,	28357,	25987,	26709,	30522,	30442,	13545,	17735,	20218,	23731,	20412,
6,	14225,	16631,	13405,	13809,	13742,	19087,	9009,	13317,	13735,	15428,
7,	7515,	6214,	7206,	5772,	7300,	5255,	10925,	6355,	9208,	8538,
8,	3631,	1661,	2313,	2400,	2329,	1736,	1842,	5817,	4029,	5779,
9,	1587,	1017,	722,	745,	945,	585,	563,	808,	3973,	2486,
+gp,	1191,	613,	848,	350,	623,	211,	289,	573,	1316,	2717,
TOTAL,	237567,	239201,	199521,	163101,	146695,	142923,	147398,	175970,	185229,	168496,

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	GMST 84-03
AGE												
2,	26769,	34806,	39833,	33301,	29132,	20598,	16222,	11157,	7190,	4117,	0,	35812,
3,	25569,	21616,	27764,	31533,	26065,	23350,	16636,	13140,	9095,	5713,	3297,	31767,
4,	32766,	20416,	16887,	20581,	22706,	18789,	17921,	12742,	10301,	6638,	3676,	26377,
5,	32411,	25295,	14593,	11582,	14000,	14260,	13260,	11357,	8770,	6325,	3540,	19582,
6,	14592,	22643,	16015,	7487,	7439,	7822,	7817,	7412,	6608,	4627,	2911,	12257,
7,	10203,	9715,	13520,	8907,	3877,	4035,	3895,	3984,	4261,	2929,	1836,	6875,
8,	4211,	5334,	4995,	7306,	3732,	1775,	1854,	2190,	1987,	2097,	1155,	3111,
9,	3038,	2078,	3051,	2206,	2984,	1403,	774,	1223,	1303,	798,	1176,	1388,
+gp,	3098,	1603,	1830,	1554,	1040,	570,	887,	775,	1501,	304,	580,	
TOTAL,	152658,	143505,	138487,	124456,	110976,	92603,	79267,	63980,	51014,	33547,	18170,	

Table 2.16

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Terminal Fs derived using XSA (With F shrinkage)

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
2,	880,	750,	360,	375,	406,	462,	432,	629,	494,	312,
3,	3218,	4278,	3663,	1545,	1831,	1986,	2265,	2123,	3083,	2426,
4,	9462,	9784,	12305,	11108,	4857,	5579,	6254,	7342,	6822,	9953,
5,	13895,	12734,	13088,	14956,	14917,	6637,	8690,	9907,	11628,	10002,
6,	10242,	11974,	9652,	9943,	9894,	13743,	6487,	9588,	9889,	11108,
7,	6613,	5468,	6341,	5080,	6424,	4625,	9614,	5592,	8103,	7514,
8,	3449,	1578,	2198,	2280,	2213,	1649,	1750,	5526,	3828,	5490,
9,	1587,	1017,	722,	745,	945,	585,	563,	808,	3973,	2486,
+gp,	1191,	613,	848,	350,	623,	211,	289,	573,	1316,	2717,

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
2,	268,	0,	0,	0,	0,	206,	162,	0,	0,	0,
3,	1534,	216,	833,	1892,	1564,	701,	998,	0,	182,	0,
4,	7864,	4083,	4053,	5969,	5676,	3946,	4301,	892,	206,	332,
5,	15881,	11888,	8172,	5212,	7420,	6274,	6498,	4202,	2280,	1834,
6,	10506,	15171,	12812,	5690,	5505,	5085,	5629,	5856,	5815,	2267,
7,	8979,	8258,	12439,	8640,	3373,	3107,	3428,	3864,	3962,	2636,
8,	4000,	4587,	4945,	7306,	3322,	1775,	1761,	2146,	1788,	2055,
9,	3038,	2078,	3051,	2206,	2984,	1403,	774,	1199,	1264,	767,
+gp,	3098,	1603,	1830,	1554,	1040,	570,	887,	775,	1501,	304,

Table 2.17

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
2,	28253,	24080,	11552,	12026,	13020,	14814,	13879,	20199,	15866,	10026,
3,	40661,	54046,	46284,	19526,	23133,	25095,	28618,	26832,	38957,	30643,
4,	58321,	60293,	75837,	68459,	29935,	34381,	38544,	45256,	42043,	61335,
5,	60609,	55536,	57082,	65229,	65059,	28945,	37906,	43218,	50718,	43619,
6,	40037,	46802,	37725,	38862,	38672,	53710,	25357,	37484,	38655,	43413,
7,	35493,	29344,	34027,	27259,	34475,	24816,	51594,	30016,	43485,	40316,
8,	24277,	11106,	15467,	16042,	15572,	11606,	12313,	38899,	26938,	38631,
9,	11081,	7102,	5042,	5200,	6596,	4083,	3928,	5644,	27733,	17354,
+gp,	11579,	5959,	8243,	3407,	6059,	2049,	2813,	5571,	12799,	26415,
TOTALBIO,	310310,	294268,	291259,	256010,	232520,	199500,	214953,	253119,	297194,	311750,

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

YEAR, AGE	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
2,	8593,	13576,	10038,	7994,	10749,	6654,	5920,	4420,	3133,	1527,
3,	19381,	17100,	20102,	21542,	22829,	19641,	13458,	12699,	8287,	4061,
4,	48461,	31138,	24201,	28080,	32792,	31478,	27847,	19428,	18259,	8393,
5,	69262,	56211,	29962,	21930,	29260,	31263,	33665,	26292,	21724,	12823,
6,	41062,	65242,	44013,	21089,	21768,	22353,	23833,	24619,	21076,	13604,
7,	48178,	45324,	63848,	39434,	16608,	18322,	16951,	14726,	18535,	10971,
8,	28150,	37230,	33394,	46811,	20823,	11681,	11500,	13463,	8893,	9741,
9,	21209,	14044,	21148,	17220,	24638,	13270,	6598,	10728,	10291,	4685,
+gp,	30125,	15867,	17790,	16826,	12867,	7361,	10696,	9662,	19849,	2920,
TOTALBIO,	314421,	295733,	264496,	220927,	192335,	162023,	150467,	136036,	130047,	68726,

Table 2.18

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
2,	283,	241,	116,	120,	130,	148,	139,	202,	159,	100,
3,	2440,	3243,	2777,	1172,	1388,	1506,	1717,	1610,	2337,	1839,
4,	13997,	14470,	18201,	16430,	7184,	8251,	9251,	10861,	10090,	14720,
5,	29698,	27213,	27970,	31962,	31879,	14183,	18574,	21177,	24852,	21373,
6,	28827,	33697,	27162,	27981,	27844,	38671,	18257,	26989,	27832,	31257,
7,	31234,	25823,	29944,	23988,	30338,	21838,	45403,	26414,	38267,	35478,
8,	23063,	10551,	14693,	15240,	14793,	11026,	11698,	36954,	25591,	36699,
9,	11081,	7102,	5042,	5200,	6596,	4083,	3928,	5644,	27733,	17354,
+gp,	11579,	5959,	8243,	3407,	6059,	2049,	2813,	5571,	12799,	26415,
TOTSPBIO,	152201,	128298,	134147,	125501,	126211,	101756,	111779,	135422,	169660,	185235,

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

YEAR, AGE	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
2,	86,	0,	0,	0,	0,	67,	59,	0,	0,	0,
3,	1163,	171,	603,	1293,	1370,	589,	807,	0,	166,	0,
4,	11631,	6228,	5808,	8143,	8198,	6610,	6683,	1360,	365,	420,
5,	33939,	26419,	16779,	9869,	15508,	13756,	16496,	9728,	5648,	3719,
6,	29565,	43712,	35210,	16028,	16109,	14529,	17160,	19449,	18547,	6666,
7,	42397,	38526,	58740,	38251,	14449,	14108,	14917,	14284,	17237,	9873,
8,	26742,	32018,	33060,	46811,	18533,	11681,	10925,	13194,	8003,	9546,
9,	21209,	14044,	21148,	17220,	24638,	13270,	6598,	10513,	9983,	4498,
+gp,	30125,	15867,	17790,	16826,	12867,	7361,	10696,	9662,	19849,	2920,
TOTSPBIO,	196855,	176985,	189138,	154440,	111671,	81971,	84341,	78190,	79799,	37642,

Table 2.19

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 5/05/2004 10:20

Table 17 Summary (with SOP correction)
Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 2,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4- 7,
1984,	88000,	310310,	152201,	74824,	.4916,	1.0002,	.6220,
1985,	75014,	294268,	128298,	75451,	.5881,	1.0000,	.5273,
1986,	35987,	291259,	134147,	68905,	.5137,	1.0001,	.5801,
1987,	37460,	256010,	125501,	60972,	.4858,	1.0001,	.4905,
1988,	40558,	232520,	126211,	59294,	.4698,	1.0001,	.6165,
1989,	46151,	199500,	101756,	40285,	.3959,	1.0000,	.3712,
1990,	43231,	214953,	111779,	28127,	.2516,	1.0002,	.1799,
1991,	62905,	253119,	135422,	24822,	.1833,	1.0003,	.1663,
1992,	49423,	297194,	169660,	41690,	.2457,	1.0001,	.2257,
1993,	31235,	311750,	185235,	52557,	.2837,	1.0000,	.2256,
1994,	26769,	314421,	196855,	54562,	.2772,	1.0000,	.2182,
1995,	34806,	295733,	176985,	57207,	.3232,	1.0001,	.2934,
1996,	39833,	264496,	189138,	61776,	.3266,	1.0001,	.3617,
1997,	33301,	220927,	154440,	63319,	.4100,	1.0003,	.3890,
1998,	29132,	192335,	111671,	51572,	.4618,	.9919,	.4100,
1999,	20598,	162023,	81971,	40732,	.4969,	1.0002,	.4061,
2000,	16222,	150467,	84341,	36715,	.4353,	.9999,	.3719,
2001,	11157,	136036,	78190,	29699,	.3798,	1.0004,	.3412,
2002,	7190,	130047,	79799,	40994,	.5137,	1.0181,	.4625,
2003,	4117,	68726,	37642,	34635,	.9201,	.9659,	.6150,
Arith.Mean,	36654,	229805,	128062,	49907,	.4227		.3937,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 2.20

Analysis by RCT3 ver3.1 of data from file :
c:\data\ices-04\rct3\ncc-inn1.txt
NORWEGIAN COASTAL COD: recruits as 2 year-olds

Data for 1 surveys over 9 years : 1994 - 2002

Regression type = C
Tapered time weighting applied
power = 0 over 20 years
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean included
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2002

	Regression					Prediction			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Norweg	1.32	-2.16	1.41	.271	8	7.64	7.91	1.864	1.000
					VPA Mean =		9.68	.793	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2002	2728	7.91	1.86	.00	.00

Table 2.21 Prediction with management option table: Input data

Year: 2004								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	2728	0.2	0	0	0	0.384	0.0244	0.491
3	3297	0.2	0	0	0	0.736	0.1731	1.179
4	3676	0.2	0.05	0	0	1.309	0.3859	1.800
5	3540	0.2	0.29	0	0	2.099	0.5883	2.485
6	2911	0.2	0.49	0	0	3.044	0.7334	3.860
7	1836	0.2	0.90	0	0	3.878	0.7524	4.760
8	1155	0.2	0.98	0	0	4.810	0.6110	5.195
9	1176	0.2	0.96	0	0	6.075	0.4116	5.507
10+	580	0.2	1.00	0	0	9.954	0.4116	9.183
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	2728	0.2	0	0	0	0.384	0.0244	0.491
3	.	0.2	0	0	0	0.736	0.1731	1.179
4	.	0.2	0.05	0	0	1.309	0.3859	1.800
5	.	0.2	0.29	0	0	2.099	0.5883	2.485
6	.	0.2	0.49	0	0	3.044	0.7334	3.860
7	.	0.2	0.90	0	0	3.878	0.7524	4.760
8	.	0.2	0.98	0	0	4.810	0.6110	5.195
9	.	0.2	0.96	0	0	6.075	0.4116	5.507
10+	.	0.2	1.00	0	0	9.954	0.4116	9.183
Unit	Thousands	-	-	-	-	Grams	-	Grams

Year: 2006								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	2728	0.2	0	0	0	0.384	0.0244	0.491
3	.	0.2	0	0	0	0.736	0.1731	1.179
4	.	0.2	0.05	0	0	1.309	0.3859	1.800
5	.	0.2	0.29	0	0	2.099	0.5883	2.485
6	.	0.2	0.49	0	0	3.044	0.7334	3.860
7	.	0.2	0.90	0	0	3.878	0.7524	4.760
8	.	0.2	0.98	0	0	4.810	0.6110	5.195
9	.	0.2	0.96	0	0	6.075	0.4116	5.507
10+	.	0.2	1.00	0	0	9.954	0.4116	9.183
Unit	Thousands	-	-	-	-	Grams	-	Grams

Basis; Weight in catch 2004-2006 - Weight in catch 2002
Weight in stock 2004-2006 - Weight in stock 2003
Maturity ogive 2004-2006 - Maturity ogive 2003
Exploit. Pattern 2004-2006 - Average 2001-2003 scaled to 2003

Table 2.22
Prediction with management option table

Year: 2004					Year: 2005					Year: 2006	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock Biomass
1	0.6150	50 171	31 222	21 847	0	0	35 264	23 604	0	39 116	28 092
					0.1	0.0615	35 264	23 604	1 825	37 254	26 577
					0.2	0.1230	35 264	23 604	3 549	35 496	25 149
					0.3	0.1845	35 264	23 604	5 179	33 836	23 803
					0.4	0.2460	35 264	23 604	6 720	32 268	22 534
					0.5	0.3075	35 264	23 604	8 178	30 786	21 338
					0.6	0.3690	35 264	23 604	9 556	29 386	20 209
					0.7	0.4305	35 264	23 604	10 861	28 062	19 145
					0.8	0.4920	35 264	23 604	12 096	26 811	18 140
					0.9	0.5535	35 264	23 604	13 265	25 627	17 192
					1	0.6150	35 264	23 604	14 373	24 507	16 297
					1.1	0.6765	35 264	23 604	15 422	23 447	15 452
					1.2	0.7380	35 264	23 604	16 417	22 444	14 654
					1.3	0.7995	35 264	23 604	17 360	21 494	13 900
					1.4	0.8610	35 264	23 604	18 254	20 595	13 187
					1.5	0.9225	35 264	23 604	19 103	19 742	12 514
					1.6	0.9840	35 264	23 604	19 908	18 935	11 878
					1.7	1.0455	35 264	23 604	20 672	18 170	11 276
					1.8	1.1070	35 264	23 604	21 398	17 444	10 707
					1.9	1.1685	35 264	23 604	22 088	16 756	10 169
					2	1.2300	35 264	23 604	22 743	16 104	9 659
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Basis for 2004: Status quo fishing mortality

Table 2.23 Catch options for 2005 with corresponding total stock biomasses and spawning stock biomasses in 2006.
Basis: F(2004) =$\mathbf{F}_{sq}$ = 0.6150; Landings(2004) = 21, 847 t, SSB(2005) = 23,604 t.

F(2005)	Basis	Catch 2005 (t)	Total stock biomass 2006 (t)	SSB 2006 (t)
0	$0*F_{sq}$	0	39 116	28 092
0.0615	$0.1*F_{sq}$	1 825	37 254	26 577
0.1230	$0.2*F_{sq}$	3 549	35 496	25 149
0.2460	$0.4*F_{sq}$	6 720	32 268	22 534
0.3690	$0.6*F_{sq}$	9 556	29 386	20 209
0.4920	$0.8*F_{sq}$	12 096	26 811	18 140
0.6150	$1.0*F_{sq}$	14 373	24 507	16 297

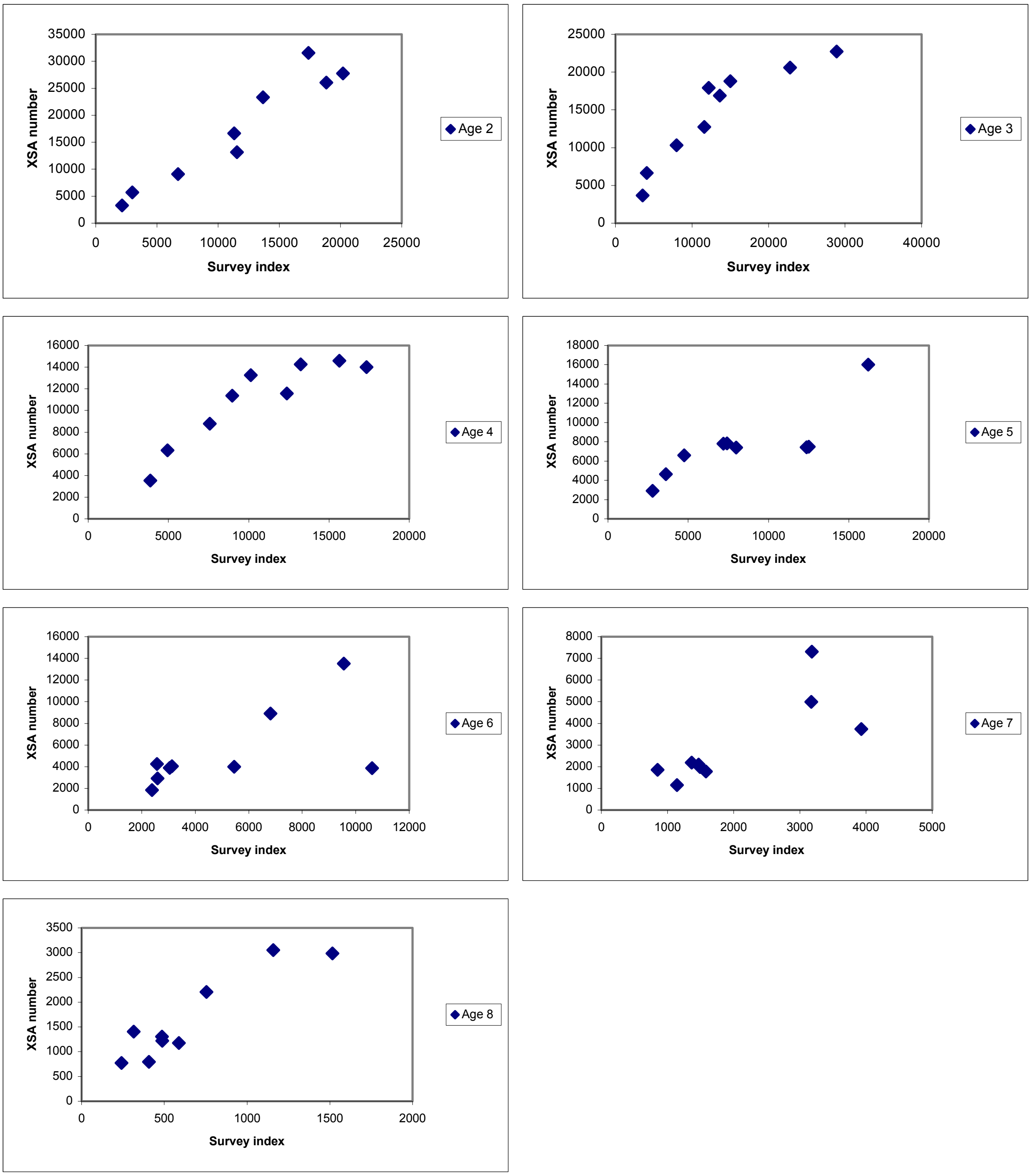


Figure 2.1 Norwegian Coastal cod – Coastal acoustic survey vs XSA. Age (n) in survey = age (n+1) from XSA the year after because the surveys are conducted late autumn (1995-2001).

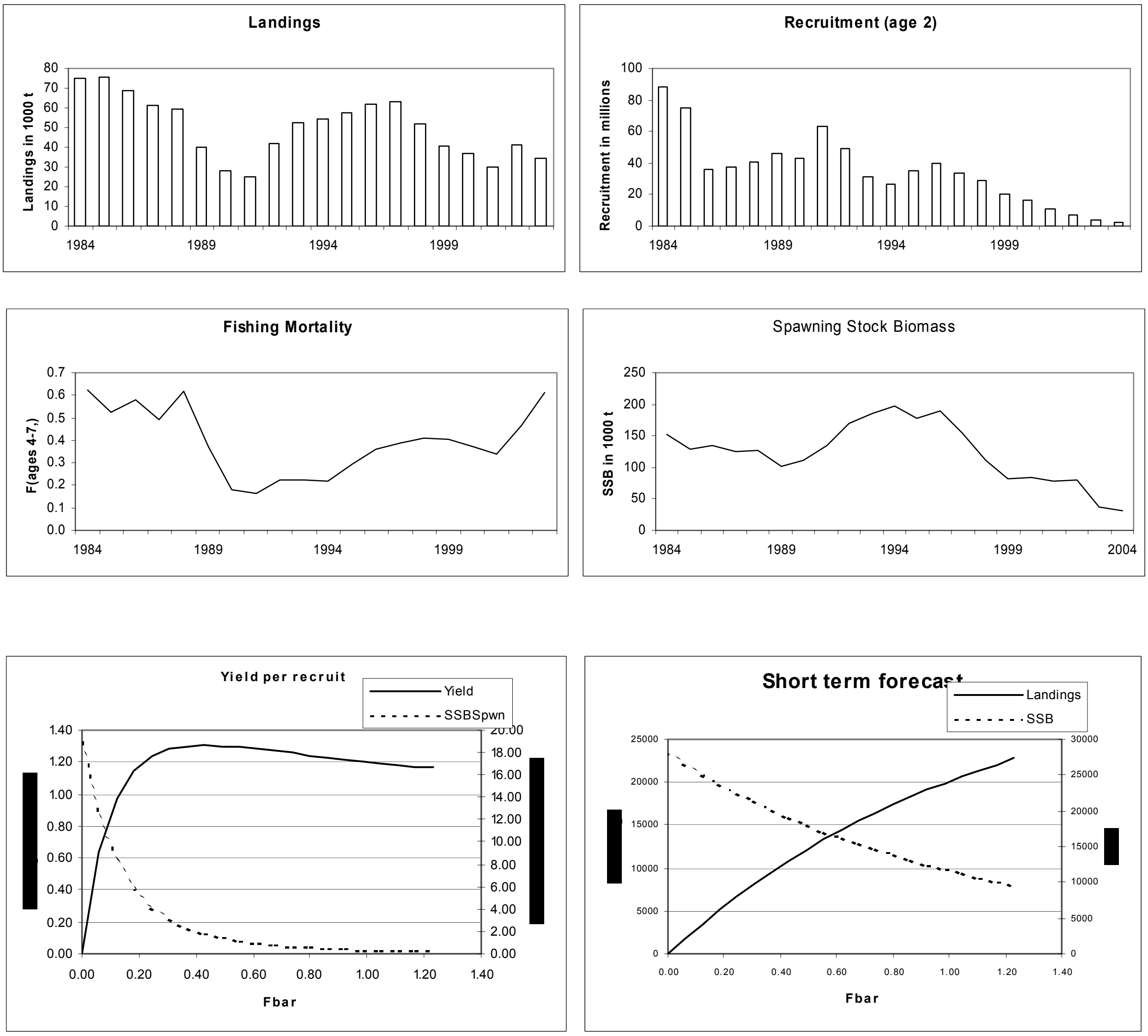


Figure 2.2 Norwegian Coastal cod: Historical landings, recruitment, fishing mortality and spawning stock biomass. Long term yield pr recruit and spawning stock biomass per recruit. Short term yield and spawning stock biomass .

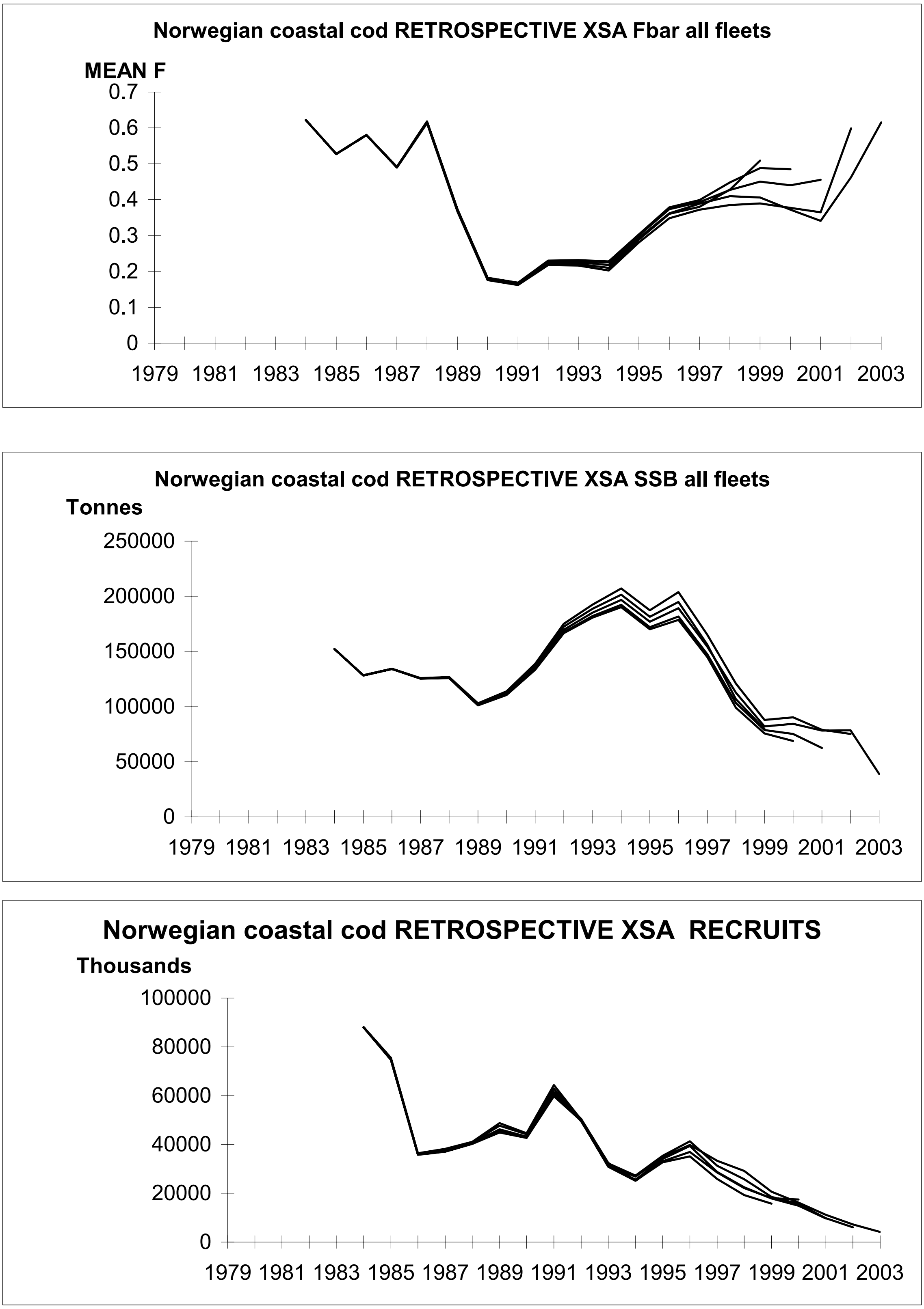


Figure 2.3 Norwegian coastal cod: Retrospective plots using XSA.with shrinkage SE=1.0.

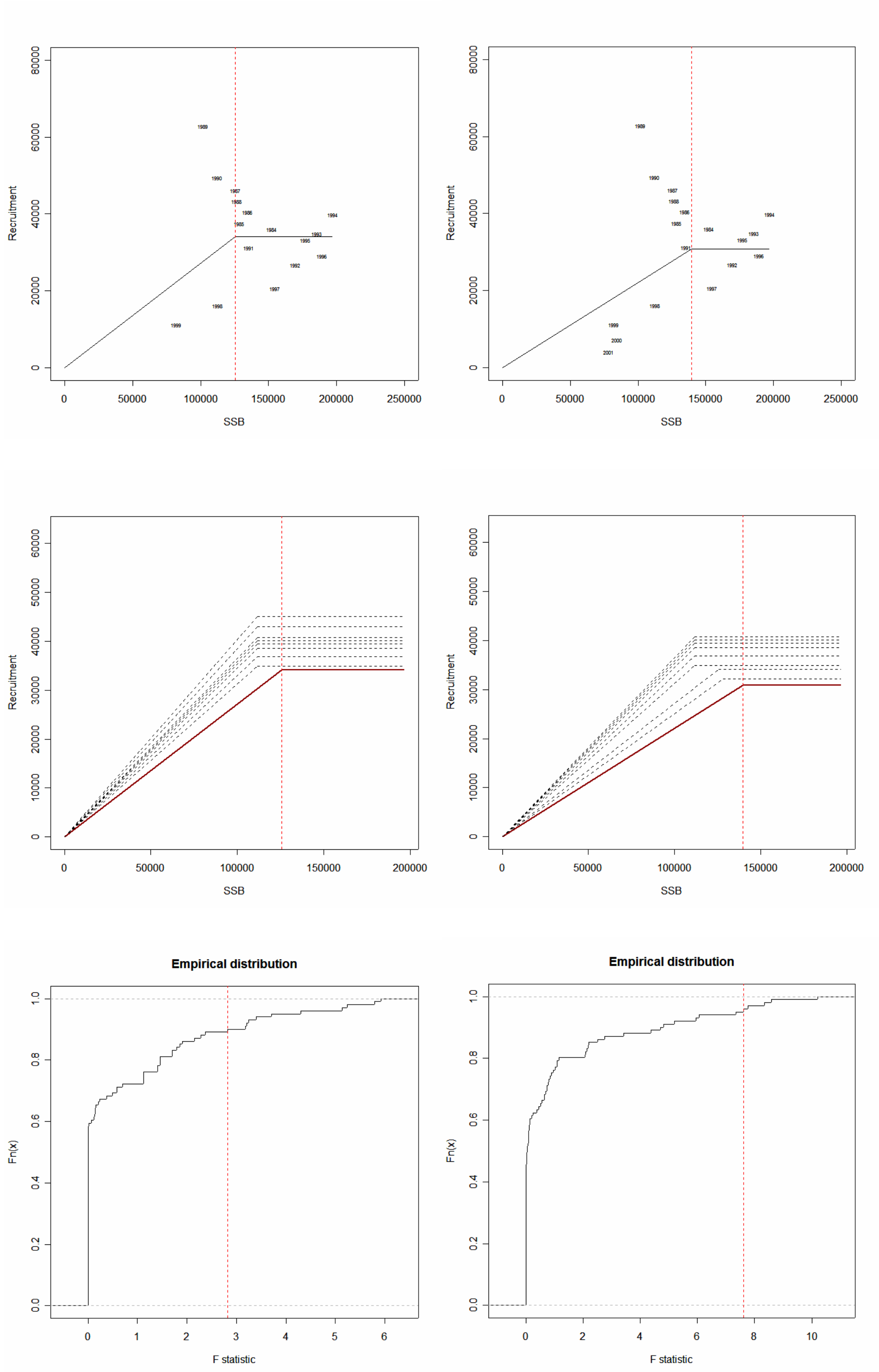


Figure 2.4 Estimated B_{lim} values, sensitivity analyses and significant level of the changepoint from segmented regression. Left panel includes year classes 1984-1999. Right panel includes year classes 1984-2001.

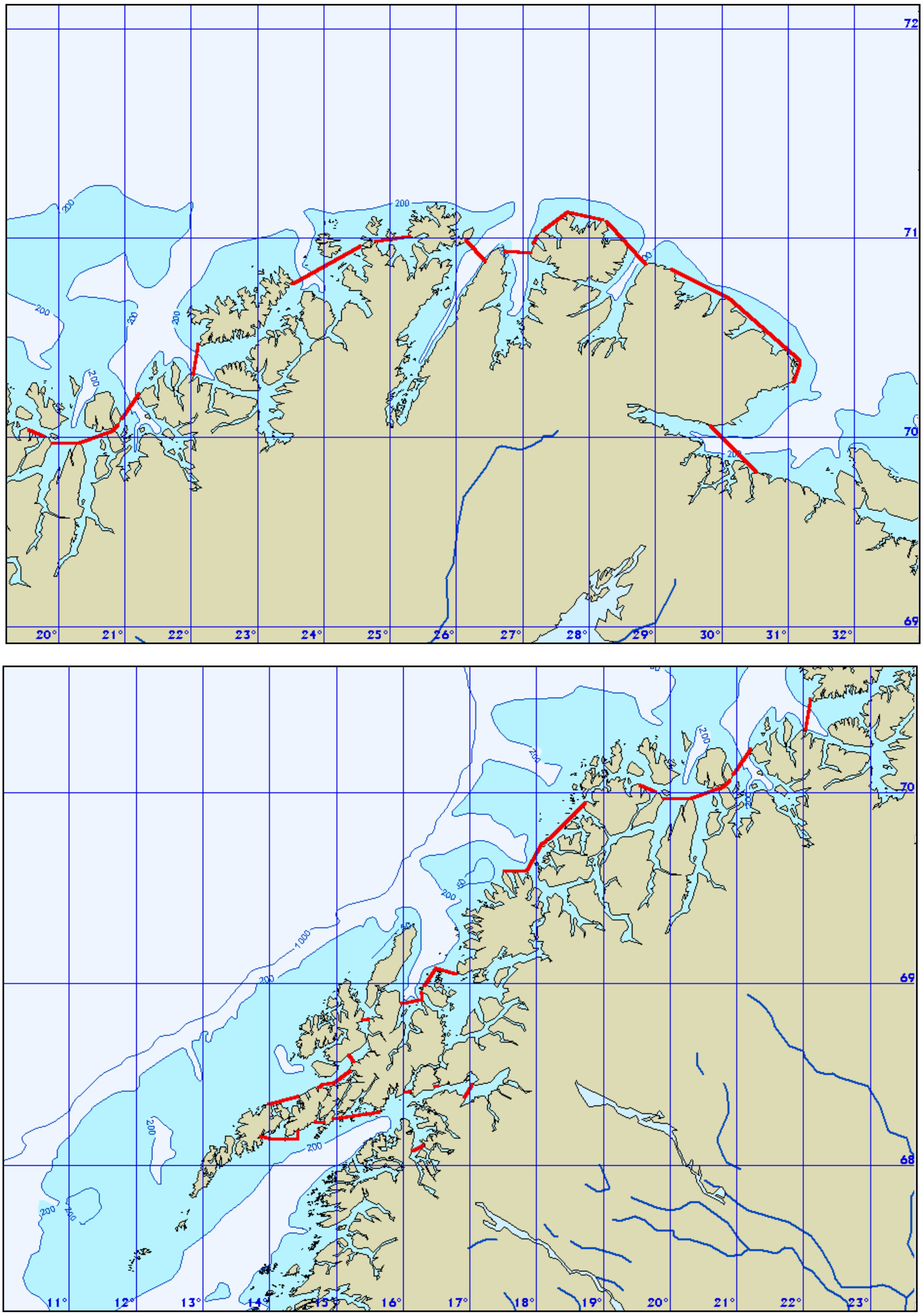


Figure 2.5. Areas inside lines drawn along the coast are closed for direct fishing of cod for vessels above 15 meters.

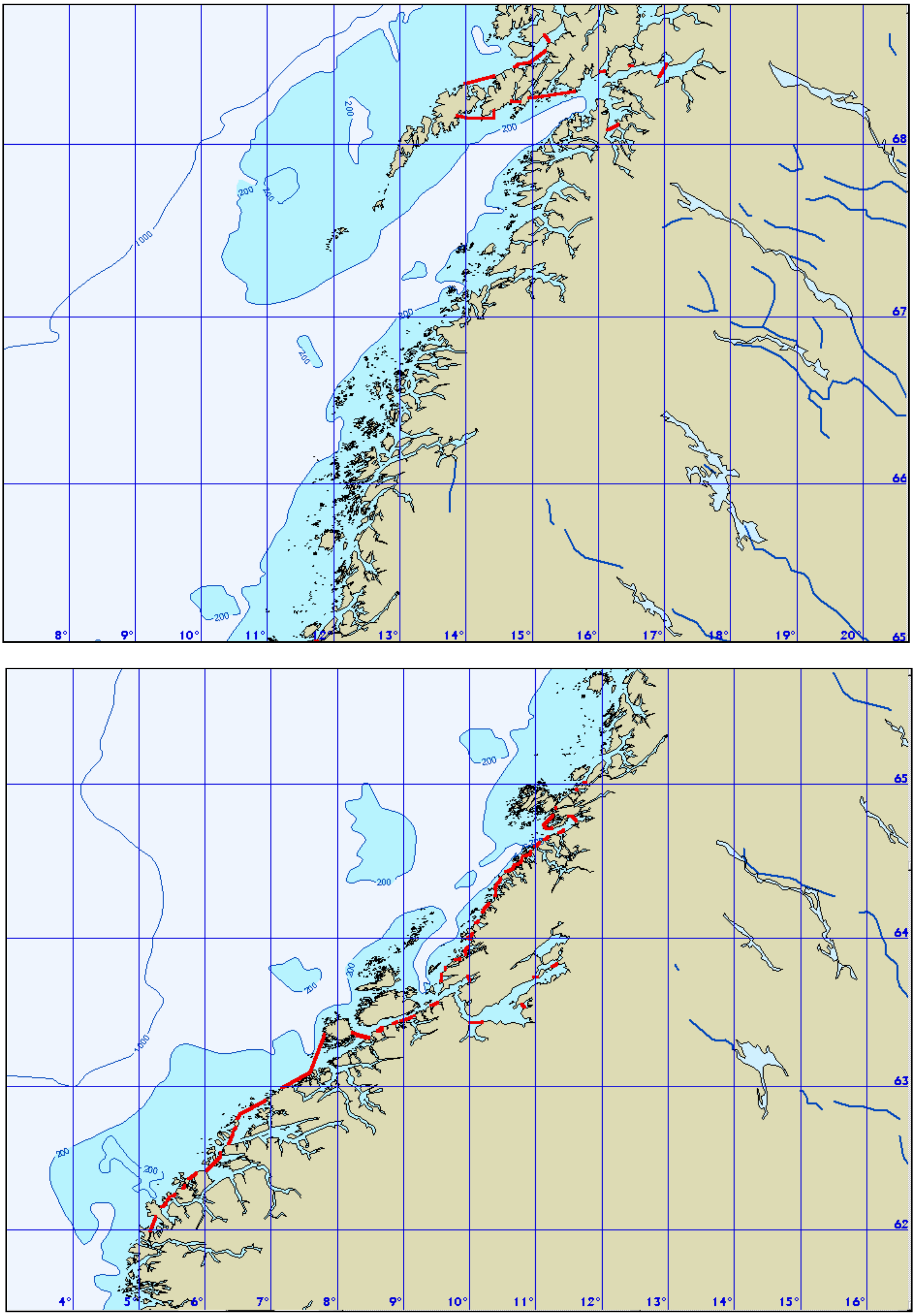


Figure 2.5 (Continued). Areas inside lines drawn along the coast are closed for direct fishing of cod for vessels above 15 meters.

3 NORTH-EAST ARCTIC COD (SUB-AREAS I AND II)

3.1 Status of the fisheries

3.1.1 Historical development of the fisheries (Table 3.1)

From a level of about 900,000 t in the mid-1970s, landings declined steadily to around 300,000 t in 1983-1985 (Table 3.1). Landings increased to above 500,000 t in 1987 before dropping to 212,000 t in 1990, the lowest level recorded in the post-war period. The catches increased rapidly from 1991 onwards, stabilised around 750,000 t in 1994-1997 but decreased to about 414,000 t in 2000. The estimated catch in 2003 was about 522,000 tonnes. The fishery is conducted both with an international trawler fleet and with coastal vessels using traditional fishing gears. Quotas were introduced in 1978 for the trawler fleets and in 1989 for the coastal fleets. In addition to quotas, the fishery is regulated by a minimum catch size, a minimum mesh size in trawls and Danish seines, a maximum by-catch of undersized fish, closure of areas having high densities of juveniles and by seasonal and area restrictions.

3.1.2 Landings prior to 2004 (Tables 3.1-3.3, Figure 3.1)

Total landings of cod in sub-area I and Divisions IIa and IIb:

Final official landings for 2002 amount to 464,839 t. The provisional official landings for 2003 are 450,493 t. Unreported landings of around 90,000 t have been estimated both for 2002 and 2003.

Landing figures used for the assessment of North-East Arctic cod:

The historical practise (considering catches between 62ºN and 67ºN for the whole year and catches between 67ºN and 69ºN for the second half of the year to be Norwegian coastal cod) lead to official landings of North-East Arctic cod of 445,045 t in 2002 and 431,949 t in 2003 (Table 3.1). For the assessment the estimated 90,000 tonnes of unreported catches was added both years.

The landings by area, split into trawl and other gears, is given in Table 3.2 and the nominal landings by country is given in Table 3.3. Compared to 2002, the landings in 2003 decreased in Division IIb and increased in Sub-area IIa (Table 3.1).

3.1.3 Expected landings in 2004

The mixed Norwegian-Russian fisheries commission agreed on a TAC of 506,000 t for 2004, including 20,000 t Norwegian coastal cod.

The Working Group has no information on the size of expected unreported landings in 2004 but believes this could continue to be a problem.

3.2 Status of research

3.2.1 Fishing effort and CPUE (Table A1)

CPUE series of the Norwegian, Russian and Spanish trawl fisheries are given in Table A1. The data reflect the total trawl effort, both for Norway and Russia. The Norwegian series is given as a total for all areas (Table A1).

3.2.2 Survey results (Tables A2-A5, A10-A11, A14-A16)

With respect to year class strength, the overall picture seen in the surveys is summarized as follows: the 2001 and 2003 year classes are weak. The 2002 year class is also observed to below average in the latest survey, while it appeared more promising in earlier surveys. Most of the age groups in the fishable stock have increased in the last autumn survey compared to the year before, while they decreased in the last winter survey compared to the year before.

Joint Barents Sea winter survey (bottom trawl and acoustics)

The preliminary swept area estimates and acoustic estimates from the Joint winter survey on demersal fish in the Barents Sea in winter 2004 are given in Tables A2 and A3.

Before 2000 this survey was made without participation from Russian vessels, while in the four latest surveys Russian vessels have covered important parts of the Russian zone.

It should be noted that the survey conducted in 1993 and later years covered a larger area compared to previous years (Jakobsen *et al*. 1997). In 1991 and 1992, the number of young cod (particularly 1- and 2-year old fish) was probably underestimated, as cod of these ages were distributed at the edge of the old survey area. Other changes in the survey methodology through time are described by Jakobsen *et al*. (1997). Note that the change from 35 to 22 mm mesh size in the codend in 1994 is not corrected for in the time series. This mainly affects the age 1 indices.

Lofoten acoustic survey on spawners

The estimated abundance indices from the Norwegian acoustic survey off Lofoten and Vesterålen (the main spawning area for this stock) in March/April are given in Table A4. A description of the survey, sampling effort and details of the estimation procedure can be found in Korsbrekke (1997). There is still a high proportion of first time spawners in the survey.

Norwegian summer/autumn survey

Table A5 gives the results of the Norwegian bottom trawl survey in the Svalbard and Barents Sea area in August/September. The results for the Svalbard area (Division IIb) have been used earlier in the XSA tuning but have been left out in the three latest assessments. The series given for the Barents Sea covers ICES Division IIa and IIb and the north-western part of sub-area I, and thus includes the Svalbard area estimates.

Russian autumn survey

Abundance estimates from the Russian autumn survey (November-December) are given in Table A10 (acoustic estimates) and Table A11 (bottom trawl estimates). The Russian autumn survey did not cover the Norwegian economical zone in 2002. The indices obtained were adjusted assuming the area distribution to be equal to the 1998-2001 average. The 2003 survey was conducted with complete area coverage.

International 0-group survey

Abundance indices of 0-group cod from the International 0-group survey are provided in Tables A14 and A15. It should be noted that in 1985 some gear changes were made, and the earlier part of the time series is now adjusted to take account of these changes (Nakken and Raknes 1996). The abundance of 0-group cod was very low in 2001, and somewhat below average in 2002 and 2003. The same pattern is observed for age 1 of the same year-classes in the groundfish surveys. The 0-group abundance in the years 1992-1997 is rather outstanding in the time series. Among those year-classes only 1994 and 1995 appear to be above average at age 3 in other surveys.

3.2.3 Age reading

The joint Norwegian-Russian work on cod otolith reading has continued, with regular exchanges of otoliths and age readers (Introduction chapter). Within laboratories (IMR, PINRO) and between laboratories (IMR-PINRO) differences in age reading will be presented at the 3rd International Symposium on otoliths (Australia, July 2004).

3.2.4 Length and Weight at age (Tables A6-A9, A12-A13)

Length at age is shown in Table A6 for the Norwegian survey in the Barents Sea in winter, in Table A8 for the Lofoten survey and in Table A12 for the Russian survey in October-December. Weight at age is shown in Table A7 for the Norwegian survey in the Barents Sea in winter, in Table A9 for the Lofoten survey and in Table A13 for the Russian survey in October-December.

Both the joint winter survey in 2004 and the Russian autumn survey in 2003 show decrease in weights for some ages (Table A7 and A13).

3.2.5 Maturity at age (Table 3.5)

Historical (pre 1982) Norwegian and Russian time series on maturity ogives were reconstructed by the 2001 AFWG meeting (ICES CM 2001/ACFM:19). The Norwegian maturity ogives were constructed using the Gulland method for individual cohorts, based on information on age at first spawning from otoliths. For the time period 1946-1958 only the Norwegian data were available. The Russian proportions mature at age, based on visual examinations of gonads, were available from 1959.

Since 1982 Russian and Norwegian survey data have been used (Table 3.5). For the years 1985-2003, Norwegian maturity at age ogives have been obtained by combining the Barents Sea and Lofoten surveys according to the method described in Marshall *et al*. (1998). Russian maturity ogives from the autumn survey are available from 1984 until present. The Norwegian maturity ogives tend to give a higher percent mature at age compared to the Russian ogives, which is consistent with the generally higher growth rates observed in cod sampled by the Norwegian surveys. The approach used is consistent with the approach used to estimate the weight at age in the stock (described in Section 3.3.2). The percent mature at age for the Russian and Norwegian surveys have been arithmetically averaged for all years, except 1982-1983 when only Norwegian observations were used and 1984 when only Russian observations were used.

The 2003 AFWG report contains an extensive section (3.2.5), addressing several issues of cod maturity investigations. Essential work is still in progress. Possible intersessional work on refining the maturity ogives includes:

- review the comparability between the Norwegian and Russian maturity stages with particular reference to the procedures used to exclude fish with uncertain maturity stages or identify individuals that may have skipped spawning;
- fill in gaps in the Russian data (by regions and months) by smoothing data using appropriate weighting factors (Lepesevich 2002).
- review the procedures used to combine the Barents Sea Joint Winter survey and the Lofoten survey.

3.2.5.1 Status of research on reproductive potential of NA cod

Research is ongoing into developing alternative indices of reproductive potential for NEA cod (Marshall et al. 1998). This research is benefiting from the improved accessibility of both Norwegian and Russian databases.

Preliminary estimates of total egg production were presented to the 2003 AFWG (Needle and Marshall WD2, 2003). These estimates require further refinements before being considered as final. These refinements include: a) developing female-only maturity ogives for the full time period (1946-2001); b) refinements to the method of hindcasting fecundity and c) developing a model to incorporate maternal effects on egg viability. Female-only SSB will also be estimated for the full time period. Additionally, software tools are being developed to estimate alternative indices of reproductive potential from standard assessment output and link this information to both recruitment and medium-term stock projections.

3.2.5.2 Potential causes of interannual variation in maturity ogives

The maturity ogives used for the medium-term stock projections have a considerable impact on the forecasted SSB values. Average values are used, however, it would be advantageous to identify factors contributing to variation in maturity ogives. There is a positive relationship between weight-at-age and maturity-at-age for age-classes 8 to 10 (Fig. 1.7), and between weight-at-length and maturity-at-length (Fig 1.8). Liver weight estimates (g) of cod (derived from the Russian liver condition index and age/length keys described in Marshall et al., in press) show a significant, positive relationship with the proportion of mature fish for three length groups for the time period 1984 to 2001 (Fig. 1.9)(Marshall, presentation for ICES Symposium Cod and Climate, Bergen May 2004). This result confirms that the magnitude of stored energy is positively correlated with the proportion mature.

The 2004 maturity-at-age values for age classes 6 and 7 are slightly higher than those for 2003. This is a bit in conflict with present growth rates. However, it may be connected with maturity stages, assumed to be skipped spawners. A decrease of maturity rates may be forecasted in the short-term particularly given the high levels of cod biomass and potentially low capelin biomass.

Bogstad et al. (WD3) found the maturity at age to be correlated with the total stock biomass. However, their analysis was based on the whole time series (1946-2002), while the correlation between weight at age and maturity at age is clearly different between the 1946-1979 and 1985-2001 periods (Section 1.4.2.2). Thus, it may be worthwhile to look at density-dependence of maturation for those periods separately.

Possible future work on projecting maturity ogives includes:

- establish a method for predicting liver weights in the upcoming year. This research can take advantage of the links between capelin stock biomass and liver condition.

3.3 Data used in the assessment

3.3.1 Catch at age (Tables 3.8, 3.9 and 3.10)

For 2002, age compositions for all areas were available from Norway (by gears), Russia, Spain and Germany. Age compositions of the total landings were calculated separately in Sub-area I and Division IIa and IIb by using the age compositions that were available and raising the landings from other countries by Russian trawl (Sub-area I and Division IIa), and by Norwegian trawl (Division IIb). For 2003, age compositions for all areas were available from Russia, Norway, Germany and Spain. Length measurements were reported from Portuguese catches. On this basis Portuguese catches were distributed by use of the age composition in the Russian catches. Unreported catches in 2002 were distributed on ages using total international catch age distribution in Division IIb only while in 2003 they were distributed using total international catch age distribution in Division IIb on half the unreported catch and total international catch age distribution in Sub-area I on the other half.

Table 3.8 show available catch at age data for all ages 1-15+. The catch numbers shown in Table 3.10 together with cannibalism figures (Tables 3.9) were used in the XSA tuning.

3.3.2 Weight at age (Tables 3.4 and 3.11-3.12).

Catch weights

For 2003, the mean weight at age in the catch (Table 3.11) was calculated as a weighted average of the weight at age in the catch for Norway, Russia, Germany and Spain. The weight at age in the catch for these countries is given in Table 3.4.

Stock weights

Since ages 12 and 13+ are scarce in the survey samples, fixed values for ages 12 to 15+ has formerly been used (set equal to typical weights for these ages observed in catches). Since the 2000 working group the assessment has applied 13 as plus group.The 13+ weights is now calculated year by year as a weighted mean of the former fixed values for older ages.

For ages 1-11 stock weights at age a (W_a) at the start of year y for 1983-2004 (Table 3.12) were calculated as follows:

$$W_a = 0.5(W_{rus,a-1} + (\frac{N_{nbar,a} W_{nbar,a} + N_{lof,a} W_{lof,a}}{N_{nbar,a} + N_{lof,a}}))$$

where

$W_{rus,a-1}$: Weight at age a-1 in the Russian survey in year y-1 (Table A13)

$N_{nbar,a}$: Abundance at age a in the Norwegian Barents Sea acoustic survey in year y (Table A2)

$W_{nbar,a}$: Weight at age a in the Norwegian Barents Sea acoustic survey in year y (Table A7)

$N_{lof,a}$: Abundance at age a in the Lofoten survey in year y (Table A4)

$W_{lof,a}$: Weight at age a in the Lofoten survey in year y (Table A9)

3.3.3 Natural mortality

A natural mortality of 0.2 was used. In addition, cannibalism was taken into account as described in Section 3.4.2. The proportion of F and M before spawning was set to zero.

3.3.4 Maturity at age (Tables 3.5 and 3.13)

As noted in Section 3.2.5, arithmetic averages of the Russian and Norwegian maturity at age values were used for 1985-2003.

3.3.5 Tuning data (Tables 3.14 and 3.15)

The following surveys and commercial CPUE data series was used for initial tuning runs by single fleets:

	Name	Place	Season	Age	Years
Fleet 17	Russian bottom trawl surv.	Total area	Oct-Dec	3-8	1982-2003
Fleet 09	Russian trawl CPUE	Total area	All year	9-12	1985-2003
Fleet 15	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2004
Fleet 16	Joint acoustic survey	Barents Sea + Lofoten	Feb-Mar	3-11	1985-2004 (Table A16)

The output tables from the tuning include ages 1 and 2, just to show the year-class abundance at age 1 and 2 created by the cannibalism numbers used in the tuning.

As in earlier assessments the surveys that were conducted during winter were allocated to the end of the previous year. This was done so that data from the surveys in 2004 could be included in the assessment. Some of the survey indices have been multiplied by a factor 10. This was done to keep the dynamics of the surveys even for very low indices, because XSA adds 1.0 to the indices before the logarithm is taken. The tuning fleet file is shown in Table 3.14.

Tuning of the VPA was carried out with XSA using default settings with the following exceptions:

1. Tapered time weighting power 3 over 10 years
2. Catchability dependent of stock size for ages less than 6
3. F of the 2 oldest age groups used in F shrinkage
4. Standard error of the mean to which estimates are shrunk set to 1.0

These settings are identical to those used by last years Working Group. The reasoning for keeping the same settings and tuning data are given in section 3.4.1.

3.3.6 Recruitment indices (Tables 3.6 and 3.7)

The survey data on ages 0,1 and 2 in the autumn survey and ages 1,2 and 3 in the joint winter survey are not used in the XSA, and are instead used to estimate the year-class strength at age 3 by making regressions with VPA estimates of recruitment at age 3 (the RCT3-program in the ICES software). The input is shown in Table 3.6, and the output is shown in Table 3.7.

3.3.7 Cannibalism

The method used for calculation of the consumption is described by Bogstad and Mehl (1997). It should be noted that the temperature is used in these calculations. The estimates were obtained as follows:

The cod stomach content data were taken from the joint PINRO-IMR stomach content database (methods described in Mehl and Yaragina 1992). On average 7,500 cod stomachs from the Barents Sea have been analysed annually. The stomachs are sampled throughout the year, although sampling is less frequent in the second quarter of the year. The consumption calculations have been updated by data for 2003 as well as additional data for 2002. The Barents Sea was divided into three areas (west, east and north) and the consumption by cod was calculated from the average stomach content of each prey group by area, half-year and cod age group.

The number of cod predators at age is taken from the VPA, and thus an iterative procedure has to be applied (Section 3.4.2). It was assumed that the mature part of the cod stock is found outside the Barents Sea for three months during the first half of the year. There were very few samples of the stomach contents of cod in the spawning areas. Thus, consumption by cod in the spawning period was omitted from the calculations. It is believed that the cod generally eats very little during spawning, although some predation by cod on herring has been observed close to the spawning areas. The geographical distribution of the cod stock by season is based on Norwegian survey data. The total number of cod ages 0–6 (million) consumed is given in Table 3.9. Alternative calculations of the number of cod consumed by cod, giving somewhat different results, were presented in WD 4.

3.3.8 Prediction data (Tables 3.23 and 3.28, Figure 3.2 and 3.14a)

The input data to the short-term prediction with management option table (2004-2006) are given in Table 3.28. For 2004 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2004 onwards and Stock weights in 2005 onwards are predicted by the method described by Brander (2002), where the latest observation of weights by cohort are used together with average annual increments to predict the weight of the cohort the following year.

$W(a+1,y+1)=W(a,y) + Incr(a)$, where $Incr(a)$ is a "medium term" average of $Incr(a,y)= W(a+1,y+1)-W(a,y)$

This method was introduced in the cod prediction in last years working group. Then it was decided that for Catch Weights average annual increments by age were calculated for the period 1994-2001 (based on weights for the period 1994-2002), and for Stock Weights average annual increments by age were calculated for the period 1995-2002 (based on weights for the period 1995-2003). Last years predictions fit well with the new observations on weights.

For the current predictions it was decided to follow the same procedure, except that for stock weights the period (2001-2003) was chosen for calculating average annual increment. The reason was that those years indicate a declining trend that could be associated with declining capelin stock. Figures 3.2a and 3.2b show how these predictions perform back in history. Evidently the fit is best over the period which is the basis for calculated Incr(a).

Last year the maturity ogive for the years 2004 and 2005 was predicted by using the 1984-2002 average. This is well below the ogive observed in 2004. The 2002-2004 period now appears rather stable, and an average over that period was applied. The exploitation pattern in 2004 and later years was set equal to the 2001-2003 average. The reference F was also averaged over the same period. Taking into account the uncertainty of the estimated F in 2003, it was concluded that there might not be a clear trend in F over this 3-year period.

The stock number at age in 2004 was taken from the final VPA (Table 3.23) for ages 4 and older. The recruitment at age 3 in year 2004 and later was estimated from surveys (section 3.3.6). Fig. 3.14a shows the development in natural mortality due to cannibalism for cod (prey) age groups 1-3 together with the abundance of capelin in the period 1984-2003. It is seen that the level of cannibalism is inversely related to the capelin abundance. Models for predicting cannibalism was presented in WD 10. High correlation was observed between the cod ssb and cannibalism mortality 3 years later. The group felt that this should be further explored, especially for a better understanding of the cause/ effect leading to such a relationship (section 1). For the current prediction the 2001-2003 average natural mortality was used.

3.4 Methods used in the assessment

3.4.1 VPA, tuning and sensitivity analysis

For several years each new assessment of this stock has shown a considerable downward revision in population size. This has been clearly shown both in the Quality Control Diagrams and in the retrospective analysis presented by some earlier Working Groups. In the assessments in August 2000, several changes in model settings and data choices were made, and since then the retrospective analysis has considerably improved, and the Quality Control Diagrams now indicate rather consistent assessments since 1999.

There were no changes in the present assessment method compared to last year.

The present assessment applies the same fleets and age groups as used since the 2000 assessment, with the exception that Norwegian trawl CPUE has been left out since the 2002 assessment. It was, however discovered that in last years assessment the ages were mis-specified in fleet 17. This was corrected and the 2003 assessment was rerun. For 2002 this gave 3% decreased SSB and 3% increased F.

The last ACFM technical minutes comments on the use of some of the fleet data and recommends evaluation of the survey data included and their influence on the results. Figures 3.3a and b show the tuning indices by age, all scaled to their average over the period 1994-2003 (the year range used for tuning) and Figures 3.4-3.7 show fleet-wise plots from the "surba" program (Needle, 2003 and Needle, 2004). Figure 3.8 shows residuals of log catchability from a run based on the settings and fleet data described above (and cannibalism "tuned" as described in section 3.4.2). High catchability residuals (Figure 3.8), discrepancies compared to other fleets (figure 3.3) and internal inconsistencies (Figures 3.4-3.7) are observed for age 12 in fleet 09, ages 10 and 11 in fleet 16 and ages 6,7 and 8 in fleet 17. An alternative tuning with those mentioned fleet data removed was made. The XSA diagnostics (Table 3.16b) improved compared to the "standard" run (Table 3.16a). Table 3.15b compares population numbers and Fs and shows that the differences between the two were marginal ("Final run" vs. "Ages with high Qres removed").

Table 3.15b also compares single fleet runs (with original data) with the final run. Figure 3.9 shows that $F_{4\text{-}8}$ follows better the expected "F-Biomass curve" than $F_{5\text{-}10}$ does. This is because the largest relative differences between fleets are observed on ages 9-10, which has much more influence on $F_{5\text{-}10}$ than on the SSB. It is noticed that the final run gives a quite low F and a high SSB compared to the single fleet runs (Figure 3.9). Since shrinkage works differently on single fleet runs than on a combined run, the fleet predictions before shrinkage (the 2003 values of F and survivors at age taken from the XSA diagnostics of single fleet runs) was examined. Figures 3.10 and 3.11 show corresponding F and stock number by age before shrinkage (left hand panels) and after shrinkage (right hand panels) in single fleet runs. Open symbols means that there is no tuning data for that fleet at that age. Before shrinkage it is observed that in all cases the combined run is located near the fleets having highest weight in combined tuning (although the distance between some fleet values are rather large). The point "ALL" for the combined is with shrinkage in both the left and right panels, which means that this point is fixed and we can see how the fleets move relative to ALL as effect of the shrinkage. In general shrinkage brings the points closer to each other, because they are influenced by the same external signals. For the age groups 3-7 they are reasonably distributed around ALL also after shrinkage. For age 8 and 9 the shrunk values moves somewhat to the left and ALL appears rather extreme.

Figure 3.9 and the right hand panels of Figures 3.10 and 3.11 tell us the result we would get if we only had that single survey available and still chose to use the same shrinkage settings in the tuning. The left hand panels in Figure 3.9 are the relevant ones for evaluating the direct effect of the surveys. The pattern seen was considered satisfactory, although the uncertainty appears large for Fs and survivors for age 9 and older. The run where ages with high q-residuals were removed from tuning fleets did not give any obvious gain in precision on age groups 9 and older, and the SSB / F for single fleets did not improve (Figure 3.12). This together with the observation that Fs and population numbers did not change for the run with these refined fleets led to the conclusion that the "standard" run was kept. One reason for being restrictive towards changes in settings and choices of data is that the PA reference points for this stock is based on a retrospective run with fixed settings and input data.

Table 3.15b also shows the effect of changing ages for stock size dependent catchabilities (less than age 4, 5 and 7, compared to 6 in "final run"). The current assessment is very little sensitive to this choice, while in the mid 90ies this choice was quite critical. An increased tuning window (15 yrs compared to 10) increased $F_{5\text{-}10}$ by 13% and reduced SSB by 6%. The earlier part of the survey series show larger discrepancies between surveys (Figure 3.3) and larger internal residuals (bubble plots, Figures 3.3-3.6). Thus an increased time window may introduce a bias. The 2000 working group observed a considerably worse retrospective pattern when the tuning window was increased.

The tuning appears to be rather sensitive to the level of shrinkage. Increasing the F and population shrinkage (reducing minimum SE for shrinkage values from 1.0 to 0.5) lead to 37% increase in $F_{5\text{-}10}$ and 14% reduced ssb. Such a tendency should be expected since the assessment indicates declining trend in F. The argument for keeping low shrinkage is that the assessment should be able to pick up recent trends in the surveys.

The effects of adding different amounts of unreported catch in 2002 and 2003 are shown in Table 3.15a and Figure 3.15.

3.4.2 Including cannibalism in the VPA (Tables 3.16-3.20, 3.22)

For the cod assessment data from annual sampling of cod stomachs has been used for estimating cannibalism, since the 1995 assessment. The argument has been raised that the uncertainty in such calculations are so large that they introduce too much noise in the assessment. A rather comprehensive analysis of the usefulness of this is presented in Appendix 1. The conclusion is that it improves the assessment.

The following procedure was followed: As a starting point the number of cod consumed by cod were estimated from the stock estimates in the last assessment. Then the number consumed was added to the catches used for tuning. The resulting stock then lead to new estimates of consumption. This procedure was repeated until the revision of consumed numbers for the latest year (2002) differed less than 1% from the previous iteration.

The tuning diagnostics from XSA with cannibalism are given in Table 3.16 and the total fishing mortalities (true fishing mortality plus mortality from cannibalism) and population numbers in Tables 3.17 and 3.18.

In order to build a matrix of natural mortality which includes predation, the fishing mortality estimated in the final XSA analyses was split into the mortality caused by the fishing fleet (true F) and the mortality caused by cod cannibalism (M2 in MSVPA terminology) by using the number caught by fishing and by cannibalism. The new natural mortality data matrix was prepared by adding 0.2 (M1) to the M2. This new M matrix (Table 3.19) was used together with the new true Fs to run the final VPA on ages 3-13+. M2 and F values for ages 1-6 in 1984-2003 are given in Tables 3.20 and 3.22.

Cannibalism on cod age 3 and older may of course also have occurred before 1984. Thus, there is an inconsistency in the recruitment time series. For comparison with the historic time series an additional VPA with the same terminal Fs and fixed natural mortality (0.2) is presented (Table 3.27).

3.5 Results of the assessment

3.5.1 Fishing mortalities and VPA (Tables 3.21-3.26, Figures 3.1)

The estimated $F_{5\text{-}10}$ in 2003 is lower than the assumed $\mathbf{F}_{sq}$ in last years prediction (0.46 vs, 0.70), while the spawning stock biomass in 2004 is estimated to be 851,000 t, which is well above last year's assessment (652,000 t).

The fishing mortalities and stock numbers are given in Tables 3.21 -3.23, while the stock biomass at age and the spawning stock biomass at age are given in Tables 3.24-3.25. A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1946 is given in Table 3.26 and Figures 3.1A and 3.1B.

Figure 3.13 shows the results of a retrospective analysis when cannibalism is taken into account. The number of cod consumed by cod was not recalculated year by year in the retrospective analysis, however.

3.5.2 Recruitment (Table 3.6- 3.7)

From the RCT3 calculations the estimated number (millions) of recruits at age 3 is 276 millions for the 2001 year-class, 604 millions for the 2002 year-class and 455 millions for the 2003 year-class. A comparison of these results with the results of other recruitment models is given in Table 1.8.

3.6 Reference points

New reference points for Northeast Arctic cod were proposed by SGBRP in January 2003 (ICES CM 2003/ACFM:11) and adopted by ACFM at the May 2003 meeting.

3.6.1 Biomass reference points (Figure 3.1)

The values adopted by ACFM in 2003 are $\mathbf{B}_{lim}$ = 220,000t, $\mathbf{B}_{pa}$ = 460,000t. (ICES CM 2003/ACFM:11).

3.6.2 Fishing mortality reference points

The values adopted by ACFM in 2003 are $\mathbf{F}_{lim}$ = 0.74 and $\mathbf{F}_{pa}$ = 0.40 . (ICES CM 2003/ACFM:11)

3.7 Catch options (Table 3.29-3.30)

Catch options are presented in Table 3.29. The detailed outputs corresponding to $\mathbf{F}_{sq}$ in 2004 and $\mathbf{F}_{pa}$ in 2005 is given in Table 3.30.

In Figure 3.1 the catch level in 2005 and spawning stock biomass level in 2006 are plotted against the fishing mortality in 2005.

3.8 Medium-term forecasts and management scenarios

3.8.1 Adopted harvesting strategy

At the 31st session of The Joint Norwegian-Russian Fishery Commission in autumn 2002, the Parties agreed on a new harvest control rule(section 3.12). This rule was applied for the first time when setting quotas for 2004.

3.8.2 Results

Prediction forecast:
Basis 2004: $\mathbf{F}_{sq}$=$F_{01\text{-}03}$=0.63, Catch=696.000 t, leads to SSB2005=794.000 t

F	Basis	Landings 2005	SSB 2006
0.00	0	0	1280
0.25	0.4*$\mathbf{F}_{sq}$	302	1016
0.40	$\mathbf{F}_{pa}$ (=0.64*$\mathbf{F}_{sq}$)	453	889
0.43	Catch rule (=0.69*$\mathbf{F}_{sq}$)	484	862
0.50	0.8*$\mathbf{F}_{sq}$	543	813
0.63	1.0*$\mathbf{F}_{sq}$	646	729

3.8.3 Management considerations

The spawning stock in 2004 is above $\mathbf{B}_{pa}$, and is expected to remain above in 2005. The fishing mortality has decreased somewhat from values around $\mathbf{F}_{lim}$ to an estimated value of 0.46 for 2003. This is the lowest since 1992, but still 15% above $\mathbf{F}_{pa}$.

The forecasts indicate that fishing at $\mathbf{F}_{pa}$ in 2005 (453,000 t) allows the stock to remain above $\mathbf{B}_{pa}$ in 2006.

The catch rule has been tested by simulations (Section 3.12). If appropriate action is taken when the stock is estimated to fall below $\mathbf{B}_{pa}$ the rule is considered to be sufficiently precautionary. The simulation study proposes the following action to be appropriate for rebuilding when the stock falls below $\mathbf{B}_{pa}$: Catches should be restricted to a fishing mortality which linearly decreases from $\mathbf{F}_{pa}$ to zero when estimated ssb decreases from $\mathbf{B}_{pa}$ to $\mathbf{B}_{lim}$. This also implies that there will be no restriction on the % annual change in TAC when the stock is below $\mathbf{B}_{pa}$.

The catch in 2005 according to this rule is estimated to 484,000 tonnes, corresponding to F=0.43 in 2005. These catch forecast covers all catches. It is then implied that all types of catches are to be included in this amount.

3.9 Comments to the assessment (Figures 3.2-3.6 and 3.13-3.16, Table 3.15 and 3.31).

There are indications of reduced precision of the surveys in the latest two years compared to those in the previous 2-3 years. The Russian autumn survey was not allowed to cover the Norwegian Zone in 2002, and the results of the Joint winter survey in 2003 now appears as an overestimate compared both to the survey in 2004 and 2002.

Previous Working Groups have been concerned about possible discarding and under-reporting (Introduction, and ACFM CM 2001/ACFM:02). This creates uncertainties in the catch statistics and undermines the basis for the assessment and catch predictions. The Working Group has underlined that this is a strong reason for additional precaution when setting quotas. Seeking for a more realistic assessment AFWG, along with official catch statistics used information on unreported catches for 2002 and 2003, as it was earlier done for the years 1990-1994. Uncertainties are nevertheless present. It is because estimates of unreported catches are quite provisional and requires more precise estimation and further consultations of relevant authorities at international level. AFWG was informed that 2002 and 2003 have been exceptional years with respect to unreported landings due to reasons explained in the introduction chapter. Incorporation of unreported catches for two years may lead to inconsistent corrections in the long-term series back in history. Further studies are required to evaluate the effect of uncertain estimates of unreported catches on the relationship between VPA and survey data.

Some analysis of the sensitivity of how vpa results changes at various levels (0, 50, 100 and 200%) of unreported catch for 2002 and 2003 are shown in Table 3.15a and Figure 3.15. Here the percentage relates to the amount of unreported catch used in the final VPA (50% = 45,000 tonnes, 200% = 180,000 tonnes).

A time series of discard estimates for cod was presented at the 2002 WG (Dingsør, 2001). Some results are shown in Table 3.31. At last years working group new estimates were presented for more recent years (WD 9, 2003). The results in the overlapping years of these two studies differ considerably. The discrepancies should be clarified before these time series are used in the assessment.

3.9.1 Comparison of this year's assessment with last year's assessment

The text table compares this years estimates with last years estimate for the year 2003 for number at age, total biomass, spawning biomass and reference F-values, as well as reference F for the year 2002. It also includes the results of re-running the 2002 assessment with unreported catch added, and with fleet adjustments (section 3.4.1), as well as the 2003-assessment based on official catch only.

		2003										
Assessment yr (specification)	F(2002)	age3	age4	age5	age6	age7	age8	age9	age10	TSB	SSB	F(2003)
2003	**0.70**	**681***	**375**	**287**	**240**	**109**	**36**	**7.5**	**0.87**	**1815**	**653**	**0.70****
2003 (added Catch 02)	0.76	616	388	293	239	107	35	7.6	0.79	1856	644	0.76**
2003 (added C02, adj. flt 17)	0.78	628	392	336	243	108	31	6.7	0.89	1921	633	0.78**
2004 (off. Catch 02, 03)	0.63	476	304	291	238	101	33	7.3	1.08	1691	626	0.40
2004 final (added C 02,03)	**0.67**	**502**	**324**	**308**	**248**	**103**	**33**	**7.4**	**1.10**	**1758**	**643**	**0.46**
Ratio 2004(off. Catch 02, 03)/2003	0.90	0.70	0.81	1,01	0.99	0.93	0.92	0.97	1.24	0.93	0.96	0.57
Ratio 2004 final/ 2003add C,adj flt	0.86	0.80	0.83	0.92	1.02	0.95	1.06	1.10	1.24	0.92	1.02	0.59
Ratio 2004 final/ 2003	0.96	0.74	0.86	1.07	1.03	0.94	0.92	0.99	1.26	0.97	0.98	0.66

*estimated by rct3 **assuming $\mathbf{F}_{sq}$

The final assessment values are fairly close to the 2003 assessment. Largest deviations are at age 3 and age 10. The upward revision of stock numbers at age 10 contributes considerably the observed decrease in $F_{5\text{-}10}$, compared to the $\mathbf{F}_{sq}$ assumption for 2003. Technically it is more relevant to compare the current assessment with the rerun 2003 assessment adjusted for unreported catch and changes in fleet data. Similar differences are observed here. F has decreased by 14 % in 2002 and by 41% compared to the $\mathbf{F}_{sq}$ assumption for 2003, and stock numbers have decreased for ages 3-5, and increased for ages 8 and older. The new estimate of SSB in 2004 (851,000 tonnes) is considerably above the prediction from last year (652,000 tonnes). Increased stock numbers and increased proportion mature contribute about equally to this upward revision of SSB.

Retrospective plots of F, SSB and recruitment are shown in Figure 3.13. Here the pattern for $F_{4\text{-}8}$ is shown for comparison. This shows less between year revision than the $F_{5\text{-}10}$, particularly some years back in time. This is most likely caused by some sampling noise associated with the age groups 9 and 10, which in some years are rather scarce in some fishing fleets and survey fleets.

3.9.2 Comparison with other sources of stock indicators.

Comparisons with individual surveys are shown in Figure 3.2a. Here they are plotted against years as used in the tuning. Since the surveys take place late in the year, it is more relevant to compare with years and ages shifted for the surveys (Figure 3.2b). Here fleet 15 is rather parallel to the VPA, but tend to be somewhat below for ages 5-8, while the other fleets fluctuates around the VPA. The mortality trends for the surveys as seen from the "surba" analysis (Figures 3.4-3.7) are quite noisy, but an observed declining trend over the latest year is in general agreement with the recent mortality trends in the VPA. Figure 3.14b compares the survey Fs and Fs from VPA.

A "calibrated" prediction of stock numbers from the Joint bottom trawl survey (WD 26) indicated lower abundance of ages 4-6 compared to VPA and Fleksibest (section 3.10), as shown in the table below. For older fish all estimates are in fair agreement.

	Stock number 2004, ages 4-6	Stock number 2004, ages 7+
Survey pred. Regres through origin	585	207
Survey pred. Regres with intercept	703	191
Vpa	836	217
Fleksibest	820	198

The cpue for the Norwegian trawl fleet has not been used in tuning since the 2001 assessment. Figure 3.16 shows effort, catch per effort and F per effort. Partial Fs for the fleet is calculated as described in WD 25 on the basis of the final VPA. The increasing trend in F per unit effort since around 1990 show that the fishing efficiency have increased and cpue for this fleet is a biased indicator of the stock size.

3.10 Alternative assessment methods (Fleksibest)

3.10.1 Introduction

A description of the mathematical formulations used in Fleksibest is given in Frøysa *et al*. (2002). Changes in the model since last year are described in Bogstad et al. (WD 14). Fleksibest is a length-structured extension of the type of age structured assessment models sometimes termed 'statistical catch at age analysis' (Fournier and Archibald, 1982; Deriso *et al*., 1985). As last year, a complete assessment including a medium-term prediction is presented for comparison with the XSA assessment. An outline of the plans for future work on Fleksibest is given in the Introduction section.

3.10.2 Stock assessment using Fleksibest

3.10.2.1 Model structure

A quarterly time step is used. The model is run for the period 1.quarter 1985- 1.quarter 2004. The age range has been extended so that it is possible to run the model on age range 1-12+. The cod stock is divided into an immature (ages 1-10, lengths 5-105 cm) and a mature part (ages 4-12+, lengths 55-135 cm). Maturation takes part at the end of the fourth quarter each year. 1 cm wide length groups are used in the model, and 5 cm wide length groups in the survey and catch data files.

3.10.2.2 3.10.2.2 Data used

Survey data

The same surveys as in last year's assessment were used. Some age and length groups with few or very noisy observations are deleted from some surveys. The table below shows the year, age and length range for the surveys used.

Survey	Quarter	Year range	Age range	Length range	Stock covered
Norwegian Winter bottom trawl	1	1985-1993	3-9	20-90 cm	Immature
Norwegian/Joint Winter bottom trawl	1	1994-2004	1-9	5-90 cm	Immature
Norwegian Winter acoustic	1	1985-1993	3-9	20-90 cm	Immature
Norwegian/Joint Winter acoustic	1	1994-2004	1-9	5-90 cm	Immature
Lofoten acoustic	1	1985-1989	5-12+	55-110 cm	Mature
Lofoten acoustic	1	1990-2004	5-12+	55-110 cm	Mature
Russian bottom trawl autumn	4	1985-1993 and 1995-2003	1-8	6-106 cm	Immature and mature

The Norwegian (from 2000 Joint) winter survey in the Barents Sea (bottom trawl and acoustic indices) was split into two time periods because of the change of gear and increase in area coverage in 1994 (Jakobsen *et al*., 1997). The Lofoten acoustic survey was split into two periods because of the change of echosounder in 1990 (Korsbrekke, 1997).

The 1994 data from the Russian bottom trawl survey gave extremely high residuals and were removed. The XSA also indicates a bad fit for this survey in 1994.

Catch data

As last year, it was decided to allow for treating the gillnet fishery separately from the other fleets, as this fleet is fishing on much larger fish than the other fleets. This is further discussed in Section 3.10.3. Thus, we use catch in numbers at age and length by quarter from the following two fleets:

- Combined fleet: All Norwegian fleets except gillnet (Danish seine, handline, longline, Norwegian trawl)+ Russian trawl
- Gillnet

Data for 1985-2003 are used, for length groups 5-135 cm and ages 1-12+.

In addition, two fleets contribute to the catch in the model: *Third countries* and *Overfishing*. For both of these fleets, it is assumed that the given catch in tonnes is caught, with the same selectivity as the combined fleet.

Consumption data

Data on the consumption (kg/time step) of cod by cod for the period 1985-2003 calculated in the same way as in Bogstad and Mehl (1997) are available. The data are given by predator age group and prey length group. For technical reasons, the consumption data could not be included in the objective function after the change from modeling cannibalism as mortalities to modeling cannibalism as predation. This will be implemented in the next release of the Gadget software and in the Fleksibest model.

Differences between data used in XSA and in Fleksibest

It should be noted that there is some difference between the tuning series used in XSA and in Fleksibest. The older part of all the survey time series are downweighted in XSA. In Fleksibest, all years are given the same weight, but the Norwegian winter bottom trawl survey, the Norwegian winter acoustic survey and the Lofoten survey are split into two time periods. Also, the Norwegian winter acoustic survey and the Lofoten survey are combined in XSA, but not in Fleksibest.

3.10.2.3 Model assumptions

The Pearson function, which is scale dependent, was used as an objective function.

The length selectivity was assumed to be a logistic function of length for all surveys. Also for the commercial fleets a logistic length selection curve was assumed.

Linear mean growth in length, variable by year, was assumed. The ratio between the growth rate of mature and immature fish was assumed to be the same for all years.

The maturation parameters were estimated to values giving clearly lower values for maturity at age than in the input to the XSA. Last year, the maturation parameters were fixed to values giving maturity ogives similar to the values used as input to the XSA. Including data for abundance of first-time and repeat spawners from the Lofoten survey could improve the estimation of maturation. First-time spawners and repeat spawners would then have to be modeled as separate stocks. For 1987, when the condition factor was very low, Fleksibest gives higher maturity ogives than XSA. This difference from the overall trend could possibly be accounted for by also including the condition factor in the maturation function, a feature which is now included in the Gadget software. Taking weight at length into account when predicting maturation is essential, as discussed in Section 1.4.2.2.

The values of the contribution to the objective function from catches were upweighted compared to the surveys in order to get approximately the same contribution to the total value of the objective function for both groups of data sources.

3.10.2.4 Optimization algorithm

A combination of the Simulated Annealing and Hooke & Jeeves algorithms was used. Repeated searches with the combination of these algorithms were performed, starting at the optimum found during the previous search. Sensitivity tests indicate that a minimum was found for the key run.

3.10.2.5 Changes from last year

- Possible age range extended from age 3-12+ to 1-12+
- Fishing mortality modeled as effort and cannibalism modeled as predation
- Different handling of catches by third countries and unreported overfishing
- Length selectivity of surveys changed from linear to logistic
- New software used

Age range extended down to age 1

The maximum age range in the model was extended down to age 1, and the length range of the immature cod was extended down to 5cm. The age and length range of the survey data files was extended accordingly. The age and length range of the Norwegian (Joint) bottom trawl and acoustic surveys was only extended for the period 1994-2004. The reason for this is that an inner net was introduced in this survey in 1994 (Jakobsen et al. 1997). Before the inner net was introduced, the data for age 1 and 2 fish in these surveys are very noisy.

Modeling of fishing and of cannibalism

Catch is now modeled by modeling effort, while previously it was modelled using fishing mortalities. This was done in order to comply with the overall modeling approach within the Gadget framework. The details of the modeling approach are described in Bogstad et al. (WD 14). Similarly, cod cannibalism is modelled as predation, not as mortality.

Modeling of catches by third countries and of unreported catches

The catch of third countries and the assumed unreported overfishing is modeled by assuming that the given catch in tonnes is caught, with the same selectivity as the combined fleet. Previously, the ratio between the F from these fleets and the F generated by the combined fleet was assumed to be the same as the ratio between the catch in tonnes of the fleets.

Length selectivity of surveys.

The length selectivity is now described by logistic curves for all surveys.

Software used

Model runs are now performed using Gadget version 2.0.05. Previously, a custom IMR version of the Gadget software was used.

3.10.2.6 Estimates of parameters outside the model

The mean length at age and the standard deviation of the mean length at age for all age groups of immature and mature fish in the first year were taken from survey data. The SD of mean length of mature in the first year was not available, and was set to values obtained during previous estimations. The ratio between growth of immature and mature fish was also taken from previous runs. The number of fish in the first year in age groups with low abundance was fixed. The residual natural mortality was set to 0.2. The weight-length relationship used is the same as for Norwegian commercial catch data. This relationship is variable by quarter and year.

3.10.3 Results from the assessment

Choice of key run

Four different runs were made: age range 1-12+ and 3-12+, both with 1 fleet or 2 fleets (gillnet and combined). An 1+ Fleksibest model should be able to give a more coherent picture of the abundance of the youngest age groups (1-3) than an XSA with cannibalism included. The main reason for this is that in the XSA with cannibalism, the numbers consumed at age are treated as exact numbers in the same way as the catch at age. The survey data for ages 1 and 2 are only taken into account in the RCT3 prognosis and not in the assessment of historical abundance of the youngest age groups. With a model like Fleksibest, where catch as well as cannibalism is modeled, the number at age 1-3 could be calculated taking all data sources into account. Since the consumption data could not be included in the objective function this year, the results of the 1+ runs were not considered to be reliable. Both the 1+ and 3+ runs gave approximately the same stock size for 4+ fish. The runs with 1 and 2 fleets gave approximately the same fit to the data, but the exploitation pattern obtained from the run with 2 fleets was considered to be more likely, and thus the 3+ run with 2 fleets was chosen as the key run, as in last year's Fleksibest assessment.

Parameter sensitivity

Components of the objective function, input data and parameter estimates for the key run are given in Table 3.32a-c. The effect on the total objective function score of changing each parameter with +/- 5% is given. Sensitivity tests show that the estimation procedure has found a well-defined optimum, and that the objective function is quadratic around the optimum with respect to each parameter.

It is seen that the total objective function score is most sensitive to L_{50} (length at 50 % selection) in the commercial fleets. It is also quite sensitive to the growth parameters and the length of a cohort at age 3.

Model results

The natural mortality, maturity, stock weight, catch weights and catch in numbers by age group from the key run are given in Table 3.33. This table also presents the fishing mortalities, stock numbers, stock biomass and spawning stock biomass. Results (total stock biomass, SSB, F, catches, recruitment, total stock number) of the key run are shown in Fig. 3.17a-f. The total annual catch in weight as estimated by the model is somewhat higher than the reported catches in almost all years, but in general there is good agreement with the reported catches in tonnes. The maximum discrepancy is about 140 000 tonnes in 1995. In general, the trends given by XSA and Fleksibest are very similar for the fishing mortality and stock biomass. Fleksibest shows the same overall trends for F_{5-10} as XSA, but the curve given by Fleksibest is smoother. One reason for this may be that Fleksibest is less vulnerable to noise in the catch data of the oldest ages due to the fixed selectivity pattern by length. The trends in total stock biomass are very similar.

The estimated maturation parameters gave lower maturity at age than the XSA assessment. Last year the maturation parameters were fixed at values which gave approximately the same maturity ogives as the XSA assessment. From the Lofoten survey, separate estimates of the number of first-time and repeat spawners are available. These estimates could be used to improve the estimation of the maturation parameters and thus the estimate of the spawning stock.

Compared to last year's Fleksibest results, the results obtained this year give a similar view of the status of the stock. The fishing mortality (F_{5-10}) in 2002 decreased from 0.58 in last year's assessment to 0.56 in this year's assessment, while the total stock biomass in 2003 was about 1.75 million tonnes in both assessments.

3.10.4 Retrospective analysis

Results (total stock biomass, SSB, F, catches, recruitment, total stock number) of a retrospective analysis with the same settings as in the key run are shown in Figure 3.18a-f. The runs stops in first quarter, and are labeled after the year that contains the last time step. The shortest run stops in first quarter in 1999, and is thus labeled 1999. The retrospective pattern seems to be quite consistent back to 1999.

3.10.5 Use of Fleksibest for predictions

Fleksibest is well suited for prognosis, because the length-dependence of population dynamics processes makes it easy to get consistency between the values of weight, maturity and mortality at age. In the prognosis runs with Fleksibest for the period 2004-2006, the same values as in the key run were used for most parameters. The growth parameter was set to the average of the 2001-2003 values, and the weight at length was set equal to the 2003 values. The mean length of age 3 fish in 2005 and 2006 was set approximately equal to the 2004 value. The distribution of the catch taken by each of the two fleets was set equal to the 2003 value. The recruitment at age 3 in 2005 and 2006 is set to the values obtained from the RCT3 analysis. This is consistent with the assumptions made in the medium-term prognosis based on the XSA run (see Section 3.3.8).

The values of recruitment, catch weight, stock weight, maturity, natural mortality and fishing mortality at age for a prediction with fishing mortality equal to the average for the period 2001-2003 (F_{5-10}=0.56) are given in Table 3.34. This is comparable to the usual prediction input table (Table 3.28). The management option table for the Fleksibest prediction is given in Table 3.35.

The standard and Fleksibest predictions differ in a fundamental way because all input values to the standard prediction (Table 3.28) are independent and can be determined separately. This may lead to internal inconsistencies in the prediction input to the standard prediction. Also, effects of different exploitation levels on weight, maturity and selection at age cannot be accounted for using standard predictions. This may be important for medium-term predictions.

The population parameters at age in the Fleksibest prediction (Table 3.34) is determined by the values of growth, recruitment and fishing mortality chosen, as mentioned in Section 3.10.5. With this method, the values of weight, maturity and fishing mortality at age will be consistent with each other.

3.10.5.1 Comments to the prognosis

The prognosis shows that fishing with F=0.55 in 2004 and 2005 will keep the total stock biomass around 1.3 million tonnes in 2005-2006.

3.10.6 Reference points related to Fleksibest

In order to use Fleksibest for providing management advice for NEA cod, reference points would need to be calculated. It needs to be outlined how reference points could be calculated using Fleksibest. It should be noted that it is somewhat difficult to extend Fleksibest to the time period when survey data are not available (before 1981). Such an extension will require assumptions about the selection pattern of the various fishing fleets backwards in time.

3.11 Comparison of results from XSA and Fleksibest.

3.11.1 Comparison of the assessments

The abundance at age in 2003 in the Fleksibest assessment is lower for ages 4-7 and higher for age 3 and age 8 and older compared to the XSA assessment (Table 3.15). The reference F in 2003 estimated by Fleksibest and XSA is quite similar (0.50 vs. 0.46*).* The reason for this discrepancy in fishing pattern should be investigated. The spawning stock biomass in 2003 is lower in Fleksibest than in XSA, 483 vs. 648 thousand tonnes. This difference is mainly due to the difference in maturity ogives. Fleksibest predicts the SSB in 2004 to be about the same as in 2003, while XSA predicts a considerable increase. The declining trend in fishing mortality from 2001 to 2003 is much stronger in XSA than in Fleksibest.

3.11.2 Comparison of the predictions

The Fleksibest predictions show a less optimistic development of the stock than the XSA predictions.

3.12 Evaluation of harvest control rule

3.12.1 Introduction

At the 31st meeting of the Joint Russian-Norwegian Fisheries Commission (JRNC) in November 2002, the following decision was made:

"The Parties agreed that the management strategies for cod and haddock should take into account the following:

- *conditions for high long-term yield from the stocks*
- *achievement of year-to-year stability in TACs*

- *full utilisation of all available information on stock development*

On this basis, the Parties determined the following decision rules for setting the annual fishing quota (TAC) for Northeast Arctic cod (NEA cod) from 2004 and onwards:

- *estimate the average TAC level for the coming 3 years based on* $\boldsymbol{F_{pa}}$*. TAC for the next year will be set to this level as a starting value for the 3-year period.*

- *the year after, the TAC calculation for the next 3 years is repeated based on the updated information about the stock development, however the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.*

- *if the spawning stock falls below* $\boldsymbol{B_{pa}}$*, the Parties should consider a lower TAC than the decision rules would imply.*

The Parties agreed on similar decision rules for haddock, based on $\boldsymbol{F_{pa}}$ *and* $\boldsymbol{B_{pa}}$ *for haddock, and with a fluctuation in TAC from year to year of no more than +/-25% (due to larger stock fluctuations).*

The Parties agreed that the working group, which worked out the "Basic Document regarding the main principles and criteria for long term, sustainable management of living marine resources in the Barents and Norwegian Seas" during the following year should illustrate how these decision rules will work. The working group shall, in particular, evaluate what level of percentage change in TAC from year to year will be reasonable to utilise.[1]"

The evaluation of this agreed management strategy is ToR b) for AFWG this year. The evaluation of the harvest control rule for haddock was postponed.

3.12.2 General considerations for evaluation of harvest control rules

Evaluation of harvest control rules (HCRs) is usually done using simulation models for the population(s) in question. The scope, nature and quality standards of simulation models that may be used in order to evaluate HCRs are discussed e.g. by Skagen et al. (2003).

Important issues for evaluation of harvest control rules are:

- Choice of population model
- Inclusion of uncertainty in population model
- Long-term simulations into the future vs. simulations on historical data
- Choice of harvest control rules for use in the evaluation (constant F rules, how to reduce F when SSB<$\mathbf{B}_{\mathrm{pa}}$, limit on year-to-year variation in catch etc.)
- Performance measures for harvest control rules (yield, stock size, F, probability of SSB<$\mathbf{B}_{\mathrm{lim}}$, annual variation in catches etc.)

3.12.3 Approaches for Harvest control rule evaluation presented to the Working Group

Two WDs addressed this issue: WD3 and WD18.

3.12.3.1 Long-term stochastic simulation (WD3)

Bogstad et al. (WD3) describe the status of joint Norwegian-Russian work on evaluation of the proposed harvest control rule for Northeast Arctic cod. A slightly modified version of WD3 is given in Appendix 1. A biologically detailed population model for cod for use in the evaluation is described. In this model, recruitment is modelled using a segmented regression approach, as well as a periodic term and a term including the mean weight of spawning fish.

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[1] This quotation is taken from point 5.1, in the Protocol of the 31th session of The Joint Norwegian-Russian Fishery Commission and translated to English. For an accurate interpretation, please consult the text in the official languages of the Commission (Norwegian and Russian).

Growth and maturation is modelled as density dependent, and cod cannibalism can also be included. Assessment error and uncertainty in the stock/recruitment relationship is included. Catch is implemented by first calculating the catch at age from the perceived stock using the fishing mortality derived from the harvest control rule and the given exploitation pattern. This catch at age is then applied to the actual stock. The general modelling approach taken is the same as described by Skagen et al. (2003). Results of long-term stochastic simulations were not given in WD3, but are given below.

Software used

The simulations were carried out using the PROST software for stochastic projections (Åsnes, WD5). PROST was especially developed for this purpose because existing software for harvest control rule simulations such as WGMTERM, STPR and CS5 do not incorporate the 3-year averaging process (hereafter called the '3-year-average-rule') for setting TAC given by the agreed decision rule. However, PROST is intended as a general tool for stochastic projections.

Model description

Several variants of the population model were tried. In all cases, 1000 simulations for the period 2003-2103 were performed and the results for the last 80 years of this period were considered. This is done in order to exclude the effect of the initial values. The stock size for 2003 (initial data) was taken from the 2003 assessment, with a normally distributed CV of 0.25.

The 'default' model was:

- Density-dependent weight at age in stock (average for 1946-2002 used for age groups where density-dependence was not found)
- Weight at age in catch is a function of weight at age in stock
- Full recruitment model from WD (includes uncertainty)
- Time series (1946-2002) average used for maturation for age groups without density-dependent model
- Cannibalism not modelled directly because stock-recruitment relationship is based on a time series of spawning stock and recruitment (1946-present) where cannibalism is not included.
- Exploitation pattern: 2000-2002 average used for all years, uncertainty in implementation as described above
- Assessment error CV 0.25, normally distributed. This value is large enough to account for the most extreme assessment error experienced, which is about a factor of 2 both for F and SSB.
- No uncertainty in weight at age, maturity at age or natural mortality at age

Reality check of model

In order to do a reality check of the 'default' model, a run was made with F_{5-10}=0.65, "flat" harvest control rule (see below), 50% maximum year-to-year-change in TAC and no assessment error. F_{5-10}=0.65 is equal to the average fishing mortality for the period 1946-2002. The average stock size, catch and recruitment for this run are shown in the text table below, together with the average values for 1946-2002 from the 2003 assessment. The values from the simulation are somewhat above the historic average, but they indicate that the model performs reasonably well at this level of fishing mortality. It should be noted that the historic exploitation pattern would give a lower yield than the present exploitation pattern, which is used in the simulations. At lower F levels, such as F=0.4, the model results may be somewhat optimistic because cannibalism is not explicitly modeled and cannibalism tends to increase with increasing stock size.

	F_{5-10}	Recruitment (million)	TSB (1000 t)	SSB (1000 t)	Catch (1000 t)
VPA average 1946-2002	0.65	578	2015	374	663
Simulation result	0.65	590	2339	460	762

The density-dependent maturation described in WD3 gave unrealistic results when combined with the 'mean weight of spawners' term in the stock-recruitment function. The reason for this was that high stock biomass caused late maturation and high average weight of spawners. This led to increased recruitment and thus caused the stock to increase way above observed levels. It was thus decided to leave out the density-dependent maturation. The relationship between weight at age and maturity at age is different for the periods 1946-1979 and 1985-2001 (Section 1.4.2.2) and this may be related to this modelling problem since the maturation model in WD3 was fit to data for the whole time series 1946-2002.

Harvest control rules

Let y denote the year for which the quota is to be set. Let the term "3-year rule (F1, x)" denote applying the 3-year average rule described above with F_{5-10}=F1 and an x % limit on year-to-year changes in TAC. The limit on increase of TAC from year to year could be set different from the limit on decrease from year to year, but such asymmetric rules were not tested. It is assumed that SSB(y) is not affected by F(y), which is in line with the current settings used by AFWG (the proportion of F and M before spawning is set to 0).

The rules tested were

1. ("linear")

F(y) set by 3-year rule(F1, 10) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) > $\mathbf{B}_{pa}$

F(y) set by 3-year rule(F1, unconstrained) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) < $\mathbf{B}_{pa}$

F(y) set by 3-year rule ($F1\dfrac{SSB(y)-B_{\lim}}{B_{pa}-B_{\lim}}$,unconstrained) if $\mathbf{B}_{lim}$< SSB(y)< $\mathbf{B}_{pa}$

F(y)=0 if SSB(y) < $\mathbf{B}_{lim}$

Thus, when SSB increases from below $\mathbf{B}_{pa}$ in year *y-1* to above $\mathbf{B}_{pa}$ in year *y*, the TAC in year *y* should not be calculated using the limit on year-to-year variations in TAC.

2. ("flat")

F(y) set by 3-year rule(F1, 10) if SSB(y) > $\mathbf{B}_{pa}$

F(y) set by 3-year rule(F1, unconstrained) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) < $\mathbf{B}_{pa}$

F(y) set by 3-year rule(F1, unconstrained) if SSB(y) < $\mathbf{B}_{pa}$

Results

The results are shown in Table 3.36 and some key results are also shown in the text table below. The figures given in Table 3.36 are average values over all simulations for the years 2024-2103. In addition, the probability of SSB< $\mathbf{B}_{lim}$ in any year in the period 2024-2103 during a simulation is given.

The average catch obtained from the 'default' run (Run 1) with F1=0.40 was about 900 thousand tonnes, with an average total stock of 3.5 million tonnes and an average spawning stock of 1.0 million tonnes. The probability of SSB< $\mathbf{B}_{lim}$ was negligible in all cases, while the probability of SSB < $\mathbf{B}_{pa}$ was < 0.01. The effect of the following changes from the default model was found to be small at this level of fishing mortality:

- Using a fixed F1 of 0.40 instead of the 3-year rule (Run 2)
- Using the 'flat' rule instead of the 'linear' rule when SSB < $\mathbf{B}_{pa}$ (Run 3)
- Increasing the maximum change from year to year to 20%, 30% or 40% (Run 4-6)
- Increasing the CV (on log scale) for the assessment error from 0.25 to 0.35 (Run 7)

In order to illustrate the possible effects of cannibalism, a run was made (Run 8) where the natural mortality on ages 3 and 4 was set close to the highest values observed in the period 1984-2002, i. e. 0.7 for age 3 and 0.4 for age 4. This is likely to be an overestimate of the effect of cannibalism. This run gave an average total stock of 2.1 million, an average spawning stock of 600 thousand tonnes and average catches of 500 thousand tonnes. The probability of SSB<$\mathbf{B}_{lim}$ remained negligible, while SSB < $\mathbf{B}_{pa}$ in 11% of the years.

PROST does at present not allow for including bias in the assessment. In order to get a coarse estimate of the effect of bias in the assessment, runs with F=0.50 (and assessment error as described above) were made for assessment error (CV) set to 0.25 and 0.35, as well as with and without high values of natural mortality for age 3 and 4 (Runs 9-12). Increasing F to 0.5 (assuming a 20% bias in F) while keeping the other default settings (Run 9) gave lower stock levels and catches, but the probability of SSB< $\mathbf{B}_{lim}$ in any year of the simulation only increased to about 1%. This was also the case for a similar run with cannibalism (Run 10). Increasing the assessment error to CV=0.35 and keeping high natural mortality on ages 3 and 4 increased the probability of SSB< $\mathbf{B}_{lim}$ in any year to 5% (Run 11). If a fixed F=0.50 is applied to the population model instead of the 3-year average rule, the probability of SSB< $\mathbf{B}_{lim}$ in any year of the simulation increases to 16% (Run 12). However, even for runs 11&12, SSB< $\mathbf{B}_{lim}$ in < 1% of all years. It is noteworthy that the 3-year average rule is considerably more precautionary than a fixed F rule, as seen from runs 11 and 12. It should be noted that the values of % mean annual change of TAC for runs 10-12 are strongly influenced by some runs where the TAC is 0 or close to 0 in some years. The values were calculated ignoring runs where TAC was set to 0 in any year.

Run no	**Catch 1000 tonnes**	**SSB 1000 tonnes**	**TSB 1000 tonnes**	**% annual change in TAC (abs. value)**	**% Years SSB<$\mathbf{B}_{lim}$**	**% Years SSB<$\mathbf{B}_{pa}$**
1	885	1018	3452	7.7	0.00	0.1
4	884	1006	3433	11.0	0.00	0.0
5	883	999	3421	12.6	0.00	0.0
6	884	996	3419	13.2	0.00	0.0
7	891	1046	3497	8.8	0.00	0.3
8	497	581	2104	15.2	0.00	13.2
9	832	722	2899	10.6	0.01	3.6
12	481	486	1925	116.2	0.22	44.4

We conclude that the "linear" harvest control rule given above is precautionary, as the probability of SSB< $\mathbf{B}_{lim}$ is low even using a rather conservative population model with large assessment error. Although uncertainty in weight at age and maturity at age is not included, we do not believe that including this would change our results significantly.

3.12.3.2 Stochastic simulations based on historical data (WD 18)

Model description

WD18 describes a simulation model, which is intended for testing and comparison of various harvest control rules for the NEA cod stock. The population model is described by Bulgakova (2003). The model is applied for the period 1981-2006, and weight-at-age, maturity at age, natural mortality at age and the exploitation pattern is taken from observed values. This allows for reducing the model output uncertainty and for testing model feasibility. The recruitment is described by a Ricker-type function, which depends on spawning biomass, the population fecundity index and on the index of in$\mathbf{F}_{low}$ of Atlantic waters. The uncertainty in initial stock size and in the stock-recruitment model is taken into consideration, but assessment error is not included. 100 stochastic simulations were run in each case. The model allows for different harvest control rules.

Harvest control rules

Three versions of the harvest control rule adopted by the JRNC are tested, in addition to the ICES-precautionary approach type scheme adopted by SGBRP.

These four harvest control rules are described in more detail below.

1: ICES-pa type scheme adopted by SGBRP

F(y)=F1 if SSB(y)> $\mathbf{B}_{pa}$,

$$F(y) = \frac{SSB(y) - B_{\lim}}{B_{pa} - B_{\lim}} F1$$ if $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$

F(y)=0 if SSB(y) < $\mathbf{B}_{\lim}$

For this scheme, simulations were made for F1=0.4, 0.5, 0.6 and 0.8

2: JRNC-1 scheme

F(y) set by 3-year rule(0.40, 10) if SSB(y) > $\mathbf{B}_{\lim}$

F(y)=0 if SSB(y) < $\mathbf{B}_{\lim}$

No limit on the year-to-year TAC variation in the first year of simulation (1981)

3: JRNC-2 scheme

F(y) set by 3-year rule(0.40, 10) if SSB(y) > $\mathbf{B}_{pa}$

$$F(y) = 0.40 \frac{SSB(y) - B_{\lim}}{B_{pa} - B_{\lim}}$$ if $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$

F(y)=0 if SSB(y) < $\mathbf{B}_{\lim}$

No limit on the year-to-year TAC variation in the first year of simulation (1981)

4: JRNC-3 scheme

F(y) set by 3-year rule(0.40, x) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) > $\mathbf{B}_{pa}$

F(y) set by 3-year rule(0.40, no limit) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) < $\mathbf{B}_{pa}$

$$F(y) = 0.40 \frac{SSB(y) - B_{\lim}}{B_{pa} - B_{\lim}}$$ if $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$

F(y)=0 if SSB(y) < $\mathbf{B}_{\lim}$

No limit on the year-to-year TAC variation in the first year of simulation (1981).

Thus, when SSB increases from below $\mathbf{B}_{pa}$ in year *y-1* to above $\mathbf{B}_{pa}$ in year *y*, the TAC in year *y* should not be calculated using the limit on year-to-year variations in TAC. For this scheme, simulations were made with x=10, x=15 and x=20.

The performance measures for the different HCRs considered were:

- Average catch during the period
- Probability of SSB< $\mathbf{B}_{\lim}$ or F > $\mathbf{F}_{\lim}$
- Realised percentage of year-to-year changes in TAC

Results

The ICES-pa scheme was found to be precautionary also for F=0.5-0.6. It was found that the JRNC-1 rule can cross the precautionary limits and lead to closure of the fishery. The JRNC-2 rule is precautionary but gives too low average catch. The JRNC-3 scheme with a limit of 10% variation in annual changes gives a 5% probability of SSB< $\mathbf{B}_{\lim}$ during the simulation period and a 10% probability of F > $\mathbf{F}_{\lim}$ during the simulation period (Fig. 3.19). This crossing of limit reference points occurs only in two years out of the 25 years in the simulation period. Increasing the limit of annual variation in TAC to 15% gave a zero probability of SSB< $\mathbf{B}_{\lim}$ and of F > $\mathbf{F}_{\lim}$ during the all simulation period. A further increase of this limit did not affect the cod population dynamics. Table 3.37 shows stochastic forecast from the model JRNC-3 described above for the period 2003-2006. Upper panel corresponds to variant where the recruitment model (Bulgakova, 2003) is used for 2004-2006. Lower panel corresponds to a variant where the recruitment is estimated by the RCT3 program. In both cases the risk probability is zero, but it should be pointed out that this is in a situation of rather high SSB levels.

Thus the JRNC-3 rule is considered precautionary (risk probability equals zero), and will decrease the inter-annual changes in TAC without loss of catches.

3.12.4 Comparison of the approaches

The only difference between the harvest control rules "linear" described in Section 3.12.2 and JRNC-3 described in Section 3.12.3 is the determination of F when $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$. In the "linear" rule, F(y) is given by

3-year rule ($0.40\dfrac{SSB(y)-B_{\lim}}{B_{pa}-B_{\lim}}$,unconstrained) if $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$

while in the JRNC-3 rule, F is given by

$$F(y)=0.40\frac{SSB(y)-B_{\lim}}{B_{pa}-B_{\lim}} \qquad \text{if } \mathbf{B}_{\lim}< SSB(y)< \mathbf{B}_{pa}$$

Thus, both rules have no constraints on the year-to-year variation in TAC when $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$. The "linear rule" uses the 3-year rule with an F= $0.40\dfrac{SSB(y)-B_{\lim}}{B_{pa}-B_{\lim}}$ to determine F when $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$, while the JRNC-3 rule in this case uses the same value F= $0.40\dfrac{SSB(y)-B_{\lim}}{B_{pa}-B_{\lim}}$ exactly, without using a 3-year average. Using the '3-year average rule' for SSB > $\mathbf{B}_{pa}$ but switching to a purely F-based strategy when SSB< $\mathbf{B}_{pa}$, as in the JRNC-3 rule, will cause TAC as a function of SSB for a given year to be discontinuous at SSB= $\mathbf{B}_{pa}$.

Thus, it seems most consistent to use the "linear" rule. However, the difference between the performance of the "linear" rule and the JRNC-3 rule will probably be insignificant.

3.12.5 Conclusions

The studies presented indicate that the HCR proposed by the Commission is in agreement with the precautionary approach, provided that the limit on annual change of TAC is not applied for SSB < $\mathbf{B}_{pa}$. It has not been thoroughly tested whether it is also a condition that the F is reduced for SSB < $\mathbf{B}_{pa}$ for the HCR to be in agreement with the precautionary approach.

The following rule is proposed and considered to be precautionary:

F(y) set by 3-year rule(0.40, 10) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) > $\mathbf{B}_{pa}$

F(y) set by 3-year rule(0.40, unconstrained) if SSB(y) > $\mathbf{B}_{pa}$ and SSB(y-1) < $\mathbf{B}_{pa}$

F(y) set by 3-year rule($0.40\dfrac{SSB(y)-B_{\lim}}{B_{pa}-B_{\lim}}$,unconstrained) if $\mathbf{B}_{\lim}$< SSB(y)< $\mathbf{B}_{pa}$

F(y)=0 if SSB(y) < $\mathbf{B}_{\lim}$

This harvest control rule also applies for a rebuilding situation.

Since the 10%-rule is found precautionary, also less restrictive rules (higher than 10% change) for allowed changes in TAC from year to year will be, since this allows for a more rapid action in case the stock is decreasing.

3.12.6 Further work on management strategies for NEA cod

The 32nd meeting of the Joint Norwegian-Russian Fisheries Commission requested an analysis of maximum long-time yield from the most important commercial species in the Barents Sea, based on existing knowledge. The starting point shall be the dynamics of the Northeast arctic cod and account should be taken of the interactions between cod and other species that influence the yield of cod. The work shall be supplied with investigation of other species in this prioritised sequence: capelin, herring, harp seal, minke whales, shrimp and haddock. The investigation shall include all ecosystem elements that are available for investigations, including natural and human-generated effects on reproduction, growth and mortality. The models shall be validated against historic stock developments. The investigation shall also specify further research that can give more precise answers to these questions.

A time schedule for this work is under preparation. This work will be done by Norwegian and Russian scientists, and will build upon the work on management strategies presented here.

The relationship between the relative yearly variation of TAC and the variation of the fishable stock is also relevant to the choice of management strategy. There is obviously a trade-off between yield and stability of catches from year to year. This fact is also worth considering when choosing the appropriate level of annual percentage change in TAC in the HCR (Borisov, WD27).

Table 3.1 North-East Arctic COD. Total catch (t) by fishing areas and unreported catch (Data provided by Working Group members.)

Year	Sub-area I	Division IIa	Division IIb	Unreported catches	Total catch
1961	409,694	153,019	220,508		783,221
1962	548,621	139,848	220,797		909,266
1963	547,469	117,100	111,768		776,337
1964	206,883	104,698	126,114		437,695
1965	241,489	100,011	103,430		444,983
1966	292,253	134,805	56,653		483,711
1967	322,798	128,747	121,060		572,605
1968	642,452	162,472	269,254		1,074,084
1969	679,373	255,599	262,254		1,197,226
1970	603,855	243,835	85,556		933,246
1971	312,505	319,623	56,920		689,048
1972	197,015	335,257	32,982		565,254
1973	492,716	211,762	88,207		792,685
1974	723,489	124,214	254,730		1,102,433
1975	561,701	120,276	147,400		829,377
1976	526,685	237,245	103,533		867,463
1977	538,231	257,073	109,997		905,301
1978	418,265	263,157	17,293		698,715
1979	195,166	235,449	9,923		440,538
1980	168,671	199,313	12,450		380,434
1981	137,033	245,167	16,837		399,037
1982	96,576	236,125	31,029		363,730
1983	64,803	200,279	24,910		289,992
1984	54,317	197,573	25,761		277,651
1985	112,605	173,559	21,756		307,920
1986	157,631	202,688	69,794		430,113
1987	146,106	245,387	131,578		523,071
1988	166,649	209,930	58,360		434,939
1989	164,512	149,360	18,609		332,481
1990	62,272	99,465	25,263	25,000	212,000
1991	70,970	156,966	41,222	50,000	319,158
1992	124,219	172,532	86,483	130,000	513,234
1993	195,771	269,383	66,457	50,000	581,611
1994	353,425	306,417	86,244	25,000	771,086
1995	251,448	317,585	170,966		739,999
1996	278,364	297,237	156,627		732,228
1997	273,376	326,689	162,338		762,403
1998	250,815	257,398	84,411		592,624
1999	159,021	216,898	108,991		484,910
2000	137,197	204,167	73,506		414,870
2001	142,628	185,890	97,953		426,471
2002	184,789	189,013	71,242	90,000	535,045
2003 [1]	162,826	217,620	51,503	90,000	521,949

[1] Provisional figures.

Table 3.2 North-East Arctic COD. Total nominal catch ('000 t) by trawl and other gear for each area, data provided by Working Group members.

	Sub-area I		Division IIa		Division IIb	
Year	Trawl	Others	Trawl	Others	Trawl	Others
1967	238.0	84.8	38.7	90.0	121.1	-
1968	588.1	54.4	44.2	118.3	269.2	-
1969	633.5	45.9	119.7	135.9	262.3	-
1970	524.5	79.4	90.5	153.3	85.6	-
1971	253.1	59.4	74.5	245.1	56.9	-
1972	158.1	38.9	49.9	285.4	33.0	-
1973	459.0	33.7	39.4	172.4	88.2	-
1974	677.0	46.5	41.0	83.2	254.7	-
1975	526.3	35.4	33.7	86.6	147.4	-
1976	466.5	60.2	112.3	124.9	103.5	-
1977	471.5	66.7	100.9	156.2	110.0	-
1978	360.4	57.9	117.0	146.2	17.3	-
1979	161.5	33.7	114.9	120.5	8.1	-
1980	133.3	35.4	83.7	115.6	12.5	-
1981	91.5	45.1	77.2	167.9	17.2	-
1982	44.8	51.8	65.1	171.0	21.0	-
1983	36.6	28.2	56.6	143.7	24.9	-
1984	24.5	29.8	46.9	150.7	25.6	-
1985	72.4	40.2	60.7	112.8	21.5	-
1986	109.5	48.1	116.3	86.4	69.8	-
1987	126.3	19.8	167.9	77.5	129.9	1.7
1988	149.1	17.6	122.0	88.0	58.2	0.2
1989	144.4	19.5	68.9	81.2	19.1	0.1
1990	51.4	10.9	47.4	52.1	24.5	0.8
1991	58.9	12.1	73.0	84.0	40.0	1.2
1992	103.7	20.5	79.7	92.8	85.6	0.9
1993	165.1	30.7	155.5	113.9	66.3	0.2
1994	312.1	41.3	165.8	140.6	84.3	1.9
1995	218.1	33.3	174.3	143.3	160.3	10.7
1996	248.9	32.7	137.1	159.0	147.7	6.8
1997	235.6	37.7	150.5	176.2	154.7	7.6
1998	219.8	31.0	127.0	130.4	82.7	1.7
1999	133.3	25.7	101.9	115.0	107.2	1.8
2000	111.7	25.5	105.4	98.8	72.2	1.3
2001	119.1	23.5	83.1	102.8	95.4	2.5
2002	147.4	37.4	83.4	105.6	69.9	1.3
2003[1]	145.7	17.1	103.4	114.2	49.7	1.8

[1] Provisional figures.

Table 3.3 North-East Arctic COD. Nominal catch (t) by countries
(Sub-area I and Divisions IIa and IIb combined, data provided by Working Group members.)

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep. Germany	Norway	Poland	United Kingdom	Russia[2]		Others	Total all countries
1961	3,934	13,755	3,921	8,129	268,377	-	158,113	325,780		1,212	783,221
1962	3,109	20,482	1,532	6,503	225,615	-	175,020	476,760		245	909,266
1963	-	18,318	129	4,223	205,056	108	129,779	417,964		-	775,577
1964	-	8,634	297	3,202	149,878	-	94,549	180,550		585	437,695
1965	-	526	91	3,670	197,085	-	89,962	152,780		816	444,930
1966	-	2,967	228	4,284	203,792	-	103,012	169,300		121	483,704
1967	-	664	45	3,632	218,910	-	87,008	262,340		6	572,605
1968	-	-	225	1,073	255,611	-	140,387	676,758		-	1,074,084
1969	29,374	-	5,907	5,543	305,241	7,856	231,066	612,215		133	1,197,226
1970	26,265	44,245	12,413	9,451	377,606	5,153	181,481	276,632		-	933,246
1971	5,877	34,772	4,998	9,726	407,044	1,512	80,102	144,802		215	689,048
1972	1,393	8,915	1,300	3,405	394,181	892	58,382	96,653		166	565,287
1973	1,916	17,028	4,684	16,751	285,184	843	78,808	387,196		276	792,686
1974	5,717	46,028	4,860	78,507	287,276	9,898	90,894	540,801		38,453	1,102,434
1975	11,309	28,734	9,981	30,037	277,099	7,435	101,843	343,580		19,368	829,377
1976	11,511	20,941	8,946	24,369	344,502	6,986	89,061	343,057		18,090	867,463
1977	9,167	15,414	3,463	12,763	388,982	1,084	86,781	369,876		17,771	905,301
1978	9,092	9,394	3,029	5,434	363,088	566	35,449	267,138		5,525	698,715
1979	6,320	3,046	547	2,513	294,821	15	17,991	105,846		9,439	440,538
1980	9,981	1,705	233	1,921	232,242	3	10,366	115,194		8,789	380,434
						Spain					
1981	12,825	3,106	298	2,228	277,818	14,500	5,262	83,000		-	399,037
1982	11,998	761	302	1,717	287,525	14,515	6,601	40,311		-	363,730
1983	11,106	126	473	1,243	234,000	14,229	5,840	22,975		-	289,992
1984	10,674	11	686	1,010	230,743	8,608	3,663	22,256		-	277,651
1985	13,418	23	1,019	4,395	211,065	7,846	3,335	62,489		4,330	307,920
1986	18,667	591	1,543	10,092	232,096	5,497	7,581	150,541		3,505	430,113
1987	15,036	1	986	7,035	268,004	16,223	10,957	202,314		2,515	523,071
1988	15,329	2,551	605	2,803	223,412	10,905	8,107	169,365		1,862	434,939
1989	15,625	3,231	326	3,291	158,684	7,802	7,056	134,593		1,273	332,481
1990	9,584	592	169	1,437	88,737	7,950	3,412	74,609		510	187,000
1991	8,981	975	**Greenland**	2,613	126,226	3,677	3,981	119,427 [3]		3,278	269,158
1992	11,663	2	3,337	3,911	168,460	6,217	6,120	182,315	**Iceland**	1,209	383,234
1993	17,435	3,572	5,389	5,887	221,051	8,800	11,336	244,860	9,374	3,907	531,611
1994	22,826	1,962	6,882	8,283	318,395	14,929	15,579	291,925	36,737	28,568	746,086
1995	22,262	4,912	7,462	7,428	319,987	15,505	16,329	296,158	34,214	15,742	739,999
1996	17,758	5,352	6,529	8,326	319,158	15,871	16,061	305,317	23,005	14,851	732,228
1997	20,076	5,353	6,426	6,680	357,825	17,130	18,066	313,344	4,200	13,303	762,403
1998	14,290	1,197	6,388	3,841	284,647	14,212	14,294	244,115	1,423	8,217	592,624
1999	13,700	2,137	4,093	3,019	223,390	8,994	11,315	210,379	1,985	5,898	484,910
2000	13,350	2,621	5,787	3,513	192,860	8,695	9,165	166,202	7,562	5,115	414,870
2001	12,500	2,681	5,727	4,524	188,431	9,196	8,698	183,572	5,917	5,225	426,471
2002	15,693	2,934	6,419	4,517	202,559	8,414	8,977	184,072	5,975	5,484	445,045
2003 [1]	14,668	2941	7026	4732	191,976	7924	8711	182160	5961	5,850	431,949

[1] Provisional figures.

[2] USSR prior to 1991.

[3] Includes Baltic countries.

Table 3.4 North-east Arctic COD. Weights at age (kg) in landings from various countries															
Norway															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983		0.41	0.82	1.32	2.05	2.82	3.94	5.53	7.70	9.17	11.46	16.59	16.42	16.96	24.46
1984		1.16	1.47	1.97	2.53	3.13	3.82	4.81	5.95	7.19	7.86	8.46	7.99	9.78	10.64
1985		0.34	0.99	1.43	2.14	3.27	4.68	6.05	7.73	9.86	11.87	14.16	14.17	13.52	15.33
1986		0.30	0.67	1.34	2.04	3.14	4.60	5.78	6.70	7.52	9.74	10.68	12.86	9.59	16.31
1987		0.24	0.48	0.88	1.66	2.72	4.35	6.21	8.78	9.78	12.50	13.75	15.12	10.43	19.95
1988		0.36	0.56	0.83	1.31	2.34	3.84	6.50	8.76	9.97	11.06	14.43	19.02	12.89	10.16
1989		0.53	0.75	0.90	1.17	1.95	3.20	4.88	7.82	9.40	11.52	11.47		19.47	14.68
1990		0.40	0.81	1.22	1.59	2.14	3.29	4.99	7.83	10.54	14.21	17.63	7.97	14.64	
1991		0.63	1.37	1.77	2.31	3.01	3.68	4.63	6.06	8.98	12.89	17.00		14.17	16.63
1992		0.41	1.10	1.79	2.45	3.22	4.33	5.27	6.21	8.10	10.51	11.59		15.81	6.52
1993		0.30	0.83	1.70	2.41	3.35	4.27	5.45	6.28	7.10	7.82	10.10	16.03	19.51	17.68
1994		0.30	0.82	1.37	2.23	3.35	4.27	5.56	6.86	7.45	7.98	9.53	12.16	11.45	19.79
1995		0.44	0.78	1.26	1.87	2.80	4.12	5.15	5.96	7.90	8.67	9.20	11.53	17.77	21.11
1996		0.29	0.90	1.15	1.67	2.58	4.08	6.04	6.62	7.96	9.36	10.55	11.41	9.51	24.24
1997		0.35	0.78	1.14	1.56	2.25	3.48	5.35	7.38	7.55	8.30	11.15	8.64	12.80	
1998		0.38	0.68	1.03	1.64	2.23	3.24	4.85	6.88	9.18	9.84	15.78	14.37	13.77	15.58
1999		0.46	0.88	1.16	1.65	2.40	3.12	4.26	6.00	6.52	10.64	14.05	12.67	9.20	17.22
2000		0.31	0.65	1.23	1.80	2.54	3.58	4.49	5.71	7.54	7.86	12.71	14.71	15.40	20.26
2001		0.30	0.77	1.18	1.83	2.75	3.64	4.88	5.93	7.43	8.90	10.22	11.11	13.03	18.85
2002		0.31	0.90	1.40	1.90	2.60	3.55	4.60	5.80	7.40	9.56	8.71	12.92	8.42	17.61
2003		0.55	0.88	1.39	2.01	2.63	3.59	4.83	5.57	7.26	9.36	9.52	9.52	10.7	21.7
Russia (trawl only)															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983		0.65	1.05	1.58	2.31	3.39	4.87	6.86	8.72	10.40	12.07	14.43			
1984		0.53	0.88	1.45	2.22	3.21	4.73	6.05	8.43	10.34	12.61	14.95			
1985		0.33	0.77	1.31	1.84	2.96	4.17	5.94	6.38	8.58	10.28				
1986		0.29	0.61	1.14	1.75	2.45	4.17	6.18	8.04	9.48	11.33	12.35	14.13		
1987		0.24	0.52	0.88	1.42	2.07	2.96	5.07	7.56	8.93	10.80	13.05	18.16		
1988		0.27	0.49	0.88	1.32	2.06	3.02	4.40	6.91	9.15	11.65	12.53	14.68		
1989		0.50	0.73	1.00	1.39	1.88	2.67	4.06	6.09	7.76	9.88				
1990		0.45	0.83	1.21	1.70	2.27	3.16	4.35	6.25	8.73	10.85	13.52			
1991		0.36	0.64	1.05	2.03	2.85	3.77	4.92	6.13	8.36	10.44	15.84	19.33		
1992		0.55	1.20	1.44	2.07	3.04	4.24	5.14	5.97	7.25	9.28	11.36			
1993		0.48	0.78	1.39	2.06	2.62	4.07	5.72	6.79	7.59	11.26	14.79	17.71		
1994		0.41	0.81	1.24	1.80	2.55	2.88	4.96	6.91	8.12	10.28	12.42	16.93		
1995		0.37	0.77	1.21	1.74	2.37	3.40	4.71	6.73	8.47	9.58	12.03	16.99		
1996		0.30	0.64	1.09	1.60	2.37	3.42	5.30	7.86	8.86	10.87	11.80			
1997		0.30	0.57	1.00	1.52	2.18	3.30	4.94	7.15	10.08	11.87	13.54			
1998		0.33	0.68	1.06	1.60	2.34	3.39	5.03	6.89	10.76	12.39	13.61	14.72		
1999		0.24	0.58	0.98	1.41	2.17	3.26	4.42	5.70	7.27	10.24	14.12			
2000		0.18	0.48	0.85	1.44	2.16	3.12	4.44	5.79	7.49	9.66	10.36			
2001		0.12	0.31	0.62	1.00	1.53	2.30	3.31	4.57	6.55	8.11	9.52	11.99		
2002		0.20	0.60	1.05	1.46	2.14	3.27	4.47	6.23	8.37	10.06	12.37			
2003		0.23	0.63	1.06	1.78	2.4	3.41	4.86	6.28	7.55	11.1	13.4	12.12	14.5	
Germany (Division IIa and IIb)															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994			0.68	1.04	2.24	3.49	4.51	5.79	6.93	8.16	8.46	8.74	9.48	15.25	
1995			0.44	0.84	1.50	2.72	3.81	4.46	4.81	7.37	7.69	8.25	9.47		
1996			0.84	1.15	1.64	2.53	3.58	4.13	3.90	4.68	6.98	6.43	11.32		
1997			0.43	0.92	1.42	2.01	3.15	4.04	5.16	4.82	3.96	7.04	8.80		
1998		0.23	0.73	1.17	1.89	2.72	3.25	4.13	5.63	6.50	8.57	8.42	11.45	8.79	
1999	[1]		0.85	1.45	2.00	2.65	3.47	4.16	5.45	6.82	5.90		8.01		
2000	[2]	0.26	0.73	1.36	2.04	2.87	3.67	4.88	5.78	7.05	8.45	8.67	9.33	6.88	
2001		0.38	0.80	1.21	1.90	2.74	3.90	4.99	5.69	7.15	7.32	11.72	9.11	6.60	
2002		0.35	1.00	1.31	1.80	2.53	3.64	4.38	5.07	6.82	9.21	7.59	13.18	19.17	19.2
2003		0.22	0.44	1.04	1.71	2.31	3.27	4.93	6.17	7.77	9.61	9.99	12.3	13.6	
	[1] Division IIa only														
	[2] IIa and IIb combined														
Spain (Division IIb)															
Year				Age											
		2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994		0.43	1.08	1.38	2.32	2.47	2.68	3.46	5.20	7.04	6.79	7.20	8.04	10.46	15.35
1995		0.42	0.51	0.98	1.99	3.41	4.95	5.52	8.62	9.21	11.42	9.78	8.08		
1996			0.66	1.12	1.57	2.43	3.17	3.59	4.44	5.48	6.79	8.10			
1997	[1]	0.51	0.65	1.22	1.68	2.60	3.39	4.27	6.67	7.88	11.34	13.33	10.03	8.69	
1998		0.47	0.74	1.15	1.82	2.44	3.32	3.71	5.00	7.26					
1999	[1]	0.21	0.69	1.06	1.69	2.50	3.32	4.72	5.76	6.77	7.24	7.63			
2000	[1]	0.23	0.61	1.24	1.75	2.47	3.12	4.65	6.06	7.66	10.94	11.40	7.20		
2001		0.23	0.64	1.25	1.95	2.86	3.55	4.95	6.46	8.50	11.07	13.09			
2002		0.16	0.55	1.00	1.48	2.17	3.29	4.47	5.35	8.29	12.23	9.01	12.16	15.2	
2003			0.58	1.05	1.70	2.33	3.33	4.92	6.24	9.98	13.07	14.74	14.17		
		[1] IIa and IIb combined													
Iceland (Sub-area I)															
1994		0.42	0.85	1.44	2.77	3.54	4.08	5.84	6.37	7.02	7.48	7.37			
1995			1.17	0.91	1.60	2.28	3.61	4.73	6.27			6.26			
1996			0.36	0.99	1.55	2.83	3.79	4.81	5.34	7.25	7.68	9.08	8.98	10.52	
1997		0.42	0.43	0.76	1.60	2.40	3.45	4.40	5.74	6.15		8.28	10.52	9.89	
UK (England & Wales)															
1995	[1]			1.47	2.11	3.47	5.57	6.43	7.17	8.12	8.05	10.2	10.1		
1996	[2]			1.55	1.81	2.42	3.61	6.3	6.47	7.83	7.91	8.93	9.38	10.9	
1997	[2]			1.93	2.17	3.07	4.17	4.89	6.46		12.3	8.44			
	[1]	Division IIa and IIb													
	[2]	Division IIa													

Table 3.5 North-East Arctic COD. Basis for maturity ogives (percent) used in the assessment. Norwegian and Russian data.

Norway

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1982	-	5	10	34	65	82	92	100
1983	5	8	10	30	73	88	97	100

Russia

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1984	-	5	18	31	56	90	99	100
1985	-	1	10	33	59	85	92	100
1986	-	2	9	19	56	76	89	100
1987	-	1	9	23	27	61	81	80
1988	-	1	3	25	53	79	100	100
1989	-	-	2	15	39	59	83	100
1990	-	2	6	20	47	62	81	95
1991	-	3	1	23	66	82	96	100
1992	-	1	8	31	73	92	95	100
1993	-	3	7	21	56	89	95	99
1994	-	1	8	30	55	84	95	98
1995	-	-	4	23	61	75	94	97
1996	-	-	1	22	56	82	95	100
1997	-	-	1	10	48	73	90	100
1998	-	-	2	15	47	87	97	96
1999	-	-	1	10	38	75	94	100
2000	-	-	6	19	51	84	96	100
2001	-	-	4	28	62	89	96	100
2002		2	11	34	68	83	98	100
2003	0	0	11	29	66	90	95	100
2004	0	1	8	34	63	83	96	96

Norway

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1985	-	1	9	38	51	85	100	79
1986	3	7	8	19	50	67	36	80
1987	-	0	4	12	16	31	19	-
1988	-	2	6	41	54	45	100	100
1989	-	1	8	21	43	79	87	100
1990	-	1	4	22	68	93	91	100
1991	-	5	12	34	65	84	99	100
1992	-	1	16	55	77	94	100	100
1993	-	3	12	40	66	94	98	99
1994	-	1	14	36	64	79	98	100
1995	-	1	9	43	63	73	96	98
1996	-	-	2	30	70	84	100	100
1997	-	-	2	17	64	92	100	89
1998	-	1	6	23	40	77	90	100
1999	-	-	-	11	52	83	83	100
2000	-	-	6	26	76	83	99	100
2001	-	1	7	39	53	64	100	100
2002	-	1	5	46	71	89	97	100
2003	0	0	9	44	60	86	90	100
2004	0	0	11	47	80	92	99	100

Table 3.6. Recruitment indices for NEA cod. Input for the RCT-analysis.

```
NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,
9,19,2            (No. of surveys, No. of years, VPA Column No.),,
1985,   205,   6,    2,   4,    -11,     -11,     -11,  -11,   -11,  -11
1986,   173,   1,    1,   3,    -11,     -11,     -11,  -11,   -11,  -11
1987,   243,   1,    1,   1,    -11,     -11,     -11,  -11,   -11,  -11
1988,   412,   1,    1,   4,    -11,     -11,     -11,  -11,   -11,  -11
1989,   721,   1,    3,   8,    -11,     -11,     -11,  -11,   -11,  -11
1990,   896,   4,    4,  44,    -11,     -11,     -11,  -11,   -11,  -11
1991,   811,   4,    8,  15,    -11,     -11,     -11    -11, 296.5, 349.8
1992,   658,  32,    3,  13,    -11,     -11,   535.8, 577.2, 274.6, 166.2
1993,   437,   3,    4,   6, 1035.9,   858.3,   541.5, 292.9, 170.0,  92.9
1994,   717,  12,    8,  10, 5253.1,  2619.2,   707.6, 339.8, 238.0, 188.3
1995,   851,  30,   13,  26, 5768.5,  2396.0,  1045.1, 430.5, 396.0, 427.7
1996,   599,  10,    7,  27, 4815.5,  1623.5,   643.7, 632.9, 211.8, 150.0
1997,   688,  16,    6,  18, 2418.5,  3401.3,   340.1, 304.3, 235.2, 245.1
1998,   541,   2,    4,  12,  484.6,   358.3,   248.3, 221.4, 191.1, 138.2
1999,   447,   1,    1,  13,  128.8,   154.1,    76.6,  63.9,  88.3,  69.3
2000,   502,   6,    7,  20,  657.9,   629.9,   443.9, 215.1, 377.0, 303.4
2001,   -11,   2,    1,   3,   35.3,    18.2,    79.1,  61.5,  76.6,  33.6
2002,   -11,  14,    5, -11, 2991.7,  1693.9,   235.4, 105.2,   -11,   -11
2003,   -11,   8,  -11, -11,  328.5,   157.6,     -11,   -11,   -11,   -11
R-0      Russian Bottom trawl survey, area I+IIb,   age 0
R-1      Russian Bottom trawl survey, area I+IIb,   age 1
R-2      Russian Bottom trawl survey, area I+IIb,   age 2
N-BST1     Norwegian Barents Sea, Bottom trawl survey, age 1
N-BSA1     Norwegian Barents Sea Acoustic survey age 1
N-BST2     Norwegian Barents Sea, Bottom trawl survey, age 2
N-BSA2     Norwegian Barents Sea Acoustic survey age 2
N-BST3     Norwegian Barents Sea, Bottom trawl survey, age 3
N-BSA3     Norwegian Barents Sea Acoustic survey age 3
```

Table 3.7. Recruitment predictions based on survey indices shrunk towards the vpa mean

Analysis by RCT3 ver3.1 of data from file :

rec20041

NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,

Data for 9 surveys over 19 years : 1985 - 2003

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1996

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.10	4.30	1.10	.237	11	2.40	6.93	1.313	.006
R-1	1.13	4.51	.52	.584	11	2.08	6.87	.628	.026
R-2	.76	4.50	.38	.726	11	3.33	7.04	.472	.046
N-BST1	.37	3.52	.10	.960	3	8.48	6.62	.208	.238
N-BSA1	.59	2.08	.16	.900	3	7.39	6.42	.328	.095
N-BST2	1.16	-1.07	.28	.608	4	6.47	6.41	.443	.052
N-BSA2	1.82	-4.44	.56	.276	4	6.45	7.33	1.151	.008
N-BST3	.94	1.28	.14	.831	5	5.36	6.31	.206	.241
N-BSA3	.46	4.05	.11	.891	5	5.02	6.36	.157	.256
					VPA Mean =		6.24	.579	.031

Yearclass = 1997

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
R-0	1.04	4.35	1.00	.245	12	2.83	7.30	1.214	.007
R-1	1.09	4.53	.50	.570	12	1.95	6.65	.584	.029
R-2	.73	4.52	.39	.677	12	2.94	6.67	.466	.046
N-BST1	.39	3.30	.16	.820	4	7.79	6.31	.266	.141
N-BSA1	.59	2.04	.12	.898	4	8.13	6.85	.227	.195
N-BST2	1.16	-1.08	.23	.613	5	5.83	5.67	.490	.042
N-BSA2	2.41	-8.16	.87	.097	5	5.72	5.60	1.382	.005
N-BST3	.91	1.45	.12	.832	6	5.46	6.42	.163	.250
N-BSA3	.45	4.09	.09	.895	6	5.51	6.59	.125	.250
					VPA Mean =		6.27	.540	.034

Table 3.7 (Cont'd)

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	----------	----------I		I----------	Prediction	----------	----------I
R-0	.95	4.45	.89	.262	13	1.10	5.49	1.063	.012
R-1	1.07	4.55	.46	.571	13	1.61	6.27	.532	.047
R-2	.71	4.55	.36	.680	13	2.56	6.38	.422	.074
N-BST1	.41	3.14	.19	.696	5	6.19	5.68	.422	.074
N-BSA1	.55	2.33	.17	.729	5	5.88	5.54	.440	.068
N-BST2	1.48	-3.01	.57	.164	6	5.52	5.17	1.056	.012
N-BSA2	3.20	-12.81	1.16	.045	6	5.40	4.51	1.946	.003
N-BST3	.92	1.42	.12	.804	7	5.26	6.25	.164	.329
N-BSA3	.45	4.09	.09	.889	7	4.94	6.32	.114	.329
					VPA Mean =		6.32	.504	.052

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	----------	----------I		I----------	Prediction	----------	----------I
R-0	.90	4.60	.84	.251	14	.69	5.22	1.023	.014
R-1	1.05	4.58	.43	.562	14	.69	5.31	.550	.047
R-2	.70	4.57	.34	.671	14	2.64	6.42	.391	.094
N-BST1	.31	4.04	.24	.549	6	4.87	5.54	.489	.060
N-BSA1	.39	3.62	.26	.505	6	5.04	5.57	.513	.055
N-BST2	.90	.80	.41	.246	7	4.35	4.72	.967	.015
N-BSA2	1.61	-3.07	.63	.123	7	4.17	3.63	1.636	.005
N-BST3	.89	1.56	.11	.827	8	4.49	5.58	.225	.283
N-BSA3	.46	4.05	.08	.896	8	4.25	6.00	.124	.359
					VPA Mean =		6.34	.462	.067

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------	Regression	----------	----------I		I----------	Prediction	----------	----------I
R-0	.77	4.90	.72	.276	15	1.95	6.41	.825	.013
R-1	.93	4.82	.42	.527	15	2.08	6.77	.494	.037
R-2	.72	4.50	.34	.631	15	3.04	6.68	.397	.057
N-BST1	.21	4.83	.20	.647	7	6.49	6.21	.262	.132
N-BSA1	.27	4.52	.21	.628	7	6.45	6.25	.270	.124
N-BST2	.42	3.87	.28	.455	8	6.10	6.44	.341	.078
N-BSA2	.53	3.38	.33	.369	8	5.38	6.23	.413	.053
N-BST3	.64	3.01	.14	.779	9	5.93	6.79	.181	.227
N-BSA3	.43	4.23	.07	.922	9	5.72	6.67	.095	.227
					VPA Mean =		6.34	.424	.050

Table 3.7 (Cont'd)

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.72	4.99	.63	.285	16	1.10	5.78	.744	.031
R-1	.92	4.79	.43	.464	16	.69	5.43	.544	.059
R-2	.74	4.40	.36	.554	16	1.39	5.43	.463	.081
N-BST1	.21	4.85	.18	.667	8	3.59	5.61	.309	.181
N-BSA1	.27	4.51	.19	.641	8	2.95	5.31	.389	.114
N-BST2	.46	3.64	.29	.413	9	4.38	5.64	.433	.092
N-BSA2	.53	3.40	.30	.389	9	4.14	5.58	.462	.081
N-BST3	.82	1.95	.30	.417	10	4.35	5.52	.451	.085
N-BSA3	.52	3.69	.20	.603	10	3.54	5.54	.333	.157
					VPA Mean =		6.35	.382	.119

Yearclass = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.64	5.12	.57	.302	16	2.71	6.87	.671	.034
R-1	.88	4.87	.41	.451	16	1.79	6.44	.474	.068
R-2									
N-BST1	.21	4.87	.18	.670	8	8.00	6.53	.228	.296
N-BSA1	.27	4.54	.19	.645	8	7.44	6.51	.239	.268
N-BST2	.45	3.69	.29	.418	9	5.47	6.14	.359	.119
N-BSA2	.52	3.45	.30	.395	9	4.67	5.87	.408	.092
N-BST3									
N-BSA3									
					VPA Mean =		6.36	.353	.123

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.56	5.28	.49	.329	16	2.20	6.52	.574	.070
R-1									
R-2									
N-BST1	.21	4.89	.18	.675	8	5.80	6.08	.238	.406
N-BSA1	.26	4.57	.19	.651	8	5.07	5.89	.275	.304
N-BST2									
N-BSA2									
N-BST3									
N-BSA3									
					VPA Mean =		6.38	.322	.221

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1996	645	6.47	.10	.07	.47	600	6.40
1997	675	6.52	.10	.09	.82	688	6.54
1998	478	6.17	.11	.10	.73	542	6.30
1999	336	5.82	.12	.13	1.16	447	6.10
2000	682	6.53	.10	.08	.65	502	6.22
2001	276	5.62	.13	.10	.52		
2002	604	6.40	.12	.09	.55		
2003	455	6.12	.15	.12	.61		

Table 3.8
NE Arctic cod. International catch (thousands) at age for ages 1-15+

	AGE														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1946	1	16	4008	10387	18906	16596	13843	15370	59845	22618	10093	9573	5460	1927	750
1947	1	1	710	13192	43890	52017	45501	13075	19718	47678	31392	9348	9330	4622	4103
1948	1	16	140	3872	31054	55983	77375	21482	15237	9815	30041	7945	4491	3899	4205
1949	1	7	991	6808	35214	100497	83283	29727	13207	5606	8617	13154	3657	1895	2167
1950	1	79	1281	10954	29045	45233	62579	30037	19481	9172	6019	4133	6750	1662	1450
1951	1615	1625	24687	77924	64013	46867	37535	33673	23510	10589	4221	1288	1002	3322	611
1952	1	1202	24099	120704	113203	73827	49389	20562	24367	15651	8327	3565	647	467	1044
1953	1	81	47413	107659	112040	55500	22742	16863	10559	10553	5637	1752	468	173	156
1954	1	9	11473	155171	146395	100751	40635	10713	11791	8557	6751	2370	896	268	123
1955	1	322	3902	37652	201834	161336	84031	30451	13713	9481	4140	2406	867	355	128
1956	81	1498	10614	24172	129803	250472	86784	51091	14987	7465	3952	1655	1292	448	166
1957	987	3487	17321	33931	27182	70702	87033	39213	17747	6219	3232	1220	347	299	173
1958	1	2600	31219	133576	71051	40737	38380	35786	13338	10475	3289	1070	252	40	141
1959	590	2601	32308	77942	148285	53480	18498	17735	23118	9483	3748	997	254	161	98
1960	465	7147	37882	97865	64222	67425	23117	8429	7240	11675	4504	1843	354	102	226
1961	1	1699	45478	132655	123458	51167	38740	17376	5791	6778	5560	1682	910	280	108
1962	1	1713	42416	170566	167241	89460	28297	21996	7956	2728	2603	1647	392	280	103
1963	1	4	13196	106984	205549	95498	35518	16221	11894	3884	1021	1025	498	129	157
1964	103	675	5298	45912	97950	58575	19642	9162	6196	3553	783	172	387	264	131
1965	1	2522	15725	25999	78299	68511	25444	8438	3569	1467	1161	131	67	91	179
1966	1	869	55937	55644	34676	42539	37169	18500	5077	1495	380	403	77	9	70
1967	1	151	34467	160048	69235	22061	26295	25139	11323	2329	687	316	225	40	14
1968	1	1	3709	174585	267961	107051	26701	16399	11597	3657	657	122	124	70	46
1969	1	275	2307	24545	238511	181239	79363	26989	13463	5092	1913	414	121	23	46
1970	1	591	7164	10792	25813	137829	96420	31920	8933	3249	1232	260	106	39	35
1971	38	2210	7754	13739	11831	9527	59290	52003	12093	2434	762	418	149	42	25
1972	1	4701	35536	45431	26832	12089	7918	34885	22315	4572	1215	353	315	121	40
1973	1	8277	294262	131493	61000	20569	7248	8328	19130	4499	677	195	81	59	55
1974	115	21347	91855	437377	203772	47006	12630	4370	2523	5607	2127	322	151	83	62
1975	1	1184	45282	59798	226646	118567	29522	9353	2617	1555	1928	575	231	15	37
1976	706	1908	85337	114341	79993	118236	47872	13962	4051	936	558	442	139	26	53
1977	1	11288	39594	168609	136335	52925	61821	23338	5659	1521	610	271	122	92	54
1978	3	802	78822	45400	88495	56823	25407	31821	9408	1227	913	446	748	48	51
1979	0	224	8600	77484	43677	31943	16815	8274	10974	1785	427	103	59	38	45
1980	31	403	3911	17086	81986	40061	17664	7442	3508	3196	678	79	24	26	8
1981	1	212	3407	9466	20803	63433	21788	9933	4267	1311	882	109	37	3	1
1982	2	94	8948	20933	19345	28084	42496	8395	2878	708	271	260	27	5	5
1983	13	86	3108	19594	20473	17656	17004	18329	2545	646	229	74	58	20	5
1984	11	999	6942	14240	18807	20086	15145	8287	5988	783	232	153	49	12	8
1985	92	1805	24634	45769	27806	19418	11369	3747	1557	768	137	36	31	32	8
1986	41	855	28968	70993	78672	25215	11711	4063	976	726	557	136	28	34	14
1987	14	390	13648	137106	98210	61407	13707	3866	910	455	187	227	21	59	20
1988	4	178	9828	22774	135347	54379	21015	3304	1236	519	106	69	43	14	5
1989	3	237	5085	17313	32165	81756	27854	5501	827	290	41	13	1	11	16
1990	6	170	1911	7551	12999	17827	30007	6810	828	179	59	15	6	5	2
1991	24	663	4963	10933	16467	20342	19479	25193	3888	428	48	12	1	1	2
1992	844	1184	21835	36015	27494	23392	18351	13541	18321	2529	264	82	3	9	1
1993	42	634	10094	46182	63578	33623	14866	9449	6571	12593	1749	377	63	22	1
1994	32	312	6531	59444	102548	59766	32504	10019	6163	3671	7528	995	121	19	4
1995	9	212	4879	42587	115329	98485	32036	7334	3014	1725	1174	1920	222	41	1
1996	184	895	7655	28782	80711	100509	54590	10545	2023	930	462	230	809	84	1
1997	79	1228	12827	36491	69633	83017	65768	28392	4651	1151	373	213	144	238	1
1998	97	1596	31887	88874	48972	40493	34513	26354	6583	965	197	69	42	22	53
1999	13	313	7501	77714	92816	31139	15778	15851	8828	1837	195	40	34	8	30
2000	32	215	4701	33094	93044	47210	12671	6677	4787	1647	321	71	11	1	14
2001	23	237	5044	35019	62139	62456	22794	5266	1773	1163	343	84	6	7	22
2002	40	150	2467	31513	78348	68030	41852	11220	1723	510	206	113	20	9	5
2003	6	186	7206	20376	60894	66372	33941	13197	2758	468	136	95	20	42	1

Table 3.9. Total number (million) of cod consumed by cod, by year and prey age group.

	Age						
Year	0	1	2	3	4	5	6
1984	0	417	21	0	0	0	0
1985	1497	376	67	0	0	0	0
1986	53	966	392	99	0	0	0
1987	681	182	281	14	0	0	0
1988	29	411	22	2	0	0	0
1989	916	144	0	0	0	0	0
1990	0	126	28	0	0	0	0
1991	123	153	215	2	0	0	0
1992	4304	1028	155	4	0	0	0
1993	3823	20292	512	52	1	0	0
1994	8352	6949	647	134	54	8	0
1995	8327	15372	757	252	87	4	0
1996	9903	21705	1498	143	56	20	1
1997	2940	16034	1869	176	17	1	0
1998	79	4866	532	209	25	2	1
1999	589	1861	299	53	4	0	0
2000	1813	2437	175	36	14	4	0
2001	99	2418	118	24	11	2	1
2002	4946	2954	488	45	6	1	0
2003	6070	2731	184	13	0	0	0

Table 3.10 Catch numbers at age

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:46

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

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	4008	710	140	991	1281	24687	24099	47413
4	10387	13192	3872	6808	10954	77924	120704	107659
5	18906	43890	31054	35214	29045	64013	113203	112040
6	16596	52017	55983	100497	45233	46867	73827	55500
7	13843	45501	77375	83283	62579	37535	49389	22742
8	15370	13075	21482	29727	30037	33673	20562	16863
9	59845	19718	15237	13207	19481	23510	24367	10559
10	22618	47678	9815	5606	9172	10589	15651	10553
11	10093	31392	30041	8617	6019	4221	8327	5637
12	9573	9348	7945	13154	4133	1288	3565	1752
+gp	8137	18055	12595	7719	9862	4935	2158	797
TOTALNUM	189376	294576	265539	304823	227796	329242	455852	391515
TONSLAND	706000	882017	774295	800122	731982	827180	876795	695546
SOPCOF %	103	91	89	99	109	115	93	105

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

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	11473	3902	10614	17321	31219	32308	37882	45478	42416	13196
4	155171	37652	24172	33931	133576	77942	97865	132655	170566	106984
5	146395	201834	129803	27182	71051	148285	64222	123458	167241	205549
6	100751	161336	250472	70702	40737	53480	67425	51167	89460	95498
7	40635	84031	86784	87033	38380	18498	23117	38740	28297	35518
8	10713	30451	51091	39213	35786	17735	8429	17376	21996	16221
9	11791	13713	14987	17747	13338	23118	7240	5791	7956	11894
10	8557	9481	7465	6219	10475	9483	11675	6778	2728	3884
11	6751	4140	3952	3232	3289	3748	4504	5560	2603	1021
12	2370	2406	1655	1220	1070	997	1843	1682	1647	1025
+gp	1287	1350	1906	819	433	513	682	1298	775	784
TOTALNUM	495894	550296	582901	304619	379354	386107	324884	429983	535685	491574
TONSLAND	826021	1147841	1343068	792557	769313	744607	622042	783221	909266	776337
SOPCOF %	93	106	105	100	112	93	104	110	124	102

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	5298	15725	55937	34467	3709	2307	7164	7754	35536	294262
4	45912	25999	55644	160048	174585	24545	10792	13739	45431	131493
5	97950	78299	34676	69235	267961	238511	25813	11831	26832	61000
6	58575	68511	42539	22061	107051	181239	137829	9527	12089	20569
7	19642	25444	37169	26295	26701	79363	96420	59290	7918	7248
8	9162	8438	18500	25139	16399	26989	31920	52003	34885	8328
9	6196	3569	5077	11323	11597	13463	8933	12093	22315	19130
10	3553	1467	1495	2329	3657	5092	3249	2434	4572	4499
11	783	1161	380	687	657	1913	1232	762	1215	677
12	172	131	403	316	122	414	260	418	353	195
+gp	782	337	156	279	240	190	180	216	476	195
TOTALNUM	248025	229081	251976	352179	612679	574026	323792	170067	191622	547596
TONSLAND	437695	444930	483711	572605	1074084	1197226	933246	689048	565254	792685
SOPCOF %	103	129	123	109	108	105	112	124	118	130

Table 3.10 (continued)

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	91855	45282	85337	39594	78822	8600	3911	3407	8948	3108
4	437377	59798	114341	168609	45400	77484	17086	9466	20933	19594
5	203772	226646	79993	136335	88495	43677	81986	20803	19345	20473
6	47006	118567	118236	52925	56823	31943	40061	63433	28084	17656
7	12630	29522	47872	61821	25407	16815	17664	21788	42496	17004
8	4370	9353	13962	23338	31821	8274	7442	9933	8395	18329
9	2523	2617	4051	5659	9408	10974	3508	4267	2878	2545
10	5607	1555	936	1521	1227	1785	3196	1311	708	646
11	2127	1928	558	610	913	427	678	882	271	229
12	322	575	442	271	446	103	79	109	260	74
+gp	296	283	218	268	847	142	58	41	37	83
TOTALNUM	807885	496126	465946	490951	339609	200224	175669	135440	132355	99741
TONSLAND	1102433	829377	867463	905301	698715	440538	380434	399038	363730	289992
SOPCOF %	137	115	127	107	109	121	127	118	125	90

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	6942	24634	28968	13648	9828	5085	1911	4963	21835	10094
4	14240	45769	70993	137106	22774	17313	7551	10933	36015	46182
5	18807	27806	78672	98210	135347	32165	12999	16467	27494	63578
6	20086	19418	25215	61407	54379	81756	17827	20342	23392	33623
7	15145	11369	11711	13707	21015	27854	30007	19479	18351	14866
8	8287	3747	4063	3866	3304	5501	6810	25193	13541	9449
9	5988	1557	976	910	1236	827	828	3888	18321	6571
10	783	768	726	455	519	290	179	428	2529	12593
11	232	137	557	187	106	41	59	48	264	1749
12	153	36	136	227	69	13	15	12	82	377
+gp	69	71	76	100	62	28	13	4	13	86
TOTALNUM	90732	135312	222093	329823	248639	170873	78199	101757	161837	199168
TONSLAND	277651	307920	430113	523071	434939	332481	212000	319158	513234	581611
SOPCOF %	95	102	102	102	100	99	101	95	103	101

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	6531	4879	7655	12827	31887	7501	4701	5044	2467	7206
4	59444	42587	28782	36491	88874	77714	33094	35019	31513	20375
5	102548	115329	80711	69633	48972	92816	93044	62139	78349	60894
6	59766	98485	100509	83017	40493	31139	47210	62456	68030	66372
7	32504	32036	54590	65768	34513	15778	12671	22794	41853	33941
8	10019	7334	10545	28392	26354	15851	6677	5266	11220	13197
9	6163	3014	2023	4651	6583	8828	4787	1773	1723	2759
10	3671	1725	930	1151	965	1837	1647	1163	510	468
11	7528	1174	462	373	197	195	321	343	206	136
12	995	1920	230	213	69	40	71	85	113	95
+gp	144	264	894	383	117	72	26	35	34	64
TOTALNUM	289313	308747	287331	302899	279024	251771	204249	196117	236018	205507
TONSLAND	771086	739999	732228	762403	592624	484910	414868	426471	535045	521950
SOPCOF %	101	100	101	100	101	100	100	100	100	100

Table 3.10 (continued)

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	91855	45282	85337	39594	78822	8600	3911	3407	8948	3108
4	437377	59798	114341	168609	45400	77484	17086	9466	20933	19594
5	203772	226646	79993	136335	88495	43677	81986	20803	19345	20473
6	47006	118567	118236	52925	56823	31943	40061	63433	28084	17656
7	12630	29522	47872	61821	25407	16815	17664	21788	42496	17004
8	4370	9353	13962	23338	31821	8274	7442	9933	8395	18329
9	2523	2617	4051	5659	9408	10974	3508	4267	2878	2545
10	5607	1555	936	1521	1227	1785	3196	1311	708	646
11	2127	1928	558	610	913	427	678	882	271	229
12	322	575	442	271	446	103	79	109	260	74
+gp	296	283	218	268	847	142	58	41	37	83
TOTALNUM	807885	496126	465946	490951	339609	200224	175669	135440	132355	99741
TONSLAND	1102433	829377	867463	905301	698715	440538	380434	399038	363730	289992
SOPCOF %	137	115	127	107	109	121	127	118	125	90

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	6942	24634	28968	13648	9828	5085	1911	4963	21835	10094
4	14240	45769	70993	137106	22774	17313	7551	10933	36015	46182
5	18807	27806	78672	98210	135347	32165	12999	16467	27494	63578
6	20086	19418	25215	61407	54379	81756	17827	20342	23392	33623
7	15145	11369	11711	13707	21015	27854	30007	19479	18351	14866
8	8287	3747	4063	3866	3304	5501	6810	25193	13541	9449
9	5988	1557	976	910	1236	827	828	3888	18321	6571
10	783	768	726	455	519	290	179	428	2529	12593
11	232	137	557	187	106	41	59	48	264	1749
12	153	36	136	227	69	13	15	12	82	377
+gp	69	71	76	100	62	28	13	4	13	86
TOTALNUM	90732	135312	222093	329823	248639	170873	78199	101757	161837	199168
TONSLAND	277651	307920	430113	523071	434939	332481	212000	319158	513234	581611
SOPCOF %	95	102	102	102	100	99	101	95	103	101

Table 1	Catch numbers at age				Numbers*10**-3					
YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	6531	4879	7655	12827	31887	7501	4701	5044	2467	7206
4	59444	42587	28782	36491	88874	77714	33094	35019	31513	20375
5	102548	115329	80711	69633	48972	92816	93044	62139	78349	60894
6	59766	98485	100509	83017	40493	31139	47210	62456	68030	66372
7	32504	32036	54590	65768	34513	15778	12671	22794	41853	33941
8	10019	7334	10545	28392	26354	15851	6677	5266	11220	13197
9	6163	3014	2023	4651	6583	8828	4787	1773	1723	2759
10	3671	1725	930	1151	965	1837	1647	1163	510	468
11	7528	1174	462	373	197	195	321	343	206	136
12	995	1920	230	213	69	40	71	85	113	95
+gp	144	264	894	383	117	72	26	35	34	64
TOTALNUM	289313	308747	287331	302899	279024	251771	204249	196117	236018	205507
TONSLAND	771086	739999	732228	762403	592624	484910	414868	426471	535045	521950
SOPCOF %	101	100	101	100	101	100	100	100	100	100

Table 3.11 Catch weights at age

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:46

Table 2 Catch weights at age (kg)

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	0,350	0,320	0,340	0,370	0,390	0,400	0,440	0,400
4	0,590	0,560	0,530	0,670	0,640	0,830	0,800	0,760
5	1,110	0,950	1,260	1,110	1,290	1,390	1,330	1,280
6	1,690	1,500	1,930	1,660	1,700	1,880	1,920	1,930
7	2,370	2,140	2,460	2,500	2,360	2,540	2,640	2,810
8	3,170	2,920	3,360	3,230	3,480	3,460	3,710	3,720
9	3,980	3,650	4,220	4,070	4,520	4,880	5,060	5,060
10	5,050	4,560	5,310	5,270	5,620	5,200	6,050	6,340
11	5,920	5,840	5,920	5,990	6,400	7,140	7,420	7,400
12	7,200	7,420	7,090	7,080	7,960	8,220	8,430	8,670
+gp	8,146	8,848	8,430	8,218	8,891	9,389	10,185	10,238
SOPCOFAC	1,030	0,914	0,892	0,992	1,088	1,148	0,935	1,049

Table 2 Catch weights at age (kg)

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0,440	0,320	0,330	0,330	0,340	0,350	0,340	0,310	0,320	0,320
4	0,770	0,570	0,580	0,590	0,520	0,720	0,510	0,550	0,550	0,610
5	1,260	1,130	1,070	1,020	0,950	1,470	1,090	1,050	0,930	0,960
6	1,970	1,730	1,830	1,820	1,920	2,680	2,130	2,200	1,700	1,730
7	3,030	2,750	2,890	2,890	2,940	3,590	3,380	3,230	3,030	3,040
8	4,330	3,940	4,250	4,280	4,210	4,320	4,870	5,110	5,030	4,960
9	5,400	4,900	5,550	5,490	5,610	5,450	6,120	6,150	6,550	6,440
10	6,750	7,040	7,280	7,510	7,350	6,440	8,490	8,150	7,700	7,910
11	7,790	7,200	8,000	8,240	8,670	7,170	7,790	8,680	9,270	9,620
12	10,670	8,780	8,350	9,250	9,580	8,630	8,300	9,600	10,560	11,310
+gp	9,680	10,077	9,944	10,605	11,631	11,621	11,422	11,952	12,717	12,737
SOPCOFAC	0,929	1,063	1,046	1,000	1,123	0,931	1,042	1,097	1,236	1,023

Table 2 Catch weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0,330	0,380	0,440	0,290	0,330	0,440	0,370	0,450	0,380	0,380
4	0,550	0,680	0,740	0,810	0,700	0,790	0,910	0,880	0,770	0,910
5	0,950	1,030	1,180	1,350	1,480	1,230	1,340	1,380	1,430	1,540
6	1,860	1,490	1,780	2,040	2,120	2,030	2,000	2,160	2,120	2,260
7	3,250	2,410	2,460	2,810	3,140	2,900	3,000	3,070	3,230	3,290
8	4,970	3,520	3,820	3,480	4,210	3,810	4,150	4,220	4,380	4,610
9	6,410	5,730	5,360	4,890	5,270	5,020	5,590	5,810	5,830	6,570
10	8,070	7,540	7,270	7,110	6,650	6,430	7,600	7,130	7,620	8,370
11	9,340	8,470	8,630	9,030	9,010	8,330	8,970	8,620	9,520	10,540
12	10,160	11,170	10,660	10,590	9,660	10,710	10,990	10,830	12,090	11,620
+gp	12,886	13,722	14,148	13,829	14,848	14,211	14,074	12,945	13,673	13,904
SOPCOFAC	1,028	1,290	1,233	1,091	1,079	1,052	1,117	1,241	1,182	1,300

Table 3.11 (continued)

Table 2 Catch weights at age (kg)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0,320	0,410	0,350	0,490	0,490	0,350	0,270	0,490	0,370	0,840
4	0,660	0,640	0,730	0,900	0,810	0,700	0,560	0,980	0,660	1,370
5	1,170	1,110	1,190	1,430	1,450	1,240	1,020	1,440	1,350	2,090
6	2,220	1,900	2,010	2,050	2,150	2,140	1,720	2,090	1,990	2,860
7	3,210	2,950	2,760	3,300	3,040	3,150	3,020	2,980	2,930	3,990
8	4,390	4,370	4,220	4,560	4,460	4,290	4,200	4,850	4,240	5,580
9	5,520	5,740	5,880	6,460	6,540	6,580	5,840	6,570	6,460	7,770
10	7,860	8,770	9,300	8,630	7,980	8,610	7,260	9,160	8,510	9,290
11	9,820	9,920	10,280	9,930	10,150	9,220	8,840	10,820	12,240	11,550
12	11,410	11,810	11,860	10,900	10,850	10,890	9,280	10,770	10,780	16,200
+gp	13,242	13,107	13,544	13,668	13,177	14,344	14,448	13,932	14,041	17,034
SOPCOFAC	1,366	1,152	1,269	1,068	1,089	1,214	1,272	1,181	1,252	0,895

Table 2 Catch weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	1,420	0,940	0,640	0,490	0,540	0,740	0,810	1,050	1,160	0,810
4	1,930	1,370	1,270	0,880	0,850	0,960	1,220	1,450	1,570	1,520
5	2,490	2,020	1,880	1,550	1,320	1,310	1,640	2,150	2,210	2,160
6	3,140	3,220	2,790	2,330	2,240	1,920	2,220	2,890	3,100	2,790
7	3,910	4,630	4,490	3,440	3,520	2,930	3,240	3,750	4,270	4,070
8	4,910	6,040	5,840	5,920	5,350	4,640	4,680	4,710	5,190	5,530
9	6,020	7,660	6,830	8,600	8,060	7,520	7,300	6,080	6,140	6,470
10	7,400	9,810	7,690	9,600	9,510	9,120	9,840	8,820	7,770	7,190
11	8,130	11,800	9,810	12,170	11,360	11,080	13,250	11,800	10,120	7,980
12	8,570	14,160	10,710	13,720	14,090	11,470	16,880	16,580	11,540	10,110
+gp	8,609	14,008	12,051	13,380	16,706	16,484	11,617	16,690	14,332	14,183
SOPCOFAC	0,948	1,018	1,016	1,022	1,000	0,988	1,011	0,952	1,027	1,013

Table 2 Catch weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0,820	0,770	0,790	0,670	0,680	0,630	0,572	0,660	0,724	0,673
4	1,300	1,200	1,110	1,040	1,050	1,010	1,036	1,050	1,134	1,131
5	2,060	1,780	1,610	1,530	1,620	1,540	1,609	1,620	1,555	1,838
6	2,890	2,590	2,460	2,220	2,300	2,340	2,344	2,510	2,298	2,523
7	3,210	3,810	3,820	3,420	3,300	3,210	3,341	3,510	3,520	3,610
8	5,200	4,990	5,720	5,200	4,860	4,290	4,476	4,780	4,819	5,087
9	6,800	6,230	6,740	7,190	6,870	6,000	5,724	6,040	6,245	6,408
10	7,570	8,050	8,040	7,730	9,300	6,730	7,523	7,540	7,705	8,280
11	8,010	8,740	9,280	8,610	10,300	10,080	8,021	9,000	9,115	10,679
12	9,480	9,220	10,400	11,070	15,050	13,880	12,478	10,480	8,191	11,902
+gp	11,978	12,319	10,966	11,117	14,524	14,036	17,241	16,180	10,990	11,985
SOPCOFAC	1,009	1,003	1,015	1,000	1,007	0,997	1,004	0,999	1,000	1,000

Table 3.12 Stock weights at age

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:46

Table 3 Stock weights at age (kg)

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	0,350	0,320	0,340	0,370	0,390	0,400	0,440	0,400
4	0,590	0,560	0,530	0,670	0,640	0,830	0,800	0,760
5	1,110	0,950	1,260	1,110	1,290	1,390	1,330	1,280
6	1,690	1,500	1,930	1,660	1,700	1,880	1,920	1,930
7	2,370	2,140	2,460	2,500	2,360	2,540	2,640	2,810
8	3,170	2,920	3,360	3,230	3,480	3,460	3,710	3,720
9	3,980	3,650	4,220	4,070	4,520	4,880	5,060	5,060
10	5,050	4,560	5,310	5,270	5,620	5,200	6,050	6,340
11	5,920	5,840	5,920	5,990	6,400	7,140	7,420	7,400
12	7,200	7,420	7,090	7,080	7,960	8,220	8,430	8,670
+gp	8,146	8,848	8,430	8,218	8,891	9,389	10,185	10,238

Table 3 Stock weights at age (kg)

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0,440	0,320	0,330	0,330	0,340	0,350	0,340	0,310	0,320	0,320
4	0,770	0,570	0,580	0,590	0,520	0,720	0,510	0,550	0,550	0,610
5	1,260	1,130	1,070	1,020	0,950	1,470	1,090	1,050	0,930	0,960
6	1,970	1,730	1,830	1,820	1,920	2,680	2,130	2,200	1,700	1,730
7	3,030	2,750	2,890	2,890	2,940	3,590	3,380	3,230	3,030	3,040
8	4,330	3,940	4,250	4,280	4,210	4,320	4,870	5,110	5,030	4,960
9	5,400	4,900	5,550	5,490	5,610	5,450	6,120	6,150	6,550	6,440
10	6,750	7,040	7,280	7,510	7,350	6,440	8,490	8,150	7,700	7,910
11	7,790	7,200	8,000	8,240	8,670	7,170	7,790	8,680	9,270	9,620
12	10,670	8,780	8,350	9,250	9,580	8,630	8,300	9,600	10,560	11,310
+gp	9,680	10,077	9,944	10,605	11,631	11,621	11,422	11,952	12,717	12,737

Table 3 Stock weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0,330	0,380	0,440	0,290	0,330	0,440	0,370	0,450	0,380	0,380
4	0,550	0,680	0,740	0,810	0,700	0,790	0,910	0,880	0,770	0,910
5	0,950	1,030	1,180	1,350	1,480	1,230	1,340	1,380	1,430	1,540
6	1,860	1,490	1,780	2,040	2,120	2,030	2,000	2,160	2,120	2,260
7	3,250	2,410	2,460	2,810	3,140	2,900	3,000	3,070	3,230	3,290
8	4,970	3,520	3,820	3,480	4,210	3,810	4,150	4,220	4,380	4,610
9	6,410	5,730	5,360	4,890	5,270	5,020	5,590	5,810	5,830	6,570
10	8,070	7,540	7,270	7,110	6,650	6,430	7,600	7,130	7,620	8,370
11	9,340	8,470	8,630	9,030	9,010	8,330	8,970	8,620	9,520	10,540
12	10,160	11,170	10,660	10,590	9,660	10,710	10,990	10,830	12,090	11,620
+gp	12,886	13,722	14,148	13,829	14,848	14,211	14,074	12,945	13,673	13,904

Table 3.12 (continued)

Table 3 Stock weights at age (kg)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0,320	0,410	0,350	0,490	0,490	0,350	0,270	0,490	0,370	0,370
4	0,660	0,640	0,730	0,900	0,810	0,700	0,560	0,980	0,660	0,920
5	1,170	1,110	1,190	1,430	1,450	1,240	1,020	1,440	1,350	1,600
6	2,220	1,900	2,010	2,050	2,150	2,140	1,720	2,090	1,990	2,440
7	3,210	2,950	2,760	3,300	3,040	3,150	3,020	2,980	2,930	3,820
8	4,390	4,370	4,220	4,560	4,460	4,290	4,200	4,850	4,240	4,760
9	5,520	5,740	5,880	6,460	6,540	6,580	5,840	6,570	6,460	6,170
10	7,860	8,770	9,300	8,630	7,980	8,610	7,260	9,160	8,510	7,700
11	9,820	9,920	10,280	9,930	10,150	9,220	8,840	10,820	12,240	9,250
12	11,410	11,810	11,860	10,900	10,850	10,890	9,280	10,770	10,780	10,850
+gp	13,242	13,107	13,544	13,668	13,177	14,344	14,448	13,932	14,041	12,988

Table 3 Stock weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0,420	0,410	0,310	0,190	0,210	0,300	0,400	0,518	0,440	0,344
4	1,160	0,880	0,880	0,510	0,400	0,520	0,710	1,136	0,931	1,172
5	1,810	1,600	1,470	1,280	0,790	0,870	1,180	1,743	1,812	1,820
6	2,790	2,810	2,470	1,940	1,900	1,480	1,720	2,428	2,716	2,823
7	3,780	4,060	3,920	3,280	2,980	2,690	2,460	3,214	3,895	4,031
8	4,570	5,830	5,810	5,170	4,390	4,630	3,570	4,538	5,176	5,497
9	6,170	7,690	6,580	6,520	7,810	7,050	4,710	6,880	6,774	6,765
10	7,700	10,120	6,830	9,300	12,110	9,980	7,800	10,719	9,598	8,571
11	9,250	14,290	11,000	13,150	13,110	9,250	8,960	9,445	12,427	10,847
12	10,850	10,850	10,850	10,850	10,850	10,850	10,850	10,850	10,850	10,850
+gp	13,033	13,413	13,587	13,826	13,018	14,479	13,423	14,100	13,662	12,887

Table 3 Stock weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0,235	0,201	0,195	0,202	0,217	0,203	0,194	0,285	0,250	0,230
4	0,753	0,485	0,487	0,521	0,533	0,520	0,465	0,522	0,604	0,537
5	1,420	1,140	1,031	1,079	1,161	1,174	1,208	1,194	1,189	1,310
6	2,413	2,118	2,054	1,878	1,939	2,031	1,972	2,231	2,138	2,009
7	3,825	3,470	3,525	3,369	2,945	3,034	3,048	3,306	3,333	3,241
8	5,416	4,938	5,503	5,263	4,574	4,464	4,096	5,050	4,767	4,971
9	6,631	7,160	7,767	8,927	7,423	6,482	5,724	6,376	6,859	6,739
10	7,630	9,119	10,159	12,154	10,367	10,269	7,457	9,115	9,334	8,706
11	8,112	10,101	10,669	10,823	11,738	10,882	9,582	11,272	10,186	15,026
12	10,850	10,850	10,850	10,850	10,850	10,850	10,850	10,850	10,850	10,850
+gp	12,754	12,727	12,634	13,377	13,896	13,697	13,900	14,351	12,995	12,995

Table 3.13

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:46

Table 5 Proportion mature at age

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
6	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03
7	0,06	0,06	0,07	0,09	0,09	0,10	0,08	0,07
8	0,11	0,13	0,13	0,17	0,23	0,24	0,22	0,19
9	0,18	0,16	0,25	0,29	0,35	0,40	0,41	0,40
10	0,44	0,42	0,47	0,54	0,52	0,58	0,63	0,64
11	0,65	0,75	0,73	0,79	0,79	0,72	0,82	0,84
12	0,86	0,91	0,91	0,88	0,95	0,85	0,92	0,94
+gp	0,96	0,95	0,97	0,97	0,97	0,96	0,97	0,97

Table 5 Proportion mature at age

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,01
5	0,01	0,01	0,01	0,01	0,01	0,01	0,03	0,01	0,01	0,01
6	0,03	0,03	0,03	0,03	0,03	0,04	0,06	0,06	0,05	0,03
7	0,08	0,07	0,06	0,06	0,06	0,12	0,10	0,12	0,15	0,07
8	0,16	0,13	0,12	0,09	0,10	0,34	0,19	0,31	0,34	0,28
9	0,37	0,26	0,14	0,12	0,10	0,49	0,45	0,65	0,61	0,42
10	0,68	0,53	0,41	0,22	0,30	0,67	0,69	0,91	0,81	0,81
11	0,87	0,83	0,67	0,60	0,50	0,84	0,77	0,98	0,92	0,98
12	0,93	0,92	0,91	0,82	0,82	0,87	0,85	0,98	0,97	0,98
+gp	0,96	0,97	0,96	0,97	0,97	1,00	0,99	1,00	1,00	1,00

Table 5 Proportion mature at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00
4	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,02	0,00
5	0,00	0,00	0,01	0,00	0,03	0,00	0,00	0,01	0,02	0,00
6	0,03	0,01	0,02	0,03	0,05	0,02	0,01	0,05	0,01	0,02
7	0,13	0,06	0,06	0,07	0,09	0,04	0,07	0,11	0,10	0,16
8	0,37	0,20	0,22	0,14	0,19	0,12	0,23	0,30	0,34	0,53
9	0,66	0,55	0,35	0,38	0,39	0,34	0,58	0,59	0,64	0,81
10	0,89	0,73	0,74	0,64	0,58	0,55	0,81	0,79	0,81	0,92
11	0,95	0,99	0,94	0,89	0,82	0,74	0,89	0,86	0,94	0,95
12	0,99	0,98	0,94	0,90	1,00	0,95	0,91	0,88	1,00	0,98
+gp	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 3.13 (continued)

Table 5 Proportion mature at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,05	0,08
5	0,00	0,01	0,00	0,02	0,00	0,00	0,00	0,02	0,10	0,10
6	0,01	0,02	0,05	0,08	0,02	0,03	0,02	0,07	0,34	0,30
7	0,03	0,09	0,12	0,26	0,13	0,13	0,13	0,20	0,65	0,73
8	0,21	0,21	0,29	0,54	0,44	0,39	0,35	0,54	0,82	0,88
9	0,50	0,56	0,45	0,76	0,71	0,77	0,65	0,80	0,92	0,97
10	0,96	0,78	0,84	0,87	0,77	0,89	0,82	0,97	1,00	1,00
11	1,00	0,79	0,83	0,93	0,81	0,83	1,00	1,00	1,00	1,00
12	0,96	0,95	1,00	0,94	0,89	0,78	0,90	1,00	1,00	1,00
+gp	1,00	1,00	0,90	0,90	0,80	0,90	0,90	1,00	1,00	1,00

Table 5 Proportion mature at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00
4	0,05	0,01	0,05	0,01	0,02	0,00	0,01	0,04	0,01	0,03
5	0,18	0,09	0,08	0,07	0,05	0,05	0,05	0,06	0,12	0,09
6	0,31	0,36	0,19	0,18	0,33	0,18	0,21	0,28	0,43	0,30
7	0,56	0,55	0,53	0,22	0,53	0,41	0,58	0,65	0,75	0,61
8	0,90	0,85	0,71	0,46	0,62	0,69	0,77	0,83	0,93	0,91
9	0,99	0,96	0,62	0,50	1,00	0,85	0,86	0,97	0,97	0,97
10	1,00	0,90	0,90	0,75	1,00	1,00	0,98	1,00	1,00	0,99
11	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
12	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
+gp	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 5 Proportion mature at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,01	0,00	0,00	0,00	0,01	0,00	0,00	0,01	0,01	0,00
5	0,11	0,07	0,02	0,02	0,04	0,01	0,06	0,05	0,08	0,10
6	0,33	0,33	0,26	0,14	0,19	0,10	0,22	0,34	0,40	0,37
7	0,60	0,62	0,63	0,56	0,44	0,45	0,64	0,58	0,70	0,63
8	0,81	0,74	0,83	0,82	0,82	0,79	0,83	0,77	0,86	0,88
9	0,97	0,95	0,98	0,95	0,93	0,88	0,97	0,98	0,98	0,93
10	0,99	0,98	1,00	0,95	0,98	1,00	1,00	1,00	1,00	1,00
11	0,99	1,00	1,00	0,95	1,00	1,00	1,00	0,97	1,00	1,00
12	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
+gp	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00

Table 3.14

North-East Arctic cod (Sub-areas I and II) (run name: XSAASA01)
104
FLT09: Russian trawl catch and effort ages 9 - 14 (Catch: Thousa (Catch: Unknown) (Effort: Unknown)
1985 2003
1 1 0.00 1.00
9 13

0.70	291	77	30	6	0
1.52	87	59	22	3	1
2.10	127	95	37	11	2
2.75	442	215	53	12	3
2.12	140	47	11	0	0
1.11	204	49	14	2	0
1.56	791	71	16	4	1
2.50	3852	689	62	10	0
2.64	2019	1778	68	13	2
2.96	1237	595	167	40	5
3.88	684	345	146	21	1
3.73	364	164	34	10	0
4.92	488	99	34	10	0
6.77	559	88	34	13	1
6.39	882	171	0	0	0
4.25	742	185	25	1	0
3.50	235	95	35	7	0
3.15	336	61	18	1	0
2.34	319	83	19	9	1

FLT15: NorBarTrSur rev99 (Catch: Unknown) (Effort: Unknown)
1980 2003
1 1 0.99 1.00
3 8

1	233	400	384	48	10	3
1	277	236	155	160	14	2
1	523	433	170	58	32	10
1	283	214	117	41	4	1
1	1260	199	77	33	2	1
1	1439	641	83	19	3	0
1	3911	543	157	20	5	0
1	805	1733	205	36	5	0
1	759	378	902	98	9	1
1	349	346	206	272	16	4
1	337	257	215	122	127	6
1	577	178	128	77	43	27
1	1401	725	158	62	39	22
1	3102	1474	506	93	24	16
1	2414	2559	767	185	24	8
1	1154	1372	1061	240	29	4
1	640	704	527	283	57	9
1	1813	365	259	178	86	10
1	1732	581	134	65	51	12
1	1321	1083	269	43	20	12
1	1828	834	382	89	11	4
1	1350	1096	425	151	24	3
1	1297	911	673	183	49	10
1	1725	569	447	273	76	17

Table 3.14 (continued)

FLT16: NorBarLofAcSur rev99 (Catch: Unknown) (Effort: Unknown)
1984 2003
1 1 0.99 1.00
3 11

1	1416	204	154	157	33	12	10	5	0
1	1343	684	116	77	31	3	0	4	1
1	2049	502	174	14	30	7	0	0	0
1	355	578	109	40	3	0	1	0	0
1	344	214	670	166	32	5	2	0	1
1	206	262	269	668	73	6	3	0	0
1	346	293	339	367	500	37	2	2	0
1	658	215	184	284	254	824	44	16	2
1	1911	1131	354	255	252	277	445	47	7
1	4045	2175	895	225	119	94	44	175	26
1	1598	2166	1040	290	44	43	36	22	80
1	705	872	891	446	65	11	7	8	13
1	517	497	422	499	205	22	5	0	8
1	1826	424	338	340	247	49	8	2	0
1	964	454	122	112	187	92	11	2	1
1	1589	1457	493	129	69	52	16	4	1
1	1716	816	573	198	24	8	6	3	1
1	1122	1043	661	345	95	12	5	6	0
1	1144	1315	1445	643	212	38	5	1	1
1	928	327	451	468	222	88	22	2	7

FLT17: RusSurCatch/hr rev00 (ages 1-8) (Catch: Unknown) ((Catch: Unknown) (Effort: Unknown)
1982 2003
1 1 0.90 1.00
3 8

1	76	94	58	32	11	4
1	73	48	20	7	11	2
1	93	49	30	12	5	3
1	397	181	45	17	6	1
1	286	140	50	14	2	1
1	402	78	34	8	2	1
1	73	193	33	10	2	1
1	91	109	161	131	55	29
1	29	65	78	96	43	11
1	48	58	66	83	71	7
1	90	45	48	26	23	9
1	526	377	117	45	32	19
1	404	383	366	120	42	13
1	235	247	105	23	7	2
1	101	126	86	36	9	1
1	83	62	37	18	5	1
1	334	97	37	16	7	1
1	475	162	31	12	8	2
1	219	169	58	8	3	1
1	372	206	115	22	3	1
1	144	241	252	117	52	12
1	293	175	202	175	60	23

Table 3.15a. NEA cod. Compared xsa results when adding different amounts of unreported catches. 50%, 100% and 200% corresponds to 45, 90 and 180 thousand tonnes unreported catch in 2002 and 2003 (equal amounts both years). Cannibalism has been removed from the catch numbers in this table.

		official catch	50 % unrep. catch	100 % unrep. catch	200 % unrep. catch
TSB	2000	1207854	1234515	1257697	1304872
	2001	1480684	1530544	1576314	1669010
	2002	1675809	1751767	1822683	1965981
	2003	1801544	1843293	1884699	1968586
SSB	2000	227108	228443	229821	232643
	2001	324106	331029	338068	352414
	2002	498123	520778	543844	590892
	2003	626258	636942	648399	673157
F(5-10)	2000	0,8926	0,8873	0,8818	0,8706
	2001	0,7801	0,7654	0,7505	0,7224
	2002	0,6285	0,6521	0,674	0,7131
	2003	0,4042	0,4323	0,4595	0,5119
N2003	age3	47573	48845	50157	52809
N*10^-4	age4	30430	31497	32478	34137
	age5	29134	30055	30967	32724
	age6	23836	24388	24955	26192
	age7	10121	10249	10395	10714
	age8	3286	3332	3384	3499
	age9	728	737	746	766
	age10	108	109	111	115
F2003	age3	0,0437	0,0447	0,0456	0,0473
	age4	0,0574	0,0647	0,0719	0,0858
	age5	0,1976	0,2217	0,245	0,2899
	age6	0,2857	0,3172	0,3481	0,4064
	age7	0,3832	0,4158	0,4476	0,51
	age8	0,5067	0,5359	0,5638	0,6167
	age9	0,4844	0,5054	0,5254	0,564
	age10	0,5675	0,5978	0,6271	0,6846
N2004	age3	53892	55445	56874	59604
N*10^-4	age4	37278	38244	39235	41239
	age5	23517	24172	24747	25652
	age6	19570	19714	19844	20050
	age7	14661	14540	14426	14283
	age8	5646	5537	5439	5268
	age9	1621	1597	1577	1546
	age10	367	364	361	357
Catch	age3	536	628	721	905
2003	age4	1535	1786	2038	2540
N*10^-4	age5	4727	5408	6089	7452
	age6	5360	5999	6637	7915
	age7	2915	3155	3394	3873
	age8	1182	1251	1320	1457
	age9	253	264	276	299
	age10	42	45	47	52

Table 3.15b. NEAcod. Compared diagnostics and results for xsa tuned by single fleets and combination of fleets.
Cannibalism included in catch

		FLT 09 Rus trawl CPUE	FLT 15 Joint BT survey	FLT 16 Joint+Lof Ac survey	FLT 17 Rus BT survey	Final run ALL Fleets	Fleksi-best Keyrun	ALL Fleets	ALL Fleets	ALL Fleets	Red.surv. weights ALL Fleets	15 yr tuning ALL fleets	Ages with high Qres removed ALL fleets
Min. SE for shrinkage		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	0.5	1.0	1.0
SS-ind.Q for age>		6	6	6	6	6	2	4	5	7	6	6	6
ages with fleet data		9 to 12	3 to 8	3 to 11	3 to 8	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	4 to 11
# of iterations to converg		19	>30	24	>30	>30	0	30	>30	>30	28	28	30
age3	PshrinkW	**0.95**	**0.58**	**0.67**	**0.77**	**0.43**	0	**0.42**	**0.42**	**0.45**	**0.45**	**0.29**	**0.44**
	FshrinkW	0.05	0.04	0.05	0.06	0.03	0	0.03	0.03	0.03	0.14	0.03	0.03
age4	PshrinkW	**0.93**	**0.31**	**0.42**	**0.31**	0.16	0	*	0.14	0.16	0.20	0.12	0.16
	FshrinkW	0.07	0.03	0.05	0.05	0.02	0	0.02	0.02	0.02	0.09	0.02	0.02
age5	PshrinkW	**0.86**	0.16	0.18	0.14	0.07	0	*	*	0.07	0.08	0.06	0.07
	FshrinkW	0.14	0.04	0.04	0.04	0.02	0	0.02	0.02	0.02	0.07	0.02	0.02
age6	FshrinkW	**1.00**	0.04	0.05	0.07	0.02	0	0.02	0.02	0.02	0.08	0.02	0.02
age7	FshrinkW	**1.00**	0.06	0.06	0.10	0.02	0	0.03	0.02	0.02	0.11	0.02	0.03
age8	FshrinkW	**1.00**	0.09	0.10	0.40	0.04	0	0.04	0.04	0.04	0.18	0.04	0.04
age9	FshrinkW	0.29	0.28	0.09	**0.80**	0.05	0	0.05	0.05	0.05	0.32	0.07	0.05
age10	FshrinkW	0.10	**0.65**	0.21	**0.93**	0.08	0	0.08	0.08	0.08	**0.44**	0.11	0.07
age11	FshrinkW	0.09	**0.82**	0.41	**0.98**	0.09	0	0.09	0.09	0.09	**0.50**	0.18	0.09
age12	FshrinkW	0.23	**0.95**	**0.64**	**0.99**	0.25	0	0.25	0.25	0.25	**0.72**	**0.36**	0.26
N2003	age3	42559	49929	42228	53590	50157	63762	50733	51188	49581	40393	50766	48818
N*10^-4	age4	29349	30543	29511	37278	32478	27112	30228	32974	32004	26924	32210	31880
	age5	21955	26599	26204	40253	30967	24818	32622	33069	30457	27757	30474	30532
	age6	14904	22589	22536	29130	24955	21688	25931	25727	22935	22325	23517	24138
	age7	6720	8689	10326	11916	10395	10303	10546	10612	10142	9108	9979	9961
	age8	2283	2839	3383	2434	3384	4731	3442	3429	3341	2850	3174	3279
	age9	550	493	749	426	746	1195	746	746	743	531	645	754
	age10	152	70	83	72	111	168	110	111	111	81	95	125
F2003	age 4	0.08	0.08	0.08	0.06	0.07	0.09	0.08	0.07	0.07	0.09	0.07	0.07
	age5	0.37	0.29	0.30	0.18	0.25	0.27	0.23	0.23	0.25	0.28	0.25	0.25
	age6	0.68	0.39	0.39	0.29	0.35	0.40	0.33	0.34	0.39	0.40	0.37	0.36
	age7	0.82	0.57	0.45	0.38	0.45	0.49	0.44	0.44	0.46	0.53	0.47	0.47
	age8	1.02	0.72	0.56	0.91	0.56	0.58	0.55	0.55	0.57	0.72	0.62	0.59
	age9	0.81	0.96	0.52	1.26	0.53	0.63	0.53	0.53	0.53	0.85	0.64	0.52
	age10	0.42	1.35	0.98	1.27	0.63	0.66	0.63	0.63	0.63	1.02	0.78	0.53
2003	F(5-10)	0.68	0.71	0.53	0.71	0.4595	0.50	0.45	0.45	0.47	0.63	0.52	0.45
	F(4-8)	0.59	0.41	0.36	0.37	0.3353	0.37	0.33	0.32	0.35	0.40	0.36	0.35
TSB2003	incl Age1-2	1338132	1660471	1728243	2104729	1976187	1746439	1922945	1943318	1822092	1638391	1819009	1835315
SSB2003	('000 T)	431755	545022	618991	655101	648399	482858	663304	663227	625726	557594	610948	630266
N2004	age3						13148						
N*10^-4	age4	33014	39048	32744	42055	39235	46446						
	age5	22186	23162	22318	28682	24747	20130						
	age6	12466	16267	15944	27459	19844	15472						
	age7	6197	12489	12446	17854	14426	11823						
	age8	2431	4043	5383	6690	5439	5179						
	age9	675	1130	1575	799	1577	2180						
	age10	201	154	364	99	361	525						
Survivors	age3		47972	30299	51272	39235	66						
end of 03	age4		24136	22809	28693	24747	23						
direct	age5		18900	18630	28747	19844							
predic.	age6		14577	14035	16358	14426	82048 4-6						
by the	age7		5056	5863	6446	5439	19795 7+						
survey	age8		1518	1761	1853	1577							
	age9	296	362	430	298	361							
	age10	79	40	41	43	49							
F2003	age3		0.037	0.059	0.035	0.046							
	age4		0.074	0.078	0.068	0.072							
direct	age5		0.256	0.259	0.175	0.245							
predic.	age6		0.345	0.356	0.313	0.348							
by the	age7		0.475	0.421	0.390	0.448							
survey	age8		0.580	0.518	0.498	0.564							
	age9	0.611	0.524	0.458	0.609	0.525							
	age10	0.431	0.727	0.714	0.689	0.627							

Table 3.16a. Diagnostics for final XSA.

Lowestoft VPA Version 3,1

7/05/2004 14:45

Extended Survivors Analysis

Arctic Cod (run: XSAASA01/X01)

CPUE data from file fleet

Catch data for 20 years, 1984 to 2003, Ages 1 to 13,

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT09: Russian tra	1994	2003	9	12	0	1
FLT15: NorBarTrS	1994	2003	3	8	0,99	1
FLT16: NorBarLof/	1994	2003	3	11	0,99	1
FLT17: RusSurCat	1994	2003	3	8	0,9	1

Time series weights :

Tapered time weighting applied
Power = 3 over 10 years

Catchability analysis :

Catchability dependent on stock size for ages < 6

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 6

Catchability independent of age for ages >= 10

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 2 oldest ages,

S,E, of the mean to which the estimates are shrunk = 1,000

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = ,00011

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	1,1929	0,2571	0,0456	0,0719	0,245	0,3481	0,4476	0,5638	0,5254	0,6272
Iteration 30	1,1929	0,2571	0,0456	0,0719	0,245	0,3481	0,4476	0,5638	0,5254	0,6271

Age	11	12
Iteration 29	0,5586	0,8948
Iteration 30	0,5586	0,8948

Regression weights

	0,02	0,116	0,284	0,482	0,67	0,82	0,921	0,976	0,997	1

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	1,717	1,867	1,988	2,479	1,556	1,086	1,447	1,064	1,380	1,193
2	0,630	0,936	1,054	1,088	0,588	0,331	0,255	0,213	0,632	0,257
3	0,210	0,555	0,472	0,340	0,371	0,118	0,068	0,061	0,124	0,046
4	0,201	0,305	0,353	0,302	0,353	0,207	0,125	0,101	0,104	0,072
5	0,339	0,338	0,412	0,571	0,526	0,548	0,402	0,251	0,252	0,245
6	0,646	0,577	0,543	0,725	0,784	0,735	0,605	0,503	0,465	0,348
7	1,168	0,891	0,750	0,844	0,774	0,819	0,775	0,672	0,751	0,448
8	0,986	0,943	0,864	1,236	1,047	1,067	1,066	0,901	0,859	0,564
9	1,056	0,962	0,752	1,343	1,176	1,412	1,215	0,962	0,877	0,525
10	1,040	1,025	0,940	1,509	1,264	1,444	1,228	1,214	0,839	0,627
11	1,173	1,254	0,879	1,444	1,333	0,985	1,174	0,952	0,718	0,559
12	1,121	1,187	0,915	1,576	1,314	1,180	1,373	1,285	1,022	0,895

Table 3.16a (continued)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1994	9,36E+06	1,53E+06	8,21E+05	6,86E+05	4,27E+05	1,40E+05	5,21E+04	1,77E+04	1,04E+04	6,27E+03
1995	2,01E+07	1,38E+06	6,67E+05	5,45E+05	4,59E+05	2,49E+05	6,00E+04	1,33E+04	5,39E+03	2,97E+03
1996	2,78E+07	2,54E+06	4,42E+05	3,13E+05	3,29E+05	2,68E+05	1,14E+05	2,01E+04	4,23E+03	1,69E+03
1997	1,93E+07	3,12E+06	7,25E+05	2,26E+05	1,80E+05	1,78E+05	1,28E+05	4,42E+04	6,96E+03	1,63E+03
1998	6,82E+06	1,33E+06	8,59E+05	4,23E+05	1,37E+05	8,34E+04	7,08E+04	4,49E+04	1,05E+04	1,49E+03
1999	3,11E+06	1,18E+06	6,04E+05	4,85E+05	2,43E+05	6,61E+04	3,12E+04	2,67E+04	1,29E+04	2,66E+03
2000	3,52E+06	8,58E+05	6,93E+05	4,39E+05	3,23E+05	1,15E+05	2,60E+04	1,13E+04	7,52E+03	2,57E+03
2001	4,08E+06	6,78E+05	5,44E+05	5,30E+05	3,17E+05	1,77E+05	5,15E+04	9,80E+03	3,17E+03	1,83E+03
2002	4,36E+06	1,15E+06	4,49E+05	4,20E+05	3,92E+05	2,02E+05	8,76E+04	2,15E+04	3,26E+03	9,93E+02
2003	4,33E+06	8,98E+05	5,02E+05	3,25E+05	3,10E+05	2,50E+05	1,04E+05	3,38E+04	7,46E+03	1,11E+03

Estimated population abundance at 1st Jan 2004

0,00E+00	1,08E+06	5,69E+05	3,92E+05	2,47E+05	1,98E+05	1,44E+05	5,44E+04	1,58E+04	3,61E+03

Taper weighted geometric mean of the VPA populations:

5,27E+06	1,12E+06	5,85E+05	4,06E+05	2,80E+05	1,49E+05	6,12E+04	2,16E+04	6,16E+03	1,66E+03

Standard error of the weighted Log(VPA populations) :

0,6703	0,4527	0,2274	0,2586	0,3511	0,5071	0,5952	0,5956	0,5505	0,4072

YEAR	AGE 11	12
1994	1,20E+04	1,63E+03
1995	1,82E+03	3,05E+03
1996	8,73E+02	4,24E+02
1997	5,40E+02	2,97E+02
1998	2,96E+02	1,04E+02
1999	3,44E+02	6,38E+01
2000	5,13E+02	1,05E+02
2001	6,17E+02	1,30E+02
2002	4,45E+02	1,95E+02
2003	3,51E+02	1,78E+02

Estimated population abundance at 1st Jan 2004

4,86E+02 1,64E+02

Taper weighted geometric mean of the VPA populations:

4,62E+02 1,51E+02

Standard error of the weighted Log(VPA populations) :

0,4194 0,7041

1

Log catchability residuals,

Fleet : FLT09: Russian trawl

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	0,81	0,57	0,13	-0,11	-0,77	-0,38	0,32	0,13	0,53	-0,20
10	0,64	0,57	0,40	-0,13	-0,57	-0,36	0,08	-0,06	0,07	0,47
11	-1,23	0,29	-0,54	-0,12	0,12	99,99	-0,33	-0,07	-0,40	0,12
12	-0,68	-2,19	-1,03	-0,70	0,20	99,99	-1,89	0,01	-2,34	0,19

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

Age	9	10	11	12
Mean Log q	-3,4626	-3,527	-3,527	-3,527
S,E(Log q)	0,4384	0,3516	0,3077	1,4914

Table 3.16a (continued)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s,e	Mean Q
9	2,38	-2,198	-3,8	0,37	10	0,79	-3,46
10	1,36	-0,674	2,11	0,44	10	0,51	-3,53
11	1,33	-0,84	2,84	0,65	9	0,36	-3,67
12	1,59	-0,402	3,92	0,12	9	2,05	-4,38
1							

Fleet : FLT15: NorBarTrSur r

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0,26	0,03	-0,30	0,21	0,02	-0,20	-0,03	-0,13	0,08	0,20
4	0,49	0,28	0,32	0,06	-0,13	0,12	-0,06	-0,04	0,04	-0,12
5	0,19	0,41	0,18	0,28	-0,07	0,00	-0,10	-0,12	0,08	-0,06
6	0,50	0,12	0,17	0,30	0,11	-0,12	-0,08	-0,08	-0,06	0,01
7	0,23	0,00	-0,11	0,29	0,29	0,21	-0,24	-0,25	0,01	-0,02
8	0,25	-0,20	0,12	-0,19	-0,21	0,33	0,09	-0,22	0,15	-0,06
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	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	6	7	8
Mean Log q	-6,2876	-6,5526	-6,7727
S,E(Log q)	0,1325	0,2194	0,2081

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s,e	ean Log q
3	1,1	-0,289	4,84	0,65	10	0,19	-5,62
4	0,83	0,691	7,08	0,79	10	0,15	-5,89
5	0,9	0,524	6,71	0,86	10	0,16	-6,05

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
6	0,94	0,568	6,65	0,95	10	0,13	-6,29
7	0,9	0,691	7,02	0,91	10	0,21	-6,55
8	1,01	-0,057	6,74	0,89	10	0,23	-6,77
1							

Fleet : FLT16: NorBarLofAcSu

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0,05	-0,28	-0,32	0,48	-0,39	0,25	0,14	-0,11	0,18	-0,26
4	0,18	-0,11	0,11	0,31	-0,24	0,27	-0,05	-0,10	0,29	-0,37
5	0,01	-0,17	-0,27	0,29	-0,14	0,22	-0,06	-0,05	0,25	-0,28
6	0,13	-0,08	-0,08	0,12	-0,17	0,16	-0,10	-0,07	0,38	-0,27
7	-0,35	-0,38	-0,01	0,16	0,40	0,27	-0,65	-0,06	0,29	-0,14
8	0,55	-0,57	-0,37	0,01	0,44	0,41	-0,60	-0,22	0,10	0,20
9	0,94	-0,13	-0,43	0,13	-0,14	0,27	-0,37	0,06	-0,05	0,25
10	0,74	0,46	99,99	0,15	0,00	0,29	-0,18	0,84	-0,71	-0,34
11	1,51	1,67	1,54	99,99	0,99	0,50	0,28	99,99	-0,03	2,00
12	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	6	7	8	9	10	11
Mean Log q	-5,4676	-5,3663	-5,388	-5,359	-5,1571	-5,1571
S,E(Log q)	0,2289	0,3619	0,3836	0,2567	0,5402	1,2481

Table 3.16a (continued)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s,e	ean Log q
3	1,14	-0,227	4,82	0,39	10	0,31	-5,84
4	0,64	0,71	8,42	0,48	10	0,3	-5,93
5	0,66	1,121	8,07	0,71	10	0,25	-5,72

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s,e	Mean Q
6	1,05	-0,2	5,18	0,82	10	0,26	-5,47
7	0,79	1,015	6,56	0,84	10	0,28	-5,37
8	0,66	2,614	6,93	0,93	10	0,18	-5,39
9	0,91	0,433	5,65	0,85	10	0,25	-5,36
10	0,57	1,474	6,13	0,74	9	0,28	-5,16
11	1,01	-0,007	4,32	0,23	8	0,99	-4,34
1							

Fleet : FLT17: RusSurCatch/h

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0,45	0,35	-0,54	-1,48	0,35	0,86	-0,44	0,54	-0,52	0,27
4	0,45	0,31	0,18	-0,31	-0,40	-0,13	-0,07	-0,07	0,34	0,22
5	0,52	-0,39	-0,15	-0,01	0,24	-0,45	-0,40	-0,02	0,30	0,38
6	1,49	-0,81	-0,46	-0,58	0,12	0,02	-1,06	-0,58	0,92	1,00
7	1,97	-0,23	-0,75	-1,36	-0,50	0,49	-0,35	-1,13	1,27	0,95
8	1,82	0,19	-0,99	-1,43	-1,62	-0,39	-0,22	-0,24	1,42	1,34
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	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	6	7	8
Mean Log q	-7,7456	-7,7928	-7,9062
S,E(Log q)	0,8227	1,0075	1,1607

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s,e	ean Log q
3	1,41	-0,272	5,06	0,09	10	0,79	-7,45
4	1,09	-0,174	7,02	0,49	10	0,29	-7,48
5	0,67	0,696	9,16	0,52	10	0,38	-7,53

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
6	0,65	0,713	9,19	0,5	10	0,57	-7,75
7	0,8	0,317	8,45	0,36	10	0,88	-7,79
8	1,31	-0,253	7,26	0,13	10	1,68	-7,91
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2002

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	1	0	0	0	0	0	0
FLT16: NorBarLof/	1	0	0	0	0	0	0
FLT17: RusSurCat	1	0	0	0	0	0	0
P shrinkage mea	1117114	0,45				0,83	1,167
F shrinkage mea	896785	1				0,17	1,323

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
1076140	0,41	13,89	2	33,677	1,193

Table 3.16a (continued)

Age 2 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	1	0	0	0	0	0	0
FLT16: NorBarLof/	1	0	0	0	0	0	0
FLT17: RusSurCat	1	0	0	0	0	0	0
P shrinkage mea	584749	0,23				0,951	0,251
F shrinkage mean	332511	1				0,049	0,406

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
568737	0,22	13,25	2	59,753	0,257

Age 3 Catchability dependent on age and year class strength

Year class = 2000

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	479720	0,3	0	0	1	0,305	0,037
FLT16: NorBarLof/	302994	0,373	0	0	1	0,198	0,059
FLT17: RusSurCat	512721	0,849	0	0	1	0,038	0,035
P shrinkage mea	406276	0,26				0,43	0,044
F shrinkage mean	114092	1				0,029	0,149

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
392350	0,17	0,14	5	0,812	0,046

Age 4 Catchability dependent on age and year class strength

Year class = 1999

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	241368	0,213	0,102	0,48	2	0,371	0,074
FLT16: NorBarLof/	228091	0,255	0,275	1,08	2	0,256	0,078
FLT17: RusSurCat	286928	0,296	0,213	0,72	2	0,2	0,062
P shrinkage mea	279747	0,35				0,155	0,064
F shrinkage mean	94266	1				0,019	0,179

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
247474	0,13	0,09	8	0,695	0,072

Age 5 Catchability dependent on age and year class strength

Year class = 1998

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	188995	0,174	0,05	0,28	3	0,396	0,256
FLT16: NorBarLof/	186304	0,19	0,169	0,89	3	0,337	0,259
FLT17: RusSurCat	287467	0,257	0,038	0,15	3	0,185	0,175
P shrinkage mea	149150	0,51				0,065	0,314
F shrinkage mean	112490	1				0,017	0,399

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
198437	0,11	0,08	11	0,699	0,245

Table 3.16a (continued)

Age 6 Catchability constant w,r,t, time and dependent on age

Year class = 1997

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	145572	0,154	0,027	0,18	4	0,435	0,345
FLT16: NorBarLof/	140348	0,165	0,126	0,76	4	0,388	0,356
FLT17: RusSurCat	163582	0,246	0,207	0,84	4	0,159	0,313
F shrinkage mea	69360	1				0,018	0,624

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
144261	0,1	0,07	13	0,648	0,348

Age 7 Catchability constant w,r,t, time and dependent on age

Year class = 1996

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	50564	0,148	0,028	0,19	5	0,467	0,475
FLT16: NorBarLof/	58627	0,16	0,107	0,67	5	0,376	0,421
FLT17: RusSurCat	64461	0,241	0,203	0,84	5	0,133	0,39
F shrinkage mea	26687	1				0,023	0,766

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
54395	0,1	0,06	16	0,642	0,448

Age 8 Catchability constant w,r,t, time and dependent on age

Year class = 1995

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	1	0	0	0	0	0	0
FLT15: NorBarTrS	15177	0,165	0,025	0,15	6	0,527	0,58
FLT16: NorBarLof/	17609	0,19	0,079	0,41	6	0,349	0,518
FLT17: RusSurCat	18525	0,305	0,325	1,07	6	0,085	0,498
F shrinkage mea	6958	1				0,039	0,999

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
15767	0,12	0,07	19	0,6	0,564

Age 9 Catchability constant w,r,t, time and dependent on age

Year class = 1994

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	2960	0,472	0	0	1	0,132	0,611
FLT15: NorBarTrS	3622	0,175	0,077	0,44	6	0,277	0,524
FLT16: NorBarLof/	4297	0,207	0,055	0,27	7	0,507	0,458
FLT17: RusSurCat	2977	0,387	0,419	1,08	6	0,034	0,609
F shrinkage mea	1170	1				0,05	1,142

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
3611	0,14	0,08	21	0,585	0,525

Table 3.16a (continued)

Age 10 Catchability constant w,r,t, time and dependent on age

Year class = 1993

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	786	0,315	0,026	0,08	2	0,371	0,431
FLT15: NorBarTrS	396	0,192	0,029	0,15	6	0,137	0,727
FLT16: NorBarLof/	407	0,236	0,069	0,29	8	0,4	0,714
FLT17: RusSurCat	427	0,498	0,102	0,21	6	0,014	0,689
F shrinkage mea	179	1				0,079	1,213

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
486	0,17	0,1	23	0,562	0,627

Age 11 Catchability constant w,r,t, time and age (fixed at the value for age) 10

Year class = 1992

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	183	0,254	0,016	0,06	3	0,645	0,515
FLT15: NorBarTrS	188	0,211	0,029	0,14	6	0,048	0,504
FLT16: NorBarLof/	169	0,284	0,294	1,04	9	0,212	0,546
FLT17: RusSurCat	173	0,564	0,117	0,21	6	0,005	0,536
F shrinkage mea	67	1				0,089	1,044

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
164	0,2	0,1	25	0,505	0,559

Age 12 Catchability constant w,r,t, time and age (fixed at the value for age) 10

Year class = 1991

Fleet	Estimated Survivors	Int s,e	Ext s,e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian tra	45	0,276	0,122	0,44	4	0,6	1,073
FLT15: NorBarTrS	81	0,231	0,013	0,06	6	0,022	0,724
FLT16: NorBarLof/	71	0,366	0,183	0,5	9	0,127	0,792
FLT17: RusSurCat	43	0,67	0,101	0,15	6	0,002	1,106
F shrinkage mea	105	1				0,249	0,598

Weighted prediction :

Survivors at end of year	Int s,e	Ext s,e	N	Var Ratio	F
59	0,3	0,1	26	0,318	0,895

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets.

```
Lowestoft VPA Version 3.1
    8/05/2004  18:54
 Extended Survivors Analysis
 Arctic Cod (run: XSAASA01/X01)

 CPUE data from file fleet

 Catch data for  20 years. 1984 to 2003. Ages  1 to  13.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,     year, year,  age ,  age
 FLT09: Russian trawl,   1994, 2003,   9,    11,   .000,  1.000
 FLT15: NorBarTrSur r,   1994, 2003,   3,     8,   .990,  1.000
 FLT16: NorBarLofAcSu,   1994, 2003,   3,     9,   .990,  1.000
 FLT17: RusSurCatch/h,   1994, 2003,   3,     5,   .900,  1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  10 years


 Catchability analysis :

      Catchability dependent on stock size for ages <    6

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  6


      Catchability independent of age for ages >=   10


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final  10 years or the   2 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.000

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

      Prior weighting not applied


 Tuning converged after   30 iterations

1


 Regression weights
       ,  .020,  .116,  .284,  .482,  .670,  .820,  .921,  .976,  .997, 1.000



 Fishing mortalities
    Age,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003

      1, 1.716, 1.867, 1.989, 2.487, 1.568, 1.092, 1.457, 1.074, 1.405, 1.268
      2,  .630,  .935, 1.054, 1.091,  .595,  .337,  .258,  .216,  .644,  .267
      3,  .210,  .555,  .471,  .340,  .373,  .120,  .069,  .061,  .126,  .047
      4,  .201,  .305,  .353,  .302,  .352,  .208,  .128,  .103,  .105,  .073
      5,  .339,  .338,  .412,  .571,  .524,  .547,  .405,  .257,  .260,  .249
      6,  .646,  .577,  .543,  .725,  .783,  .730,  .604,  .509,  .481,  .362
      7, 1.168,  .891,  .750,  .843,  .774,  .818,  .763,  .670,  .768,  .473
      8,  .986,  .943,  .863, 1.236, 1.045, 1.067, 1.063,  .871,  .853,  .588
      9, 1.056,  .962,  .752, 1.340, 1.176, 1.402, 1.216,  .955,  .810,  .518
     10, 1.037, 1.025,  .939, 1.508, 1.253, 1.443, 1.198, 1.217,  .824,  .534
     11, 1.165, 1.242,  .879, 1.442, 1.330,  .961, 1.173,  .888,  .722,  .539
     12, 1.114, 1.163,  .890, 1.576, 1.307, 1.172, 1.267, 1.279,  .857,  .907
```

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets.

1
XSA population numbers (Thousands)

	AGE									
YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,
1994 ,	9.36E+06,	1.53E+06,	8.21E+05,	6.86E+05,	4.27E+05,	1.40E+05,	5.21E+04,	1.77E+04,	1.04E+04,	6.29E+03,
1995 ,	2.01E+07,	1.38E+06,	6.67E+05,	5.45E+05,	4.59E+05,	2.49E+05,	6.00E+04,	1.33E+04,	5.39E+03,	2.97E+03,
1996 ,	2.78E+07,	2.54E+06,	4.43E+05,	3.13E+05,	3.29E+05,	2.68E+05,	1.14E+05,	2.02E+04,	4.23E+03,	1.69E+03,
1997 ,	1.93E+07,	3.11E+06,	7.25E+05,	2.26E+05,	1.80E+05,	1.78E+05,	1.28E+05,	4.42E+04,	6.96E+03,	1.63E+03,
1998 ,	6.79E+06,	1.32E+06,	8.56E+05,	4.23E+05,	1.37E+05,	8.34E+04,	7.08E+04,	4.49E+04,	1.05E+04,	1.49E+03,
1999 ,	3.10E+06,	1.16E+06,	5.94E+05,	4.83E+05,	2.43E+05,	6.65E+04,	3.12E+04,	2.67E+04,	1.29E+04,	2.66E+03,
2000 ,	3.51E+06,	8.50E+05,	6.78E+05,	4.32E+05,	3.21E+05,	1.15E+05,	2.62E+04,	1.13E+04,	7.52E+03,	2.61E+03,
2001 ,	4.06E+06,	6.70E+05,	5.38E+05,	5.18E+05,	3.11E+05,	1.75E+05,	5.16E+04,	1.00E+04,	3.19E+03,	1.83E+03,
2002 ,	4.33E+06,	1.14E+06,	4.42E+05,	4.14E+05,	3.82E+05,	1.97E+05,	8.63E+04,	2.16E+04,	3.43E+03,	1.00E+03,
2003 ,	4.20E+06,	8.69E+05,	4.88E+05,	3.19E+05,	3.05E+05,	2.41E+05,	9.96E+04,	3.28E+04,	7.54E+03,	1.25E+03,

Estimated population abundance at 1st Jan 2004

, 0.00E+00, 9.68E+05, 5.45E+05, 3.81E+05, 2.43E+05, 1.95E+05, 1.38E+05, 5.08E+04, 1.49E+04, 3.68E+03,

Taper weighted geometric mean of the VPA populations:

, 5.23E+06, 1.10E+06, 5.76E+05, 4.02E+05, 2.77E+05, 1.48E+05, 6.07E+04, 2.16E+04, 6.23E+03, 1.69E+03,

Standard error of the weighted Log(VPA populations) :

, .6732, .4583, .2314, .2552, .3431, .4960, .5839, .5860, .5400, .3866,

	AGE	
YEAR ,	11,	12,
1994 ,	1.21E+04,	1.64E+03,
1995 ,	1.82E+03,	3.09E+03,
1996 ,	8.73E+02,	4.31E+02,
1997 ,	5.40E+02,	2.97E+02,
1998 ,	2.96E+02,	1.05E+02,
1999 ,	3.49E+02,	6.41E+01,
2000 ,	5.14E+02,	1.09E+02,
2001 ,	6.44E+02,	1.30E+02,
2002 ,	4.43E+02,	2.17E+02,
2003 ,	3.61E+02,	1.76E+02,

Estimated population abundance at 1st Jan 2004

, 6.00E+02, 1.72E+02,

Taper weighted geometric mean of the VPA populations:

, 4.68E+02, 1.54E+02,

Standard error of the weighted Log(VPA populations) :

, .4207, .7103,

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets.

Log catchability residuals.

Fleet : FLT09: Russian trawl

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	.82	.58	.15	-.10	-.76	-.36	.34	.14	.47	-.20
10	.67	.60	.43	-.10	-.54	-.33	.09	-.02	.08	.34
11	-1.20	.31	-.51	-.09	.15	99.99	-.30	-.11	-.36	.11

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

Age	9	10	11
Mean Log q	-3.4796	-3.5594	-3.5594
S.E(Log q)	.4229	.3149	.2896

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
9	2.26	-2.097	-3.14	.39	10	.75	-3.48
10	1.20	-.425	2.80	.52	10	.41	-3.56
11	1.32	-.877	2.88	.68	9	.34	-3.69

1

Fleet : FLT15: NorBarTrSur r

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	.26	.02	-.33	.21	.02	-.20	-.02	-.14	.08	.22
4	.45	.26	.31	.06	-.15	.11	-.05	-.03	.04	-.11
5	.16	.37	.16	.28	-.06	-.01	-.11	-.11	.09	-.05
6	.49	.10	.16	.28	.09	-.15	-.09	-.08	-.03	.05
7	.22	-.01	-.12	.28	.28	.20	-.28	-.27	.03	.03
8	.26	-.20	.12	-.19	-.22	.33	.09	-.27	.14	-.01
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	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	6	7	8
Mean Log q	-6.2727	-6.5410	-6.7744
S.E(Log q)	.1321	.2252	.2161

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets. (Cont'd)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3,	1.13,	-.362,	4.60,	.64,	10,	.19,	-5.61,
4,	.81,	.808,	7.21,	.81,	10,	.14,	-5.87,
5,	.87,	.689,	6.88,	.87,	10,	.15,	-6.03,

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
6,	.90,	.918,	6.82,	.95,	10,	.12,	-6.27,
7,	.87,	.906,	7.14,	.91,	10,	.20,	-6.54,
8,	.98,	.133,	6.85,	.89,	10,	.23,	-6.77,

1

Fleet : FLT16: NorBarLofAcSu

Age	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
3 ,	.04,	-.30,	-.34,	.47,	-.40,	.26,	.16,	-.11,	.18,	-.25
4 ,	.14,	-.13,	.10,	.30,	-.25,	.25,	-.05,	-.09,	.28,	-.35
5 ,	-.01,	-.19,	-.28,	.28,	-.13,	.20,	-.07,	-.04,	.26,	-.27
6 ,	.12,	-.10,	-.09,	.11,	-.18,	.13,	-.11,	-.07,	.41,	-.23
7 ,	-.36,	-.39,	-.02,	.15,	.39,	.25,	-.68,	-.08,	.31,	-.08
8 ,	.55,	-.57,	-.37,	.01,	.44,	.41,	-.60,	-.27,	.09,	.25
9 ,	.96,	-.11,	-.41,	.15,	-.11,	.28,	-.34,	.08,	-.14,	.26
10 ,	No data for this fleet at this age									
11 ,	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 ,	6,	7,	8,	9
Mean Log q,	-5.4527,	-5.3547,	-5.3897,	-5.3843,
S.E(Log q),	.2313,	.3696,	.3961,	.2584,

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3,	1.16,	-.261,	4.65,	.39,	10,	.32,	-5.82,
4,	.62,	.771,	8.54,	.50,	10,	.29,	-5.91,
5,	.64,	1.170,	8.17,	.71,	10,	.24,	-5.70,

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
6,	1.01,	-.048,	5.38,	.82,	10,	.26,	-5.45,
7,	.76,	1.163,	6.69,	.85,	10,	.27,	-5.35,
8,	.65,	2.904,	7.02,	.94,	10,	.16,	-5.39,
9,	.87,	.651,	5.81,	.86,	10,	.24,	-5.38,

1

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets. (Cont'd)

Fleet : FLT17: RusSurCatch/h

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	.47	.36	-.60	-1.57	.38	.91	-.44	.56	-.56	.29
4	.44	.30	.17	-.33	-.41	-.14	-.06	-.05	.34	.22
5	.50	-.41	-.16	-.02	.22	-.45	-.40	-.01	.31	.38
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	1.48	-.310	4.61	.09	10	.83	-7.43
4	1.09	-.171	7.00	.48	10	.30	-7.47
5	.67	.690	9.19	.50	10	.38	-7.51

1

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT16: NorBarLofAcSu,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT17: RusSurCatch/h,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	1101644.,	.46,,,,				.826,	1.177
F shrinkage mean ,	522454.,	1.00,,,,				.174,	1.746

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
967831.,	.42,	13.79,	2,	33.088,	1.268

1

Age 2 Catchability dependent on age and year class strength

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT16: NorBarLofAcSu,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT17: RusSurCatch/h,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	576437.,	.23,,,,				.949,	.254
F shrinkage mean ,	191429.,	1.00,,,,				.051,	.626

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
545025.,	.23,	13.21,	2,	58.595,	.267

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets. (Cont'd)

```
 Age  3   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,  Ratio,     , Weights,    F
 FLT09: Russian trawl,         1.,  .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,    472892.,  .300,       .000,    .00,   1,  .305,     .038
 FLT16: NorBarLofAcSu,    296017.,  .380,       .000,    .00,   1,  .190,     .060
 FLT17: RusSurCatch/h,    507853.,  .897,       .000,    .00,   1,  .034,     .035

   P shrinkage mean  ,    401567.,   .26,,,,                          .442,     .045

   F shrinkage mean  ,     66972.,  1.00,,,,                          .029,     .242

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    381387.,       .17,      .17,    5,   1.034,   .047


1
 Age  4   Catchability dependent on age and year class strength

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,  Ratio,     , Weights,    F
 FLT09: Russian trawl,         1.,  .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,    238300.,  .213,       .093,    .44,   2,  .369,     .075
 FLT16: NorBarLofAcSu,    222498.,  .253,       .264,   1.04,   2,  .260,     .080
 FLT17: RusSurCatch/h,    283429.,  .303,       .219,    .72,   2,  .190,     .063

   P shrinkage mean  ,    276965.,   .34,,,,                          .161,     .064

   F shrinkage mean  ,     76319.,  1.00,,,,                          .019,     .216

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    242581.,       .13,      .10,    8,    .736,   .073


 Age  5   Catchability dependent on age and year class strength

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,  Ratio,     , Weights,    F
 FLT09: Russian trawl,         1.,  .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,    185358.,  .174,       .051,    .30,   3,  .395,     .260
 FLT16: NorBarLofAcSu,    184737.,  .188,       .168,    .89,   3,  .342,     .261
 FLT17: RusSurCatch/h,    282690.,  .261,       .040,    .15,   3,  .178,     .178

   P shrinkage mean  ,    147660.,   .50,,,,                          .068,     .317

   F shrinkage mean  ,    111093.,  1.00,,,,                          .017,     .403

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    194877.,       .11,      .08,   11,    .693,   .249
```

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets.

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	141101.,	.154,	.028,	.18,	4,	.440,	.355
FLT16: NorBarLofAcSu,	136004.,	.163,	.119,	.73,	4,	.402,	.366
FLT17: RusSurCatch/h,	143366.,	.259,	.151,	.58,	3,	.139,	.350
F shrinkage mean ,	71299.,	1.00,,,,				.019,	.611

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
137570.,	.10,	.06,	12,	.537,	.362

Age 7 Catchablity constant w.r.t. time and dependent on age
Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	48687.,	.148,	.037,	.25,	5,	.481,	.489
FLT16: NorBarLofAcSu,	56188.,	.160,	.105,	.66,	5,	.386,	.436
FLT17: RusSurCatch/h,	51026.,	.253,	.140,	.55,	3,	.107,	.471
F shrinkage mean ,	24633.,	1.00,,,,				.025,	.809

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
50843.,	.10,	.06,	14,	.563,	.473

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	14791.,	.166,	.023,	.14,	6,	.550,	.592
FLT16: NorBarLofAcSu,	17015.,	.192,	.086,	.45,	6,	.354,	.532
FLT17: RusSurCatch/h,	11797.,	.270,	.122,	.45,	3,	.053,	.699
F shrinkage mean ,	7371.,	1.00,,,,				.042,	.963

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14908.,	.12,	.06,	16,	.459,	.588

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	3024.,	.455,	.000,	.00,	1,	.144,	.602
FLT15: NorBarTrSur r,	3645.,	.175,	.078,	.45,	6,	.282,	.522
FLT16: NorBarLofAcSu,	4378.,	.208,	.059,	.28,	7,	.508,	.451
FLT17: RusSurCatch/h,	2321.,	.321,	.126,	.39,	3,	.017,	.730
F shrinkage mean ,	1353.,	1.00,,,,				.050,	1.045

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
3679.,	.14,	.08,	18,	.529,	.518

Table 3.16b. Alternative xsa, where age groups with high q-residuals are removed from tuning fleets.

1

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT09: Russian trawl,	866.,	.287,	.052,	.18,	2,	.464,	.398
FLT15: NorBarTrSur r,	472.,	.191,	.035,	.18,	6,	.155,	.641
FLT16: NorBarLofAcSu,	502.,	.221,	.069,	.31,	7,	.303,	.612
FLT17: RusSurCatch/h,	612.,	.410,	.196,	.48,	3,	.006,	.526
F shrinkage mean ,	204.,	1.00,,,,				.073,	1.124

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
600.,	.17,	.10,	19,	.602,	.534

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1992

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT09: Russian trawl,	191.,	.235,	.012,	.05,	3,	.742,	.496
FLT15: NorBarTrSur r,	195.,	.211,	.027,	.13,	6,	.049,	.489
FLT16: NorBarLofAcSu,	171.,	.240,	.096,	.40,	7,	.121,	.541
FLT17: RusSurCatch/h,	184.,	.438,	.071,	.16,	3,	.002,	.512
F shrinkage mean ,	65.,	1.00,,,,				.087,	1.060

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
172.,	.20,	.07,	20,	.380,	.539

1

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1991

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
FLT09: Russian trawl,	44.,	.254,	.122,	.48,	3,	.659,	1.082
FLT15: NorBarTrSur r,	79.,	.231,	.016,	.07,	6,	.022,	.737
FLT16: NorBarLofAcSu,	48.,	.253,	.116,	.46,	7,	.058,	1.031
FLT17: RusSurCatch/h,	56.,	.639,	.144,	.23,	3,	.001,	.930
F shrinkage mean ,	120.,	1.00,,,,				.260,	.541

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
58.,	.31,	.12,	20,	.392,	.907

1

Table 3.17

Run title : Arctic Cod (run: XSAASA01/X01)

At 7/05/2004 14:47

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0,2458	0,3591	0,9369	0,5267	0,8044	0,2166	0,0961	0,1027	0,4657	2,5649
2	0,0373	0,0578	0,8027	0,8029	0,1102	0,0020	0,0594	0,2370	0,1444	0,4482
3	0,0199	0,0533	0,1452	0,1137	0,0630	0,0327	0,0086	0,0183	0,0405	0,0790
4	0,1235	0,1701	0,2122	0,2286	0,1270	0,1284	0,0622	0,0624	0,1265	0,0963
5	0,3075	0,3763	0,4933	0,5098	0,3706	0,2660	0,1343	0,1875	0,2205	0,3467
6	0,6274	0,6051	0,7053	0,9364	0,5973	0,4019	0,2310	0,3211	0,4428	0,4597
7	1,1361	0,9248	0,9481	1,1399	1,0448	0,7158	0,2507	0,4259	0,5399	0,5663
8	1,2111	1,0189	1,0910	1,0143	0,9836	0,8897	0,3744	0,3456	0,5993	0,5982
9	1,2623	0,7786	0,8281	0,7784	1,1593	0,7171	0,3061	0,3808	0,4567	0,6666
10	0,9579	0,5057	1,1120	1,3242	1,7183	0,9860	0,3246	0,2564	0,4593	0,6656
11	1,0876	0,4205	0,8745	1,0270	1,5374	0,5824	0,5406	0,1342	0,2487	0,6780
12	1,0346	0,4665	1,0046	1,1899	1,6500	0,7921	0,4357	0,1962	0,3562	0,6781
+gp	1,0346	0,4665	1,0046	1,1899	1,6500	0,7921	0,4357	0,1962	0,3562	0,6781
FBAR 5-10	0,9171	0,7016	0,8630	0,9505	0,9790	0,6627	0,2702	0,3195	0,4531	0,5505
FBAR 4- 8	0,6811	0,6191	0,6900	0,7658	0,6247	0,4804	0,2105	0,2685	0,3858	0,4134

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR 01-
AGE											
1	1,7166	1,8674	1,9882	2,4788	1,5560	1,0860	1,4470	1,0644	1,3802	1,1929	1,2125
2	0,6304	0,9362	1,0543	1,0884	0,5875	0,3305	0,2551	0,2131	0,6317	0,2571	0,3673
3	0,2096	0,5553	0,4718	0,3401	0,3710	0,1182	0,0677	0,0606	0,1236	0,0456	0,0766
4	0,2014	0,3048	0,3530	0,3023	0,3526	0,2070	0,1253	0,1008	0,1037	0,0719	0,0921
5	0,3392	0,3383	0,4118	0,5707	0,5258	0,5480	0,4025	0,2512	0,2523	0,2450	0,2495
6	0,6459	0,5773	0,5430	0,7249	0,7838	0,7346	0,6048	0,5028	0,4652	0,3481	0,4387
7	1,1681	0,8914	0,7499	0,8441	0,7744	0,8192	0,7746	0,6724	0,7509	0,4476	0,6236
8	0,9864	0,9434	0,8636	1,2360	1,0468	1,0669	1,0664	0,9008	0,8592	0,5638	0,7746
9	1,0564	0,9619	0,7518	1,3432	1,1761	1,4117	1,2147	0,9617	0,8773	0,5254	0,7881
10	1,0402	1,0253	0,9398	1,5090	1,2639	1,4440	1,2279	1,2141	0,8390	0,6271	0,8934
11	1,1727	1,2543	0,8791	1,4436	1,3331	0,9854	1,1745	0,9520	0,7177	0,5586	0,7428
12	1,1208	1,1871	0,9151	1,5763	1,3135	1,1797	1,3730	1,2850	1,0221	0,8948	1,0673
+gp	1,1208	1,1871	0,9151	1,5763	1,3135	1,1797	1,3730	1,2850	1,0221	0,8948	
FBAR 5-10	0,8727	0,7896	0,7100	1,0380	0,9285	1,0041	0,8818	0,7505	0,6740	0,4595	
FBAR 4- 8	0,6682	0,6110	0,5843	0,7356	0,6967	0,6752	0,5947	0,4856	0,4863	0,3353	

Table 3.18. Stock number at age

Run title : Arctic Cod (run: XSAASA01/X01)

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Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	211631	137712	175521	49253	82175	81894	151884	173209	305461	2429512
2	67031	135510	78736	56312	23815	30098	53993	112954	127971	156981
3	40281	52870	104720	28886	20656	17463	24593	41657	72967	90684
4	13543	32330	41041	74152	21108	15880	13837	19962	33487	57370
5	7852	9799	22328	27177	48305	15221	11435	10646	15355	24158
6	4763	4727	5507	11162	13365	27302	9552	8186	7226	10084
7	2465	2082	2113	2227	3583	6022	14955	6207	4861	3800
8	1304	648	676	670	583	1032	2410	9529	3320	2320
9	923	318	192	186	199	179	347	1357	5522	1493
10	140	214	120	69	70	51	71	209	759	2863
11	39	44	106	32	15	10	16	42	133	393
12	26	11	24	36	9	3	5	7	30	85
+gp	12	21	13	16	8	6	4	2	5	19
TOTAL	350010	376287	431095	250179	213890	195159	283101	383968	577097	2779760

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST	AMST
AGE												84-03	84-03
1	936200	2009420	2779442	1934263	681543	310542	352212	407966	436198	433302	0	359741	733880
2	153016	137717	254214	311613	132783	117720	85825	67849	115217	89827	107614	96609	116897
3	82097	66693	44213	72518	85914	60411	69255	54445	44888	50157	56874	50981	57240
4	68606	54503	31337	22584	42254	48536	43948	52991	41955	32478	39235	33610	38193
5	42659	45922	32900	18025	13667	24314	32307	31744	39227	30967	24747	20968	24101
6	13984	24879	26805	17843	8340	6614	11508	17687	20216	24955	19844	10979	12752
7	5213	6002	11435	12750	7076	3118	2598	5146	8759	10395	14426	4689	5647
8	1766	1327	2015	4423	4488	2671	1125	980	2151	3384	5439	1679	2294
9	1044	539	423	696	1052	1290	752	317	326	746	1577	591	935
10	627	297	169	163	149	266	257	183	99	111	361	200	371
11	1205	182	87	54	30	34	51	62	44	35	49	60	141
12	163	305	42	30	10	6	11	13	20	18	16	20	45
+gp	23	41	162	52	17	11	4	5	6	12	10		
TOTAL	1306603	2347826	3183245	2395014	977323	575535	599854	639389	709106	676386	270192		

Table 3.19

Run title : Arctic Cod (run: SVPASA15/V15)

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Table 4 Natural Mortality (M) at age

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
+gp	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Table 4 Natural Mortality (M) at age

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
+gp	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

1

Table 4 Natural Mortality (M) at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
+gp	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Table 3.19 (continued)

Table 4 Natural Mortality (M) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
+gp	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Table 4 Natural Mortality (M) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0.2006	0.2004	0.3108	0.2580	0.2087	0.2000	0.2000	0.2050	0.2067	0.2662
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2030
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2026
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
+gp	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Table 4 Natural Mortality (M) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0.3999	0.7448	0.6478	0.5170	0.5219	0.3036	0.2599	0.2500	0.3171	0.2294
4	0.2957	0.4046	0.4325	0.2954	0.2768	0.2111	0.2367	0.2240	0.2163	0.2000
5	0.2259	0.2112	0.2811	0.2104	0.2166	0.2000	0.2158	0.2066	0.2025	0.2000
6	0.2047	0.2015	0.2060	0.2020	0.2097	0.2000	0.2005	0.2062	0.2001	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
+gp	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

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Table 3.20 Natural mortality of cod (M2) due to cannibalism.

Year	M2 age 1	M2 age 2	M2 age 3	M2 age 4	M2 age 5	M2 age 6
1984	0.2458	0.0356	0.0006	0.0000	0.0000	0.0000
1985	0.3590	0.0563	0.0004	0.0000	0.0000	0.0000
1986	0.9369	0.8010	0.1123	0.0000	0.0000	0.0000
1987	0.5267	0.8018	0.0585	0.0000	0.0000	0.0000
1988	0.8044	0.1093	0.0087	0.0000	0.0000	0.0000
1989	0.2166	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0961	0.0590	0.0000	0.0000	0.0000	0.0000
1991	0.1027	0.2363	0.0050	0.0000	0.0000	0.0000
1992	0.4653	0.1433	0.0067	0.0000	0.0000	0.0000
1993	2.5649	0.4476	0.0662	0.0030	0.0026	0.0000
1994	1.7166	0.6301	0.1999	0.0957	0.0259	0.0047
1995	1.8674	0.9359	0.5448	0.2046	0.0112	0.0015
1996	1.9882	1.0537	0.4478	0.2325	0.0811	0.0060
1997	2.4788	1.0877	0.3170	0.0954	0.0104	0.0020
1998	1.5560	0.5857	0.3219	0.0768	0.0166	0.0097
1999	1.0860	0.3302	0.1036	0.0111	0.0000	0.0000
2000	1.4470	0.2548	0.0599	0.0367	0.0158	0.0005
2001	1.0644	0.2127	0.0500	0.0240	0.0066	0.0062
2002	1.3802	0.6315	0.1171	0.0163	0.0025	0.0001
2003	1.1929	0.2568	0.0294	0.0000	0.0000	0.0000

Table 3.21

Run title : Arctic Cod (run: SVPASA15/V15)

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Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	0.0061	0.0018	0.0003	0.0023	0.002	0.0254	0.0225	0.0334
4	0.02	0.0249	0.0124	0.0209	0.0321	0.1612	0.1667	0.1325
5	0.0532	0.1101	0.0751	0.1484	0.1167	0.2637	0.37	0.2299
6	0.0973	0.2024	0.1997	0.3662	0.2882	0.2787	0.5501	0.3125
7	0.1781	0.416	0.5201	0.5101	0.4096	0.4122	0.5311	0.3243
8	0.1932	0.2545	0.3536	0.3869	0.348	0.4046	0.4175	0.3469
9	0.3125	0.4047	0.5286	0.3832	0.4741	0.5057	0.579	0.3932
10	0.2798	0.4405	0.3617	0.3766	0.5031	0.5149	0.7613	0.5364
11	0.3432	0.7827	0.5536	0.6259	0.9031	0.4585	1.026	0.698
12	0.312	0.6182	0.4604	0.5039	0.7111	0.4879	0.9056	0.6217
+gp	0.312	0.6182	0.4604	0.5039	0.7111	0.4879	0.9056	0.6217
0 FBAR 5-10								
1	0.1857	0.3047	0.3398	0.3619	0.3566	0.3966	0.5348	0.3572
FBAR 4- 8								
	0.1084	0.2016	0.2322	0.2865	0.2389	0.3041	0.4071	0.2692

Table 8 Fishing mortality (F) at age

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0.0199	0.0159	0.027	0.024	0.0718	0.0535	0.0543	0.0562	0.0663	0.0313
4	0.1457	0.084	0.1291	0.1128	0.2589	0.2564	0.2266	0.2717	0.3063	0.2366
5	0.2676	0.2859	0.4568	0.2094	0.3626	0.5093	0.3477	0.4944	0.6498	0.742
6	0.3333	0.5297	0.69	0.4862	0.5517	0.5121	0.4607	0.5168	0.8279	1.0069
7	0.3969	0.5139	0.6129	0.5494	0.5357	0.5251	0.4363	0.5279	0.6094	0.9764
8	0.2494	0.588	0.688	0.6287	0.4593	0.5111	0.4855	0.6931	0.6564	0.8798
9	0.4364	0.5805	0.6551	0.5463	0.4535	0.6141	0.4053	0.7389	0.8167	0.9416
10	0.6441	0.7645	0.738	0.6333	0.7388	0.686	0.7381	0.8379	0.9855	1.3731
11	0.8035	0.7621	0.8756	0.8584	0.8415	0.6511	0.8449	1.0011	0.9522	1.4366
12	0.7304	0.7704	0.8152	0.7529	0.799	0.6734	0.7981	0.9284	0.9756	1.4264
+gp	0.7304	0.7704	0.8152	0.7529	0.799	0.6734	0.7981	0.9284	0.9756	1.4264
0 FBAR 5-10										
1	0.3879	0.5437	0.6401	0.5089	0.5169	0.5596	0.4789	0.6348	0.7576	0.9866
FBAR 4- 8										
	0.2786	0.4003	0.5154	0.3973	0.4337	0.4628	0.3914	0.5008	0.61	0.7683
1										

Table 8 Fishing mortality (F) at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0.0174	0.0226	0.0398	0.0298	0.0251	0.023	0.0409	0.0214	0.0394	0.1959
4	0.1449	0.111	0.1037	0.1525	0.2064	0.2292	0.1422	0.1028	0.1673	0.1996
5	0.3537	0.3909	0.2119	0.1814	0.4087	0.4792	0.4004	0.2285	0.2976	0.3536
6	0.4854	0.4494	0.3818	0.2026	0.4683	0.5382	0.568	0.2517	0.3849	0.3917
7	0.5787	0.4033	0.4713	0.432	0.4019	0.7725	0.6211	0.5144	0.3427	0.421
8	0.7409	0.5303	0.5797	0.6844	0.5291	0.9302	0.8479	0.833	0.6583	0.7375
9	1.0674	0.7389	0.7183	0.8781	0.8041	1.1783	0.9682	0.9584	1.1338	0.9698
10	0.8476	0.8074	0.8182	0.885	0.8105	1.0769	1.09	0.7876	1.3393	0.7386
11	1.2968	0.7617	0.5024	1.2253	0.6772	1.5554	0.8533	0.8388	1.2904	0.7222
12	1.0883	0.7927	0.6634	1.0696	0.7458	1.3377	0.9829	0.8179	1.3377	0.7358
+gp	1.0883	0.7927	0.6634	1.0696	0.7458	1.3377	0.9829	0.8179	1.3377	0.7358
0 FBAR 5-10										
1	0.6789	0.5533	0.5302	0.5439	0.5704	0.8292	0.7493	0.5956	0.6928	0.602
FBAR 4- 8										
	0.4607	0.377	0.3497	0.3306	0.4029	0.5899	0.5159	0.3861	0.3702	0.4207

Table 3.21 (continued)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0.2141	0.0837	0.166	0.1338	0.146	0.0489	0.0318	0.0252	0.0672	0.0208
4	0.4959	0.2106	0.3121	0.5671	0.2234	0.209	0.1296	0.1003	0.2121	0.205
5	0.5375	0.5211	0.48	0.7544	0.6703	0.3475	0.3562	0.23	0.3045	0.3308
6	0.5078	0.7021	0.5715	0.6857	0.8497	0.5478	0.6225	0.5163	0.5518	0.5033
7	0.4451	0.705	0.6973	0.6763	0.8581	0.6643	0.6766	0.8475	0.7996	0.7821
8	0.4863	0.7032	0.8908	0.9121	0.9296	0.7789	0.7123	1.0788	0.9846	1.0295
9	0.5192	0.6109	0.7746	1.2298	1.3057	1.0352	0.939	1.2765	1.1588	0.9701
10	0.8842	0.7149	0.46	0.7689	1.0301	0.9848	1.038	1.2299	0.7508	0.9203
11	0.9905	0.9079	0.6132	0.6231	1.8042	1.4314	1.4798	0.9557	0.9516	0.5854
12	0.9492	0.8218	0.5389	0.6958	1.4375	1.2219	1.2775	1.1082	0.8607	0.759
+gp	0.9492	0.8218	0.5389	0.6958	1.4375	1.2219	1.2775	1.1082	0.8607	0.759
0 FBAR 5-10										
1	0.5633	0.6595	0.6457	0.8379	0.9406	0.7264	0.7241	0.8632	0.7583	0.756
FBAR 4- 8										
	0.4945	0.5684	0.5904	0.7191	0.7062	0.5095	0.4994	0.5546	0.5705	0.5701

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0.0194	0.0533	0.033	0.0555	0.0546	0.033	0.0087	0.0134	0.0341	0.0129
4	0.1247	0.1717	0.2133	0.2294	0.1277	0.1292	0.0627	0.0631	0.1276	0.0942
5	0.3096	0.3788	0.496	0.5105	0.3712	0.2671	0.1352	0.1889	0.2226	0.3464
6	0.6301	0.6078	0.7079	0.9363	0.5975	0.4027	0.2324	0.3229	0.4449	0.4635
7	1.135	0.9264	0.9487	1.1364	1.0414	0.7144	0.2521	0.4277	0.542	0.5693
8	1.2083	1.0192	1.091	1.0144	0.979	0.8856	0.3757	0.3475	0.6013	0.6015
9	1.2572	0.7818	0.8325	0.7842	1.1548	0.7138	0.307	0.3827	0.4595	0.6698
10	0.9564	0.5088	1.1134	1.3246	1.7031	0.9796	0.3246	0.2576	0.4619	0.6695
11	1.081	0.4237	0.8774	1.033	1.5285	0.5814	0.5383	0.1347	0.2502	0.6815
12	1.0346	0.4665	1.0046	1.1899	1.65	0.7921	0.4357	0.1962	0.3562	0.6781
+gp	1.0346	0.4665	1.0046	1.1899	1.65	0.7921	0.4357	0.1962	0.3562	0.6781
0 FBAR 5-10										
1	0.9161	0.7038	0.8649	0.951	0.9745	0.6605	0.2712	0.3212	0.4554	0.5533
FBAR 4- 8										
	0.6815	0.6208	0.6914	0.7654	0.6234	0.4798	0.2116	0.27	0.3877	0.415

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR 01-03
AGE											
3	0.0098	0.0106	0.0241	0.0231	0.0492	0.0146	0.0078	0.0106	0.0065	0.0162	0.0111
4	0.1065	0.1008	0.1212	0.208	0.2769	0.1969	0.0889	0.0771	0.0876	0.0719	0.0788
5	0.3153	0.3292	0.3326	0.5621	0.5108	0.5487	0.3877	0.2454	0.2501	0.245	0.2468
6	0.6435	0.5787	0.5399	0.7245	0.7751	0.7352	0.6048	0.4975	0.465	0.3481	0.4369
7	1.1663	0.8929	0.7539	0.8468	0.7772	0.8207	0.7752	0.6726	0.7494	0.4476	0.6232
8	0.9867	0.9447	0.8676	1.2361	1.0497	1.068	1.0643	0.8996	0.8559	0.5638	0.7731
9	1.0566	0.9634	0.7575	1.3418	1.1783	1.4088	1.2133	0.9594	0.8749	0.5254	0.7866
10	1.0413	1.0266	0.9442	1.5065	1.2625	1.4414	1.2252	1.2096	0.8364	0.6271	0.8911
11	1.1728	1.2506	0.8853	1.4421	1.3314	0.9891	1.1757	0.9527	0.7192	0.5586	0.7435
12	1.1208	1.1871	0.9151	1.5763	1.3135	1.1797	1.373	1.285	1.0221	0.8948	1.0673
+gp	1.1208	1.1871	0.9151	1.5763	1.3135	1.1797	1.373	1.285	1.0221	0.8948	
0 FBAR 5-10											
1	0.8683	0.7893	0.6993	1.0363	0.9256	1.0038	0.8784	0.7473	0.6719	0.4595	
FBAR 4- 8											
	0.6437	0.5692	0.5231	0.7155	0.6779	0.6739	0.5842	0.4784	0.4816	0.3353	
1											

Table 3.22. Fishing mortality of age 1-6 cod.

Year	F age 1	F age 2	F age 3	F age 4	F age 5	F age 6
1984	0.0000	0.0017	0.0193	0.1235	0.3075	0.6274
1985	0.0001	0.0015	0.0529	0.1701	0.3763	0.6051
1986	0.0000	0.0017	0.0329	0.2122	0.4933	0.7053
1987	0.0000	0.0011	0.0552	0.2286	0.5098	0.9364
1988	0.0000	0.0009	0.0543	0.1270	0.3706	0.5973
1989	0.0000	0.0009	0.0327	0.1284	0.2660	0.4019
1990	0.0000	0.0004	0.0086	0.0622	0.1343	0.2310
1991	0.0000	0.0007	0.0133	0.0624	0.1875	0.3211
1992	0.0004	0.0011	0.0338	0.1265	0.2205	0.4428
1993	0.0000	0.0006	0.0128	0.0933	0.3441	0.4597
1994	0.0000	0.0003	0.0097	0.1057	0.3133	0.6412
1995	0.0000	0.0003	0.0105	0.1002	0.3271	0.5758
1996	0.0000	0.0006	0.0240	0.1205	0.3307	0.5370
1997	0.0000	0.0007	0.0231	0.2069	0.5603	0.7229
1998	0.0000	0.0018	0.0491	0.2758	0.5092	0.7741
1999	0.0000	0.0003	0.0146	0.1959	0.5480	0.7346
2000	0.0000	0.0003	0.0078	0.0886	0.3867	0.6043
2001	0.0000	0.0004	0.0106	0.0768	0.2446	0.4966
2002	0.0000	0.0002	0.0065	0.0874	0.2498	0.4651
2003	0.0000	0.0003	0.0162	0.0719	0.2450	0.3481

Table 3.23. Stock number at age

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:46

Traditional vpa using file input for terminal F

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

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	728139	425311	442592	468348	704908	1083753	1193111	1590377
4	577860	592530	347574	362238	382556	575973	865011	955076
5	402060	463732	473210	281072	290427	303320	401364	599477
6	197212	312115	340097	359415	198391	211595	190765	226975
7	93323	146496	208708	228044	204032	121764	131099	90099
8	96213	63939	79121	101579	112107	110900	66016	63110
9	244722	64933	40588	45487	56484	64808	60583	35603
10	101777	146581	35470	19586	25387	28785	32000	27799
11	38117	62991	77255	20227	11003	12568	14083	12237
12	39205	22142	23578	36361	8856	3651	6506	4133
+gp	33324	42765	37377	21337	21133	13989	3938	1880
TOTAL	2551952	2343535	2105569	1943694	2015284	2531108	2964476	3606766

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

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	641584	272778	439602	804781	496824	683690	789653	916842	728338	472064
4	1259285	514924	219807	350332	643259	378598	530599	612324	709603	558039
5	684912	891184	387619	158175	256234	406511	239862	346346	382037	427678
6	389987	429102	548181	200984	105033	145989	199996	138702	172949	163321
7	135956	228785	206850	225110	101196	49529	71623	103298	67732	61876
8	53333	74845	112048	91748	106395	48488	23986	37908	49883	30149
9	36525	34028	34036	46105	40060	55027	23813	12084	15518	21185
10	19673	19329	15591	14474	21860	20840	24380	13000	4726	5614
11	13311	8459	7368	6103	6291	8550	8592	9541	4605	1444
12	4985	4880	3232	2513	2118	2220	3650	3022	2871	1455
+gp	2707	2738	3722	1687	857	1142	1351	2332	1351	1113
TOTAL	3242259	2481052	1978057	1902013	1780129	1800584	1917505	2195401	2139612	1743938

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	338678	776941	1582560	1295416	164955	112039	197105	404774	1015319	1818949
4	374580	272501	621906	1245195	1029477	131705	89647	154909	324399	799193
5	360621	265306	199663	458995	875269	685697	85743	63671	114439	224670
6	166726	207288	146941	132256	313440	476187	347649	47037	41482	69576
7	48854	84015	108284	82121	88421	160667	227600	161288	29940	23112
8	19083	22424	45954	55340	43651	48433	60756	100131	78947	17401
9	10240	7448	10803	21072	22854	21054	15642	21306	35642	33463
10	6764	2883	2913	4313	7170	8373	5306	4863	6690	9391
11	1164	2373	1053	1052	1457	2610	2335	1461	1811	1435
12	281	261	907	522	253	606	451	815	517	408
+gp	1278	670	351	461	498	278	312	421	697	408
TOTAL	1328269	1642109	2721334	3296742	2547445	1647648	1032545	960676	1649883	2998007

Table 3.23 (continued)

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

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	523916	621616	613942	348054	638490	198490	137735	150868	151830	166828
4	1224278	346265	468089	425778	249276	451722	154747	109237	120444	116234
5	535936	610486	229669	280485	197708	163230	300088	111295	80899	79768
6	129164	256342	296843	116349	108003	82807	94414	172067	72401	48848
7	38504	63643	104000	137232	47987	37806	39202	41481	84063	34138
8	12421	20199	25746	42398	57130	16658	15929	16316	14551	30937
9	6815	6253	8186	8650	13943	18463	6259	6397	4542	4451
10	10388	3320	2779	3089	2070	3093	5368	2004	1461	1167
11	3673	3513	1330	1436	1172	605	946	1557	480	565
12	571	1117	1160	590	631	158	118	176	490	152
+gp	525	550	572	583	1198	218	87	66	70	170
TOTAL	2486189	1933303	1752317	1364643	1317608	973250	754893	611464	531230	483257

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

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	397819	523638	1036924	286228	204599	172779	242750	411793	721210	896222
4	133781	319244	406318	735243	209189	157231	136869	197021	330995	566889
5	77524	96694	220148	268762	478585	150741	113124	105245	151441	238531
6	46916	46570	54205	109756	132074	270319	94489	80902	71339	99245
7	24176	20455	20762	21866	35232	59492	147957	61320	47960	37431
8	12785	6362	6631	6582	5746	10181	23841	94144	32733	22837
9	9048	3127	1880	1824	1954	1767	3438	13406	54452	14688
10	1381	2107	1171	669	682	504	709	2071	7486	28157
11	381	435	1037	315	146	102	155	419	1310	3862
12	257	106	233	353	92	26	47	74	300	835
+gp	116	209	130	156	82	56	40	25	48	191
TOTAL	704184	1018945	1749441	1431754	1068381	823199	763419	966419	1419273	1908888

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

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST	AMST
AGE												84-03	84-03
3	810708	658394	437082	717449	850964	599287	687793	541503	447293	501672	0	500642	613185
4	677955	538178	309341	223245	418034	480720	435950	526261	417284	323649	392425	379254	463351
5	421152	453451	324662	177822	134940	240304	319677	314783	389450	307937	246598	259306	314401
6	137764	245132	264137	175746	82125	65200	113658	174837	200322	247672	197333	148079	180733
7	51115	58987	112352	125279	69583	30677	25591	50798	86497	103014	143166	72503	91409
8	17343	13037	19775	43281	43979	26189	11054	9651	21226	33474	53907	32355	44149
9	10246	5293	4150	6799	10295	12604	7369	3122	3214	7384	15595	13921	24652
10	6155	2916	1654	1593	1455	2595	2522	1793	979	1097	3575	5522	13141
11	11802	1779	855	527	289	337	503	607	438	347	480	2083	6779
12	1599	2991	417	289	102	63	103	127	192	175	163	757	3457
+gp	231	411	1621	520	173	113	38	52	58	118	98		
TOTAL	2146070	1980570	1476046	1472549	1611939	1458087	1604256	1623534	1566953	1526538	1053340		

Table 3.24

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:48

Traditional vpa using file input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes

YEAR / AGE	1946	1947	1948	1949	1950	1951	1952	1953
3	254849	136099	150481	173289	274914	433501	524969	636151
4	340937	331817	184214	242699	244836	478058	692009	725857
5	446286	440545	596245	311990	374651	421615	533814	767331
6	333289	468173	656387	596629	337265	397799	366270	438062
7	221176	313502	513421	570111	481515	309280	346101	253178
8	304996	186702	265846	328099	390132	383714	244919	234769
9	973994	237005	171279	185131	255308	316264	306548	180151
10	513974	668411	188345	103218	142673	149682	193600	176245
11	225651	367868	457348	121160	70420	89737	104495	90555
12	282275	164292	167165	257435	70497	30013	54844	35831
+gp	271456	378386	315087	175349	187892	131347	40110	19247
TOTALBIO	4168882	3692801	3665819	3065111	2830103	3141009	3407679	3557376

Table 12 Stock biomass at age (start of year) Tonnes

YEAR / AGE	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
3	282297	87289	145069	265578	168920	239291	268482	284221	233068	151061
4	969649	293507	127488	206696	334495	272591	270606	336778	390282	340404
5	862989	1007038	414753	161338	243423	597571	261449	363663	355294	410571
6	768275	742347	1003170	365792	201664	391251	425991	305145	294013	282545
7	411947	629160	597796	650567	297518	177809	242086	333654	205229	188104
8	230934	294890	476204	392683	447924	209470	116810	193710	250910	149537
9	197233	166739	188902	253117	224738	299899	145737	74320	101645	136428
10	132792	136079	113501	108698	160673	134210	206985	105953	36390	44408
11	103693	60902	58944	50286	54540	61300	66934	82819	42684	13894
12	53190	42844	26988	23247	20287	19159	30297	29013	30314	16454
+gp	26204	27591	37015	17892	9967	13275	15429	27875	17178	14173
TOTALBIO	4039204	3488383	3189831	2495895	2164149	2415826	2050805	2137149	1957006	1747579

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Table 12 Stock biomass at age (start of year) Tonnes

YEAR / AGE	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	111764	295238	696327	375671	54435	49297	72929	182148	385821	691201
4	206019	185301	460210	1008608	720634	104047	81578	136320	249787	727266
5	342590	273265	235602	619644	1295399	843407	114895	87866	163647	345992
6	310111	308859	261555	269803	664492	966659	695298	101599	87943	157241
7	158775	202475	266378	230760	277642	465934	682799	495154	96707	76038
8	94841	78931	175545	192584	183771	184531	252138	422555	345787	80219
9	65640	42675	57905	103040	120443	105690	87437	123791	207793	219854
10	54588	21740	21174	30662	47678	53839	40323	34676	50977	78601
11	10875	20098	9087	9500	13129	21742	20948	12590	17245	15127
12	2856	2911	9669	5524	2444	6492	4958	8822	6248	4742
+gp	16470	9201	4967	6369	7389	3953	4396	5449	9529	5674
TOTALBIO	1374529	1440693	2198418	2852164	3387455	2805591	2057698	1610969	1621485	2401955

Table 3.24 (continued)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	167653	254863	214880	170547	312860	69471	37188	73925	56177	61726
4	808024	221610	341705	383200	201913	316206	86659	107052	79493	106935
5	627045	677639	273307	401093	286676	202406	306090	160265	109213	127629
6	286743	487049	596655	238515	232207	177208	162392	359620	144077	119188
7	123596	187748	287041	452865	145879	119088	118389	123613	246304	130406
8	54527	88269	108649	193334	254800	71461	66900	79133	61698	147262
9	37616	35894	48132	55876	91184	121484	36552	42028	29340	27463
10	81651	29113	25849	26656	16521	26635	38975	18354	12436	8986
11	36074	34848	13669	14264	11898	5579	8362	16843	5870	5224
12	6512	13192	13760	6427	6843	1720	1099	1899	5283	1645
+gp	6947	7206	7750	7970	15783	3124	1256	924	979	2209
TOTALBIO										
	2236387	2037430	1931396	1950748	1576565	1114381	863861	983657	750870	738673

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	167084	214691	321447	54383	42966	51834	97100	213309	317332	308300
4	155186	280935	357560	374974	83676	81760	97177	223816	308156	664394
5	140319	154710	323618	344016	378082	131145	133486	183442	274412	434127
6	130896	130861	133887	212927	250940	400073	162521	196430	193756	280169
7	91385	83047	81388	71720	104992	160035	363975	197081	186803	150886
8	58429	37092	38529	34032	25227	47139	85112	427227	169424	125534
9	55823	24045	12370	11890	15263	12460	16193	92233	368858	99364
10	10636	21322	8001	6226	8254	5032	5528	22196	71850	241334
11	3521	6210	11408	4142	1911	940	1389	3961	16284	41889
12	2794	1147	2527	3831	996	281	505	804	3256	9063
+gp	1513	2797	1768	2151	1074	807 5	41	348	650	2456
TOTALBIO										
	817587	956857	1292503	1120291	913379	891506	963528	1560846	1910781	2357518

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	190516	132337	85231	144925	184659	121655	133432	154328	111823	115384
4	510500	261016	150649	116311	222812	249975	202717	274708	252040	173799
5	598036	516934	334726	191869	156665	282117	386170	375851	463056	403397
6	332424	519190	542537	330051	159241	132422	224133	390062	428288	497573
7	195513	204684	396042	422066	204922	93073	78001	167937	288294	333869
8	93930	64375	108822	227787	201159	116906	45276	48736	101184	166397
9	67941	37900	32233	60696	76419	81697	42182	19906	22044	49762
10	46961	26594	16800	19360	15083	26643	18810	16346	9141	9550
11	95740	17967	9125	5700	3394	3668	4816	6837	4461	5220
12	17354	32447	4524	3135	1106	678	1114	1378	2078	1895
+gp	2952	5233	20478	6950	2402	1541	522 7	50	749	1529
TOTALBIO										
	2151869	1818679	1701167	1528850	1227864	1110375	1137171	1456839	1683159	1758376

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Table 3.25

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:48

Traditional vpa using file input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1946	1947	1948	1949	1950	1951	1952	1953
AGE								
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	4463	4405	5962	3120	3747	4216	5338	7673
6	9999	14045	19692	17899	10118	11934	10988	13142
7	13271	18810	35939	51310	43336	30928	27688	17722
8	33550	24271	34560	55777	89730	92091	53882	44606
9	175319	37921	42820	53688	89358	126506	125685	72060
10	226148	280733	88522	55738	74190	86815	121968	112796
11	146673	275901	333864	95716	55632	64611	85686	76066
12	242756	149506	152120	226543	66972	25511	50457	33681
+gp	260598	359467	305634	170088	182256	126093	38907	18670
TOTSPBIO								
	1112776	1165059	1019114	729879	615339	568705	520599	396417

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	2706	0	0	3404
5	8630	10070	4148	1613	2434	5976	7843	3637	3553	4106
6	23048	22270	30095	10974	6050	15650	25559	18309	14701	8476
7	32956	44041	35868	39034	17851	21337	24209	40038	30784	13167
8	36949	38336	57144	35341	44792	71220	22194	60050	85309	41870
9	72976	43352	26446	30374	22474	146950	65582	48308	62004	57300
10	90299	72122	46535	23914	48202	89921	142819	96417	29476	35970
11	90213	50549	39492	30172	27270	51492	51539	81163	39269	13616
12	49467	39416	24559	19063	16635	16668	25753	28433	29404	16125
+gp	25156	26763	35534	17356	9668	13275	15274	27875	17178	14173
TOTSPBIO										
	429694	346919	299823	207840	195377	432489	383479	404228	311678	208207

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Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0	0	0	0	0	0	0	0	3858	0
4	0	0	0	0	0	0	816	0	4996	0
5	0	0	2356	0	38862	0	0	879	3273	0
6	9303	3089	5231	8094	33225	19333	6953	5080	879	3145
7	20641	12149	15983	16153	24988	18637	47796	54467	9671	12166
8	35091	15786	38620	26962	34917	22144	57992	126766	117567	42516
9	43323	23471	20267	39155	46973	35935	50714	73036	132988	178082
10	48583	15870	15669	19624	27653	29611	32662	27394	41292	72313
11	10332	19897	8542	8455	10766	16089	18644	10827	16210	14370
12	2828	2853	9089	4972	2444	6167	4512	7763	6248	4647
+gp	16470	9201 4	967	6369	7389	3953	4396	5449 9	529	5674
TOTSPBIO										
	186570	102315	120722	129784	227215	151870	224482	311662	346511	332913

Table 3.25 (continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR / AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	0	0	0	0	0	0	0	0	0	617
4	0	0	0	0	0	0	0	0	3975	8555
5	0	6776	0	8022	0	0	0	3205	10921	12763
6	2867	9741	29833	19081	4644	5316	3248	25173	48986	35756
7	3708	16897	34445	117745	18964	15481	15391	24723	160097	95196
8	11451	18536	31508	104400	112112	27870	23415	42732	50592	129590
9	18808	20100	21659	42466	64741	93543	23759	33622	26992	26639
10	78385	22708	21713	23191	12721	23705	31960	17804	12436	8986
11	36074	27530	11345	13266	9637	4630	8362	16843	5870	5224
12	6251	12532	13760	6041	6090	1342	989	1899	5283	1645
+gp	6947	7206	6975	7173	12626	2812	1130	924	979	2209
TOTSPBIO	164491	142028	171238	341385	241536	174699	108253	166926	326132	327180

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR / AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0	0	0	0	0	0	0	0	3173	0
4	7759	2809	17878	3750	1674	0	972	8953	3082	19932
5	25257	13924	25889	24081	18904	6557	6674	11006	32929	39071
6	40578	47110	25438	38327	82810	72013	34130	55001	83315	84051
7	51176	45676	43136	15778	55646	65614	211106	128103	140102	92041
8	52586	31528	27356	15654	15640	32526	65537	354598	157564	114236
9	55265	23083	7669	5945	15263	10591	13926	89466	357792	96383
10	10636	19190	7201	4669	8254	5032	5417	22196	71850	238921
11	3521	6210	11408	4142	1911	940	1389	3961	16284	41889
12	2794	1147	2527	3831	996	281	505	804	3256	9063
+gp	1513	2797	1768	2151	1074	807	541	348	650	2456
TOTSPBIO	251086	193474	170270	118329	202171	194362	340196	674435	869998	738043

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR / AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0	0	0	0	0	0	0	0	0	0
4	5105	0	0	0	2228	0	0	2747	2520	0
5	65784	36185	6695	3837	6267	2821	23170	18793	37045	40743
6	109700	171333	141060	46207	30256	13242	49309	132621	171315	181614
7	117308	126904	249506	236357	90166	41883	49920	97403	201806	209670
8	76083	47638	90322	186785	164951	92356	37579	37527	87018	146263
9	65903	36005	31588	57661	71070	71893	40917	19507	21603	46129
10	46492	26062	16800	18392	14782	26643	18810	16346	9141	9550
11	94782	17967	9125	5415	3394	3668	4816	6632	4461	5220
12	17354	32447	4524	3135	1106	678	1114	1378	2078	1895
+gp	2952	5233	20478	6950	2402	1541	522	750	749	1529
TOTSPBIO	601464	499775	570098	564741	386620	254726	226157	333704	537737	642613

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Table 3.26

Run title : Arctic Cod (run: SVPASA15/V15)

At 10/05/2004 16:46

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RE(Age 3	TOTALE	TOTSPE	LANDIN	YIELD/S:	FBAR 5-'	FBAR 4- 8
1946	728139	4168882	1112776	706000	0.6344	0.1857	0.1084
1947	425311	3692801	1165059	882017	0.7571	0.3047	0.2016
1948	442592	3665819	1019114	774295	0.7598	0.3398	0.2322
1949	468348	3065111	729879	800122	1.0962	0.3619	0.2865
1950	704908	2830103	615339	731982	1.1896	0.3566	0.2389
1951	1083753	3141009	568705	827180	1.4545	0.3966	0.3041
1952	1193111	3407679	520599	876795	1.6842	0.5348	0.4071
1953	1590377	3557376	396417	695546	1.7546	0.3572	0.2692
1954	641584	4039204	429694	826021	1.9223	0.3879	0.2786
1955	272778	3488383	346919	1147841	3.3087	0.5437	0.4003
1956	439602	3189831	299823	1343068	4.4795	0.6401	0.5154
1957	804781	2495895	207840	792557	3.8133	0.5089	0.3973
1958	496824	2164149	195377	769313	3.9376	0.5169	0.4337
1959	683690	2415826	432489	744607	1.7217	0.5596	0.4628
1960	789653	2050805	383479	622042	1.6221	0.4789	0.3914
1961	916842	2137149	404228	783221	1.9376	0.6348	0.5008
1962	728338	1957006	311678	909266	2.9173	0.7576	0.61
1963	472064	1747579	208207	776337	3.7287	0.9866	0.7683
1964	338678	1374529	186570	437695	2.346	0.6789	0.4607
1965	776941	1440693	102315	444930	4.3486	0.5533	0.377
1966	1582560	2198418	120722	483711	4.0068	0.5302	0.3497
1967	1295416	2852164	129784	572605	4.412	0.5439	0.3306
1968	164955	3387455	227215	1074084	4.7272	0.5704	0.4029
1969	112039	2805591	151870	1197226	7.8832	0.8292	0.5899
1970	197105	2057698	224482	933246	4.1573	0.7493	0.5159
1971	404774	1610969	311662	689048	2.2109	0.5956	0.3861
1972	1015319	1621485	346511	565254	1.6313	0.6928	0.3702
1973	1818949	2401955	332913	792685	2.3811	0.602	0.4207
1974	523916	2236387	164491	1102433	6.7021	0.5633	0.4945
1975	621616	2037430	142028	829377	5.8395	0.6595	0.5684
1976	613942	1931396	171238	867463	5.0658	0.6457	0.5904
1977	348054	1950748	341385	905301	2.6518	0.8379	0.7191
1978	638490	1576565	241536	698715	2.8928	0.9406	0.7062
1979	198490	1114381	174699	440538	2.5217	0.7264	0.5095
1980	137735	863861	108253	380434	3.5143	0.7241	0.4994
1981	150868	983657	166926	399038	2.3905	0.8632	0.5546
1982	151830	750870	326132	363730	1.1153	0.7583	0.5705
1983	166828	738673	327180	289992	0.8863	0.756	0.5701
1984	397819	817587	251086	277651	1.1058	0.9161	0.6815
1985	523638	956857	193474	307920	1.5915	0.7038	0.6208
1986	1036924	1292503	170270	430113	2.5261	0.8649	0.6914
1987	286228	1120291	118329	523071	4.4205	0.951	0.7654
1988	204599	913379	202171	434939	2.1513	0.9745	0.6234
1989	172779	891506	194362	332481	1.7106	0.6605	0.4798
1990	242750	963528	340196	212000	0.6232	0.2712	0.2116
1991	411793	1560846	674435	319158	0.4732	0.3212	0.27
1992	721210	1910781	869998	513234	0.5899	0.4554	0.3877
1993	896222	2357518	738043	581611	0.788	0.5533	0.415
1994	810708	2151869	601464	771086	1.282	0.8683	0.6437
1995	658394	1818679	499775	739999	1.4807	0.7893	0.5692
1996	437082	1701167	570098	732228	1.2844	0.6993	0.5231
1997	717449	1528850	564741	762403	1.35	1.0363	0.7155
1998	850964	1227864	386620	592624	1.5328	0.9256	0.6779
1999	599287	1110375	254726	484910	1.9037	1.0038	0.6739
2000	687793	1137171	226157	414868	1.8344	0.8784	0.5842
2001	541503	1456839	333704	426471	1.278	0.7473	0.4784
2002	447293	1683159	537737	535045	0.995	0.6719	0.4816
2003	501672	1758376	642613	521950	0.8122	0.4595	0.3353
Arith, Mean	608402	2026012	379578	661888	2.4162	0.6453	0.4762
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)			

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Table 3.27 Summary, no cannibalism included.

Run title : Arctic Cod (run: SVPASA15/V15)

At 12/05/2004 20:04

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RE(Age 3	TOTALE	TOTSPE	LANDIN	YIELD/S!	FBAR 5-'	FBAR 4- 8
1946	728139	4168882	1112776	706000	0.6344	0.1857	0.1084
1947	425311	3692801	1165059	882017	0.7571	0.3047	0.2016
1948	442592	3665819	1019114	774295	0.7598	0.3398	0.2322
1949	468348	3065111	729879	800122	1.0962	0.3619	0.2865
1950	704908	2830103	615339	731982	1.1896	0.3566	0.2389
1951	1083753	3141009	568705	827180	1.4545	0.3966	0.3041
1952	1193111	3407679	520599	876795	1.6842	0.5348	0.4071
1953	1590377	3557376	396417	695546	1.7546	0.3572	0.2692
1954	641584	4039204	429694	826021	1.9223	0.3879	0.2786
1955	272778	3488383	346919	1147841	3.3087	0.5437	0.4003
1956	439602	3189831	299823	1343068	4.4795	0.6401	0.5154
1957	804781	2495895	207840	792557	3.8133	0.5089	0.3973
1958	496824	2164149	195377	769313	3.9376	0.5169	0.4337
1959	683690	2415826	432489	744607	1.7217	0.5596	0.4628
1960	789653	2050805	383479	622042	1.6221	0.4789	0.3914
1961	916842	2137149	404228	783221	1.9376	0.6348	0.5008
1962	728338	1957006	311678	909266	2.9173	0.7576	0.61
1963	472064	1747579	208207	776337	3.7287	0.9866	0.7683
1964	338678	1374529	186570	437695	2.346	0.6789	0.4607
1965	776941	1440693	102315	444930	4.3486	0.5533	0.377
1966	1582560	2198418	120722	483711	4.0068	0.5302	0.3497
1967	1295416	2852164	129784	572605	4.412	0.5439	0.3306
1968	164955	3387455	227215	1074084	4.7272	0.5704	0.4029
1969	112039	2805591	151870	1197226	7.8832	0.8292	0.5899
1970	197105	2057698	224482	933246	4.1573	0.7493	0.5159
1971	404774	1610969	311662	689048	2.2109	0.5956	0.3861
1972	1015319	1621485	346511	565254	1.6313	0.6928	0.3702
1973	1818949	2401955	332913	792685	2.3811	0.602	0.4207
1974	523916	2236387	164491	1102433	6.7021	0.5633	0.4945
1975	621616	2037430	142028	829377	5.8395	0.6595	0.5684
1976	613942	1931396	171238	867463	5.0658	0.6457	0.5904
1977	348054	1950748	341385	905301	2.6518	0.8379	0.7191
1978	638490	1576565	241536	698715	2.8928	0.9406	0.7062
1979	198490	1114381	174699	440538	2.5217	0.7264	0.5095
1980	137735	863861	108253	380434	3.5143	0.7241	0.4994
1981	150868	983657	166926	399038	2.3905	0.8632	0.5546
1982	151830	750870	326132	363730	1.1153	0.7583	0.5705
1983	166828	738673	327180	289992	0.8863	0.756	0.5701
1984	397582	817487	251086	277651	1.1058	0.9161	0.6815
1985	523434	956773	193474	307920	1.5915	0.7038	0.6208
1986	929970	1259347	170270	430113	2.5261	0.8649	0.6914
1987	270548	1117312	118329	523071	4.4205	0.951	0.7654
1988	202876	913017	202171	434939	2.1513	0.9745	0.6234
1989	172779	891506	194362	332481	1.7106	0.6605	0.4798
1990	242750	963528	340196	212000	0.6232	0.2712	0.2116
1991	408112	1558939	674435	319158	0.4732	0.3212	0.27
1992	700267	1900315	869893	513234	0.59	0.4554	0.3878
1993	758954	2292742	737396	581611	0.7887	0.5536	0.4157
1994	516348	2018541	599103	771086	1.2871	0.8692	0.6461
1995	306270	1681895	499121	739999	1.4826	0.7898	0.5736
1996	256164	1610277	569001	732228	1.2869	0.7017	0.5293
1997	491758	1469919	564631	762403	1.3503	1.0373	0.7192
1998	608715	1157836	386195	592624	1.5345	0.9267	0.6813
1999	519647	1088363	254725	484910	1.9037	1.0038	0.6747
2000	632030	1111991	225764	414868	1.8376	0.8792	0.5855
2001	507357	1436202	332883	426471	1.2811	0.7477	0.4791
2002	398027	1665893	537603	535045	0.9952	0.672	0.4818
2003	494631	1756757	642613	521950	0.8122	0.4595	0.3353
Arith. Mean	577231	2014106	379462	661888	2.4165	0.6454	0.4767
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)			

1

Table 3. 28. Short term prediction input

MFDP version 1a
Run: sta
Time and date: 13:24 12.05.04
Fbar age range: 5-10

2004 Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	276000	0.2655	0.000	0	0	0.240	0.0111	0.779
4	392425	0.2134	0.006	0	0	0.480	0.0788	1.068
5	246598	0.2030	0.093	0	0	1.112	0.2468	1.644
6	197333	0.2021	0.403	0	0	2.054	0.4369	2.555
7	143166	0.2000	0.717	0	0	2.972	0.6232	3.565
8	53907	0.2000	0.876	0	0	4.567	0.7731	5.057
9	15595	0.2000	0.979	0	0	6.601	0.7866	6.524
10	3575	0.2000	0.982	0	0	8.760	0.8911	7.866
11	480	0.2000	1.000	0	0	10.900	0.7435	9.767
12	163	0.2000	1.000	0	0	16.493	1.0673	12.175
13	98	0.2000	1.000	0	0	13.139	1.0673	13.443

2005 Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	604000	0.2655	0.001	0	0	0.220	0.0111	0.748
4	.	0.2134	0.006	0	0	0.526	0.0788	1.159
5	.	0.2030	0.090	0	0	1.128	0.2468	1.579
6	.	0.2021	0.390	0	0	1.939	0.4369	2.360
7	.	0.2000	0.680	0	0	3.112	0.6232	3.594
8	.	0.2000	0.871	0	0	4.438	0.7731	5.005
9	.	0.2000	0.960	0	0	6.033	0.7866	6.495
10	.	0.2000	0.994	0	0	8.068	0.8911	7.964
11	.	0.2000	1.000	0	0	10.227	0.7435	9.306
12	.	0.2000	1.000	0	0	12.366	1.0673	11.207
13	.	0.2000	1.000	0	0	17.959	1.0673	13.615

2006 Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	455000	0.2655	0.001	0	0	0.227	0.0111	0.748
4	.	0.2134	0.006	0	0	0.506	0.0788	1.129
5	.	0.2030	0.090	0	0	1.174	0.2468	1.670
6	.	0.2021	0.390	0	0	1.956	0.4369	2.294
7	.	0.2000	0.680	0	0	2.998	0.6232	3.399
8	.	0.2000	0.871	0	0	4.579	0.7731	5.034
9	.	0.2000	0.960	0	0	5.905	0.7866	6.443
10	.	0.2000	0.994	0	0	7.500	0.8911	7.935
11	.	0.2000	1.000	0	0	9.534	0.7435	9.404
12	.	0.2000	1.000	0	0	11.694	1.0673	10.746
13	.	0.2000	1.000	0	0	13.833	1.0673	12.647

Input units are thousands and kg - output in tonnes

Table 3.29. Management option table

MFDP version 1a
Run: sta
Arctic Cod (run: SVPASA15/V15)
Time and date: 13:24 12.05.04
Fbar age range: 5-10

2004 Biomass	SSB	FMult	FBar	Landings
1749284	851223	1	0.6263	695936

2005 Biomass	SSB	FMult	FBar	Landings	2006 Biomass	SSB
1667191	793531	0.0000	0.0000	0	2268383	1279933
.	793531	0.1000	0.0626	82178	2178042	1207487
.	793531	0.2000	0.1253	159745	2092937	1139617
.	793531	0.3000	0.1879	232995	2012731	1076015
.	793531	0.4000	0.2505	302201	1937109	1016395
.	793531	0.5000	0.3131	367620	1865778	960490
.	793531	0.6000	0.3758	429489	1798465	908055
.	793531	0.7000	0.4384	488032	1734914	858857
.	793531	0.8000	0.5010	543455	1674888	812683
.	793531	0.9000	0.5636	595951	1618166	769333
.	793531	1.0000	0.6263	645702	1564540	728621
.	793531	1.1000	0.6889	692876	1513818	690374
.	793531	1.2000	0.7515	737629	1465821	654431
.	793531	1.3000	0.8141	780110	1420379	620643
.	793531	1.4000	0.8768	820455	1377336	588869
.	793531	1.5000	0.9394	858793	1336546	558978
.	793531	1.6000	1.0020	895243	1297871	530850
.	793531	1.7000	1.0646	929917	1261185	504372
.	793531	1.8000	1.1273	962921	1226366	479437
.	793531	1.9000	1.1899	994352	1193305	455947
.	793531	2.0000	1.2525	1024302	1161896	433811

Input units are thousands and kg - output in tonnes

Table 3.30. Single option prediction : Detailed tables

MFDP version 1a
Run: det
Time and date: 17:41 13.05.04
Fbar age range: 5-10

Year:		2004	F multiplier	1	Fbar:	0.6263				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0111	2672	2081	276000	66240	0	0	0	0
	4	0.0788	26829	28653	392425	188364	2158	1036	2158	1036
	5	0.2468	49018	80586	246598	274217	22884	25447	22884	25447
	6	0.4369	63704	162763	197333	405323	79506	163304	79506	163304
	7	0.6232	60800	216751	143166	425489	102636	305033	102636	305033
	8	0.7731	26642	134730	53907	246195	47228	215691	47228	215691
	9	0.7866	7798	50871	15595	102943	15264	100761	15264	100761
	10	0.8911	1939	15252	3575	31316	3511	30752	3511	30752
	11	0.7435	231	2255	480	5229	480	5229	480	5229
	12	1.0673	98	1198	163	2683	163	2683	163	2683
	13	1.0673	59	796	98	1285	98	1285	98	1285
Total			239789	695936	1329340	1749284	273927	851223	273927	851223

Year:		2005	F multiplier	0.6387	Fbar:	0.4				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0071	3741	2799	604000	132880	483	106	483	106
	4	0.0504	9265	10738	209311	110098	1298	683	1298	683
	5	0.1577	38775	61225	292970	330470	26455	29841	26455	29841
	6	0.279	34831	82202	157259	304926	61284	118830	61284	118830
	7	0.398	31204	112147	104160	324145	70860	220516	70860	220516
	8	0.4938	22381	112017	62854	278946	54752	242990	54752	242990
	9	0.5024	7353	47755	20372	122907	19564	118028	19564	118028
	10	0.5691	2309	18387	5815	46914	5780	46632	5780	46632
	11	0.4749	415	3858	1201	12279	1201	12279	1201	12279
	12	0.6817	85	948	187	2309	187	2309	187	2309
	13	0.6817	33	452	73	1317	73	1317	73	1317
Total			150391	452528	1458202	1667191	241936	793531	241936	793531

Year:		2006	F multiplier	0.6387	Fbar:	0.4				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0071	2818	2108	455000	103285	364	83	364	83
	4	0.0504	20356	22982	459895	232707	2851	1443	2851	1443
	5	0.1577	21279	35536	160779	188754	14518	17045	14518	17045
	6	0.279	45241	103783	204258	399529	79599	155697	79599	155697
	7	0.398	29119	98975	97200	291404	66125	198242	66125	198242
	8	0.4938	20395	102669	57277	262270	49894	228463	49894	228463
	9	0.5024	11335	73033	31408	185462	30161	178099	30161	178099
	10	0.5691	4007	31798	10093	75696	10032	75241	10032	75241
	11	0.4749	931	8751	2695	25691	2695	25691	2695	25691
	12	0.6817	277	2976	611	7150	611	7150	611	7150
	13	0.6817	49	617	108	1490	108	1490	108	1490
Total			155808	483229	1479322	1773438	256958	888643	256958	888643

Table 3.31. North East arctic cod. Stock numbers at age (in thousands) estimated by VPA including discard estimates, and % increase in stock numbers relative to a VPA without discards. From Dingsør (2001).

Year	Estimated stock numbers (thousands)			Percent increase		
	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5
1946	875 346	602 579	407 163	20 %	4 %	1 %
1947	531 993	676 806	465 099	27 %	14 %	0 %
1948	570 356	392 309	497 476	29 %	14 %	5 %
1949	589 367	416 668	285 459	26 %	16 %	3 %
1950	799 732	414 016	291 200	13 %	9 %	1 %
1951	1 235 322	586 054	302 346	14 %	2 %	0 %
1952	1 388 731	889 509	401 768	17 %	3 %	0 %
1953	1 801 114	975 004	600 908	13 %	2 %	0 %
1954	830 653	1 321 053	684 303	29 %	5 %	0 %
1955	381 489	615 696	907 875	40 %	19 %	2 %
1956	567 555	274 235	399 344	29 %	25 %	3 %
1957	914 850	387 496	161 710	14 %	10 %	2 %
1958	552 600	672 221	262 135	11 %	4 %	2 %
1959	757 567	391 906	406 694	11 %	3 %	0 %
1960	855 470	534 350	240 047	8 %	1 %	0 %
1961	1 041 570	620 707	347 043	13 %	1 %	0 %
1962	894 728	739 196	382 556	23 %	4 %	0 %
1963	551 938	614 025	429 068	17 %	10 %	0 %
1964	389 151	396 165	361 790	15 %	5 %	0 %
1965	845 469	293 844	266 134	9 %	8 %	0 %
1966	1 618 188	647 435	203 168	2 %	4 %	2 %
1967	1 404 569	1 249 506	465 035	9 %	0 %	1 %
1968	210 875	1 088 071	876 095	24 %	6 %	0 %
1969	143 791	155 947	699 033	28 %	15 %	2 %
1970	222 635	104 415	92 541	13 %	17 %	4 %
1971	462 474	164 397	65 112	14 %	6 %	2 %
1972	1 221 559	358 357	115 892	20 %	10 %	1 %
1973	1 858 123	947 409	249 400	2 %	19 %	11 %
1974	598 555	1 246 499	583 612	14 %	2 %	9 %
1975	654 442	382 692	627 793	5 %	10 %	3 %
1976	622 230	477 390	233 608	1 %	2 %	1 %
1977	397 826	426 386	280 645	14 %	0 %	0 %
1978	653 256	277 410	198 204	2 %	11 %	0 %
1979	225 935	460 104	164 243	14 %	2 %	1 %
1980	152 937	171 954	300 312	11 %	11 %	0 %
1981	161 752	116 964	116 337	7 %	7 %	4 %
1982	151 642	125 307	81 780	0 %	4 %	1 %
1983	166 310	115 423	82 423	0 %	-1 %	3 %
1984	408 525	133 333	77 728	3 %	0 %	0 %
1985	543 828	324 072	96 327	4 %	2 %	0 %
1986	1 114 252	412 683	219 993	7 %	2 %	0 %
1987	307 425	767 656	268 642	7 %	4 %	0 %
1988	222 819	215 720	490 161	9 %	3 %	2 %
1989	180 066	166 955	151 576	4 %	6 %	0 %
1990	249 968	139 922	114 006	3 %	2 %	1 %
1991	418 955	200 700	105 559	2 %	2 %	0 %
1992	748 962	333 517	151 973	4 %	1 %	0 %
1993	1 002 933	576 112	238 980	10 %	2 %	0 %
1994	896 184	744 062	420 039	9 %	8 %	0 %
1995	733 664	584 808	476 048	10 %	6 %	3 %
1996	467 093	341 918	344 124	3 %	7 %	3 %
1997	765 234	238 202	193 102	3 %	0 %	4 %
1998	836 301	429 147	144 629	2 %	1 %	-1 %

Table 3.32a Likelihood components at end of keyrun

Likelihood Component	Unweighted Likelihood		Weight	Weighted Likelihood	
	Keyrun	2003 wg		Keyrun	2003 wg
rusnorfleetlik	379	374	40.0	**15168**	14968
gillfleetlik	107	103	40.0	**4276**	4108
wintersur-85-93	1838	1540	0.5	**919**	770
wintersur-94-04	1472	926	0.5	**736**	463
acousticsur-85-93	1183	1296	0.5	**592**	648
acousticsur-94-04	1802	1441	0.5	**901**	721
lofotensur-85-89	77	101	10.0	**769**	1009
lofotensur-90-04	536	563	10.0	**5356**	5629
rustrawlsur-85-03	1880	1428	2.0	**3760**	2856
bounds	0	0	1.0	**0**	0
Total	9274	7772	105	**32477**	31171

Table 3.32b Parameter values and sensitivity (effect off parameter change on likelihood score)

Parameter	Value	- 5 %	+ 5 %	Parameter	Value	- 5 %	+ 5 %
ba1ac.cbt	0.71494069	0.02	0.01	gil.1993	0.68808491	0.00	0.01
ba1ac.slope	0.002669868	0.00	0.00	gil.1994	0.8650188	0.00	0.01
ba1ac.l50	61.774353	0.00	0.00	gil.1995	1.6820192	0.01	0.01
ba1tr.cbt	0.82362833	0.02	0.02	gil.1996	1.4431385	0.01	0.01
ba1tr.slope	0.001		0.00	gil.1997	1.8815524	0.01	0.01
ba1tr.l50	1.8021663	0.00	0.00	gil.1998	2.0358722	0.00	0.01
ba2ac.cbt	0.89747448	0.03	0.02	gil.1999	2.2222329	0.01	0.00
ba2ac.slope	0.001308665	0.00	0.00	gil.2000	2.4663214	0.00	0.00
ba2ac.l50	23.819125	0.00	0.00	gil.2001	1.7571029	0.00	0.00
ba2tr.cbt	0.51221998	0.03	0.03	gil.2002	1.2152772	0.00	0.00
ba2tr.slope	0.46947169	0.00	0.00	gil.2003	0.86223558	0.01	0.00
ba2tr.l50	17.903125	0.02	0.07	growth.1985	7.2017966	0.21	0.20
betabin	52.069807	0.01	0.01	growth.1986	6.9385635	0.27	0.24
cann.noncod	0.000489331	0.01	0.02	growth.1987	7.8510416	0.23	0.21
cann.high	0.000252348	0.02	0.03	growth.1988	6.9750812	0.11	0.11
cann.m0	0.000397122	0.06	0.04	growth.1989	10.206428	0.16	0.15
d minage.1986	4.3280262	0.06	0.06	growth.1990	12.428799	0.24	0.25
d minage.1987	3.4623719	0.01	0.01	growth.1991	13.055784	0.35	0.34
d minage.1988	3.880284	0.01	0.01	growth.1992	5.5155058	0.08	0.08
d minage.1989	5.8516171	0.01	0.01	growth.1993	10.090755	0.42	0.36
d minage.1990	6.0462395	0.01	0.01	growth.1994	9.5497934	0.34	0.30
d minage.1991	6.4132015	0.04	0.03	growth.1995	10.594271	0.36	0.31
d minage.1992	7.3986325	0.06	0.05	growth.1996	9.1937929	0.20	0.16
d minage.1993	4.7280258	0.04	0.03	growth.1997	11.561364	0.37	0.30
d minage.1994	6.3753066	0.06	0.06	growth.1998	9.1664456	0.23	0.21
d minage.1995	5.7602929	0.04	0.03	growth.1999	10.376816	0.23	0.23
d minage.1996	6.1387795	0.03	0.03	growth.2000	13.150014	0.40	0.40
d minage.1997	4.2085115	0.04	0.03	growth.2001	9.4573921	0.17	0.16
d minage.1998	4.8660838	0.05	0.06	growth.2002	12.161023	0.19	0.19
d minage.1999	4.9903194	0.02	0.03	growth.2003	7.3740523	0.02	0.02
d minage.2000	3.6689203	0.01	0.01	imm.n age3	54.952045	0.10	0.10
d minage.2001	5.2341238	0.02	0.02	imm.n age4	36.655432	0.08	0.07
d minage.2002	7.4850299	0.01	0.01	imm.n age5	9.8817854	0.02	0.02
d minage.2003	6.027588	0.01	0.02	imm.n age6	3.1886734	0.00	0.00
d minage.2004	3.5946719	0.00	0.00	imm.n age7	0.97675113	0.00	0.00
gil.slope	0.037368873	0.35	0.33	imm.n age8	0.2150041	0.00	0.00
gil.l50	82.862251	6.04	6.59	imm.n age9	0.17105467	0.00	0.00
gil.1985	2.6383522	0.01	0.01	l minage.1986	33.412469	4.08	3.39
gil.1986	1.5743364	0.00	0.00	l minage.1987	31.667943	1.14	1.09
gil.1987	1.3345452	0.00	0.00	l minage.1988	32.975217	0.84	0.96
gil.1988	1.6380134	0.00	0.00	l minage.1989	31.790078	0.35	0.31
gil.1989	2.6952929	0.01	0.00	l minage.1990	30.871158	0.39	0.43
gil.1990	0.76175311	0.00	0.00	l minage.1991	36.960655	1.10	1.06
gil.1991	0.55683818	0.01	0.00	l minage.1992	39.271556	1.74	1.59
gil.1992	0.46651081	0.00	0.00	l minage.1993	32.558912	2.09	1.83

Table 3.32b **(continued)**

Parameter	**Value**	**- 5 %**	**+ 5 %**
l minage.1994	28.616287	0.93	0.77
l minage.1995	27.856105	0.71	0.58
l minage.1996	30.464077	0.60	0.49
l minage.1997	29.974801	1.50	1.40
l minage.1998	31.33046	1.84	1.84
l minage.1999	27.619417	0.69	0.71
l minage.2000	27.666453	0.86	0.86
l minage.2001	31.548285	0.56	0.52
l minage.2002	25.84871	0.09	0.10
l minage.2003	28.669821	0.15	0.13
l minage.2004	30.339597	0.03	0.03
lof1ac.cbt	1.4568562	0.01	0.01
lof1ac.slope	0.00857473	0.00	0.00
lof1ac.l50	90.169251	0.04	0.04
lof2ac.cbt	1.5943528	0.09	0.09
lof2ac.slope	0.018028114	0.01	0.01
lof2ac.l50	71.900752	0.41	0.51
mat.n age5	1.5996258	0.00	0.00
mat.n age6	2.2349267	0.00	0.00
mat.n age7	1.5778418	0.00	0.00
mat.n age8	0.47031707	0.00	0.00
mat.n age9	0.15831277	0.00	0.00
mat.n age10	0.19841344	0.00	0.00
maturation.slope	0.012753952	0.07	0.07
maturation.l50	90.522435	0.84	0.87
n minage.1986	125.61592	0.18	0.16
n minage.1987	38.434667	0.04	0.05
n minage.1988	25.352163	0.03	0.04
n minage.1989	18.91604	0.03	0.02
n minage.1990	27.404165	0.04	0.04
n minage.1991	44.295303	0.07	0.07
n minage.1992	70.564133	0.14	0.09
n minage.1993	87.247387	0.14	0.12
n minage.1994	84.784588	0.09	0.09
n minage.1995	59.73904	0.06	0.05
n minage.1996	31.959305	0.06	0.04
n minage.1997	54.321126	0.09	0.09
n minage.1998	64.575065	0.12	0.09
n minage.1999	51.587386	0.07	0.07
n minage.2000	57.299645	0.06	0.05
n minage.2001	42.783662	0.03	0.03
n minage.2002	35.265155	0.01	0.01
n minage.2003	64.08572	0.01	0.01
n minage.2004	13.148221	0.00	0.00
rusnor.slope	0.050244166	0.59	0.59

Parameter	**Value**	**- 5 %**	**+ 5 %**
rusnor.l50	52.516449	19.02	24.35
rusnor.1985	1.1660244	0.03	0.03
rusnor.1986	1.8889334	0.07	0.05
rusnor.1987	3.0812744	0.11	0.09
rusnor.1988	2.5588423	0.07	0.08
rusnor.1989	1.7482983	0.05	0.05
rusnor.1990	0.68237229	0.01	0.03
rusnor.1991	0.64979178	0.03	0.02
rusnor.1992	0.75707022	0.04	0.03
rusnor.1993	1.2206731	0.05	0.05
rusnor.1994	1.6730763	0.08	0.07
rusnor.1995	1.8341515	0.08	0.07
rusnor.1996	2.048169	0.08	0.08
rusnor.1997	2.9363285	0.10	0.10
rusnor.1998	3.1916298	0.09	0.09
rusnor.1999	3.1603742	0.07	0.08
rusnor.2000	2.1327509	0.04	0.05
rusnor.2001	1.5784411	0.05	0.04
rusnor.2002	1.3047331	0.05	0.04
rusnor.2003	1.2145135	0.03	0.04
rustr.cbt	0.33709242	0.04	0.03
rustr.slope	0.006711531	0.01	0.00
rustr.l50	65.983025	0.04	0.03

Table 3.32c Fixed parameter values used in keyrun

Name	Value	Name	Value
growth.exponent	0	mat.l_age4	51
cann.p1	2.219829	mat.l_age5	59.6
cann.p3	5.702254	mat.l_age6	71.1
cann.p2	0.643658	mat.l_age7	79
cann.m1	0.104	mat.l_age8	88.2
cann.m2	0.000112	mat.l_age9	97.3
cann.m3	2.4	mat.l_age10	105.2
cann.hf	0	mat.l_age11	114
imm.n_age10	0	mat.l_age12	114
imm.l_age3	40.6	mat.d_age4	14.9
imm.l_age4	48.7	mat.d_age5	1.1
imm.l_age5	61.3	mat.d_age6	6.74503
imm.l_age6	71.1	mat.d_age7	3.184107
imm.l_age7	81.2	mat.d_age8	5.107078
imm.l_age8	85.7	mat.d_age9	3.064587
imm.l_age9	90	mat.d_age10	5.437319
imm.l_age10	90	mat.d_age11	10.62126
imm.d_age3	5.1	mat.d_age12	3.265886
imm.d_age4	4.1	other.level	10000
imm.d_age5	4.9		
imm.d_age6	5.3		
imm.d_age7	5.4		
imm.d_age8	8.7		
imm.d_age9	8.7		
imm.d_age10	8.7		
growth.ratio	0.740864		
mat.n_age4	0		

Table 3.33 Results from the keyrun

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
```

Total fishing mortality at age

Year	1985	1986	1987	1988	1989
Age					
3	0.0684	0.0432	0.0465	0.0392	0.0373
4	0.1630	0.2351	0.1846	0.1134	0.0899
5	0.3540	0.4141	0.5986	0.3103	0.1970
6	0.5116	0.6192	0.8605	0.6594	0.3619
7	0.7034	0.7484	1.0788	0.8417	0.5950
8	0.8846	0.8802	1.2055	1.0378	0.7693
9	0.9903	0.9627	1.3200	1.1713	1.0425
10	1.1229	1.0072	1.3712	1.2891	1.2196
11	1.1344	1.0590	1.4024	1.3305	1.3736
12+	1.1478	1.0639	1.4283	1.3600	1.4239
F 5-10	0.7611	0.7720	1.0724	0.8849	0.6976

Total fishing mortality at age

Year	1990	1991	1992	1993	1994	1995	1996
Age							
3	0.0176	0.0385	0.0514	0.0322	0.0487	0.0444	0.0559
4	0.0673	0.0758	0.1420	0.1412	0.1618	0.1583	0.1463
5	0.1299	0.1589	0.2058	0.2750	0.3676	0.3676	0.3393
6	0.1838	0.2140	0.2920	0.3450	0.5266	0.5565	0.5869
7	0.2345	0.2458	0.3336	0.4366	0.5912	0.7133	0.7295
8	0.2988	0.2772	0.3582	0.4879	0.6838	0.7948	0.8601
9	0.3455	0.3193	0.3821	0.5206	0.7409	0.9360	0.9233
10	0.3970	0.3449	0.4080	0.5503	0.7752	1.0259	1.0214
11	0.4203	0.3655	0.4202	0.5794	0.7995	1.0682	1.0715
12+	0.4396	0.3740	0.4291	0.5927	0.8222	1.0978	1.0988
F 5-10	0.2649	0.2600	0.3299	0.4359	0.6142	0.7323	0.7434

Total fishing mortality at age

Year	1997	1998	1999	2000	2001	2002	2003	2001-2003
Age								
3	0.0478	0.0482	0.0275	0.0186	0.0245	0.0317	0.0286	0.0283
4	0.2109	0.2153	0.1883	0.1076	0.0906	0.1147	0.0928	0.0994
5	0.4831	0.5292	0.4948	0.3569	0.2524	0.2611	0.2677	0.2604
6	0.7644	0.8497	0.7848	0.5818	0.4530	0.4162	0.4007	0.4233
7	1.0373	1.0702	1.0546	0.7435	0.5796	0.5592	0.4885	0.5424
8	1.2047	1.3126	1.2457	0.9396	0.6787	0.6496	0.5760	0.6348
9	1.3681	1.4616	1.4873	1.1077	0.8043	0.7120	0.6311	0.7158
10	1.4402	1.6014	1.6164	1.3157	0.8919	0.7825	0.6621	0.7788
11	1.5366	1.6558	1.7378	1.4086	0.9792	0.8212	0.6918	0.8307
12+	1.5904	1.7331	1.7968	1.4983	1.0132	0.8567	0.7073	0.8591
F 5-10	1.0496	1.1375	1.1139	0.8409	0.6100	0.5634	0.5043	

Table 3.33 (Continued)

```
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stocks cod.imm cod.mat
areas  1

Residual natural mortality (M1)
Year        1985    1986    1987    1988    1989
Age
  3       0.2000  0.2000  0.2000  0.2000  0.2000
  4       0.2000  0.2000  0.2000  0.2000  0.2000
  5       0.2000  0.2000  0.2000  0.2000  0.2000
  6       0.2000  0.2000  0.2000  0.2000  0.2000
  7       0.2000  0.2000  0.2000  0.2000  0.2000
  8       0.2000  0.2000  0.2000  0.2000  0.2000
  9       0.2000  0.2000  0.2000  0.2000  0.2000
 10       0.2000  0.2000  0.2000  0.2000  0.2000
 11       0.2000  0.2000  0.2000  0.2000  0.2000
 12+      0.2000  0.2000  0.2000  0.2000  0.2000

Residual natural mortality (M1)
Year        1990    1991    1992    1993    1994    1995    1996
Age
  3       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
  4       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
  5       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
  6       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
  7       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
  8       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
  9       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
 10       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
 11       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000
 12+      0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000

Residual natural mortality (M1)
Year        1997    1998    1999    2000    2001    2002    2003   2001-2003
Age
  3       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
  4       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
  5       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
  6       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
  7       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
  8       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
  9       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
 10       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
 11       0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000
 12+      0.2000  0.2000  0.2000  0.2000  0.2000  0.2000  0.2000      0.2000


Predation mortality (M2)
Year        1985    1986    1987    1988    1989
Age
  3       0.0082  0.1391  0.1811  0.0327  0.0154
  4       0.0037  0.0211  0.0470  0.0114  0.0047

Predation mortality (M2)
Year        1990    1991    1992    1993    1994    1995    1996
Age
  3       0.0030  0.0015  0.0030  0.0376  0.2909  0.5599  0.1383
  4       0.0007  0.0008  0.0012  0.0083  0.0432  0.1137  0.0295

Predation mortality (M2)
Year        1997    1998    1999    2000    2001    2002    2003   2001-2003
Age
  3       0.0465  0.0052  0.0037  0.0028  0.0032  0.0168  0.0933      0.0378
  4       0.0108  0.0016  0.0008  0.0007  0.0011  0.0021  0.0193      0.0075
```

Table 3.33 (Continued)

```
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stocks cod.imm cod.mat
areas  1
```

Stock numbers (thousands) at age by Jan. 1

Year	1985	1986	1987	1988	1989	1990
Age						
3	549520	1256159	384347	253522	189160	274042
4	366554	416751	857034	250632	193175	146920
5	114814	254037	264084	556642	181131	143877
6	54236	65897	136071	117364	332668	121506
7	25546	26610	28954	46832	49616	189427
8	6853	10349	10293	8044	16514	22397
9	3294	2316	3511	2522	2332	6263
10	1984	1002	757	775	643	676
11	400	528	267	149	172	152
12+	300	183	202	93	52	46
Total	1123501	2033832	1685519	1236574	965463	905305

Stock numbers (thousands) at age by Jan. 1

Year	1991	1992	1993	1994	1995	1996	1997
Age							
3	442953	705641	872474	847846	597390	319593	543211
4	219800	348445	547164	666176	494282	267263	215469
5	112375	166693	247231	385776	444345	308310	183546
6	103410	78467	111001	153174	215230	244041	177648
7	82758	68343	47963	64202	73522	99583	110554
8	122657	52984	40074	25349	28959	29304	39211
9	13601	76104	30316	20131	10450	10660	10139
10	3640	8191	42767	16076	8315	3482	3518
11	362	2012	4210	18855	5589	2304	971
12+	106	265	1223	2485	7834	3712	1659
Total	1101663	1507144	1944422	2200069	1885916	1288252	1285926

Stock numbers (thousands) at age by Jan. 1

Year	1998	1999	2000	2001	2002	2003	2004
Age							
3	645751	515874	572996	427837	352652	640857	131482
4	404711	501197	409386	459219	340704	275049	464461
5	141335	266747	339660	300761	343035	248188	201301
6	92231	68111	133117	194590	191232	216098	154720
7	67545	32271	25435	60906	101257	103216	118227
8	32043	18962	9203	9900	27929	47383	51787
9	9618	7059	4467	2944	4112	11941	21796
10	2155	1844	1326	1224	1109	1679	5247
11	640	337	280	275	380	388	662
12+	448	165	71	69	105	174	229
Total	1396476	1412568	1495942	1457725	1362515	1544972	1149911

Table 3.33 (Continued)

; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas 1

Spawning stock biomass (tons) at Jan. 1

Year	1985	1986	1987	1988
Age				
3	-	0	0	0
4	-	0	0	0
5	-	40545	33579	16100
6	-	58967	69806	51092
7	-	61355	51897	54772
8	-	41465	36632	24816
9	-	12537	19653	12878
10	-	5981	5258	5633
11	-	5650	2562	1419
12+	-	2429	2910	1290
SSB total	-	228928	222296	168000

Spawning stock biomass (tons) at Jan. 1

Year	1989	1990	1991	1992	1993	1994	1995	1996
Age								
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	2689	7852	19537	39392	48853	69043	43128	23817
6	57121	26280	50703	69776	68592	111761	128781	118302
7	50778	121573	79455	118050	83444	90946	117272	145622
8	37070	45488	225760	143063	119734	77652	73886	88622
9	11133	23105	53190	314694	128481	93041	49344	44781
10	4486	4387	21305	54075	249481	87565	52147	22229
11	1675	1379	3223	18428	37646	150809	48499	20848
12+	722	607	1278	3326	13681	26166	84238	43955
SSB total	165674	230671	454451	760802	749912	706982	597294	508177

Spawning stock biomass (tons) at Jan. 1

Year	1997	1998	1999	2000	2001	2002	2003	2004
Age								
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	10971	12435	14739	20680	23082	19890	31516	7830
6	61571	34321	22521	43106	87916	74088	101610	67030
7	135047	69937	30182	22537	68982	132130	132676	134767
8	104157	85569	36631	18214	20899	70851	142877	123316
9	47458	43942	27564	15028	11006	15951	57798	100265
10	20860	14947	10317	7463	6499	6363	10676	34439
11	8966	5858	2815	2243	2315	3156	3620	5834
12+	22720	6940	1939	809	761	1199	2085	2705
SSB total	411750	273949	146707	130079	221459	323627	482858	476184

Table 3.33 (Continued)

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
```

Total stock biomass (tons) at Jan. 1

Year	1985	1986	1987	1988
Age				
3	-	413045	106048	79445
4	-	377578	448777	136051
5	-	360181	329588	527444
6	-	168258	256750	213898
7	-	99844	93994	124009
8	-	52250	47364	34333
9	-	14741	21721	14558
10	-	7633	5639	5853
11	-	5650	2810	1480
12+	-	2429	2910	1290
Total	-	1501609	1315600	1138361

Total stock biomass (tons) at Jan. 1

Year	1989	1990	1991	1992	1993	1994	1995	1996
Age								
3	56181	75430	204817	395046	268677	191431	122125	85037
4	117477	109870	186432	412566	467896	495289	307478	175613
5	171288	169969	173567	278832	386897	575449	569129	359447
6	491197	198612	226274	216662	236091	368402	458532	490693
7	129543	433681	232741	255802	163214	196793	236579	309278
8	61298	81246	451674	245331	182550	113962	115776	131380
9	13148	30698	71898	437719	168804	115160	60016	57180
10	4728	4726	24249	61425	290262	99257	57230	24346
11	1703	1407	3315	19312	39723	160791	52415	21991
12+	722	607	1278	3326	13681	26166	84238	43955
Total	1047284	1106245	1576245	2326022	2217796	2342699	2063519	1698921

Total stock biomass (tons) at Jan. 1

Year	1997	1998	1999	2000	2001	2002	2003	2004
Age								
3	129911	178649	99998	107011	122016	64064	143424	32082
4	138542	266688	298262	207636	281934	219067	157711	214156
5	206644	167719	290286	374095	342075	386341	341895	179100
6	311414	170643	115360	232622	387777	353672	460624	292220
7	314279	184036	81146	63257	176008	310010	325000	332612
8	161493	137340	65684	32859	37631	118495	225396	206434
9	58250	55717	35450	20917	15005	21782	74148	126257
10	23499	16443	11629	8423	7633	7347	12296	38436
11	9417	6196	2949	2377	2441	3388	3860	6211
12+	22720	6940	1939	809	761	1199	2085	2705
Total	1376170	1190369	1002702	1050004	1373280	1485364	1746439	1430212

Table 3.33 (Continued)

```
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stocks cod.imm cod.mat
areas  1
```

Weight (kg) in catch (Observed)

Year	1985
Age	
3	0.91
4	1.30
5	1.96
6	3.18
7	4.63
8	6.04
9	7.66
10	9.80
11	11.82
12+	14.32

Weight (kg) in catch (Observed)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Age									
3	0.62	0.49	0.53	0.74	0.83	1.03	1.15	0.76	0.83
4	1.25	0.87	0.83	0.92	1.22	1.43	1.56	1.44	1.27
5	1.87	1.53	1.29	1.26	1.61	2.11	2.22	2.07	1.97
6	2.80	2.34	2.22	1.86	2.13	2.80	3.14	2.71	2.89
7	4.46	3.55	3.52	2.86	3.15	3.58	4.31	4.05	3.41
8	5.78	5.97	5.28	4.58	4.57	4.61	5.24	5.44	5.33
9	6.76	8.60	7.92	7.51	7.26	5.99	6.16	6.40	6.91
10	7.60	9.61	9.01	9.09	9.85	8.78	7.89	7.13	7.67
11	9.76	12.26	11.21	11.40	13.54	11.82	10.32	7.99	8.06
12+	10.63	13.77	13.99	12.00	17.13	16.58	11.81	10.31	9.70

Weight (kg) in catch (Observed)

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2001-2003
Age										
3	0.80	0.80	0.67	0.61	0.62	0.55	0.66	0.73	0.72	0.70
4	1.22	1.09	0.99	0.98	1.00	1.00	1.02	1.15	1.17	1.11
5	1.73	1.59	1.45	1.54	1.48	1.56	1.58	1.62	1.90	1.70
6	2.55	2.41	2.13	2.22	2.25	2.29	2.48	2.44	2.62	2.51
7	3.81	3.82	3.34	3.22	3.16	3.29	3.48	3.70	3.71	3.63
8	5.02	5.83	5.26	4.83	4.30	4.45	4.75	4.98	5.14	4.96
9	6.18	6.91	7.28	6.88	6.03	5.71	5.99	6.48	6.46	6.31
10	8.03	8.16	7.83	9.39	6.86	7.52	7.42	7.88	8.38	7.89
11	8.84	9.65	8.57	10.75	11.01	7.71	8.67	9.22	10.69	9.53
12+	9.24	10.75	11.32	15.23	14.27	12.34	10.87	7.87	12.11	10.28

Table 3.33 (Continued)

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stocks cod.imm cod.mat
areas  1
```

Weight (kg) in catch (Model)

Year	1985
Age	
3	0.94
4	1.30
5	2.31
6	3.63
7	4.88
8	6.40
9	7.74
10	10.81
11	13.80
12+	13.69

Weight (kg) in catch (Model)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Age									
3	0.58	0.46	0.56	0.70	0.85	1.11	1.07	0.66	0.62
4	1.28	0.86	0.87	0.97	1.36	1.48	1.65	1.41	1.14
5	1.72	1.57	1.32	1.31	1.70	2.15	2.11	2.05	1.94
6	2.86	2.15	2.16	1.83	2.13	2.75	3.15	2.59	2.79
7	4.09	3.57	2.95	2.98	2.83	3.44	4.12	3.87	3.47
8	5.35	5.02	4.59	4.08	4.31	4.42	5.04	5.02	4.98
9	6.66	6.67	6.11	5.98	5.61	6.13	6.18	6.05	6.26
10	7.89	8.39	7.92	7.69	7.71	7.52	8.00	7.32	7.40
11	10.83	10.36	9.80	9.89	9.74	9.81	9.53	9.43	8.71
12+	13.29	15.58	14.14	13.95	13.90	13.06	12.86	11.69	11.52

Weight (kg) in catch (Model)

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2001-2003
Age										
3	0.58	0.65	0.57	0.60	0.50	0.49	0.60	0.68	0.55	0.61
4	1.10	1.05	1.13	1.05	1.03	1.01	0.97	1.16	1.10	1.08
5	1.71	1.60	1.58	1.61	1.51	1.62	1.56	1.61	1.75	1.64
6	2.68	2.44	2.22	2.23	2.14	2.26	2.40	2.37	2.43	2.40
7	3.87	3.68	3.38	3.15	3.00	3.10	3.37	3.66	3.48	3.50
8	4.72	5.17	4.78	4.76	4.10	4.29	4.40	4.93	5.10	4.81
9	6.51	6.12	6.47	6.31	5.86	5.50	5.76	6.07	6.52	6.12
10	8.09	8.23	7.55	8.30	7.43	7.38	7.07	7.66	7.73	7.49
11	9.43	10.12	10.07	9.70	9.70	9.09	9.27	9.21	9.53	9.33
12+	11.53	13.26	14.67	16.04	13.74	12.83	12.06	12.56	12.11	12.25

Table 3.33 (Continued)

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
```

Weight (kg) in stock at Jan. 1

Year	1985	1986
Age		
3		0.33
4		0.91
5		1.42
6		2.55
7		3.75
8		5.05
9		6.36
10		7.62
11		10.70
12+		13.27

Weight (kg) in stock at Jan. 1

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age									
3	0.28	0.31	0.30	0.28	0.46	0.56	0.31	0.23	0.20
4	0.52	0.54	0.61	0.75	0.85	1.18	0.86	0.74	0.62
5	1.25	0.95	0.95	1.18	1.54	1.67	1.56	1.49	1.28
6	1.89	1.82	1.48	1.63	2.19	2.76	2.13	2.41	2.13
7	3.25	2.65	2.61	2.29	2.81	3.74	3.40	3.07	3.22
8	4.60	4.27	3.71	3.63	3.68	4.63	4.56	4.50	4.00
9	6.19	5.77	5.64	4.90	5.29	5.75	5.57	5.72	5.74
10	7.45	7.55	7.35	6.99	6.66	7.50	6.79	6.17	6.88
11	10.52	9.94	9.90	9.25	9.16	9.60	9.44	8.53	9.38
12+	14.41	13.87	13.88	13.20	12.06	12.55	11.19	10.53	10.75

Weight (kg) in stock at Jan. 1

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2002-2004
Age										
3	0.27	0.24	0.28	0.19	0.19	0.29	0.18	0.22	0.24	0.22
4	0.66	0.64	0.66	0.60	0.51	0.61	0.64	0.57	0.46	0.56
5	1.17	1.13	1.19	1.09	1.10	1.14	1.13	1.38	0.89	1.13
6	2.01	1.75	1.85	1.69	1.75	1.99	1.85	2.13	1.89	1.96
7	3.11	2.84	2.72	2.51	2.49	2.89	3.06	3.15	2.81	3.01
8	4.48	4.12	4.29	3.46	3.57	3.80	4.24	4.76	3.99	4.33
9	5.36	5.75	5.79	5.02	4.68	5.10	5.30	6.21	5.79	5.77
10	6.99	6.68	7.63	6.31	6.35	6.24	6.62	7.32	7.33	7.09
11	9.54	9.70	9.68	8.75	8.49	8.88	8.92	9.95	9.38	9.42
12+	11.84	13.70	15.49	11.75	11.39	11.02	11.42	11.99	11.81	11.74

Table 3.33 (Continued)

Proportion mature at age

Year	1985	1986
Age		
3	0.000	0.000
4	0.000	0.000
5	0.139	0.092
6	0.412	0.352
7	0.618	0.616
8	0.686	0.804
9	0.481	0.836
10	1.000	0.747
11	1.000	1.000
12+	1.000	1.000

Proportion mature at age

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age									
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.073	0.018	0.009	0.030	0.081	0.103	0.089	0.082	0.052
6	0.244	0.198	0.085	0.105	0.196	0.280	0.232	0.255	0.228
7	0.553	0.419	0.349	0.246	0.315	0.438	0.466	0.412	0.450
8	0.777	0.725	0.588	0.530	0.476	0.567	0.634	0.652	0.598
9	0.910	0.888	0.848	0.746	0.726	0.708	0.747	0.798	0.802
10	0.882	0.955	0.946	0.926	0.876	0.865	0.845	0.804	0.854
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Proportion mature at age

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2002-2004
Age										
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000
5	0.042	0.033	0.047	0.032	0.035	0.043	0.032	0.063	0.020	0.0384
6	0.205	0.155	0.164	0.150	0.150	0.191	0.165	0.186	0.181	0.1775
7	0.418	0.394	0.335	0.333	0.308	0.360	0.390	0.368	0.368	0.3752
8	0.641	0.602	0.598	0.522	0.523	0.521	0.574	0.611	0.562	0.5820
9	0.758	0.792	0.762	0.762	0.695	0.718	0.710	0.768	0.777	0.7517
10	0.868	0.858	0.879	0.862	0.865	0.830	0.834	0.844	0.880	0.8528
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000
12+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000

Table 3.33 (Continued)

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
fleets  allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm
        gilfleet-cod.mat
```

Model catch in numbers (thousands) at age

Year	1985	1986	1987
Age			
3	26684	27150	9411
4	43512	67421	103012
5	27906	70133	98435
6	18306	25381	66372
7	11198	11920	16414
8	3562	5234	6260
9	1848	1248	2255
10	1206	557	497
11	245	304	177
12+	185	106	136
Total	134650	209452	302969

Model catch in numbers (thousands) at age

Year	1988	1989	1990	1991	1992	1993	1994	1995
Age								
3	6533	4035	2788	10685	19448	13825	10979	7091
4	20847	12831	6516	10712	27656	49744	62419	39334
5	121886	26102	12211	11431	18908	44103	85657	101479
6	47952	83626	14470	14098	12456	24440	47291	72145
7	22855	18982	28740	13022	12480	13110	21952	30456
8	4542	7731	4377	21987	10514	12158	9853	13101
9	1541	1355	1426	2845	16312	9785	8394	5360
10	502	412	178	827	1896	14547	6968	4555
11	99	118	42	88	482	1501	8386	3147
12+	62	36	13	26	65	446	1132	4495
Total	226819	155228	70760	85722	120217	183658	263030	281162

Model catch in numbers (thousands) at age

Year	1996	1997	1998	1999	2000	2001	2002	2003
Age								
3	6690	14885	22183	9692	7340	7054	3270	4970
4	24833	31011	62916	69250	32269	30945	22789	11802
5	68510	56758	47744	85740	81752	54094	51181	37830
6	87291	78339	44024	30983	48108	58646	43948	47947
7	42471	60057	37470	17838	11136	22606	30634	27689
8	14199	23453	20111	11611	4786	4187	9781	15015
9	5447	6540	6413	4777	2600	1422	1574	4152
10	1913	2336	1507	1303	858	638	463	612
11	1308	668	455	247	189	153	166	148
12+	2144	1161	325	122	49	39	48	68
Total	254808	275207	243147	231563	189087	179784	163853	150232

Table 3.33 (Continued)

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
fleets  allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm
        gilfleet-cod.mat
```

Observed catch in numbers (thousands) at age

Year	1985	1986	1987
Age			
3	19823	24597	10450
4	41151	59086	117698
5	24948	71517	84253
6	16753	23479	57239
7	10561	10439	13074
8	3508	3797	3568
9	1432	888	867
10	713	688	449
11	134	519	183
12+	38	134	204
Total	119061	195143	287984

Observed catch in numbers (thousands) at age

Year	1988	1989	1990	1991	1992	1993	1994	1995
Age								
3	9317	4902	1315	3493	14276	7680	5558	4741
4	19548	15828	5807	8514	22802	37098	49632	35100
5	117460	28904	9870	12308	18685	54328	79314	95618
6	48949	66506	13786	15174	17113	28245	50230	79441
7	19899	24993	23668	14189	12899	11520	28770	28290
8	3151	5186	5151	18096	9543	7441	7676	6786
9	1163	789	605	2701	12820	5183	4523	2495
10	381	275	125	264	1761	9806	2498	1433
11	107	42	47	37	192	1296	5464	808
12+	68	14	12	12	46	249	751	1664
Total	220041	147438	60386	74787	110136	162845	234417	256374

Observed catch in numbers (thousands) at age

Year	1996	1997	1998	1999	2000	2001	2002	2003
Age								
3	7034	10454	28160	8084	4266	4348	1547	4409
4	25574	32828	78268	72593	27993	30719	20480	12674
5	70969	63737	42650	81439	76991	53307	49756	38360
6	87253	75825	35602	27616	40926	53506	45010	44574
7	46081	60395	29462	13875	11508	20104	30600	25478
8	8729	22648	23799	14370	6318	4707	8910	10735
9	1791	3191	6133	7967	4563	1622	1343	2276
10	808	814	883	1812	1517	1063	402	341
11	357	352	174	210	261	275	145	88
12+	174	146	60	41	41	49	86	63
Total	248771	270388	245190	228007	174384	169700	158279	138998

Table 3.33 (Continued)

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
fleets  allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm
        gilfleet-cod.mat

Model catch in biomass (tons) at age
Year        1985    1986    1987
Age
  3        24976   15684    4363
  4        56654   86565   88801
  5        64485  120790  154970
  6        66358   72592  142693
  7        54647   48804   58559
  8        22808   27975   31404
  9        14302    8311   15035
 10        13041    4393    4167
 11         3376    3289    1838
 12+        2530    1403    2113

Total     323176  389805  503942
Total+    360405  439905  561533
(+ Also includes: overfish-new otherfleet )


Model catch in biomass (tons) at age
Year        1988    1989    1990    1991    1992    1993    1994    1995
Age
  3         3678    2831    2372   11890   20768    9091    6805    4130
  4        18217   12471    8852   15811   45664   69954   71270   43139
  5       160757   34271   20751   24544   39959   90434  165908  173205
  6       103551  152656   30801   38764   39288   63348  131868  193406
  7        67356   56553   81286   44774   51453   50713   76092  117928
  8        20869   31535   18876   97198   52992   61059   49067   61799
  9         9414    8104    7993   17430  100766   59198   52554   34895
 10         3974    3165    1370    6225   15176  106516   51578   36833
 11          966    1165     413     858    4591   14164   73057   29669
 12+         881     506     185     343     837    5209   13039   51832

Total     389662  303257  172898  257837  371493  529685  691238  746835
Total+    435257  344084  222084  332900  537823  645505  852380  871107
(+ Also includes: overfish-new otherfleet )


Model catch in biomass (tons) at age
Year        1996    1997    1998    1999    2000    2001    2002    2003
Age
  3         4332    8454   13263    4834    3605    4254    2227    2721
  4        26191   34930   65772   71205   32752   30127   26363   13019
  5       109656   89405   77082  129517  132089   84226   82439   66300
  6       213222  174007   98331   66428  108631  141004  104225  116502
  7       156418  202824  117891   53578   34520   76275  112019   96266
  8        73395  112094   95693   47590   20512   18433   48194   76564
  9        33344   42283   40486   28016   14311    8198    9549   27048
 10        15742   17647   12515    9677    6336    4510    3548    4734
 11        13247    6722    4408    2392    1716    1418    1529    1405
 12+       28446   17033    5218    1681     634     475     598     818

Total     673993  705399  530658  414918  355104  368919  390691  405377
Total+    776911  790303  591044  466164  410330  423399  539319  554185
(+ Also includes: overfish-new otherfleet )
```

Table 3.33 (Continued)

```
; Gadget version 2.0.05 running on ress8645 Thu May 13 11:36:47 2004
stocks cod.imm cod.mat
areas  1
fleets  allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm
        gilfleet-cod.mat
```

Observed catch in biomass (tons) at age

Year	1985	1986	1987
Age			
3	17948	15226	5086
4	53604	73787	101978
5	48903	133381	128842
6	53331	65666	133719
7	48851	46521	46379
8	21169	21949	21314
9	10971	5997	7454
10	6993	5232	4318
11	1580	5068	2247
12+	547	1422	2810
Total	263894	374248	454146
Total+	301123	424348	511737

(+ Also includes: overfish-new otherfleet)

Observed catch in biomass (tons) at age

Year	1988	1989	1990	1991	1992	1993	1994	1995
Age								
3	4968	3624	1090	3597	16410	5869	4605	3802
4	16313	14598	7070	12153	35478	53248	62856	42832
5	151174	36498	15879	25920	41467	112199	156455	165865
6	108829	123969	29412	42533	53720	76633	144955	202254
7	69956	71372	74450	50742	55633	46655	98004	107761
8	16648	23732	23544	83487	49966	40484	40920	34062
9	9215	5923	4394	16169	78925	33172	31231	15421
10	3431	2496	1229	2314	13899	69911	19171	11505
11	1195	477	632	437	1976	10359	44041	7145
12+	947	168	199	192	548	2563	7283	15370
Total	382675	282856	157898	237543	348022	451093	609520	606017
Total+	428270	323683	207084	312606	514352	566913	770662	730289

(+ Also includes: overfish-new otherfleet)

Table 3.33 (Continued)

Observed catch in biomass (tons) at age

Year	1996	1997	1998	1999	2000	2001	2002	2003
Age								
3	5644	7034	17085	5037	2354	2860	1122	3177
4	27948	32452	76328	72744	27998	31436	23522	14809
5	112514	92423	65520	120373	120413	84341	80738	72956
6	210237	161292	79064	62170	93671	132679	109755	116677
7	175919	201478	94788	43800	37826	70012	113273	94646
8	50900	119086	114831	61825	28120	22370	44387	55140
9	12384	23228	42175	48013	26052	9711	8708	14709
10	6598	6372	8289	12422	11409	7887	3167	2856
11	3449	3012	1869	2313	2012	2384	1337	940
12+	1874	1650	917	590	506	532	677	763
Total	607465	648026	500866	429287	350362	364212	386685	376673
Total+	710383	732930	561252	480533	405588	418692	535313	525481

(+ Also includes: overfish-new otherfleet)

Table 3.34 Fleksibest equivalent to standard prediction input table (3.28)

Year: 2004								
Age	Stock size	Natural	Maturity	Prop.Of F	Prop.Of M	Weight in	Exploit	Weight in
3	131482	0.284	0.000	0	0	0.240	0.030	0.530
4	462781	0.233	0.000	0	0	0.460	0.098	0.970
5	198473	0.200	0.020	0	0	0.890	0.229	1.500
6	154719	0.200	0.180	0	0	1.890	0.489	2.320
7	118648	0.200	0.367	0	0	2.810	0.595	3.200
8	51711	0.200	0.559	0	0	3.980	0.646	4.390
9	21752	0.200	0.776	0	0	5.800	0.688	6.200
10	5248	0.200	0.880	0	0	7.330	0.708	7.780
11	660	0.200	1.000	0	0	9.410	0.718	9.180
12+	230	0.200	1.000	0	0	11.840	0.727	12.120
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2005								
Age	Stock size	Natural	Maturity	Prop.Of F	Prop.Of M	Weight in	Exploit	Weight in
3	604000	0.281	0.000	0	0	0.240	0.031	0.540
4	96083	0.221	0.000	0	0	0.580	0.122	1.020
5	332235	0.200	0.016	0	0	0.900	0.235	1.440
6	127630	0.200	0.093	0	0	1.470	0.386	2.000
7	77394	0.200	0.354	0	0	2.800	0.589	3.200
8	53463	0.200	0.565	0	0	3.990	0.648	4.390
9	22167	0.200	0.735	0	0	5.390	0.680	5.800
10	9048	0.200	0.882	0	0	7.400	0.709	7.870
11	2012	0.200	1.000	0	0	9.790	0.721	9.690
12+	354	0.200	1.000	0	0	11.870	0.727	12.120
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2006								
Age	Stock size	Natural	Maturity	Prop.Of F	Prop.Of M	Weight in	Exploit	Weight in
3	455000	0.274	0.000	0	0	0.240	0.030	0.540
4	442155	0.219	0.000	0	0	0.570	0.119	1.020
5	68231	0.200	0.027	0	0	1.100	0.305	1.550
6	212744	0.200	0.096	0	0	1.510	0.410	1.990
7	70581	0.200	0.229	0	0	2.210	0.520	2.680
8	35077	0.200	0.550	0	0	3.950	0.645	4.360
9	22874	0.200	0.743	0	0	5.410	0.682	5.810
10	9361	0.200	0.849	0	0	6.880	0.704	7.420
11	3470	0.200	1.000	0	0	9.890	0.721	9.800
12+	941	0.200	1.000	0	0	12.010	0.728	12.280
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Table 3.35 Management options table from Fleksibest

Year: 2004					Year: 2005					Year: 2006	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1	0.5592	1427191	474932	560376	0.0000	0.0000	1303340	423946	0	1803492	686872
					0.0452	0.0253		423946	29001	1771162	667736
					0.0903	0.0505		423946	57438	1739459	649013
					0.1354	0.0757		423946	85317	1708371	630698
					0.1804	0.1009		423946	112646	1677891	612784
					0.2259	0.1263		423946	139433	1648010	595265
					0.2715	0.1518		423946	165685	1618721	578136
					0.3172	0.1774		423946	191411	1590013	561391
					0.3636	0.2033		423946	216616	1561879	545023
					0.4099	0.2292		423946	241310	1534312	529027
					0.4567	0.2554		423946	265500	1507301	513397
					0.5038	0.2817		423946	289191	1480839	498128
					0.5510	0.3081		423946	312393	1454919	483213
					0.5987	0.3348		423946	335111	1429531	468647
					0.6466	0.3616		423946	357353	1404669	454424
					0.6949	0.3886		423946	379129	1380322	440538
					0.7436	0.4158		423946	400440	1356487	426986
					0.7926	0.4432		423946	421297	1333153	413761
					0.8417	0.4707		423946	441709	1310310	400856
					0.8915	0.4985		423946	461676	1287955	388269
					0.9413	0.5264		423946	481210	1266079	375992
					0.9918	0.5546		423946	500319	1244671	364019
					1.0424	0.5829		423946	519006	1223729	352348
					1.0935	0.6115		423946	537280	1203240	340971
					1.1450	0.6403		423946	555145	1183202	329885
					1.1967	0.6692		423946	572609	1163605	319083
					1.2489	0.6984		423946	589680	1144440	308560
					1.3015	0.7278		423946	606362	1125704	298313
					1.3544	0.7574		423946	622662	1107387	288337
					1.4079	0.7873		423946	638589	1089480	278623
					1.4619	0.8175		423946	654145	1071981	269171
					1.5161	0.8478		423946	669339	1054881	259974
					1.5706	0.8783		423946	684178	1038170	251026
					1.6257	0.9091		423946	698664	1021846	242326
					1.6813	0.9402		423946	712808	1005899	233865
					1.7373	0.9715		423946	726611	990324	225641

Table 3.36 Results of long-term stochastic simulations using the approach presented in WD3.

Rule						Model	
Run no	F	3-year rule used	F below B_{pa}	percent change increase	percent change decrease	CV stock number	High M age 3, 4 (0.7 and 0.4)
1	0.40	Yes	Linear	10	10	0.25	No
2	0.40	No	Linear	10	10	0.25	No
3	0.40	Yes	Flat	10	10	0.25	No
4	0.40	Yes	Linear	20	20	0.25	No
5	0.40	Yes	Linear	30	30	0.25	No
6	0.40	Yes	Linear	40	40	0.25	No
7	0.40	Yes	Linear	10	10	0.35	No
8	0.40	Yes	Linear	10	10	0.25	Yes
9	0.50	Yes	Linear	10	10	0.25	No
10	0.50	Yes	Linear	10	10	0.25	Yes
11	0.50	Yes	Linear	10	10	0.35	Yes
12	0.50	No	Linear	10	10	0.35	Yes

Results

Run	% of runs	Realised F	Catch	SSB	TSB	Recruits	%annual change	% Years	% Years	% Years where various parts of HCR decide TAC			
										SSB above B_{pa}			SSB below B_{pa}
no	$SSB<B_{lim}$ in any year		1000 tonnes	1000 tonnes	1000 tonnes	million age 3	in TAC (abs. value)	$SSB<B_{lim}$	$SSB<B_{pa}$	3-year rule	%increase	%decrease	
1	0.0	0.406	885	1018	3452	674	7.7	0.00	0.1	46.2	28.8	24.8	0.2
2	0.0	0.408	886	1039	3485	674	10.0	0.00	0.9	35.1	34.7	29.0	1.2
3	0.0	0.406	885	1019	3452	673	7.6	0.00	0.1	46.1	28.9	24.8	0.2
4	0.0	0.407	884	1006	3433	674	11.0	0.00	0.0	78.9	13.3	7.8	0.0
5	0.0	0.409	883	999	3421	673	12.6	0.00	0.0	92.2	6.1	1.6	0.0
6	0.0	0.410	884	996	3419	675	13.2	0.00	0.0	97.3	2.5	0.2	0.0
7	0.0	0.418	891	1046	3497	678	8.8	0.00	0.3	36.4	33.3	29.5	0.8
8	0.1	0.402	497	581	2104	714	15.2	0.00	13.2	45.5	15.1	22.1	17.3
9	0.8	0.518	832	722	2899	634	10.6	0.01	3.6	44.3	24.5	25.7	5.5
10	1.1	0.454	478	482	1915	689	35.0	0.01	44.6	35.3	4.4	13.7	46.6
11	5.2	0.465	482	501	1950	693	60.1	0.07	39.4	35.1	7.6	14.1	43.1
12	16.4	0.485	481	486	1925	688	116.2	0.22	44.4	34.9	6.3	11.4	47.3

Table 3.37. Stochastic forecast results for JRNC-3 HCR with 10% limit in TAC for changes of catches

	SSB					Fbar(5-10)			
	2003	2004	2005	2006		2003	2004	2005	2006
p (ssb<B_{lim})	0	0	0	0	p (F>F_{lim})	0	0	0	0
p(SSB<B_{pa})	0	0	0	0	p(F>F_{pa})	0.93	0.97	0.81	0.89
Percentiles:					Percentiles:				
1	524806	699800	723529	788324	1	0.377615	0.387509	0.354592	0.348967
5	558152	719313	758747	833879	5	0.397697	0.403623	0.376494	0.375034
10	569367	728740	790927	858681	10	0.406858	0.411887	0.387138	0.397131
25	598691	791271	862529	941761	25	0.419821	0.433173	0.403517	0.41927
50	642113	858764	949734	1021128	50	0.445973	0.4492	0.41935	0.440019
75	688859	948691	1033522	1109834	75	0.461148	0.467611	0.43992	0.457196
90	732374	1015357	1124758	1189725	90	0.467846	0.484372	0.460431	0.479001
100	828140	1099489	1191475	1453668	100	0.619125	0.582835	0.486395	0.487616
Average	645009	868826	949166	1031445	Average	0.441736	0.449223	0.420816	0.436345
Percentiles:	Catch (TAC)				Percentiles:	R(3)			
1	362001	468057	480316	521526	1	308467	284921	218016	333480
5	441738	477105	506986	534460	5	347790	316059	264069	434523
10	448554	491858	519286	546012	10	390226	406760	306138	463912
25	481634	513088	544191	578617	25	423965	481202	363120	528738
50	509152	547766	584759	613408	50	501429	591764	455496	663849
75	540787	576836	611824	650845	75	577865	718487	567089	827311
90	561407	607939	644866	691780	90	637466	898286	679350	939736
100	615416	651694	676323	743956	100	855373	1680435	965657	1385428
Average	506476	547113	580536	616482	Average	506132	614781	476904	695628

	SSB					F(5-10)			
	2003	2004	2005	2006		2003	2004	2005	2006
p (ssb<B_{lim})	0	0	0	0	p (F>F_{lim})	0	0	0	0
p(SSB<B_{pa})	0	0	0	0	p(F>F_{pa})	0.93	0.95	0.52	0.89
Percentiles:					Percentiles:				
1	532914.4	718800.7	782086.8	828321.4		0.381416	0.38435	0.369172	0.381053
5	542879.6	730391.9	806131.7	867698.1		0.394268	0.401045	0.373939	0.394492
10	574591.4	754008.9	819159.2	891653.2		0.405752	0.4117	0.382895	0.397748
25	606615.8	805213.1	875506.3	943409.4		0.42641	0.424538	0.394286	0.407428
50	650785.5	880296.9	970173.4	1036249		0.441971	0.436431	0.401526	0.422676
75	694808.2	949809.2	1038215	1103438		0.452993	0.447846	0.412606	0.439563
90	747045.3	1017886	1134278	1217698		0.465512	0.456403	0.422826	0.451072
100	916716.5	1205205	1326032	1453046		0.595895	0.545331	0.459462	0.484047
Average	656453.7	884970	970641.7	1042203	Average	0.440893	0.43752	0.403772	0.423769
Percentiles:	C(TAC)				Percentiles:	R(3)			
1	426231.3	457478.1	480998.4	486534.1	1	272859.6	149220.3	201149.2	227700.2
5	444480.1	469504.9	484494.4	504880.2	5	355338.3	173293.2	376832.4	281664
10	461566.1	481302.6	493229.1	513221.4	10	376509	183658	439690.8	322731.5
25	482432	503275.7	518312.6	533741.7	25	426794.4	229985.6	520879.1	379771.3
50	511529.7	534452.1	556383.1	577126.2	50	503322.2	278097.6	614474.1	442912.1
75	538336.5	570898.5	590794.3	608164.5	75	579696.9	332694.7	703393.2	556246.1
90	576896.6	606326.3	633570.5	661426.3	90	666396.1	375681.9	859947.7	687931.8
100	723870.4	748755.4	754824.6	763737.2	100	813136.1	977326.8	1402528	974924.9
Average	514573.8	542336.1	561146.7	578992.4	Average	508456.6	290911.2	628131.4	479555.6

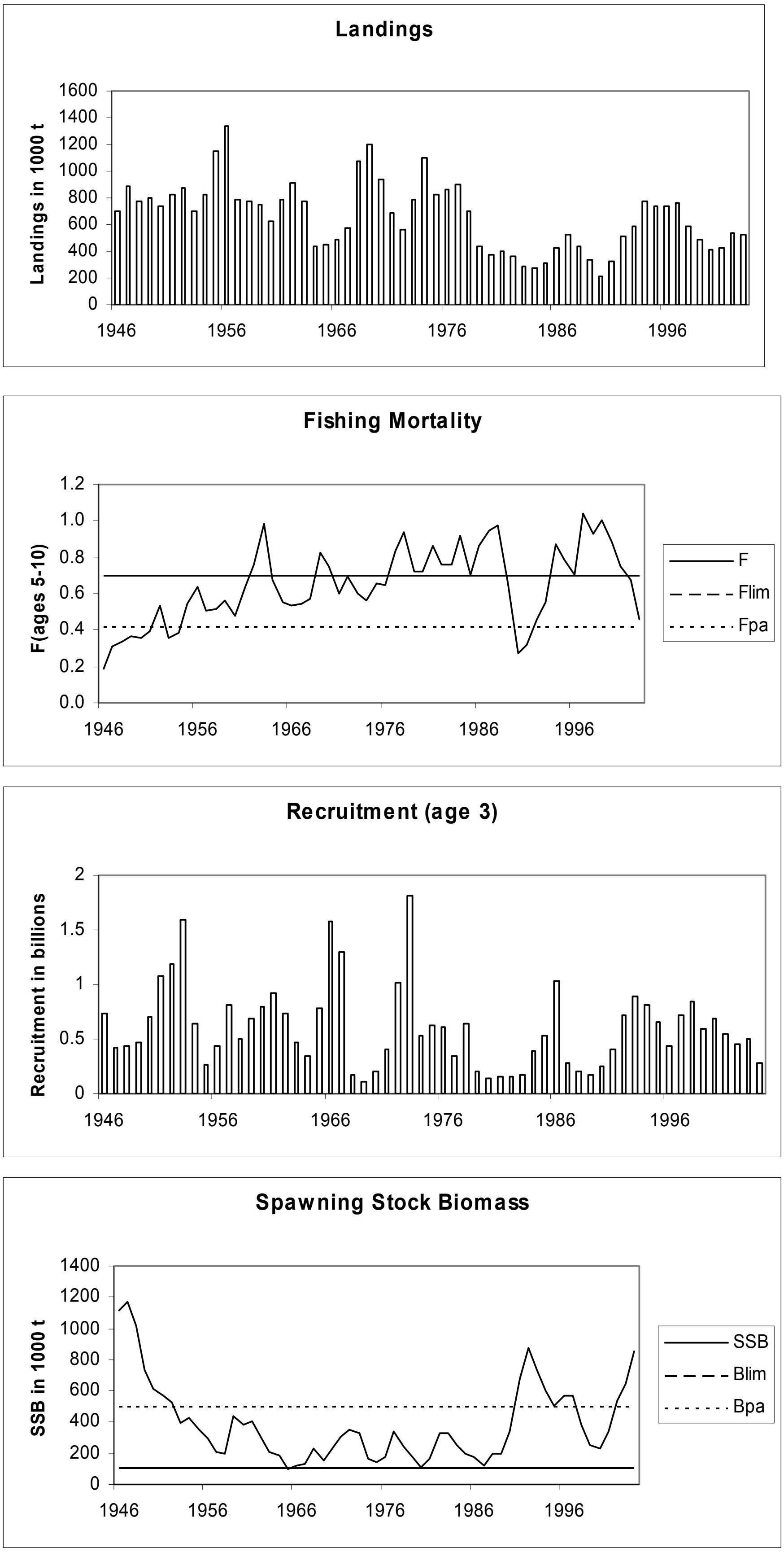
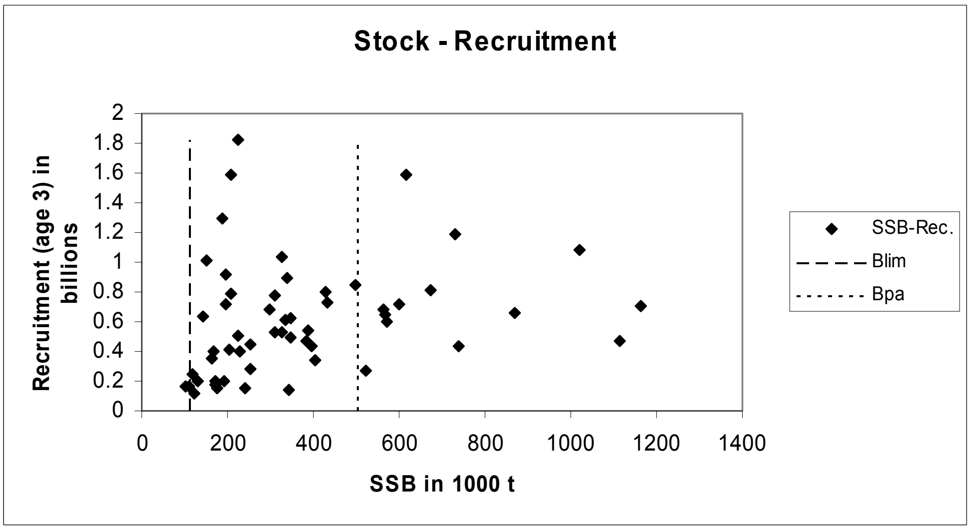
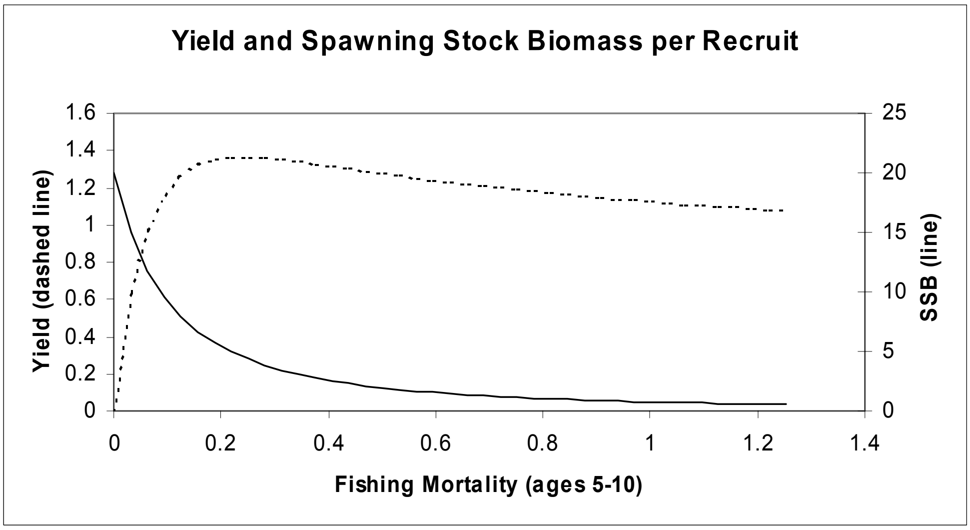


Figure 3.1. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)





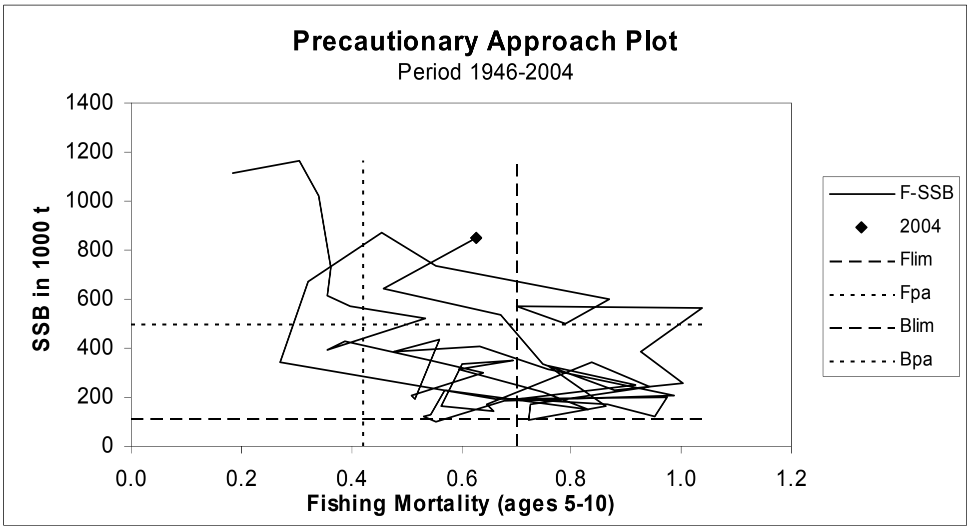


Figure 3.1. Continued. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)

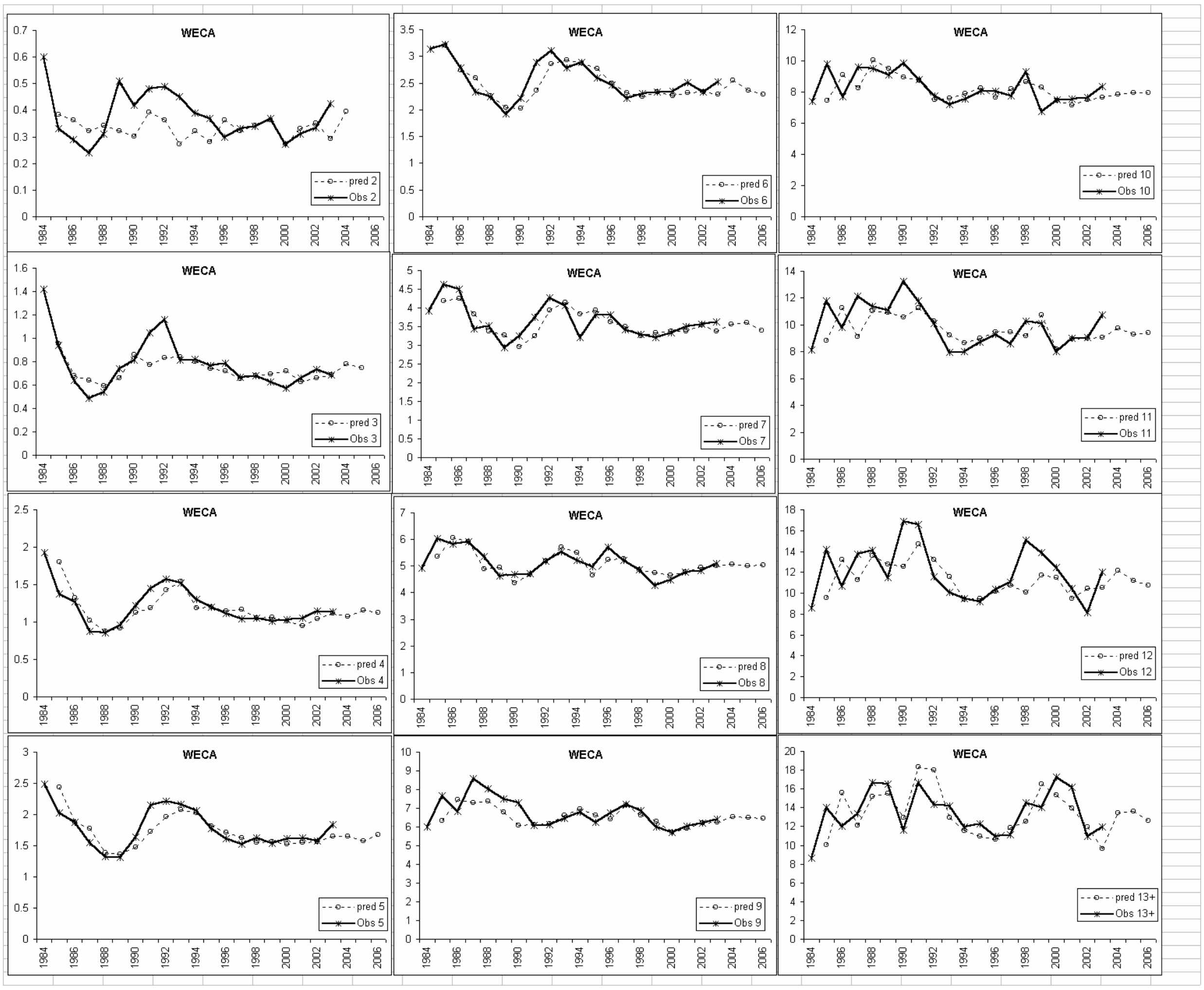


Figure 3.2a . North-east arctic cod. Weight in catch predictions.

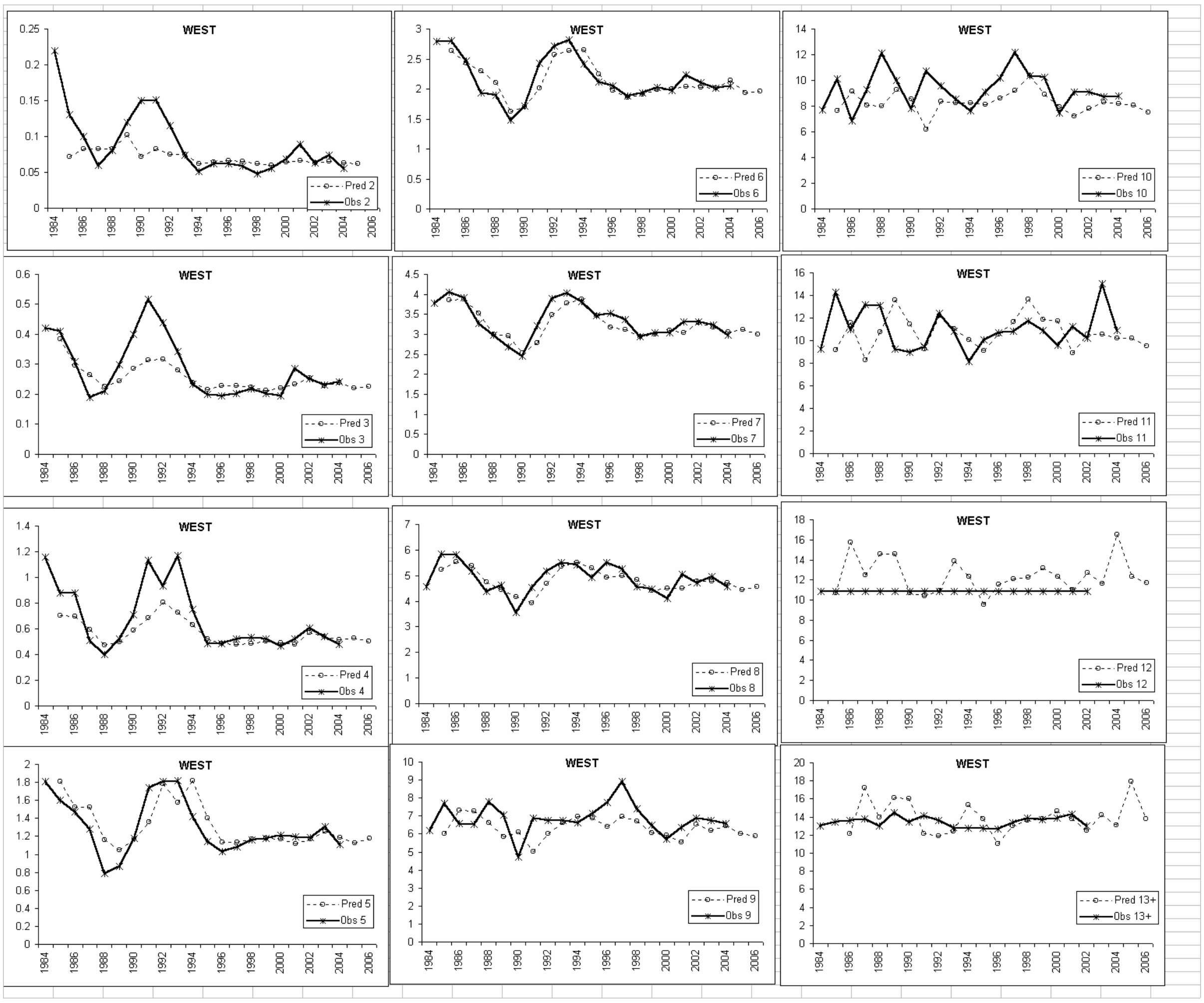
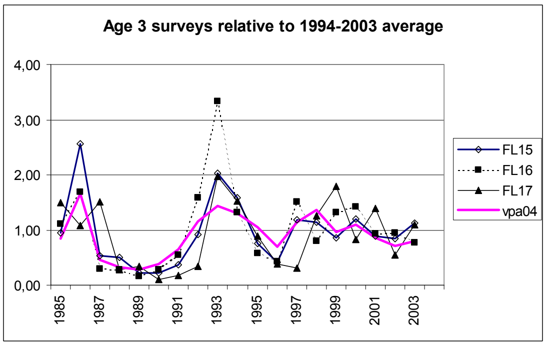
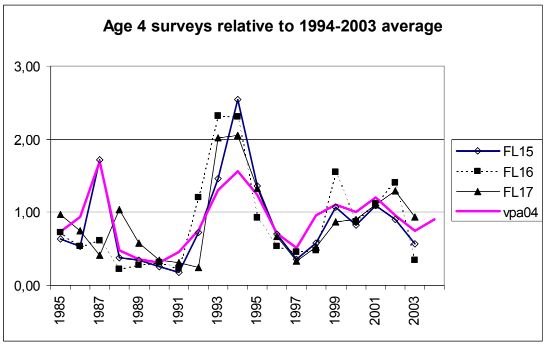
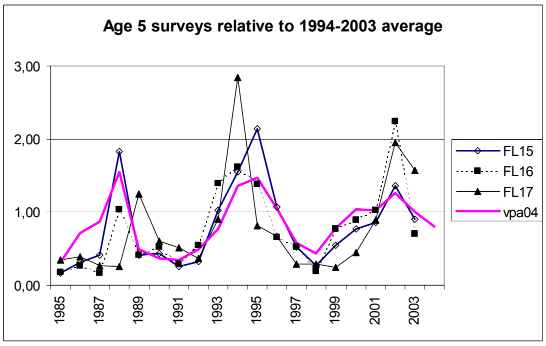
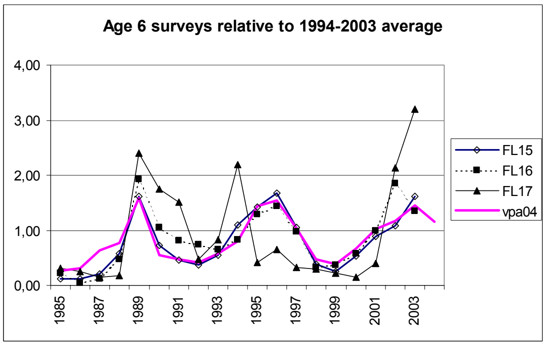


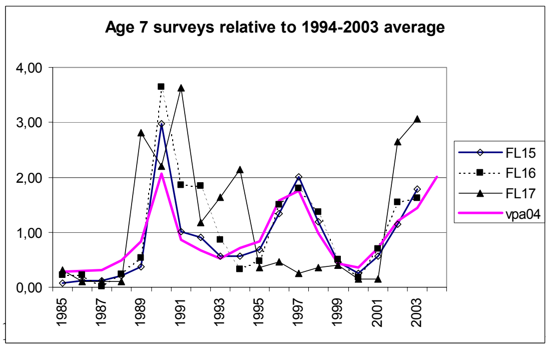
Figure 3.2b . North-east arctic cod. Weight in stock predictions.

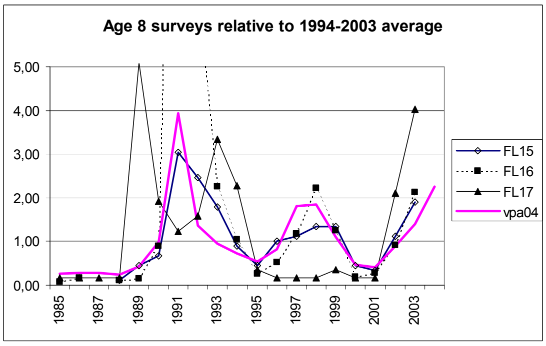

Age 3 surveys relative to 1994-2003 average
FL15
FL16
FL17
vpa04

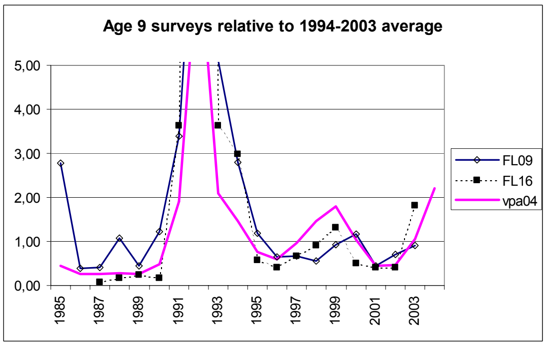

Age 4 surveys relative to 1994-2003 average
FL15
FL16
FL17
vpa04

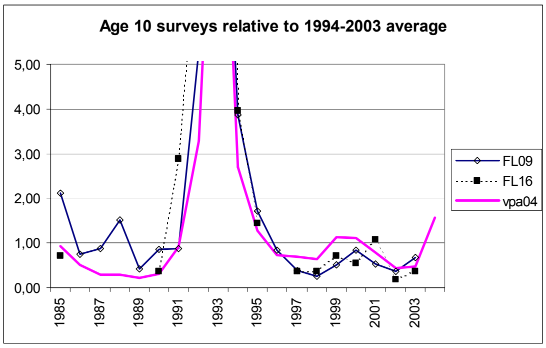

Age 5 surveys relative to 1994-2003 average
FL15
FL16
FL17
vpa04

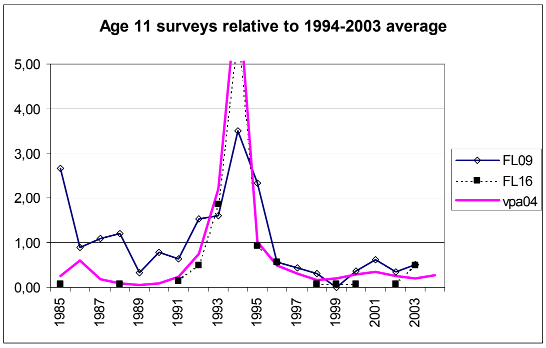

Age 6 surveys relative to 1994-2003 average
FL15
FL16
FL17
vpa04

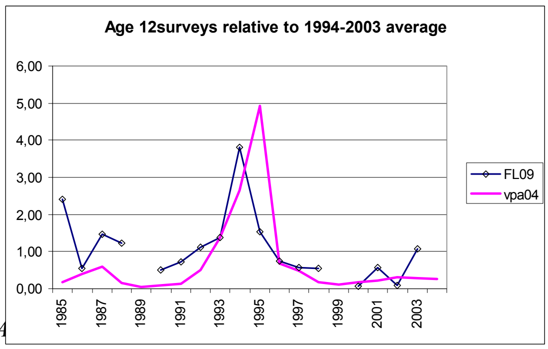

Age 7 surveys relative to 1994-2003 average
FL15
FL16
FL17
vpa04


Age 8 surveys relative to 1994-2003 average
FL15
FL16
FL17
vpa04


Age 9 surveys relative to 1994-2003 average
FL09
FL16
vpa04


Age 10 surveys relative to 1994-2003 average
FL09
FL16
vpa04


Age 11 surveys relative to 1994-2003 average
FL09
FL16
vpa04


Age 12surveys relative to 1994-2003 average
FL09
vpa04

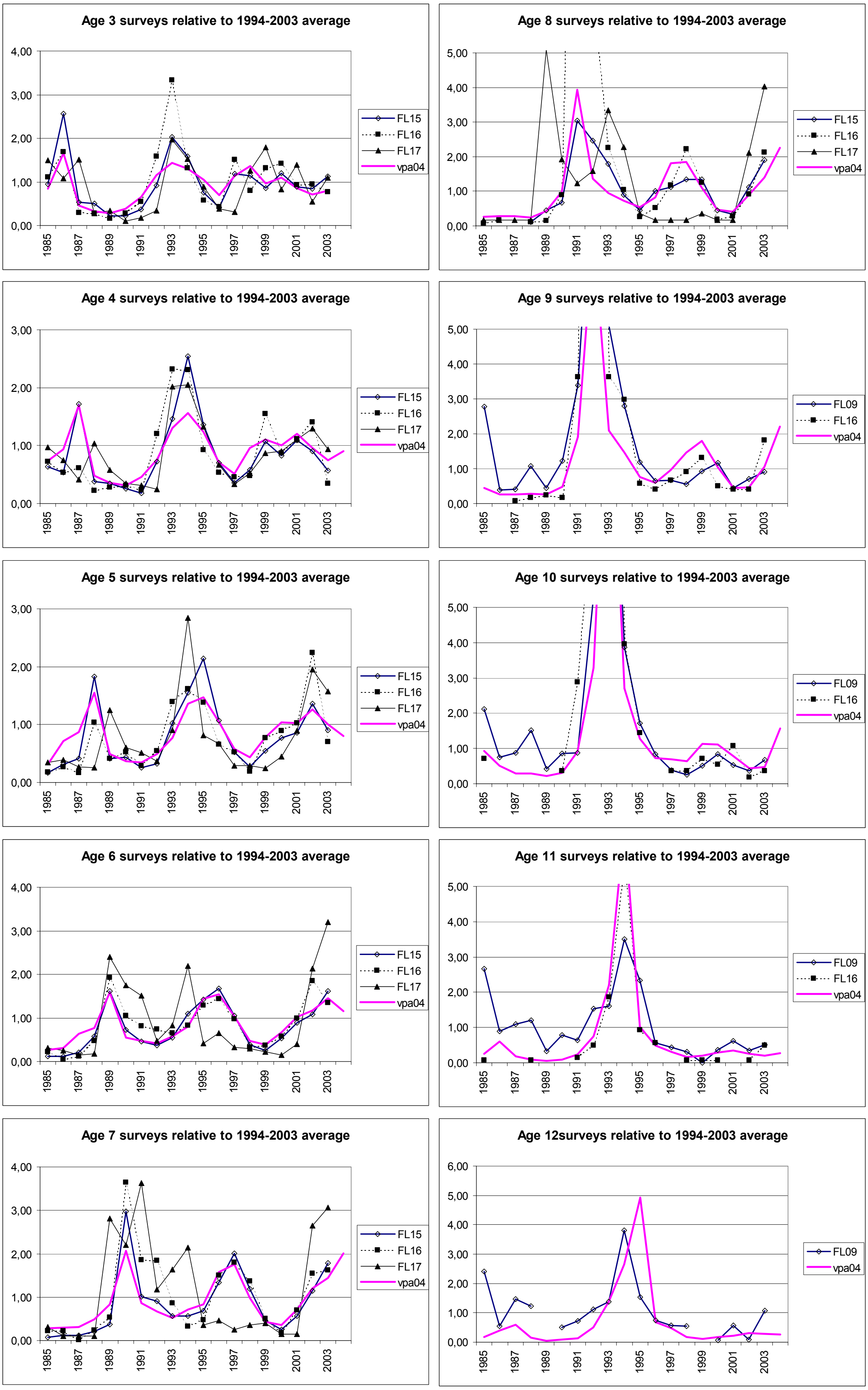


Figure 3.3a. Tuning indices by ages, plotted relative to 1994-2003 average values. Years and ages as specified in the tuning input.

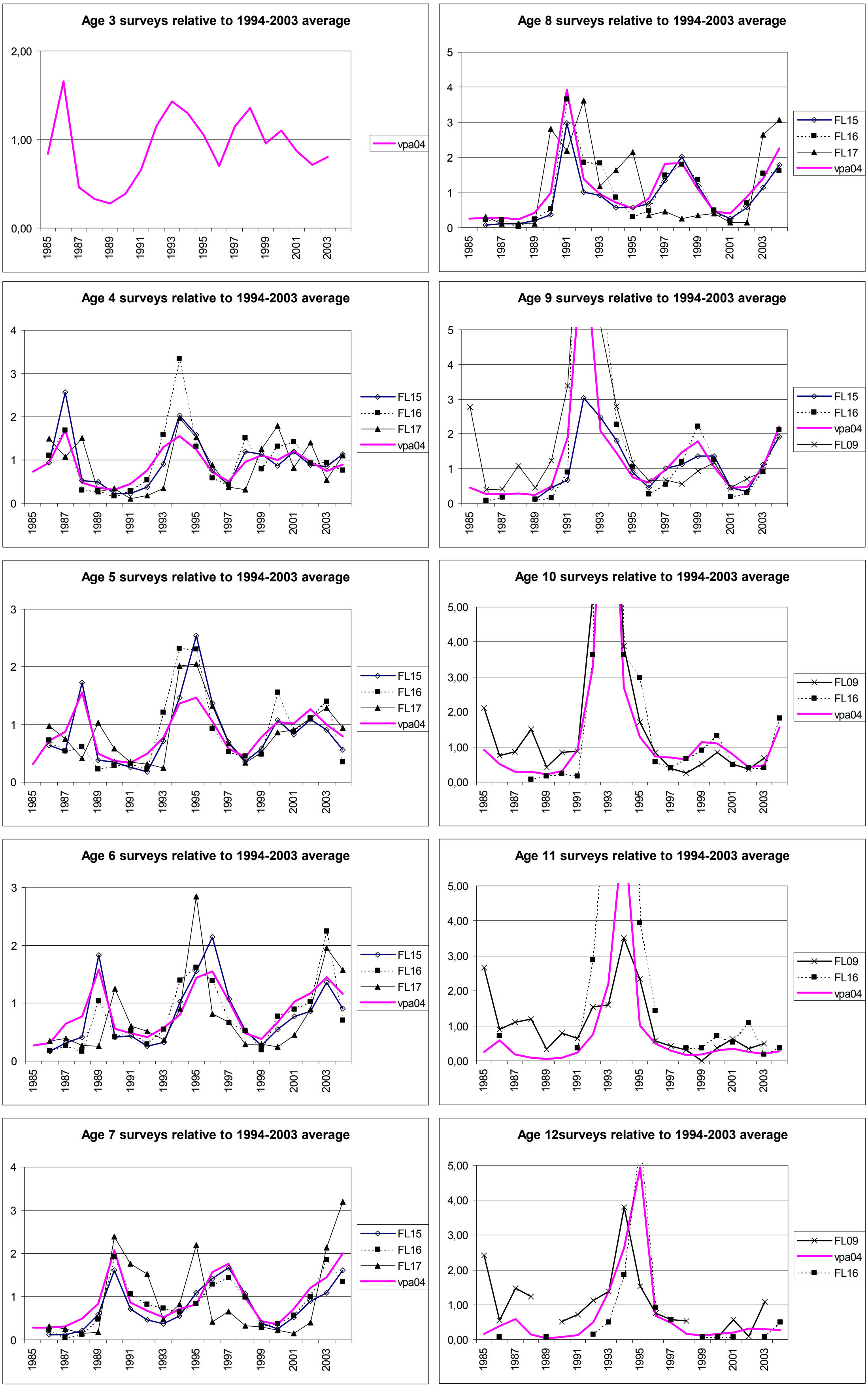
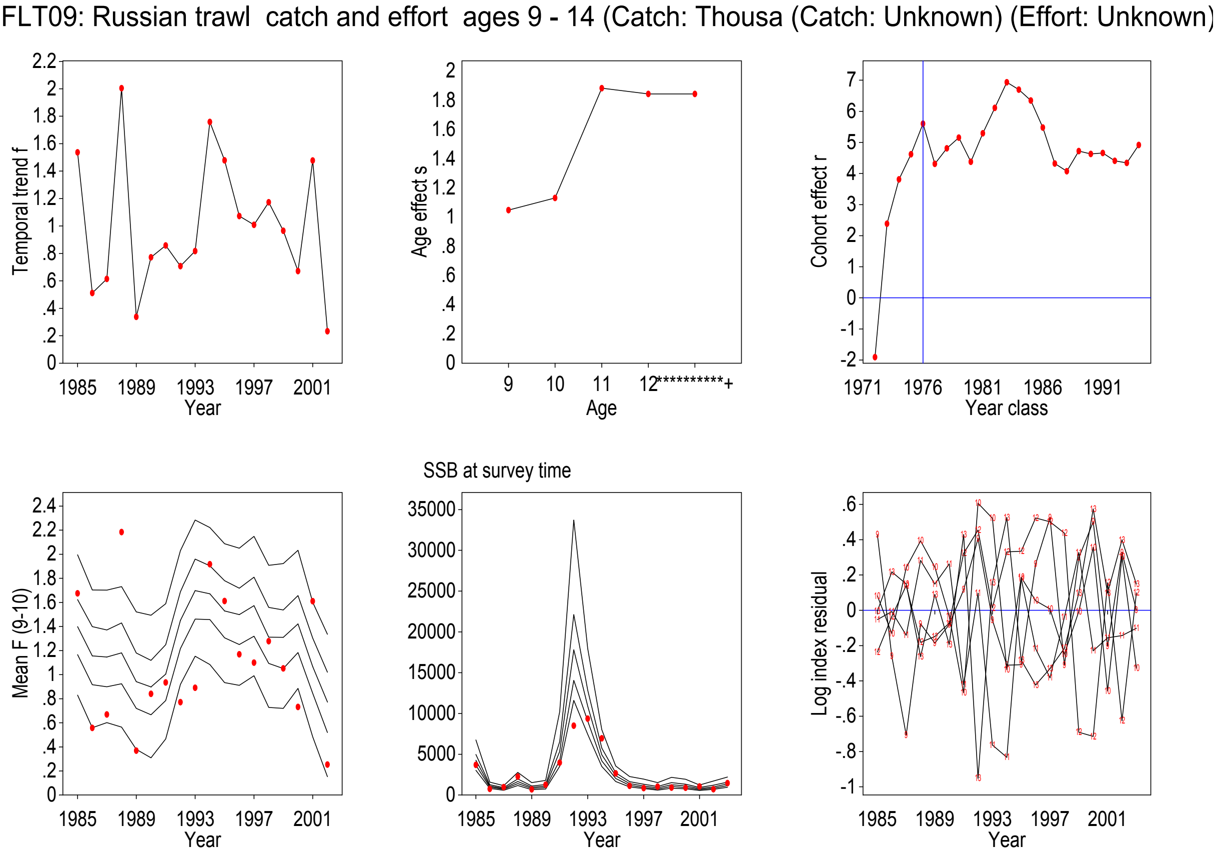


Figure 3.3b. Tuning indices by ages, plotted relative to 1994-2003 average values. Years and ages for fleets 15, 16 and 17 shifted to reflect that the surveys take place close to the beginning of the year.



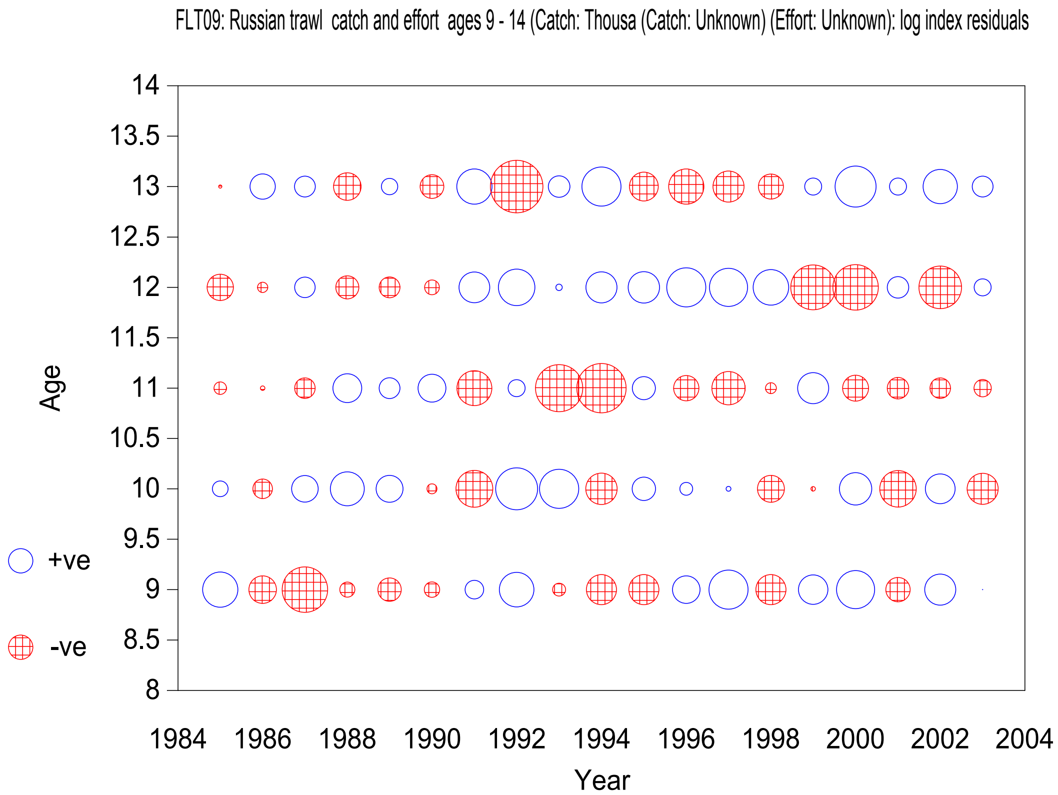
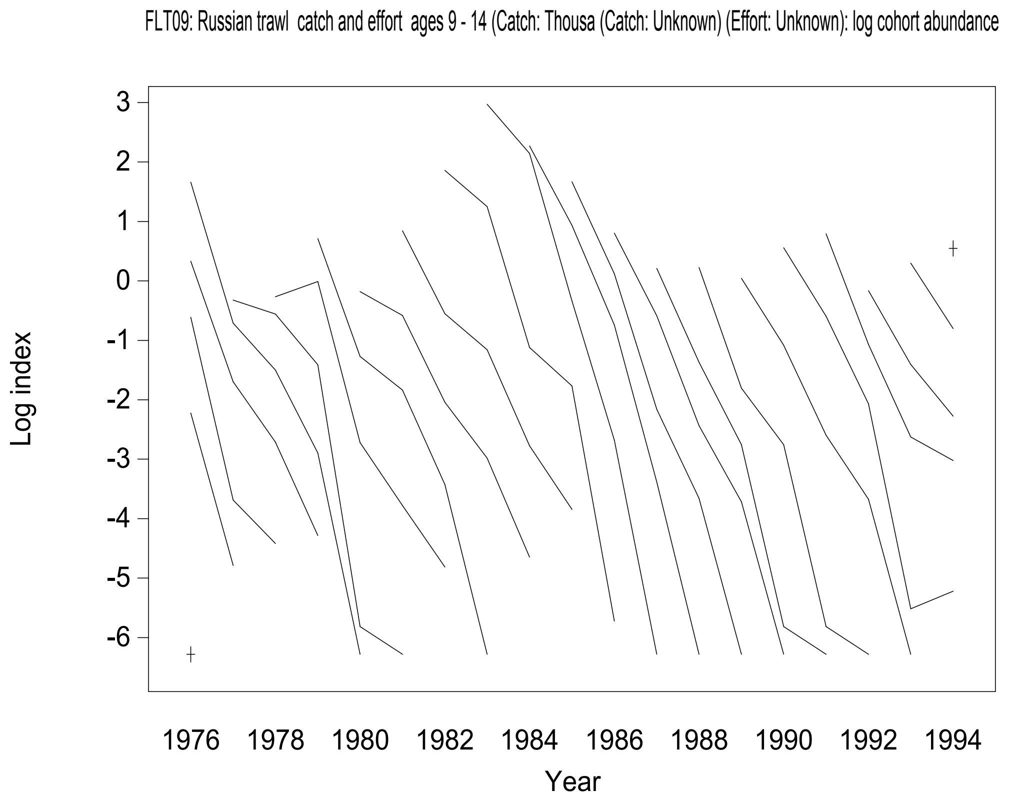


Figure 3.4. Standard SURBA plots for fleet 09



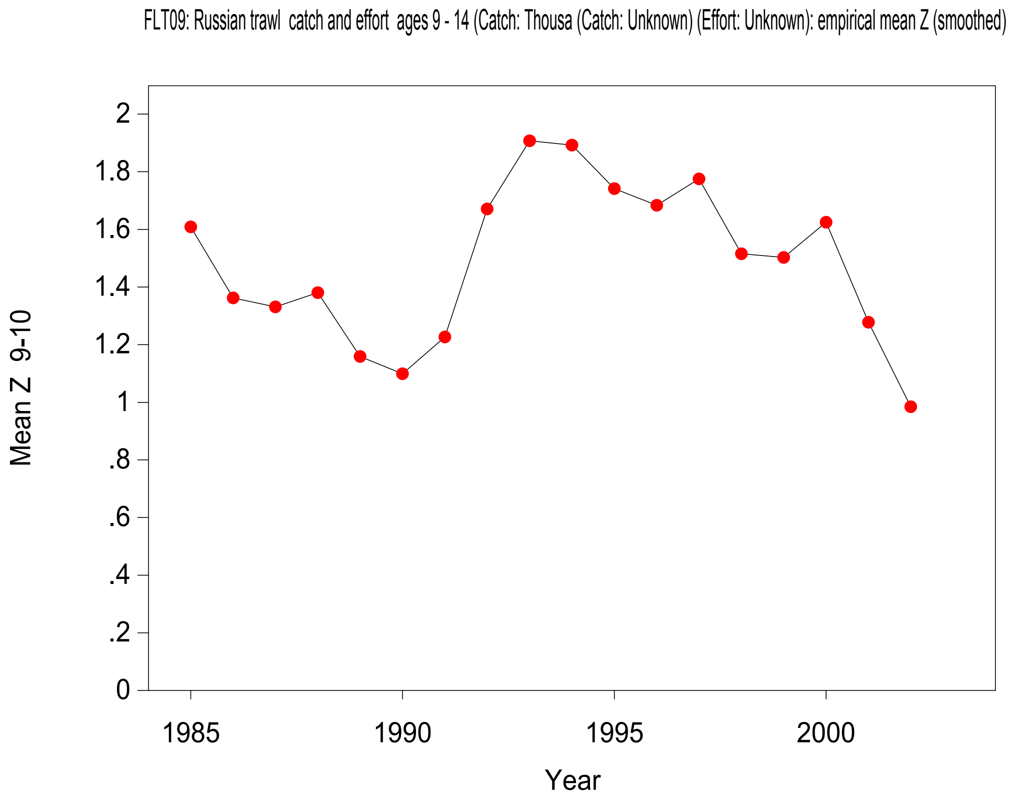


Figure 3.4 (continued). Standard SURBA plots for fleet 09.

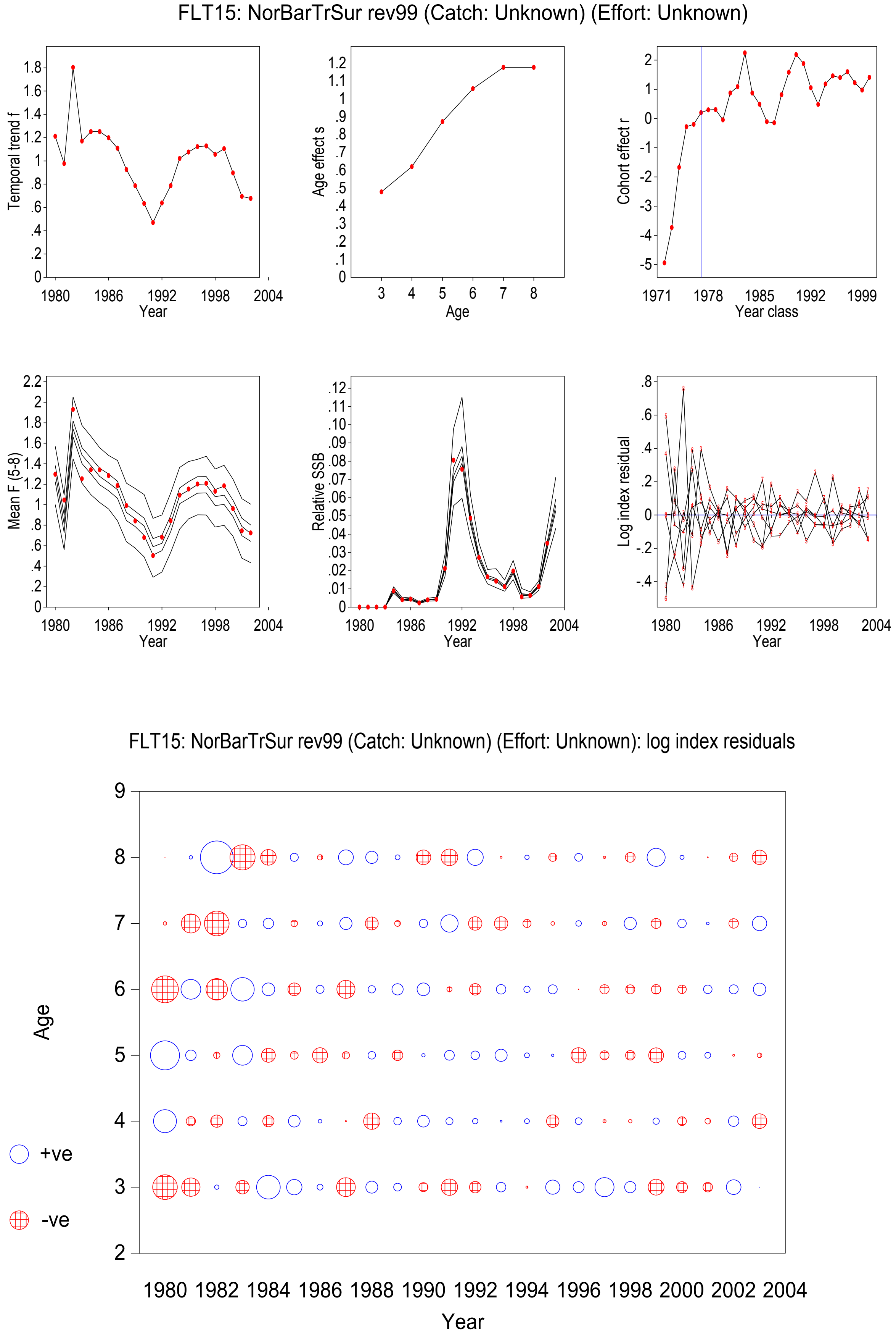


Figure 3.5. Standard SURBA plots for fleet 15.

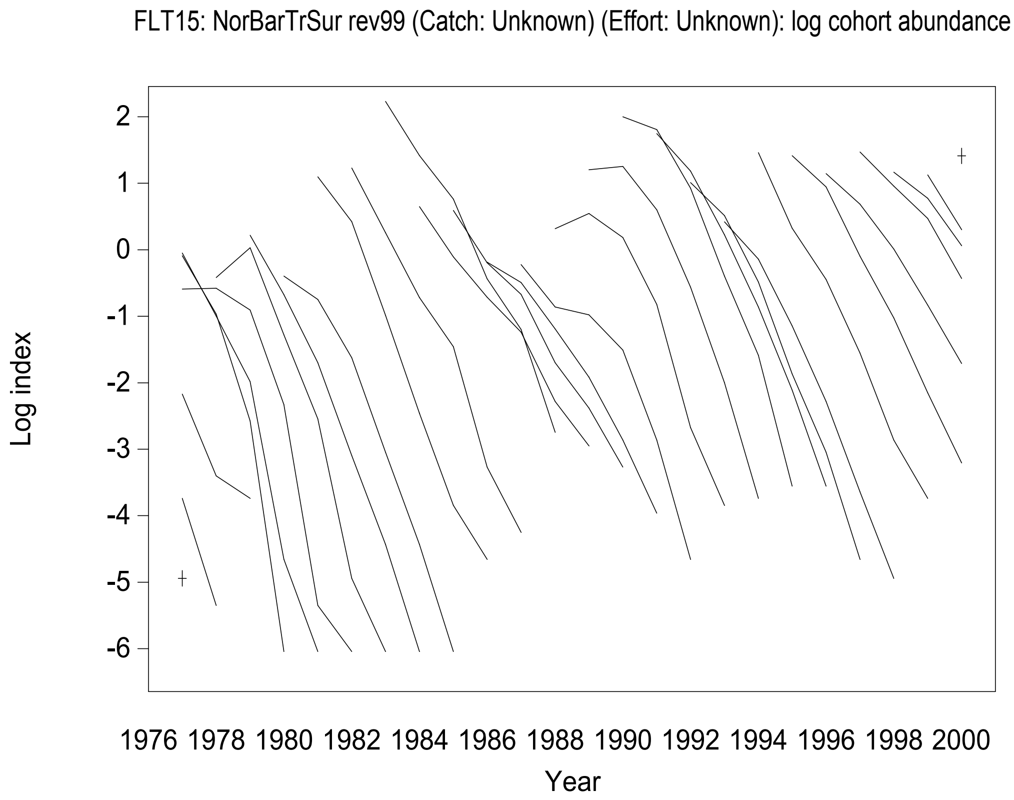


Figure 3.5 (continued). Standard SURBA plots for fleet 15.

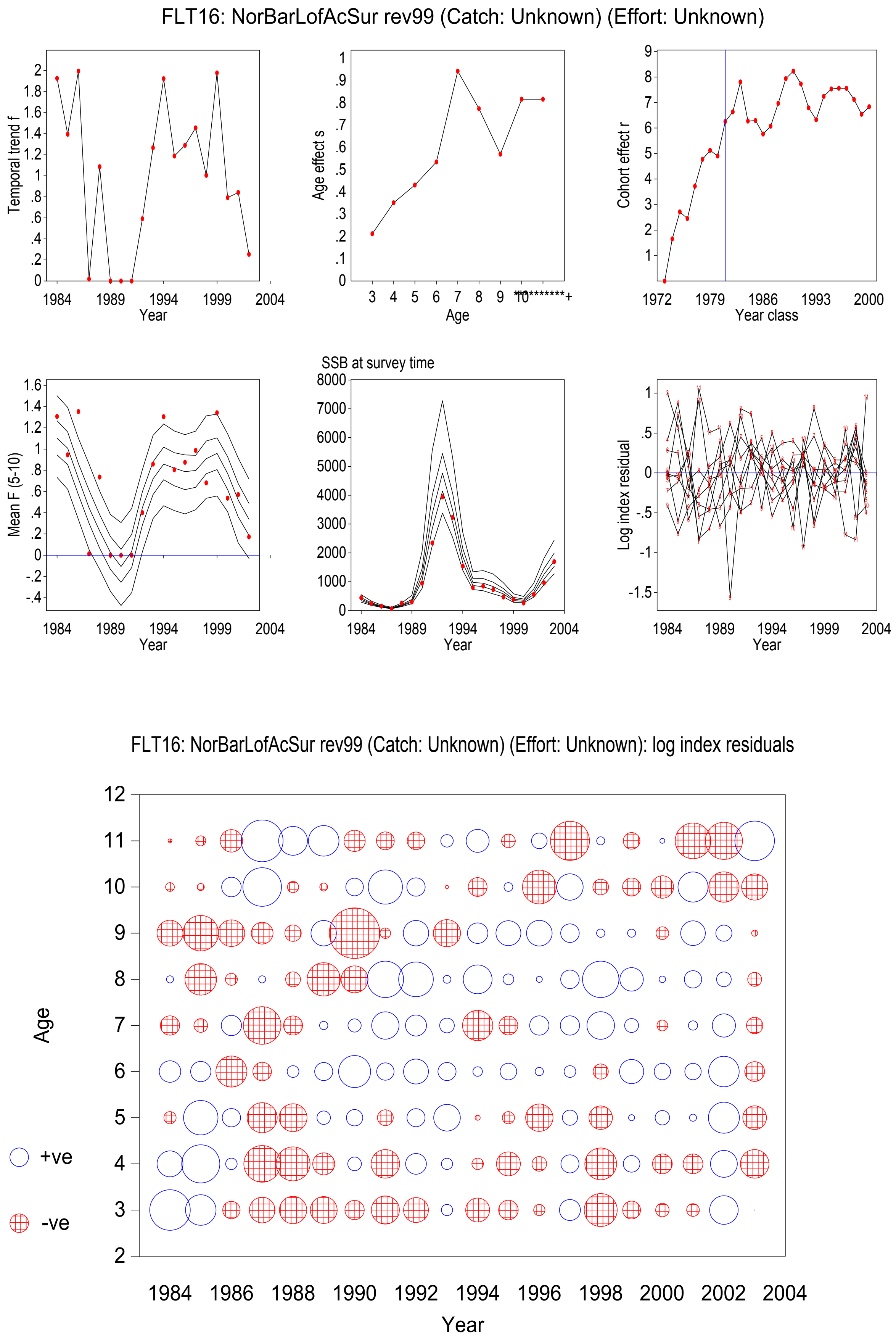
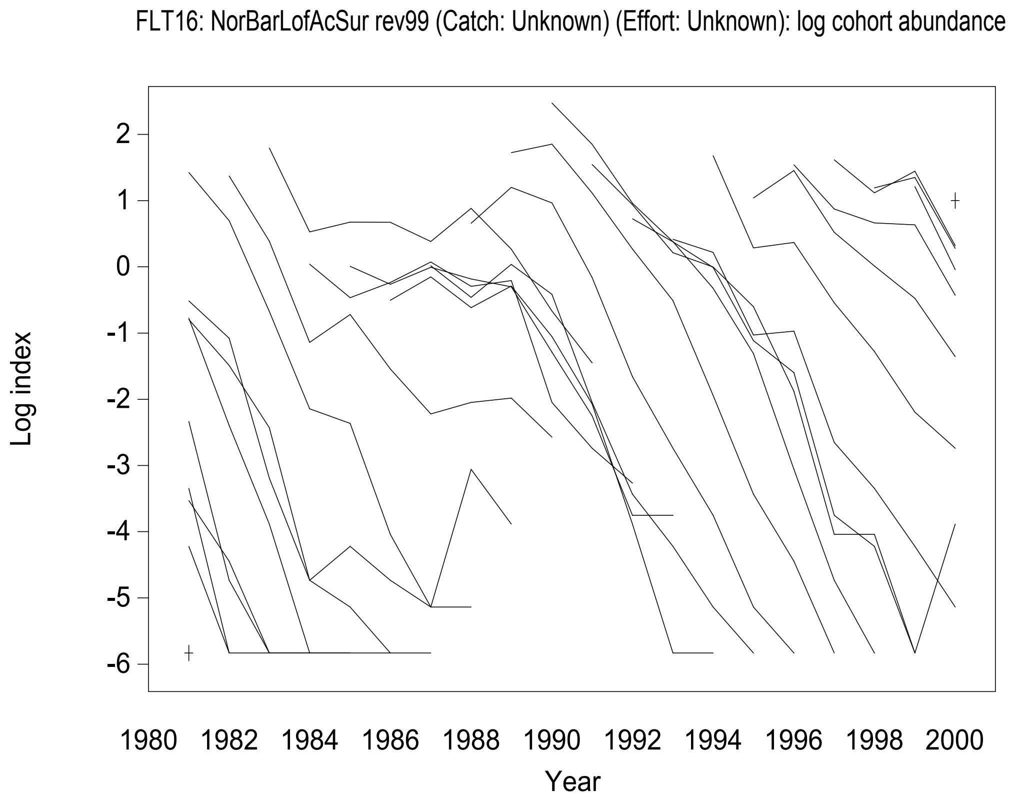


Figure 3.6. Standard SURBA plots for fleet 16.



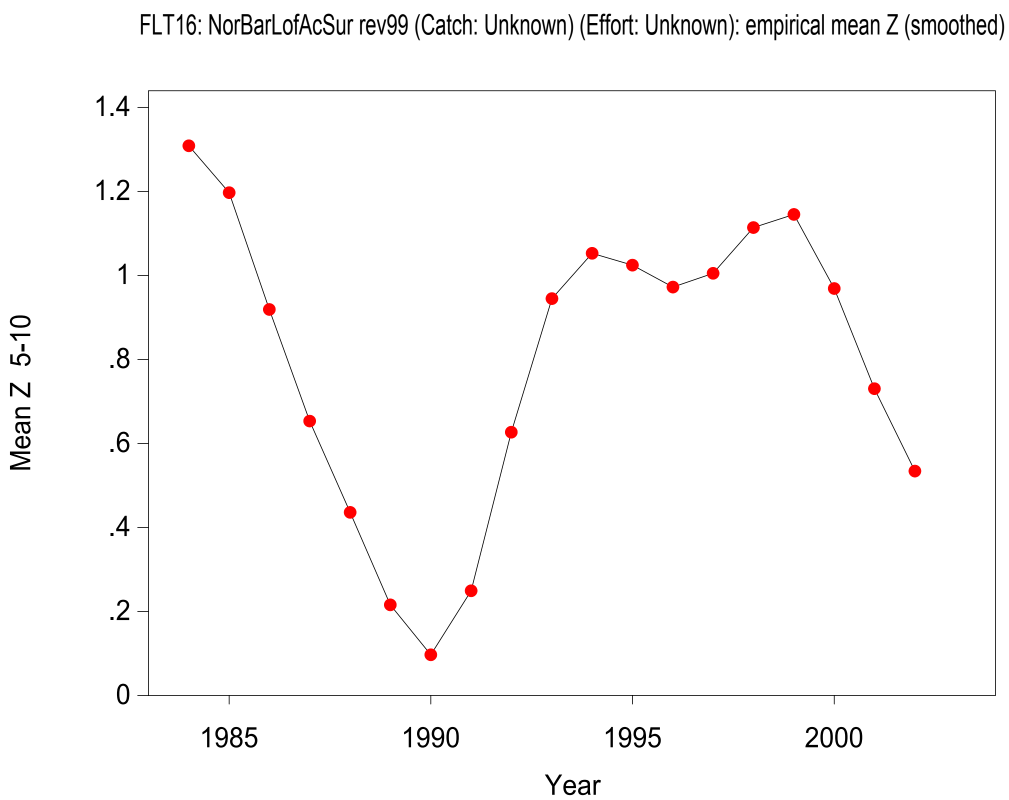
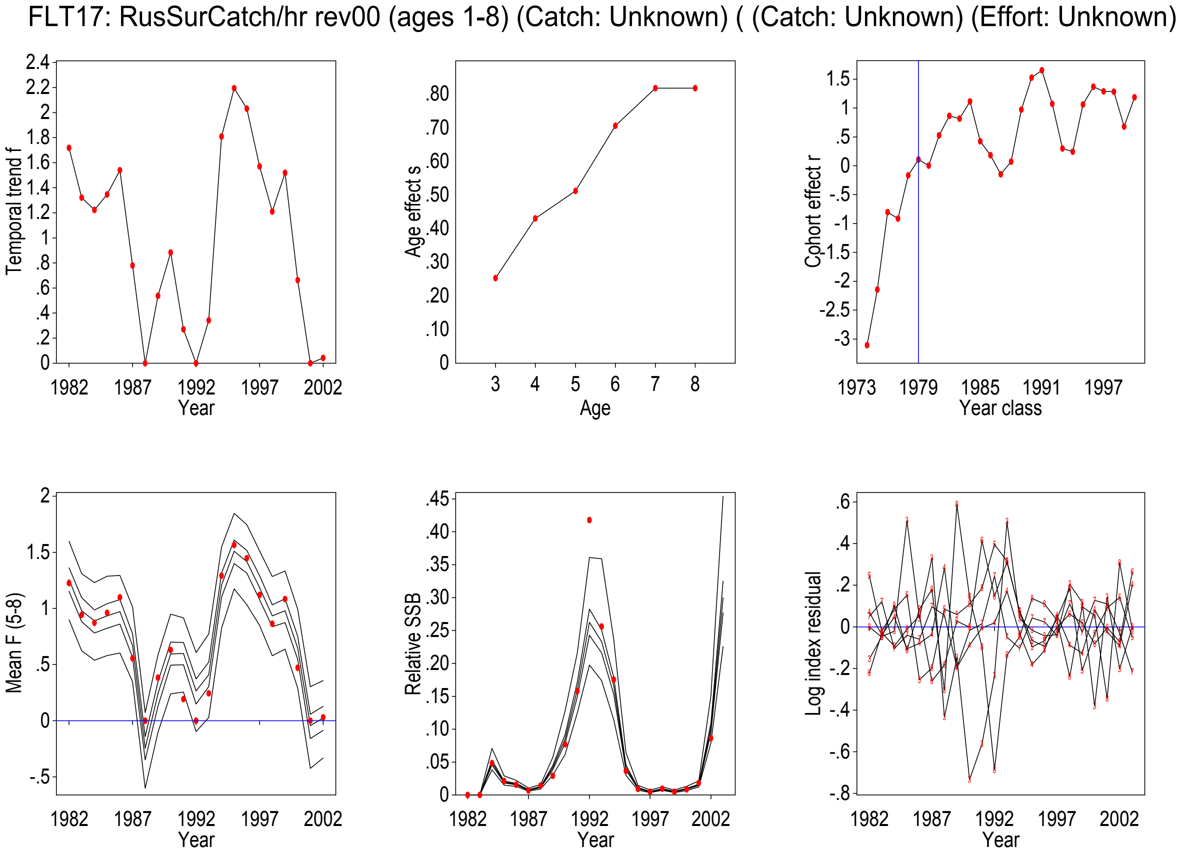


Figure 3.6 (continued). Standard SURBA plots for fleet 16.



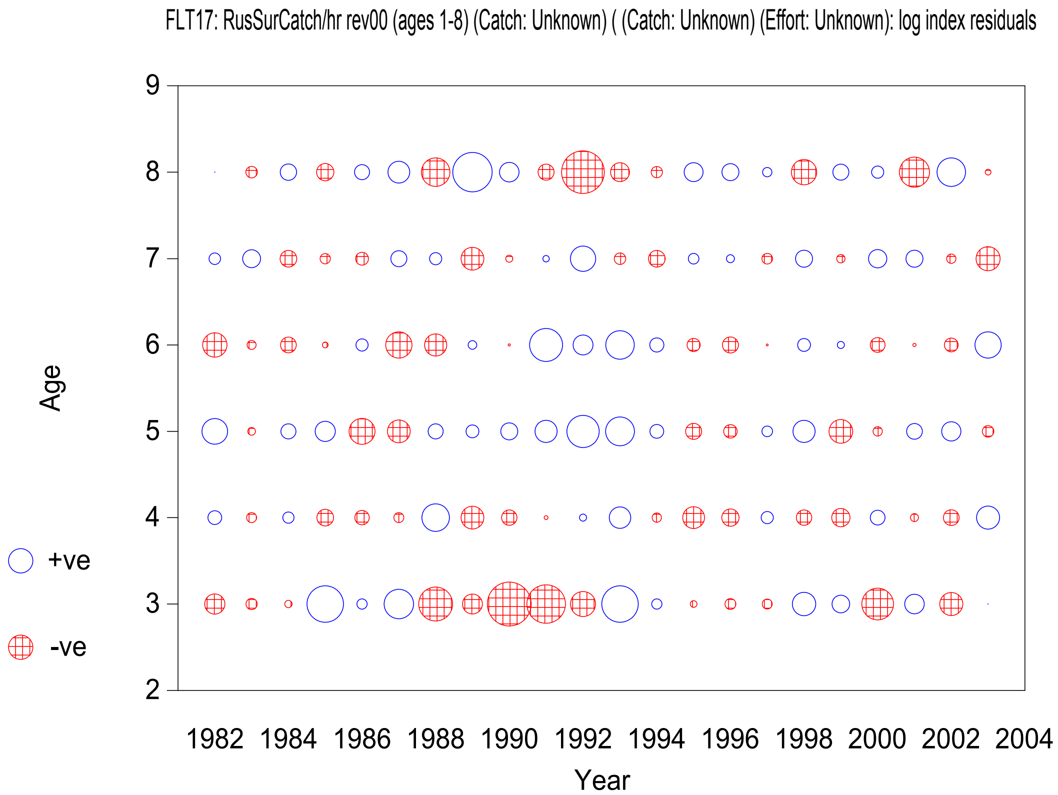


Figure 3.7. Standard SURBA plots for fleet 17.

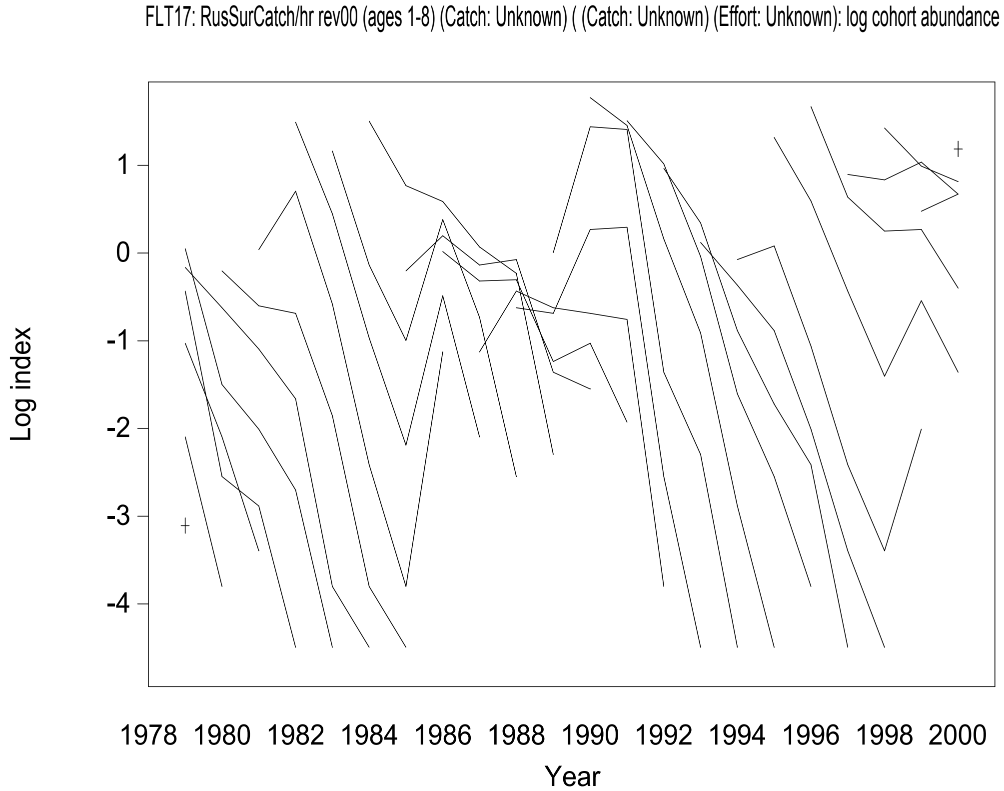


Figure 3.7 (continued). Standard SURBA plots for fleet 17.

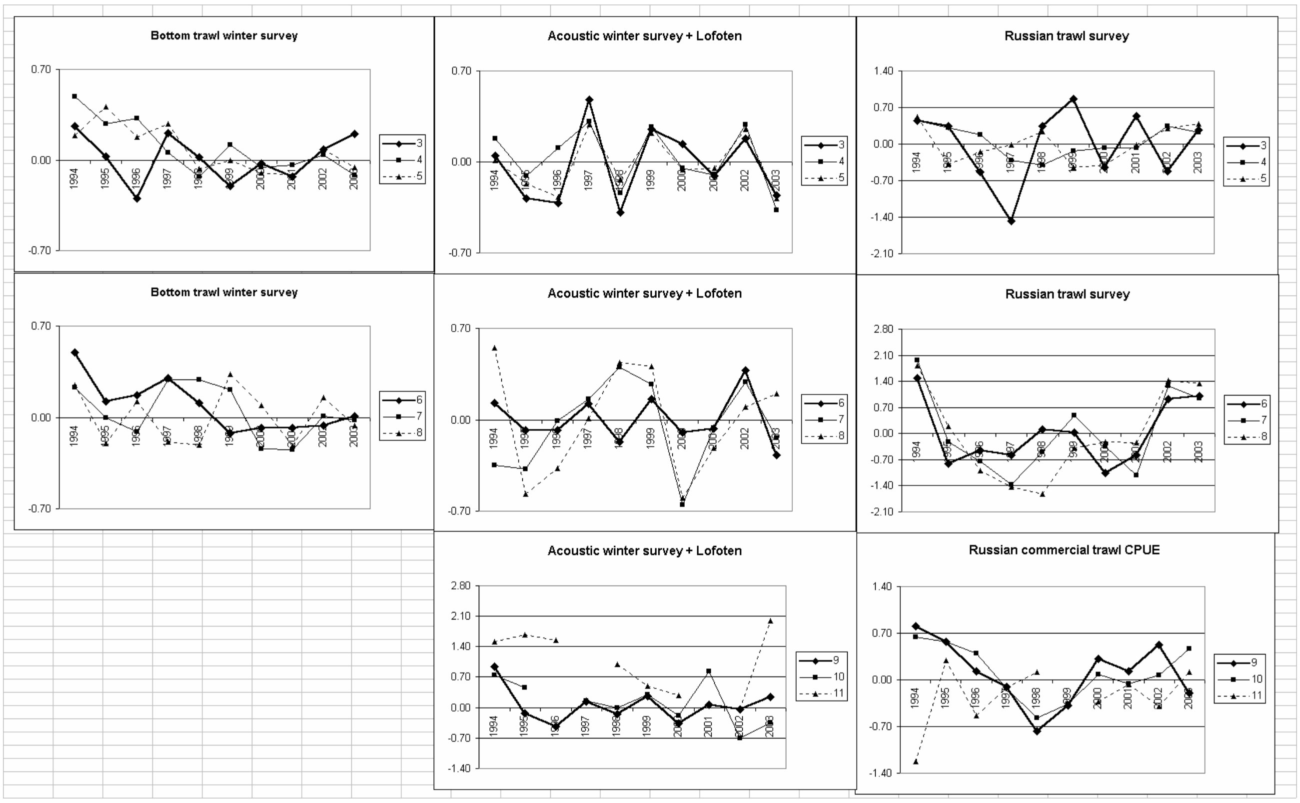


Figure 3.8. North-east arctic cod. Residual log catchability by fleet and age from the XSA output in the 2004 assessment.

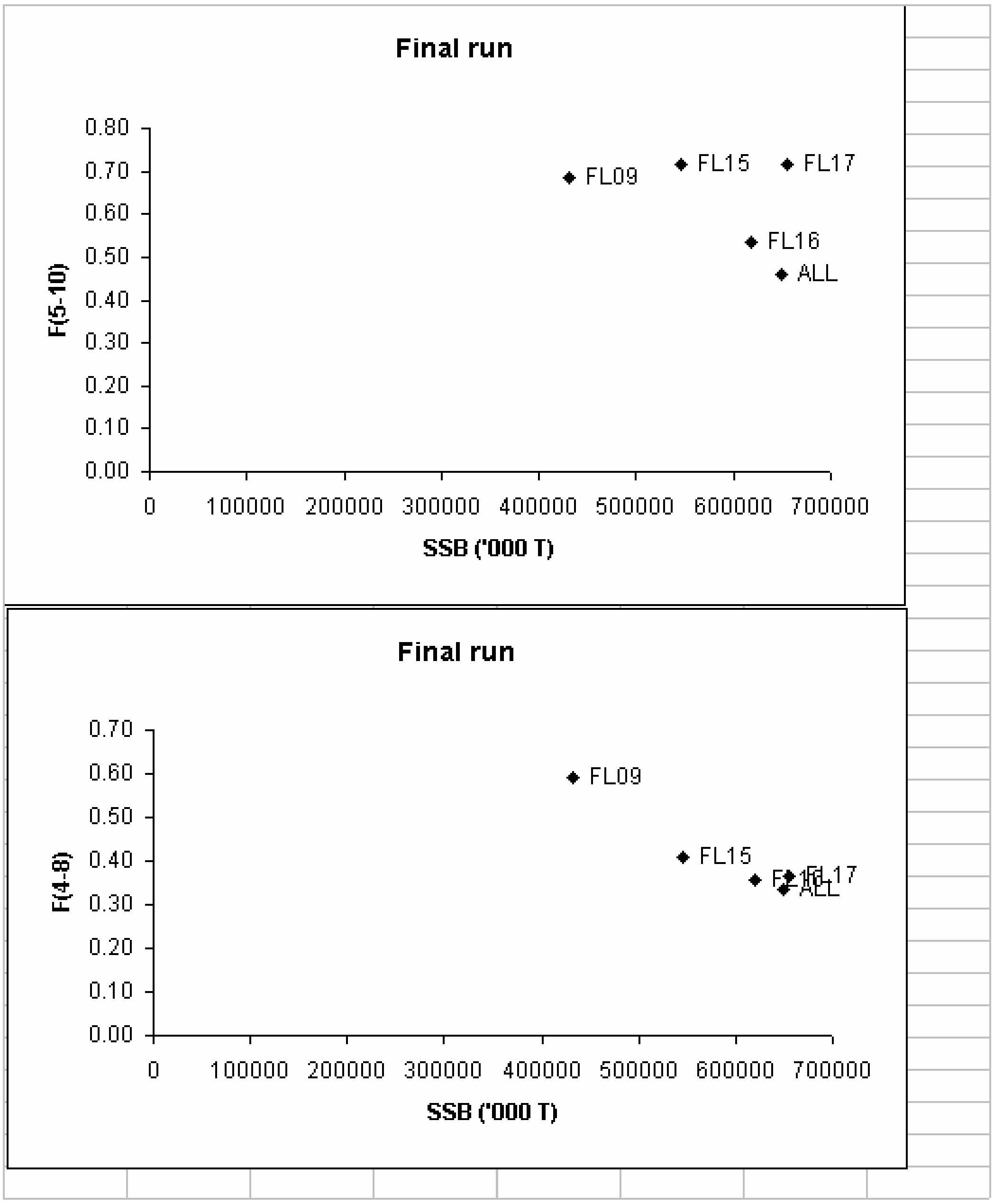


Figure 3.9. Single fleet tuning results, used as the final run.

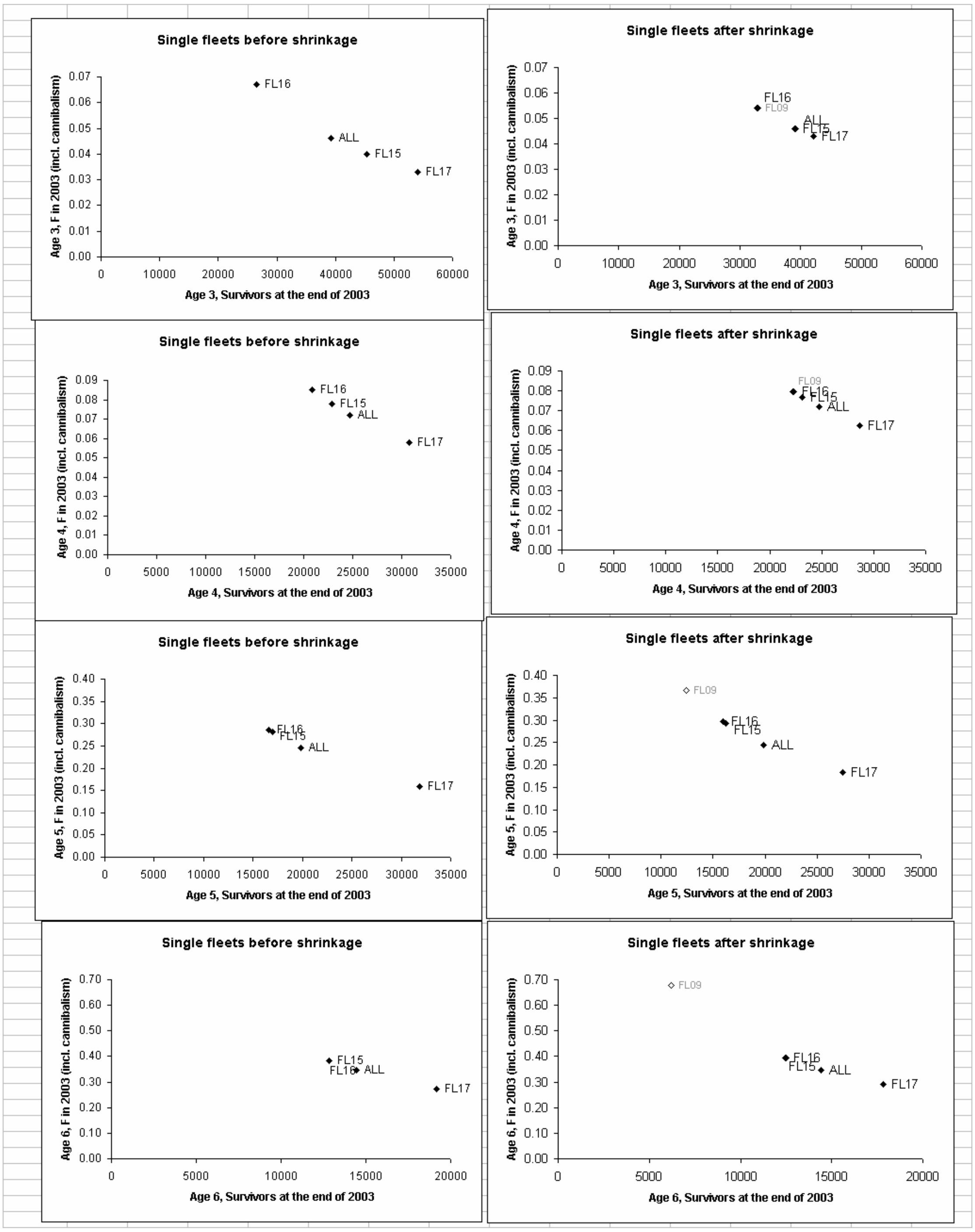


Figure 3.10. Tuning results by fleets and ages 3-6 before and after shrinkage.

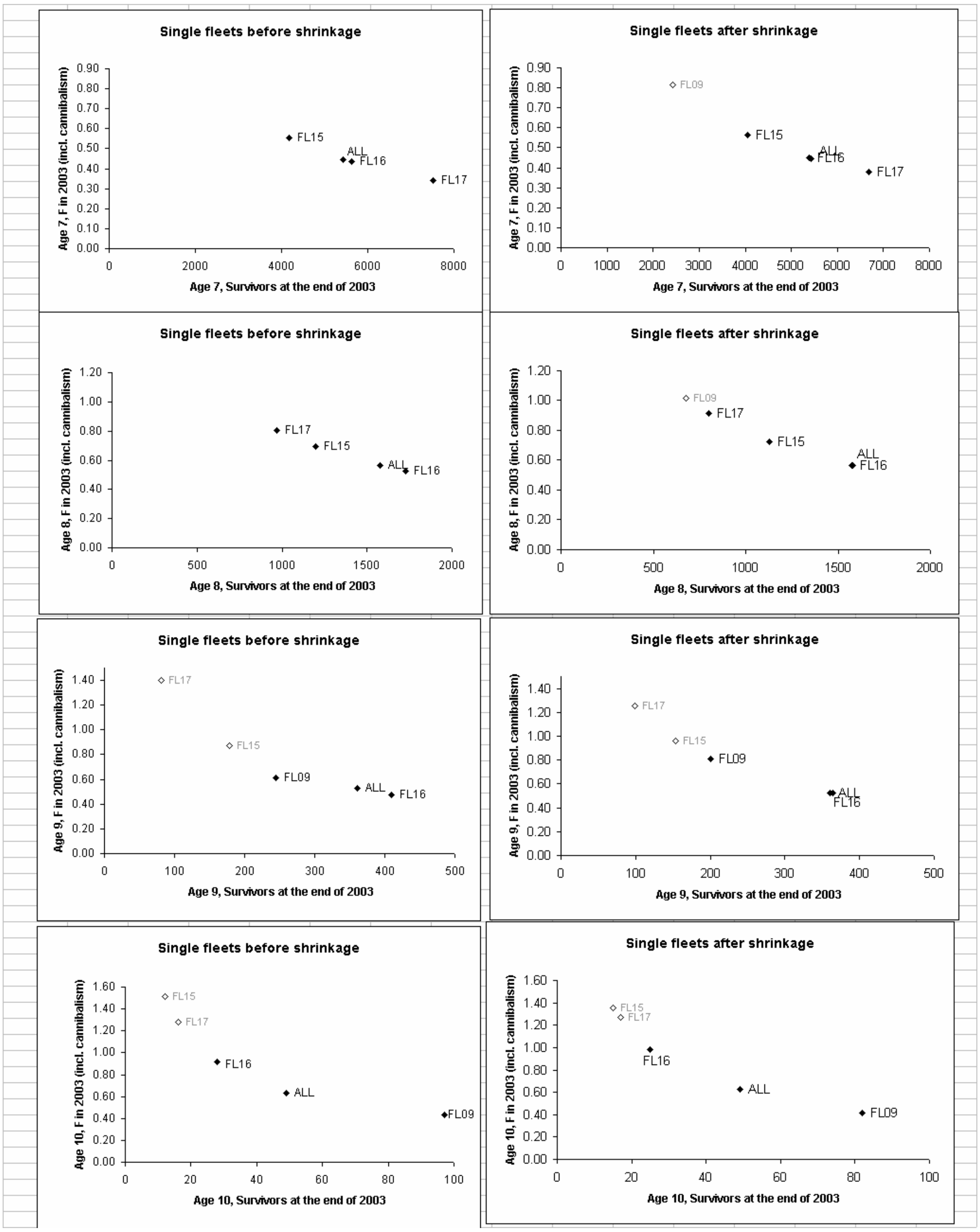


Figure 3.11. Tuning results by fleets and ages 7-10 before and after shrinkage.

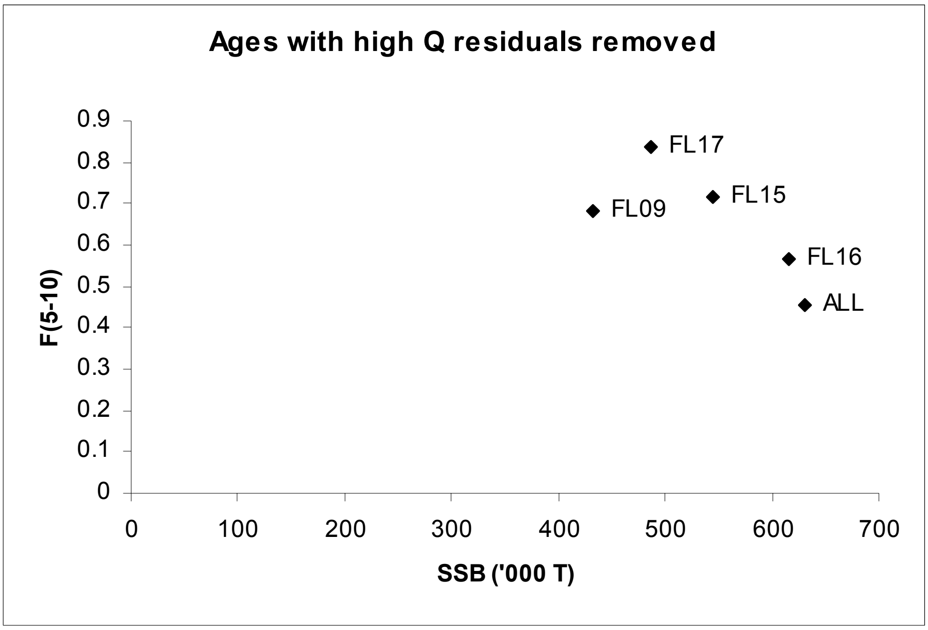


Figure 3.12. Single fleet tuning results when removing entire age groups with high catchability residuals

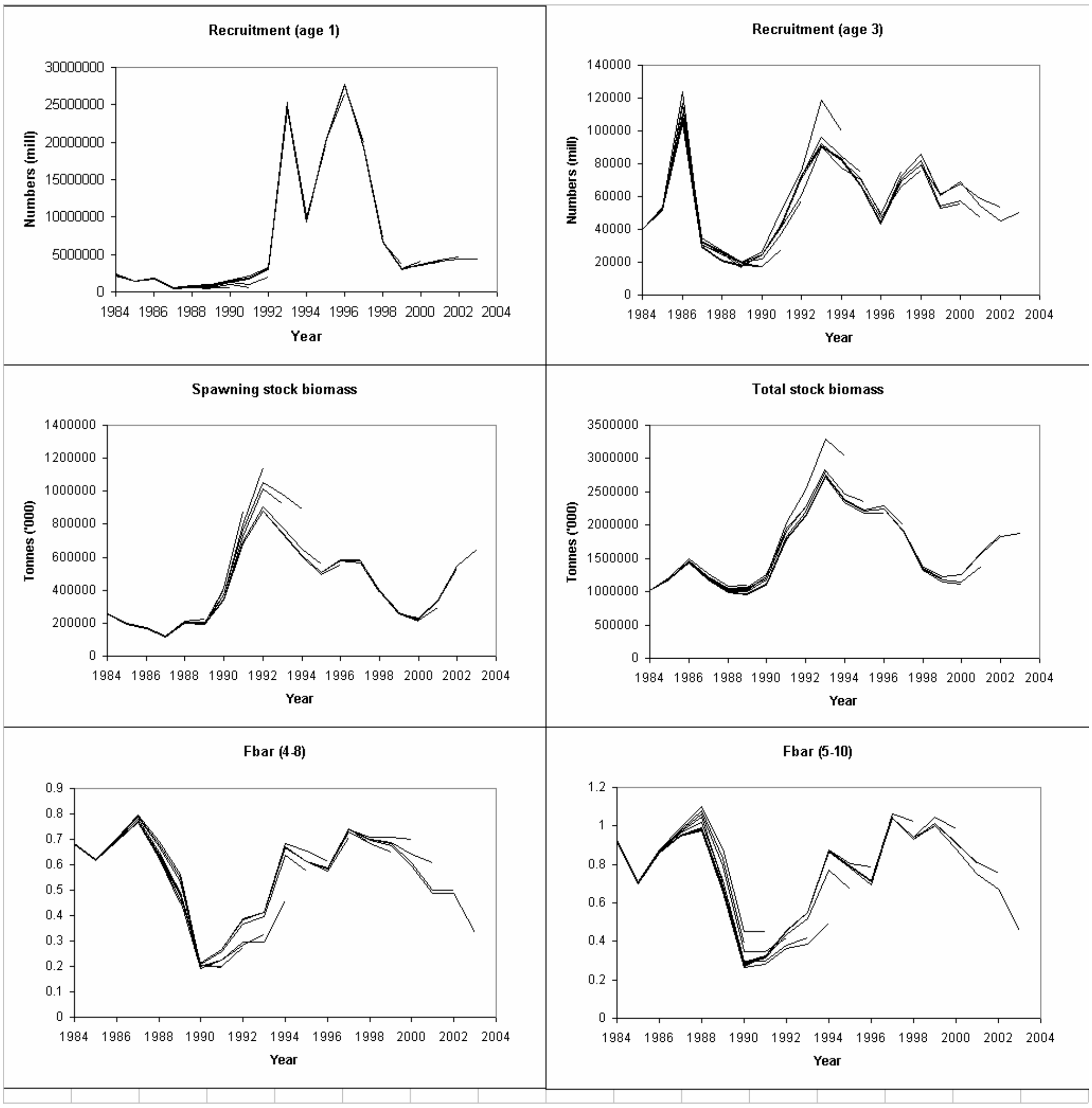


Figure 3.13. Retrospective plots.

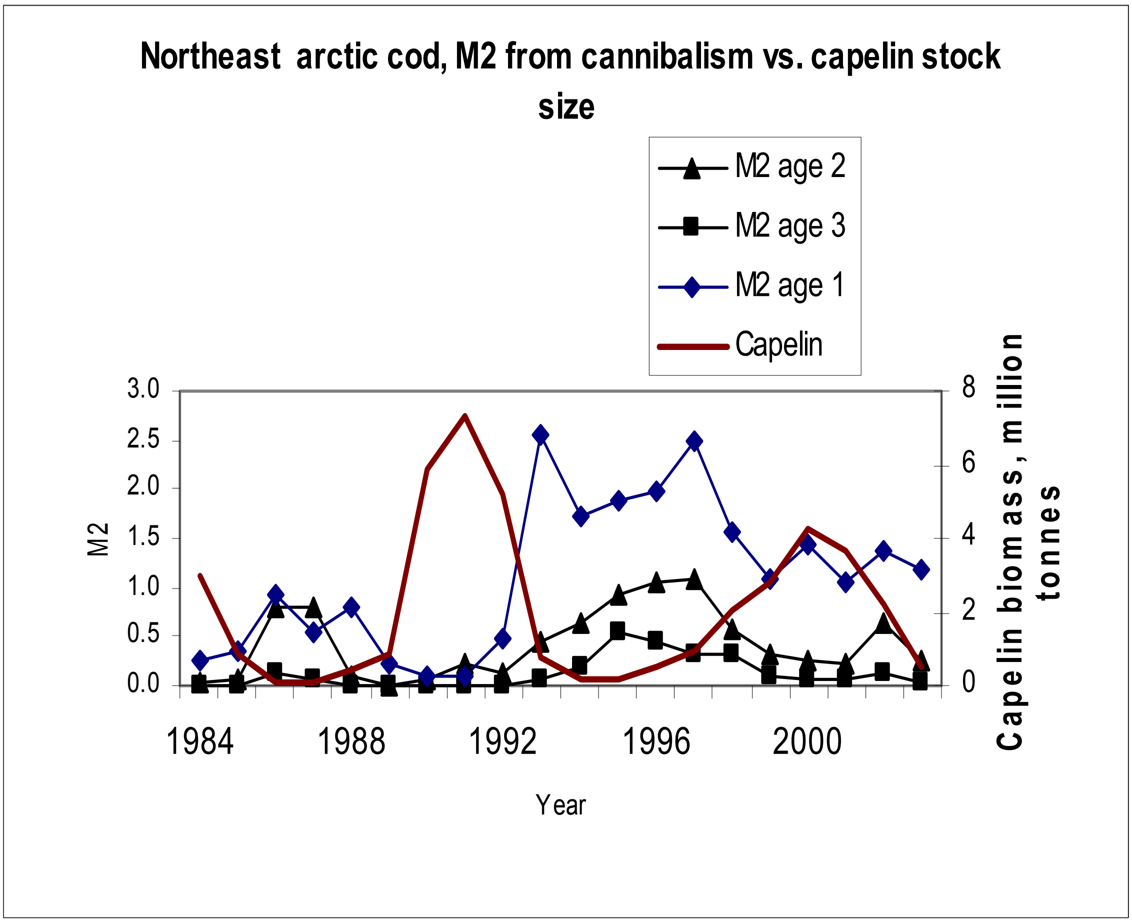


Figure 3.14a. North-east arctic cod. Temporal trends in cod M2 by ages 1-3 from cannibalism and capelin stock size.

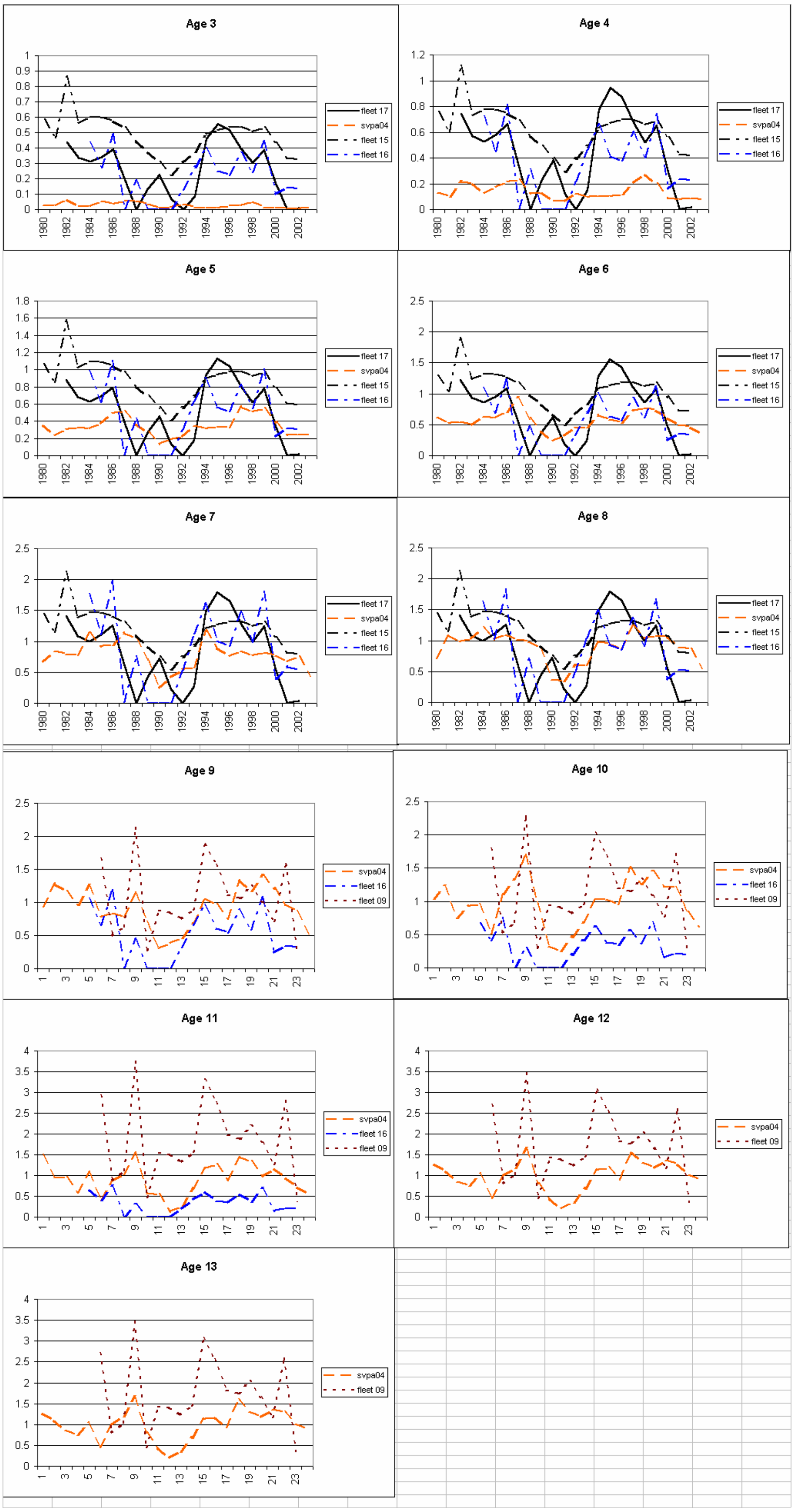


Figure 3.14b. Different survey's F by age, derived from SURBA – compared with F in the VPA

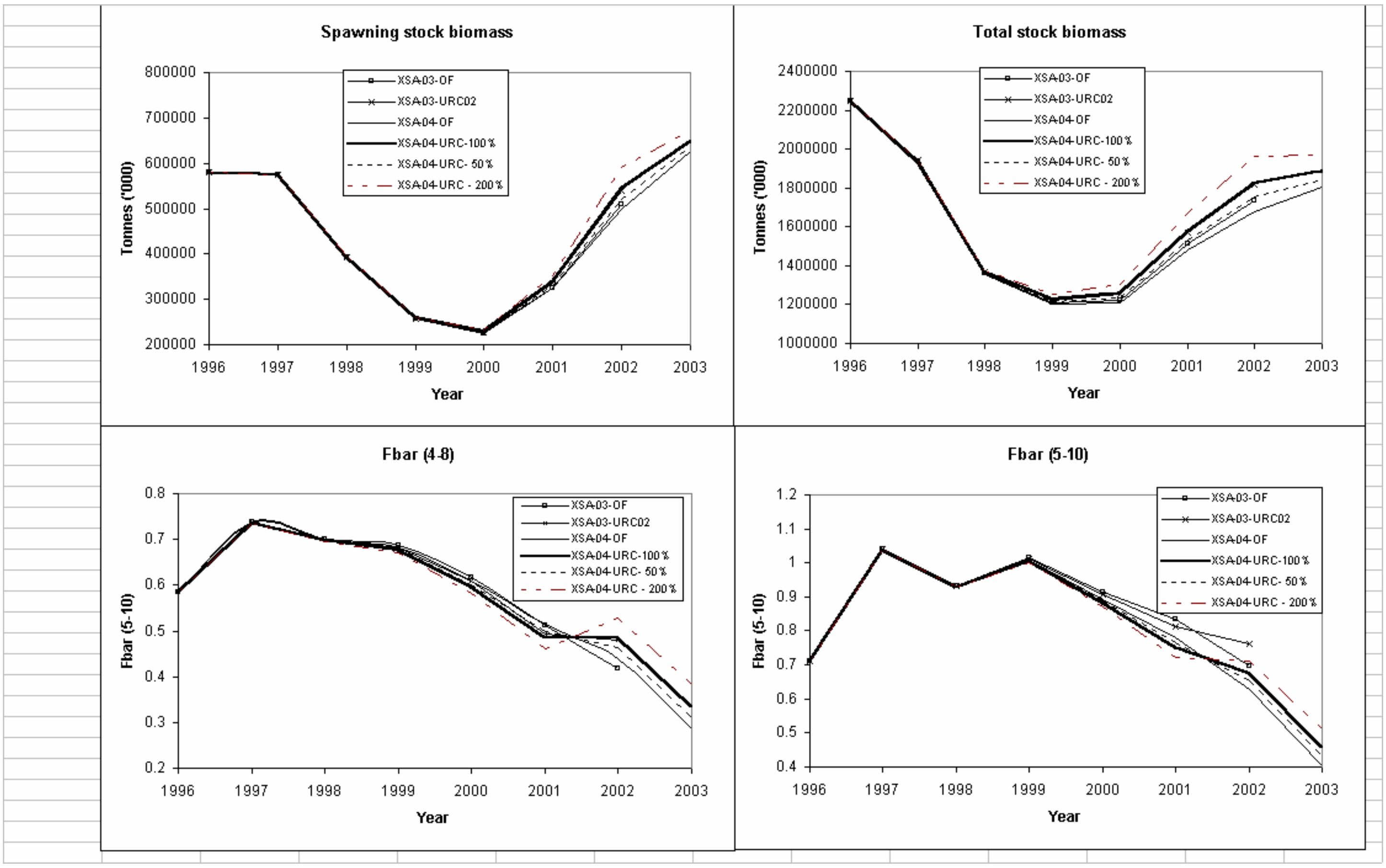


Figure 3.15. Sensitivity of the XSA output results on overfishing values in 2002- 2003 (XSA 03-OF – 2003 XSA results with official landings, XSA 03-URC02 -2003 XSA results including unreported catches, XSA 04 OF -2004 XSA results with official landings, XSA 04 URC-100% -2004 XSA results including 100% unreported catches, XSA 04 URC-50% - 2004 XSA results including 50% unreported catches, XSA 04 URC-200% -2004 XSA results including 200% unreported catches).

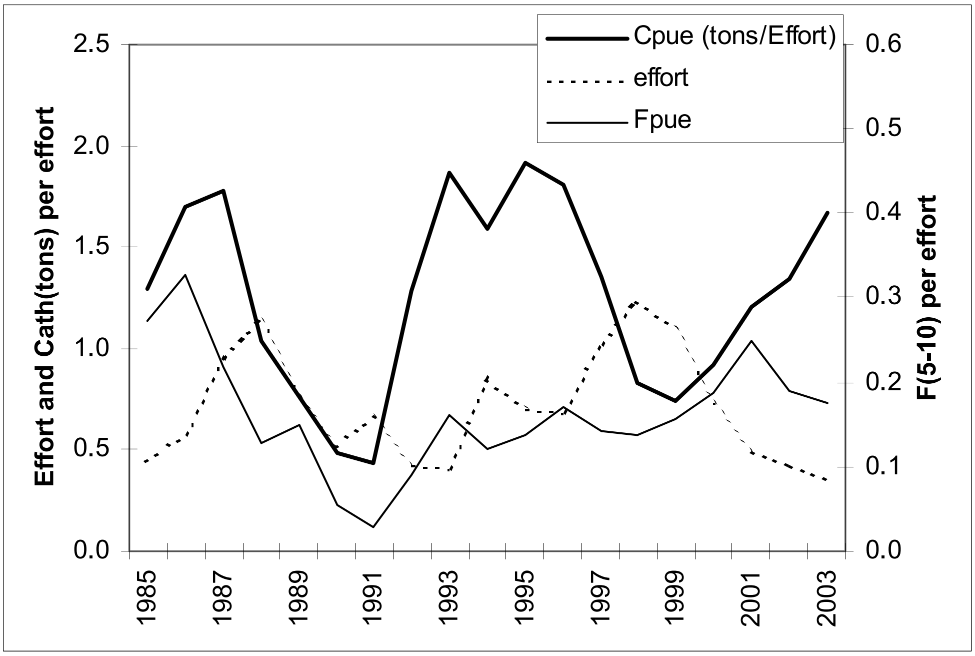


Figure 3.16. Norwegian trawl fleet effort, catch per effort and F per effort (based on partial F for that fishing fleet)

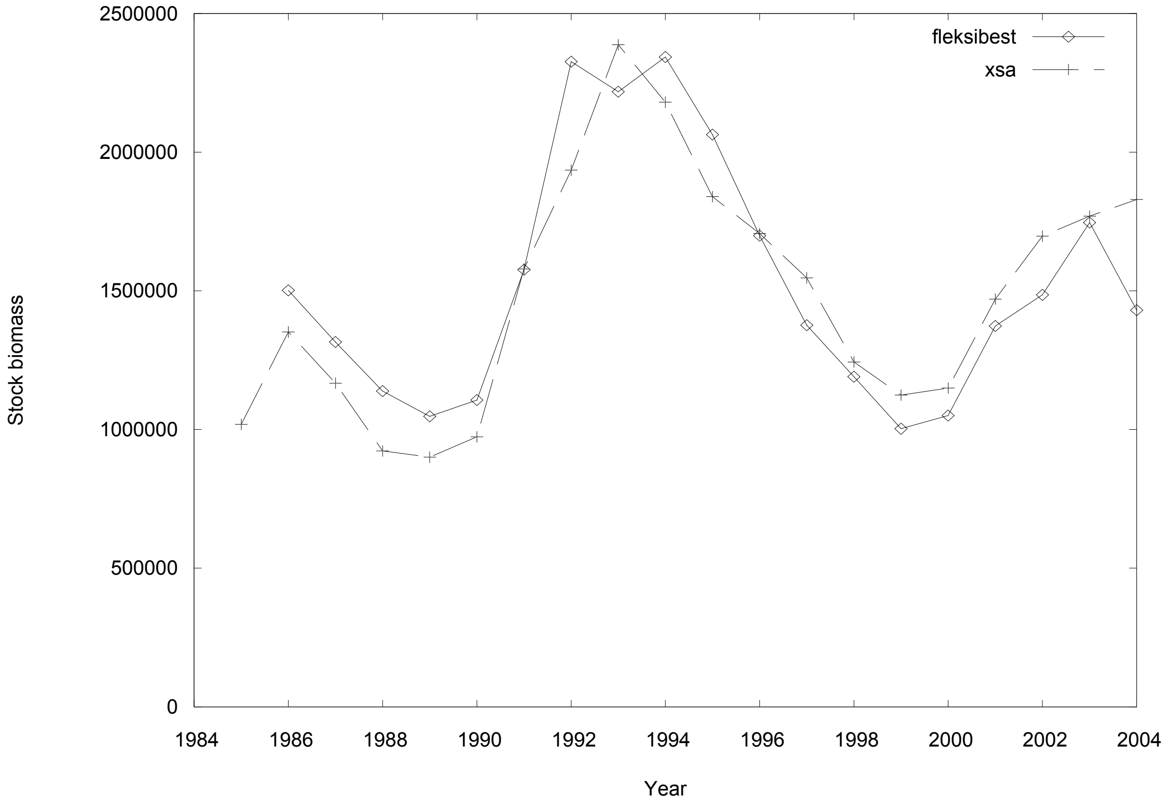


Figure 3.17a stock biomass in keyrun, and XSA

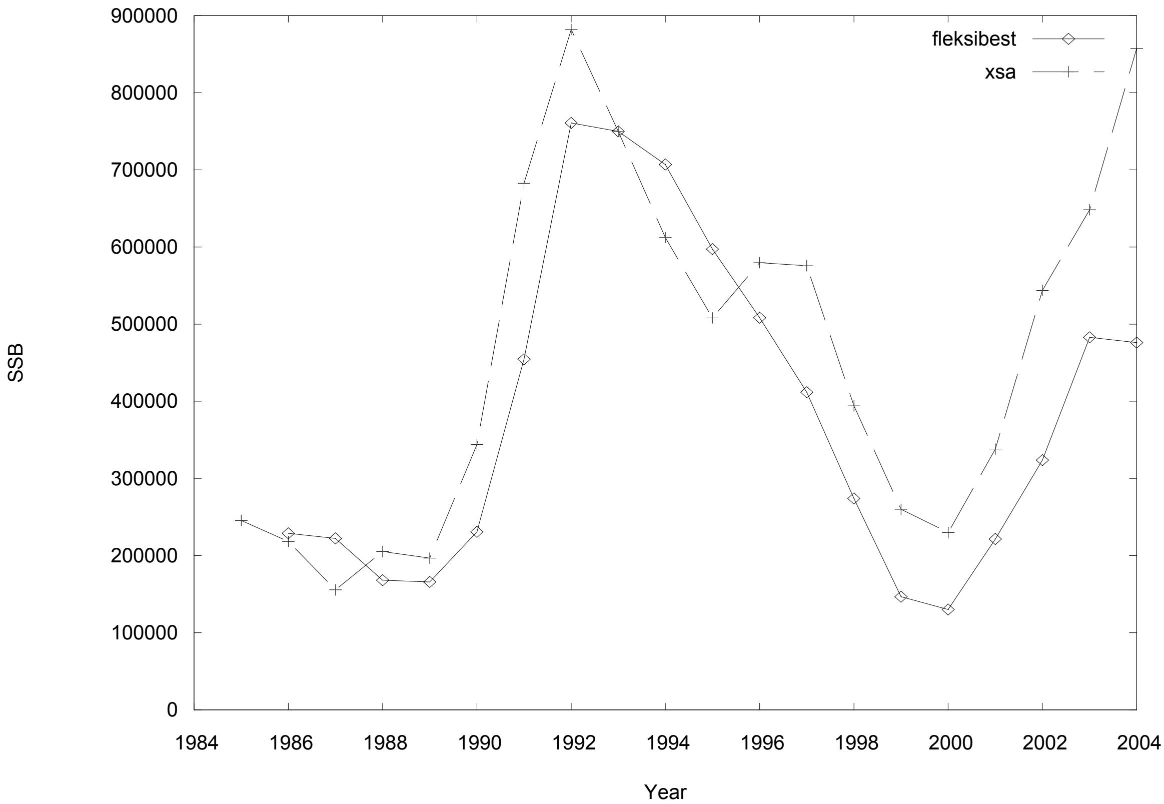


Figure 3.17b ssb in keyrun and XSA

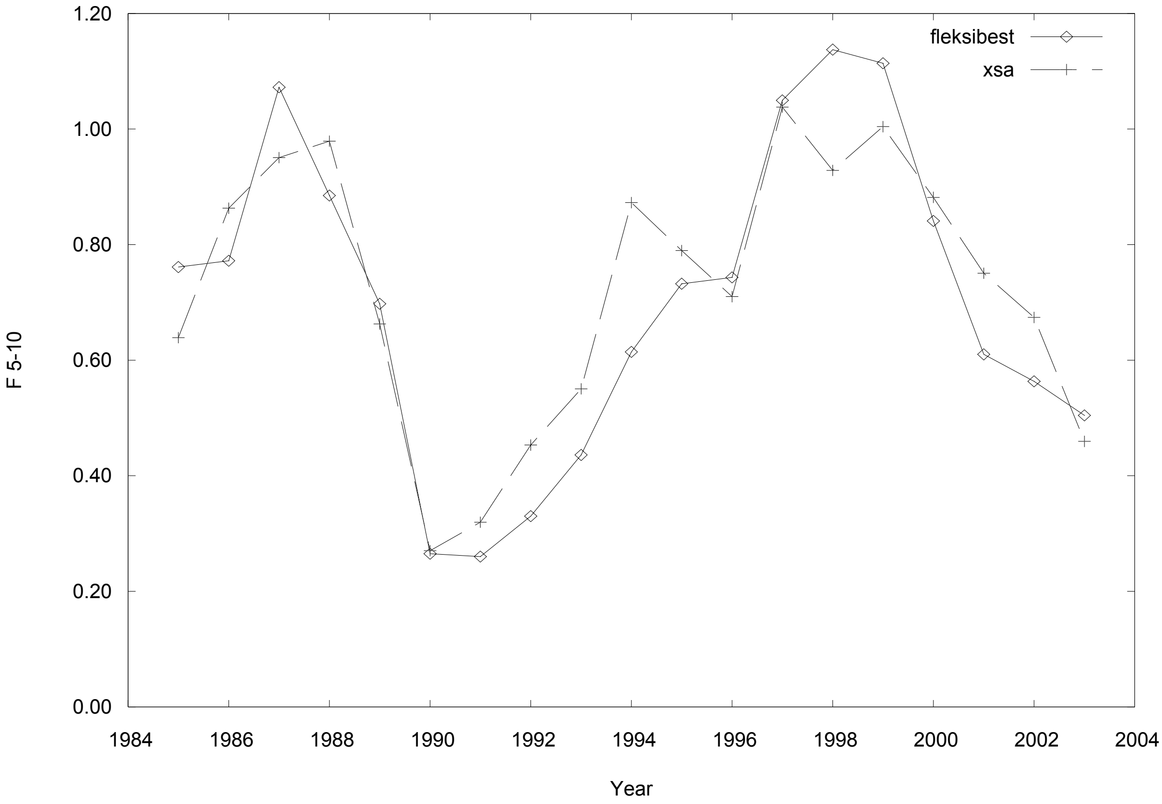


Figure 3.17c F5-10 in keyrun and XSA

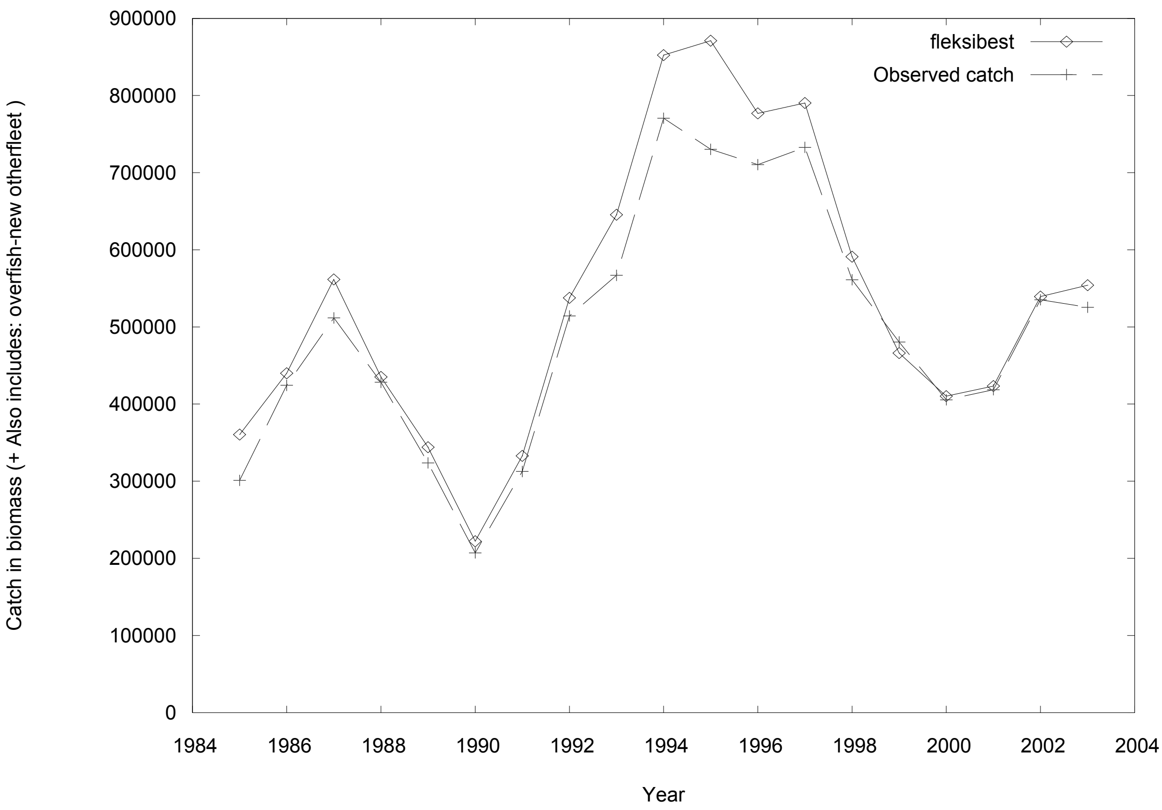


Figure 3.17d Catch in biomass in keyrun, and observed catches

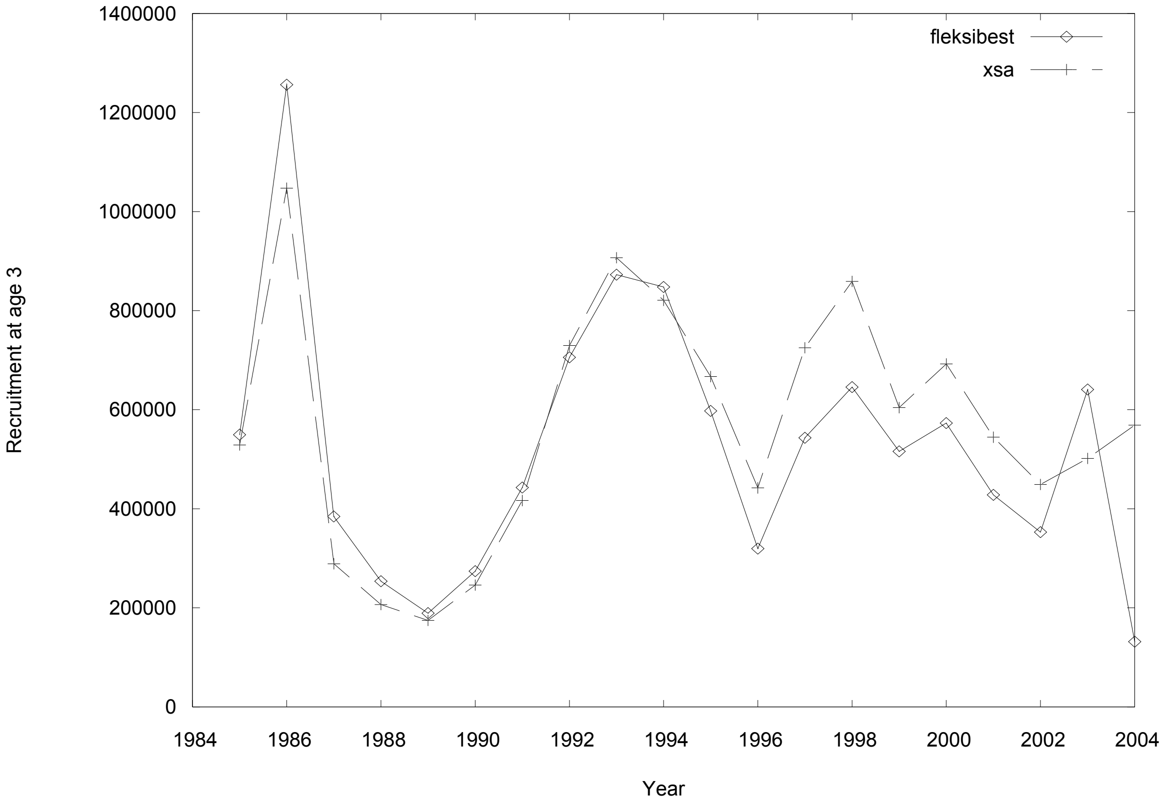


Figure 3.17e Recruitment (number of 3 year old) in keyrun and XSA

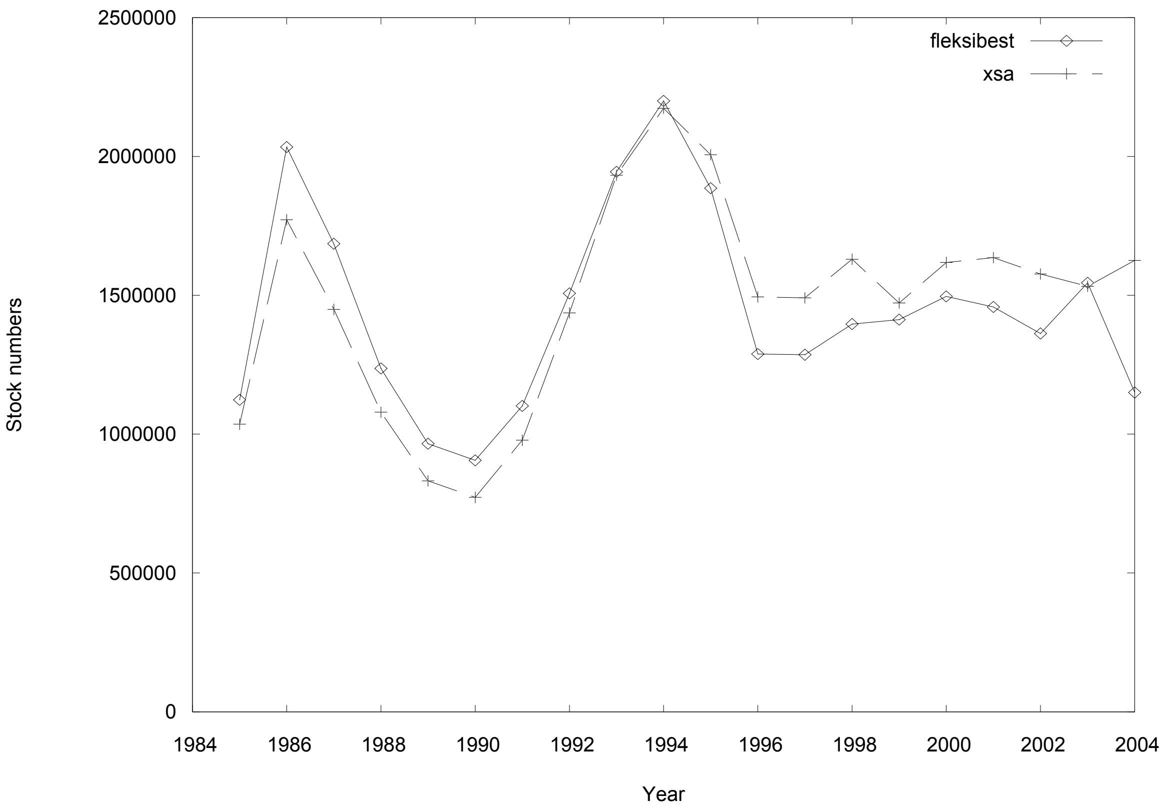


Figure 3.17f Stock numbers in keyrun and XSA

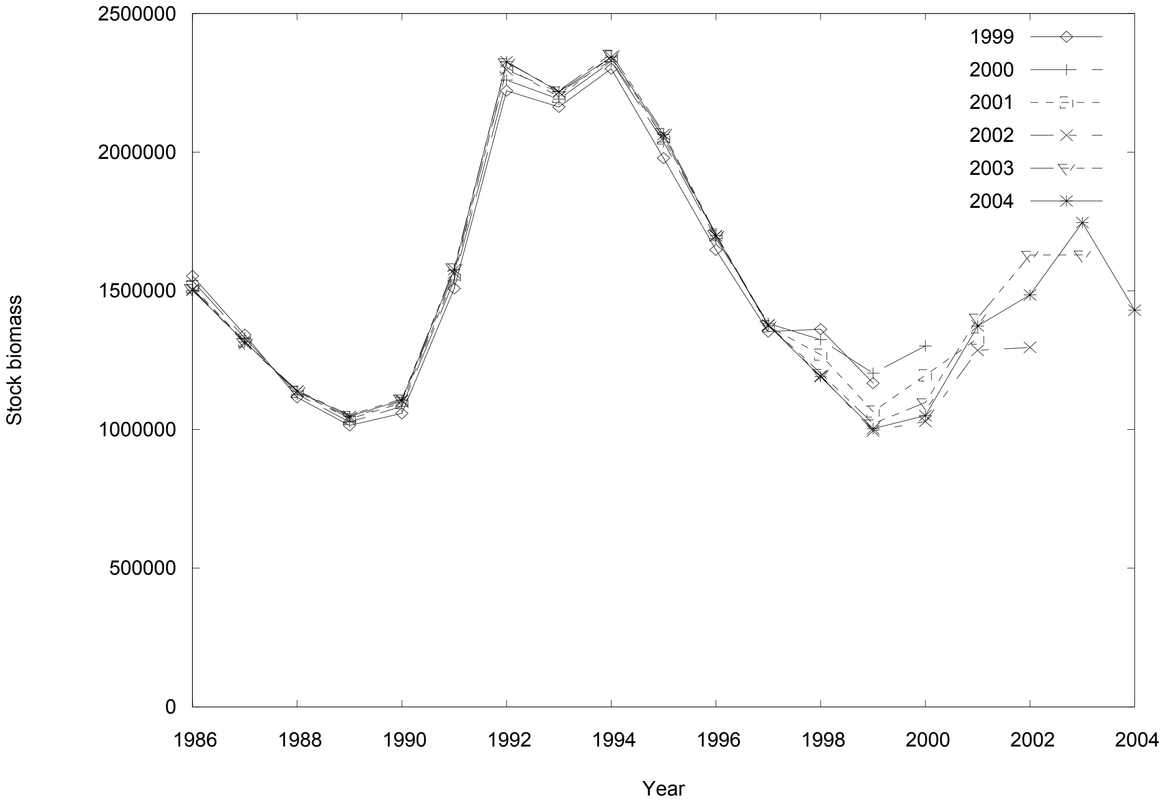


Figure 3.18a Retrospective pattern for stock biomass in keyrun

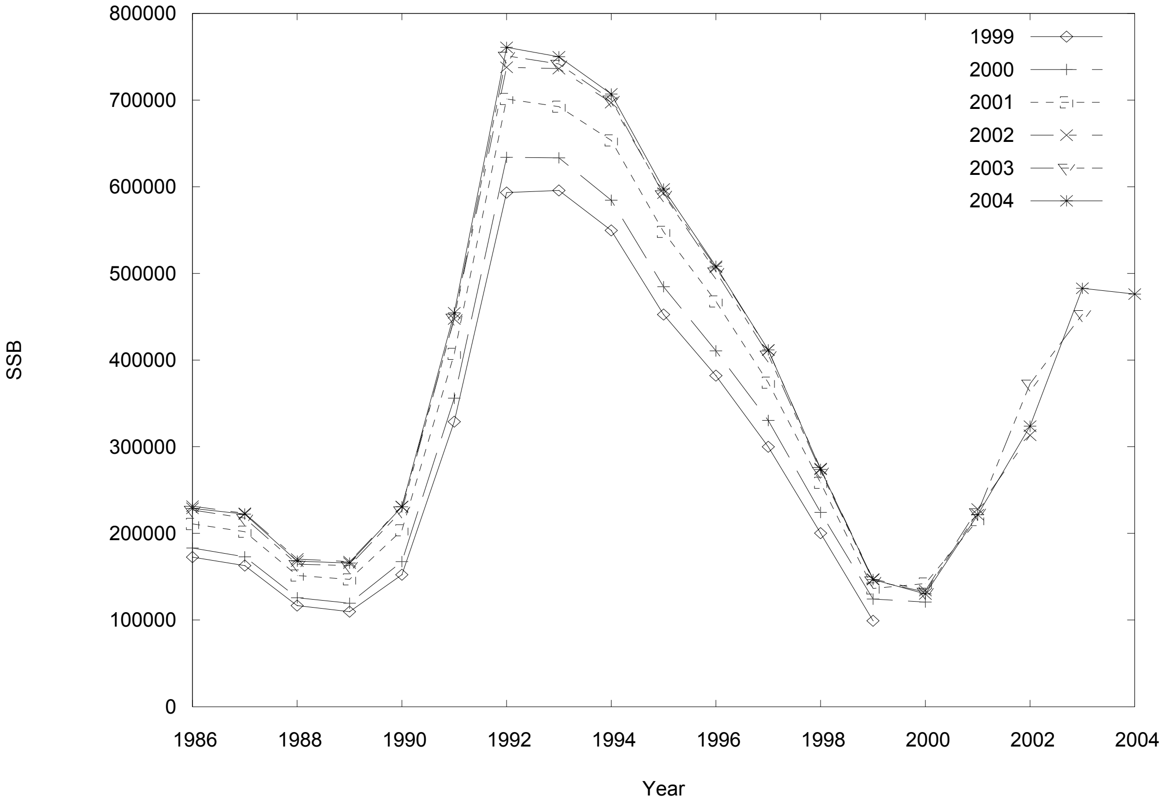


Figure 3.18b Retrospective pattern for SSB in keyrun

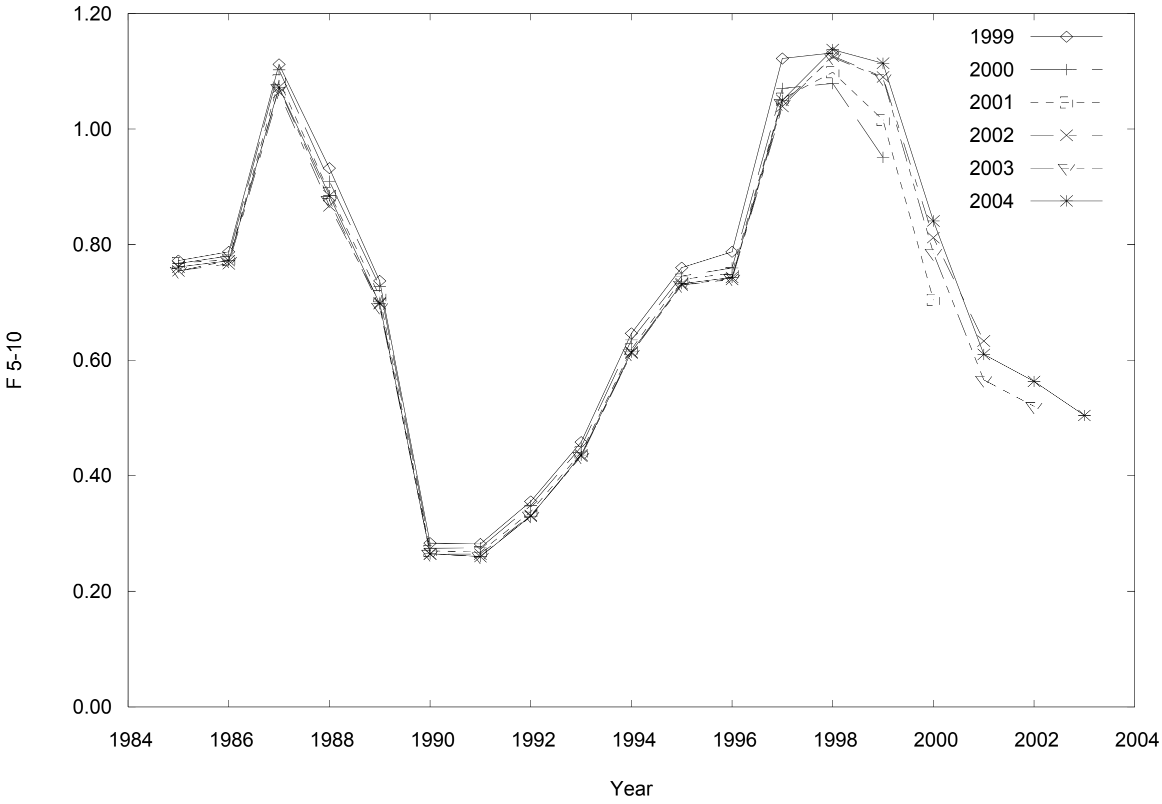


Figure 3.18c Retrospective pattern for F5-10 in keyrun

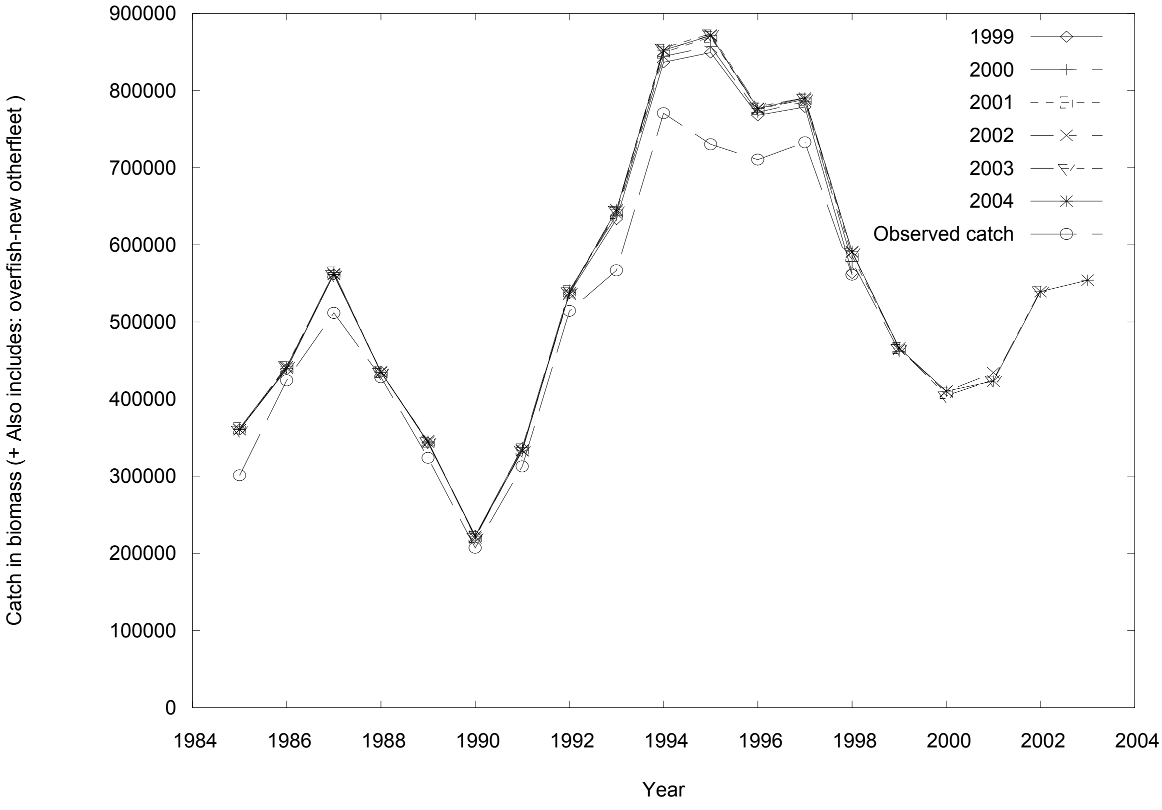


Figure 3.18d Retrospective pattern for Catch in biomass in key run

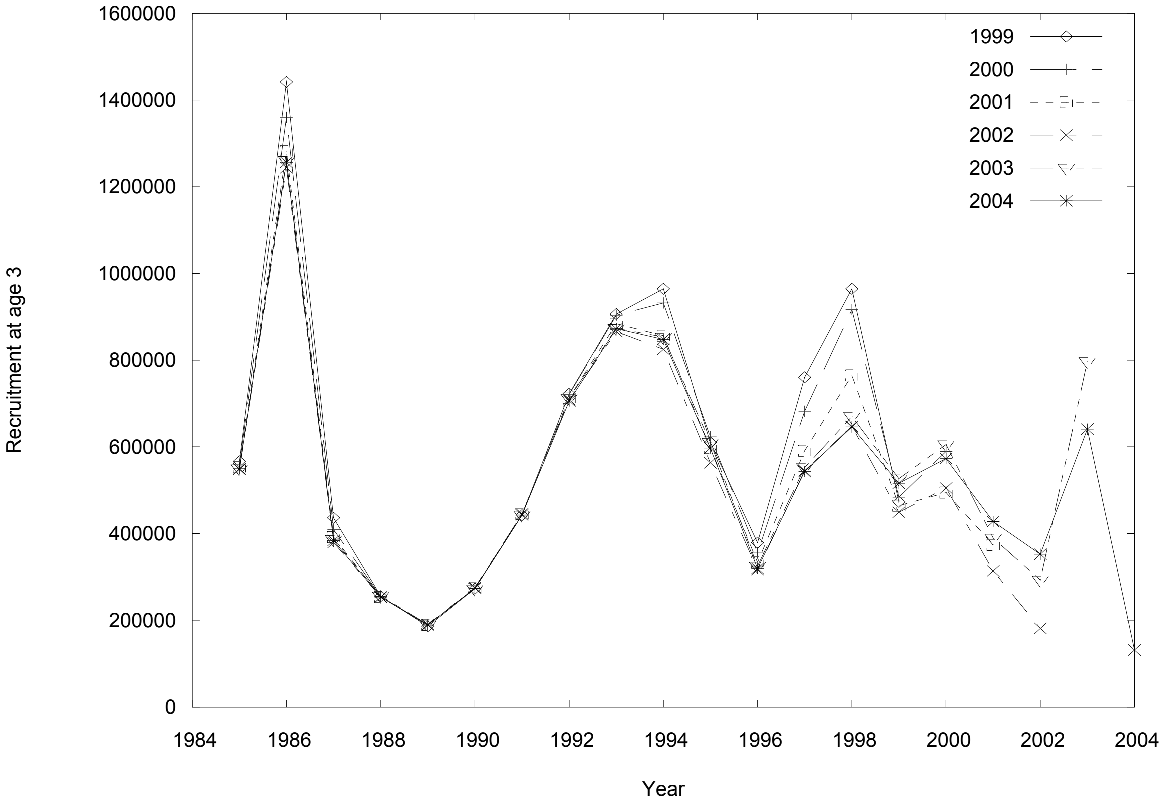


Figure 3.18e Retrospective pattern for recruitment in keyrun

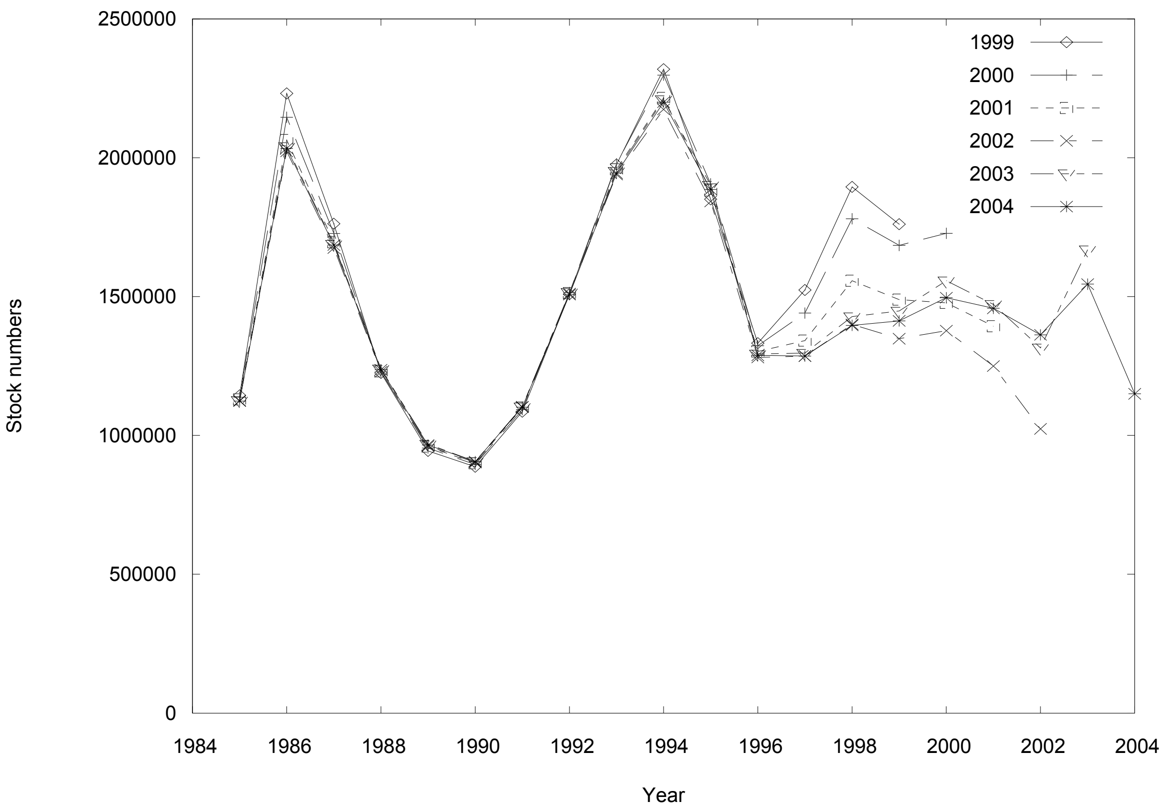


Figure 3.18f Retrospective pattern for stock numbers in keyrun

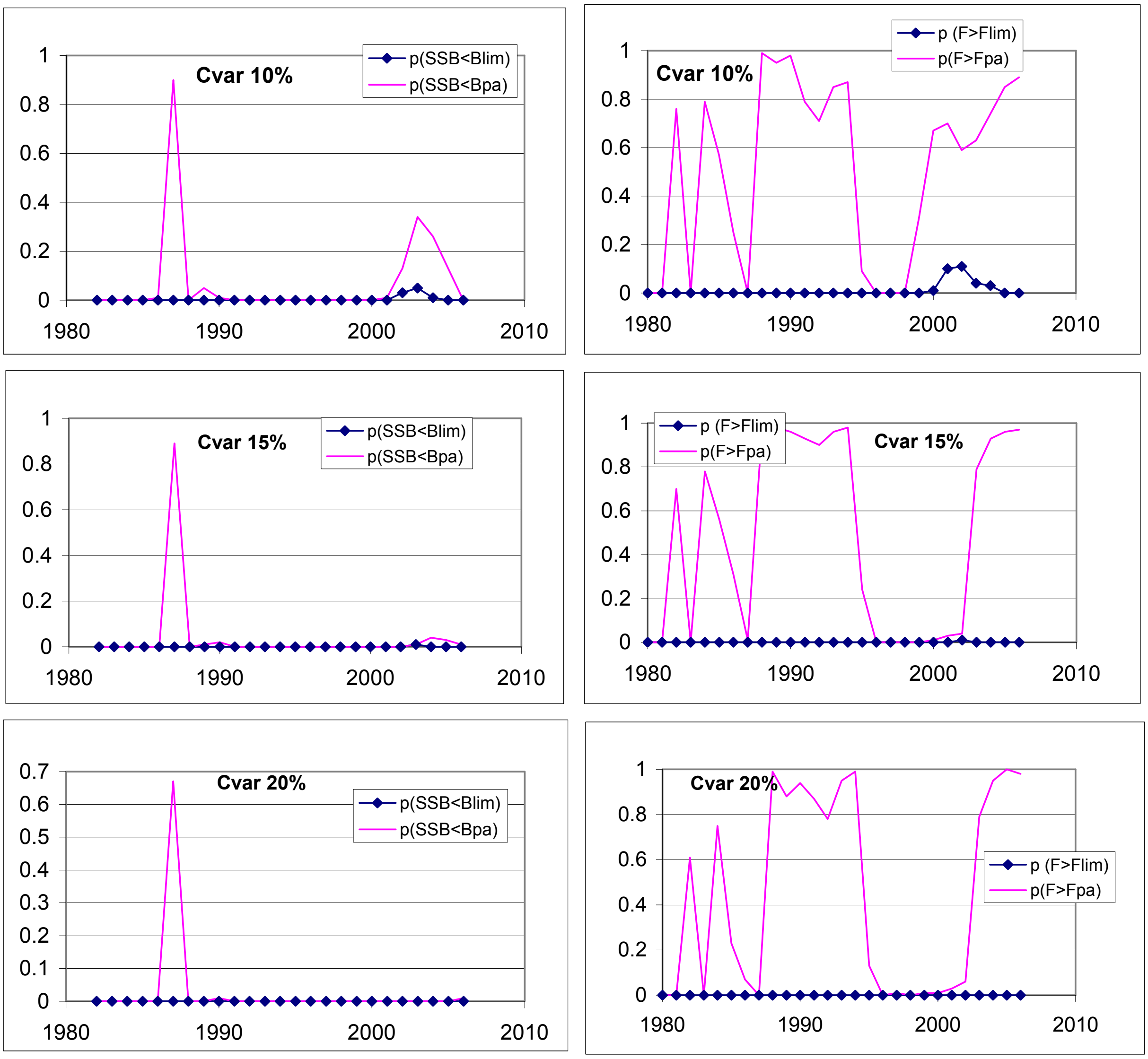


Figure 3.19. The probability for SSB to fall below the $\mathbf{B}_{\mathrm{lim}}$ and $\mathbf{B}_{\mathrm{pa}}$ levels (3 left diagrams) and $\mathbf{F}_{\mathrm{lim}}$ and $\mathbf{F}_{\mathrm{pa}}$ levels (3 right diagrams) by year, given for three Cvar values. Cvar is the limit on % year-to-year variation in TAC.

Table A1 North-East Arctic COD. Catch per unit effort.

	Sub-area |I			Division IIb			Division IIa		Total
Year	Norway[2]	UK[3]	Russia[4]	Norway[2]	UK[3]	Russia[4]	Norway[2]	UK[3]	Norway
1960	-	0.075	0.42	-	0.105	0.31	-	0.067	
1961	-	0.079	0.38	-	0.129	0.44	-	0.058	
1962	-	0.092	0.59	-	0.133	0.74	-	0.066	
1963	-	0.085	0.60	-	0.098	0.55	-	0.066	
1964	-	0.056	0.37	-	0.092	0.39	-	0.070	
1965	-	0.066	0.39	-	0.109	0.49	-	0.066	
1966	-	0.074	0.42	-	0.078	0.19	-	0.067	
1967	-	0.081	0.53	-	0.106	0.87	-	0.052	
1968	-	0.110	1.09	-	0.173	1.21	-	0.056	
1969	-	0.113	1.00	-	0.135	1.17	-	0.094	
1970	-	0.100	0.80	-	0.100	0.80	-	0.066	
1971	-	0.056	0.43	-	0.071	0.16	-	0.062	
1972	0.90	0.047	0.34	0.59	0.051	0.18	1.08	0.055	
1973	1.05	0.057	0.56	0.43	0.054	0.57	0.71	0.043	
1974	1.75	0.079	0.86	1.94	0.106	0.77	0.19	0.028	
1975	1.82	0.077	0.94	1.67	0.100	0.43	1.36	0.033	
1976	1.69	0.060	0.84	1.20	0.081	0.30	1.69	0.035	
1977	1.54	0.052	0.63	0.91	0.056	0.25	1.16	0.044	1.17
1978	1.37	0.062	0.52	0.56	0.044	0.08	1.12	0.037	0.94
1979	0.85	0.046	0.43	0.62	-	0.06	1.06	0.042	0.85
1980	1.47	-	0.49	0.41	-	0.16	1.27	-	1.23
					Spain[5]			**Russia[4]**	
1981	1.42	-	0.41	(0.96)	-	0.07	1.02	0.35	1.21
1982	1.30	-	0.35	-	0.86	0.26	1.01	0.34	1.09
1983	1.58	-	0.31	(1.31)	0.92	0.36	1.05	0.38	1.11
1984	1.40	-	0.45	1.20	0.78	0.35	0.73	0.27	0.96
1985	1.86	-	1.04	1.51	1.37	0.50	0.90	0.39	1.29
1986	1.97	-	1.00	2.39	1.73	0.84	1.36	1.14	1.70
1987	1.77	-	0.97	2.00	1.82	1.05	1.73	0.67	1.77
1988	1.58	-	0.66	1.61	(1.36)	0.54	0.97	0.55	1.03
1989	1.49	-	0.71	0.41	2.70	0.45	0.78	0.43	0.76
1990	1.35	-	0.70	0.39	2.69	0.80	0.38	0.60	0.49
1991	1.38	-	0.67	0.29	4.96	0.76	0.50	0.90	0.44
1992	2.19	-	0.79	3.06	2.47	0.23	0.98	0.65	1.29
1993	2.33	-	0.85	2.98	3.38	1.00	1.74	1.03	1.87
1994	2.50	-	1.01	2.82	1.44	1.14	1.27	0.86	1.59
1995	1.57	-	0.59	2.73	1.65	1.10	1.00	1.01	1.92
1996			0.74		1.11	0.85		0.99	1.81
1997			0.61			0.57		0.74	1.36
1998			0.37			0.29		0.40	0.83
1999			0.29			0.34		0.39	0.74
2000			0.34			0.37		0.53	0.92
2001			0.46			0.46		0.69	1.21
2002			0.58			0.66		0.57	1.35
2003[1]			0.70			1.22		0.73	1.67

[1]Preliminary figures.
[2]Norwegian data - t per 1,000 tonnage*hrs fishing.
[3]United Kingdom data - t per 100 tonnage*hrs fishing.
[4]Russian data - t per hr fishing.
5panish data - t per hr fishing.

Period	Sub-area I	Divisions IIa and IIb
1960–1973	RT	RT
1974–1980	PST	RT
1981–	PST	PST

Vessel type:
RT = side trawlers, 800–1000 HP.
PST = stern trawlers, up to 2000 HP.

Table A2. North-east Arctic COD. Abundance indices (millions) from the Norwegian acoustic survey in the Barents Sea in January-March. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
1981	8.0	82.0	40.0	63.0	106.0	103.0	16.0	3.0	1.0	1.0	423.0
1982	4.0	5.0	49.0	43.0	40.0	26.0	28.0	2.0	+	0.0	197.0
1983	60.5	2.8	5.3	14.3	17.4	11.1	5.6	3.0	0.5	0.1	120.5
1984	745.4	146.1	39.1	13.6	11.3	7.4	2.8	0.2	0.0	0.0	966.0
1985	69.1	446.3	153.0	141.6	19.7	7.6	3.3	0.2	0.1	0.0	840.9
1986	353.6	243.9	499.6	134.3	65.9	8.3	2.2	0.4	0.1	0.0	1308.2
1987	1.6	34.1	62.8	204.9	41.4	10.4	1.2	0.2	0.7	0.0	357.3
1988	2.0	26.3	50.4	35.5	56.2	6.5	1.4	0.2	0.0	0.0	178.4
1989	7.5	8.0	17.0	34.4	21.4	53.8	6.9	1.0	0.1	0.1	150.1
1990	81.1	24.9	14.8	20.6	26.1	24.3	39.8	2.4	0.1	0.0	234.1
1991	181.0	219.5	50.2	34.6	29.3	28.9	16.9	17.3	0.9	0.0	578.7
1992	241.4	562.1	176.5	65.8	18.8	13.2	7.6	4.5	2.8	0.2	1092.9
1993 [1]	1074.0	494.7	357.2	191.1	108.2	20.8	8.1	5.0	2.3	2.5	2264.0
1994 [1]	858.3	577.2	349.8	404.5	193.7	63.6	12.1	3.7	1.7	0.9	2465.4
1995 [1]	2619.2	292.9	166.2	159.8	210.1	68.8	16.7	2.1	0.7	1.0	3537.4
1996 [1]	2396.0	339.8	92.9	70.5	85.8	74.7	20.6	2.8	0.3	0.4	3083.8
1997 [1,2]	1623.5	430.5	188.3	51.7	49.3	37.2	22.3	4.0	0.7	0.1	2407.5
1998 [1,2]	3401.3	632.9	427.7	182.6	42.3	33.5	26.9	13.6	1.7	0.3	4762.8
1999	358.3	304.3	150.0	96.4	45.1	10.3	6.4	4.1	0.8	0.3	976.1
2000	154.1	221.4	245.2	158.9	142.1	45.4	9.6	4.7	3.0	1.1	985.5
2001	629.9	63.9	138.2	171.6	77.3	39.7	11.8	1.4	0.5	0.2	1134.5
2002	18.2	215.5	69.3	112.2	102.0	47.0	18.0	3.0	0.4	0.3	585.9
2003	1693.9	61.5	303.4	114.4	129.0	114.9	34.3	7.7	1.9	0.5	2461.5
2004	157.6	105.2	33.6	92.8	30.7	27.6	17.0	5.9	1.2	0.2	471.8

[1] Survey covered a larger area

[2] Adjusted indices

Table A3. North-East Arctic COD. Abundance indices (millions) from the Norwegian bottom trawl survey in the Barents Sea in January-March. Rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
1981	4.6	34.3	16.4	23.3	40	38.4	4.8	1	0.3	0	163.1
1982	0.8	2.9	28.3	27.7	23.6	15.5	16	1.4	0.2	0	116.4
1983	152.9	13.4	25.0	52.3	43.3	17.0	5.8	3.2	1.0	0.1	313.9
1984	2755.0	379.1	97.5	28.3	21.4	11.7	4.1	0.4	0.1	0.1	3297.7
1985	49.5	660.0	166.8	126.0	19.9	7.7	3.3	0.2	0.1	0.1	1033.6
1986	665.8	399.6	805.0	143.9	64.1	8.3	1.9	0.3	0.0	0.0	2089.1
1987	30.7	445.0	240.4	391.1	54.3	15.7	2.0	0.5	0.0	0.0	1179.8
1988	3.2	72.8	148.0	80.5	173.3	20.5	3.6	0.5	0.0	0.0	502.5
1989	8.2	15.6	46.4	75.9	37.8	90.2	9.8	0.9	0.1	0.1	285.0
1990	207.2	56.7	28.4	34.9	34.6	20.6	27.2	1.6	0.4	0.0	411.5
1991	460.5	220.1	45.9	33.7	25.7	21.5	12.2	12.7	0.6	0.0	832.7
1992	126.6	570.9	158.3	57.7	17.8	12.8	7.7	4.3	2.7	0.2	959.0
1993 [1]	534.5	420.4	273.9	140.1	72.5	15.8	6.2	3.9	2.2	2.4	1471.9
1994 [1]	1035.9	535.8	296.5	310.2	147.4	50.6	9.3	2.4	1.6	1.3	2391.0
1995 [1]	5253.1	541.5	274.6	241.4	255.9	76.7	18.5	2.4	0.8	1.1	6666.2
1996 [1]	5768.5	707.6	170.0	115.4	137.2	106.1	24.0	2.9	0.4	0.5	7032.5
1997 [1,2]	4815.5	1045.1	238.0	64.0	70.4	52.7	28.3	5.7	0.9	0.5	6321.1
1998 [1,2]	2418.5	643.7	396.0	181.3	36.5	25.9	17.8	8.6	1.0	0.5	3729.8
1999 [1]	484.6	340.1	211.8	173.2	58.1	13.4	6.5	5.1	1.2	0.4	1294.4
2000	128.8	248.3	235.2	132.1	108.3	26.9	4.3	2.0	1.2	0.4	887.5
2001	657.9	76.6	191.1	182.8	83.4	38.2	8.9	1.1	0.4	0.2	1240.6
2002	35.3	443.9	88.3	135.0	109.6	42.5	15.1	2.4	0.3	0.2	872.6
2003	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	3760.3
2004	328.5	235.4	76.6	172.5	56.9	44.7	27.3	7.6	1.7	0.4	951.6

[1] Survey covered a larger area

[2] Adjusted indices

Table A4. North East Arctic COD. Abundance at age (millions) from the Norwegian acoustic survey on the spawning grounds off Lofoten in March-April.

Year	5	6	7	8	9	10	11	12+	Sum
1985	0.68	7.45	12.36	3.11	1.15	1.01	0.45		26.21
1986	2.49	3.30	5.54	2.71	0.16		0.40	0.08	14.68
1987	8.77	7.04	0.23	2.83	0.04		0.03	0.03	18.97
1988	1.57	4.43	2.56	0.05	0.01	0.05			8.67
1989	0.04	13.20	9.73	2.20	0.38	0.12		0.06	25.73
1990	0.13	2.60	27.02	4.85	0.49	0.32			35.41
1991	0.00	5.00	19.83	32.67	2.75	0.19	0.17		60.61
1992	2.74	5.23	20.80	20.87	79.60	4.17	1.61	0.22	135.24
1993	4.87	14.58	17.35	20.22	25.44	41.95	4.74	0.71	129.86
1994	23.78	25.85	10.36	8.21	7.68	3.49	17.53	2.61	99.51
1995	6.49	35.24	12.34	2.27	3.60	2.56	2.15	7.96	72.61
1996	1.41	14.43	24.00	3.65	0.79	0.25	0.80	1.30	46.63
1997	0.40	4.95	27.56	16.50	1.50	0.42		0.75	52.08
1998	0.05	0.30	7.06	11.05	3.24	0.51	0.18	0.02	22.41
1999	0.25	1.92	4.84	14.58	8.42	0.75	0.19	0.10	31.05
2000	3.61	3.85	3.25	2.15	2.23	0.45	0.39	0.05	15.98
2001	4.33	17.61	8.03	0.96	0.33	0.36	0.26	0.09	31.97
2002	2.3	19.11	16.5	6.49	0.83	0.31	0.47	0.01	46.02
2003	2.49	29.56	30.01	13.46	1.9	0.11	0.04	0.02	77.59
2004	1.96	17.52	29.82	16.34	7.67	2.04	0.15	0.68	76.18

Table A5. North-east Arctic COD.
Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard area in September-October (1983-1994) and July-August (1995-2003).
Swept area estimates of number of fish at each age. Rock-hopper gear.
(1983-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

			Age							
Year	1	2	3	4	5	6	7	8	9+	Total
1983	191.2	17.0	4.3	4.4	1.3	1.1	0.5	0.8	0.2	220.8
1984	598.4	106.8	6.3	3.3	3.4	1.3	0.3	0.3	0.3	720.3
1985	280.6	447.7	81.1	21.5	9.8	3.9	0.7	0.3	0.2	845.8
1986	49.8	182.3	260.6	32.5	11.0	1.9	0.7	0.2	0.1	539.1
1987	48.8	117.7	147.1	137.2	20.2	5.0	0.5	0.3	0.1	476.7
1988	2.6	26.8	30.8	24.4	37.2	7.1	1.5	0.1	0.1	130.6
1989	4.0	1.4	12.1	11.3	9.3	14.7	3.0	0.4	0.1	56.3
1990	95.0	10.3	7.0	10.9	17.0	11.4	17.4	1.6	0.3	170.8
1991	144.5	88.0	22.4	6.1	9.5	10.2	8.5	13.2	1.5	303.7
1992	168.0	125.6	81.8	37.9	8.4	3.9	4.4	2.1	4.5	436.6
1993	157.9	153.1	116.0	44.8	16.8	3.4	2.4	1.5	4.1	499.9
1994	105.6	149.3	103.1	48.5	39.7	18.6	4.3	1.6	3.0	473.7
1995	465.2	67.1	101.4	80.8	82.5	43.1	14.6	3.2	1.4	859.2
1996	553.2	195.6	60.0	38.1	35.1	32.0	17.7	2.3	0.9	934.9
1997	243.2	209.1	55.0	18.2	10.3	10.2	6.9	2.0	0.4	555.4
1998	189.9	272.2	168.5	62.8	17.1	8.2	5.6	2.7	0.5	727.4
1999	105.0	179.2	132.2	106.2	20.8	4.0	3.9	2.1	0.4	553.8
2000	30.3	121.3	130.9	52.5	43.5	9.6	0.9	1.4	0.3	390.7
2001	75.8	20.7	39.6	28.4	15.4	18.3	3.8	0.6	0.2	202.8
2002	6.6	80.5	28.6	18.5	17.2	6.8	3.4	0.5	0.1	162.2
2003	45.4	12.3	63.5	25.2	24.6	31.2	10.4	4.3	1.2	218.1

Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard and Barents Sea area in July-August (1995-2002).
Swept area estimates of number of fish at each age. Rock-hopper gear.
This survey covers ICES Division IIa and IIb, as well as the north-eastern part of Sub-area I.
The figures given above for the Svalbard area are included in these estimates

			Age							
Year	1	2	3	4	5	6	7	8	9+	Total
1995	746.1	116.5	176.7	178.3	106.0	47.4	18.1	3.8	2.1	1395.0
1996	1314.8	440.9	104.9	87.8	73.4	45.6	25.0	4.2	1.5	2098.1
1997	745.3	551.7	163.8	38.3	27.0	29.5	20.1	7.4	2.0	1585.1
1998	841.0	466.2	299.3	104.9	27.2	14.6	10.6	5.3	1.6	1770.7
1999	200.2	274.6	191.2	145.6	35.3	6.7	5.2	3.3	0.9	863.0
2000	64.5	181.5	220.4	98.5	74.0	21.7	2.7	2.1	1.1	666.5
2001	319.0	42.3	62.6	49.6	29.1	24.2	6.7	0.7	0.4	534.6
2002	20.0	147.7	49.2	41.4	38.9	19.4	14.5	2.4	0.7	334.2
2003	132.3	31.1	149.2	39.8	39.3	43.5	16.6	7.9	2.4	462.1

Table A6. North-east Arctic COD. Mean length at age(cm) from Norwegian surveys in January-March 1983-1999 values re-calculated from raw data.

Year	1	2	3	4	5	6	7	8
1978	14.2	23.1	32.1	45.9	54.2	64.6	67.6	76.9
1979	12.8	22.9	33.1	40.0	52.3	64.4	74.7	83.0
1980	17.6	24.8	34.2	40.5	52.5	63.5	73.6	83.6
1981	17.0	26.1	35.5	44.7	52.0	61.3	69.6	77.9
1982	14.8	25.8	37.6	46.3	54.7	63.1	70.8	82.9
1983	12.8	27.6	34.8	45.9	54.5	62.7	73.1	78.6
1984	14.2	28.4	35.8	48.6	56.6	66.2	74.1	79.7
1985	16.5	23.7	40.3	48.7	61.3	71.1	81.2	85.7
1986	11.9	21.6	34.4	49.9	59.8	69.4	80.3	93.8
1987	13.9	21.0	31.8	41.3	56.3	66.3	77.6	87.9
1988	15.3	23.3	29.7	38.7	47.6	56.8	71.7	79.4
1989	12.5	25.4	34.7	39.9	46.8	56.2	67.0	83.3
1990	14.4	27.9	39.4	47.1	53.8	60.6	68.2	79.2
1991	13.6	27.2	41.6	51.7	59.5	67.1	72.3	77.6
1992	13.2	23.9	41.3	49.9	60.2	68.4	76.1	82.8
1993	11.3	20.3	35.9	50.8	59.0	68.2	76.8	85.8
1994	12.0	18.3	30.5	44.7	55.4	64.3	73.5	82.4
1995	12.7	18.7	29.9	42.0	54.1	64.1	74.8	80.6
1996	12.6	19.6	28.1	41.0	49.3	61.4	72.2	85.3
1997 [1]	11.4	18.8	28.0	40.4	49.9	59.3	69.1	80.6
1998 [1]	10.9	17.4	28.7	40.0	50.5	58.9	67.5	76.3
1999	12.1	18.8	29.0	40.6	50.6	59.9	70.3	78.0
2000	13.0	21.0	28.7	39.7	51.5	61.6	70.5	75.7
2001	12.0	22.5	33.1	41.6	52.2	63.1	71.2	79.2
2002	12.2	19.9	30.1	43.6	52.2	61.7	71.6	79.1
2003	12.0	21.2	29.1	39.2	53.3	61.6	70.3	80.7
2004	11.0	18.9	32.0	40.9	52.0	61.8	69.0	79.0

[1] Adjusted lengths

Table A7. North-east Arctic COD. Weight (g) at age from Norwegian surveys in January-March

Year	Age							
	1	2	3	4	5	6	7	8
1983		190	372	923	1597	2442	3821	4758
1984	23	219	421	1155	1806	2793	3777	4566
1985		171	576	1003	2019	3353	5015	6154
1986		119	377	997	1623	2926	3838	7385
1987 [2]	21	65	230	490	1380	2300	3970	
1988	24	114	241	492	892	1635	3040	4373
1989	16	158	374	604	947	1535	2582	4906
1990	26	217	580	1009	1435	1977	2829	4435
1991	18	196	805	1364	2067	2806	3557	4502
1992	20	136	619	1118	1912	2792	3933	5127
1993	9	71	415	1179	1743	2742	3977	5758
1994	13	55	259	788	1468	2233	3355	4908
1995	16	54	248	654	1335	2221	3483	4713
1996	15	62	210	636	1063	1999	3344	5514
1997 [1]	12	54	213	606	1112	1790	2851	4761
1998 [1]	10	47	231	579	1145	1732	2589	3930
1999	13	55	219	604	1161	1865	2981	3991
2000	17	77	210	559	1189	1978	2989	3797
2001	14	103	338	664	1257	2188	3145	4463
2002	15	68	256	747	1234	2024	3190	4511
2003	14	82	228	569	1302	1980	2975	4666
2004	11	58	294	600	1167	1934	2657	4025

[1] Adjusted weights
[2] Estimated weights

Table A8. Northeast Arctic COD. Length at age in cm in the Lofoten survey

Year/age	5	6	7	8	9	10	11	12+
1985	59.6	71.1	79.0	88.2	97.3	105.2	114.0	
1986	62.7	70.0	80.0	89.4	86.6		105.8	115.0
1987	58.2	64.5	76.7	86.2	88.0		118.5	116.0
1988	53.1	67.1	71.6	94.0	97.0	119.6		
1989	54.0	59.0	69.8	80.8	96.6	103.0		125.0
1990	56.9	65.1	69.2	79.5	83.7	100.1		
1991	59.0	67.3	74.4	81.0	91.3	99.8	85.0	
1992	66.3	68.7	78.3	83.9	89.2	92.2	101.9	127.0
1993	58.3	66.1	72.8	83.6	87.4	92.7	95.4	111.2
1994	64.3	70.6	82.0	87.3	90.0	95.3	92.4	101.4
1995	61.5	69.7	77.8	84.4	92.6	96.7	100.3	99.5
1996	62.2	67.1	75.9	81.0	93.6	100.9	97.4	104.1
1997	63.7	68.6	74.2	83.8	99.9	108.4		109.0
1998	55.0	62.6	70.2	80.0	92.0	98.0	96.7	115.0
1999	52.7	67.0	69.4	78.6	85.8	100.3	102.0	125.0
2000	58.4	66.5	72.6	77.0	83.9	90.6	93.7	112.4
2001*	59.3	66.9	73.2	87.1	88.7	102.8	98.5	128.2
2002*	58.6	66.0	73.2	80.8	88.2	101.8	91.0	101.4
2003	62.3	65.0	73.2	80.9	88.9	86.4	120.0	122.0
2004	58.8	64.7	71.2	80.1	85.6	97.0	102.6	115.8

* preliminary

Table A9. Northeast Arctic COD. Mean weight at age (kg) in the Lofoten survey

Year	5	6	7	8	9	10	11	12+
1985	2.00	3.42	4.61	6.67	8.89	10.73	14.29	
1986	2.22	3.22	4.74	6.40	5.80		10.84	13.48
1987	1.44	1.94	3.61	5.40	5.64		13.15	12.55
1988	1.46	2.82	3.39	6.63	7.27	13.64		
1989	1.30	1.77	2.89	4.74	8.28	9.98		26.00
1990	1.54	2.32	2.55	3.78	4.77	8.80		
1991	2.21	2.52	3.51	5.18	7.40	11.36	5.35	
1992	2.56	2.85	3.99	5.43	6.35	8.03	9.50	17.80
1993	1.79	2.58	3.55	5.31	6.21	7.69	9.28	14.71
1994	2.31	3.27	5.06	6.39	6.64	7.92	7.73	10.10
1995	2.20	3.24	4.83	5.98	7.80	10.03	10.39	10.68
1996	2.22	2.75	4.11	5.63	7.92	10.53	10.58	12.08
1997	2.42	2.92	3.86	5.71	9.65	13.41		12.67
1998	1.88	2.09	2.98	4.85	7.92	9.91	11.05	18.34
1999	1.51	2.80	2.96	4.22	5.92	9.33	9.17	16.00
2000	1.71	2.50	3.16	3.85	5.32	7.07	7.62	12.84
2001	1.90	2.72	3.49	6.23	6.82	10.95	10.29	28.58
2002	1.87	2.57	3.52	4.71	6.18	10.56	8.70	10.48
2003	2.30	2.34	3.48	4.59	5.89	8.07	24.5	27.7
2004'	1.74	2.30	3.02	4.50	5.77	7.81	9.95	13.25

' - preliminary

Table A10 North-east Arctic COD. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent wates in the autumn. Stock number in millions.

Year	Age										
	1	2	3	4	5	6	7	8	9	10+	Total
1985 [1]	77	569	400	568	244	51	20	8	1	3	1941
1986 [1]	25	129	899	612	238	69	20	3	2	1	1998
1987 [2]	2	58	103	855	198	82	19	4	1	1	1323
1988 [2]	3	23	96	100	305	54	16	3	1	1	602
1989 [1]	1	3	17	45	57	91	75	25	13	5	332
1990 [1]	36	27	8	27	62	74	91	39	10	3	377
1991 [1]	63	65	96	45	50	54	66	49	5	1	494
1992 [1]	133	399	380	121	56	58	33	29	11	2	1222
1993 [1]	20	44	220	234	164	51	19	13	8	10	783
1994 [1]	105	38	147	275	303	314	100	35	10	8	1335
1995 [1]	242	42	111	219	229	97	21	6	2	2	971
1996 [1,3,5]	424	275	189	316	449	314	126	27	3	4	2127
1997 [4,5]	72	160	263	198	112	57	27	9	1	1	900
1998 [1]	26	86	279	186	57	23	10	4	1	0	672
1999 [1]	19	79	166	260	98	20	8	5	2	1	658
2000 [1, rev]	24	82	191	159	127	48	6	3	1	1	642
2001 [1]	38	59	148	204	120	70	14	2	1		656
2002 [1,5,6]	83	2	106	85	140	151	67	30	7	1	672
2003	69	36	25	218	142	167	163	60	23	4	908

[1] October-December
[2] September-October
[3] Area IIb not covered
[4] Areas IIa, IIb covered in October-December, part of Area I covered in February-March 1998
[5] Adjusted for incomplete area coverage
[6] Area IIa not covered

Table A11. North-East Arctic COD. Results from the Russian bottom trawl survey in the Barents Sea and adjacent waters in November-December (numbers per hour trawling)

Year	Age										
	0	1	2	3	4	5	6	7	8	9+	Total
			Total (Sub-area I and Division IIa and IIb)								
1982	2.1	2.5	14.1	7.6	9.4	5.8	3.2	1.1	0.4	0.3	46.3
1983	11.7	5.1	6.0	7.3	4.8	2.0	0.7	1.1	0.2	0.2	39.2
1984	11.1	11.3	15.6	9.3	4.9	3.0	1.2	0.5	0.3	0.2	57.2
1985	6.2	39.6	28.3	39.7	18.1	4.5	1.7	0.6	0.1	0.2	139.0
1986	1.5	8.0	49.5	28.6	14.0	5.0	1.4	0.2	0.1	0.1	108.4
1987	0.1	2.5	6.1	40.2	7.8	3.4	0.8	0.2	0.1	0.1	61.2
1988	0.2	1.5	6.6	7.3	19.3	3.3	1.0	0.2	0.1	0.1	39.5
1989	0.3	0.6	3.4	9.1	10.9	16.1	13.1	5.5	2.9	0.8	62.7
1990	3.8	2.9	0.9	2.9	6.5	7.8	9.6	4.3	1.1	0.3	40.1
1991	6.9	7.1	10.2	4.8	5.8	6.6	8.3	7.1	0.7	0.1	57.6
1992	10.8	30.6	30.9	9.0	4.5	4.8	2.6	2.3	0.9	0.1	96.4
1993	4.5	10.3	49.1	52.6	37.7	11.7	4.5	3.2	1.9	2.5	178.0
1994	11.4	5.8	23.0	40.4	38.3	36.6	12.0	4.2	1.3	1.4	174.3
1995	26.0	4.5	11.9	23.5	24.7	10.5	2.3	0.7	0.2	0.2	104.5
1996 [1]	17.8	11.6	7.7	10.1	12.6	8.6	3.6	0.9	0.1	0.1	73.1
1997 [1]	7.3	17.3	9.9	8.3	6.2	3.7	1.8	0.5	0.1	0.0	55.1
1998	4.9	15.9	50.8	33.4	9.7	3.7	1.6	0.7	0.1	0.1	120.9
1999	3.6	14.3	28.4	47.5	16.2	3.1	1.2	0.8	0.2	0.1	115.4
2000	3.1	11.7	27.6	21.9	16.9	5.8	0.8	0.3	0.1	0.1	88.3
2001	6.7	11.0	27.7	37.2	20.6	11.5	2.2	0.3	0.1	0.1	117.4
2002 [2]	12.6	0.3	18.0	14.4	24.1	25.2	11.7	5.2	1.2	0.3	113.1
2003	8.1	4.0	2.8	29.3	17.5	20.2	17.5	6.0	2.3	0.4	108.3

[1] Adjusted assuming area distribution as 1982-1995 average.

[2] Adjusted assuming area distribution as 1998-2001 average.

Table A12 North-East Arctic COD. Length at age (cm) from Russian surveys in November–December

Year	Age									
	0	1	2	3	4	5	6	7	8	9
1984	15.7	22.3	30.7	44.3	51.7	63.6	73.4	82.5	88.4	97.0
1985	15.0	21.1	30.6	43.2	53.7	61.2	72.8	83.0	92.8	101.3
1986	15.2	19.7	28.3	39.0	51.8	62.2	70.9	83.0	91.3	104.0
1987	-	19.2	27.9	33.4	41.4	59.1	69.2	80.1	95.7	102.6
1988	11.3	21.3	28.7	36.2	43.9	53.3	65.3	79.5	85.0	-
1989	-	20.8	28.8	34.8	46.0	53.9	61.8	69.8	78.7	88.6
1990	16.0	24.0	30.4	46.5	54.9	62.5	69.7	77.6	87.8	102.0
1991	11.5	22.4	30.6	43.0	55.9	64.6	72.8	78.5	87.9	101.8
1992	11.3	21.3	31.9	50.1	59.8	69.1	78.6	84.0	90.8	97.5
1993	12.1	17.4	29.1	43.4	52.7	64.3	73.9	81.2	89.1	91.8
1994	12.2	20.3	26.3	33.7	47.4	58.7	70.6	80.8	90.1	96.1
1995	11.6	19.8	27.6	33.8	45.2	60.5	71.1	83.5	92.9	99.1
1996	10.2	20.0	28.1	36.7	48.7	58.9	70.5	80.0	93.6	102.7
1997	9.6	18.5	28.8	38.2	50.8	62.0	70.5	80.1	88.9	103.5
1998	11.4	19.0	28.0	36.4	50.5	61.0	70.7	80.3	91.1	102.5
1999	11.7	19.7	27.9	35.3	51.6	60.6	70.6	78.9	86.8	94.3
2000	10.7	20.8	30.1	34.7	49.8	61.1	71.6	82.0	88.3	85.7
2001	10.6	19.4	29.8	37.3	50.4	61.9	71.9	81.4	91.0	98.7
2002	10.7	19.2	29.9	38.2	52.5	60.4	70.6	82.2	91.3	97.2
2003	9.8	18.9	28.3	34.9	49.2	62.2	71.0	81.5	92.3	100.9

Table A13 North-East Arctic COD. Weight (g) at age from Russian surveys in November–December.

Year	Age										
	0	1	2	3	4	5	6	7	8	9	10
1984	26	90	250	746	1,187	2,234	3,422	5,027	6,479	9,503	-
1985	26	80	245	762	1,296	1,924	3,346	5,094	7,360	6,833	11,167
1986	25	63	191	506	1,117	1,940	2,949	4,942	7,406	9,300	-
1987	-	54	182	316	672	1,691	2,688	3,959	8,353	10,583	13,107
1988	15	78	223	435	789	1,373	2,609	4,465	5,816	-	-
1989	-	73	216	401	928	1,427	2,200	3,133	4,649	6,801	8,956
1990	28	106	230	908	1,418	2,092	2,897	4,131	6,359	10,078	13,540
1991	26	93	260	743	1,629	2,623	3,816	4,975	7,198	11,165	15,353
1992	10	76	273	1,165	1,895	2,971	4,377	5,596	7,319	9,452	12,414
1993	11	46	211	717	1,280	2,293	3,509	4,902	6,621	7,339	8,494
1994	12	69	153	316	919	1,670	2,884	4,505	6,520	8,207	9,812
1995	11	61	180	337	861	1,987	3,298	5,427	7,614	9,787	10,757
1996	7	64	191	436	1,035	1,834	3,329	5,001	8,203	10,898	11,358
1997	6	48	203	487	1,176	2,142	3,220	4,805	6,925	10,823	12,426
1998	11	55	187	435	1,186	2,050	3,096	4,759	7,044	11,207	12,593
1999	10	58	177	371	1,214	1,925	3,064	4,378	6,128	7,843	11,543
2000	8	74	232	379	1,101	2,128	3,341	5,054	6,560	8,497	12,353
2001	9	58	221	459	1,125	2,078	3,329	4,950	7,270	9,541	11,672
2002	8	65	232	505	1,299	1,964	3,271	5,325	7,249	9,195	11,389
2003	6	49	205	492	972	1,993	2,953	4,393	6,638	9,319	11,085

Table A14 Abundance indices of 0-group fish in the Barents Sea and adjacent waters in 1965-2003
Indices for 1965-1985 adjusted according to Nakken and Raknes (1996).

Year	Cod	Haddock	Polar cod		Redfish	Greenland halibut	Long rough Dab
			West	East			
1965	11	13		0	159		66
1966	2	2		129	236		97
1967	62	76		165	44		73
1968	45	14		60	21		17
1969	211	186		208	295		26
1970	1097	208		197	247	1	12
1971	356	166		181	172	1	81
1972	225	74		140	177	8	65
1973	1101	87		(26)	385	3	67
1974	82	237		227	468	13	83
1975	453	224		75	315	21	113
1976	57	148		131	447	16	96
1977	279	187	157	70	472	9	72
1978	192	110	107	144	460	35	76
1979	129	95	23	302	980	22	69
1980	61	68	79	247	651	12	108
1981	65	30	149	73	861	38	95
1982	136	107	14	50	694	17	150
1983	459	219	48	39	851	16	80
1984	559	293	115	16	732	40	70
1985	742	156	60	334	795	36	86
1986	434	160	111	366	702	55	755
1987	102	72	17	155	631	41	174
1988	133	86	144	120	849	8	72
1989	202	112	206	41	698	5	92
1990	465	227	144	48	670	2	35
1991	766	472	90	239	200	1	28
1992	1,159	313	195	118	150	3	32
1993	910	240	171	156	162	11	55
1994	899	282	50	448	414	20	272
1995	1,069	148	6	-	220	15	66
1996	1,142	196	59	484	19	5	10
1997	1,077	150	129	453	50	13	42
1998	576	593	144	457	78	11	28
1999	194	184	116	696	27	13	66
2000	870	417	76	387	195	28	81
2001	212	394	148	146	11	32	86
2002	1,055	412	179	588	28	34	173
2003	694	705	164	337	57	9	58

Table A15 Estimated logarithmic indices with 90% confidence limits of year class abundance for 0-group herring, cod and haddock in the Barents Sea and adjacent waters 1965-2003

Year	Herring[1]			Cod			Haddock		
	Index	Confidence limits		Index	Confidence limits		Index	Confidence limits	
1965				+					
1966	0.14	0.04	0.31	0.02	0.01	0.04	0.01	0.00	0.03
1967	0.00	-	-	0.04	0.02	0.08	0.08	0.03	0.13
1968	0.00	-	-	0.02	0.01	0.04	0.00	0.00	0.02
1969	0.01	0.00	0.04	0.25	0.17	0.34	0.29	0.20	0.41
1970	0.00	-	-	2.51	2.02	3.05	0.64	0.42	0.91
1971	0.00	-	-	0.77	0.57	1.01	0.26	0.18	0.36
1972	0.00	-	-	0.52	0.35	0.72	0.16	0.09	0.27
1973	0.05	0.03	0.08	1.48	1.18	1.82	0.26	0.15	0.40
1974	0.01	0.01	0.01	0.29	0.18	0.42	0.51	0.39	0.68
1975	0.00	-	-	0.90	0.66	1.17	0.60	0.40	0.85
1976	0.00	-	-	0.13	0.06	0.22	0.38	0.24	0.51
1977	0.01	0.00	0.03	0.49	0.36	0.65	0.33	0.21	0.48
1978	0.02	0.01	0.05	0.22	0.14	0.32	0.12	0.07	0.19
1979	0.09	0.01	0.20	0.40	0.25	0.59	0.20	0.12	0.28
1980	-	-	-	0.13	0.08	0.18	0.15	0.10	0.20
1981	0.00	-	-	0.10	0.06	0.18	0.03	0.00	0.05
1982	0.00	-	-	0.59	0.43	0.77	0.38	0.30	0.52
1983	1.77	1.29	2.33	1.69	1.34	2.08	0.62	0.48	0.77
1984	0.34	0.20	0.52	1.55	1.18	1.98	0.78	0.60	0.99
1985	0.23	0.18	0.28	2.46	2.22	2.71	0.27	0.23	0.31
1986	0.00	-	-	1.37	1.06	1.70	0.39	0.28	0.52
1987	0.00	0.00	0.03	0.17	0.01	0.40	0.10	0.00	0.25
1988	0.32	0.16	0.53	0.33	0.22	0.47	0.13	0.05	0.34
1989	0.59	0.49	0.76	0.38	0.30	0.48	0.14	0.10	0.20
1990	0.31	0.16	0.50	1.23	1.04	1.34	0.61	0.48	0.75
1991	1.19	0.90	1.52	2.30	1.97	2.65	1.17	0.98	1.37
1992	1.06	0.69	1.50	2.94	2.53	3.39	0.87	0.71	1.06
1993	0.75	0.45	1.14	2.09	1.70	2.51	0.64	0.48	0.82
1994	0.28	0.17	0.42	2.27	1.83	2.76	0.64	0.49	0.81
1995	0.16	0.07	0.29	2.40	1.97	2.88	0.25	0.13	0.40
1996	0.65	0.47	0.85	2.87	2.53	3.24	0.39	0.25	0.56
1997	0.39	0.25	0.54	1.60	1.35	1.86	0.21	0.12	0.31
1998	0.59	0.40	0.82	0.68	0.48	0.91	0.59	0.44	0.76
1999	0.41	0.25	0.59	0.21	0.11	0.34	0.25	0.11	0.44
2000	0.30	0.17	0.46	1.49	1.21	1.78	0.64	0.46	0.84
2001	0.13	0.04	0.25	0.23	0.12	0.36	0.67	0.52	0.84
2002	0.53	0.36	0.73	1.22	0.97	1.50	0.99	0.75	1.25
2003	0.51	0.36	0.68	0.85	0.63	1.10	0.85	0.61	1.12

[1]Assessment for 1965–1984 made by Toresen (1985).

Table A16. Sum of acoustic abundance estimates (millions) in the Joint winter Barents Sea aurvey (Table A2) and the Norwegian Lofoten acoustic survey (Table A4)

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1985	69.1	446.3	153.0	141.6	20.4	15.1	15.7	3.3	1.3	1.0	0.5	0.0
1986	353.6	243.9	499.6	134.3	68.4	11.6	7.7	3.1	0.3	0.0	0.4	0.1
1987	1.6	34.1	62.8	204.9	50.2	17.4	1.4	3.0	0.7	0.0	0.0	0.0
1988	2.0	26.3	50.4	35.5	57.8	10.9	4.0	0.3	0.0	0.1	0.0	0.0
1989	7.5	8.0	17.0	34.4	21.4	67.0	16.6	3.2	0.5	0.2	0.0	0.1
1990	81.1	24.9	14.8	20.6	26.2	26.9	66.8	7.3	0.6	0.3	0.0	0.0
1991	181.0	219.5	50.2	34.6	29.3	33.9	36.7	50.0	3.7	0.2	0.2	0.0
1992	241.4	562.1	176.5	65.8	21.5	18.4	28.4	25.4	82.4	4.4	1.6	0.2
1993	1074.0	494.7	357.2	191.1	113.1	35.4	25.5	25.2	27.7	44.5	4.7	0.7
1994	858.3	577.2	349.8	404.5	217.5	89.5	22.5	11.9	9.4	4.4	17.5	2.6
1995	2619.2	292.9	166.2	159.8	216.6	104.0	29.0	4.4	4.3	3.6	2.2	8.0
1996	2396.0	339.8	92.9	70.5	87.2	89.1	44.6	6.5	1.1	0.7	0.8	1.3
1997	1623.5	430.5	188.3	51.7	49.7	42.2	49.9	20.5	2.2	0.5	0.0	0.8
1998	3401.3	632.9	427.7	182.6	42.4	33.8	34.0	24.7	4.9	0.8	0.2	0.0
1999	358.3	304.3	150.0	96.4	45.4	12.2	11.2	18.7	9.2	1.1	0.2	0.1
2000	154.1	221.4	245.2	158.9	145.7	49.3	12.9	6.9	5.2	1.6	0.4	0.1
2001	629.9	63.9	138.2	171.6	81.6	57.3	19.8	2.4	0.8	0.6	0.3	0.1
2002	18.2	215.5	69.3	112.2	104.3	66.1	34.5	9.5	1.2	0.5	0.6	0.0
2003	1693.9	61.5	303.4	114.4	131.5	144.5	64.3	21.2	3.8	0.5	0.1	0.1
2004	157.7	105.2	33.6	92.8	32.7	45.1	46.8	22.2	8.8	2.2	0.2	0.7

4 NORTHEAST ARCTIC HADDOCK (SUBAREAS I AND II)

4.1 Status of the Fisheries

4.1.1 Historical development of the fisheries

Haddock is mainly fished by trawl as a by-catch in the fishery for cod. There is also a directed trawl fishery for haddock and the proportion of total catches taken by this directed fishery varies between years. On average approximately 33% of the catch is with conventional gears, mostly longline, which in the past was used almost exclusively by Norway. Russian longliners have increased their fishing and their total landings was 2 101 t in 2003. Parts of the longline catches are from a directed fishery. National quotas restrict the fishery. In the Norwegian fishery the quotas are set separately for trawl and other gears. The fishery is also regulated by a minimum landing size, a minimum mesh size in trawls and Danish seine, a maximum by-catch of undersized fish, closure of areas with high density/catches of juveniles and other seasonal and areas restrictions.

The exploitation rate of haddock has been variable. The highest fishing mortalities for haddock have occurred at intermediate stock levels and show little relationship with the exploitation rate of cod, in spite of haddock being primarily a by-catch in the cod fishery. The exception is the 1990s when more restrictive quota regulations resulted in a similar pattern in the exploitation rate for both species.

4.1.2 Landings prior to 2004 (Tables 4.1–4.3, Figure 4.1A)

Final reported landings in 2002 are 83 726 t (Table 4.1), which is close to the figure used in last year's assessment. The provisional landings for 2003 are 96 992 t, which is slightly less than the 101 000 t landings expected by the Working Group last year. The agreed TAC was 101 000 t. Catches increased in subareas I and IIa. The catch by area, broken down by trawl and other gears, is given in Table 4.2. The nominal catch by country is given in Table 4.3. Landings from 2002 and 2003 were revised according to official statistics from ICES or reports given directly to the working group.

4.1.3 Expected landings in 2004

The 101 000 t TAC agreed for 2003 was not exceeded. ACFM recommended to set a TAC lower than 120 000 t for 2004. The agreed TAC for 2004 is 130 000 t. The total landing in 2004 is expected to be equal to the agreed TAC.

4.2 Status of Research

4.2.1 Fishing effort and CPUE (Table 4.2)

After a period of reduced trawl fishery for haddock, it has increased in recent years (Table 4.2). The CPUE series of Norwegian trawl fisheries has previously been updated for tuning of the older ages in the VPA. The basis was the trawl effort in Norwegian statistical areas 03, 04, and 05, covering the Norwegian coastal banks north of Lofoten. These areas account for approximately 70% of the Norwegian trawl landings. However, because of the large proportion taken as by-catch it is difficult to estimate the actual trawl effort on haddock. The CPUE series was not used for tuning the XSA in the two previous assessments and the series has not been updated with values for 2002 and 2003.

4.2.2 Survey results (Tables B1-B4)

The overall picture seen in the surveys is summarized as follows: the year class 1997 seems to be poor, the 1998, 1999 and the 2001 year classes appear above average. The 2000 and 2003 year classes appear closer to the average, while the 2002 year class seems to be well above average. The numbers of 6+ appear at low levels. An other important finding common for all 3 surveys are the relatively high indices observed in 2002 relative to the observations in 2001 and 2003. This "year" effect may contribute towards overestimation of the stock size.

Norwegian bottom trawl and acoustic survey

Norway provided indices from the 2004 Barents Sea bottom trawl and acoustic survey in January-March (Table B1 and B3). There was a reduced coverage of the Barents Sea in 1997-1998, but full coverage since then. Trawl survey indices from 1983 onwards have been recalculated in the same way as for cod (Section 3.2.2). High indices, caused by the good period of recruitment around 1990, can be tracked from year to year in both series and the 1990-year class appears as the strongest for age groups 3–8. The year classes 1998 to 2001 have been observed as stronger than the 1992-1997 year classes. The 2002 year class has been observed twice and the last observation is around half of the level observed for the 1990 year class at the same age.

Russian bottom trawl and acoustic survey

Russia provided indices from the 2003 Barents Sea trawl and acoustic survey (Tables B2, B4a, and B4b), which was carried out in October-December. The Russian surveys show the same main trends as the Norwegian survey. From 1995 onwards there has been a substantial change in the method for calculating acoustic indices. The acoustic survey is therefore presented in 2 tables (Table B4a and B4b) for old and new method of calculating indices.

International 0-group survey

Estimates of the abundance of 0-group haddock from the International 0-group survey are presented in Tables A14 and A15. The indices indicate good recruitment for haddock from 1990 to 1994, average from 1995 to 1997, good in 1998, average in 1999 and good again in 2000 and 2001 and very good in 2002. The 2003 year class appear as the strongest ever in the area based index (Table A14) while the logarithmic index suggests a year class strength above the 2000 and 2001 year classes, but lower than the 2002 year class.

4.2.3 Weight-at-age (Tables B5, B6)

Length and weight-at-age from the surveys are given in Tables B5 and B6, respectively. Weights-at-age seems to be somewhat reduced and are very much in line with the weights used in the predictions last year.

4.3 Data Used in the Assessment

4.3.1 Catch-at-age (Table 4.7)

Age and length compositions of the landings for 2003 were available from Norway and Russia in Subarea I, from Norway, Russia, and Germany in Division IIa and IIb. The catches of the other countries were distributed among ages using the combined Norwegian/Russian age composition in Subarea I and in Division IIb, and the Russian trawl age composition in Division IIa (Table 4.7). The SOP check gave no deviation from the nominal catch of 2003.

4.3.2 Weight-at-age (Tables 4.8–4.9, Table B.6)

The mean weights-at-age in the catch (Table 4.8) were calculated as weighted averages of the weights in the catch of Norway and Russia. The weights-at-age in the catch in 2003 are showing a declining tendency for most ages.

Stock weights (Table 4.9) used from 1985 to 2004 are averages of values derived from Russian surveys in autumn (mostly October-December) and Norwegian surveys in January-March the following year (Table B6). These averages are assumed to give representative values for the beginning of the year.

4.3.3 Natural mortality (Table 4.10)

Natural mortality (Table 4.10) was set to 0.2+mortality from predation by cod (see Section 4.4.1). The proportion of F and M before spawning was set to zero.

4.3.4 Maturity-at-age (Table 4.4 and 4.11)

A maturity ogive was available from Russia for the period 1981-2004 (Table 4.4). The ogives for 2001-2003 shows a relatively early maturation compared to the period 1994 to 1998, while the ogive for 2004 indicates a reduction in the proportions mature at age (later spawning). The maturity-at-age series for the whole period 1950-2002 is shown in Table 4.11. The proportions mature for year classes 1989 and 1990 observed in 1994 made “strange jumps” and has been replaced with average proportions observed in 1993 and 1995 for those age groups.

4.3.5 Data for tuning (Table 4.12)

The following surveys series (Table 4.12) are included in the data for tuning:

Name	Place	Season	Age	Year	prior weight
Russian bottom trawl	Total area	Autumn	1–7	1983–2003	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2003	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2003	1

The indices for the 1996 year class were not used for tuning the XSA. See Section 4.4.1 in the 2002 report. Initial inspection of catch curves revealed a very strong year effect in the 1990 Russian BT survey. The working group choose to delete this survey year from this tuning series without further investigations.

4.3.6 Recruitment indices (Table 4.5)

The table with recruitment indices (Table 4.5) covers the year classes 1980 and later. The 0-group index was not used for input to the RCT3. Since the indices of the 1996-year class were removed from the tuning of the XSA, they were also removed from recruitment estimation. See section 4.4.1 in the 2002 report. Similar reasoning led to the removal of the points from the 1990 Russian BT survey.

4.3.7 Prediction data (Table 4.19, Table 4.6)

Weights at age and proportions mature at age shows strong cyclic patterns related to periods of good recruitment. The working group believes that the estimated recruitment in the latest years is so high that it will affect growth and maturation processes. The working group therefore decided to use similar trends in weight at age, maturity and natural mortality as has been observed in previous periods following good recruitment. The input data for making the prediction are presented in Table 4.19 (with only minor changes relative to the procedure in last years assessment):

- The estimated recruitment given in Table 4.6.
- The average fishing pattern observed in the 3 last years.
- Observed maturity for 2004, average maturity for the periods 1987-1989 and 1994-1997 (7 years) for 2006 and maturity at age in 2005 as the average between 2004 and 2006
- Weight at age in the stock for 2005 and 2006 was calculated as the average observed in the period 1994-1997. Last years assessment estimated the 2004 stock weights as the average of the 2003 observations and the 2005 estimates. The 2004 estimates were replaced with the 2004 observations (they were very close).
- Weight at age in the catches for 2005 and 2006 was calculated similarly as the weights in stock. 2004 weights were estimated as average between 2003 and 2004.
- Natural mortality for 2005 and 2006 was calculated similar to the maturity in 2006. Natural mortality in 2004 was calculated as the average of the 2003 and 2005 numbers.
- And stock numbers and fishing mortalities from the standard VPA.

4.4 Methods Used in the Assessment

4.4.1 VPA and tuning (Table 4.10, Table 4.12, Table A16, Figures 4.5-4.8)

The Extended Survivors Analysis (XSA) was used to tune the VPA to the available index series (Table 4.12). The settings used by the AFWG in 2003 were used with the following changes:

- The tuning window was reduced from 20 to 14 years.

- The F shrinkage was giving a weight corresponding to SE=0.5 (changed from 1.0)

Reduction of the tuning window: All the surveys seem to have consistently negative log catchability residuals for the period previous to 1990. The Norwegian BT survey changed gear in 1989 (from bobbins to rockhopper) and even though the previous indices were recalculated using some kind of conversion factor this would introduce more noise (especially for the younger age groups with the highest conversion factor). The Norwegian acoustic survey changed echosounder in 1990 without any calibration between old and new equipment (the new echosounder being the Simrad EK500 with improved bottom detection algorithm). The log catchability residuals from the XSA (see Figures 4.8 and 4.9) tuning are indicative of a trend in catchability even in the 1990's, but since the working group is using stock dependent catchability estimates up to age 7 a tuning window as low as 10 years would be uncomfortably short for estimating 2 catchability parameters per age group.

Increased F shrinkage: The survey indices of the last years are producing results with conflicting signals. See Figure 4.7 that summarises single fleet runs. The Russian BT survey and Norwegian acoustic survey indicates a much more rapid increase in SSB and reduction in F than the Norwegian BT survey. The Norwegian BT survey is the survey with the highest weight in the tuning (all ages). Due to the strong decreasing trend in F the XSA results are very sensitive to changes in the level of F shrinkage. Due to the conflicting signals and rapid change in F (not corresponding to the observed level of fishing effort) the working group choose a conservative solution with increased shrinkage (producing results more similar to the results indicated in the Norwegian BT survey single fleet run). The observed high indices in 2002 (see 4.2.2) did also contribute towards the WG choice of increased F shrinkage in the tuning.

The estimated consumption of NEA haddock by NEA cod is incorporated into the XSA analysis by first constructing a catch number-at-age matrix, adding the numbers of haddock eaten by cod to the catches for the years where such data are available (1984–2003) (Table A16). The consumption of NEA haddock by NEA cod is given below:

	Consumption of Haddock by NEA Cod (millions)					
	1	2	3	4	5	6
1984	980.0	14.7	0.1	0.0	0.0	0.0
1985	1203.5	5.2	0.0	0.0	0.0	0.0
1986	563.9	244.9	168.0	0.0	0.0	0.0
1987	766.7	0.0	0.0	0.0	0.0	0.0
1988	17.1	0.5	9.1	0.0	0.2	0.0
1989	236.4	0.0	0.0	0.0	0.0	0.0
1990	142.3	36.4	3.5	0.0	0.0	0.0
1991	460.5	14.4	0.0	0.0	0.0	0.0
1992	2114.9	151.1	1.1	0.0	0.0	0.0
1993	1377.8	167.7	37.4	3.4	2.9	0.0
1994	1411.1	80.9	25.1	7.8	0.9	0.0
1995	2902.0	164.0	12.0	30.1	30.2	0.3
1996	1593.3	161.0	40.0	5.4	2.6	3.4
1997	904.8	35.5	25.7	1.7	0.8	0.5
1998	1527.6	27.9	2.0	2.9	0.5	0.0
1999	921.9	23.6	0.3	0.0	0.0	0.0
2000	1309.7	66.4	2.0	1.1	0.2	0.1
2001	610.6	55.1	4.8	0.1	0.0	0.0
2002	2588.6	249.2	42.4	2.2	0.1	0.0
2003	3593.9	240.5	40.5	8.7	0.6	0.0

The fishing mortality estimated by this XSA was split into the mortality caused by the fishing fleet (F) and the mortality caused by the cod's predation (M2) according to the ratio of fleet catch and predation "catch". The new natural mortality data set was then prepared by adding 0.2 (M1) to the predation mortality. This new M matrix (Table 4.10) was used in the final XSA. Future work should include the modelling of natural mortalities taking into account the size of the cod stock, the degree of overlap between the cod and haddock stocks and the availability of other prey (mainly capelin).

The retrospective performance of the XSA is illustrated in Figures 4.5 and 4.6.

4.4.2 Recruitment (Tables 4.5-4.6)

The recruiting year classes 2001-2003 were estimated using RCT3 (input given in Tables 4.5 and output given in 4.6). The 0-group index was not used and the indices for the 1996-year class was also removed as were the indices from the Russian 1990 BT survey. The 2003-year class estimate included high weight to "shrinkage" (high weight given to average recruitment). The age 1 indices from both the Norwegian surveys indicated year classes close to the average recruitment.

4.5 Results of the Assessment

4.5.1 Fishing mortality and VPA (Tables 4.10, 4.13–4.18 and Figures 4.1A-D, 4.5-4.7)

The tuning diagnostics of the final XSA (predation included) are given in Table 4.13.

Natural mortalities, fishing mortalities, and stock numbers of the final VPA are given in Tables 4.10, 4.14, and 4.15, respectively, while the stock biomass at age and the spawning biomass at age are given in Tables 4.16 and 4.17. A summary of landings, fishing mortality, spawning stock biomass, and recruitment since 1950 is given in Table 4.18 and Figures 4.1A, 4.1B, 4.1C and 4.1D.

This assessment revised the 2002 fishing mortality slightly downwards compared to last assessment. F_{4-7} indicates a reduced fishing mortality relative to the period 1997-1999.

The most important year class in the fishery in 2001 was the 1996-year classes contributing to 60% of total landings. This contribution was reduced to 31% in 2002 with the younger 1998-year class contributing 42%. The 1998-year class contributes to 52% of the landings in 2003. Of more concern is the observation that the weight proportion of 6+ age groups in the landings is as low as 29% in 2003. (The proportion of 6+ was as high as 86% in 1997.)

The spawning stock biomass estimates represented only minor changes relative to last year's assessment (SSB in 2000-2002). The 1998 year class is making an impact in 2003 and increases the SSB estimate to 125 000 t. The observed proportions mature in 2004 shows a reduction relative to the most recent years and this is a factor contributing to the estimated reduction in 2004 down to 117 000 t.

4.5.2 Recruitment (Tables 4.6, 4.15 and Figure 4.1C)

This year's assessment (Table 4.6, Figure 4.1C) made the following revisions to the estimated year class strength of the recruiting year classes (numbers in millions at age 3). The numbers marked with * are XSA estimates (Table 4.15):

Year Class	2002	2003	2004
1998	265	309 *	273 *
1999	241	330 *	280 *
2000	199	250	187 *
2001	284	277	239
2002		422	384
2003			159

The overall picture is towards lower estimates than the previous assessment more in line with the 2002 assessment.

4.5.3 Yield per Recruit, SSB per Recruit (Table 4.19-4.20, Figures 4.2-4.3)

Yield and SSB per recruit based on the parameters in Table 4.19 are presented in Table 4.20. $F_{0.1}$ and F_{max} were estimated to 0.18 and 0.7 respectively. A plot of SSB versus recruitment is shown in Figures 4.2-4.3.

4.5.4 Catch options for 2003 (Tables 4.19, 4.21-4.22)

The catch in 2003 corresponds to Fbar=0.44 and the estimated spawning stock biomass will be 117 000 t in the beginning of 2004. Assuming a status quo F in 2004 the deterministic projection suggests an increase in SSB to 140 000 t in the beginning of 2005 (which is well above $\mathbf{B}_{pa}$). Fishing at $\mathbf{F}_{pa}$ in 2005 corresponds to total landings of 106 000 t, with a further strengthening of the SSB into the beginning of 2006 (table 4.21). A prediction with single option table is shown in Table 4.22. The input to the prediction is given in Table 4.19.

4.6 Biological reference points.

4.6.1 Biomass reference points

The biomass reference points adopted by ACFM for this stock are $\mathbf{B}_{lim}$=50,000 t and $\mathbf{B}_{pa}$ =80,000 t. No revisions to these values were put forward for consideration at this meeting. However, in light of the strong retrospective year-class dependent bias in haddock assessments it appears that the separation between $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ is rather small. Therefore, a more conservative level for $\mathbf{B}_{pa}$ should be investigated. There is also a need to investigate these reference points relative to the agreed 3 year catch rule and the use of these points in this strategy.

4.6.2 Fishing mortality reference points (Figure 4.4)

The fishing mortality reference points adopted by ACFM for this stock are $\mathbf{F}_{lim}$=0.49 and $\mathbf{F}_{pa}$ =0.35. No revisions to these values were put forward for consideration at this meeting either. However, given the concerns noted above a more conservative level for $\mathbf{F_{pa}}$ should be investigated. The potential need for a more conservative F_{pa} should also be a part of future evaluations of the agreed 3-year catch rule.

4.7 Medium-term simulations

In order to give appropriate advice in accordance with a three-year management strategy, there are three aspects that needs to be considered: the quality of forecasts, the level of reference points and an evaluation of specific harvest control rules. The working group had some discussions related to potential input to a medium-term forecast (deterministic or stochastic), but could not draw any conclusion on the quality of the different suggestions. There was no time to evaluate the uncertainty or the interpretive flexibility due to several reasonable choices of input.

The working group has already addressed concerns about the $\mathbf{B_{pa}}$ not reflecting the uncertainty well enough. We remind that the $\mathbf{B_{pa}}$ is meant to reflect the uncertainty in short-term forecasts. Alternative reference points taking the even higher uncertainty in medium-term forecasts into account should therefore be explored.

A three-year harvest control rule is yet not evaluated for haddock. When neither the quality of a short-term prediction, relevant reference points nor the harvest control rule are evaluated, the working group considers a medium-term prediction inappropriate. The uncertainty would not be sufficiently reflected and a decision based on a medium-term forecast would therefore not be in accordance with the precautionary approach.

4.8 Comments to the assessment and forecasts

These comments relates mainly to uncertainties in assessment and forecasts

Source of uncertainty	*Description*	*Comments*
Incomplete survey coverage (1)	Since 1997 has all of the surveys used for tuning been affected by an incomplete coverage for some of the years. (Due to Norwegian vessels not been given access to REZ, Russian vessels not been given access to NEZ).	All indices affected have been corrected using a factor based on geographical distributions observed before and after the incomplete coverage. This procedure is likely to introduce increased uncertainty to the indices.
Incomplete survey coverage (2)	None of the surveys have a complete coverage of the stock. The proportion of a year class being outside the coverage varies between year classes (see also the WG report from 2002). The most recent “extreme” case is the 1996 year class (deleted from tuning).	May appear as year class dependent changes in survey catchability.
Correlated error structures	Year effects in a survey are quite common. 2 of the tuning series are really the output of two different methods used in the same survey (Norwegian BT and acoustic). The year effect introduces correlated errors between the age groups, but in this case also between survey series.	
Discards	The level of discarding is not known.	Discarding is known to be a (varying) problem in the longline fisheries related to the abundance of haddock close to, but below the minimum landing size.
Unreported catches	See Introduction (description of unreported landings of cod in 2002 and 2003)	Unreported landings of cod: The estimation suggested that other species was also subject to this activity. Which species and how much is not known.

The WG believe that the contributions of the sources of error mentioned above may have increased the uncertainty in the assessment and the predictions the last few years.

The short term forecast is very much depending on the estimates of the year class strength of the incoming year classes. The forecast is also quite depending on the maturity at age, natural mortality and weight at age numbers used as input. These parameters are known to vary quite a lot for this stock and we have tried to create a trend towards observations of such parameters made after period of good recruitment (1987-1989 and 1994-1997). This makes the forecast much more conservative than the traditional average over some range of most recent years. But the working group believes this to be a more realistic approach.

4.8.1 Changes from last year

The following changes was made to the assessment compared to last year:

1) Total landings in 2002 were revised slightly.
2) As in the two previous assessments the tuning data for the 1996 year class was removed.
3) Based on the inspection of catch curves the data from the Russian BT survey in 1990 was not used in tuning.
4) Based on the inspection of Log Catchability Residuals, the working group choose to reduce the tuning window from 20 years to 14 years.
5) Based on the single fleet diagnostics (which showed conflicting signals between the surveys) and the (somewhat unexpected) rapid decline in estimated fishing mortalities the WG decided to change the weight given to F shrinkage from the weight corresponding to SE=1.0 to SE=0.5.

4.9 Technical minutes from ACFM

We quote: "*Catch weights and stock weights-at-age should be re-examined to account for the abrupt change in ages 9 and 10 during the 1980s*."

The cause of the abrupt change in these weights is the replacing of missing (not observed) data points with historic data. These historic data (1950-1982) represents the average of observed values from a period with very high weights (the period is unknown to the current WG, but could possibly be found by looking into old WG reports). The problematic (originally missing) values from 1983-1986 have now been replaced with more realistic values derived using average increments of growth along a cohort. The year classes in question was relatively weak and the changes are expected to produce only minor changes to the perception of the stock.

We quote: "*The WG should consider modelling natural mortality related to cannibalism to determine a method of predicting an alternative to M=0.2 for years prior to 1984*."

None of the WG members prepared anything for this topic. There was not enough time during the WG to look into this and the WG also recognizes a potential need to model natural mortality from 1984 onwards due to the highly varying estimates and a possible need to "smooth" these.

We quote: "*The report should clearly identify which recruitment estimates are results of XSA versus those from the RCT3 model.*"

Done.

Table 4.1 North-East Arctic HADDOCK. Total nominal catch (t) by fishing areas. (Data provided by Working Group members).

Year	Sub-area I	Division IIa	Division IIb	Total
1960	125,026	27,781	1,844	154,651
1961	165,156	25,641	2,427	193,224
1962	160,561	25,125	1,723	187,408
1963	124,332	20,956	936	146,224
1964	79,262	18,784	1,112	99,158
1965	98,921	18,719	943	118,578
1966	125,009	35,143	1,626	161,778
1967	107,996	27,962	440	136,397
1968	140,970	40,031	725	181,726
1969	89,948	40,306	566	130,820
1970	60,631	27,120	507	88,257
1971	56,989	21,453	463	78,905
1972	221,880	42,111	2,162	266,153
1973	285,644	23,506	13,077	322,226
1974	159,051	47,037	15,069	221,157
1975	121,692	44,337	9,729	175,758
1976	94,054	37,562	5,648	137,264
1977	72,159	28,452	9,547	110,158
1978	63,965	30,478	979	95,422
1979	63,841	39,167	615	103,623
1980	54,205	33,616	68	87,889
1981	36,834	39,864	455	77,153
1982	17,948	29,005	2	46,955
1983	7,550	13,872	185	21,607
1984	4,000	13,247	71	17,318
1985	30,385	10,774	111	41,270
1986	69,865	26,006	714	96,585
1987	109,425	38,181	3,048	150,654
1988	43,990	47,087	668	91,745
1989	31,116	23,390	353	54,859
1990	15,093	10,344	303	25,741
1991	18,772	14,417	416	33,605
1992	30,746	22,177	964	53,887
1993	47,574	27,010	3,037	77,621
1994	75,059	46,329	7,315	128,703
1995	70,390	54,169	14,118	138,677
1996	112,781	57,189	3,294	173,264
1997	78,335	67,917	2,504	148,756
1998	45,471	47,774	701	93,946
1999	36,096	42,036	4,214	82,346
2000	25,312	31,857	4,126	61,295
2001	35,071	39,449	7,323	81,842
2002	40,559	30,630	12,537	83,726
2003 [1]	53,124	36,124	7,743	96,992

[1] Provisional figures, Norwegian catches on Russian quotas are included

Table 4.2 North-East Arctic HADDOCK.
Total nominal catch ('000 t) by trawl and other gear for each area.

	Sub-area I		Division IIa		Division IIb
Year	Trawl	Others	Trawl	Others	Trawl
1967	73.7	34.3	20.5	7.5	0.4
1968	98.1	42.9	31.4	8.6	0.7
1969	41.4	47.8	33.2	7.1	1.3
1970	37.4	23.2	20.6	6.5	0.5
1971	27.5	29.2	15.1	6.7	0.4
1972	193.9	27.9	34.5	7.6	2.2
1973	242.9	42.8	14.0	9.5	13.1
1974	133.1	25.9	39.9	7.1	15.1
1975	103.5	18.2	34.6	9.7	9.7
1976	77.7	16.4	28.1	9.5	5.6
1977	57.6	14.6	19.9	8.6	9.5
1978	53.9	10.1	15.7	14.8	1.0
1979	47.8	16.0	20.3	18.9	0.6
1980	30.5	23.7	14.8	18.9	0.1
1981	18.8	17.7	21.6	18.5	0.5
1982	11.6	11.5	23.9	13.5	-
1983	3.7	3.8	7.6	6.3	0.2
1984	1.6	2.4	6.4	6.9	0.1
1985	24.4	6.0	4.5	6.3	0.1
1986	51.7	18.1	12.8	13.2	0.7
1987	77.8	31.6	22.1	16.1	3.0
1988	27.5	16.5	33.6	13.5	0.7
1989	21.4	9.7	11.6	11.7	0.4
1990	5.9	9.2	4.8	5.6	0.3
1991	9.8	9.0	7.8	6.6	0.4
1992	21.2	9.5	9.3	12.9	1.0
1993	37.9	9.7	18.0	9.0	3.0
1994	61.3	13.8	31.3	15.1	7.3
1995	57.0	12.1	32.6	20.5	13.9
1996	96.3	14.2	34.0	22.0	3.2
1997	56.9	20.6	42.1	25.1	2.5
1998	26.4	20.0	25.3	23.5	0.7
1999	28.5	8.5	16.8	23.7	4.9
2000	19.5	5.8	17.1	14.8	4.0
2001	28.4	6.7	21.5	17.9	7.0
2002	30.4	10.2	15.6	15.1	12.5
2003 [1]	40.5	12.7	19.7	16.5	7.3

[1] Provisional

Table 4.3 North-East Arctic HADDOCK. Nominal catch (t) by countries
Sub-area I and Divisions IIa and IIb combined. (Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Re.	Fed. Re. Germ.	Norway	Poland	United Kingdom	Russia[2]	Others	Total
1960	172	-	-	5,597	46,263	-	45,469	57,025	125	154,651
1961	285	220	-	6,304	60,862	-	39,650	85,345	558	193,224
1962	83	409	-	2,895	54,567	-	37,486	91,910	58	187,408
1963	17	363	-	2,554	59,955	-	19,809	63,526	-	146,224
1964	-	208	-	1,482	38,695	-	14,653	43,870	250	99,158
1965	-	226	-	1,568	60,447	-	14,345	41,750	242	118,578
1966	-	1,072	11	2,098	82,090	-	27,723	48,710	74	161,778
1967	-	1,208	3	1,705	51,954	-	24,158	57,346	23	136,397
1968	-	-	-	1,867	64,076	-	40,129	75,654	-	181,726
1969	2	-	309	1,490	67,549	-	37,234	24,211	25	130,820
1970	541	-	656	2,119	37,716	-	20,423	26,802	-	88,257
1971	81	-	16	896	45,715	43	16,373	15,778	3	78,905
1972	137	-	829	1,433	46,700	1,433	17,166	196,224	2,231	266,153
1973	1,212	3,214	22	9,534	86,767	34	32,408	186,534	2,501	322,226
1974	925	3,601	454	23,409	66,164	3,045	37,663	78,548	7,348	221,157
1975	299	5,191	437	15,930	55,966	1,080	28,677	65,015	3,163	175,758
1976	536	4,459	348	16,660	49,492	986	16,940	42,485	5,358	137,264
1977	213	1,510	144	4,798	40,118	-	10,878	52,210	287	110,158
1978	466	1,411	369	1,521	39,955	1	5,766	45,895	38	95,422
1979	343	1,198	10	1,948	66,849	2	6,454	26,365	454	103,623
1980	497	226	15	1,365	61,886	-	2,948	20,706	246	87,889
1981	381	414	22	2,398	58,856	**Spain**	1,682	13,400	-	77,153
1982	496	53	-	1,258	41,421	-	827	2,900	-	46,955
1983	428	-	1	729	19,371	139	259	680	-	21,607
1984	297	15	4	400	15,186	37	276	1,103	-	17,318
1985	424	21	20	395	17,490	77	153	22,690	-	41,270
1986	893	33	75	1,079	48,314	22	431	45,738	-	96,585
1987	464	26	83	3,106	69,333	99	563	76,980	-	150,654
1988	1,113	116	78	1,324	57,273	72	435	31,293	41	91,745
1989	1,218	125	26	171	31,825	1	590	20,903	-	54,859
1990	875	-	5	128	17,634	-	494	6,605	-	25,741
1991	1,117	60	**Greenld**	219	19,285	-	514	12,388	22	33,605
1992	1,093	151	1,719	387	30,203	38	596	19,699	1	53,887
1993	546	1,215	880	1,165	36,590	76	1,802	34,700	646	77,620
1994	2,761	678	770	2,412	64,688	22	4,673	51,822	877	128,703
1995	2,833	598	1,351	2,675	72,864	14	3,108	54,516	718	138,677
1996	3,743	537	1,524	942	89,500	669	2,275	73,857	217	173,264
1997	3,327	495	1,877	972	97,789	424	2,340	41,228	304	148,756
1998	1,566	241	854	385	68,747	257	1,241	20,559	96	93,946
1999	1,003	64	252	437	48,632	652	694	30,520	92	82,346
2000	631	169	432	931	34,172	582	814	22,738	823	61,292
2001	1,210	324	553	554	41,269	1,497	1,068	34,307	2,471	81,842
2002	1,564	297	858	627	39,910	1,505	1,125	37,157	683	83,726
2003[1]	1,737	336	1363	918	48,548	846	1,018	41,140	1,086	96,992

[1] Provisional figures, Norwegian catches on Russian quotas are included.
[2] USSR prior to 1991.

Table 4.4 North-East Arctic HADDOCK. Maturity at age in percent from Russian data

	Age									
Year	3	4	5	6	7	8	9	10	11	12
1981	1	12	64	73	96	100	100	-	-	-
1982	9	55	73	93	96	100	93	-	-	-
1983	17	70	100	99	99	100	-	-	-	-
1984	7	14	35	47	74	82	89	-	-	-
1985	2	8	80	93	96	91	96	-	-	-
1986	0	22	53	86	86	100	83	100	-	-
1987	0	1	21	53	100	100	-	100	-	-
1988	0	3	33	51	-	-	-	-	-	-
1989	0	4	30	63	82	100	-	-	-	-
1990	0	2	30	54	77	87	80	100	-	-
1991	0	7	30	50	80	92	100	100	-	-
1992	2	13	50	62	77	80	94	100	-	-
1993	2	7**	49	76	79	88	88	87	100	100
1994	0	2	31**	59**	90	88	100	100	97	100
1995	0	2	12	42	81	88	100	87	100	94
1996	0	0	10	36	78	86	90	93	90	100
1997	0	3	10	29	60	82	100	83	100	100
1998	0	5	28	50	66	81	91	100	-	100
1999	1	17	50	71	81	91	92	100	100	-
2000	0	10	32	59	72	94	94	96	100	100
2001	0	6	54	72	87	94	90	100	91	100
2002	1	13	33	73	83	90	100	94	100	100
2003	0	5	40	69	91	100	94	100	100	100
2004*	0	3	20	58	84	93	100	88	100	100

* Preliminary data (not used in assessment)
(Data provided by Working Group members).
** Values changed in 2004

Table 4.5 North-East Arctic HADDOCK. Input data for recruitment prediction (RCT3).

Yearclass in first column, VPA numbers at age 3 in second.

Year	VPA	RT1	RT2	NT2	NT3	NT4	RT0	NT1	NA1	0GP_A
1980	4.7	-11.0	-11.0	1.5	3.1	1.5	-11.0	3.1	7.0	68.0
1981	8.4	-11.0	9.5	4.8	18.9	14.7	-11.0	3.9	9.0	30.0
1982	254.7	59.2	58.4	514.6	475.9	110.8	-11.0	2919.3	0.3	107.0
1983	525.8	58.6	134.3	1593.8	384.6	290.2	29.8	3832.6	1685.0	219.0
1984	86.2	14.4	10.7	370.3	154.4	68.9	6.4	1901.1	1530.0	293.0
1985	43.1	1.4	1.7	79.9	25.3	21.6	3.0	665.0	556.0	156.0
1986	16.8	0.9	0.7	15.3	14.1	3.4	0.2	163.8	85.0	160.0
1987	24.4	0.3	2.4	9.5	4.5	5.1	0.3	35.4	18.0	72.0
1988	81.4	1.8	10.6	54.6	33.4	24.4	1.3	81.2	52.0	86.0
1989	194.4	14.3	17.6	300.3	150.5	105.6	2.2	644.1	270.0	112.0
1990	632.5	42.9	128.6	1375.5	507.7	436.6	44.8	2006.0	1890.0	227.0
1991	276.8	28.2	35.7	599.0	339.5	171.1	16.7	1659.4	1135.0	472.0
1992	79.9	4.8	5.8	228.0	53.6	48.1	16.4	727.9	947.0	313.0
1993	90.1	4.9	4.2	179.3	52.5	28.0	3.5	603.2	562.0	240.0
1994	99.2	7.2	5.7	263.6	86.1	33.2	9.1	1463.6	1379.0	282.0
1995	41.0	2.3	1.9	67.9	22.7	12.2	6.4	309.5	249.0	148.0
1996	187.7	4.6	11.5	137.9	59.8	35.4	6.0	1268.0	693.0	196.0
1997	63.8	2.9	6.1	57.6	27.2	29.3	1.8	212.9	220.0	150.0
1998	272.9	28.9	26.2	452.2	296.0	185.3	10.7	1244.9	856.0	593.0
1999	280.1	20.7	26.1	460.3	314.7	182.0	11.7	847.2	1024.0	184.0
2000	187.2	14.9	18.9	534.7	317.4	102.7	15.1	1220.5	976.0	417.0
2001	-11.0	19.3	25.1	513.1	188.1	-11.0	20.8	1680.3	2062.0	394.0
2002	-11.0	32.8	-11.0	711.2	-11.0	-11.0	33.2	3332.1	2394.0	412.0
2003	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0	19.8	715.9	752.0	705.0

1996 yearclass also removed from XSA tuning
RT1 Russian bottom trawl survey age 2
RT2 Russian bottom trawl survey age 3
NT2 Norwegian bottom trawl survey age 2
NT3 Norwegian bottom trawl survey age 3
NT4 Norwegian bottom trawl survey age 4
RT0 Russian bottom trawl survey age 0
NT1 Norwegian bottom trawl survey age 1
NA1 Norwegian acoustic survey age 1
0GP_A International 0 Group Suarea based index

Table 4.6

```
Analysis by RCT3 ver3.1 of data from file :
t1_96new
NORTHEAST ARCTIC HADDOCK: recruits as 3 year-olds
Data for    8 surveys over   14 years :  1990 - 2003
Regression type = C
Tapered time weighting applied power =    3 over  20 years Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression
Forecast/Hindcast variance correction used.
Yearclass =   2000
I-----------Regression----------I  I-----------Prediction---------I
Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std  WAP
Series  cept   Error    Pts  Value   Value    Error   Weights
RT1 .   91      2.76    .18 .964    9   2.77    5.28    .223    .247
RT2 .   76      2.98    .21 .952    9   2.99    5.26    .259    .184
NT2 .   92      -.19    .34 .886    9   6.28    5.62    .423    .069
NT3 .   76      1.37    .20 .959    9   5.76    5.76    .250    .197
NT4 .   77      1.69    .18 .965    9   4.64    5.25    .221    .252
RT0     2.02    .38   1.18   .323  8   2.78    5.99    1.545  .005
NT1     1.44  -4.65    .73   .626  9   7.11    5.58    .902    .015
NA1     1.54  -5.21    .80   .583  9   6.88    5.39    .977    .013
VPA Mean =    4.97  .827    .018
Yearclass =   2001
I-----------Regression----------I  I-----------Prediction---------I
Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std  WAP
Series  cept   Error    Pts  Value   Value    Error   Weights
RT1        .91   2.77    .17   .964     10   3.01    5.49     .206     .379
RT2        .77   2.97    .20   .952     10   3.26    5.47     .242     .276
NT2        .91   -.12    .34   .872     10   6.24    5.53     .412     .095
NT3        .74   1.43    .25   .925     10   5.24    5.30     .302     .177
NT4
RT0 1.86    .65   1.03   .358   9   3.08    6.40    1.380   .008
NT1 1.41  -4.48    .68   .626  10   7.43    5.99   .855    .022
NA1 1.52  -5.07    .74   .587  10   7.63    6.51   .979    .017
VPA Mean =    4.99  .780    .026
Yearclass =   2002
I-----------Regression----------I  I-----------Prediction---------I
Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std  WAP
Series  cept   Error    Pts  Value   Value    Error   Weights
RT1 .90   2.77    .17   .965   10   3.52    5.95   .219    .691
RT2
NT2 .90   -.10    .34   .868   10   6.57    5.83   .435    .175
NT3
NT4
RT0 1.85    .69   1.03   .364   9   3.53    7.24    1.550   .014
NT1 1.40  -4.41    .68   .621  10   8.11    6.95   .989    .034
NA1 1.51  -4.98    .74   .586  10   7.78    6.73    1.025  .032
VPA Mean =    4.98  .774    .055
Yearclass =   2003
I-----------Regression----------I  I-----------Prediction---------I
Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std  WAP
Series  cept   Error    Pts  Value   Value    Error   Weights
RT1
RT2
NT2
NT3
NT4
RT0 1.84    .73   1.03   .371   9   3.03    6.32    1.393   .106
NT1 1.39  -4.34    .69   .616  10   6.57    4.81   .842    .290
NA1 1.49  -4.88    .74   .585  10   6.62    5.00   .898    .255
VPA Mean =    4.97  .767    .349
Year    Weighted    Log Int Ext Var VPA Log
Class   Average WAP Std Std    Ratio    VPA
Prediction  Error   Error
2000    219 5.39    .11 .08 .48    188  5.24
2001    239 5.48    .13 .08 .39
2002    384 5.95    .18 .16 .79
2003    159 5.07    .45 .25 .31
```

Table 4.7

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

YEAR	1950	1951	1952	1953
AGE				
3	3189	65643	6012	64528
4	37949	9178	151996	13013
5	35344	18014	13634	70781
6	18849	13551	9850	5431
7	28868	6808	4693	2867
8	9199	6850	3237	1080
9	1979	3322	2434	424
10	1093	1182	606	315
+gp	2977	1348	880	1005
0 TOTALNUM	139447	125896	193342	159444
TONSLAND	132125	120077	127660	123920
SOPCOF %	45	65	51	57

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

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	6563	1154	16437	2074	1727	20318	39910	15429	39503	28466
4	154696	10689	5922	24704	5914	7826	70912	56855	30868	72736
5	5885	176678	14713	7942	31438	7243	13647	63351	48903	18969
6	27590	4993	127879	12535	5820	14040	7101	8706	33836	13579
7	3233	28273	3182	46619	12748	3154	6236	3578	3201	9257
8	1302	1445	8003	1087	17565	2237	1579	4407	1341	1239
9	712	271	450	1971	822	5918	2340	788	1773	559
10	319	100	200	356	1072	285	2005	527	242	409
+gp	543	100	185	176	601	500	606	1434	756	375
0 TOTALNUM	200843	223703	176971	97464	77707	61521	144336	155075	160423	145589
TONSLAND	156788	202286	213924	123583	112672	88211	154651	193224	187408	146224
SOPCOF %	60	47	55	57	61	80	84	80	75	74

1

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	22363	5936	26345	15907	657	1524	23444	1978	230942	70679
4	49290	46356	22631	41346	67632	1968	2454	24358	22315	260520
5	30672	40201	63176	13496	41267	44634	1906	1257	42981	24180
6	5815	12631	29048	25719	7748	19002	22417	918	3206	6919
7	3527	1679	5752	8872	15599	3620	8100	9279	1611	422
8	2716	974	582	1616	5292	4937	2012	3056	6758	426
9	833	897	438	218	655	1628	2016	826	2638	1692
10	104	123	189	175	182	316	740	1043	900	529
+gp	633	802	242	271	286	109	293	534	1652	584
0 TOTALNUM	115953	109599	148403	107620	139318	77738	63382	43249	313003	365951
TONSLAND	99158	118578	161778	136397	181726	130820	88257	78905	266153	322226
SOPCOF %	62	70	66	79	79	80	75	101	86	83

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

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	9685	10037	13994	55967	47311	17540	627	486	883	704
4	41706	14088	13454	22043	18812	35290	22878	2561	900	1930
5	88120	33871	6810	7368	4076	10645	21794	22124	3372	884
6	5829	49711	20796	2586	1389	1429	2971	10685	12203	1374
7	4138	2135	40057	7781	1626	812	250	1034	2625	3282
8	382	1236	1247	11043	2596	546	504	162	344	906
9	618	92	1350	311	6215	1466	230	162	75	52
10	2043	131	193	388	162	2310	842	72	80	37
+gp	1870	934	1604	379	400	323	1460	963	649	172
0 TOTALNUM	154391	112235	99505	107866	82587	70361	51556	38249	21131	9341
TONSLAND	221157	175758	137264	110158	95422	103623	87889	77153	46955	21607
SOPCOF %	87	81	63	77	95	113	104	99	95	96

Table 4.7 (continued)

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

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	3	447	29548	25596	3928	794	1045	516	3968	12342	13398
	4	825	1153	61470	88294	9031	3932	1171	1967	12652	25902
	5	820	546	1013	52609	50869	12246	1866	1886	2411	13154
	6	301	715	376	586	19465	22922	4126	2876	1740	2784
	7	750	316	346	207	382	3407	6734	4442	2070	973
	8	2206	634	144	123	65	246	849	4422	2619	1297
	9	489	1312	295	74	35	11	388	398	2737	2131
	10	69	416	484	119	44	36	50	21	241	2011
	+gp	284	113	157	285	310	66	30	17	18	384
0	TOTALNUM	6191	34753	89881	146225	80995	43911	15730	19997	36830	62034
	TONSLAND	17318	41270	96585	150654	91745	54859	25741	33605	53887	77621
	SOPCOF %	96	98	91	99	100	97	99	96	101	100

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

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE										
	3	3048	1282	1622	2193	2411	20329	939	12010	4735	3270
	4	43740	12915	5512	6043	13615	7722	30029	5268	35258	19767
	5	32614	71007	34791	11506	8214	16295	5458	35236	7224	38441
	6	8330	20209	70893	32302	7303	5765	4489	4045	15782	5044
	7	1627	3361	10315	47298	12003	3574	1686	2468	1651	6993
	8	660	367	1885	4579	17811	7095	1206	885	1017	699
	9	1142	295	417	530	1117	2764	1390	493	261	309
	10	1756	447	281	183	227	255	1830	855	235	148
	+gp	1889	963	1230	536	227	139	327	1014	758	472
0	TOTALNUM	94806	110846	126946	105170	62928	63938	47354	62274	66921	75143
	TONSLAND	128703	138677	173264	148756	93946	82346	61292	81842	83726	96992
	SOPCOF %	111	105	105	105	106	106	100	100	100	100
	1										

Table 4.8

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 2 Catch weights at age (kg)

	YEAR	1950	1951	1952	1953
	AGE				
	3	0.66	0.66	0.66	0.66
	4	1.03	1.03	1.03	1.03
	5	1.79	1.79	1.79	1.79
	6	2.38	2.38	2.38	2.38
	7	2.86	2.86	2.86	2.86
	8	3.33	3.33	3.33	3.33
	9	3.7	3.7	3.7	3.7
	10	4.41	4.41	4.41	4.41
	+gp	5.4	5.4	5.4	5.4
0	SOPCOFAC	0.4545	0.6514	0.5127	0.5742

Table 2 Catch weights at age (kg)

	YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
	AGE										
	3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
	5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
	6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
	7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
	8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
	9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
	10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
	+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
0	SOPCOFAC	0.6021	0.4731	0.5529	0.5679	0.6146	0.8007	0.8379	0.8026	0.7459	0.7442
	1										

Table 4.8 (continued)

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 2 Catch weights at age (kg)

YEAR		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE											
	3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
	5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
	6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
	7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
	8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
	9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
	10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp		5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
0 SOPCOFAC		0.6183	0.6978	0.6601	0.7919	0.7921	0.8028	0.7547	1.0105	0.8593	0.8281

Table 2 Catch weights at age (kg)

YEAR		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE											
	3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	1.52
	4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.86
	5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	2.1
	6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.443
	7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.753
	8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.014
	9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.32
	10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	3.635
+gp		5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	3.914
0 SOPCOFAC		0.8657	0.8127	0.6296	0.7708	0.9507	1.1278	1.0352	0.9942	0.951	0.9552

Table 2 Catch weights at age (kg)

YEAR		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE											
	3	1.57	0.92	0.86	0.64	0.58	0.8	0.89	0.77	0.84	0.59
	4	1.99	1.66	1.25	0.86	0.84	0.89	1.22	1.31	1.36	1.06
	5	2.42	2.39	1.88	1.33	1.05	1.17	1.4	1.61	1.7	1.52
	6	2.68	2.71	2.41	2.45	1.43	1.37	1.6	1.86	1.96	1.84
	7	2.93	2.89	2.66	2.98	1.97	1.71	1.77	2.11	2.29	2.18
	8	3.37	3.22	3.04	2.98	2.52	2.01	2.16	2.34	2.39	2.3
	9	3.676	3.526	3.346	3.286	2.826	2.316	2.466	2.93	2.32	2.52
	10	3.39	3.84	3.66	3.6	3.14	2.63	2.78	2.34	2.88	2.64
+gp		4.27	4.12	3.94	3.88	3.42	2.91	3.06	3.24	3.14	3.11
0 SOPCOFAC		0.9616	0.983	0.9078	0.9872	1.0026	0.9675	0.9884	0.9599	1.0132	1.0021

Table 2 Catch weights at age (kg)

YEAR		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE											
	3	0.54	0.63	0.64	0.66	0.71	0.73	0.6	0.63	0.583	0.608
	4	0.88	0.66	0.79	0.99	0.9	1.06	1.09	0.97	0.999	0.86
	5	1.33	1.06	1.04	1.09	1.27	1.27	1.39	1.4	1.403	1.305
	6	1.74	1.68	1.34	1.22	1.38	1.55	1.59	1.76	1.663	1.715
	7	2.06	2.11	1.81	1.48	1.54	1.66	1.82	1.95	2.145	2.089
	8	2.2	2.34	2.29	1.99	1.79	1.79	1.91	2.13	2.254	2.356
	9	2.5	2.67	2.31	2.26	2.37	2.06	2.07	2.32	2.725	2.627
	10	2.58	2.91	3.18	2.26	2.51	2.6	2.22	2.41	2.505	3.294
+gp		2.89	3.02	2.62	2.98	2.68	2.85	2.58	2.56	2.762	3.314
0 SOPCOFAC		1.1128	1.0546	1.0524	1.0498	1.0595	1.0552	1.0019	1.0027	1.0016	1.0007
	1										

Table 4.9

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 3 Stock weights at age (kg)

YEAR	1950	1951	1952	1953
AGE				
3	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875
1										

Table 3 Stock weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.48
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.043
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.641
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.081
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.592
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	2.345
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	2.741
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	3.022
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	3.705

Table 4.9 (continued)

Table 3 Stock weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0.289	0.435	0.296	0.241	0.214	0.279	0.264	0.373	0.342	0.298
4	0.964	0.773	0.776	0.481	0.386	0.441	0.73	0.774	0.82	0.808
5	1.81	1.874	1.049	0.927	0.62	0.679	0.945	1.438	1.519	1.43
6	2.506	2.456	1.47	1.47	1.124	1.005	1.291	1.63	1.962	2.002
7	2.24	1.835	1.835	1.835	1.835	1.415	1.557	1.793	2.24	2.265
8	2.345	2.345	2.345	3.1	2.345	2.345	2.004	2.233	2.32	3.045
9	2.741	2.741	2.741	2.741	2.741	2.741	2.716	2.731	2.568	3.391
10	3.022	3.022	3.022	3.022	3.022	3.022	3.022	3.092	3.525	3.4
+gp	3.705	3.705	3.705	3.705	3.705	3.705	3.705	3.705	3.705	4.2

Table 3 Stock weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0.234	0.215	0.208	0.205	0.234	0.282	0.23	0.308	0.194	0.241
4	0.54	0.362	0.448	0.388	0.459	0.592	0.684	0.492	0.578	0.475
5	1.059	0.803	0.685	0.684	0.829	1.017	1.059	1.174	0.973	1.074
6	1.531	1.444	1.125	1.108	1.193	1.488	1.296	1.555	1.518	1.44
7	1.939	1.95	1.845	1.468	1.462	1.653	1.487	2.026	2.049	1.953
8	2.509	2.913	2.43	2.442	1.966	1.914	1.608	2.488	2.469	2.484
9	2.374	2.934	2.815	3.218	3.155	2.539	1.814	2.625	2.704	2.784
10	2.621	3.033	3.323	3.333	2.815	3.893	2.21	2.648	2.867	2.962
+gp	3.16	3.163	3.479	4.648	3.423	3.9	2.978	3.817	3.141	4.655

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Table 4.10

Table 4 Natural Mortality (M) at age

YEAR	1950	1951	1952	1953
AGE				
3	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

1

Table 4.10 (continued)

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 4 Natural Mortality (M) at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0.2103	0.2	0.6402	0.2	0.4744	0.2	0.3742	0.2	0.2062	0.2674
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2285
5	0.2	0.2	0.2	0.2	0.2023	0.2	0.2	0.2	0.2	0.3035
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0.3045	0.382	0.8656	0.5352	0.2525	0.202	0.2324	0.2195	0.3738	0.439
4	0.219	0.3851	0.326	0.2578	0.2668	0.2	0.2101	0.2015	0.2127	0.2521
5	0.2135	0.3165	0.2273	0.2322	0.2299	0.2	0.2125	0.2	0.2042	0.2057
6	0.2009	0.2105	0.2259	0.2115	0.2	0.2	0.2094	0.2	0.2011	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

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Table 4.11

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 5 Proportion mature at age

YEAR	1950	1951	1952	1953
AGE				
3	0	0	0	0
4	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98
9	1	1	1	1
10	1	1	1	1
+gp	1	1	1	1

Table 5 Proportion mature at age

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

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Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 5 Proportion mature at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0	0	0	0	0	0	0	0.01	0.09	0.17
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.12	0.55	0.7
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.64	0.73	1
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.73	0.93	1
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.96	0.96	1
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 4.11(continued)

Table 5 Proportion mature at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0.07	0.02	0	0	0	0	0	0	0.02	0.015
4	0.14	0.08	0.22	0.01	0.03	0.04	0.02	0.07	0.13	0.0735
5	0.35	0.8	0.53	0.21	0.33	0.3	0.3	0.3	0.5	0.49
6	0.47	0.93	0.86	0.53	0.51	0.63	0.54	0.5	0.62	0.76
7	0.74	0.96	0.86	1	1	0.82	0.77	0.8	0.77	0.79
8	1	1	1	1	1	1	0.87	0.92	0.8	0.88
9	1	1	1	1	1	1	0.8	1	0.94	0.88
10	1	1	1	1	1	1	1	1	1	0.87
+gp	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0	0	0	0	0	0.01	0	0.004	0.008	0.003
4	0.017	0.02	0	0.03	0.05	0.17	0.1	0.06	0.13	0.05
5	0.305	0.12	0.1	0.1	0.28	0.5	0.32	0.54	0.33	0.4
6	0.59	0.42	0.36	0.29	0.5	0.71	0.59	0.72	0.73	0.69
7	0.9	0.81	0.78	0.6	0.66	0.81	0.72	0.87	0.83	0.91
8	0.88	0.88	0.86	0.82	0.81	0.91	0.94	0.94	0.9	1
9	1	1	0.9	1	0.91	0.92	0.94	0.9	1	0.94
10	1	0.87	0.93	0.83	1	1	0.96	1	0.94	1
+gp	0.97	1	0.9	1	1	1	1	0.91	1	1
1										

Table 4.12

NEA haddock final 2004
103
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7
1983 2003
1 1 0.90 1.00
1 7

1	592.0	95.0	5.0	4.0	0.1	0.0	0.0
1	586.0	584.0	15.0	2.0	1.0	0.1	0.0
1	144.0	1343.0	900.0	4.0	1.0	1.0	0.0
1	14.0	107.0	363.0	164.0	1.0	0.1	0.1
1	9.0	17.0	83.0	225.0	57.0	0.1	0.1
1	3.0	7.0	17.0	40.0	76.0	8.0	0.1
1	18.0	24.0	4.0	14.0	41.0	81.0	11.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	429.0	176.0	62.0	9.0	3.0	6.0	18.0
1	282.0	1286.0	346.0	50.0	4.0	6.0	9.0
1	48.0	357.0	1985.0	356.0	48.0	8.0	4.0
1	49.0	58.0	442.0	1014.0	116.0	15.0	1.0
1	72.0	42.0	31.0	123.0	370.0	40.0	5.0
1	23.0	57.0	28.0	49.0	362.0	334.0	29.0
1	0.0	19.0	32.0	32.0	10.0	27.0	10.0
1	29.0	0.0	38.0	46.0	8.0	5.0	15.0
1	289.0	61.0	0.0	39.0	37.0	8.0	3.0
1	207.0	262.0	60.0	0.0	26.0	11.0	2.0
1	149.0	261.0	334.0	40.0	0.0	11.0	4.0
1	193.0	189.0	399.0	450.0	47.0	0.0	4.0
1	328.0	251.0	221.0	299.0	231.0	34.0	0.0

FLT02: Norwegian acoustic, age 1-7, shifted
1980 2003
1 1 0.99 1.00
1 7

1	140	50	210	600	180	10	0
1	20	30	40	40	100	60	0
1	50	20	30	10	10	40	20
1	1730	60	20	10	0	0	0
1	7760	2150	50	0	0	0	0
1	2660	4520	1890	0	0	0	0
1	170	490	1710	500	0	0	0
1	40	80	230	460	70	0	0
1	50	60	110	200	210	20	0
1	350	30	30	40	70	110	20
1	2520	450	80	30	30	30	60
1	8680	1340	230	20	0	0	10
1	6260	5630	1300	130	0	0	0
1	1930	2550	6310	1110	120	0	0
1	2850	360	1110	3870	420	20	0
1	2290	440	310	760	1510	80	0
1	240	510	170	120	430	430	20
1	0	200	280	120	50	130	160
1	460	0	130	140	40	10	20
1	5090	320	0	190	110	20	10
1	3160	2100	230	0	10	10	0
1	2820	2160	1490	140	0	10	0
1	2790	1450	1980	1690	170	0	0
1	4740	1270	760	760	660	70	0

Table 4.12 (contin.)

FLT04: Norwegian BT survey, age 1-8, shifted
1982 2003
1 1 0.99 1.00
1 8

1	48	31	24	9	19	25	7	0
1	5146	189	15	8	2	1	4	1
1	15938	4759	147	5	5	1	1	4
1	3703	3846	1108	6	2	1	1	1
1	799	1544	2902	529	0	0	0	0
1	153	253	689	1164	138	1	0	0
1	95	141	216	340	327	34	1	0
1	546	45	34	50	92	118	18	0
1	3003	334	51	42	27	17	42	0
1	13755	1505	244	21	6	7	16	23
1	5990	5077	1056	105	6	4	3	4
1	2280	3395	4366	497	34	2	1	2
1	1793	536	1711	3395	345	28	0	1
1	2636	525	481	1486	2528	116	9	0
1	679	861	280	194	467	622	35	1
1	0	227	332	132	34	80	81	7
1	576	0	122	102	28	10	17	11
1	4522	272	0	84	40	8	3	7
1	4603	2960	293	0	17	9	1	1
1	5347	3147	1853	176	0	8	3	0
1	5131	3174	1820	736	55	0	2	1
1	7112	1881	1027	804	462	59	0	2

Table 4.13

Lowestoft VPA Version 3.1

11/05/2004 10:49

Extended Survivors Analysis

NEA Haddock (Final XSA AFWG04)

CPUE data from file fleet

Catch data for 54 years. 1950 to 2003. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: Russiar	1990	2003	1	7	0.9	1
FLT02: Norweg	1990	2003	1	7	0.99	1
FLT04: Norweg	1990	2003	1	8	0.99	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 7

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 7

Catchability independent of age for ages >= 9

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00021

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	0	0.0009	0.0218	0.1257	0.369	0.2785	0.6808	0.5725	0.6471	0.663
Iteration 30	0	0.0009	0.0218	0.1257	0.369	0.2785	0.6808	0.5726	0.6472	0.6631

Table 4.13 (continued)

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0	0	0	0	0	0	0	0	0	0
2	0.003	0.001	0.002	0.004	0.009	0.006	0.002	0.002	0.001	0.001
3	0.013	0.019	0.028	0.029	0.068	0.126	0.017	0.05	0.02	0.022
4	0.108	0.08	0.128	0.203	0.318	0.334	0.28	0.124	0.207	0.126
5	0.479	0.276	0.363	0.472	0.497	0.832	0.422	0.627	0.25	0.369
6	0.671	0.637	0.537	0.704	0.644	0.82	0.578	0.651	0.648	0.278
7	0.701	0.637	0.816	0.885	0.628	0.778	0.605	0.75	0.611	0.681
8	0.477	0.328	0.941	1.151	1.064	0.996	0.664	0.762	0.826	0.573
9	0.617	0.406	0.775	0.77	1.034	0.446	0.526	0.636	0.531	0.647
10	0.726	0.524	0.875	0.988	0.932	0.703	0.605	0.733	0.73	0.663

1

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1994	1.90E+06	1.89E+05	2.80E+05	4.78E+05	9.53E+04	1.89E+04	3.57E+03	1.92E+03	2.74E+03	3.76E+03
1995	3.55E+06	2.91E+05	8.08E+04	2.04E+05	3.45E+05	4.77E+04	7.89E+03	1.45E+03	9.77E+02	1.21E+03
1996	1.77E+06	3.00E+05	9.12E+04	5.41E+04	1.28E+05	1.91E+05	2.04E+04	3.42E+03	8.54E+02	5.33E+02
1997	1.31E+06	8.80E+04	1.01E+05	3.73E+04	3.44E+04	7.11E+04	8.90E+04	7.40E+03	1.09E+03	3.22E+02
1998	1.65E+06	2.64E+05	4.14E+04	5.72E+04	2.35E+04	1.70E+04	2.84E+04	3.01E+04	1.92E+03	4.14E+02
1999	1.49E+06	1.02E+05	1.90E+05	3.01E+04	3.19E+04	1.14E+04	7.30E+03	1.24E+04	8.50E+03	5.58E+02
2000	1.87E+06	4.08E+05	6.42E+04	1.37E+05	1.76E+04	1.14E+04	4.10E+03	2.75E+03	3.76E+03	4.45E+03
2001	1.18E+06	4.03E+05	2.75E+05	5.00E+04	8.36E+04	9.34E+03	5.17E+03	1.83E+03	1.16E+03	1.82E+03
2002	2.69E+06	4.77E+05	2.82E+05	2.10E+05	3.61E+04	3.66E+04	3.99E+03	2.00E+03	7.01E+02	5.01E+02
2003	3.07E+06	4.00E+05	1.89E+05	1.90E+05	1.38E+05	2.29E+04	1.57E+04	1.77E+03	7.17E+02	3.37E+02

Estimated population abundance at 1st Jan 2004

0.00E+00	3.52E+05	1.60E+05	1.19E+05	1.30E+05	7.77E+04	1.42E+04	6.49E+03	8.18E+02	3.07E+02

Taper weighted geometric mean of the VPA populations:

1.67E+06	2.55E+05	1.28E+05	8.19E+04	4.77E+04	2.18E+04	9.42E+03	3.82E+03	1.63E+03	7.63E+02

Standard error of the weighted Log(VPA populations) :

0.6673	0.81	0.8764	0.9726	1.0082	1.0068	1.0713	1.1063	1.082	1.2252

1

Log catchability residuals.

Fleet : FLT01: Russian BT su

Age	1990	1991	1992	1993
1	99.99	0.21	0.16	-0.31
2	99.99	0.07	0.25	0.1
3	99.99	-0.01	0.24	0.19
4	99.99	-0.25	-0.2	0.47
5	99.99	-0.45	-0.44	0.29
6	99.99	-0.79	0.06	0.28
7	99.99	0.16	0.33	0.43
8	No data for this fleet at this age			

Table 4.13 (continued)

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.63	-0.53	-0.32	99.99	-0.24	0.55	0.24	-0.01	0.1	0.56
2	-0.02	-0.47	-0.33	-0.11	99.99	0.37	-0.03	-0.04	-0.06	0.31
3	0.06	-0.35	-0.24	-0.45	0.4	99.99	0.21	-0.13	0.04	0.1
4	0.03	-0.65	-0.05	0	-0.05	0.42	99.99	-0.22	0.29	0.04
5	0.02	-0.51	0.46	-0.7	-0.46	0.53	0.6	99.99	0.18	0.06
6	0.06	0.04	0.58	-0.67	-0.9	0.11	0.2	0.45	99.99	0.29
7	-0.69	0.07	1.04	-1.43	-0.13	-0.23	-0.23	0.37	0.5	99.99
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	7
Mean Log q	-6.6357
S.E(Log q)	0.6577

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.77	0.557	9.44	0.42	12	0.43	-7.95
2	0.71	2.218	8.68	0.88	12	0.27	-7.07
3	0.64	3.069	8.5	0.9	12	0.28	-6.63
4	0.77	1.961	7.5	0.9	12	0.33	-6.38
5	0.71	1.798	7.63	0.83	12	0.5	-6.37
6	0.95	0.321	6.56	0.81	12	0.52	-6.37

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
7	1.35	-1.287	5.75	0.62	12	0.86	-6.64
1							

Fleet : FLT02: Norwegian aco

Age	1990	1991	1992	1993
1	0.42	0.17	0.3	0.25
2	0.05	0.08	-0.04	0.13
3	0.27	-0.26	0.17	0.17
4	0.02	-0.5	-0.38	0.36
5	-0.19	99.99	99.99	0.24
6	-0.55	99.99	99.99	99.99
7	0.14	-1.11	99.99	99.99
8	No data for this fleet at this age			

Table 4.13 (continued)

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.2	-0.11	-0.88	99.99	-0.45	0.45	0.02	-0.15	-0.14	0.4
2	-0.17	-0.22	-0.19	0.07	99.99	0.06	0.06	0.06	0.02	0.09
3	-0.27	0.09	-0.11	-0.08	0.06	99.99	-0.01	-0.07	0.21	-0.06
4	0.03	-0.22	-0.27	0.11	-0.12	0.72	99.99	-0.17	0.31	-0.21
5	0.19	-0.29	-0.16	-0.23	0.01	0.61	-0.7	99.99	0.39	0.05
6	-0.1	0.07	-0.04	0.11	-0.58	0.52	-0.22	0.03	99.99	0.39
7	99.99	99.99	0.01	0.69	-0.5	0.31	99.99	99.99	99.99	99.99
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	7
Mean Log q	-5.9337
S.E(Log q)	0.6189

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.85	0.48	6.29	0.56	13	0.42	-4.87
2	0.76	3.971	6.84	0.97	13	0.12	-5.06
3	0.74	4.102	6.85	0.97	13	0.17	-5.11
4	0.74	2.209	6.74	0.9	13	0.36	-5.16
5	0.68	2.163	7.08	0.86	11	0.41	-5.3
6	0.8	1.429	6.64	0.89	10	0.37	-5.78

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
7	0.85	0.432	6.55	0.77	6	0.6	-5.93
1							

Fleet : FLT04: Norwegian BT

Age	1990	1991	1992	1993
1	0.28	0.3	0.01	0.13
2	-0.24	-0.02	-0.43	0.04
3	-0.2	-0.33	-0.07	-0.17
4	0.3	-0.45	-0.48	-0.13
5	0.14	-0.03	-0.23	-0.28
6	-0.67	-0.45	0.02	-0.53
7	0.44	0.02	-0.79	-0.98
8	99.99	0.34	-0.86	-0.62

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.46	-0.24	-0.26	99.99	-0.53	0.08	0.08	0.12	0.13	0.51
2	-0.01	-0.25	0	0.11	99.99	-0.11	0.05	0.08	0.29	0.12
3	-0.04	0.31	0.15	-0.06	-0.12	99.99	0.05	0.01	0.06	0.08
4	0.09	0.41	0.16	0.24	-0.29	0.17	99.99	0.07	-0.2	-0.06
5	0.18	0	0	-0.14	0.13	0.22	0.08	99.99	-0.06	-0.09
6	0.35	0.32	-0.03	-0.27	-0.24	0.13	0.06	0.22	99.99	0.38
7	99.99	0.64	1.23	0.67	-0.01	-0.24	-0.93	0.08	-0.2	99.99
8	-0.29	99.99	-0.4	0.98	-0.05	0.31	-0.46	99.99	0.02	0.58

Table 4.13 (continued)

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

Age	7	8
Mean Log q	-6.5876	-6.6024
S.E(Log q)	0.6891	0.55

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.87	0.535	5.85	0.67	13	0.33	-4.57
2	0.67	3.586	7.39	0.93	13	0.19	-4.79
3	0.76	3.908	6.64	0.97	13	0.16	-4.98
4	0.77	2.563	6.66	0.94	13	0.28	-5.27
5	0.58	8.282	7.83	0.98	13	0.16	-5.78
6	0.65	3.172	7.46	0.91	13	0.34	-6.12

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
7	0.71	2.291	7.38	0.89	12	0.4	-6.59
8	0.96	0.21	6.68	0.79	11	0.56	-6.6
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2002

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	619440	0.518	0	0	1	0.187	0
FLT02: Norweg	525405	0.482	0	0	1	0.216	0
FLT04: Norweg	585146	0.397	0	0	1	0.319	0
P shrinkage m	254792	0.81				0.077	0
F shrinkage m	68293	0.5				0.201	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
352094	0.22	0.49	5	2.192	0

Table 4.13 (continued)

1

Age 2 Catchability dependent on age and year class strength

Year class = 2001

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	204958	0.251	0.099	0.4	2	0.282	0.001
FLT02: Norweg	162468	0.248	0.107	0.43	2	0.289	0.001
FLT04: Norweg	180523	0.23	0.007	0.03	2	0.336	0.001
P shrinkage m	128046	0.88				0.023	0.001
F shrinkage m	33531	0.5				0.071	0.004

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
159762	0.13	0.18	8	1.329	0.001

Age 3 Catchability dependent on age and year class strength

Year class = 2000

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	121168	0.193	0.051	0.26	3	0.3	0.021
FLT02: Norweg	114534	0.193	0.044	0.23	3	0.302	0.023
FLT04: Norweg	141485	0.182	0.068	0.37	3	0.34	0.018
P shrinkage m	81939	0.97				0.012	0.032
F shrinkage m	44864	0.5				0.046	0.057

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
119396	0.11	0.08	11	0.759	0.022

1

Age 4 Catchability dependent on age and year class strength

Year class = 1999

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	135943	0.169	0.052	0.3	4	0.3	0.121
FLT02: Norweg	136337	0.171	0.086	0.5	4	0.293	0.12
FLT04: Norweg	135239	0.155	0.034	0.22	4	0.358	0.121
P shrinkage m	47712	1.01				0.01	0.311
F shrinkage m	60208	0.5				0.04	0.254

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
130153	0.09	0.06	14	0.647	0.126

Table 4.13 (continued)

Age 5 Catchability dependent on age and year class strength

Year class = 1998

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	84950	0.164	0.114	0.7	5	0.269	0.342
FLT02: Norweg	86769	0.163	0.088	0.54	5	0.277	0.336
FLT04: Norweg	74769	0.139	0.05	0.36	5	0.389	0.381
P shrinkage m	21807	1.01				0.013	0.952
F shrinkage m	49627	0.5				0.052	0.53

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
77709	0.09	0.06	17	0.727	0.369

1

Age 6 Catchability dependent on age and year class strength

Year class = 1997

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	16205	0.157	0.106	0.67	6	0.261	0.248
FLT02: Norweg	15248	0.151	0.116	0.77	6	0.294	0.262
FLT04: Norweg	14246	0.132	0.109	0.83	6	0.387	0.278
P shrinkage m	9417	1.07				0.01	0.395
F shrinkage m	4739	0.5				0.047	0.675

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14213	0.08	0.08	20	0.976	0.278

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	1	0	0	0	0	0	0
FLT02: Norweg	1	0	0	0	0	0	0
FLT04: Norweg	1	0	0	0	0	0	0
F shrinkage m	6486	0.5				1	0.681

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6486	0.5	0	1	0	0.681

Table 4.13 (continued)

1
Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	1116	0.184	0.116	0.63	7	0.2	0.449
FLT02: Norweg	809	0.166	0.194	1.17	6	0.191	0.578
FLT04: Norweg	966	0.173	0.102	0.59	8	0.395	0.504
F shrinkage m	455	0.5				0.213	0.872

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
818	0.14	0.1	22	0.737	0.573

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	302	0.201	0.147	0.73	7	0.131	0.655
FLT02: Norweg	289	0.178	0.119	0.67	6	0.125	0.676
FLT04: Norweg	310	0.204	0.05	0.25	8	0.275	0.643
F shrinkage m	312	0.5				0.469	0.64

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
307	0.24	0.04	22	0.159	0.647

1
Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1993

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russiar	112	0.195	0.09	0.46	7	0.12	0.787
FLT02: Norweg	159	0.166	0.125	0.75	6	0.116	0.612
FLT04: Norweg	132	0.154	0.155	1.01	7	0.176	0.7
F shrinkage m	150	0.5				0.587	0.639

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
142	0.3	0.05	21	0.178	0.663

Table 4.14

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 8 Fishing mortality (F) at age

YEAR	1950	1951	1952	1953
AGE				
3	0.0547	0.14	0.1163	0.072
4	0.5936	0.2196	0.5485	0.3926
5	0.8245	0.6341	0.5849	0.5373
6	0.8125	0.9135	0.8887	0.4899
7	1.157	0.8053	0.9961	0.7145
8	1.0055	1.0036	1.2502	0.6589
9	0.6504	1.4256	1.3695	0.5162
10	0.946	1.0901	1.2251	0.6331
+gp	0.946	1.0901	1.2251	0.6331
0 FBAR 4	0.8469	0.6431	0.7546	0.5336

Table 8 Fishing mortality (F) at age

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	0.0619	0.0254	0.1141	0.0454	0.0287	0.0719	0.2012	0.1697	0.1995	0.1219
4	0.246	0.1356	0.1753	0.2502	0.176	0.175	0.3802	0.4876	0.5958	0.6784
5	0.3091	0.4901	0.2792	0.3751	0.5789	0.3383	0.5192	0.6974	1.0616	0.9366
6	0.4146	0.4691	0.8125	0.4072	0.5215	0.5583	0.6531	0.7516	1.0617	1.0265
7	0.6139	1.0131	0.6249	0.8167	0.9643	0.6025	0.5207	0.8335	0.7002	1.0012
8	0.8609	0.6211	0.9345	0.4513	0.8693	0.4321	0.7026	0.8825	0.904	0.6536
9	1.3582	0.43	0.3985	0.6298	0.743	0.8446	1.1478	0.9636	1.1812	1.3586
10	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374	1.0158
+gp	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374	1.0158
0 FBAR 4	0.3959	0.527	0.473	0.4623	0.5602	0.4185	0.5183	0.6925	0.8548	0.9107
1										

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 8 Fishing mortality (F) at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0.0811	0.0671	0.1303	0.0615	0.0421	0.1016	0.1708	0.0234	0.2858	0.3385
4	0.3193	0.2401	0.3875	0.3091	0.3971	0.1707	0.2355	0.2691	0.392	0.6043
5	0.6929	0.4682	0.5962	0.4224	0.5791	0.498	0.2483	0.1818	1.0699	0.9919
6	0.871	0.6985	0.7436	0.5206	0.4594	0.5818	0.504	0.1815	0.9505	0.4782
7	0.8437	0.6762	0.8235	0.5329	0.7022	0.4051	0.5298	0.4033	0.5516	0.2982
8	0.9605	0.5955	0.5278	0.5806	0.716	0.5023	0.4139	0.3896	0.581	0.2728
9	1.3821	1.0492	0.5925	0.384	0.4946	0.5017	0.3945	0.2979	0.6928	0.2772
10	1.0779	0.7832	0.6549	0.5027	0.6449	0.4735	0.4494	0.365	0.6151	0.2829
+gp	1.0779	0.7832	0.6549	0.5027	0.6449	0.4735	0.4494	0.365	0.6151	0.2829
0 FBAR 4	0.6817	0.5208	0.6377	0.4462	0.5344	0.4139	0.3794	0.2589	0.741	0.5931

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0.2252	0.2573	0.3213	0.7669	0.3617	0.1543	0.0378	0.0932	0.1269	0.181
4	0.3429	0.5905	0.6487	1.2664	0.6432	0.5042	0.308	0.2128	0.2489	0.4454
5	0.4214	0.5185	0.644	0.9364	0.8653	0.969	0.6797	0.5521	0.4777	0.4128
6	0.6968	0.4478	0.7091	0.5448	0.4462	0.889	0.8182	0.8699	0.684	0.3643
7	0.5926	0.6002	0.8047	0.6392	0.807	0.5126	0.3692	0.7738	0.5418	0.3916
8	0.4829	0.3512	0.8775	0.5412	0.4554	0.713	0.7054	0.4355	0.6455	0.3625
9	0.8009	0.2027	0.8146	0.5624	0.6782	0.5066	0.7652	0.5167	0.3695	0.1848
10	0.6318	0.3856	0.8431	0.5858	0.6531	0.582	0.6197	0.5812	0.5242	0.3142
+gp	0.6318	0.3856	0.8431	0.5858	0.6531	0.582	0.6197	0.5812	0.5242	0.3142
0 FBAR 4	0.5134	0.5393	0.7016	0.8467	0.6904	0.7187	0.5438	0.6022	0.4881	0.4035

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	0.061	0.1366	0.0679	0.0515	0.0234	0.0709	0.0257	0.0552	0.0728	0.0244
4	0.3331	0.2215	0.4621	0.4672	0.1604	0.1803	0.1059	0.142	0.249	0.2184
5	0.3448	0.3846	0.3088	0.9397	0.543	0.3387	0.1217	0.2474	0.2587	0.469
6	0.2397	0.5742	0.5004	0.2953	1.2097	0.5069	0.1819	0.2785	0.3793	0.5353
7	0.3469	0.425	0.6128	0.573	0.3193	0.7071	0.2715	0.3035	0.3314	0.3783
8	0.4991	0.5563	0.3497	0.459	0.3535	0.3506	0.3777	0.2879	0.2949	0.3574
9	0.3398	0.6331	0.5499	0.3052	0.2272	0.0921	1.5779	0.3053	0.2906	0.4158
10	0.3972	0.5432	0.509	0.4491	0.3	0.3851	0.7551	0.3002	0.3066	0.3599
+gp	0.3972	0.5432	0.509	0.4491	0.3	0.3851	0.7551	0.3002	0.3066	0.3599
0 FBAR 4	0.3161	0.4013	0.471	0.5688	0.5581	0.4332	0.1703	0.2428	0.3046	0.4003

Table 4.14 (continued)

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR **-**
AGE											
3	0.0129	0.0195	0.0272	0.0289	0.0687	0.1271	0.0166	0.0502	0.0205	0.0218	0.0308
4	0.1086	0.0801	0.1283	0.2046	0.3187	0.335	0.2815	0.1241	0.2072	0.1257	0.1523
5	0.481	0.2765	0.3641	0.4724	0.4976	0.8308	0.4231	0.627	0.2504	0.369	0.4155
6	0.6713	0.6384	0.5391	0.7038	0.645	0.8189	0.5787	0.6506	0.6483	0.2785	0.5258
7	0.7012	0.6387	0.8181	0.8852	0.6297	0.7773	0.606	0.7499	0.6111	0.6808	0.6806
8	0.4786	0.3308	0.9403	1.1488	1.0584	0.9929	0.6644	0.7609	0.8243	0.5726	0.7193
9	0.6164	0.4087	0.7771	0.771	1.0302	0.4466	0.527	0.6371	0.5315	0.6472	0.6052
10	0.7264	0.5243	0.8747	0.9883	0.9322	0.7032	0.6052	0.733	0.7297	0.6631	0.7086
+gp	0.7264	0.5243	0.8747	0.9883	0.9322	0.7032	0.6052	0.733	0.7297	0.6631	
0 FBAR	0.4905	0.4084	0.4624	0.5665	0.5227	0.6905	0.4723	0.5379	0.4292	0.3635	

1

Table 4.15

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

YEAR	1950	1951	1952	1953
AGE				
3	66026	553019	60283	1023249
4	92622	51179	393614	43935
5	68513	41886	33641	186200
6	36893	24596	18190	15346
7	45596	13404	8078	6123
8	15745	11738	4905	2442
9	4518	4716	3523	1150
10	1941	1930	928	733
+gp	5287	2201	1348	2339
0 TOT.	337141	704669	524510	1281518

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

YEAR	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
AGE										
3	120542	50765	167878	51537	67410	322648	240840	108736	240221	273037
4	779545	92769	40521	122627	40323	53631	245830	161251	75127	161110
5	24292	499066	66319	27842	78175	27687	36860	137614	81075	33898
6	89074	14600	250291	41068	15665	35875	16162	17956	56095	22960
7	7697	48176	7478	90933	22377	7613	16806	6886	6934	15885
8	2454	3411	14321	3277	32898	6985	3412	8175	2450	2818
9	1035	849	1501	4605	1709	11292	3712	1384	2769	812
10	562	218	452	825	2009	665	3973	964	432	696
+gp	957	218	418	408	1126	1168	1201	2624	1350	638
0 TOT.	1026158	710071	549179	343123	261691	467564	568796	445591	466453	511853

1

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	316145	100872	237489	293825	17580	17380	164303	94306	1020039	270060
4	197881	238663	77231	170693	226209	13800	12855	113402	75425	627508
5	66931	117722	153693	42919	102594	124511	9526	8317	70941	41726
6	10878	27406	60348	69323	23033	47073	61952	6084	5677	19925
7	6735	3728	11159	23488	33723	11912	21540	30640	4155	1797
8	4779	2372	1552	4010	11286	13681	6504	10382	16760	1959
9	1200	1497	1070	750	1837	4516	6778	3520	5757	7676
10	171	247	429	485	418	917	2239	3740	2140	2358
+gp	1040	1609	550	750	657	316	886	1915	3927	2603
0 TOT.	605760	494115	543521	606242	417336	234107	286584	272307	1204821	975611

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

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	52804	48609	55885	113854	170972	135027	18629	6016	8155	4677
4	157618	34516	30770	33181	43292	97498	94747	14686	4488	5881
5	280759	91586	15657	13168	7657	18630	48211	57011	9719	2864
6	12670	150819	44649	6732	4227	2639	5788	20004	26873	4935
7	10112	5168	78906	17988	3197	2215	888	2091	6862	11102
8	1092	4578	2322	28893	7772	1168	1086	503	790	3268
9	1221	551	2638	790	13769	4036	469	439	266	339
10	4763	449	369	956	369	5721	1991	179	214	151
+gp	4359	3200	3064	934	910	800	3452	2388	1740	700
0 TOT.	525399	339477	234259	216496	252163	267733	175261	103316	59107	33918

Table 4.15 (continued)

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

	YEAF	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	3	8368	254695	525821	86238	43136	16832	24398	81417	194380	632500
	4	3195	6380	181895	258990	67061	26220	12838	16357	63078	147056
	5	3084	1875	4186	93819	132898	46768	17926	9455	11620	40262
	6	1552	1789	1045	2517	30013	63073	27291	12994	6044	7345
	7	2807	1000	825	519	1534	7330	31107	18628	8053	3387
	8	6144	1624	535	366	239	912	2959	19412	11259	4734
	9	1862	3054	763	309	189	138	526	1661	11918	6864
	10	231	1085	1327	360	186	123	103	89	1002	7297
	+gp	950	295	431	863	1313	226	62	72	75	1393
0	TOT.	28194	271797	716828	443979	276570	161624	117209	160086	307428	850836

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

	YEAF	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 50-**	AMST 50-**
	AGE													
	3	276808	79859	90091	99221	41038	187684	63784	272944	280082	187206	0	95567	182154
	4	472434	201539	53452	36891	56441	29763	135045	49722	208422	188830	118084	65344	123900
	5	94057	340461	126563	33934	23234	31429	17431	82603	35903	136961	129414	38168	71900
	6	18596	46968	188167	70058	16773	11226	11211	9232	36128	22789	77094	18016	34456
	7	3521	7774	20097	87565	28051	7205	4052	5098	3944	15451	14122	8317	15960
	8	1899	1430	3360	7261	29582	12236	2711	1810	1972	1752	6404	3740	6697
	9	2711	964	841	1074	1885	8405	3712	1142	692	708	809	1696	2898
	10	3708	1198	524	316	407	551	4403	1794	495	333	303	735	1333
	+gp	3988	2582	2295	927	407	300	787	2128	1595	1063	589		
0	TOT.	877722	682775	485389	337249	197817	288799	243136	426473	569232	555092	346820		
	1													

Table 4.16

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

	YEAF	1950	1951	1952	1953
	AGE				
	3	19804	237753	20398	387813
	4	43355	34338	207854	25986
	5	55734	48839	30873	191395
	6	39904	38131	22195	20973
	7	59263	24971	11844	10057
	8	23827	25461	8374	4671
	9	7596	11367	6682	2444
	10	3890	5545	2098	1857
	+gp	16519	9858	4751	9236
0	TOTAL	269894	436263	315070	654431

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

	YEAF	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
	AGE										
	3	47898	15852	61258	19316	27344	170497	133185	57597	118254	134114
	4	483407	45207	23075	71725	25527	44228	212155	133299	57716	123500
	5	26179	422644	65632	28301	86005	39680	55284	197698	108244	45158
	6	127633	16440	329341	55505	22915	68363	32229	34299	99578	40668
	7	13254	65187	11824	147685	39334	17433	40273	15807	14791	33811
	8	4920	5374	26366	6198	67331	18622	9521	21848	6085	6985
	9	2305	1487	3070	9677	3886	33452	11508	4109	7642	2237
	10	1492	454	1103	2066	5444	2350	14680	3414	1422	2284
	+gp	3960	708	1591	1592	4758	6427	6917	14481	6924	3264
0	TOTAL	711048	573353	523259	342063	282543	401051	515752	482552	420654	392020
	1										

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

	YEAF	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
	AGE										
	3	129020	46459	103472	153559	9191	9209	81845	62897	578499	147604
	4	126029	171543	52513	139218	184567	11411	9994	118034	66757	535242
	5	74082	147049	181611	60834	145472	178927	12869	15044	109116	61851
	6	16009	45517	94815	130647	43424	89943	111285	14633	11611	39270
	7	11910	7440	21067	53192	76402	27350	46495	88554	10210	4255
	8	9840	5511	3412	10573	29771	36575	16347	34936	47958	5403
	9	2746	3866	2615	2196	5384	13414	18929	13162	18304	23518
	10	466	759	1250	1692	1460	3247	7452	16669	8108	8610
	+gp	4422	7717	2495	4086	3577	1746	4600	13304	23202	14818
0	TOTAL	374524	435861	463249	555997	499249	371822	309815	377233	873765	840573

Table 4.16 (continued)

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

	YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	3	30171	26074	23224	57918	107280	100512	12728	3948	5119	2145
	4	140548	28894	19955	26342	42393	113262	101023	15039	4395	5860
	5	435079	133236	17647	18168	13030	37611	89333	101456	16544	4490
	6	26106	291723	66909	12349	9563	7083	14260	47331	60821	9810
	7	25038	12012	142094	39651	8692	7144	2629	5945	18663	27488
	8	3147	12388	4868	74158	24605	4386	3744	1664	2500	7321
	9	3912	1658	6145	2254	48434	16841	1795	1616	937	888
	10	18184	1609	1024	3251	1546	28456	9088	783	899	435
	+gp	25947	17881	13264	4950	5951	6203	24568	16319	11376	2478
0	TOTAL	708132	525475	295129	239040	261494	321498	259169	194100	121254	60914

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

	YEAF	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	3	2325	108907	141291	20517	9255	4544	6366	29151	67358	188888
	4	2962	4848	128135	122975	25953	11188	9263	12153	52408	119075
	5	5368	3454	3986	85853	82611	30725	16744	13051	17884	57698
	6	3740	4319	1394	3652	33822	61331	34824	20332	12016	14736
	7	6046	1804	1374	940	2822	10035	47872	32061	18277	7687
	8	13854	3744	1139	1120	563	2070	5861	41610	26466	14445
	9	4908	8228	1897	836	520	365	1412	4353	31011	23324
	10	670	3224	3642	1075	565	361	307	264	3578	24863
	+gp	3383	1074	1448	3155	4878	812	226	256	281	5865
0	TOTAL	43256	139601	284307	240122	160988	121431	122877	153231	229278	456581

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

	YEAF	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE										
	3	72080	18107	19721	21353	10175	55846	14698	84292	54423	45149
	4	283893	76941	25201	15026	27449	18592	92548	24529	120662	89758
	5	110843	288317	91238	24367	20408	33726	18495	97236	34990	147202
	6	31683	71525	222778	81489	21201	17625	14558	14395	54930	32839
	7	7597	15986	39022	134945	43452	12567	6038	10356	8094	30198
	8	5303	4392	8593	18613	61620	24711	4368	4515	4876	4356
	9	7161	2981	2491	3629	6300	22517	6746	3007	1875	1972
	10	10814	3833	1833	1107	1213	2262	9749	4763	1420	988
	+gp	14025	8611	8401	4523	1476	1235	2347	8143	5019	4950
0	TOTAL	543398	490694	419279	305053	193294	189081	169547	251235	286290	357412
	1										

Table 4.17

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

	YEAF	1950	1951	1952	1953
	AGE				
	3	0	0	0	0
	4	2168	1717	10393	1299
	5	12819	11233	7101	44021
	6	21149	20209	11764	11116
	7	52152	21975	10423	8850
	8	23351	24952	8207	4577
	9	7596	11367	6682	2444
	10	3890	5545	2098	1857
	+gp	16519	9858	4751	9236
0	TOTSF	139644	106855	61418	83400

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

	YEAF	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	24170	2260	1154	3586	1276	2211	10608	6665	2886	6175
	5	6021	97208	15095	6509	19781	9126	12715	45471	24896	10386
	6	67646	8713	174551	29417	12145	36232	17082	18179	52776	21554
	7	11664	57364	10405	129963	34613	15341	35440	13910	13016	29754
	8	4821	5267	25839	6074	65985	18250	9330	21411	5963	6845
	9	2305	1487	3070	9677	3886	33452	11508	4109	7642	2237
	10	1492	454	1103	2066	5444	2350	14680	3414	1422	2284
	+gp	3960	708	1591	1592	4758	6427	6917	14481	6924	3264
0	TOTSF	122079	173462	232807	188884	147888	123389	118280	127639	115524	82499
	1										

Table 4.17 (continued)

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

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

YEAF	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	6301	8577	2626	6961	9228	571	500	5902	3338	26762
5	17039	33821	41771	13992	33459	41153	2960	3460	25097	14226
6	8485	24124	50252	69243	23015	47670	58981	7756	6154	20813
7	10481	6547	18539	46809	67233	24068	40915	77928	8985	3745
8	9643	5401	3344	10362	29176	35843	16020	34237	46999	5295
9	2746	3866	2615	2196	5384	13414	18929	13162	18304	23518
10	466	759	1250	1692	1460	3247	7452	16669	8108	8610
+gp	4422	7717	2495	4086	3577	1746	4600	13304	23202	14818
0 TOTSF	59583	90813	122890	155341	172533	167712	150357	172417	140186	117788

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

YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	0	0	0	0	0	0	0	39	461	365
4	7027	1445	998	1317	2120	5663	5051	1805	2417	4102
5	100068	30644	4059	4179	2997	8651	20547	64932	12077	4490
6	13836	154613	35462	6545	5069	3754	7558	34552	56564	9810
7	22033	10571	125042	34893	7649	6287	2314	5707	17916	27488
8	3084	12141	4770	72675	24113	4298	3669	1664	2500	7321
9	3912	1658	6145	2254	48434	16841	1795	1616	937	888
10	18184	1609	1024	3251	1546	28456	9088	783	899	435
+gp	25947	17881	13264	4950	5951	6203	24568	16319	11376	2478
0 TOTSF	194092	230562	190764	130063	97878	80153	74590	127416	105148	57376

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

YEAF	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	163	2178	0	0	0	0	0	0	1347	2833
4	415	388	28190	1230	779	448	185	851	6813	8752
5	1879	2763	2113	18029	27262	9218	5023	3915	8942	28272
6	1758	4016	1199	1936	17249	38639	18805	10166	7450	11199
7	4474	1731	1182	940	2822	8229	36862	25648	14074	6073
8	13854	3744	1139	1120	563	2070	5099	38281	21173	12711
9	4908	8228	1897	836	520	365	1130	4353	29150	20525
10	670	3224	3642	1075	565	361	307	264	3578	21631
+gp	3383	1074	1448	3155	4878	812	226	256	281	5865
0 TOTSF	31503	27347	40810	28319	54637	60141	67638	83735	92807	117862

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

YEAF	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	0	0	0	0	0	558	0	337	435	135
4	4826	1539	0	451	1372	3161	9255	1472	15686	4488
5	33807	34598	9124	2437	5714	16863	5918	52507	11547	58881
6	18693	30041	80200	23632	10601	12514	8589	10364	40099	22659
7	6837	12949	30438	80967	28679	10179	4347	9010	6718	27480
8	4667	3865	7390	15263	49912	22487	4106	4244	4388	4356
9	7161	2981	2242	3629	5733	20715	6341	2706	1875	1854
10	10814	3335	1705	919	1213	2262	9359	4763	1335	988
+gp	13604	8611	7561	4523	1476	1235	2347	7410	5019	4950
0 TOTSF	100409	97919	138660	131821	104700	89974	50263	92814	87103	125791

1

Table 4.18

Run title : NEA Haddock (SVPA AFWG04)

At 12/05/2004 11:52

Table 17 Summary (with SOP correction)

	RI Age 3	TOTALE	TOTSPI	LANDIN	YIELD/S	SOPCC	FBAR 4- 7
1950	66026	269894	139644	132125	0.9462	0.4545	0.8469
1951	553019	436263	106855	120077	1.1237	0.6514	0.6431
1952	60283	315070	61418	127660	2.0785	0.5127	0.7546
1953	1023249	654431	83400	123920	1.4859	0.5742	0.5336
1954	120542	711048	122079	156788	1.2843	0.6021	0.3959
1955	50765	573353	173462	202286	1.1662	0.4731	0.527
1956	167878	523259	232807	213924	0.9189	0.5529	0.473
1957	51537	342063	188884	123583	0.6543	0.5679	0.4623
1958	67410	282543	147888	112672	0.7619	0.6146	0.5602
1959	322648	401051	123389	88211	0.7149	0.8007	0.4185
1960	240840	515752	118280	154651	1.3075	0.8379	0.5183
1961	108736	482552	127639	193224	1.5138	0.8026	0.6925
1962	240221	420654	115524	187408	1.6222	0.7459	0.8548
1963	273037	392020	82499	146224	1.7724	0.7442	0.9107
1964	316145	374524	59583	99158	1.6642	0.6183	0.6817
1965	100872	435861	90813	118578	1.3057	0.6978	0.5208
1966	237489	463249	122890	161778	1.3164	0.6601	0.6377
1967	293825	555997	155341	136397	0.8781	0.7919	0.4462
1968	17580	499249	172533	181726	1.0533	0.7921	0.5344
1969	17380	371822	167712	130820	0.78	0.8028	0.4139
1970	164303	309815	150357	88257	0.587	0.7547	0.3794
1971	94306	377233	172417	78905	0.4576	1.0105	0.2589
1972	1020039	873765	140186	266153	1.8986	0.8593	0.741
1973	270060	840573	117788	322226	2.7356	0.8281	0.5931
1974	52804	708132	194092	221157	1.1394	0.8657	0.5134
1975	48609	525475	230562	175758	0.7623	0.8127	0.5393
1976	55885	295129	190764	137264	0.7195	0.6296	0.7016
1977	113854	239040	130063	110158	0.847	0.7708	0.8467
1978	170972	261494	97878	95422	0.9749	0.9507	0.6904
1979	135027	321498	80153	103623	1.2928	1.1278	0.7187
1980	18629	259169	74590	87889	1.1783	1.0352	0.5438
1981	6016	194100	127416	77153	0.6055	0.9942	0.6022
1982	8155	121254	105148	46955	0.4466	0.951	0.4881
1983	4677	60914	57376	21607	0.3766	0.9552	0.4035
1984	8368	43256	31503	17318	0.5497	0.9616	0.3161
1985	254695	139601	27347	41270	1.5091	0.983	0.4013
1986	525821	284307	40810	96585	2.3667	0.9078	0.471
1987	86238	240122	28319	150654	5.3198	0.9872	0.5688
1988	43136	160988	54637	91745	1.6792	1.0026	0.5581
1989	16832	121431	60141	54859	0.9122	0.9675	0.4332
1990	24398	122877	67638	25741	0.3806	0.9884	0.1703
1991	81417	153231	83735	33605	0.4013	0.9599	0.2428
1992	194380	229278	92807	53887	0.5806	1.0132	0.3046
1993	632500	456581	117862	77621	0.6586	1.0021	0.4003
1994	276808	543398	100409	128703	1.2818	1.1128	0.4905
1995	79859	490694	97919	138677	1.4162	1.0546	0.4084
1996	90091	419279	138660	173264	1.2496	1.0524	0.4624
1997	99221	305053	131821	148756	1.1285	1.0498	0.5665
1998	41038	193294	104700	93946	0.8973	1.0595	0.5227
1999	187684	189081	89974	82346	0.9152	1.0552	0.6905
2000	63784	169547	50263	61292	1.2194	1.0019	0.4723
2001	272944	251235	92814	81842	0.8818	1.0027	0.5379
2002	280082	286290	87103	83726	0.9612	1.0016	0.4292
2003	187206	357412	125791	96992	0.7711	1.0007	0.3635
Arith. Mean	184061	362319	112698	119936	1.1750		.5307
0 Units	(Thousai	(Tonnes	(Tonnes	(Tonnes)			
1							

Table 4.19

PREDICTION WITH MANAGEMENT OPTION TABLE: INPUT DATA

MFDP version 1a
Run: NEA_Had_final_fcons
Time and date: 15:49 12/05/2004
Fbar age range: 4-7

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	239000	0.4311	0.002	0	0	0.243	3.08E-02	0.613
4	118084	0.2538	0.026	0	0	0.439	0.152333	0.845
5	129414	0.2165	0.199	0	0	0.8175	0.415467	1.218
6	77094	0.2035	0.577	0	0	1.257	0.5258	1.605
7	14122	0.2	0.835	0	0	1.586	0.6806	1.977
8	6404	0.2	0.927	0	0	2.402	0.719267	2.281
9	809	0.2	1	0	0	2.923	0.605267	2.531
10	303	0.2	0.875	0	0	2.582	0.7086	3.013
11	589	0.2	1	0	0	3.898	0.7086	3.096

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	384000	0.4231	0.001	0	0	0.215	3.08E-02	0.618
4	.	0.2554	0.0235	0	0	0.434	0.152333	0.83
5	.	0.2274	0.1916	0	0	0.808	0.415467	1.13
6	.	0.207	0.5135	0	0	1.302	0.5258	1.495
7	.	0.2	0.8396	0	0	1.801	0.6806	1.865
8	.	0.2	0.9235	0	0	2.574	0.719267	2.205
9	.	0.2	1	0	0	2.835	0.605267	2.435
10	.	0.2	1	0	0	3.078	0.7086	2.733
11	.	0.2	1	0	0	3.613	0.7086	2.878

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	159000	0.4231	0	0	0	0.215	3.08E-02	0.618
4	.	0.2554	0.021	0	0	0.434	0.152333	0.83
5	.	0.2274	0.1843	0	0	0.808	0.415467	1.13
6	.	0.207	0.45	0	0	1.302	0.5258	1.495
7	.	0.2	0.8443	0	0	1.801	0.6806	1.865
8	.	0.2	0.92	0	0	2.574	0.719267	2.205
9	.	0.2	1	0	0	2.835	0.605267	2.435
10	.	0.2	1	0	0	3.078	0.7086	2.733
11	.	0.2	1	0	0	3.613	0.7086	2.878

Input units are thousands and kg - output in tonnes

Table 4.20 Yield per recruit. Input data and results.

MFYPR version 2a
Run: stagra
NEA Haddock (AFWG04: Final run)
Time and date: 18:56 12.05.2004
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.4390	0.003	0	0	0.2476	3.08E-02	0.607
4	0.2521	0.05	0	0	0.515	0.15233	0.943
5	0.2056	0.4	0	0	1.0736	0.41546	1.3693
6	0.2	0.69	0	0	1.5043	0.5258	1.7126
7	0.2	0.91	0	0	2.0093	0.6806	2.0613
8	0.2	1	0	0	2.4803	0.7192	2.2466
9	0.2	0.94	0	0	2.7043	0.6052	2.5573
10	0.2	1	0	0	2.8256	0.7086	2.7363
11	0.2	1	0	0	3.871	0.7086	2.8786

Weights in kilograms

Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	4.3957	7.4077	2.3158	6.2357	2.3158	6.2357
0.1	0.0444	0.1236	0.2574	3.7842	5.3671	1.7251	4.2275	1.7251	4.2275
0.2	0.0887	0.1983	0.3897	3.4165	4.2226	1.3767	3.1122	1.3767	3.1122
0.3	0.1331	0.2491	0.4653	3.1682	3.5015	1.1464	2.4176	1.1464	2.4176
0.4	0.1774	0.2864	0.5116	2.9875	3.0108	0.9826	1.9509	0.9826	1.9509
0.5	0.2218	0.3152	0.5412	2.849	2.6577	0.8599	1.62	0.8599	1.62
0.6	0.2661	0.3383	0.5609	2.7387	2.3925	0.7646	1.3753	0.7646	1.3753
0.7	0.3105	0.3574	0.5742	2.6483	2.1866	0.6883	1.1883	0.6883	1.1883
0.8	0.3548	0.3736	0.5834	2.5724	2.0222	0.6259	1.0416	0.6259	1.0416
0.9	0.3992	0.3875	0.5898	2.5075	1.888	0.5738	0.9239	0.5738	0.9239
1	0.4436	0.3998	0.5943	2.4512	1.7763	0.5297	0.8277	0.5297	0.8277
1.1	0.4879	0.4106	0.5974	2.4017	1.6817	0.4919	0.7478	0.4919	0.7478
1.2	0.5323	0.4203	0.5995	2.3576	1.6006	0.4591	0.6805	0.4591	0.6805
1.3	0.5766	0.4291	0.6008	2.3181	1.5302	0.4303	0.6232	0.4303	0.6232
1.4	0.621	0.4372	0.6016	2.2824	1.4685	0.4049	0.5739	0.4049	0.5739
1.5	0.6653	0.4446	0.602	2.2498	1.4138	0.3823	0.531	0.3823	0.531
1.6	0.7097	0.4514	0.6021	2.22	1.365	0.362	0.4935	0.362	0.4935
1.7	0.754	0.4577	0.602	2.1925	1.3211	0.3438	0.4604	0.3438	0.4604
1.8	0.7984	0.4636	0.6016	2.167	1.2815	0.3273	0.431	0.3273	0.431
1.9	0.8427	0.4692	0.6012	2.1433	1.2454	0.3122	0.4047	0.3122	0.4047
2	0.8871	0.4744	0.6006	2.1211	1.2124	0.2985	0.3811	0.2985	0.3811

Reference point	F multiplier	Absolute F
Fbar(4-7)	1	0.4436
FMax	1.5824	0.7019
F0.1	0.3981	0.1766
F35%SPR	0.3458	0.1534

Weights in kilograms

Table 4.21

PREDICTION WITH MANAGEMENT OPTION TABLE

MFDP version 1a
Run: NEA_Had_final_fcons
NEA_Had_final_fconsMFDP Index file 12/05/2004
Time and date: 15:49 12/05/2004
Fbar age range: 4-7

2004				
Biomass	SSB	FMult	FBar	Landings
355842	116739	1	0.4436	132472

2005					2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
392722	139575	0.5891	0.2613	82484	432594	172345
.	139575	0.6391	0.2835	88495	426291	167899
.	139575	0.6891	0.3056	94370	420146	163579
.	139575	0.7391	0.3278	100113	414154	159380
.	139575	0.7891	0.35	105726	408311	155301
.	139575	0.8391	0.3722	111215	402613	151336
.	139575	0.8891	0.3944	116581	397055	147483
.	139575	0.9391	0.4165	121828	391633	143739
.	139575	0.9891	0.4387	126960	386345	140099
.	139575	1.0391	0.4609	131980	381186	136562
.	139575	1.0891	0.4831	136889	376152	133124
.	139575	1.1391	0.5052	141692	371241	129782
.	139575	1.1891	0.5274	146392	366448	126534
.	139575	1.2391	0.5496	150990	361770	123376
.	139575	1.2891	0.5718	155489	357205	120306
.	139575	1.3391	0.594	159893	352749	117321
.	139575	1.3891	0.6161	164204	348399	114420
.	139575	1.4391	0.6383	168423	344153	111599
.	139575	1.4891	0.6605	172555	340007	108856
.	139575	1.5391	0.6827	176600	335958	106188
.	139575	1.5891	0.7048	180561	332005	103595

Input units are thousands and kg - output in tonnes

Table 4.22

Prediction single option table

MFDP version 1a
Run: NEA_Had_final_fcons
Time and date: 19:55 12/05/2004
Fbar age range: 4-7

Year:	2004	F multiplier:	1	Fbar:	0.4436				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0308	5902	3618	239000	58077	478	116	478	116
4	0.1523	14783	12492	118084	51839	3070	1348	3070	1348
5	0.4155	39856	48544	129414	105796	25753	21053	25753	21053
6	0.5258	28778	46188	77094	96907	44483	55915	44483	55915
7	0.6806	6390	12633	14122	22397	11792	18702	11792	18702
8	0.7193	3012	6871	6404	15382	5937	14259	5937	14259
9	0.6053	336	851	809	2365	809	2365	809	2365
10	0.7086	141	425	303	782	265	685	265	685
11	0.7086	274	849	589	2296	589	2296	589	2296
Total		99473	132472	585819	355842	93176	116739	93176	116739

Year:	2005	F multiplier:	0.7891	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0243	7532	4655	384000	82560	384	83	384	83
4	0.1202	15090	12525	150585	65354	3539	1536	3539	1536
5	0.3278	19791	22364	78670	63565	15073	12179	15073	12179
6	0.4149	21252	31772	68789	89564	35323	45991	35323	45991
7	0.5371	14127	26347	37178	66958	31215	56218	31215	56218
8	0.5676	2320	5115	5854	15068	5406	13916	5406	13916
9	0.4776	886	2157	2554	7241	2554	7241	2554	7241
10	0.5591	142	387	362	1113	362	1113	362	1113
11	0.5591	141	405	360	1299	360	1299	360	1299
Total		81280	105726	728352	392722	94216	139575	94216	139575

Year:	2006	F multiplier:	0.7891	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0243	3119	1927	159000	34185	0	0	0	0
4	0.1202	24599	20417	245479	106538	5155	2237	5155	2237
5	0.3278	26021	29403	103433	83574	19063	15403	19063	15403
6	0.4149	13949	20854	45151	58787	20318	26454	20318	26454
7	0.5371	14034	26174	36935	66519	31184	56162	31184	56162
8	0.5676	7049	15544	17791	45793	16367	42130	16367	42130
9	0.4776	943	2295	2717	7703	2717	7703	2717	7703
10	0.5591	508	1389	1297	3992	1297	3992	1297	3992
11	0.5591	132	381	338	1220	338	1220	338	1220
Total		90354	118384	612141	408311	96439	155301	96439	155301

Input units are thousands and kg - output in tonnes

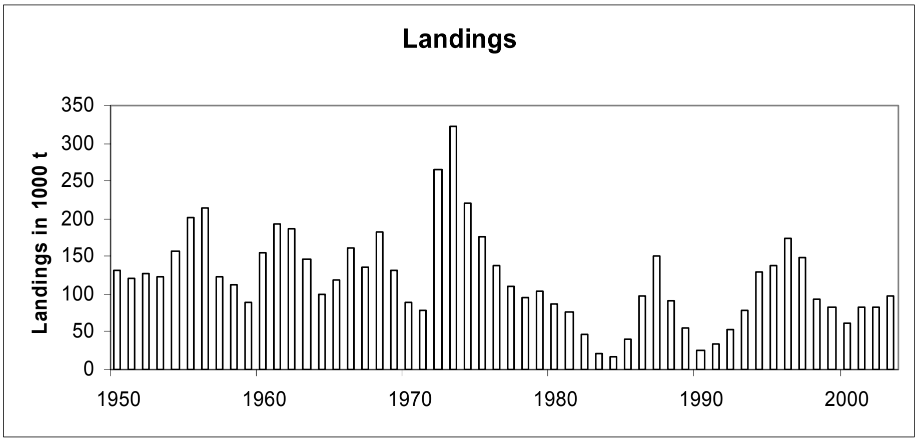


Figure 4.1 A Landings of Northeast Arctic Haddock

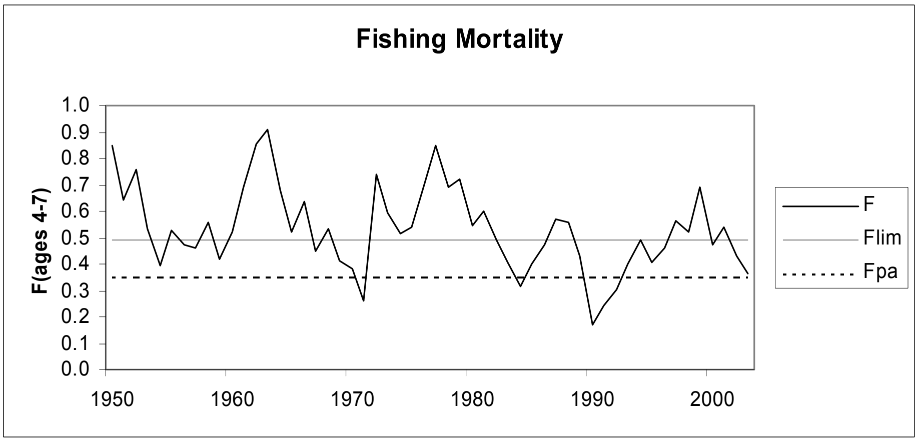


Figure 4.1 B Fishing mortality of Northeast Arctic Haddock

Figure 4.1C Recruitment of Northeast Arctic Haddock

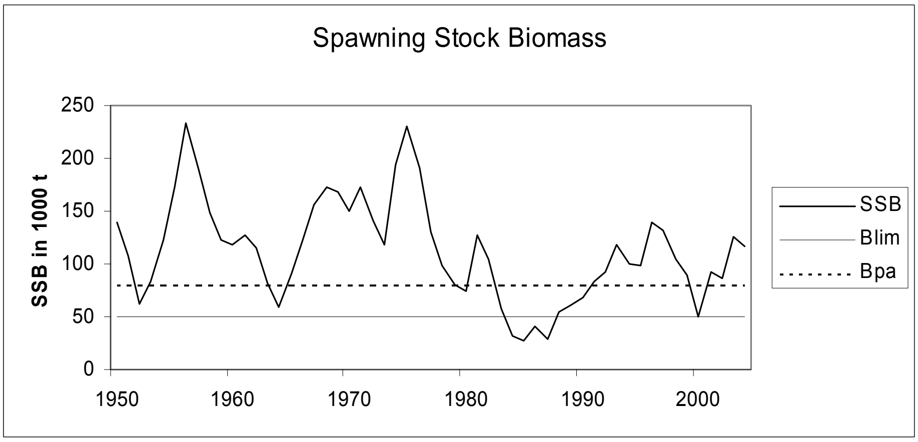


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock

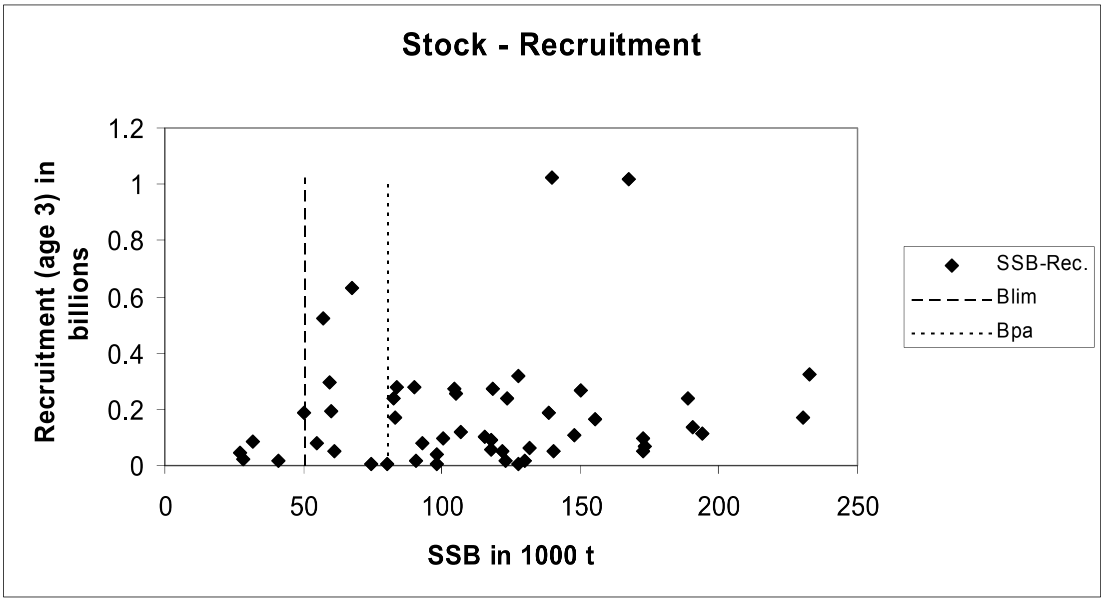


Figure 4.2 Northeast Arctic haddock

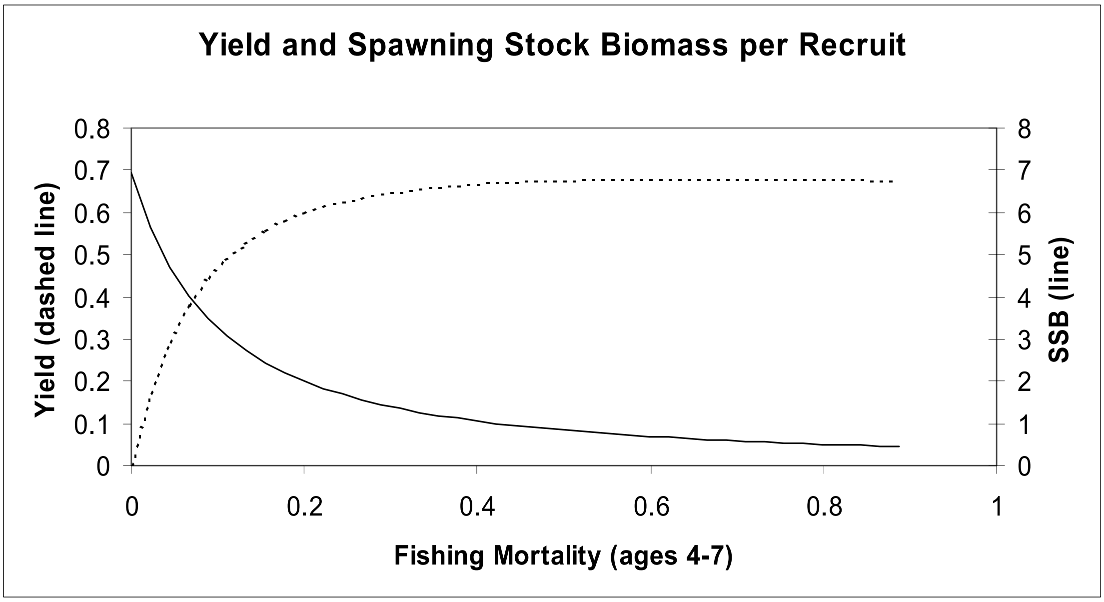


Figure 4.3 Northeast Arctic haddock

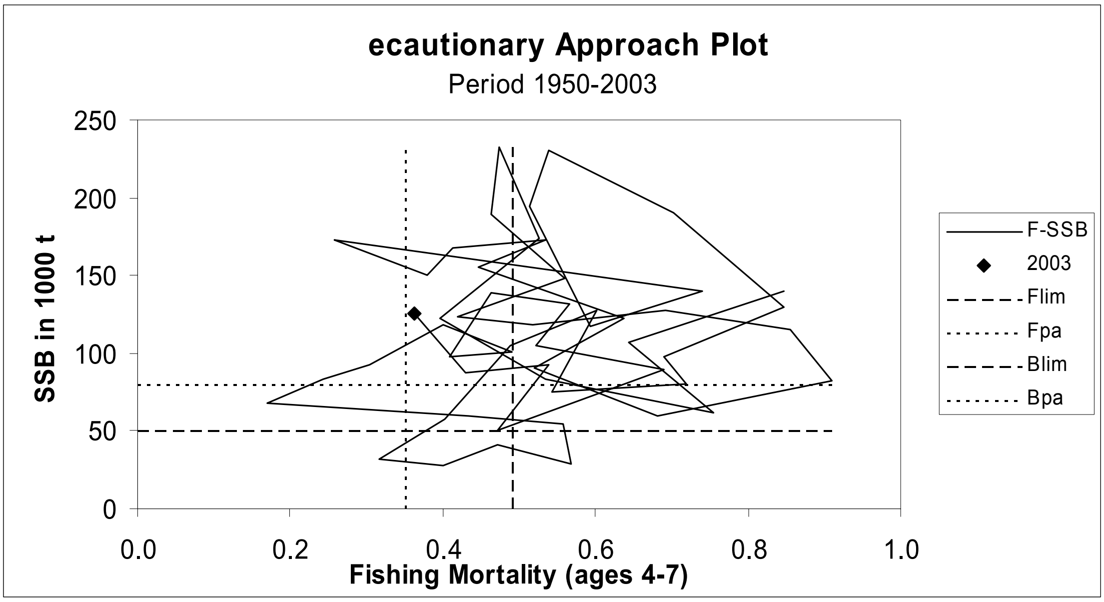


Figure 4.4 Northeast Arctic haddock

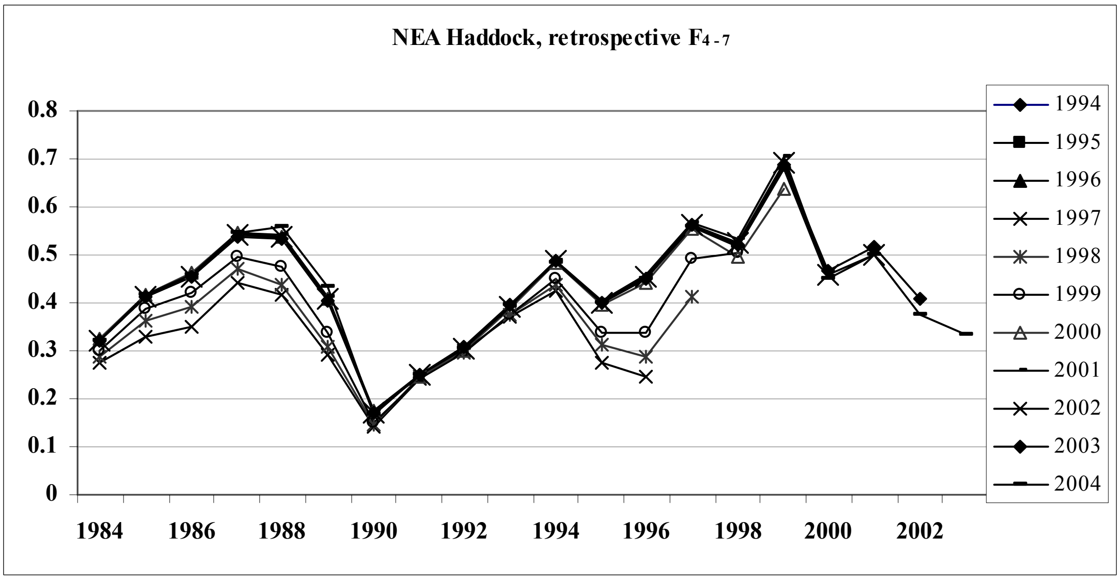
Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-7
1950	66026	139644	132125	0.8469
1951	553019	106855	120077	0.6431
1952	60283	61418	127660	0.7546
1953	1023249	83400	123920	0.5336
1954	120542	122079	156788	0.3959
1955	50765	173462	202286	0.5270
1956	167878	232807	213924	0.4730
1957	51537	188884	123583	0.4623
1958	67410	147888	112672	0.5602
1959	322648	123389	88211	0.4185
1960	240840	118280	154651	0.5183
1961	108736	127639	193224	0.6925
1962	240221	115524	187408	0.8548
1963	273037	82499	146224	0.9107
1964	316145	59583	99158	0.6817
1965	100872	90813	118578	0.5208
1966	237489	122890	161778	0.6377
1967	293825	155341	136397	0.4462
1968	17580	172533	181726	0.5344
1969	17380	167712	130820	0.4139
1970	164303	150357	88257	0.3794
1971	94306	172417	78905	0.2589
1972	1020039	140186	266153	0.7410
1973	270060	117788	322226	0.5931
1974	52804	194092	221157	0.5134
1975	48609	230562	175758	0.5393
1976	55885	190764	137264	0.7016
1977	113854	130063	110158	0.8467
1978	170972	97878	95422	0.6904
1979	135027	80153	103623	0.7187
1980	18629	74590	87889	0.5438
1981	6016	127416	77153	0.6022
1982	8155	105148	46955	0.4881

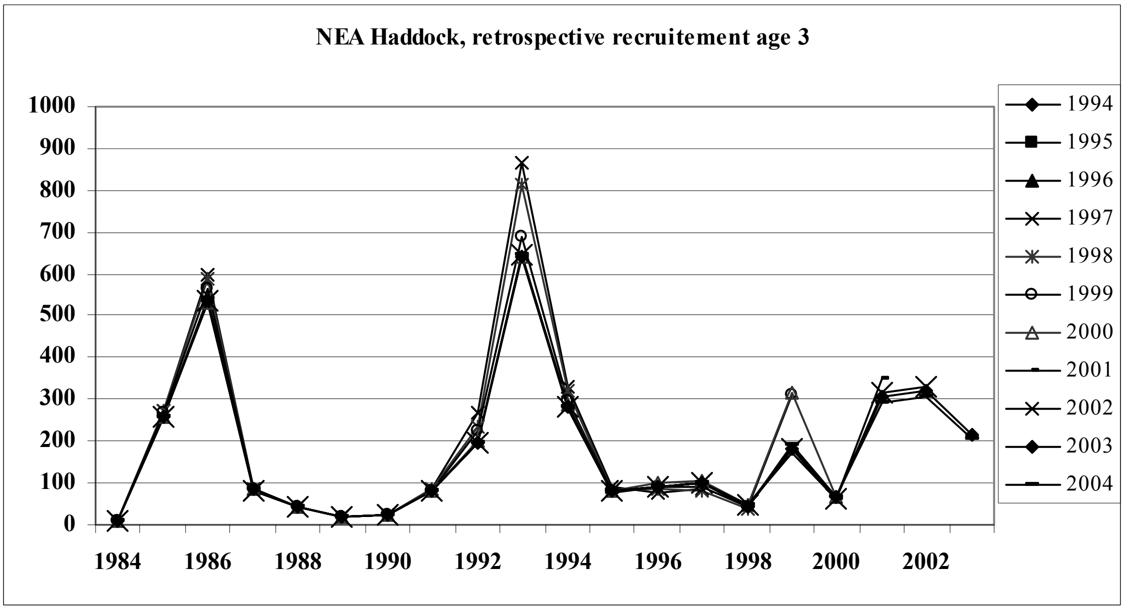
1983	4677	57376	21607	0.4035
1984	8368	31503	17318	0.3161
1985	254695	27347	41270	0.4013
1986	525821	40810	96585	0.4710
1987	86238	28319	150654	0.5688
1988	43136	54637	91745	0.5581
1989	16832	60141	54859	0.4332
1990	24398	67638	25741	0.1703
1991	81417	83735	33605	0.2428
1992	194380	92807	53887	0.3046
1993	632500	117862	77621	0.4003
1994	276808	100409	128703	0.4905
1995	79859	97919	138677	0.4084
1996	90091	138660	173264	0.4624
1997	99221	131821	148756	0.5665
1998	41038	104700	93946	0.5227
1999	187684	89974	82346	0.6905
2000	63784	50263	61292	0.4723
2001	272944	92814	81842	0.5379
2002	280082	87103	83726	0.4292
2003	187206	125791	96992	0.3635
2004	239000	116739		
Average	185060	112771	119936	0.5307

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 4-7	Yield/R	SSB/R
Average last 3 years	0.444	0.672	0.953
Fmax	0.664	0.679	0.623
F0.1	0.176	0.578	2.214
Fmed	0.418	0.669	1.012

Figure 4.5 NEA haddock. Retrospective plots with shrinkage 1.0





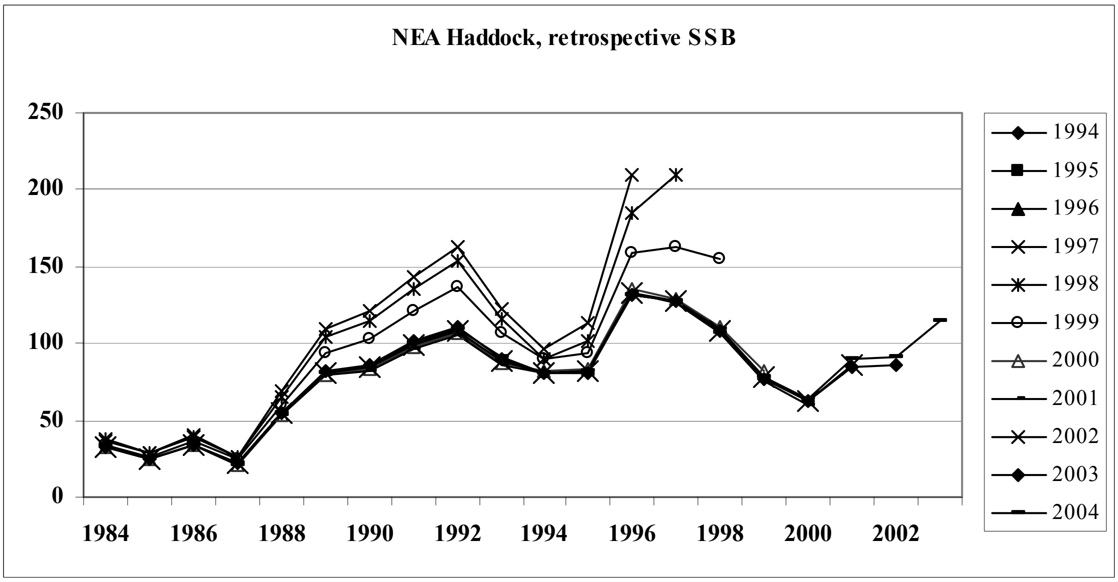
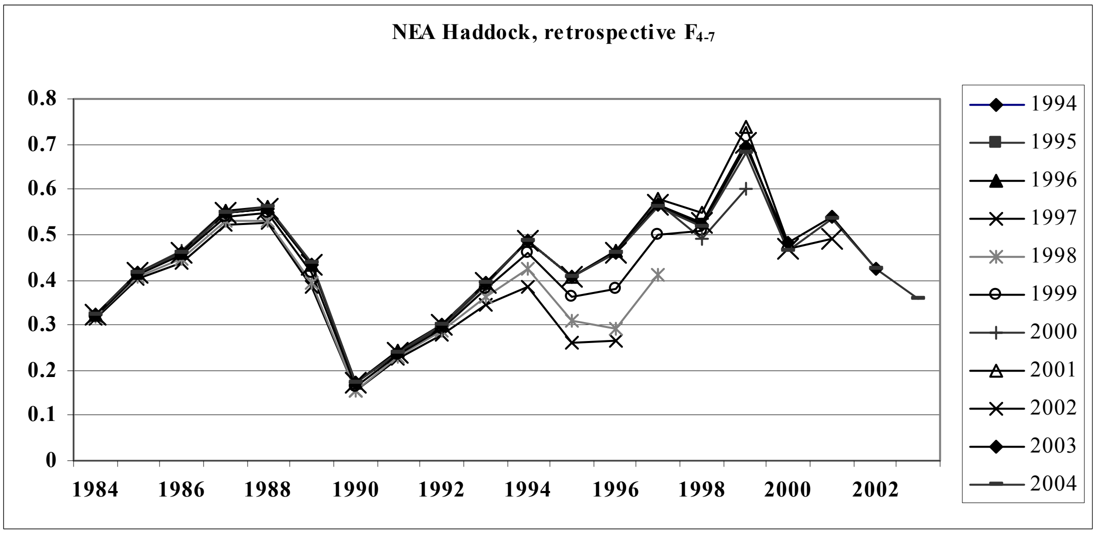
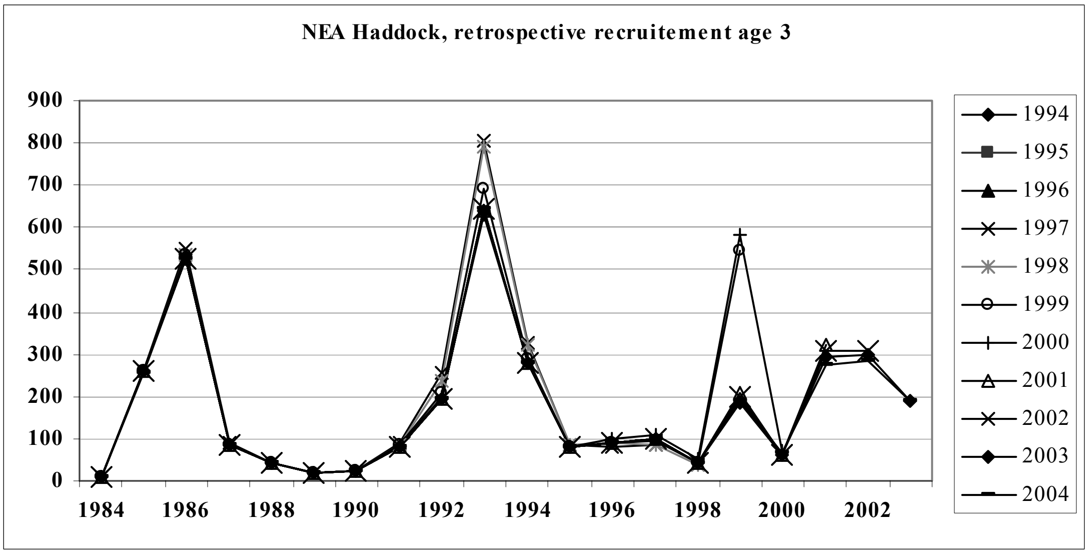
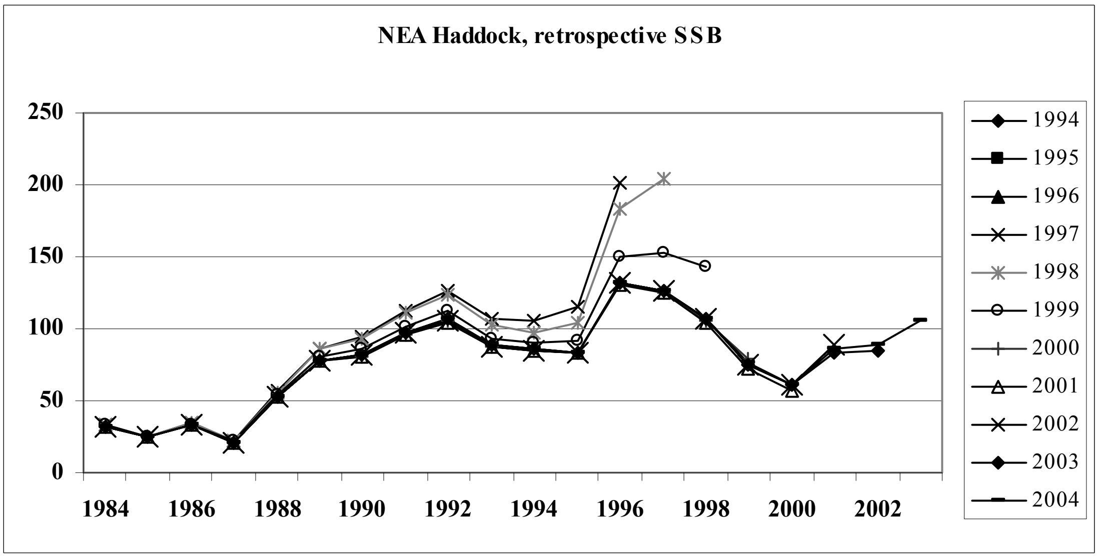


Figure 4.6. NEA haddock. Restrospective plots with shrinkage 0.5







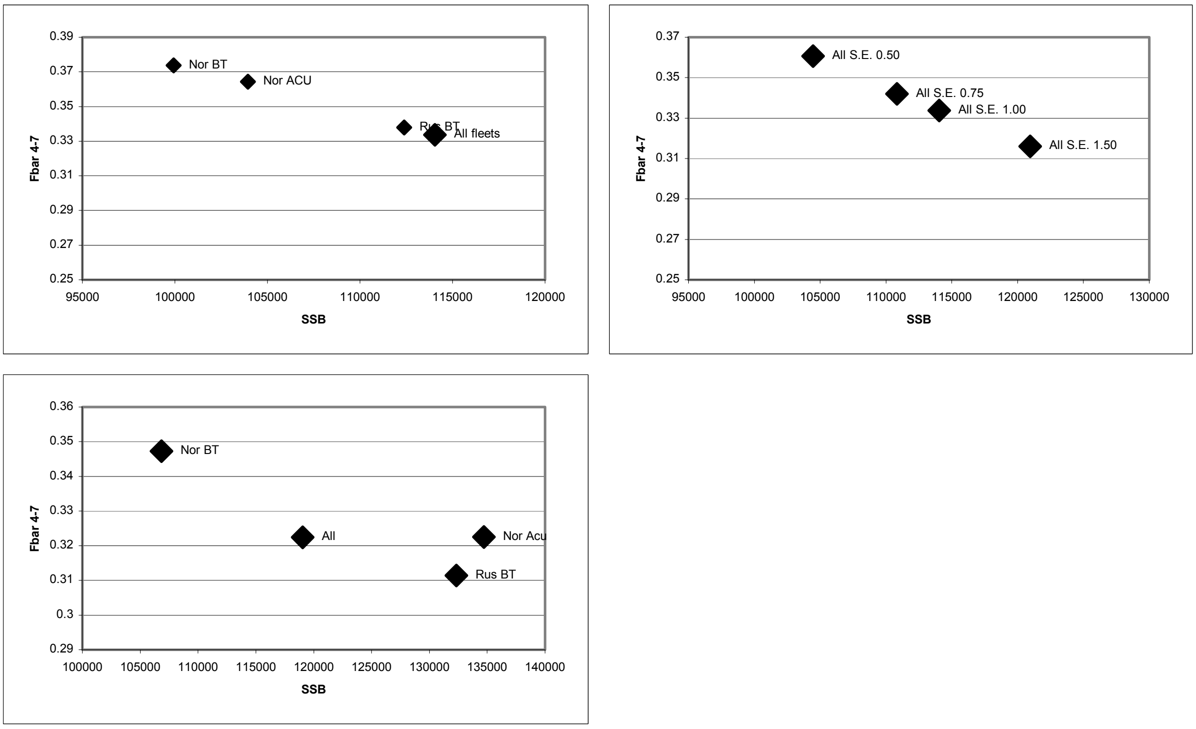
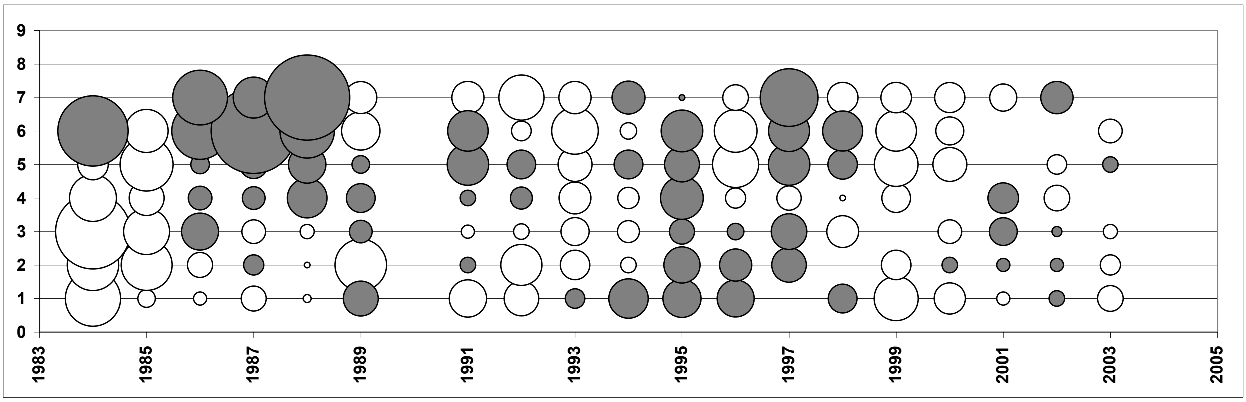


Figure 4.7. The upper left panel compares single fleet runs to the combined run. (All runs are made with F shrinkage given as much weight as a tuning fleet with SE=1.0.) The sensitivity of the assessment to changes in the F shrinkage is illustrated in the upper right panel. The signals from the different surveys are illustrated also in the bottom left panel (this time without shrinkage).

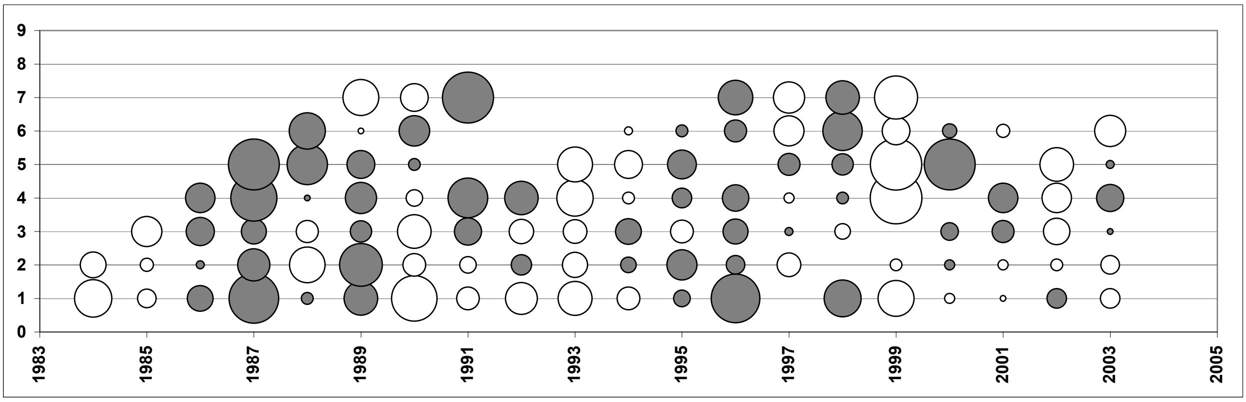
NEA Haddock, single fleets, no shrinkage

Residuals

FLT01: Russian BT su Min.: -2.05 St. Error: 0.49 Max.: 1.58



FLT02:Norw aco Min.: -0.74 St. Error: 0.30 Max.: 0.76



FLT04: Norwegian BT Min.: -0.84 St. Error: 0.33 Max.: 1.61

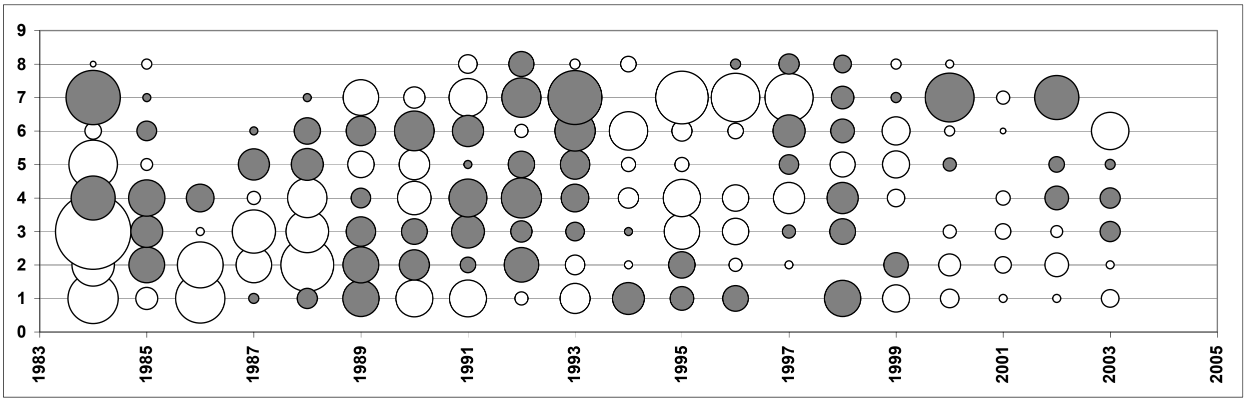


Figure 4.8. NEA Haddock, Log catchability residuals, single fleets, without shrinkage

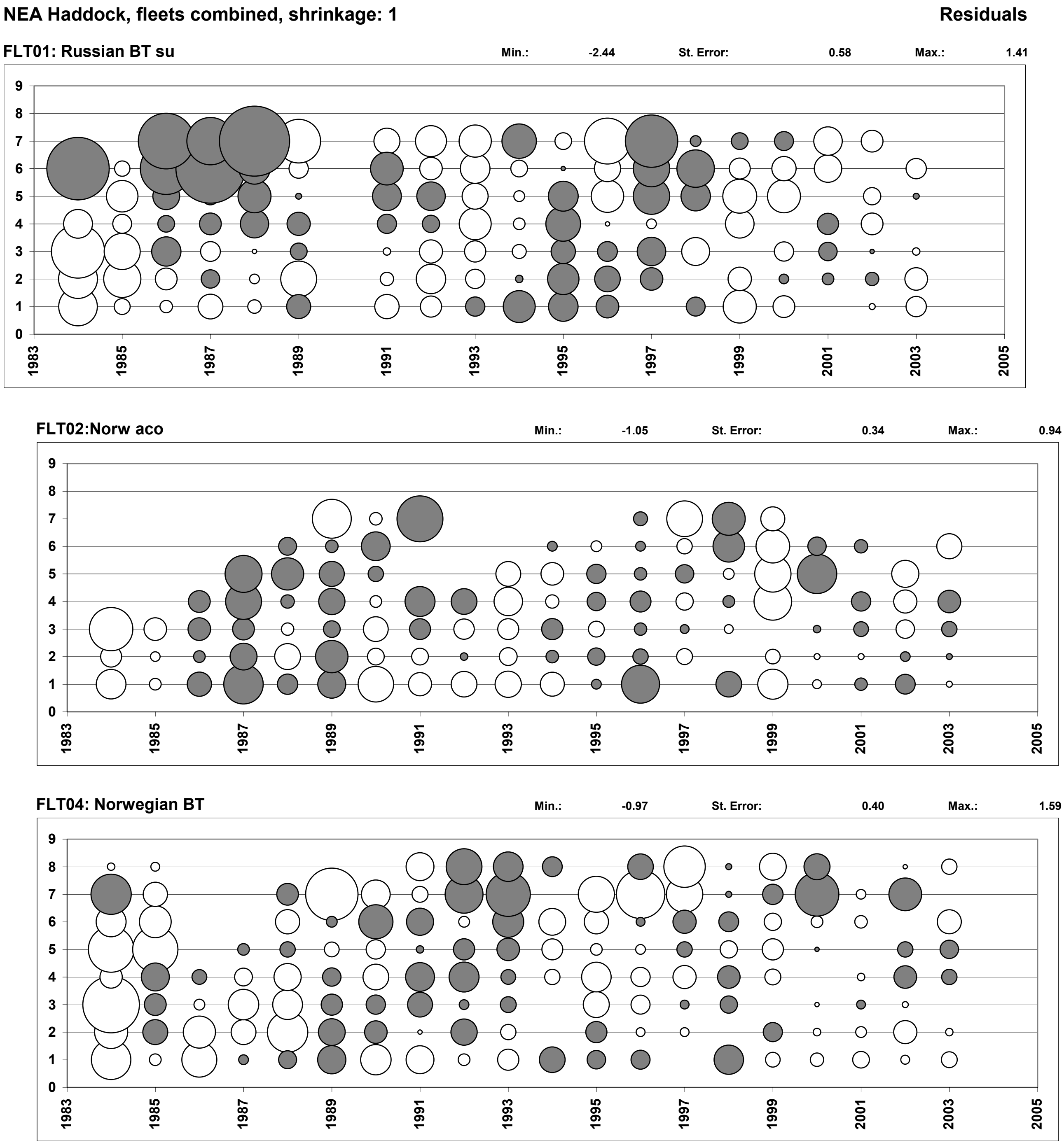


Figure 4.9. NEA Haddock, Log catchability residual plot, fleets combined, with shrinkage 1

Table B1 North-East Arctic HADDOCK. Results from the Norwegian bottom trawl survey in the Barents Sea in January-March. Index of number of fish at age. Indices for 1983-1998 revised August 1999.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	3.1	7.3	2.3	7.8	1.8	5.3	0.5	0.2 -	-		28.3
1982	3.9	1.5	1.7	1.8	1.9	4.8	2.4	0.2 -	-		18.2
1983	2919.3	4.8	3.1	2.4	0.9	1.9	2.5	0.7	-	-	2935.6
1984	3832.6	514.6	18.9	1.5	0.8	0.2	0.1	0.4	0.1	-	4369.2
1985	1901.1	1593.8	475.9	14.7	0.5	0.5	0.1	0.1	0.4	0.3	3987.4
1986	665.0	370.3	384.6	110.8	0.6	0.2	0.1	0.1	0.1	0.1	1531.9
1987	163.8	79.9	154.4	290.2	52.9	0.0	-	-	-	0.3	741.5
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	-	-	-	275.2
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	-	-	196.6
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	- -		734.4
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	-	-	2357.6
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3 -		3217.1
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1953.5
1994	603.2	228.0	339.5	436.6	49.7	3.4	0.2	0.1	0.2	0.6	1661.5
1995	1463.6	179.3	53.6	171.1	339.5	34.5	2.8 -		0.1 -		2244.5
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	-	0.1	1087.7
1997[1]	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	-	1581.9
1998[1]	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440.2
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1 -		1391.3
2000	847.2	452.2	27.2	35.4	8.4	4.0	0.8	0.3	0.7	0.2	1376.4
2001	1220.5	460.3	296.0	29.3	25.1	1.7	0.9	0.1	0.1	0.3	2034.3
2002	1680.3	534.7	314.7	185.3	17.6	8.2	0.8	0.3	+	0.3	2742.2
2003	3332.1	513.1	317.4	182	73.6	5.5	2.3	0.2	0.1	0.2	4426.5
2004	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.1	1852

[1] Indices adjusted to account for limited area coverage.
Survey area extended from 1993 onwards.

Table B2 North-East Arctic HADDOCK. Results from the Russian trawl survey in the Barents Sea and adjacent waters in late autumn (numbers per hour trawling).

Year	Age 0	1	2	3	4	5	6	7	8	9	Older	Total
						Sub-area I						
1983	39.9	97.3	16.5	0.8	0.7	+					1.1	156.3
1984	9.7	100.2	110.6	2.8	0.4	0.2	+				0.7	224.6
1985	3.9	19.1	213.4	168.8	0.8	0.2	0.1	-			0.3	406.6
1986	0.2	2.3	16.6	58.1	27.6	0.1	+	+	+		-	105.0
1987	0.4	1.4	2.5	12.5	34.2	8.6	+	+	-	+		59.8
1988	1.9	0.4	1.1	2.8	6.2	11.6	1.1	+	+	+		25.2
1989	3.3	3.0	3.6	0.7	2.5	7.1	13.9	1.8	0.1	+		36.0
1990	71.7	22.2	18.6	13.2	7.5	13.2	13.3	10.3	0.6	0.1		170.7
1991	15.9	61.5	27.5	10.8	1.6	0.6	1.0	3.3	2.6	0.3		125.1
1992	19.6	44.2	180.6	52.1	8.4	0.7	1.0	1.6	1.3	0.2		309.7
1993	5.5	8.1	69.2	371.5	78.4	10.2	1.4	0.7	0.8	1.8		547.7
1994	13.5	6.7	8.0	65.9	146.0	15.9	1.7	0.1	0.2	0.7		258.8
1995	9.9	12.7	6.5	4.0	26.8	77.6	7.3	1.0	0.1	0.5		146.3
1996	5.0	3.1	5.6	3.4	7.7	62.3	56.5	4.8	0.4	0.6		149.3
1997[1]	2.7	6.9	3.2	5.3	5.5	1.5	4.5	1.7	1.5	-		32.7
1998	10.5	2.9	17.2	6.7	7.8	0.6	0.9	2.1	0.7	+		49.4
1999	6.9	34.9	8.8	34.0	5.3	5.6	1.2	0.3	0.9	0.3		98.2
2000	18.0	25.4	37.5	9.3	13.0	3.2	1.1	0.2	0.1	0.4		108.3
2001	30.5	18.6	42.3	58.9	5.8	6.8	0.8	0.5	0.1	0.1		164.5
2002	39.7	29.2	29.4	69.2	74.7	6.7	3.2	0.6	0.1	0.2		252.7
2003	28.1	38.9	35.4	28.1	43	28	3.5	0.8	0.1	0.1		206.0
						Division IIa						
1983	5.4	5.5	0.1	0.2	0.3	0.1					1.0	12.6
1984	4.9	14.4	5.6	0.1	0.1	0.1	-				0.2	25.4
1985	3.8	7.0	11.7	4.1	0.1	-	+	-			0.1	26.8
1986	0.4	0.3	3.5	10.4	2.9	0.1	+	+	-		-	17.6
1987	-	-	-	-	0.3	0.3	-	-	-	-		0.6
1988	1.0	0.1	-	+	0.2	0.5	0.2	-	-	-		2.1
1989	0.1	0.7	2.7	+	0.1	0.1	0.1	-	-	-		3.8
1990	6.1	0.9	0.9	0.1	0.1	0.1	0.1	0.1	-	-		8.4
1991	5.7	3.8	0.6	0.1	+	-	-	-	-	-		10.2
1992	1.2	2.3	5.6	2.3	3.0	0.3	0.3	0.4	0.4	-		15.9
1993	1.8	1.1	1.5	4.5	2.5	0.8	0.2	0.1	0.2	0.2		12.8
1994	1.0	0.6	0.5	3.1	15.9	4.4	1.5	+	0.1	0.1		27.2
1995	5.0	8.5	6.3	5.3	6.2	23.9	4.1	0.6	+	0.2		60.1
1996	29.2	4.1	25.0	8.1	4.9	9.1	13.4	1.3	0.4	0.1		95.7
1997	1.2	2.8	0.8	1.3	0.7	0.6	0.9	0.5	0.1	-		8.9
1998	23.2	7.8	15.5	1.1	2.4	3.2	0.5	2.8	0.8	0.1		57.3
1999	34.8	34.1	4.3	16.9	3.9	6.3	1.7	0.9	1.2	0.5		104.6
2000	27.9	23.9	13.5	1.8	9.3	2.0	0.9	0.2	0.2	0.4		80.1
2001	39.0	13.5	7.6	8.4	2.2	7.9	1.4	0.3	0.1	0.4		80.8
2002[2]	61.9	16.6	5.3	10.2	29.9	6.0	3.3	0.3	0.1	0.2		133.7
2003	20.6	30.8	9.8	8.3	10.4	16.1	2.4	2.1	0.2	+		100.7

Table B2 (continued)

Year	Age											Total
	0	1	2	3	4	5	6	7	8	9	Older	
						Division IIb						
1983	22.1	9.9	0.2	0.1	+	+					0.1	32.4
1984	2.2	14.3	1.8	-	-	-	-				+	18.3
1985	1.4	10.2	61.4	5.1	+	+	+	-			+	78.1
1986	+	0.2	3.1	7.2	1.4	-	-	+	+		-	12.0
1987	-	-	0.1	0.7	1.4	0.5	+	-	-	-		2.8
1988	0.2	-	-	+	0.3	1.1	0.2	-	+	-		1.8
1989	0.7	0.1	0.2	+	0.1	0.3	0.6	0.1	+	-		2.1
1990	12.9	5.4	0.8	+	+	0.2	0.1	0.1	+	-		19.5
1991	20.0	22.9	6.2	0.4	0.1	0.1	0.1	+	+	-		49.8
1992	13.3	9.1	69.8	13.9	0.5	+	+	-	+	+		106.6
1993	0.7	0.9	1.9	24.7	1.9	0.2	+	+	+	+		30.4
1994	0.4	1.7	1.7	2.3	15.7	2.7	0.8	0.2	+	+		25.5
1995	0.1	0.4	0.4	0.8	0.6	1.6	0.4	+	+	+		4.3
1996[1]	4.3	0.6	0.5	0.3	0.2	0.4	0.5	0.3	-	-		7.1
1997	0.4	1.1	0.1	0.1	0.1	0.1	0.1	0.1	+	+		2.1
1998	5.8	1.1	0.2 +		0.1	0.1 +		0.1	+	-		7.5
1999	8.6	20.1	1.8	1.2	0.5	0.3	0.1 -		0.2	0.1		7.5
2000	7.9	10.0	13.4	1.3	5.5	2.2	1.2	0.4	0.2	0.3		42.4
2001	2.7	13.1	15.9	11.4	0.8	4.7	1.2	0.4	0.1	0.6		51.0
2002	9.0	4.2	7.7	5.1	2.6	0.7	0.8	0.1	0.1	0.1		26.8
2003	3.6	21.5	10.4	15.5	11.3	15.9	3.6	3	0.4	0.3		85.7
						Total - Sub-area I and Divisions IIa and IIb						
1983	29.8	59.2	9.5	0.5	0.4	+					0.8	100.2
1984	6.4	58.6	58.4	1.5	0.2	0.1	+				0.3	125.5
1985	3.0	14.4	134.3	90.0	0.4	0.1	0.1	-			0.2	242.7
1986	0.2	1.4	10.7	36.3	16.4	0.1	+	+	+		+	65.1
1987	0.3	0.9	1.7	8.3	22.5	5.7	+	+	-	+		39.4
1988	1.3	0.3	0.7	1.7	4.0	7.6	0.8	+	+	+		16.4
1989	2.2	1.8	2.4	0.4	1.4	4.1	8.1	1.1	0.1	+		21.6
1990	44.8	14.3	10.6	7.3	4.2	7.3	7.4	5.7	0.3	0.1		102.0
1991	16.7	42.9	17.6	6.2	0.9	0.3	0.6	1.8	1.5	0.2		88.7
1992	16.4	28.2	128.6	34.6	5.0	0.4	0.6	0.9	0.8	0.1		215.6
1993	3.5	4.8	35.7	198.5	35.6	4.8	0.8	0.4	0.4	-		284.5
1994	9.1	4.9	5.8	44.2	101.4	11.6	1.5	0.1	0.1	0.5		179.2
1995	6.4	7.2	4.2	3.1	12.3	37.0	4.0	0.5	0.1	0.3		75.1
1996[1]	6.0	2.3	5.7	2.8	4.9	36.2	33.4	2.9	0.3	0.3		94.8
1997[1]	1.8	4.6	1.9	3.2	3.2	1.0	2.7	1.0	0.8	-		20.2
1998	10.7	2.9	11.5	3.8	4.6	0.8	0.5	1.5	0.5	+		36.8
1999	11.7	28.9	6.1	19.6	3.9	3.7	0.8	0.3	0.7	0.7		76.4
2000	15.1	20.7	26.2	6	10.9	2.6	1.1	0.2	0.1	0.4		83.3
2001	20.8	14.9	26.1	33.4	4.0	6.5	1.1	0.4	0.1	0.3		107.5
2002[2]	33.2	19.3	18.9	39.9	45	4.7	2.4	0.4	0.1	0.2		164.0
2003	19.8	32.8	25.1	22.1	29.9	23.1	3.4	1.6	0.2	0.1		158.3

1) Adjusted data based on average 1985-1995 distribution.

2) Adjusted data based on 2001 distribution.

Table B3. North-East Arctic HADDOCK. Results from the Norwegian acoustic survey in the Barents Sea in January-March. Stock numbers in millions. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length dependent effective spread of the trawl.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	7	14	5	21	60	18	1	+	+	+	126
1982	9	2	3	4	4	10	6	+	+	+	38
1983	0	5	2	3	1	1	4	2	+	+	18
1984	1,685	173	6	2	1	+	+	+	+	+	1,867
1985	1,530	776	215	5	+	+	+	+	+	+	2,526
1986	556	266	452	189	+	+	+	+	+	+	1,463
1987	85	17	49	171	50	+	+	+	-	+	372
1988	18	4	8	23	46	7	+	-	-	+	106
1989	52	5	6	11	20	21	2	-	-	-	117
1990	270	35	3	3	4	7	11	2	+	+	335
1991	1,890	252	45	8	3	3	3	6	+	-	2,210
1992	1,135	868	134	23	2	+	+	1	2	+	2,165
1993	947	626	563	130	13	+	+	+	+	3	2,282
1994	562	193	255	631	111	12	+	+	+	+	1,764
1995	1,379	285	36	111	387	42	2	+	+	+	2,242
1996	249	229	44	31	76	151	8	+	-	+	788
1997[1]	693	24	51	17	12	43	43	2	+	+	885
1998[1]	220	122	20	28	12	5	13	16	1	+	437
1999	856	46	57	13	14	4	1	2	2	+	994
2000	1,024	509	32	65	19	11	2	1	2	+	1,664
2001	976	316	210	23	22	1	1	+	+	1	1,549
2002	2,062	282	216	149	14	12	1	+	+	1	2,737
2003	2394	279	145	198	169	17	5	+	+	1	3208
2004	752	474	127	76	76	66	7	2	+	+	1580

[1] Indices adjusted to account for limited area coverage.
Survey area extended from 1993 onwards.

Table B4a. North-East Arctic HADDOCK. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters in late autumn 1985-2001 (old method). Index of number of fish at age.

Year	Age 0	1	2	3	4	5	6	7	8	9+	Total
1985[1]	194	434	1,468	636	3	1	+	-	-	1	2,737
1986[1]	34	37	208	917	910	2	+	+	+	+	2,109
1987[2]	6	16	29	62	197	61	+	-	-	12	383
1988[2]	2	1	3	18	83	301	46	-	-	+	454
1989[1]	41	32	94	2	14	35	67	9	1	+	295
1990[1]	594	176	75	28	17	23	43	44	4	1	1,004
1991[1]	240	368	143	65	11	4	7	21	17	2	878
1992[1]	199	245	758	218	35	3	4	7	6	+	1,475
1993[1]	20	26	199	1,076	228	31	5	2	3	5	1,595
1994[1]	118	51	39	252	591	76	9	+	1	4	1,141
1995[1]	38	40	18	18	77	225	23	3	1	1	443
1996[1,4]	281	44	148	93	69	280	242	19	3	2	1,181
1997[1,4]	70	138	41	207	82	48	41	25	20	-	671
1998[3]	107	27	82	22	25	7	3	9	3	+	284
1999[1]	222	330	43	129	25	29	7	3	7	2	798
2000[1]	246	292	238	49	86	23	9	2	1	4	949
2001[1]	256	122	200	229	24	45	7	3	1	2	888
2002[1,5,6]	868	811	581	447	237	329	49	20	12	10	3364
2003[6]	352	310	189	124	161	124	19	9	1	1	1290

[1] October-December
[2] September-October
[3] November-January
[4] Adjusted data based on average 1985-1995 distribution
[5] Adjusted data based on 2001 distribution
[6] Adjusted data in 2004

Table B4b. North-East Arctic HADDOCK. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters in late autumn 1996-2001 (new method). Index of number of fish at age.

Year	Age 0	1	2	3	4	5	6	7	8	9	10+	Total
1995[5]	163	170	79	72	230	404	41	5	1	1	2	1,168
1996[1,3]	992	245	291	91	63	206	187	17	1	+	+	2,092
1997[1,3]	185	104	21	121	94	48	47	31	20	+	+	671
1998[2]	257	44	83	20	20	6	2	7	2	+	+	442
1999[1]	632	499	60	123	14	16	4	1	4	1	+	1,355
2000[1]	524	395	287	54	57	14	6	1	1	1	1	1,340
2001[1]	491	160	227	221	19	35	5	2	1	1	1	1,163
2002[1,4,5]	1045	209	139	268	239	27	17	2	1	+	1	1,947
2003	1168	473	217	116	134	94	14	6	1	+	+	2,223

[1] October-December
[2] November-January
[3] Adjusted data based on average 1985-1995 distribution
[4] Adjusted data based on 2001 distribution
[5] Adjusted data 2004

Table B5 North-East Arctic HADDOCK. Length data (cm) from Norwegian surveys in January-March and Russian surveys in November-December.

	Year	Age									
Norway		1	2	3	4	5	6	7			
	1983	16.8	25.2	34.9	44.7	52.5	58.0	62.4			
	1984	16.6	27.5	32.7	-	56.6	62.4	61.8			
	1985	15.7	23.9	35.6	41.9	58.5	61.9	63.9			
	1986	15.1	22.4	31.5	43.0	54.6	-	-			
	1987	15.4	22.4	29.2	37.3	46.5	-	-			
	1988	13.5	24.0	28.7	34.7	41.5	47.9	54.6			
	1989	16.0	23.2	31.1	36.5	41.7	46.4	52.9			
	1990	15.7	24.7	32.7	43.4	46.1	50.1	52.4			
	1991	16.8	24.0	35.7	44.4	52.4	54.8	55.6			
	1992	15.1	23.9	33.9	45.5	53.1	59.2	60.6			
	1993	14.5	21.4	31.8	42.4	50.6	56.1	59.4			
	1994	14.7	21.0	29.7	38.5	47.8	54.2	56.9			
	1995	15.4	20.1	28.7	34.2	42.8	51.2	55.8			
	1996	15.4	21.6	28.6	37.8	42.0	46.7	55.3			
	1997	16.1	27.7	27.7	35.4	39.7	47.5	50.1			
	1998	14.4	29.2	29.2	35.8	41.3	48.4	50.9			
	1999	14.7	20.8	32.3	39.4	45.5	52.3	54.6			
	2000	15.8	22.5	30.3	41.6	47.7	50.8	51.1			
	2001	22.2	22.2	32.2	37.8	47.2	51.2	58.7			
	2002	21.1	21.1	29.6	40.2	44.2	50.9	58.4			
	2003	16.5	24.1	28	37.2	46.5	49.6	54.7			
	2004	14.2	22.3	30.6	36.3	43.4	49.8	51.4			
Russia		0	1	2	3	4	5	6	7	8	9
	1984	-	24.1	35.8	44.4	56.4	62.8	64.8	-	-	-
	1985	16.5	22.4	30.9	44.1	53.8	61.3	64.7	-	-	-
	1986	17.0	20.7	28.1	35.4	46.7	62.0	-	68.0	-	-
	1987	12.1	21.5	27.8	32.3	37.3	48.6	-	-	-	-
	1988	13.7	23.2	29.7	33.7	39.3	46.2	51.2	-	-	-
	1989	14.9	22.2	26.5	38.5	44.5	49.3	53.0	57.7	64.1	-
	1990	17.0	24.5	30.9	40.4	50.6	53.2	55.7	59.7	63.8	67.7
	1991	17.2	24.2	30.5	39.7	53.4	55.4	58.3	60.5	62.7	70.2
	1992	16.0	22.8	31.1	44.6	53.8	63.8	61.2	66.4	69.0	69.6
	1993	15.3	21.7	28.7	38.3	48.3	54.3	60.9	64.2	63.2	65.0
	1994	15.7	22.5	28.1	33.0	44.1	54.9	61.5	67.5	67.7	67.8
	1995	15.5	22.5	28.5	33.3	39.7	49.9	58.2	63.1	66.3	69.5
	1996[2]	15.8	22.8	28.4	33.7	42.0	48.7	54.8	63.4	69.3	72.0
	1997[2]	13.8	23.5	29.3	36.1	45.3	50.0	54.6	58.9	69.4	66.0
	1998	15.0	22.0	29.0	38.3	47.7	52.1	54.5	57.8	63.4	-
	1999	-	22.8	27.4	40.1	47.4	50.9	54.6	55.9	58.0	61.6
	2000	15.0	22.7	30.4	35.2	49.3	55.1	57.8	62.4	63.3	63.6
	2001	15.1	22.4	29.8	37.8	48	55.3	58.8	62.1	63.6	65.4
	2002	14.6	23.8	30.1	35.6	48.2	55.1	60.2	60.5	63.3	66.8
	2003	14.0	22.9	28.9	35.3	44.8	52.2	57.5	63.1	66.3	69.6

[1] Lengths adjusted to account for limited area coverage.
[2] Limited area coverage.

Table B6 North-East Arctic HADDOCK. Weight data (g) from Norwegian surveys in January-March and Russian surveys in November-December.

	Year	Age										
Norway		1	2	3	4	5	6	7				
	1983	52	133	480	1,043	1,641	2,081	2,592				
	1984	36	196	289	964	1,810	2,506	2,240				
	1985	35	138	432	731	1,970	2,517	-				
	1986	47	100	310	734	-	-	-				
	1987	24	91	273	542	934	-	-				
	1988	23	139	232	442	743	1,193	1,569				
	1989	43	125	309	484	731	1,012	1,399				
	1990	34	148	346	854	986	1,295	1,526				
	1991	41	138	457	880	1,539	1,726	1,808				
	1992	32	136	392	949	1,467	2,060	2,274				
	1993	26	93	317	766	1,318	1,805	2,166				
	1994	25	86	250	545	1,041	1,569	1,784				
	1995	30	71	224	386	765	1,286	1,644				
	1996	30	93	220	551	741	1,016	1,782				
	1997	35	88	200	429	625	1,063	1,286				
	1998	25	112	241	470	746	1,169	1,341				
	1999	27	85	333	614	947	1,494	1,616				
	2000	32	108	269	720	1,068	1,341	1,430				
	2001	28	106	337	556	1,100	1,429	2,085				
	2002	30	84	144	623	848	1,341	2,032				
	2003	38	127	202	493	981	1189	1613				
	2004	23	98	266	459	780	1,167	1,328				
Russia		0	1	2	3	4	5	6	7	8	9	10
	1984	36	127	438	815	1,777	2,395	2,688	-	-	-	-
	1985	37	105	282	817	1,530	2,262	2,263	-	-	-	-
	1986	38	88	209	419	919	2,240	-	3,100	-	-	-
	1987	-	95	196	330	497	1,055	-	-	-	-	-
	1988	35	106	248	398	627	997	1,431	-	-	-	-
	1989	52	105	181	606	903	1,287	1,587	2,004	2,716	-	-
	1990	62	143	288	667	1,337	1,533	1,778	2,233	2,731	3,092	-
	1991	57	133	292	690	1,570	1,863	2,206	2,320	2,568	3,525	-
	1992	40	108	279	850	1,542	2,199	2,363	3,045	3,391	3,400	4,200
	1993	31	96	217	535	1,077	1,493	2,094	2,509	2,374	2,621	3,160
	1994	27	106	205	337	841	1,602	2,256	2,913	2,934	3,033	3,163
	1995	28	95	196	345	628	1,234	1,908	2,430	2,815	3,323	3,479
	1996[2]	30	103	209	347	743	1,152	1,650	2,442	3,218	3,333	4,648
	1997[2]	22	115	227	447	911	1,216	1,583	1,966	3,155	2,815	3,423
	1998	27	94	230	569	1,087	1,482	1,690	1,914	2,539	3,893	3,900
	1999	-	104	191	648	1,049	1,251	1,544	1,608	1,814	2,210	2,978
	2000	29	110	278	427	1,249	1,681	1,966	2,488	2,625	2,648	-
	2001	26	102	244	533	1,097	1,695	2,065	2,469	2,704	2,867	3,141
	2002	25	127	280	457	1166	1690	2293	2484	2784	2962	4655
	2003	21	104	220	419	855	1,347	1,844	2,402	2,923	2,582	-

[1] Lengths adjusted to account for limited area coverage.
[2] Limited area coverage.

5 NORTHEAST ARCTIC SAITHE (SUB-AREAS I AND II)

5.1 Status of the Fishery

5.1.1 Landings prior to 2004 (Tables 5.1-5.2, Figure 5.1)

Landings of saithe were highest in 1970-1976 with an average of 238,000 t and a maximum of 265,000 t in 1970. This period was followed by a sharp decline to a level of about 160,000 t in the years 1978-1984. Another decline followed and from 1985 to 1991 the landings ranged from 67,000-122,000 t (Table 5.1). An increasing trend was seen after 1990 to 171,348 t in 1996. Since then the annual landings have been between 136,000 and 160,000 t.

In spring 2002 ICES advised that the fishing mortality should be below F_{pa}, corresponding to catch in 2003 of less than 168,000 t. Due to the later increased TAC for 2002 Norwegian authorities set the TAC for 2003 to 164,000 t. Provisional figures show that the landings in 2003 were approximately 160,000 t, which is slightly below the level expected by the WG last year.

5.1.2 Expected landings in 2004

Last year ICES advised that the fishing mortality should be below F_{pa}, corresponding to catch in 2003 of less than 186,000 t. However, in order to stabilise catches and spawning stock development, The Institute of Marine Research, Bergen, Norway, advised a TAC at the 2003 level. Norwegian authorities set the TAC for 2004 to 169,000 t. Official landings in 2004 are expected to be around the TAC of 169,000 t, not accounting for problems with bycatch and discards of saithe in the cod fishery.

5.2 Status of Research

5.2.1 Fishing Effort and Catch-per-unit-effort (Tables C1-C2)

In 2001 new trawl CPUE indices by age were estimated. All days with 20% or more saithe from vessels larger than the median length are include. A yearly index is calculated by first averaging all CPUE observations for each quarter, and then averaging over the year. The CPUE indices are finally splitted on age groups by yearly catch in numbers and weight at age data from the trawl fishery. There has been an increase in the CPUE from 1999 to 2003, when it reached the highest level in the time series going back to 1980. Due to rather large negative log q residuals in the first part of the new time series, only the period after 1993 is used for tuning.

In the purse seine fishery, more than half of the vessels catch less than 100 tonnes per year, and the sum of these catches represents only about 5 – 10% of the total purse seine catch. Therefore the number of vessels catching more than 100 tonnes annually seems to be a more representative and stable measure of effort in the purse seine fishery. These numbers are raised to the total purse seine catch. There was an increase in purse seine effort in 2003 due to better availability of schooling saithe (1999-year class) and transfer of quota, allowing for a longer fishing season.

5.2.2 Survey results (Tables C3)

Autumn 2003 the saithe- and coastal cod surveys were combined and extended (Berg, Korsbrekke and Mehl, WD 11). However, until a new time series is established, the estimation of abundance indices going into the tuning is done very much in the same way as before and the results should be comparable. The results from the last survey show a lower total index, with fewer age 3, more of age 4 and 5 and the same amount of 6 years and older fish compared to 2002.

5.3 Data used in the Assessment

5.3.1 Catch numbers at age (Table 5.3)

The age composition of Norwegian landings in 2002 was revised, resulting in only minor changes in the catch numbers-at-age. Age composition data for 2003 was available from Norway, Russia (Sub-area I) and Germany (Division IIA). These countries accounted for 98% of the landings. Other areas and countries were assumed to have the same age composition as Norwegian trawlers.

5.3.2 Weight at age (Table 5.4)

Constant weight at age values were used for the period 1960-1979. For subsequent years, annual estimates of weight at age in the catches were used. Weight at age in the stock was assumed to be the same as weight at age in the catch. A decrease in individual weight at age from 2002 to 2003 was found for all age groups except age 2, and most pronounced for age groups 8 to 11+.

5.3.3 Natural mortality

A fixed natural mortality of 0.2 was used both in the assessment and the forecast.

5.3.4 Maturity at age (Table 5.14)

The same ogive was used for all years.

5.3.5 Tuning data (Table 5.5)

The tuning is based on three data series: indices from the Norwegian acoustic survey on saithe, data from the purse seine fishery and a CPUE series from the trawl fisheries (see chapter 5.2.1). The time span in the Norwegian acoustic survey series include data from 1992 – 2003 only because area coverage was extended from 1992 and onwards. Since the 2003 WG age 2 data are not included in the tuning due to large mean s.e. log q residuals.

5.3.6 Recruitment indices

Reliable recruitment indices are crucial for the predictions. Attempts at establishing year class strength at age 0 or 1 have so far failed. An observer program aimed at establishing a 0-group index series has started (2000) (Borge and Mehl, WD 21 2002). The accuracy of the recruitment indices varies from year to year according to the extent to which 2 year old saithe (and in some years even 3 year olds) have migrated out from the near coast areas and become available to the acoustic saithe survey on the banks.

5.3.7 Prediction data (Table 5.14)

The input data to the predictions based on results from the XSA-analysis are given in Table 5.14. The stock number at age in 2004 was taken from the XSA for age 5 and older. The recruitment at ages 2 and 3 in 2003 (2000 and 2001 year classes) was estimated using RCT3 (Section 5.5.2). The corresponding numbers at age 3 and 4 in 2004 was calculated applying a natural mortality of 0.2 and fishing mortalities according to the catches taken of these year classes. The long-term geometric mean recruitment 1960-1997 (the last year for which the retrospective analyses show some stability in recruitment) of 215 million was used for the 2002 and subsequent year classes. The natural mortality and the maturity ogive are the same as were used in the assessment. For the exploitation pattern the average of 2001-2003 has been used. For weight at age in stock and catch the average of the last three years in the VPA is normally used. However, the estimates of weight-at-age in the catches show a decreasing trend towards 2003, and therefore the 2003 weights at age have been applied in the predictions. The effect is approximately a 10 % decrease in estimated SSB and catch in the short term predictions.

5.4 Methods used in the Assessment

5.4.1 XSA and tuning (Table 5.6, Figures 5.2A-C, 5.3A-B)

Extended Survivors Analysis (XSA) was used for the assessment with the same settings as last year. Figures 5.2A-C show plots of the tuning indices versus stock numbers from the XSA. The tuning fleet diagnostics are given in Table 5.6. Figure 5.3A shows mean S.E. Log q from single fleet tuning and Fig. 5.3B presents Log q residuals from the combined tuning. There are some rather large residuals and S.E., especially in the purse seine fleet. As mentioned in section 5.11, this will be further analysed in connection with the full assessment in 2005.

5.4.2 Recruitment (Tables 5.8, 5.12-5.13 and C.3, Figure 5.1)

Estimates of the recruiting year classes up to the 1999-year class from the XSA were accepted. Catches of age group 2 have declined to very low levels in recent years except for an increase in 2000, probably due to a strong 1998-year class (Tables 5.3, Table C3). RCT3-runs were therefore conducted to estimate both the 2000- and 2001- year classes, with 2 and 3 year olds from the survey as input for the estimation.

5.5 Results of the Assessment

5.5.1 Fishing mortalities and VPA (Tables 5.7-5.11, Figures 5.1 and 5.4)

The fishing mortality ($F_{3\text{-}6}$) in 2002 was 0.21, which is just below the value of 0.22 from last year's assessment. Using the RCT3 estimation of the 2000-year class gives a fishing mortality ($F_{3\text{-}6}$) in 2003 of 0.18, i.e lower than the corresponding figure for 2002 and well below the F_{pa} of 0.26. Fishing mortalities and stock size tend to be over- and underestimated, respectively, in the assessment year as is illustrated by the retrospective plots in Figure 5.4. Retrospective analysis carried out fleet by fleet all showed the same trend (Mehl and Fotland,WD 15 2003).

The XSA-estimates of the 2000-2001 year classes are not considered to be valid and these estimates are therefore put in brackets (Tables 5.8-5.9). The summary table (Table 5.11) presents the recalculated recruitment figures and total biomass. The 1996 year class were well represented in the catches over several years, and appear to be above average in the current assessment, while the 1997-year class seems to be weak and the 1998-year class a little below average. In 2003 the 1999-year class is dominating the catches, especially in the purse seine fishery, and in the present assessment appear to be almost as strong as the 1992-year class.

The total biomass (ages 2+) has been at a stable and high level above the long-term (1960-2003) mean since 1993. Likewise, the SSB has been above the long-term mean since 1996 (Tables 5.9-5.11).

5.5.2 Recruitment (Tables 5.12-5.13)

The RCT3 estimate (with 2 year olds as input, Table 5.12) of the 2001-year class is 228 million individuals, while the RCT3 estimate (with 3 year olds as input and back calculating the strength as 2 year olds, Table 5.13) of the 2000-year class gives 231 million individuals. Thus, both year classes are estimated to be slightly above the long term mean. These estimates are strongly weighted towards the mean value of the input XSA-numbers, which due to the short survey time series also contain year classes that are still not converged. The estimates are therefore not much better than the long term average recruitment, but since this is an update assessment, it was decided to still use the RCT3 estimates for ages 2 and 3 in 2003, and the long-term geometric mean of 215 million individuals for the 2002 and subsequent year classes in the predictions.

5.6 Reference points

5.6.1 Biomass reference points

In 1995 MBAL for Northeast Arctic saithe was set at 170,000 t. (ICES 1996/Assess:4). This was also proposed as a suitable level for B_{pa} by The Study Group on the Precautionary Approach to Fisheries Management (SGPAFM, ICES 1998/ACFM:10). Based on a examination of the stock-recruitment plot ACFM reduced the B_{pa} to 150,000 t (ICES 1998).

5.6.2 Fishing mortality reference points (Tables 5.14, 5.15, Figures 5.1)

Yield and SSB per recruit were based on the parameters in Table 5.14 and are presented in Table 5.15. $F_{0.1}$ and F_{max} were estimated to be 0.12 and 0.29, respectively, which is higher than the values obtained last year. The plot of SSB versus recruitment is shown in Figure 5.1. The values of F_{low}, F_{med} and F_{high} obtained in 1999 were 0.18, 0.34 and 0.70, respectively, while the values that were recalculated by WG 2002 were 0.11, 0.34 and 0.69, respectively. ACFM estimated F_{pa} using the formula $F_{pa}=F_{lim} \cdot e^{-1.645\sigma}$ with $\sigma = 0.3$ giving a $F_{pa} = 0.26$ based on an estimated $F_{lim} = 0.45$ (ICES 1998). Since then the fishing pattern has changed due to the introduction of new minimum catch sizes effective 1 March 1999. A revision of the present fishing mortality reference points will be conducted if and when the new regulation has manifested itself in a stable and improved fishing pattern.

5.7 Catch options for 2005 (short term predictions) (Table 5.16)

The management option table (Table 5.16) shows that the expected catch of 169,000 t in 2004 will keep the fishing mortality below F_{pa}. A catch in 2005 corresponding to $F_{status\ quo}$ level of 0.18 will give 160,000 t, while the catch corresponding to F_{pa} in 2005 is 215,000 t. The SSB is expected to increase to 545,000 t in the beginning of 2005, which is well above the prediction made by last year's working group. At $F_{status\ quo}$ SSB is estimated to remain at this level, while at F_{pa} it will decrease somewhat.

5.8 Medium-term forecasts and management scenarios (Table 5.17A-B, Figures 5.5A-B)

The input data were the same as used for the short-term predictions (Table 5.14). At $F_{status\ quo}$ the catch will decrease to about 150,000 t in 2006-2008, while the SSB will remain at a stable level of about 540,000 t. At F_{pa} the catch will increase to 215,000 t in 2005, and stay above 160,000 t during the forecast period. At the same fishing mortality the SSB will increase to about 545,000 t in 2005 and decrease to about 400,000 t in 2009. Results from a projection using RISK show the development of SSB and catch fishing at F_{sq} and F_{pa} (Figure 5.5A-B).

5.9 Comparison of this year's assessment with last year's assessment.

The current assessment estimated the total stock and SSB in 2003 to be about 18 and 2 % higher, respectively, than in the previous assessment. The F in 2002 is estimated to be marginally lower than in the previous assessment.

	Total stock (2+) by 1 January 2003	SSB by 1 January 2003	F3-6 in 2003	F3-6 in 2002
WG 2003	866212	437232	0.23 (prediction)	0.22
WG 2004	1021393	447940	0.18	0.21

5.10 Comments on the assessment and the forecast

The new increased minimum landing size together with growing interest to fish larger saithe will probably improve the exploitation patterns further. Current fishing mortality reference points should be updated accordingly when an improved exploitation pattern are realised, and the retrospective assessment trend can be dealt with in the new estimation framework.

For comparisons, the summary table (Table 5.11) also presents F_{4-7} fishing mortalities. For the current fishing pattern, age 4-7 is probably a more correct reference age group. This will be further investigated and evaluated in connection with the full assessment in 2005.

Prediction of growth has been a small problem in some periods, especially for abundant year classes. Difficulties in estimating initial stock size due to the widely divergent indices of abundance used in the tuning of the XSA is, in addition to recruitment, at present the major problem in the forecast. This may also be the cause for underestimating the stock size in the assessment year. Prediction of catches beyond the TAC year will, to a large extent, be dependent on assumptions of average recruitment.

5.11 Response to ACFM technical minutes

The review committee last year recommended that the commercial CPUE series be examined using generalized linear models to remove possible seasonal and vessel effects. The plan is to do this before the full assessment next year. The trawl CPUE series is already to some extent analysed for seasonal and vessel effects. Only vessels larger than the median lengths are now include, and the yearly index is calculated by first averaging all CPUE observations for each quarter, and then averaging over the year. The WG will further investigate the data from purse seine tuning series to clarify the use of this tuning fleet series in the assessment. In general, the working group tends to put greater reliance in the survey, especially for ages 4 and 5, compared with purse seine commercial CPUEs. The applicability of only using the survey or together with the trawl series will be further investigated.

The review committee further stated that "Use of RCT3 for recruitment predictions may be no better then a geometric mean since RCT3 uses VPA estimates that have not converged." The reviewers suggested that the working group should justify use of the RCT3 model for projections and that the number of years used in GM estimate should be consistent.

The WG agree that the RCT3 estimates are strongly weighted towards the mean value of the input XSA-numbers, which due to the short survey time series also contain year classes that are still not converged. The estimates are therefore not much better than the long-term average recruitment, but since this is an update assessment, it was decided to still use the RCT3 estimates. When the observer time series of 0-group indices becomes a little longer, alternative recruitment models will be considered. For consistency, the WG used the long-term geometric mean recruitment 1960-1997 (the last year for which the retrospective analyses show some stability in recruitment) of 215 million for projections.

Table 5.1 Northeast Arctic saithe. Nominal catch (t) by countries as officially reported to ICES. (Sub-area I and Divisions IIa and IIb combined.)

Year	Faroe Islands	France	Germany Dem.Rep	Fed.Rep. Germany	Norway	Poland	Portugal	Russia[3]	Spain	UK (England & Wales)	UK (Scotland)	Others[5]	Total all countries
1960	23	1,700	-	25,948	96,050	-	-	-	-	9,780	-	14	133,515
1961	61	3,625	-	19,757	77,875	-	-	-	-	4,595	20	18	105,951
1962	2	544	-	12,651	101,895	-	-	912	-	4,699	-	4	120,707
1963	-	1,110	-	8,108	135,297	-	-	-	-	4,112	-	-	148,627
1964	-	1,525	-	4,420	184,700	-	-	84	-	6,511	-	186	197,426
1965	-	1,618	-	11,387	165,531	-	-	137	-	6,741	5	181	185,600
1966	-	2,987	813	11,269	175,037	-	-	563	-	13,078	-	41	203,788
1967	-	9,472	304	11,822	150,860	-	-	441	-	8,379	-	48	181,326
1968	-	-	70	4,753	96,641	-	-	-	-	8,781	2	-	110,247
1969	20	193	6,744	4,355	115,140	-	-	-	-	13,585	-	23	140,060
1970	1,097	-	29,362	23,466	151,759	-	-	43,550	-	15,469	221	-	264,924
1971	215	14,536	16,840	12,204	128,499	6,017	-	39,397	13,097	10,361	106	-	241,272
1972	109	14,519	7,474	24,595	143,775	1,111	-	1,278	13,125	8,223	125	-	214,334
1973	7	11,320	12,015	30,338	148,789	23	-	2,411	2,115	6,593	248	-	213,859
1974	46	7,119	29,466	33,155	152,699	2,521	-	38,931	7,075	3,001	103	5	274,121
1975	28	3,156	28,517	41,260	122,598	3,860	6,430	13,389	11,397	2,623	140	55	233,453
1976	20	5,609	10,266	49,056	131,675	3,164	7,233	9,013	21,661	4,651	73	47	242,468
1977	270	5,658	7,164	19,985	139,705	1	783	989	1,327	6,853	82	-	182,817
1978	809	4,345	6,484	18,190	121,069	35	203	381	121	2,790	37	-	154,464
1979	1,117	2,601	2,435	14,823	141,346	-	-	3	685	1,170	-	-	164,180
1980	532	1,016	-	12,511	128,878	-	-	43	780	794	-	-	144,554
1981	236	194	-	8,431	166,139	-	-	121	-	395	-	-	175,516
1982	339	82	-	7,224	159,643	-	-	14	-	731	1	-	168,034
1983	539	418	-	4,933	149,556	-	-	206	33	1,251	-	-	156,936
1984	503	431	6	4,532	152,818	-	-	161	-	335	-	-	158,786
1985	490	657	11	1,873	103,899	-	-	51	-	202	-	-	107,183
1986	426	308	-	3,470	66,152	-	-	27	-	54	21	-	70,458
1987	712	576	-	4,909	85,710	-	-	426	-	54	3	1	92,391
1988	441	411	-	4,574	108,244	-	-	130	-	436	6	-	114,242
1989	388	460 [2]	-	606	119,625	-	-	23	506	-	702	-	122,310
1990	1,207	340 [2]	-	1,143	92,397	-	-	52	-	681	28	-	95,848
1991	963	77 [2]	**Greenland**	2,003	103,283	-	-	504 [4]	-	449	42	5	107,326
1992	165	1,890 [2]	734	3,451	119,765	-	-	964	6	516	25	-	127,516
1993	31	566 [2]	78	3,687	139,288	-	1	9,509	4	408	7	5	153,584
1994	67	151 [2]	15	1,863	141,589	-	1	1,640	655	548	9	6	146,544
1995	172 [2]	358 [2]	53	935	165,001	-	5	1,148	-	589	99	18	168,378
1996	248 [2]	346 [2]	165 [2]	2,615	166,045	-	24	1,159	6 [2]	691 [2]	16	33 [2]	171,348
1997	193 [2]	560	363 [2]	2,915	136,927	-	12	1,774	41 [2]	676	123	45	143,629
1998	366 [2]	932	437 [2]	2,936	144,103	-	47 [2]	3,836	275 [2]	334	21	40 [2]	153,327
1999	181 [2]	638 [2]	655 [2]	2,473	141,941	-	17 [2]	3,929	24 [2]	336	3	178 [2]	150,375
2000	224 [2]	1438 [2]	651 [2]	2,573 [6]	125,950	-	46	4,452	117 [2]	445	9	40 [2]	135,945
2001	519	1279	701	2,690	125,495	-	75	4,951	119	352	162	59	136,402
2002	520 [2]	1048 [1]	1138 [2]	2,642 [6]	143,941	-	118	5,402	37 [2]	345	75	81 [1]	155,347
2003 [1]	561 [2]	848 [1]	929 [2]	2,763 [6]	150,205	-	143	3,893	13 [2]	265		98 [1]	159,718

[1] Provisional figures.
[2] As reported to Norwegian authorities.
[3] USSR prior to 1991.
[4] Includes Estonia.
[5] Includes Denmark,Netherlands, Iceland, Ireland and Sweden
[6] As reported by Working Group members

Table 5.2 Northeast Arctic saithe. Landings ('000 tonnes) by gear category for Sub-area I, Division IIa and Division IIb combined.

Year	Purse Seine	Trawl	Gill Net	Others	Total
1977	75.2	69.5	19.3	12.7	176.7 [2]
1978	62.9	57.7	21.1	13.9	155.6 [2]
1979	74.7	52.0	21.6	15.9	164.2
1980	61.3	46.8	21.1	15.4	144.6
1981	64.3	72.4	24.0	14.8	175.5
1982	76.4	59.4	16.7	15.5	168.0
1983	54.1	68.2	19.6	15.0	156.9
1984	36.4	85.6	23.7	13.1	158.8
1985	31.1	49.9	14.6	11.6	107.2
1986	7.9	36.2	12.3	8.2	64.6 [2]
1987	34.9	28.0	19.0	10.8	92.7 [2]
1988	43.5	45.4	15.3	10.0	114.2
1989	48.6	44.8	16.8	12.1	122.3
1990	24.6	44.0	19.3	7.9	95.8
1991	38.9	40.1	18.9	9.4	107.3
1992	27.1	66.9	21.2	12.3	127.5
1993	33.1	83.5	21.2	15.8	153.6
1994	30.2	81.7	21.1	13.5	146.5 [3]
1995	21.8	103.5	26.9	15.9	168.4 [4]
1996	46.9	72.7	31.6	20.3	171.3
1997	44.4	56.1	24.4	19.0	143.6
1998	44.4	58.2	27.6	23.6	153.3
1999	39.2	57.9	29.7	23.5	150.4
2000	28.2	52.2	29.6	25.9	135.9
2001	28.1	58.3	28.1	21.9	136.4
2002	27.4	75.4	30.3	22.3	155.3
2003 [1]	43.3	72.0	25.1	19.3	159.7

[1] Provisional figures.

[2] Unresolved discrepancy between Norwegian catch by gear figures and the total reported to ICES for these years.

[3] Includes 4,300 tonnes not categorized by gear, proportionally adjusted.

[4] Reduced by 1,200 tonnes not categorized by gear, proportionally adjusted.

Table 5.3 Catch numbers at age
Run title : North-East Arctic saithe

At 6/05/2004 16:43

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

	YEAF	1960	1961	1962	1963
	AGE				
	2	7381	4936	1246	2815
	3	10509	17824	37266	42050
	4	13083	9131	11131	28925
	5	13545	12506	4421	5888
	6	5064	3799	8290	4650
	7	4883	1332	2427	3861
	8	2401	968	1024	1099
	9	1315	520	938	1075
	10	743	405	451	697
	+gp	1525	1229	1728	1777
0	TOTAL	60449	52650	68922	92837
	TONSL	133515	105951	120707	148627
	SOPC(	126	138	123	121

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

	YEAF	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
	AGE										
	2	20308	30430	7450	6952	5297	4090	25952	19842	11608	13829
	3	9001	37115	22392	29664	25196	77333	43540	77019	65178	76296
	4	59601	5001	54537	24836	18384	11949	62846	59280	52389	25206
	5	13154	26300	13124	35956	5101	16939	13987	26961	29146	26911
	6	2718	10142	12899	4125	8282	4747	16189	9556	10186	16031
	7	3472	2861	4652	5616	787	4798	5122	9592	5616	7114
	8	2655	2110	1374	2916	1913	1126	7950	2901	3547	3935
	9	1251	2733	933	1413	900	1711	2504	4352	1865	2871
	10	1221	699	965	1397	577	675	3697	2195	2140	2610
	+gp	3559	3593	2900	3493	1166	511	2799	5490	3149	3924
0	TOTAL	116940	120984	121226	116368	67603	123879	184586	217188	184824	178727
	TONSL	197426	185600	203788	181326	110247	140060	264924	241272	214334	213859
	SOPC(	116	108	111	95	117	97	97	78	84	81

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

	YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	2	21159	81601	54151	31662	45758	28334	18226	10467	17225	11638
	3	36782	60832	125030	99049	48969	61963	40796	83954	34733	17244
	4	44027	11691	30576	34317	27685	23328	36644	21822	65052	23768
	5	15671	16366	7947	10140	12476	14122	9211	21528	13060	32700
	6	20419	4436	8712	2062	4534	4400	6379	3619	8212	3226
	7	12148	7808	3435	4332	1468	2901	3200	2550	1054	3008
	8	4802	6789	3212	1456	1848	963	1338	2008	1251	1177
	9	3258	2914	2679	1606	938	1356	147	369	461	760
	10	2505	2350	1724	963	976	438	730	279	263	247
	+gp	3821	4140	2880	1134	2150	1192	1629	629	448	760
0	TOTAL	164592	198927	240346	186721	146802	138997	118300	147225	141759	94528
	TONSL	274121	233453	242486	182817	154464	164180	144554	175516	168034	156936
	SOPC(	101	102	100	101	103	114	94	100	98	101

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

	YEAF	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	2	14624	2216	3311	3867	5017	11157	11543	6135	14333	3379
	3	41466	48917	22115	17869	8126	12378	21002	73878	49750	26933
	4	33233	11974	12895	49829	35847	19915	13463	11619	26640	63451
	5	12064	7189	6062	4339	32827	32643	8996	5395	4865	26254
	6	11204	5279	4525	3118	4560	18751	9152	5066	5594	3427
	7	1135	3740	2805	3490	2328	1939	7735	2988	4850	1636
	8	1772	775	1399	755	1219	377	1126	2009	3353	1263
	9	560	878	351	620	966	191	154	272	1480	950
	10	557	134	454	257	320	179	121	81	291	650
	+gp	897	701	285	797	102	149	253	132	267	106
0	TOTAL	117512	81803	54202	84941	91312	97679	73545	107575	111423	128049
	TONSL	158786	107183	70458	92391	114242	122310	95848	107326	127516	153584
	SOPC(	100	99	99	102	99	99	100	99	100	100

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

	YEAF	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE										
	2	1432	70	961	326	35	91	1192	246	93	102
	3	9369	16402	10225	14827	3100	9644	9397	4101	6595	2528
	4	38499	48351	57448	13295	16261	12220	22921	8795	17583	51423
	5	48587	37268	18667	43309	11981	22804	7865	27411	11636	13278
	6	17617	32240	17805	13029	31918	10321	11282	8610	25900	7966
	7	1772	4842	17861	11219	8405	18932	5806	6858	5308	9395
	8	517	572	2765	5837	5556	3384	8177	3041	4328	5471
	9	305	139	485	755	2881	3335	2330	4625	2403	3457
	10	275	280	202	63	731	2293	2526	1834	3461	2484
	+gp	697	305	443	160	397	589	1210	2076	2400	4030
0	TOTAL	119070	140469	126862	102820	81265	83613	72706	67597	79707	100134
	TONSL	146544	168378	171348	143629	153327	150375	135945	136402	155347	159718
	SOPC(	100	100	100	100	100	100	101	100	100	100

Table 5.4 Catch weight at age
Run title : North-East Arctic saithe

At 6/05/2004 16:43

Table 2 Catch weights at age (kg)

YEAR	1960	1961	1962	1963
AGE				
2	0.34	0.34	0.34	0.34
3	0.71	0.71	0.71	0.71
4	1.11	1.11	1.11	1.11
5	1.63	1.63	1.63	1.63
6	2.33	2.33	2.33	2.33
7	3.16	3.16	3.16	3.16
8	4.03	4.03	4.03	4.03
9	4.87	4.87	4.87	4.87
10	5.63	5.63	5.63	5.63
+gp	8.03	8.039	7.924	7.851
0 SOPC	1.2559	1.3848	1.2272	1.2075

Table 2 Catch weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
2	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
3	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
4	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
5	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
6	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
7	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
8	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03
9	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87	4.87
10	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63	5.63
+gp	7.781	7.959	8.106	7.994	7.716	7.479	7.404	7.052	7.477	7.385
0 SOPC	1.1644	1.0782	1.1067	0.9475	1.1662	0.9734	0.9741	0.7841	0.8362	0.8099

Table 2 Catch weights at age (kg)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
2	0.34	0.34	0.34	0.34	0.34	0.34	0.45	0.43	0.51	0.6
3	0.71	0.71	0.71	0.71	0.71	0.71	0.79	0.73	0.77	1.05
4	1.11	1.11	1.11	1.11	1.11	1.11	1.27	1.4	1.12	1.33
5	1.63	1.63	1.63	1.63	1.63	1.63	2.03	2.05	2.02	1.86
6	2.33	2.33	2.33	2.33	2.33	2.33	2.55	2.76	2.61	2.8
7	3.16	3.16	3.16	3.16	3.16	3.16	3.29	3.3	3.27	4
8	4.03	4.03	4.03	4.03	4.03	4.03	4.34	4.38	3.91	4.18
9	4.87	4.87	4.87	4.87	4.87	4.87	5.15	5.95	4.69	5.33
10	5.63	5.63	5.63	5.63	5.63	5.63	5.75	6.39	5.63	5.68
+gp	7.217	7.127	7.32	7.394	7.527	7.809	6.937	6.841	7.558	8.665
0 SOPC	1.0131	1.0155	1.002	1.0062	1.0278	1.1384	0.9355	0.9975	0.9794	1.0089

Table 2 Catch weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
2	0.53	0.38	0.32	0.34	0.33	0.45	0.54	0.4	0.45	0.46
3	0.71	0.75	0.59	0.53	0.62	0.74	0.76	0.72	0.7	0.63
4	1.26	1.33	1.22	0.84	0.87	0.97	1.08	1.19	1.1	1.02
5	2.02	2.07	1.97	1.66	1.31	1.39	1.56	1.78	1.98	1.7
6	2.7	2.63	2.3	2.32	2.43	1.81	2.12	2.24	2.34	2.5
7	3.88	3.28	2.87	2.97	3.87	3.02	2.4	2.86	2.81	2.88
8	4.47	3.96	3.72	4	5.38	3.76	3.65	3.32	3.25	3.09
9	5.36	4.54	4.3	4.72	5.83	4.64	3.6	4.53	4.06	3.7
10	6.06	5.55	4.69	5.44	5.36	4.75	6.37	5.7	6.19	6.19
+gp	7.19	8.012	6.597	6.904	7.448	7.5	4.795	7.125	7.376	8.175
0 SOPC	0.9997	0.9933	0.9929	1.0233	0.9879	0.9949	1.0049	0.9912	0.9993	1.0008

Table 2 Catch weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
2	0.35	0.5	0.4	0.38	0.35	0.64	0.37	0.426	0.4	0.421
3	0.52	0.56	0.59	0.62	0.68	0.67	0.61	0.752	0.69	0.669
4	0.74	0.78	0.82	0.92	1	1.05	1.02	1.108	1.009	0.914
5	1.22	1.21	1.32	1.19	1.48	1.45	1.61	1.531	1.49	1.413
6	2.16	1.74	1.83	1.66	1.87	1.93	2.12	2.037	1.956	1.78
7	3.19	2.8	2.47	2.31	2.58	2.28	2.66	2.62	2.538	2.491
8	3.97	3.74	3.72	3.1	3.07	2.97	3.21	3.172	3.258	2.536
9	4.62	4.4	4.49	4.34	4.12	3.6	3.74	3.657	3.773	3.455
10	5.28	5.28	5.3	6.04	5.45	4.11	4.35	4.585	4.307	3.694
+gp	6.072	7.451	7.016	7.62	8.052	5.513	5.975	5.37	5.599	4.871
0 SOPC	1.0038	1.0011	0.9991	1.0002	0.9983	1.001	1.0088	0.9991	1.0002	1.0001

Table 5.5 Tuning data

North-East Arctic saithe (Sub-areas I and II)
103
FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
1989 2003
1 1 0.00 1.00
3 7

119.2	5250	8521	18211	2880	24
56.4	7207	3319	2582	1845	673
98.5	43110	1907	453	162	95
88.8	29527	5214	89	45	38
71.9	8010	24251	1302	39	23
79.3	6365	16182	8997	1151	90
52.2	5524	13357	4368	1335	105
81.9	4053	36274	6022	2610	589
92.0	9665	6691	18403	1852	1329
130.1	1994	9690	5302	10330	1226
133.0	6420	5990	10422	2275	2749
125.6	8000	13543	1316	1247	281
104.6	2420	4321	11502	651	279
77.8	4820	9957	3209	3079	307
116.3	1926	38583	2326	444	592

FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown)
1994 2003
1 1 0.00 1.00
5 9

1	395.6	260.4	37.4	8.2	4.2
1	293.8	359.1	65.8	11.1	1.2
1	139.5	205.6	293.0	32.9	8.5
1	371.4	194.1	183.4	112.0	16.9
1	55.3	244.0	93.1	56.6	16.1
1	105.5	80.0	187.5	43.0	30.8
1	78.7	170.1	100.2	156.2	44.5
1	276.4	194.4	183.1	77.1	109.9
1	123.8	385.6	87.1	89.3	40.9
1	224.1	148.3	214.7	145.4	119.9

FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)
1992 2003
1 1 0.75 0.85
3 6

1	273.6	57.5	6.2	8.8
1	227.7	103.9	12.7	3.2
1	87.8	112.4	39.5	11.3
1	165.2	87.0	46.8	19.9
1	118.9	214.7	32.1	19.5
1	36.7	185.8	79.8	61.7
1	96.5	200.6	70.0	95.5
1	233.8	72.9	62.2	47.8
1	142.5	176.3	11.6	26.5
1	275.9	45.9	53.8	20.2
1	230.2	92.6	18.9	15.7
1	87.5	151.7	26.1	15.8

Table 5.6 Tuning Diagnostics

Lowestoft VPA Version 3.1

6/05/2004 16:42

Extended Survivors Analysis

North-East Arctic saithe

CPUE data from file fleetnew.dat

Catch data for 44 years. 1960 to 2003. Ages 2 to 11.

Fleet	Fi year	Last year	First age	Last age	Alpha	Beta
FLT08: Norway Purse	1989	2003	3	7	0	1
FLT12: Nor new trawl	1994	2003	5	9	0	1
FLT13: Norway Ac Su	1992	2003	3	6	0.75	0.85

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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 46 iterations

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	0.003	0	0.005	0.003	0	0.001	0.007	0.001	0.001	0.002
3	0.052	0.048	0.085	0.094	0.03	0.045	0.104	0.029	0.02	0.04
4	0.235	0.406	0.236	0.152	0.141	0.159	0.142	0.134	0.168	0.216
5	0.374	0.375	0.27	0.281	0.199	0.301	0.146	0.253	0.263	0.185
6	0.681	0.459	0.309	0.306	0.345	0.264	0.238	0.235	0.404	0.289
7	0.622	0.397	0.501	0.327	0.332	0.354	0.233	0.223	0.223	0.249
8	0.435	0.416	0.416	0.301	0.266	0.215	0.254	0.183	0.214	0.377
9	0.257	0.197	0.765	0.189	0.238	0.253	0.225	0.223	0.216	0.264
10	0.476	0.398	0.49	0.201	0.282	0.302	0.31	0.279	0.258	0.363

Table 5.6 (Cont'd)

1

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9	10
1994	4.75E+05	2.06E+05	2.03E+05	1.72E+05	3.94E+04	4.23E+03	1.62E+03	1.49E+03	8.03E+02
1995	1.69E+05	3.88E+05	1.60E+05	1.32E+05	9.68E+04	1.63E+04	1.86E+03	8.57E+02	9.42E+02
1996	2.25E+05	1.39E+05	3.02E+05	8.73E+04	7.40E+04	5.01E+04	8.98E+03	1.00E+03	5.76E+02
1997	1.42E+05	1.83E+05	1.04E+05	1.96E+05	5.46E+04	4.45E+04	2.48E+04	4.85E+03	3.82E+02
1998	2.98E+05	1.16E+05	1.36E+05	7.33E+04	1.21E+05	3.29E+04	2.63E+04	1.50E+04	3.29E+03
1999	1.29E+05	2.44E+05	9.19E+04	9.70E+04	4.92E+04	7.02E+04	1.93E+04	1.65E+04	9.71E+03
2000	1.94E+05	1.05E+05	1.91E+05	6.41E+04	5.88E+04	3.09E+04	4.03E+04	1.28E+04	1.05E+04
2001	4.46E+05	1.58E+05	7.77E+04	1.36E+05	4.54E+04	3.79E+04	2.00E+04	2.56E+04	8.34E+03
2002	8.75E+04	3.65E+05	1.26E+05	5.57E+04	8.62E+04	2.94E+04	2.49E+04	1.37E+04	1.68E+04
2003	5.93E+04	7.16E+04	2.93E+05	8.70E+04	3.50E+04	4.71E+04	1.93E+04	1.64E+04	9.01E+03

Estimated population abundance at 1st Jan 2004

0.00E+00	4.85E+04	5.63E+04	1.93E+05	5.92E+04	2.15E+04	3.01E+04	1.08E+04	1.03E+04

Taper weighted geometric mean of the VPA populations:

1.93E+05	1.73E+05	1.35E+05	7.79E+04	4.36E+04	2.24E+04	1.02E+04	4.87E+03	2.26E+03

Standard error of the weighted Log(VPA populations) :

0.6663	0.5915	0.6175	0.68	0.7724	0.9477	1.1478	1.3443	1.4765

1

Log catchability residuals.

Fleet : FLT08: Norway Purse

Age	1989	1990	1991	1992	1993
3	0.84	1.95	1.86	0.92	0.17
4	0.49	0.74	-0.21	-0.53	0.41
5	1.79	1.15	-0.69	-2.04	-0.67
6	1.01	1.82	-0.92	-1.45	-1.33
7	-1.23	1.77	-0.47	-0.91	-0.39
8	No data for this fleet at this age				
9	No data for this fleet at this age				

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0.11	-0.24	0.04	0.52	-0.98	-0.57	0.58	-0.88	-0.73	-0.41
4	0.2	0.74	0.58	-0.2	-0.45	-0.55	-0.42	-0.48	0.18	0.31
5	0.32	0.29	0.52	0.72	0.07	0.49	-1.18	0.47	0.39	-0.82
6	0.54	0.11	0.53	0.37	0.96	0.29	-0.44	-0.65	0.63	-0.86
7	0.75	-0.13	0.07	0.81	0.69	0.72	-0.73	-0.77	-0.12	-0.33
8	No data for this fleet at this age									
9	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	3	4	5	6	7
Mean Log q	-7.8405	-6.895	-7.3727	-8.0338	-8.5904
S.E(Log q)	0.8192	0.4758	0.8582	0.8483	0.7224

Table 5.6 (Cont'd)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.18	-0.338	7.1	0.28	15	1.01	-7.84
4	0.79	1.135	7.92	0.75	15	0.37	-6.89
5	0.6	1.889	8.94	0.7	15	0.46	-7.37
6	0.57	2.661	9.19	0.8	15	0.39	-8.03
7	0.88	0.537	8.76	0.68	15	0.66	-8.59
1							

Fleet : FLT12: Nor new trawl

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	0.37	0.34	-0.04	0.14	-0.82	-0.41	-0.36	0.2	0.29	0.4
6	0.84	0.16	-0.19	0.05	-0.5	-0.75	-0.19	0.2	0.33	0.22
7	0.92	0.03	0.45	0.02	-0.35	-0.4	-0.26	0.13	-0.36	0.09
8	0.32	0.47	-0.02	0.14	-0.62	-0.61	-0.04	-0.08	-0.13	0.69
9	-0.35	-1.08	0.97	-0.17	-1.33	-0.76	-0.15	0.05	-0.31	0.6

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

Age	5	6	7	8	9
Mean Log q	-6.1746	-5.4486	-5.2606	-5.2993	-5.2993
S.E(Log q)	0.4167	0.4392	0.3967	0.4249	0.7491

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
5	0.72	1.154	7.67	0.7	10	0.29	-6.17
6	1.54	-0.926	2.44	0.29	10	0.68	-5.45
7	1.47	-2.01	2.85	0.71	10	0.5	-5.26
8	1.22	-1.361	4.37	0.84	10	0.49	-5.3
9	1.05	-0.238	5.38	0.75	10	0.78	-5.54
1							

Fleet : FLT13: Norway Ac Sur

Age	1989	1990	1991	1992	1993
3	99.99	99.99	99.99	-0.03	0.12
4	99.99	99.99	99.99	-0.4	-0.62
5	99.99	99.99	99.99	0.15	-0.63
6	99.99	99.99	99.99	0.97	-0.09
7	No data for this fleet at this age				
8	No data for this fleet at this age				
9	No data for this fleet at this age				

Table 5.6 (Cont'd)

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	-0.58	-0.59	0.14	-1.31	0.07	0.22	0.61	0.81	-0.22	0.46
4	-0.26	-0.14	-0.01	0.84	0.64	0.04	0.18	-0.28	-0.03	-0.34
5	-0.37	0.07	0.02	0.13	0.91	0.6	-0.79	0.08	-0.07	-0.26
6	-0.21	-0.72	-0.59	0.86	0.53	0.68	-0.11	-0.13	-0.89	-0.07
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	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	3	4	5	6
Mean Log q	-6.9746	-6.8923	-7.5483	-7.2421
S.E(Log q)	0.6031	0.4213	0.4849	0.6091

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.93	-1.456	2.18	0.22	12	1.1	-6.97
4	1.44	-1.064	4.65	0.4	12	0.6	-6.89
5	0.98	0.054	7.61	0.6	12	0.5	-7.55
6	1.33	-0.91	6.07	0.47	12	0.82	-7.24
1							

Terminal year survivor and F summaries :

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

Year class = 2001

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	1	0	0	0	0	0	0
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	1	0	0	0	0	0	0
F shrinkage mean	48462	0.5				1	0.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48462	0.5	0	1	0	0.002

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

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	37243	0.854	0	0	1	0.171	0.06
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	89163	0.631	0	0	1	0.312	0.025
F shrinkage mean	48934	0.5				0.517	0.046

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
56327	0.36	0.25	3	0.71	0.04

Table 5.6 (Cont'd

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

Year class = 1999

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	203749	0.429	0.452	1.05	2	0.301	0.206
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sui	142999	0.361	0.057	0.16	2	0.423	0.282
F shrinkage mean	288761	0.5				0.276	0.149

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
193134	0.24	0.21	5	0.848	0.216

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	46720	0.388	0.358	0.92	3	0.223	0.229
FLT12: Nor new trawl	88270	0.439	0	0	1	0.199	0.128
FLT13: Norway Ac Sui	62466	0.296	0.276	0.93	3	0.394	0.176
F shrinkage mean	45703	0.5				0.184	0.233

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
59217	0.19	0.16	8	0.828	0.185

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	16403	0.36	0.301	0.83	4	0.192	0.364
FLT12: Nor new trawl	27604	0.321	0.035	0.11	2	0.287	0.232
FLT13: Norway Ac Sui	20657	0.272	0.164	0.6	4	0.344	0.299
F shrinkage mean	20694	0.5				0.177	0.299

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
21485	0.17	0.11	11	0.615	0.289

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	26058	0.342	0.217	0.63	5	0.193	0.282
FLT12: Nor new trawl	35888	0.263	0.072	0.27	3	0.394	0.213
FLT13: Norway Ac Sui	27393	0.272	0.255	0.94	4	0.239	0.27
F shrinkage mean	26933	0.5				0.175	0.274

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
30086	0.16	0.09	13	0.578	0.249

Table 5.6 (Cont'd

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	6058	0.332	0.173	0.52	5	0.159	0.597
FLT12: Nor new trawl	11840	0.226	0.268	1.19	4	0.457	0.349
FLT13: Norway Ac Sur	8512	0.272	0.212	0.78	4	0.211	0.458
F shrinkage mean	19373	0.5				0.173	0.228

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10814	0.16	0.15	14	0.957	0.377

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

Year class = 1994

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	7374	0.342	0.231	0.68	5	0.141	0.354
FLT12: Nor new trawl	10109	0.223	0.143	0.64	5	0.492	0.27
FLT13: Norway Ac Sur	12248	0.278	0.386	1.39	4	0.179	0.227
F shrinkage mean	11970	0.5				0.188	0.232

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10333	0.16	0.11	15	0.702	0.264

1

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

Year class = 1993

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norway Purse	4122	0.343	0.184	0.54	5	0.133	0.435
FLT12: Nor new trawl	3521	0.223	0.145	0.65	5	0.46	0.494
FLT13: Norway Ac Sur	10622	0.28	0.145	0.52	4	0.171	0.192
F shrinkage mean	7120	0.5				0.237	0.274

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5130	0.17	0.14	15	0.81	0.363

Table 5.7

Run title : North-East Arctic saithe

At 6/05/2004 16:43

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1960	1961	1962	1963
AGE				
2	0.0694	0.0259	0.0039	0.0259
3	0.1412	0.2383	0.2772	0.1747
4	0.1843	0.1755	0.2297	0.3606
5	0.5007	0.2695	0.1204	0.1825
6	0.2407	0.2519	0.2882	0.1797
7	0.3847	0.0915	0.253	0.2108
8	0.4184	0.1206	0.0942	0.1734
9	0.3585	0.1479	0.1645	0.1355
10	0.3832	0.177	0.1849	0.1771
+gp	0.3832	0.177	0.1849	0.1771
0 FBAR 3	0.2667	0.2338	0.2289	0.2244

Table 8 Fishing mortality (F) at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
2	0.0628	0.1742	0.0347	0.0409	0.016	0.0131	0.0785	0.1052	0.0472	0.1396
3	0.108	0.1562	0.1876	0.1886	0.2041	0.3402	0.188	0.3511	0.5893	0.4905
4	0.4012	0.0805	0.3616	0.3278	0.1709	0.1406	0.5146	0.4216	0.4299	0.4766
5	0.276	0.3093	0.3131	0.4319	0.1024	0.2354	0.2432	0.4348	0.3782	0.411
6	0.1198	0.3557	0.2447	0.1522	0.1649	0.1307	0.3709	0.261	0.2894	0.3693
7	0.1978	0.1786	0.2736	0.1595	0.0391	0.1356	0.2034	0.3929	0.2409	0.3373
8	0.2195	0.1772	0.1219	0.2757	0.0747	0.0721	0.348	0.1697	0.2451	0.2654
9	0.3055	0.369	0.1106	0.1777	0.1274	0.0885	0.2271	0.3262	0.1569	0.321
10	0.2248	0.2795	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635	0.3429
+gp	0.2248	0.2795	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635	0.3429
0 FBAR 3	0.2262	0.2254	0.2767	0.2751	0.1606	0.2117	0.3292	0.3671	0.4217	0.4369

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
2	0.1204	0.2763	0.2181	0.2178	0.1964	0.2067	0.0582	0.0788	0.1461	0.1145
3	0.6669	0.5962	0.9053	0.786	0.6157	0.4446	0.5171	0.4112	0.4041	0.2136
4	0.5911	0.459	0.6942	0.6807	0.524	0.6834	0.5182	0.5842	0.6566	0.5382
5	0.623	0.4556	0.6609	0.5207	0.5675	0.5605	0.6404	0.668	0.8678	0.8438
6	0.637	0.3551	0.4704	0.3522	0.467	0.399	0.5356	0.5631	0.5848	0.5393
7	0.5334	0.5379	0.5163	0.4538	0.4574	0.6257	0.572	0.4245	0.3133	0.4393
8	0.4017	0.6559	0.4431	0.4306	0.3556	0.6248	0.673	0.8954	0.3811	0.6968
9	0.3673	0.4563	0.592	0.4163	0.5508	0.4824	0.1765	0.3907	0.5211	0.422
10	0.5166	0.496	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934	0.538	0.5933
+gp	0.5166	0.496	0.5409	0.4378	0.4833	0.5429	0.5237	0.5934	0.538	0.5933
0 FBAR 3	0.6295	0.4665	0.6827	0.5849	0.5435	0.5219	0.5528	0.5566	0.6283	0.5337

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
2	0.1249	0.009	0.018	0.042	0.0724	0.1481	0.0439	0.0139	0.0456	0.0147
3	0.7502	0.7844	0.1174	0.1278	0.1167	0.2566	0.4575	0.4322	0.149	0.1132
4	0.822	0.5011	0.4837	0.4197	0.4067	0.4626	0.4921	0.4976	0.2719	0.2882
5	0.5833	0.4108	0.5145	0.2953	0.5442	0.8169	0.3924	0.3728	0.4	0.4718
6	0.8088	0.5505	0.4952	0.5494	0.5815	0.7023	0.5668	0.4013	0.849	0.5503
7	0.3669	0.7086	0.647	0.9256	1.1017	0.527	0.7197	0.3626	0.8611	0.6495
8	0.5058	0.4616	0.637	0.3554	1.0495	0.5066	0.6774	0.4069	0.9139	0.5699
9	0.8805	0.5081	0.3923	0.6582	1.0993	0.4389	0.3991	0.3367	0.6012	0.7278
10	0.6347	0.5322	0.5416	0.5614	0.8846	0.6035	0.5557	0.3785	0.7403	0.5838
+gp	0.6347	0.5322	0.5416	0.5614	0.8846	0.6035	0.5557	0.3785	0.7403	0.5838
0 FBAR 3	0.7411	0.5617	0.4027	0.3481	0.4123	0.5596	0.4772	0.4259	0.4175	0.3559

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR **-**
AGE											
2	0.0033	0.0005	0.0047	0.0025	0.0001	0.0008	0.0068	0.0006	0.000444	0.000494	0.0012
3	0.0516	0.0479	0.0851	0.0938	0.0301	0.0447	0.1038	0.0291	0.0202	0.014864	0.0297
4	0.2349	0.4063	0.2356	0.152	0.1412	0.159	0.1424	0.1336	0.1679	0.2159	0.1725
5	0.3745	0.3755	0.2697	0.2806	0.1993	0.3007	0.1456	0.2529	0.2627	0.1847	0.2334
6	0.6815	0.4591	0.3091	0.3064	0.3447	0.2641	0.2382	0.2352	0.4036	0.2893	0.3094
7	0.6225	0.3974	0.5013	0.3268	0.3319	0.354	0.2327	0.2228	0.2227	0.2489	0.2315
8	0.4354	0.4162	0.416	0.3008	0.2663	0.2151	0.2537	0.1835	0.2137	0.3769	0.258
9	0.2569	0.1974	0.765	0.1888	0.2378	0.2532	0.2255	0.2225	0.2162	0.2645	0.2344
10	0.4757	0.3981	0.4901	0.2012	0.282	0.3023	0.31	0.2786	0.2585	0.3634	0.3002
+gp	0.4757	0.3981	0.4901	0.2012	0.282	0.3023	0.31	0.2786	0.2585	0.3634	
0 FBAR 3	0.3356	0.3222	0.2249	0.2082	0.1788	0.1921	0.1575	0.1627	0.2136	0.184164	

Table 5.8

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

	YEAF	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
	AGE										
	2	368899	210354	241202	191872	367843	347431	379816	219524	278465	117299
	3	97187	283654	144689	190738	150801	296372	280751	287484	161778	217485
	4	199330	71425	198653	98200	129322	100667	172675	190463	165683	73477
	5	60271	109269	53953	113296	57927	89246	71608	84509	102299	88246
	6	26611	37443	65664	32298	60225	42811	57741	45971	44795	57383
	7	21379	19328	21479	42090	22711	41814	30755	32626	28992	27458
	8	14890	14362	13236	13376	29379	17882	29893	20546	18033	18655
	9	5252	9788	9850	9593	8313	22322	13622	17281	14197	11554
	10	6703	3168	5541	7220	6576	5992	16728	8887	10210	9936
	+gp	19432	16183	16565	17951	13243	4518	12585	22073	14934	14828
0	TOT/	819953	774974	770831	716635	846340	969055	1066173	929364	839385	636321

Run title : North-East Arctic saithe

At 6/05/2004 16:43

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	2	206220	373550	305467	178777	283594	167697	356260	152606	140079	118928
	3	83523	149693	232001	201097	117721	190784	111661	275189	115472	99101
	4	109026	35101	67515	76814	75021	52073	100134	54506	149341	63113
	5	37350	49426	18160	27611	31839	36372	21526	48826	24881	63409
	6	47900	16400	25658	7677	13431	14779	17000	9289	20496	8553
	7	32476	20741	9413	13124	4420	6894	8119	8147	4331	9350
	8	16044	15597	9916	4599	6825	2290	3019	3751	4363	2592
	9	11713	8790	6627	5212	2448	3916	1004	1261	1255	2440
	10	6862	6642	4560	3002	2814	1155	1979	689	699	610
	+gp	10361	11586	7538	3503	6140	3111	4371	1535	1177	1855
0	TOT/	561475	687526	686856	521416	544253	479070	625072	555801	462093	369952

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

	YEAF	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	2	137628	271968	204641	103892	79362	89550	296964	491783	355418	255130
	3	86839	99448	220664	164550	81560	60437	63222	232689	397087	278022
	4	65534	33578	37159	160654	118553	59423	38281	32759	123662	280091
	5	30166	23584	16657	18755	86445	64628	30632	19160	16307	77141
	6	22326	13782	12804	8152	11430	41072	23376	16939	10805	8949
	7	4084	8142	6507	6389	3853	5232	16660	10858	9285	3785
	8	4933	2317	3282	2790	2073	1048	2529	6641	6186	3213
	9	1057	2436	1195	1421	1601	594	517	1052	3620	2031
	10	1310	359	1200	661	602	437	314	284	615	1624
	+gp	2084	1858	745	2028	189	359	649	459	556	262
0	TOT/	355963	457472	504854	469292	385669	322780	473144	812624	923541	910249

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

	YEAF	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 60-**	AMST 60-**
	AGE													
	2	474937	169313	224709	141580	297858	128712	194369	445863	[87543]	[59304]	[0]	217932	242424
	3	205825	387550	138558	183106	115621	243834	105298	158057	364819	[71590]	[48462]	160518	179779
	4	203255	160038	302458	104190	136499	91857	190908	77708	125695	292721	[56327]	95596	112221
	5	171907	131576	87278	195650	73274	97042	64149	135562	55664	87001	193134	52418	64488
	6	39402	96782	74004	54567	120997	49151	58818	45405	86187	35045	59217	27423	35089
	7	4226	16319	50066	44479	32886	70184	30902	37947	29383	47128	21485	14707	19896
	8	1619	1857	8980	24830	26265	19320	40331	20047	24863	19254	30086	7660	11307
	9	1488	857	1003	4850	15047	16476	12756	25621	13662	16440	10814	4091	6792
	10	803	942	576	382	3288	9713	10472	8335	16792	9011	10333	2200	3927
	+gp	2016	1018	1251	965	1774	2478	4982	9376	11575	14507	13389		
0	TOT/	1105477	966252	888883	754599	823509	728767	712986	963923	[816184]	[652002]	[443247]		

Table 5.9

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
2	125426	71520	82009	65237	125067	118126	129137	74638	94678	39882
3	69002	201394	102729	135424	107069	210424	199334	204114	114862	154414
4	221257	79282	220505	109002	143548	111741	191669	211414	183908	81559
5	98241	178108	87943	184673	94421	145470	116720	137749	166748	143841
6	62003	87243	152998	75254	140323	99750	134537	107113	104371	133703
7	67559	61076	67874	133004	71766	132132	97187	103098	91613	86767
8	60005	57880	53339	53906	118396	72064	120469	82800	72672	75179
9	25578	47669	47968	46718	40485	108710	66337	84158	69137	56270
10	37737	17837	31196	40649	37021	33734	94178	50032	57485	55938
+gp	151201	128800	134275	143498	102186	33794	93178	155657	111663	109507
0 TOTAL	918009	930808	980836	987365	980282	1065945	1242746	1210774	1067138	937060

At 6/05/2004 16:43

Terminal Fs derived using XSA (With F shrinkage)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
2	70115	127007	103859	60784	96422	57017	160317	65621	71440	71357
3	59301	106282	164721	142779	83582	135456	88212	200888	88914	104056
4	121019	38962	74942	85264	83273	57801	127170	76309	167262	83940
5	60881	80564	29601	45005	51898	59286	43697	100093	50259	117940
6	111606	38212	59783	17888	31293	34435	43351	25638	53494	23949
7	102624	65541	29747	41471	13967	21783	26710	26885	14162	37400
8	64656	62856	39963	18534	27505	9231	13102	16431	17058	10835
9	57041	42810	32273	25385	11921	19070	5170	7503	5884	13005
10	38634	37392	25675	16899	15845	6505	11380	4402	3933	3465
+gp	74775	82570	55177	25903	46217	24295	30321	10504	8899	16078
0 TOTAL	760652	682197	615738	479912	461924	424879	549431	534275	481305	482026

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
2	72943	103348	65485	35323	26189	40298	160360	196713	159938	117360
3	61656	74586	130192	87211	50567	44723	48049	167536	277961	175154
4	82573	45666	45334	134949	103141	57641	41344	38983	136028	285693
5	60936	49291	32814	31134	113243	89832	47786	34105	32288	131140
6	60281	36247	29450	18913	27774	74341	49557	37944	25285	22373
7	15845	26704	18676	18975	14912	15800	39985	31053	26090	10901
8	22052	9197	12208	11159	11153	3921	9230	22050	20104	9929
9	5667	11034	5140	6707	9333	2757	1862	4764	14696	7513
10	7939	1988	5627	3597	3229	2074	1998	1619	3806	10055
+gp	14985	15215	4916	14001	1407	2694	3111	3272	4104	2141
0 TOTAL	404878	373277	349842	361970	360948	334079	403282	538039	700300	772259

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
2	166228	84656	89883	53800	104250	82376	71916	189938	[35017]	[24967]
3	107029	217028	81749	113526	78622	163369	64232	118859	251725	[47894]
4	150409	124830	248015	95855	136499	96450	194726	86101	126827	267547
5	209726	159207	115207	232824	108445	140711	103281	207546	82940	122932
6	85108	168401	135427	90581	226265	94861	124693	92489	168581	62381
7	13481	45694	123664	102746	84847	160019	82200	99422	74575	117397
8	6426	6944	33405	76972	80633	57380	129463	63590	81005	48829
9	6875	3773	4501	21050	61994	59315	47707	93698	51545	56801
10	4239	4975	3054	2307	17918	39919	45554	38218	72324	33286
+gp	12239	7585	8780	7355	14286	13663	29769	50349	64809	70664
0 TOTAL	761761	823092	843687	797015	913760	908063	893541	1040208	[1009348]	[852697]

Table 5.10

Run title : North-East Arctic saithe

At 6/05/2004 16:43

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1960	1961	1962	1963
	AGE				
	2	0	0	0	0
	3	0	0	0	0
	4	954	696	665	1172
	5	34068	52452	38601	34972
	6	51820	37346	72459	61894
	7	52327	52150	37165	69533
	8	31275	37946	50706	30748
	9	23490	20363	33278	45655
	10	14524	15534	16625	26719
	+gp	42179	66999	89227	94556
0	TOTSF	250637	283486	338725	365250

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	2213	793	2205	1090	1435	1117	1917	2114	1839	816
	5	54033	97959	48369	101570	51932	80009	64196	75762	91711	79112
	6	52703	74156	130048	63966	119275	84787	114356	91046	88716	113648
	7	66208	59854	66516	130344	70331	129489	95244	101036	89781	85032
	8	60005	57880	53339	53906	118396	72064	120469	82800	72672	75179
	9	25578	47669	47968	46718	40485	108710	66337	84158	69137	56270
	10	37737	17837	31196	40649	37021	33734	94178	50032	57485	55938
	+gp	151201	128800	134275	143498	102186	33794	93178	155657	111663	109507
0	TOTSF	449677	484948	513917	581741	541060	543704	649874	642605	583004	575501

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	1210	390	749	853	833	578	1272	763	1673	839
	5	33485	44310	16280	24753	28544	32607	24033	55051	27642	64867
	6	94865	32481	50815	15205	26599	29269	36849	21793	45470	20357
	7	100572	64231	29152	40642	13688	21348	26176	26347	13878	36652
	8	64656	62856	39963	18534	27505	9231	13102	16431	17058	10835
	9	57041	42810	32273	25385	11921	19070	5170	7503	5884	13005
	10	38634	37392	25675	16899	15845	6505	11380	4402	3933	3465
	+gp	74775	82570	55177	25903	46217	24295	30321	10504	8899	16078
0	TOTSF	465238	367039	250084	168173	171152	142904	148303	142795	124438	166098

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	826	457	453	1349	1031	576	413	390	1360	2857
	5	33515	27110	18048	17124	62284	49408	26282	18758	17759	72127
	6	51239	30810	25033	16076	23608	63189	42124	32252	21492	19017
	7	15529	26170	18302	18596	14614	15484	39185	30432	25568	10683
	8	22052	9197	12208	11159	11153	3921	9230	22050	20104	9929
	9	5667	11034	5140	6707	9333	2757	1862	4764	14696	7513
	10	7939	1988	5627	3597	3229	2074	1998	1619	3806	10055
	+gp	14985	15215	4916	14001	1407	2694	3111	3272	4104	2141
0	TOTSF	151751	121981	89727	88609	126658	140103	124206	113537	108890	134323

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE										
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	1504	1248	2480	959	1365	965	1947	861	1268	2675
	5	115349	87564	63364	128053	59645	77391	56804	114150	45617	67613
	6	72342	143140	115113	76994	192325	80632	105989	78616	143294	53023
	7	13212	44780	121191	100691	83150	156818	80556	97434	73084	115049
	8	6426	6944	33405	76972	80633	57380	129463	63590	81005	48829
	9	6875	3773	4501	21050	61994	59315	47707	93698	51545	56801
	10	4239	4975	3054	2307	17918	39919	45554	38218	72324	33286
	+gp	12239	7585	8780	7355	14286	13663	29769	50349	64809	70664
0	TOTSF	232186	300009	351888	414380	511317	486083	497789	536915	532946	447940

Table 5.11

Run title : North-East Arctic saithe

At 6/05/2004 16:43

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RE Age 2	TOTALBI	TOTSPI	LANDIN	YIELD/S	FBAR 3- 6	FBAR 4- 7
1960	121650	487106	250637	133515	0.5327	0.2667	0.3276
1961	213269	541421	283486	105951	0.3737	0.2338	0.1971
1962	355505	691404	338725	120707	0.3564	0.2289	0.2228
1963	121815	769500	365250	148627	0.4069	0.2244	0.2334
1964	368899	918009	449677	197426	0.439	0.2262	0.2487
1965	210354	930808	484948	185600	0.3827	0.2254	0.2310
1966	241202	980836	513917	203788	0.3965	0.2767	0.2983
1967	191872	987365	581741	181326	0.3117	0.2751	0.2679
1968	367843	980282	541060	110247	0.2038	0.1606	0.1193
1969	347431	1065945	543704	140060	0.2576	0.2117	0.1606
1970	379816	1242746	649874	264924	0.4077	0.3292	0.3330
1971	219524	1210774	642605	241272	0.3755	0.3671	0.3776
1972	278465	1067138	583004	214334	0.3676	0.4217	0.3346
1973	117299	937060	575501	213859	0.3716	0.4369	0.3986
1974	206220	760652	465238	274121	0.5892	0.6295	0.5961
1975	373550	682197	367039	233453	0.636	0.4665	0.4519
1976	305467	615738	250084	242486	0.9696	0.6827	0.5855
1977	178777	479912	168173	182817	1.0871	0.5849	0.5018
1978	283594	461924	171152	154464	0.9025	0.5435	0.5040
1979	167697	424879	142904	164180	1.1489	0.5219	0.5672
1980	356260	549431	148303	144554	0.9747	0.5528	0.5666
1981	152606	534275	142795	175516	1.2291	0.5566	0.5600
1982	140079	481305	124438	168034	1.3503	0.6283	0.6056
1983	118928	482026	166098	156936	0.9448	0.5337	0.5902
1984	137628	404878	151751	158786	1.0464	0.7411	0.6453
1985	271968	373277	121981	107183	0.8787	0.5617	0.5427
1986	204641	349842	89727	70458	0.7852	0.4027	0.5351
1987	103892	361970	88609	92391	1.0427	0.3481	0.5475
1988	79362	360948	126658	114242	0.902	0.4123	0.6585
1989	89550	334079	140103	122310	0.873	0.5596	0.6272
1990	296964	403282	124206	95848	0.7717	0.4772	0.5428
1991	491783	538039	113537	107326	0.9453	0.4259	0.4086
1992	355418	700300	108890	127516	1.1711	0.4175	0.5955
1993	255130	772259	134323	153584	1.1434	0.3559	0.4899
1994	474937	761761	232186	146544	0.6311	0.3356	0.4783
1995	169313	823092	300009	168378	0.5612	0.3222	0.4096
1996	224709	843687	351888	171348	0.4869	0.2249	0.3289
1997	141580	797015	414380	143629	0.3466	0.2082	0.2664
1998	297858	913760	511317	153327	0.2999	0.1788	0.2543
1999	128712	908063	486083	150375	0.3094	0.1921	0.2694
2000	194369	893541	497789	135945	0.2731	0.1575	0.1897
2001	445863	1040208	536915	136402	0.254	0.1627	0.2111
2002	230948	1152753	532946	155347	0.2915	0.2136	0.2642
2003	228000	1021393	447940	159718	0.3566	0.1842	0.2347
Arith. Mean	241835	728111	328673	159747	0.6451	0.3742	0.4041
0 Units	(Thousan	(Tonnes)	(Tonnes	(Tonnes)			

GMST 1960-1997

	215723

Table 5.12 Input to RCT3 analysis program

```
NORTHEAST ARCTIC SAITHE : recruits as 2 year-olds
1 12 2  (No. of surveys   No. of years   VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1990   355  163.5
1991   255  106.9
1992   475    34.4
1993   169    38.7
1994   225    37.0
1995   142     5.1
1996   298    43.6
1997   129    61.1
1998   194   164.8
1999   446   104.7
2000   -11    25.5
2001   -11    31.6

NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds
1 12 2  (No. of surveys, No. of years, VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv'
1989       397    273.6
1990       278    227.7
1991       206     87.8
1992       388    165.2
1993       139    118.9
1994       183     36.7
1995       116     96.5
1996       244    233.8
1997       105    142.5
1998       158    275.9
1999       365    230.2
2000       -11     87.5
```

Table 5.13 Analysis by RCT3 program

Analysis by RCT3 ver3.1 of data from file :

rct2-03.txt

Analysis by RCT3 ver3.1 of data from file :

rct2-03.txt

NORTHEAST ARCTIC SAITHE : recruits as 2 year-olds

Data for 1 surveys over 12 years : 1990 - 2001

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

	Regression					Prediction			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	1.26	.44	1.24	.136	10	3.28	4.59	1.513	.085
					VPA Mean =		5.49	.461	.915

Yearclass = 2001

	Regression					Prediction			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	1.27	.41	1.26	.135	10	3.48	4.85	1.524	.084
					VPA Mean =		5.49	.463	.916

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	224	5.41	.44	.25	.33		
2001	228	5.43	.44	.18	.16		

Table 5.13 Analysis by RCT3 program

Analysis by RCT3 ver3.1 of data from file :

rct3-03.txt

Analysis by RCT3 ver3.1 of data from file :

rct3-03.txt

NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds

Data for 1 surveys over 12 years : 1989 - 2000

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2000

	Regression					Prediction			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Ac-sur	1.89	-4.12	1.13	.167	11	4.58	4.54	1.358	.110
					VPA Mean =		5.33	.478	.890

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	189	5.24	.45	.25	.30		

Table 5.14

North-East Arctic saithe (Sub-areas I and II)

MFDP version 1a
Run: 000
Time and date: 18:07 06.05.2004
Fbar age range: 3-6

Prediction with management option table: Input data

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	215723	0.2	0	0	0	0.421	0.0005160	0.421
3	186578	0.2	0	0	0	0.669	0.0213780	0.669
4	152457	0.2	0.01	0	0	0.914	0.1724733	0.914
5	193134	0.2	0.55	0	0	1.413	0.2334500	1.413
6	59217	0.2	0.85	0	0	1.780	0.3093733	1.780
7	21485	0.2	0.98	0	0	2.491	0.2314600	2.491
8	30086	0.2	1	0	0	2.536	0.2580267	2.536
9	10814	0.2	1	0	0	3.455	0.2343867	3.455
10	10333	0.2	1	0	0	3.694	0.3001500	3.694
11+	13389	0.2	1	0	0	4.871	0.3001500	4.871

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	215723	0.2	0	0	0	0.421	0.0005160	0.421
3	.	0.2	0	0	0	0.669	0.0213780	0.669
4	.	0.2	0.01	0	0	0.914	0.1724733	0.914
5	.	0.2	0.55	0	0	1.413	0.2334500	1.413
6	.	0.2	0.85	0	0	1.780	0.3093733	1.780
7	.	0.2	0.98	0	0	2.491	0.2314600	2.491
8	.	0.2	1	0	0	2.536	0.2580267	2.536
9	.	0.2	1	0	0	3.455	0.2343867	3.455
10	.	0.2	1	0	0	3.694	0.3001500	3.694
11+	.	0.2	1	0	0	4.871	0.3001500	4.871

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	215723	0.2	0	0	0	0.421	0.0005160	0.421
3	.	0.2	0	0	0	0.669	0.0213780	0.669
4	.	0.2	0.01	0	0	0.914	0.1724733	0.914
5	.	0.2	0.55	0	0	1.413	0.2334500	1.413
6	.	0.2	0.85	0	0	1.780	0.3093733	1.780
7	.	0.2	0.98	0	0	2.491	0.2314600	2.491
8	.	0.2	1	0	0	2.536	0.2580267	2.536
9	.	0.2	1	0	0	3.455	0.2343867	3.455
10	.	0.2	1	0	0	3.694	0.3001500	3.694
11+	.	0.2	1	0	0	4.871	0.3001500	4.871

Input units are thousands and kg - output in tonnes

Table 5.15 Yield per recruit analysis
North-East Arctic saithe (Sub-areas I and II)

MFYPR version 2a
Run: y00
Time and date: 18:11 06.05.2004
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpNoJan	SSBJan	SpNosSp	SSBSp
0.0000	0.0000	0.0000	0.0000	5.5167	10.8765	2.7126	8.8140	2.7126	8.8140
0.1000	0.0184	0.0759	0.2025	5.1386	9.3353	2.3441	7.2871	2.3441	7.2871
0.2000	0.0368	0.1352	0.3407	4.8433	8.1748	2.0581	6.1406	2.0581	6.1406
0.3000	0.0553	0.1830	0.4372	4.6056	7.2744	1.8296	5.2537	1.8296	5.2537
0.4000	0.0737	0.2225	0.5057	4.4097	6.5589	1.6425	4.5514	1.6425	4.5514
0.5000	0.0921	0.2557	0.5549	4.2451	5.9791	1.4866	3.9844	1.4866	3.9844
0.6000	0.1105	0.2840	0.5904	4.1047	5.5017	1.3546	3.5194	1.3546	3.5194
0.7000	0.1289	0.3085	0.6163	3.9834	5.1030	1.2415	3.1327	1.2415	3.1327
0.8000	0.1473	0.3300	0.6350	3.8773	4.7661	1.1435	2.8075	1.1435	2.8075
0.9000	0.1658	0.3489	0.6485	3.7838	4.4785	1.0578	2.5313	1.0578	2.5313
1.0000	0.1842	0.3658	0.6582	3.7006	4.2306	0.9822	2.2944	0.9822	2.2944
1.1000	0.2026	0.3810	0.6650	3.6261	4.0152	0.9152	2.0898	0.9152	2.0898
1.2000	0.2210	0.3946	0.6696	3.5589	3.8267	0.8553	1.9118	0.8553	1.9118
1.3000	0.2394	0.4070	0.6726	3.4980	3.6606	0.8016	1.7558	0.8016	1.7558
1.4000	0.2578	0.4183	0.6743	3.4426	3.5133	0.7531	1.6185	0.7531	1.6185
1.5000	0.2763	0.4287	0.6750	3.3918	3.3821	0.7091	1.4969	0.7091	1.4969
1.6000	0.2947	0.4383	0.6751	3.3452	3.2645	0.6692	1.3887	0.6692	1.3887
1.7000	0.3131	0.4471	0.6746	3.3022	3.1586	0.6327	1.2920	0.6327	1.2920
1.8000	0.3315	0.4553	0.6736	3.2624	3.0628	0.5993	1.2051	0.5993	1.2051
1.9000	0.3499	0.4629	0.6724	3.2255	2.9759	0.5685	1.1269	0.5685	1.1269
2.0000	0.3683	0.4700	0.6709	3.1911	2.8966	0.5402	1.0562	0.5402	1.0562

Ref. point	F mult.	Abs. F
Fbar(3-6)	1.0000	0.1842
FMax	1.5547	0.2863
F0.1	0.6641	0.1223
F35%SPR	0.7137	0.1314

Weights in kilograms

Table 5.16 Management option table (short term prediction)
North-East Arctic saithe (Sub-areas I and II)

MFDP version 1a
Run: 000
North-East Arctic saithe
Time and date: 18:07 06.05.2004
Fbar age range: 3-6

Prediction with management option table

2004				
Biomass	SSB	FMult	FBar	Landings
1003860	510582	1.0862	0.2	169000

2005					2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
988931	544670	0	0	0	1165028	719950
.	544670	0.1	0.0184	17894	1144285	701495
.	544670	0.2	0.0368	35346	1124072	683530
.	544670	0.3	0.0553	52366	1104374	666041
.	544670	0.4	0.0737	68967	1085177	649015
.	544670	0.5	0.0921	85159	1066468	632440
.	544670	0.6	0.1105	100953	1048235	616303
.	544670	0.7	0.1289	116359	1030464	600592
.	544670	0.8	0.1473	131387	1013143	585296
.	544670	0.9	0.1658	146048	996261	570404
.	544670	1	0.1842	160351	979805	555904
.	544670	1.1	0.2026	174304	963764	541786
.	544670	1.2	0.221	187919	948127	528040
.	544670	1.3	0.2394	201202	932884	514655
.	544670	1.4	0.2578	214163	918024	501622
.	544670	1.5	0.2763	226810	903537	488931
.	544670	1.6	0.2947	239151	889413	476573
.	544670	1.7	0.3131	251194	875643	464539
.	544670	1.8	0.3315	262947	862217	452820
.	544670	1.9	0.3499	274418	849125	441408
.	544670	2	0.3683	285613	836361	430295

Input units are thousands and kg - output in tonnes

Table 5.17A F sq medium term projection
North-East Arctic saithe (Sub-areas I and II)

MFDP version 1a
Run: fsq
North-East Arctic saithe
Time and date: 18:20 06.05.2004
Fbar age range: 3-6

2004				
Biomass	SSB	FMult	FBar	Landings
1003860	510582	1.0862	0.2	169000

2005				
Biomass	SSB	FMult	FBar	Landings
988931	544670	1	0.1842	160351

2006				
Biomass	SSB	FMult	FBar	Landings
979805	555904	1	0.1842	154517

2007				
Biomass	SSB	FMult	FBar	Landings
959403	540687	1	0.1842	151292

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
954189	536411	0	0	0	1111117	673826
.	536411	0.1	0.0184	16573	1092354	657177
.	536411	0.2	0.0368	32751	1074051	640954
.	536411	0.3	0.0553	48544	1056196	625143
.	536411	0.4	0.0737	63962	1038779	609735
.	536411	0.5	0.0921	79014	1021787	594719
.	536411	0.6	0.1105	93710	1005210	580084
.	536411	0.7	0.1289	108058	989037	565821
.	536411	0.8	0.1473	122067	973257	551920
.	536411	0.9	0.1658	135746	957862	538372
.	536411	1	0.1842	149102	942841	525167
.	536411	1.1	0.2026	162145	928184	512296
.	536411	1.2	0.221	174882	913882	499751
.	536411	1.3	0.2394	187320	899926	487523
.	536411	1.4	0.2578	199467	886308	475605
.	536411	1.5	0.2763	211330	873018	463987
.	536411	1.6	0.2947	222917	860049	452662
.	536411	1.7	0.3131	234233	847392	441623
.	536411	1.8	0.3315	245287	835040	430863
.	536411	1.9	0.3499	256084	822984	420373
.	536411	2	0.3683	266631	811217	410147

Input units are thousands and kg - output in tonnes

Table 5.17B F pa medium term projection
North-East Arctic saithe (Sub-areas I and II)

MFDP version 1a
Run: fpa
North-East Arctic saithe
Time and date: 18:25 06.05.2004
Fbar age range: 3-6

Medium term prediction

2004

Biomass	SSB	FMult	FBar	Landings
1003860	510582	1.0862	0.2	169000

2005

Biomass	SSB	FMult	FBar	Landings
988931	544670	1.4119	0.26	215690

2006

Biomass	SSB	FMult	FBar	Landings
916274	500088	1.4119	0.26	190494

2007

Biomass	SSB	FMult	FBar	Landings
856977	447335	1.4119	0.26	174758

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
824589	415988	0	0	0	986582	552035
.	415988	0.1	0.0184	13552	971040	538547
.	415988	0.2	0.0368	26785	955874	525400
.	415988	0.3	0.0553	39708	941074	512585
.	415988	0.4	0.0737	52328	926631	500093
.	415988	0.5	0.0921	64652	912535	487916
.	415988	0.6	0.1105	76689	898778	476047
.	415988	0.7	0.1289	88444	885351	464476
.	415988	0.8	0.1473	99927	872246	453197
.	415988	0.9	0.1658	111142	859454	442201
.	415988	1	0.1842	122096	846969	431482
.	415988	1.1	0.2026	132797	834781	421032
.	415988	1.2	0.221	143251	822884	410844
.	415988	1.3	0.2394	153463	811270	400911
.	415988	1.4	0.2578	163440	799932	391227
.	415988	1.5	0.2763	173187	788863	381786
.	415988	1.6	0.2947	182710	778057	372581
.	415988	1.7	0.3131	192015	767507	363606
.	415988	1.8	0.3315	201106	757205	354855
.	415988	1.9	0.3499	209990	747147	346323
.	415988	2	0.3683	218672	737326	338003

Input units are thousands and kg - output in tonnes

Figure 5.1 North-East Arctic saithe (Sub-areas I and II)

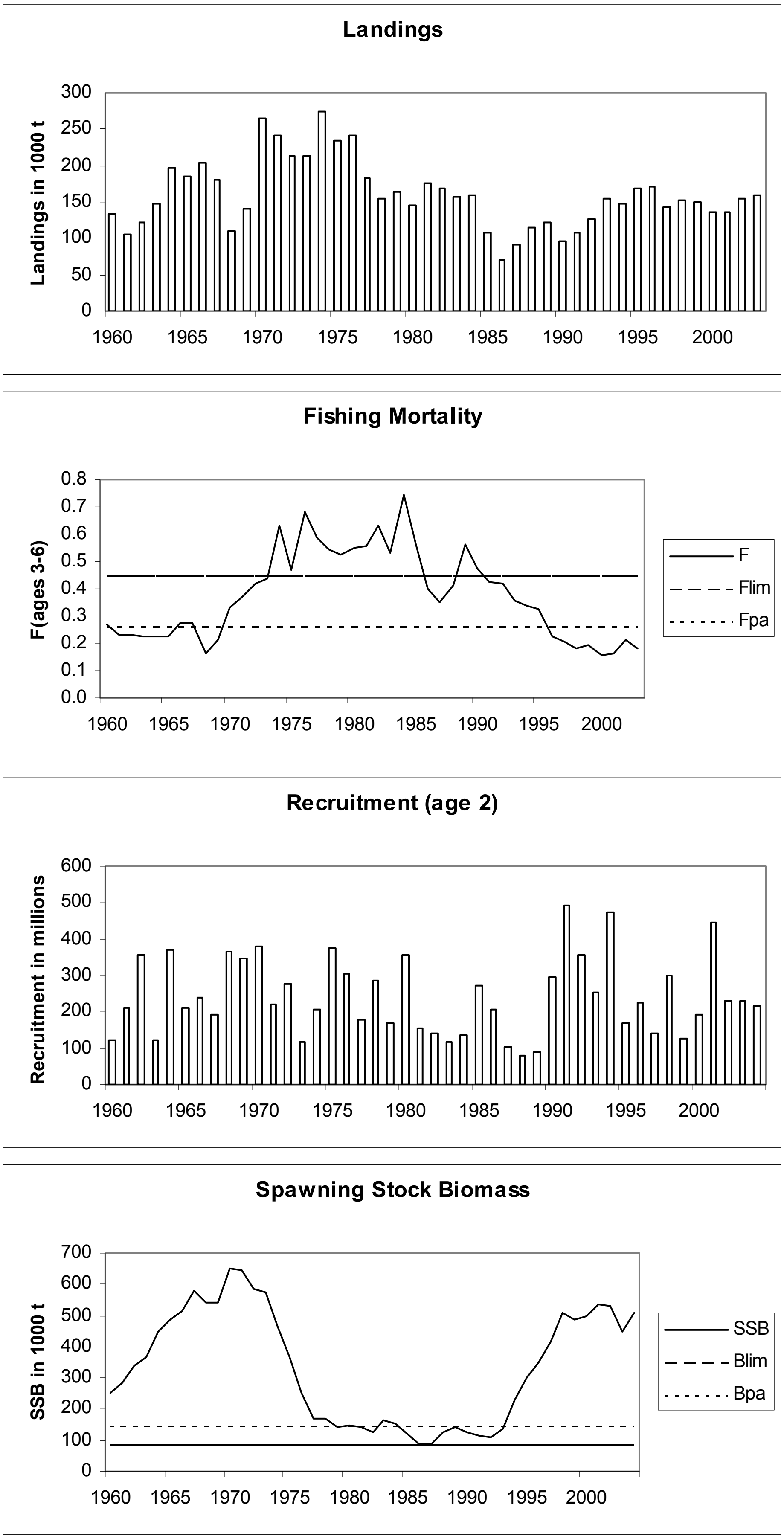
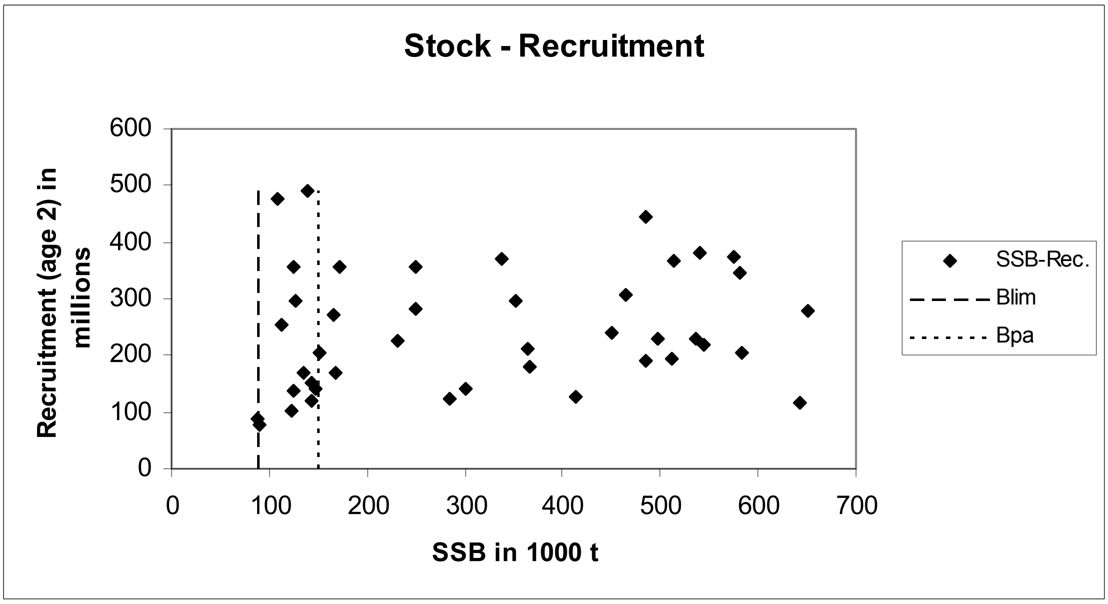
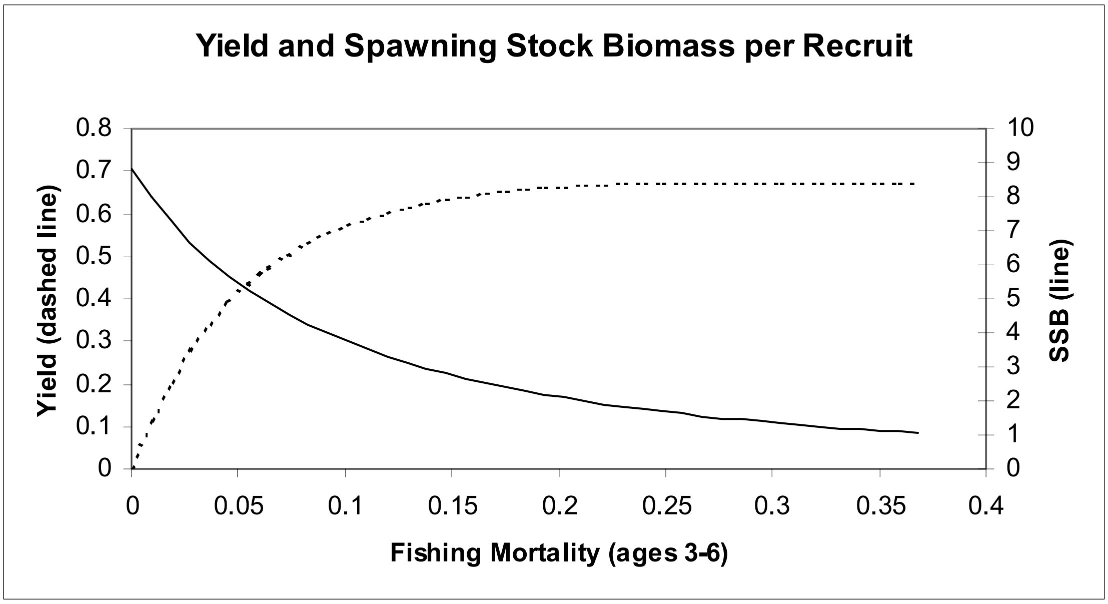
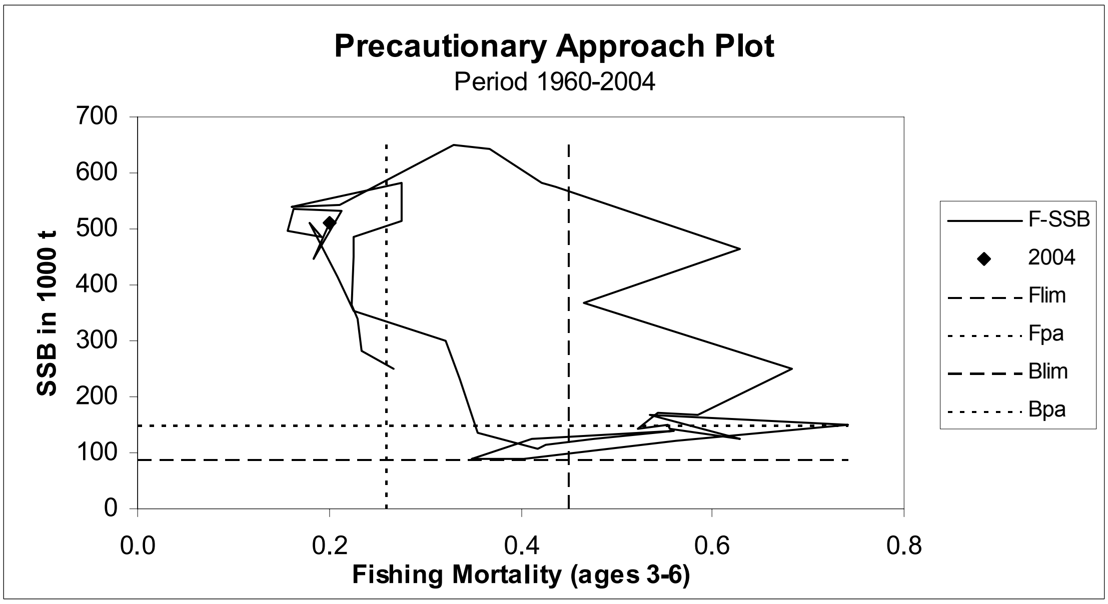


Figure 5.1 continue. North-East Arctic saithe (Sub-areas I and II)







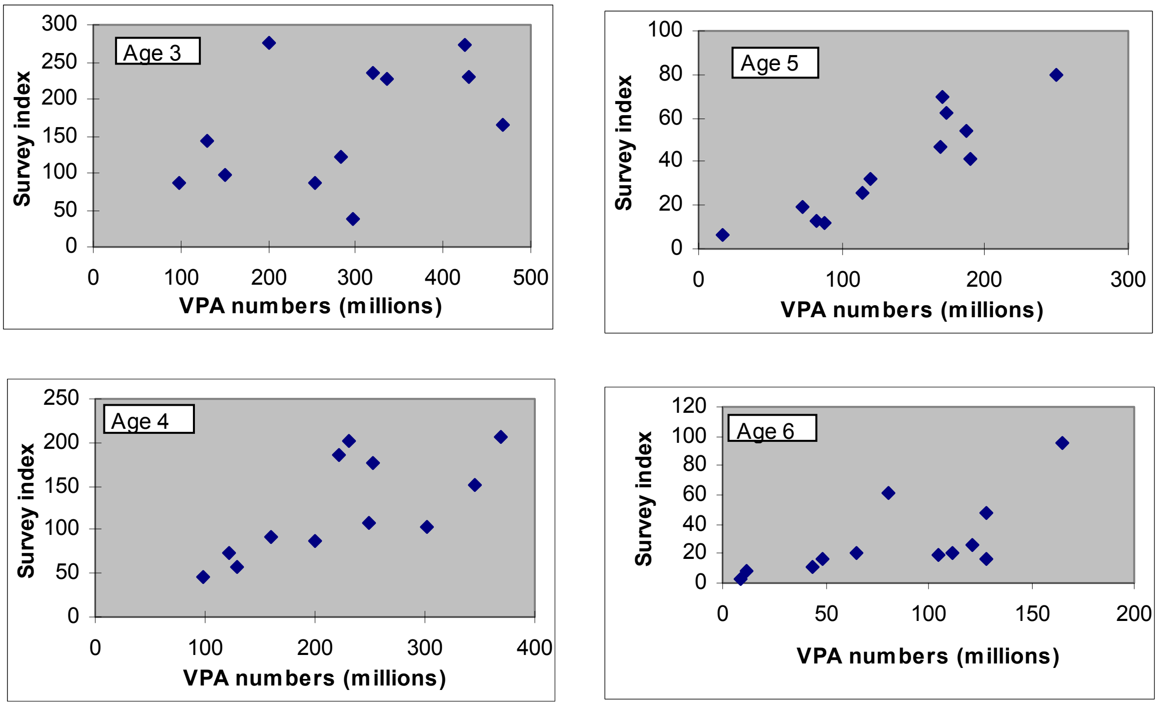


Figure 5.2A. North-East Arctic Saithe - Acoustic survey vs VPA

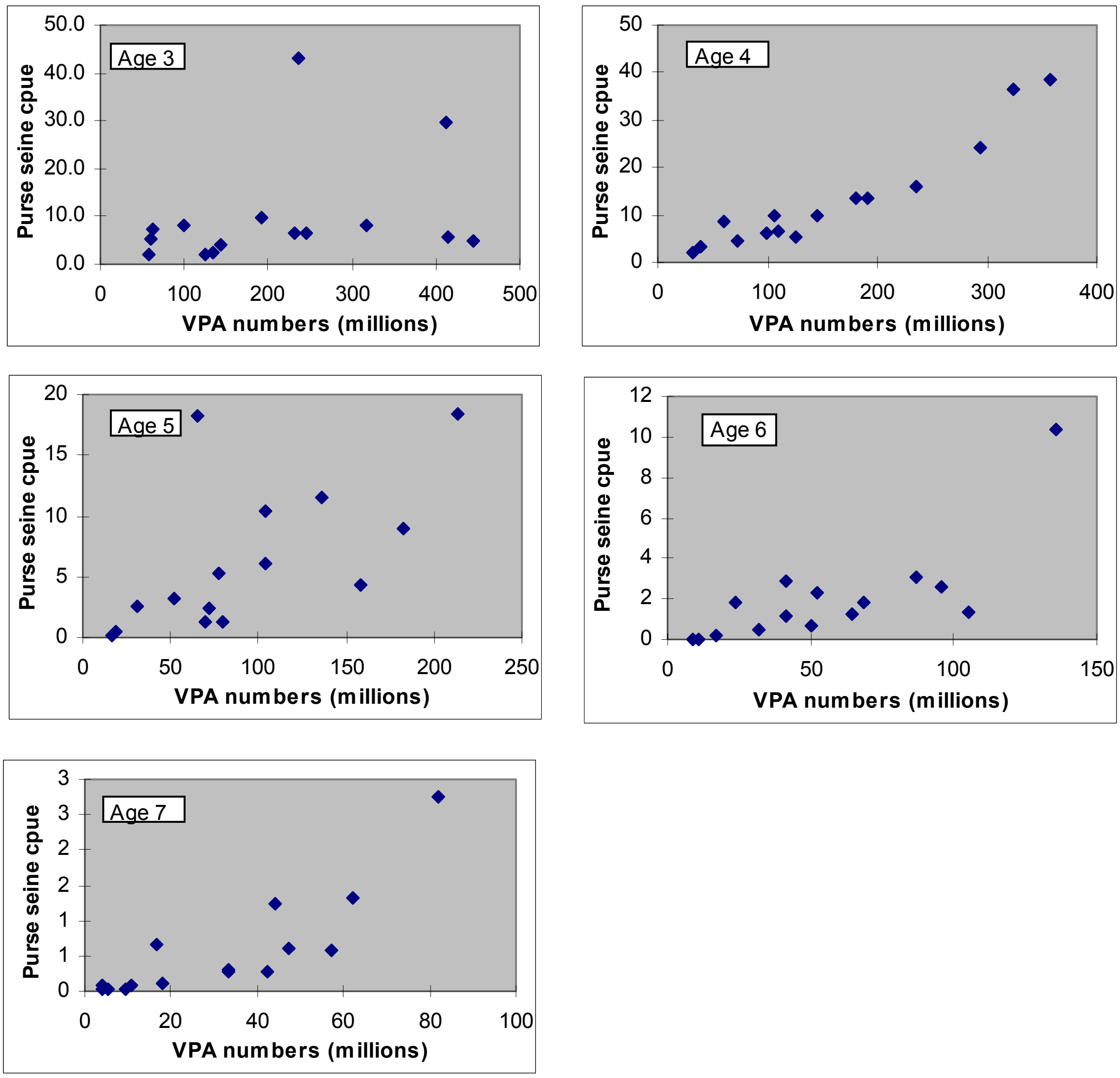


Figure 5.2B. North-East Arctic Saithe - Norwegian purse seine vs VPA

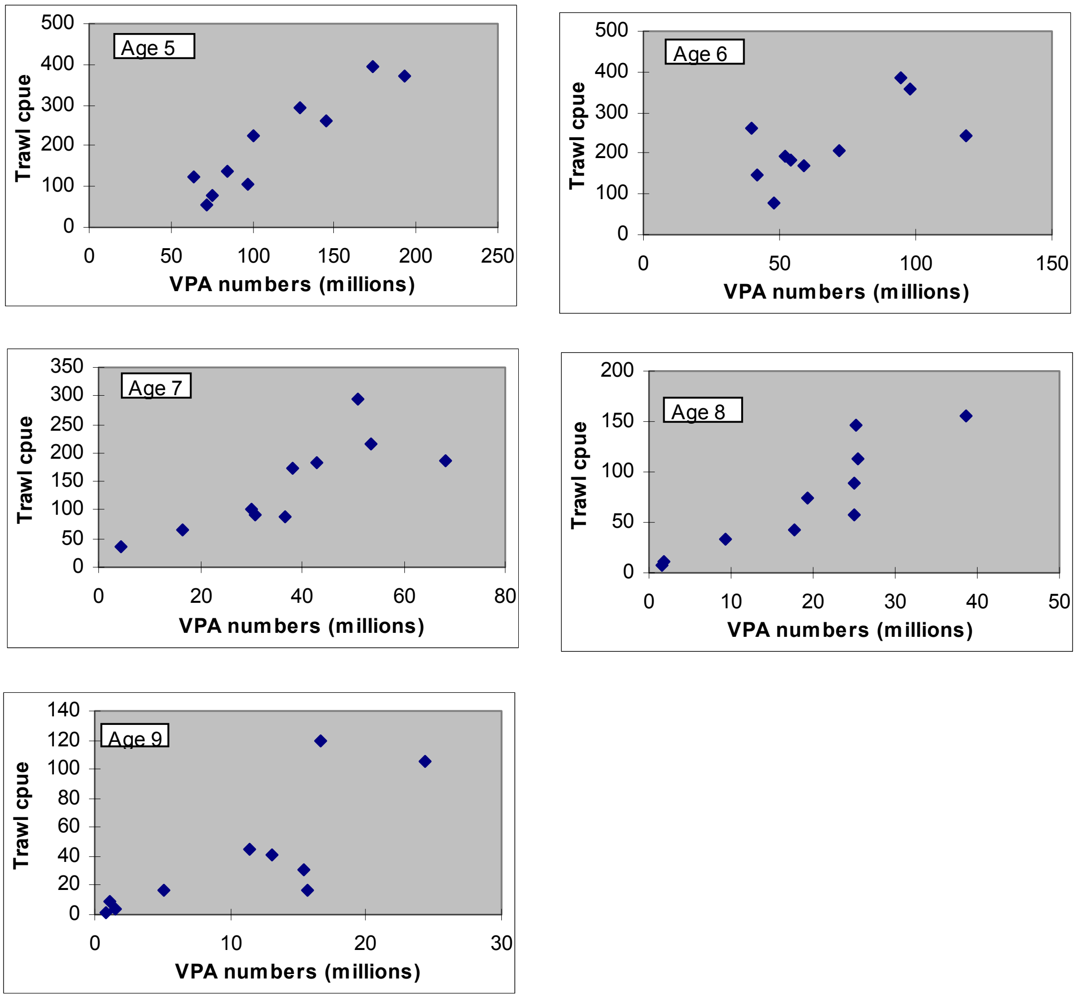


Figure 5.2C. North-East Arctic Saithe - Norwegian trawl vs VPA

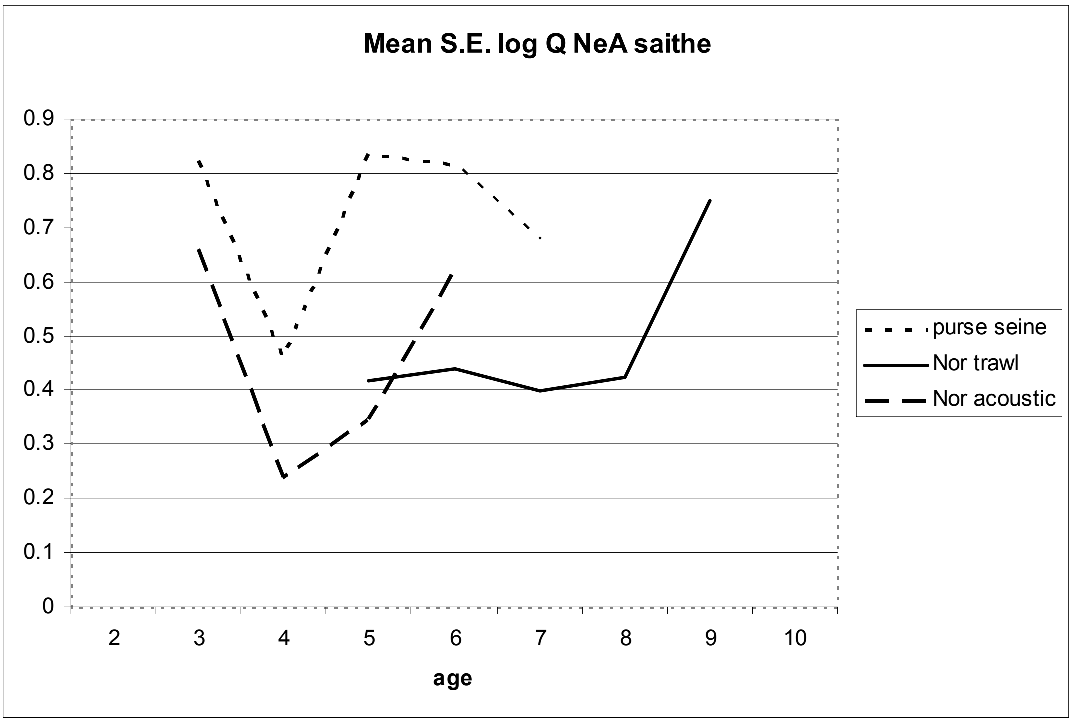
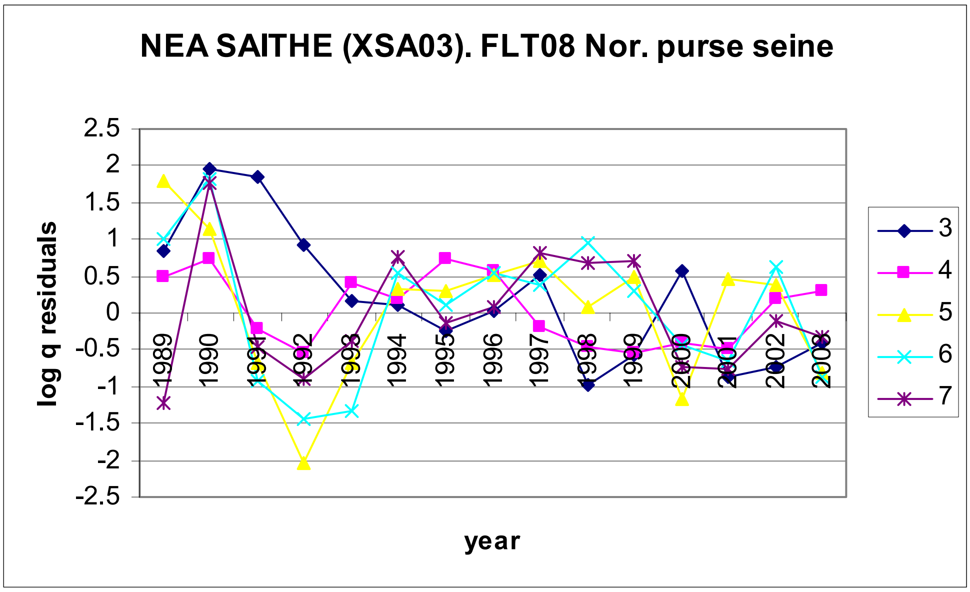
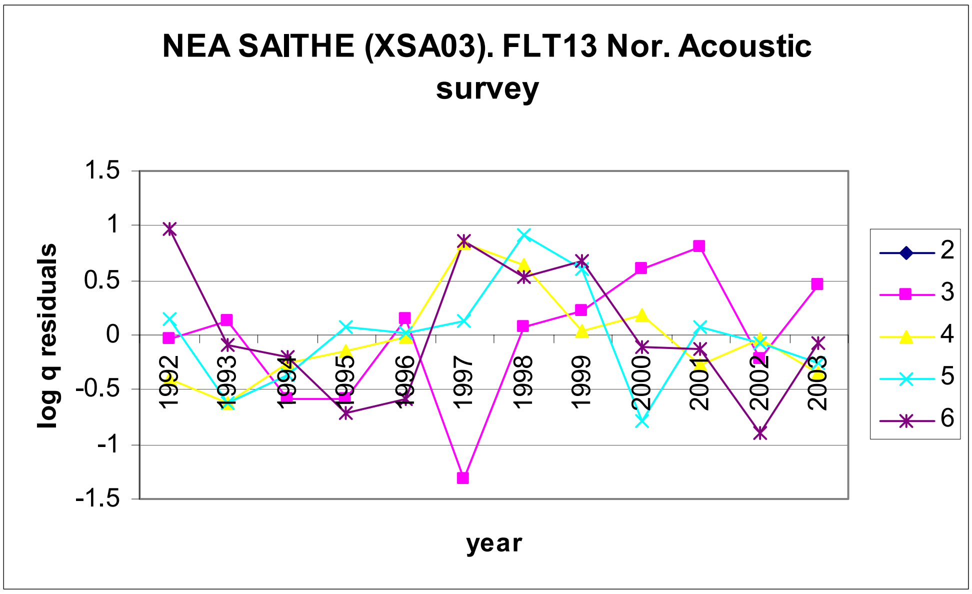


Figure 5-3A Mean S.E. log Q per tuning fleet (single fleet runs)
North-East Arctic saithe (Sub-areas I and II)





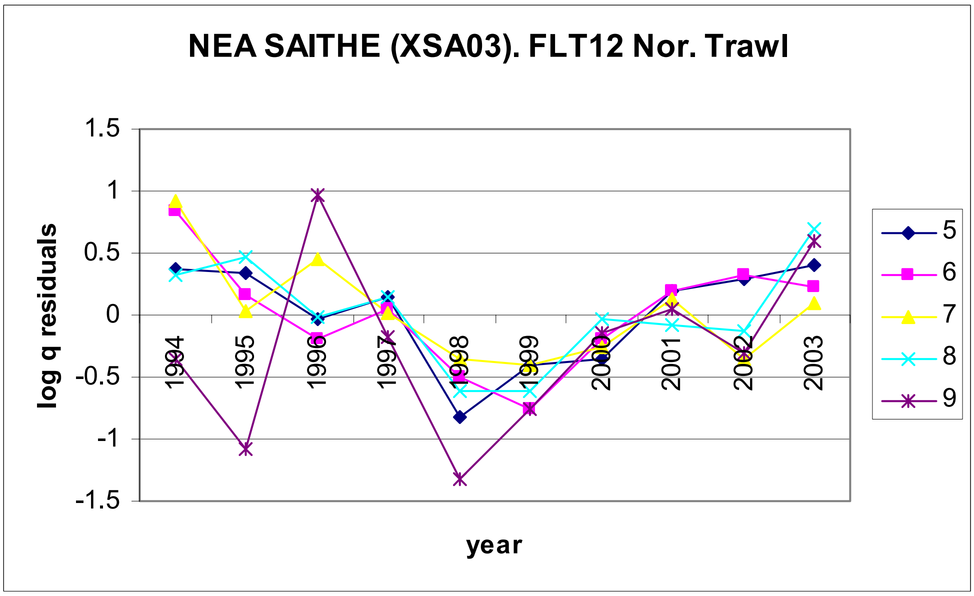


Figure 5.3b log Q residuals per tuning fleet from combined tuning

NeA Saithe RETROSPECTIVE XSA
(Shrinkage SE=0.5) P-shrinkage OFF

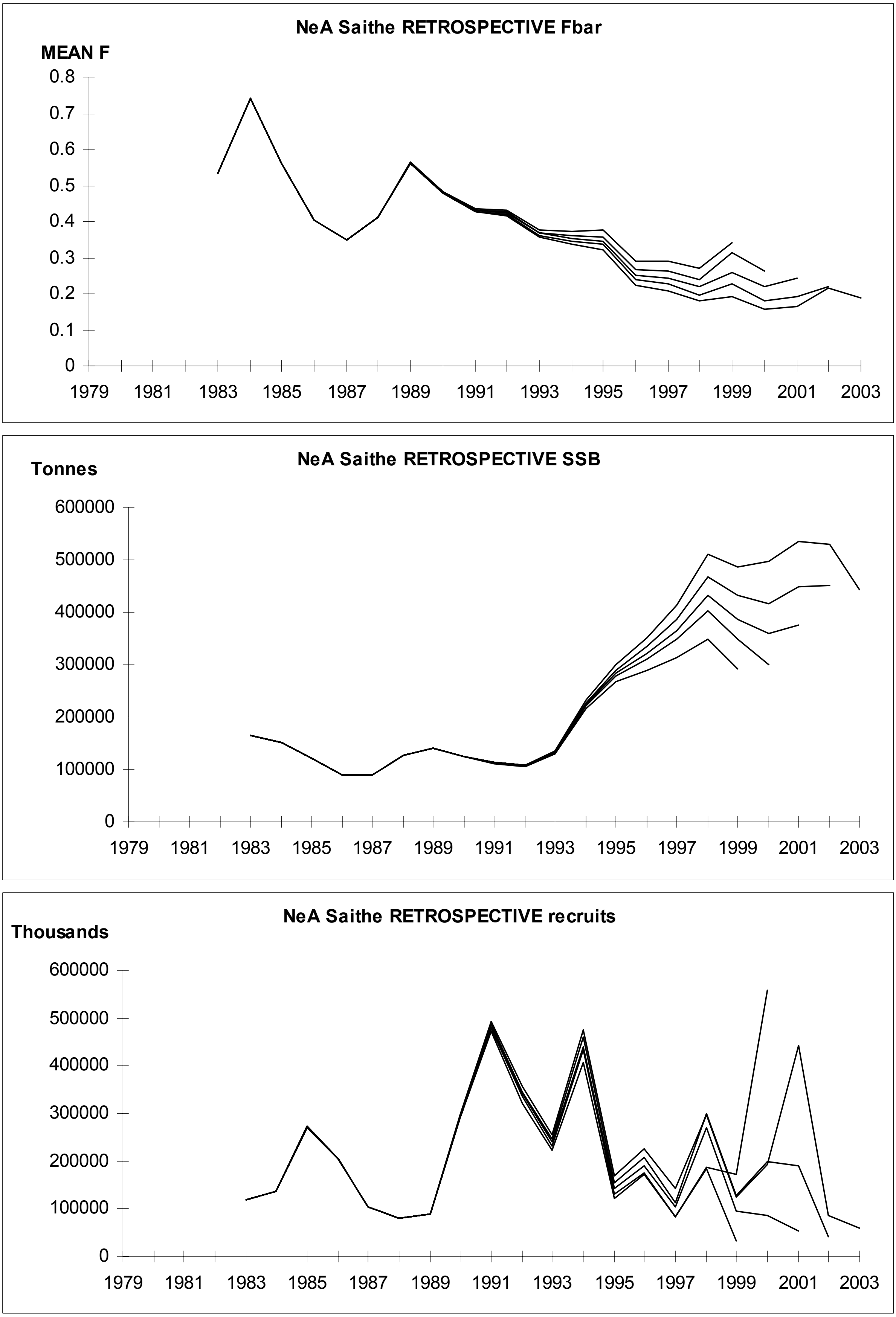
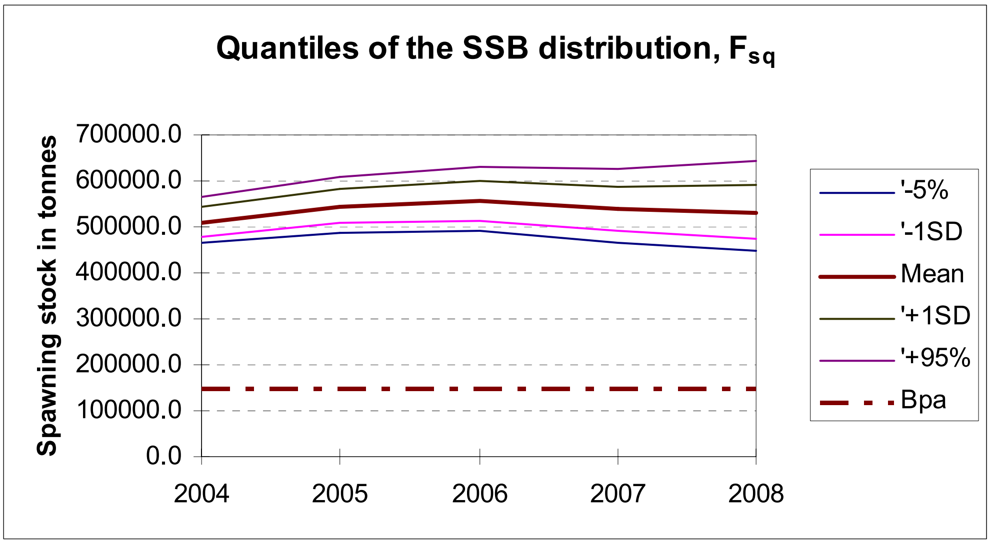


Figure 5.4



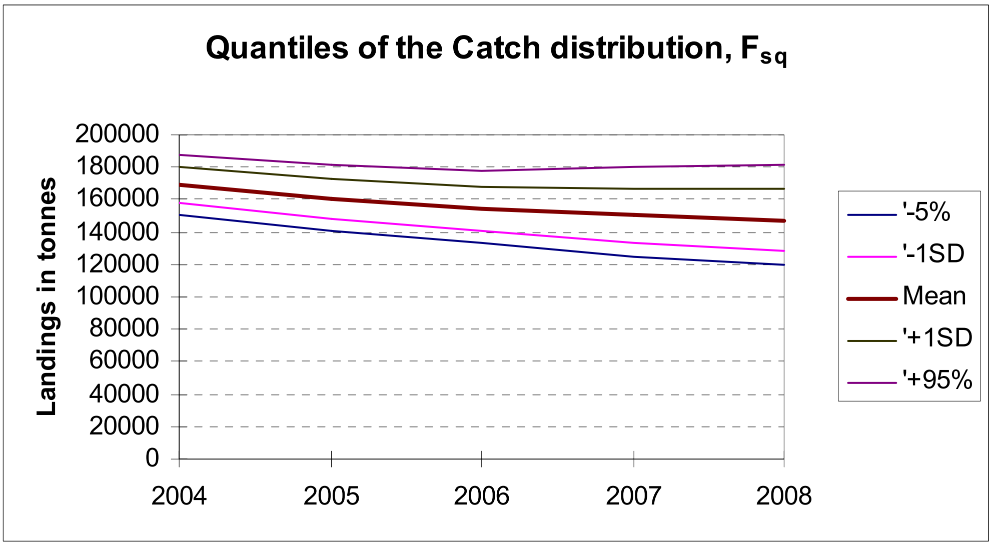
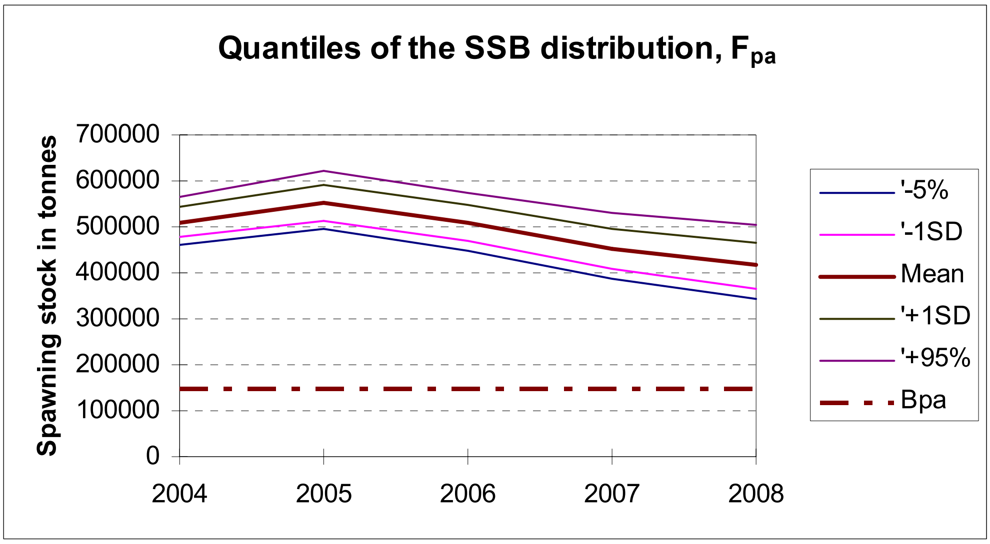


Figure 5.5 A NeA saithe medium term RISK analysis for Fsq



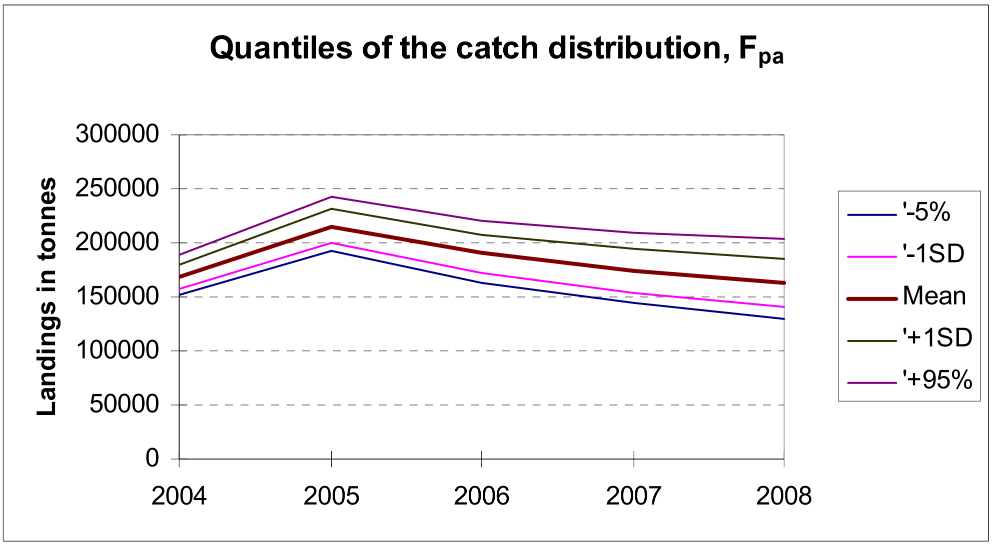


Figure 5.5 B NeA saithe medium term RISK analysis for Fpa

Table C.1 Northeast Arctic saithe. Catches splitted on vessels with catch < 100 t and > 100 t,
and number of vessels with catch > 100 t scaled by total purse seine catch

Year	No. of vessels with catch < 100 (t)	> 100 (t)	total	No. of vessels in % with catch < 100 (t)	> 100 (t)	Catch from vessel with catch < 100 (t)	> 100 (t)	total	Catch in % by vessel < 100 (t)	> 100 (t)	Catch per vessel by vessel < 100 (t)	> 100 (t)	effort, by vessel>100(t) scaled to total
1989	160	109	269	59%	41%	4,164.8	44,308.7	48,473.5	9%	91%	26.0	406.5	119.2
1990	110	51	161	68%	32%	2,340.7	22,277.5	24,618.2	10%	90%	21.3	435.8	56.4
1991	105	92	197	53%	47%	2,568.5	36,329.4	38,897.9	7%	93%	24.5	394.9	98.5
1992	89	80	169	53%	47%	2,670.7	24,206.3	26,877.0	10%	90%	30.0	302.6	88.8
1993	41	69	110	37%	63%	1,319.4	31,831.5	33,150.9	4%	96%	32.2	461.3	71.9
1994	56	75	131	43%	57%	1,601.3	27,746.3	29,347.6	5%	95%	28.6	370.0	79.3
1995	72	48	120	60%	40%	1,762.7	20,137.6	21,900.3	8%	92%	24.5	419.5	52.2
1996	83	79	162	51%	49%	1,653.7	45,194.5	46,848.2	4%	96%	19.9	572.1	81.9
1997	69	88	157	44%	56%	1,942.7	42,357.8	44,300.5	4%	96%	28.2	481.3	92.0
1998	193	118	311	62%	38%	4,141.5	40,234.0	44,375.5	9%	91%	21.5	341.0	130.1
1999	213	115	328	65%	35%	5,314.0	33,885.0	39,199.0	14%	86%	24.8	293.8	133.0
2000	200	102	302	66%	34%	5,308.0	22,922.0	28,230.0	19%	81%	26.5	224.7	125.6
2001	215	87	302	71%	29%	4,732.0	23,396.0	28,128.0	17%	83%	22.0	268.9	104.6
2002	219	68	287	76%	24%	3,435.0	23,938.0	27,373.0	13%	87%	15.7	352.0	77.8
2003 [1]	186	108	294	63%	37%	3,098.0	40,225.0	43,323.0	7%	93%	16.7	372.5	116.3
Mean	134.1	85.9	####	58%	42%	3,070.2	31,932.6	35,002.8	9%	91%	24.2	379.8	95.2

[1] Provisional figures.

Table C.2 Northeast Arctic saithe. Trawl CPUE by agegroup.
Catch in numbers per trawlhour.

Year	Agegroup effort	3	4	5	6	7	8	9	10
1993	1	91.3	338.6	376.7	59.5	23.4	23.7	10.9	15.5
1994	1	8.1	136.9	395.6	260.4	37.4	8.2	4.2	5.6
1995	1	40.8	200.4	293.8	359.1	65.8	11.1	1.2	3.0
1996	1	27.3	140.3	139.5	205.6	293.0	32.9	8.5	0.2
1997	1	49.1	65.7	371.4	194.1	183.4	112.0	16.9	3.0
1998	1	3.3	33.0	55.3	244.0	93.1	56.6	16.1	7.8
1999	1	15.6	37.7	105.5	80.0	187.5	43.0	30.8	9.2
2000	1	9.4	71.5	78.7	170.1	100.2	156.2	44.5	56.0
2001	1	8.3	50.2	276.4	194.4	183.1	77.1	109.9	48.4
2002	1	10.1	76.0	123.8	385.6	87.1	89.3	40.9	76.0
2003 [2]	1	5.6	147.6	224.1	148.3	214.7	145.4	119.9	73.7

[2] Provisional figures.

Table C.3 Northeast Arctic saithe. Acoustic abundance indices from Norwegian surveys in October-November. In 1985 - 1987 the area was incomplete. Numbers in millions.

Year	Age					
	2	3	4	5	6+	Total
1985	3.1	4.9	2.4	0.5	0.0	10.9
1986	19.5	40.8	3.6	1.8	1.8	67.5
1987	1.8	22.0	48.4	1.8	1.7	75.7
1988	15.7	22.5	19.0	7.1	0.6	64.9
1989	24.8	28.4	17.0	10.1	12.4	92.7
1990	99.6	31.9	14.7	5.1	7.4	158.7
1991	87.8	104.0	4.6	4.0	7.1	207.5
1992	163.5	273.6	57.5	6.2	8.8	509.6
1993	106.9	227.7	103.9	12.7	3.2	454.4
1994	34.4	87.8	112.4	39.5	11.3	285.4
1995	38.7	165.2	87.0	46.8	19.9	357.6
1996	37.0	118.9	214.7	32.1	19.5	422.2
1997	5.1	36.7	185.8	79.8	61.7	369.1
1998	43.6	96.5	200.6	70.0	95.5	506.2
1999	61.1	233.8	72.9	62.2	47.8	477.8
2000	164.8	142.5	176.3	11.6	26.5	521.7
2001	104.7	275.9	45.9	53.8	20.2	500.4
2002	25.5	230.2	92.6	18.9	15.7	382.9
2003	31.0	87.5	151.7	26.1	15.8	312.1

6 *SEBASTES MENTELLA* (DEEP-SEA REDFISH) IN SUB-AREAS I AND II

6.1 Status of the Fisheries

6.1.1 Historical development of the fishery

A description of the historical development of the fishery is found in the Quality handbook for this stock (see Annex "AFWG-S.Mentella").

Since 1 January 2003 the regulations for this stock have been enlarged since from this date all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) outside the permanently closed areas is forbidden in the Norwegian Economic Zone north of 62°N and in the Svalbard area. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and on board at any time.

6.1.2 Landings prior to 2004 (Tables 6.1–6.4, D1-D2, Figure 6.1)

Nominal catches of *S. mentella* by country for Sub-areas I and II combined are presented in Table 6.1, and for both redfish species (i.e., *S. mentella* <u>and</u> *S. marinus*) in Table D1. The nominal catches by country for Sub-area I and Divisions IIa and IIb are shown in Tables 6.2–6.4. Total international landings in 1965-2003 are also shown in Figure 6.1.

After a continuous decrease in the total landings from 48,727 t in 1991 to a historical low at about 8,000 t in 1996 and 1997. Apart from a temporary increase of 18,434 t in 2001, caused by Norwegian trawlers obtaining very good catch rates along the continental slope outside the closed areas in winter 2001, the catches decreased to 7,022 t in 2002. Due to stronger regulations enforced in 2003, the total catch further decreased to 2,443 t in 2003.

The redfish population in Sub-area IV (North Sea) is believed to belong to the North-east Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The total redfish landings from Sub-area IV have been 1,000–3,000 t per year, and show a preliminary landing of about 1,000 t in 2003 (Table D2).

6.1.3 Expected landings in 2004

There will be no directed fishery for *S. mentella* in 2004, and all the regulations in 2003 will be continued in 2004. Based on the current regulations, and reports from the first months in 2004, the total landings of *S. mentella* for 2004 are expected to be maximum **3,000 t**.

6.2 Data used in the Assessment

All input data sets were updated up to and including 2003.

6.2.1 Fishing effort and catch-per-unit-effort

The former CPUE-series (catch per hour trawling) from Russian BMRT-trawlers fishing in ICES Division IIa in March-May 1975-2002, representative for the directed Russian fishery during these years, has been removed from the current report. The reason for this is the stronger regulations enforced on the fishery making the current CPUEs not comparable with previous years.

6.2.2 Catch at age (Table 6.5)

Catch at age for 2000 and 2002 were revised according to new catch data. Age data for 2003 for *S. mentella* were available from Norway for all areas, and from Russia in Division IIb. Russian catch-at-length from Sub-area I and Division IIa were converted to catch-at-age by using the Norwegian age-length key from Sub-area I and Division IIa (northern part), respectively. Other countries were assumed to have the same relative age distribution and mean weight as Norway.

6.2.3 Weight at age (Table 6.6)

Catch weight-at-age data for 2003 were available from Norway for all areas, and from Russia in Division IIb. The weight at age in the stock was set equal to the weight at age in the catch. It should be investigated further whether it would be better to use a constant weight-at-age series (e.g., based on survey information) instead of catch weight-at-age which may vary due to changes and selections in the fisheries and not due to growth changes in the stock.

6.2.4 Maturity at age (Table D8)

Age-based maturity ogives for *S. mentella* (sexes combined) were available for 2000 and 2001 from Russian research vessel observations in spring. For 2002 and 2003, when the Russian research vessel did not get access to the survey area, a weighted (by sample size) average of the 2000 and 2001 data was used.

6.2.5 Survey results (Tables A14, D3-D7, Figures 6.2–6.6)

The results from the following research vessel survey series were evaluated by the Working Group:

1) The international 0-group survey in the Svalbard and Barents Sea areas in August-September (Table A14 and Figure 6.2).

2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December from 1978–2003 in fishing depths of 100–900 m (Table D3, Figure 6.3).

3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1986–2003 in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2003 (Table D4a,b).

4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2004 (joint with Russia since 2000) in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2004 (Tables D5a,b).

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area. This has been done in Figures 6.4a,b.

5) A new Norwegian survey designed for redfish and Greenland halibut covers the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen in August 1996-2003 from less than 100 m to 500 m depth (Table D6, Figures 6.5-6.6). This survey includes survey no. 3 above.

6) Russian acoustic survey in April-May from 1992–2001 (except 1994 and 1996) on *S. mentella* spawning grounds in the western Barents Sea (Table D7).

A considerable reduction in the abundance of 0-group redfish has been observed since 1991: abundance decreased to only 20% of the 1979–1990 average. With the exception of an abundance index of twice the 1991-level in 1994, the indices have remained very low. Record low levels of less than 20% of the 1991–1995 average have been observed for the 1996-1999 year classes. The 2000 year class was stronger than the preceding four year classes, whereas the estimate of the 2001-2003 year classes are among the lowest on record.

Results from the Norwegian ecosystem survey (Table D6 and Figure 6.5) confirm the stock development as interpreted from the 0-group survey (Figure 6.2), i.e., relative strong 1988-1990 year classes, followed by weaker 1991-1995 year classes, and very weak year classes since 1996 onwards. The survival of the 1991-1995 year classes seems, however, to have been better than for the previous ones, making them more similar in size at an age of 8-9 years and older than could be expected from the 0-group survey.

In the Russian bottom trawl survey the most recent estimates are among the lowest observed (Table D3, Figure 6.3). The overall picture of the relative strength of the year classes is, however, very similar in the Russian and Norwegian surveys. However, both the Russian survey back to 1977 and results from combining the Norwegian Barents Sea February and the Svalbard August surveys back to 1986 (Figure 6.4) show lower and more variable abundance of *S. mentella* in the 1980-ies than could be expected from the 0-group indices and when compared with the abundance observed at present.

The decrease in the abundance of young redfish in the surveys is consistent with the decline in the consumption of redfish by cod from 1995 onwards (Tables 1.3, 1.4).

Russian acoustic surveys estimating the commercial sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. Table D7 shows a 43% decrease in the estimated spawning stock biomass in 1997 to a low level that was observed up to 2000 inclusive. The strong 1982-year class migrating west-southwest and out of the surveyed area could explain this. The next year classes expected to contribute significantly to the spawning stock (i.e., the 1987–1990 year classes) are now more than 50% mature (males before females), and these year classes contributed in the 2001 survey to a three fold increase in the survey abundance of mature fish (Table D7). This is the only survey targeting commercial sized *S. mentella*, but only a limited area of its distribution. In 2002 and 2003 it was unfortunately impossible to run this survey.

6.3 Results of the Assessment

All available information since last year's assessment confirms the poor condition of this stock. The surveys indicate that recruitment continues to decline.

Length and age data from Norwegian and Russian surveys show that the 1982 and 1983 year classes are stronger than those just before and after. The 1988–1990 year classes (possibly also the 1987 year class) appear to be at a similar level to those of 1982–1983. Although at the youngest stages only ca. 20% of the 1988-1990 year classes' strength, the 1991-1995 year classes seem to have experienced better protection and survival than the former ones. The 0-group survey indicates at present record low levels of *S. mentella* recruiting to the stock. There is no doubt that the recruitment to the fishable biomass will be poor after a short period of expected increase, or delayed decrease, in the fishable stock due to the 1987–1990 year classes and seemingly better survival of the 1991-1995 year classes than earlier could be expected.

Any improvement of the stock condition is not expected until a significant increase in spawning stock biomass has been detected in surveys with a following increase in the number of juveniles. As long as the recruitment of new year classes is very poor and no signs of improved recruitment have appeared, it is of crucial importance that the 1987–1990 year classes (approx. 34–39 cm) which currently have recruited more than 75% to the spawning stock are protected.

It is also of vital importance that the younger recruiting year classes be given the strongest possible protection from being taken as by-catch in any fishery, e.g., the shrimp fisheries in the Barents Sea and Svalbard area. This will ensure that they can contribute as much as possible to the stock rebuilding.

6.4 Comments to the assessment

The survey series may still be improved further, and it is imperative for good results that valuable research survey time series are continued, and that Norwegian and Russian research vessels get full access to each other's exclusive economic zones. With great restrictions on the *S. mentella* fishery, it is even more important that surveys are conducted to cover the entire area of this stock's distribution.

6.5 Biological reference points

Until an analytical assessment can be accepted and used as basis for reference points calculations, candidate reference points for the biomass or numbers (U_{lim}) could be set at the average biomass (or number) level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. Such practice is currently used by ICES for the Icelandic redfish stocks (ICES CM 2002/ACFM:20 Ask Kjell) and is a procedure mentioned and recommended as an alternative by the ICES Study Groups on the Precautionary Approach. It is, however, difficult at present to calculate a reasonable level for Ulim from the available survey data due to short survey time series, and the fact that the present surveys started after the stock had already declined for a long time.

6.6 Management advice

ICES recommended last year a continuation of the measures introduced in 2003, i.e. that there be no directed trawl fishery on this stock and that the area closures and low bycatch limits should be retained, until a significant increase in the spawning stock biomass (and a subsequent increase in the number of juveniles) has been detected in surveys. In addition, it is of vital importance that the juvenile age classes be given the strongest protection from being caught as bycatch in any fishery, i.e. the shrimp fisheries in the Barents Sea and Svalbard area. This will ensure that the recruiting year classes can contribute as much as possible to the stock rebuilding.

The by-catch of redfish in other fisheries should be reduced to the lowest possible level. The current assessment indicates no improvement in recruitment while a stabilizing or temporary increase of the SSB is expected if the catches are kept low.

As long as the recruitment of new year classes is very poor and no signs of improved recruitment have appeared, it is of crucial importance and urgent that the 1987–1990 year classes (approx. 34–39 cm) which currently have recruited more than 75% to the spawning stock are protected. The Working Group is therefore satisfied with the stronger regulations enforced in the trawl fisheries from 1 January 2003 onwards. It is also of vital importance that the younger recruiting year classes be given the strongest possible protection to ensure that they can contribute as much as possible to the stock rebuilding.

Given the current depleted state of the stock and less data from the fishery, it is imperative that data collection and survey time series be maintained and improved in order to monitor the development and rebuilding of the resource.

6.7 Response to ACFM technical minutes

ACFM recommends that other analytical methods involving survey and/or length data should be explored. Possible alternative methods to conventional catch-at-age analyses, such as the FLEKSIBEST model, have been discussed but not yet explored for this redfish stock. This model is closely related to the BORMICON model which currently is used by the ICES North-Western WG on *S. marinus* (Björnsson and Sigurdsson 2003). As for *S. marinus*, possible alternative methods may also be found in assessments of *Sebastes* stocks in the eastern North Pacific (e.g Methot). During the Working Group the survey based model SURBA was presented, and this may be a useful tool for improved evaluation and estimation of the redfish stocks from survey results (Needle 2003, 2004).

Table 6.1 *Sebastes mentella*. Nominal catch (t) by countries in Sub-area I, Divisions IIa and IIb combined.

Year	Canada	Denmark	Faroe Islands	France	Germany[3]	Greenland	Ireland
1986	-	-	-	-	1,252	-	-
1987	-	-	200	63	1,321	-	-
1988	No species specific data available by country.						
1989	-	-	335	1,111	3,833	-	-
1990	-	-	108	142	6,354	36	-
1991	-	-	487	85	-	23	-
1992	-	-	23	12	-	-	-
1993	8	4	13	50	35	1	-
1994	-	28	4	74	18	1	3
1995	-	-	3	16	176	2	4
1996	-	-	4	75	119	3	2
1997	-	-	4	37	81	16	6
1998	-	-	20	73	100	14	9
1999	Iceland	-	73	26	202	50	3
2000	48	Estonia	50	12	62	29	1
2001	3	-	52	16	198	17	4
2002	41	15	53	58	99	18	4
2003[1]	5	-	8	18	32	8	5

Year	Norway	Poland	Portugal	Russia[4]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986	1,274	-	1,273	17,815	-	84	-	23,112[2]
1987	1,488	-	1,175	6,196	25	49	1	10,455
1988	No species specific data available by country.							15,586
1989	4,633	-	340	13,080	5	174	1	23,512
1990	10,173	-	830	17,355	-	72	-	35,070
1991	33,592	-	166	14,302	1	68	3	48,727
1992	10,751	-	972	3,577	14	238	3	15,590
1993	5,182	-	963	6,260	5	293	-	12,814
1994	6,511	-	895	5,021	30	124	12	12,721
1995	2,646	-	927	6,346	67	93	4	10,284
1996	6,053	-	467	925	328	76	23	8,075
1997	4,657	1	474	2,972	272	71	7	8,598
1998	9,733	13	125	3,646	177	93	41	14,045
1999	7,884	6	65	2,731	29	112	28	11,209
2000	6,020	2	115	3,519	87		130[5]	10,075
2001	13,975[1]	5	179	3,775	90		120[5]	18,434
2002	2,129[1]	8	242	3,904	190		188[5]	6,949
2003[1]	1,193	7	44	952	47		124[5]	2,443

[1] Provisional figures.
[2] Including 1,414 tonnes in Division IIb not split on countries.
[3] Includes former GDR prior to 1991.
[4] USSR prior to 1991.
[5]UK(E&W)+UK(Scot.)

Table 6.2 *Sebastes mentella*. Nominal catch (t) by countries in Sub-area I.

Year	Faroe Islands	Germany[4]	Greenland	Norway	Russia[5]	UK(Eng. &Wales)	Iceland	Total
1986[3]	-	-	-	1,274	911	-	-	2,185
1987[3]	-	2	-	1,166	234	3	-	1,405
1988	No species specific data presently available							
1989	13	-	-	60	484	9[2]	-	566
1990	2	-	-	-	100	-	-	102
1991	-	-	-	8	420	-	-	428
1992	-		-	561	408	-	-	969
1993	2[2]	-	-	16	588	-	-	606
1994	2[2]	2	-	36	308	-	-	348
1995	2[2]	-	-	20	203	-	-	225
1996	-	-	-	5	101	-	-	106
1997	-	-	3[2]	12	174	1[2]	-	190
1998	20[2]	-	-	26	378	-	-	424
1999	69[2]	-	-	69	489	-	-	627
2000	-	-	-	47	406	-	48[2]	501
2001	-	-	-	8[1]	296	-	3[2]	307
2002	-	-	-	4[1]	587	-	.	591
2003[1]	-	-	-	2	292	-	.	294

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.

Table 6.3 *Sebastes mentella*. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Norway
1986[3]	-	-	1,252	-	-	-
1987[3]	200	63	970	-	-	149
1988	No species specific data presently available					
1989	312[2]	1,065[2]	3,200	-	-	4,573
1990	98[2]	137[2]	1,673	-	-	8,842
1991	487[2]	72[2]	-	-	-	32,810
1992	23[2]	7[2]	-	-	-	9,816
1993	11[2]	15[2]	35	1[2]	-	5,029
1994	2[2]	33[2]	16[2]	1[2]	2[2]	6,119
1995	1[2]	16[2]	176[2]	2[2]	2[2]	2,251
1996	-	75[2]	119[2]	3[2]	-	5,895
1997	-	37[2]	77	12[2]	2[2]	4,422
1998	-	73[2]	58[2]	14[2]	6[2]	9,186
1999	-	16[2]	160[2]	50[2]	3[2]	7,358
2000	50[2]	11[2]	35[2]	29[2]	-	5,892
2001	33[2]	12[2]	161[2]	17[2]	4[2]	13,673[1]
2002	14[2]	54[2]	59[2]	18[2]	4[2]	1,917[1]
2003[1]	5[2]	17[2]	17[2]	8[2]	5[2]	995

Year	Portugal	Russia[5]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986[3]	1,273	16,904	-	84	-	19,513
1987[3]	1,156	4,469	-	34	1	7,042
1988	No species specific data presently available					
1989	251	9,749	-	158[2]	1[2]	19,309
1990	824	6,492	-	9	-	18,075
1991	159[2]	7,596	-	23[2]	-	41,147
1992	824[2]	1,096	-	27[2]	-	11,793
1993	648[2]	5,328	-	2[2]	-	11,069
1994	687[2]	4,692	8[2]	4[2]	-	11,564
1995	715[2]	5,916	65[2]	41[2]	2[2]	9,187
1996	429[2]	677	5[2]	42[2]	19[2]	7,264
1997	410[2]	2,341	9[2]	48[2]	7[2]	7,365
1998	118[2]	2,626	55[2]	65[2]	41[2]	12,242
1999	56[2]	1,340	14[2]	94[2]	26[2]	9,117
2000	98[2]	2,167	18[2]	Iceland	103[2, 6]	8,403
2001	105[2]	2,716	18[2]	-	95[2, 6]	16,834
2002	124[2]	2,615	8[2]	41[2]	157[2, 6]	5,011
2003[1]	17[2]	448	8[2]	5[2]	102[2, 6]	1,627

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 6.4 *Sebastes mentella*. Nominal catch (t) by countries in Division IIb.

Year	Canada	Denmark	Faroe Islands	France	Germany[5]	Greenland	Ireland
1986[4]	Data not available on countries						
1987[4]	-	-	-	-	349	-	-
1988	No species specific data presently available						
1989	-	-	10	28	633	-	-
1990	-	-	8[2]	5[2]	4,681	36[2]	-
1991	-	-	-	13[2]	-	23	-
1992	-	-	-	5[2]	-	-	-
1993	8[2]	4[2]	-	35[2]	-	-	-
1994	-	28[2]	-	41[2]	-	-	1[2]
1995	-	-	-	-	-	-	2[2]
1996	-	-	4[2]	-	-	-	2[2]
1997	-	-	4[2]	-	3	1[2]	4[2]
1998	-	-	-	-	42[2]	-	3[2]
1999	-	-	4[2]	10[2]	42[2]	-	-
2000	-	-	-	1[2]	27[2]	-	1[2]
2001	-	-	19[2]	4[2]	37[2]	-	-
2002	-	-	39[2]	4[2]	40[2]	-	-
2003[1]	-	-	3[2]	1[2]	15	-	-

Year	Norway	Poland	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986[4]	Data not available on countries							1,414
1987[4]	173	-	19	1,493	25	12	-	2,071
1988	No species specific data presently available							
1989	-	-	89	2,847	5	7[2]	-	3,619
1990	1,331	-	6	10,763	-	63[2]	-	16,893
1991	774	-	7	6,286	1	45[2]	3[2]	7,152
1992	374	-	148[2]	2,073	14	211[2]	3[2]	2,828
1993	137	-	315[2]	344	57[3]	291[2]	-	1,191
1994	356	-	208[2]	21	22[3]	120[2]	12[2]	809
1995	375	-	212[2]	227	2[3]	52[2]	2[2]	872
1996	153	-	38[2]	147	323[2]	34[2]	4[2]	705
1997	223	1[2]	64[2]	457	263[2]	22[2]	-	1,042
1998	521	13[2]	7[2]	642	122[2]	28[2]	1[2]	1,379
1999	457	6[2]	9[2]	902	15[2]	18[2]	2[2]	1,465
2000	82	2[2]	17[2]	946	69[2]		27[2, 7]	1,172
2001	294[1]	5[2]	74[2]	763	72[2]	Estonia	25[2, 7]	1,293
2002	208[1]	8[2]	118[2]	702	182[2]	15[8]	31[2, 7]	1,347
2003[1]	196	7[2]	27[2]	212	39[2]	-	22[2, 7]	522

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Split on species according to the 1992 catches.
[4] Based on preliminary estimates of species breakdown by area.
[5] Includes former GDR prior to 1991.
[6] USSR prior to 1991.
[7] UK(E&W)+UK(Scot.)
[8] Split on species by Working Group.

Table 6.5. Catch numbers at age

Run title : Arctic S. mentella

At 8/05/2004 21:15

Numbers*10**-3

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE													
6	1653	1873	159	738	662	223	125	37	9	1	117	2	1
7	5453	2498	159	730	941	634	533	882	83	24	372	40	120
8	7994	1898	174	722	1279	1699	1287	2904	441	390	542	252	151
9	6781	1622	512	992	719	1554	1247	4236	1511	1235	977	572	165
10	8226	1780	2094	2561	740	1236	1297	3995	2250	2460	926	710	192
11	5344	1531	3139	2734	1230	1078	1244	2741	3262	2149	1713	532	262
12	6227	2108	2631	3060	2013	1146	876	1877	1867	1816	2652	1380	374
13	9880	2288	2308	1535	4297	1413	1416	1373	1454	1205	2660	1889	423
14	10824	2258	2987	2253	3300	1865	1784	1277	1447	1001	1911	1609	450
15	4049	2506	1875	2182	2162	880	1217	1595	1557	993	1772	850	406
16	2105	2137	1514	3336	1454	621	537	1117	1418	932	1219	625	501
17	9603	1512	1053	1284	757	498	1177	784	1317	505	714	162	128
18	6522	677	527	734	794	700	342	786	658	596	813	236	194
+gp	19299	9258	6022	3257	2404	2247	3568	6241	3919	5705	16201	4046	1000
TOTALNUM	**103960**	**33946**	**25154**	**26118**	**22752**	**15794**	**16650**	**29845**	**21193**	**19012**	**32589**	**12905**	**4367**
TONSLAND	48727	15590	12866	12721	10284	8075	8597	14045	11209	10075	18434	6949	2443
SOPCOF %	100	103	101	104	100	95	101	101	102	101	101	99	104

Table 6.6. Catch weights at age

Run title : Arctic S. mentella

At 8/05/2004 21:15

Catch weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE													
6	0.13	0.19	0.17	0.16	0.14	0.2	0.18	0.14	0.15	0.1	0.11	0.13	0.13
7	0.18	0.22	0.23	0.22	0.16	0.2	0.21	0.19	0.22	0.15	0.15	0.17	0.14
8	0.21	0.26	0.25	0.24	0.19	0.25	0.25	0.23	0.22	0.22	0.2	0.22	0.22
9	0.27	0.28	0.28	0.3	0.21	0.31	0.29	0.29	0.28	0.26	0.25	0.29	0.28
10	0.34	0.31	0.33	0.34	0.28	0.42	0.33	0.33	0.33	0.31	0.3	0.34	0.34
11	0.35	0.33	0.38	0.37	0.32	0.44	0.38	0.38	0.37	0.36	0.34	0.39	0.4
12	0.42	0.38	0.44	0.4	0.37	0.47	0.46	0.43	0.44	0.42	0.39	0.44	0.43
13	0.46	0.46	0.47	0.44	0.41	0.59	0.48	0.48	0.49	0.44	0.44	0.44	0.45
14	0.51	0.43	0.5	0.45	0.47	0.67	0.51	0.54	0.53	0.51	0.48	0.53	0.51
15	0.58	0.43	0.57	0.49	0.53	0.69	0.55	0.59	0.56	0.56	0.53	0.57	0.55
16	0.59	0.45	0.58	0.55	0.58	0.71	0.6	0.61	0.62	0.62	0.59	0.58	0.59
17	0.58	0.52	0.62	0.58	0.66	0.74	0.66	0.64	0.66	0.63	0.62	0.62	0.62
18	0.59	0.57	0.65	0.67	0.71	0.74	0.65	0.66	0.67	0.67	0.65	0.61	0.64
+gp	0.7	0.67	0.662	0.79	0.806	0.847	0.787	0.753	0.805	0.774	0.695	0.738	0.77
SOPCOFAC	1.0032	1.0291	1.0052	1.0377	0.9998	0.9465	1.0103	1.0085	1.0184	1.0058	1.0077	0.9863	1.0442

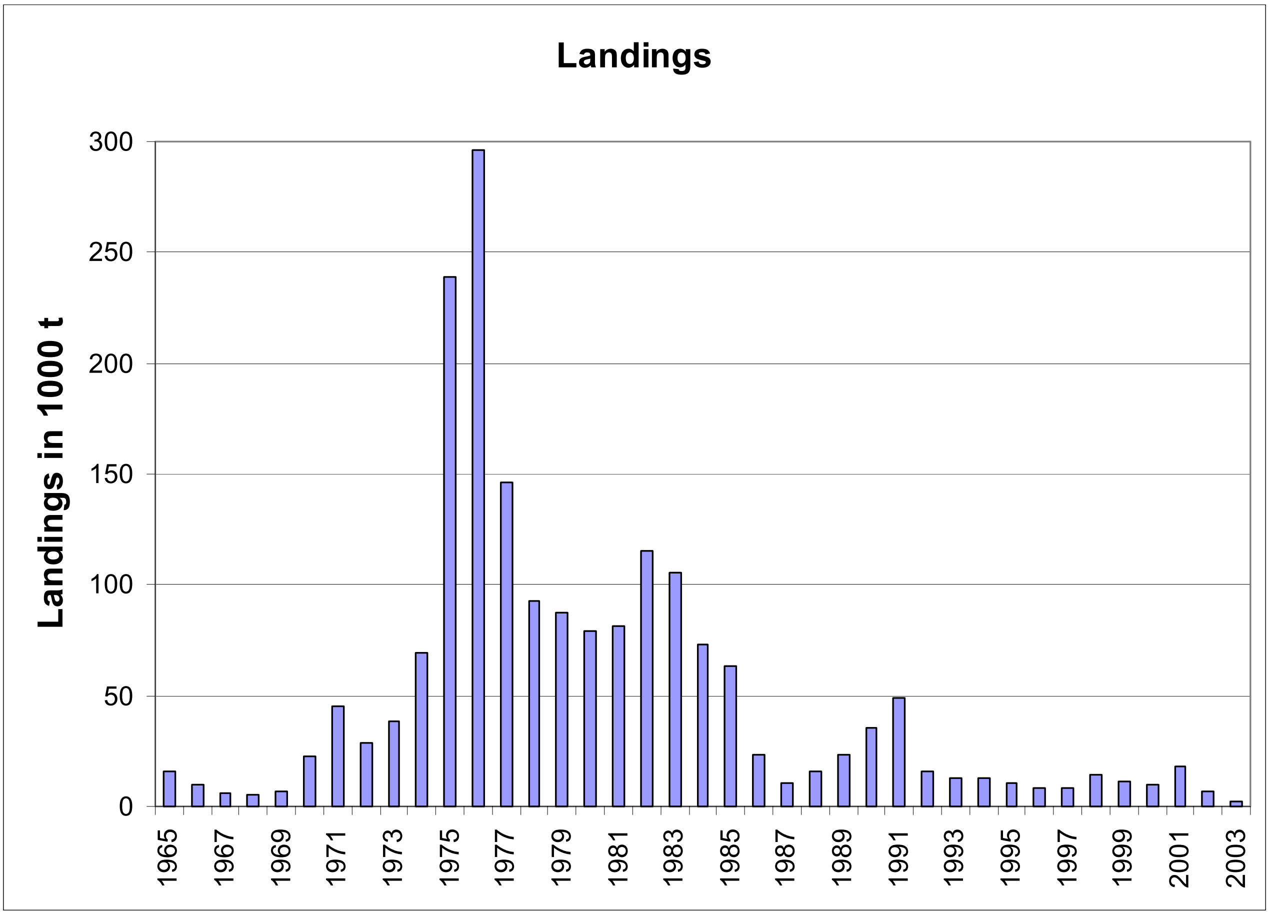


Table 6.1. *Sebastes mentella* in Sub-areas I and II, Total international landings 1965-2003 (thousand tonnes).

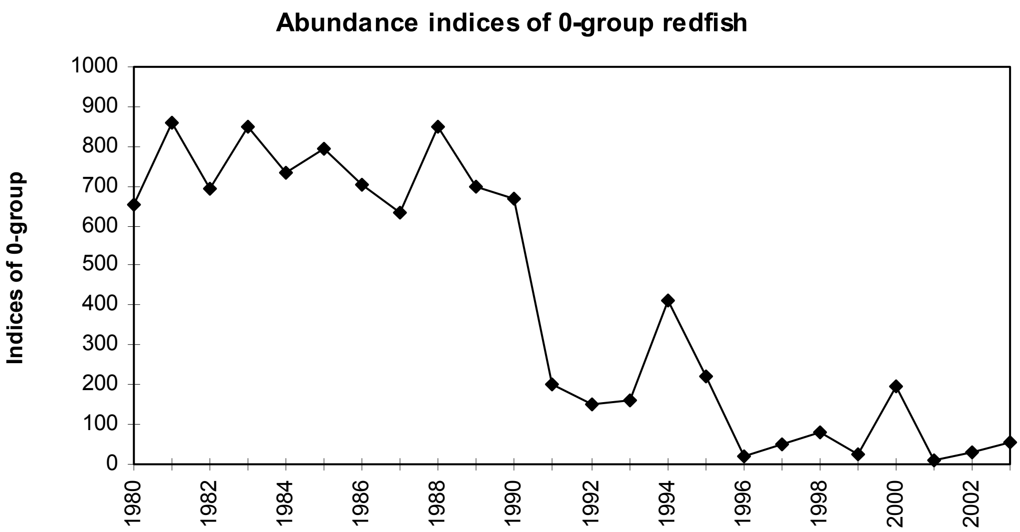


Figure 6.2. Abundance indices of 0-group redfish (believed to be mostly *S.mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2003.

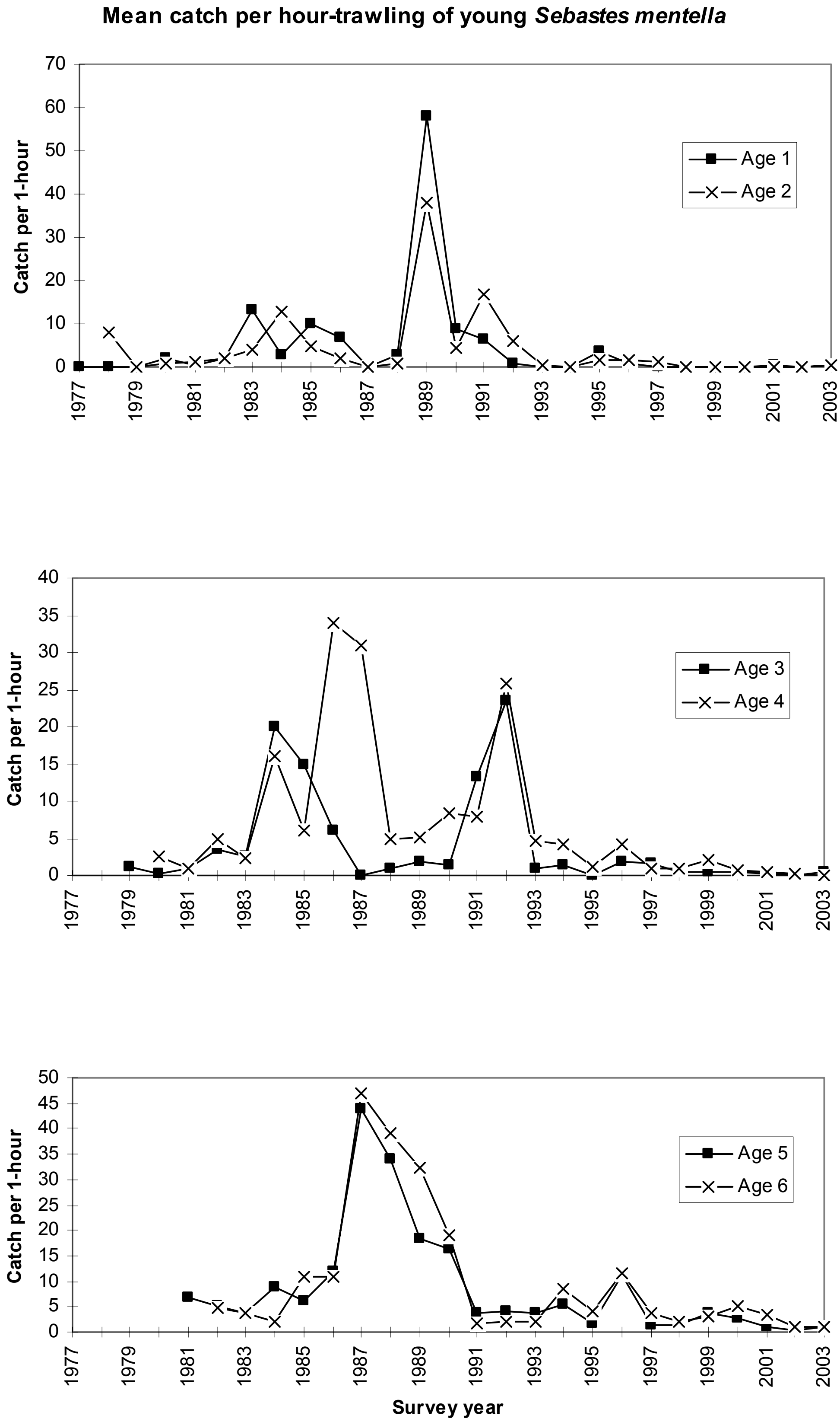


Figure 6.3. Catch (numbers of specimens) per hour trawling of different ages of *Sebastes mentella* in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D4).

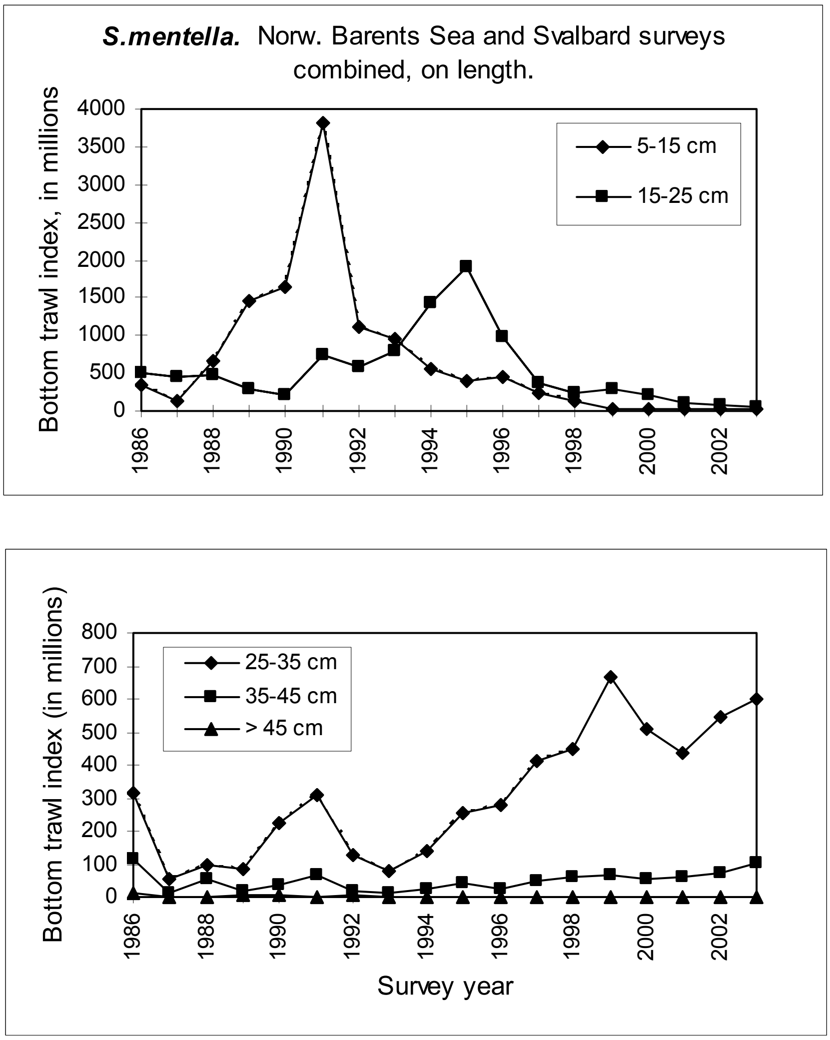
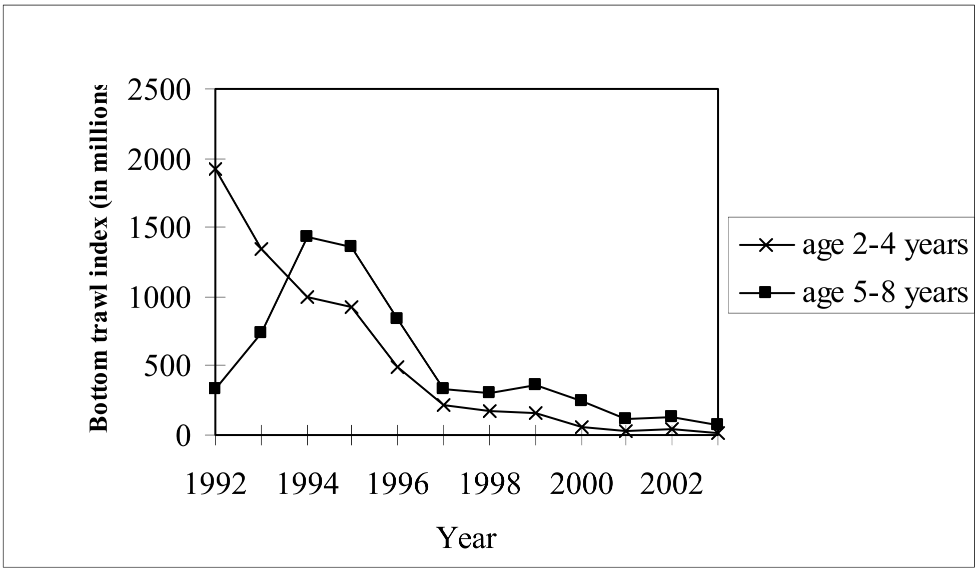


Figure 6.4a. *Sebastes mentella.* Abundance indices (**on length**) when combining the Norwegian bottom trawl surveys 1986-2003 at Svalbard (summer/fall) and in the Barents Sea (winter).



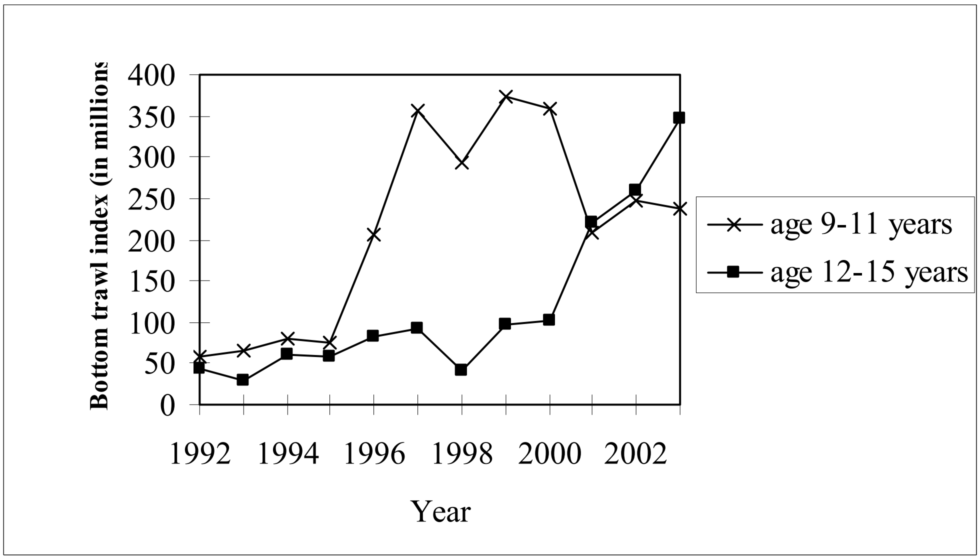


Figure 6.4b. *Sebastes mentella* . Abundance indices (**on age**) when combining the Norwegian bottom trawl surveys 1992-2003 at Svalbard (summer/fall) and in the Barents Sea (winter).

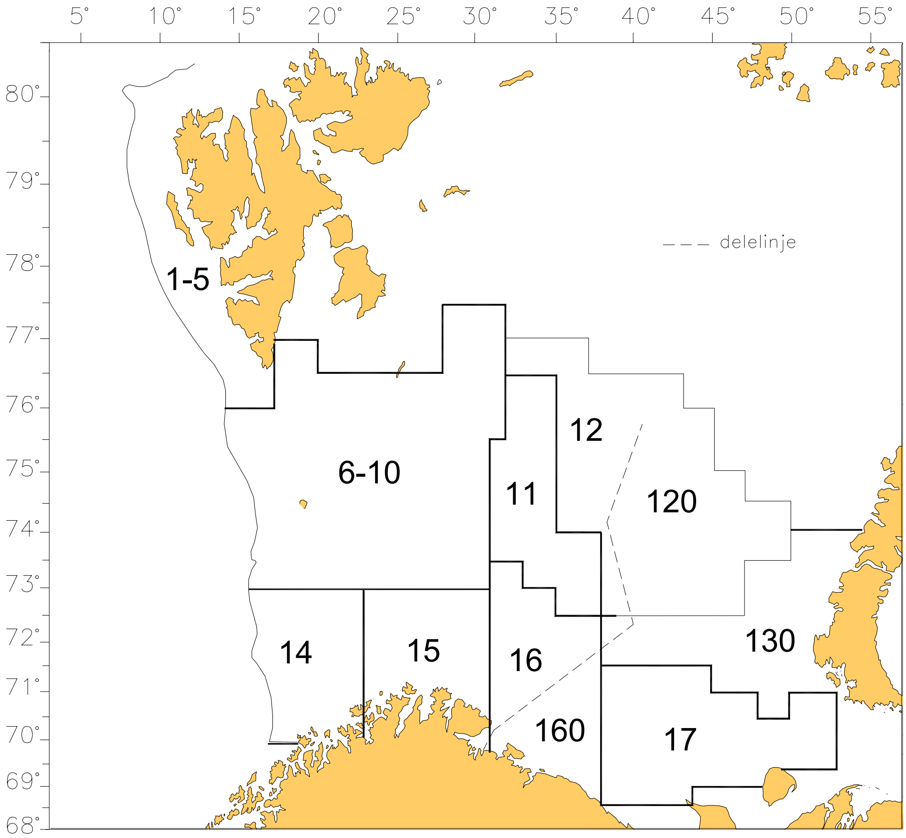


Figure 6.5. Survey regions and subareas in the new Norwegian ecosystem survey in the Barents Sea and adjacent areas in August-September 1996-2003 covered by the standard 1800 Campelen research trawl shallower than ca. 500 m. Subareas 1-10 are further depth stratified. The Svalbard region comprises these ten subareas, while the Barents Sea region comprises subareas 11-16, excl. the Russian Economic Zone. In addition to the areas shown on the map comes the area north and east of Spitsbergen which is also included in the survey estimate (ref. Table 6.5).

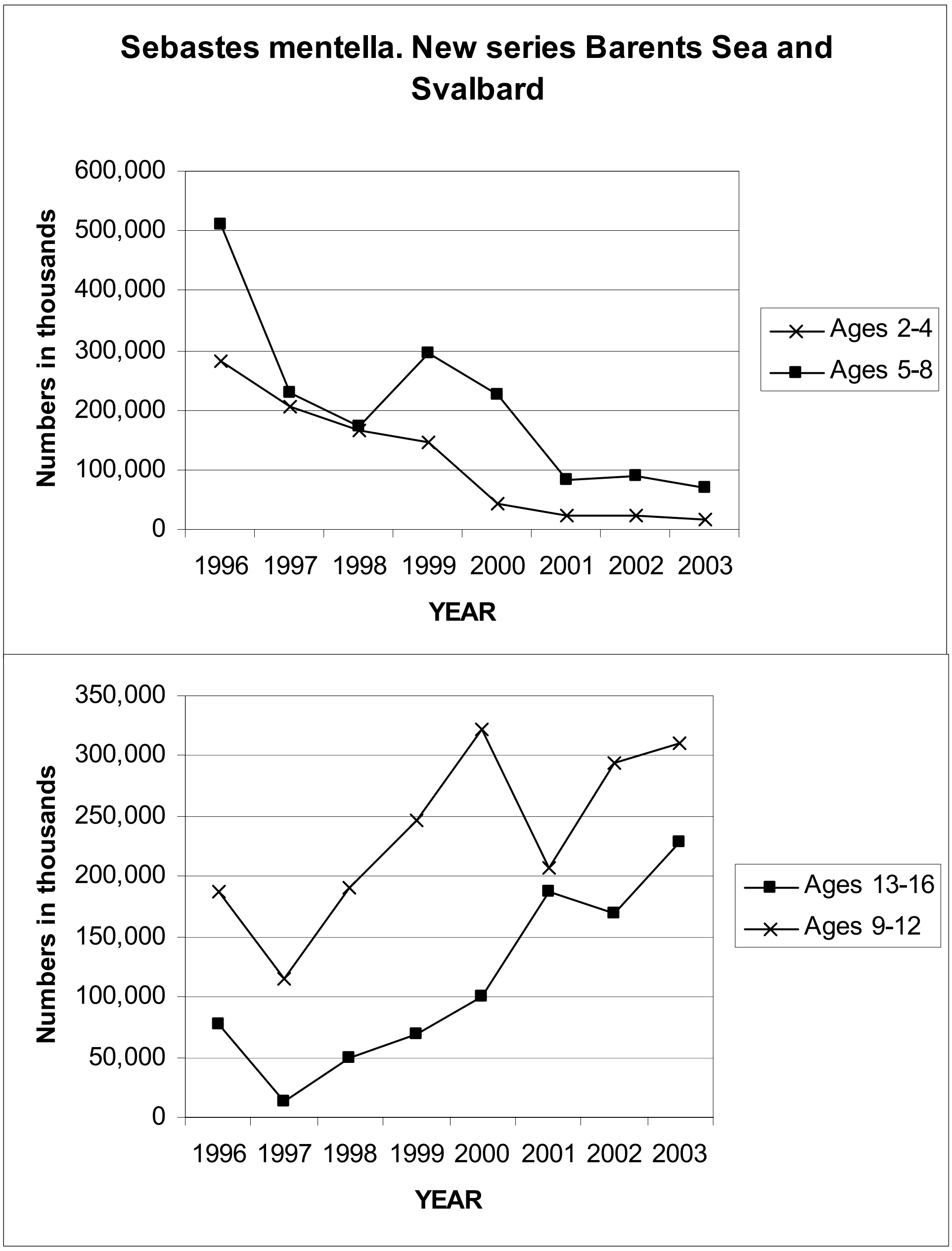


Figure 6.6. *Sebastes mentella* . Abundance indices (**on age**) from the new Norwegian demersal fish survey in August-September 1996-2003 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (ref. Table D6).

Table D1 REDFISH in Sub-areas I and II. Nominal catch (t) by countries in Sub-area I, Divisions IIa and IIb combined as officially reported to ICES.

Year	Canada	Denmark	Faroe Islands	France	Germany[4]	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia[5]	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	2,970	7,457	-	-	-	-	18,650	-	1,806	69,689	25	716	-	101,313
1985	-	-	-	3,326	6,566	-	-	-	-	20,456	-	2,056	59,943	38	167	-	92,552
1986	-	-	29	2,719	4,884	-	-	-	-	23,255	-	1,591	20,694	-	129	14	53,315
1987	-	+	450[3]	1,611	5,829	-	-	-	-	18,051	-	1,175	7,215	25	230	9	34,595
1988	-	-	973	3,349	2,355	-	-	-	-	24,662	-	500	9,139	26	468	2	41,494
1989	-	-	338	1,849	4,245	-	-	-	-	25,295	-	340	14,344	5[2]	271	1	46,688
1990	-	37[3]	386	1,821	6,741	-	-	-	-	34,090	-	830	18,918	-	333	-	63,156
1991	-	23	639	791	981	-	-	-	-	49,463	-	166	15,354	1	336	13	67,768
1992	-	9	58	1,301	530	614	-	-	-	23,451	-	977	4,335	16	479	3	31,773
1993	8[3]	4	152	921	685	15	-	-	-	18,319	-	1,040	7,573	65	734	1	29,517
1994	-	28	26	771	1026	6	4	3	-	21,466	-	985	6,220	34	259	13	30,841
1995	-	-	30	748	692	7	1	5	1	16,162	-	936	6,985	67	252	13	25,899
1996	-	-	42[3]	746	618	37	-	2	-	21,675	-	523	1,641	408	305	121	26,118
1997	-	-	7	1,011	538	39[2]	-	11	-	18,839	1	535	4,556	308	235	29	26,109
1998	-	-	98	567	231	47[3]	-	28	-	26,273	13	131	5,278	228	211	94	33,199
1999	-	-	108	61[3]	430	97	14	10	-	24,634	6	68	4,422	36	247	62	30,195
2000	-	-	67[3]	25	222	51	65	1	-	19,052	2	131	4,631	87		203[6]	24,537
2001	-	-	69[3]	397	436	39	38	5	-	23,133[1]	5	186	4,738	91	Estonia	239[6]	29,376
2002	-	-	70[3]	89	141	49[1]	44	4	-	10,601[1]	8[3]	276	4,736	193[2]	15	234[6]	16,460
2003[1]	-	-	16[3]	26	153	43[3]	9	5[3]	89	8,158	7	50	1,431	47[3]	-	258	10,291

[1] Provisional figures.
[2] Working Group figure.
[3] As reported to Norwegian authorities.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table D2 REDFISH in Sub-area IV (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Nether-lands	Norway	UK (England & Wales)	UK (Scotl)	Total
1986	-	24	-	578	183	-	-	1,048	35	1	1,869
1987	-	16	3	833	70	-	-	411	16	55	1,404
1988	-	32	90	915	188	-	-	696	125	9	2,055
1989	1	23	13	554	111	-	-	500[2]	134	6	1,342
1990	+	41	25	554	47	-	-	483[2]	369	6	1,525
1991	5	29	144	914	213	-	2	415[2]	43	38	1,803
1992	4	22	23	1,960	170	-	1	416	65	122	2,783
1993	28	14	4	1,211	33	-	1	373	138	71	1,873
1994	4	13	1	863	324	-	8	371	38	66	1,688
1995	16	12	65	1,120	80	-	16	297	46	241	1,893
1996	20	20	1	932	74	-	41	363	37	146	1,634
1997	16	23	-	1,049	45	-	53	595	21	528	2,330
1998	2	27	12	570[1]	370	4	21	1,113	68	681	2,868
1999	3	52	1	n.a.	58	39	16	862	67	465	1,563
2000	5	41	n.a.	224.	19	28	19	443	132	486	1,397
2001	4	96	n.a.	272[1]	13	19	+	422[1]	80	458	1,364
2002	2	40	n.a.	97	11	7	+	235[1]		524[3]	916
2003[1]	1	71	n.a.	21	2	n.a.	-	496		463[3]	1,027

[1] Provisional figures.
[2] Working Group figure.
[3] UK(E/W/)+UK(Scotl)
n.a. = not available.

Table D3. *Sebastes mentella*. Average catch (numbers of specimens) per hour trawling of different ages of *Sebastes mentella* in the Russian groundfish survey in the Barents Sea and Svalbard areas (1976–1983 published in "Annales Biologiques").

Year class	0	1	2	3	4	5	6	7	8	9	10	11
1965	-	-	-	-	-	-	-	-	-	-	-	0.4
1966	-	-	-	-	-	-	-	-	-	-	3.0	-
1967	-	-	-	-	-	-	-	-	-	11.7	-	0.3
1968	-	-	-	-	-	-	-	-	16.2	-	1.5	0.3
1969	-	-	-	-	-	-	-	43.4	-	8.7	12.2	3.1
1970	-	-	-	-	-	-	85.8	-	19.8	34.9	11.9	-
1971	-	-	-	-	-	22.7	-	19.5	51.9	18.0	5.7	-
1972	-	-	-	-	9.4	-	6.7	57.6	12.3	6.7	-	-
1973	-	-	-	0.6	-	4.3	37.3	8.6	5.6	-	-	-
1974	-	-	4.8	-	4.9	22.8	4.8	4.8	-	-	-	3.0
1975	-	7.4	-	1.7	6.4	2.4	3.5	5.0	-	-	4.0	-
1976	7.0	-	8.1	1.2	2.5	6.8	4.9	5.0	1.0	13.0	-	-
1977	-	0.2	0.2	0.2	0.9	5.1	3.7	1.0	19.0	2.0	-	-
1978	0.8	0.02	0.9	1.0	5.0	3.8	2.0	20.0	6.0	-	-	-
1979	-	1.9	1.4	3.6	2.3	9.0	11.0	16.0	1.0	-	-	0.1
1980	0.3	0.4	2.0	2.5	16.0	6.0	11.0	25.0	2.0	-	1.5	2.0
1981	-	2.2	3.9	20.0	6.0	12.0	47.0	18.0	6.3	1.6	0.5	1.0
1982	19.8	13.2	13.0	15.0	34.0	44.0	39.0	32.6	4.3	3.1	4.9	+
1983	12.5	3.0	5.0	6.0	31.0	34.0	32.3	13.3	4.0	4.2	0.6	1.1
1984	-	10.0	2.0	-	5.0	18.3	19.0	2.2	2.4	0.2	1.7	2.4
1985	107.0	7.0	-	1.0	5.2	16.2	1.7	1.7	0.6	2.8	3.8	0.3
1986	2.0	-	1.0	1.8	8.4	3.6	2.1	1.2	5.6	8.2	0.9	0.7
1987	-	3.0	37.9	1.3	8.0	4.1	2.0	10.6	9.6	1.4	2.0	1.3
1988	4.0	58.1	4.3	13.3	25.8	3.9	8.6	11.2	2.8	4.2	3.0	4.7
1989	8.7	9.0	17.0	23.4	4.6	5.4	4.0	6.6	6.6	4.1	7.7	5.3
1990	2.5	6.3	6.1	1.0	4.3	1.7	11.5	6.5	5.5	6.7	7.4	3.6
1991	0.3	1.0	0.5	1.5	1.2	11.3	3.9	3.3	4.6	5.8	2.7	1.9
1992	0.6	+	0.2	0.1	4.3	1.3	2.0	2.3	4.9	2.3	1.0	4.1
1993[1]	-	+	1.5	1.8	1.0	1.2	3.0	4.2	2.6	2.0	3.2	-
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	3.1	3.3	-	-
1995	2.8	1.0	1.1	0.4	2.2	2.6	3.5	3.4	2.9	-	-	-
1996[2]	+	0.1	0.1	0.4	0.7	1.1	1.0	1.4	-	-	-	-
1997	-	-	+	0.4	0.5	0.3	0.9	-	-	-	-	-
1998	-	0.1	0.2	0.3	0.2	1.1	-	-	-	-	-	-
1999	0.1	-	0.1	+	0.1	-	-	-	-	-	-	-
2000	-	0.6	0.1	0.5	-	-	-	-	-	-	-	-
2001	-	0.1	0.4	-	-	-	-	-	-	-	-	-
2002[3]	0.1	0.5										
2003	-											

[1] - Not complete area coverage of Division IIb.
[2] - Area surveyed restricted to Subarea I and Division IIa only.
[3] - Area surveyed restricted to Subarea I and Division IIb only.

Table D4a. *Sebastes mentella*[1] in Division IIb. Abundance indices (**on length**) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1986-2003 (numbers in millions).

	Length group (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1986[2]	6	101	192	17	10	5	2	4	+	338
1987[2]	20	14	140	19	6	2	1	2	+	208
1988[2]	33	23	82	77	7	3	2	2	+	228
1989	566	225	24	72	17	2	2	8	4	921
1990	184	820	59	65	111	23	15	7	3	1,287
1991	1,533	1,426	563	55	138	38	30	7	1	3,791
1992	149	446	268	43	22	15	4	7	4	958
1993	9	320	272	89	16	13	3	1	+	722
1994	4	284	613	242	10	9	2	2	1	1,165
1995	33	33	417	349	77	18	5	1	+	933
1996	56	69	139	310	97	8	4	1	1	685
1997	3	44	13	65	57	9	5	+	+	195
1998	+	37	35	28	132	73	45	2	+	353
1999	4	3	121	62	259	169	42	1	0	661
2000	+	10	31	59	126	143	21	1	0	391
2001	1	5	3	32	57	228	50	3	0	378
2002	1	4	6	21	62	266	47	4	+	410
2003	1	5	7	11	56	271	50	1	0	403

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.
[2] - Old trawl equipment (bobbins gear and 80 meter sweep length)

Table D4b. *Sebastes mentella*[1] in Division IIb. Norwegian bottom trawl survey indices (**on age**) in the Svalbard area (Division IIb) in summer/fall 1992-2003 (numbers in millions).

	Age													
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	283	419	484	131	58	45	14	8	5	2	7	2	1	3	1,462
1993	2	527	117	202	142	8	23	6	13	1	7	1	1	+	1,050
1994	7	280	290	202	235	42	94	1	1	3	4	1	1	+	1,161
1995	4	50	365	237	132	61	19	17	11	+	1	3	0	0	900
1996	23	47	15	37	105	144	84	17	51	32	34	9	6	2	605
1997	8	43	6	6	40	20	30	25	7	3	1	2	2	1	194
1998	+	26	28	14	10	13	69	66	49	15	1	6	15	5	317
1999	3	16	114	27	36	53	117	78	67	41	45	11	19	13	640
2000	4	6	6	14	35	22	31	54	81	60	24	24	10	8	379
2001	2	4	3	1	9	16	22	30	34	57	57	50	54	6	344
2002	3	2	4	2	5	22	34	23	88	36	62	64	15	21	379
2003	0.3	3	4	3	5	4	29	31	50	59	45	70	38	23	365

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.

Table D5a. *Sebastes mentella*[1]. Abundance indices (**on length**) from the bottom trawl surveys in the Barents Sea in the winter 1986-2004 (numbers in millions). The area coverage was extended from 1993.

	Length group (cm)								
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	950.2
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	432.9
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1068.2
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	961.0
1990	323.6	304.5	36.4	55.9	80.2	12.9	12.5	1.5	0.2	827.7
1991	395.2	448.8	86.2	38.9	95.6	34.8	24.3	2.5	0.2	1126.5
1992	139.0	366.5	227.1	34.6	55.2	34.4	7.5	1.8	0.5	866.6
1993	30.8	592.7	320.2	116.3	24.2	25.0	6.3	1.0	+	1116.5
1994	6.9	258.6	289.4	284.3	51.4	69.8	19.9	1.4	0.1	981.8
1995	263.7	71.4	637.8	505.8	90.8	68.8	31.3	3.9	0.5	1674.0
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1036.6
1997[2]	62.8	121.1	24.7	277.9	274.4	72.3	40.7	5.1	0.2	879.0
1998[2]	1.3	90.6	62.8	100.8	203.1	40.7	13.0	1.7	0.2	514.0
1999	2.2	6.8	67.6	36.8	167.4	71.9	21.0	3.1	0.1	376.8
2000	9.0	12.9	39.3	76.8	141.9	97.2	26.6	6.9	1.5	412.1
2001	9.3	22.5	7.0	54.9	77.4	73.2	9.4	0.6	0.1	254.2
2002	16.1	7.2	19.1	41.7	103.9	113.7	22.9	1.4	+	326.0
2003	3.9	3.9	10.0	12.4	70.8	199.8	46.9	6.0	0.3	354.0
2004	2.2	3.0	6.9	18.5	32.9	86.7	31.8	2.0	0.1	184.1

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.
[2] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D5b. *Sebastes mentella*[1] in Sub-areas I and II. Preliminary Norwegian bottom trawl indices (**on age**) from the annual Barents Sea survey in February 1992-2004 (numbers in millions). The area coverage was extended from 1993 onwards.

	Age														
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	351	252	132	56	14	11	3	9	18	16	12	11	2	5	892
1993	38	473	192	242	62	45	19	22	13	11	10	4	2	3	1,136
1994	7	85	332	189	370	228	73	42	3	30	8	14	25	7	1,413
1995	308	45	146	264	364	211	69	23	7	17	23	9	11	10	1,507
1996	173	119	109	114	128	122	106	64	24	19	12	7	8	4	1,009
1997[2]	43	101	19	54	96	43	44	171	76	74	39	29	10	9	808
1998[2]	1	73	49	27	13	52	107	104	41	18	7	4	3	3	502
1999	1	+	32	43	30	24	30	81	79	28	2	1	6	+	357
2000	9	12	21	17	9	39	77	73	50	41	14	10	7	6	385
2001	1	17	8	1	7	22	39	30	34	23	24	17	9	3	236
2002	18	4	12	7	4	14	49	55	27	19	34	24	28	11	306
2003	0	2	2	4	6	6	14	39	24	34	39	65	46	20	301
2004	0	2	3	1	9	12	15	20	36	8	28	3	25	12	172

[1] - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.
[2] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D6. *Sebastes mentella* in Sub-areas I and II. Abundance indices (on age) from the new Norwegian demersal fish survey in August-September 1996-2003 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (numbers in thousands).

Year	Age														
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1996	146198	112742	22353	53507	165531	181980	108738	43328	65310	40546	38254	19843	29446	10931	17414	1366761
1997	62682	130816	12492	23452	74342	55880	76607	82503	17640	14274	675	2238	1723	633	8765	587223
1998	313	78767	85715	39849	25805	23413	84825	100332	54287	24329	11334	7457	15250	576	25212	577670
1999	5359	23240	117170	47851	41608	76797	128677	73306	58018	64781	49890	13565	18458	12171	24672	755562
2000	5964	23169	14336	19960	52666	68081	83857	77513	100442	72294	71148	36599	17183	20590	26501	690837
2001	5026	6541	10957	1093	19766	25591	36594	51644	44407	61704	50083	86122	53952	15699	31877	507131
2002	9112	6646	7379	3821	8635	28215	47456	63903	103368	49964	76133	71970	25241	36765	34957	573565
2003	3954	7394	6142	3540	8030	9388	48564	59051	98554	69901	83192	73521	69970	37162	47323	625687

Table D7. *Sebastes mentella* in Sub-areas I and II.
Results of the Russian trawl/acoustic redfish survey in the western Barents Sea in April-May 1992-2001. Abundance indices in millions.

Year	Period of survey	Age																		Total				Area of survey
		1-4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21+	Numbers 10^6	Biomass t 10^3	SSN 10^6	SSB t 10^3	in n.m.^{2}
1992	April	29	27	27	37	36	50	78	39	34	40	44	43	28	17	13	4	7	3	566	218	191	114	25300
1993	April	31	15	13	6	6	20	56	56	38	28	29	27	19	12	7	3	1	2	396	150	151	90	23500
1994													No Data											
1995	May	+	32	51	83	90	41	31	31	41	94	73	48	30	10	9	4	1	+	669	202	211	102	23300
1996													No Data											
1997	Apr-May	86	6	24	102	150	53	48	24	20	26	36	28	11	9	4	2	1	+	630	170	111	58	22400
1998	April	1	+	8	47	77	63	71	46	27	19	23	23	25	6	3	2	1	+	442	153	106	57	22931
1999	Apr-May	11	1	9	14	57	75	63	73	31	25	17	15	11	8	3	1	1	1	415	134	120	55	19333
2000	Apr-May	2	2	14	15	62	100	143	122	54	34	24	29	12	11	7	2	1	1	635	208	114	53	22000
2001	Apr-May	11	1	11	22	24	84	123	134	144	115	78	40	27	19	10	4	+	3	850	316	339	152	23000
2002													No Data											
2003													No Data											

Table D8. *Sebastes mentella.* Maturity ogives from Russian research vessels. Sexes combined. Data collected during April-June in the Kopytov area (western Barents Sea) and adjacent waters.

Age	1988	1989	1990	1991	1992	1993	1995	1997	1998	1999	2000	2001
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.021	0.000	0.000	0.000
8	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.000	0.014	0.016	0.000	0.000
9	0.000	0.000	0.012	0.139	0.013	0.033	0.000	0.027	0.000	0.059	0.048	0.082
10	0.028	0.074	0.131	0.174	0.092	0.133	0.055	0.130	0.074	0.110	0.087	0.196
11	0.125	0.178	0.300	0.138	0.169	0.364	0.111	0.312	0.171	0.333	0.202	0.405
12	0.297	0.473	0.688	0.358	0.396	0.480	0.368	0.281	0.276	0.579	0.375	0.442
13	0.562	0.684	0.714	0.470	0.452	0.696	0.587	0.566	0.622	0.689	0.489	0.442
14	0.760	0.716	0.824	0.637	0.761	0.925	0.696	0.736	0.714	0.788	0.742	0.648
15	0.855	0.794	0.848	0.762	0.939	0.962	0.729	0.831	0.871	0.813	0.833	0.775
16	1.000	1.000	1.000	1.000	0.886	0.953	0.789	0.958	0.919	0.903	0.904	0.865
17	1.000	1.000	1.000	1.000	1.000	0.977	1.000	0.950	1.000	0.923	1.000	0.909
18	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

7 *SEBASTES MARINUS* (GOLDEN REDFISH) IN SUB-AREAS I AND II

7.1 Status of the Fisheries

7.1.1 Historical development of the fishery

A description of the historical development of the fishery is found in the Quality handbook for this stock (see Annex afwg-smr).

Until 1 January 2003 there were no regulations particularly for the *S. marinus* fishery, and the regulations aimed at *S. mentella* (see chapter 6.1.1) had only marginal effects on the *S. marinus* stock. After this date, all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) outside the permanently closed areas have been forbidden in the Norwegian Economic Zone north of 62°N and in the Svalbard area. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and on board at any time. Until 14 April 2004 there were no regulations of the other gears/fleets fishing for *S. marinus*. After this date, a minimum legal catch size of 32 cm has been set for all fisheries, with the allowance to have up to 10% undersized (i.e., less than 32 cm) specimens of *S.marinus* (in numbers) per haul. In addition, a limited moratorium during 1-31 May has been enforced in all fisheries except trawl. When fishing for other species (also during the moratorium) it is allowed to have up to 20% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday. Furthermore, after 1 January 2006 it will be forbidden to use gillnets with meshsize less than 120 mm when fishing for redfish.

7.1.2 Landings prior to 2004 (Tables 7.1–7.5, D1 and D2, Figure 7.1)

Nominal catches of *S. marinus* by country for Sub-areas I and II combined are presented in Table 7.1 and the totals for both *S. marinus* and *S. mentella* in Tables D1 and D2. Landings of *S. marinus* showed a decrease in 1991 from a level of 23,000–30,000 t in 1984–1990 to a stable level of about 16,000-19,000 t in the years 1991–1999. Since then the landings have decreased further, and the provisional total landings figure for *S. marinus* in 2003 of 7,849 t is the lowest since the mid-1940ies (!). The Norwegian landings are presented by gear and month in Figure 7.1.

Information describing the splitting of the redfish landings by species and area is given in the Quality handbook. The time series of *S. marinus* landings are given in Table 7.5 and shows a long-term (1908-2003) mean of 17,344 t.

7.1.3 Expected landings in 2004

On the basis of reports from the first months of the year, a legal by-catch of 20% in any trawl fishery, and an assumed minor effect of the regulations for the other gears, the Norwegian landings in 2004 are not expected to decrease by more than about 1,000 t compared to 2003, leading to a total Norwegian catch of about 6,000 t. The Russian catch is expected to be 400 t. On this basis landings of **6,800 t** are expected in 2004.

7.2 Data Used in the Assessment

7.2.1 Fishing effort and catch-per-unit-effort (Tables D9, Figure 7.2)

The former CPUE-series for *S. marinus* from Norwegian 32-50 meter freezer trawlers was improved (e.g., analysing the trawl data with regards to vessel length instead of vessel tonnage) and presented from 1992 onwards (Table D9). Only data from days with more than 10% *S. marinus* in the catches (in weight) were included in the annual averages. The sensitivity/consequences of using different percentages should be further investigated, though the present 20% bycatch regulation puts limitations on what's possible to use. Mean CPUEs with standard errors together with number of vessel days meeting the 10% criterion are presented in Table D9 and Figure 7.2.

Although the trawl fishery until 2003 was almost unregulated, the trawlers experienced fewer and fewer fishing days with more than 10% of their catches composed of *S. marinus*. From 1996 until 2001, Figure 7.2 shows an inverse correlation between catch-rates and number of vessel-days. Since 2001, however, both the catch-rates and the number of vessel-days are decreasing, and this is worrying despite the fact that *S. marinus* since 2003, due to regulations, should not compose more than maximum 20% of the catch in each trawl haul. With some variation, the average annual catch-rates have decreased from an average level of 350 kg/trawlhour during mid 1990ies to a provisional figure of 136 kg/h in 2003, i.e., less than 40% of the former recent level.

Catch at age data for 2000, and 2002-2003 were revised. Age composition data for 2003 were only provided by Norway, accounting for 89% of the total landings. Russian catch-at-length from each Sub-area were converted to catch-at-age by using the Norwegian age-length keys in Subarea I, Divisions IIa (northern part) and IIb, respectively. Other countries were assumed to have the same relative age distribution and mean weight as Norway. The updated catch-in-numbers at age matrix is shown in Table 7.6.

7.2.2 Weight at Age (Table 7.7).

Weight-at-age data for ages 7–24+ were available from the Norwegian landings in 2003.

7.2.3 Maturity at age

A maturity ogive was not available for *S. marinus,* and knife-edge maturity at age 15 is assumed.

7.2.4 Survey results (Tables D10a,b-D11a,b-D12, Figures 7.3a,b–7.4a,b)

The results from the following research vessel survey series were evaluated by the Working Group:

1) Norwegian Barents Sea bottom trawl survey (February) from 1986–2004 (joint with Russia since 2000) in fishing depths of 100–500 m. Length compositions for the years 1986–2004 are shown in Table D10a and Fig 7.3a. Age compositions for the years 1992–2004 are shown in Table D10b and Figure 7.3b. This survey covers important nursery areas for the stock

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2003 in fishing depths of 100–500 m. Length compositions for the years 1985–2003 and age compositions for the years 1992–2003 are shown in Table D11a and D11b, respectively. This survey covers the northernmost part of the species' distribution.

Data on length and age from both these surveys have been combined and are shown in Figures 7.4a,b.

3) Catch rates (numbers/nautical mile averaged for all stations within subareas and finally averaged, weighted by subarea, for the total surveyed area) of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2003 from Finnmark to Møre (Table D12).

The bottom trawl surveys covering the Barents Sea and the Svalbard areas show that the abundance indices over the commercial size range (> 25 cm) were relatively stable up to 1998. Since then the abundance has decreased. In addition, fewer pre-recruit sized fish (< 25 cm) will lead to poorer recruitment to the fishable biomass.

Results from the Norwegian Coastal and Fjord survey confirm poor recruitment and also show an overall reduction in the abundance of this species irrespective of fish size (except for fish > 35 cm). Some variation in the results from year to year may be due to a variable number of trawl stations taken in some of the areas from year to year, and annual variations in local fish migrations (Table D12).

7.3 Results of the Assessment

The current assessment is an update of last year's assessment with a minor improvement of the commercial CPUE series. All present available information confirms last years' evaluation of stock status.

The current assessment raises great concern about the stock. Data from both the scientific surveys and commercial CPUE show a very disturbing reduction in fishable biomass. The survey covering the near-coast and fjord resources show an overall reduction in abundance from 1995 to 2003 for sizes less than 35 cm. Concerns are again expressed about the low number of pre-recruit size groups in all the recent surveys suggesting that future recruitment to the fishery may be poor. Further declines in the stock can therefore be expected in the near future.

7.4 Biological reference points

Candidate limit reference point for the biomass or numbers (Ulim) could be set at the average biomass (or number) level of *S. marinus* above 25 cm, or at a certain percentage of this level, estimated by the Norwegian trawl surveys for the time period 1986-1997. Such practice is currently used by ICES for the Icelandic redfish stocks (ICES CM 2003/ACFM:23) and is a procedure mentioned and recommended as an alternative by the ICES Study Groups on the Precautionary Approach. The Working Group proposes such a Ulim to be set at 41 mill. specimens above 25 cm corresponding to the average number of the five lowest survey abundance estimates during 1986-1997, and Upa to be set at 64 mill. specimens above 25 cm which corresponds to 80% of the three highest survey trawl indices in the combined February Barents Sea survey and the August Svalbard summer survey during 1986-1997 (Tables D10a, D11a, Figure 7.4a). These survey series are at present only available by numbers.

The stock is expected to continue to decline over the next several years as a series of poor year-classes will recruit to the fishery. Consistent with a precautionary approach, ICES recommends that a management plan, including monitoring of the development of the stock and of the fishery, based on legal obligations, should be further developed.

Such a plan may consider stronger bycatch regimes, restricted fishing periods, closure of areas and TAC. The Working Group is confident with the new regulations enforced in 2003 and 2004, but re-iterates the need for a management plan and strategy for how and how fast the rebuilding should be.

The Working Group evaluated the recently enforced regulations of both the trawl fishery and the conventional gears, of which gillnets impose the greatest impact on the stock. Data available to the Working Group show that the trawl catches went down from 4,009 t in 2002 to 2,241 in 2003, i.e., 55% of the 2002 level. The limited moratorium is at the best expected to reduce the annual catch by ca. 800 t, or to ca. 85% of the 2003 catch taken by other gears than trawl.

The Norwegian combined Barents Sea and Svalbard surveys show a decrease in numbers of *S. marinus* above 25 cm to ca. 35% of the average of the five lowest survey indices in 1986-1997 (the level proposed as Ulim). In addition, the trawl CPUE series shows a decrease to a present level that is less than 40% of the average 1992-1996 level. Much stronger regulations than those recently enforced are therefore needed. Continuing using moratorium that allows for 20% bycatch as the regulation measure, at least 4-5 of the best fishing months needs to be included to obtain the necessary effect. In addition, further improvement of the trawl bycatch regulations should also be considered.

7.5 Response to ACFM technical minutes

S. marinus is considered to be an easier species to age than *S. mentella*, and it is possible to follow year classes through the input survey data series. An annual updated database on catch-in-numbers at age and length, weight-at-age, and trawl survey indices both by length and age should be continued to be used in future alternative assessment methods. Possible alternative methods to conventional catch-at-age analyses, such as the FLEKSIBEST model, have been discussed but not yet explored for this redfish stock. This model is closely related to the BORMICON model which currently is used by the ICES North-Western WG on *S. marinus* (Björnsson and Sigurdsson 2003). ACFM recommends the Working Group to investigate other alternative methods which may be found in assessments of *Sebastes* stocks in the eastern North Pacific (e.g Methot). Additional effort should be made to consider survey and length-based models, and explore alternative methods for estimating uncertainty around CPUE and survey time-series (e.g. jack-knife or bootstrap methods). The Working Group will follow up on this recommendation and conduct preparatory international work to explore this. During the Working Group the survey based model SURBA was presented, and this may be a useful tool for improved evaluation and estimation of the *S. marinus* stock from survey results (Needle 2003, 2004).

Table 7.1 *Sebastes marinus*. Nominal catch (t) by countries in Sub-area I and Divisions IIa and IIb combined.

Year	Faroe Islands	France	Germany[2]	Greenland	Iceland	Ireland	Netherlands
1986	29	2,719	3,369	-	-	-	-
1987	250	1,553	4,508	-	-	-	-
1988	No species specific data presently available on countries						
1989	3	796	412	-	-	-	-
1990	278	1,679	387	1	-	-	-
1991	152	706	981	-	-	-	-
1992	35	1,289	530	623	-	-	-
1993	139	871	650	14	-	-	-
1994	22	697	1,008	5	4	-	-
1995	27	732	517	5	1	1	1
1996	38	671	499	34	-	-	-
1997	3	974	457	23	-	5	-
1998	78	494	131	33	-	19	-
1999	35	35	228	47	14	7	-
2000	17	13	160	22	16	-	-
2001	17	30	238	17	-	1	-
2002	17	31	42	31	3	-	-
2003[1]	8	8	121	35	4	-	89

Year	Norway	Portugal	Russia[3]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986	21,680	-	2,350	-	42	14	30,203
1987	16,728	-	850	-	181	7	24,077
1988	No species specific data presently available on countries						25,908
1989	20,662	-	1,264	-	97	-	23,234
1990	23,917	-	1,549	-	261	-	28,072
1991	15,872	-	1.052	-	268	10	19,041
1992	12,700	5	758	2	241	2	16,185
1993	13,137	77	1,313	8	441	1	16,651
1994	14,955	90	1,199	4	135	1	18,120
1995	13,516	9	639	-	159	9	15,616
1996	15,622	55	716	81	229	98	18,043
1997	14,182	61	1,584	36	164	22	17,511
1998	16,540	6	1,632	51	118	53	19,155
1999	16,750	3	1,691	7	135	34	18,986
2000	13,032	16	1,112	-		73[4]	14,461
2001	9,158[1]	7	963	1		119[4]	10,551
2002	8,472[1]	34	832	3		46[4]	9,511
2003[1]	6955[1]	6	479	-		134[4]	7,849

[1] Provisional figures.
[2] Includes former GDR prior to 1991.
[3] USSR prior to 1991.
[4] UK(E&W)+UK(Scot.)

Table 7.2 *Sebastes marinus*. Nominal catch (t) by countries in Sub-area I.

Year	Faroe Islands	Germany[4]	Greenland	Iceland	Norway	Russia[5]	UK(Eng &Wales)	UK (Scotland)	Total
1986[3]	-	50	-	-	2,972	155	32	3	3,212
1987[3]	-	8	-	-	2,013	50	11	-	2,082
1988				No species specific data presently available					
1989	-	-	-	-	1,763	110	4[2]	-	1,877
1990	5	-	-	-	1,263	14	-	-	1,282
1991	-	-	-	-	1,993	92	-	-	2,085
1992	-	-	-	-	2,162	174	-	-	2,336
1993	24[2]	-	-	-	1,178	330	-	-	1,532
1994	12[2]	72	-	4	1,607	109		-	1,804
1995	19[2]	1[2]	-	1[2]	1,947	201	1[2]	-	2,170
1996	7[2]	-	-	-	2,245	131	3[2]	-	2,386
1997	3[2]	-	5[2]	-	2,431	160	2[2]	-	2,601
1998	78[2]	5[2]	-	-	2,109	308	30[2]	-	2,530
1999	35[2]	18[2]	9[2]	14[2]	2,114	360	11[2]	-	2,561
2000	-	1[2]	-	16[2]	1,983	146		12[6]	2,159
2001	-	11[2]	-	-	1,056[1]	128	France	16[6]	1,211
2002	-	5[2]	-	-	686[1]	220	1[2]	9[2,6]	921
2003[1]	-	-	-	-	834	140		4	978

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6]UK(E&W)+UK(Scot.)

Table 7.3 *Sebastes marinus*. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Netherlands	Norway	Portugal	Russia[5]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986[3]	29	2,719	3,319	-	-	-	18,708	-	2,195	-	10	11	26,991
1987[3]	250	1,553	2,967	-	-	-	14,715	-	800	-	170	7	20,462
1988	No species specific data presently available												
1989	3[2]	784[2]	412	-	-	-	18,833	-	912	-	93[2]	-	21,037
1990	273	1,684[2]	387	-	-	-	22,444	-	392	-	261	-	25,441
1991	152[2]	706[2]	678	-	-	-	13,835	-	534	-	268[2]	10[2]	16,183
1992	35[2]	1,294[2]	211	614	-	-	10,536	-	404	-	206[2]	2[2]	13,302
1993	115[2]	871[2]	473	14[2]	-	-	11,959	77[2]	940	-	431[2]	1[2]	14,881
1994	10[2]	697[2]	654[2]	5[2]	-	-	13,330	90[2]	1,030	-	129[2]	-	15,945
1995	8[2]	732[2]	328[2]	5[2]	1[2]	1	11,466	2[2]	405	-	158[2]	9[2]	13,115
1996	27[2]	671[2]	448[2]	34[2]	-	-	13,329	51[2]	449	5[2]	223[2]	98[2]	15,335
1997	-	974[2]	438	18[2]	5[2]	-	11,708	61[2]	1,199	36[2]	162[2]	22[2]	14,623
1998	-	494[2]	116[2]	33[2]	19[2]	-	14,326	6[2]	1,078	51[2]	85[2]	52[2]	16,260
1999	-	35[2]	210[2]	38[2]	7[2]	-	14,598	3[2]	976	7[2]	122[2]	34[2]	16,030
2000	17[2]	13[2]	159[2]	22[2]	-	-	11,038	16[2]	658	-		61[6]	11,984
2001	17[2]	30[2]	227[2]	17[2]	1[2]	-	8,023[1]	6[2]	612	1[2]	Iceland	103[2, 6]	9,037
2002	17[2]	30[2]	37[2]	31[2]	-	-	7,680[1]	18[2]	192	2[2]	3[2]	32[2, 6]	8,042
2003[1]	8[2]	8[2]	121[2]	35[2]	-	89[2]	6,074	6[2]	264		4[2]	130[2, 6]	6,739

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

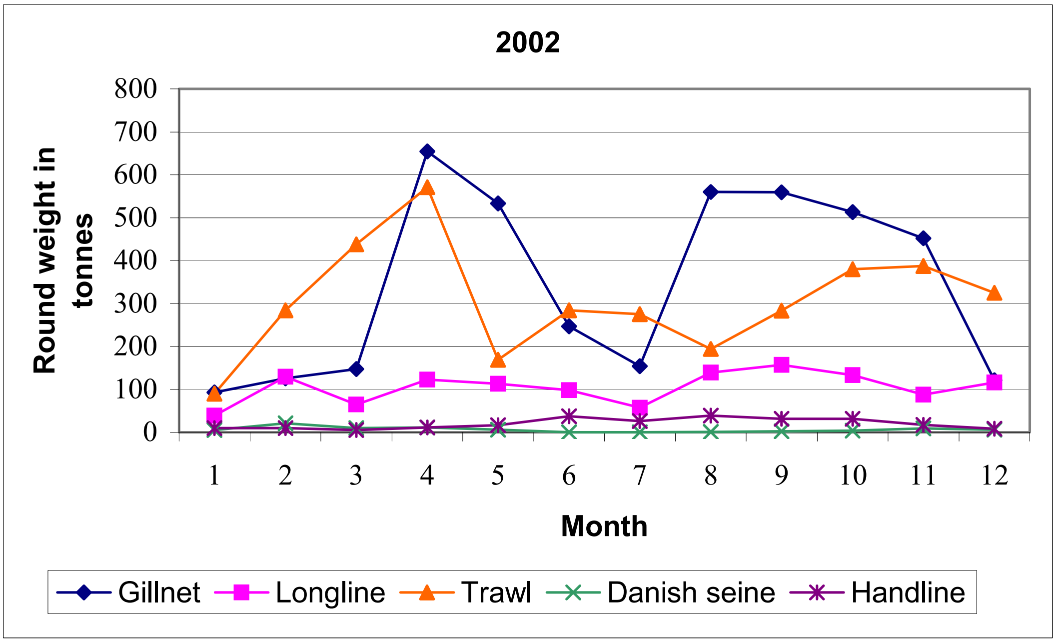
Table 7.4 *Sebastes marinus*. Nominal catch (t) by countries in Division IIb.

Year	Faroe Islands	Germany[5]	Greenland	Norway	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
1986	-									+
1987[4]	-	1533	-	-	-	-	-	-	-	1533
1988	No species specific data presently available									
1989	-	-	-	66	-	242	-	-	-	308
1990	-	-	1[2]	210	-	1157	-	-	-	1368
1991	-	303	-	44	-	426	-	-	-	773
1992	-	319	9[2]	2	5[2]	180	2	35[2]	-	552
1993	-	177	-	-	-	43	8[3]	10[2]	-	238
1994	-	282	-	18	-	60	4[3]	6[2]	1[2]	371
1995	-	187	-	103	7	33	-	-	-	330
1996	4	51[2]	-	27	5	136	76[2]	3[2]	-	302
1997	-	20	-	43	-	225	-	-	-	288
1998	-	10[2]	-	105	-	246	-	3[2]	-	364
1999	-	-	-	38	-	355	-	2[2]	-	395
2000	-	-	-	10	-	308	-	-	-	318
2001	-	-	-	79[1]	1[2]	223	-	-	-	303
2002	-	-	-	106[1]	16[2]	420	1[2]	-	5[2, 7]	548
2003[1]	-	-	-	57	-	75	-		-	132

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Split on species according to the 1992 catches.
[4] Based on preliminary estimates of species breakdown by area.
[5] Includes former GDR prior to 1991.
[6] USSR prior to 1991.
[7] UK(E&W)+UK(Scot.)

Table 7,5 *Sebastes marinus* in Sub-areas I and II, Total international landings 1908-2003 (thousand tonnes),

Year	Landings '000 t	Year	Landings '000 t
1908	0.65	1957	51.61
1909	1.00	1958	33.12
1910	1.03	1959	28.07
1911	1.01	1960	31.77
1912	1.01	1961	26.73
1913	0.81	1962	22.82
1914	1.14	1963	28.10
915	1.31	1964	26.55
1916	1.46	1965	24.31
1917	1.16	1966	25.63
1918	1.11	1967	17.73
1919	1.51	1968	13.35
1920	1.17	1969	24.07
1921	1.83	1970	12.82
1922	1.47	1971	13.82
1923	1.94	1972	17.73
1924	2.21	1973	21.44
1925	2.72	1974	27.27
1926	3.19	1975	39.13
1927	4.47	1976	48.58
1928	1.95	1977	39.51
1929	5.28	1978	31.74
1930	5.29	1979	26.48
1931	5.88	1980	23.41
1932	6.10	1981	20.83
1933	9.59	1982	16.37
1934	15.86	1983	19.26
1935	17.69	1984	28.38
1936	21.03	1985	29.48
1937	34.59	1986	30.20
1938	39.17	1987	24.08
1939	21.87	1988	25.91
1940	2.29	1989	23.23
1941	1.68	1990	28.07
1942	1.43	1991	19.04
1943	1.02	1992	16.19
1944	0.92	1993	16.65
1945	0.56	1994	18.12
1946	3.57	1995	15.62
1947	14.88	1996	18.04
1948	20.00	1997	17.51
1949	22.36	1998	19.15
1950	25.56	1999	18.99
1951	45.30	2000	14.46
1952	56.17	2001	10.55
1953	34.83	2002	9.51
1954	35.78	2003	7.85
1955	35.47	Average	17.44
1956	43.38		



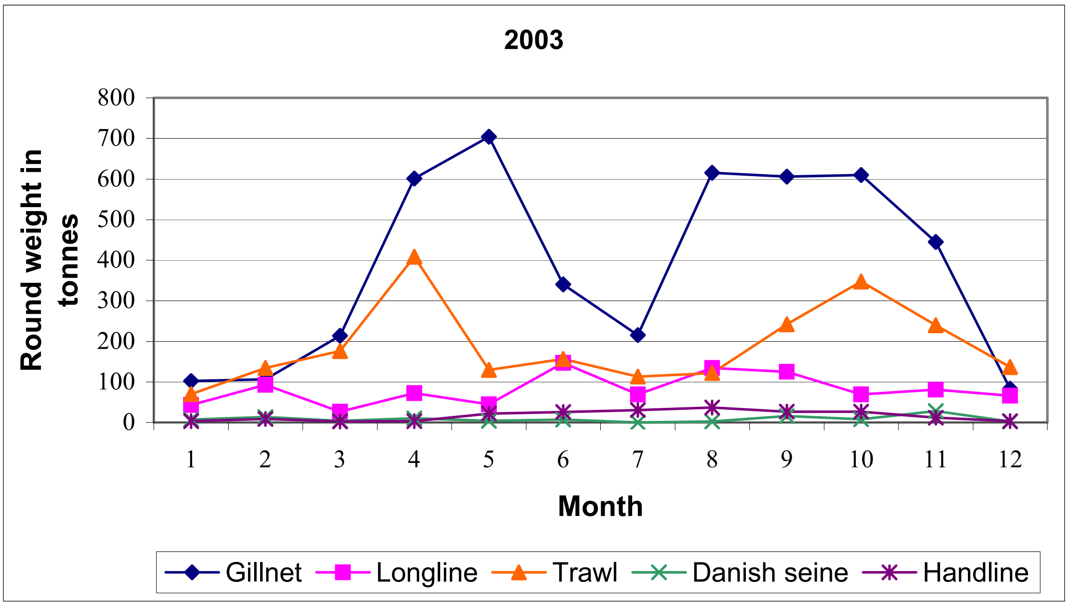


Figure 7.1. Illustration of the seasonality in the different Norwegian *S. marinus* fisheries.

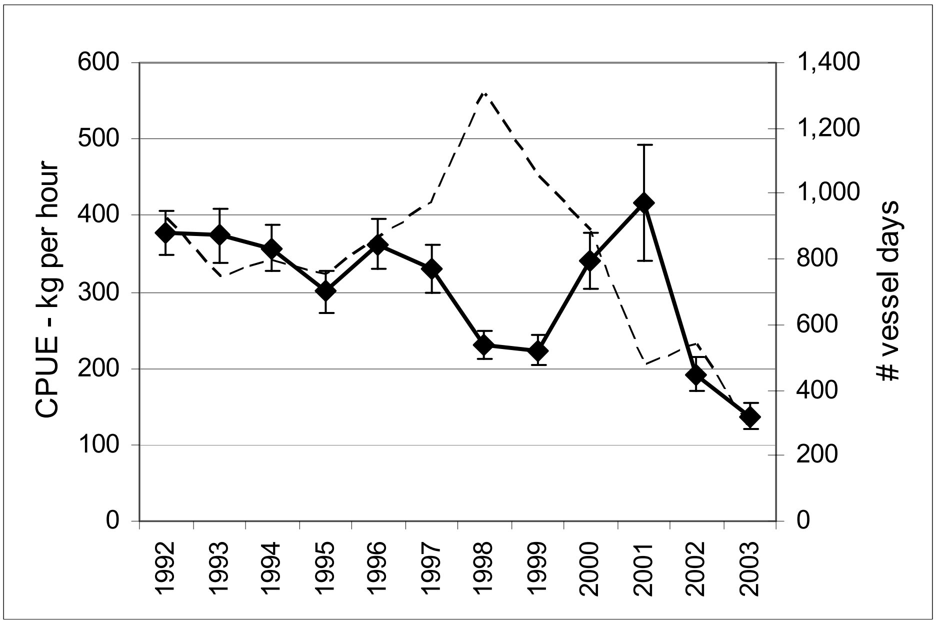
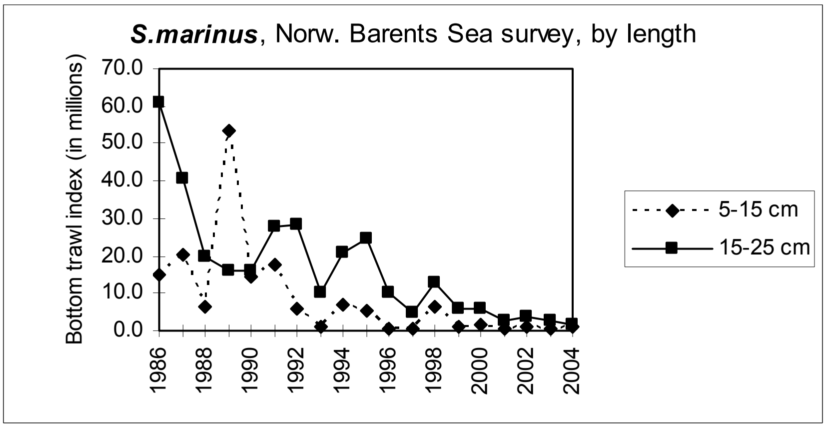


Figure 7.2. *Sebastes marinus.* Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery, and numbers of vessel days (stippled curve) meeting the criterium of minimum 10% *S. marinus* in the catch per day. The figure is an illustration of the data given in Table D9.



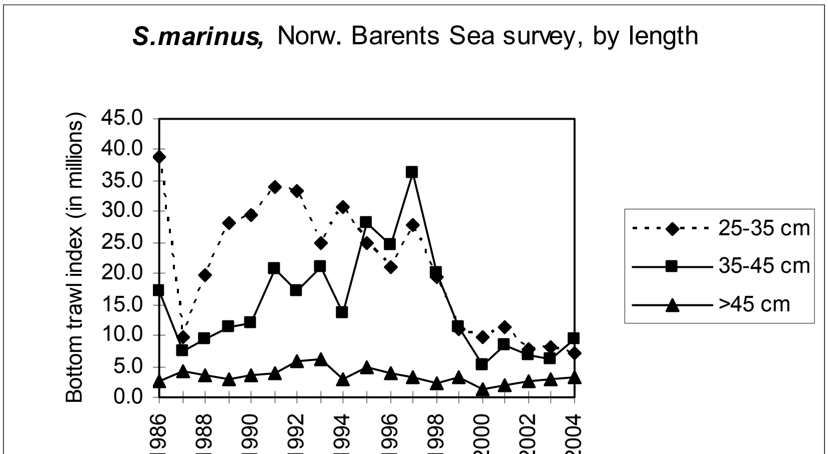
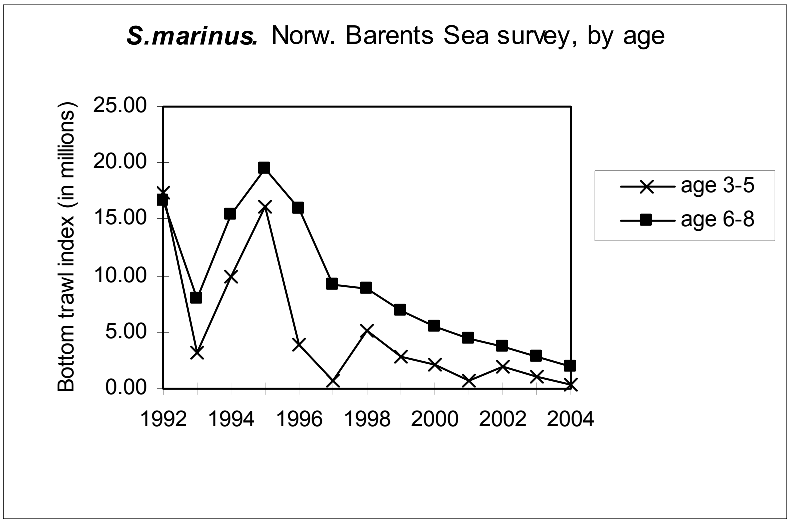


Figure 7.3a. *Sebastes marinus.* Abundance indices **(by length)** from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2004 (ref. Table D10a).



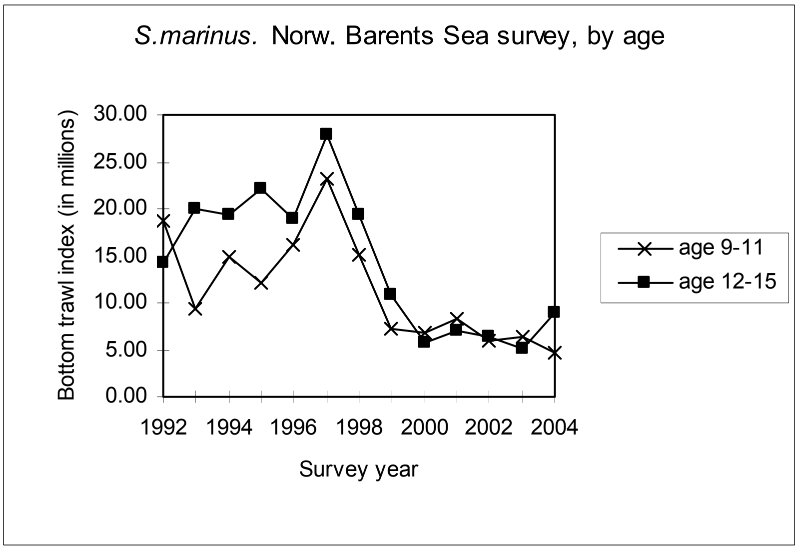
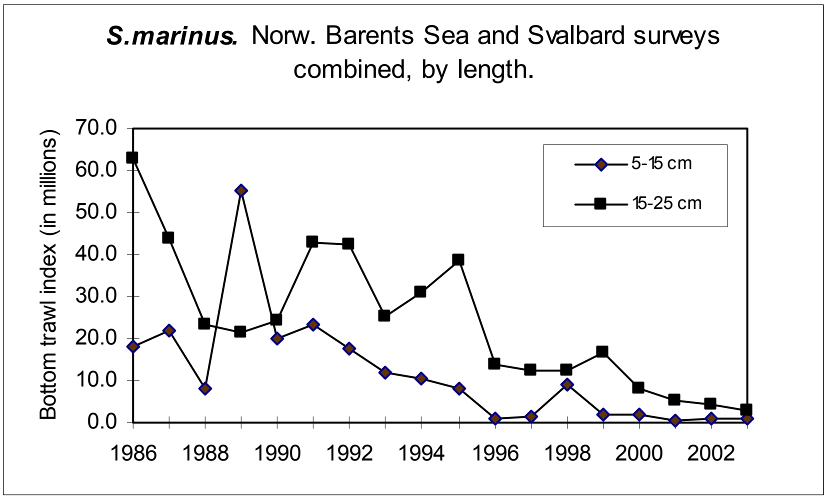


Figure 7.3b. *Sebastes marinus.* Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2004 in the Barents Sea (ref. Table D10b).



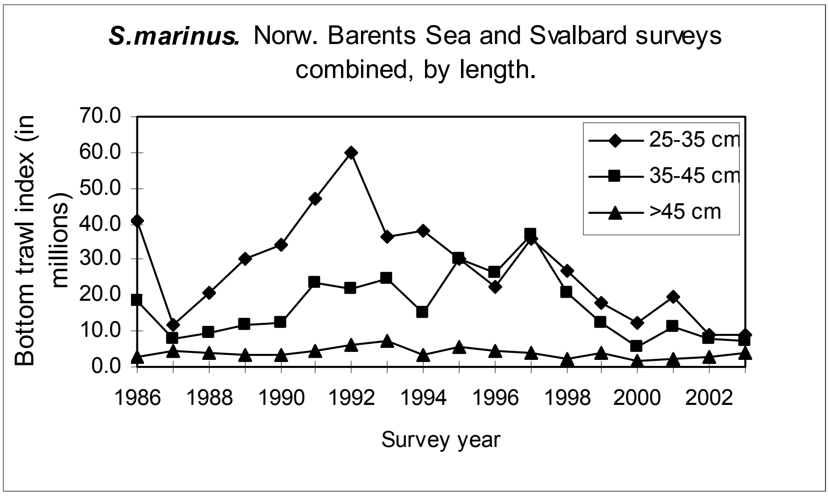


Figure 7.4a. *Sebastes marinus.* Abundance indices (**by length**) when combining the Norwegian bottom trawl surveys 1986-2003 in the Barents Sea (winter) and at Svalbard (summer/fall).

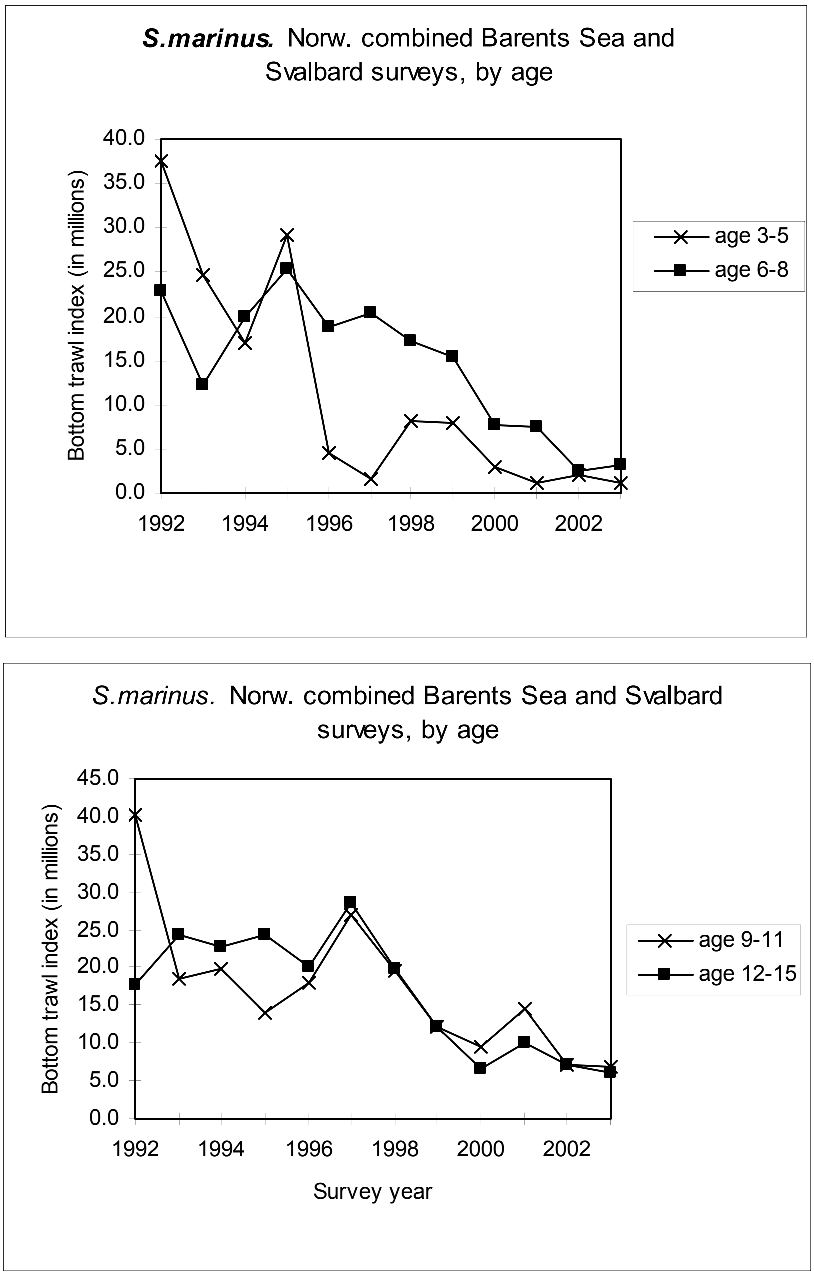


Figure 7.4b. *Sebastes marinus.* Abundance indices **(by age)** when combining the Norwegian bottom trawl surveys 1992-2003 in the Barents Sea (winter) and at Svalbard (summer/fall).

Table D9. *Sebastes marinus*. Effort (vessel days) and catch per unit effort (kg per trawl hour) with 2 x st.error for Norwegian stern trawlers (32-50 meters long).[1]

Year	Number of vessel days meeting the 10% requirement	Catch (t) associated with the effort in the second column	Mean CPUE per year (kg/hour)	2 x standard error of the mean
1992	926	8 693	378	29.4
1993	743	5 764	374	34.4
1994	793	6 950	357	30.1
1995	754	4 262	300	26.7
1996	864	6 042	363	32.1
1997	972	4 516	331	31.9
1998	1 303	7 147	230	17.2
1999	1 054	5 890	224	18.8
2000	884	5 119	340	36.8
2001	478	8 175	417	75.6
2002	535	2 374	192	22.6
2003	274	676	137	17.3

[1] Only including days with more than 10% *S. marinus* in the catches.
[2] Provisional figures.

Table D10a. *Sebastes marinus*. Abundance indices **(on length)** from the bottom trawl surveys in the Barents Sea in the winter 1986-2004 (numbers in millions). The area coverage was extended from 1993.

Year	Length group (cm)									Total
	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	
1986	3.0	11.7	26.4	34.3	17.7	21.0	12.8	4.4	2.6	133.9
1987	7.7	12.7	32.8	7.7	6.4	3.4	3.8	3.8	4.2	82.5
1988	1.0	5.6	5.5	14.2	12.6	7.3	5.2	4.1	3.7	59.2
1989	48.7	4.9	4.3	11.8	15.9	12.2	6.6	4.8	3.0	112.2
1990	9.2	5.3	6.5	9.4	15.5	14.0	8.0	4.0	3.4	75.3
1991	4.2	13.6	8.4	19.4	18.0	16.1	14.8	6.0	4.0	104.5
1992	1.8	3.9	7.7	20.6	19.7	13.7	10.5	6.6	5.8	90.3
1993	0.1	1.2	3.5	6.9	10.3	14.5	12.5	8.6	6.3	63.9
1994	0.7	6.5	9.3	11.7	11.5	19.4	9.1	4.4	2.8	75.4
1995	0.6	5.0	13.1	11.5	9.1	15.9	17.2	10.9	4.7	88.0
1996	+	0.7	3.5	6.4	9.4	11.7	16.6	7.9	3.9	60.1
1997[1]	-	0.5	1.3	2.7	6.9	21.4	28.2	8.5	3.3	72.7
1998[1]	0.1	3.9	2.0	7.4	5.8	25.3	13.2	7.0	2.3	67.0
1999	0.2	0.9	2.1	4.0	4.6	6.4	6.0	5.3	3.5	33.0
2000	0.5	1.1	1.5	4.2	4.7	5.0	3.5	1.8	1.2	24.0
2001	0.1	0.4	0.4	2.4	5.8	5.6	5.0	3.5	1.8	25.0
2002	0.1	1.0	1.9	1.7	3.7	4.1	3.3	3.6	2.5	22.0
2003	0.0	0.5	1.2	1.5	4.3	3.8	2.7	3.3	2.9	20.2
2004	0.7	0.2	0.4	1.0	2.9	4.4	5.5	4.0	3.2	22.3

[1] - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D10b. *Sebastes marinus* in Sub-areas I and II. Norwegian bottom trawl indices **(on age)** from the annual Barents Sea survey in February 1992-2004 (numbers in thousands). The area coverage was extended from 1993 onwards.

	Age													
Year	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	2,295	4,261	10,760	2,043	1,474	13,178	4,230	6,302	8,251	3,751	3,865	3,064	3,568	67,042
1993	468	1,218	1,424	2,020	979	5,048	2,968	4,230	2,142	4,634	3,338	2,951	9,148	40,568
1994	2,951	4,485	2,573	3,801	8,338	3,254	1,297	7,231	6,443	248	10,192	6,341	2,612	59,766
1995	2,540	7,450	6,090	7,150	5,820	6,590	5,670	2,000	4,440	6,500	4,320	5,330	6,030	69,930
1996	310	1,300	2,340	3,520	3,660	8,720	5,650	3,960	6,590	5,730	6,230	4,070	2,950	55,030
1997	190	80	360	1,320	2,530	5,370	10,570	6,840	5,810	7,390	8,790	9,740	1,980	60,980
1998	2,380	1,930	850	660	1,140	7,090	6,124	4,962	4,091	5,190	8,790	2,730	2,560	48,487
1999	737	916	1,246	3,469	1,650	1,826	1,679	3,084	2,371	2,953	3,837	2,132	1,979	27,879
2000	490	720	900	1,310	1,800	2,440	2,020	2,710	2,090	940	1,440	2,940	430	20,230
2001	320	170	190	940	1,360	2,220	3,110	2,400	2,690	2,230	2,180	1,200	1,370	20,380
2002	130	910	902	1,590	544	1,546	2,153	1,822	1,900	2,220	1,073	1,294	1,730	17,814
2003	220	250	590	1,080	680	1,020	2,910	1,180	2,250	1,370	1,530	840	1,310	15,230
2004	780	100	100	90	240	540	1,130	1,260	1,590	1,740	1,490	2,570	1,890	16,410

[1] Preliminary

Table D11a. *Sebastes marinus* in Division IIb. Abundance indices (**on length**) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1985-2003 (numbers in thousands).

	Length group (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1985[1]	158	1,307	795	1,728	2,273	1,417	311	142	194	8,325
1986[1]	200	2,961	1,768	547	643	1,520	639	467	196	8,941
1987[1]	124	1,343	1,964	1,185	1,367	652	352	29	44	7,060
1988[1]	520	1,001	1,953	1,609	684	358	158	68	95	6,450
1989	197	1,629	2,963	2,374	1,320	846	337	323	104	10,100
1990	1,673	3,886	4,478	4,047	2,972	1,509	365	140	122	19,185
1991	127	5,371	5,821	9,171	8,523	4,499	1,531	982	395	36,420
1992	1,689	10,228	8,858	5,330	13,960	12,720	4,547	494	346	58,172
1993	205	10,160	9,078	5,855	7,071	4,327	2,088	1,552	948	41,284
1994	51	3,340	5,883	4,185	3,922	3,315	1,021	845	423	22,985
1995	470	2,000	9,100	5,070	3,060	2,400	1,040	920	780	24,840
1996	80	130	1,260	2,480	1,030	480	550	990	400	7,400
1997	40	810	1,980	5,470	5,560	2,340	590	190	450	17,430
1998	210	2,698	1,741	4,620	4,053	1,761	535	545	241	16,403
1999	0	794	7,057	3,698	4,563	2,449	467	619	369	20,017
2000	40	360	1,240	1,390	2,010	760	400	160	390	6,750
2001	10	110	790	1,470	3,710	4,600	1,880	680	370	13,660
2002	0	0	64	415	459	880	620	565	519	3,522
2003	90	90	108	83	525	565	447	760	769	3,437

[1] - Old trawl equipment (bobbins gear and 80 meter sweep length)

Table D11b. *Sebastes marinus* in Sub-areas I and II. Norwegian bottom trawl survey indices **(on age)** in the Svalbard area (Division IIb) in summer/fall 1992-2003 (numbers in thousands).

	Age													
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	284	12,378	5,576	2,279	371	2,064	3,687	5,704	9,215	6,413	1,454	1,387	696	22	51,530
1993	32	10,704	5,710	5,142	1,855	1,052	1,314	3,520	2,847	2,757	2,074	1,245	844	119	39,215
1994	429	1,150	3,418	2,393	1,723	1,106	1,714	1,256	1,938	1,596	2,039	484	550	319	20,115
1995	600	1,600	6,400	5,100	1,800	2,200	1,800	700	700	400	700	500	400	500	23,400
1996	40	110	+	560	1,050	940	930	400	1,050	280	320	590	160	70	6,500
1997	320	490	+	480	1,500	6,950	2,720	1,680	800	1,310	550	30	+	120	16,950
1998	210	1,817	881	202	1,555	2,187	4,551	1,913	1,010	797	49	264	73	187	15,696
1999	0	760	2,893	1,339	3,534	1,037	3,905	2,603	762	1,663	481	361	258	152	19,748
2000	40	20	400	350	840	480	730	1,670	620	340	510	100	80	70	6,250
2001	0	40	50	450	330	790	1,760	1,970	3,300	1,200	1,810	150	660	430	12,940
2002	0	0	+	+	65	160	204	326	364	614	442	328	15	0	2,518
2003	30	30	30	+	108	+	219	263	126	259	306	199	248	411	2,229

8 GREENLAND HALIBUT IN SUBAREAS I AND II

8.1 Status of the fisheries

8.1.1 Landings prior to 2003 (Tables 8.1 - 8.5, E10)

Nominal catches by country for Subareas I and II combined are presented in Table 8.1. Tables 8.2–8.4 give the catches for Subarea I and Divisions IIa and IIb separately. For most countries the catches listed in the tables are similar to those officially reported to ICES. Some of the values in the tables vary slightly from the official statistics, and represents those presented to the Working Group by the members. The tables also incorporate data presented to the Working Group on Spanish survey catches. Landings separated by gear type are presented in Table 8.5.

The revised total catch for 2002 is 13,161 t, which is 21 t more than used in the previous assessment. The preliminary estimate of the total catch for 2003 is 13,002 t. This is about 2,000 t below the projected catch for 2003 estimated by the Working Group during its 2003 meeting.

In recent years, some fishing for Greenland halibut has taken place in the northern part of Division IVa. In the period 1973–1990, the annual catch in Division IVa was usually well below 100 t, occasionally reaching 200 t. Since then, catches increased sharply from 558 t in 1991 to 2,010 t in 1996 (Table E10). Catches remained comparatively high until they dropped to below 900 t in 2000. The increase from 1973 to 1991 was due mainly to a gillnet fishery. In recent years most of the catch has been taken by trawl. This fishery is in another management area and is not restricted by any TAC regulations. Although there is a continuous distribution of this species from the southern part of Division IIa along the continental slope towards the Shetland area, little is known about the stock structure and the catch taken from this area has therefore not been added to the catch from Subareas I and II.

Around Jan Mayen, small catches of Greenland halibut have been taken in some years. In the period 1992–97 the reported annual catches were 56 t, 0, 140 t, 270 t, 59 t, and 54 t respectively. In the period 1998 – 1999 no catches were reported from this area. In the period 2000 - 2003 catches in this area were around 60 t or lower. Jan Mayen is within Subarea IIa, but little is known about the relationship with the stock assessed by the Arctic Fisheries Working Group. Catches from this area have therefore not been included in the catches given for Subarea II.

8.1.2 Expected landings in 2004

The fishery for Greenland halibut is regulated by quotas that should be taken by gillnetters and longliners within a restricted time period, and by restricting allowed bycatch in the trawl fishery. The total Norwegian catch in 2004 is expected to be 9,100 t. In addition 4,400 t is expected to be caught by Russian vessels and 500 t by other countries. Expected total landings (officially) for 2004 are thus 14,000 t. It is believed that there may be additional landings that are not reported.

The catches from Division IVa are expected to be maintained at the same level as last year.

8.2 Status of research

8.2.1 Survey results (Tables A14, E1-E8)

Over the last several years the Working Group has been concerned about trends in catchability within individual surveys used for tuning of the XSA. The trends were seen for younger ages of year classes in the late 80’s and early 90’s that were initially estimated very low in abundance. With increasing age these year classes were estimated much closer to the mean abundance. In previous meetings the Working Group therefore increased the lower age used in tuning to five years in order to reduce the problem. This only partly solved the problem though, and in all subsequent assessments estimated recruitment of the last 2-3 years has increased from one year to the next.

Most of the surveys considered by the Working Group in 2003 cover either the adult population in the slope area or juvenile distribution in northern areas. The problem of underestimation of recruitment in the last few years included in the analyses has been attributed to shortcomings in survey coverage. The Working Group has at previous meetings noted the need for annual surveys that sample most of the population within a short period of time. Prior to the 2002 WG meeting effort was therefore made to combine some of these surveys into a new total index. The new index is termed the Norwegian Combined Survey Index and is established back to 1996, the first year with survey coverage northeast of Svalbard. It includes bottom trawls from the Norwegian bottom trawl survey in August in the Barents Sea and Svalbard (Tables E1 and E2), the Norwegian Greenland halibut survey in August along the continental slope (Table E3), and the Norwegian bottom trawl survey in August-September north and east of Svalbard (Table E4). Prior to the meeting in 2003 work was done to evaluate the combination of these survey series into one index and this was reported to the Working Group (Pennington, WD 5#2003). Based on these results it was decided to use the combined index in the years assessment.

The Norwegian Combined Survey Index (Table E5) indicates an increase in the total stock during the last four years. However, there is no clear year class pattern in the data and some ages are consistently underestimated relative to adjacent age groups (e.g. age 9 and partly age 4). The highest indices were observed for age seven, with exception of the three last years when age 1 was most abundant. That indicates that the catchability of younger ages (i.e. those primarily from northern surveys) are not comparable with the older ones (i.e. those primarily from the slope). This is probably a result of pooling different surveys using different gears. These weaknesses reduce the applicability of the combined surveys, and the Working Group advises that further work be done to improve the combined index in the future.

Also in the Russian bottom trawl surveys in October-December (Table E6) it is difficult to identify year classes that appear consistently either strong or weak across ages. In previous Working Group reports this survey series was the one with the clearest and strongest trends in catchability with age in the XSA calibrations. These surveys are important since they usually cover large parts of the total known distribution of the Greenland halibut within 100–900 m depth. During the 2002 survey, however, no observations were available from the Exclusive Economic Zone of Norway (NEEZ). Greenland halibut abundance for 2002 was adjusted therefore assuming the same distribution by area as in 2001. The results of the 2003 survey indicated a drastic decline in abundance and biomass of Greenland halibut in the eastern Norwegian Sea in comparison with previous years, however, in 2003 the survey again had significant limitations (WD#19). Observations on the main spawning grounds were conducted three week later than usual because access to NEEZ was obtained too late (only in December). The number of trawl stations was also insufficient due to the same reason. Much of the work in this area was conducted when peak spawning had been completed and spawning concentrations had already begun to disperse. It is considered that these deficiencies in 2003 survey likely resulted in considerable underestimation of abundance and biomass as well as biased age distribution. It was considered therefore imprudent to use the 2003 data from this survey series in the current assessment.

The Spanish bottom trawl survey (Table E7) shows an increase of Greenland halibut abundance and biomass in the Svalbard-Bear Island area in 2003 after three years with a declining trend. The Norwegian Bottom trawl Survey in the Barents Sea in winter (Table E8) shows no clear trend in the total abundance.

Although representing a larger part of the stock, the new combined survey indices were not successful in establishing consistency in the relative size of year classes at age. Future inclusion of northern parts of the Russian zone may improve the index. Also the joint Russian-Norwegian research program on Greenland halibut may eventually contribute by increasing our understanding of the processes involved. The main objectives are to clarify the migration dynamics of the stock, including vertical distribution and relations with Greenland halibut in other areas. The results may improve both biological sampling and the subsequent assessments.

Abundance indices of 0-group Greenland halibut are shown in Table A14. There has been a significant decrease of this index compared to previous year.

8.2.2 Commercial catch-per-unit-effort (Table 8.6 and E9)

The CPUE from the experimental fishery was found to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1650 kg/h with the highest value in 2003 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series also shows the highest value in 2003.

8.2.3 Age readings

In the current assessment of the Greenland halibut stock, the problem of low abundance at age 9 in the Norwegian data from surveys and catches remains unresolved. Analysis of size composition suggested that the problem is more likely to be related to age reading uncertainties rather than to peculiarities in distribution and migration. At present, work is still underway to address this problem for the future including comparative age reading by Russian and Norwegian experts. Some preliminary results were given to the Working Group, but it is still too early to draw any conclusions. When this work is finished the historical time series will be revised and the results will be submitted to the AFWG meeting for review. The program is planned to come to an end in summer 2005.

8.3 Data used in the assessment

Based on the arguments in Section 8.2.1 the Working Group also this year considers the survey indices for ages below age 5 not appropriate for inclusion in the tuning data. Consequently, a standard XSA was run for age 5 and above.

8.3.1 Catch-at-age (Table 8.7)

The catch-at-age data for 2002 were updated using revised catch figures and revised Norwegian age composition. Catch-at-age data for 2003 were available from both the Norwegian and Russian fisheries. The combined Norwegian and Russian catch-at-age were used to allocate catches from other countries by age groups. Total international catch-at-age is given in Table 8.7. Greenland halibut are usually caught in the range of 3–16 years old, but the catch is mainly dominated by ages 5–10. Generally, fish older than age 10 comprise a very low proportion of the catches. The Working Group noted that similar low numbers of age 9 were observed in the catches.

8.3.2 Weight-at-age (Table 8.8)

For the years 1964-1969 separate weight-at-age data were used for the Norwegian and the Russian catches. Both data sets were mean values for the period and were combined as a weighted average for each year. A constant set of weight-at-age data was used for the total catches in the years 1970–1978. For subsequent years annual estimates were used. The mean weight-at-age in the catch in 2003 (Table 8.8) was calculated as a weighted average of the weight in the catch from Norway and Russia. The weight-at-age in the stock was set equal to the weight-at-age in the catch for all years.

8.3.3 Natural mortality

Natural mortality of Greenland halibut was set to 0.15 for all ages and years. This is the same assumption as was used in previous years.

8.3.4 Maturity-at-age (Tables 8.9)

Annual ogives were derived to estimate the spawning stock biomass based on females only using Russian survey data for the years 1984–2002, except for the year 1991. An average ogive computed for 1984–1987 was applied to 1964–1983. The average of 1990 and 1992 was used to represent the maturity ogive for 1991. For 1984-2002 a three-year running average was applied. In previous assessments a similar procedure using the same data set was implemented but was based on sexes combined. The ogive for 2003 was rejected due to the problems with the Russian survey mentioned above (Section 8.2.1) and the data used was the mean value for 2001 and 2002.

8.3.5 Tuning data

The XSA was run with the same tuning series as used in last year's assessment :

Fleet 4: Experimental commercial fishery CPUE from 1992–2003 for ages 5–14.

Fleet 7: Russian trawl survey from 1992-2002 for ages 5-14. The 2003 data was not included in this series due to the problems mentioned in section 8.2.1

Fleet 8: Norwegian Combined Survey from 1996-2003 for ages 5-15.

8.4 Recruitment indices (Tables A14, E1-E9)

In addition to the indices mentioned in Section 8.3.5, all surveys in Section 8.2.1 may provide information on recruitment. However, because the dynamics of migration and distribution patterns are not well understood for this stock, it is not known which age should be used for a reliable recruitment estimate. As outlined in previous Working Group reports there is no longer evidence for a major recruitment failure in the 1990's. Nevertheless, the relative size of the individual year classes is still poorly estimated, especially at ages below 5 years.

8.5 Methods used in the assessment

8.5.1 VPA and tuning

The Extended Survivors Analysis (XSA) was used to tune the VPA to the fleets as mentioned in Section 8.3.5. The analyses used survivor estimates shrunk towards the mean of the final 2 years and 5 ages and the standard error of the mean to which the estimates were shrunk was set to 0.5. The catchability was considered to be independent of stock size for all ages and independent of age for ages 10 and older. These are the same settings as used in last years assessment.

Input data and diagnostics of the final XSA run are given in Tables 8.7-8.10 and log catchability residuals for the three fleets used in the tuning are shown in Figure 8.1.

8.6 Results of the Assessment

The diagnostics of the assessment indicate that it is generally unbiased, and describes the trend in stock development reasonably well. The survivor estimates for 2004 for most of the important year classes are determined primarily from the tuning fleet data and in most instances each tuning fleet contributes significantly to the determinations with little effect from inclusion of F shrinkage means in the tuning process. Nevertheless, the assessment diagnostics also indicated substantial uncertainties in absolute values of the survivor estimates determined by the analysis shown by instances of very high residuals, large S.E. (log q)'s and low R^2's in the regression statistics for certain fleets and ages.

8.6.1 Results of the VPA (Figure 8.2, Tables 8.11-8.15)

The fishing mortality (F) matrix indicates that historically Greenland halibut were fully recruited to the fishery at approximately age 6–7. Since 1991 the age of full recruitment appears closer to age 10 (Table 8.11). This is likely due to a substantial proportional reduction in trawler effort since 1991 combined with reduced catchability of some year classes in the fishing areas. Trawlers catch more young fish compared to gillnetters and longliners. Nevertheless, F on ages 6–10 continues to represent the average fishing mortality on the major age groups procecuted by the fishery.

Until 1976 the female spawning stock varied between 60,000 and 140,000 t, then it was relatively stable at around 40,000 t until the late 1980's after which it declined markedly. It reached an all time low of 14,000 t by 1995-96 but has been increasing since then to an estimate of 27,000 by 2003, the highest estimated since the late 1980's. .

Prior to the reduction in the early 1990's the fishing mortality had increased continuously for more than a decade and peaked in 1991 at 0.66. After the reduction the fishing mortality has averaged around 0.3. The high catch in 1999 resulted in an increase in fishing mortality to 0.40 but since then has declined to 0.21 by 2003, the lowest value estimated for the last 20 years.

Recruitment-at-age 5 has been relatively low in recent years compared to the long term average, and since 1990 lower than in all previous years. Nevertheless, the reduction is not especially dramatic and the 1990-2003 average is about 80% of the average during the 1980's.

8.6.2 Biological reference points

Given the continuing levels of uncertainty in the current assessment no further attempts were made to develop reference points for this stock.

8.6.3 Catch options for 2004

Given the uncertainty around the absolute values of population size at age no catch options are provided.

8.7 Comparison of this years assessment with last years assessment

Compared to last years assessment fishing mortality for 2003 remains the same, however some reduction in stock size is indicated.

	Total stock (5+) by 1 January 2003	SSB by 1 January 2003	F6-10 in 2003	F6-10 in 2002
WG 2003	87378	31556	0.21*	0.20
WG 2004	80084	26991	0.21	0.23

*prediction

8.8 Comments to the assessment

The current assessment was conducted using input data and settings similar to previous years, however, the 2003 results from the Russian survey was not used for reasons stated above (section 8.2.1). The assessment is considered uncertain due to age-reading problems yet to be resolved. Despite the continuing uncertainties in the assessment of this stock as noted above, the current analysis indicated similar trends in F and stock size as observed in the 2003 assessment (see Figure 8.3).

Table 8.1 GREENLAND HALIBUT in Sub-areas I and II.
Nominal catch (t) by countries (Subarea I,Divisions IIa and IIb combined) as officially reported to ICES.

Year	Den-mark	Est onia	Faroe Isl.	France	Fed. Rep. Germ any	Gre enl.	Ice land	Ire land	Lithu ania	Norway	Pola nd	Portu gal	Rus sia[3]	Spain	UK (Engl. & Wales)	UK (Scot land)	Total
1984	0	0	0	138	2 165	0	0	0	0	4 376	0	0	15 181	0	23	0	21 883
1985	0	0	0	239	4 000	0	0	0	0	5 464	0	0	10 237	0	5	0	19 945
1986	0	0	42	13	2 718	0	0	0	0	7 890	0	0	12 200	0	10	2	22 875
1987	0	0	0	13	2 024	0	0	0	0	7 261	0	0	9 733	0	61	20	19 112
1988	0	0	186	67	744	0	0	0	0	9 076	0	0	9 430	0	82	2	19 587
1989	0	0	67	31	600	0	0	0	0	10 622	0	0	8 812	0	6	0	20 138
1990	0	0	163	49	954	0	0	0	0	17 243	0	0	4 764 [2]	0	10	0	23 183
1991	11	2564	314	119	101	0	0	0	0	27 587	0	0	2 490 [2]	132	0	2	33 320
1992	0	0	16	111	13	13	0	0	0	7 667	0	31	718	23	10	0	8 602
1993	2	0	61	80	22	8	56	0	30	10 380	0	43	1 235	0	16	0	11 933
1994	4	0	18	55	296	3	15	5	4	8 428	0	36	283	1	76	2	9 226
1995	0	0	12	174	35	12	25	2	0	9 368	0	84	794	1 106	115	7	11 734
1996	0	0	2	219	81	123	70	0	0	11 623	0	79	1 576	200	317	57	14 347
1997	0	0	27	253	56	0	62	2	0	7 661	12	50	1 038	157 [2]	67	25	9 410
1998	0	0	57	67	34	0	23	2	0	8 435	31	99	2 659	259 [2]	182	45	11 893
1999	0	0	94	0	34	38	7	2	0	15 004	8	49	3 823	319 [2]	94	45	19 517
2000 [1]	0	0	0	45	15	0	16	1	0	9 083	3	37	4 568	375 [2]	111	43	14 297
2001 [1]	0	0	0	122	58	0	9	1	0	10 896 [2]	2	35	4 694	418 [2]	100	30	16 365
2002 [1]	0	219	0	7	42	22	4	6	0	7 011 [2]	5	14	5 584	178 [2]	41	28	13 161
2003 [1]	0	0	0	2	18	0	2	0	0	8 303 [2]	5	20	4 384	169 [2]	41	58	13 002

[1] Provisional figures.
[2] Working Group figures.
[3] USSR prior to 1991.

Table 8.2 GREENLAND HALIBUT in Sub-areas I and II. Nominal catch (t) by countries in Sub-area I as officially reported to ICES.

Year	Estonia	Faroe Islands	Fed. Rep. Germany	Greenland	Iceland	Norway	Poland	Russia[3]	Spain	UK (England & Wales)	UK (Scotland)	Total
1984	-	-	-		-	593	-	81	-	17	-	691
1985	-	-	-		-	602	-	122	-	1	-	725
1986	-	-	1		-	557	-	615	-	5	1	1 179
1987	-	-	2		-	984	-	259	-	10	+	1 255
1988	-	9	4		-	978	-	420	-	7	-	1 418
1989	-	-	-		-	2039	-	482	-	+	-	2 521
1990	-	7	-		-	1304	-	321 [2]	-	-	-	1 632
1991	164	-	-		-	2 029	-	522 [2]	-	-	-	2 715
1992	-	-	+	-	-	2 349	-	467	-	-	-	2 816
1993	-	32	-	-	56	1 754	-	867	-	-	-	2 709
1994	-	17	217	-	15	1 165	-	175	-	+	-	1 589
1995	-	12	-	-	25	1 352	-	270	84	-	-	1 743
1996	-	2	+	-	70	911	-	198	-	+	-	1 181
1997	-	15	-	-	62	610	-	170	-	+	-	857
1998	-	47	+	-	23	859	-	491	-	2	-	1 422
1999	-	91	-	13	7	1101	-	1203	-	+	-	2 415
2000 [1]	-	-	+	-	16	1021	+	1169	-	+	-	2 206
2001 [1]	-	-	-	-	9	925 [2]	+	951	-	2	-	1 887
2002 [1]	-	-	3	-	+	791 [2]	-	1167	-	-	-	1 961
2003 [1]	-	-	-	-	1	937 [2]	1	735	-	-	+	1 674

[1] Provisional figures.

[2] Working Group figures.

[3] USSR prior to 1991.

Table 8.3. GREENLAND HALIBUT in Sub areas I and II. Nominal catch (t) by countries in Division IIa as officially reported to ICES.

Year	Estonia	Faroe Islands	France	Fed. Rep. Germ.	Green-land	Ire-land	Icela nd	Norway	Portu-gal	Russia[5]	Spain	UK (Engl. & Wales)	UK (Scot-land)	Total
1984		-	138	265	-	-		3 703	-	5 459	-	1	-	9 566
1985		-	239	254	-	-		4 791	-	6 894	-	2	-	12 180
1986		6	13	97	-	-		6 389	-	5 553	-	5	1	12 064
1987		-	13	75	-	-		5 705	-	4 739	-	44	10	10 586
1988		177	67	150	-	-		7 859	-	4 002	-	56	2	12 313
1989		67	31	104	-	-		8 050	-	4 964	-	6	-	13 222
1990		133	49	12	-	-		8 233	-	1 246 [2]	-	1	-	9 674
1991	1 400	314	119	21	-	-		11 189	-	305 [2]	-	+	1	13 349
1992	-	16	108	1	13 [4]	-		3 586	15 [3]	58	-	1	-	3 798
1993	-	29	78	14	8 [4]	-		7 977	17	210	-	2	-	8 335
1994	-	-	47	33	3 [4]	4		6 382	26	67	+	14	-	6 576
1995	-	-	174	30	12 [4]	2		6 354	60	227	-	83	2	6 944
1996	-	-	219	34	123 [4]	-		9 508	55	466	4	278	57	10 744
1997	-	-	253	23	- [4]	-		5 702	41	334	1	21	25	6 400
1998	-	-	67	16	- [4]	1		6 661	80	530	5	74	41	7 475
1999	-	-	-	20	25 [4]	2		13 064	33	734	1	63	45	13 987
2000 [1]	-	-	43	10	[4]	+		7 536	18	690	1	65	43	8 406
2001 [1]	-	-	122	49	[4]	1	9	8 740 [2]	13	726	5	56	30	9 751
2002 [1]	-	-	7	9	22 [4]	-	4	5 780 [2]	3	849	-	12	28	6 714
2003 [1]	-	-	2	5	-	-	1	6 708 [2]	10	1762	2	6	58	8 554

[1] Provisional figures.

[2] Working Group figure.

[3] As reported to Norwegian authorities.

[4] Includes Division IIb.

[5] USSR prior to 1991.

Table 8.4 GREENLAND HALIBUT in Sub-areas I and II.
Nominal catch (t) by countries in Division IIb as officially reported to ICES.

Year	Denmark	Estonia	Faroe Islands	France	Fed. rep. Germ.	Ireland	Lithuania	Norway	Poland	Portugal	Russia[4]	Spain	UK (Engl. & Wales)	UK (Scotland)	Total
1984	-		-	-	1 900	-		80	-	-	9 641	-	5	-	11 626
1985	-		-	-	3 746	-		71	-	-	3 221	-	2	-	7 040
1986	-		36	-	2 620	-		944	-	-	6 032	-	+	-	9 632
1987	+		-	-	1 947	-		572	-	-	4 735	-	7	10	7 271
1988	-		-	-	590	-		239	-	-	5 008	-	19	+	5 856
1989	-		-	-	496	-		533	-	-	3 366	-	-	-	4 395
1990	-		23 [2]	-	942	-		7 706	-	-	3 197 [2]	-	9	-	11 877
1991	11	1 000	-	-	80	-	-	14 369	-	-	1 663 [2]	132	+	1	17 256
1992	-	-	-	3 [2]	12	-	-	1 732	-	16	193	23	9	-	1 988
1993	2 [3]	-	-	2 [3]	8	-	30 [3]	649	-	26	158	-	14	-	889
1994	4	-	1 [3]	8 [3]	46	1	4 [3]	881	-	10	41	1	62	2	1 061
1995	-	-	-	-	5	-	-	1 662	-	24	297	1022	32	5	3 047
1996	+	-	-	-	47	-	-	1 204	-	24	912	196	39	+	2 422
1997	-	-	12	-	33	2	-	1 349	12	9	534	156 [2]	46	+	2 153
1998	-	-	10	-	18	1	-	915	31	19	1 638	254 [2]	106	4	2 996
1999	-	-	3	-	14	-	-	839	8	16	1 886	318 [2]	31	-	3 115
2000 [1]	-	-		2	5	1	-	526	3	19	2 709	374 [2]	46	-	3 685
2001 [1]	-	-		-	9	-	-	1 231 [2]	2	22	3 017	413 [2]	42	-	4 736
2002 [1]	-	219		-	30	6	-	440 [2]	5	11	3 568	178 [2]	29	-	4 486
2003 [1]	-	-		-	13		-	658 [2]	4	10	1 887	167 [2]	35	-	2 774

[1] Provisional figures.

[2] Working Group figure.

[3] As reported to Norwegian authorities.

[4] USSR prior to 1991.

Table 8.5 GREENLAND HALIBUT in the Sub-areas I and II.
Landings by gear (tonnes). Approximate figures, the total may differ slightly from Table 8.1

Year	Gillnet	Longline	Trawl	Total
1980	1 189	336	11 759	13 284
1981	730	459	13 829	15 018
1982	748	679	15 362	16 789
1983	1 648	1 388	19 111	22 147
1984	1 200	1 453	19 230	21 883
1985	1 668	750	17 527	19 945
1986	1 677	497	20 701	22 875
1987	2 239	588	16 285	19 112
1988	2 815	838	15 934	19 587
1989	1 342	197	18 599	20 138
1990	1 372	1 491	20 325	23 188
1991	1 904	4 552	26 864	33 320
1992	1 679	1 787	5 787	9 253
1993	1 497	2 493	7 889	11 879
1994	1 403	2 392	5 353	9 148
1995	1 500	4 034	5 494	11 028
1996	1 480	4 616	7 977	14 073
1997	998	3 378	5 198	9 574
1998	1 327	3 891	6 664	11 882
1999	2 565	6 804	10 177	19 546
2000	1 707	5 029	7 700	14 437
2001	2 041	6 303	7 968	16 312
2002	1 737	5 309	6 115	13 161
2003	2 046	5 483	5 474	13 003

Table 8.6. GREENLAND HALIBUT in Sub-areas I and II. Catch per unit effort and total effort.

Year	USSR catch/hour trawling (t)		Norway[10] catch/hour trawling (t)		Average CPUE		Total effort (in '000 hrs trawling)[5]	CPUE 7+[6]	GDR[7] (catch/day tonnage (kg)
	RT[1]	PST[2]	A[8]	B[9]	A[3]	B[4]			
1965	0,80	-	-	-	0,80	-	-	-	-
1966	0,77	-	-	-	0,77	-	-	-	-
1967	0,70	-	-	-	0,70	-	-	-	-
1968	0,65	-	-	-	0,65	-	-	-	-
1969	0,53	-	-	-	0,53	-	-	-	-
1970	0,53	-	-	-	0,53	-	169	0,50	-
1971	0,46	-	-	-	0,46	-	172	0,43	-
1972	0,37	-	-	-	0,37	-	116	0,33	-
1973	0,37	-	0,34	-	0,36	-	83	0,36	-
1974	0,40	-	0,36	-	0,38	-	100	0,36	-
1975	0,39	0,51	0,38	-	0,39	0,45	99	0,37	-
1976	0,40	0,56	0,33	-	0,37	0,45	100	0,34	-
1977	0,27	0,41	0,33	-	0,30	0,37	96	0,26	-
1978	0,21	0,32	0,21	-	0,21	0,27	123	0,17	-
1979	0,23	0,35	0,28	-	0,26	0,32	67	0,19	-
1980	0,24	0,33	0,32	-	0,28	0,33	47	0,25	-
1981	0,30	0,36	0,36	-	0,33	0,36	42	0,28	-
1982	0,26	0,45	0,41	-	0,34	0,43	39	0,37	-
1983	0,26	0,40	0,35	-	0,31	0,38	58	0,32	-
1984	0,27	0,41	0,32	-	0,30	0,37	59	0,30	-
1985	0,28	0,52	0,37	-	0,33	0,45	44	0,37	-
1986	0,23	0,42	0,37	-	0,30	0,40	57	0,32	-
1987	0,25	0,50	0,35	-	0,30	0,43	44	0,35	-
1988	0,20	0,30	0,31	-	0,26	0,31	63	0,26	4,26
1989	0,20	0,30	0,26	-	0,23	0,28	73	0,19	2,95
1990	-	0,20	0,27	-	-	0,24	95	0,16	1,66
1991	-	-	0,24	-	-	-	134	0,18	-
1992	-	-	0,46	0,72	-	-	20	0,29	-
1993	-	-	0,79	1,22	-	-	15	0,65	-
1994	-	-	0,77	1,27	-	-	11	0,70	-
1995	-	-	1,03	1,48	-	-	-	-	-
1996	-	-	1,45	1,82	-	-	-	-	-
1997	0,71	-	1,23	1,60	-	-	-	-	-
1998	0,71	-	0,98	1,35	-	-	-	-	-
1999	0,84	-	0,82	1,77	-	-	-	-	-
2000	0,94	-	1,38	1,92	-	-	-	-	-
2001	0,82 [11]	-	1,18	1,57	-	-	-	-	-
2002	0,85	-	1,07	1,82	-	-	-	-	-
2003	0,97 [12]	-	0,86	2,45	-	-	-	-	-

[1] Side trawlers, 800-1000 hp. From 1983 onwards, side trawlers (SRTM), 1,000 hp. From 1997 based on research fishing.
[2] Stern trawlers, up to 2,000 HP.
[3] Arithmetic average of CPUE from USSR RT (or SRTM trawlers) and Norwegian trawlers.
[4] Arithmetic average of CPUE from USSR PST and Norwegian trawlers.
[5] For the years 1981-1990, based on average CPUE type B. For 1991-1993, based on the Norwegian CPUE, type A.
[6] Total catch (t) of seven years and older fish divided by total effort.
[7] For the years 1988-1989, frost-trawlers 995 BRT (FAO Code 095). For 1990, factory trawlers FVS IV, 1943 BRT (FAO Code 090).
[8] Norwegian trawlers, ISSCFV-code 07, 250-499.9 GRT.
[9] Norwegian factory trawlers, ISSCFV-code 09, 1000-1999.9 GRT
[10] From 1992 based on research fishing. 1992-1993: two weeks in May/June and October; 1994-1995: 10 days in May/June
[11] Based on fishery from april-october only, a period with relatively low CPUE. In previous years fishery was carried out throughout the whole year.
[12] Based on fishery from october-december only, a period with relatively high CPUE.

Table 8.7

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

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

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
5,	372,	253,	170,	156,	114,	1064,	526,	80,	1109,	212,
6,	1480,	853,	563,	332,	283,	2420,	2792,	4486,	3521,	1117,
7,	2808,	1735,	1106,	623,	452,	3208,	10464,	12712,	9605,	3923,
8,	5674,	3868,	2715,	2006,	1976,	6288,	18562,	12283,	6438,	3515,
9,	4951,	4203,	4054,	3237,	3923,	4921,	10034,	6130,	2775,	2551,
10,	3981,	3799,	2499,	2409,	2950,	4431,	6671,	4339,	1734,	1919,
11,	1853,	1799,	1284,	1718,	2234,	2381,	2517,	2703,	1368,	1536,
12,	1018,	1002,	783,	871,	792,	812,	1250,	1660,	1234,	1127,
13,	364,	372,	246,	315,	146,	229,	616,	1044,	675,	716,
14,	251,	282,	261,	155,	43,	100,	1104,	300,	200,	251,
+gp,	76,	50,	28,	19,	7,	30,	281,	143,	80,	126,
0 TOTALNUM,	22828,	18216,	13709,	11841,	12920,	25884,	54817,	45880,	28739,	16993,
TONSLAND,	40391,	34751,	26321,	24267,	26168,	43789,	89484,	79034,	43055,	29938,
SOPCOF %,	100,	100,	101,	100,	100,	103,	94,	104,	98,	92,

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

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
5,	917,	840,	830,	2037,	1897,	2218,	731,	1896,	1304,	1543,
6,	2519,	2337,	2982,	3255,	3589,	3155,	1138,	1917,	1494,	1864,
7,	6204,	6520,	5824,	4200,	4118,	2727,	1665,	1919,	1276,	1851,
8,	3838,	4118,	5002,	2524,	2365,	1234,	1341,	933,	1208,	2287,
9,	1834,	2265,	3000,	1610,	1509,	495,	944,	484,	1493,	1491,
10,	1942,	1654,	1350,	1104,	946,	319,	473,	448,	1258,	1228,
11,	1622,	1857,	915,	1062,	934,	296,	511,	482,	838,	713,
12,	1338,	1536,	1212,	858,	438,	243,	275,	380,	502,	488,
13,	734,	1122,	698,	595,	349,	103,	242,	384,	324,	247,
14,	531,	600,	526,	384,	147,	45,	145,	150,	108,	201,
+gp,	216,	368,	358,	180,	112,	51,	78,	62,	46,	64,
0 TOTALNUM,	21695,	23217,	22697,	17809,	16404,	10886,	7543,	9055,	9851,	11977,
TONSLAND,	37763,	38172,	36074,	28827,	24617,	17312,	13284,	15018,	16789,	22147,
SOPCOF %,	98,	88,	93,	101,	105,	104,	109,	107,	100,	98,

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
5,	915,	1219,	1672,	1212,	907,	2080,	2139,	3312,	1098,	1140,
6,	3698,	2874,	3335,	2972,	2540,	4453,	5163,	3889,	1195,	1088,
7,	3350,	2561,	2712,	3572,	3141,	3655,	4642,	4716,	1069,	1608,
8,	1938,	1548,	1531,	1746,	2096,	1657,	1932,	2355,	778,	1118,
9,	1064,	972,	1128,	752,	1182,	801,	1221,	1031,	360,	140,
10,	1191,	1037,	997,	828,	860,	318,	499,	1284,	600,	976,
11,	602,	614,	530,	362,	481,	228,	264,	774,	188,	444,
12,	340,	363,	434,	202,	313,	126,	314,	673,	150,	144,
13,	171,	161,	314,	186,	133,	120,	42,	177,	79,	36,
14,	132,	120,	305,	63,	140,	140,	96,	266,	89,	20,
+gp,	71,	63,	239,	7,	47,	28,	44,	517,	56,	4,
0 TOTALNUM,	13472,	11532,	13197,	11902,	11840,	13606,	16356,	18994,	5662,	6718,
TONSLAND,	21883,	19945,	22875,	19112,	19587,	20138,	23183,	33320,	8602,	11933,
SOPCOF %,	100,	99,	98,	101,	100,	103,	102,	105,	95,	102,

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
5,	631,	846,	1034,	330,	359,	433,	380,	441,	277,	372,
6,	708,	992,	2083,	921,	1116,	1905,	735,	1347,	921,	1067,
7,	1252,	1719,	3795,	1822,	2466,	3955,	1926,	2338,	1475,	1806,
8,	817,	990,	1426,	953,	1464,	1810,	1464,	1325,	983,	897,
9,	310,	405,	262,	342,	527,	914,	743,	788,	631,	605,
10,	642,	726,	655,	822,	924,	1905,	1318,	1140,	1097,	1003,
11,	416,	461,	270,	231,	237,	380,	457,	519,	563,	500,
12,	330,	371,	132,	150,	122,	237,	330,	372,	301,	297,
13,	88,	154,	29,	18,	15,	67,	49,	115,	132,	76,
14,	39,	56,	22,	41,	29,	42,	37,	54,	59,	103,
+gp,	3,	8,	1,	1,	15,	7,	14,	12,	42,	23,
0 TOTALNUM,	5236,	6728,	9709,	5631,	7274,	11655,	7453,	8451,	6481,	6749,
TONSLAND,	9226,	11734,	14347,	9410,	11893,	19517,	14437,	16307,	13161,	13003,
SOPCOF %,	99,	101,	101,	99,	100,	102,	101,	100,	100,	99,

Table 8.8

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

Table 2 Catch weights at age (kg)

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,

AGE										
5,	.4200,	.4200,	.4200,	.4200,	.4200,	.4200,	.5670,	.5670,	.5670,	.5670,
6,	.6400,	.6400,	.6400,	.6500,	.6600,	.6400,	.7370,	.7370,	.7370,	.7370,
7,	.9000,	.9000,	.9100,	.9300,	.9600,	.9100,	1.0790,	1.0790,	1.0790,	1.0790,
8,	1.2000,	1.2200,	1.2400,	1.2700,	1.3100,	1.2500,	1.4210,	1.4210,	1.4210,	1.4210,
9,	1.6300,	1.6600,	1.7000,	1.7100,	1.7400,	1.6400,	1.8480,	1.8480,	1.8480,	1.8480,
10,	2.2600,	2.2300,	2.2200,	2.2000,	2.1900,	2.2500,	2.2810,	2.2810,	2.2810,	2.2810,
11,	3.1100,	3.0000,	2.9400,	2.8400,	2.7900,	2.9900,	2.8870,	2.8870,	2.8870,	2.8870,
12,	3.7400,	3.4900,	3.3900,	3.3000,	3.1900,	3.6300,	3.2470,	3.2470,	3.2470,	3.2470,
13,	4.5700,	4.4000,	4.3800,	4.2700,	4.2700,	4.6800,	4.3030,	4.3030,	4.3030,	4.3030,
14,	5.0100,	4.9100,	4.8400,	4.8800,	5.0000,	5.3800,	4.9310,	4.9310,	4.9310,	4.9310,
+gp,	5.9400,	5.8900,	5.8800,	5.8000,	5.9900,	5.9900,	5.7940,	5.8410,	6.0370,	6.0060,
0 SOPCOFAC,	.9986,	1.0046,	1.0054,	1.0024,	.9994,	1.0262,	.9436,	1.0434,	.9752,	.9231,

Table 2 Catch weights at age (kg)

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
5,	.5670,	.5670,	.5670,	.5670,	.5670,	.9000,	.7020,	.6600,	.6900,	.7500,
6,	.7370,	.7370,	.7370,	.7370,	.7370,	1.2000,	.8720,	.8400,	.8400,	1.0400,
7,	1.0790,	1.0790,	1.0790,	1.0790,	1.0790,	1.5000,	1.1410,	1.1500,	1.0300,	1.3400,
8,	1.4210,	1.4210,	1.4210,	1.4210,	1.4210,	1.8000,	1.4680,	1.5600,	1.3100,	1.5700,
9,	1.8480,	1.8480,	1.8480,	1.8480,	1.8480,	2.2000,	1.7780,	2.0400,	1.7400,	1.9700,
10,	2.2810,	2.2810,	2.2810,	2.2810,	2.2810,	2.6000,	2.3020,	2.5700,	2.2400,	2.7300,
11,	2.8870,	2.8870,	2.8870,	2.8870,	2.8870,	3.0000,	2.6640,	2.9800,	2.7700,	3.2900,
12,	3.2470,	3.2470,	3.2470,	3.2470,	3.2470,	3.5000,	3.0460,	3.4300,	3.3700,	4.2200,
13,	4.3030,	4.3030,	4.3030,	4.3030,	4.3030,	4.1000,	3.3680,	4.1300,	4.3200,	4.7100,
14,	4.9310,	4.9310,	4.9310,	4.9310,	4.9310,	4.8000,	4.2850,	4.6800,	5.3500,	6.0800,
+gp,	5.9640,	5.9100,	5.9230,	6.0270,	5.9060,	6.1760,	5.3460,	5.9990,	5.8330,	6.1220,
0 SOPCOFAC,	.9825,	.8805,	.9255,	1.0095,	1.0485,	1.0364,	1.0894,	1.0680,	1.0038,	.9783,

Table 2 Catch weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
5,	.6300,	.6000,	.6200,	.7090,	.7400,	.7600,	.7100,	.7700,	.6800,	.7900,
6,	.9600,	.8900,	.9200,	1.0030,	.9620,	1.0300,	1.0600,	1.0500,	.9700,	1.0200,
7,	1.1800,	1.2000,	1.2800,	1.2660,	1.2490,	1.3200,	1.2900,	1.3800,	1.2700,	1.3500,
8,	1.5300,	1.8500,	1.9000,	1.6830,	1.6260,	1.8000,	1.7000,	1.7500,	1.7600,	1.8800,
9,	2.3100,	2.5900,	2.4800,	2.4820,	2.1640,	2.4200,	2.1000,	2.2000,	2.2100,	2.4600,
10,	2.8700,	3.1800,	3.1100,	2.9820,	2.8970,	3.1300,	2.6100,	2.6000,	2.5600,	2.6700,
11,	3.4600,	3.6200,	3.3500,	3.5470,	3.4060,	3.3700,	2.8700,	2.7900,	3.1100,	3.4300,
12,	3.7700,	3.9500,	3.7200,	3.8000,	3.6610,	4.0500,	3.4500,	3.2800,	3.5900,	4.2900,
13,	3.9900,	4.4800,	4.0000,	4.5600,	4.2470,	4.2900,	3.7200,	3.8900,	3.8300,	5.0800,
14,	4.3500,	4.2500,	4.1800,	5.0020,	4.1870,	4.5000,	4.0900,	4.3800,	4.2500,	6.3300,
+gp,	4.5250,	4.8250,	4.5260,	5.9530,	4.4630,	4.7200,	4.5200,	5.2900,	4.8000,	8.9100,
0 SOPCOFAC,	1.0009,	.9858,	.9782,	1.0116,	.9973,	1.0346,	1.0204,	1.0470,	.9519,	1.0183,

Table 2 Catch weights at age (kg)

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
5,	.7200,	.7300,	.7700,	.7700,	.7300,	.7000,	.7600,	.7400,	.6900,	.7400,
6,	.9400,	.9400,	.9700,	.9400,	.9300,	.9500,	.9700,	1.0300,	.9400,	1.0500,
7,	1.2700,	1.2500,	1.3100,	1.2800,	1.3000,	1.2700,	1.3300,	1.3900,	1.3600,	1.4200,
8,	1.7200,	1.7400,	1.7400,	1.6400,	1.6100,	1.5500,	1.6300,	1.7500,	1.6800,	1.7400,
9,	2.1900,	2.0900,	2.2400,	2.0700,	2.1200,	2.0000,	2.1100,	2.2900,	2.1800,	2.3000,
10,	2.5200,	2.5100,	2.5900,	2.5900,	2.5700,	2.4600,	2.6100,	2.6800,	2.6800,	2.6100,
11,	2.9700,	2.9500,	3.2900,	3.3000,	3.2500,	3.2200,	3.3500,	3.3300,	3.1900,	3.0200,
12,	3.2900,	3.3400,	4.0200,	4.0100,	3.9100,	3.8500,	3.9700,	3.9200,	3.8900,	3.6700,
13,	3.8400,	3.8300,	4.7500,	4.8300,	4.9000,	4.6100,	4.9700,	4.8100,	4.4600,	4.7000,
14,	4.9500,	4.9800,	6.2400,	5.9500,	5.6600,	5.8400,	5.8200,	5.8100,	5.2500,	5.5100,
+gp,	6.6800,	8.1500,	6.0900,	6.2600,	4.9100,	5.9800,	7.2200,	7.4100,	6.3200,	6.1600,
0 SOPCOFAC,	.9937,	1.0095,	1.0066,	.9851,	.9983,	1.0172,	1.0055,	1.0014,	1.0000,	.9853,

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Table 8.9

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

Table 5 Proportion mature at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
8,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,
9,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,
10,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,
11,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
12,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	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

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
8,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,	.1800,
9,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6700,	.6000,
10,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8600,	.8200,
11,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9600,
12,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,	.9800,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,
6,	.0400,	.0400,	.0300,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
7,	.0300,	.0400,	.0300,	.0200,	.0100,	.0200,	.0200,	.0400,	.0600,	.0800,
8,	.1800,	.1900,	.2400,	.2200,	.2100,	.1800,	.1700,	.1500,	.2800,	.3200,
9,	.6100,	.6500,	.7400,	.6600,	.5300,	.4900,	.5100,	.5400,	.6600,	.6800,
10,	.8300,	.8500,	.9100,	.9000,	.8700,	.8000,	.7700,	.7700,	.8600,	.8300,
11,	.9700,	.9700,	.9900,	.9500,	.8900,	.8900,	.9100,	.8900,	.8700,	.8800,
12,	.9800,	.9900,	.9800,	.9800,	.9800,	1.0000,	1.0000,	1.0000,	1.0000,	.9400,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
5,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0200,	.0200,
6,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0100,	.0300,	.0400,	.0400,
7,	.0700,	.0800,	.0700,	.0700,	.0400,	.0200,	.0300,	.0600,	.0900,	.0900,
8,	.3400,	.2900,	.2500,	.2100,	.1000,	.0700,	.1000,	.1900,	.2600,	.2600,
9,	.6900,	.5800,	.5800,	.5300,	.4500,	.3300,	.3700,	.4900,	.6300,	.6300,
10,	.8100,	.7900,	.8800,	.8500,	.8200,	.6600,	.6300,	.6500,	.7200,	.7200,
11,	.9500,	.9600,	.9700,	.9400,	.9200,	.8600,	.8700,	.8400,	.9100,	.9100,
12,	.9400,	.8900,	.9400,	.9400,	1.0000,	.9900,	.9600,	.9600,	.9600,	.9600,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	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,

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Table 8.10

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

Arctic Green.halibut (run: XSAAAG47/X47)

CPUE data from file fleet

Catch data for 40 years. 1964 to 2003. Ages 5 to 15.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT04: Norw. Exp. CP,	1992,	2003,	5,	14,	.380,	.440
FLT07: Russ.Surv. ne,	1992,	2003,	5,	14,	.750,	.920
FLT08: Norw.Comb.Sur,	1996,	2003,	5,	14,	.550,	.720

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 10

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 2 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 50 iterations

Regression weights

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

Fishing mortalities

Age,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
5,	.038,	.056,	.068,	.021,	.025,	.033,	.027,	.035,	.019,	.024
6,	.080,	.074,	.181,	.076,	.085,	.167,	.069,	.122,	.090,	.089
7,	.262,	.267,	.417,	.225,	.283,	.455,	.240,	.309,	.180,	.242
8,	.308,	.321,	.349,	.163,	.269,	.326,	.285,	.244,	.194,	.150
9,	.171,	.233,	.124,	.124,	.121,	.253,	.203,	.230,	.166,	.166
10,	.535,	.711,	.680,	.656,	.534,	.778,	.660,	.514,	.543,	.406
11,	.518,	.893,	.593,	.510,	.371,	.411,	.398,	.558,	.488,	.482
12,	.848,	1.214,	.654,	.740,	.524,	.739,	.721,	.620,	.701,	.487
13,	.607,	1.287,	.242,	.158,	.136,	.580,	.305,	.558,	.437,	.354
14,	.659,	.962,	.572,	.598,	.387,	.643,	.701,	.610,	.589,	.688

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Table 8.10 (Continued)

XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12	13	14
1994	1.81E+04	9.95E+03	5.86E+03	3.32E+03	2.12E+03	1.67E+03	1.11E+03	6.22E+02	2.08E+02	8.71E+01
1995	1.67E+04	1.50E+04	7.91E+03	3.88E+03	2.10E+03	1.54E+03	8.41E+02	5.69E+02	2.29E+02	9.77E+01
1996	1.68E+04	1.36E+04	1.20E+04	5.21E+03	2.42E+03	1.43E+03	6.50E+02	2.96E+02	1.45E+02	5.45E+01
1997	1.75E+04	1.35E+04	9.74E+03	6.81E+03	3.16E+03	1.84E+03	6.23E+02	3.09E+02	1.33E+02	9.82E+01
1998	1.59E+04	1.48E+04	1.08E+04	6.69E+03	4.98E+03	2.41E+03	8.23E+02	3.22E+02	1.27E+02	9.74E+01
1999	1.42E+04	1.34E+04	1.17E+04	7.01E+03	4.40E+03	3.80E+03	1.21E+03	4.89E+02	1.64E+02	9.54E+01
2000	1.51E+04	1.18E+04	9.73E+03	6.37E+03	4.35E+03	2.94E+03	1.50E+03	6.93E+02	2.01E+02	7.91E+01
2001	1.38E+04	1.27E+04	9.49E+03	6.59E+03	4.13E+03	3.06E+03	1.31E+03	8.68E+02	2.90E+02	1.27E+02
2002	1.60E+04	1.15E+04	9.65E+03	6.00E+03	4.44E+03	2.82E+03	1.57E+03	6.44E+02	4.02E+02	1.43E+02
2003	1.71E+04	1.35E+04	9.04E+03	6.94E+03	4.25E+03	3.24E+03	1.41E+03	8.31E+02	2.75E+02	2.23E+02

Estimated population abundance at 1st Jan 2004

	0.00E+00	1.43E+04	1.06E+04	6.11E+03	5.14E+03	3.10E+03	1.86E+03	7.50E+02	4.40E+02	1.66E+02

Taper weighted geometric mean of the VPA populations:

	1.55E+04	1.24E+04	9.11E+03	5.56E+03	3.43E+03	2.35E+03	1.08E+03	5.47E+02	2.26E+02	1.26E+02

Standard error of the weighted Log(VPA populations) :

	.1576	.2112	.2509	.2734	.3096	.3058	.3341	.4321	.5197	.6576

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992	1993
5	.01	.58
6	-.30	-.05
7	-.62	-.04
8	-.25	.12
9	-1.34	-1.30
10	-.64	-.10
11	-.41	-.33
12	-.09	-.38
13	-.54	-.25
14	-1.52	-.42

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5	.33	.52	.78	.76	-.76	-.44	.10	-.55	-.45	-.41
6	.09	-.20	.70	.14	-.13	-.06	-.01	-.09	-.14	-.03
7	-.01	-.01	.22	.00	.00	-.08	.36	-.20	.19	-.05
8	.22	.23	.12	-.27	-.07	-.12	.06	.50	-.06	-.47
9	-.81	.41	-.09	.13	-.07	-.87	.42	.83	.69	.87
10	.11	.57	-.16	.30	-1.22	.04	.39	-.06	.26	.30
11	-.40	.04	-.83	.37	-1.16	-1.28	-1.29	-.60	-.57	.17
12	-1.02	.01	-.87	.33	-1.00	.40	-.22	-.22	-.24	.40
13	-.94	-.35	99.99	.02	99.99	-.71	.23	-.88	-1.66	.47
14	-.74	-.03	-.30	-.19	99.99	-.14	99.99	-.45	.12	-.06

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

Age	5	6	7	8	9	10	11	12	13	14
Mean Log q	-4.7680	-3.9444	-3.1227	-3.6349	-4.6423	-3.3979	-3.3979	-3.3979	-3.3979	-3.3979
S.E(Log q)	.5623	.2487	.2244	.2707	.7706	.4965	.8090	.5669	.8283	.5395

Table 8.10 (Continued)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5,	.54,	.639,	7.02,	.18,	12,	.31,	-4.77,
6,	.80,	.618,	5.06,	.52,	12,	.20,	-3.94,
7,	.71,	1.593,	4.87,	.78,	12,	.15,	-3.12,
8,	1.37,	-.882,	1.81,	.40,	12,	.37,	-3.63,
9,	.50,	1.366,	6.38,	.47,	12,	.37,	-4.64,
10,	.97,	.054,	3.52,	.31,	12,	.51,	-3.40,
11,	1.72,	-.762,	1.77,	.12,	12,	1.01,	-3.94,
12,	.73,	.865,	4.31,	.55,	12,	.38,	-3.62,
13,	6.62,	-1.350,	-4.61,	.01,	10,	4.21,	-3.86,
14,	1.04,	-.113,	3.67,	.51,	10,	.47,	-3.71,

1

Fleet : FLT07: Russ.Surv. ne

Age	1992	1993
5	1.73	.59
6	.74	.44
7	.38	.41
8	.17	.15
9	-.73	-.16
10	-.60	-.17
11	.21	-.30
12	.12	.24
13	-.58	-.47
14	-5.12	.59

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5	-.11	-.55	-.40	-.98	-.23	-.37	.15	.73	.09	99.99
6	.04	-.34	-.12	-.64	-.47	-.53	-.25	.60	.83	99.99
7	-.08	-.10	-.04	-.30	-.30	-.40	-.13	.35	.42	99.99
8	-.11	.14	.02	-.20	-.02	-.11	.23	-.25	.09	99.99
9	-.09	.23	.66	-.23	.06	.10	.21	-.05	-.27	99.99
10	.13	.07	-.97	-.14	.07	-.02	.31	.26	.68	99.99
11	-.61	-.16	-.77	.21	.63	-.32	.44	.39	-.29	99.99
12	-.19	-.03	-.92	-.47	.51	.19	.54	.76	1.22	99.99
13	-.53	-.37	-.47	.41	.37	.67	-.80	1.19	1.52	99.99
14	.38	-1.82	-.37	-.34	-.25	-.15	.67	.60	-.81	99.99

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

Age ,	5,	6,	7,	8,	9,	10,	11,	12,	13,	14
Mean Log q,	-.3445,	.7194,	1.1055,	1.3408,	.8291,	.5625,	.5625,	.5625,	.5625,	.5625,
S.E(Log q),	.6839,	.5448,	.3160,	.1621,	.3304,	.4486,	.4654,	.6534,	.8354,	1.5317,

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
5,	-.33,	-4.386,	12.70,	.59,	11,	.13,	-.34,
6,	-1.57,	-2.206,	25.28,	.09,	11,	.71,	.72,
7,	2.23,	-1.497,	-13.65,	.16,	11,	.66,	1.11,
8,	1.28,	-1.190,	-4.10,	.71,	11,	.20,	1.34,
9,	1.15,	-.378,	-2.19,	.45,	11,	.40,	.83,
10,	.56,	1.883,	3.09,	.71,	11,	.22,	.56,
11,	.94,	.126,	-.10,	.39,	11,	.46,	.53,
12,	.50,	2.233,	2.70,	.73,	11,	.25,	.77,
13,	.47,	1.720,	2.47,	.58,	11,	.34,	.72,
14,	-.73,	-1.868,	7.96,	.13,	11,	.93,	.11,

1

Table 8.10 (Continued)

Fleet : FLT08: Norw.Comb.Sur

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
5	99.99	99.99	.24	-.05	-.22	-.26	.11	-.06	.09	.15
6	99.99	99.99	.24	.11	-.32	.01	-.14	.04	-.04	.11
7	99.99	99.99	.10	-.08	.04	-.07	-.18	.06	.06	.07
8	99.99	99.99	.33	-.53	-.24	.25	.04	.10	.09	-.05

```
  9 , 99.99, 99.99,  -.09,  -.53,  -.77,  -.34,   .50,   .06,   .61,   .45
 10 , 99.99, 99.99,   .44,   .00,  -.02,   .04,  -.40,   .04,  -.07,   .02
 11 , 99.99, 99.99,  -.24,  -.28,  -.27,  -.68, -1.26,  -.66,  -.08,  -.35
 12 , 99.99, 99.99,  -.02,   .13,   .49,   .51,  -.54,  -.33,   .52,   .16
 13 , 99.99, 99.99,  -.67, -1.33, -3.20,  -.13,  -.80,  -.73,  -.30,   .36
 14 , 99.99, 99.99,  -.04,  -.11,   .15,   .05,  -.61,  -.27,  -.04,  -.44


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

  Age ,         5,        6,        7,        8,        9,       10,       11,       12,       13,       14
Mean Log q,  -.1435,   .4591,  1.1786,   .6567,  -.0054,  1.1004,  1.1004,  1.1004,  1.1004,  1.1004,
S.E(Log q),   .1790,   .1701,   .0989,   .2693,   .5134,   .2244,   .6439,   .4207,  1.4001,   .3187,


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

 5,     .50,    1.323,     4.92,     .55,      8,     .08,    -.14,
 6,    1.09,    -.091,    -1.31,     .16,      8,     .20,     .46,
 7,     .96,     .095,     -.80,     .54,      8,     .10,    1.18,
 8,   -2.79,   -1.317,    35.08,     .02,      8,     .71,     .66,
 9,     .78,     .293,     1.79,     .24,      8,     .43,    -.01,
10,    1.64,   -1.555,    -6.81,     .51,      8,     .33,    1.10,
11,    1.71,   -1.062,    -6.00,     .28,      8,     .65,     .62,
12,    1.48,    -.927,    -4.80,     .39,      8,     .60,    1.21,
13,     .40,    1.768,     3.09,     .60,      8,     .37,     .27,
14,    1.19,    -.635,    -2.01,     .66,      8,     .33,     .93,
1

Terminal year survivor and F summaries :

Age  5   Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT04: Norw. Exp. CP,     9559.,   .588,      .000,    .00,   1,  .160,     .035
FLT07: Russ.Surv. ne,        1.,   .000,      .000,    .00,   0,  .000,     .000
FLT08: Norw.Comb.Sur,    16714.,   .300,      .000,    .00,   1,  .614,     .020

  F shrinkage mean  ,    12636.,    .50,,,,                       .226,     .027

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    14350.,       .24,      .15,    3,    .641,   .024


Age  6   Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT04: Norw. Exp. CP,     9443.,   .267,      .166,    .62,   2,  .330,     .100
FLT07: Russ.Surv. ne,    11639.,   .719,      .000,    .00,   1,  .045,     .082
FLT08: Norw.Comb.Sur,    11782.,   .212,      .010,    .05,   2,  .521,     .081

  F shrinkage mean  ,     8830.,    .50,,,,                       .104,     .106
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Table 8.10 (Continued)

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 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     10624.,       .15,      .07,    6,    .447,   .089


 Age  7   Catchability constant w.r.t. time and dependent on age

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      5305.,   .200,       .104,    .52,   3,  .369,     .274
 FLT07: Russ.Surv. ne,     13451.,   .448,       .049,    .11,   2,  .070,     .117
 FLT08: Norw.Comb.Sur,      6085.,   .174,       .041,    .24,   3,  .482,     .243

   F shrinkage mean  ,      6030.,    .50,,,,                        .079,     .245

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6109.,       .12,      .09,    9,    .710,   .242


1
 Age  8   Catchability constant w.r.t. time and dependent on age

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      4506.,   .168,       .160,    .95,   4,  .369,     .169
 FLT07: Russ.Surv. ne,      7846.,   .268,       .089,    .33,   3,  .135,     .101
 FLT08: Norw.Comb.Sur,      5316.,   .152,       .035,    .23,   4,  .440,     .145

   F shrinkage mean  ,      3382.,    .50,,,,                        .056,     .220

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      5139.,       .10,      .08,   12,    .803,   .150


 Age  9   Catchability constant w.r.t. time and dependent on age

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      2952.,   .166,       .130,    .78,   5,  .320,     .174
 FLT07: Russ.Surv. ne,      3451.,   .203,       .122,    .60,   4,  .221,     .151
 FLT08: Norw.Comb.Sur,      3125.,   .149,       .102,    .69,   5,  .399,     .165

   F shrinkage mean  ,      2551.,    .50,,,,                        .060,     .199

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3099.,       .10,      .06,   15,    .645,   .166

1
 Age 10   Catchability constant w.r.t. time and dependent on age

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,      2439.,   .163,       .143,    .88,   6,  .275,     .323
 FLT07: Russ.Surv. ne,      1452.,   .178,       .046,    .26,   5,  .241,     .495
 FLT08: Norw.Comb.Sur,      1893.,   .139,       .092,    .66,   6,  .415,     .400

   F shrinkage mean  ,      1325.,    .50,,,,                        .069,     .532

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1858.,       .09,      .07,   18,    .803,   .406
```

Table 8.10 (Continued)

```
Age 11   Catchability constant w.r.t. time and age (fixed at the value for age) 10

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT04: Norw. Exp. CP,       844.,   .176,       .104,    .59,   7,  .247,     .438
 FLT07: Russ.Surv. ne,       812.,   .174,       .179,   1.03,   6,  .247,     .452
```

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT08: Norw.Comb.Sur,	684.,	.149,	.055,	.37,	7,	.385,	.518
F shrinkage mean ,	670.,	.50,,,,				.122,	.526

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
750.,	.10,	.06,	21,	.583,	.482

1

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1991

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT04: Norw. Exp. CP,	479.,	.196,	.112,	.57,	8,	.242,	.454
FLT07: Russ.Surv. ne,	407.,	.175,	.105,	.60,	7,	.234,	.517
FLT08: Norw.Comb.Sur,	504.,	.162,	.048,	.30,	8,	.387,	.436
F shrinkage mean ,	292.,	.50,,,,				.137,	.665

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
440.,	.11,	.06,	24,	.529,	.487

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1990

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT04: Norw. Exp. CP,	180.,	.251,	.143,	.57,	9,	.245,	.330
FLT07: Russ.Surv. ne,	229.,	.197,	.184,	.94,	8,	.221,	.268
FLT08: Norw.Comb.Sur,	169.,	.196,	.159,	.81,	8,	.307,	.348
F shrinkage mean ,	109.,	.50,,,,				.227,	.500

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
166.,	.15,	.10,	26,	.641,	.354

1

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1989

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT04: Norw. Exp. CP,	71.,	.268,	.183,	.68,	10,	.220,	.854
FLT07: Russ.Surv. ne,	143.,	.214,	.207,	.96,	9,	.149,	.510
FLT08: Norw.Comb.Sur,	64.,	.224,	.090,	.40,	8,	.403,	.911
F shrinkage mean ,	206.,	.50,,,,				.228,	.381

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
97.,	.16,	.13,	28,	.791,	.688

1

Table 8.11

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

Table 8 Fishing mortality (F) at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
5,	.0094,	.0053,	.0032,	.0024,	.0019,	.0207,	.0139,	.0027,	.0363,	.0074,
6,	.0484,	.0255,	.0138,	.0072,	.0051,	.0484,	.0659,	.1491,	.1510,	.0442,
7,	.1146,	.0699,	.0397,	.0180,	.0116,	.0691,	.2864,	.4473,	.5110,	.2370,
8,	.2531,	.2160,	.1411,	.0891,	.0694,	.2081,	.6556,	.6021,	.4033,	.3335,
9,	.4566,	.2848,	.3476,	.2356,	.2381,	.2332,	.5603,	.4392,	.2444,	.2597,
10,	.7003,	.7254,	.2583,	.3382,	.3302,	.4350,	.5339,	.4739,	.1999,	.2516,
11,	.6375,	.7606,	.5421,	.2684,	.5685,	.4571,	.4457,	.4037,	.2511,	.2585,
12,	.5666,	.8214,	.8585,	.8373,	.1802,	.3905,	.4362,	.5627,	.3063,	.3191,

13,	.4065,	.3910,	.4515,	1.0092,	.2945,	.0686,	.5465,	.7562,	.4414,	.2765,
14,	.5568,	.6004,	.4943,	.5409,	.3237,	.3182,	.5074,	.5302,	.2898,	.2741,
+gp,	.5568,	.6004,	.4943,	.5409,	.3237,	.3182,	.5074,	.5302,	.2898,	.2741,
0 FBAR 6-10,	.3146,	.2643,	.1601,	.1376,	.1309,	.1988,	.4204,	.4223,	.3019,	.2252,

Table 8 Fishing mortality (F) at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
5,	.0378,	.0410,	.0413,	.0973,	.1046,	.1294,	.0433,	.1214,	.0772,	.0916,
6,	.1079,	.1211,	.1895,	.2135,	.2346,	.2396,	.0859,	.1448,	.1258,	.1430,
7,	.3447,	.4197,	.4666,	.4176,	.4305,	.2659,	.1815,	.1933,	.1284,	.2143,
8,	.3623,	.3818,	.6251,	.3558,	.4142,	.2074,	.1912,	.1388,	.1696,	.3358,
9,	.2744,	.3558,	.5001,	.3927,	.3521,	.1333,	.2293,	.0925,	.3240,	.3079,
10,	.3041,	.4017,	.3509,	.3249,	.3981,	.1094,	.1723,	.1533,	.3462,	.4552,
11,	.3298,	.5023,	.3824,	.4848,	.4738,	.1957,	.2424,	.2519,	.4462,	.3180,
12,	.3546,	.5617,	.6829,	.7082,	.3551,	.2024,	.2657,	.2705,	.4256,	.4788,
13,	.3347,	.5355,	.5074,	.8180,	.6673,	.1238,	.3005,	.6807,	.3677,	.3613,
14,	.3208,	.4740,	.4874,	.5490,	.4516,	.1533,	.2429,	.2909,	.3837,	.3861,
+gp,	.3208,	.4740,	.4874,	.5490,	.4516,	.1533,	.2429,	.2909,	.3837,	.3861,
0 FBAR 6-10,	.2787,	.3360,	.4264,	.3409,	.3659,	.1911,	.1720,	.1445,	.2188,	.2912,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
5,	.0570,	.0682,	.0951,	.0696,	.0435,	.1147,	.1734,	.3328,	.1201,	.1010,
6,	.3109,	.2407,	.2542,	.2309,	.1931,	.2927,	.4314,	.5106,	.1810,	.1589,
7,	.3870,	.3473,	.3543,	.4465,	.3840,	.4403,	.5308,	.8498,	.2392,	.3713,
8,	.3436,	.2927,	.3402,	.3828,	.4840,	.3382,	.4150,	.5324,	.2966,	.3981,
9,	.2430,	.2730,	.3394,	.2630,	.4571,	.3236,	.4223,	.3841,	.1334,	.0749,
10,	.4075,	.3731,	.4686,	.4226,	.5104,	.1998,	.3237,	1.0273,	.3807,	.5968,
11,	.3980,	.3585,	.3127,	.2906,	.4385,	.2296,	.2400,	1.1674,	.3640,	.5081,
12,	.2324,	.4192,	.4371,	.1774,	.4136,	.1833,	.5326,	1.6261,	.6900,	.4954,
13,	.2877,	.1554,	.7410,	.3188,	.1608,	.2590,	.0811,	.6173,	.8141,	.3245,
14,	.3150,	.3172,	.4622,	.2957,	.3980,	.2399,	.3213,	.9724,	.6908,	.4617,
+gp,	.3150,	.3172,	.4622,	.2957,	.3980,	.2399,	.3213,	.9724,	.6908,	.4617,
0 FBAR 6-10,	.3384,	.3054,	.3514,	.3492,	.4057,	.3189,	.4247,	.6608,	.2462,	.3200,

Table 8 Fishing mortality (F) at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR **-**
AGE											
5,	.0382,	.0563,	.0685,	.0205,	.0246,	.0334,	.0275,	.0350,	.0189,	.0238,	.0259,
6,	.0798,	.0739,	.1810,	.0762,	.0850,	.1668,	.0694,	.1218,	.0903,	.0891,	.1004,
7,	.2617,	.2669,	.4166,	.2252,	.2826,	.4548,	.2399,	.3086,	.1800,	.2424,	.2437,
8,	.3084,	.3214,	.3493,	.1634,	.2690,	.3264,	.2845,	.2442,	.1943,	.1501,	.1962,
9,	.1714,	.2333,	.1239,	.1238,	.1211,	.2534,	.2034,	.2305,	.1661,	.1665,	.1877,
10,	.5354,	.7108,	.6805,	.6555,	.5341,	.7783,	.6602,	.5145,	.5434,	.4061,	.4880,
11,	.5179,	.8934,	.5933,	.5099,	.3714,	.4115,	.3979,	.5583,	.4878,	.4816,	.5092,
12,	.8481,	1.2141,	.6544,	.7399,	.5245,	.7393,	.7207,	.6202,	.7008,	.4867,	.6026,
13,	.6075,	1.2873,	.2420,	.1583,	.1362,	.5798,	.3050,	.5577,	.4374,	.3536,	.4496,
14,	.6587,	.9622,	.5716,	.5975,	.3871,	.6435,	.7013,	.6101,	.5889,	.6879,	.6290,
+gp,	.6587,	.9622,	.5716,	.5975,	.3871,	.6435,	.7013,	.6101,	.5889,	.6879,	
0 FBAR 6-10,	.2713,	.3212,	.3503,	.2488,	.2584,	.3959,	.2915,	.2839,	.2348,	.2108,	

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Table 8.12

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

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

	YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
	AGE										
	5,	42840,	51686,	57828,	70443,	64280,	55932,	41112,	31550,	33555,	31061,
	6,	33792,	36528,	44251,	49616,	60486,	55221,	47154,	34898,	27081,	27852,
	7,	27961,	27712,	30648,	37565,	42397,	51798,	45284,	37995,	25875,	20042,
	8,	27353,	21461,	22243,	25353,	31755,	36072,	41607,	29268,	20909,	13360,
	9,	14559,	18279,	14883,	16626,	19961,	25498,	25214,	18591,	13796,	12024,
	10,	8521,	7938,	11833,	9049,	11307,	13541,	17381,	12393,	10314,	9300,
	11,	4237,	3641,	3307,	7867,	5554,	6995,	7544,	8771,	6641,	7269,
	12,	2537,	1928,	1465,	1656,	5177,	2707,	3812,	4158,	5042,	4447,
	13,	1175,	1239,	730,	534,	617,	3721,	1577,	2121,	2039,	3195,
	14,	634,	673,	721,	400,	168,	395,	2990,	786,	857,	1128,
	+gp,	190,	118,	77,	49,	27,	118,	756,	372,	341,	564,
0	TOTAL,	163799,	171203,	187987,	219156,	241727,	251998,	234430,	180902,	146450,	130242,

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

	YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
	AGE										
	5,	26642,	22539,	22097,	23686,	20591,	19699,	18600,	17874,	18928,	18995,
	6,	26538,	22080,	18621,	18249,	18497,	15963,	14898,	15331,	13625,	15082,
	7,	22936,	20504,	16836,	13260,	12688,	12591,	10813,	11767,	11417,	10341,
	8,	13611,	13986,	11599,	9088,	7517,	7100,	8307,	7762,	8347,	8643,
	9,	8238,	8154,	8217,	5343,	5480,	4276,	4966,	5906,	5815,	6064,
	10,	7983,	5389,	4917,	4289,	3105,	3317,	3221,	3399,	4634,	3620,
	11,	6224,	5069,	3104,	2980,	2668,	1795,	2559,	2333,	2510,	2822,
	12,	4831,	3852,	2640,	1822,	1579,	1430,	1270,	1729,	1561,	1383,
	13,	2782,	2917,	1891,	1148,	773,	953,	1005,	838,	1135,	878,
	14,	2085,	1713,	1470,	980,	436,	341,	725,	641,	365,	676,
	+gp,	844,	1044,	993,	456,	330,	386,	388,	264,	155,	214,
0	TOTAL,	122714,	107248,	92386,	81302,	73664,	67851,	66752,	67842,	68493,	68717,

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

	YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
	AGE										
	5,	17811,	19922,	19857,	19420,	22952,	20693,	14486,	12610,	10457,	12794,
	6,	14918,	14481,	16016,	15540,	15591,	18913,	15881,	10484,	7781,	7982,
	7,	11252,	9409,	9797,	10691,	10618,	11063,	12148,	8879,	5416,	5589,
	8,	7184,	6576,	5722,	5917,	5888,	6225,	6131,	6149,	3267,	3670,
	9,	5317,	4385,	4224,	3505,	3473,	3123,	3821,	3484,	3108,	2090,
	10,	3836,	3589,	2872,	2589,	2319,	1892,	1945,	2156,	2042,	2341,
	11,	1976,	2197,	2127,	1547,	1461,	1198,	1334,	1211,	664,	1201,
	12,	1767,	1143,	1321,	1339,	996,	811,	820,	903,	324,	397,
	13,	737,	1206,	647,	734,	965,	567,	581,	414,	153,	140,
	14,	527,	476,	888,	265,	460,	708,	377,	461,	192,	58,
	+gp,	282,	249,	691,	29,	153,	141,	172,	885,	120,	12,
0	TOTAL,	65606,	63632,	64164,	61578,	64875,	65334,	57694,	47637,	33525,	36273,

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

	YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	GMST 64-**	AMST 64-**
	AGE													
	5,	18128,	16665,	16843,	17502,	15912,	14199,	15123,	13837,	15975,	17073,	0,	22867,	26030,
	6,	9954,	15018,	13559,	13538,	14758,	13362,	11819,	12664,	11500,	13493,	14350,	19025,	22053,
	7,	5860,	7911,	12005,	9738,	10797,	11667,	9734,	9491,	9650,	9044,	10624,	14448,	17434,
	8,	3318,	3883,	5214,	6812,	6691,	7006,	6372,	6591,	6000,	6937,	6109,	9519,	12315,
	9,	2121,	2098,	2423,	3165,	4979,	4401,	4351,	4127,	4444,	4252,	5139,	6124,	8055,
	10,	1669,	1538,	1430,	1843,	2407,	3797,	2940,	3055,	2821,	3239,	3099,	4102,	5256,
	11,	1109,	841,	650,	623,	823,	1214,	1501,	1308,	1572,	1410,	1858,	2314,	3076,
	12,	622,	569,	296,	309,	322,	489,	693,	868,	644,	831,	750,	1328,	1816,
	13,	208,	229,	145,	133,	127,	164,	201,	290,	402,	275,	440,	679,	1024,
	14,	87,	98,	54,	98,	97,	95,	79,	127,	143,	223,	166,	389,	614,
	+gp,	7,	14,	2,	2,	50,	16,	30,	28,	101,	49,	118,		
0	TOTAL,	43085,	48863,	52624,	53763,	56964,	56409,	52841,	52385,	53251,	56827,	42651,		
1														

Table 8.13

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
5,	17993,	21708,	24288,	29586,	26998,	23491,	23311,	17889,	19026,	17612,
6,	21627,	23378,	28321,	32250,	39921,	35341,	34752,	25719,	19959,	20527,
7,	25165,	24941,	27890,	34936,	40701,	47136,	48861,	40997,	27919,	21626,
8,	32824,	26182,	27581,	32199,	41599,	45090,	59123,	41590,	29712,	18984,
9,	23731,	30343,	25301,	28430,	34732,	41817,	46595,	34355,	25495,	22220,
10,	19258,	17701,	26270,	19908,	24761,	30467,	39646,	28267,	23526,	21213,
11,	13178,	10923,	9724,	22341,	15494,	20915,	21779,	25322,	19172,	20985,
12,	9488,	6728,	4965,	5463,	16515,	9828,	12376,	13501,	16370,	14438,
13,	5368,	5452,	3196,	2281,	2634,	17415,	6786,	9127,	8772,	13746,
14,	3175,	3306,	3491,	1952,	838,	2128,	14746,	3875,	4226,	5565,
+gp,	1131,	697,	452,	282,	163,	707,	4378,	2171,	2060,	3388,
0 TOTALBIO,	172936,	171359,	181480,	209627,	244355,	274335,	312353,	242814,	196237,	180303,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
5,	15106,	12780,	12529,	13430,	11675,	17729,	13057,	11797,	13060,	14246,
6,	19558,	16273,	13723,	13450,	13632,	19156,	12991,	12878,	11445,	15685,
7,	24748,	22124,	18166,	14308,	13690,	18886,	12337,	13532,	11759,	13857,
8,	19341,	19874,	16483,	12914,	10681,	12780,	12195,	12108,	10935,	13569,
9,	15223,	15069,	15186,	9874,	10128,	9406,	8830,	12048,	10118,	11946,
10,	18208,	12292,	11216,	9784,	7083,	8624,	7414,	8734,	10381,	9882,
11,	17969,	14634,	8960,	8603,	7702,	5385,	6817,	6953,	6951,	9283,
12,	15687,	12508,	8572,	5918,	5129,	5004,	3870,	5929,	5261,	5834,
13,	11970,	12551,	8136,	4939,	3325,	3908,	3385,	3462,	4904,	4135,
14,	10283,	8448,	7247,	4831,	2150,	1638,	3106,	2998,	1954,	4113,
+gp,	5034,	6168,	5883,	2747,	1949,	2381,	2076,	1581,	902,	1311,
0 TOTALBIO,	173128,	152722,	126102,	100798,	87144,	104898,	86078,	92021,	87672,	103863,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
5,	11221,	11953,	12311,	13769,	16984,	15727,	10285,	9710,	7111,	10107,
6,	14321,	12888,	14735,	15587,	14998,	19481,	16834,	11008,	7548,	8141,
7,	13277,	11291,	12541,	13535,	13262,	14603,	15671,	12253,	6878,	7545,
8,	10991,	12166,	10872,	9958,	9574,	11205,	10422,	10761,	5750,	6899,
9,	12283,	11357,	10476,	8699,	7515,	7558,	8023,	7666,	6868,	5142,
10,	11009,	11414,	8933,	7721,	6718,	5923,	5077,	5605,	5229,	6250,
11,	6838,	7952,	7127,	5488,	4975,	4038,	3828,	3379,	2066,	4121,
12,	6662,	4513,	4915,	5089,	3646,	3284,	2828,	2962,	1165,	1704,
13,	2942,	5401,	2587,	3349,	4100,	2432,	2161,	1611,	586,	711,
14,	2290,	2023,	3713,	1327,	1924,	3184,	1540,	2020,	817,	368,
+gp,	1275,	1200,	3129,	175,	685,	665,	776,	4680,	575,	103,
0 TOTALBIO,	93109,	92158,	91339,	84697,	84381,	88099,	77446,	71655,	44592,	51092,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
5,	13052,	12166,	12969,	13476,	11616,	9939,	11493,	10239,	11023,	12634,
6,	9357,	14116,	13152,	12725,	13725,	12694,	11465,	13044,	10810,	14168,
7,	7443,	9889,	15727,	12464,	14037,	14817,	12946,	13192,	13124,	12842,
8,	5708,	6756,	9073,	11172,	10773,	10859,	10387,	11534,	10080,	12071,
9,	4645,	4385,	5428,	6551,	10556,	8802,	9180,	9450,	9687,	9780,
10,	4207,	3861,	3704,	4773,	6185,	9340,	7673,	8188,	7559,	8455,
11,	3295,	2481,	2140,	2057,	2676,	3910,	5027,	4354,	5015,	4258,
12,	2047,	1900,	1191,	1240,	1260,	1882,	2750,	3401,	2505,	3049,
13,	800,	878,	691,	640,	622,	757,	998,	1395,	1791,	1293,
14,	431,	486,	340,	585,	551,	557,	460,	740,	750,	1230,
+gp,	44,	112,	15,	15,	246,	94,	214,	208,	638,	304,
0 TOTALBIO,	51028,	57030,	64430,	65699,	72246,	73651,	72593,	75746,	72983,	80084,

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Table 8.14

Run title : Arctic Green.halibut (run: Final Run 2004)

At 7/05/2004 11:52

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	649,	701,	850,	968,	1198,	1060,	1043,	772,	599,	616,
7,	755,	748,	837,	1048,	1221,	1414,	1466,	1230,	838,	649,
8,	6893,	5498,	5792,	6762,	8736,	9469,	12416,	8734,	6240,	3987,
9,	15900,	20330,	16952,	19048,	23270,	28018,	31218,	23018,	17082,	14888,
10,	16562,	15223,	22592,	17121,	21295,	26201,	34096,	24310,	20233,	18243,
11,	12914,	10704,	9529,	21895,	15184,	20496,	21343,	24816,	18789,	20565,
12,	9298,	6594,	4866,	5354,	16185,	9631,	12129,	13231,	16043,	14150,
13,	5368,	5452,	3196,	2281,	2634,	17415,	6786,	9127,	8772,	13746,
14,	3175,	3306,	3491,	1952,	838,	2128,	14746,	3875,	4226,	5565,
+gp,	1131,	697,	452,	282,	163,	707,	4378,	2171,	2060,	3388,
0 TOTSPBIO,	72644,	69254,	68557,	76709,	90723,	116540,	139620,	111283,	94880,	95795,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
6,	587,	488,	412,	403,	409,	575,	390,	386,	343,	471,
7,	742,	664,	545,	429,	411,	567,	370,	406,	353,	416,
8,	4062,	4174,	3461,	2712,	2243,	2684,	2561,	2543,	2296,	2442,
9,	10200,	10096,	10174,	6616,	6786,	6302,	5916,	8072,	6779,	7168,
10,	15659,	10571,	9646,	8415,	6091,	7417,	6376,	7512,	8927,	8104,
11,	17609,	14341,	8781,	8431,	7548,	5277,	6681,	6814,	6812,	8912,
12,	15373,	12258,	8401,	5799,	5026,	4904,	3792,	5810,	5156,	5718,
13,	11970,	12551,	8136,	4939,	3325,	3908,	3385,	3462,	4904,	4135,
14,	10283,	8448,	7247,	4831,	2150,	1638,	3106,	2998,	1954,	4113,
+gp,	5034,	6168,	5883,	2747,	1949,	2381,	2076,	1581,	902,	1311,
0 TOTSPBIO,	91519,	79760,	62686,	45322,	35937,	35652,	34653,	39585,	38428,	42789,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
5,	0,	0,	0,	0,	0,	0,	0,	0,	0,	101,
6,	573,	516,	442,	156,	150,	195,	168,	110,	75,	81,
7,	398,	452,	376,	271,	133,	292,	313,	490,	413,	604,
8,	1978,	2312,	2609,	2191,	2010,	2017,	1772,	1614,	1610,	2208,
9,	7492,	7382,	7752,	5741,	3983,	3703,	4092,	4139,	4533,	3497,
10,	9138,	9702,	8129,	6949,	5845,	4738,	3909,	4316,	4497,	5188,
11,	6633,	7714,	7055,	5214,	4427,	3594,	3483,	3007,	1797,	3626,
12,	6529,	4468,	4816,	4988,	3573,	3284,	2828,	2962,	1165,	1602,
13,	2942,	5401,	2587,	3349,	4100,	2432,	2161,	1611,	586,	711,
14,	2290,	2023,	3713,	1327,	1924,	3184,	1540,	2020,	817,	368,
+gp,	1275,	1200,	3129,	175,	685,	665,	776,	4680,	575,	103,
0 TOTSPBIO,	39249,	41168,	40610,	30361,	26830,	24104,	21044,	24950,	16068,	18089,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
5,	131,	122,	0,	0,	0,	0,	0,	102,	220,	253,
6,	94,	141,	0,	0,	0,	0,	115,	391,	432,	567,
7,	521,	791,	1101,	873,	561,	296,	388,	792,	1181,	1156,
8,	1941,	1959,	2268,	2346,	1077,	760,	1039,	2192,	2621,	3139,
9,	3205,	2543,	3148,	3472,	4750,	2905,	3397,	4630,	6103,	6161,
10,	3407,	3050,	3260,	4057,	5072,	6164,	4834,	5322,	5443,	6087,
11,	3130,	2382,	2075,	1934,	2462,	3363,	4373,	3658,	4564,	3875,
12,	1924,	1691,	1120,	1166,	1260,	1863,	2640,	3265,	2405,	2927,
13,	800,	878,	691,	640,	622,	757,	998,	1395,	1791,	1293,
14,	431,	486,	340,	585,	551,	557,	460,	740,	750,	1230,
+gp,	44,	112,	15,	15,	246,	94,	214,	208,	638,	304,
0 TOTSPBIO,	15628,	14156,	14018,	15087,	16602,	16759,	18458,	22695,	26148,	26991,

1

Table 8.15

Run title : Arctic Green.halibut (run: Final Run 2004) ,

At 7/05/2004 11:52

Table 16 Summary (without SOP correction)

,	RECRUITS, Age 5	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 6-10,
1964,	42840,	172936,	72644,	40391,	.5560,	.3146,
1965,	51686,	171359,	69254,	34751,	.5018,	.2643,
1966,	57828,	181480,	68557,	26321,	.3839,	.1601,
1967,	70443,	209627,	76709,	24267,	.3164,	.1376,
1968,	64280,	244355,	90723,	26168,	.2884,	.1309,
1969,	55932,	274335,	116540,	43789,	.3757,	.1988,
1970,	41112,	312353,	139620,	89484,	.6409,	.4204,
1971,	31550,	242814,	111283,	79034,	.7102,	.4223,
1972,	33555,	196237,	94880,	43055,	.4538,	.3019,
1973,	31061,	180303,	95795,	29938,	.3125,	.2252,
1974,	26642,	173128,	91519,	37763,	.4126,	.2787,
1975,	22539,	152722,	79760,	38172,	.4786,	.3360,
1976,	22097,	126102,	62686,	36074,	.5755,	.4264,
1977,	23686,	100798,	45322,	28827,	.6360,	.3409,
1978,	20591,	87144,	35937,	24617,	.6850,	.3659,
1979,	19699,	104898,	35652,	17312,	.4856,	.1911,
1980,	18600,	86078,	34653,	13284,	.3833,	.1720,
1981,	17874,	92021,	39585,	15018,	.3794,	.1445,
1982,	18928,	87672,	38428,	16789,	.4369,	.2188,
1983,	18995,	103863,	42789,	22147,	.5176,	.2912,
1984,	17811,	93109,	39249,	21883,	.5575,	.3384,
1985,	19922,	92158,	41168,	19945,	.4845,	.3054,
1986,	19857,	91339,	40610,	22875,	.5633,	.3514,
1987,	19420,	84697,	30361,	19112,	.6295,	.3492,
1988,	22952,	84381,	26830,	19587,	.7300,	.4057,
1989,	20693,	88099,	24104,	20138,	.8355,	.3189,
1990,	14486,	77446,	21044,	23183,	1.1017,	.4247,
1991,	12610,	71655,	24950,	33320,	1.3355,	.6608,
1992,	10457,	44592,	16068,	8602,	.5354,	.2462,
1993,	12794,	51092,	18089,	11933,	.6597,	.3200,
1994,	18128,	51028,	15628,	9226,	.5904,	.2713,
1995,	16665,	57030,	14156,	11734,	.8289,	.3212,
1996,	16843,	64430,	14018,	14347,	1.0235,	.3503,
1997,	17502,	65699,	15087,	9410,	.6237,	.2488,
1998,	15912,	72246,	16602,	11893,	.7163,	.2584,
1999,	14199,	73651,	16759,	19517,	1.1645,	.3959,
2000,	15123,	72593,	18458,	14437,	.7821,	.2915,
2001,	13837,	75746,	22695,	16307,	.7185,	.2839,
2002,	15975,	72983,	26148,	13161,	.5033,	.2348,
2003,	17073,	80084,	26991,	13003,	.4818,	.2108,
Arith. Mean ,	25555,	119107,	47784,	25520,	.6099,	.2982,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

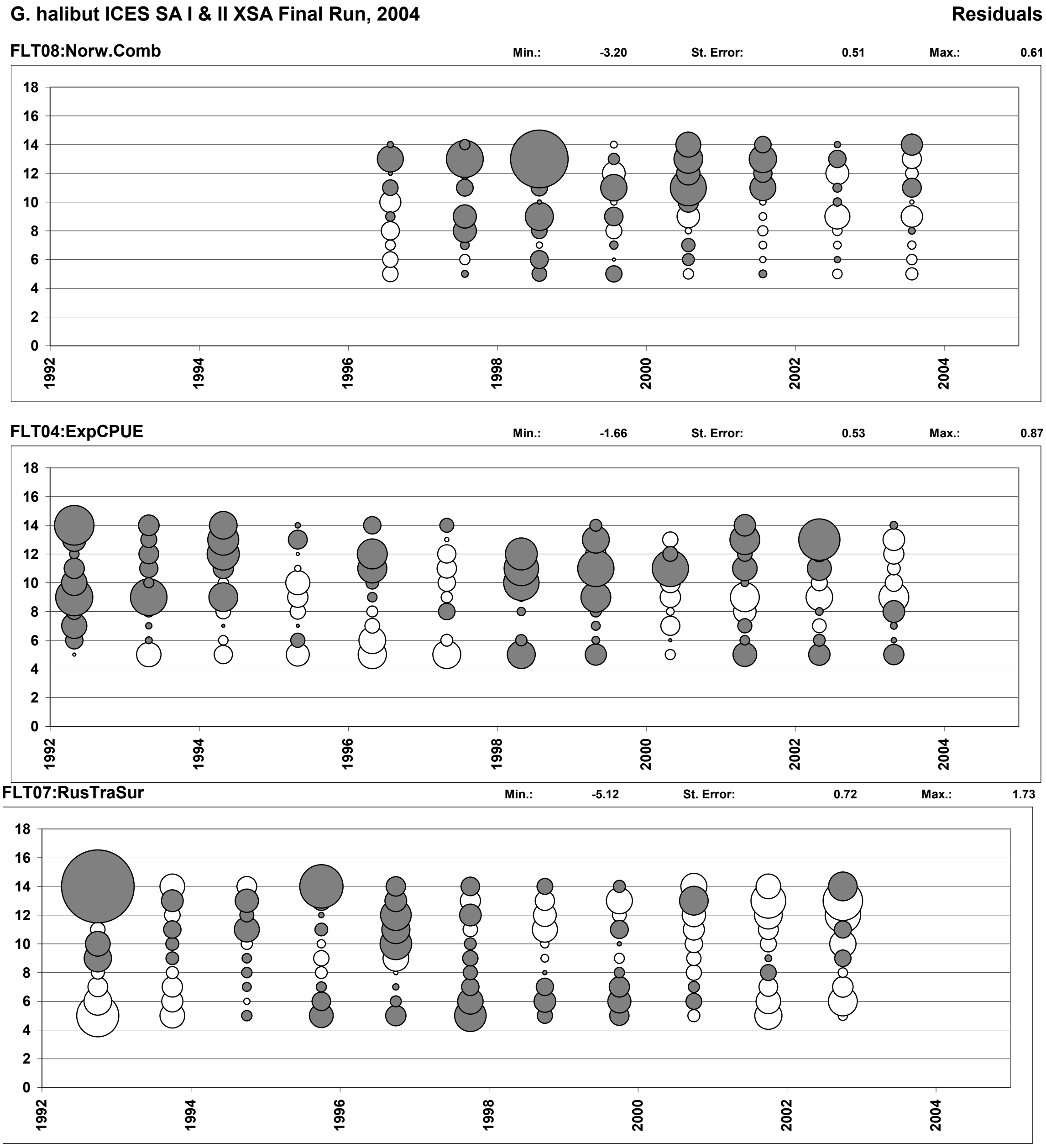

Figure 8.1. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.

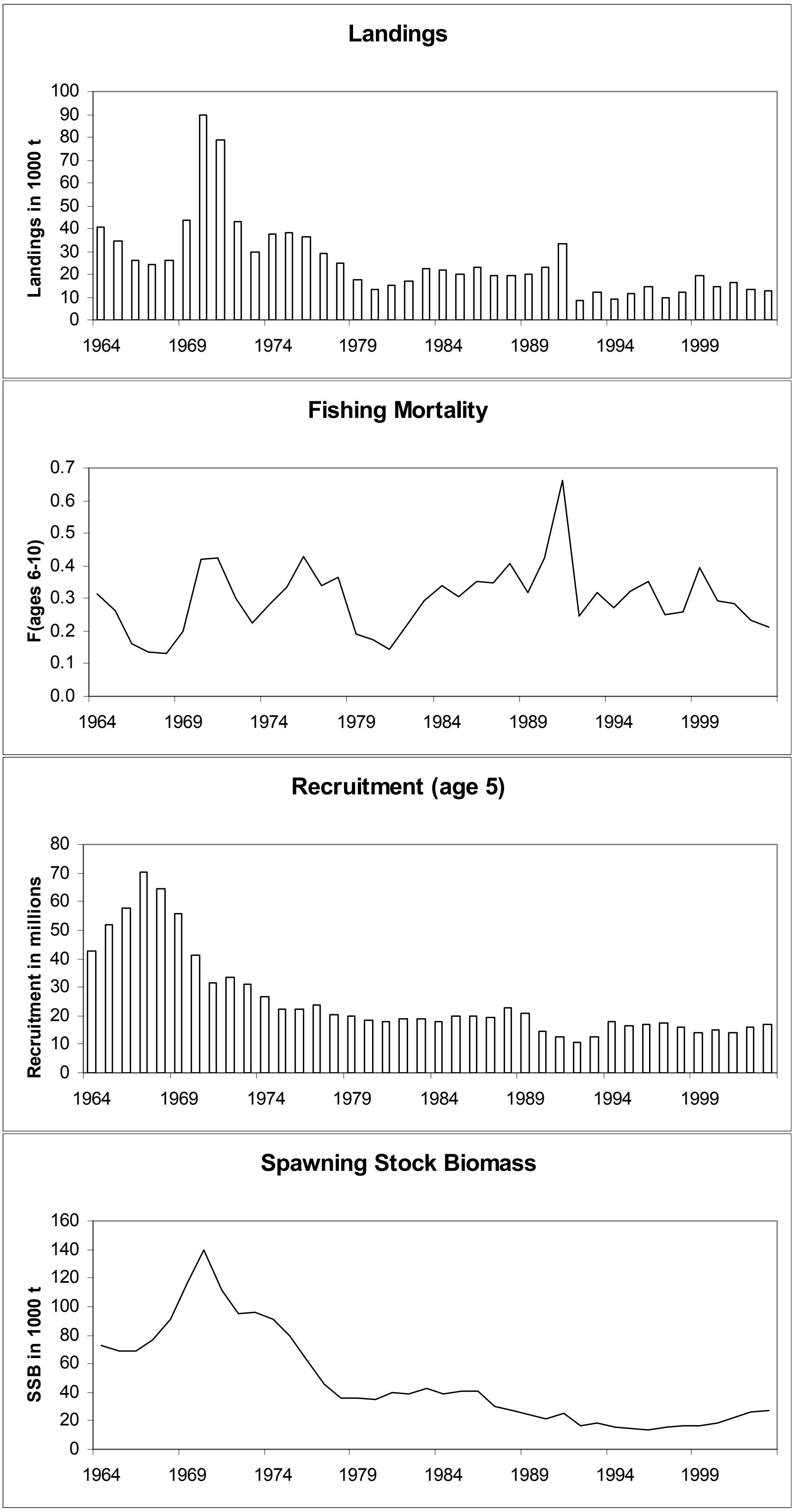

Figure 8.2. Historical landings, recruitment, fishing mortality and spawning stock biomass.

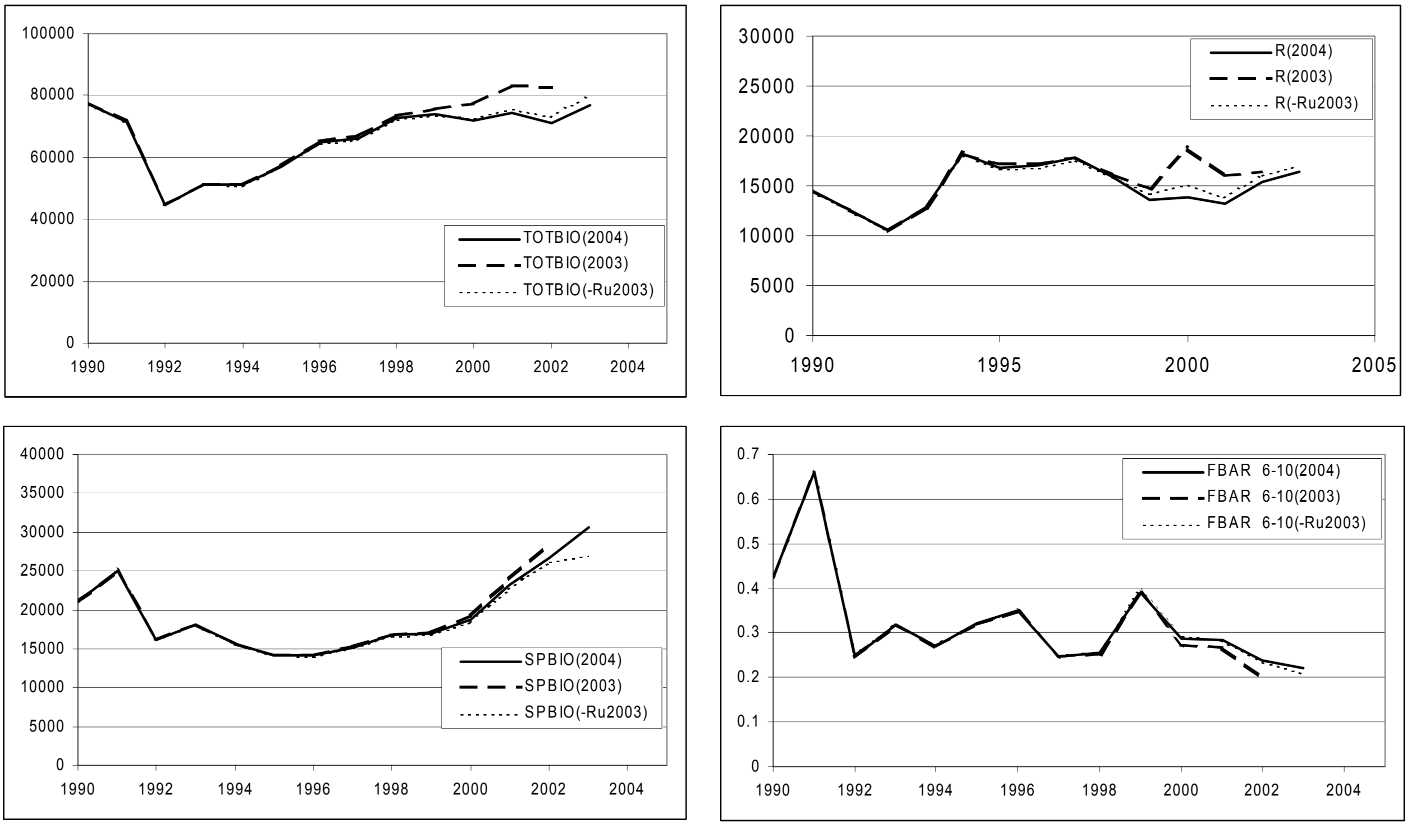

Figure 8.3. Comparison between last years assessment and this years assessment both with and without the 2003 data point from the Russian survey.

Table E1. GREENLAND HALIBUT in Sub-area I and II. Norwegian bottom trawl survey indices (numbers in thousands) in the Svalbard area (Division IIb).

Year	Fish <20 cm [2]	Age									Total
		1	2	3	4	5	6	7	8	9+	
1981	2,1	No age data									20 100
1982	0,7										2 600
1983	5,9										26 690
1984	3,2	550	3 042	2 924	8 573	6 847	5 657	4 345	2 796	1 896	36 630
1985	1,6	884	3 921	4 294	6 674	8 793	8 622	3 920	1 817	525	39 450
1986	0,1	49	1 005	1 967	7 314	4 671	1 754	2 301	372	37	19 470
1987	1	630	1 014	3 076	4 409	4 786	3 141	964	364	116	18 500
1988	2,5	818	4 298	6 191	6 696	12 289	2 396	6 015	338	1 277	40 318
1989 [1]	1,4	712	3 232	8 158	7 493	7 069	2 374	1 753	353	744	31 888
1990 [1]	0,4	115	336	5 050	7 130	7 730	4 490	2 330	918	544	28 643
1991 [1]	0,1	71	877	3 080	6 720	9 270	5 450	2 800	1 660	524	30 452
1992 [1]	+	33	30	338	1 190	3 520	4 420	2 280	1 280	474	13 565
1993 [1]	+	25	60	51	1 049	2 369	2 056	2 772	1 114	665	10 161
1994 [1]	+	4	238	296	652	2 775	2 371	2 593	531	844	10 304
1995 [1]	0,1	76	+	+	322	886	1 200	1 950	487	497	5 418
1996 [1]	0,4	410	61	104	171	881	2 052	2 587	862	976	8 104
1997 [1]	0,4	268	484	21	65	284	2 089	2 143	379	295	6 028
1998 [1]	2,5	1 999	2 351	2 715	493	609	2 192	2 814	1 252	822	15 247
1999 [1]	1,3	126	+	995	1 789	415	709	2 501	507	674	7 716
2000 [1]	2	2 009	540	323	1 347	2 135	2 634	1 784	1 197	530	12 499
2001 [1]	4,3	4 258	1 235	873	1 506	2 456	1 718	1 504	558	1 079	15 187
2002 [1]	2,3	1 435	2 019	1 176	2 437	3 413	2 685	3 304	847	2 229	19 545
2003 [1]	0,8	410	638	901	2 937	2 630	3 146	2 602	452	684	14 400

[1] New standard trawl equipment (rockhopper gear and 40 meter sweep length).

[2] In millions.

Table E2. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from bottom trawl surveys in the Barents Sea and Svalbard area in August (in thousands).

A: The Barents Sea area; **B**: The expanded Svalbard area.

A Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1995	42	-	-	596	989	1 239	1 673	1 020	-	195	-	-	-	5 754
1996	12 028	900	-	-	-	415	829	861	85	261	118	82	-	15 579
1997 [1]	143	1 162	53	331	589	1 579	2 736	1 120	550	44	-	-	-	8 307
1998 [1]	46	446	328	416	481	323	1 828	924	432	234	-	-	-	5 458
1999	11 637	5 910	384	280	201	1 508	1 729	215	134	661	255	218	-	23 132
2000	-	619	302	417	816	620	1 163	844	605	270	54	221	-	5 931
2001	-	-	259	203	743	1 120	293	697	-	215	107	-	-	3 637
2002	-	-	-	85	773	2 509	3 047	165	290	839	-	255	-	7 963
2003	-	-	-	420	450	1 630	1 070	840	250	410	-	-	-	5 070

B Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1995	77	-	-	429	1 255	1 720	2 535	665	135	281	136	95	-	7 328
1996	1 760	360	105	291	1 144	2 717	3 525	1 290	309	603	30	92	45	12 271
1997	593	2 357	311	116	593	3 053	3 019	478	312	20	-	-	-	10 852
1998	2 295	2 836	2 918	540	770	2 477	3 248	1 472	340	346	130	-	65	17 437
1999	387	263	1 516	3 095	809	836	2 773	486	333	360	-	87	140	11 085
2000	1 976	818	1 280	2 836	3 946	3 216	2 112	1 560	460	199	-	95	-	18 498
2001	4 659	1 690	1 789	2 517	3 536	2 474	1 889	690	383	773	134	27	50	20 611
2002	2 174	2 475	1 718	2 962	4 291	3 620	4 205	1 031	293	1 267	453	304	212	25 005
2003	1 390	600	1 170	3 510	3 350	4 310	3 470	640	520	150	90	140	-	19 340

[1] Only Norwegian and international zones covered. Adjusted (according to the mean distribution in the period 1991-1999) to include the Russian EEZ.

Table E3. GREENLAND HALIBUT in Sub-area I and II. Abundance indices on age from the Norwegian stratified bottom trawl survey in August using a hired commercial vessel (numbers in thousands). Trawls were made at 400-1500 m depth along the continental slope from 68-80°N.

Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1994	0	0	1	2 001	16 980	11 008	15 552	6 173	1 241	3 628	1 460	443	129	81	11	58 708
1995	0	0	0	1 432	16 945	12 946	20 925	6 737	1 975	4 393	1 385	648	152	103	21	67 662
1996	0	0	10	704	13 623	18 538	24 908	8 114	1 473	3 223	820	396	131	100	2	72 042
1997	0	0	16	1 446	11 738	17 005	18 927	5 383	1 107	3 261	936	600	87	165	16	60 687
1998	0	0	66	1 726	7 868	12 399	23 487	6 243	1 458	4 317	1 238	969	13	183	14	59 981
1999	0	0	27	1 300	5 901	15 383	20 209	12 019	1 872	5 913	1 167	1 198	273	183	15	65 460
2000	0	0	383	1 920	6 901	10 352	17 885	7 795	5 038	3 284	867	458	204	75	16	55 178
2001	0	10	95	986	6 107	15 068	22 584	10 086	3 130	5 442	1 146	1 147	267	180	67	66 315
2002	0	3	427	2 492	7 730	10 913	21 660	9 847	6 327	4 248	2 468	1 642	619	208	183	68 767
2003	6	18	662	3 972	10 293	14 552	20 438	9 191	4 507	6 388	1 902	1 795	861	253	125	74 963

Table E4. GREENLAND HALIBUT in Sub-area I and II. Abundance indices on age from the Norwegian bottom trawl survey north and east of Spitsbergen in September (numbers in thousands).

A: Survey area, Russian EEZ excluded **B:** Including Russian EEZ

A Year	Age 1	2	3	4	5	6+	Total
1996	15 655	14 510	10 025	3 487	1 593	3 349	48 619
1997	3 415	15 271	14 140	2 803	403	434	36 466
1998	8 482	18 718	9 463	5 161	1 166	932	43 922
1999	5 370	9 074	3 328	2 271	1 492	954	22 489
2000	9 529	16 844	8 007	6 274	1 746	722	43 122
2001	26 206	15 765	4 515	1 767	802	465	49 520
2002	40 186	34 065	15 441	3 862	1 320	556	95 430
2003	49 146	37 344	6 336	3 188	1 035	327	97 376

B Year	Age 1	2	3	4	5	6+	Total
1998	10 210	28 020	17 186	6 380	1 551	932	64 279
1999	7 514	16 159	8 045	3 067	2 401	954	38 140
2000			No coverage in Russian EEZ				
2001	38 112	40 377	7 960	4 300	1 215	510	92 475
2002	96 231	58 113	31 500	5 665	1 576	556	193 641
2003			No coverage in Russian EEZ				

Table E5. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from three Norwegian bottom trawl surveys in the Barents Sea in August - September combined to one index (in thousands).

Antall i tusen

Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1996	17 926	14 906	10 134	4 486	16 194	22 217	30 014	10 163	1 857	3 954	957	523	175	100	2	133 608
1997	4 050	18 107	14 547	4 481	12 917	20 753	22 984	6 362	1 563	3 312	936	600	87	165	16	110 880
1998	10 704	21 705	12 521	7 603	9 915	14 680	27 784	7 800	1 937	4 586	1 353	1 027	13	241	14	121 883
1999	5 895	9 451	5 200	7 116	8 412	17 437	24 175	12 857	2 407	6 595	1 294	1 387	273	183	144	102 826
2000	11 474	17 755	9 870	11 359	13 093	14 139	20 608	9 704	5 707	3 548	901	695	204	75	16	119 148
2001	30 631	17 452	6 521	5 115	10 077	17 548	24 465	10 973	3 440	6 280	1 302	1 147	267	180	67	135 464
2002	42 348	36 537	17 472	9 105	13 649	15 040	27 076	10 130	6 679	5 104	2 909	1 893	619	257	183	188 999
2003	50 512	37 972	8 298	11 410	15 428	20 553	24 664	10 521	5 437	6 958	1 992	1 955	861	253	125	196 939

Table E6. GREENLAND HALIBUT in Sub-area I and II. Russian autumn bottom trawl surveys: Abundance indices at different age (numbers in thousands).

Year	Age-group													Total
	≤ 3	4	5	6	7	8	9	10	11	12	13	14	15+	
1984	4 124	5 359	7 788	24 951	19 863	11 499	6 750	5 416	2 420	1 196	247	146	143	89 902
1985	3 331	4 371	17 076	35 648	27 826	11 717	5 722	4 090	1 937	895	311	31	131	113 086
1986	2 687	6 600	15 853	25 696	16 468	5 436	3 811	2 660	974	539	184	72	6	80 986
1987	289	6 761	9 724	12 703	7 633	3 867	1 903	1 627	721	416	110	0	38	45 792
1988	2 591	4 409	7 891	14 181	11 311	4 308	2 253	1 756	820	307	125	163	54	50 169
1989	1 429	11 310	13 124	25 881	12 782	5 989	2 381	1 285	334	271	98	102	118	75 104
1990	2 820	8 360	16 252	15 621	11 393	4 120	1 911	1 158	307	198	58	36	0	62 234
1991 [1]	1 422	8 455	25 408	21 843	15 235	9 419	2 369	1 211	655	142	95	16	26	86 296
1992	685	7 461	33 341	25 498	17 272	10 178	2 720	1 262	938	318	67	0	0	99 740
1993	114	2 166	13 317	19 752	16 528	10 305	3 370	1 868	903	519	103	111	111	69 167
1994	49	1 604	9 868	17 549	11 533	7 746	3 401	1 876	605	394	114	114	57	54 910
1995	19	467	5 759	18 222	15 296	11 539	4 393	1 413	529	312	84	11	32	58 076
1996 [2]	0	1 670	6 680	18 722	21 714	13 354	8 512	476	284	106	115	36	20	71 689
1997	235	1 575	4 023	12 165	15 919	16 452	4 591	1 432	779	162	271	66	88	57 758
1998	3 917	5 542	7 768	15 589	16 842	17 727	9 676	2 548	1 752	535	254	85	72	82 307
1999	4 057	4 961	5 951	12 350	14 255	16 078	7 952	3 009	965	494	307	74	-	70 453
2000	2 841	5 327	10 718	15 719	18 694	21 235	9 155	3 593	2 580	1 011	108	133	120	91 234
2001	1 592	6 884	17 365	37 881	27 661	14 163	6 576	3 988	1 875	1 713	929	217	180	121 024
2002 [3]	2 145	7 127	10 771	44 220	33 675	18 747	5 947	5 477	1 216	1 877	1 973	60	120	133 355
2003	1 735	6 479	10 029	19 751	14 160	7 592	3 519	2 555	2 200	1 664	831	141	470	71 126

[1] Age composition based on combined age-length-keys for 1990 and 1992.

[2] Only half of standard area investigated

[3] Adjusted assuming area distibution as in 2001

Table E7.- Greenland halibut catch in weight, numbers, and biomass and abundance estimated from Spanish survey 1997-2003.

Year	Catch (Kg)	Catch (numbers)	Biomass™	Abundance ('000)
1997	195 056	211 533	344 014	379 444
1998	180 974	187 259	351 466	373 149
1999	198 781	172 687	436 956	377 792
2000	169 389	140 355	340 619	291 265
2001	152 681	129 289	283 511	249 219
2002	144 335	115 213	256 460	207 466
2003	151 952	132 117	283 644	256 327

Table E8. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from bottom trawl surveys in the Barents Sea in winter (in thousands).

A: Restricted area surveyed every year; **B**: Enlarged area (includes the restricted one) surveyed since 1993

A

Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1989	1 078	788	1 056	2 284	3 655	2 655	864	971	210	-	19	76	56	13 712
1990	66	907	2 071	1 716	1 996	2 262	1 046	365	175	-	30	119	165	10 918
1991	-	279	755	1 323	1 257	1 526	2 440	906	450	457	-	55	127	9 575
1992	63	128	719	897	1 554	543	1 069	791	-	648	135	40	53	6 640
1993	-	17	168	502	1 730	868	1 490	758	88	655	382	31	35	6 724
1994	-	16	142	1 178	2 259	1 644	1 750	885	-	506	38	25	-	8 443
1995	-	-	-	168	786	749	1 331	760	359	486	60	199	-	4 898
1996	1 816	-	28	40	709	1 510	2 964	1 000	307	808	154	152	45	9 533
1997	-	21	-	21	176	812	1 788	1 440	653	209	94	73	-	5 287
1998	-	-	-	67	474	1 172	2 491	1 144	302	401	89	19	4	6 163
1999	-	77	276	243	495	485	1 058	555	408	152	75	56	-	3 880
2000	-	40	56	396	719	519	1 187	261	290	531	131	23	55	4 208
2001	19	36	112	558	517	260	497	697	267	478	43	42	30	3 556
2002	-	-	32	609	1 019	1 148	989	362	139	591	106	54	54	5 103

B

Year	Age 1	2	3	4	5	6	7	8	9	10	11	12	13+	Total
1993	-	17	279	1 002	3 129	2 818	3 895	1 632	309	1 406	616	31	35	15 169
1994	-	16	152	1 482	3 768	2 698	3 420	1 615	-	1 171	135	25	-	14 482
1995	-	-	-	216	2 824	6 229	10 624	2 727	1 250	1 902	172	718	57	26 719
1996	3 149	-	28	102	1 547	3 043	4 991	1 599	472	1 211	317	250	72	16 781
1997 [1]	-	163	-	203	624	2 742	5 759	4 170	1 653	562	240	181	66	16 363
1998 [1]	220	501	2 797	1 011	1 847	3 477	6 539	3 057	867	1 179	301	96	57	21 949
1999	41	195	691	825	829	1 531	3 130	1 496	1 011	500	115	129	101	10 594
2000	169	482	947	5 425	2 575	1 310	3 035	553	796	1 109	284	27	55	16 767
2001	69	250	363	2 046	4 250	2 730	2 983	1 123	416	1 148	111	137	94	15 720
2002	233	104	248	1 373	2 748	3 265	3 641	932	449	1 714	365	177	178	15 427
2003	50	89	151	785	1 786	2 860	5 411	1 313	289	951	356	189	92	14 322
2004	67	118	128	527	1 294	1 099	3 207	1 220	624	504	201	281	266	9 536

[1] Adjusted (according to the 1996 distribution) to include the Russian EEZ which was not covered by the survey.

Table E9. GREENLAND HALIBUT in Sub-areas I and II. Results from a research program using trawlers in a limited commercial fishery 1992-2003. All areas combined. Spring and autumn combined in 1992-1993, otherwise only spring-data.

Catch in numbers on age (%)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1												
2												
3	0,1			0,1		0,0	0,0	0,0				
4	4,6	4,2	3,2	0,7	0,5	0,9	0,2	0,7	1,2	1,3	0,7	1,8
5	19,1	25,0	24,7	22,5	19,5	24,8	6,6	7,7	10,8	6,3	7,7	8,5
6	23,0	18,4	23,8	22,6	31,6	22,9	25,5	23,0	17,1	20,2	16,8	21,7
7	25,9	27,1	26,8	30,2	35,6	30,5	44,5	39,6	43,0	28,5	42,5	30,5
8	13,3	12,4	11,2	11,0	8,7	10,1	15,5	14,5	12,3	24,5	12,4	9,6
9	1,7	0,7	1,0	2,7	1,3	2,6	4,5	1,6	4,5	7,8	7,1	8,1
10	6,8	7,4	5,9	6,6	2,0	5,0	2,0	9,7	8,5	7,3	8,8	11,0
11	2,9	3,1	2,4	2,0	0,5	1,9	0,8	1,0	0,9	1,9	2,2	4,1
12	1,7	1,0	0,6	1,1	0,2	0,8	0,3	1,8	1,1	1,7	1,2	3,1
13	0,5	0,4	0,2	0,3	0,0	0,3		0,2	0,6	0,3	0,2	1,2
14	0,2	0,2	0,1	0,2	0,1	0,2		0,2	0,0	0,2	0,4	0,5
15	0,1					0,0		0,0	0,0	0,2	0	0,0

Mean individual weight (kg)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1												
2												
3	0,26			0,40		0,39						
4	0,50	0,53	0,52	0,47	0,48	0,45	0,41	0,51	0,5	0,60	0,44	0,48
5	0,71	0,76	0,73	0,70	0,74	0,69	0,76	0,74	0,69	0,66	0,69	0,68
6	0,96	0,98	0,95	0,94	0,94	0,88	0,96	0,92	0,98	0,94	0,93	1,00
7	1,29	1,33	1,28	1,24	1,23	1,15	1,19	1,25	1,23	1,12	1,22	1,28
8	1,77	1,85	1,79	1,71	1,66	1,55	1,79	1,64	1,57	1,48	1,39	1,67
9	2,00	2,28	2,23	2,03	2,00	1,87	2,26	2,18	1,9	1,84	1,69	1,97
10	2,46	2,65	2,55	2,50	2,50	2,34	2,54	2,38	2,4	2,30	2,31	2,37
11	3,10	3,43	3,37	3,28	3,16	2,95	3,47	3,17	3,13	2,92	3,19	3,20
12	3,86	4,32	4,22	3,71	3,70	3,46	4,16	3,79	4,04	3,82	3,91	3,48
13	4,44	5,18	5,01	4,62		4,52		5,07	4,47	3,68	5,20	4,28
14	6,00	6,44	6,29	5,59		5,47		5,60	6,00	5,74	5,59	4,74
15	5,22								8,79	5,52	7,03	9,17

CPUE (N) on age

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1												
2												
3	0			1	0	0	0	0	0	0	0	0
4	19	30	26	7	7	11	2	7	14	12	7	19
5	80	176	198	219	286	298	59	72	132	63	81	90
6	97	130	191	220	463	275	229	214	208	201	176	229
7	109	191	215	294	521	366	400	369	524	284	447	322
8	56	87	90	107	127	121	139	135	150	244	130	101
9	7	5	8	26	19	31	40	15	55	78	75	86
10	29	52	47	64	29	60	18	90	104	73	92	116
11	12	22	19	19	7	23	7	9	11	18	23	43
12	7	7	5	11	3	10	3	17	13	17	12	32
13	2	3	2	3	0	4	0	2	7	3	2	12
14	1	1	1	2	1	2	0	2	0	2	4	5
15	0			0	0	0	0	0	0	2	1	0

CPUE (kg) on age

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1												
2												
3	0			0	0	0	0	0	0	0	0	0
4	10	16	13	3	4	5	1	3	7	7	3	9
5	57	134	145	153	211	207	45	53	91	41	56	61
6	93	127	182	207	435	243	220	197	204	189	164	229
7	140	254	276	364	641	423	476	461	645	318	543	411
8	99	162	161	183	211	189	249	221	236	361	181	169
9	14	11	18	53	38	59	91	32	105	143	127	169
10	70	138	121	161	73	141	46	215	250	167	213	275
11	38	75	65	64	23	68	25	30	33	54	74	138
12	28	30	20	40	11	33	11	64	53	66	48	113
13	9	15	8	13	0	16	0	9	32	11	9	52
14	5	9	5	11	0	13		10	2	10	24	23
15	2			0	0	0			3	11	4	4

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Overall mean individual weight (kg)	1,35	1,38	1,27	1,29	1,12	1,16	1,30	1,39	1,35	1,38	1,38	1,57
CPUE (kg round weight per trawlhour)*	567	973	1020	1255	1640	1393	1169	1294	1647	1377	1449	1657
CPUE (Number fish per trawlhour)*	420	705	803	973	1464	1201	899	931	1220	998	1050	1055
Catch (in tonnes)	695	862	811	368	436	274	272	269	295	297	288	305

*) Average for freezer- and factorytrawler

Table E10. GREENLAND HALIBUT in ICES Sub-area IV (North Sea. Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment .

Year	Denmark	Faroe Islands	France	Germany	Ireland	Norway	Russia	UK England & Wales	UK Scotland	Total
1973	-	-	-	4	-	9	8	28	-	49
1974	-	-	-	2	-	2	-	30	-	34
1975	-	-	-	1	-	4	-	12	-	17
1976	-	-	-	1	-	2	-	18	-	21
1977	-	-	-	2	-	2	-	8	-	12
1978	-	-	2	30	-	-	-	1	-	33
1979	-	-	2	16	-	2	-	1	-	21
1980	-	177	-	34	-	5	-	-	-	216
1981	-	-	-	-	-	7	-	-	-	7
1982	-	-	2	26	-	17	-	-	-	45
1983	-	-	1	64	-	89	-	-	-	154
1984	-	-	3	50	-	32	-	-	-	85
1985	-	1	2	49	-	12	-	-	-	64
1986	-	-	30	2	-	34	-	-	-	66
1987	-	28	16	1	-	35	-	-	-	80
1988	-	71	62	3	-	19	-	1	-	156
1989	-	21	14 [1]	1	-	197	-	5	-	238
1990	-	10	30 [1]	3	-	29	-	4	-	76
1991	-	48	291 [1]	1	-	216	-	2	-	558
1992	1	15	416 [1]	3	-	626	-	+	1	1 062
1993	1	-	78 [1]	1	-	858	-	10	+	948
1994	+	103	84 [1]	4	-	724	-	6	-	921
1995	+	706	165	2	-	460	-	52	283	1 668
1996	+	-	249	1	-	1 496	-	105	159	2 010
1997	+	-	316	3	-	873	-	1	162	1 355
1998	+	-	71 [1]	10	10	804	-	35	435	1 365
1999	+	-		1	18	2 157	-	43	358	2 577
2000	+		41	10	19	498 [1]	-	67	192	827
2001 [1]	+		43	-	10	470	-	122	202	847
2002 [1]	+		8	+	2	200	-	10	246	466
2003 [1]	+		1	-		453	-		125	579

[1] Provisional figures

9 WORKING DOCUMENTS

WD#	Title	Authors
1.	Ecological conditions in the Barents Sea, 2003-2004	Stiansen, J. E, Loeng H., Dalpadado P., Ottersen, G., and Ingvaldsen, R.
2.	Prognosis for the development of the Barents Sea capelin stock	Gjøsæter H. and Bogstad B.
3.	Evaluation of the proposed harvest control rule for Northeast Arctic cod	Bogstad B., Aglen A., Skagen D., Åsnes M. N., Kovalev Y. and Yaragina N.
4.	Consumption of various prey species by cod in 1984-2003	Dolgov A.
5.	Prost User Guide	Åsnes M. N.
6.	Predicting growth of Northeast Arctic cod	Bogstad B. and Gjøsæter H.
7.	Estimation of cod discards in the Barents Sea and adjacent waters during the Russian bottom trawl fishery in 1983-2002	Sokolov K.
8.	Assessment of population recruitment abundance of northeastern arctic cod and the Barents Sea capelin considering the environment data	Titov O.
9.	The inclusion of data on NEA cod cannibalism into assessment - a step forward or two steps back?	Kovalev Y. and Korzhev V.
10.	Predicting natural mortality due to cannibalism for Northeast Arctic cod	Kovalev Y.
11.	Acoustic abundance of saithe, coastal cod and juvenile herring Finnmark – Møre autumn 2003	Berg E., Korsbrekke K. and Mehl S.
12.	Abundance of spawning Northeast Arctic cod spring 2004	Mehl S.
13.	Estimates of Norwegian catch at age of Northeast Arctic cod	Aanes S. and Fotland Å.
14.	Extensions and changes of the Fleksibest model from 2003 to 2004	Bogstad B., Howell, D., and Åsnes M. N.
15.	Comparison of NEA cod recruitment estimates obtained in AFWG runs and with help of recruitment model	Bulgakova T.
16.	Simulation of year-to-year abundance dynamics of euphausids as fish prey in the Barents Sea	Nikiforov A.
17.	Results from macroplankton om research in the Barents Sea in Autumn-Winter 2003/04	Zhukova N., Nesterova V. and Aleksandrov D.
18.	Is it reasonable to apply the new management scheme adopted by the Joint Rusian-Norwegian Fisheries Commission to NEA cod ?	Bulgakova T.
19.	Results of the Russian survey of Greenland halibut in the Barents Sea in 2003	Smirnov O.V.
20.	Modelling of feeding, growth rate and recuitment of the northeast arctic cod with allowance for the ecosystem factors	Filin A.
21.	The Spanish NE Arctic Cod Fishery in 2003	Casas, J.M. and H. Murua

22. Spanish Bottom Trawl Survey *"Fletán Ártico 2003"* In The Slope of Svalbard Area, Ices Division IIb.	Paz, X., C. González and E. Román
23. Joint Winter Survey 2004, preliminary results	Aglen, Alvsvåg, Høines, Korsbrekke, Smirnov
24. By catch in shrimp fishery	Ajiad, Aglen and Nedreaas
25. F and effort in Norwegian cod trawl fishery	Aglen
26. Stock status based on surveys	Pennington and Nakken
27. Relative stability of TAC: is it good or bad for cod fisheries ?	Borisov V.

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APPENDIX 1

WORKING DOCUMENTS

ARCTIC FISHERIES WORKING GROUP 2004

Working Document № **9** to the AFWG,
May 2004

Is the inclusion of NEA cod cannibalism data into assessment a step forward or two steps back?

by
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ABSTRACT

The study concludes that incorporation of the North-East Arctic cod cannibalism data into the VPA model improves the overall quality of its assessment but only when the entire time-series is considered (1985-2002). This is achieved by better consistency between survey abundance indices and VPA estimates for juvenile cod. In addition, variability in model estimates is also reduced according to retrospective analysis. The improvement is most apparent for estimates of recruitment at age 3, which enhances confidence in predicting recruitment. However, when examining XSA diagnostics for the most recent years the improvement in the quality of the assessment is not quite so clear.

INTRODUCTION

Data on cod cannibalism were incorporated for the first time into the stock assessment by the ICES Arctic Fisheries Working Group (AFWG) in 1995 (Anon, 1996). Prerequisites to this were calculations of predation by cod on juvenile cod carried out by PINRO and IMR (Dolgov A.V., 1995; Bogstad B. and Mehl S., 1997) using a joint cod stomach content data base (Mehl S. and Yaragina N., 1992). These studies show that predation on juvenile cod by older cod can b0e0 0q0u0i0t0e0 0s0i0g0n0i0f0i0c0a0n0t0 0a0nd that abundance estimates of cod at younger ages can be improved substantially using this information. After having derived initial estimates of abundance with cannibalism taken into account the Group showed that they were better correlated with survey indices for ages 1 and 2, which resulted in increased coefficients of determination (Anon., 1996).

Nevertheless, incorporating cod cannibalism data into the NEA cod stock assessment has not been without criticism since it is subject to large estimation errors and that consumption estimates derived by PINRO and IMR differ considerably due to different methods applied (Anon., 1999). The calculation methods underwent a number of modifications in 1997 (Bogstad B. and Mehl S., 1997). However, the Arctic Fisheries Working Group concluded that although consistency with survey indices for ages 1 and 2 improved after incorporation of cannibalism data into the model, further confirmation of its usefulness was required since quality control for stock estimates done on a regular basis by the Arctic Fisheries Working Group, indicates that of abundance for ages 1 and 2 are still poorly estimated (Anon., 2003).

Given these concerns, a study was initiated to examine the effects from incorporation of cannibalism data into the VPA on the quality of stock assessment, to analyze the results from simulations including and excluding cannibalism, and to evaluate their impact on predictions of stock dynamics.

MATERIALS AND METHODS

The following criteria were used for comparing the quality of the NEA cod stock assessment including cannibalism data with the assessment using constant coefficient of natural mortality (M):

- degree of coherence between model abundance dynamics and survey abundance indices;
- comparison of XSA diagnostics;
- stability of key population parameters in the VPA model when new data are added (retrospective analysis);
- quality of recruitment predictions.

Input data for VPA and survey indices were taken from the 2003 AFWG Report (Anon., 2003). Tuning of the model with XSA using data without cannibalism was carried out in the vpa95-program (Darby C.D. and Flatman S., 1994) and all model parameters were taken identical to those contained in the Group Report. Retrospective estimates were derived by the retroVPA-program. The RCT3-program was used to predict the abundance of cod recruitment at age 3 for the next one to three years. Statistical calculations were done in Excel.

RESULTS

The effect from incorporating cannibalism on the coherence of VPA abundance estimates and survey indices

VPA abundance estimates cannot be regarded as independent from survey indices as the latter are used for tuning the model. However, VPA estimates become less dependent on surveys with increasing distance from the terminal year (convergence of the model). For NEA cod convergence of the VPA usually occurs within 5-8 years. Therefore, they can be regarded as independent from survey indices and derived only on the basis of catch-at-age data.

Consistency between VPA estimates and survey indices

As calculations show estimates derived with cannibalism incorporated are much more consistent with abundance indices from the joint Russian-Norwegian winter trawl-acoustic survey of cod and haddock and with combined acoustic indices of abundance from the same survey and Lofoten acoustic survey (Figs. 1-4).

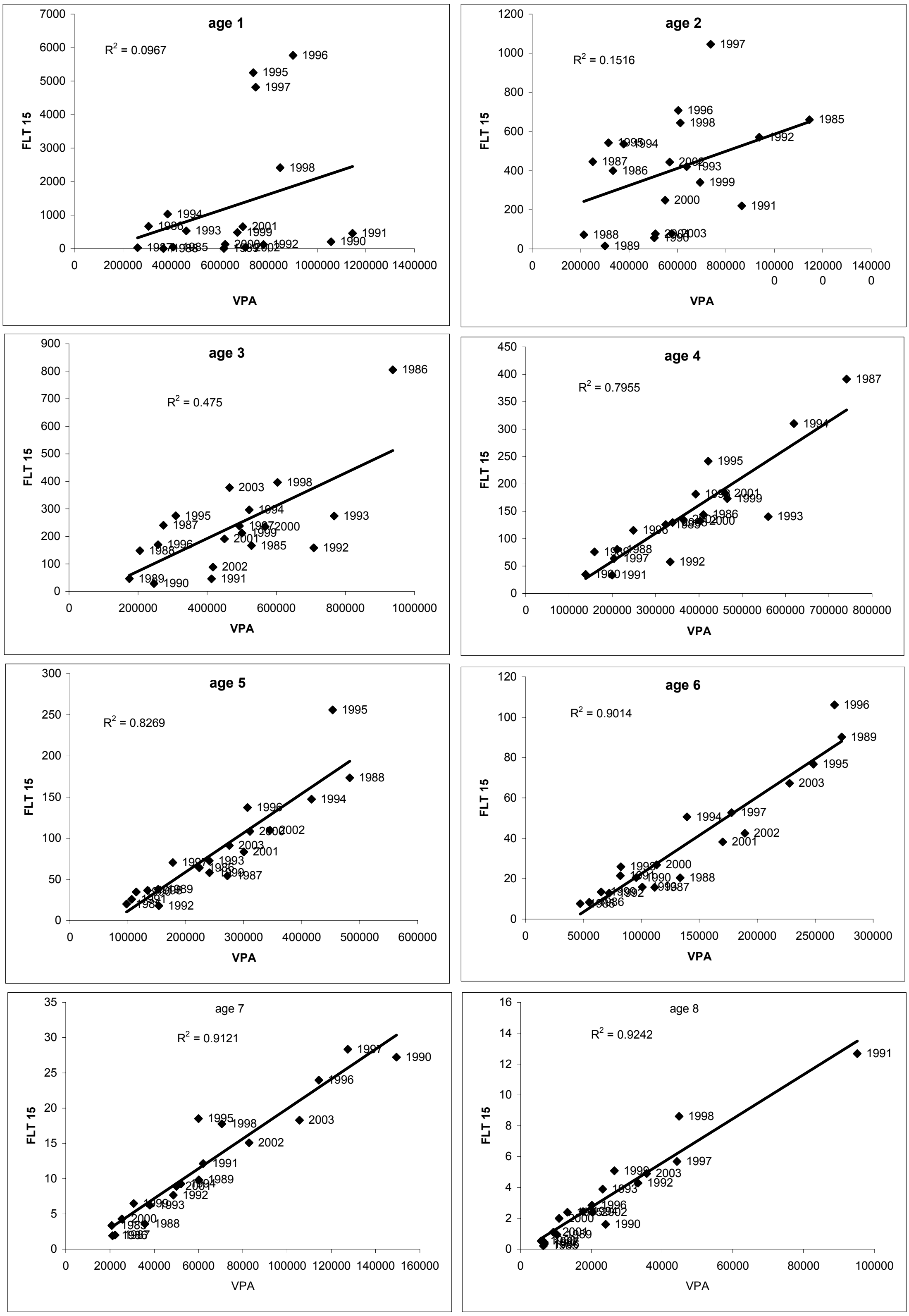

Figure 1 Indices from joint Russian-Norwegian trawl acoustic surveys of cod and haddock and VPA abundance (x 1 000 fish) estimated with M=0.2.
R^2 - coefficient of determination.

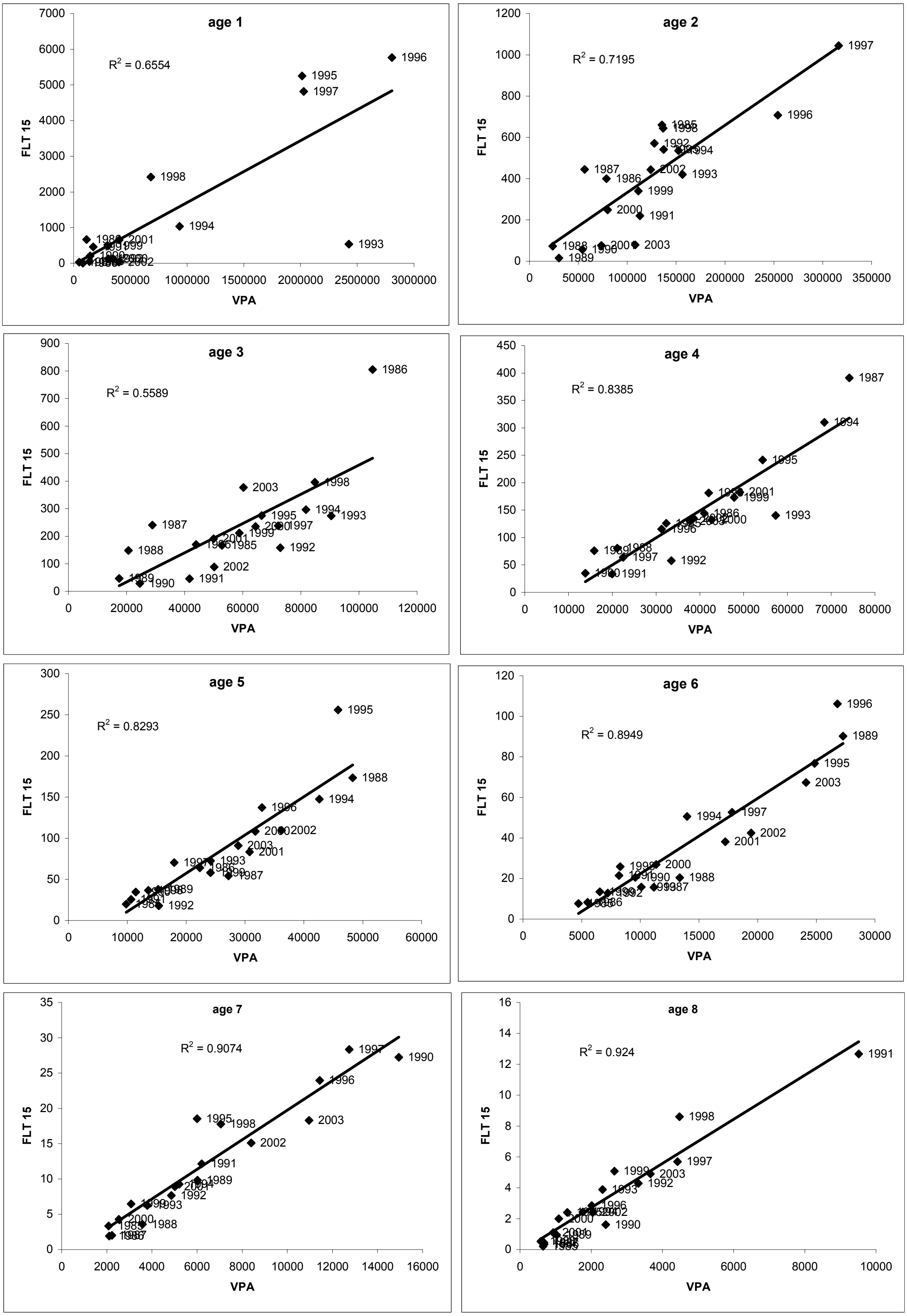

Figure 2 Indices from joint Russian-Norwegian trawl-acoustic survey of cod and haddock and VPA abundance (x 1 000 fish) estimated with cannibalism included.
R^2 - coefficient of determination.

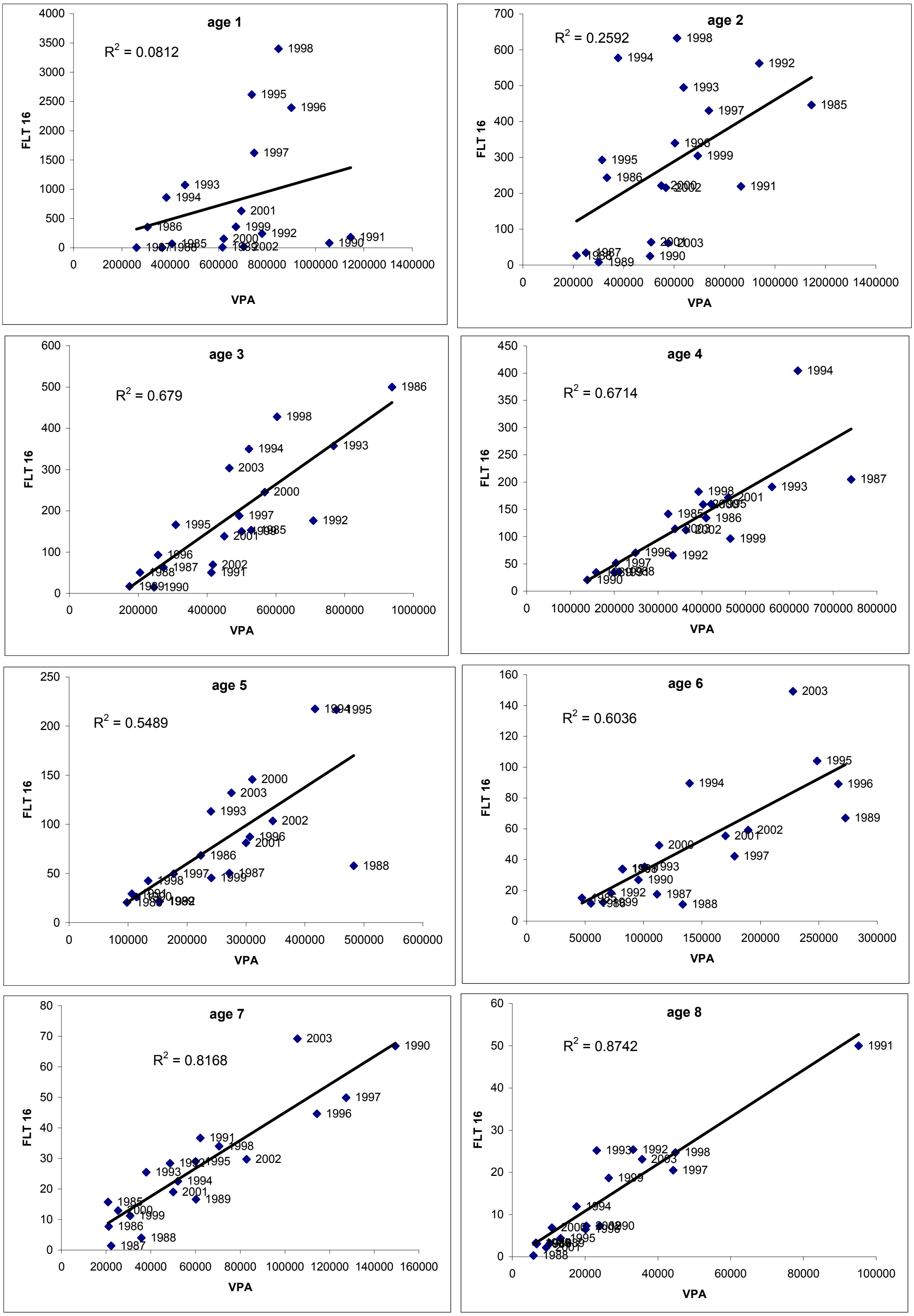

Figure 3 Combined acoustic abundance indices from joint Russian-Norwegian trawl-acoustic survey of cod and haddock and Norwegian Lofoten survey and VPA abundance (x 1 000 fish) estimated with M=0.2.
R^2 - coefficient of determination.

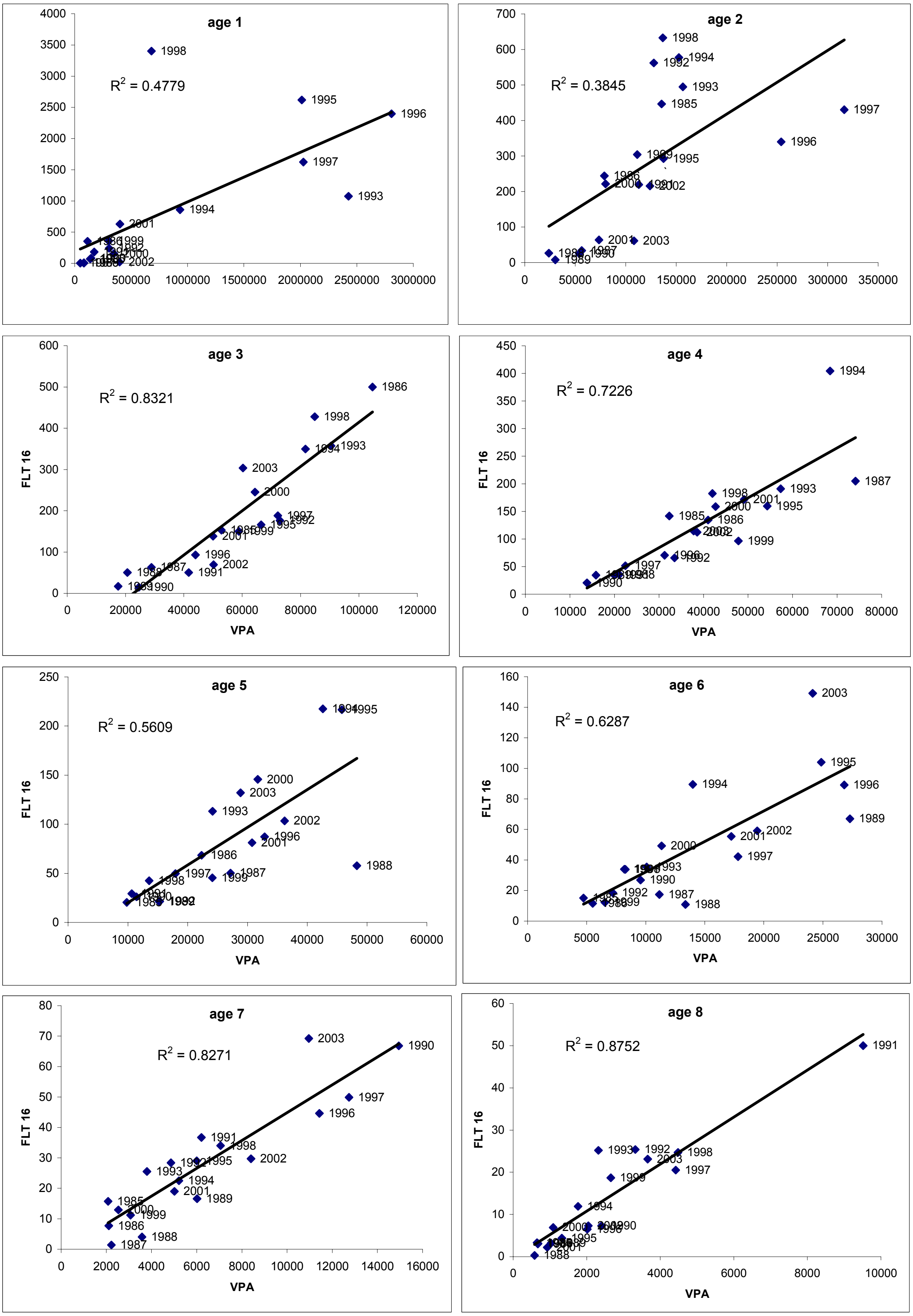

Figure 4 Combined acoustic abundance indices from joint Russian-Norwegian trawl-acoustic survey of cod and haddock and VPA abundance (x 1 000 fish) estimated with cannibalism included.
R^2 - coefficient of determination.

Coefficients of determination between indices and estimated abundance increase considerably for ages 1-2 for all surveys after incorporation of cannibalism into the stock assessment (Table 1).

Table 1. Coefficients of determination between survey indices and VPA estimates from tuning with XSA including cannibalism and using M=const=0.2 (for 1985-2003).

Age group in VPA	**Survey**					
	Joint winter survey		**Joint winter acoust.+ Lofot.**		**Russian survey in Nov−Dec**	
	with can.	**without can.**	**with can.**	**without can.**	**with can.**	**without can.**
1	0.66	0.10	0.48	0.08	-	-
2	0.72	0.15	0.38	0.26	0.75	0.11
3	0.56	0.48	0.83	0.68	0.59	0.70
4	0.84	0.80	0.72	0.67	0.76	0.79
5	0.83	0.83	0.56	0.55	0.64	0.65
6	0.89	0.90	0.63	0.60	0.39	0.39
7	0.91	0.91	0.83	0.82	0.18	0.17
8	0.92	0.92	0.88	0.87	0.17	0.17
9	0.66	0.66	0.94	0.94	0.38	0.38
10	0.73	0.73	0.97	0.97	0.02	0.02

However, as was said before estimates of absolute abundance for these age groups by VPA are not regarded as reliable and therefore not used when management measures for this stock are developed. Nevertheless, fairly good correlation between abundance estimates for younger ages, derived with incorporation of cannibalism data and survey indices represents confirmation in the reliability of estimates of consumption by cod of juvenile cod. Somewhat less was an increase in coefficients of determination for age 3 and even still less for age 4. This increase of r^2 is specific only for combined acoustic abundance indices and joint winter bottom survey (Table 1, Figs. 1-4). Conversely, correlation between abundance indices for ages 3 and 4 from the Russian bottom fish survey and VPA abundance estimates slightly deteriorates when cannibalism is incorporated in the assessment (Table 1, Figs. 5,6). It should be noted, that this survey, on the whole, is characterized by noisier signal compared to the two other surveys. For ages older than 4, incorporation of cannibalism into the stock assessment has had only insignificant effect on abundance estimates and has not affected the consistency between estimates and survey indices.

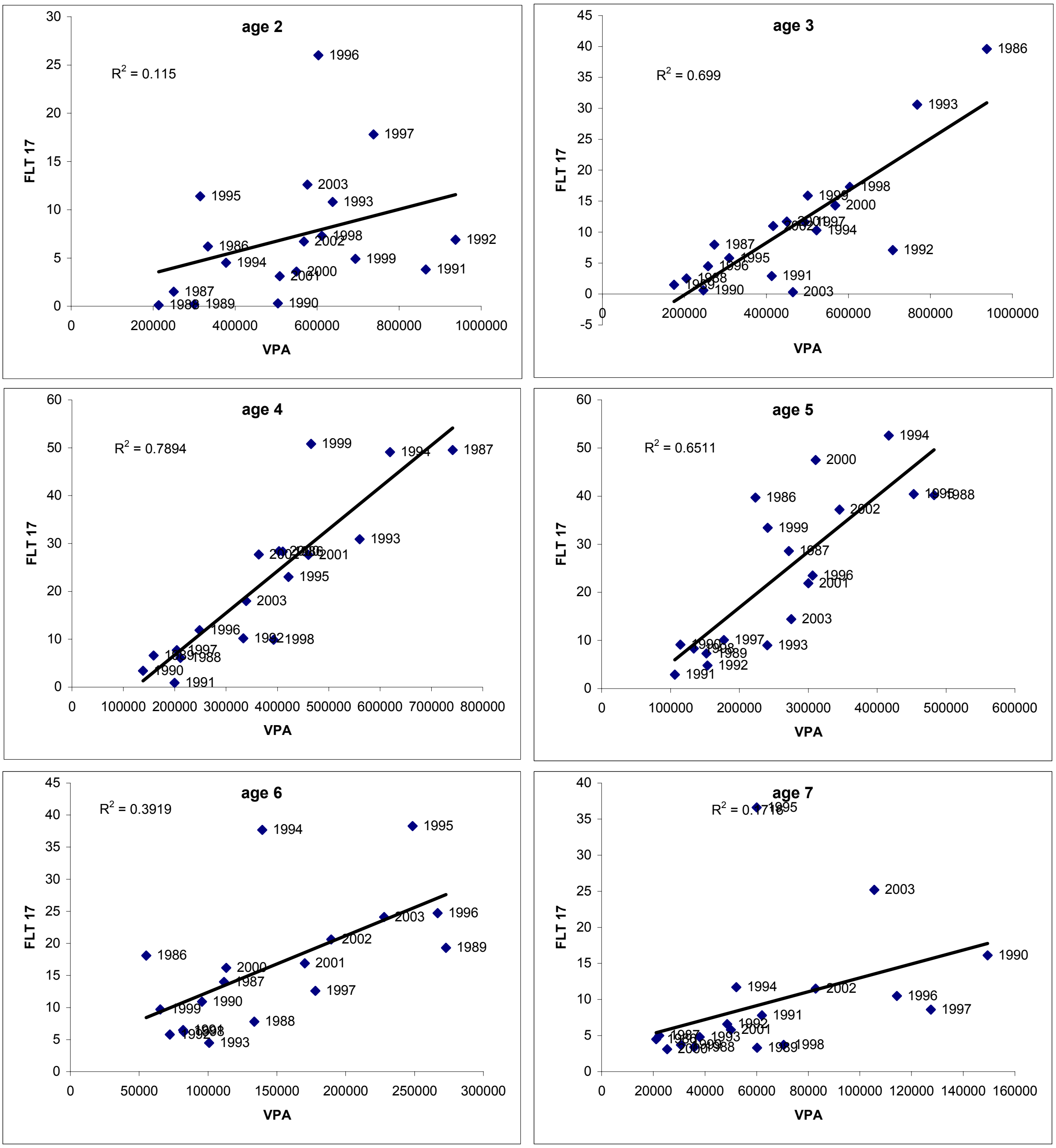

Figure 5 Indices (catch per hour haul) from the Russian bottom fish survey and VPA abundance (x 1 000 fish) estimated with M=0.2.

R^2 - coefficient of determination.

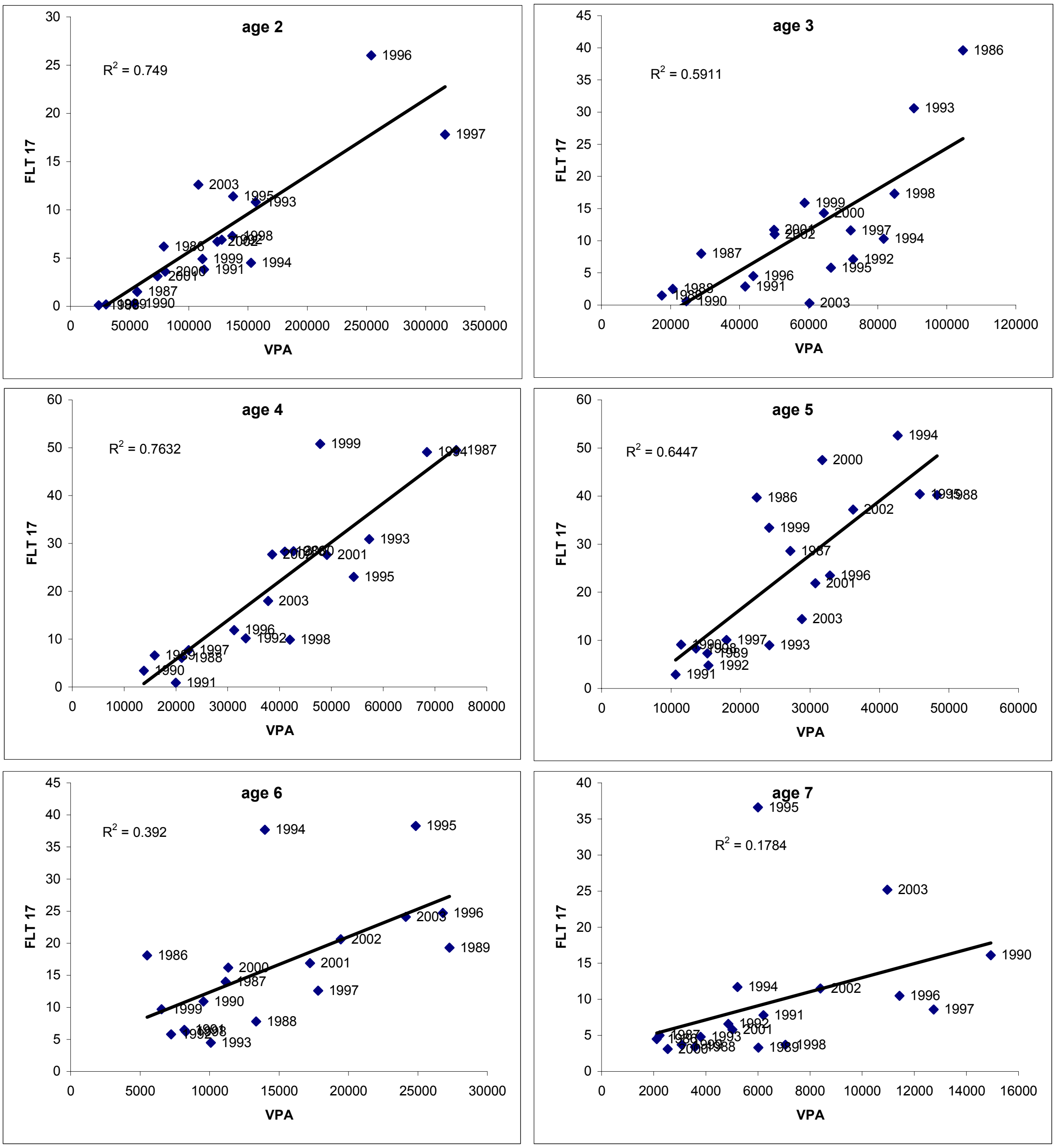

Figure 6 Indices (catch per hour haul) from the Russian bottom fish survey and VPA abundance (x 1 000 fish) estimated with cannibalism included.

R^2 - coefficient of determination.

XSA diagnostics

Based on the analysis of consistency between VPA estimates and survey abundance indices it can be concluded that incorporation of cannibalism data should have a positive effect on the quality of assessment. However, this conclusion becomes less definitive when results from VPA tuning carried out with XSA are reviewed. A comparison of log abundance residuals between the model and surveys indicates that when cannibalism is incorporated values of residuals can both decline and increase (Table 2). A slightly improved correlation between VPA estimates and survey indices after cannibalism data had been included in the analysis was noted only for the joint winter survey, which indicated in a considerable reduction of residuals for most problematic points (years from 1993 to 1995).

Table 2. Difference between absolute values of residuals in XSA tuned with and without cannibalism

age	ABS(residuals for VPA without cannibalism) - ABS(residuals for VPA with cannibalism)									
	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
	Joint Russian-Norwegian winter survey									
3	0.11	0.26	0.21	0.03	0.06	-0.02	0.05	-0.01	-0.02	-0.02
4	0.02	0.05	0.1	0	0.06	0.04	0	0.01	-0.02	0.01
5	-0.02	-0.02	-0.03	-0.01	-0.01	0	0.02	0.01	-0.01	0.03
6	0.01	-0.01	-0.01	0	-0.01	-0.01	0.01	0.01	-0.01	-0.03
7	0.01	0	0	0	0	0	-0.01	0.01	0	-0.02
8	0	0	0	0	0	0.01	0	0	0	0.02
	Combined acoustic indices from the Joint survey and Lofoten survey									
3	-0.23	0.11	-0.24	-0.19	-0.11	0.02	-0.07	-0.07	-0.01	0.03
4	-0.07	-0.08	-0.06	-0.03	0.03	-0.01	-0.05	0	-0.01	-0.01
5	-0.03	0.02	0.03	-0.01	-0.01	-0.01	-0.02	0.01	-0.01	0.01
6	0	0	0.01	0.01	-0.01	0.01	-0.01	0.01	0	0.03
7	0	0.01	0	0	0	-0.01	0	0.01	0	0.02
8	0	0	0.01	0	0	0	0	0.01	0	0.02
9	0	0	0	0.01	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
	Russian bottom fish survey									
3	-0.02	-0.18	-0.22	-0.23	-0.15	-0.13	-0.08	0.07	-0.1	-0.03
4	-0.04	0.01	-0.11	-0.08	0.01	-0.03	-0.04	0.02	0	0
5	-0.06	-0.07	0.03	0.02	-0.04	0	-0.03	0.01	0	0.03
6	0	0	0	0.01	0.01	0	0.01	0	0	0.03
7	-0.01	0	-0.01	0.01	0.01	0.01	-0.01	0	0	0.02

Although including cannibalism data in the assessment generally improves the quality of the overall assessment for the full time series it is less clear for the most recent years. The matrix of residuals in VPA tuning was examined further as a way of presenting the degree of correlation between survey indices and VPA estimates, with the only difference being that VPA tuning is carried out for a considerably shorter time-series (1993-2003) and power regressions are used for ages 3-5. In addition, an important difference is the time series weighting used in XSA. Under this option, the further the year under consideration is from the terminal year the less is the weight of data (i.e. reduced impact on the regression function and assessment output).

Calculation of abundance for the terminal year deserves special scrutiny as it has the highest significance in developing management measures for the fishery. Fig. 7 shows results from comparison of various parameters for diagnostics of abundance estimates for the terminal year, in the 2002 and 2003 assessment years. Clearly, incorporation of cannibalism data into VPA increases, as a rule, estimates of initial abundance for each age in proportion to abundance of cod of that age consumed. Correspondingly, estimates of survivors' abundance in the end of the year derived on the basis of regression and survey index in terminal year will be higher in the model, which incorporates cannibalism (two top diagrams in the figure). It will increase proportionately to the increase in consumption by cod of successive age groups.

A comparison of internal log standard errors, which are a measure of the total log standard error for all surveys, shows that in the model without cannibalism they are, as a rule, smaller. External log standard errors show the degree of divergence between estimates of terminal abundance derived from individual surveys. As shown by the two bottom diagrams in Fig. 7 divergence between estimates from different surveys can both increase and decline after incorporating cannibalism data into the model. The effect from inclusion of cannibalism is related to the year of assessment (data series used) and can impact on the magnitude of between estimated errors with and without cannibalism and even on their behaviour. For instance, with respect to the 2002 assessment (Fig. 7 c, e) it can be stated, that inclusion of cannibalism, in a large part, had an adverse effect on the quality of abundance estimates for survivors in the terminal year by having increased the internal log standard error for practically all ages. This led to considerably increased inconsistency in abundance estimate for ages 3 and 4. With respect to the 2003 assessment the conclusion is not that explicit. Internal and external log standard error increased only slightly, and for age 3 the divergence between estimates by different surveys was reduced markedly (Fig. 7 d, f).

The effect from inclusion of cannibalism on variability of estimates when new data are added into VPA (retrospective analysis)

Retrospective analysis of population parameters such as recruitment at age 3, spawning stock biomass and fishing mortality has shown that VPA estimates for individual years could vary considerably in later assessments (new data added). For the period under consideration, the estimates for years 1993 and 1994 were most unstable (Fig.8). Inclusion of cannibalism into the model reduces both the level of bias and length of the period over which estimates stabilize. This is particularly clear for recruitment estimates. For instance, recruitment estimates by the model without cannibalism derived using data for 1994-1996 differ considerably from estimates derived the longer time series (Fig. 8 a). However, in the model with cannibalism, only the 1994 estimate for recruitment differs from later calculations (Fig.8 b). This model also reduced bias in SSB and F estimates for 1994. These tendencies are stronger when variations in estimates of recruitment, SSB and F for each individual year are reviewed. In the first three years of assessment CV's for estimates of these parameters are generally smaller for the model with cannibalism (Fig. 9b). And CV's for a larger number (more than 5) of assessments (years in retrospective analysis) by the same model are always smaller (Fig.9a), which is also indicative of their faster stabilization.

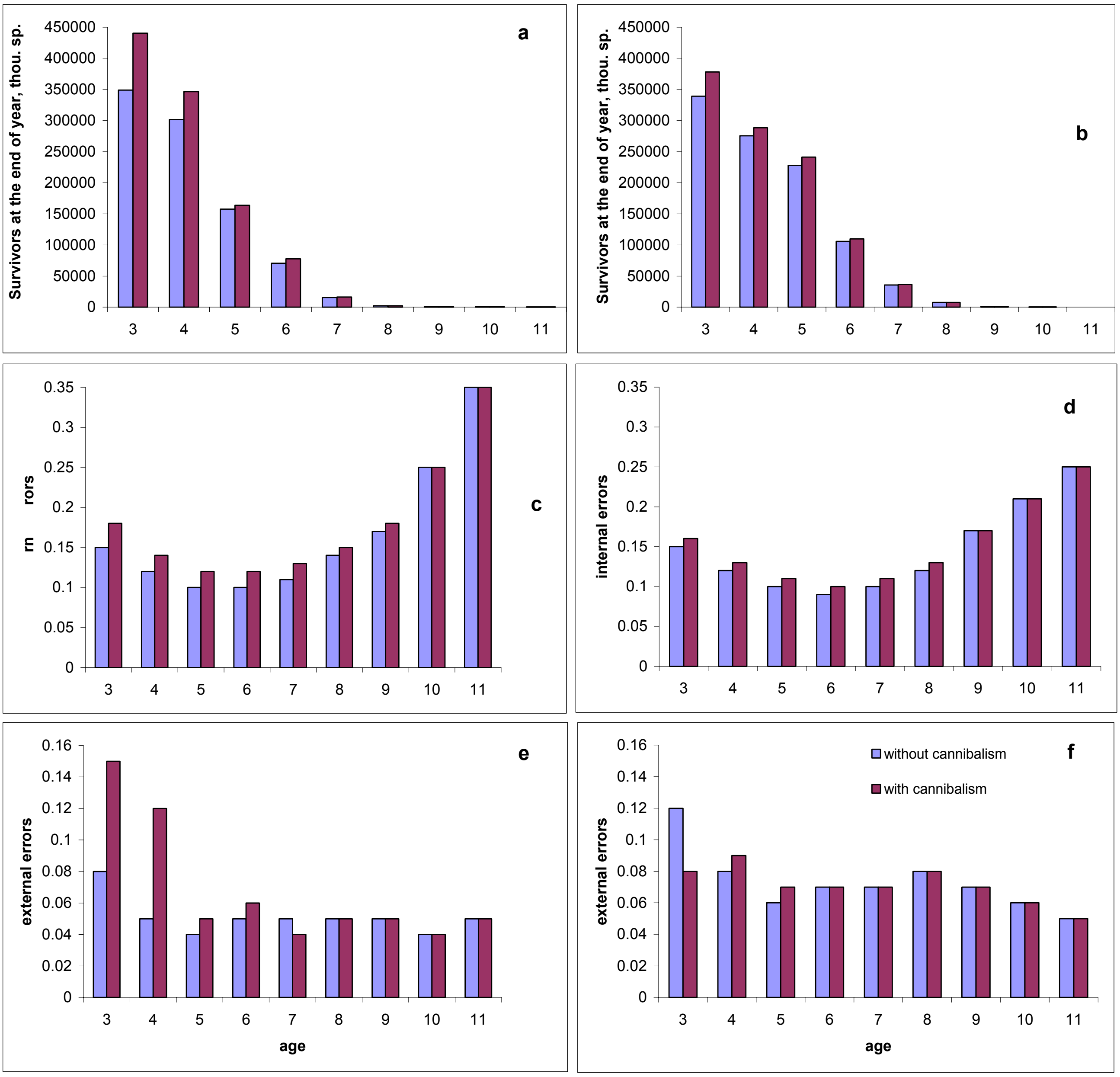

Figure 7 Diagrams of diagnostics parameters from XSA with and without cannibalism.

a, c, e - based on data from AFWG-2002; b, d, f – AFWG-2003,

a, b – abundance of survivors in terminal year (2001 and 2002, respectively),

c, d – internal log standard errors, e, f – external log standard errors

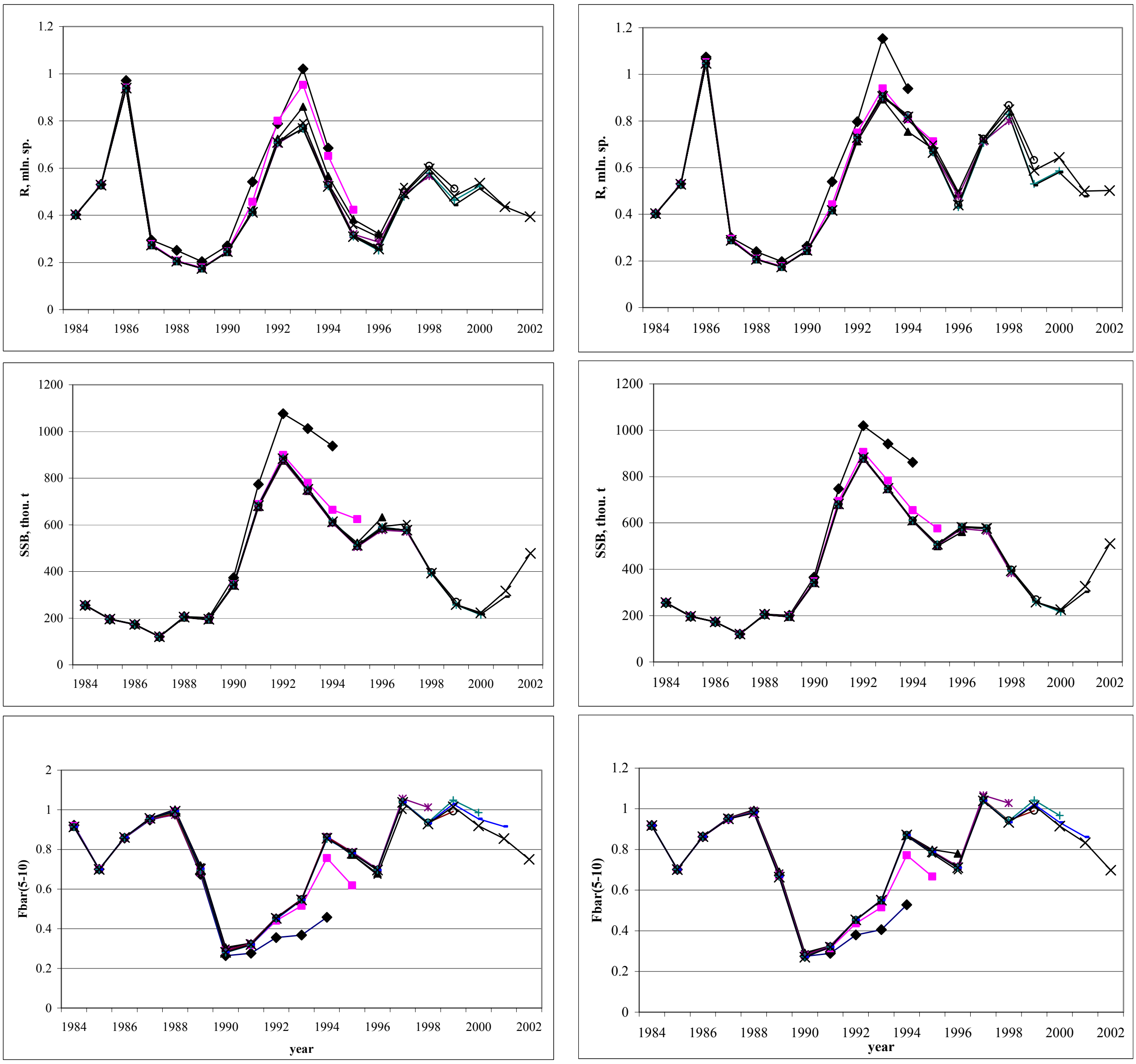

Figure 8 Diagrams of retrospective estimates for recruitment, spawning stock biomass and fishing mortality derived in stock assessment by VPA without (a) and with (b) cannibalism.

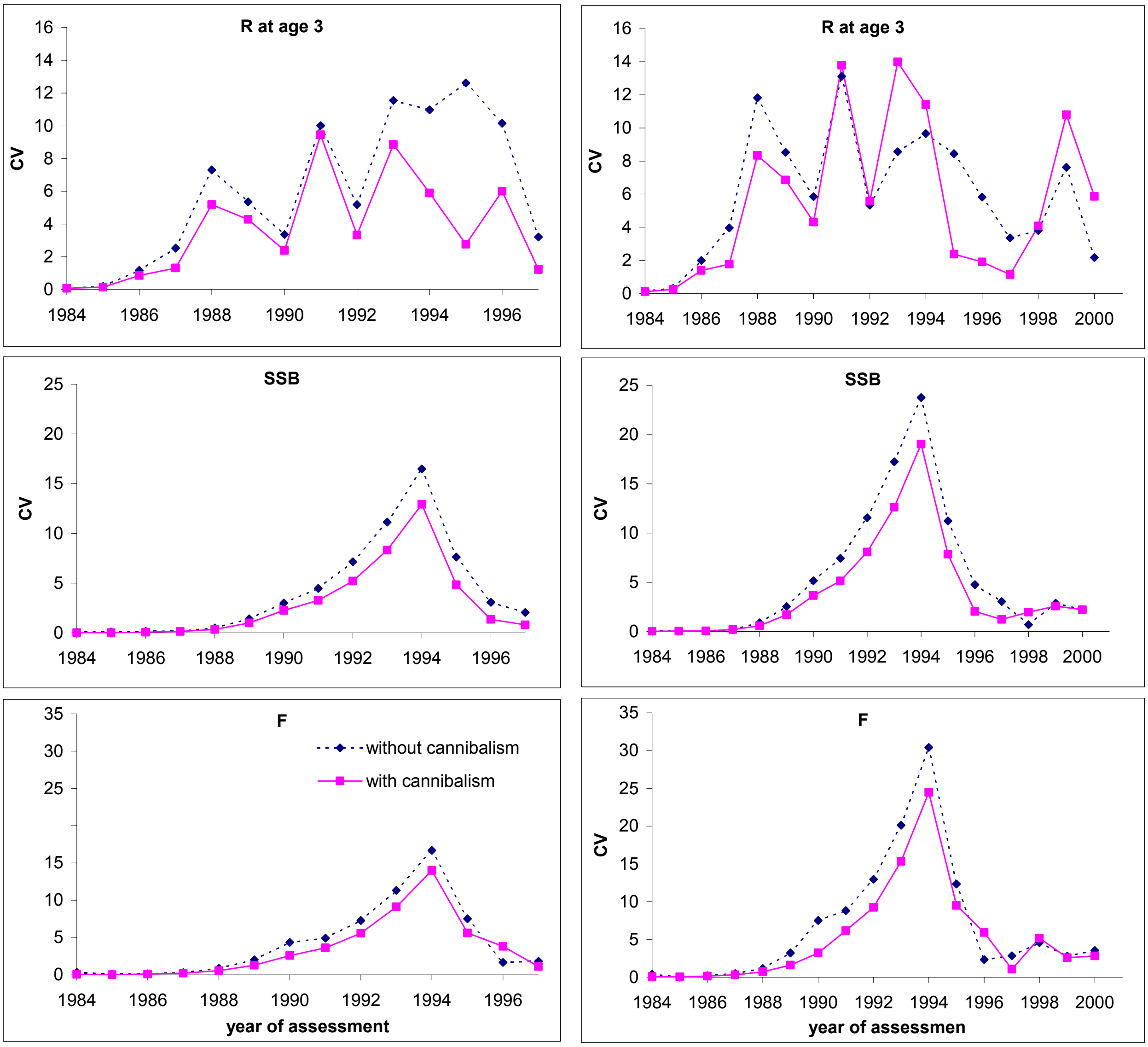

Figure 9 Coefficients of variation for estimates derived by VPA in retrospective analysis.
For the whole period of observations (a) and in the first three years of assessment (b).

The effect from inclusion of cannibalism into the VPA on the quality of recruitment predictions

A time-series comparison for recruitment at age 3 and abundance of the same year classes at a younger age (survey indices) indicates that inclusion of cannibalism into VPA results in more reliable estimates. Dynamics of abundance at age 3 estimated with cannibalism shows much better consistency with almost all indices (Fig.10).

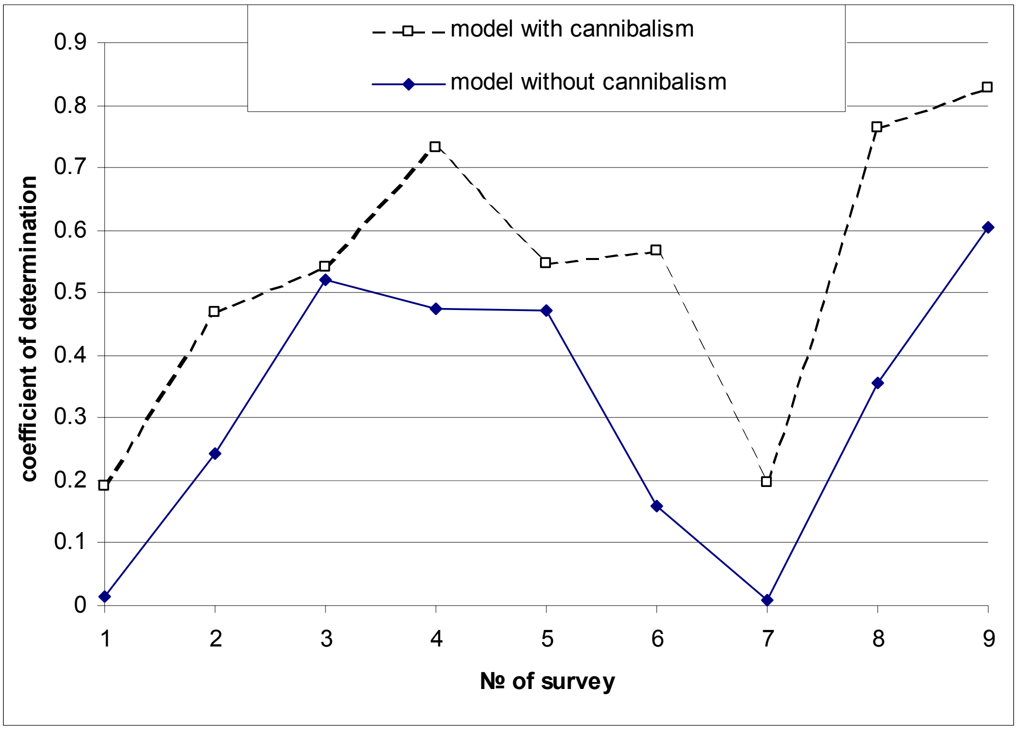

Figure 10 Coefficients of determination between recruitment at age 3 estimated by VPA and survey indices: Russian trawl-acoustic survey, catch per hour haul in ICES SA I+IIb

1 - age 0+;

2 - age 1+;

3 - age 2+ ;

Joint Russian-Norwegian survey of cod and haddock

4 - age 1, catch per effort;

5 - age 1, acoustic estimate;

6 - age 2, catch per effort;

7 - age 2, acoustic estimate;

8 - age 3, catch per effort;

9 - age 3, acoustic estimate.

Relationships between indices at age 0-2 and abundance at age 3 estimated by VPA are used as a basis for predicting recruitment by the AFWG applying RCT3. Including cannibalism data into the assessment produces recruitment predictions of better quality (Fig.11). Excluding cannabalism data from the assessment gives higher predictions of recruitment but with a clear trend in bias (Fig. 11). Before 1998, predictions tended to overestimate the recruitment abundance, but after 1999 to underestimate it. This probably may be explained in that variability of estimates derived without cannibalism is smaller than variability of actual abundance of age 3. Given this, in a situation when survey indices show a considerable increase in abundance for this age group, subsequent calculations by VPA, which uses catch data only, do not show an icreases to the same extent. Similarly, VPA estimates "do not catch up" with actual rapid decline of recruitment abundance. Therefore, an effect of "smoothing" the real dynamics of abundance for younger age groups in the model without cannibalism takes place (Fig.11 a and b, VPA).

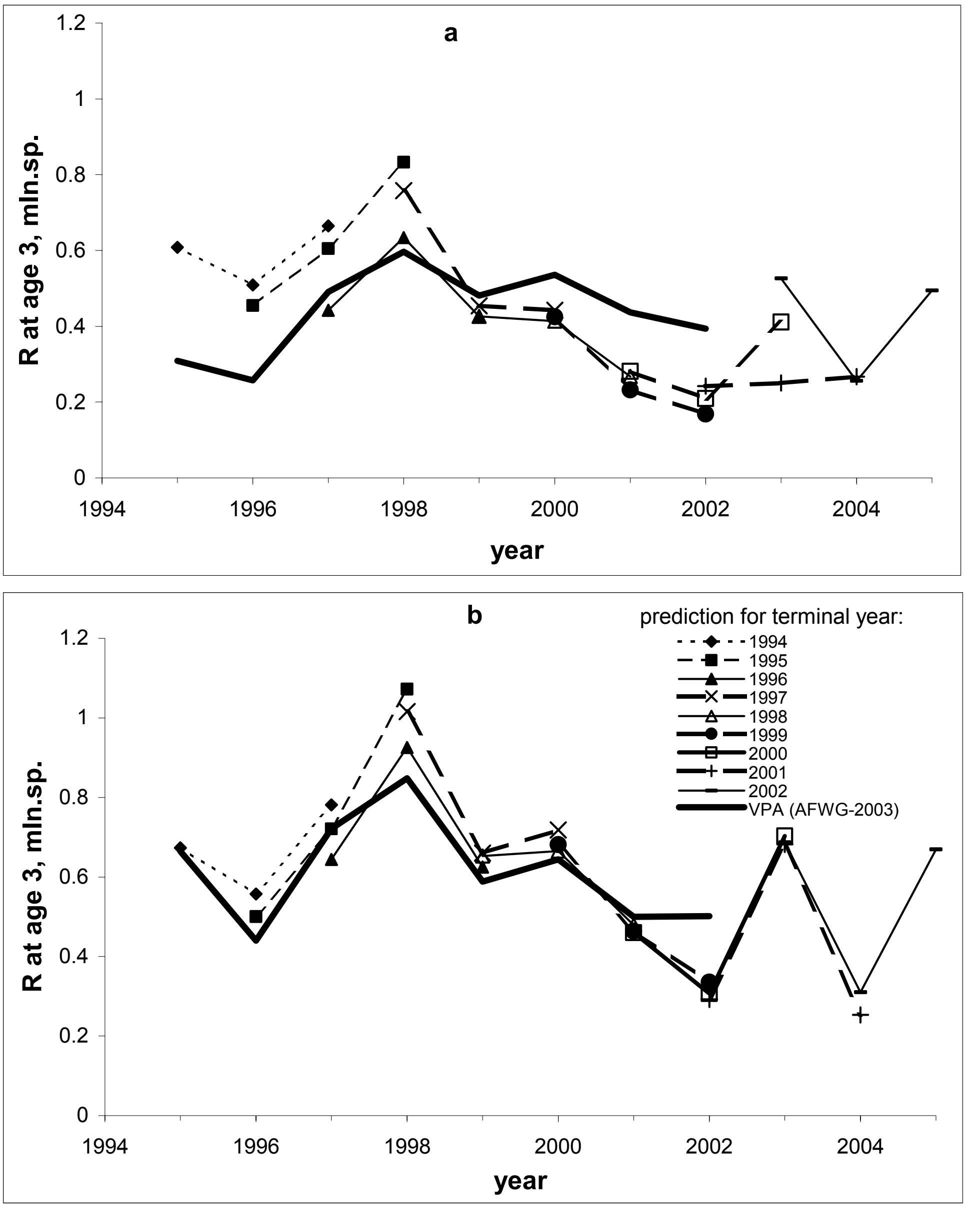

Figure 11 Consistency between VPA estimates of recruitment and predictions for 1, 2 and 3 years ahead done in RCT3-program on the basis of VPA calculations without (a) and with (b) cannibalism.

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Evaluation of the proposed harvest control rule for Northeast Arctic cod

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(Slightly modified from the version submitted to the WG)

1 Introduction

This document contains an evaluation of the harvest control rule for Northeast Arctic cod suggested by the Joint Norwegian-Russian Fisheries Commission in November 2002. The Commission also asked for a similar evaluation for Northeast Arctic haddock, but this evaluation will be delayed until the evaluation for cod has been completed.

2. Background

2.1 Decisions made at the 31st Session of The Joint Norwegian-Russian Fishery Commission in November 2002

At the 31st Session of The Joint Norwegian-Russian Fishery Commission (hereafter referred to as the Commission) in November 2002 the following decision was made:

"The Parties agreed that the management strategies for cod and haddock should take into account the following:

- *conditions for high long-term yield from the stocks*
- *achievement of year-to-year stability in TACs*
- *full utilisation of all available information on stock development*

On this basis, the Parties determined the following decision rules for setting the annual fishing quota (TAC) for Northeast Arctic cod (NEA cod) from 2004 and onwards:

- *estimate the average TAC level for the coming 3 years based on F_{pa}. TAC for the next year will be set to this level as a starting value for the 3 year period.*
- *the year after, the TAC calculation for the next 3 years is repeated basing on the updated information about the stock development, however the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.*
- *if the spawning stock falls below B_{pa}, the Parties should consider a lower TAC than the decision rules would imply.*

The Parties agreed on similar decision rules for haddock, based on F_{pa} and B_{pa} for haddock, and with a fluctuation in TAC from year to year of no more than +/-25% (due to larger stock fluctuations).

The Parties agreed that the working group, which worked out the "Basic Document regarding the main principles and criteria for long term, sustainable management of living marine resources in the Barents and Norwegian Seas" during the following year should illustrate how these decision rules will work. The working group shall, in particular, evaluate what level of percentage change in TAC from year to year will be reasonable to utilise.[1]"

[1] This quotation is taken from point 5.1, in the Protocol of the 31th session of The Joint Norwegian Russian Fishery Commission and translated to English. For an accurate interpretation, please consult the text in the official languages of the Commission (Norwegian and Russian).

Following this request, the 'Basic Document group' prepared a report to Norwegian and Russian authorities (Anon., 2003).

2.2 Request to ICES

The Norwegian Ministry of Fisheries sent a letter to ICES (February 2003), requesting that the advice for TAC on cod and haddock should correspond to the decision rule given in Section 2.1.

Although the letter contained a request that ICES should give advice according to the decision rules established by the Commission, ICES was not asked to evaluate if the decision rules are in accordance with the precautionary approach (PA). However, for any catch option, ICES will routinely state whether it is compatible with the PA, depending on the resulting fishing mortality.

2.3 Evaluation of biological reference points by SGBRP

To evaluate whether the existing biological reference points for Northeast Arctic cod should be modified, a Study Group on Biological Reference Points for Northeast Arctic cod (SGBRP) established by ICES met in Svanhovd, Norway in January 2003 (ICES, 2003b). Based on the approach outlined in by the Study Group on the Further Development of the Precautionary Approach to Fishery Management (SGPA) at its December 2002 meeting (ICES 2003a), the SGBRP proposed the following new reference points for Northeast Arctic cod: B_{lim}=220 000 t, B_{pa}=460 000 t, F_{lim}=0.74 and F_{pa}=0.40. ACFM accepted the proposed revisions in June, 2003.

2.4 Evaluation of the proposed harvesting strategy by ICES' Arctic Fisheries Working Group in 2003

The Arctic Fisheries Working Group met in San Sebastian, Spain, 23 April - 2 May 2003 (ICES, 2003d). Concerning the proposed harvesting strategy for cod, the Group stated that (Section 3.8.4 in the report).

"The appropriateness of the maximum percentage change will be evaluated by a dedicated working group appointed by the Joint Norwegian Russian Fishery Commission before a final decision is made. However, the AFWG notice that the stock fluctuations from year to year may exceed +/- 10%. An attempt to retain catch variations within the 10% may entail both underfishing and overfishing of the stock. It is necessary to test the decision rule with simulation models in order to consider various scenarios of SSB dynamics (both for an increasing and decreasing stock situation). This work needs to be done before the rule is adopted.

A "multi-annual" rule as described above for setting the TAC for Northeast Arctic cod has not previously been considered by ICES Working and Study Groups. Some general points relating to such rules were noted:

According to the ACFM form of Advise any target F should be below F_{pa} to be in accordance with the Precautionary Approach. The medium-term prognosis shows that the new strategy will not always keep F below F_{pa}. The reason is that when F= F_{pa} is applied for a three-year period, the stock will in many cases increase, so that the catch corresponding to F= F_{pa} will also increase during the period. When applying the 3-year averaging method to find the TAC in the first year, this will thus be higher than the TAC corresponding to F= F_{pa} in the first year.

Involving the medium-term prognosis (three years into future) in the setting of quotas for the next year also introduces additional uncertainty due to uncertainty in the prognosis of growth, maturation, recruitment and mortality. Thus, the fishing mortality associated with a multi-annual TAC may have to be set lower than F_{pa} in order to ensure the same probability of avoiding limit values. The ICES should provide guidelines on how to evaluate the effect on multi-annual TAC rules on reference points.

The Working Group did not have available software which could perform a risk analysis applying the agreed harvest control rule."

2.5 Advice given by The Advisory Committee on Fisheries Management (ACFM) in 2003

The ACFM report on NEA cod as of May 2003 and its answer to the request for advice made by the Commission (Section 3.1.10) is given in ICES (2003c). ACFM gave the advice that the TAC on NEA Cod should not exceed 398 000 tonnes, corresponding to a fishing mortality of F_{pa}=0.40. ACFM also calculated the catch corresponding to the decision rule, as requested, and did not find this catch in accordance with the PA, because it would lead to a fishing mortality above F_{pa} for 2004. ACFM did not evaluate whether the decision rule as such would be in accordance with the PA, but made the following statement:

"The 2004 catches calculated by applying the harvest rule imply a fishing mortality above F_{pa}. However, the precautionary reference points as currently used by ICES are defined in the context of advising on an annual TAC based on a predicted catch based on a maximum F. The objective of this Harvest Control Law is to have a low risk of falling below a B_{lim} point. The proposed harvest control rule or modifications of it may actually secure a low probability of SSB dropping below a B_{lim} point and hence be in accordance with the Precautionary Approach because the decision rule is different from that implied in calculating F_{pa}. Simulation studies are needed to reveal if this is the case. ICES is prepared to review and evaluate results of such studies. "

To summarize, ACFM states that the decision rules may be in accordance with the precautionary approach, but conclusions cannot be drawn at the moment. As a consequence, advice for 2004 was given on the basis of the existing "Form of ICES advice", that is, on an annual assessment of F_{pa}.

2.6 Commission meeting 2003

The 32nd meeting of the Commission in November 2003 asked for studies of the maximum long-term yield for cod. Such studies can also be carried out using the model described in this document.

3. Method for evaluating harvest control rules

3.1 Theoretical background

The approach used for evaluating the proposed management plan is the same as outlined in Skagen et al. (2003). The proposed management plan, as well as alternative plans, will be tested by doing **long-term stochastic simulations**. This approach is in line with that outlined by ICES (2003e). We also take into account the work done by the Study group for Long-Term Advice (ICES, 2004).

3.2 Description of the software used

Software, which could evaluate the '3-year' rule in a stochastic setting, was not available. Thus, it was decided at IMR to develop new software for such projections. This new program (Åsnes, 2004) is named 'PROjections Stochastic' or PROST. It is written in Java.

4. Population model for Northeast Arctic cod

It is important to remember that the results of an evaluation of a harvest control rule are dependent on the population model used. Previous analyses concerning reference points and harvest control rules (e.g. ICES, 2003b) have used a rather simplistic population biology, with no modelling of density-dependent effects and recruitment only being dependent on SSB. However, we found it appropriate to try to include as much biological knowledge as possible in our population model, as advocated e.g. by Ulltang (1996). Our results will be compared with results using a simpler population model.

The results may be altered e.g. by introducing TEP instead of SSB in the model, modelling cannibalism explicitly or by introducing length structure in the model. Multispecies models may also give different results from single-species models.

The following units are used in this paper:

Individual weight: kg
Recruitment: billion (10^9) individuals
Stock biomass: million tonnes

4.1 Recruitment

4.1.1 The segmented regression approach

ICES (2003b) modelled the stock/recruitment relationship for NEA cod using the segmented regression approach. In that analysis, recruitment at age 5 was used due to problems with including discards and cannibalism of age 3 and 4 in the time series. The report states that age 5 should be used until more accurate estimates of the number at age 3 are available. For our simulation studies, however, we want to use recruitment at age 3.

The choice of time series is crucial here. If we use the entire time series it will be logical not to include natural mortality from cannibalism in the model at all when the stock-recruitment function is based on data without cannibalism. If we hypothetically had a full time series including cannibalism we would expect this to show higher recruitments at high stock and rather unchanged at low stock, thus giving another stock-recruitment function. In that case our model for estimating stock size and yield should take account of the increased cannibalism at high stock. When our stock-recruitment function does not include cannibalism, our population model should not either. Our main analysis will thus be without cannibalism. We will include some additional analysis to illustrate some effects of cannibalism.

A segmented regression between spawning stock and recruitment at age 3 (no cannibalism) for the year classes 1946-1999 is shown in Fig. 1. The segmented regression was performed in the same way as described in ICES (2003b), using the method described by O'Brien and Maxwell (2002).

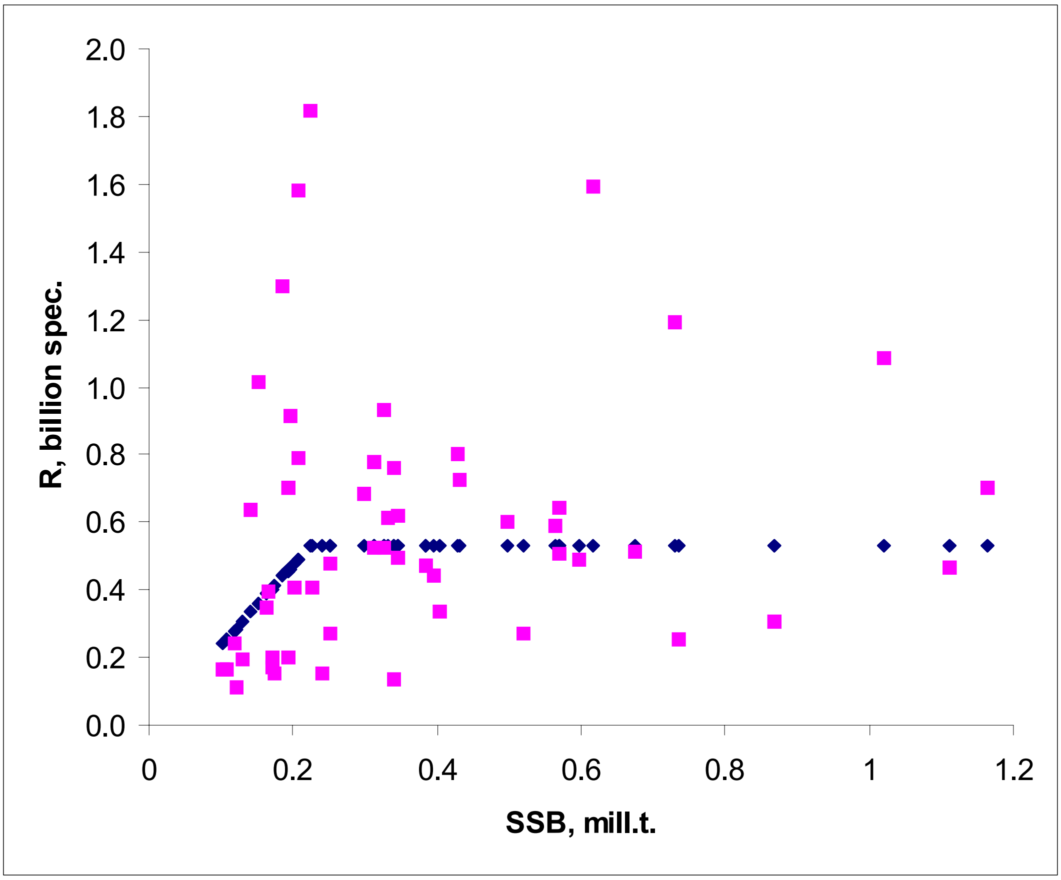

Figure 1. Segmented regression between spawning stock biomass and recruitment at age 3 (no cannibalism).

The segmented regression shown in Figure 1 can be written as

$$f(SSB) = \min(\frac{\alpha}{\beta} SSB, \alpha) \quad (1)$$

where α=0.529 and β=0.224.

4.1.2 Extending the segmented regression approach by including a cyclic term and the mean weight in the spawning stock

Fig. 2 shows the residuals obtained when fitting the segmented regression. These residuals vary in a cyclic way with time, but there is also a significant ($p < 0.05$) declining trend over time. This trend may be due to the change in size and sex composition of the spawning stock. Marshall et al. (2003) found that the correlation between total egg production (TEP) and recruitment is stronger than the correlation between spawning stock biomass and recruitment. The TEP/SSB ratio is affected both by the size composition and the sex ratio in the spawning stock. The relative fecundity (g eggs/kg spawner) increases with increasing size (length/weight) of spawners (ICES 2003f), and the mean weight of spawners has declined. Fig. 3 shows the mean weight $\overline{w}$ in the spawning stock, which has a significant ($p<0.01$) declining time trend. Also, stocks having a higher proportion of large cod have higher proportions of females simply because of the earlier maturation and mortality of females (Ajiad et al. 1999; Jakobsen and Ajiad 1999). Fig 4.9 in ICES (2004) shows that the female SSB/total SSB ratio for Northeast Arctic cod covaries systematically with the mean length of the spawning stock.

Thus, we chose to include $\overline{w}$ in the stock/recruitment relationship in order to take into account the change in the ratio between TEP and SSB over time. A more satisfactory approach would be to use a length-and sex-structured population model where fecundity can be calculated for each length class of female fish based on the equations given in ICES (2003f). Such a population model is under development (Bogstad et al., 2004), but could not be used in the present study. The TEP/recruitment relationship given in Marshall et al. (2003) could be compared with a relationship where SSB and $\overline{w}$ is included to check how much of the recruitment variation is explained by TEP vs. that explained by SSB and $\overline{w}$.

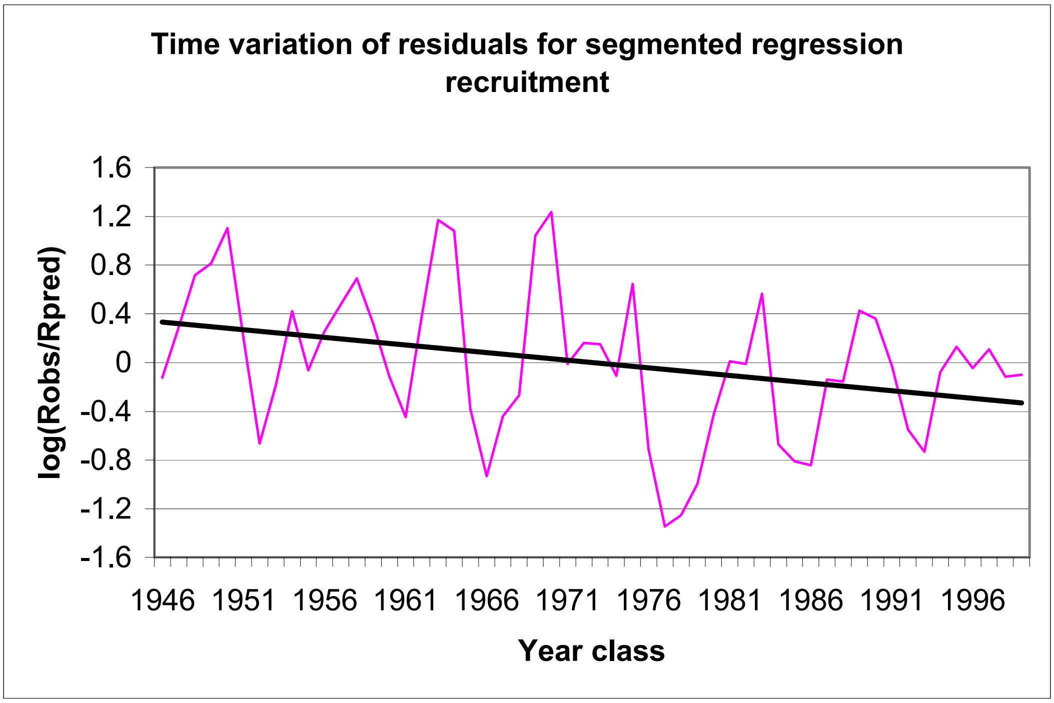

Figure 2. Time variation of residuals for segmented regression recruitment

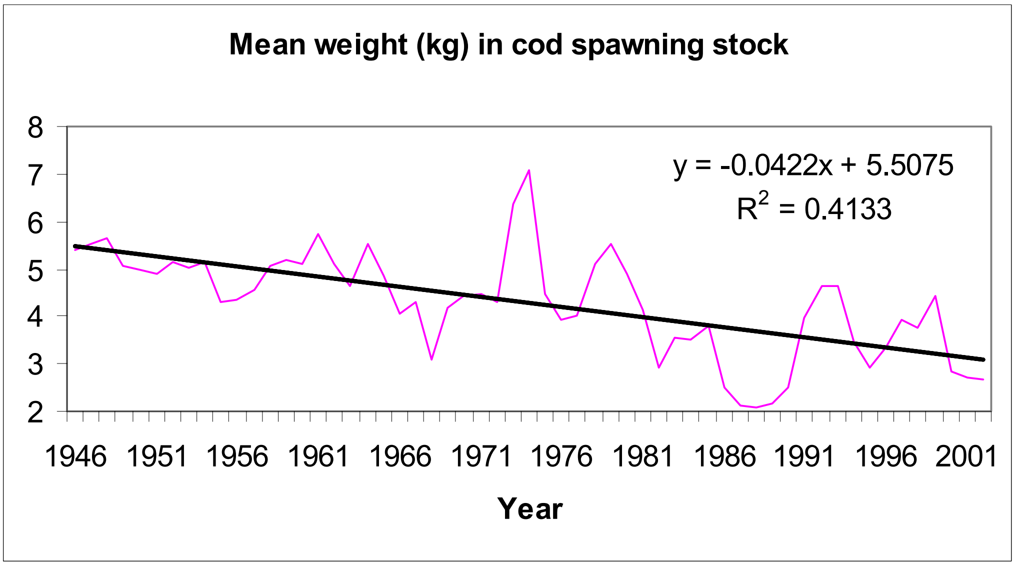

Figure 3. Mean weight (kg) in cod spawning stock

A reasonable description of the stock/recruitment relationship may thus be

$$R_3(year+3) = f(SSB(year))e^{A\circ Sin(\frac{2\pi(year-1946+\varphi)}{T})+k(\overline{w}(year)-w_0)+\varepsilon} \quad (2)$$

where ε is a stochastic term and f(SSB) is given by equation (1). $R_3(year+3)$ is the number of age 3 fish in the beginning of year $y+3$.

We first tried to include the cyclic term in the exponent, and then both this term and the $\overline{w}$ term. The results of the model fit (minimising log SSQ), which was carried out using Solver in Excel, are given in Table 1. The residuals when both terms are included are shown in Fig. 4, and the predicted vs. observed values of recruitment using equation (2) with $\varepsilon=0$ are shown in Fig. 5. The model does not pick up the outstanding year classes, but still performs fairly well. The time trend is no longer significant ($p>0.05$).

Model	α	β	A	φ	T	k	w_0	ε	Log (SSQ)	proportion of variability explained compared to constant recruitment
Constant recruitment									26.90	
Only segmented regression	0.529	0.224							19.76	0.27
Cyclic term included	0.529	0.224	0.43	-1.92	6.57				14.55	0.46
Cyclic and mean weight term included	0.529	0.224	0.53	-2.02	6.55	0.19	4.29		12.68	0.53
Cyclic, mean weight and stochastic terms included	0.581	0.286	0.52	-2.04	6.53	0.19	4.30	0.497	13.11	0.51

Table 1. Results of fit of recruitment model

It is important to include the cyclic variation in our recruitment model because the harvest control rule has to be capable of dealing with a series of weak year classes in a precautionary way. Several authors (e.g. Ottersen and Stenseth, 2001) have found a good correlation between temperature and recruitment, and there are cyclic variations in temperature. However, reliable long-term (or even medium-term) predictions of temperature variation are not available (Ottersen et al., 2000), and thus we do not include temperature in our recruitment model.

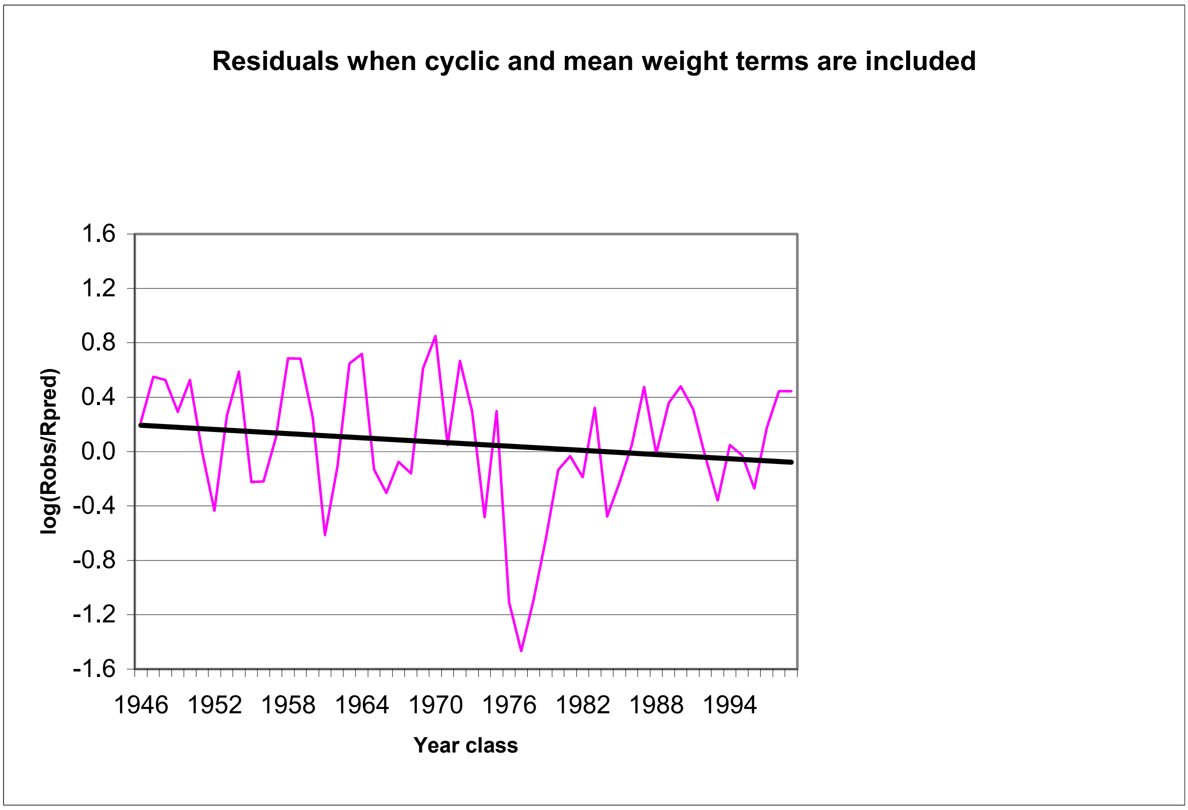

Figure 4. Residuals when cyclic and mean weight terms are included in the recruitment function.

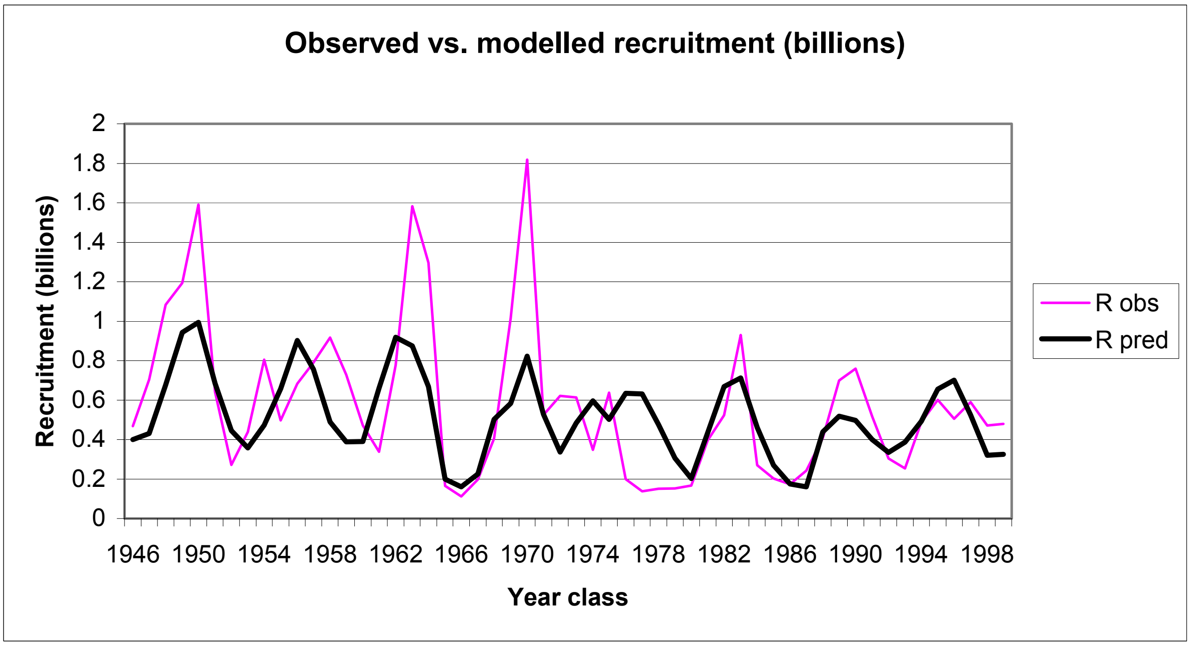

Figure 5. Observed vs. modelled recruitment when cyclic and mean weight terms are included in the recruitment function.

Figures 6 and 7 show the residuals vs. SSB and vs. $\overline{w}$, using the model with a cyclic term as well as a mean weight term. The residuals are not significantly correlated ($p>0.05$) with SSB or $\overline{w}$.

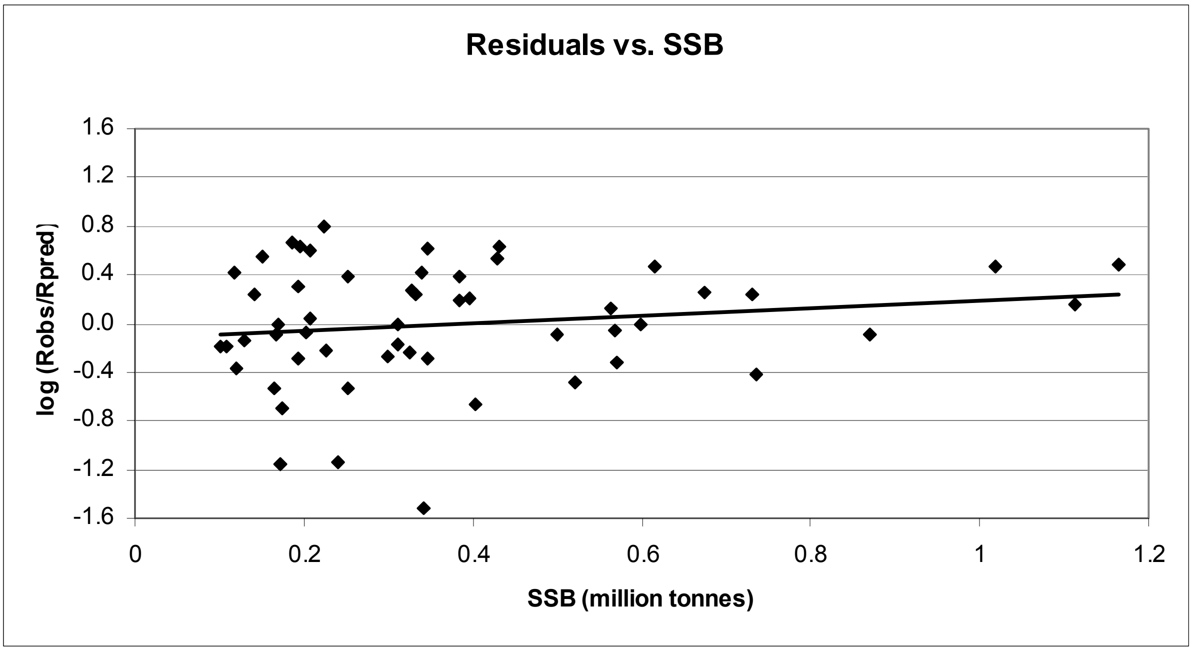

Figure 6. Dependence of SSB on residuals

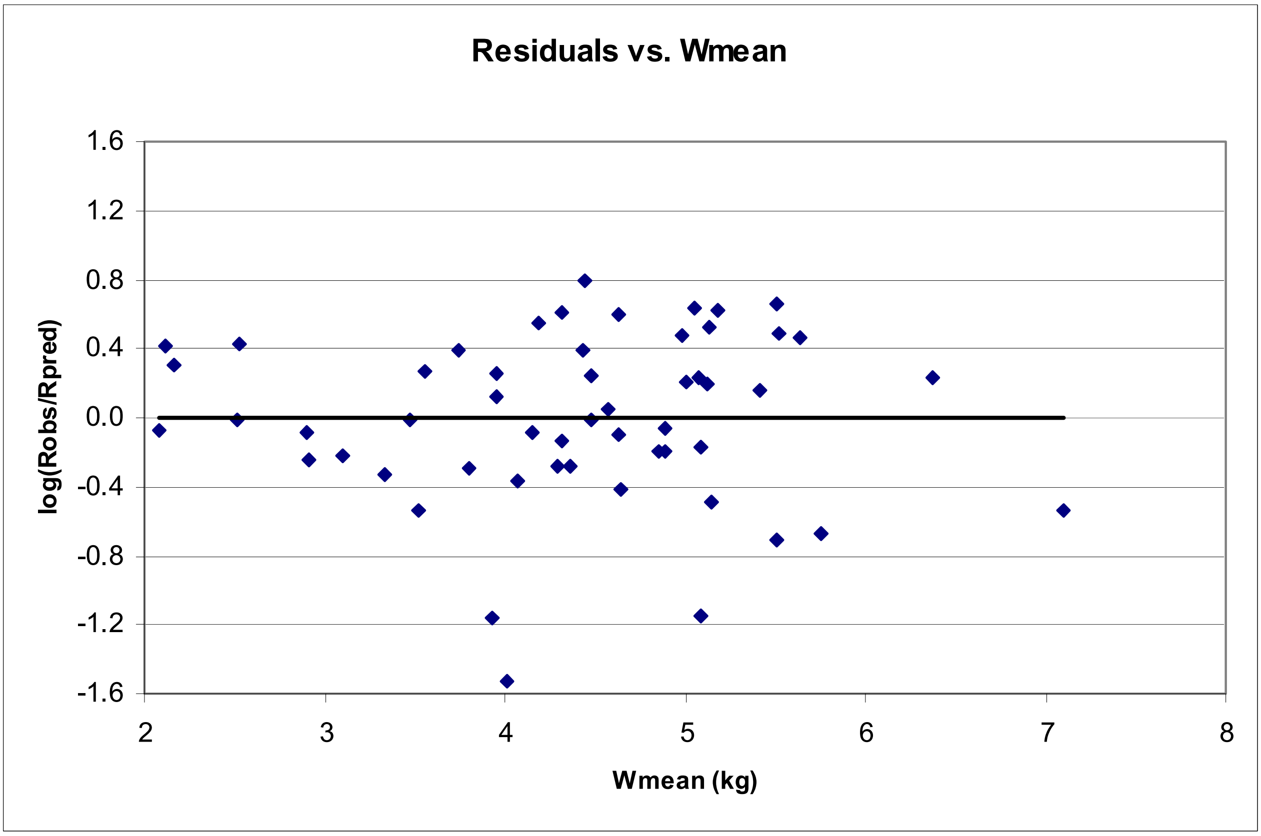

Figure 7. Dependence of $\overline{w}$ on residuals.

4.1.3 Determining the variance in the stock-recruitment function

We then need to determine the stochastic term ε in (2). We will follow the approach outlined by Skagen and Aglen (2002). They suggested 3 quality criteria for stochastic stock-recruitment functions:

1. Independence between residuals and SSB
2. Probability coverage
3. The recruitment estimates should be unbiased.

Criterion 1) has been tested for by looking at the deterministic stock-recruitment function (Fig. 6). The residuals are not correlated with SSB, but the variability in recruitment seems to be higher at low SSBs, and this could be modelled by making the variance a function of SSB.

2) is a control that the distribution assumed for the residuals is adequate, while 3) may be used as an additional constraint when finding the parameters of the stock-recruitment function.

Assuming that each of the historic residuals is equally likely, the rank of each of them, divided by the number of observed residuals, gives the empirical cumulated probability of the historical residuals. On the other hand, according to the model that is assumed for the residuals in the prediction, there corresponds a cumulated probability for the value of each observed residual. Each of these model probabilities should be close to the empirical cumulated probability of the same historic residual. The Kolmogorov goodness of fit test is based on this reasoning, and the Kolmogorov test statistic can be derived directly from the pairs of modelled and observed values.

The fit was done using Solver in Excel spreadsheets described by Skagen and Aglen (2002). Constraints on zero correlation between residuals and SSB and on the sum of the difference between modelled and observed recruitments being zero were applied. In the fitting procedure, all the parameters in the stock-recruitment function were re-estimated (Table 1). The parameters α and β in the segmented regression (equation (1)) changed somewhat, but the other parameters were very close to the values estimated using the corresponding deterministic model. Assuming a log-normal distribution, i.e. $\varepsilon = N(0,\sigma)$, σ =0.497 gave the best fit to the data. Fig. 8 and 9 show the probability coverage and observed vs. modelled recruitment for this distribution. The fit seems to be rather satisfactory.

The final test in any case is to take the distribution (or at least the standard percentiles) of recruitments from a long-term prediction and compare with the historic recruitments generated by similar levels of SSB.

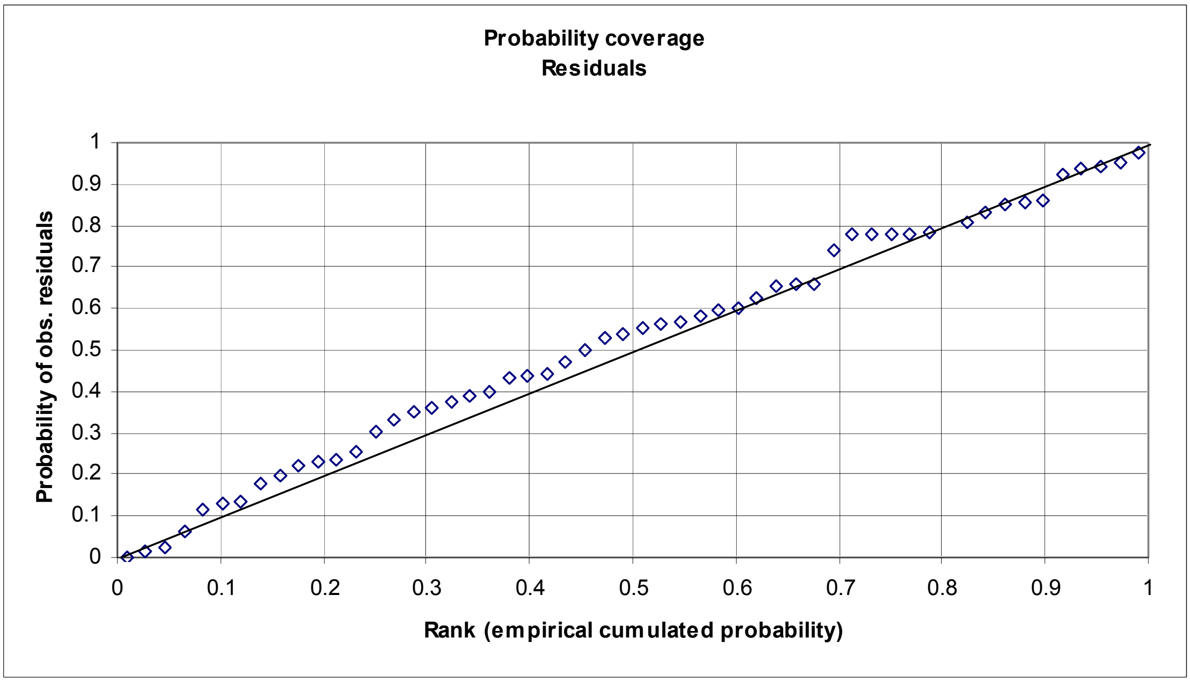

Figure 8. Probability coverage for stochastic stock-recruitment function

Figure 9. Observed vs. modelled recruitment for stochastic stock-recruitment function.

4.2 Growth(weight at age)/Maturity

There are several possibilities for modelling this:

1) Using a time series average

2) To draw randomly weight at age in stock and catch and maturity at age from the entire time series (i.e. draw a year)

3) To fit a model for stock size dependence of growth and maturity to the entire time series and to simulate the uncertainty using a statistical model (e.g. normal distributed residuals with estimated σ) or draw randomly observed residuals around fitted trends. For weight at age, the model could probably be linearly dependent of total stock biomass (TSB), while for the maturity at age, it could be assumed to be a sigmoid function of TSB.

Approach 1 does not take the uncertainty in those parameters in account. Approach 2 will overestimate the uncertainty related to changes in those parameters. We have not observed so wide range of changes in weight and maturity as we will simulate by this approach. Actually there are trends in these data and considerably less variation around trends. This approach will also give a bias in the results. When F is low, we will overestimate TSB, SSB and yield, when F is high we will underestimate those quantities. In order to avoid that, we will try approach 3). For all approaches, it could be discussed whether the entire time series should be used.

Heino et al. (2002) found that both increase in growth rate and change in age-and sex-specific tendency to mature have contributed to the observed trend towards earlier maturation. Thus, part of the change may represent a fisheries-induced adaptive genetic change. We will not take this into account in our analysis.

4.2.1 Growth (weight at age)

We have used the entire time series (stock weights in 1947-2003 vs. total stock biomass in 1946-2002) to fit a density-dependent model for weight at age (kg) in the stock $ws_{a,y}$ for ages 3-9. The model is of the form

$$ws_{a,y} = -\alpha_a TSB_{y-1} + \beta_a \quad (3),$$

where TSB_y is the total stock biomass in year *y*, *a* is age and α_a and β_a are constants. The regressions are shown in Figure 10a-g, and the parameters in the regressions are given in Table 2.

Age	α_a	β_a	R^2	p
3	0.010745	0.3206	0.0138	> 0.05
4	-0.030914	0.7607	0.0249	> 0.05
5	0.058946	1.3779	0.0524	> 0.05
6	-0.11788	2.2852	0.1202	< 0.01
7	-0.21385	3.5271	0.2076	< 0.01
8	-0.37067	5.1876	0.2771	< 0.01
9	-0.70013	7.4611	0.4273	< 0.01

Table 2. Parameters in regression for density-dependent weight at age in the stock.

We see that the relationship for ages 3-5 is insignificant. For those ages TSB could not be used as predictor. The biology and food composition of those age groups is different from that of older ages. We may use average values and model residuals or we may try to find relationship between weights at age and abundance at age for these age groups. For age 10+ we will use a historic average.

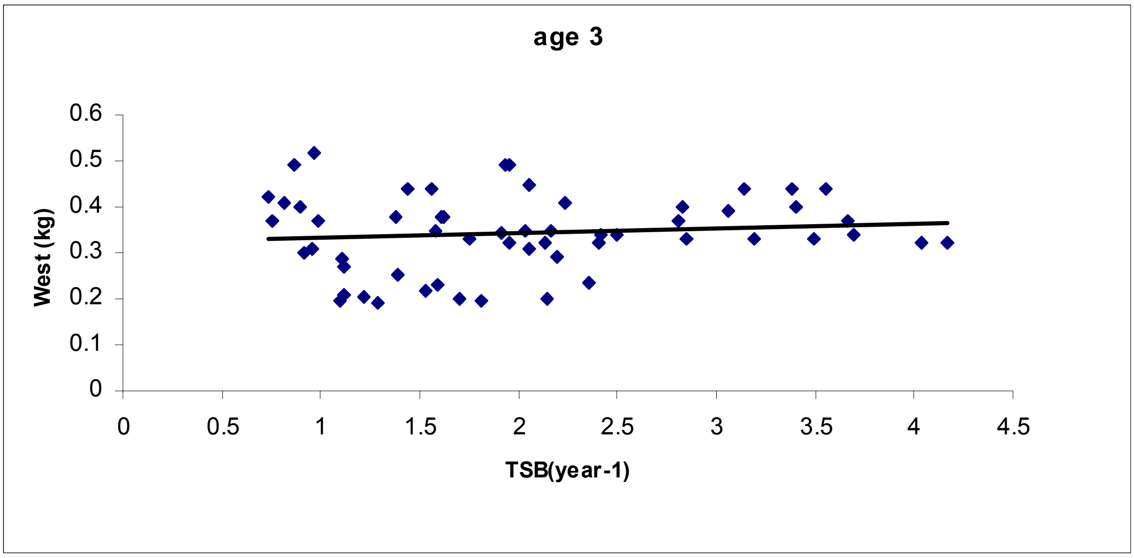

Figure 10a. Weight in stock vs. total stock biomass for age 3 cod.

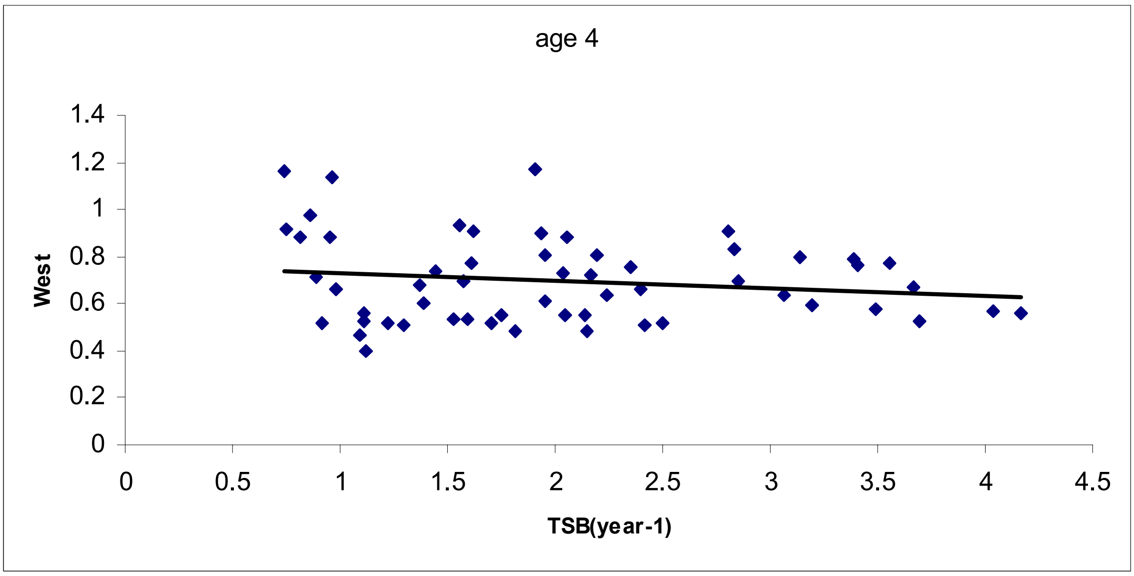

Figure 10b. Weight in stock vs. total stock biomass for age 4 cod.

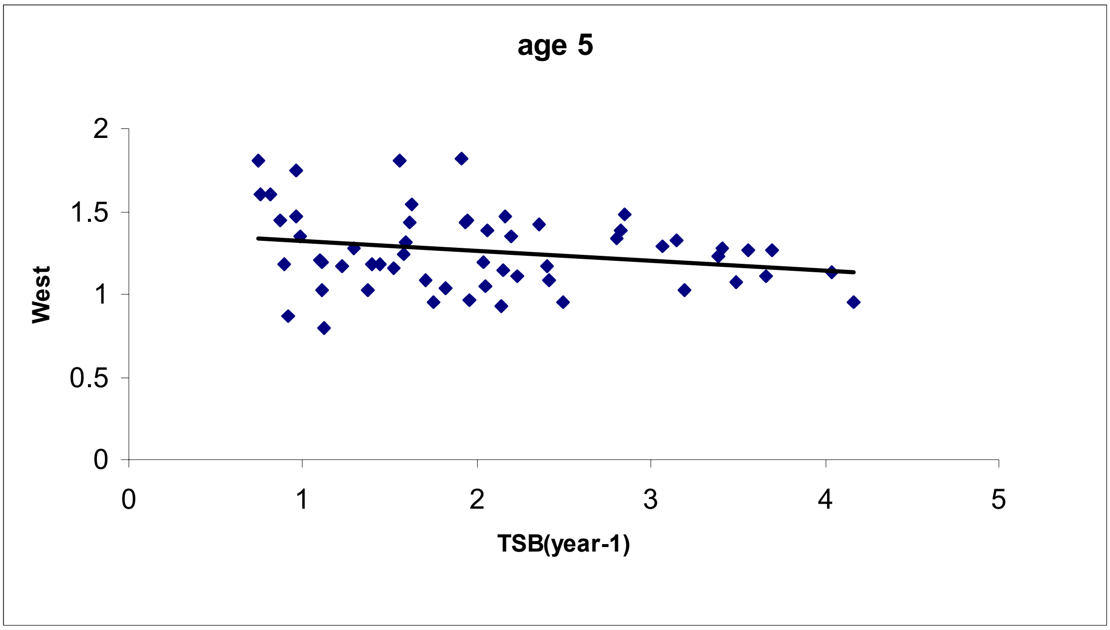

Figure 10c. Weight in stock vs. total stock biomass for age 5 cod.

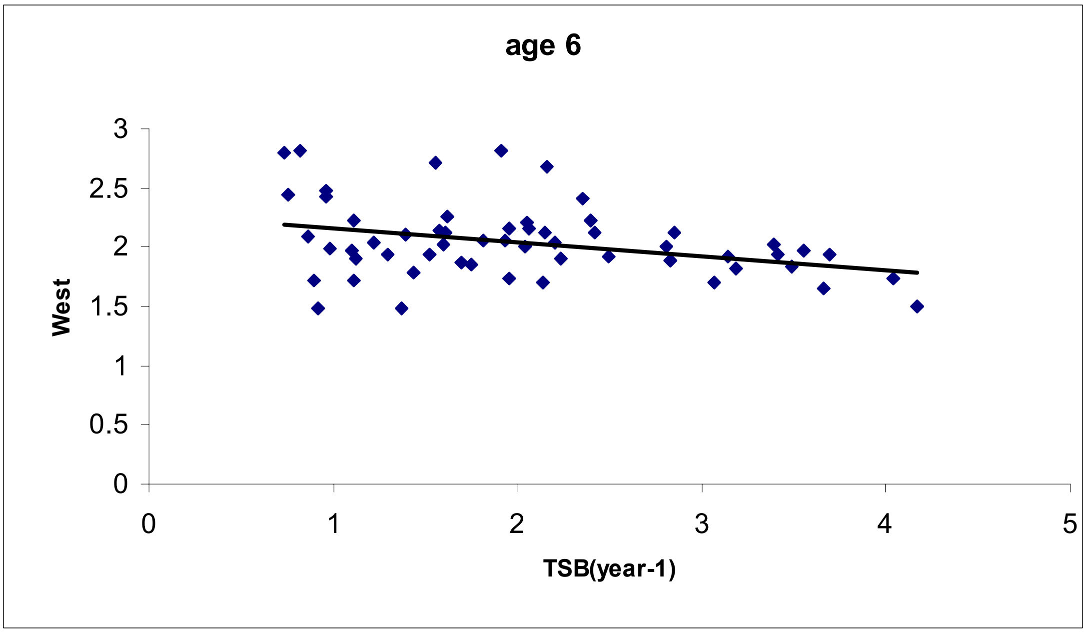

Figure 10d. Weight in stock vs. total stock biomass for age 6 cod.

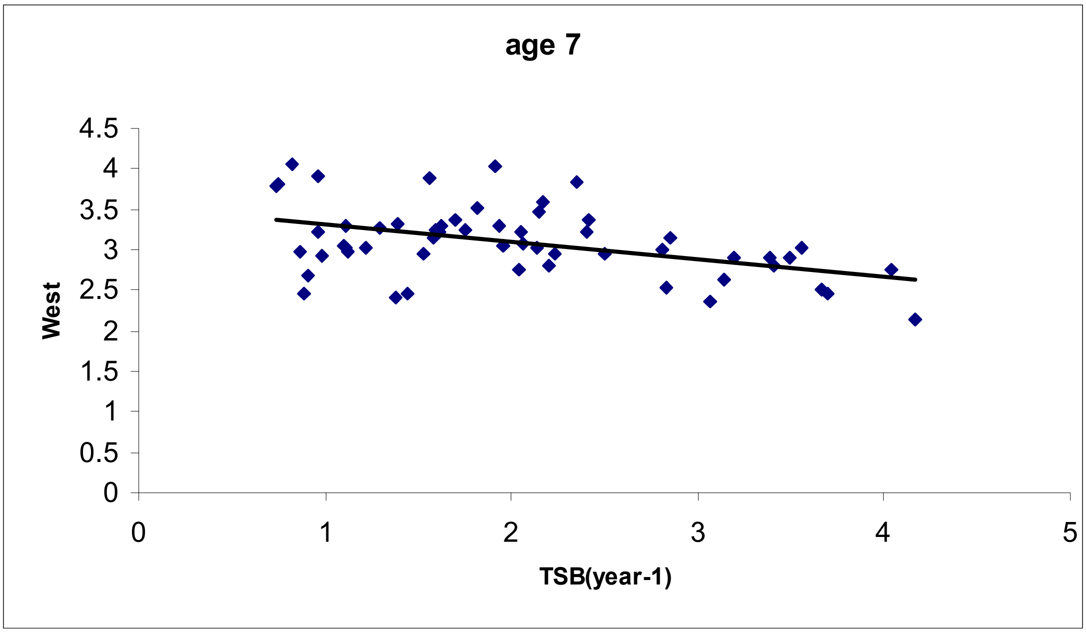

Figure 10e. Weight in stock vs. total stock biomass for age 7 cod.

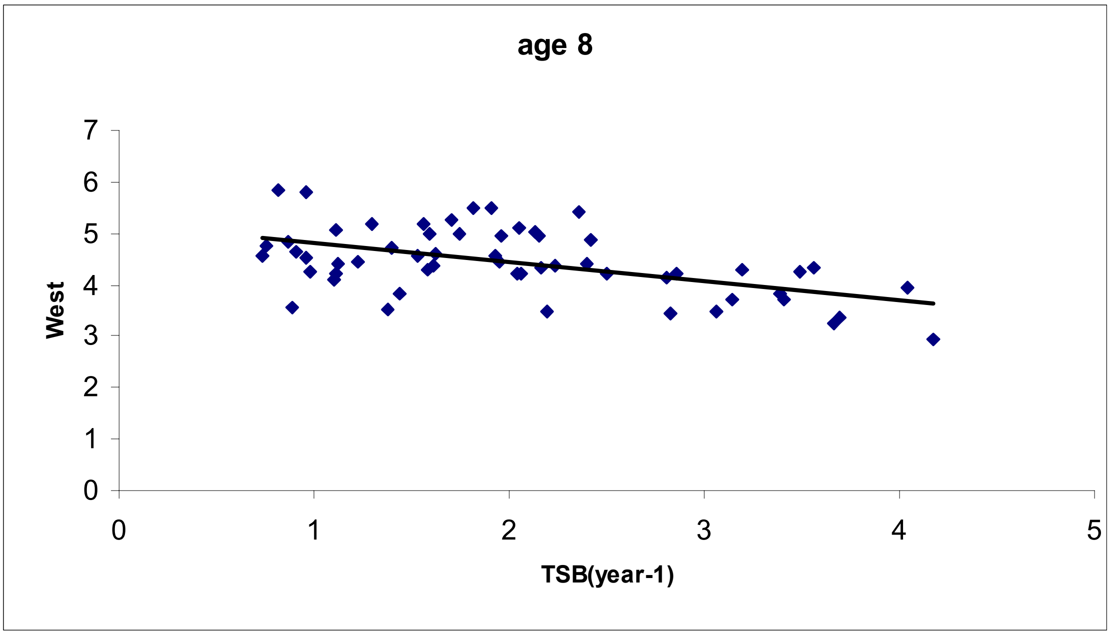

Figure 10f. Weight in stock vs. total stock biomass for age 8 cod.

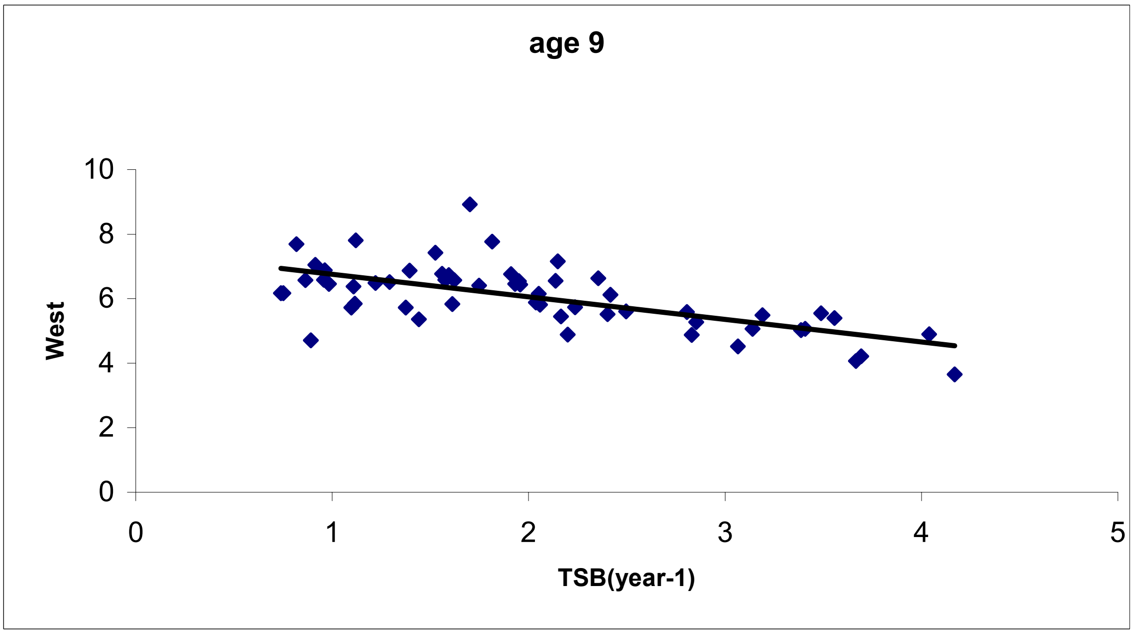

Figure 10g. Weight in stock vs. total stock biomass for age 9 cod.

Weight at age in catch is modelled as a function of weight at age in stock, using equation (4):

$$wc_{a,y} = \alpha_a ws_{a,y} + \beta_a \quad (4)$$

The values of α_a and β_a for ages 3-9 are given in Table 3. The regressions are based on data from 1983-2002, when observations of stock weights at age from surveys are available.

Age	α_a	β_a	R^2	p
3	1.6652	0.2978	0.5847	<0.01
4	0.9358	0.5561	0.8108	<0.01
5	0.9738	0.4948	0.8935	<0.01
6	0.9008	0.5807	0.9077	<0.01
7	0.7962	0.9652	0.6450	<0.01
8	0.6539	1.9342	0.5599	<0.01
9	0.1927	5.4996	0.0447	>0.05

Table 3. Parameters in regression for weight at age in the catch vs. weight at age in the stock.

Weight at age in the catch will be calculated directly from weight at age in the stock using equation (4). Uncertainties associated with the regression will not be taken into account, as the uncertainty in weight at age in the stock already is modelled. For ages 9 and older weight at age in the catch is set equal to weight at age in the stock.

4.2.2 Maturity at age

We suggest the following model for density-dependent maturation:

$$p_{a,y} = \frac{1}{1+e^{-\alpha_a (TSB_{50,a} - TSB_{y-1})}} \quad (5)$$

where $p_{a,y}$ is the proportion of mature cod at age *a* in year *y*. We first fitted values for α_a and $TSB_{50,a}$ separately for each age group (3-13). This gave a total sum of squares ($\sum_{a,y} (p_{a,y}^{\text{mod}} - p_{a,y}^{obs})^2$) of 7.95. It was then seen that the number of parameters could be reduced significantly by assuming that α_a is the same for all age groups and that

$$TSB_{50,a} = \gamma a - \kappa \quad (6)$$

This gave a marginally higher total sum of squares: 8.16. Also, the proportion mature at age 4 became unrealistically high (higher than age 5 values) at low stock sizes when fitting age-specific values of α_a and $TSB_{50,a}$ .This is avoided when using equation (6) to describe the age-dependence of TSB and assuming that α_a is the same for all age groups. This gives the following equation for the proportion mature at age:

$$p_{a,y} = \frac{1}{1+e^{-\alpha(\gamma a-\kappa-TSB_{y-1})}} \quad (7)$$

with parameter values α=1.08, κ=5.54, γ=0.91.

The model fit for ages 4-10 is shown in Figures 11a-g.

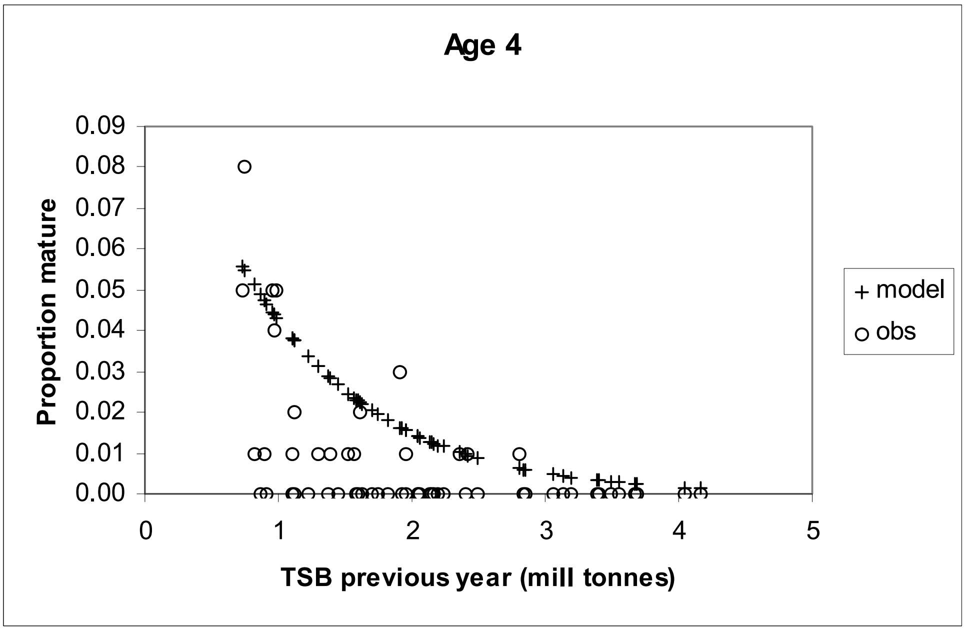

Figure 11a. Observed vs. modelled maturity at age 4.

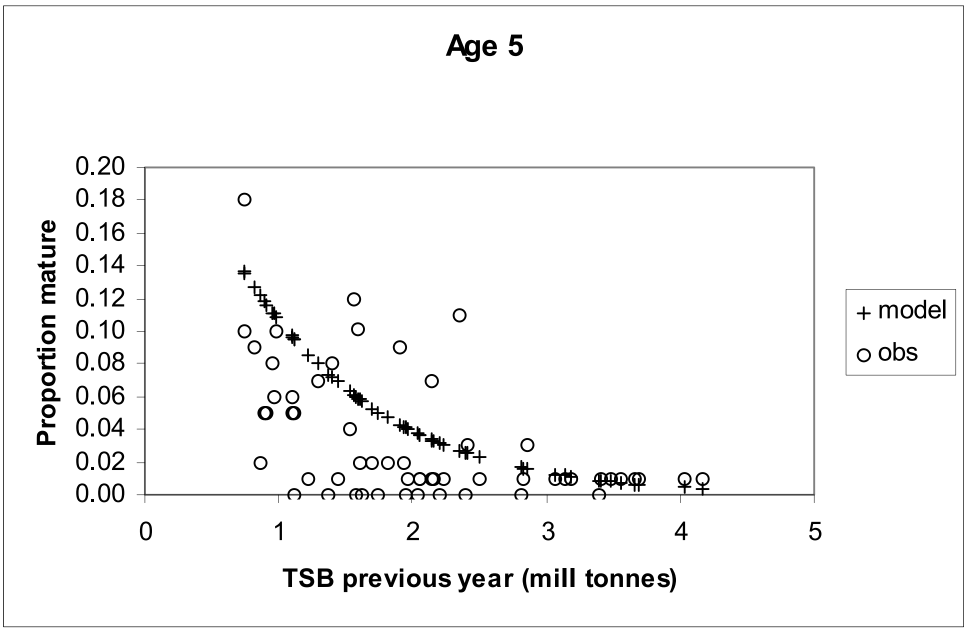

Figure 11b. Observed vs. modelled maturity at age 5.

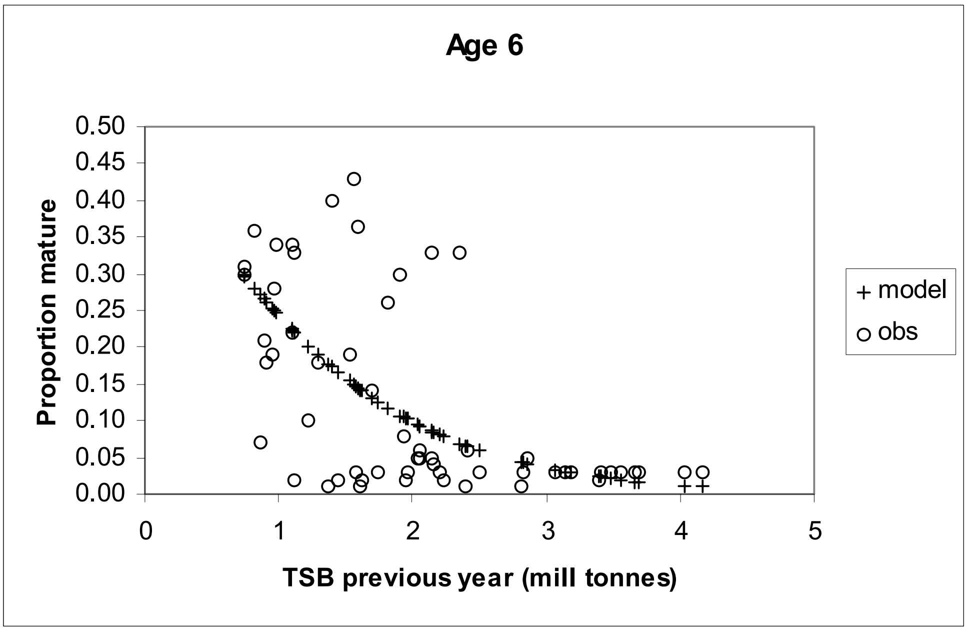

Figure 11c. Observed vs. modelled maturity at age 6.

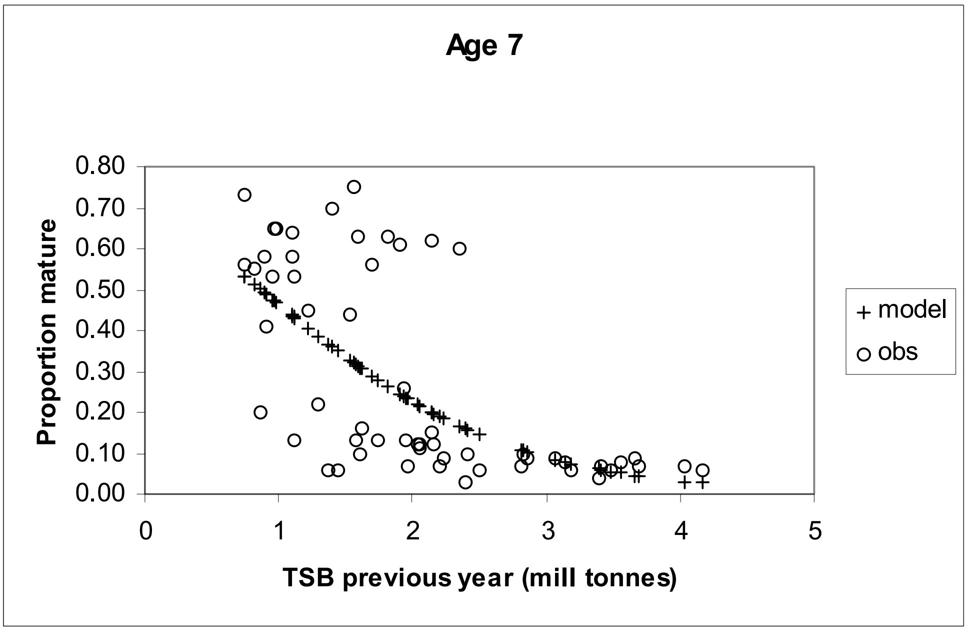

Figure 11d. Observed vs. modelled maturity at age 7.

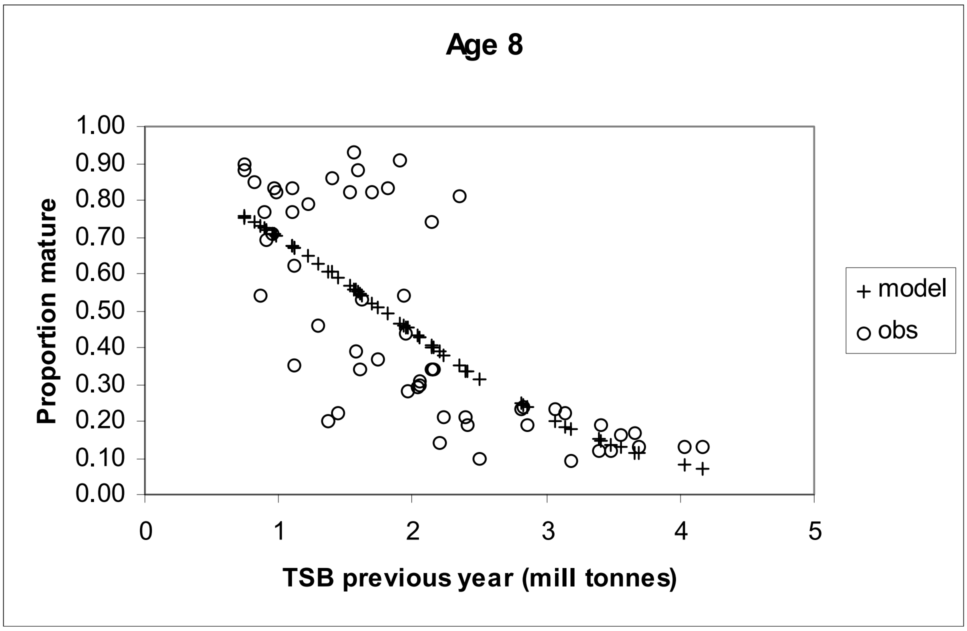

Figure 11e. Observed vs. modelled maturity at age 8.

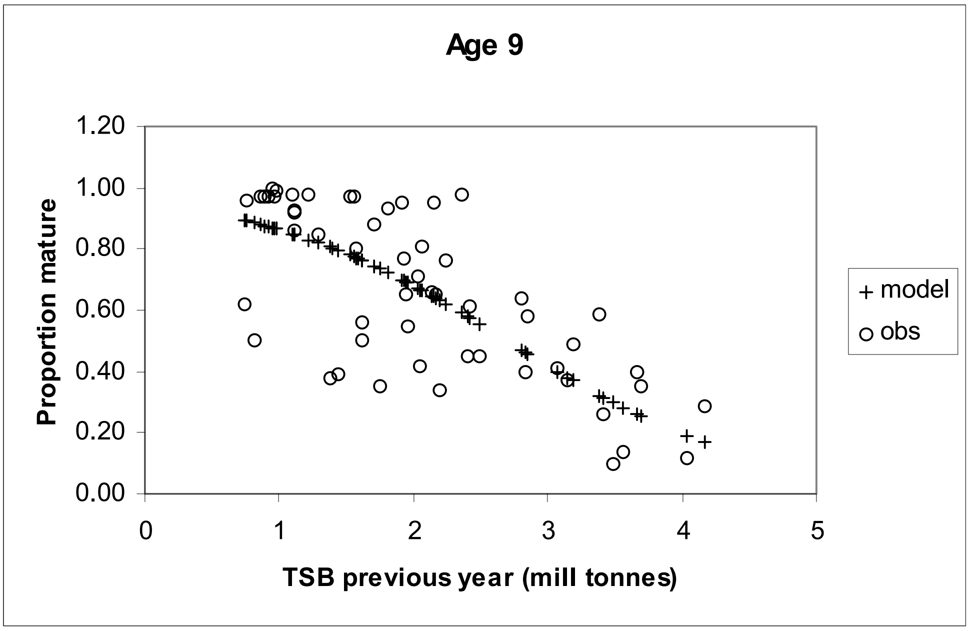

Figure 11f. Observed vs. modelled maturity at age 9.

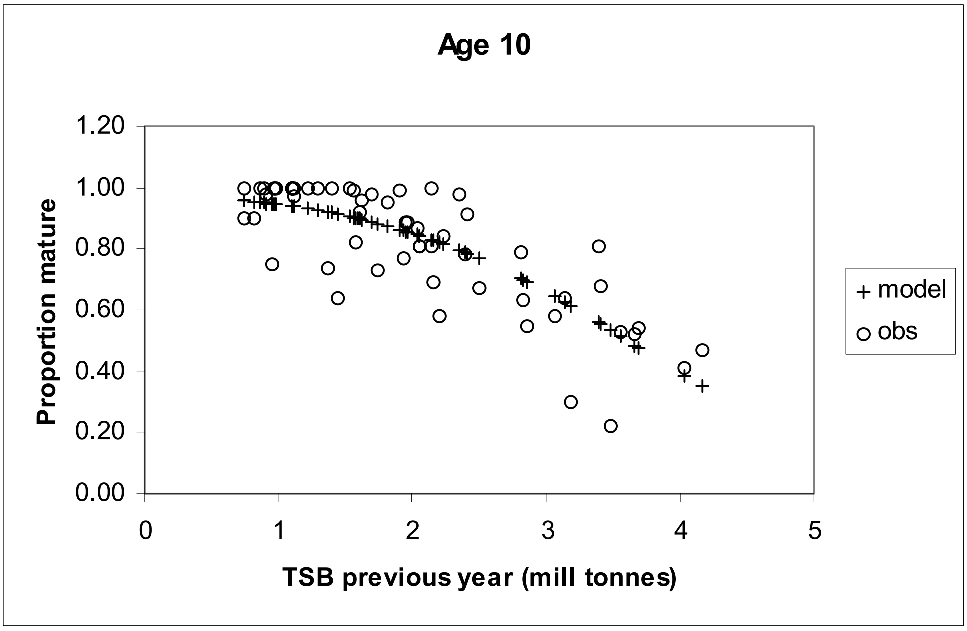

Figure 11g. Observed vs. modelled maturity at age 10.

4.3 Cannibalism mortality

As mentioned in Section 4.1.1, cannibalism will not be included in our main analysis because our stock-recruitment function does not include cannibalism. However, it is important to have models for cannibalism mortality available so that the effect of cannibalism on the population dynamics can be explored. Natural mortality due to cannibalism (M2) has been calculated for the period 1984-present, when annual stomach content data are available. This mortality can be significant for age 3 and 4 cod (ICES 2003d), and should thus be modelled. Kovalev (2004) found that cannibalism mortality for age 3 and 4 in year *y* showed good correlation both with SSB_{y-3} (Fig. 12a and b) and with the biomass of age 6 and 7 cod in the beginning of year *y* (Fig. 13a and b). The two models can be described by the following formulas:

$$M2_{y,a} = \alpha_a SSB_{y-3} + \beta_a \quad (8)$$

or

$$M2_{y,a} = \alpha_a (N_{y,6}W_{y,6} + N_{y,7}W_{y,7}) + \beta_a \quad (9)$$

where the parameter values are given in Table 4 for equation (8) and in Table 5 for equation (9). Observed residuals around trends could be used to model uncertainty.

At a later stage, the population model should be extended down to age 1 and cannibalism on age 1 and 2 cod could then be modelled explicitly instead of including it in the stock-recruitment relationship. Such work is in progress (Bogstad et al., 2004).

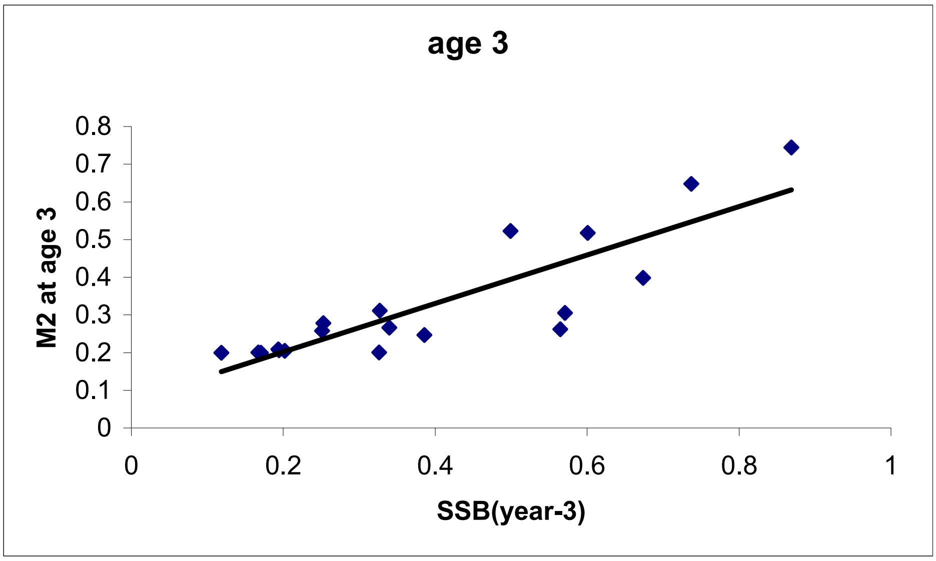

Figure 12a. M2 for age 3 vs. SSB in year-3

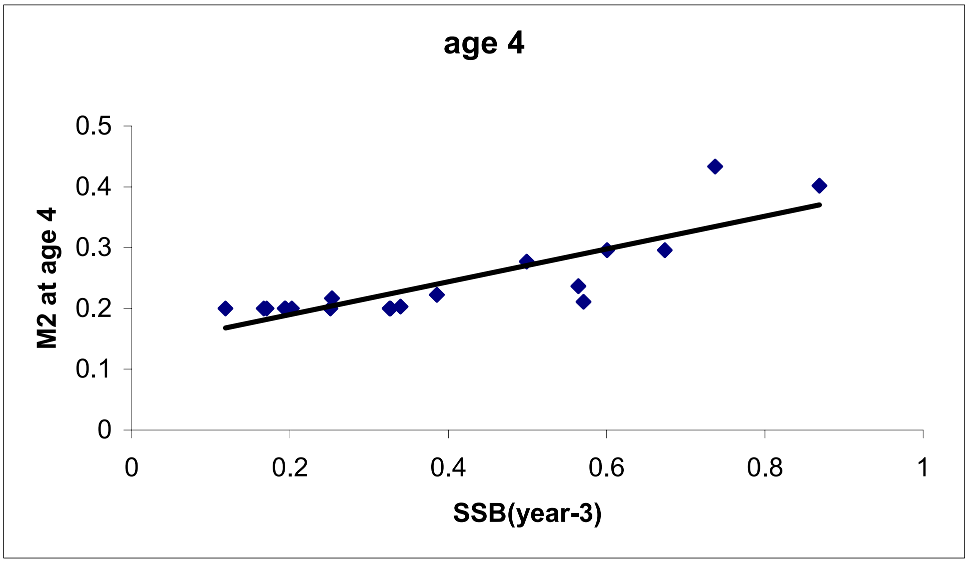

Figure 12b. M2 for age 4 vs. SSB in year-3

Age	α_a	β_a	R^2	p
3	0.6419	0.0738	0.75	<0.01
4	0.2694	0.1362	0.72	<0.01

Table 4. Parameters in regression for cannibalism mortality as a function of spawning stock biomass 3 years earlier.

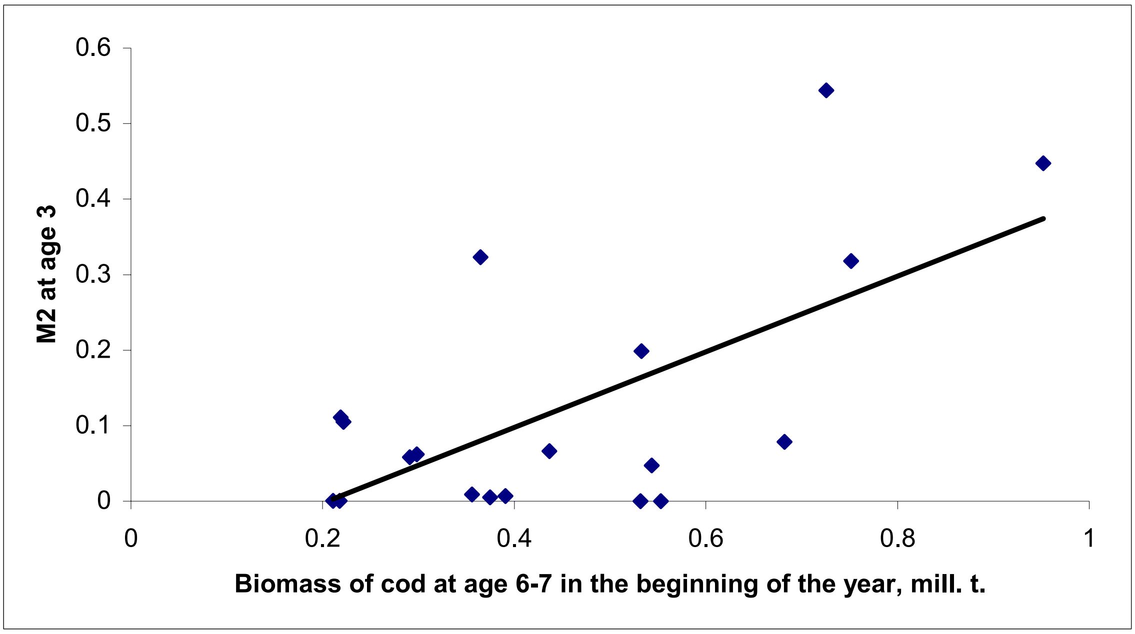

Figure 13a. M2 for age 3 vs. biomass of age 6 and 7 cod.

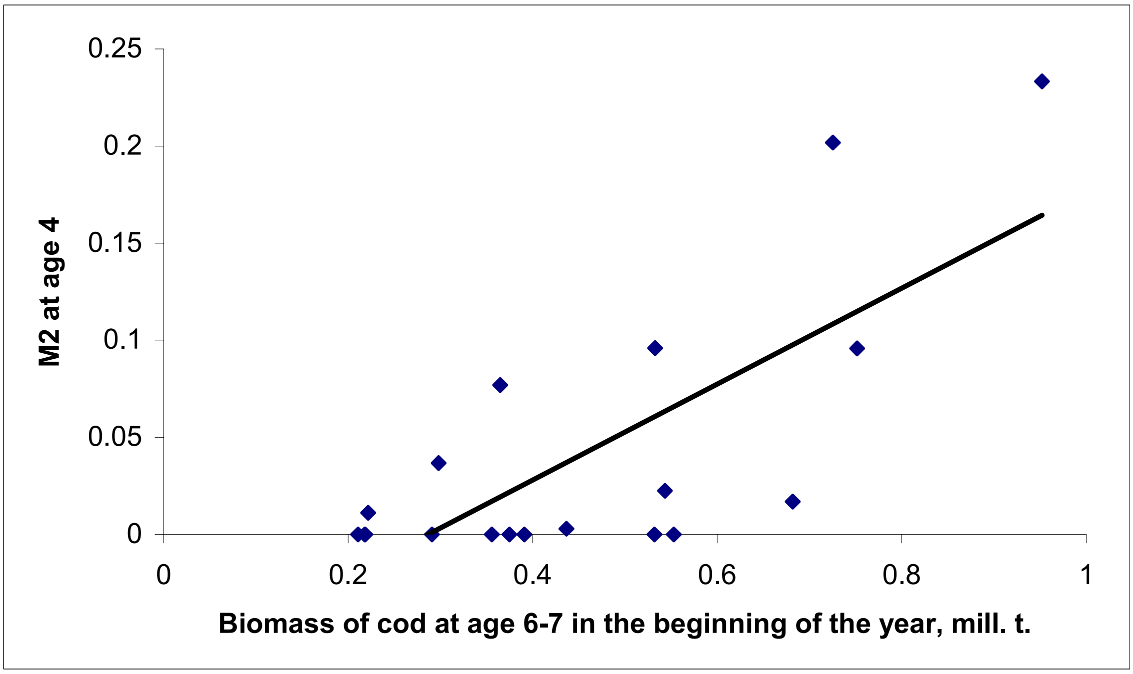

Figure 13b. M2 for age 4 vs. biomass of age 6 and 7 cod.

Age	α_a	β_a	R^2	p
3	0.5004	- 0.1026	0.41	<0.01
4	0.2470	- 0.0707	0.55	<0.01

Table 5. Parameters in regression for cannibalism mortality as a function of the biomass of age 6 and 7 cod in the beginning of the year.

4.4 Fishing pattern

The fishing pattern could be drawn randomly from some period. There is, however, no reason to include periods when the pattern was significantly different from what it can be expected to be in the future, due to different regulations. It should also be taken into account that the fishing pattern is dependent on the size at age. Since the fishing patterns are calculated by a VPA, the computed Fs contain all the noise in the catch data. It may be necessary to smooth the fishing pattern in order not to include more noise than appropriate.

5. Modeling of assessment error

Special attention is needed to model the assessment uncertainty (random error/bias) properly. The way this is done at present, without reproducing future assessments, it becomes more of a test on robustness of the rule to errors in the assessment. We suggest to leave it at that, and use the experience from the Svanhovd meeting (ICES, 2003b) as a guideline as to how much error the decision rule should be able to cope with. If we follow the logics used for our PA reference points we could argue that the decision rule should ensure against collapse even in case of one year with extreme assessment error. (The most extreme experienced is about a factor of 2 both for F and SSB). The standard error could thus be set such that the 95% percentile of the distribution gives an error of a factor 2.

6. Choice of harvest control rules to be explored

We will explore harvest control rules both with usual F-based strategies as well as F-based strategies of the ‘3-year average’ type (see Section 2.1 and 2.4). The fishing mortality may in both cases depend on SSB in the following way:

$F=F_1$=constant when SSB> B_1 (B_1 should be set > B_{lim}).
For SSB< B_1 we will explore two rules:
- $F=F_1$
- reduce F linearly from F_1 at SSB=B_1 toward 0 at SSB=0 (or some other SSB level e.g. B_{lim}).

Let the dependence of F on SSB be given as *g(SSB)*. When using the ‘3-year average rule’, we first compute $F_y = g(SSB(y))$, where *y* is the year for which we want to determine the quota. We then use the ‘3-year average rule’ with $F=F_y$ to calculate the quota in year *y*. This is done in order to ensure that F never increases when SSB decreases. If one use the ‘3-year average rule’ above SSB=B_1 but switch to a purely F-based strategy when SSB< B_1, one could in some cases find that SSB values slightly below B_1 would give a higher F than SSB values above B_1.

When SSB< B_1, the limit on percentage change in quota from year to year is not applied.

We should have in mind that both F_{pa} and B_{pa} are defined in a somewhat different context. These pa-values may be good guesses for F_1 and B_1, but other values should be explored, to find optimal values. The really important thing here is that the ‘real’ model spawning stock biomass remains above B_{lim} with high probability.

7. References

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APPENDIX 2

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4 – 13 May 2004

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Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Norwegian Coastal cod ….

Working Group: Arctic Fisheries Working Group

Date: 12-05-04…

A General

A.1. Stock definition

Cod in the Barents Sea, the Norwegian Sea and in the coastal areas living under variable environmental conditions form groups with some peculiarities in geographical distribution, migration pattern, growth, maturation rates, genetics features, etc. The degree of intermingle of different groups is uncertain (Borisov, Ponomarenko and Yaragina, 1999). However, taking into account some biological characteristics of cod in the coastal zone and the specifics of the coastal fishery, the Working Group considered it acceptable to assess the Norwegian coastal cod stock (in the frame of ICES) separately from North-East Arctic cod.

Both types of cod (the Norwegian Coastal cod and the North-East Arctic cod) can be met together on spawning grounds during spawning period as well as in catches all the year round both inshore and offshore in variable proportions.

The Norwegian Coastal cod (NCC) is distributed in the fjords and along the coast of Norway from the Kola peninsula in northeast and south to Møre at 62º N. Spawning areas are located in fjords as well as offshore along the coast. Spawning season extents from March to late June. The 0 and 1-group of NCC inhabit shallow water both in fjords and in coastal areas and are hardly found in deeper trawling areas until reaching about 25 cm. Afterwards they gradually move towards deeper water. NCC starts on average to mature at age 4-6 and migrates towards spawning grounds in early winter. The majority of the biomass (about 75 %) is located in the northern part of the area (North of 67º N).

Tagging experiments of cod inhabiting fjords indicate only short migrations (Jakobsen 1987, Nøstvik and Pedersen 1999, Skreslet, et al. 1999). From these experiments very few tagged cod migrated into the Barents Sea (<1%). Investigations based on genetics find large difference between NCC and North-East Arctic cod (NEAC) (Fevolden and Pogson 1995, Fevolden and Pogson 1997, Jørstad and Nævdal 1989, Møller 1969), while others do not find any difference (Árnason and Pálsson 1996, Mork, et al. 1984, Artemjeva and Novikov, 1990). Investigations also indicate that NCC probably consists of several separate populations.

Ongoing investigations on the genetic structure of cod along the Norwegian coast, the Murman coast and in the White Sea will hopefully further elucidate the stock structure of cod in these areas.

A.2. Fishery

The fishery is conducted both with trawlers and with smaller coastal vessels using traditional fishing gears like gillnet, longline, hand line and danish seine. In addition to quotas, the fishery is regulated by the same minimum catch size, minimum mesh size on the fishing gears as for the North-East Arctic cod, maximum by-catch of undersized fish, closure of areas having high densities of juveniles and by seasonal and area restrictions. The fishery is dominated by gillnet (50%), while longline/hand line account for about 20%, Danish seine 20% and Trawl 10% of the total catch. There was a shift around 1995 in the portion caught by the different gears. After 1995 the portion taken by longline and hand line has decreased, while the portion taken by danish seine has increased. Norwegian vessels take all the reported catch. However, trawlers from other countries probably take a small amount of NCC when fishing near the Norwegian coast fishing for North-East Arctic cod and North-East Arctic haddock.

A.3. Ecosystem aspects

Not investigated

B. Data

B.1 Commercial catch

From 1996, cod caught inside the 12 n.mile zone have been separated into Norwegian coastal cod and Noertheast Arctic cod based on biological sampling (Berg, et al. 1998) The method is based on otolith-typing. This is the same method as is used in separating the two stocks in the surveys targeting NEAC. The catches of Norwegian coastal cod (NCC) have been calculated back to 1984. During this period the catches have been between 25,000 and 75,000 t.

The separation of the Norwegian catches into NEAC and NCC is based on:

- No catches outside the 12 n.mile zone have been allocated to the NCC catches.

- The catches inside 12 n.mile zone are separated into quarter, fishing gear and Norwegian statistical areas.

- From the otolith structure, catches inside the 12 n.mile zone have been allocated to NCC and NEAC. The Institute of Marine Research in Bergen has been taking samples of commercial catches along the coast for a long period.

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from 8 sub areas are aggregated on 6 main areas for the gears gillnet, long line, hand line, Danish seine and trawl. No discards are reported or accounted for, but there are reports of discards and incorrect landings with respect to fish species and amount of catch. The scientific sampling strategy from the commercial fishing is to have age-length samples from all major gears in each area and quarter.

There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches. The following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. Age-length keys from research surveys with shrimp trawl (Norwegian coastal survey) are also used to fill holes.

Weight at age is calculated from the commercial catch back to 1984.

Proportions mature at age from 1984 to 1994 are obtained from the commercial catch data. From 1995-2001 the proportions mature at age are obtained from the Norwegian coastal survey.

Norway is assumed to account for most of the NCC landings. The text table below shows which kind of data are collected:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	X	X	X	X	X

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\year\stock\coas_cod** or **w:\ifapdata\eximport\afwg\coas_cod**.

B.2. Biological

Weight at age in the stock is obtained from the Norwegian coastal survey in the period 1995 to 2001. From 1984 to 1994 weight at age in stock is taken from weight at age in the catch because no survey data from this period are available.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing moratlity before spawning (Fprop) are to 0.

B.3. Survey

Since 1995 a Norwegian trawl-acoustic survey (Norwegian coastal survey) specially designed for coastal cod has been conducted annually in October-November (28 days). The survey covers the fjords and coastal areas from the Varangerfjord close to the Russian border and southwards to 62° N. The aim of conducting a acoustic survey targeting Norwegian coastal cod has been to support the stock assessment with fishery-independent data of the abundance of both the commercial size cod as well as the youngest pre-recruit coastal cod. The survey therefore covers the main areas where the commercial fishery takes place, normally dominated by 4 - 7 year old fish.

The 0- and 1 year-old coastal cod, mainly inhabiting shallow water (0-50 meter) near the coast and in the fjords, are also represented in the survey, although highly variable from year to year. However, the 0-group cod caught in the survey is impossible to classify to NCC or NEAC by the otoliths since the first winter zone is used in this separation. A total number of more than 200 trawl hauls are conducted during the survey (100 bottom trawl, 100 pelagic trawl).

The survey abundance indexes at age are total numbers (in thousands) computed from the acoustics.

Ages 2-8 are used in the XSA-tuning.

B.4. Commercial CPUE

No commercial CPUE are available for this stock.

B.5. Other relevant data

None

C. Historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

Survivor estimates shrunk towards the mean F of the final 2 years or the 4 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.0

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1984 – last data year	2 – 10+	Yes
Canum	Catch at age in numbers	1984 – last data year	2 – 10+	Yes
Weca	Weight at age in the commercial catch	1984 – last data year	2 – 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1984 – last data year	2 – 10+	Yes/No - assumed to be the same as weight at age in the catch from 1984-1994
Mprop	Proportion of natural mortality before spawning	1984 – last data year	2 – 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1984 – last data year	2 – 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1984 – last data year	2 – 10+	Yes
Natmor	Natural mortality	1984 – last data year	2 – 10+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian coastal survey	1995 – last data year	2-8

D. Short-term projection

Model used: Age structured

Software used: MFDP- prediction with management option table and MFYPR- yield per recruit.

Initial stock size. Taken from the XSA for age 3 and older. The recruitment at age 2 in intermediate year is estimated using the RCT-3 software and indices from the Norwegian Acoustic survey. The same recruitment is used for age 2 in all projection years.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: Same as previous year.

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Same as previous year.

Weight at age in the catch: Same as two years ago.

Exploitation pattern: Average of the three last years, scaled by the Fbar (4-7) to the level of the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: RCT3

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Not done.

F. Long-term projections

Not done.

G. Biological reference points

Not available.

H. Other issues

I. References

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Stock specific documentation of standard assessment procedures used by ICES.

Stock: North-East Arctic Greenland Halibut

Working Group: Arctic Fisheries Working Group

Date: 30-04-03

A. General

A.1 Stock definition

Greenland halibut (*Reinhardtius hippoglossoides,* Walbaum) is distributed in the Arctic and boreal waters in the North Atlantic and in the North Pacific (Fedorov 1971; Godø and Haug 1989; Bowering and Brodie 1995; Bowering and Nedreaas 2000). In the northeastern Atlantic the distribution is more or less continuous along the continental slope from the Faeroe Islands and Shetland to north of Spitsbergen (Whitehead et al. 1986; Godø and Haug 1989; Nizovtsev, 1989), with the highest concentrations from 500 to 800 m depth between Norway and Bear Island, which is also regarded as the main spawning area (Nizovtsev, 1968; Godø and Haug 1987; Albert et al. 2001b). Peak spawning occurs in December in the main spawning area, but also in nearby localities during summer (Nizovtsev, 1989; Albert et al. 2001b). Atlantic currents transport eggs and larvae northwards and the juveniles are distributed around Svalbard and in the northeastern Barents Sea, to the waters around Franz Josef Land and Novaja Zemlya area (Borkin, 1983; Nizovtsev, 1983; Godø and Haug 1987; Godø and Haug 1989; Albert et al. 2001a). As they grow older they gradually move southwards and eventually alternate between the spawning area and feeding areas in the central-western Barents Sea (Nizovtsev, 1989).

The Northeast arctic Greenland halibut stock is a pragmatically defined management unit. The degree of exchange with other stocks is not resolved, but is believed to be low. Potential routes of exchange may be drift of larvae towards Greenland and migration of adults between the Barents Sea and the Iceland-Faeroe Islands area.

A.2 Fishery

Before the mid 1960s the fishery for Greenland halibut was mainly a coastal long line fishery off the coasts of eastern Finnmark and Vesterålen in Norway. The annual catch of the coastal fishery was about 3,000 t. In recent years this fishery has landed 3,000–6,000 t although now gillnets are also used in the fishery. In 1964 dense Greenland halibut concentrations were found by Soviet trawlers in the slope area to the west of the Bear Island (Nizovtsev, 1989). Following the introduction of international trawlers in the fishery in the mid 1960s, the total landings increased to about 80,000 t in the early 1970s.The total Greenland halibut landings decreased steadily to about 20,000 t during the early 1980s. This level was maintained until 1991, when the catch increased sharply to 33,000 t. From 1992 total landings varied between 9 000-19 000 t with a peak in 1999.

From 1992 the fishery has been regulated by allowing only the long line and gillnet fisheries by vessels smaller than 28 m to be directed for Greenland halibut. This fishery is also regulated by seasonal closure. Target trawl fishery has been prohibited and trawl catches are limited to bycatch only. From 1992 to autumn 1994 bycatch in each haul was not to exceed 10% by weight. In autumn 1994 this was changed to 5% bycatch of Greenland halibut onboard at any time. In autumn 1996 it was changed to 5% bycatch in each haul, and from January 1999 this percentage was increased to 10%. In August 1999 it was adjusted further to 10% in each haul but only 5% of the landed catch. From 2001 the bycatch regulations again was changed to 12% in each haul and 7% of the landed catch.

The regulations enforced in 1992 reduced the total landings of Greenland halibut by trawlers from 20,000 to about 6,000 t. Since then and until 1998 annual trawler landings have varied between 5,000 and 8,000 t without any clear trend attributable to changes in allowable bycatch. However, the increase of trawler landings in 1999 to 10 000 t may be attributable partly to the less restrictive bycatch regulations. Landings of Greenland halibut from the directed longline and gillnet fisheries have also increased in recent years to well above the level of 2,500 t set by the Norwegian authorities. This is attributed to the increased difficulties of regulating a fishery that only lasts for a few weeks.

A.3 Ecosystem aspects

As investigations show, among the variety of fish, seabirds and marine mammals Greenland halibut were found in the diet of just three species - Greenland shark (*Somniosus microcephalus*), cod (*Gadus morhua morhua*) and Greenland halibut itself. Besides, killer whale (*Orcinus orca*), grey seal (*Halichoerus grypus*) and narwhal (*Monodon monoceros*) could be its potential predators. However, the presence of Greenland halibut in the diet of the above species was minor. Predators fed mainly on juvenile Greenland halibut up to 30-40 cm long.

The mean annual percentage of Greenland halibut in cod diet in 1984-1999 constituted 0,01-0,35% by weight (0,05% in average) (DOLGOV & SMIRNOV 2001). Low levels of consumption are related to the distribution pattern of juvenile Greenland halibut as they spend the first years of the life mainly in the outlying areas of their distribution, in the northern Barents Sea, where both adult Greenland halibut and other abundant predator species are virtually absent.

Cannibalism was the highest in 1960's (up to 1,2% by frequency of occurrence). During the 1980's, in the Greenland halibut stomachs the frequency of occurrence of their own juveniles did not exceed 0,1 %. During the 1990's, the portion of their own juveniles (by weight) was at the level of 0,6-1,3%.

Food composition of the Greenland halibut in the Barents Sea includes more than 40 prey species (NIZOVTSEV 1989; DOLGOV & SMIRNOV 2001). Investigations over a wide area of the continental slope up to the Novaya Zemlya show that the main food source of Greenland halibut consists of fish, mostly capelin (*Mallotus villosus villosus*) and polar cod (*Boreogadus saida*) followed by cephalopods and shrimp (*Pandalus borealis*). During the 1990's an important component of the diet was waste products from fisheries for other species (heads, guts etc.). With growth, a decrease in the importance of small food items (shrimp, capelin) in Greenland halibut diet and the increase of a portion of large fish such as cod and haddock (*Melanogrammus aeglefinus*) were observed.

With the Greenland halibut stock being nearly 100 000 tonnes, the total food consumption of the population is estimated to be about 280 000 tonnes. The biomass of commercial species consumed (shrimp, capelin, herring, polar cod, cod, haddock, redfish (*Sebastes sp.*), long rough dab (*Hippoglossoides platessoides*) does not exceed 5 000-10 000 tonnes per species (DOLGOV & SMIRNOV 2001).

The Greenland halibut as a species thus has a negligible effect on the other commercial species in the Barents Sea both as predator and prey.

Greenland halibut occurs over a wide range of depths (from 20 to 2200 m) and temperatures (from -1.5 to 10º C) (BOJE & HAREIDE, 1993; SHUNTOV, 1965; NIZOVTSEV, 1989). Young Greenland halibut occur mostly in the northeastern Barents Sea (Spitsbergen archipelago and further east to Franz Josef Land) where the presence adult Greenland halibut or other predators appears minimal. Therefore, Greenland halibut mortality after settling in the area is low and stable and driven mainly by envionmental factors.

B Data

B.1 Commercial catch

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of the Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, bottom trawl and shrimp trawl. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for in the catch statistics.

Russian catch based on daily reports from the vessels are combined in the statistics of the All-Russian Research Institute of Fisheries and Oceanography (VNIRO, Moscow). Data are provided separately by ICES areas and gears.

The sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and then from neighbouring areas and similar gears. ALKs from research surveys (shrimp trawl) are also used to fill gaps in age sampling data.

Norway and Russia, on average, have accounted for about 90-95% of the Greenland halibut landings during more recent years. Data on catch in tonnes from other countries are either taken from ICES official statistics (by ICES area) or from reports to Norwegian authorities. A few countries also supply some additional data. The text table below indicates the type of data provided by country:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x		x
Russia	x	x	x	x	x
Germany	x				
United Kingdom	x				
France[1]	x				
Spain[1]	x				
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				
Poland[1]	x				

[1] As reported to Norwegian authorities

The Norwegian input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later input to Excel spreadsheet files before aggregation to international data. The data are archived in the national laboratories and with the Norwegian stock co-ordinator.

The national data have been aggregated with international data on Excel spreadsheet files. The Russian length composition has been applied to Russian landings together with an age-length-key (ALK) and weight at age data from the Norwegian landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian landings. The Excel spreadsheet files used for age distribution, adjustments and aggregations are held by the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, under **w:\acfm\afwg\year\data\grh_arct**.

B.2 Biological

For 1964-1969, separate weight at age data are used for the Norwegian and the Russian catches. Both data sets are mean values for the period and are combined as a weighted average for each year. A constant set of weight-at-age data is used for the total catches in 1970–1978. For subsequent years annual estimates are used. The mean weight at age in the catch is calculated as a weighted average of the weight in the catch from Norway and Russia. The weight at age in the stock is set equal to the weight at age in the catch for all years.

A fixed natural mortality of 0.15 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Annual ogives based on sexes combined using Russian survey data are given for the years 1984–1990 and 1992–last data year. An average ogive derived from 1984–1987 is used for 1964–1983. For 1984 to the last data year a three-year running average is used.

B.3 Surveys

The results from the following research vessel survey series are evaluated by the Working Group:

1. Norwegian bottom trawl survey in August in the Barents Sea and Svalbard from 1984 in fishing depths of less than 100 m and down to 500 m. (Table E1 and E2).

2. Norwegian Greenland halibut surveys in August from 1994. The surveys cover the continental slope from 68 to 80ºN, in depths of 400–1500 m north of 70º30'N, and 400–1000 m south of this latitude. This series has in 2000 been revised to also include depths between 400 – 500 m in all years (Table E3).

3. Norwegian bottom trawl surveys east and north of Svalbard in autumn from 1996 (Table E4).

4. The Norwegian Combined Survey index Table E5, combination of the results from Tables E1-E4.

5. Russian bottom trawl surveys in the Barents Sea from 1984 in fishing depths of 100–900 m. This series has been revised substantially since the 1998 assessment in order to make the years more comparable with respect to area coverage and gear type (Table E6).

6. Spanish bottom trawl survey in the slope of Svalbard area in October, ICES Division IIb: from 1997 (Table E7).

7. Norwegian Barents Sea bottom trawl survey (winter) from 1989 in fishing depths of less than 100 m and down to 500 m. In order to utilise the last year values in the VPA calibration, this series was adjusted back by one year and one age group to reflect sampling as if it occurred in the autumn of the previous year (Table E8).

8. International pelagic 0-group surveys from 1970. (Table A14).

Over the last several years the Working Group has been concerned about trends in catchability within individual surveys used for tuning of the XSA. The trends were seen for younger ages of year classes in the late 80's and early 90's that were initially estimated to be very low in abundance. With increasing age these year classes were estimated to be much closer to the mean abundance. In previous meetings the Working Group therefore increased the lower age used in tuning to five years in order to reduce the problem. This only partly resolved the problem though, and in all subsequent assessments estimated recruitment of the last 2-3 years has increased from one year to the next.

The Norwegian bottom trawl survey in the Barent Sea and Svalbard catch Greenland halibut mainly in the range of ages 1–8, although in most years age 1 is poorly represented and all age group younger than five years are not considered to be well represented in this survey due to the limited depth range covered. The relative strength of the year classes varies considerably with age. In more recent years there has been low but somewhat better representation of young fish in this survey.

The Norwegian juvenile Greenland halibut survey north and east of Svalbard were started in 1996 and from 2000 this survey is conducted as a joint survey between Norway and Russia. As a result it is expected that the area coverage will improve, better representing the distribution of juveniles and will provide a more comparable time series. Only the Norwegian part of these northern surveys is currently included in the Norwegian Combined Survey index (see below) . In future, when the extended coverage in the Russian zone has been repeated for at least five years the Working Group will consider revising the combined index.

The Norwegian Greenland halibut survey along the deep continental slope south and west of Spitsbergen began in 1994. Although Greenland halibut older than 15 years are caught, few fish are represented in the catch over age 12 or less than age 5 (Table E4). Most of the abundance indices are dominated by ages 5–8.

Most of the surveys considered by the Working Group in 2002 cover either the adult population in the slope area or juvenile distribution in northern areas. The problem of underestimation of recruitment in the last few years included in the analyses has been attributed to shortcomings in survey coverage. The Working Group at previous meetings has noted the need for annual surveys that sample most of the population within a short period of time. Prior to the 2002 WG meeting effort was therefore made to combine some of these surveys into a new total index. The new index is termed the Norwegian Combined Survey Index and is established back to 1996, the first year with survey coverage northeast of Svalbard. It includes bottom trawls from the Norwegian bottom trawl survey in August in the Barents Sea and Svalbard (Tables E1 and E2), the Norwegian Greenland halibut survey in August along the continental slope (Table E3), and the Norwegian bottom trawl survey in August-September north and east of Svalbard (Table E4). Prior to the meeting in 2003 work was done to evaluate the combination of these survey series into one index and this was reported in Working Document 5 to the Working Group. Based on these results it was decided to use this combined index in this years assessment.

The Norwegian Combined Survey Index (Table E5) indicates a significant increase in the total stock during the last three years and a stock size in 2002, nearly 40% above last years index. However, there is no clear year class pattern in the data and some ages are consistently underestimated relative to adjacent age groups (e.g. age 9 and partly age 4). The highest indices were observed for age seven, with exception of the two last years when age 1 was most abundant. That indicates that the catchability of younger ages (i.e. those primarily from northern surveys) are not comparable with the older ones (i.e. those primarily from the slope). This is probably a result of pooling different surveys using different gears. These weaknesses reduce the applicability of the combined surveys, and the Working Group advises that further work be done to improve the combined index in the future.

The Russian Barents Sea bottom trawl survey, which extends back to 1984 catch fish mainly in the range of 4–10 years old. The relative abundance of the year classes against age is similar to the surveys above. This survey covers the Barents Sea including the continental slope of the Norwegian Sea. Total abundance indices from this survey show trend to grow since 1996.

The Spanish bottom trawl surveys along the continental slope north of 73°30’ N from 1997 (Table E7) differ from the other survey series indicating reduced abundance in this area since 1999.

The Norwegian bottom trawl survey during winter in the Barents Sea catch Greenland halibut older than 12 years, but are not particularly effective in catching fish older than 7 years. This is likely due to the limited depth distribution of the survey area. Nevertheless, the survey appears very effective at catching Greenland halibut up to age 6. The relative abundance of the year classes against age is comparable with the survey above.

The strengths of the Greenland halibut year classes of 1970–1997 from the International pelagic 0-group surveys in the Barents Sea are shown in Table A14. The results are highly variable over the time period. However, most of the 1970’s and 1980’s year classes are represented in reasonably high numbers. In recent years the 1988–1992 and the 1996 year classes have been well below the long term average. The 1993–1995 and 1997-1999 year classes are closer to the average. Significant increase of 0-group abundance indices with compare to previous years was observed in 2000-2002.

All in all, the surveys seem to indicate that the catchability of the 1990–1995 year classes increased considerably as the fish becomes five years and older. Based on extremely low catch rates in the surveys, these year classes were considered very poor in previous assessments by the Working Group, but improved considerably at older ages. The reason for this change in catchability is not clear. However, it is known that important areas for young Greenland halibut may be found north and east of Svalbard (Table E4). Albert *et al*. (2001a) showed that the south-western end of the distribution area of age 1 fish was gradually displaced northwards along west Spitsbergen in the period 1989–92 and southwards in the period 1994–1996. These displacements corresponded to changes in hydrography and may be explained by increased migration of the 1990–1995 year classes to areas outside the survey area.

B.4 Commercial CPUE

The restrictive regulations imposed on the trawl fishery after 1991 disrupted the traditional time series of commercial CPUE data. However, an attempt to continue the series was made through a research program using two Norwegian trawlers in a limited commercial fishery (Tables 8.6 and E9). This comprises fishing during two weeks in May-June and October, representing an effort somewhat less than 20% of the 1991 level. Since 1994 the fishery has been restricted to May-June. This fishery was conducted, as much as possible, in the same way as the commercial fishery in the previous years. Since 1997 also two Russian trawlers conducted a limited research fishery for Greenland halibut.

The CPUE from the experimental fishery was found, however, to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1650 kg/h with the highest value in 2000 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series also shows the highest value in 2000.

B.5 Other relevant data

None

C. Historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 10

Survivor estimates shrunk towards the mean F of the final 2 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1964 – last data year	- (total)	Yes
Canum	Catch at age in numbers	1964 – last data year	5 – 15+	Yes
Weca	Weight at age in the commercial catch	1964 – last data year	5 – 15+	Yes/No - constant at age from 1964 - 1978
West	Weight at age of the spawning stock at spawning time.	1964 – last data year	5 – 15+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1964 – last data year	5 – 15+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1964 – last data year	5 – 15+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1964 – last data year	5 – 15+	Yes/No – three year running mean, constant at age from 1964 - 1983
Natmor	Natural mortality	1964 – last data year	5 – 15+	No – set to 0.15 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian Combined survey index	1996 – last data year	5 – 15+
Tuning fleet 2	Norwegian experimental CPUE	1992 – last data year	5 - 14
Tuning fleet 3	Russian trawl survey from 1992	1992 – last data year	5 – 15+

D. Short-term projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size. Taken from the XSA for age 6 and older. The recruitment at age 5 in the last data year is estimated using the mean from 1990 to two years before the last data year following the argument that recruitment at age 5 shows a sharp reduction in the most recent years in the previous assessments, which is not believed to reflect the true recruitment.

Natural mortality: Set to 0.15 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight at age for the last three years used in the assessment

Weight at age in the catch: Average weight at age for the last three years used in the assessment

Exploitation pattern: Average of the three last years

Intermediate year assumptions: Catch constraint

Stock recruitment model used: Constant recruitment as described earlier

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Not done

F. Long-term projections

Not done

G. Biological reference points

No limit or precautionary reference points for the fishing mortality or the spawning stock biomass are proposed.

H. Other issues

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Stock specific documentation of standard assessment procedures used by ICES.

Stock:… North-East Arctic Saithe

Working Group:… Arctic Fisheries Working Group

Date: 10.05.2004

A. General

A.1. Stock definition

The North-East Arctic saithe is mainly distributed along the coast of Norway from the Kola peninsula in northeast and south to Møre at 62º N. The 0-group saithe drifts from the spawning grounds to inshore waters. 2-3 years old the saithe gradually moves to deeper waters, and at age 3-6 it is found at typical saithe grounds. It starts to mature at age 5-7, and in early winter a migration towards the spawning grounds further out and south starts.

The stock boundary 62º N is more for management purposes than a biological basis for stock separation. Tagging experiments show a regular annual migration of mature fish from the North-Norwegian coast to the spawning areas off the west coast of Norway and also to a lesser extent to the northern North Sea (ICES 1965). There is also a substantial migration of immature saithe to the North Sea from the Norwegian coast between 62º and 66º N (Jakobsen 1981). In some years there are also examples of mass migration from northern Norway to Iceland and to a lesser extent to the Faroe Islands (Jakobsen 1987). 0-group saithe, on the other side, drifts from the northern North Sea to the coast of Norway north of 62º N.

A.2. Fishery

Since the early 1960s the fishery has been dominated by purse seine and trawl fisheries accounting for 60% in 2000. A traditional gill net fishery for spawning saithe accounts for about 22%. The remaining catches are taken by Danish seine and hand line in addition to minor by-catches in the long line fishery for other species. Some changes in recent regulations have led to fewer amounts taken by purse seine. Catches declined sharply after 1976. This was partly caused by the introduction of national economic zones in 1977. The stock was accepted as exclusively Norwegian and quota restrictions were put on fishing by other countries while the Norwegian fishery for some years remained unrestricted. In recent years the purse seine and trawl fisheries have been regulated by quotas where account has been taken of expected landings from other gears. Quotas can be transferred between purse seine and trawl fisheries if the quota allocated to one of the gears will not be taken. The target set for the total landings has generally been consistent with the scientific recommendations. Norway presently accounts for about 93% of the landings.

The number of vessels taking part in the purse seine fishery has varied between 112 and 429 since 1977, with the highest participation in the first part of the period. There have been some variations from year to year, and many of the vessels that have taken part in the fishery the last decade have accounted for only a small fraction of the purse seine catches. The annual effort in the Norwegian trawl fishery has varied between 12 000 and 77 000 hours, with the highest effort from 1989 to 1995. Like in the purse seine fishery there have been rather large changes from year to year.

1 March 1999 the minimum landing size was increased from 35-40 cm to 45 cm for trawl and conventional gears, and to 42 cm (north of Lofoten) and 40 cm (between 62° N and Lofoten) for purse seine, with an exception for the first 3000 t purse seine catch between 62° N and 65° 30 N, where the minimum landing size still is 35 cm.

A.3. Ecosystem aspects

The recruitment of saithe may suffer in years with reduced inflow of Atlantic water (Jakobsen 1986).

B. Data

B.1. Commercial catch

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for, but there are several reports of discards. In later years there are also reports of misreporting, saithe is landed as cod in a period with decreasing quotas and availability of cod and good availability of saithe.

The sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Constant weight at age values is used for the period 1960 – 1979. For subsequent years, Norwegian weights at age in the catch are estimated from length at age by the formula:

$$\text{weight (kg)} = (l^3 *5.0+l^2 *37.5+l*123.75+153.125)*0.0000017,$$

where

l = length in cm.

Norway have on average accounted for about 95% of the saithe landings. Data on catch in tonnes from other countries are either taken from ICES official statistics (by ICES area) or from reports to Norwegian authorities. A few countries also supply some additional data. The text table below shows which country supply which kind of data:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x	x	x
Russia	x				x
Germany	x	x	x		
United Kingdom	x				
France[1]	x				
Spain[1]	x				
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				

[1] As reported to Norwegian authorities

The Norwegian, Russian and German input files are Excel spreadsheet files. Russian input data earlier than 2002 are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the Norwegian stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. Age composition data for 2002 was available from Norway, Russia (Sub-area I and Division IIA) and Germany (Division IIA). Generally the Russian length composition has been applied on the Russian landings together with an age-length-key (ALK) and weight at age data from the Norwegian trawl landings. In 2002 Russian length compositions were available for Division IIB, and were applied on the Russian landings together with an age-length-key from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian trawl landings. In some years the final German and Russian numbers at age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\year\Stock\sai_arct** or **w:\ifapdata\eximport\afwg\sai_arct**.

B.2. Biological

Weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Regarding the proportion mature at age, until 1995 knife-edge maturity at age 6 was used for this stock. When data on spawning zones recorded in otoliths in Norway were investigated, no evidence of change in maturation rates over the period in the assessment was found and it was decided to use the same ogive for all years. This ogive is based on the distribution of age at first spawning among 8 year and older fish. It represents an approximation of the data from 1973 to 1994, with most weight given to recent observations.

B.3. Surveys

Since 1985 a Norwegian acoustic survey specially designed for saithe has been conducted annually in October-November (Nedreaas 1997). The survey covers the near coastal banks from the Varangerfjord close to the Russian border and southwards to 62° N. The whole area has been covered since 1992, and the major parts since 1988. The aim of conducting an acoustic survey targeting Northeast Arctic saithe has been to support the stock assessment with fishery-independent data of the abundance of the youngest saithe. The survey mainly covers the grounds where the trawl fishery takes place, normally dominated by 3 - 5(6) year old fish. 2-year-old saithe, mainly inhabiting the fjords and more coastal areas, are also represented in the survey, although highly variable from year to year. In 1997 and 1998 there was a large increase in the abundance of age 5 and older saithe, confirming reports from the fishery. In 1999 the abundance of these age groups decreased somewhat, but was still at a high level compared to years before 1997 (Mehl 2000). Abundance indices for ages 2-5 from 1988 and onwards have traditionally been used for tuning, but including older ages as a 6+ group in the tuning series improved the scaled weights a little and at the 2000 WG meeting it was decided to apply the extended series in the assessment. The results from the survey autumn 2000 showed a further decrease in the abundance of age 5 and older saithe (Korsbrekke and Mehl 2000). It is not known how well the survey covers the oldest age groups from year to year, but at least for precautionary reasons the 6+ group was kept in the tuning series.

Since 1995 a Norwegian acoustic survey for coastal cod has been conducted along the coast and in the fjords from Varanger to Stad in September, just prior to the saithe survey described above. This survey covers coastal areas not included in the regular saithe survey. Because saithe is also acoustically registered, this survey provides supplementary information, especially about 2- and 3-year-old saithe that have not yet migrated out to the banks. At the WG meeting in 2000 analyses were done on combining these indices with indices from the regular saithe survey in the tuning series, but it did not influence the assessment much. The WG therefore decided, for the time being, to only apply indices from the regular saithe survey in the assessment since this series is longer.

B.4. Commercial CPUE

Two CPUE data series are used, one from the Norwegian purse seine fishery and one from the Norwegian trawl fishery.

Until 1999 indices of fishing effort in the purse seine fishery was based on the number of vessels of 20-24.9 m length and the effort (number of vessels) of this length category was raised by the catches to represent the total purse seine effort. The number of vessels taking part in the fishery almost doubled from 1997 to 1998, but due to regulations the catches were almost the same as in 1997. In such a situation the total number of vessels participating in a fishery is perhaps not a good measure of effort. Many of the vessels that have taken part in the fishery the last decade have accounted for only a small fraction of the purse seine catches. Roughly half of the vessels have caught less than 100 tonnes per year, and the sum of these catches represents only about 5 – 10% of the total purse seine catch. Therefore the number of vessels catching more than 100 tonnes annually seems to be a more representative and more stable measure of effort in the purse seine fishery. These numbers are raised to the total purse seine catch. The new effort series show a smaller decrease in later years than the old one and in XSA runs it gets higher scaled weights. The 2000 WG meeting therefore decided to use the new CPUE data series in the assessment.

Catch and effort data for Norwegian trawlers were until 2000 taken from hauls where the effort almost certainly had been directed towards saithe, i.e., days with more than 50% saithe and only on trips with more than 50% saithe in the catch. The effort estimated for the directed fishery was raised by the catches to give the total effort of Norwegian trawlers. From 1997 to 1998 the effort increased by more than 50%, but due to regulations the catches were slightly lower in 1998 and the CPUE decreased by almost 40% from 1997 to 1998 and stayed low in 1999. This may at least partly be explained by change in fishing strategies in a period with increasing problems with bycatch of saithe in the declining cod fishery due to good availability of saithe. In 2001 new CPUE indices by age were estimated based on the logbook database of the Directorate of Fisheries, which has a daily resolution (Salthaug and Godø 2000). After some initial analyses it was decided to only include data from vessels larger than the median length since they showed the least noisy trends. One single CPUE observation from a given vessel is the total catch per day divided by the duration of all the trawl hauls that day. To increase the number of observations during a time period with decreasing directed saithe fishery, all days with 20% or more saithe were included. The effort (hours trawling) for each CPUE observation is standardised or calibrated to a standard vessel. Until 2002, a yearly index was calculated by first averaging all CPUE observations for each month, and then averaging over the year. The CPUE indices were splitted on age groups by quarterly weight, length and age data from the trawl fishery. From 2003, a yearly index is calculated by first averaging all CPUE observations for each quarter, and then averaging over the year. The CPUE indices are finally splitted on age groups by yearly catch in numbers and weight at age data from the trawl fishery. The new approach is less influenced by short periods with poor data, while it still evens out seasonal variations.

Due to rather large negative log q residuals in the first part of the new time series, it was shortened to only cover the period after 1993.

B.5. Other relevant data

None.

C. Historical Stock Development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1960 – last data year	2 – 11+	Yes
Canum	Catch at age in numbers	1960 – last data year	2 – 11+	Yes
Weca	Weight at age in the commercial catch	1960 – last data year	2 – 11+	Yes/No - constant at age from 1960 - 1979
West	Weight at age of the spawning stock at spawning time.	1960 – last data year	2 – 11+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1960 – last data year	2 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1960 – last data year	2 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1960 – last data year	2 – 11+	No – the same ogive for all years
Natmor	Natural mortality	1960 – last data year	2 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norway ac survey extended 2000	1992 – last data year	3 – 6+
Tuning fleet 2	Norway purse seine revised 2000	1989 – last data year	3 - 7
Tuning fleet 3	Nor new trawl revised 2001	1994 – last data year	5 - 9

For analysis of alternative procedures see WG reports from AFWG 1997-2002.

D. Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines, until 2002.

Software used: MFDP prediction with management option table and yield per recruit routines, MFYPR.

Initial stock size. Taken from the XSA for age 5 and older. The recruitment at age 2 and 3 in the last data year is estimated using RCT3 and the corresponding numbers at age 3 and 4 in the start year of the projection is calculated applying a natural mortality of 0.2 and fishing mortality according to the catches taken of these age groups. For consistency, the WG 2004 used the long-term geometric mean recruitment for age 2 from 1960 to the last year for which the retrospective analyses show some stability in recruitment (e.g. 1997 in the 2004 assessment), for projections.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: For weight at age in stock and catch the average of the last three years in the VPA is normally used. In 2004 WG, the estimates of weight-at-age in the catches show a decreasing trend towards 2003, and therefore the 2003 weights at age have been applied in the predictions.

Exploitation pattern: The average of the last three years, scaled by the Fbar (3-6) to the level of the last year if there is a trend.

Intermediate year assumptions: TAC constraint

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Model used: Age structured

Software used: IFAP single option prediction, until 2002

Software used: MFDP single option prediction

Initial stock size: Same as in the short-term projections.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Assumed to be the same as weight at age in the catch

Weight at age in the catch: Same as in the short-term projections.

Exploitation pattern: Same as in the short-term projections.

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Uncertainty models used: @RISK for excel, Latin Hypercubed, 1000 iterations, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 2, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years
- F and M before spawning: Set to 0 for all ages in all years
- Weight at age in the stock: Assumed to be the same as weight at age in the catch
- Weight at age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

- Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4th last year.

F. Long-Term Projections

Not done

G. Biological Reference Points

In 1994 the WG proposed a MBAL of 150,000 t, based on the frequent occurrence of poor year classes below this level of SSB. The new maturity ogive introduced in 1995 gave somewhat higher historical SSB estimates. 150,000 t was considered to represent a less restrictive MBAL and 170,000 t was found to correspond better with the arguments used in 1994. The Study Group on the Precautionary Approach to Fisheries Management (SGPAFM, ICES 1998/ACFM:10) also found this to be a suitable level for B_{pa}. However, based on a visual examination of the stock-recruitment plot ACFM later reduced the B_{pa} to 150,000 t (ICES 1998b).

$F_{0.1}$ and F_{max} are estimated by the MFDP yield per recruit routine, and increased from 0.08 to 0.11 and from 0.14 to 0.24 for $F_{0.1}$ and F_{max}, respectively, in the 1999 - 2003 assessments.

The SGPAFM (ICES 1998/ACFM:10) suggested the limit reference point $F_{lim} = F_{med}$ for Northeast Arctic cod, haddock and saithe. A precautionary fishing mortality (F_{pa}) was defined as $F_{pa} = F_{lim} \cdot e^{-1.645\sigma}$ (σ = 0.2-0.3). The 1998 WG, however, found that setting $F_{lim} = F_{med}$ did not correspond very well with the exploitation history for those fish stocks. It was therefore decided to estimate F_{pa} and other reference points by the PASoft program package (MRAG 1997). The estimates for $F_{0.1}$, F_{max}, and F_{med} were exactly the same as the values already estimated by other routines. The median value for F_{loss} was estimated at 0.43. F_{lim} can be set at F_{loss} (ICES 1998/ACFM:10). The probability of exceeding F_{lim} should be no more than 5 % (ICES 1997/Assess: 7). The 5th percentile of the F_{loss} estimated here was 0.30 and the 1998 WG recommended using this value for F_{pa}. ACFM considered the 5th percentile calculated from the PASoft program package to be too unstable for long term use and re-estimated F_{pa} using the formula $F_{pa} = F_{lim} \cdot e^{-1.645\sigma}$ with σ = 0.3 giving a F_{pa} = 0.26, based on an estimated F_{lim} = 0.45 (ICES 1998c). An updated version of the PASoft program package (CEFAS 1999) was available at the 1999 WG and F_{pa} was re-estimated to 0.26. The WG therefore agreed to use this value for a precautionary fishing mortality for saithe (F_{pa} = 0.26).

Recent increments in minimum landing size and an improved exploitation pattern indicate that the PA fishing mortality reference point (F_{pa}) should be re-estimated in the near future.

H. Other Issues

None.

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Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock: North-East Arctic Cod

Working Group: Arctic Fisheries Working Group

Date: 20-02-02

A. General

A.1 Stock definition

The North-East Arctic cod (*Gadus morhua*) is distributed in the Barents Sea and adjacent waters, mainly in waters above 0° Celsius. The main spawning areas are along the Norwegian coast between N 67°30' and 70°. The 0-group cod drifts from the spawning grounds eastwards and northwards and during the international 0-group survey in august it is observed over wide areas in the Barents Sea.

A.2 Fishery

The fishery for North-east Arctic cod is conducted both by an international trawler fleet operating in offshore waters and by vessels using gillnets, longlines, handlines and Danish seine operating both offshore and in the coastal areas. 60-80% of the annual landings are from trawlers. Catch quotas were introduced in the trawl fishery in 1978 and for the fisheries with conventional gears in 1989. In addition to quotas the fisheries are regulated by mesh size limitations including sorting grids, a minimum catching size, a maximum by-catch of undersized fish, maximum by-catch of non-target species, closure of areas with high densities of juveniles and by seasonal and area restrictions. Since January 1997 sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area. Discarding is prohibited. The minimum catching size of cod is 42 cm in the Russian Economic zone, 47 cm in Norwegian Economic zone; both minimum landing sizes are used by respective fleets in the Svalbard area pursuant to the Svalbard Treaty 1920). The fisheries are controlled by inspections at sea, requirement of reporting to catch control points when entering and leaving the EEZs and by inspections when landing the fish for all fishing vessels. Keeping a detailed fishing log-book on board is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis. There is some evidence that the present catch control and reporting systems are not sufficient to prevent discarding and under-reporting of catches, but it has considerably improved in comparison with historical period.

A.3 Ecosystem aspects

Considerable effort has been devoted to investigate multispecies interactions in the Northeast Arctic. Some of these investigations have reached the stage where quantitative results are available for use in assessments. Growth of cod depends on availability of prey such as capelin (*Mallotus villosus*), and variability in cod growth has had major impacts on the cod fishery. Cod are able to compensate only partially for low capelin abundance, by switching to other prey species. This may lead to periods of high cannibalism on young cod, and may result in impacts on other prey species which are greater than those estimated for periods when capelin are abundant. In a situation with low capelin abundance, juvenile herring (*Clupea harengus)* experience increased predation mortality by cod. The timing of cod spawning migrations is influenced by the presence of spawning herring in the relevant area. The interaction between capelin and herring is illustrated by the recruitment failure of capelin coinciding with years of high abundance of young herring in the Barents Sea. Herring predation on capelin larvae is believed to be partially responsible for the recruitment failure of capelin when young herring are abundant in the Barents Sea.

The composition and distribution of species in the Barents Sea depend considerably on the position of the polar front which separates warm and salty Atlantic waters from colder and fresher waters of arctic origin. Variation in the recruitment of some species including cod and capelin has been associated with the changes in the influx of Atlantic waters to the large areas of the Barents Sea shelf.

The annual consumption of herring, capelin and cod by marine mammals (mainly harp seals and minke whales) has been estimated to be in the order of 1.5-2.0 million t (Bogstad, Haug and Mehl, 2000; See also Section 1.3.4 AFWG Report 2003).

However, estimates of total annual food consumption of Barents Sea harp seals are in the range of about 3.3-5 million tons (depending on choice of input parameters, ICES 2000d). The applied model used different values for the field metabolic rate of the seals (corresponding to two or three times their predicted basal metabolic rate) and under two scenarios: with an abundant capelin stock and with a very low capelin stock.

1. If capelin was abundant the total harp seal consumption was estimated to be about 3.3 million tons (using lowest field metabolic rate). The estimated consumption of various commercially important species was as follows (in tons): capelin approximately 800,000, polar cod (*Boreogadus saida*) 600,000, herring 200,000 and Atlantic cod 100,000.

2. A low capelin stock in the Barents Sea (as it was in 1993-1996) led to switches in seal diet composition, with estimated increased consumption of polar cod (870,000 tons), other codfishes (mainly Atlantic cod; 360,000 tons), and herring (390,000 tons).

B. Data

B.1 Commercial catch

Norway

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES.

No discards are reported or accounted for, but there are several reports of discards. In later years there are also reports of misreporting, saithe is landed as cod in a period with decreasing quotas and availability of cod and good availability of saithe.

The sampling strategy is to have age and length samples from all major gears in each main area and quarter. The main sampling program is sampling the landings. Additional samples from catches are obtained from the coast guard, from observers and from crew members reporting according to an agreed sampling procedure.

There are at present no defined criteria on how to allocate samples to unsampled catches, but the following general procedure has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Russia

Russian commercial catch in tonnes by quarter and area are derived from the All-Russian Institute of fishery and oceanography (Moscow) statistics department. Data from each fishing vessel are aggregated on three ICES sub-Division (1, IIa and IIb).Russian fishery by passive gears was almost stopped by the end of the 1940s. At present bottom trawl fishery constitutes more than 95 % cod catch.

The sampling strategy was to conduct mass measurements and collect age samples directly at sea, onboard of both research and commercial vessels to have age and length distributions from each area and quarter. Data on length distribution of cod in catches were collected in areas of cod fishery all the year round by a "standard" fishery trawl (mesh size is 125 mm in the Russian Economic zone and Svalbard area and 135 mm in the Norwegian Economic zone) and summarized by three ICES sub-areas (1, IIa and IIb). Previously the PINRO area divisions were used, differed from the ICES sub-Divisions.

Age sampling was carried out by two ways: without any selection (otoliths were taken from any fish caught in one trawl, usually from 100-300 sp.) or using a stratified by length sampling method (i.e. approximately 10-15 sp. per each 10-cm length group). The last method has been used since 1988.

All fish taken for age-reading were measured and weighted individually.

Catch at age are reported to ICES AFWG by sub-Division (1, IIa and IIb) and quarter (before 1984 – by sub-Division and year). Data on length distribution of cod in catches, as well as age-length keys, are formed for each quarter and area. In the case when a catch is present in the area/quarter but a length frequency is absent, a length frequency for the corresponding quarter, summarised for the whole sea is used. If there is no data on length composition of cod in catches per a quarter within the whole sea, a frequency summarised for the whole year and whole sea is used. Gaps in age-length distributions in sub-Divisions are filled in with data from the corresponding quarter, summarised for the whole sea. Rest gaps are filled in with information from the age-length key formed for the long-term period (1984-1997) for each quarter and for the whole sea. (Kovalev and Yaragina, 1999). Before 1984 calculation of annually catch cod numbers in sub-Divisions was derived from summarized for both the whole year age-length keys and length distribution in catches.

Germany and Spain

Catch at age reported to the WG by ICES sub-Division (I, IIa and IIb) and quarter, according to national sampling. Missing quarters/sub-Divisions filled in by use of Russian or Norvegian sampling data.

Other nations

Total annual catch in tonnes is reported by ICES sub-Divisions. All caches by other nations are taken by trawl. The age composition from the sampled trawl fleets is therefore applied to the catches by other nations.

The text table below shows which country supplied which kind of data for 2000:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x	x	x
Russia	x	x	x	x	x
Germany	x	x	x		x
United Kingdom	x				
France[1]	x				
Spain	x	x	x		x
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				

[1] As reported to Norwegian and Russian authorities

The nations that sample the catches, provide the catch at age data and mean weights at age on Excel spreadsheet files, and the national catches are combined in Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator.

For 1983 and later years mean weight at age in the catch is calculated as the weighted average for the sampled catches. For the earlier period (1946-1982) mean weight at age in catches is set equal to mean weight at age in the stock (ICES 2001).

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\2000\data\cod_arct** or **w:\ifapdata\eximport\afwg\cod_arct**.

B.2 Biological

For 1983 and later years weight at age in the stock and maturity at age is calculated as weighted averages from Russian and Norwegian surveys during the winter season. Stock weights at age a (W_a) at the start of year y are calculated as follows:

$$W_a = 0.5(W_{rus,a-1} + (\frac{N_{nbar,a}W_{nbar,a} + N_{lof,a}W_{lof,a}}{N_{nbar,a} + N_{lof,a}}))$$

where

$W_{rus,a-1}$: Weight at age a-1 in the Russian survey in year y-1

$N_{nbar,a}$: Abundance at age a in the Norwegian Barents Sea acoustic survey in year y

$W_{nbar,a}$: Weight at age a in the Norwegian Barents Sea acoustic survey in year y

$N_{lof,a}$: Abundance at age a in the Lofoten survey in year y

$W_{lof,a}$: Weight at age a in the Lofoten survey in year y

Maturity at age is estimated from the same surveys by the same formulae, replacing weight by proportion mature.

For age groups 12 and older, the stock weights is set equal to the catch weights, since most of this fish is taken during the spawning fisheries, and in most years considerably more fish from these ages are sampled from the catches than from the surveys.

For the earlier period (1946-1982) the maturity at age and weight at age in the stock is based on Russian sampling in late autumn (both from fisheries and from surveys) and Norwegian sampling in the Lofoten spawning fishery. These data were introduced and described in the 2001 assessment report (ICES 2001).

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0. The peak spawning in the Lofoten area occurs most years in late March-early April.

B.3 Surveys

Russia

Russian surveys of cod in the southern Barents Sea started in the late 1940s as trawl surveys of young demersal fishes. Since 1957 such surveys have been conducted over the whole feeding area including the Bear Island - Spitbergen area (Baranenkova, 1964; Trambachev, 1981), both young and adult cod have been surveyed simultaneously. In 1984, acoustic methods started to be implemented during surveys of fish stocks (Zaferman, Serebrov, 1984; Lepesevich, Shevelev, 1997; Lepesevich *et al.,* 1999). In 1995 a new acoustic assessment method was applied for the first time, which allowed the differentiation and registration of echo intensities from fish of different length (Shevelev *et al.,* 1998). Methods of calculations of survey indices also changed, e.g. due to the necessity to derive length-based indices for the FLEKSIBEST model (Bogstad *et al.*1999; Gusev, Yaragina, 2000).

Time of survey conducting has reduced from 5-6 months (September-February) in 1946-1981 to 2-2.5 months (October-December) since 1982. The aim of conducting a survey is to investigate both the commercial size cod as well as the young cod. The survey covers the main areas where fries settle down as well as the commercial fishery takes place, included cod at age 0+ - 10+ years. A total number of more than 400 trawl hauls are conducted during the survey (mainly bottom trawl, a few pelagic trawl).

There are two survey abundance indices at age: 1). absolute numbers (in thousands) computed from the acoustics and 2). trawl indices, calculated as relative numbers per hour trawling.

Ages 3-8 are used in the XSA-tuning.

Joint Russian-Norwegian winter (February) survey

The survey started in 1981 and covers the ice-free part of the Barents see. Both swept area estimates from bottom trawl and acoustic estimates are produced. The swept area estimates are used in the tuning for ages 3-8, and the acoustic estimate are added to the Norwegian acoustic survey in Lofoten and used for tuning for ages 3-11. The survey is described in Jakobsen et al (1997) and Aglen et al. (2002).

Norwegian Lofoten survey

Acoustic estimates from the Lofoten survey extends back to 1984. The survey is described by Korsbrekke (1997).

B.4 Commercial CPUE

Russia

Two CPUE data series exist, one is historical series, based on RT vessel type (side trawler, 800-1000 HP), which stopped operating in the Barents Sea in the middle of the 1970-s, and other one is presently used, based on PST vessel type (stern trawler, 2000 HP). Information from each fishing trawler was daily transferred to PINRO, including data on each haul (timing, location, gear and catch by species). Yearly catch f cod by the PST trawlers as well as number of hour trawling were summarized and CPUE index (catch on tons per hour fishing) was calculated.

The effort (hours trawling) was scaled to the whole Russian catch. The CPUE indices are split on age groups by age data from the trawl fishery. Data on ages 9-13+ are used in the XSA-tuning.

C. Estimation of historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 10 years

Catchability independent of stock size for ages >6

Catchability independent of age for ages >= 10

Survivor estimates shrunk towards the mean F of the final 5 years or the 2 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1946 – last data year	3 – 13+	Yes
Canum	Catch at age in numbers	1946 – last data year	3 – 13+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	3 – 13+	Yes, set equal to west for 1946-1981
West	Weight at age of the spawning stock at spawning time.	1946 – last data year	3 – 13+	Yes
Mprop	Proportion of natural mortality before spawning	1946 – last data year	3 – 13+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1960 – last data year	3 – 13+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1960 – last data year	3 – 13+	yes
Natmor	Natural mortality	1960 – last data year	3 – 13+	Includes annual est. of cannibalism from 1984, otherwise set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Russian com. CPUE, trawl	1985 – last data year	9 –13+
Tuning fleet 2	Joint Barents Sea trawl survey, february	1981– last data year	3 - 8
Tuning fleet 3	Joint Barents Sea Acoustic, February+ Lofoten Acoustic survey	1985 – last data year	3 -11
Tuning fleet 4	Russian bottom trawl survey, November	1984 – last data year	3-8

XSA-settings

Type of setting	Settings last year	Used this year (why changed)
Time series weighting	Tapered time weighting power = 3 over 10 years	The same
Recruitment regression model (catchability analysis)	Catchability dependent of stock size for ages < 6 Regression type = C Min. 5 points used Survivor estimates shrunk to the population mean for ages < 6 Catchability independent of age for ages >= 10	The same
Terminal population estimation	Survivor estimates shrunk towards the mean F of the final 5 years or the 2 oldest ages. S.E. of the mean to which the estimate are shrunk = 1.0. Minimum standard error for population estimates derived from each fleet = 0.300.	The same
Prior fleet weighting	Prior weighting not applied	The same

D. Short-term projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size. Taken from the XSA for age 4 and older. The recruitment at age 3 for the initial stock and the following 2 years are estimated from survey data and….(have to decide)

Natural mortality: Set equal to the values estimated for the terminal year.

Maturity: average of the three last years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Predicted by applying (10yr average) annual increments by cohort on last years observations.

Weight at age in the catch: Predicted by applying (10yr average) annual increments by cohort on last years observations.

Exploitation pattern: Average of the three last years, scaled by the Fbar (3-6) to the level of the last year

Intermediate year assumptions: F constraint

Stock recruitment model used: None

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Model used: Age structured

Software used: ????

Initial stock size: Same as in the short-term projections.

Natural mortality: Same as in the short-term projections

Maturity: Same as in the short-term projections

F and M before spawning: Same as in the short-term projections

Weight at age in the stock: Same as last year in the short-term projections

Weight at age in the catch: Same as last year in the short-term projections

Exploitation pattern: Same as in the short-term projections

Intermediate year assumptions: Same as in the short-term projections

Stock recruitment model used: ????

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

1. Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics

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: Average of the three last years, scaled by the Fbar to the level of the last year

8. Intermediate year assumptions: F-constraint

9. Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4th last year.

F. Long-term projections

SPR and YPR calculations

G. Biological reference points

Introduced 1998: Blim=112000t, Bpa=500000t, Flim=0.7, Fpa=0.42

Proposed SGBRP 2003: Blim=220000t, Bpa=460000t, Flim=0.74, Fpa=0.40

H. Other issues

Since the 1999 AFWG a new assessment model (Fleksibest) has been used to provide alternative assessments and to describe characteristics of the data for this stock.

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Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock: North-East Arctic Haddock

Working Group: Arctic Fisheries Working Group

Date: 13-05-04

A. General

A.1 Stock definition

The North-East Arctic Haddock (*Melanogrammus aeglefinus*) is distributed in the Barents Sea and adjacent waters, mainly in waters above 2° Celsius. Tagging carried out in 1953-1964 showed the contemporary area of the Northeast Arctic haddock to embrace the continental shelf of the Barents Sea, adjacent waters and polar front. The main spawning grounds are located along the Norwegian coast and area between 70°30' and 73° N along the continental slope. Larvae extruded are widely drifted over the Barents Sea by warm currents. The 0-group haddock drifts from the spawning grounds eastwards and northwards and during the international 0-group survey in august it is observed over wide areas in the Barents Sea.Until maturity, haddock are mostly distributed in the southern Barents Sea being their nursery area. Having matured, haddock migrate to the Norwegian Sea.

A.2 Fishery

Haddock are harvested throughout a year; in years when the commercial stock is low they are mostly caught as bycatch in cod trawl fishery; when the commercial stock abundance and biomass are high haddock are harvested during their target fishery. On average approximately 25% of the catch is with conventional gears, mostly longline, which are used almost exclusively by Norway. Part of the longline catches are from a directed fishery.

The fishery is restricted by national quotas. In the Norwegian fishery the quotas are set separately for trawl and other gears. The fishery is also regulated by a minimum landing size, a minimum mesh size in trawls and Danish seine, a maximum by-catch of undersized fish, closure of areas with high density/catches of juveniles and other seasonal and areal restrictions.

In recent years Norway and Russia have accounted for more than 90% of the landings. Before the introduction of national economic zones in 1977, UK (mainly England) landings made up 10–30% of the total. Each country fishing for haddock and engaged in the stock assessment provide catch statistic annually. Summary sheets in AFWG Report indicate total yield of haddock by Subareas I, IIa and IIb as well as catch by each country by years. Catch information by fishing gear used by Norway in the haddock fishery is used internally when making estimations at AFWG meeting. Catch quotas were introduced in the trawl fishery in 1978 and for the fisheries with conventional gears in 1989. Since January 1997 sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area. Discarding is prohibited. The minimum catching size of haddock is 39 cm in the Russian Economic zone, 44 cm in Norwegian Economic zone; both minimum landing sizes are used by respective fleets in the Svalbard area pursuant to the Svalbard Treaty 1920). The fisheries are controlled by inspections at sea, requirement of reporting to catch control points when entering and leaving the EEZs and by inspections when landing the fish for all fishing vessels. Keeping a detailed fishing log-book on board is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis. There is some evidence that the present catch control and reporting systems are not sufficient to prevent discarding and under-reporting of catches.

The historical high catch level of 320,000 t in 1973 divides the time-series into two periods. In the first period, highs were close to 200,000 t around 1956, 1961 and 1968, and lows were between 75,000 and 100,000 t in 1959, 1964 and 1971. The second period showed a steady decline from the peak in 1973 down to the historically low level of 17,300 t in 1984. Afterwards, landings increased to 151,000 t before declining to 26,000 t in 1990. A new increase peaked in 1996 at 174,000 t. The exploitation rate of haddock has been variable.

The highest fishing mortalities for haddock have occurred at intermediate stock levels and show little relationship with the exploitation rate of cod, in spite of haddock being primarily a by-catch in the cod fishery. The exception is the 1990s when more restrictive quota regulations resulted in a similar pattern in the exploitation rate for both species. It might be expected that good year classes of haddock would attract more directed trawl fishing, but this is not reflected in the fishing mortalities.

A.3 Ecosystem aspects

The composition and distribution of species in the Barents Sea depend considerably on the position of the polar front which separates warm and salty Atlantic waters from colder and fresher waters of arctic origin. Variation in the recruitment of haddock has been associated with the changes in the influx of Atlantic waters to the large areas of the Barents Sea shelf.

In dependence on age and season haddock can vary their diet and act as both predator and plankton-eater or benthos-eater. During spawning migration of capelin (*Mallotus villosus*) haddock prey on capelin and their eggs on the spawning grounds. When the capelin abundance is low or when their areas do not overlap, haddock can compensate for lacking capelin with other fish species, i.e. young herring (*Clupea harengus*) or euphausiids and benthos, which are predominant in the haddock diet throughout a year. Haddock growth rate depends on the population abundance, stock status of main preys and water temperature.

Water temperature at the first and second years of the haddock life cycle is a fairly reliable indicator of year-class strength. If mean annual water temperature in the bottom layer during the first two years of haddock life does not exceed 3.75 C (Kola-section), the probability that strong year-classes will appear is very low even under favourable effect of other factors. Besides, a steep rise or fall of the water temperature shows a marked effect on abundance of year-classes.

Nevertheless, water temperature is not always a decisive factor in the formation of year-class abundance. Strength of year-classes is also determined to a great extent by size and structure of the spawning stock. Under favourable environmental conditions strong year-classes are mainly observed in years when the spawning stock is dominated by individuals from older age groups which abundance is at a fairly high level.

Annual consumption of haddock by marine mammals, mostly seals and whales, depends on stock status of capelin as their main prey. In years when the capelin stock is large the importance of haddock in the diet of marine mammals is minimal, while under the capelin stock reduction a considerable increase in consumption by marine mammals of all the rest abundant Gadoid species including haddock is observed (Korzhev and Dolgov, 1999; Bogstad, 2000).

The appearance of haddock strong year classes usually leads to a substantial increase in natural mortality of juveniles as a result of cod predation.

B. Data

B.1 Commercial catch

Norway (for Knut's consideration)

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub-areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for.

The sampling strategy is to have age and length samples from all major gears in each main area and quarter. The main sampling program is sampling the landings. Additional samples from catches are obtained from the coast guard, from observers and from crew members reporting according to an agreed sampling procedure.

There are at present no defined criteria on how to allocate samples to unsampled catches, but the following general procedure has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Russia

Russian commercial catch in tonnes by seasons and area are derived from the All-Russian Institute of fishery and oceanography (Moscow) statistics department. Data from each fishing vessel are aggregated on three ICES sub-Division (I, IIa and IIb). Russian fishery by passive gears was almost stopped by the end of the 1940s. Until late 1990's, relative weight (percentage) of haddock taken by bottom trawls in the total Russian yield exceeded 99%. Only in recent years an upward trend in a proportion of Russian long-line fishery for haddock was observed to be up to 5% on the average.

The sampling strategy was to conduct mass measurements and collect age samples directly at sea, onboard of both research and commercial vessels to have age and length distributions from each area and season. Data on length distribution of haddock in catches are collected in areas of cod and haddock fishery all the year round by a "standard" fishery trawl (mesh size is 125 mm in the Russian Economic zone and Svalbard area and 135 mm in the Norwegian Economic zone) and summarized by three ICES sub-areas (I, IIa and IIb). Previously the PINRO area divisions were used, differed from the ICES sub-Divisions.

Age sampling was carried out by two ways: without any selection (otoliths were taken from any fish caught in one trawl, usually from 100-300 sp.) or using a stratified by length sampling method (i.e. approximately 10-15 sp. per each 10-cm length group). The last method has been used since 1988.

All fish taken for age-reading were measured and weighted individually.

Data on length distribution of haddock in catches, as well as age-length keys, are formed for each ICES Subarea, each fishing gear (trawl and longline) and each half year. Catch at age are reported to ICES AFWG by sub-Division (I, IIa and IIb) for the whole year. In case data on size or age composition of catches by half year are lacking or not representative, aggregated data from corresponding areas for year are used. In the lack of data by ICES Subareas, information on size-age composition of catches from other areas is used.

Germany

Catch at age reported to the WG by ICES sub-Division (I, IIa and IIb) according to national sampling. Missing sub-Divisions filled in by use of Russian or Norwegian sampling data.

Other nations

Total annual catch in tonnes is reported by ICES sub-Divisions or by Russian and Norwegian authorities directly to WG. All catches by other nations are taken by trawl. The age composition from the sampled trawl fleets is therefore applied to the catches by other nations.

The text table below shows which country supplied which kind of data:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x		x
Russia	x	x	x	x	x
Germany	x	x	x		x
United Kingdom	x				
France	x				
Spain	x				
Portugal	x				
Ireland	x				
Greenland	x				
Faroe Islands	x				
Iceland	x				

The nations that sample the catches, provide the catch at age data and mean weights at age on Excel spreadsheet files, and the national catches are combined in Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator.

For 1983 and later years mean weight at age in the catch is calculated as the weighted average for the sampled catches. For the earlier period (1946-1982) mean weight at age in catches is set equal to mean weight at age in the stock.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\2000\data\had_arct** or **w:\ifapdata\eximport\afwg\had_arct**.

B.2 Biological

For 1983 and later years weight at age in the stock is calculated as weighted averages from Russian (mainly October-December) and Norwegian (February) surveys during the autumn-winter season. Stock weights at age a (W_a) at the start of year y are calculated as follows:

$$W_a = 0.5(W_{rus,a-1} + W_{nbar,a})$$ where

$W_{rus,a-1}$: Weight at age a-1 in the Russian survey in year y-1

$W_{nbar,a}$: Weight at age a in the Norwegian Barents Sea survey in year y

Mean weight at age in the stock reflects weight of haddock in the beginning of a year fairly accurately. In case data on weight of individuals from older age groups are lacking or not representative, the fixed long-term mean estimates are used.

For 1989-2001 Norway presented mean weights from the February and Lofoten surveys and for this period the Norwegian weights were from the Lofoten and the Barents Sea (combined).

Because of the deficiency in the observed data from 1984 to 2002, in 2002 for the mentioned period expert estimates of mean weight of older age groups were given which were reduced to values being more in compliance with the haddock growth rate.

Proportion of mature haddock at age is estimated from data presented by Russia for the period 1981-2003 from late autumn – early spring (both from fisheries and from surveys). Russian data on proportion mature in the stock is to a great extent depends on sampling areas and not always reflects true maturity rate for different age groups (WD# AFWG, 2002). In this relation there is a need to simulate haddock maturity rate by years and age groups or to adjust Russian data to arrive at a more realistic picture. For the earlier period (1946-1980) the maturity at age is set average and based on Russian sampling.

For both estimations and predictions the fixed natural mortality of 0.2 is used, and for age 3-6 mortality from predation is applied in addition.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0. The peak spawning occurs most years in the middle of April.

B.3 Surveys

Russia

Russian surveys of cod and haddock in the southern Barents Sea started in the late 1940s as trawl surveys of young demersal fishes. Since 1957 such surveys have been conducted over the whole feeding area including the Bear Island - Spitbergen area (Baranenkova, 1964; Trambachev, 1981), both young and adult haddock have been surveyed simultaneously. In 1984, acoustic methods started to be implemented during surveys of fish stocks (Zaferman, Serebrov, 1984; Lepesevich, Shevelev, 1997; Lepesevich *et al.,* 1999). In 1995 a new acoustic assessment method was applied for the first time, which allowed the differentiation and registration of echo intensities from fish of different length (Shevelev *et al.,* 1998).

Time of survey conducting has reduced from 5-6 months (September-February) in 1946-1981 to 2-2.5 months (October-December) since 1982. The aim of conducting a survey is to investigate both the commercial size haddock as well as the young haddock. The survey covers the main areas where fries settle down as well as the commercial fishery takes place. A total number of more than 400 trawl hauls are conducted during the survey (mainly bottom trawl, a few pelagic trawl).

There are two survey abundance indices at age: 1). absolute numbers (in thousands) computed from the acoustics and 2). trawl indices, calculated as relative numbers per hour trawling. From 1995 onwards there has been a substantial change in the method for calculating acoustic indices. The acoustic survey is therefore presented in 2 tables (Table B4a and B4b) for old and new method of calculating indices.

Ages 1-7 are used in the XSA-tuning.

Norwegian (from 2000 - Joint Norwegian-Russian) winter (February) survey

The survey started in 1981 and covers the ice-free part of the Barents see. Both swept area estimates from bottom trawl and acoustic estimates are produced. The swept area estimates are used in the tuning for ages 1-8. The survey is described in Jakobsen et al (1997) and Aglen et al. (2002).

Before 2000 this survey was made without participation from Russian vessels, while in the three latest surveys Russian vessels have covered important parts of the Russian zone. The indices for 1997 and 1998, when the Russian EEZ was not covered, have been adjusted as reported previously (Mehl, 1999). The number of fish (age group by age group) in the Russian EEZ in 1997 and 1998 was interpolated assuming a linear development in the proportion found in the Russian EEZ from 1996 to 1999. These estimates were then added to the numbers of fish found in the Norwegian EEZ and the Svalbard area in 1997 and 1998.

It should be noted that the survey conducted in 1993 and later years covered a larger area compared to previous years (Jakobsen *et al*. 1997). In 1991 and 1992, the number of young cod (particularly 1- and 2-year old fish) was probably underestimated, as cod of these ages were distributed at the edge of the old survey area. Other changes in the survey methodology through time are described by Jakobsen *et al*. (1997). Note that the change from 35 to 22 mm mesh size in the codend in 1994 is not corrected for in the time series. This mainly affects the age 1 indices.

B.4 Commercial CPUE

Russia

No Russian data are used in the stock estimations.

Norway

Historical time series of observations from onboard Norwegian trawlers were earlier used for tuning of older age groups in VPA. The basis was catch per unit effort (CPUE) in Norwegian statistical areas 03, 04 and 05 embracing coastal banks north of the Lofoten, on which approximately 70% of Norwegian haddock catch fell. However, proportion of haddock taken as by-catch is pretty high and thus it is difficult to estimate their actual catch per unit effort. Since 2002, CPUE indices have not been used in XSA tuning.

Other data

Not used.

C Estimation of historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for ages >6

Catchability independent of age for ages >= 9

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

S.E. of the mean to which the estimate are shrunk = 1.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1950 – last data year	1 – 11+	Yes
Canum	Catch at age in numbers	1950 – last data year	1 – 11+	Yes
Weca	Weight at age in the commercial catch	1983 – last data year	1 – 11+	Yes, set equal to west for 1950-1982
West	Weight at age of the spawning stock at spawning time.	1950 – last data year	1 – 11+	Yes
Mprop	Proportion of natural mortality before spawning	1950 – last data year	1 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1950 – last data year	1 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1950 – last data year	1 – 11+	Yes, set equal to average for 1950-1980
Natmor	Natural mortality	1950 – last data year	1 – 11+	Includes annual est. of predation by cod from 1984, otherwise set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Russian bottom trawl survey, October-December	1983 – last data year	1-7
Tuning fleet 2	Joint Barents Sea trawl survey, February	1982– last data year	1 - 8
Tuning fleet 3	Joint Barents Sea Acoustic survey, February	1980 – last data year	1 - 7

D Short-term projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock status: is estimated in XSA as abundance of individuals survived in the terminal year for age 3 and older.

Recruitment at age 3 for the start year and the 2 consecutive years is estimated from survey data in RCT3.

Natural mortality is mainly assumed equal to the level estimated for terminal year or to the average for the recent 3 years in dependence on expected cod predation. Method used to determine this parameter and its substantiation are given in the AFWG Reports.

Proportion mature: for current year preliminary actual data presented by Russia are used; for subsequent years – expert estimates by AFWG members. Method used to determine this parameter and its substantiation are given in the AFWG Reports.

F and M prior to spawning are assumed equal to 0 for all ages in all years.

Weight at age in the stock: Method used to determine this parameter and its substantiation are given in the AFWG Reports.

Weight at age in catch: Method used to determine this parameter and its substantiation are given in the AFWG Reports.

Distribution of fishing mortality at age (fishing pattern): For current year it is taken to be at the level of previous year ($F_{Status\ quo}$) or to be equal to average for the recent 3 years; for subsequent years method used to determine this parameter and its substantiation are given in the AFWG Reports.

F and M before spawning: Set to 0 for all ages in all years

Stock recruitment model used: None

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Time lag: 4 years

Software used: Excel with the build-in @RISK to make statistical estimations.

Initial stock status, natural mortality, proportion mature, proportion of F and M prior to spawning, mean weight at age in stock and in catch, exploitation pattern, predicted F in intermediate year: the same as in the short-term prediction.

Stock recruitment model used: ????

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

1. Initial stock size: Lognormal distribution, LOGNORM (mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics

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: Average of the three last years, scaled by the Fbar to the level of the last year

8. Intermediate year assumptions: F-constraint

9. Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4th last year.

F. Long-term projections

Spawning stock biomass per recruit (SPR) and yield per recruit (YPR) are estimated annually.

G. Biological reference points

Introduced 1998: Blim=50000t, Bpa=80000t, Flim=0.49, Fpa=0.35

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Stock specific documentation of standard assessment procedures used by ICES.

Stock:… *Sebastes marinus* in ICES Sub-areas I and II

Working Group:… Arctic Fisheries Working Group

Date: 11.05.2004

A. General

A.1. Stock definition

The stock of *Sebastes marinus* (golden redfish) in ICES Sub-areas I and II is found in the northeast Arctic from 62ºN in the south to north of Spitsbergen. The Barents Sea area is first of all a nursery areas, and relatively few fish are distributed outside Spitsbergen. S. marinus are distributed all over the continental shelf southwards to beyond 62ºN, and also along the coast and in the fjords. The main areas of larval extrusion are outside Vesterålen, on the Halten Bank area and on the banks outside Møre. The peak of larval extrusion takes place ca. one month later than S. mentella, i.e. during beginning of May. Genetic studies have not revealed any hybridisation with *S. marinus* or *S. viviparus* in the area.

A.2. Fishery

The fishery for *Sebastes marinus* (golden redfish) is mainly conducted by Norway which accounts for 80–90% of the total catch. Germany also has a long tradition of a trawl fishery for this species. The fish are caught mainly by trawl and gillnet, and to a lesser extent by longline and handline. The trawl and gillnet fishery have benefited from the females concentrating on the “spawning” grounds during spring. Some of the catches, and most of the catches taken by other countries, are taken in mixed fisheries together with saithe and cod. Important fishing grounds are the Møre area (Svinøy), Halten Bank, the banks outside Lofoten and Vesterålen, and Sleppen outside Finnmark. Traditionally, *S. marinus* has been the most popular and highest priced redfish species.

Until 1 January 2003 there were no regulations particular for the *S. marinus* fishery, and the regulations aimed at *S. mentella* (see chapter 6.1.1) had only marginal effects on the *S. marinus* stock. After this date, all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and on board at any time.

A minimum legal catch size of 32 cm has been set for all fisheries (since 14 April 2004), with the allowance to have up to 10% undersized (i.e., less than 32 cm) specimens of *S.marinus* (in numbers) per haul.

Until 14 April 2004 there were no regulations of the other gears/fleets than trawl fishing for *S. marinus*. After this date, limited moratorium during 1-31 May has been enforced in all fisheries except trawl. When fishing for other species (also during the moratorium) it is allowed to have up to 20% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday.

After 1 January 2006 it will be forbidden to use gillnets with meshsize less than 120 mm when fishing for redfish.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated for the gears gill net, long line, hand line, Danish seine and bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters <u>length</u> samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights at age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length at age.

The text table below shows which country supply which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. marinus*	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x				x
Germany	x	x[3)]				x
United Kingdom	x	[1)]				
France	x	[1)]				
Spain	x	[1)]				
Portugal	x	[1)]				
Ireland	x	[1)]				
Greenland	x	[1)]				
Faroe Islands[1)]						
Iceland	x	[1)]				

[1)] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)
[2)] For main fishing area until 2001
[3)] Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight at age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian trawl landings. In some years the final German and Russian numbers at age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smr-arct** or **w:\ifapdata\eximport\afwg\smr-arct**.

B.2. Biological

The total catch-at-age data back to 1991 are based on Norwegian otolith readings. In 1989–1990 it was a combination of the German scale readings on the German catches, and Norwegian otolith readings for the rest. In 1984–1989 only German scale readings were available, while in the years prior to 1984 Russian scale readings exist.

Weight at age in the stock is assumed to be the same as weight at age in the catch.

When an analytical assessment is made, a fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A knife-edge maturity at age 15 has been used for this stock.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the Working Group:

1) Norwegian Barents Sea bottom trawl survey (February) from 1986–2003 in fishing depths of 100–500 m. Data are available on length for the years 1986–2003, and on age for the years 1992–2003. This survey covers important nursery areas for the stock

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2002 in fishing depths of 100–500 m. This survey covers the northernmost part of the species' distribution.

Data on length and age from both these surveys have been simply added together and used in the assessments.

3) Catch rates (numbers/nautical mile) and acoustic indices of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2002 from Finnmark to Møre. Since 2003, only catch rates are available.

B.4. Commercial CPUE

The former (until 2002) CPUE-series for *S. marinus* from Norwegian 32-50 meter freezer trawlers has been improved (e.g., analysing the trawl data with regards to vessel length instead of vessel tonnage) and presented from 1992 onwards. Only data from days with more than 10% *S. marinus* in the catches (in weight) were included in the annual averages. The sensitivity/consequences of using different percentages should be further investigated, though the present 20% bycatch regulation puts limitations on what's possible to use.

Although the trawl fishery until 2003 was almost unregulated, the trawlers experience fewer and fewer fishing days with more than 10% of their catches composed of *S. marinus*.

B.5. Other relevant data

None.

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.

In some years trial analytical XSA assessments have been made and discussed by the Working Group. In such cases the following settings have been used/recommended, but NOTE that this is subject to further improvement and evaluation before being adopted:

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 24

Survivor estimates shrunk towards the mean F of the final 2 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 2.00

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1965 – last data year	2 – 24+	Yes
Canum	Catch at age in numbers	1965 – last data year [1)]	2 – 24+	Yes
Weca	Weight at age in the commercial catch	1965 – last data year [1)]	2 – 24+	Yes/No - constant at age in begiining of time series
West	Weight at age of the stock	1965 – last data year [1)]	2 – 24+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1965 – last data year	2 – 24+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1965 – last data year	2 – 24+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1965 – last data year	2 – 24+	No – knife edged at age 15
Natmor	Natural mortality	1965 – last data year	2 – 24+	No – set to 0.1 for all ages in all years

[1)] Age reading based on only otoliths since 1991 (incl.).

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norway bottom trawl, Svalbard, fall	1992 – last data year	2-15
Tuning fleet 2	Norway bottom trawl, Barents Sea, winter	1992 – last data year	3-15
Tuning fleet 3	Norway trawl CPUE	1992 – last data year	9-23

D. Short-Term Projection

Model used: Visual inspection/analysis of survey results together with information from the fishery.

No analytical short-term projection has been made for this stock.

E. Medium-Term Projections

Model used: Visual inspection/analysis of survey results together with information from the fishery.

No analytical short-term projection has been made for this stock.

Uncertainty models used: None

F. Long-Term Projections

Not done

G. Biological Reference Points

It is proposed to adopt the average number of the five lowest survey abundance estimates for specimens above 25 cm in the combined February Barents Sea survey and the August Svalbard summer survey during 1986-1997, and Upa as 80% of the three highest abundance estimates for the same size groups in the same surveys/years. The survey series are at present only available in numbers.

Stock specific documentation of standard assessment procedures used by ICES.

Stock: *Sebastes Mentella* (Deep-Sea Redfish) in Sub-Areas I and II

Working Group: Arctic Fisheries Working Group (Afwg)

Date: 01.05.03

A. General

A.1. Stock definition

The stock of *Sebastes mentella* (deep-sea redfish) in ICES Sub-areas I and II is found in the northeast Arctic from 62ºN in the south to the Arctic ice north and east of Spitsbergen. The south-western Barents Sea and the Spitsbergen areas are first of all nursery areas. Although some adult fish may be found in smaller subareas, the main behaviour of *S. mentella* is to migrate westwards and south-westwards towards the continental slope as it grows and becomes adult. South of 70°N only few specimens less than 28 cm are observed, and south of this latitude *S. mentella* are only found along the slope from about 450 m down to about 650 m depth. The southern limit of its distribution is not well defined but is believed to be somewhere on the slope northwest of Shetland. The stock boundary 62º N is therefore more for management purposes than a biological basis for stock separation, although the abundance of this species south of this latitude becomes less. The main areas of larval extrusion are along the slope from north of Shetland to west of Bear Island. The peak of larval extrusion takes place during the first half of April. Genetic studies have not revealed any hybridisation with *S. marinus* or *S. viviparus* in the area.

A.2. Fishery

The only directed fisheries for *Sebastes mentella* (deep-sea redfish) are trawl fisheries. By-catches are taken in the cod fishery and as juveniles in the shrimp trawl fisheries. Traditionally, the fishery for *S. mentella* was conducted by Russia and other East European countries on grounds located south of Bear Island towards Spitsbergen. The highest landings of *S. mentella* were 269,000 t in 1976. This was followed by a rapid decline to 80,000 t in 1980–1981 then a second peak of 115,000 t in 1982. The fishery in the Barents Sea decreased in the mid-1980s to the low level of 10,500 t in 1987. At this time Norwegian trawlers showed interest in fishing *S. mentella* and started fishing further south, along the continental slope at approximately 500 m depth. These grounds had never been harvested before and were inhabited primarily by mature redfish. After an increase to 49,000 t in 1991 due to this new fishery, landings have been at a level of 10,000–15,000 t, except in 1996-1997 when they dropped to 8,000 t. Since 1991 the fishery has been dominated by Norway and Russia. Since 1997 ACFM has advised that there should be no directed fishery and that the by-catch should be reduced to the lowest possible level.

The redfish population in Sub-area IV (North Sea) is believed to belong to the North-east Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The landings from Sub-area IV have been 1,000–3,000 t per year. Historically, these landings have been *S. marinus*, but since the mid-1980s trawlers have also caught *S. mentella* in Sub-area IV along the northern slope of the North Sea. Approximately 80% of the Norwegian catches are considered to be *S. mentella*.

Strong regulations were enforced in the fishery in 1997. Since then it has been forbidden to fish redfish (both *S.marinus* and *S. mentella*) in the Norwegian EEZ north and west of straight lines through the positions:

1. N 7000’ E 0521’
2. N 7000’ E 1730’
3. N 7330’ E 1800’
4. N 7330’ E 3556’

and in the Svalbard area (Division IIb). When fishing for other species in these areas, a maximum 25% by-catch (in weight) of redfish in each trawl haul is allowed.

To provide additional protection of the adult *S. mentella* stock, two areas south of Lofoten have been closed for all trawl fishing since 1 March 2000. The two areas (A and B) are delineated by straight lines between the following positions:

A	B
1. N 6630' E 0659'	1. N 6236' E 0300'
2. N 6621' E 0644'	2. N 6210' E 0115'
3. N 6543' E 0600'	3. N 6240' E 0052'
4. N 6520' E 0600'	4. N 6300' E 0300'
5. N 6520' E 0530'	
6. N 6600' E 0530'	
7. N 6630' E 0634.27'	

Area A has recently been enlarged to include the continental slope north to N 67º10'.

Since 1 January 2003 all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and on board at any time.

Since 1 January 2000 a maximum legal by-catch criterion of 10 juvenile redfish (both *S.marinus*, *S. mentella* and *S. viviparus*) per 10 kg shrimp has been enforced in the shrimp fishery.

A.3. Ecosystem aspect

As 0-group and juvenile this stock is an important plankton eater in the Barents Sea, and when this stock was sound, 0-group were observed in great abundance in the upper layers utilizing the plankton production. Especially during the first five-six years of life *S. mentella* is also preyed upon by other species, of which its contribution to the cod diet is well documented.

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data are aggregated on 17 areas for bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights at age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length at age

The text table below shows which country supply which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. mentella*	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x	x[2]	x[2]	x	x
Germany	x	x[3]				x[3]
United Kingdom	x	[1]				
France	x	[1]				
Spain	x	[1]				
Portugal	x	[1]				
Ireland	x	[1]				
Greenland	x	[1]				
Faroe Islands[1]						
Iceland	x	[1]				

[1] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)
[2] For main fishing area until 2001
[3] Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight at age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian trawl landings. In some years the final German and Russian numbers at age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smn_arct** or **w:\ifapdata\eximport\afwg\smn_arct**.

B.2. Biological

Since 1991, the catch in numbers at age of *S. mentella* from Russia is based on otolith readings. The Norwegian catch-at-age is based on otoliths back to 1990. Before 1990, when the Norwegian catches of *S. mentella* were smaller, Russian scale-based age-length keys were used to convert the Norwegian length distribution to age.

As input to trial analytical assessments, weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Age-based maturity ogives for *S. mentella* (sexes combined) are available for 1986–1993, 1995 and 1997–2001 from Russian research vessel observations in spring. Average ogives for 1966-1972 and 1975-1983 have been used for the periods 1965-1975 and 1976-1983, respectively. Average ogives for 1975-1983, 1984-1985 and data for 1986-1993 (Table D8) were used to generate a smoothed maturity ogive for 1984-1992 (3 year running average). The 1992-1993 average was used for 1993 and 1994, the 1995 data for 1995, the average for 1995 and 1997 for 1996, and the collected material for the subsequent years up to 2001 were taken as representative for these years.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the AFWG:

1) The international 0-group survey in the Svalbard and Barents Sea areas in August-September since 1980 (incl.).

2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December since 1978 (incl.) in fishing depths of 100–900 m.

3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since1992.

4) Norwegian Barents Sea bottom trawl survey (February) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since 1992.

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area.

5) A new Norwegian survey designed for redfish and Greenland halibut is covering the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen in August since 1996 from less than 100 m to 500 m depth. The results from this survey includes survey no. 3) above.

6) Russian acoustic survey in April-May since 1992 (except 1994, 1996 and 2002) on spawning grounds in the western Barents Sea .

The international 0-group fish survey carried out in the Barents Sea in August-September since 1965 does not distinguish between the species of redfish but it is believed to be mostly *S. mentella*. The survey design has improved and the indices earlier than 1980 are not directly comparable with subsequent years. A considerable reduction in the abundance of 0-group redfish was observed in the 1991 survey: abundance decreased to only 20% of the 1979–1990 average. With the exception of an abundance index of twice the 1991-level in 1994, the indices have remained very low. Record low levels of less than 20% of the 1991–1995 average have been observed for the 1996-1999 year classes. The 2000 year class was stronger than the preceding four year classes, whereas the estimate of the 2001 and 2002 year classes are among the lowest on record.

Russian acoustic surveys estimating the commercially sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. In 1992 the area covered was extended, and data on age are available for 1992–1993, 1995 and 1997–2001. This is the only survey targeting commercially sized *S. mentella*, but only a limited area of its distribution.

B.4. Commercial CPUE

Revised catch-per-hour-trawling data for the *S. mentella* fishery have been available from Russian PST- and BMRT-trawlers fishing in ICES Division IIa in March-May 1975-2002, representative for the directed Russian fishery accounting for 60-80% of the total Russian catch. The Working Group mean that the Russian trawl CPUE series do not represent the trend in stock size but is more a reflection of stock density. This is because the fishery on which these data are based since 1996 was carried out by one or two vessels on localised concentrations in the Kopytov area southwest of Bear Island. This is also reflected by the relative low effort at present. Due to this change in fishing behaviour/effort, CPUEs have been plotted only for the period after 1991.

B.5. Other relevant data

None

C. Historical Stock Development

Model used:
Software used:
Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1965-2002	6-19+	yes
Canum	Catch at age in numbers	1965-2002[1]	6-19+	yes
Weca	Weight at age in the commercial catch	1965-2002	6-19+	yes
West	Weight at age of the spawning stock at spawning time.	1965-2002	6-19+	yes
Mprop	Proportion of natural mortality before spawning	1965-2002	6-19+	Constant=0
Fprop	Proportion of fishing mortality before spawning	1965-2002	6-19+	Constant=0
Matprop	Proportion mature at age	1965-2002	6-19+	1965-1975, const. 1976-1983, const. 1984-variable
Natmor	Natural mortality	1965-2002	6-19+	Constant=0.1

[1] Based on otoliths since 1991

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	FLT10 Rus young	1991-2002	6-8
Tuning fleet 2	FLT13 Rus acous	1995-2001	6-14
Tuning fleet 3	FLT14 Norw bottom	1996-2002	2-11
….			

D. Short-Term Projection

Model used: Visual analysis of survey results.

Software used: none

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Model used: Visual analysis of survey results.

Software used: none

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

H. Other Issues

I. References

ANNEX 1

Minutes of the review of the Report of the Artic Fisheries Working Group (ACFM 25-27 May 2004)

The reviewers compliment the Artic Fisheries Working Group for providing a comprehensive report. All of the terms of references were met, with the exception of the testing of the harvest control rule for haddock. Significant progress have been made with the quality handbook which was attached to the report and which contained a lot of information which was relevant to the ACFM report in the new format. Also significant progress has been made in evaluation of harvest control rules.

The paragraphs in the different stock sections highlighting the specific action taken as a response on last years ACFM technical minutes were appreciated. The chair of the WG presented the assessments and other evaluations done by the WG and highlighted the issues which he considered to be of importance to the review group. He was a great help to the reviewers. The reviewers have a number of general comments and some specific comments to the individual assessments which are given in this report. In addition some points raised at the ACFM meeting are included in this report.

A general comment from the reviewers to the new review process. The review group met three days in advance of ACFM. The first drafts of the report became available only a few days before the review took place. The review group had also to deal with the Report of the North Western Group. In addition one reviewer was not able to come to the meeting. This lead to the situation that only two reviewers had to deal with 2 reports (about 1000 pages) to be read and commented within a week. Also summary sheets for each stock and an overview for each area had to be provided in a new format which took a considerable time. The reviewers felt that the heavy workload and time pressure has negatively affected the quality of the review and recommend that the review procedure is evaluated.

A number of general comments were made on the report in arbitrary order:

1. A lot of standard information (information which does not change from year to year) is given in the quality handbook. It is not considered necessary to duplicate this information in the stock sections of the report since this may lead to inconsistencies. It would be better to update the handbook if this is required.
2. The main body of the report would than consist of the available data, exploitations of the data and the technical assessment including the conclusions from these (the haddock is a good example).
3. The review group advises the group to reconsider the structure of the assessment sections and asks the WG to present the information in a logical order. Although almost all required information was available it was scattered all over the section. The WG should realise that the report is written as a working document to ACFM (reviewers). Preferably the sequence of the information would be structured in such a way that by reading the sections in the presented order, the reviewer can follow the assessment procedure. Also consider the headers of the paragraphs covers the contents and can be used to find information easily. An good example how to structure a section would be the assessment of North Sea herring.
4. Within each stock section a paragraph labelled advice applicable in the last data year and current year is required. (not all users have this information at hand)
5. Also a paragraph labelled management applicable to 2003 and 2004 is required. The information is needed for the ACFM report in the template for the stock advice. Also ACFM must be aware of what kind of management/regulations are presently in place when it formulates its advice
6. The section fisheries becomes redundant when it is in the quality handbook unless the fisheries have changed recently. Describing trends in landings belongs in a different section.
7. Mention routinely whether discard information included in assessment. If it is not mentioned this could be interpreted as forgotten. Mention also whether discarding is thought to be occurring and whether this considered to be is a significant problem.
8. In principle all available information can be presented in tables or figures, even when this is not used for good reasons (to be mentioned). In most cases this has been done. This has been done in most cases
9. The WG is encouraged to use alternative assessment models to explore the data and to illustrate the (un)certainties in the results of the assessment. Many new tools have become available in recent time and are used in various Working Groups.
10. ACFM requires information how the exploitation of the different species is linked though the different fisheries in the area. A descriptions is required defining the different fisheries and comment on the mixed fishery character of the fisheries. Which species are target in these fisheries and which are by catch.

Norwegian coastal cod

This stock was originally listed as an update assessment but later upgraded as a benchmark. This became not clear from the report. A more extensive evaluation of the data was expected in a benchmark assessment.

Although the assessment is not considered precise, there is not doubt that present recruitment and SSB are very low. The assessment was accepted as a basis for providing advice. The WG is asked to get explore alternative models to explore the available data and investigate how to improve the assessment. This is a stock for which ACFM advises no fishing. So being able to detect any signal of recovery or further deterioration is important. Information on discarding and whether this may be a problem to the assessment should be mentioned. The WG should attempt do bring discard estimates to the meeting. Catches of cod have been split up between NEA cod and Norwegian coastal cod based on the otolith structure. The accuracy of splitting catches between NEA and coastal cod should be discussed.

It was noted that catches (at age 0 decline less in the survey compared to the landings and the mean q values suggest different Z in survey and landings. The input table to RCT is missing. There is a difference in rsquare in XSA tuning fleet for age 2 and the same age in RCT (.96 and .27 respectively). The reviewers thought they should be the same as it concerns the same data and should be further investigated. The data shown in fig 2.1 show no outlier, suggesting .96 as the most likely value.

NEA Haddock

This is a benchmark assessment. The assessment was accepted. The way the assessment was presented is close to the (by the reviewers) desired situation given above in the general comments. The information in the haddock section is restricting to the actual information needed to document the assessment while the auxiliary information was available in the quality handbook. The evaluation of an agreed harvest control rule for haddock was postponed because of lack of time.

More attention should be given to the discussion of the results. For instance there is only line with a reference to a figure with retrospective performance of the assessment. The patterns and possible reasons should be discussed (in a paragraph with a recognisable header).

The arbitrary decision to use a time taper in the XSA assessment was questioned. The usefulness of tapering should have been looked at; certainly in a benchmark procedure. P shrinkage was applied up to age 7. This choice should be justified because it is in general not the recommended option. Also the P-shrinker gets no weight in estimation of survivors.

The assessment has not converged indicating estimated level of fishing mortality is not well defined. One reviewer noted that the discussion on the signals given by the individual fleets the data exploration is less relevant given the dynamics of the stocks. All tuning fleets basically give the same information.

Attention should be given to the comparison of the assessment with those in previous years. ACFM comments on a comparison in its report.

An output table of the predictions (over 3 years) was missing to justify the TAC which would have been set using the agreed harvesting rule. Such a table was provided by the chair and is attached to the minutes.

There may be an error in the SSB on the x-scale in figure 4.7. The SSB value for the final assessment point 'All SE=0.50' in the upper right figure does not correspond with the summary table (Fig 4.4). The F-value is OK.

For this stock a management plan has been agreed. A run with a prognoses based on the agreed management plan is missing. On request by the review group the chairman of the WG provided the review group with such a run.

NEA saithe

This is an update assessment. The assessment was accepted. As a consequence the WG did not deal with all comments in last years minutes and postponed the requested analyses to next year when a full comprehensive assessment is expected to be undertaken. However, the review group thinks that this should not prevent the WG to introduce minor improvements if they do not require extra analyses (the update procedure was primarily introduced to save time).

As last year the reviewers considered the estimated recruitment by RCT is basically the mean and the Acoustic survey does not provide additional information. It would be more transparent to use the GM mean.

The way the corrections was made to calculate the survivors in 2004 for those year classes recruitment estimates were changed manually was questioned. Normally the F values, estimated by XSA, would have been applied to the revised recruitment to calculate the survivors instead of recalculating F at age from the actual catches. To avoid these problems, at least partially, it was suggested that the 1-group index could be included as a tuning fleet and apply P-shrinkage to this age group. The graphs between index and Stock as diagnostic were considered to be instructive.

Retrospective analyses show large trends of overestimating F and underestimating SSB and inability to predict recruitment. This demonstrates considerable uncertainty on de estimated values of the assessment in the most recent years. It was suggested to try other assessment methods such as ADAPT which will also provide CV's of the estimates of fishing mortality and stock numbers. This should be explored next year, when this stock is assessed as a benchmark. Similar retrospective patterns (underestimating SSB and overestimating F) have been observed in other saithe stocks. There may be several explanation (choice of wrong M, immigration) to explain these patterns.

The medium term analyses was not considered reliable as the results are mainly driven by the assumption of mean recruitment and ignoring the bias in the assessment.

North-East Arctic cod

This is a benchmark assessment since the stock is on the observation list. The assessment was accepted. The review group appreciated that the WG came with estimates of unreported landings and investigated the effect of these on the assessment. However, the validity of the procedure used was questioned. The review group is of the opinion that such evaluation should be carried out within a statistical framework for instance AMCI which can be set up to estimate catches, also for the period 1990- 1994. It was noted that Flexibest estimates of catches in this period and later is higher than the reported catch.

If the underreporting only occurred in the years where estimates where available this causes no problems to the assessment. If underreporting also existed in preceding or intermediate years and no estimates are available, this may cause a serious problem to the assessment. It is noted that the assessment indicates a declining trend in F in recent years where the problems with the catch data are known to be existing. The analyses of the individual surveys separately by SURBA come up with same signals with regard to recent trends in F and SSB and support the overall results of the XSA assessment. It is strongly recommended to try alternative assessment models on this stock.

Comparison of tables 3.26 and 3.27 summary with or without cannibalism is confusing because cannibalism was not included in the whole time series presented. The effect of including cannibalism on the presented final results of the assessment is not presented clear. The WG is asked to demonstrate the change to the assessment of including cannibalism s on the estimates of fishing mortality, SSB and recruitment.

Most of the cannibalism mortality takes place before the age of recruitment used in the assessment. It is recognised that survey estimates of age groups younger than the youngest age used in the assessment are affected and would have to be corrected for cannibalism before being used as predictors of recruitment.

The configuration of the XSA assessment includes the use of a power function (P-shrinkage) for ages less than 6 year old. The review group notes that the slopes and t-values ect. give no strong argument to include power function in assessment.

Comparison of this years assessment with that of last year show that they are consistent. The differences are well explained by changes in previous years data and corrections for errors.

An output table of the predictions (over 3 years) was missing to justify the TAC which would have been set using the agreed harvesting rule. Such a table was provided by the chair and is attached to the minutes.

It was noted that there was a considerable decline in weight at age in the Norwegian survey for some age groups (eg age group 3). This was not evident in the Russian survey (compare tables A7 and A9)

The results of Flexibest results were compared with those of XSA. There is a difference in the Flexibest SSB estimate and XSA for 2003, but this due to way maturity was modelled. The forecasts were compared as well (long discussion on this). It was noted that the yield forecast from Flexibest is somewhat lower than XSA, particularly so for status quo forecast. However, the difference was lesser for F-values below Fpa. Also, in order to use this model for providing management advice, reference points would need to be recalculated. It would be difficult to extend Flexibest to the time period when survey data are not available. The WG notes that such an extension will require assumptions about the selection pattern of the various fishing fleets backwards in time. The Review Group accepted XSA as the basis for the forecast.

The WG carried out an evaluation of the adopted harvest control rule for cod using a new simulation programme (PROST). The reviewers complimented the Working Group for this exercise. The chair of the WG was complemented for the clear presentation how the evaluation had been done. A lot of progress have been made in how to conduct such an evaluation. It would be helpful for similar exercises in the future that ICES provides a document with guidelines based on the experience from this group.

In the simulation, cyclic processes observed in recruitment, stock size dependent weight at age and maturation were modelled and compared to the observed trends. All observed and assumed relationships have been taken account, including assessment uncertainty but not possible bias is assessment. Although the current assessment shows no retrospective bias presently, it was a big problem in the past it and it may occur in the future again e.g. in periods of large changes in the stock or fishery. It is recommended to test the robustness of the rule with respect to different levels of bias.

It was noted that the present Fpa, in the way it was derived, takes into account the recent bias in the assessments, but bias may increase in the future for unknown reasons as has been observed in many other stocks

In principle the rule is incomplete because it does not specify how the reduction in TAC will be done when the stock falls below Bpa. In practice, while fishing at Fpa the occurrence of this situation in the simulations was less than 1% so it did not matter. While testing a number of assumed possible actions the rule for these actions would lead to a very low probability of SSB below Bpa in any year. The test runs assume either 1) that the fishing mortality will be reduced proportionally to zero when SSB is between Bpa and Blim or 2) that the TAC is set according to Fpa ignoring the 10% constraint on flexibility in TAC between successive years. Another assumption would be that the 10% constraint on the TAC would be maintained if SSB<Bpa. Such an option would likely be the default option when no agreement on the additional measures can be achieved.

The evaluation should have taken account for implementation error (non compliance with the management rules). Given the existence of underreporting at present, this is important.

It was noted that estimation of future recruitment in the model is different from common practice in the WG. The WG would estimate recruitment based on (survey) indices while the model estimates it from the S/R function.

In most predictions a certain percentage of the catch contains of "assumed" recruitment, in other words recruitment estimated from a S/R function or mean. It would be relevant to demonstrate how much of the predicted catch in the 3 year rule is made up by 'assumed' year classes.

It is not clear in Table 3.36 what the last 4 columns represent.

The output presents the results of the last 80 years of a simulation with rule over 100 years having already achieved an increase of the stock comparable with high historical observations. It would have been also interesting to see the results of the years immediate after the implementation of the rule because these would reflect the kind of action which is required by managers in the recent medium term. This information was provided by the chairman of the WG and is attached to the minutes (see Appendix).

The rule has not been tested as a tool to rebuild the stock. Simulations of the rule would have to be done from a poor stock situation in order to do this. The rule is expected to bring the stock in a situation not observed historically and biological responses are extrapolated.

All simulations indicate that the risk of bringing the stock below Blim is very low. This would also have been expected when the PA reference points are chosen correctly. The probability of bringing the stock below Bpa is also low. This implies that the situations where other management decisions have to be taken are rare. In particular the omission of assuming bias in the assessment and implementation error (for instance by implementing an F of 20% or 40% higher than intended) should be further investigated before the rule can be considered in accordance with the Precautionary Approach. Also testing the performance of the HCR to rebuild the stock in poor situations should be further investigated.

The rule was also tested with F=0.5 instead of Fpa(0.4). This leads to high probability of SSB<Bpa (40%). The analyses support the choice of the value Fpa to be consisted with Bpa. The F =0.5 run can be considered as a implementation error or an assessment error of 20%. What really matters is that the stock does not drop below Blim.

Greenland halibut

This is an update assessment. The precision of the actual estimates of SSB and F by assessment is considered to be low. Nevertheless the assessment was accepted indicative to trends.

The XSA diagnostics are relatively poor and indicate noisy data. They need more considerations because they show high t-values and negative slopes, some of them being significant.

In addition to the presented survey graphs, the review group would like to see, if possible, graphs of the results of the three surveys in biomass units.

There seems to be a problem with the catch at age matrix with unexpected high numbers of 10 year olds in almost all years. These numbers originate from Norwegian data (The problem also exists in the survey). It was explained that there were age reading problems with this age group. However, de reviewers cannot understand why this problem would be specific for 10-year-olds in Norwegian catches and not/less for other age groups.

Sebastes mentella and Sebastes marinus

For both stocks no analytical assessments were attempted. In the technical minutes of last year it was recommended that alternative models should be explored. Without trying to discourage to do such attempts it is considered doubtful whether the results of such models would give a different perception of the situation of these stocks compared to the information present in the report.

It is not considered necessary to consider these stocks every year and updating the tables and figures is sufficient. Presently both stocks are in a very poor situation and this situation is expected to remain for a considerable period irrespective current management actions. Year-classes recruit in the SSB at old age (e.g. 10 years old) and surveys indicate failure of recruitment over a long period.

The WG should attempt to get estimates of bycatch of redfish in the shrimp fisheries.

In addition to the presented survey graphs, the review group would like to see, if possible, graphs of the results of the three surveys in biomass units.

For both species U-type reference points could be developed provided that a sufficient long time series demonstrating a dynamic range is available. Also the reference point would be expressed in biomass units (SSB or fishable stock). The present time series are considered to be too short to do this.

NEA Cod: Catch prediction according HCR redone (input as in WG report)

MFDP version 1
Run: h
Time and date: 18:40 27/05/2004
Fbar age range: 5-10

Year:	2004	F multiplier:	1	Fbar:	0.6263				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0111	2672	2081	276000	66240	0	0	0	0
4	0.0788	26829	28653	392425	188364	2158	1036	2158	1036
5	0.2468	49018	80586	246598	274217	22884	25447	22884	25447
6	0.4369	63704	162763	197333	405323	79506	163304	79506	163304
7	0.6232	60800	216751	143166	425489	102636	305033	102636	305033
8	0.7731	26642	134730	53907	246195	47228	215691	47228	215691
9	0.7866	7798	50871	15595	102943	15264	100761	15264	100761
10	0.8911	1939	15252	3575	31316	3511	30752	3511	30752
11	0.7435	231	2255	480	5229	480	5229	480	5229
12	1.0673	98	1198	163	2683	163	2683	163	2683
13	1.0673	59	796	98	1285	98	1285	98	1285
Total		239789	695936	1329340	1749284	273927	851223	273927	851223

Year:	2005	F multiplier:	0.6387	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0071	3741	2799	604000	132880	483	106	483	106
4	0.0504	9265	10738	209311	110098	1298	683	1298	683
5	0.1577	38775	61225	292970	330470	26455	29841	26455	29841
6	0.279	34831	82202	157259	304926	61284	118830	61284	118830
7	0.398	31204	112147	104160	324145	70860	220516	70860	220516
8	0.4938	22381	112017	62854	278946	54752	242990	54752	242990
9	0.5024	7353	47755	20372	122907	19564	118028	19564	118028
10	0.5691	2309	18387	5815	46914	5780	46632	5780	46632
11	0.4749	415	3858	1201	12279	1201	12279	1201	12279
12	0.6817	85	948	187	2309	187	2309	187	2309
13	0.6817	33	452	73	1317	73	1317	73	1317
Total		150391	452528	1458202	1667191	241936	793531	241936	793531

Year:	2006	F multiplier:	0.6387	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0071	2818	2108	455000	103285	364	83	364	83
4	0.0504	20356	22982	459895	232707	2851	1443	2851	1443
5	0.1577	21279	35536	160779	188754	14518	17045	14518	17045
6	0.279	45241	103783	204258	399529	79599	155697	79599	155697
7	0.398	29119	98975	97200	291404	66125	198242	66125	198242
8	0.4938	20395	102669	57277	262270	49894	228463	49894	228463
9	0.5024	11335	73033	31408	185462	30161	178099	30161	178099
10	0.5691	4007	31798	10093	75696	10032	75241	10032	75241
11	0.4749	931	8751	2695	25691	2695	25691	2695	25691
12	0.6817	277	2976	611	7150	611	7150	611	7150
13	0.6817	49	617	108	1490	108	1490	108	1490
Total		155808	483229	1479322	1773438	256958	888643	256958	888643

Year:	2007	F multiplier:	0.6387	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0071	3103	2321	501000	113727	401	91	401	91
4	0.0504	15335	17313	346444	175301	2148	1087	2148	1087
5	0.1577	46754	78079	353261	414728	31899	37450	31899	37450
6	0.279	24828	56955	112095	219258	43683	85445	43683	85445
7	0.398	37821	128555	126249	378495	85887	257490	85887	257490
8	0.4938	19032	95808	53449	244745	46560	213197	46560	213197
9	0.5024	10329	66552	28621	169005	27484	162295	27484	162295
10	0.5691	6178	49022	15560	116697	15466	115997	15466	115997
11	0.4749	1615	15189	4677	44592	4677	44592	4677	44592
12	0.6817	622	6680	1372	16047	1372	16047	1372	16047
13	0.6817	135	1706	298	4119	298	4119	298	4119
Total		165753	518181	1543026	1896713	259876	937810	259876	937810
average yield 2005-2007			484646						

NEA Haddock: Catch prediction according HCR redone (input as in WG report)
MFDP version 1
Run: h1
Time and date: 19:02 27/05/2004
Fbar age range: 4-7

Year:		2004	F multiplier:	1	Fbar:	0.4436				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0308	5902	3618	239000	58077	478	116	478	116
	4	0.1523	14783	12492	118084	51839	3070	1348	3070	1348
	5	0.4155	39856	48544	129414	105796	25753	21053	25753	21053
	6	0.5258	28778	46188	77094	96907	44483	55915	44483	55915
	7	0.6806	6390	12633	14122	22397	11792	18702	11792	18702
	8	0.7193	3012	6871	6404	15382	5937	14259	5937	14259
	9	0.6053	336	851	809	2365	809	2365	809	2365
	10	0.7086	141	425	303	782	265	685	265	685
	11	0.7086	274	849	589	2296	589	2296	589	2296
Total			99473	132472	585819	355842	93176	116739	93176	116739

Year:		2005	F multiplier:	0.7891	Fbar:	0.35				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0243	7533	4655	384000	82560	384	83	384	83
	4	0.1202	15090	12525	150585	65354	3539	1536	3539	1536
	5	0.3278	19791	22364	78670	63565	15073	12179	15073	12179
	6	0.4149	21252	31772	68789	89564	35323	45991	35323	45991
	7	0.5371	14127	26347	37178	66958	31215	56218	31215	56218
	8	0.5676	2320	5115	5854	15068	5406	13916	5406	13916
	9	0.4776	886	2157	2554	7241	2554	7241	2554	7241
	10	0.5592	142	387	362	1113	362	1113	362	1113
	11	0.5592	141	405	360	1299	360	1299	360	1299
Total			81281	105728	728352	392722	94216	139575	94216	139575

Year:		2006	F multiplier:	0.7891	Fbar:	0.35				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0243	3119	1928	159000	34185	0	0	0	0
	4	0.1202	24600	20418	245479	106538	5155	2237	5155	2237
	5	0.3278	26021	29404	103433	83574	19063	15403	19063	15403
	6	0.4149	13949	20854	45151	58787	20318	26454	20318	26454
	7	0.5371	14034	26174	36934	66519	31184	56162	31184	56162
	8	0.5676	7049	15544	17790	45793	16367	42129	16367	42129
	9	0.4776	943	2295	2717	7703	2717	7703	2717	7703
	10	0.5592	508	1389	1297	3992	1297	3992	1297	3992
	11	0.5592	132	381	338	1220	338	1220	338	1220
Total			90355	118385	612140	408310	96438	155300	96438	155300

Year:		2007	F multiplier:	0.7891	Fbar:	0.35				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	3	0.0243	1883	1164	96000	20640	0	0	0	0
	4	0.1202	10186	8454	101644	44113	2135	926	2135	926
	5	0.3278	42418	47933	168613	136239	31075	25109	31075	25109
	6	0.4149	18340	27419	59363	77291	26714	34781	26714	34781
	7	0.5371	9212	17180	24243	43661	20468	36863	20468	36863
	8	0.5676	7003	15442	17674	45492	16260	41853	16260	41853
	9	0.4776	2864	6975	8257	23409	8257	23409	8257	23409
	10	0.5592	541	1477	1380	4247	1380	4247	1380	4247
	11	0.5592	300	863	765	2764	765	2764	765	2764
Total			92747	126906	477939	397857	107053	169952	107053	169952
average yield 2005-2007				117006.3						

NEA Cod: Results for the first 10 years of the simulation from runs selected by the evaluaters of this stock

Medium-term stochastic simulations to investigate effect of HCR

Time period: 2004-2013
Averages in table given for period 2005-2013

Input: 2004-2006: As in short-term prediction – Table 3.28
2007 and later years: Weight, maturity, fishing mortality and natural mortality as in 2006
Recruitment as described in HCR document

Uncertainty:

Assessment error (uncertainty on number at age in any year):
Normally distributed, cv 0.25
This also applies to recruitment in 2005 and 2006
Also uncertainty in SSB-R relationship, as described in HCR document

Table 3.x Results of medium-term stochastic simulations using the approach presented in WD3. Averages over the period 2005-2013

		Rule				Model	
Run no	**F**	**3-year rule used**	**F below Bpa**	**percent change increase**	**percent change decrease**	**CV stock number**	**High M age 3, 4 (0.7 and 0.4)**
1	0.40	Yes	Linear	10	10	0.25	No
2	0.40	No	Linear	10	10	0.25	No
3	0.40	Yes	Flat	10	10	0.25	No
9	0.50	Yes	Linear	10	10	0.25	No

Results

										No Years where various parts of HCR decide TAC			
										SSB above Bpa			*SSB below Bpa*
Run no	**% of runs SSB<Blim in any year**	**Realised F**	**Catch 1000 tonnes**	**SSB 1000 tonnes**	**TSB 1000 tonnes**	**Recruits million age 3**	**% annual change in TAC (abs. value)**	**No Years SSB<Blim**	**No Years SSB<Bpa**	***3-year rule***	***%increase***	***%decrease***	
1	0	0.415	520	963	1858	490	6.6	0	0	4.9	2.9	1.2	0.0
2	0	0.389	514	1018	1923	494	7.0	0	0	4.2	3.5	1.3	0.0
3	0	0.415	519	958	1853	490	6.6	0	0	5.0	2.8	1.2	0.0
9	0	0.525	531	789	1646	479	6.9	0	0.01	5.0	2.8	1.1	0.1