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0 Introduction

0.1 Participants

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0.2 Planning of Working Group activities 2006-2008

Specific ToRs

a) assess the status of and provide management options for the year 2007 for the stocks of cod, haddock, saithe, Greenland halibut, and redfish in Subareas I and II, taking into account interactions with other species;

b) update the data files on Barents Sea capelin and oversee the process of providing inter-sessional assessment and predictions on the stock;

c) for the stocks mentioned in a) and b) perform the tasks described in C.Res. 2005/2/ACFM01.

Planning of Working Group activities 2006-2008

GENERIC TERM OF REFERENCE	YEAR	COMMENTS
1) based on input from e.g. WGRED and for the North Sea NORSEPP, consider existing knowledge on important environmental drivers for stock productivity and management and if such drivers are considered important for management advice incorporate such knowledge into assessment and prediction, and important impacts of fisheries on the ecosystem;	yearly	A number of approaches already have been presented to the group and/or implemented in assessment and prediction. There are different ecosystem factors taking into account for prediction and/or assessment of growth, recruitment, maturation and mortality. The Group keep using alternative approaches together with ones previously used in order to collect data series of quality of prediction and accuracy of assessment.
2) Evaluate existing management plans to the extent that they have not yet been evaluated. Develop options for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) and where it is considered relevant review limit reference points (and come forward with new ones where none exist) – following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006); If mixed fisheries are considered important consider the consistence of options for target reference points and management strategies. If the WG is not in a position to perform this evaluation then identify the problems involved and suggest and initiate a process to perform the management evaluation;	2006	The evaluation of HCR and revision of reference points for NEA haddock will be done by WKHAD (A Workshop on Biological Reference Points for Northeast Arctic Haddock). The results is reviewed by AFWG in 2006 meeting. The conclusion on the evaluation is presented in section 4.9
3) where mixed catches are an important feature of the fisheries assess the influence of individual fleet activities on the stocks and the technical interactions;	yearly	Low priority There is no requests from client (JRNC). The general observation of the problem have been done in 2005 and in this report.
4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. Comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;	Done, will be yearly updated	Description of fisheries is presented in Quality Handbooks.

GENERIC TERM OF REFERENCE	YEAR	COMMENTS
5) where misreporting is considered significant provide qualitative and where possible quantitative information, for example from inspection schemes, on its distribution on fisheries and the methods used to obtain the information; document the nature of the information and its influence on the assessment and predictions.	yearly	At recent AFWG meetings it has been recognized that there is growing evidence of both substantial discarding and mis-/unreporting of catches throughout the Barents Sea for most groundfish stocks in recent years. Estimates of NEA cod and haddock unreported landings in 2002-2005 included into the assessment. The information has been presented to the Group several times but not on the regular basis. There are needs for plans of regular data collection.
6) provide for each stock and fishery information on discards (its composition and distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessments;	yearly	The information has been presented to the Group several times but not on the regular basis. The total effect of the discarding is still very unclear and requires more work before it can be included in the assessments. There are national plans of regular data collection.
7) report as prescribed by the Secretariat on a national basis an overview of the sampling of the basic assessment data for the stocks considered;	done	
8) provide specific information on possible deficiencies in the 2006 assessments including, at least, any major inadequacies in the data on landings, 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 both the assessment of the status of the stocks and the projection should be clarified.	yearly	
9) Further develop and implement the roadmap for medium and long term strategy of the group as developed by AMAWGC.	yearly	
10) Working Group Chairs will set appropriate deadlines for submission of the basic assessment data. Data submitted after the deadline will be considered at a later meeting at the discretion of the WG Chair.	2007	The deadline for data submission has been set as 1st April; NEA cod survey deadline is the first day of the AFWG meeting.

0.3 Management strategy for haddock

The Joint Norwegian-Russian Fishery Commission has adopted the HCR for NEA haddock and in 2003 ICES was requested to evaluate the new rule and provide an advice in accordance to it. The evaluation of the harvesting strategy for haddock was postponed in 2003-2005 due to necessity of data revision for the stock. This year the special ICES group – WKHAD (6-10 March 2006) has evaluated the HCR for NEA haddock. Based on the results of WKHAD AFWG performs the additional evaluation of the HCR. The results of that evaluation could be found in Section 4.9.

0.4 Unreported landings

ICES received a report from the Norwegian Directorate of Fisheries with information about unreported landings of cod and haddock in the Barents Sea and Svalbard areas. Besides, a number of WDs relevant to the issue were presented at the AFWG meeting (WDs #4 and #5).

Similar to last year and based on the information available, the AFWG thus decided to include unreported landings of cod in the assessment for 2002-2005. For the first time, and based on the information available, the AFWG also included unreported landings of haddock in the assessment for 2002-2005. The AFWG has revised the amount of unreported landings for 2004 according to updated and more complete information, and included new data for 2005.

The current situation with actual catches of cod much exceeding those reported officially to ICES raises great concern. AFWG repeat it's strongly encourages relevant national authorities to combine their efforts in developing measures against unreported landings in the future. It is believed that regulatory measures recently introduced in the Barents and Norwegian Seas pursuant to the Protocol of the 34th Session of the Mixed Russian-Norwegian Fisheries Commission will contribute to decrease the illegal catches of cod and other species if they become enforced.

Estimates of unreported landings included into the assessment were based on a number of assumptions, thus AFWG believes that it will be useful if the different national inspecting authorities better coordinate and assist each other when estimating the amount of unreported landings, which there is an obvious need for.

0.5 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-/unreporting 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, Ajiad *et al*. WD18 and 24 2004 WG). During the present meeting, In addition to these WDs, Dingsør (2001) estimated discards in the commercial trawl fishery for Northeast Arctic cod (*Gadus morhua* L.) and some effects on assessment, and Sokolov (2004) estimated cod discard in the Russian bottom trawl fishery in the Barents Sea in 1983-2002. 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 two most recent Norwegian winter surveys in 2004 and 2005.

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 (WDs # 2 and 3). Later, a similar exchange program has been established for haddock, Greenland halibut and capelin 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, despite still observed discrepancies for cod in the magnitude of 15-30%. An even more positive development is seen for haddock age readings showing that the frequency of a different reading (usually ±1 year) has decreased from above 25% in 1996-1997 to less than 10% at present. The discrepancies are always discussed and a final agreement on the exchanged cod and haddock otoliths is at present achieved for all otoliths except ca. 2%.

The otoliths of Greenland halibut are not easy to read especially for older fish. Consequently the readers have difficulties in interpreting real age zones when the fish become older than 5 years (e.g., AFWG2005, WD 8). Comparative readings among three Norwegian age readers, and also between Russian and Norwegian age readers show good agreement and low CV. However, even with acceptable between reader precisions, there are strong evidences of low accuracy of the age estimates. Since last year, validation work has been continued and presented at international meetings, i.e. an international symposium in Japan and a workshop in Canada. There has been established a new approach, but this is not validated fully yet. However, Norway has decided to change their reading method to this new approach and all Norwegian otoliths sampled in 2006 will be read using this method.

For capelin otoliths there is a very good correspondence between the Norwegian and Russian age readings, with a discrepancy in less than 5% of the otoliths.

From 2006 onwards, an exchange of *Sebastes mentella* otoliths will be conducted annually between the Norwegian and Russian laboratories.

0.6 Use of age - and length structured models in assessment (Gadget/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). The Fleksibest model has now been incorporated into Gadget and we will hereafter use the term 'Gadget applied to Northeast Arctic cod' instead of Fleksibest.

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 Gadget 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 EU project BECAUSE (http://www.rrz.uni-hamburg.de/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. Length-structured single-species models have now been constructed for capelin, herring and minke whale, and these will be linked together to a multi-species model before the end of the BECAUSE project (i.e. before February 2007). The clear impact of cod on haddock recruitment (Sec 4.8, WD 25) indicates that it would be worthwhile to also include haddock in such a multispecies model.

For NEA cod, Gadget has been used as a supplementary model to XSA for some years. As last year, Gadget was also applied to the *Sebastes marinus* stock in Sub-areas I and II (Section 7). The approach used there is similar to that used for the same species in Icelandic waters (Björnsson and Sigurdsson, 2003). The assessment was conducted for the time period (1986)1990-2004 (see chapter 7.3). Input data to the model were two fishing fleets (gillnet and other gears) with catch in tonnes, by length and age on a quarterly basis, and the annual Barents Sea joint bottom trawl survey on length and age. The optimisation and run of the Gadget model on *S. marinus* went well, and this assessment is considered to be an important quantitative supplement to previous more qualitative survey results evaluations of the stock. Further work on developing and testing this model is ongoing.

WD 26 outlines how a Gadget model for Greenland halibut could be set up. It is planned to do so before next year's AFWG meeting. For this stock, it is planned to split immature and mature fish by sex in order to take sex differences in maturity, growth and natural mortality into account.

WD 24 used a simple, single species, single area, single commercial fleet, single annual survey, hypothetical model to test the ability of Gadget to model under-reporting of catches. A Gadget model was created and artificial data taken from the model. This provided a case where (a) truth was fully known, and (b) Gadget was able to model that truth exactly. To this truth a number of experiments were conducted with various patterns of under-reporting of the catch. The Gadget model was then presented with this altered data, and allowed to attempt to optimize parameter values to "correct" for the missing catches. This represents a "best case" scenario – the model is able to exactly fit the data, the assumptions about processes (e.g. formulation of the growth equation) are correct, and there is no noise or error in the data other than the missing catches. In addition the basic structure of the under reporting of catches (the years it occurred, and if a trend was present) was assumed to be known. In all cases the model was able to estimate the under-reporting to a reasonable degree, with the accuracy depending on the exact timing and pattern of the catch error. This can be seen to represent a first step "proof of concept". Further work will be needed to examine the ability to model missing catches in more realistic situations.

Age-length structured models such as Gadget are studied by the ICES Study Group on Age-Length Structured Assessment Models (SGASAM) which has met in 2003 (ICES CM 2003/D:07) and 2005 (ICES CM 2005/D:01). A third meeting is scheduled for 27 November – 1 December 2006.

0.7 ICES Quality Handbook

Following the guidelines as adopted by ACFM in October 2002, in 2004 WG 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, and the report has been re-structured accordingly. In this report there were some changes in Quality Handbooks. The corrected versions are presented as appendices to the working group report.

0.8 Scientific Presentations

WD 1 (presented by K.H. Nedreaas) provides estimated numbers of 5cm to 25cm Northeast Arctic cod taken as bycatch in the Norewegian shrimp fishery during the period 1983-2005. Estimates raised to total international shrimp catch in the Barents Sea were also presented. The results show high estimated bycatch of cod in 1985, 1992 and 1998. The highest recorded numbers of cod was in 1985 (92 millions). Both cod bycatches and the shrimp landings have declined during the last two years (< 3 millions). Sorting grids (to avoid catching cod > 20-25 cm) and closure of shrimp fields with much cod < 20 cm are necessary to protect the cod from being caught before it grows above the minimum legal catch size.

WD 2 (presented by K.H. Nedreaas) describes the status of the PINRO - IMR's routine exchange program of cod and haddock otoliths which started in 1992. The age reading procedure has to a great extent been standardized except for the fact that the IMR readers prefer reading the opaque summer growth while the PINRO readers read the hyaline winter growth. Most often PINRO reads (if any) one year more than IMR, and this seems to be area/season related. The results show increased percentage overlap/agreement in age readings over the whole time period both for cod and haddock. But differences in age reading vary by years, e.g., they increased to almost 30% for cod in recent period (2003-2004). The percentage of haddock age readings shows better results with disagreement in less than 10% of the otoliths. All in all, the effort invested by PINRO and IMR in harmonizing the age readings among the readers has given positive results.

WD 3 (presented by N. Yaragina) describes some results from the twelve years project on annual Norwegian-Russian cod comparative age readings. Differences in age estimates by years (1992-2003) were both significant and insignificant. Age estimates obtained in 1997-1999 showed insignificant differences, while data for 2000 were at the boundary of significance. In the rest of years differences were significant with the most pronounced ones in 1993-1994. The differences appeared to show a certain bias, i.e. Russian estimates usually showed older age compared to corresponding Norwegian estimates. Significant differences were noted in the majority months of the year, especially in July and November-December, confirming appearance of the largest differences in the periods, when the last rings (both winter and summer ones) began to form. No significant differences were found in age estimates of fish collected in June, September and October. Otoliths from the Bear Island-Spitsbergen area should be admitted as the easiest to read (83.2% of coincided age estimates as a whole) and otoliths from the southern Barents Sea as the most difficult for age reading (75.7%). Differences in age estimates obtained by Norwegian and Russian experts increased with cod age. Significant differences were noted in fish at age from 1 to 5 years, while no significant differences were observed in fish at age 6-9 and 11 years. For fish older than 11 years very little material was collected to get an indisputable answer.

WD 4 (presented by S. Aanes). Data from the satellite based Vessel Monitoring System (VMS) in the Norwegian Economical Zone (NEZ) provides detailed information about individual trips by vessel. The size of the vessels is available through official registries, and the storage capacity of fish is estimated using established conversion factors as a function of gross tonnage of the vessel. For 2005 the scientists have had access to the database concerning both transport vessels and fishing vessels, which includes the individual trip, in addition to information about the total amount of round weight of both cod and haddock for trips that has been inspected by the coastguard. The analysis has been done without making assumptions about filling percentages or product types, but rather assumed that the trips with full documentation concerning amounts fish onboard conforms a random sample of trips, and thus estimated the mean amount of both cod and haddock per trip, which is used to estimate the total amount given the total number of trips by vessel. This gave a significantly higher total estimate of catches of both cod and haddock compared to what is reported in the report from

Norwegian Directorate of Fisheries (2006). The estimates show that TAC is exceeded with about 35% and 55% for cod and haddock, respectively.

WD 5 (presented by K.H. Nedreaas) presents some information about unreported landings of cod fished in the Barents Sea 'loop-hole' by flag-of-convenience vessels, and also the Norwegian Coast Guard inspections and reactions in 2005. Altogether about 2000 tonnes northeast arctic cod were taken by four such vessels in 2005. In 2005 the Norwegian coast-guard made 976 inspections of Norwegian and international vessels in the NEZ north of 65°N in 2005. Such annual statistics from the Coast Guard (similar statistics also available from the Directorate of Fisheries concerning port controls of fish landings) should be further explored to find possibilities to utilize such information for monitoring and quantifying irregularities/errors in the official catch statistics.

WD 6 (presented by K.H. Nedreaas) presents estimated bycatch of haddock and Greenland halibut in the Norwegian Barents Sea shrimp fishery for the period 2000-2005, as well as these estimates raised to the total international shrimp catch in the Barents Sea. The highest estimated bycatch (0-25 cm) of haddock (9.2 millions) and Greenland halibut (13.2 millions) were found in 2002 and 2000, respectively, whereas, for both species, the lowest bycatch was found in the most recent years.

WD 7 (presented by H. Gjøsæter) is a draft of chapter 9 in the AFWG report. It summarises the assessment work done after the capelin survey in autumn 2005, and describes additional information about capelin during winter 2005-2006. The capelin stock is at a very low level, and ACFM during its autumn meeting 2005 recommended that no catches should be taken in the winter season 2006. Acoustic stock estimation during the winter survey in February indicated that the spawning stock size was somewhat larger than the estimate based on the 2005 autumn survey. Possible sources of error both in this survey and in the autumn survey are discussed in the WD.

WD 8 (presented by H. Gjøsæter) describes the assessment methodology for Barents Sea capelin. The models Bifrost and CapTool, used for assessing the stock and projecting it forward to time of spawning half a year after the autumn survey that is basis for the assessment, are described. The results from using these tools during autumn 2005 is also included in the WD. These show that even without any fishing the SSB would drop under the Blim of 200 000 tonnes at spawning time in 2006 with a high probability. A projection further on for one and one and a half year shows that the stock will most likely stay at a low level also during 2006 and up to spawning in spring of 2007.

WD 9 (presented by T. Bulgakova) describes the example of implementation of the new for AFWG and elaborated in VNIRO (Russia) separable stock assessment model ISVPA to the NEA cod. The model parameter estimation represents the procedure of minimization of some loss function. The procedure allows to obtain unbiased estimates of the parameters, to use as the stock indices with age structure as integral ones and to have gaps in auxiliary data, including the terminal year. The NEA cod stock assessment is realized on the base of the same input information which is used by XSA model at the AFWG meeting in 2005. The results obtained by means of ISVPA are compared with XSA key run results.

WD 10 (presented by S. Mehl) describes a suggested management strategy for Northeast Arctic saithe. Based on the assumption that a maximum sustainable yield is achieved at a fishing mortality below Fpa, a strategy targeting an F about 0.05 below Fpa was proposed and sent for public hearing. A strategy targeting a fishing mortality below Fpa will imply that the expected spawning stock biomass will be above Bpa. Taking into account that saithe is an important predator on commercial valuable prey stocks, some stakeholders were concerned that an increased spawning stock biomass would have its costs in the form of lesser output from fisheries based on the saithe's prey species, especially Norwegian spring-spawning herring. Based on stomach samples of saithe, it was estimated what the herring consumed by saithe could have contributed to in the Norwegian herring fishery. Taking this into account, the long-term economic yield was estimated for different exploitation levels of saithe. The results indicate, viewing the combined economic output from the fisheries on saithe and herring, that there will be no economic loss in applying an F of about 0.05 below Fpa as a long time management target for the saithe fishery

WD 13 (presented by B. Bogstad) describes a method for 'tuning' the yearly bottom trawl winter survey of Northeast Arctic cod (*Gadus morhua*) using converged VPA-type abundance estimates during a calibration period (1981-1995). For the two age groups considered in this paper (4-6 and 7+), it was found that a regression with intercept gave the best fit to the data.

WD 15 (presented by J.E. Stiansen and A. Filin) describes the status of the Barents Sea ecosystem. It includes a general description, monitoring overview, the present and expected situation, description of mixed fisheries, and impacts of the fisheries on the ecosystem. The working document includes relevant ecosystem factors for the AFWG assessment, such as conditions in climate, phytoplankton, zooplankton, marine mammals and bottom fauna, as well as trophic relations and mixed fisheries information.

WD 19 (presented by A. Aglen) shows a recalculation of maturity observations of cod from the Barents Sea and the Lofoten acoustic survey. Maturity observations coded as doubtful were excluded from the analyses and the combination between the two surveys was according to the estimated number at age in the two surveys (the same way as for combining weights at age for the same surveys). The new calculation was done for the period 1989-2006. The revisions compared to the earlier calculations were minor for most years and age groups. In average the new estimates gave slightly higher maturation at age.

WD 20 (presented by B. Bogstad) describes four different methods for calculating consumption by cod. The discrepancy between two of those methods (results in Tables 1.3 and 1.5) have previously been noted by AFWG. The Bogstad & Mehl method (Table 1.3) is used in the assessment of cod and haddock, while the Dolgov method (Table 1.5) gives somewhat lower consumption estimates. The Tjelmeland method is used in the capelin assessment, while the Johansen method is not at the moment used in assessments and can only be applied to length-measurable prey. All methods calculate the consumption by cod age group taking cod abundance from VPA estimates. The methods differ by choice of stomach evacuation rate model, use of individual stomachs or not, temperature, spatial and temporal resolutions etc. A comparison between the results of the methods for calculation of capelin by cod in the first quarter is made. Further work on consumption calculation methodology is outlined.

WD 21 (presented by S. Golovanov) describes revision of Northeast Arctic cod abundance indices done using the data from Russian autumn trawl-acoustic survey for 1994-2005. Stratification of survey areas has been specified with the allowance for haul depth. The calculation of abundance index was based on four strata received and trawl swept area methods described in paper by Jakobsen et al., 1997. Cod abundance swept area index reflected Northeast Arctic cod stock dynamics more precisely as compared to the previous one - catch per an hour trawling (fleet 17). It was proposed to use the new index to tune VPA.

WD 23 (presented by A. Aglen) shows the results of the 2006 Barents Sea winter survey. Less vessel time was available this year, and the coverage was thus less complete; 271 valid bottom trawl stations compared to 373 in the 2005 survey. The uncertainty is considered to be larger than in the preceding 5 years. For cod and haddock this relates in particular to the age groups 2-3 due to incomplete coverage of the coastal areas in the REZ.

WD 24 (presented by B. Bogstad) used a simple, single species, single area, single commercial fleet, single annual survey, hypothetical model to test the ability of Gadget to model under-reporting of catches. A Gadget model was created and artificial data taken from the model. This provided a case where (a) truth was fully known, and (b) Gadget was able to model that truth exactly. To this truth a number of experiments were conducted with various patterns of under-reporting of the catch. The Gadget model was then presented with this altered data, and allowed to attempt to optimize parameter values to "correct" for the missing catches. This represents a "best case" scenario – the model is able to exactly fit the data, the assumptions about processes (e.g. formulation of the growth equation) are correct, and there is no noise or error in the data other than the missing catches. In addition the basic structure of the under reporting of catches (the years it occurred, and if a trend was present) was assumed to be known. In all cases the model was able to estimate the under-reporting to a reasonable degree, with the accuracy depending on the exact timing and pattern of the catch error. This can be seen to represent a first step "proof of concept". Further work will be needed to examine the ability to model missing catches in more realistic situations.

WD 25 (presented by K. Korsbrekke) shows a considerable effect of NEA cod predation on survival of young haddock.

WD 26 (presented by M. Åsnes) outlines the structure for a proposed Gadget model for Northeast Arctic Greenland Halibut. This model will form a single-area, single-species model, with a split by sex and maturity into four separate "population groups". This will allow for differences in growth between males and females, and differences in maturation. The aim is to produce a working first run of the model for Arctic Fisheries Working Group 2007.

0.9 Time of Next Meeting

The Working Group proposes the dates of April 18 – 27, 2007 for its next meeting.

0.10 Nomination of new Chair

The Working Group was pleased to unanimously endorse the renomination of Yuri Kovalev, Russia as chairman of the Arctic Fisheries Working Group.

1 Ecosystem considerations (Figures 1.1-1.22, Tables 1.1-1.20)

The stock size of commercial species in the Barents Sea is subject to significant year-to-year variations, which is reflected in the level of harvest. Certainly, fishing mortality has a significant impact on the population dynamics of commercial species. But it should be remembered that abundance fluctuations are also an adaptive response of a population to environmental impact. Sudden variations in abundance are typical not only of those species, which are exposed to impact of intensive fisheries but also in non-target species as well as species under minor exploitation. Along with this there are a lot of examples of species in a depleted condition that were capable of producing strong year classes.

A new element in changing landscape of fishery management policy is the "ecosystem approach". The ecosystem approach is variously defined, but principally puts emphasis on a management regime that maintains the health of the ecosystem alongside appropriate use of the marine environment, for the benefit of current and future generations (Jennings, 2004).

Changes in the Barents Sea ecosystem are, in the first place, caused by variations of the ocean climate. Increased impact of warm Atlantic water in the Barents Sea contributes to advection of zooplankton, faster growth rate in fish and emergence of abundant year classes (Dalpadado *et al.* 2002). A cold period is, conversely, characterized by reduced primary biological production in the Barents Sea and emergence of weak year classes of commercial species. In addition to climatic conditions, which govern the formation of primary biological production and feeding conditions for fish as well as the survival of their offspring, an important factor that influences the abundance dynamics of commercial species, is inter-specific trophic relations.

Movement towards "an ecosystem approach to the fishery management" in the Barents Sea should include: (Filin and Røttingen 2005):

11) More extensive use of ecosystem information in the population parameters applied in assessment and prognosis,

12) Expansion of the use of multi-species models for fishing management.

The aim of this chapter is to identify important ecosystem information influencing the fish stocks, and further try to implement this knowledge into the fish stock assessment and predictions. There has been a steadily development in this aspect over the last few years and the work is still in a developing phase. Hopefully, the gathering of information on the ecosystem in this chapter will lead to a better understanding of the complex dynamics and interactions that takes place in the ecosystem, and also participate in reaching an ecosystem based management of the Barents Sea.

This chapter was in general based on the "Joint PINRO/IMR report on the state of the Barents Sea ecosystem 2005/2006" (Stiansen *et al.,* WD 15). Text, figures and tables taken from this WD are not further cited in this chapter.

1.1 General description of the Barents Sea ecosystem (Figure 1.1)

The Barents Sea is a shelf area of approx. 1.4 million km^2, which borders to the Norwegian Sea in the west and the Arctic Ocean in the north, and is part of the continental shelf area surrounding the Arctic Ocean. The extent of the Barents Sea is limited by the continental slope between Norway and Spitsbergen in west, the top of the continental slope against the Arctic Ocean in north, Novaja Zemlya in east and the coast of Norway and Russia in the south

(Figure 1.1). The average depth is 230 m, with a maximum depth of about 500 m at the western entrance. There are several bank areas, with depths around 50-200 m.

Climate

The general circulation pattern (Figure 1.1) is strongly influenced by topography. Warm Atlantic waters from the Norwegian Atlantic Current with a salinity of approx. 35 flows in through the western entrance. This current divides into two branches, one southern branch, which follows the coast eastwards against Novaja Zemlya and one northern branch, which flow into the Hopen Trench. The relative strength of these two branches depends on the local wind conditions in the Barents Sea. South of the Norwegian Atlantic Current and along the coastline flows the Norwegian Coastal Current. The Coastal Water is fresher than the Atlantic water, and has a stronger seasonal temperature signal. In the northern part of the Barents Sea fresh and cold Arctic water flows from northeast to southwest. The Atlantic and Arctic water masses are separated by the Polar Front, which is characterised by strong gradients in both temperature and salinity. In the western Barents Sea the position of the front is relatively stable, but in the eastern part the position of this front has large seasonal, as well as year- to-year, variations. In general, the Barents Sea is characterised by large year-to-year variations in both heat content and ice conditions. The most important cause of this is variation in amount and temperature of the Atlantic water that enters the Barents Sea (Figures 1.2-1.4).

Phytoplankton

The Barents Sea is a spring bloom system and during winter the primary production is close to zero. The timing of the phytoplankton bloom is variable throughout the Barents Sea, and has also high interannual variability. In early spring, the water is mixed but even though there are nutrients and light enough for production, the main bloom does not appear until the water becomes stratified. The stratification of the water masses in the different parts of the Barents Sea may occur in different ways; through fresh surface water along the marginal ice zone due to ice melting, through solar heating of the surface waters in the Atlantic water masses, and through lateral spreading of coastal water in the southern coastal (Rey 1981). The dominating algal group in the Barents Sea is diatoms like in many other areas (Rey 1993). Particularly, diatoms dominate the first spring bloom, and the most abundant species is *Chaetoceros socialis*. The concentrations of diatoms can reach up to several million cells per litre. The diatoms require silicate and when this is consumed other algal groups such as flagellates take over. The most important flagellate species in the Barents Sea is *Phaeocyctis pouchetii*. However, in individual years other species may dominate the spring bloom.

Zooplankton

Zooplankton biomass has shown large year-to-year variation among years in the Barents Sea (e.g. Figures 1.5-1.8). Crustaceans form the most important group of zooplankton, among which the copepods of the genus Calanus play a key role in the Barents Sea ecosystem. *Calanus finmarchicus*, which is the most abundant in the Atlantic waters, is the main contributor to the zooplankton biomass. *Calanus glacialis* is the dominant contributor to zooplankton biomass of the Arctic region of the Barents Sea. The Calanus species are predominantly herbivorous, feeding especially on diatoms (Mauchlin 1998). Krill (euphausiids) is another group of crustaceans playing a significant role in the Barents Sea ecosystem as food for both fish and sea mammals. The Barents Sea community of euphausiids is represented by four abundant species: neritic shelf boreal *Meganyctiphanes norvegica*, oceanic arcto-boreal *Thysanoessa longicaudata*, neritic shelf arcto-boreal *Th. inermis* and neritic coastal arcto-boreal *Th. raschii* (Drobysheva 1994). The two latter species make up 80-98% of the total euphausiids abundance. Species ratio in the Barents Sea euphausiid community is characterized by year-to-year variability, most probably due to climatic changes (Drobysheva 1994). Observations have shown that after a cooling period the abundance of *Th.*

raschii increases and of *Th. inermis* – decreases, and contrary after a period of warm years the abundance of *Th. inermis* grows and the number of cold-water species becomes smaller (Drobysheva, 1967). The advection of species brought from the Norwegian Sea is determined by the intensity of the Atlantic water inflow (Drobysheva 1967, Drobysheva *et al*. 2003).

Three abundant amphipod species are found in the Barents Sea; *Themisto abyssorum* and *T. libellula* are common in the western and central Barents Sea, while *T. compressa* is less common in the central and northern parts of the Barents Sea. *T. abyssorum* is predominant in the sub-arctic waters. In contrast, the largest in size of the Themisto species, *T. libellula*, is mainly restricted to the mixed Atlantic and Arctic water masses. Very high abundance of *T. libellula* is often formed close to the Polar Front.

The results from long-term investigations of macroplankton in autumn-winter indicate that the abundance of euphausiids (Figure 1.7), as well as the distribution and specific composition, is affected by interannual dynamics. This leads to changes in the feeding conditions of fish. Possible reasons for the large year-to-year variations in biomass plankton in the Barents Sea (Figure 1.5) are the differences in advective transport (Figure 1.2) and predation pressure. Figure 1.6 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. Other plankton feeding fish, which is found in high numbers in the Barents Sea, are polar cod, young herring and young blue whiting.

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.

Fish

The Barents Sea is a relatively simple ecosystem with few fish species of potentially high abundance. These are Northeast Arctic cod, haddock, Barents Sea capelin, polar cod and immature Norwegian Spring-Spawning herring. There have been significantly variations in abundance among these species (Figures 1.9-1.10). These variations are due to a combination of fishing pressure and environmental variability. The last few years there has in addition been an relatively strong increase of blue whiting migrating into the Barents Sea. Until the 1970's the redfish (*Sebastes mentella*) was an abundant stock in the Barents Sea. Due to heavily overfishing the stock declined strongly during the 1980's, and has since then stayed at a low level. The recruitment of the Barents Sea fish species have also a large year-to year variability (Figure 1.11, Tables 1.1-1.4). The most important factors for this variability are variations in the spawning biomass, climate conditions, food availability and predator abundance and distribution. Variation in the recruitment of some species, including cod and herring, has been associated with changes in the influx of Atlantic waters into the Barents Sea.

Cod, together with capelin and herring, is a key species among fish in the Barents Sea ecosystem. The mature cod has an annual spawning migration from the Barents Sea to the western coast of Norway. The main spawning occurs in the Lofoten area in March/April. The cod larvae are advected with the Norwegian coastal current and Norwegian Atlantic current back to the Barents Sea where it settles at the bottom around October. Cod is the most important predator fish species in the Barents Sea. It feeds on a large range of prey, including the larger zooplankton species, most of the available fish species and shrimp (Tables 1.5-1.8). Cod prefer capelin as a prey, and feed on them heavily as the capelin spawning migration brings them into the southern and central Barents Sea. Fluctuations of the capelin stock (Tabs. 1.9-1.10) have a strong effect on growth, maturation and fecundity of cod, as well as on cod recruitment because of cannibalism. The role of euphausiids for cod feeding increases in the years when capelin stock is at a low level (Ponomarenko and Yaragina 1990). Also, according to Ponomarenko (1973, 1984) interannual changes of euphausiid abundance is important for the survival rate of cod during the first year of life.

Capelin is a key species because it feeds on the zooplankton production near the ice edge and is usually the most important prey species for top predates in the Barents Sea, serving as a major transporter of biomass from the northern Barents Sea to the south (von Quillfeldt and Dommasnes, 2005). During summer they migrate northwards as the ice retreats, and thus have continuous access to new zooplankton production in the productive zone recently uncovered by the ice. They often end up at 78-80˚N by September-October, and then they start a southward migration to spawn on the northern coasts of Norway and Russia. During spawning migration capelin is considerably preyed on by cod. Capelin also is important prey for other predatory fishes as well as for several species of marine mammals and birds.

The herring spawns along the Norwegian western coast and the larvae drifts into the Barents Sea. The juveniles of the Norwegian spring-spawning herring stock are distributed in the southern parts of the Barents Sea. They stay in this area for about three years before they migrate west and southwards along the Norwegian coast and mix with the adult part of the stock. The presence of young herring in the area has a profound effect on the recruitment of capelin, and it has been shown that when rich year classes of herring enters to the Barents Sea, the recruitment to the capelin stock is poor, and in the following years the capelin stock collapses (Gjøsæter and Bogstad, 1998). This happened after the rich 1983 and 1992 year-classes of herring entered the Barents Sea. Also when medium sized year classes of herring are spread into the area there is a clear sign of reduction in recruitment to the capelin stock, In this way, the herring impact both on the capelin stock (directly) and the cod stock (indirectly).

Haddock is also a common species, and migrates partly out of the Barents Sea. The stock has large natural variations in stock size. Food composition of haddock consists mainly of benthic organisms (Figure 1.12, Table 1.11). Totally the mean weight percent of polychaets, mollusks and echinoderms was up to 40 %. Capelin is the dominant prey among fish species. Zooplankton and other fish species are of only marginal importance. There are not any clear changes in the food composition of haddock among various length groups. The total annual food biomass consumed by haddock shows large variation (from 348 thousand tonnes to 1268 thousand tonnes, with a mean value of 736 thousand tonnes according to Dolgov, WD29.

Saithe is found mainly along the Norwegian coast, but also occurs in the Norwegian Sea and in the southern Barents Sea. 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 smaller individuals feed on crustaceans, while larger saithe depends more on fish. Gastropods and cephalopods are also found in saithe stomachs (Dolgov, WD 29 Mehl, WD7, AFWG 2005). The main fish prey is young herring, Norway pout, haddock, blue whiting and capelin, while the dominating crustacean prey is krill. The importance of fish is highest in north, while in south the importance of crustaceans increases.

Polar cod is a cold-water species found particularly in the eastern Barents Sea and in the north. It seems to be an important forage fish for several marine mammals, but to some extent also for cod. There is little fishing on this stock.

Deep-sea redfish and golden redfish used to be important elements in the fish fauna in the Barents Sea, but presently the stocks are severely reduced. Young redfish are plankton eaters, but larger individuals take larger prey, including fish. Until 1990 huge amounts of redfish postlarvae filled the pelagic Barents Sea every summer and autumn. These 0-group redfish utilized the plankton production and contributed themselves to the diet of other predators. We don't know whether other planktoneaters have taken over this niche. Since the redfish species are ovoviparous giving birth to live larvae, it is believed to be a strong relationship between the size and age composition of the mature stock and the recruitment. Lack of larvae and juvenile redfish in the sea is therefore a confirmation of low "spawning" stocks. On the other hand is a rebuilding of the mature stock expected to give an immediate and correspondingly increase in the amounts of larvae in the sea. Fishing on these two redfish species is at present severely restricted in order to rebuild the stocks.

Greenland halibut is a large and voracious fish predator with the continental slope between the Barents Sea and the Norwegian Sea as its most important area, but it is also found in the deeper parts of the Barents Sea. Investigations in the period 1980-1990 showed that cephalopods (squids, octopuses) dominated in the Greenland halibut stomachs, as well as fish, mainly capelin and herring (Figure 1.12). However, the largest portion of the stomach contents (approximately 34 % by weight) constituted by fisheries wastes (heads, guts etc). Ontogenetic shift in prey preference was clear with decreasing proportion of small prey (shrimps and small capelin) and increasing proportion of larger fish with increasing predator length. The largest Greenland halibut (length more than 65-70 cm) had a rather big portion of cod and haddock in the diet.

The blue whiting has its main distribution area in the Norwegian Sea and Northeast Atlantic, and the marginal northern distribution is at the entrance to the Barents Sea. Usually the blue whiting population in the Barents Sea is small. In years with warm Atlantic water masses the blue whiting may enter the Barents Sea in large numbers, and the blue whiting is a dominant species in the western areas. This situation occurred in 2001, and the blue whiting has since been present in high numbers. The blue whiting is mainly a plankton feeder at young ages (below age 5), but changes preference towards fish during its life cycle. In 2004 the abundance of blue whiting were estimated to be 1.4 mill tonnes, mostly age 1-4. This makes it the second most abundant pelagic plankton feeding fish after young herring in the Barents Sea, followed by polar cod and capelin. In general these four species have minor overlapping distributions; with the blue whiting in the west, the herring in the south, the polar cod in the east (except for an overlapping part of the stock in the Svalbard region) and the capelin in the north. In southwestern areas blue whiting and herring partly overlap. However, they occupy different parts of the water column. The competitive effect for food by blue whiting on the other three species for the local zooplankton production is assumed to be low. However, the blue whiting is situated as a filter of zooplankton in their main advection pathway from the Norwegian Sea into the Barents Sea. What effect this has on the total zooplankton production, and thereby indirect on the whole ecosystem in the Barents Sea is not known.

However, zooplankton is the most important prey at young ages of blue whiting (age < 5), which is the dominant part of the stock present in the Barents Sea (Anon. 2004a). Among fishes, the pelagic species were the most important (*i.e.* polar cod, capelin, haddock, saithe and redfish). The analysis of diet dynamics in blue whiting from different length groups showed a clear downward trend in the proportion of zooplankton by weight (copepods, hyperiids and euphausiids) and an increasing importance of fish. It should be noted that fish became the dominant part of blue whiting diet when it reached a length of about 27 cm. (Dolgov, WD 29). Cod juveniles occurred in the stomachs of blue whiting with a length of approximately 25 cm.

When present in the western Barents Sea the blue whiting is not the main prey for any other fish species. In these periods the blue whiting can account for approximately 2-7% (Dolgov, WD 29) of the diet of cod and Greenland halibut. Due to the high numbers of cod, this is then the main fish predator on blue whiting. Other fishes, like larger saithe and haddock, may also prey on blue whiting, but the proportion of the diet is low (<1%). Information on predation of mammals on blue whiting in the Barents Sea is at present lacking.

Long rough dab is a typical ichthyobenthophage, which main food is benthos (ophiura, polychaetes etc.) and different fish species (Dolgov, WD 29). At older stages the proportion of fish increases (polar cod and cod, capelin and juvenile redfish). The larger long rough dab also feed on on their own juveniles and juvenile haddock. Mean annual food consumption by long rough dab is estimated to be 240 thousand tonnes. Among commercial species, capelin (33 thousand tonnes), juvenile cod (27 thousand tonnes) and polar cod (24 thousand tonnes) as well as euphausiids and shrimp were consumed most intensively (Dolgov,WD 29).

Thorny skate preys primarily on fish and large crustaceans, shrimps and crabs (Dolgov, WD 29), but may also in a lesser extent feed on fish. The most common fish species are young cod and capelin. Mean annual biomass of food consumed by thorny skate during 1994–2000 was calculated at 165.7 tonnes, of which 73.7 thousand tonnes comprised commercial fishes and invertebrates. The major items of food were northern shrimp and cod at 31.8 and 16.4 thousand tonnes, respectively. Round skate fed mainly on bottom benthos, especially Polychaeta and *Gammaridae*. Northern shrimp and fisheries waste are also major components of their diets. Fish (mostly capelin and young cod) occurred in small quantities. Arctic skate feed mainly on fish and shrimp (herring, capelin, redfish and northern shrimp). Blue skate diet consists largely of fish, mainly young cod and haddock, redfish, and long rough dab). Spinytail skate also prey mostly on fish, which included haddock, redfish and long rough dab. Total food consumption by all skate species, except thorny skate, was 31.4 thousand tonnes, of which 18.2 thousand tonnes was commercial species (Dolgov, WD 29).

Mammals

Marine mammals, as top predators, are significant ecosystem components. About 24 species of marine mammals regularly occur in the Barents Sea, comprising 7 pinnipeds (seals), 12 large cetaceans (large whales) and 5 small cetaceans (porpoises and dolphins). Some of these species have temperate mating and calving areas and feeding areas in the Barents Sea (*e.g.* minke whale *Balaenoptera acutorostrata*), others reside in the Barents Sea all year round (*e.g.* white-beaked dolphin *Lagenorhynchus albirostris* and harbour porpoise *Phocoena phocoena*). The currently available abundance estimates of the most abundant cetaceans in the north-east Atlantic (*i.e.* comprising the North, Norwegian, Greenland and Barents Seas) are: minke whales 107,205; fin whales *B. physalus* 5,400; humpback whales *Megaptera novaeangliae* 1,200; sperm whales *Physeter catodon* 4,300 (Skaug *et al.* 2002, Øien 2003, Skaug *et al.* 2004). *Lagenorhyncus* dolphins are the most numerous smaller cetaceans, with an abundance of 130,000 individuals (Øien 1996), while harp seals are the most numerous seal in the Barents Sea with approximately 2.2 million seals.

In the Barents Sea the marine mammals may eat 1.5 times the amount of fish caught by the fisheries. Minke whales and harp seals may consume 1.8 million and 3,5 million tonnes of prey per year, respectively (*e.g.*, crustaceans, capelin, herring, polar cod and gadoid fish; Folkow *et al.* 2000, Nilssen *et al.* 2000). Functional relationships between marine mammals and their prey seem closely related to fluctuations in the marine systems. Both minke whales and harp seals are thought to switch between krill, capelin and herring depending on the availability of the different prey species (Lindstrøm *et al.* 1998, Haug *et al.* 1995, Nilssen *et al.* 2000).

The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 1.12. 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.

Seabirds

The Barents Sea holds one of the largest concentrations of seabirds in the world (Norderhaug *et al.* 1977; Anker-Nilssen *et al.* 2000). About 20 million seabirds harvest approximately 1.2 million tonnes of biomass annually from the area (Barrett *et al.* 2002). About 40 species are thought to breed regularly around the northern part of the Norwegian Sea and the Barents Sea. The most typical species belong to the auk and gull families. There are about 1 750 000 breeding pairs of Brünnich's guillemot (*Uria lomvia*) in the Barents region. They feed on fish, particularly polar cod, and other ice fauna species. The population of common guillemots (*Uria aalge*) is about 140 000 breeding pairs. Capelin is the most important food source all the year round. There are thought to be more than 1.3 million pairs of little auk (*Alle alle*) in the Barents Sea. It is found throughout most of the year and many probably winter along the ice margin between Greenland and Svalbard and in the Barents Sea. Small pelagic crustaceans are the main food for this species, but they may also feed on small fish.The black-legged kittiwake (*Rissa tridactyle*) breeds around the whole of Svalbard, but like the Brünnich's guillemot it is most common on Bjørnøya, Hopen and around Storfjorden. Its most important food items in the Barents Sea are capelin, polar cod and crustaceans. The breeding population seems stable, comprising 850 000 pairs in the Barents region. The northern fulmar (*Fulmarus glacialis*) is an abundant Arctic and sub-Arctic species living far out to sea except in the breeding season. It lives on plankton and small fish taken from the surface. The population estimates are uncertain, but high (100 000 - 1 000 000 pairs).

Benthos

Red king crab (*Paralithodes camtschatica*) was introduced to the Barents Sea in the 1960s. The stock is growing and expanding eastwards but more dominantly along the Norwegian coast westwards. Adult red king crabs are opportunistic omnivores. Decapods (i.e. crabs and lobsters) are known predators of benthic bivalves, including epibenthic species such as the commercial Iceland scallop *Chlamys islandica*. Both the red king crab and the scallop have a sub-Arctic distribution, and as the Iceland scallop has a life span of 30 years, and matures after 3-6 years, it might be particularly exposed to risk of local extinction with increasing numbers of king crabs (Jørgensen 2005).

1.2 Monitoring of the ecosystem

Monitoring of the Barents Sea started already in 1900 (initiated by Nicolai Knipovich), with regular measurement of temperature in the Kola section. Since then monitoring of ecosystem components in the Barents Sea on a regular basis have been conducted by IMR and PINRO at several standard sections and fixed stations as well as by area covering surveys. In addition there are conducted many short time special investigation, designed to study specific processes or knowledge gaps. Also the quality of large hydrodynamical numeric models are now at level where they are useful for filling observation gaps in time and space for some parameters. Satellite data and hindcast global reanalysed datasets are also useful information sources.

1.2.1 Standard sections (Figure 1.13, Tables 1.13)

Some of the longest ocean time series in the world are along standard sections (Figure 1.13) in the Barents Sea. The monitoring of basic oceanographic variables for most of the sections goes back 30-50 years, with the longest time series stretching over one century. In the last decades also zooplankton is sampled at some of these sections. An overview of length, observation frequency and present measured variables for the standard sections in the Barents Sea is given in Table 1.13. Specific considerations for the most important sections are giving in the following text.

Kola section

The Kola section was taken quarterly in the period 1900-1921, and monthly afterwards. The Kola section is situated partly in the coastal water masses and partly in the Atlantic water masse, and is the section most representative for the Atlantic branch going eastwards parallel to the coastline, i.e. the southern part of the Barents Sea. Some holes in the time series exists, but in general the section has been taken quite regularly. Even during World War II the section was taken 2-3 times a year.

Vardø-North section

The Vardø-N section has been monitored in August regularly since 1953, and increased in observation frequency to 4 times per year in 1977. Situated in the central Barents Sea it is the most representative section for the Atlantic branch going into the Hopen Trench, i.e. the central part of the Barents Sea. The northern part of the sections usually is in Arctic water masses.

Fugløya-Bear Island section

The Fugløya-Bear Island section is situated at the western entrance to the Barents Sea, where the inflow of Atlantic water from the Norwegian Sea takes place. The section is therefore representative for the western part of the Barents Sea. It has been monitored regularly in August since 1964, and increased observation frequency to 6 times per year in 1977. Zooplankton monitoring began in 1987.

1.2.2 Fixed stations

IMR operates one fixed stations, Ingøy, related to the Barents Sea. The Ingøy station is situated in the coastal current along the Norwegian coast. Temperature and salinity is monitored 1-4 times a month. The observations were obtained in two periods, 1936-1944 and 1968-present.

1.2.3 Area coverage (Table 1.14)

Area surveys are conducted throughout the year. The number of vessels in each survey differs, not only between surveys but may also change from year to year for the same survey. However, most surveys are conducted with only one vessel. It is not possible to measure all ecosystem components during each survey. Effort is always put on measuring as many parameters as possible on each survey, but available time put restrictions on what is possible to accomplish. Also, an investigation should not take to long time in order to give a synoptic picture of the conditions. Therefore the surveys must focus on a specific set of parameters/species. Other measured parameters may therefore not have optimal coverage and thereby increased uncertainty, but will still give important information. An overview of the measured parameters/species on each main survey is given in Table 1.14. Specific considerations for the most important surveys are giving in the following text.

Norwegian/Russian winter survey

The survey is carried out during February-early March, and covers the main cod distribution area in the Barents Sea. The coverage is in some years limited by the ice distribution. Three vessels are normally applied, two Norwegian and one Russian. The main observations are mad with bottom trawl, pelagic trawl, echo sounder and ctd. Plankton studies have been done in some years. Cod and haddock are the main targets for this survey. Swept area indices are calculated for cod, haddock, Greenland halibut, *S. marinus* and *S. mentella*. Acosutic observations are made for cod, haddock, capelin, redfish, polar cod and herring. The survey started in 1981.

Lofoten survey

The main spawning grounds of North East Arctic cod are in the Lofoten area. Echosounder equipment was first used in 1935 to detect concentrations of spawning cod (Sund 1935a, Sund 1935b). The first attempt to map such concentrations was made in 1938 (Sund 1938). Later investigations have provided valuable information on the migratory patterns, the geographical distribution and the age composition and abundance of the stock.

The current time series of survey data starts in 1985. Due to the change in echo sounder equipment in 1990 results obtained earlier are not directly comparable with later results. The survey is designed as equidistant parallell acoustic transects covering 3 strata (North, South and Vestfjorden). In most surveys previous to 1990 the transects are not parallell, but more as parts of a zig-zag pattern across the spawning grounds aimed at mapping the distribution of cod. Trawl samples are not taken according to a proper trawl survey design. This is due to practical reasons. The spawning concentrations can be located with echosounder thus effectively reduce the number of trawl stations needed. The ability to properly sample the composition of the stock (age, sex, maturity stage etc.) is limited by the amount of fixed gear (gillnets and longlines) in the different areas.

Norwegian coastal surveys

In 1985-2002 a Norwegian acoustic survey specially designed for saithe was conducted annually in October-November (Nedreaas 1998). The survey covered 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 was to support the stock assessment with fishery-independent data of the abundance of the youngest saithe. The survey mainly covered 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, were also represented in the survey, although highly variable from year to year. In 1995-2002 a Norwegian acoustic survey for coastal cod was conducted along the coast and in the fjords from Varanger to Stad in September, just prior to the saithe survey described above. This survey covered coastal areas not included in the regular saithe survey. Autumn 2003 the saithe- and coastal cod surveys were combined.

Joint ecosystem autumn survey

The survey is carried out from early August to early October, and covers the whole Barents Sea. Five vessels are normally applied, three Norwegian and two Russian. Most aspects of the ecosystem are covered, from physical and chemical oceanography, primary and secondary production, fish (both young and adult stages), sea mammals, benthos and birds. Many kinds of methods and gears are used, from water sampling, plankton nets, pelagic and demersal trawls, grabs and sledges, acoustics, directs observations (birds and sea mammals). The survey has developed from joint surveys on capelin and juvenile Greenland halibut, through general acoustic surveys including observations of physical oceanography and plankton, gradually developing into the ecosystem survey carried out in recent years. The predecessor of the survey dates back to 1972 and has been carried out every fall since.

Russian Autumn-winter trawl-acoustic survey

The survey is carried out in October-December, and cover the whole Barents Sea up to the continental slope. Two Russian vessels are usually used. The survey has developed from a young cod and haddock trawl survey, started in 1946. The current trawl-acoustic time series of survey data starts in 1984, targeting both young and adult stages of bottom fish. The surveys include observations of physical oceanography and meso- and macro-zooplankton.

Norwegian Greenland halibut survey

The survey is carried out in August, and 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 survey was run the first time in 1994, and is now part of the Norwegian Combined survey index for Greenland halibut.

1.2.4 Numerical models

Large 3D hydrodynamical numeric models for the Barents Sea are runned at both IMR and PINRO. These models have, through validation with observations, proved to be a useful tool for filling observation gaps in time and space. The hydrodynamical models have also proved useful for scenario testing, and for study of drift patterns of various planktonic organisms.

Sub-models for phytoplankton and zooplankton are now implemented in some of the hydrodynamical models. However, due to the present assumptions in these sub-models care must be taken in the interpretation of the model results.

1.2.5 Other information sources

Satellites can be for several monitoring tasks. Ocean colour spectre can be used to identify and estimate the amount of phytoplankton in the skin (~1 m) layer. Several climate variables can be monitored (e.g. ice cover, cloud cover, heat radiation, sea surface temperature). Marine mammals, ice bears and seabirds can be traced with attached transmitters.

Aircraft surveys can also be used for monitoring several physical parameters associated with the sea surface as well as observations of mammals at the surface.

Several international hindcast databases (e.g.. NCEP, ERA40) are available. They use a combination of numerical models and available observations to estimate several climate variables, covering the whole world.

Along the Norwegian coast ship-of-opportunity supply weekly the surface temperature along their path.

1.2.6 Monitoring divided by ecosystem components

Climate

In order to evaluate the state of the physical environment several sources of information are used. Area surveys of temperature and salinity are conducted in January-February at the joint winter survey and in August-October at the joint ecosystem survey. The standard sections also form an important base for the evaluation of temperature and salinity. Especially the seasonal development is monitored at the Kola and Fugløya-Bjørnøya section, and at the fixed station Ingøy. In the Fugløya-Bear Island section a series of current meters monitors give a high resolution of the flow through the western entrance of the Barents Sea. In addition hydrodynamical numeric models give insight into horizontal and vertical variation of temperature, water masses distribution and transports.

Phytoplankton

The bloom situation in the Barents Sea is covered on a regular basis both during the survey coverage in August-October and on the standard sections Fugløya-Bear Island and Vardø-Nord. During these surveys the chlorophyll concentration is measured as fluorescence in water samples taken from standard depths down to 100 m depth. This gives an indication on the primary production in the area. In addition to the chlorophyll concentration, which is a measure of the phytoplankton production, analyses in 2005 included species composition. In addition to observations, the primary production is simulated using numerical models.

Zooplankton

Zooplankton area coverage is monitored during the joint autumn ecosystem survey. Joint investigations have taken place since 2002. Regular sampling by IMR began in 1979.

Monitoring of zooplankton along the Fugløya-Bear Island section by IMR started in 1987 and are now conducted 5-6 times each year usually in January, March/April, May/June, July/August and September/October. However, the data prior to 1994 are scarce and does not give a full seasonal coverage. The WP2 plankton net has been used regularly during this monitoring since 1987. In addition some vertically stratified MOCNESS stations are also taken each year.

Regular macroplankton area 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. In the 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 this survey, and both species and size composition of the euphausiids are determined.

Fish

Most of the area surveys mentioned above have monitoring of commercial fish species as their main objective. The different fish stocks and life stages are targeted at these surveys. In addition to catch data the surveys are the main data source for the assessment of the stocks.

Among additional sources of information are biological data collected by observers onboard commercial fishing vessels, and some regular fishing vessels with special reporting demands acting as reference fishing vessels.

Mammals

Abundance and distribution of some marine mammal species in the Barents Sea are regularly monitored. Sighting surveys of pelagic cetaceans provide abundance estimates every 6 years, while harp and hooded seal abundances in the Greenland Sea are monitored every 5 years. Since 2002 distribution of marine mammals in the Barents Sea are observed from research vessels during ecosystem survey. In addition aircraft observations and observations from fishing vessels with observer are used. In the White Sea aircraft observations are used to estimate the abundance of harp seals.

Benthos

The main monitoring of the benthos community takes place during the joint autumn ecosystem survey.

1.3 State and expected situation of the ecosystem

1.3.1 Climate (Figures 1.2–1.4)

Current situation of temperature, salinity and bottom oxygen

Processes of both external and local origin operating on different time scales govern the temperature in the Barents Sea. Important factors that influence the temperature regime are the advection of warm Atlantic water masses from the Norwegian Sea, the temperature of this water masses, local heat exchange with the atmosphere and the density difference in the ocean itself. The volume flux into the Barents Sea from the Norwegian Sea is influenced by the wind conditions in the western Barents Sea, which again is related to the Norwegian Sea wind field (Ingvaldsen *et al.*, 2004). Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered when describing the variation in the temperature of the Barents Sea.

Temperatures in the Barents Sea were relatively high during most of the 1990s (Figure 1.3). There was a continuous warm period from 1989-1995, followed by a short period with below average conditions. Since 1998 the temperature has, with few exceptions, stayed well above average. Although the 1990s decade was warm, it still was only the third warmest decade in the 20th century (Ingvaldsen *et al.* 2002b).

In 2005 the temperature in the Barents Sea was among the highest ever observed (Figure 1.3) with anomalies ranging between 0.5 and 1.5 ^{o}C the long-term average throughout the year. In the beginning of 2006 the temperatures are still at record high levels. In 2005 anomalies in the Atlantic water masses were highest in the beginning and end of 2005, with values close to all time high observations in several sections. In the summer the anomalies dropped, but were still well above average levels (Figure 1.4). Bottom temperature anomalies from survey data in August/September also indicate that the warming of the whole Barents Sea reaches all the way to the bottom, with anomalies between 0.5 and 1 ^{o}C over most of the Barents Sea, negative anomalies occurs only at small areas in the northwestern and southeasten part The coastal water followed the same pattern as the Atlantic water, but had larger variations with a maximum anomaly of about 2^{o}C in November. The Polar front in August was displaced more eastern and northern than usual.

The salinity in the western and central parts of the Barents Sea generally fluctuates in phase with the variation of the temperature, due to influence by the Atlantic water masses. Since the summer of 2003 there has in general been increase in the salinity in the southwestern Barents Sea, and in 2005 the salinity is still high. Since 1998 the bottom layer oxygen level has been low in the southern Barents Sea. In 2005 the oxygen level was back at average level.

Current situation of inflow of Atlantic water

Transport of Atlantic water into the Barents Sea has been measured since August 1997 by current meter moorings and ADCP's situated across the western entrance. The observed current is predominantly barotropic, and reveals large fluctuations in both current speed and lateral structure (Ingvaldsen *et al.* 2002a and 2004). The inflow of Atlantic water may take place in one wide core or split in several cores. Between the cores there is a weaker inflow or a return flow. In the northern parts of the section there is usually outflow from the Barents Sea. The time series of volume and heat transports reveal fluxes with strong variability on time scales ranging from one to several months (Figure 1.2). In 2005 the inflow of Atlantic water from the Norwegian Sea into the Barents Sea was in general higher than in 2004, and was also higher than the average for the observation period (1997-2005). However, the fluctuations through the year were the largest that is observed in this time series. In the beginning of the year the inflow were high, but dropped drastically in the spring, which is a crucial period for advection of zooplankton into the Barents Sea. In the summer the inflow increased again, reaching the highest observed values in the autumn. According to a wind driven model, which is roughly in accordance with observations, the inflow in December had strong negative anomalies.

The heat transport into the Barents Sea in 2005 was in general high. This is due to the combination of high temperatures upstream in the Norwegian Sea and above normal inflow conditions. However, though the temperature remained stationary high in the spring months the decrease in the inflow in the spring months resulted in a decreased heat transport in this period (Figure 1.2).

Current situation of ice conditions

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. In 2005 and beginning of 2006 the ice coverage in the Barents Sea was low, and about the same level as is 2004.

Expected situation

Prediction of Barents Sea temperature is complicated by the variation being governed by processes of both external and local origin operating on different time scales. The volume flux of Atlantic water masses flowing in from the Norwegian Sea is an important factor. It is influenced by the wind conditions in the western Barents Sea, which again is related to the Norwegian Sea wind field (Ingvaldsen *et al.* 2004). Also the temperature of these water masses as well as local heat exchange with the atmosphere, possibly linked to atmospheric teleconnections, is important in determining the temperature of the Barents Sea (Ådlandsvik and Loeng 1991, Loeng *et al.* 1992). Furthermore, also density differences in the ocean itself are of importance. Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered.

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 December 2005 allow for a six-month forecast until June 2006. The predictions indicates that the temperatures in the southern Barents Sea will be about 0.5-0.7°C above average in the summer of 2006. This is in accordance with a model based on harmonic analysis of the Kola section temperature time series. This model also predicts that the temperature will decrease at the end of 2006, but still be well above average. Further this model predicts that the temperature during 2007 will reach average levels.

Based upon the prognosis together with the record high temperatures in the western Barents Sea at the end of 2005 and further into the beginning of 2006 and relatively high temperatures in the Norwegian Sea during late 2005 and beginning of 2006, it is expected that the temperatures in the southern Barents Sea will be high also during 2006. Especially the first half of the year is expected to be warm. Later on the temperature anomalies are likely to become smaller, but still well above the long-term average.

The ice conditions in the Barents Sea in 2006 is expected to still be low, due to the extremely warm Atlantic waters in the end of 2005 and beginning of 2006. However, at the end of the year it is expected to be somewhat more ice than in 2005, but still less than average, due to the expected decrease towards the average in the temperatures at the end of 2006.

1.3.2 Phytoplankton

Current situation

In the period from January to March at the Fugløya-Bear Island section small flagellates dominated. In May there was low diversity of species and the dominating group was diatoms. Relatively high concentrations of the diatom *Chatoceros decipience* were observed on the southernmost stations of the section. In August the chlorophyll values was evenly distributed, with a tendency to higher production in the southern part. Small flagellates and big dinoflagellates were abundant along most of the section except for the southernmost stations were the big diatom *Proboscia alata* was frequently observed. Low concentrations of chlorophyll throughout the water column were found in October.

At the Vardø-North section, high diversity of phytoplankton was observed in June, but concentrations were relatively low. Species of the *Chatoceros* genus dominated. In September, small flagellates dominated and *Emiliania huxley* was most abundant.

Simulations of the primary production in the Barents Sea using the ROMS numerical model (Skogen *et al*., in prep.) Even though we suspect the model to produce the bloom somewhat too early in the year, we expect the trends to be correct. According to the model the the peak of the bloom may vary with about three weeks from year to year and in 2005 the results indicates that the bloom was relatively late, and in general occurred 1-2 weeks later than in 2004. It shows that the bloom was earliest in the coastal waters close to the coast at the western entrance of the Barents Sea. Also along the Polar front and close to some of the bank areas, the bloom started early. Particularly in the eastern part close to Goose Bank and North Kanin Bank but also at the Svalbard Bank. Some of these banks are very shallow and water masses may be trapped there. The bank may therefore act as a barrier to downward transport of plankton cells in the same way as a stratification of the water masses. This may explain the early bloom in the bank areas. The peak of the bloom in the Arctic water masses occurred 1-2 weeks later than in the Atlantic water masses, and at about the same time as in 2004. This indicates that the time difference in the peak of the blooms in the two water masses were closer in time than in 2004.

Expected situation

Based on the expected warm temperature, especially during the spring, it is expected a similar phytoplankton situation in 2006 as in 2005. However, the re-supply of nutrients to the upper layers depend on both local wind mixing and advection from the deeper layers of the Norwegian Sea. Both these factors depend on the wind regime, which again can’t be predicted longer than about a week ahead. Therefore the expected phytoplankton situation is of great uncertainty. Even more difficult is to predict which species that will dominate blooms.

1.3.3 Zooplankton (Figures 1.5–1.7)

Current situation

Results from the WP2 stations during autumn ecosystem survey in 2005 (Figure 1.6) show a mean biomass of 7.8 g m^{-2}, quite similar to 2004 values. When combining MOCNESS and WP2 zooplankton data average biomass was slightly higher in 2005 compared to 2004, 8.3 g m^{-2} and 8.0 g m^{-2} respectively. Although the average biomass was similar in both years, a low zooplankton biomass region in the south was observed in 2005 contrasting the situation in 2004. Predation, especially by 0+ herring might explain the low plankton biomass found in the south. In general, the zooplankton biomass was higher in Atlantic/subarctic waters compared to Arctic waters (Figure 1.6). *Calanus* and krill species contributed significantly to the high biomass of zooplankton observed in the western and central Barents Sea, while the high biomass localities observed in Arctic waters, was normally due to the presence of the large hyperid amphipod, *Themisto libellula*.

The mean zooplankton biomass along the Fugløya-Bear Island section in 2005 was very low during the winter months (Figure 1.5). Small amount of zooplankton biomass (0.43 g m^{-2}) was observed in the upper 100m during winter. A low biomass was also observed from bottom-0 m (1.7 gm^{-2}), indicating that the production is quite low in winter and that the majority of zooplankton stays in the deeper part of the water column. In summer, the biomass in the upper 100 m (mean =5.3 g m^{-2}) varied little except for 1994, where one station contributed to the very high mean biomass. The average biomass in spring/summer for the whole water column was 7.8 g m^{-2}. The average biomass was 3.2 and 3.9 gm-2 in 2004 and 2005 respectively. This is below the long-term (1994-2005) average of 5.4 g m-2.

Results from autumn-winter macroplankton survey show that the abundance of the pre-spawning krill in the beginning of 2005 was close to the long-term mean (Figure 1.7). The krill indices in the northern and southern regions during 2005 were slightly lower than in 2004. In 2005, the densest concentrations of krill (>5 000 ind./1 000 m^3) were registered northeast of the Hopen Island and in the southeastern shallows. Low concentrations of krill (1-100 ind./1 000 m^3) were observed in the coastal areas.

Although the krill abundance shows significant fluctuations, an increase in krill abundance can be seen from early 1990s. Krill are mainly restricted to Atlantic/subarctic waters and penetrate very little into cold Arctic waters. The recent increase in krill abundance can be due to warmer conditions in the Barents Sea. This is supported by more frequent observations of the warm water krill species *Nematocelis megalops* in the Barents Sea in the recent years.

Expected situation

Predators feeding on zooplankton in the Atlantic/subarctic waters would benefit, as warming conditions will provide optimal conditions also for zooplankton growth. However, the warming conditions of the Barents Sea may have a negative impact on the abundance and distribution of Arctic zooplankton species, as well as their predators. Published results show that the abundance of the true Arctic amphipod, *T. libellula* significantly dependent on the amount of Arctic water present in the Barents Sea (Dalpadado, *et al*. 2002). In the high Arctic food web, zooplankton species such as *T. libellula* and *Calanus glacialis* play a significant role. The Barents Sea harp seal, sea birds particularly the Brunnich´s guillemots, have been observed to feed mainly on *Themisto libellula*. Seabirds such as the little auk that rely on large Arctic *Calanus* species with high lipid content, may suffer if their primary prey declines due to a warmer ocean climate.

The average zooplankton biomass in 2005 from combined WP2 and MOCNESS data (8.3 g m^{-2}) was higher than long term mean (7.9 g m^{-2}). Abundance indices of the pre-spawning euphausiids in the beginning of 2005 were close to the long-term mean. Based on the biomass information we have from 2005 and the trend observed since 2001 the zooplankton production in 2006 is expected to compare to 2005, probably providing good feeding conditions for capelin, herring and other juvenile fish. However, a significant uncertainty exist with respect to the recovery of capelin, the developments of the blue whiting and herring stocks and how this might influence the growth in zooplankton stocks.

1.3.4 Fish (Tables 1.5 – 1.8, 1.11)

Current situation

The current situation of the commercial stocks in the Barents Sea addressed by the AFWG is given in later chapters. In this part the focus is therefore only on special conditions about fish species that deviates from the general situation, and is related to trophic relations and distribution aspects.

NEA cod diet

So far, in IMR 321 0-group cod stomachs from 24 stations sampled by 0-group trawl have been analysed, as well as 142 stomachs of 0-group cod sampled by the bottom trawl. The analysis showed generally the same pattern for the two sampling gears. PINRO sampled 280 stomachs during the autumn ecosystem survey 2005 and 898 stomachs from the 2005 autumn-winter trawl-acoustic survey for demersal fishes. Copepods and krill were the main food item for the 0-group cod, most of which were in the length range 7-11 cm. Only few stomachs contained fish and shrimp, but as these stomachs had a high content of food, these food items show up noticeably in the diet. The dominant copepod was *Calanus finmarchicus*, followed by *Metridia longa*. The krill species found were mainly *Thysanoessa inermis*.

The results by PINRO of analysis of diet composition of the juvenile cod corresponded in general to the data of IMR. The following groups of items dominated: Euphausiacea, Copepoda, Teleostei, Gammaridea and Hyperiidea. In August-September age 0 cod that was distributed pelagically fed mainly on Copepoda, Euphausiacea and Teleostei (86% by weight of stomach content). For fish found near the bottom the portion of Gammaridea increased and portion of Teleostei decreased, and the prime items were Copepoda and Euphausiacea (56%). In October-December, when cod age 0 descended to bottom layers, the proportion of different kind of preys in its diet abruptly changed: portion of Copepoda decreased from 29% to 2% and the proportion of Hyperiidea increased to 13%. The dominant groups of prey in the diet of cod age 0 in October-December were Euphusiacea, Gammaridea and Hyperiidea, which totally consist 74% by weight of stomach content.

During the ecosystem survey in 2005, krill and amphipods were the most important prey groups for age 1-2 cod, while shrimp and polar cod were also important in some areas. The most important fish prey was *Lumpenus* spp. For cod age 3-6, the diet composition during the ecosystem survey in autumn 2005 was very variable between the areas, reflecting the difference in geographical distribution of the various prey items. Blue whiting was the dominant prey item in the south-western part, while herring, krill, shrimp and capelin dominated in the south-eastern part. In the central Barents Sea shrimp was the most important prey in a large area, while polar cod dominated in the area east of 42° E and between 73° and 76° N. North of 76° N, polar cod, capelin and amphipods dominated. For cod age 7-13, the diet composition during the ecosystem survey was to a large extent similar to that of age 3-6 cod. Thus, blue whiting dominated in the south-western part and polar cod, capelin and amphipods dominated north of 76° N, and polar cod dominated in the area east of 42° E and between 73° and 76° N. Shrimp was the dominant prey item in the central Barents Sea, but over a smaller area than for age 3-6 cod. Also, the proportion of cod and haddock in the diet was high in several parts of the central Barents Sea, with cod also being an important prey west of Svalbard.

The consumption calculations made by IMR show that the total consumption by age 1 and older cod in 2005 was about 4 million tonnes (Table 1.5), while calculations by PINRO (table 1.6) gave about 3 million tonnes. The consumption per cod for the various age groups seems to be stable (Table 1.7 – 1.8). The consumption of capelin by cod decreased strongly from 2004 to 2005, but capelin was also in 2005 the most important prey item for cod, followed by polar cod and crustaceans (Table 1.5). The consumption of haddock by cod has been high in recent years. The consumption of cod by cod has been at an intermediate level in the last years.

Blue whiting diet and abundance

The increased abundance of blue whiting in the Barents Sea in recent years may be due to increased temperature. Blue whiting has been observed in the western and southern Barents Sea for many years, but never in such quantities as now, and never as far east and north in this area as in 2004-2005. In autumn 2005, the acoustic abundance of blue whiting was estimated to 1.1 million tonnes, mainly age 1-5 fish. During the ecosystem survey 2005, IMR analysed 262 blue whiting stomachs. The blue whiting fed mainly on macroplankton species (Table 1.11), in particular *Themisto abyssorum* and Euphausiids (56% by weight of pooled stomach content). Blue whiting also fed on fish (22% by weight of pooled stomach content), with other blue whiting being the most important species of fish in the diet (15.9% by weight of pooled stomach content). Also during the winter survey 2006 blue whiting stomachs were sampled, and some of them contained capelin.

Abundance of herring and capelin

During the 2005 Joint Norwegian/Russian Ecosystem Survey the abundance of juvenile herring was still high, but slightly lower than in 2004. The capelin abundance is still very low.

Expected situation.

There is not any evidence that capelin stock will rebuild in 2007 after the collapse in 2003 (Section 9). Which consequences does the capelin collapse have for the Barents Sea ecosystem? The collapses of the capelin stock in the 1980s and 1990s had major consequences for the predators preying on capelin, in particular cod and harp seal. In particular, during the collapse in the 1980s, length growth of cod decreased and age at maturity increased, and the condition factor also decreased. The cod switched to less nutritious food (krill and amphipods), and predation on young cod (cannibalism) increased. The harp seal searched for food to the south and west of its usual habitat, and drowned in gillnets along the Norwegian coast. Seabirds feeding on capelin had very low breeding success, and the mortality of adult seabirds also increased. During the second collapse in 1993-1995 the effect on growth and maturation was much smaller, although the cod stock was higher during this period than in 1986-1988. The cod also switched to other fish prey, including young cod, but also seemed to have more capelin available. During this period there was no seal invasion on the Norwegian coast, and the seabirds also did fairly well.

Herring is the only other prey item with similar abundance and energy content as capelin. If herring is an important food item and may replace capelin in the period where the capelin stock is low, may this be an explanation of the differences between the first and second capelin collapse. During the first capelin collapse, herring disappeared from the Barents Sea during the first year of the collapse, as the herring in the Barents Sea consisted almost exclusively of the 1983-year class. During the second collapse, several strong herring year classes, in particular the 1991 and 1992 year classes, were present, and thus there was herring in the Barents Sea also in parts of the period when the capelin stock was depleted. Also before and during the third capelin collapse, several strong years classes (1998, 1999, 2002, 2004) appeared in the Barents Sea.

Although the amount of herring in cod stomachs increased during all the three previous capelin collapses, it cannot be said that herring wholly or partially replaced capelin as food for cod. Data from the joint IMR-PINRO stomach content data base, together with Russian qualitative stomach content data (Ponomarenko & Yaragina 1979), show that the proportion of cod stomachs containing herring was much higher in many years during the 1950s and 1960s than during the capelin collapses in the 1980s and 1990s. The reason for this difference is not known. Possible explanations could be: more young herring in the Barents Sea in the 1950s and 1960s; higher overlap between cod and herring, or that a larger proportion of the cod stock in the 1950s and 1960s was large cod, which is more capable of feeding on herring. The herring abundance in the Barents Sea will probably be high up to at least spring 2007, since the 2004 year class is strong. The situation is fairly similar to that in the mid-1990s. The period with high abundance of herring will, however, be at least one year longer this time, and this may cause the period of low recruitment of capelin to become longer than the life cycle of capelin (4 years). This may hamper capelin recovery.

An increased amount of blue whiting in the Barents Sea may imply competition with other predators on capelin, especially cod. PINRO studies (Dolgov et al., WD11, AFWG 2002) show that blue whiting will not have a significant impact on the recruitment of cod and other commercial fishes (haddock and redfishes). Increased competition between blue whiting and juvenile commercial fishes grazing on zooplankton is possible. Concerning blue whiting as prey, we mainly know about the diet of cod. In this time series (Table 1.5) we can see that blue whiting appears at the end of the period (2001-2005). We may conclude that a ‘new’ prey species has become available for cod, and then mainly for larger individuals (ages 5 and older). Since blue whiting is nutritious prey, it may influence cod growth positively, at least in periods with low capelin abundance.

Recruitment seems to be strong for most fish species, so that, in addition to young herring, also haddock, blue whiting, polar cod and cod are abundant in the Barents Sea. It is thus likely that cod and other predators, except capelin specialists like guillemot, has alternative fish prey available, as in the mid-1990s. So far, the consequences of this capelin collapse have been modest, and this situation is likely to continue. Another interesting phenomenon is that the collapse of the capelin stock is less abrupt this time than in the two previous collapses, because the recruitment failure has not been so drastic. We also note that recruitment of 0-group capelin has been around or above average in 2002-2004, while the survival from 0-group to age 1 seems to be poor. Whether this is due to predation by herring on 0-group capelin after the survey on 0-group capelin in August-September, is unknown.

1.3.5 Marine mammals (Figures 1.14-1.15)

Current situation of distribution and abundance

In 2005 the minke whale was the most frequently seen species of the large cetaceans, but fin whales were also quite common, even within the Barents Sea proper. The dolphin-like species observed were dominated by whitebeaked dolphins (*Lagenorhynchus albirostris*). A significant number of sperm whales were seen off the continental shelf of northern Norway south of about 72ºN.

The minke whales were distributed all over the area surveyed, while fin whales were mostly seen north of about 74ºN within the Barents Sea, along the continental shelf break and offshore within the Norwegian Sea (Figure 1.15). Humpback whales were seen south of Bear Island and in an area northeast of Hopen Island, both traditional feeding grounds for humpbacks at this time of the year. Dolphins were observed all over the survey area with exception of the deepest areas in the Norwegian Sea.

In 2005, migrations of cetaceans in the Barents Sea appeared to be more prolonged both in time of presence in the sea and distance. An increase was observed in occurrence of rare species for this area (northern bottlenose whale, pilot whale, sei whale, fin whale, sperm whale). Concentrations of sea mammals (humpback whales and dolphins) at sites of high potential food aggregations were more dense and prolonged than in 2003 and 2004. From 2004 to 2005 some changes in distribution of marine mammals were evident; for example in 2005 fin and humpback whales were mainly observed in the northern part of the sampling area in association with capelin and polar cod.

In the Barents Sea, minke whales were distributed practically in the entire area and observed to form considerable aggregations off the Murman coast (Figure 1.14). The large group of minke whales in the southeastern Barents Sea was connected with the approaches of both capelin and Cheshsko-Pechorskaya herring to that area. The concentration was stable during the whole summer.

The occurrence of northern bottlenose whales *Hyperoodon ampullatus* to the Barents Sea area (primarily to the western part) has become more frequent. The whales were observed in the area of the Kopytov Bank and off the western slope of the Bear Island Bank, over depths from 200-700 m to 1500 m. Mean water temperature in the areas of their occurrence was +4º - +6ºC. To the east of 20ºE and to the north of 76ºN, no bottlenose whales were recorded. The animals were registered as single specimens or in groups of 2-5 to 8-11 individuals. In the groups both adult and young whales as well as calves were recorded. The total abundance of the observed group of bottlenose whales was estimated at 190-200 individuals. This species may have an influence on long-line fishing since some groups of bottlenose whales feed on fish caught by longlines.

In March 2005 an airborne estimation of pups of harp seals was conducted in the White Sea. The estimated abundance of harp seal pups, 122.4 x 103 individuals (SE=19,900), was less than those estimated in recent years. The total abundance of seals having been registered in the moulting grounds in April 2005 was estimated by an automatized method using the thermal scanner images and control comparison with the data obtained in the traditional way (based on the joint procession of IR-images and digital video). According to the data from the assessment in the seal moulting grounds in the White Sea, the total abundance amounted to 654,05 x 103 individuals (SE=174,200). The data obtained indicate a decrease in harp seal abundance at the reproduction and moulting grounds in spring 2005, however, the reasons for this are unknown.

During the aerial surveys in March-April in the White Sea ice area, a group of white whales was observed scattered in the open water along the dense ice edge, and their abundance was estimated to be 1,000-1,500 individuals. In March, the group was located in the White Sea Basin; in April, a second group was formed in Voronka. In April, in the Voronka of the White Sea, a group of walruses (23 animals recorded), the largest one observed in recent years, was found.

A character of the revealed distribution of marine mammals in summer/autumn in the Barents Sea is probably a consequence of the influence of both warming (earlier spring migration) and decrease of food base (capelin). However, at present time the spatial associations between the marine mammal species and potential prey species have not yet been properly quantified and assessed. Also, effects of varying observer effort and weather conditions needs to be taken into account before any conclusions can be drawn as some baleen whale species are difficult to observe under windy conditions, and weather conditions may thus severely influence the observed distributions.

Predation by mammals

Analyses of consumptions by marine mammals in the Barents Sea for 2005 are not available.

1.3.6 Long-term trends (Figure 1.16)

According to ACIA (ACIA 2005, Arctic Climate Impact Assessment) the air temperature in the world is on expected to increase by 1-2 °C during the next 100 year. An important assumption for this prediction is a continuing increase in the CO2 outlet to the atmosphere at a rate giving a doubling of the CO2 level in 100 year compared with today's level. For the Arctic region the effect is assumed to be higher, with air temperatures increasing between 2-7 °C. This is mainly associated with the connected retreat of the ice cover. In the summer the ice cover may disappear, but the effect in the winter is not expected to be so drastic. However, ice habitat species may suffer dramatically under such circumstances. In the Barents Sea the water temperature is expected to increase by 1-2 °C throughout the water column.

The recent warming period in the North Atlantic region (including the Barents Sea) opens for the question about regime shifts in the ecosystem. The question if the ecosystem has reached a different state, which may be irreversible, or is just at a maximum in a natural cycle is hard to evaluate. However, a similar warming period took place in the 1930's. The whole ecosystem responds to long-term changes (e.g. temperature). This is illustrated in Figure 1.16, which shows a collection of time series from the Barents Sea ecosystem. Each time series have been normalised, and positive and negative anomalies coloured red and blue, respectively. From this figure it looks like several, but not all, factors responds within a few years to cycles in the system. More knowledge is needed before any conclusions on possible regime shifts can be drawn.

1.3.7 Main conclusions

Climate

- The temperature in the whole Barents Sea was very high in 2005, especially in the beginning and end of the year. In the Atlantic water masses the temperature was between 0.5 and 1 °C above normal. The Coastal water masses showed the same pattern as the Atlantic waters, but with larger variations (anomalies between 0.5 and 2 °C above normal. At the beginning of 2006 the temperatures are at record high values at several sections.

- Inflow of Atlantic waters varied strongly during 2005. Highest inflow occurred in the beginning and second half of the year. Low inflow occurred in the spring.

- The temperature in 2006 is expected to remain high with some reduction at the end of the year.

- The ice concentration in 2005 was low. Similar conditions are expected in 2006.

Phytoplankton

- Model results indicate that spring bloom in 2005 was late.

- The phytoplankton situation in 2006 is expected to be similar to 2005. However, this prediction is highly uncertain due to the dependence on the rapid changes in local water vertical stability.

Zooplankton

- The average zooplankton biomass in 2005 from autumn ecosystem survey data was some higher than long-term mean. Abundance indices of krill in the beginning of 2005 were close to the long-term mean.

- The zooplankton production in 2006 is expected to compare to 2005, probably providing good feeding conditions for capelin, herring and other juvenile fish.

Fish

- Capelin was at a low level in 2005, and is expected to remain at low level in 2006.

- Young herring is presently at a high level. The strong 2002 year class has now migrated out of the Barents Sea, but the 2004 year class which seams to be strong will remain.

- An expected low capelin level may affect the growth of cod, although herring may partly replace capelin as an energy-rich prey for cod.

- Blue whiting is still abundant in the western areas in 2005, mostly individuals at age 1-5. Blue whiting abundance in the Barents Sea is expected to remain high in 2006.

- Blue whiting prey mainly on krill, amphipods and shrimps. Larger individuals prey also on fish, mainly polar cod and capelin. Blue whiting is not a common prey item, and are only found in small amounts in cod and Greenland halibut stomachs.

Mammals

- In 2005 marine mammals were widely distributed in the Barents Sea

- The most abundant and widely distributed species of the cetaceans were minke whale, white-beaked dolphin, humpback whale, harbour porpoise and white whale.

- The distribution of sea mammals in 2005 in the Barents Sea was determined by both high temperatures (earlier spring migration) and decrease in food availability (capelin). Main concentrations of whales and dolphins were found at sites with polar cod and herring aggregation.

- There seems to have been an increase in abundance of bottlenose whales in the western Barents Sea and walrus in the south-eastern part (White Sea). Some reduction in the abundance of harp seals from aircraft survey in the White Sea has been noticed.

1.4 Impact of the fisheries on the ecosystem

1.4.1 General description of the fisheries and mixed fisheries (Tables 1.15–1.16)

The major demersal stocks in the Northeast Arctic include cod, haddock, saithe, and shrimp. In addition, redfish, Greenland halibut, wolffish, and flatfishes (*e.g.*, long rough dab, plaice) are common on the shelf and at the continental slope, with ling and tusk also found at the slope and in deeper waters. In 2005, catches slightly more than 1.0 million tonnes are reported from the stocks of cod, haddock, saithe, redfish, and Greenland halibut, which is an increase of about 10% compared to 2004. An additional catch of about 100 000 tonnes was taken from other demersal stocks, including crustaceans, not assessed at present. The annual fishing mortalities F (the mortality rate is linked to the proportion of the population being fished by $1-e^{-F}$) for the assessed demersal fish stocks shows large temporal variation within species and large differences across species from 0.1 (≈10% mortality) for some years for Sebastes marinus to above 1 (≈63% mortality) for some years for cod (Figure 1.17). The major pelagic stocks are capelin, herring, and polar cod. There was no fishery for capelin in the area in 2004 and 2005 due to a stock in poor condition, and there is no directed fishery for herring in the area. The highly migratory species blue whiting and mackerel extend their feeding migrations into this region, but there is no directed fishery for the species in the area. Species with relatively small landings include salmon, halibut, hake, pollack, whiting, Norway pout, anglerfish, lumpsucker, argentines, grenadiers, flatfishes, horse mackerel, dogfishes, skates, crustaceans, and molluscs.

The most widespread gear used in the central Barents Sea is bottom trawl, but also long line and gillnets for the demersal fisheries, and purse seine and pelagic trawl for the pelagic fisheries. Other gears more common along the coast include handline and danish seine. Gears used in a relatively minor degree are float line (used in a small but directed fishery for haddock along the coast of Finnmark in Norway) and various pots and traps for fish and crabs. The variety of the gears varies with time, space and countries, with Norway having the largest variety caused by the coastal fishery. For Russia, the most common gear is trawl, but a longline fishery is present (mainly directed for cod and wolffish). The other countries mainly use trawl.

For most of the exploited stocks an agreed quota is decided (TAC). In addition to an agreed quota, a number of additional regulations are applied. The regulation differs among gears and species and may be different from country to country, and a non-exhaustive list is summarised in Table 1.15. A description of the major fisheries in the Barents Sea is summarised by species in Table 1.15.

The demersal fisheries are highly mixed, usually with a clear target species dominating, and with low linkage to the pelagic fisheries (Table 1.16). Although the degree of mixing may be high, the effect of the fisheries will vary among the species. More specifically, the coastal cod stock and the two redfish stocks are presently at very low levels. Therefore, the effect of the mixed fishery will be largest for these stocks. In order to rebuild these stocks, further restrictions in the regulations should be considered (*e.g.* closures, moratorium, restrictions in gears).

Successful management of an ecosystem includes being able to predict the effect on having a mixed fishery on the individual stocks and ICES is requested to provide advice which is consistent across stocks for mixed fisheries. Work on incorporating mixed fishery effects in ICES advice is ongoing and various approaches have been evaluated (ICES 2006/ACFM:14). At present such approaches is largely missing due to a need for improving methodology combined with lack of necessary data. However, technical interaction between the fisheries can be explored by the correlation in fishing mortalities among species. The correlation in fishing mortality is positive for Northeast Arctic cod and coastal cod (p=0.004), haddock and coastal cod (p=0.059) and Northeast Arctic cod and Sebastes marinus (p=0.218) confirming the linkage in these fisheries (Figure 1.18). There is also a significant relationship between Saithe and Greenland halibut (p=0.021) although the linkage in these fisheries is believed to be small (Table 1.16). The relationships between the other fishing mortalities are scattered and inconclusive. In case of strong dependencies in fishing mortalities this method can in principle be used to produce consistent advice across species concerning fishing mortality, but is considered too simple since the correlation this correlation is influenced by too many confounding factors whose effect cannot be removed without a detailed analyses on a higher resolution of the data (e.g. saithe and Greenland halibut, Figure 1.18) and on e.g. changes in distribution of the stocks (ICES 2006/ACFM:14).

A further quantification of the degree of mixing and impact among species requires detailed information about the target species and mix per catch/landing and gear. Such data exist for some fleets (*e.g.* the trawler fleet), but is incomplete for other fleets. In 2005 the composition of cod, haddock and other species caught by the Russian and Norwegian trawl fleet shows large spatial differences in both catch compositions and catch sizes as well as large differences between the countries (Figures 1.19-1.22). In the north eastern part of the Barents Sea the major part of the catches consists of cod. In the western part of the Barents Sea the composition of the Norwegian catches consists of other species while the Russian catches mainly consist of cod. The main reason for this difference is the difference in spatial resolution of the data; the strata for the Norwegian system extends more westerly and cover the fishing grounds for Greenland halibut, while the Russian strata do not. The Norwegian trawl fishery along the Norwegian coast includes areas closer to the coast and is also more southerly distributed where other species is more dominating the catches (e.g. saithe). However there is a difference in the composition in the eastern part in the Russian zone; the proportion of haddock in the Norwegian catches are much larger than in the Russian catches. The reason for this difference is not fully understood, but may be explained by differences in quotas for the respective fleets, although discards cannot be excluded as one of the reasons. The available data for other years and with higher resolution has not yet been gathered and compiled for a further quantitative analysis, necessary to approach consistent model based advices for all stocks.

Estimates of unreported catches of cod and haddock in 2002 - 2005 indicate that this is a considerable problem. Unreported landings are estimated at 90 000, 115 000, 117 000 and 166 000 tonnes in 2002, 2003, 2004 and 2005, respectively, *i.e.* 20-35% in addition to official landing statistics for cod (Table 3.1a), and 20738, 28946, 30469 and 40284 tonnes in 2002, 2003, 2004 and 2005, respectively, *i.e.* 18-26% in addition to official landing statistics for haddock (Table 4.1a). Discarding of cod, haddock and saithe is thought to be significant in periods although discarding of these, and a number of other species, is illegal in Norway and Russia. Data on discarding are scarce, but attempts to obtain a better quantification of this matter continue.

1.4.2 Impact of fisheries

In order to conclude on the total impact of trawling, an extensive mapping of fishing effort and bottom habitat would be necessary. However, its qualitative effects have been studied to some degree. The most serious effects of otter trawling have been demonstrated for hard-bottom habitats dominated by large sessile fauna, where erected organisms such as sponges, anthozoans and corals have been shown to decrease considerably in abundance in the pass of the ground gear. In sandy bottoms of high seas fishing grounds trawling disturbances have not produced large changes in the benthic assemblages, as these habitats may be resistant to trawling due to natural disturbances and large natural variability. Studies on impacts of shrimp trawling on clay-silt bottoms have not demonstrated clear and consistent effects, but potential changes may be masked by the more pronounced temporal variability in these habitats (Løkkeborg, in press). The impacts of experimental trawling have been studied on a high seas fishing ground in the Barents Sea (Kutti *et al*., 2005.) Trawling seems to affect the benthic assemblage mainly through resuspension of surface sediment and through relocation of shallow burrowing infaunal species to the surface of the seafloor.

Lost gears such as gillnets may continue to fish for a long time (ghostfishing). The catching efficiency of lost gillnets has been examined for some species and areas, but at present no estimate of the total effect is available. Other types of fishery-induced mortality include burst net, and mortality caused by contact with active fishing gear such as escape mortality. Some small-scale effects are demonstrated, but the population effect is not known.

The harbour porpoise is common in the Barents Sea region south of the polar front and is most abundant in coastal waters. The harbour porpoise is subject to by-catches in gillnet fisheries (Bjørge and Kovacs, in prep). In 2004 Norway initiated a monitoring program on by-catches of marine mammals in fisheries. Several bird scaring devices has been tested for long-lining, and a simple one, the bird-scaring line (Løkkeborg 2003), not only reduces significantly bird by-catch, but also increases fish catch, as bait loss is reduced. This way there is an economic incentive for the fishermen, and where bird by-catch is a problem, the bird scaring line is used without any forced regulation.

1.4.3 Main conclusions

- The most widespread gear is trawl.
- The fisheries for the demersal species are mixed fisheries currently with largest effect on coastal cod and redfish due to stocks in a poor condition.
- The fisheries for the pelagic species are less mixed with low linkage to the demersal fisheries (reported by-catch of young pelagic stages of demersal species in some fisheries).
- A significant quantity of unreported catches is documented for cod and haddock.
- The total effect of trawling has largest effect on hard bottom habitats, the demonstrated effects on other habitats are not clear and consistent.
- Fishery induced mortality (lost gillnets, contact with active fishing gears, etc.) on fish is a potential problem but not quantified at present.

1.5 Ecosystem information with potential for implementation in fisheries management in the Barents Sea

1.5.1 Overview

The main method for including ecosystem data and knowledge in fisheries management is mathematic modelling. There are many examples of application of regression models for the prognosis of the change in population parameters and distribution of commercial species in the Barents Sea under the influence of variation environmental factors. Development of complex models to improve fisheries management in the Barents Sea based on species interactions stated in the mid 1980s. At the first stage, the work was focused on complex models that included maximum number of species interacted according to their trophic relations. This approach was used in IMR to develop such models as MULTSPEC, AGGMULT and SYSMOD (Tjelmeland and Bogstad, 1998, Hamre and Hatlebakk, 1998). In PINRO this approach was employed for development of the MSVPA model (Korzhev and Dolgov, 1999). All these models can give quantitative characteristics of species interaction of cod in the Barents Sea and can be useful to solve some theoretical problems of multispecies harvest management. However, the use of these models for practical tasks of fisheries management is limited by high level of uncertainty in calculations due to assumptions employed in the models and incomplete data.

Therefore, since the second part of the 1990s some more simple, in structural sense, models have been prioritised. An overview of multispecies models for the Barents Sea currently in use is given below.

At present, predation by cod on cod, haddock and capelin is included in the assessment for those stocks. However, capelin is the only of these stocks for which predation by cod is modelled in the prediction. There is a need for also including predation by cod in short/medium term stock predictions of cod, haddock and herring. Also, harvest control rules and precautionary reference points should be studied in a multispecies context. Such studies should be carried out both by the suggested new multispecies working group (see Section 1.5.1) and by AFWG.

Several of the models mentioned in Section 1.5.2 could be used in such studies. However, it is not clear which (if any) of the models are suitable for use in annual assessments.

1.5.2 Existing models

EcoCod

This model has been developed since 2005 as the main task of the first stage of the joint PINRO-IMR Programme of Estimation of Maximum Long-Term Yield of North-East Arctic Cod taking into account the effect of ecosystem factors (Filin, Tjelmeland, 2005). This 10-year research programme was initiated following a request from the Russian-Norwegian Fishery Commission. EcoCod is a stepwise extension of a single species model for cod (CodSim, Kovalev and Bogstad, 2005), where cod growth, maturation, cannibalism and recruitment is modelled, to a multispecies model. Preliminary sub-models for cod growth, fecundity and malformation of eggs have been implemented in EcoCod. EcoCod also contains a biomass-based cod-capelin-plankton sub-model, which during the first half of 2006 will be developed into an age-structured capelin sub-model. Recruitment scenarios from the herring assessment model SeaStar will be used in the modeling of recruitment in the capelin sub-model.

Bifrost (Boreal integrated fish resource optimization and simulation tool)

This is a multispecies model for the Barents Sea (Tjelmeland, 2005) with main emphasis on the cod-capelin dynamics. The prey items for cod are cod, capelin and other food. The predation model is estimated by comparing simulated consumption to consumption calculated from individual stomach content data using the dos Santos evacuation rate model with a parameterisation where the initial meal size is excluded. The capelin partly shields the cod juveniles from cannibalism, and by including this effect the recruitment relation for cod is significantly improved.

In prognostic mode Bifrost is coupled to the assessment model for herring – SeaStar (Tjelmeland and Lindstrøm, 2005) – and the negative effect of herring juveniles on capelin recruitment is modelled through the recruitment function for capelin. Bifrost is also used to evaluate cod-capelin-herring multispecies harvesting control rules.

STOCOBAR (STOck of COd in the BARents Sea)

This is a model that describes species interactions cod in the Barents Sea (Filin, 2005). This model is designed to improve the harvest management of cod stock taking into account species interactions and environmental influence. First version of STOCOBAR was developed at PINRO in 2001. Now the work on improvement of this model is continued. It can be applied for prediction or historical analysis of cod stock dynamics as well as for model analysis of effectiveness of different harvest strategies. Outputs from this model on growth rate, maturation, consumption and cannibalism of cod have been presented at AFWG since 2002.

STOCOBAR is age-structured, and the time step can be one year or half a year. The model is spatially unstructured. The model includes cod as predator and seven prey species of cod (capelin, shrimp, polar cod, herring, krill and juveniles of haddock and cod) that are divided in age groups except for shrimp and krill.

The work on development of this model is a part of the Barents Sea Case Study within the EU project UNCOVER (2006 - 2009).

GADGET

The model (www.hafro.is/gadget, Begley and Howell, 2004, see also section 0.8), developed during the EU project dst[2] (2000-2003), will be used for modeling the interactions between cod, herring, capelin and minke whale in the Barents Sea during the EU project BECAUSE (2004-2007). The modeling approach taken has many similarities to the MULTSPEC approach (Bogstad et al., 1997). Further, the modeling of recruitment processes in Gadget will be enhanced during the EU project UNCOVER (2006-2010).

1.5.3 Process models

Recruitment

Predictions of the recruitment in fish stocks are essential for predicting harvesting of the fish stocks, both in a single-species and multi-species context. Traditionally prediction methods have not included effects of climate variability. Multiple linear regression models can be used to incorporate both climate and fish effects. 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. (Bulgakova, WD20, AFWG 2005, Stiansen *et al*., WD15, Titov *et al*., WD16, AFWG 2005)

Maturation

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. One approach to investigating the links between food availability and maturation is to examine the correlation between weight- and maturity-at-age. Weight- and maturity-at age were converted to weight- and maturity-at-length using age/length keys as described by Marshall et al. (2004). 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 period 1985-2001.

Estimates of weight-at-length were multiplied by the Russian liver condition index at length (Yaragina and Marshall 2000) to derive estimates of liver weights in grams for cod at a standard length (see Marshall et al. 2004 for details of the calculation). This analysis indicated that for the 1985-2001 period there is a consistently significant, positive relationship between liver weight and proportion mature. A modeling approach to implement this knowledge in the assessment could be developed. This subject was described in more details in last years AFWG report (ICES 2005).

Consumption models

When calculating the prey consumption by a given predator, both the overall consumption level and the prey composition in the diet are used. The prey composition is usually derived from stomach content data, while the overall consumption level can be calculated using two approaches:

1) A bioenergetic approach (as is usually the case for marine mammals and seabirds as predators)
2) By combining data on stomach content weight with models for stomach evacuation rate, based on experiments.

As shown in Johannesen *et al*, WD 20, different methods of type 2) to calculating cod consumption give significantly different results, and thus further work is needed.

It is also important to compare results from these two approaches, as they supplement each other. For cod both methods have been applied (e.g. Ajiad 1996, Bogstad and Mehl, 1997), and the results were in good agreement with each other.

1.5.4 Expected impact of ecosystem factors on dynamics of stock parameters in the Barents Sea (Tables 1.17-1.20)

Recruitment

Prognosis estimates from the recruitment models mentioned in section 1.5.3 are shown in Table 1.17, together with estimates from the assessment. The recruitment estimates from XSA/RCT3 and from Gadget are also given in Table 1.17. There is relatively good correspondence between the various methods concerning recruitment in 2006, except that the estimate from Gadget is about half of the estimates from the other methods. The estimates for 2007 and 2008 from the various methods are quite close (note that Gadget does not provide recruitment estimates for these years). It was decided to use the 'traditional' RCT3 estimates in the predictions of cod recruitment.

Prediction of NEA cod growth rate

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. The main factors influencing cod growth are water temperature, food supply and cod population abundance.

There exist different regressions for the projection of growth of cod in the Barents Sea. The growth of cod is an important element in all complex models that includes cod. The STOCOBAR model gives prognoses of the mean weight of cod in the beginning of the year. These estimates have not been updated in 2005. However, in the calculations from 2004 prognoses of growth cod by STOCOBAR was projected until 2007 (Table 1.18).

According to these results for 2006-2007 the mean weight of fish is in general expected to be lower than the long-term mean average (1984-2003). This is in accordance with expected ecosystem condition for this period.

Expected stock parameters based on qualitative analysis of ecosystem impact factors

An alternative approach for looking at the future development of the commercial fish stocks is to give qualitatively assignments on different stock parameters from major impact factor. Then an overall effect on the specific stock can be given. The overall effect, together with the impact factors and the stock parameters are shown in Table 1.20.

Cannibalism mortality for cod

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 by Kovalev (2004). Using this approach the predicted natural mortality coefficient for cod including cannibalism for resent years seems to be higher compared to "the standard" assessment and prediction (sec. 3.3.7).

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

Values for the years 2004 to 2007, predicted by the regression, are given in the text table below:

	M2 AGE 3	**M2 AGE 4**
	by regression	
2005	0.38	0.26
2006	0.41	0.28
2007	0.48	0.30
2008	0.44	0.29
	values used in assessment	
2006-2008	0.27	0.22

1.6 Response to comments from WGRED and ACFM Technical minutes

There were no specific comments from WGRED this year.

However, the ecosystem description from WGRED has been a valuable source material, and text from the WGRED report has been incorporated throughout the ecosystem chapter. The working group greatly appreciated the WGRED work.

There was one comment from the reviewer in the technical minutes concerning this chapter: “The information on water temperature and climate lead to a discussion on regime shifts. It was noted that such information needs to be related to the productivity of the stocks. While the effect of such factors is incorporated in the assessments by relating them to changes in maturity and growth, this is done case-by-case. The overall picture on historical productivity and its relation to environment or climate is not apparent from the report and would deserve some attention in future reports. “

This is an important issue, and presently several projects addresses these questions for stocks in the Barents Sea. Their results will be very useful for understanding shifts and oscillations in the ecosystem. In the chapter the issue have not been addressed in any special subchapter. However, throughout the chapter attempt has been made to point on factors influencing stock productivity. Especially concerning recruitment and growth conditions, but also trophic relations and climatic response. Also, a section (section 1.3.6) on long-term trends has been added.

Table 1.1. Abundance indices of 0-group fish in the Barents Sea and adjacent waters in 1965-2005. Indices for 1965-1985 adjusted according to Nakken and Raknes (1996).

Year	Capelin[1]	Cod[2]	Haddock[2]	Herring[3]	Polar cod West	Polar cod East	Redfish	Greenland halibut	Long rough dab
1965	37	11	13	-		0	159	-	66
1966	119	2	2	-		129	236	-	97
1967	89	62	76	-		165	44	-	73
1968	99	45	14	-		60	21	-	17
1969	109	211	186	-		208	295	-	26
1970	51	1097	208	-		197	247	1	12
1971	151	356	166	-		181	172	1	81
1972	275	225	74	-		140	177	8	65
1973	125	1101	87	-		26	385	3	67
1974	359	82	237	-		227	468	13	93
1975	320	453	224	-		75	315	21	113
1976	281	57	148	-		131	447	16	96
1977	194	279	187	-			472	9	72
1978	40	192	110	-	157	70	460	35	76
1979	660	129	95	-	107	144	980	22	69
1980	502	61	68	-	23	302	651	12	108
1981	570	65	30	-	79	247	861	38	95
1982	393	136	107	-	149	93	694	17	150
1983	589	459	219	-	14	50	851	16	80
1984	320	559	293	-	48	39	732	40	70
1985	110	742	156	-	115	16	795	36	86
1986	125	434	160	-	60	334	702	55	755
1987	55	102	72	-	111	366	631	41	174
1988	187	133	86	-	17	155	949	8	72
1989	1330	202	112	-	144	120	698	5	92
1990	324	465	227	-	206	41	670	2	35
1991	241	766	472	-	144	48	200	1	28
1992	26	1159	313	-	90	239	150	3	32
1993	43	910	240	188	195	118	162	11	55
1994	58	899	282	120	171	156	414	20	272
1995	43	1069	148	73	50	448	220	15	66
1996	291	1142	196	378	6	0	19	5	10
1997	522	1077	150	390	59	484	50	13	42
1998	428	576	593	524	129	453	78	11	28
1999	722	194	184	242	144	457	27	13	66
2000	303	870	417	213	116	696	195	28	81
2001	221	212	394	77	76	387	11	32	86
2002	327	1055	412	315	110	146	28	34	173
2003	630	694	705	277	179	588	57	9	58
2004	288	983	977	639	164	337	98	29	35
2005	348	972	1103	205	62	355	247	8	89
					154	273			
1985-2005	315	698	352		114	266	305	18	111
1965-2005	290	494	243				368	18	94

[1] Assessment for 1965-1978 in Anon. 1980 and for 1979-1993 in Ushakov and Shamray 1995

[2] Indices for 1965-1985 for cod and haddock adjusted according to Nakken and Raknes (1996)

[3] Calculated by Prozorkevich (2001)

Table 1.2. 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 1965-2004. Not calculated for 2005.

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
2004	1.20	0.92	1.51	1.92	1.67	2.19	1.44	1.19	1.71

[1]Assessment for 1965–1984 made by Toresen (1985).

Table 1.3 . New abundance indices (in millions) for 0-group fish with 95% confidence limits, corrected for catching efficiency. Note that all values have been revised since last year.

YEAR	CAPELIN			COD			HADDOCK			HERRING			SAITHE			POLAR COD (EAST)			POLAR COD (WEST)		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	809 193	553 831	1064555	316	167	465	309	190	427	93	25	161	21	0	47	0	0	0	126 699	0	307667
1981	428 316	228 724	627 909	277	195	358	71	31	111	38	0	86	0	0	0	2 479	1 147	3 810	48 351	19 163	77 538
1982	611 698	152 679	1070717	2 581	1 893	3 269	2 296	1 690	2 902	798	219	1 378	266	0	665	3	0	6	2 751	0	6 070
1983	332 287	173 699	490 875	15 863	7 716	24 011	4 453	3 220	5 686	121 992	28 954	215 030	420	130	709	1 406	0	3 256	55 760	0	120841
1984	168 660	103 049	234 270	20 342	5 689	34 995	3 753	2 572	4 934	18 193	1 301	35 084	1 006	332	1680	123	0	313	26 718	6 475	46 962
1985	73 436	726	146 146	63 561	31 160	95 962	2 463	1 535	3 392	30 140	6 135	54 146	34	4	64	84 185	23 055	145 316	6 907	0	14 133
1986	56 472	4 969	107 976	9 675	6 654	12 695	2 071	1 228	2 915	112	31	193	4	0	9	64 160	21 966	106 355	18 414	0	37 224
1987	2 302	471	4 133	1 036	497	1 574	749	459	1 039	50	0	112	4	0	10	64 879	0	148 667	652	273	1 032
1988	92 075	16 757	167 392	2 668	1 547	3 789	1 687	616	2 758	62 354	21 253	103 455	31	11	50	2 721	56	5 386	41 910	0	91 010
1989	881 764	702 020	1061507	2 781	1 659	3 903	665	461	868	17 640	8 202	27 078	11	0	23	1 593	0	3 393	156 778	17 601	295955
1990	115 198	77 600	152 796	23 609	13 304	33 915	3 081	2 278	3 885	7 925	621	15 228	28	3	53	2 774	668	4 880	250 497	0	558091
1991	164 819	73 881	255 757	41 545	30 446	52 644	14 216	10 877	17 556	270 770	103 481	438 060	9	4	14	580 649	262623	898 675	293 904	0	841007
1992	349	0	743	169 569	92 199	246939	4 889	3 343	6 435	88 619	51 003	126 236	332	161	504	47 171	0	94 701	81 776	12 754	150797
1993	776	161	1 391	96 425	52 852	139998	3 107	2 141	4 072	328 180	2 398	653 963	1 050	0	2551	97 783	24 623	170 943	71 105	12 557	129653
1994	20 987	1 942	40 032	86 942	45 935	127950	5 191	2 922	7 459	131 190	0	273 976	6	0	13	1 212 620	548275	1876966	49 512	0	109966
1995	2 067	0	4 743	279 395	134 482	424308	1 366	694	2 038	14 320	5 680	22 960	473	210	735	0	0	0	217	12	423
1996	143 826	73 868	213 783	278 201	185 042	371361	2 618	1 980	3 257	568 532	269 319	867 745	471	197	745	611 412	383278	839 546	46 883	0	116490
1997	196 013	84 792	307 235	298 365	221 488	375242	2 058	1 412	2 704	468 285	173 000	763 571	350	166	534	289 215	155738	422 691	63 047	6 053	120041
1998	88 035	48 283	127 788	24 066	15 780	32 352	14 160	9 429	18 891	474 513	274 346	674 681	164	80	249	17 195	8 796	25 595	95 558	0	220902
1999	294 999	150 183	439 814	4 406	987	7 826	2 782	1 041	4 523	36 959	13 919	59 999	272	136	408	1 164 168	734544	1593792	26 605	4 450	48760
2000	140 131	5 619	274 643	108 728	58 115	159341	11 003	6 913	15 092	470 181	23 065	917 297	863	456	1270	889 767	509481	1270052	205 736	141129	270343
2001	19 895	3 266	36 523	4 552	934	8 171	5 431	3 719	7 142	10 243	1 839	18 646	48	0	107	0	0	0	144 870	0	315443
2002	21 887	12 610	31 164	33 939	21 774	46 104	4 380	2 944	5 816	93 210	13 660	172 759	517	300	734	97 154	57 155	137 153	234 204	47 674	420734
2003	458 890	235 602	682 178	89 964	52 287	127641	33 050	17 840	48 260	192 343	69 648	315 038	2 705	0	7090	82 300	42 482	122 118	14 595	1 032	28 157
2004	69 251	22 963	115 539	77 737	56 183	99 291	41 646	28 141	55 152	799 415	546 550	1052281	4 869	2786	6952	259 201	113764	404 638	2 437	667	4 206
2005	154 692	54 006	255 378	71 955	50 378	93 532	92 889	68 915	116862	125 719	19 941	231 496	173	112	234	39 715	18 247	61 183	27 431	9 833	45 028

Table 1.4. New abundance indices (in millions) with 95% confidence limits, without correction for catching efficiency. Note that all values have been revised since last year.

YEAR	CAPELIN			COD			HADDOCK			HERRING			REDFISH		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	217 454	149174	285735	66	38	94	67	42	93	5	1	9	282 673	0	707218
1981	110 142	59 430	160855	49	34	65	14	7	22	3	0	9	156 507	0	371639
1982	181 125	45 504	316745	498	359	638	537	390	683	49	12	87	169 453	10 618	328287
1983	100 817	54 303	147331	3 979	1 746	6 213	1 362	895	1 830	32 830	12 326	53 334	53 589	26 931	80 247
1984	73 228	45 396	101061	5 905	1 900	9 911	1 285	877	1 692	4 258	1 570	6 946	43 094	14 054	72 133
1985	24 191	0	48 833	15 113	7 622	22 605	692	397	987	7 858	1 389	14 328	319 308	119797	518818
1986	13 519	668	26 370	1 870	1 289	2 450	472	273	672	9	0	18	110 738	0	228698
1987	600	134	1 066	167	85	250	128	77	179	2	0	5	24 678	13 351	36 006
1988	28 826	5 975	51 678	526	301	751	393	155	630	8 946	3 366	14 526	68 636	43 844	93 429
1989	258 741	205163	312318	718	412	1 024	175	120	230	4 113	1 407	6 819	16 016	7 667	24 364
1990	36 041	24 438	47 643	6 616	3 550	9 682	1 139	838	1 440	4 541	0	9 493	92 985	50 944	135025
1991	55 879	25 342	86 417	11 082	7 997	14 166	3 961	2 966	4 956	79 417	41 631	117203	38 620	0	78 044
1992	116	0	248	45 546	24813	66 278	1 678	1 200	2 155	39 073	22 509	55 636	13 810	0	36 539
1993	257	72	442	26 917	14421	39 414	1 217	824	1 611	68 077	4 138	132016	5 717	0	13 927
1994	9 237	905	17 569	26 762	13870	39 654	1 940	1 025	2 854	18 918	0	40 609	53 599	0	123179
1995	614	0	1 412	89 604	45220	133988	540	275	805	1 700	611	2 790	16 516	3 373	29 660
1996	47 055	24 214	69 896	70 783	46761	94 804	1 066	796	1 336	59 120	29 516	88 724	27	8	47
1997	57 585	24 634	90 535	68 060	50188	85 932	626	432	819	46 833	21 013	72 652	147	0	296
1998	35 881	23 090	48 671	6 798	4 310	9 287	5 993	3 739	8 247	79 577	44 037	115118	746	9	1 483
1999	88 855	48 623	129088	1 364	151	2 577	1 154	378	1 931	16 525	2 116	30 934	41	15	66
2000	39 380	590	78 170	26 112	13948	38 276	2 945	1 883	4 008	49 710	3 342	96 078	7 539	0	16 907
2001	5 212	639	9 786	981	188	1 775	2 016	1 293	2 739	852	152	1 553	6	1	11
2002	20 722	11 632	29 811	19 128	11086	27 170	1 848	1 274	2 421	23 494	12 217	34 772	132	22	243
2003	130 672	68 070	193273	19 098	11174	27 021	8 643	4 481	12 805	31 400	17 390	45 410	192	0	412
2004	20 737	5 641	35 834	22 420	16392	28 448	20 081	13354	26 808	138 995	98 698	179291	1 024	0	2 105
2005	47 256	16 240	78 272	21 427	14610	28 245	33 785	24 796	42 774	26 361	1 151	51 571	12 370	665	24 074

Table 1.4 (cont.). New abundance indices (in millions) with 95% confidence limits, without correction for catching efficiency. Note that all values have been revised since last year.

Year	Saithe			Gr halibut			Long rough dab			Polar cod (east)			Polar cod (west)		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	3	0	5	57	17	97	1 183	869	1 497	0	0	0	14 767	0	35 894
1981	0	0	0	69	42	95	517	253	780	302	140	464	5 398	2 108	8 689
1982	137	0	364	40	11	70	861	577	1 146	0	0	1	308	0	680
1983	244	83	404	39	20	57	433	263	603	1 406	0	3 256	6 180	0	13 218
1984	760	221	1 299	31	18	45	45	31	59	123	0	313	3 236	788	5 684
1985	14	0	28	45	28	63	282	120	445	20 346	5 399	35 292	839	0	1 692
1986	1	0	2	115	62	167	7 218	5 149	9 288	8 490	2 873	14 107	2 113	129	4 096
1987	1	0	1	37	24	50	837	436	1 238	7 791	0	18 096	77	33	122
1988	17	4	29	8	3	13	198	111	285	403	8	798	4 722	0	10 104
1989	1	0	3	2	1	3	175	95	254	228	0	489	17 293	2 350	32 236
1990	10	1	20	3	0	5	54	25	83	384	97	671	32 403	0	72 485
1991	4	2	5	3	0	7	83	49	118	62 589	28 607	96 572	40 526	0	116 372
1992	162	88	237	9	0	18	130	20	239	7 153	0	14 371	10 083	1 542	18 624
1993	372	0	927	4	2	7	51	22	80	13 235	3 458	23 012	8 380	1 385	15 376
1994	3	0	5	39	0	93	1 823	1 155	2 490	189 989	100 120	279 857	5 485	0	12 090
1995	172	75	269	19	5	32	261	43	478	0	0	0	28	2	53
1996	146	63	228	6	3	9	43	2	84	74 321	46 479	102 162	4 925	0	12 253
1997	81	38	124	5	3	7	97	44	150	32 700	17 919	47 481	7 711	623	14 799
1998	78	33	123	8	3	12	27	13	42	12 442	7 336	17 549	10 307	0	23 356
1999	134	66	202	16	10	23	107	1	212	131 108	83 614	178 601	3 134	502	5 766
2000	209	114	304	39	14	65	216	105	327	112 525	64 870	160 179	24 526	15 767	33 286
2001	21	0	46	52	11	93	78	0	165	0	0	0	16 492	0	36 246
2002	322	186	457	61	0	142	755	352	1 158	97 154	57 155	137 153	30 117	5 580	54 654
2003	348	0	824	14	0	30	122	66	178	10 821	5 700	15 943	2 739	197	5 281
2004	1 426	859	1 993	81	23	140	37	19	55	33 277	14 843	51 710	317	88	546
2005	54	36	73	9	4	13	189	95	283	5 823	2 526	9 119	3 367	1 269	5 464

Table 1.5. The North-east arctic cod stock's consumption of various prey species in 1984-2005 (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	719	798	240	130	562	3	32	8	10	225	0	0	2728
1990	1450	138	84	195	1610	7	6	19	16	243	0	88	3856
1991	1078	65	75	188	2915	8	12	26	20	313	7	10	4719
1992	1016	102	158	373	2461	332	97	55	106	189	20	2	4911
1993	782	253	715	315	3019	162	278	285	71	100	2	2	5983
1994	670	563	704	518	1087	147	582	225	49	79	0	1	4624
1995	852	982	515	361	626	114	254	392	115	192	1	0	4404
1996	639	631	1156	340	537	47	104	535	68	96	0	10	4162
1997	427	380	516	308	897	5	113	338	41	34	0	55	3114
1998	430	363	457	325	717	87	151	156	33	9	0	13	2741
1999	389	147	274	252	1732	129	223	62	26	16	1	31	3281
2000	408	167	460	452	1736	54	194	76	51	8	0	38	3646
2001	712	168	356	274	1722	71	249	66	49	6	1	151	3826
2002	371	93	256	224	1885	82	266	103	123	1	0	226	3630
2003	574	267	504	223	2036	196	259	111	163	3	0	73	4410
2004	731	571	323	226	1227	193	349	118	192	2	12	70	4014
2005	718	256	464	229	986	128	487	67	210	4	1	98	3646

Table 1.6. The North-east arctic COD stock's consumption of various prey species in 1984-2005 (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	608	31	93	351	592	33	17	13	50	195	0	5	1987
1985	755	432	30	202	990	24	0	98	34	97	0	18	2679
1986	576	833	55	141	786	46	154	28	103	155	1	4	2880
1987	475	506	69	200	161	8	105	27	2	117	0	10	1679
1988	500	168	209	118	292	19	0	20	92	127	0	0	1544
1989	505	290	167	104	679	4	34	34	2	158	0	0	1977
1990	361	30	101	270	1254	64	8	21	16	232	0	39	2396
1991	342	83	54	286	3285	28	44	52	22	144	5	7	4352
1992	832	38	213	263	2019	374	190	84	38	121	1	0	4172
1993	607	175	186	221	2767	176	170	145	152	41	5	4	4649
1994	475	287	351	445	1265	102	462	362	69	55	0	1	3873
1995	536	433	374	519	656	186	182	522	125	110	3	0	3645
1996	701	346	936	190	455	74	72	435	57	69	0	8	3344
1997	532	85	386	207	492	49	108	409	33	37	2	3	2342
1998	300	189	660	246	821	67	121	125	21	15	0	23	2587
1999	177	77	479	247	1427	77	168	47	14	13	1	25	2751
2000	253	113	418	384	1733	50	162	57	29	4	0	27	3230
2001	407	75	366	314	1518	93	151	60	52	4	3	147	3189
2002	244	47	276	196	2377	51	310	93	83	3	0	114	3794
2003	461	164	243	218	1263	157	239	152	331	2	0	33	3262
2004	471	413	297	237	947	149	357	80	180	7	16	69	3320
2005	538	181	406	159	879	128	316	82	219	9	0	64	2835

Table 1.7 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	10	11+
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	2.071	3.698	4.954	5.839	8.572	9.516	10.538	10.801	11.399
1991	0.293	0.974	2.185	3.564	5.346	7.111	9.531	10.303	11.364	12.417	12.059
1992	0.216	0.663	2.103	3.137	4.143	5.094	7.896	9.069	9.440	10.166	10.212
1993	0.112	0.528	1.547	3.046	4.811	6.289	9.423	11.286	11.813	12.303	11.959
1994	0.130	0.408	0.922	2.521	3.512	4.541	6.411	8.923	9.731	10.038	10.238
1995	0.103	0.296	0.921	1.821	3.363	5.271	7.735	10.458	12.411	12.816	13.264
1996	0.108	0.356	0.929	1.848	3.071	4.437	7.426	11.254	15.010	15.190	15.588
1997	0.138	0.310	0.937	1.769	2.694	3.537	5.242	8.223	12.756	13.667	13.269
1998	0.117	0.398	0.984	1.943	2.924	4.190	5.749	8.079	11.574	12.099	12.154
1999	0.163	0.505	1.093	2.718	3.720	5.446	6.970	9.189	11.031	12.036	12.137
2000	0.170	0.499	1.244	2.462	4.254	5.656	7.980	9.429	12.750	13.539	13.577
2001	0.171	0.455	1.309	2.440	3.685	5.304	7.555	11.328	13.731	14.444	14.759
2002	0.199	0.551	1.167	2.440	3.381	4.723	6.367	9.082	10.449	11.794	11.144
2003	0.207	0.648	1.284	2.400	4.008	5.984	8.506	10.538	13.055	13.869	14.575
2004	0.200	0.626	1.266	2.442	3.936	5.750	7.682	11.384	15.945	17.058	17.463
2005	0.186	0.591	1.464	2.751	4.029	5.695	7.359	9.213	13.423	13.879	14.438

Table 1.8 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	12	13+
1984	0.262	0.893	1.612	2.748	3.848	5.486	6.99	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	12.5	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	16.511
1989	0.282	0.91	1.468	2.207	3.244	4.799	6.581	8.725	11.134	15.799	15.95	17.909	17.643
1990	0.288	1.007	1.696	2.694	3.278	3.833	5.584	6.871	10.716	11.428	12.66	15.053	16.064
1991	0.241	0.936	2.67	4.473	6.038	7.846	9.59	11.542	14.97	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	11.6	14.067	14.893	15.922
1994	0.18	0.512	1.212	2.402	3.517	5.359	7.56	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	18.29
1996	0.17	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	7.98	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	13.57	14.54	15.762
1999	0.261	0.431	1.128	2.49	3.676	5.222	6.398	8.22	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	18.77	20.33
2001	0.15	0.413	1.163	2.109	3.43	5.569	6.834	10.218	12.454	15.062	16.767	17.473	19.788
2002	0.252	0.677	1.302	2.698	3.847	5.591	7.846	10.797	13.238	18.788	16.761	18.424	19.578
2003	0.233	0.623	1.322	2.141	3.622	4.918	7.008	9.249	13.794	17.936	18.878	17.929	19.056
2004	0.233	0.62	1.28	2.453	3.679	5.363	7.571	10.506	14.032	20.109	21.127	20.086	21.342
2005	0.236	0.594	1.412	2.59	3.753	4.944	6.761	9.074	13.237	16.457	17.559	18.952	20.037

Table 1.9. Capelin stock history from 1973 and prognosis for capelin biomass in 2006. 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)	MATURING BIOMASS IN 1000 TONNES (OCT. 1)	M OUTPUT BIOMASS (MOB) DURING YEAR (1000 TONNES)
1973	961	5144	1350	5504
1974	1029	5733	907	4542
1975	921	7806	2916	4669
1976	696	6417	3200	5633
1977	681	4796	2676	4174
1978	561	4247	1402	3782
1979	464	4162	1227	5723
1980	654	6715	3913	5708
1981	660	3895	1551	5658
1982	735	3779	1591	3729
1983	754	4230	1329	3884
1984	393	2964	1208	3051
1985	109	860	285	1975
1986	14	120	65	681
1987	39	101	17	200
1988	50	428	200	80
1989	209	864	175	537
1990	894	5831	2617	415
1991	1016	7287	2248	3307
1992	678	5150	2228	7745
1993	75	796	330	4631
1994	28	200	94	982
1995	17	193	118	163
1996	96	503	248	261
1997	140	911	312	828
1998	263	2056	931	915
1999	285	2776	1718	2070
2000	595	4273	2099	2464
2001	364	3630	2019	3906
2002	201	2210	1290	2939
2003	104	533	280	2306
2004	82	628	293	490
2005	42	324	174	305
2006*		663	131	

*** Estimates, includes the 2004 year class, which size is estimated from a regression on an 0-group index**

Table 1.10. 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
2004	1.7	0.6
2005	0.7	0.3
2006	0.5	

Table 1.11. Diet composition of main fish species in 2005, % by weight (Data from Dolgov, WD 28 and WD 29)

PREY SPECIES	PREDATORS SPECIES						
	Cod (3+)	haddock	Greenland halibut	Thorny skate	Long rough dab	Saithe	Blue whiting
Euphausiidae	5,2	21,7	0,4	0,8	0,1	24,4	44,4
Hyperiidae	4,1	0,2	3,8	0	0	0,3	18,2
Cephalopoda	0	0	2,1	0	0	0	0
Pandalus borealis	4,6	1,2	1,4	15,8	1,4	0,2	1,4
Echinodermata	0	24,1	0	0	4,7	0	0
Mollusca	0	7,9	0	0	3,6	0	0
Polychaeta	0	9,2	0	4,2	2,9	0	0
Cod	4,5	0,4	0,2	0	0,5	0,3	1,7
Herring	8,9	0,2	1,3	0,5	0,6	3,0	0
Capelin	11,6	2,1	8,7	30,8	17,5	54,9	0,9
Haddock	10,7	0,2	6,6	0,6	10,1	8,0	0
Polar cod	10,4	0	16,5	0	11,6	0,2	4,7
Blue whiting	4,8	0	2,6	0	0	0	0
Greenland halibut	0,2	0	1,4	0	0	0	0
Redfish	0,4	0	0,1	0	0	0	0
Long rough dab	1,8	0,1	4,8	2,9	0	0	0
Other fish	23,6	3,7	31,9	31,6	7,8	7,0	25,5
Other food	8,9	22,4	0,3	7,9	7,2	0	2,6
Fishery waste	0	4,1	17,7	4,9	31,4	0,9	0
Undetermined	0	2,4	0,2	1,4	0,7	0,5	0,3
Total number of stomachs	12209	7078	5223	432	2221	776	575
Percentage of empty stomachs	28,9	21,1	71,5	23,8	54,4	34,1	33,4
Average filling degree	1,7	1,6	0,7	1,9	1,1	1,6	1,7
Mean index of stomach fullness	213,8	110,5	84,4	182,7	139,0	116,3	111,2

Table 1.12. Annual 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 1.13. Overview of the standard sections monitored by IMR and PINRO in the Barents Sea, with observed paramters. Parameters are: T-temperature, S-Salinity, N-nutrients, chla-chlorophyll, zoo-zooplankton.

SECTION	INSTITUTION	TIME PERIOD	OBSERVATION FREQUENCY	PARAMETERS
Fugløya-Bear Island	IMR	1977-present	6 times pr year	T,S,N,chla,zoo
North cape-Bear Island	PINRO	1950's-present	yearly	T,S
Bear Island-East	PINRO	1950's-present	yearly	T,S
Vardø-North	IMR	1977-present	4 times pr year	T,S,N,chla
Kola	PINRO	1921-present	monthly	T,S,O,N
Kanin	PINRO	1950's-present	yearly	T,S
Sem Islands	IMR	1970's-present	Intermittently*	T,S

*** The Sem Island section is not observed each year, and have not been observed the last 3-4 years.**

Table 1.14. Overview of conducted monitoring surveys by IMR and PINRO in the Barents Sea, with observed parameters and species. For zooplankton, mammals and benthos abundance and distribution for many species are investigated. Therefore, in the table it is only indicated whether sampling is conducted. Parameters are: T-temperature, S-Salinity, N-nutrients, chla-chlorophyll.

SURVEY	INTSITUTION	PERIOD	CLIMATE	PHYTO-PLANKTON	ZOO-PLANKTON	JUVENILE FISH	TARGET FISH STOCKS	MAMMALS	BENTHOS
Winter	Joint	Feb-Mar	T,S	N, chla	intermittent	All commercial species and some additional	Cod, Haddock	-	-
Lofoten	IMR	Mar-Apr	T,S	-	-		Cod, haddock, saithe	-	-
Ecosystem survey	Joint	Aug-Oct	T,S	N,chla	Yes	All commercial species and some additional	All commercial species and some additional	Yes	Yes
Norwegian coastal surveys	IMR	Oct-Nov	T,S	N,chla	Yes	Herring, sprat, demersial species	Saithe, coastal cod	-	-
Autumn-winter trawl-acoustic survey	PINRO	Oct-Des	T,S	-	Yes	Demersial species	Demersial species	-	-
Norwegian Greenland halibut survey	IMR	Aug	-	-	-	-	Greenland halibut, redfish	-	-

Table 1.15. Description of the fisheries by gears. The gears are abbreviated as: trawl roundfish (TR), trawl shrimp (TS), longline (LL), gillnet (GN), handline (HL), purse seine (PS), Danish seine (DS) and trawl pelagic (TP). The regulations are abbreviated as: Quota (Q), mesh size (MS), sorting grid (SG), minimum catching size (MCS), minimum landing size (MLS), maximum by-catch of undersized fish (MBU), maximum by-catch of non-target species (MBN), maximum as by-catch (MB), closure of areas (C), restrictions in season (RS), restrictions in area (RA), restriction in gear (RG), maximum by-catch per haul (MBH), as by-catch by maximum per boat at landing (MBL), number of effective fishing days (ED), number of vessels (EF), restriction in effort combined with quota and tonnage of the vessel (ER).

Species	Directed fishery by gear	Type of fishery	Landings in 2005 (tonnes)	As by-catch in fleet(s)	Location	Agreements and regulations
Capelin	PS, TP	seasonal	1[1]	TR, TS	Northern coastal areas to south of 74°N	bilateral agreement, Norway and Russia
Coastal cod	GN, LL, HL, DS	all year	30936	TS, PS, DS, TP	Norwegian coast line	Q, MS, MCS, MBU, MBN, C, RS, RA
Cod	TR, GN, LL, HL	all year	641276	TS, PS, TP, DS	North of 62°N, Barents Sea, Svalbard	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Wolffish[2]	LL	all year	21081[3]	TR, (GN), (HL)	North of 62°N, Barents Sea, Svalbard	Q, MB
Haddock	TR, GN, LL, HL	all year	154116	TS, PS, TP, DS	North of 62°N, Barents Sea, Svalbard	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Saithe	PS, TR, GN	seasonal	176129	TS, LL, HL, DS, TP	Coastal areas north of 62°N, southern Barents Sea	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Greenland halibut[4]	LL, GN	Seasonal	19248	TR	deep shelf and at the continental slope	Q, MS, RS, RG, MBH, MBL
Sebastes mentella	No directed fishery	all year	7511	TR	deep shelf and at the continental slope	C, SG, MB
Sebastes marinus	GN, LL,HL	all year	7557	TR	Norwegian coast	SG, MB MCS, MBU, C
Shrimp	TS	all year	43590[3]		Spitsbergen, Barents Sea, Coastal	ED, EF, SG, C, MCS

[1]On a research quota

[2]The directed fishery for wolffish is mainly Russian EEZ and in ICES area IIB, and the regulations are mainly restricted to this fishery

[3]The total catch in 2004

[4]The only directed fishery for Greenland halibut is by a limited Norwegian fleet, comprising vessels less than 28 m.

Table 1.16. Flexibility in coupling between the fisheries. Fleets and impact on the other species (H, high, M, medium, L, low and 0, nothing). The lower diagonal indicates what gears couples the species, and the strength of the coupling is given in the upper diagonal. The gears are abbreviated as: trawl roundfish (TR), trawl shrimp (TS), longline (LL), gillnet (GN), handline (HL), purse seine (PS), Danish seine (DS) and trawl pelagic (TP).

Species	Cod	Coastal cod	Haddock	Saithe	Wolffish	S. mentella	S. marinus	Greenland halibut	Capelin	Shrimp
Cod		H	H	H	M	M	M	M	L	M-H juvenile cod
Coastal cod	TR, PS, GN, LL, HL, DS		H	H	L	L	M-L	L	0-L	L
Haddock	TR, PS, GN, LL, HL, DS	TR, PS, GN,LL, HL, DS		H	M	M	M	L	0-L	M-H juvenile haddock
Saithe	TR, PS, GN, LL, HL, DS	TR, PS, GN,LL, HL, DS	TR, PS, GN, LL, HL, DS		L	L	M	0	0	0
Wolffish	TR, GN, LL, HL	TR,GN, LL, HL	TR, GN, LL, HL	TR, GN, LL, HL		M	M	M	0	M juvenile wolffish
S. mentella	TR	TR	TR	TR	TR		M	H	H juvenile Sebastes	H juvenile Sebastes
S. marinus	TR,GN, LL	TR,GN, LL	TR,GN, LL	TR,GN	TR, LL	TR		L	0	L-M juvenile Sebastes
Greenland halibut	TR, GN, LL,DS	TR,GN, LL	TR, GN, LL,DS	TR, GN, LL,DS	TR, LL	TR	TR		0	M-H juvenile
Capelin	TR, PS, TS, TP	PS, TP	TR, PS, TS, TP	PS	TP	TP	TP	None		L
Shrimp	TS	TS	TS	TS	TS	TS	TS	TS	TS	

Table 1.17. Overview of available recruitment models prognoses (section 1.5.3) together with the 2006 assessment estimates (Section 3.5.2, 3.10.4). Note that the given month in the fifth column indicates when the prognoses can be extended for another year.

MODEL	SPECIES	VARIABLE	# PROGNOSTIC YEARS	PROGNOSES AVAILABLE	2006 PROGNOSES	2007 PROGNOSES	2008 PROGNOSES	UNIT
Titov (WD 16, AFWG 2005)	Barents Sea capelin	Recruits (age 1)	1	At assessment	0 **	24 **		$*10^9$
Titov (WD 16, AFWG 2005)	NEA cod	Recruits (age 3)	4	At assessment	538 **	839 **	800 **	$*10^6$
Bulgakova (WD20, AFWG 2005)	NEA cod	Recruits (age 3)	3	Before assessment	703 *	532 *		$*10^6$
Stiansen et al., WD15	NEA cod	Recruits (age 3)	2 (3 [1])	November (March [1])	**478**	**578**	**565** [1]	$*10^6$
Stiansen et al., WD15	NEA cod	Recruits (age 3)	1 (2 [1])	November (March [1])	**416**	**434** [1]		$*10^6$
Stiansen et al., WD15	NEA cod	Recruits (age 3)	0 (1 [1])	November (March [1])	**440** [1]			$*10^6$
Gadget Assessment 2006	NEA cod	Recruits (age 3)	1	At assessment	224			$*10^6$
RCT3 Assessment 2006	NEA cod	Recruits (age 3)	3	At assessment	431	533	546	$*10^6$
RCT3 Assessment 2005	NEA cod	Recruits (age 3)	3	At assessment	478	574		$*10^6$

[1] Based on prognosis estimate of capelin maturing biomass for October 1 2005 of 272 000 tonnes, thereby allowing for an additional year.

*** Numbers were calculated before the 2005 assessment (ICES, 2005), and have not been updated for in the 2006 assessment.**

**** Numbers have been updated for in the 2006 assessment**

Table 1.18 Prognoses of mean weight at age of NEA cod at the 2004 – 2007 by the STOCOBAR model, together with the observations in 2003-2005.

AGE	2003	2004		2005		2006	2007
	Observed	Observed	Model	Observed	Model	Model	Model
2	0.074	0.055	0.064	0.056	0.067	0.064	0.059
3	0.230	0.240	0.242	0.230	0.251	0.246	0.221
4	0.537	0.480	0.560	0.624	0.630	0.614	0.562
5	1.310	1.112	1.111	1.121	1.241	1.276	1.171
6	2.009	2.054	2.145	1.933	1.840	1.975	2.017
7	3.241	2.972	2.997	3.047	3.127	2.843	2.971
8	4.971	4.567	4.686	3.955	4.348	4.485	4.241
9	6.739	6.601	6.511	5.811	6.401	6.124	6.263
10	8.706	8.760	9.133	8.289	8.958	8.967	8.777

Table 1.19 Proportion of cod in the diet of cod

Cod (predator)age	1	2	3	4	5	6	7	8	9	10	11
Year											
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	0.0036	0.0036	0.0040	0.0038	0.0041
1990	0.0000	0.0000	0.0000	0.0007	0.0010	0.0010	0.0168	0.0174	0.0188	0.0188	0.0182
1991	0.0000	0.0005	0.0000	0.0003	0.0032	0.0020	0.0217	0.0224	0.0228	0.0233	0.0237
1992	0.0000	0.0021	0.0037	0.0129	0.0249	0.0477	0.0117	0.0155	0.0230	0.0230	0.0228
1993	0.0000	0.0413	0.0368	0.0515	0.0537	0.1177	0.0499	0.0801	0.0798	0.0799	0.0816
1994	0.0000	0.0038	0.0917	0.0348	0.0284	0.0771	0.1245	0.1326	0.2675	0.2697	0.2663
1995	0.0069	0.0811	0.0744	0.1101	0.0926	0.1123	0.1383	0.2510	0.2536	0.2544	0.2558
1996	0.0000	0.1492	0.2548	0.2059	0.1321	0.1265	0.1832	0.2075	0.2412	0.2423	0.2416
1997	0.0000	0.0719	0.0767	0.1139	0.1588	0.1564	0.2358	0.2273	0.2859	0.2783	0.2799
1998	0.0000	0.0135	0.0272	0.0417	0.1041	0.0985	0.1080	0.1498	0.2707	0.2707	0.2719
1999	0.0000	0.0000	0.0049	0.0137	0.0148	0.0337	0.0621	0.1121	0.1929	0.1949	0.1846
2000	0.0000	0.0000	0.0286	0.0147	0.0134	0.0266	0.0502	0.0558	0.2714	0.2695	0.2723
2001	0.0000	0.0159	0.0116	0.0082	0.0131	0.0242	0.0499	0.0370	0.3221	0.3185	0.3213
2002	0.0000	0.0380	0.0587	0.0150	0.0186	0.0285	0.0360	0.0619	0.1567	0.1539	0.1553
2003	0.0000	0.0194	0.0197	0.0199	0.0206	0.0188	0.0457	0.1032	0.2225	0.2251	0.2230
2004	0.0194	0.0212	0.0300	0.0208	0.0202	0.0269	0.0386	0.0736	0.1196	0.1200	0.1217
2005	0.0000	0.0202	0.0109	0.0209	0.0105	0.0133	0.0277	0.0359	0.1127	0.1210	0.1146
Average	0.0013	0.0219	0.0335	0.0316	0.0371	0.0523	0.0698	0.0874	0.1457	0.1458	0.1455

Table 1.20. Qualitative analysis of effects of ecosystem impact factors on some stocks in the Barents Sea for 2006.

species	Stock parameters	Ecosystem parameters: Temperature of water	Zooplankton biomass	Capelin biomass	Herring biomass	Polar cod biomass	Blue whiting biomass	Cod biomass	Harp seal abundance	Whales abundance	Total expectation
NEA Cod	Abundance at age 0+	++	++	+	− −	?	−	+ −	?	?	H
	Cannibalism	++	− −	++	− −	−	−	+	?	+	M
	Rate of growth	++	+ −	− −	++	− +	+	−	+ −	−	M
	Rate of maturation	+ −	+ −	− −	++	?	+	+ −	+ −	+ −	L
Capelin	Abundance at age 0+	+	++	− −	− −	−	−	−	?	?	L
	Natural mortality	++	− −	− −	+	−	+ −	+	+	++	H
	Rate of growth	++	+	++	−	−	−	+ −	?	+	H
	Rate of maturation	++	+	++	−	−	−	+ −	?	?	H

H – high, M – medium and L – low expectation of biological parameters.

+ positive (++ strongly positive)) influence of ecosystem parameters on biological parameters;

+ − Influence of ecosystem parameter on biological parameter without clear positive or negative effects;

− negative (-- strongly negative) influence of ecosystem parameters on biological parameters;

? knowledge are not available.

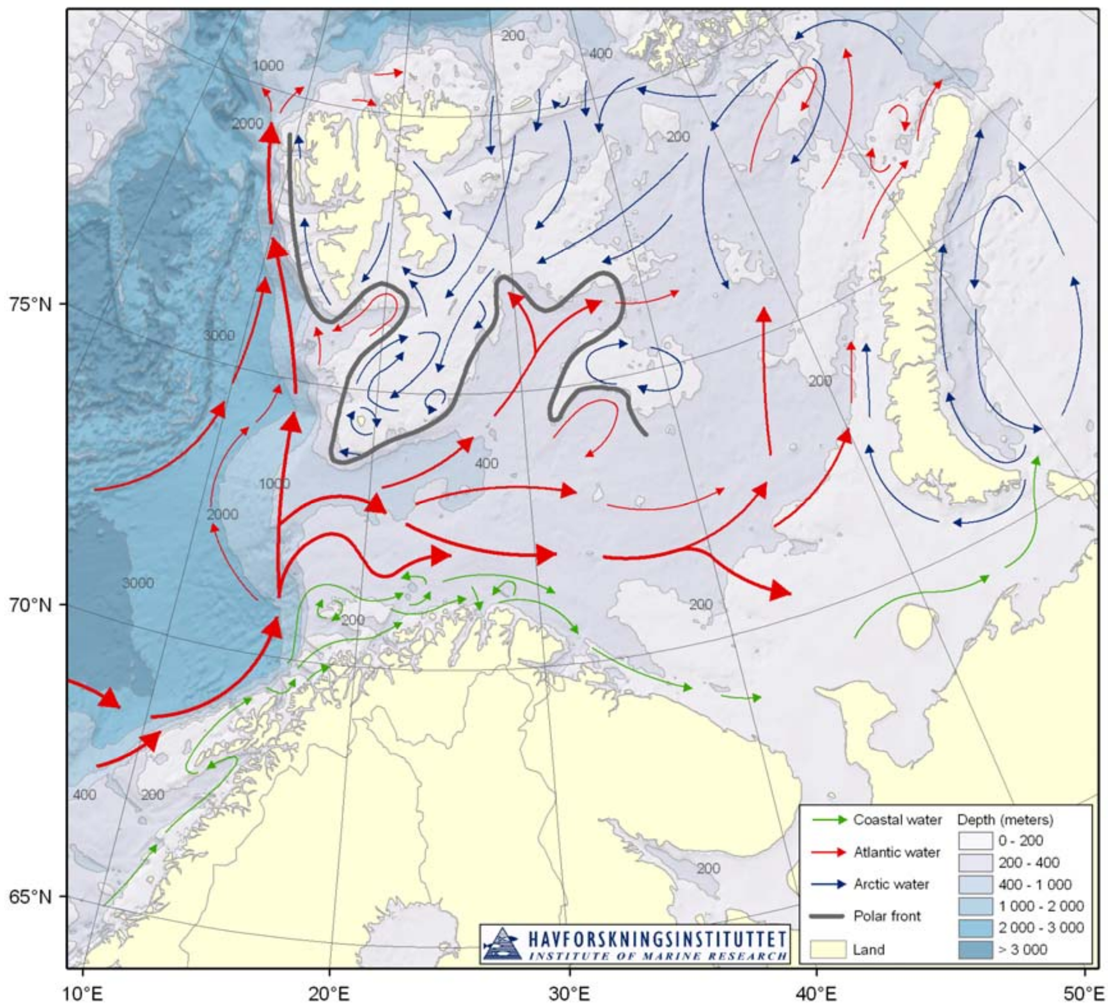


Figure 1.1. The main features of the circulation and bathymetry of the Barents Sea.

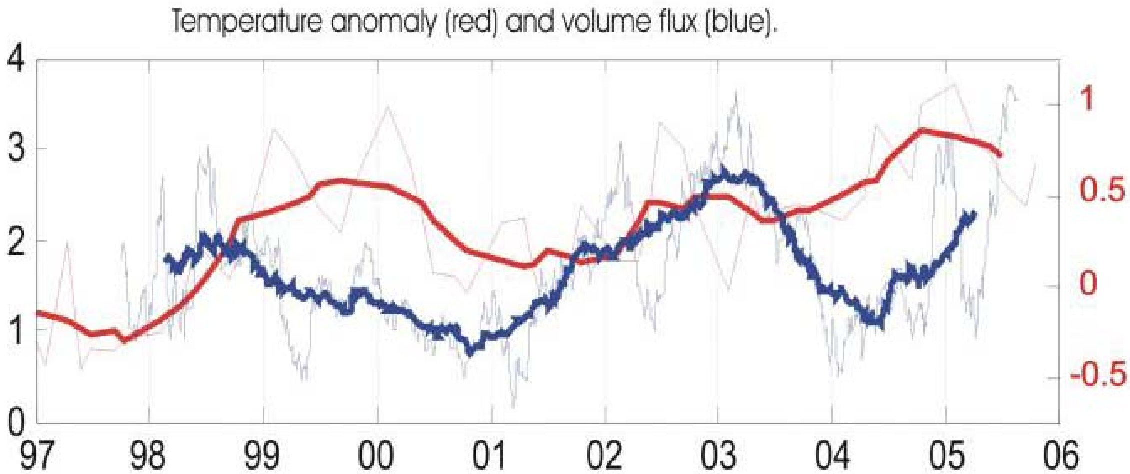


Figure 1.2. Temperature and inflow of Atlantic water at the western entrance. The blue lines show Atlantic water volume flux across the section Norway-Bear Island. Time series are 3 and 12 months running means. The red lines show temperature anomalies the section Fugløya – Bear Island section. Time series are actual values and 12 months running means.

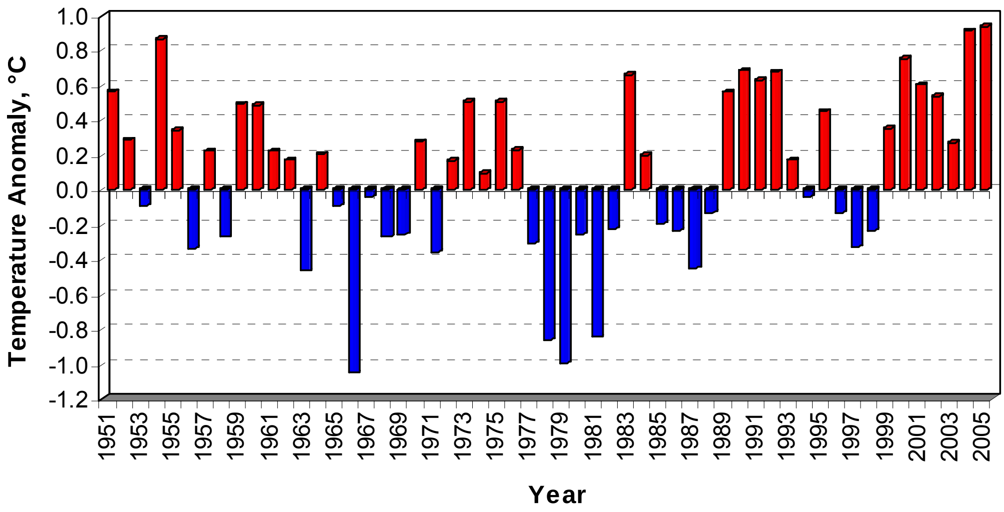


Figure 1.3. Average annual temperature anomalies in the 0-200 m layer in the Kola section.

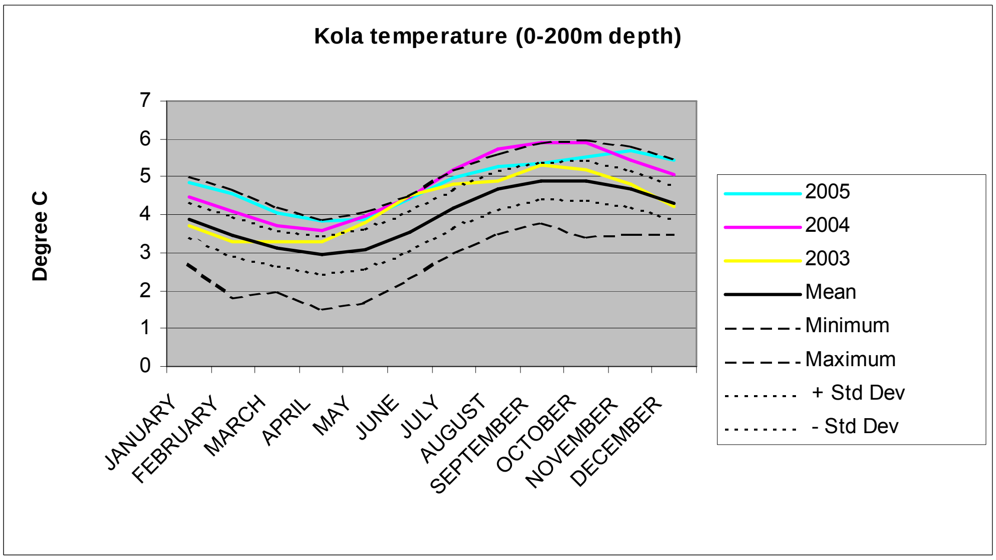


Figure 1.4. Southern Barents Sea seasonal temperature development. The figure shows the Kola section monthly temperature statistics (long-term seasonal mean, minimum, maximum and standard deviations) for the period 1921-1999, together with the values for 2003-2005, given for each calendar month for the 0-200 m depth interval.

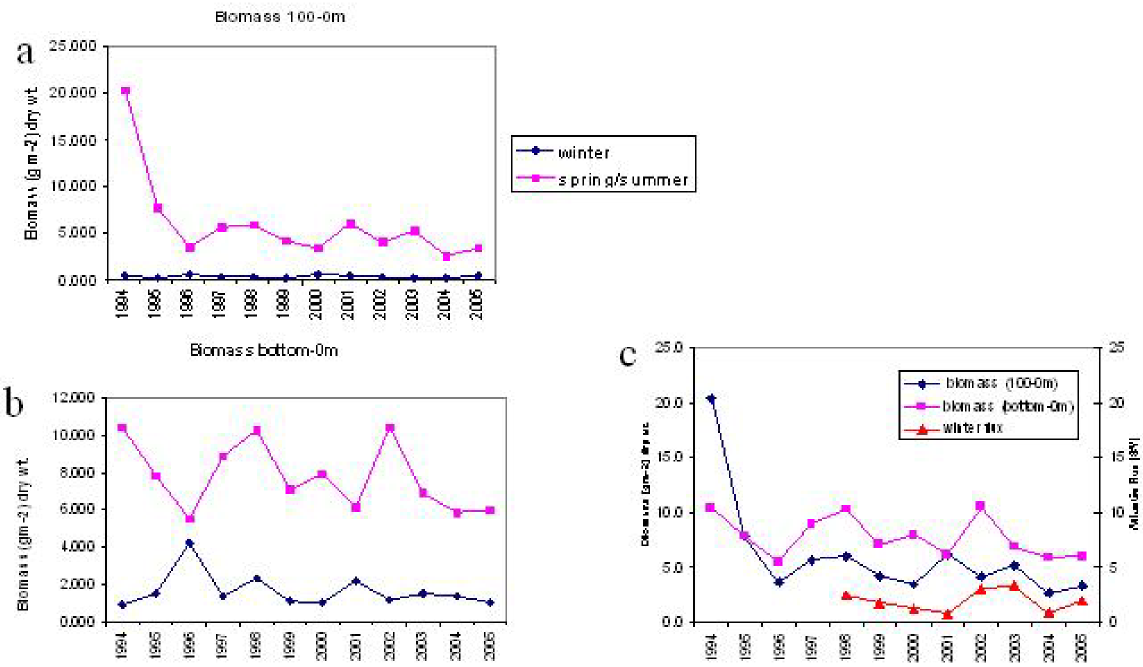


Figure 1.5. Mean annual zooplankton biomass (gm-2 dry weight) in the Fugløya-Bjørnøya transect a) 100-0m, and b) bottom-0m during winter (January-March) and spring/summer (May-August), c) Spring/summer biomass together in upper 100m with winter (January-march) Atlantic flux, from bottom-0m

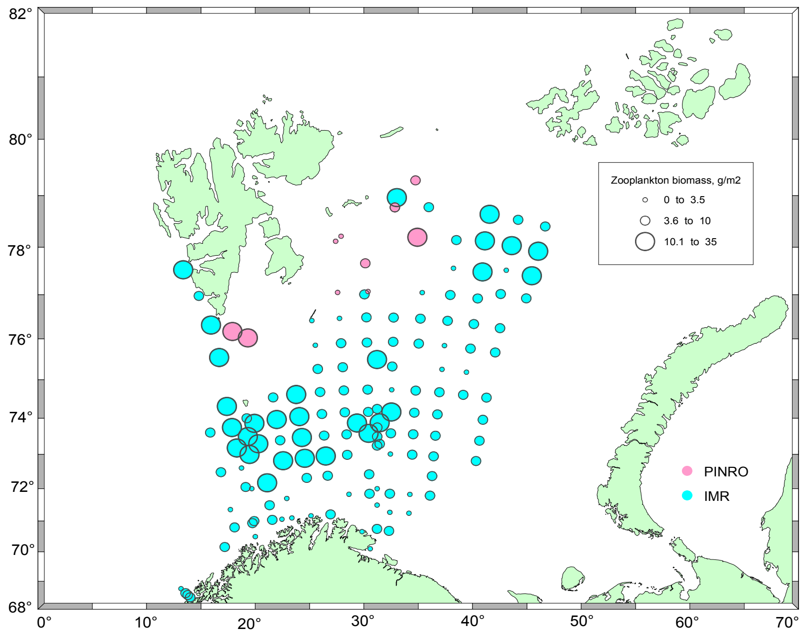
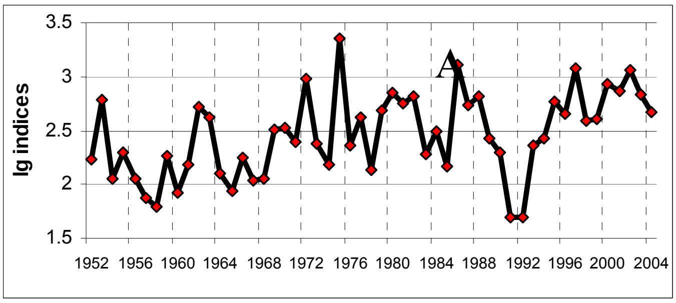


Figure 1.6. Horizontal distribution of zooplankton in 2005 (g m^{-2} of dry weight from bottom-0 m) based on WP2.



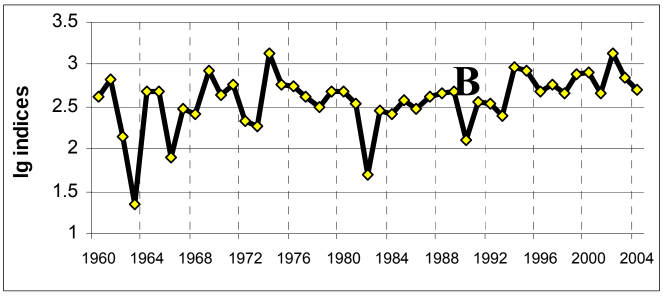


Figure 1.7. Indices of krill abundance in the southern (A) and in the northwestern part of the Barents Sea (B). More details area definitions can be found in Drobysheva *et al.* (2003).

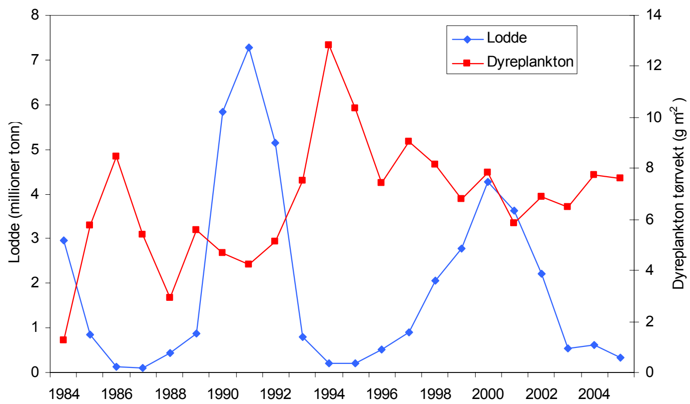


Figure 1.8. Average zooplankton biomass (dry weight, g m^{-2}, red line) together with biomass of one year old and older capelin (million tones, blue line) during 1984 – 2005, in the Barents Sea (from Dalpadado et al. 2002, updated with data for 2001-2005).

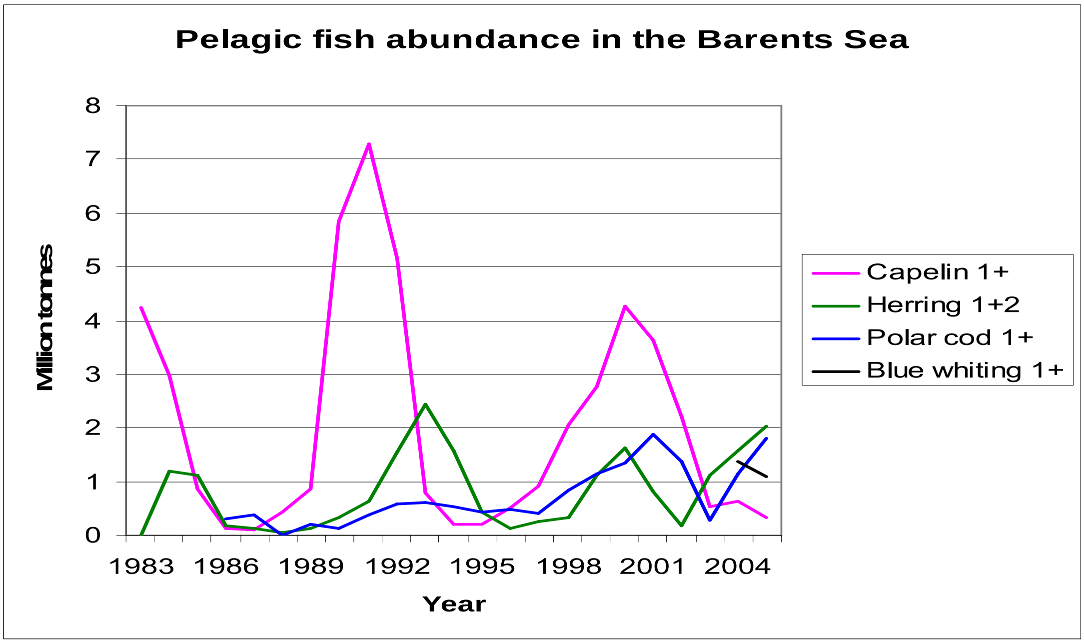


Figure 1.9. Abundance of pelagic fish species in the Barents Sea. The data are taken from; capelin: Acoustic estimates in September-October, age 1+ (ICES, 2005; Anon., 2005;, herring: VPA estimates of age 1 and 2 herring (ICES, 2006) using standard weights at age (9 g for age 1 and 20g for age 2); polar cod: Acoustic estimates in September-October, age 1+ (Anon., 2005); blue whiting: Acoustic estimates in September-October, age 1+ (Anon., 2004; Anon., 2005).

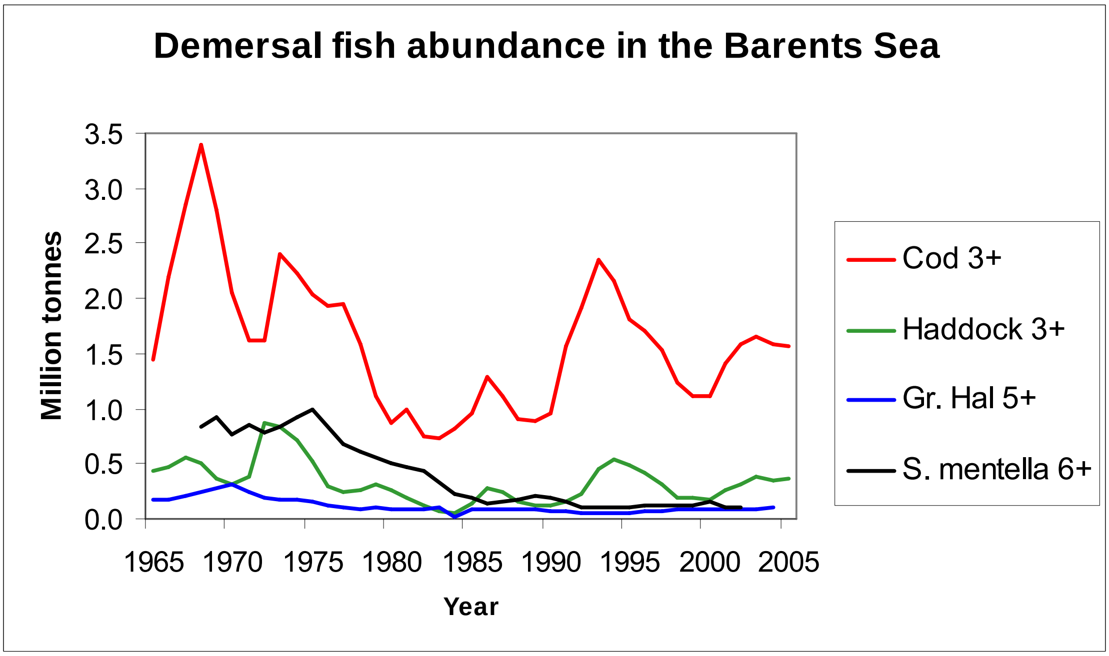
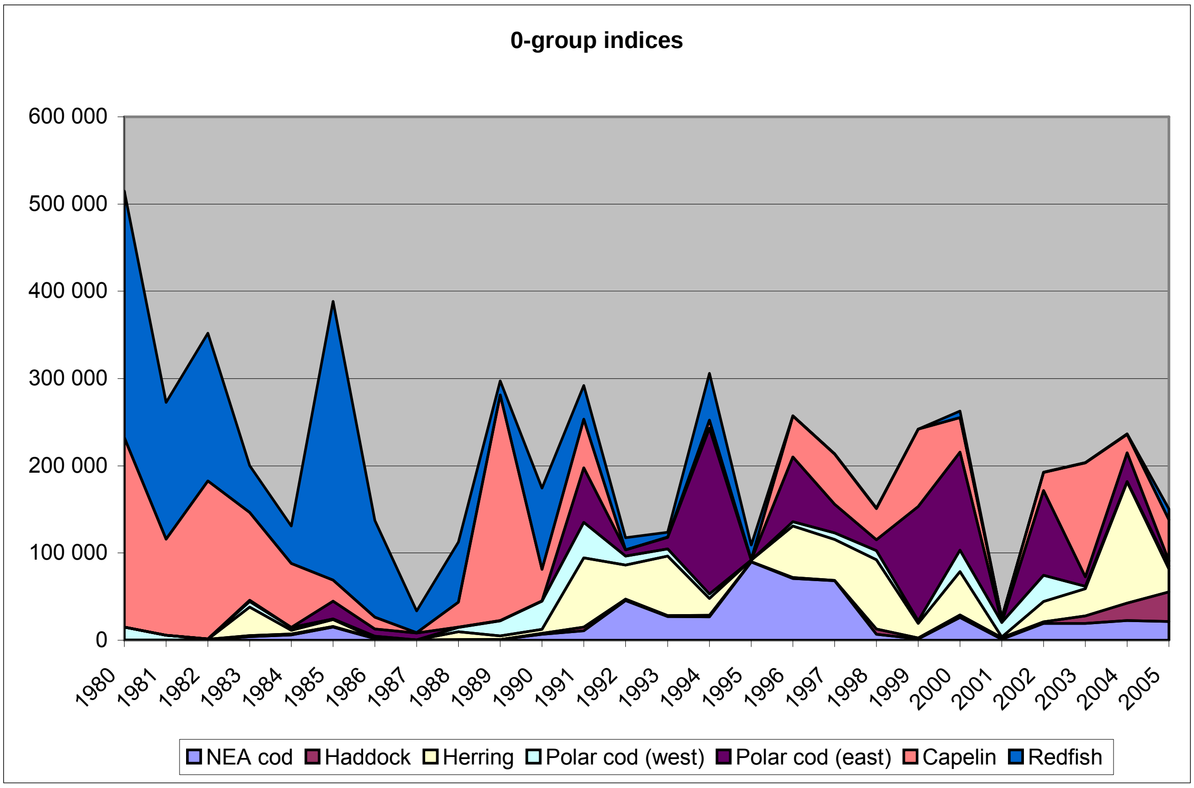


Figure 1.10. Abundance of demersal fish species in the Barents Sea. The data are taken from; cod: VPA estimates, age 3+ (ICES, 2005); haddock: VPA estimates, age 3+ (ICES, 2005); Greenland halibut: VPA estimates, age 5+ (ICES, 2005); Sebastes mentella: VPA estimates, age 6+ (ICES, 1995 for the years 1968-1990; ICES, 2003 for the years 1991-2002).



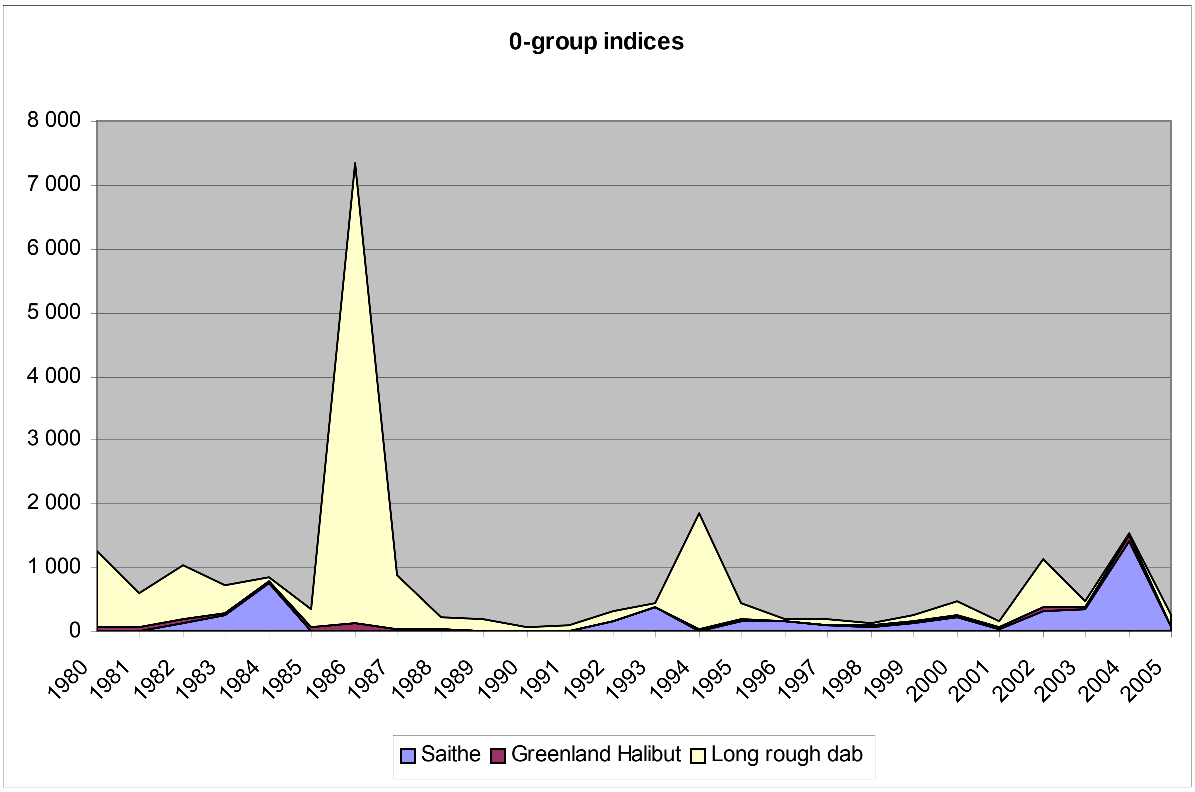


Figure 1.11. 0-group abundance indices (in millions), not corrected for catching efficiency. Please note that the vertical axes differ between the two panels.

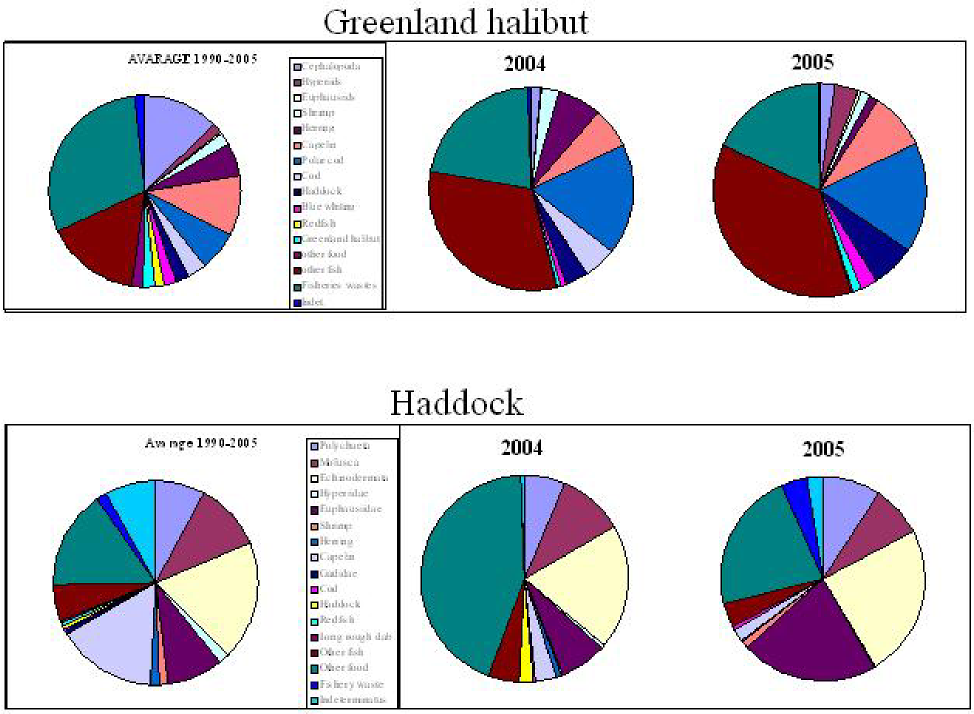


Figure 1.12. Stomach contents in Greenland halibut and Haddock from Russian data.

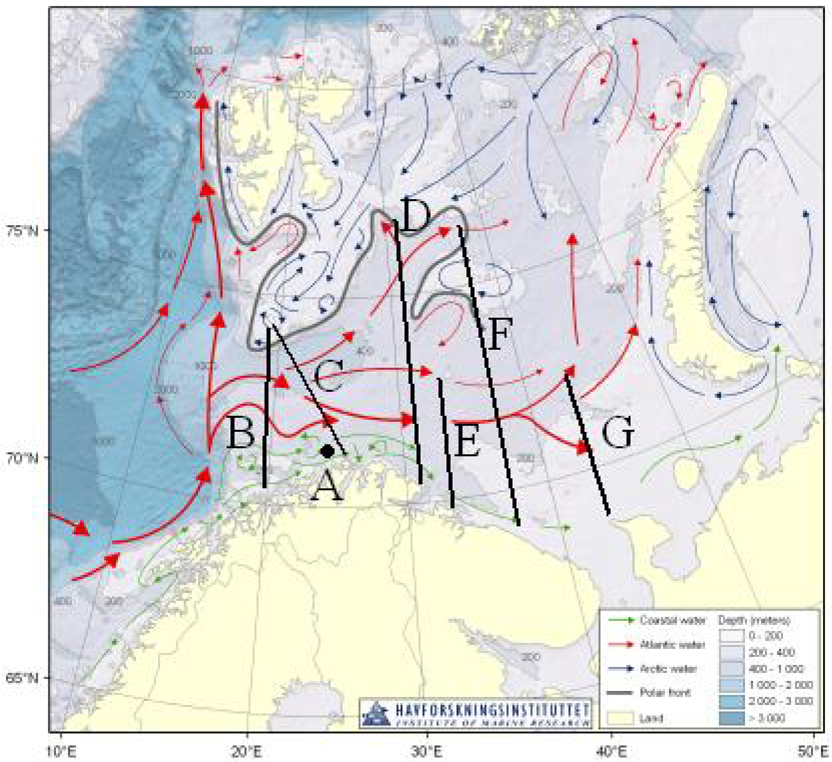


Figure 1.13. Positions of the standard sections monitored in the Barents Sea. A is fixed station Ingøy, B is Fugløya-BearIsland, C is North cape-Bear Island, D is Vardø-North, E is Kola, F is Sem Island-North and G is Kanin section.

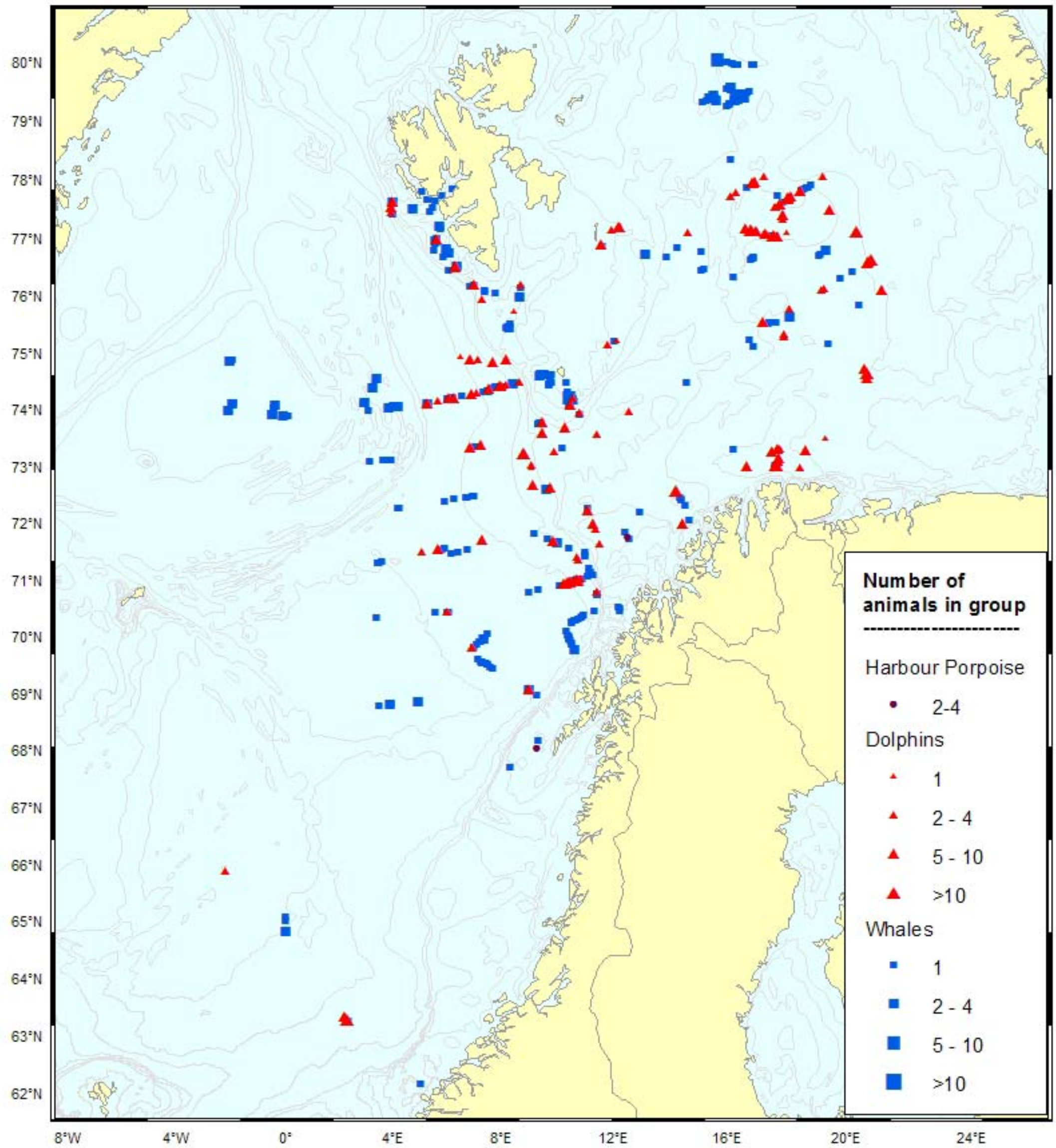


Figure1.14. Distribution of observations of marine mammals in 2005.

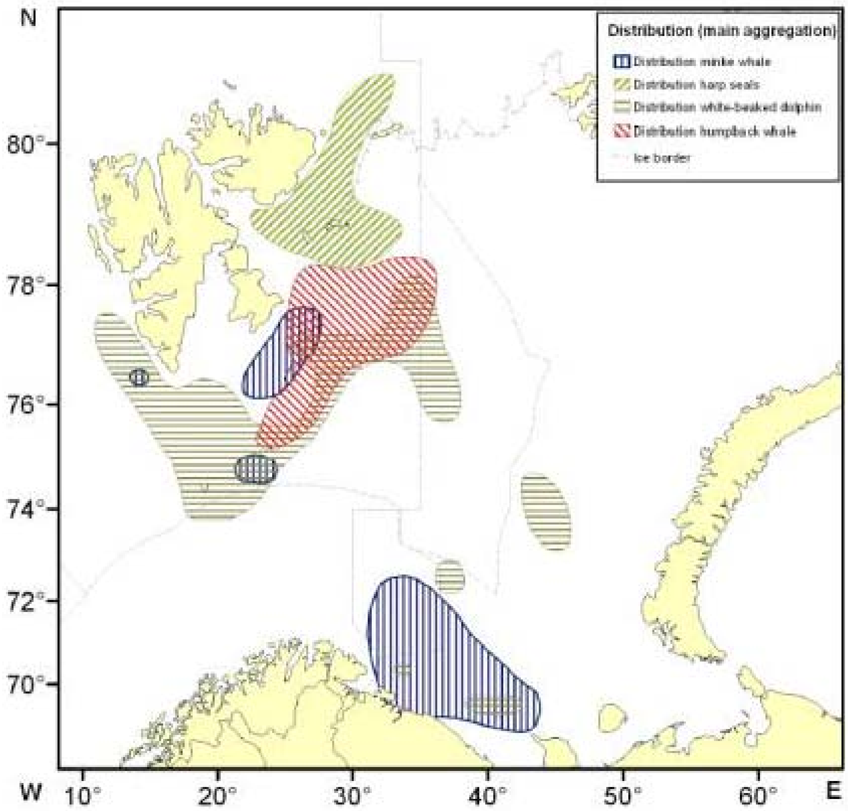


Figure 1.15. Main feeding aggregation of marine mammals in the Barents Sea in September 2005.

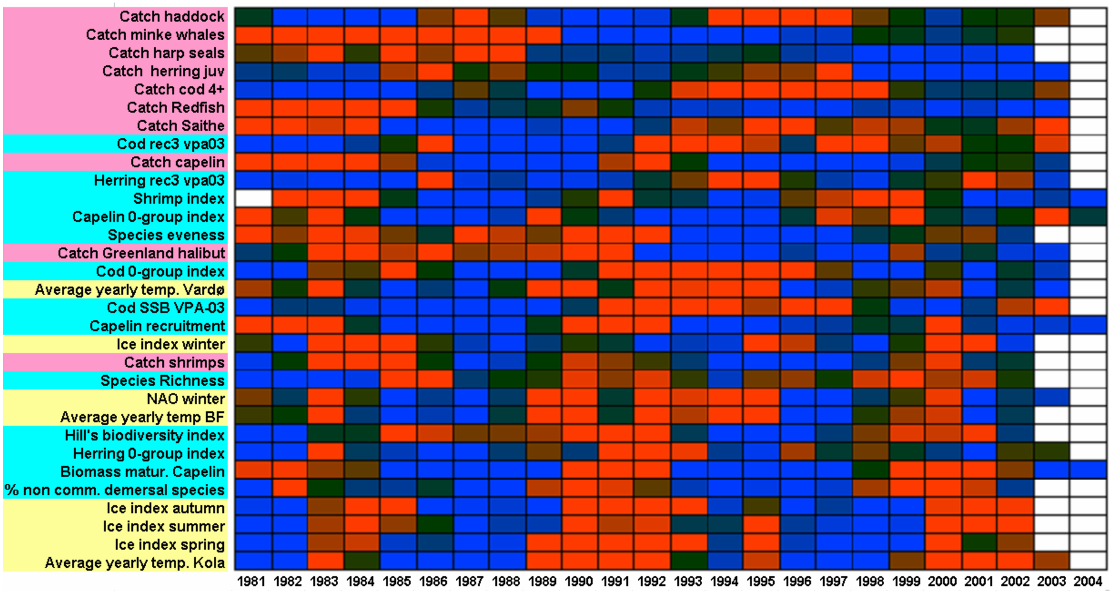


Figure 1.16. Normalized time series from the Barents Sea Ecosystem 1981 to 2004. Blue colour is negative deviation and red colour is positive deviations.

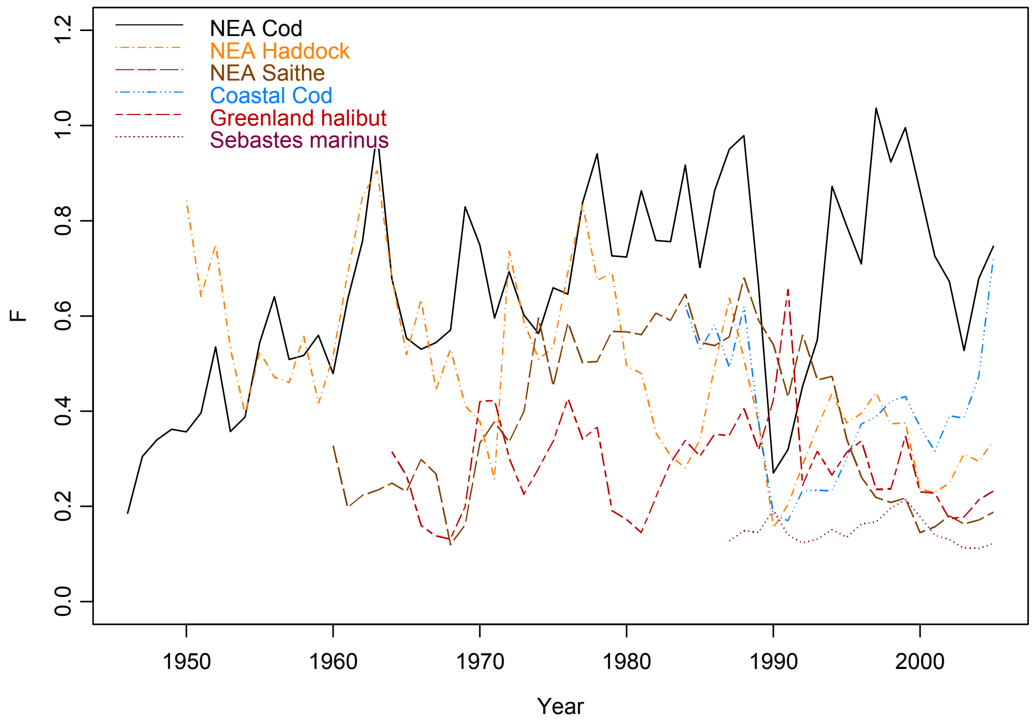


Figure 1.17. Time series of annual average fishing mortalities for Northeast Arctic cod (time period 1946-2005, average for ages 5-10), Northeast Arctic haddock (time period 1950-2005, average for ages 4-7), Northeast Arctic saithe (time period 1960-2005, average for ages 4-7), coastal cod (1984-2005, average for ages 4-7) and Greenland halibut (time period 1964-2005, average for ages 6-10) and Sebastes marinus (time period 1987-2005, average for ages 12-19).

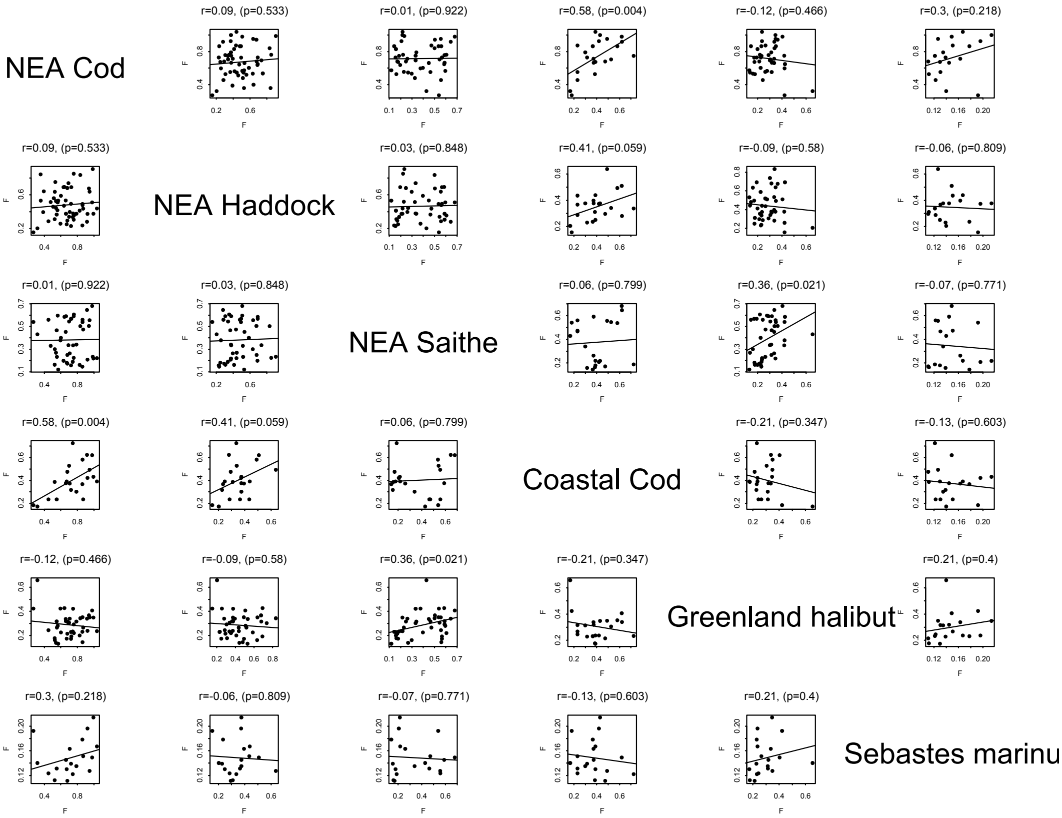


Figure 1.18. Pairwise plots of annual average fishing mortalities for overlapping time periods for Northeast Arctic cod (time period 1946-2005, average for ages 5-10), Northeast Arctic haddock (time period 1950-2005, average for ages 4-7), Northeast Arctic saithe (time period 1960-2005, average for ages 4-7), coastal cod (1984-2005, average for ages 4-7), Greenland halibut (time period 1964-2005, average for ages 6-10) and Sebastes marinus (time period 1987-2005, average for ages 12-19). The correlation and the corresponding p-value are given in the legend.

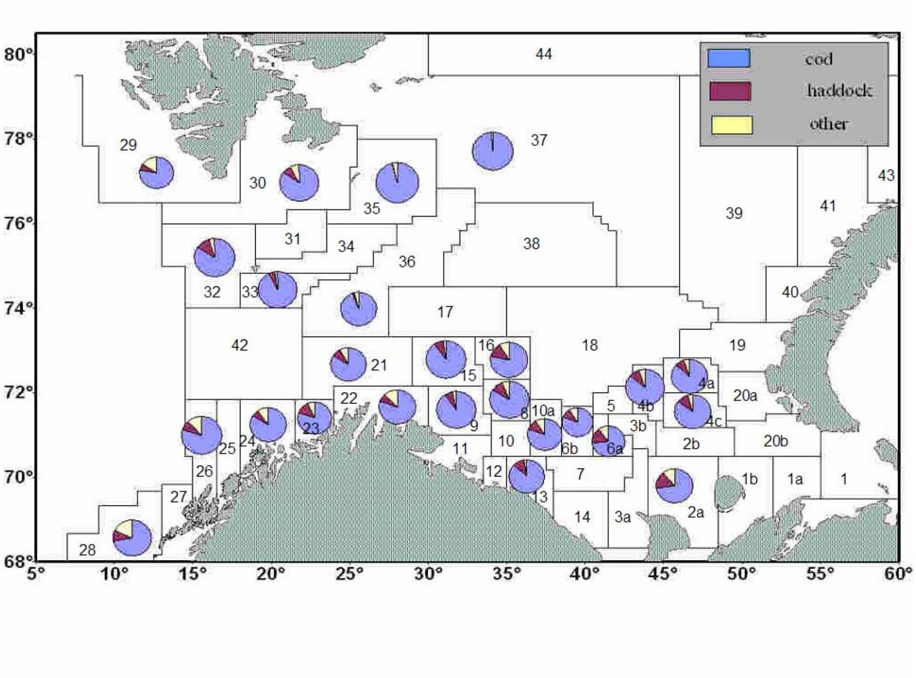


Figure 1.19. Relative distribution of composition of cod, haddock and other species taken by Russian bottom trawl in 2005 per main areas for the Russian strata system.

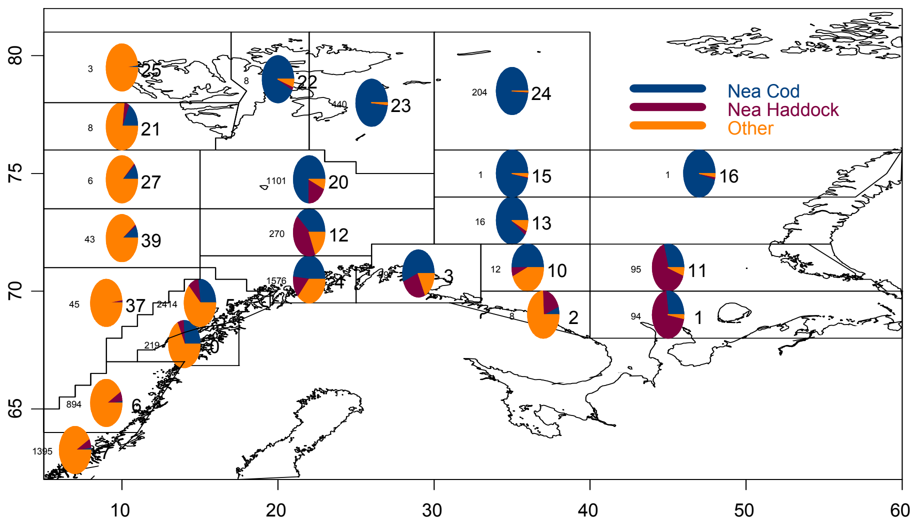


Figure 1.20. Relative distribution of composition of cod, haddock and other species taken by Norwegian bottom trawl in 2005 per main areas for the Norwegian strata system. The large numbers to the right of the pie diagrams are the name of the stratum, while the small numbers to the left is the number of vessel days recorded in the area.

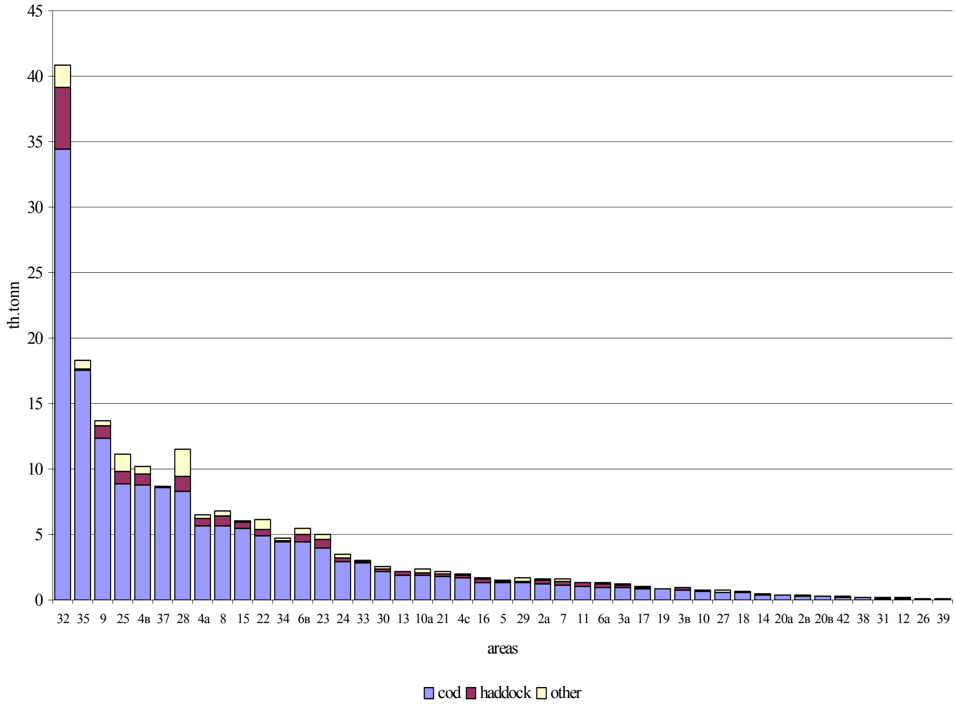


Figure 1.21. The Russian catch of cod, haddock and other species taken by bottom trawl by main statistical areas in 2005, thousand tons. The statistical areas correspond to the areas shown in Figure 1.19.

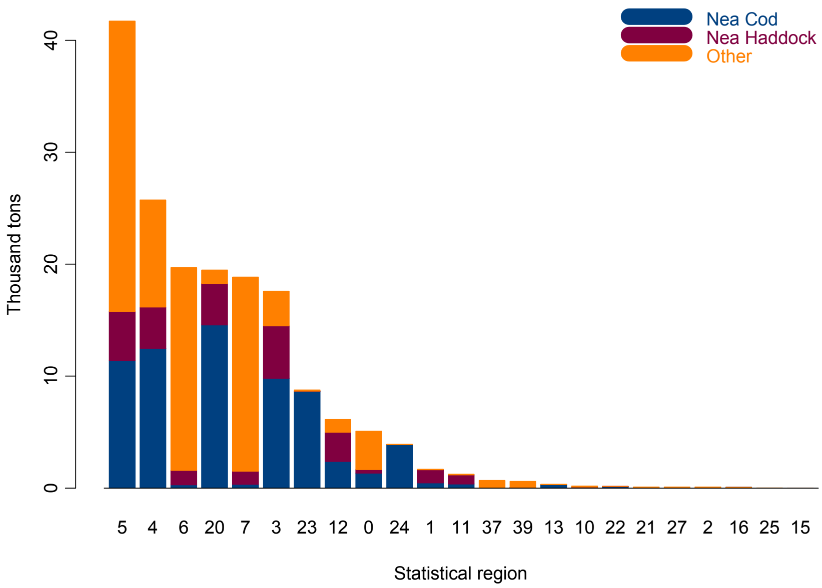


Figure 1.22. The Norwegian catch of cod, haddock and other species taken by bottom trawl by main statistical areas in 2005, thousand tons. The statistical areas correspond to the areas shown in Figure 1.20.

2 Norwegian coastal cod in sub-areas I and II

A benchmark assessment is presented for this stock. General information is located in the Quality Handbook Stock Annex.

2.1 Status of the Fisheries

2.1.1 Landings prior to 2006 (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 2004 reported to the Working Group is 32,599 t and the provisional figure for 2005 is 30,936 t (Tables 2.9, 2.19, Figure 2.2). The landings in 2005 decreased compared with 2004. However, the landings were higher than expected. The landings decreased in all areas except for the northernmost and southernmost areas where the landings increased. In the Lofoten region the availability of Northeast Arctic cod was lower than usually because most of the Northeast Arctic cod in 2005 were spawning on the coastal banks outside the Vestfjord. 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 and chapter 2.2.2). A total of 15,888 otoliths were collected from the commercial catches (Table 2.1.A) separated into quarter of catch and fishing gear. Approximately 23 % of the otoliths were classified as coastal cod.

2.1.2 Expected landings in 2006 (Figure 2.5)

The quota for Norwegian coastal cod was reduced from 40,000 t. in 2003 to 20,000 t. in 2004 and 21,000 t. in 2005 and 2006. To achieve a reduction in landings of coastal cod new technical regulations were adopted in 2004 and extended in 2005 and 2006 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). In addition, all trawl fishing for cod are restricted to areas outside 6 n.mile from shore. 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.

During winter/spring the amount of Northeast Arctic cod at spawning migration near the Norwegian coast was at the same level as in 2005. 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 also in 2006. In 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 2006 accurate. The working group therefore assume a status quo fishing mortality in 2006, which will result in landings of 19,871 tonnes using the same exploitation pattern as in the period 2003-2005, scaled to the 2005 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 along the Norwegian coast from Varanger to Stadt in October-November was established in 2003. 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 2003-2005 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 2005 estimated a total survey biomass of NCC of about 30,000 t (17 million fish) from Varanger to Stadt at 62° N (Tables 2.1.B, 2.2, 2.7). The spawning biomass accounted for 20,000 t (7 million fish) of the total (Tables 2.3, 2.4). The bulk of the biomass was comprised of ages 3-7 (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° N) nearly all otoliths collected were of the NCC type, which is similar to the results of the 1995-2004 surveys.

The numbers of NCC per age groups from all the coastal surveys is given in Table 2.7. The total numbers was lower in 2005 compared to the 2004 survey. For age groups 2-4 the numbers increased and for age groups 5 and 7-9 the numbers decreased from 2004 to 2005. The Norwegian 2006 coastal survey (October-November) will be conducted in a similar way as the previous ones to further extend the time series for NCC over its distribution area.

At next WG a bottom trawl index based on fixed trawl stations extending back to 1995 will be presented.

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 NEA cod. A total of 1555 cod otoliths were sampled during the 2004 survey, and separated into NCC type (1012) and NEA cod (543). The precision and accuracy of the separation method has been investigated by comparison of different otolith readers and results from genetic investigation of cod. The results indicate high accuracy using in the otolith method (Berg *et al*., 2005).

As in previous years, NCC was found throughout the survey area. The 2005 survey data shows the same pattern as the 1995-2003 surveys. The proportion of the NCC increases going from north to south along the Norwegian coast. The NCC type otoliths dominate south of 67° N (Norwegian statistical areas 06 and 07). Although the proportion is lower, there is significant biomass of NCC north of 67° N. It must be emphasised that the Norwegian coastal surveys have been conducted in August-November, and there may be more NEA cod 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 in the southernmost area (Tables 2.5, 2.11). The same tendency was found for the surveys in 1995-2004. The number of cod measured at the 2005 survey was considerably lower than previous years. The accuracy (weight at age) is therefore lower than earlier. For some age-classes weight at age are well below those observed in 2004, and the weight for the 1997 year-class (8 year in the 2005 survey) decreased from 2004 to 2005 (see also chapter 2.3.2).

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 approximately 5.5-6 year on average for the surveyed area in 2005 (Tables 2.6, 2.12). There are some variations between the different areas. The 2005 data show that the average M_{50} is at a higher age as that found in the 2004 survey. 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 NEA cod in 2004 is about one year higher.

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 1984-2005 is given in Table 2.9. The exploitation pattern in 2005 was slightly different to that observed last year. There was a tendency to higher exploitation of age groups 4-6.

The landings of coastal cod are expected to be severely underestimated. In addition to the official landings from commercial vessels an unknown amount of coastal cod is landed from both tourist fishing and recreational fishing activity by Norwegian citizen. Two different investigations have estimated the amount of cod landed from these two activities and the reports were published in 2003 (in Norwegian). A summary of these two reports was presented as a WD to the 2005 WG (WD 23). The unreported catch of coastal cod in 2003 was estimated to approximately 9.300 tonnes from the recreational fishing activity and 500-800 tonnes from the tourist fishing. This sums up to almost 30% of the official landings of coastal cod in 2003. There have also been conducted two investigations trying two estimate the level of discarding and misreporting from the coastal vessels in two periods (2000 and 2002-2003, WD 14 at 2002 WG). The amount of the discard was calculated and the report from the 2000-investigation concluded there was both discard and misreport by species in 2000. Landings of cod with gillnet should be increased by approximately 8-10%. 1/3 of this is probably Coastal cod. The last report concluded that misreporting in the Norwegian coastal gillnet fisheries have been reduced significantly since 2000.

Dependent on financing, the Institute of Marine Research in co-operation with other organizations plan to conduct an improved enquiry about every fifth year to estimate and monitor the more general recreational fishing activity. The Institute of Marine Research in cooperation with the Directorate of Fisheries, Statistics Norway and relevant tourist organizations will this year start a 3-year project “Coastal fish resources: the foundation for tourist fishing and related commerce”, financed by the Norwegian Research Council (NRC), to estimate the catches taken by tourists in Norway.

Although it certainly has been unreported catches for a long period, there are no available data for other years. It is also unknown whether the amount of unreported catch fluctuates with the stock size or with other factors. The WG therefore considered that unreported landings should not be included in the assessment until data is available for a longer time period.

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. However, weight-at-age obtained in the 2005 survey is quite noisy and seems unrealistic for some ages due to low sample size (see chapter 2.2.3). Weight at age in stock in 2005 is therefore calculated as a 3-year average (2002-2004). The weight-at-age in the catch is given in Table 2.10, and is at the same level as observed in 2004.

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 2005 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 (Table 2.12).

2.3.5 Tuning data (Table 2.7)

In previous assessments (until 2002) the acoustic indices (age 2-9) from the Norwegian coastal survey conducted late autumn (1995-2001) has 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 the 2003 assessment. The same age groups are used in the 2004, 2005 and this year's assessment.

2.4 Data screening and exploratory runs

2.4.1 Exploratory runs

2.4.1.1 XSA; SE shrinkage changed from 1.0 to 0.5 (Figures 2.3, 2.4)

Last year the WG performed several exploratory XSA-runs with different settings for the level of SE of the mean to which the estimates are shrunk, number of years and ages used in shrinkage and different settings for catchability dependent of ages and stock size. This years WG was asked to explore the metrics of retrospective performance when changing SE-setting using the *ab* and *asd* as derived by Jónsson & Hjörleifsson, 2000. This was done and the results are shown below and in figure 2.3 and 2.4. The bias is higher when using SE=0.5 for total biomass, SSB and recruitment, and lower for fishing mortality.

Retrospective Metrics	Total biomass	SSB	R	F $_{(4-7)}$
ab SE 1.0	-0.219	-0.106	-0.492	0.322
asd SE 1.0	0.059	0.069	0.140	0.087
ab SE 0.5	-0.261	-0.150	-0.767	0.272
asd SE 0.5	0.134	0.181	0.293	0.172

Previous assessments of coastal cod are based upon XSA estimates with SE for shrinkage fixed at 1.0. The retrospective pattern when using SE 0.5 in total biomass, SSB and recruitment was worse, while the retrospective pattern of F somewhat better than using shrinkage=1.0. Both the SSB and total stock biomass for the final year was lower with SE=0.5 (see table below). Since both the stock and the SSB the latest years have been underestimated in the assessment year, SE=0.5 will probably lead to an even higher underestimation of the SSB. Although the differences were small the WG decided to use the previous settings for SE (1.0).

Assessment / settings	F (4-7) 2004 from 2005 assessment	F (4-7) 2004 from 2006 assessment	Total Biom. 2004 from 2005 assesment	Total Biom. 2004 from 2006 assesment	SSB 2004 from 2005 assessment	SSB 2004 from 2006 assessment	Recruits 2004 from 2005 assessment	Recruits 2004 from 2006 assessment
XSA - SE 1.0	0.70	0.47	82964	97115	58352	63276	6066	8312
XSA - SE 0.5	0.62	0.46	75225	95816	50805	58104	2278	8495

2.4.1.2 Adapt

In addition to estimating stock size with XSA, VPA analyses using ADAPT software were explored for coastal cod. The model structure was selected independently from the XSA settings.

The catch at age matrix for coastal cod includes a plus group. Within ADAPT, there are two methods for specifying cohorts using F-constraints: “FRATIO” or “FIRST” (see Gavaris, 1988). All ADAPT results presented herein use the FRATIO method for F-constraints on the plus group. Using the FRATIO method, it is assumed that the fishing mortality for the plus group is proportional to the fishing mortality on the oldest “true age”. The constant of proportionality may be either fixed or estimated. The results presented below all have the FRATIO value fixed at 1.0, so that $F_{10+}=F_9$.

Results are presented below for an ADAPT analysis with the following inputs and structure:

Catch at age, 1984-2005, ages 2-10+
M=0.2 for all years, ages

Tuning Data:
Fleet 1 – Norwegian coastal survey, 1995-2005, ages 2-8

Estimation:
Survivors ages 4-10+ estimated for Jan 1 2006
FRATIO fixed at 1 over 1984-2005.
Catchabilities estimated for each index-age.

Model diagnostics indicate a poor fit to the data (see table below). This is consistent with an apparent lack of cohort consistency in the coastal survey results. The CV of the parameter estimates from Adapt is quite large: for the older age classes, the estimated standard error exceeds the magnitude of the actual parameter estimate. The results are therefore considered unreliable and are not shown. It should be noted, however, that estimated trends are similar to those obtained from XSA.

Estimated parameters from ADAPT. Shaded cells highlight relative errors/biases exceeding 25%.

Survivors	Estimate	Std Error	Bias	Relative Error	Relative Bias
N[2006 4]	5450	2180	451	40 %	8.3%
N[2006 5]	2550	1220	217	48 %	8.5%
N[2006 6]	1340	1090	187	81 %	13.9%
N[2006 7]	396	766	170	193 %	42.8%
N[2006 8]	359	663	150	185 %	41.7%
N[2006 9]	446	473	96.8	106 %	21.7%
N[2006 10]	659	812	134	123 %	20.3%
Catchabilities (Fleet_age)	Estimate	Std Error	Bias	Relative Error	Relative Bias
N.Surv_2	0.3490	0.0563	0.0018	16 %	0.5%
N.Surv_3	0.5680	0.0920	0.0029	16 %	0.5%
N.Surv_4	0.6010	0.0951	0.0033	16 %	0.5%
N.Surv_5	0.5750	0.0907	0.0035	16 %	0.6%
N.Surv_6	0.5160	0.0825	0.0039	16 %	0.7%
N.Surv_7	0.3720	0.0613	0.0035	17 %	0.9%
N.Surv_8	0.2620	0.0466	0.0040	18 %	1.5%

2.5 Methods Used in the Assessment

2.5.1 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 and also in this years WG (see 2.4.2.3), the regression statistics showed a slope not significantly different from one when catchability was set to be stock size independent for all ages.
2. Catchability was set to be age independent for ages 8 and older. This setting was determined 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 in the last few years (see 2.4.2.2). 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 (see also 2.4.2.1). In addition the retrospective pattern is somewhat better than using SE 0.5 (see 2.4.1.1).

The XSA converged after 87 iterations. The log catchability residuals were positive for all ages in 2005. The mean log catchabilities has slightly increased for age 7 and 8, and decreased for ages 6 and younger compared to last years assessment. This is probably the main source of the retrospective pattern in average fishing mortality.

2.6 Results of the Assessment

2.6.1 Fishing mortality and VPA (Tables 2.13–2.19, Figure 2.2)

The average fishing mortality on ages 4-7 in 2005 was estimated to be 0.72 (Table 2.13). This is the highest observed level and well above the level in 2004 (0.47). Retrospective analyses indicate that fishing mortalities tend to be overestimated while SSB tends to be underestimated in the assessment year (Figures 2.3 and 2.4). If the retrospective pattern is continued, the average fishing mortality (F_{4-7}) in 2005 is likely an overestimate. However, despite this retrospective pattern, estimates of the fishing mortality have increased since 2001.

In 1990 and 1991 the lowest F-values in the time series were estimated (0.18 and 0.17). Fishing mortality was quite stable in the period 1996-2002 at a level varying from 0.32-0.43, but has increased for the last two years. The total biomass of the stock in the period from 1984-2005 has been between 82,000 t and 304,000 t (Tables 2.17, 2.19). In 2005, the biomass was estimated to be the lowest in the time series, and about half the biomass in 2002. The spawning stock biomass has been between 36,000 t and 188,000 t (Tables 2.18, 2.19, Figure 2.2), and the 2005 estimate is the lowest estimate. The SSB has declined from 1996 to present but was quite stable in the period 1999-2002. The decline both in the total stock biomass and the SSB seems to be accelerating, and will probably 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.

2.6.2 Recruitment (Tables 2.7, 2.15, 2.19)

Both the survey estimates of abundance in 2005 (age 1-4, Table 2.7) and the XSA-estimate (age 2 and 3, Tables 2.15, 2.19) indicate that the year-classes from 1997-2004 are much lower than the long-term average. These eight year-classes are the lowest estimated values in the time series. The 2003 year-class is the lowest estimated in the time series. Recent estimates of SSB are relatively low, so the probability of weak year-classes in the next few years is likely to be high.

2.7 Comments to the Assessment

2.7.1 Comparison of the assessment results and the survey results (Figure 2.1)

Both the assessment and the surveys from 1995-2005 show a steep declines in stock size, and current stock size at a relatively low level. For ages 2-8 the survey indices and the XSA estimates are well correlated (Figure 2.1). Although the absolute level is uncertain, it seems like the survey and the XSA assessment reflect the trends in the stock quite well. There is a general trend towards decreasing catchability with increasing age.

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

Fishing mortalities in the assessment year tend to be overestimated while SSB tends to be underestimated as illustrated by the retrospective plots in Figure 2.3. The retrospective pattern for the recruitment is better, especially from 2000 and onwards. The 2004 estimates of fishing mortality (F_{4-7}) is lower (33%) compared with last years assessment. Conversely, estimated SSB and recruitment (age 2) in 2004 are higher (8% and 37%, respectively) in this year’s assessment compared with last years assessment (see table below).

ASSESSMENT YEAR	F_{4-7} (2004)	SSB YEAR 2004	TOTAL STOCK BIOMASS 2004	RECRUITS AGE 2 YEAR 2004
2005	0.70	58,357	82,971	6,066
2006	0.47	63,282	97,123	8,312

2.7.3 Uncertainties in the assessment

- The landings of Coastal cod are severely underestimated (see 2.3.1). Although unreported catches have certainly existed for a long period, there are no available data for years other than 2003. Also, it is unknown whether the amount of unreported catch fluctuates with the stock size or with other factors. The WG therefore considered that unreported landings should not be included in the assessment until data is available for a longer time period.
- 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 coastal cod and Northeast Arctic cod by inspection of the otoliths. The precision and accuracy of the method has been investigated 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 (Berg *et al*., 2005).

- 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 2003-2005 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 2003-2005 might still suffer from this.

The substantial level of unreported landings of coastal cod (WD 23, 2005 WG) increases the uncertainty on the absolute level of both the total stock, SSB, recruitment and fishing mortality considerably. Assuming the amount of unreported landings has fluctuated with the official landings and the age composition in the unreported landings is equal to the official landings, the assessment is considered to show the trends in the stock. This assumption is supported by the fact that the trend in the total stock, the SSB and recruitment is the same in the survey. The assessment is therefore considered to reflect the trend in the stock. The level of SSB and recruitment is uncertain but considered to show a clear stock-recruitment pattern. The 5 last and lowest observed year classes are all produced by the 5 last and lowest observed SSB. The recruitment is therefore clearly impaired at the SSB levels observed the last few years.

2.8 Prediction

Although a prediction was carried out, the WG decided not to include it in this years report. The decision was based on poor retrospective pattern especially for the fishing mortality, unreliable level of SSB and total stock in the assessment year, and therefore not suitable as input to a prediction as a basis for advice The stock is continuing to be underestimated and the fishing mortality overestimated in the assessment year. The catches are also severely underestimated since the recreational and tourist fishing is expected to be in the range of 20-50% of the commercial catch. However, the status of the stock is clear and the survey has not yet shown any sign of recovery for the stock. The index from the latest survey is the lowest observed in the series extending back to 1995. Previous short term predictions have shown that even if the fishing mortality is overestimated in the assessment year, and a *status quo* fishing mortality is used in a short term prediction the expected catch in the intermediate year is underestimated, and the resulting SSB the following year is underestimated.

2.8.1 Catch Options for 2007 and Management Scenarios

Since the WG has decided not to include a short term prediction in the report, no catch option for 2007 is available (see also 2.10).

2.9 Reference points (Figure 2.2)

No reference points have been established for this stock. The WG has not tried to calculate reference points for this stock during this years meeting. Although the exact amount is unknown, the historical unreported landings are considered to be rather high compared with the official landings. The historical level of the total stock, SSB and recruitment are therefore considered to be severely underestimated.

The level of SSB and recruitment is uncertain but considered to show a clear stock-recruitment pattern. The 5 last and lowest observed year classes are all produced by the 5 last and lowest observed SSB. The recruitment is therefore clearly impaired at the SSB levels observed the last few years (figure 2.2). At present, the SSB is well below the level where recruitment is impaired and below any $\mathbf{B}_{\text{lim}}$ candidate with or without taking the unreported catch into consideration.

2.10 Management considerations

New regulations for coastal cod became operative in May 2004 and extended in 2005 (see chapter 2.1.2). In accordance with the precautionary approach and the state of the stock, the new regulations should be closely evaluated. It is quite clear that the new regulations in 2004 and 2005 did not decrease the catches to any great extent. If catches are not substantially reduced further action needs to be taken.

Although the absolute level in SSB is uncertain, the assessment is considered to show the trend in SSB and recruitment, and recruitment from XSA-estimated SSB below 100,000 t is clearly impaired. The SSB is present the lowest observed and less than half of this level. In that sense, SSB in 2007 will likely be well below any $\mathbf{B}_{\text{lim}}$ candidate, and the probability of poor recruitment is very high. This being the case, the SSB should be rebuilt to a level where recruitment is not impaired before fishing is resumed. Due to low recruitment, rebuilding of the SSB to this level will probably take several years, even with zero fishing mortality.

2.11 Response to ACFM technical minutes

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

"As a general point it is helpful to calculate one or more metrics of retrospective performance (e.g. *ab* and *asd* as derived by Jónsson & Hjörleifsson, 2000, or the rho of Mohn, 1999) and include these on the retrospective figures."

Response:
The WG has calculated *ab* and *asd* and included the result in the retrospective figures. Based on the results the WG decided still to use SE=1.0

"The WG did an ICA run for the first time for this stock. This is a useful development, and the group are encouraged to continue such work……."

Response:
The WG made an assessment using Adapt. Model diagnostics indicate a poor fit to the data. It should be noted, however, that estimated trends are similar to those obtained from XSA.

"Although there is uncertainty in the level of total catches from the stock it should still be possible to define reference points based on the perceived stock level."

Response:
The WG has not calculated reference points for this stock because the retrospective pattern shows a clear underestimation of the SSB and underestimation of the R. Most of the SSB and resulting low year-classes are observed in the latest years and are assumed to be very uncertain. Within some years when these years in the XSA have converged, the estimation of reference points will be a lot more reliable. However, at present the SSB is well below the level where recruitment is impaired and below any $\mathbf{B}_{\text{lim}}$ candidate.

Regarding short term prediction: "In particular the RG questioned the use of the point estimate of mean F in 2004 (0.70) as fishing mortality in 2005."

Response:
The WG has not done a short term prediction this year (see chapter 2.8).

Table 2.1.A Number of otoliths sampled from commercial catches in the period 1985-2005. 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	1656	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
2004	1 511	7 539	758	2 565	532	685	531	1 317	3 332	12 106	22
2005	1 583	6 219	767	4 383	473	258	877	1 258	3 700	12 188	23

Table 2.1.B Estimated survey number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2005.

AGE										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	641	284	634	409	329	181	58	36	24	2	2598
04 W. Finnm./Troms	316	575	1080	907	1027	636	239	183	128	16	5107
05 Lofoten/Vesterålen	41	0	14	70	154	66	6	13		50	414
00 Vestfjord	28	20	21	62	288	39	111	56		10	635
06 Nordland	404	951	1650	1160	1374	646	471	252	178		7086
07 Møre	13	13	126	590	45	132	235	12			1166
Total	1443	1843	3525	3198	3217	1700	1120	552	330	78	17006

Table 2.2 Estimated survey biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2005.

	Age										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	28	102	449	504	530	399	186	143	87	5	2433
04 W. Finnm./Troms	32	262	1031	1526	2299	1704	874	615	706	184	9233
05 Lofoten/Vesterålen	6	0	19	160	359	200	22	76		906	1748
00 Vestfjord	3	10	20	136	502	136	442	174		109	1532
06 Nordland	37	299	1111	2214	3236	1701	1252	805	522		11177
07 Møre	3	4	318	1981	241	667	871	130			4215
Total	109	677	2948	6521	7167	4807	3647	1943	1315	1204	30338

Table 2.3 Estimated survey spawning stock number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2005.

	Age										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	0	0	47	220	185	167	58	36	24	2	739
04 West Finnmark/Troms	0	0	108	291	526	525	227	183	128	16	2004
05 Lofoten/Vesterålen	0	0	0	14	98	57	4	13		50	236
00 Vestfjord	0	0	0	12	144	26	111	56		10	359
06 Nordland	0	0	0	541	687	646	471	252	89		2686
07 Møre	0	0	21	516	45	110	235				927
Total	0	0	176	1594	1685	1531	1106	540	241	78	6951

Table 2.4 Estimated survey spawning stock biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2005.

	Age										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	0	0	33	272	299	370	186	143	87	5	1395
04 West Finnmark/Troms	0	0	103	490	1177	1408	830	615	706	184	5513
05 Lofoten/Vesterålen	0	0	0	32	228	171	17	76		906	1430
00 Vestfjord	0	0	0	27	251	91	442	174		109	1094
06 Nordland	0	0	0	1033	1618	1701	1252	805	261		6670
07 Møre	0	0	53	1733	241	556	871				3454
Total	0	0	189	3587	3814	4297	3598	1813	1054	1204	19556

Table 2.5 Weight (gram)-at-age (year) for Norwegian Coastal cod from the Norwegian coastal survey during the autumn 2005.

	Age									
Area	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	65	369	719	1310	1736	2298	2979	4441	4262	.
04 West Finnmark/Troms	119	418	850	1661	2237	2548	3759	3263	6871	12487
05 Lofoten/Vesterålen	232		690	2265	2309	2622	3878	5687		18240
00 Vestfjord	156	414	758	2032	1679	3502	3978	2910		10470
06 Nordland	162	321	635	2238	2445	2647	2819	3263	2833	.
07 Møre	257	286	2558	3405	4890	4768	7714			
Weighted average	112	359	786	2168	2265	2756	4174	3373	4502	15887

Table 2.6 Percent mature at age for Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2005.

	Age									
Area	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	0	0	7	54	56	93	100	100	100	100
04 West Finnmark/Troms	0	0	10	32	51	83	95	100	100	100
05 Lofoten/Vesterålen	0	0	0	20	64	86	75	100		100
00 Vestfjord	0	0	0	20	50	67	100	100		100
06 Nordland	0	0	0	47	50	100	100	100	50	
07 Møre	0	0	17	88	100	83	100	0		100
Weighted average	0	0	0	7	40	56	89	98	100	100

Table 2.7 Estimated survey numbers at age (x1000) of Norwegian Coastal cod from the coastal surveys from 1995-2005.

	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
2004	3217	3541	3696	4320	2758	1940	783	448	98	110	20914
2005	1443	1843	3525	3198	3217	1700	1120	552	330	78	17006

Table 2.8

```
Lowestoft VPA Version 3.1
21/04/2006  19:16

Extended Survivors Analysis
Norwegian Coastal Cod,COMBSEX,PLUSGROUP
CPUE data from file c:\vpa\data\2006\xsa\input\coast-9.txt

Catch data for  22 years. 1984 to 2005. Ages  2 to  10.


      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 Norw. Coast. survey ,   1995, 2005,   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   87 iterations


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


 Fishing mortalities
    Age,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005
      2,  .033,  .046,  .020,  .011,  .007,  .003,  .018,  .011,  .002,  .004
      3,  .100,  .126,  .129,  .061,  .052,  .029,  .076,  .137,  .054,  .080
      4,  .187,  .187,  .258,  .151,  .241,  .130,  .185,  .257,  .180,  .388
      5,  .468,  .259,  .388,  .387,  .389,  .314,  .303,  .310,  .421,  .803
      6,  .379,  .460,  .451,  .509,  .449,  .364,  .538,  .402,  .550,  .931
      7,  .457,  .648,  .584,  .675,  .390,  .454,  .532,  .573,  .743,  .776
      8,  .644,  .830,  .728,  .636,  .274,  .337,  .608,  .406,  .830,  .695
      9,  .494,  .710,  .626,  .808,  .212,  .249,  .347,  .340,  .345,  .614


 XSA population numbers (Thousands)
                               AGE
 YEAR ,          2,         3,         4,         5,         6,         7,         8,         9,
 1996 ,    4.06E+04, 2.75E+04, 1.61E+04, 1.46E+04, 1.63E+04, 1.25E+04, 4.85E+03, 2.55E+03,
 1997 ,    3.29E+04, 3.22E+04, 2.04E+04, 1.09E+04, 7.47E+03, 9.12E+03, 6.49E+03, 2.09E+03,
 1998 ,    3.06E+04, 2.57E+04, 2.32E+04, 1.38E+04, 6.92E+03, 3.86E+03, 3.90E+03, 2.32E+03,
 1999 ,    2.64E+04, 2.46E+04, 1.85E+04, 1.47E+04, 7.68E+03, 3.61E+03, 1.76E+03, 1.54E+03,
 2000 ,    2.37E+04, 2.13E+04, 1.89E+04, 1.30E+04, 8.17E+03, 3.78E+03, 1.50E+03, 7.64E+02,
 2001 ,    1.65E+04, 1.92E+04, 1.66E+04, 1.22E+04, 7.24E+03, 4.27E+03, 2.09E+03, 9.36E+02,
 2002 ,    1.19E+04, 1.35E+04, 1.53E+04, 1.19E+04, 7.28E+03, 4.12E+03, 2.22E+03, 1.22E+03,
 2003 ,    7.94E+03, 9.55E+03, 1.02E+04, 1.04E+04, 7.21E+03, 3.48E+03, 1.98E+03, 9.90E+02,
 2004 ,    8.31E+03, 6.43E+03, 6.82E+03, 6.47E+03, 6.25E+03, 3.95E+03, 1.61E+03, 1.08E+03,
 2005 ,    4.25E+03, 6.79E+03, 4.99E+03, 4.66E+03, 3.47E+03, 2.95E+03, 1.54E+03, 5.74E+02,
```

Table 2.8 (continued)

Estimated population abundance at 1st Jan 2006

, 0.00E+00, 3.46E+03, 5.13E+03, 2.77E+03, 1.71E+03, 1.12E+03, 1.11E+03, 6.29E+02,

Taper weighted geometric mean of the VPA populations:

, 1.90E+04, 1.83E+04, 1.59E+04, 1.26E+04, 8.51E+03, 5.18E+03, 2.67E+03, 1.35E+03,

Standard error of the weighted Log(VPA populations) :

, .7569, .6167, .5673, .4956, .4702, .4829, .5303, .5549,

Log catchability residuals.

Fleet : Norw. Coast. survey

Age	1995
2	.36
3	.21
4	.28
5	.10
6	-.15
7	-.05
8	.00

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	.06	.36	.09	.04	.16	-.02	-.49	-.42	.03	.05
3	.48	.58	.15	-.07	.01	-.27	-.54	-.30	.07	-.01
4	.32	.42	.08	-.05	-.12	-.25	-.55	-.33	.12	.30
5	.57	.68	.04	-.05	.17	-.34	-.60	-.72	-.17	.62
6	-.18	1.11	-.04	-.12	.35	-.35	-.21	-.39	-.34	.42
7	-.33	.35	.24	-.23	-.04	-.02	.07	.02	-.35	.32
8	-.28	.28	-.87	-.41	.16	-.12	-.14	.18	.45	.60

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	-.7178	-.4220	-.2746	-.1891	-.2316	-.5109	-.9073
S.E(Log q)	.2681	.3264	.3107	.4799	.4470	.2414	.4213

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.84	1.704	2.13	.94	11	.21	-.72
3	.80	1.361	2.24	.86	11	.25	-.42
4	1.07	-.324	-.42	.70	11	.35	-.27
5	1.21	-.446	-1.69	.37	11	.61	-.19
6	1.29	-.656	-2.29	.39	11	.60	-.23
7	1.09	-.451	-.20	.76	11	.28	-.51
8	1.41	-1.089	-1.95	.47	11	.59	-.91

Terminal year survivor and F summaries :

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

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. survey	3627.	.300	.000	.00	1	.917	.004
F shrinkage mean	2088.	1.00				.083	.006

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3465.	.29	.16	2	.553	.004

Table 2.8 (continued)

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

Year class = 2002

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
Norw. Coast. survey ,	5187.,	.226,	.018,	.08,	2,	.948,	.079
F shrinkage mean ,	4263.,	1.00,,,,				.052,	.096

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
5134.,	.22,	.03,	3,	.154,	.080

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

Year class = 2001

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
Norw. Coast. survey ,	2675.,	.186,	.220,	1.19,	3,	.950,	.399
F shrinkage mean ,	5342.,	1.00,,,,				.050,	.220

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
2770.,	.18,	.20,	4,	1.073,	.388

Age 5 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 ,	1566.,	.176,	.223,	1.27,	4,	.921,	.852
F shrinkage mean ,	4739.,	1.00,,,,				.079,	.368

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1710.,	.18,	.24,	5,	1.344,	.803

Age 6 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 ,	1004.,	.171,	.166,	.97,	5,	.892,	.999
F shrinkage mean ,	2799.,	1.00,,,,				.108,	.480

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1121.,	.19,	.21,	6,	1.100,	.931

Table 2.8 (continued)

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Norw. Coast. survey ,	1091.,	.163,	.169,	1.04,	6,	.920,	.787
F shrinkage mean ,	1385.,	1.00,,,,				.080,	.664

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1112.,	.17,	.15,	7,	.890,	.776

Age 8 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
Norw. Coast. survey ,	619.,	.168,	.170,	1.01,	7,	.901,	.703
F shrinkage mean ,	729.,	1.00,,,,				.099,	.624

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
629.,	.18,	.15,	8,	.832,	.695

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

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Norw. Coast. survey ,	278.,	.172,	.101,	.58,	7,	.814,	.574
F shrinkage mean ,	173.,	1.00,,,,				.186,	.809

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
254.,	.23,	.11,	8,	.491,	.614

Table 2.9

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17

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

YEAR,	1984,	1985,
AGE		
2,	829,	396,
3,	3478,	7848,
4,	6954,	7367,
5,	7278,	8699,
6,	6004,	7085,
7,	4964,	3066,
8,	2161,	705,
9,	819,	433,
+gp,	624,	264,
TOTALNUM,	33111,	35863,
TONSLAND,	74824,	75451,
SOPCOF %,	100,	100,

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

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	4095,	170,	110,	41,	7,	125,	40,	4,	332,	810,
3,	4095,	940,	1921,	1159,	349,	607,	665,	369,	573,	896,
4,	12662,	8236,	3343,	1434,	1233,	1452,	3160,	1706,	1693,	2345,
5,	8906,	12430,	6451,	2299,	1330,	3114,	4422,	2343,	4302,	5188,
6,	5750,	4427,	6626,	5197,	1129,	1873,	2992,	2684,	2467,	5546,
7,	3868,	2649,	4687,	2720,	3456,	1297,	1945,	3072,	3337,	3270,
8,	1270,	1127,	1461,	949,	773,	873,	898,	1871,	1514,	1455,
9,	342,	313,	497,	236,	141,	132,	837,	627,	777,	557,
+gp,	407,	149,	333,	86,	73,	94,	279,	690,	798,	433,
TOTALNUM,	41395,	30441,	25429,	14121,	8491,	9567,	15238,	13366,	15793,	20500,
TONSLAND,	68905,	60972,	59294,	40285,	28127,	24822,	41690,	52557,	54562,	57207,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP

At 21/04/2006 19:17

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

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
2,	1193,	1326,	554,	252,	156,	44,	192,	81,	12,	15,
3,	2376,	3438,	2819,	1322,	971,	505,	893,	1107,	306,	474,
4,	2480,	3150,	4786,	2346,	3664,	1837,	2331,	2094,	1017,	1450,
5,	4930,	2258,	4023,	4263,	3807,	2974,	2822,	2506,	2011,	2328,
6,	4647,	2490,	2272,	2773,	2671,	1998,	2742,	2158,	2394,	1904,
7,	4160,	3935,	1546,	1602,	1104,	1409,	1538,	1374,	1874,	1442,
8,	2082,	3312,	1826,	751,	326,	542,	915,	598,	820,	698,
9,	898,	959,	975,	774,	132,	187,	325,	258,	285,	238,
+gp,	543,	684,	343,	320,	152,	119,	377,	99,	307,	168,
TOTALNUM,	23309,	21552,	19144,	14403,	12983,	9615,	12135,	10275,	9026,	8717,
TONSLAND,	61776,	63319,	51572,	40732,	36715,	29699,	40994,	34635,	32599,	30936,
SOPCOF %,	100,	100,	99,	100,	100,	100,	102,	100,	100,	100,

Table 2.10

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17

Table 2 Catch weights at age (kg)

YEAR,	1984,	1985,
AGE		
2,	.2480,	.2140,
3,	.6190,	.7120,
4,	1.1490,	1.4150,
5,	1.7340,	2.0360,
6,	2.3250,	2.7370,
7,	3.4860,	4.0120,
8,	4.8450,	6.1160,
9,	5.6080,	6.4600,
+gp,	8.8400,	10.7550,
SOPCOFAC,	1.0002,	1.0000,

Table 2.10 (Continued)

Table 2 Catch weights at age (kg)

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	.2270,	.3310,	.2460,	.3000,	.3450,	.1640,	.1680,	.2410,	.2540,	.3020,
3,	.5250,	.6730,	.6340,	.6610,	1.1740,	.9220,	.5560,	.6450,	.8050,	.7100,
4,	1.0800,	1.1200,	1.1700,	1.8360,	1.5150,	1.6080,	1.3590,	1.7100,	1.4760,	1.3350,
5,	1.7060,	1.6930,	1.7270,	2.1700,	1.6780,	2.1080,	2.2670,	2.5910,	2.0970,	1.8420,
6,	2.2560,	2.3590,	2.3280,	2.4480,	2.7080,	2.5070,	2.9570,	3.5880,	3.2870,	2.4670,
7,	3.3530,	3.7430,	3.2560,	4.3910,	3.8980,	3.4690,	3.9030,	4.3660,	4.0950,	4.1910,
8,	4.8380,	5.3260,	4.7000,	4.8990,	6.5150,	4.9760,	5.3170,	5.8990,	5.5920,	5.7780,
9,	5.8380,	6.1290,	5.4500,	6.6610,	7.2990,	5.7340,	4.5580,	6.4940,	7.2170,	6.3760,
+gp,	7.0530,	11.6230,	8.2020,	11.6080,	13.9240,	11.0590,	7.0320,	7.5090,	8.3310,	9.9030,
SOPCOFAC,	1.0001,	1.0001,	1.0001,	1.0000,	1.0002,	1.0003,	1.0001,	1.0000,	1.0000,	1.0001,

Table 2 Catch weights at age (kg)

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
2,	.2740,	.2770,	.3760,	.4670,	.5150,	.1640,	.4910,	.9440,	.8240,	.8200,
3,	.9210,	.9700,	.9780,	1.1550,	1.3050,	.9520,	1.1790,	1.5520,	1.3740,	1.3170,
4,	1.4640,	1.5540,	1.5180,	1.6330,	2.2720,	1.6370,	1.8000,	2.1460,	1.9200,	2.1000,
5,	1.9790,	1.9700,	2.2810,	2.1710,	2.5550,	2.8810,	2.4850,	3.0820,	2.7550,	3.0440,
6,	2.5160,	2.8970,	3.1250,	3.2490,	3.2830,	3.4240,	3.8600,	3.5940,	3.5290,	3.8080,
7,	3.4610,	3.7160,	3.9000,	4.0950,	4.5040,	4.0380,	4.7600,	4.9530,	4.2810,	4.5230,
8,	4.8660,	4.8290,	5.5200,	5.0130,	5.4000,	5.3970,	5.1950,	5.7360,	5.3480,	5.3860,
9,	5.3910,	6.3490,	6.3330,	6.0180,	6.3790,	7.2080,	5.5070,	6.4770,	6.1600,	6.6880,
+gp,	8.8540,	9.2670,	9.3370,	6.2550,	6.4200,	6.8810,	9.1830,	9.6860,	6.7130,	6.2310,
SOPCOFAC,	1.0001,	1.0003,	.9919,	1.0002,	.9999,	1.0004,	1.0181,	1.0001,	1.0001,	.9999,

Table 2.11

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17

Table 3 Stock weights at age (kg)

YEAR,	1984,	1985,
AGE		
2,	.3210,	.3210,
3,	.7580,	.7580,
4,	1.4790,	1.4790,
5,	2.1370,	2.1370,
6,	2.8140,	2.8140,
7,	4.7220,	4.7220,
8,	6.6850,	6.6850,
9,	6.9800,	6.9800,
+gp,	9.7230,	9.7230,

Table 3 Stock weights at age (kg)

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3900,
3,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7910,
4,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.5250,
5,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.2220,
6,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8810,
7,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.6650,
8,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.9790,
9,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.7590,
+gp,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.8970,

Table 3 Stock weights at age (kg)

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
2,	.2520,	.2400,	.3720,	.3230,	.3650,	.3960,	.4280,	.3840,	.3520,	.3680,
3,	.7240,	.6830,	.8830,	.8410,	.8090,	.9660,	.8950,	.7360,	.8340,	.7850,
4,	1.4330,	1.3640,	1.4560,	1.6750,	1.5540,	1.5240,	1.7410,	1.3090,	1.6900,	1.4950,
5,	2.0530,	1.8930,	2.1070,	2.1920,	2.5390,	2.3140,	2.4330,	2.0990,	2.2550,	2.1770,
6,	2.7480,	2.8160,	2.9500,	2.8570,	3.0490,	3.3200,	3.1330,	3.0440,	3.3120,	3.1780,
7,	4.7220,	4.4260,	4.3190,	4.5400,	4.3520,	3.6950,	4.2730,	3.8780,	4.1500,	4.0140,
8,	6.6850,	6.4060,	5.6250,	6.5790,	6.2030,	6.1440,	4.3970,	4.8100,	4.5940,	4.7020,
9,	6.9320,	7.8050,	8.3230,	9.4540,	8.5270,	8.7680,	7.7590,	6.0750,	6.4940,	6.2850,
+gp,	9.7230,	10.8270,	12.4680,	12.9020,	12.0660,	12.4680,	12.9920,	9.9540,	9.7330,	9.8440,

Table 2.12

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
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Table 5 Proportion mature at age

YEAR, AGE	1984,	1985,
2,	.0100,	.0100,
3,	.0600,	.0600,
4,	.2400,	.2400,
5,	.4900,	.4900,
6,	.7200,	.7200,
7,	.8800,	.8800,
8,	.9500,	.9500,
9,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR, AGE	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
2,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0000,
3,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0100,
4,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2000,
5,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4700,
6,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.6700,
7,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8500,
8,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.8600,
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	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
2,	.0000,	.0000,	.0000,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.0300,	.0600,	.0600,	.0300,	.0600,	.0000,	.0200,	.0000,	.0100,	.0000,
4,	.2400,	.2900,	.2500,	.2100,	.2400,	.0700,	.0200,	.0500,	.0900,	.0700,
5,	.5600,	.4500,	.5300,	.4400,	.4900,	.3700,	.2600,	.2900,	.3700,	.4000,
6,	.8000,	.7600,	.7400,	.6500,	.7200,	.7900,	.8800,	.4900,	.7600,	.5600,
7,	.9200,	.9700,	.8700,	.7700,	.8800,	.9700,	.9300,	.9000,	.9500,	.8900,
8,	.9900,	1.0000,	.8900,	1.0000,	.9500,	.9800,	.9000,	.9800,	.9800,	.9800,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9800,	.9700,	.9600,	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 2.13

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR, AGE	1984,	1985,
2,	.0105,	.0059,
3,	.0744,	.1298,
4,	.2169,	.2229,
5,	.3337,	.4621,
6,	.6283,	.6366,
7,	1.3095,	.7883,
8,	1.0724,	.6332,
9,	.8447,	.6357,
+gp,	.8447,	.6357,
FBAR 4- 7,	.6221,	.5275,

Table 2.13 (Continued)

Table 8 Fishing mortality (F) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	.1356,	.0051,	.0030,	.0010,	.0002,	.0023,	.0009,	.0001,	.0144,	.0263,
3,	.0775,	.0416,	.0733,	.0399,	.0107,	.0194,	.0151,	.0100,	.0251,	.0491,
4,	.3190,	.2205,	.2038,	.0719,	.0543,	.0565,	.1327,	.0487,	.0581,	.1359,
5,	.4600,	.5988,	.2691,	.2105,	.0882,	.1889,	.2435,	.1376,	.1669,	.2535,
6,	.6430,	.4379,	.7633,	.3622,	.1515,	.1726,	.2798,	.2287,	.2103,	.3369,
7,	.9002,	.7086,	1.2399,	.8540,	.4378,	.2607,	.2731,	.5189,	.4945,	.4764,
8,	.9338,	.7332,	1.1860,	.9345,	.6316,	.1857,	.2902,	.4604,	.5267,	.4166,
9,	.7414,	.6251,	.8738,	.5954,	.3293,	.2029,	.2731,	.3385,	.3518,	.3733,
+gp,	.7414,	.6251,	.8738,	.5954,	.3293,	.2029,	.2731,	.3385,	.3518,	.3733,
FBAR 4- 7,	.5806,	.4914,	.6190,	.3747,	.1830,	.1697,	.2323,	.2335,	.2325,	.3007,

Table 8 Fishing mortality (F) at age

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	FBAR
AGE											
2,	.0330,	.0455,	.0202,	.0106,	.0073,	.0030,	.0180,	.0113,	.0016,	.0039,	.0056,
3,	.1003,	.1257,	.1290,	.0613,	.0516,	.0295,	.0762,	.1371,	.0540,	.0802,	.0905,
4,	.1865,	.1874,	.2584,	.1507,	.2407,	.1305,	.1846,	.2570,	.1802,	.3878,	.2750,
5,	.4683,	.2588,	.3880,	.3868,	.3893,	.3145,	.3031,	.3095,	.4212,	.8029,	.5112,
6,	.3793,	.4596,	.4510,	.5093,	.4486,	.3640,	.5381,	.4015,	.5504,	.9308,	.6276,
7,	.4574,	.6483,	.5841,	.6750,	.3900,	.4537,	.5324,	.5731,	.7425,	.7764,	.6974,
8,	.6437,	.8300,	.7279,	.6363,	.2739,	.3369,	.6077,	.4063,	.8301,	.6952,	.6439,
9,	.4935,	.7098,	.6256,	.8081,	.2119,	.2494,	.3472,	.3397,	.3450,	.6136,	.4328,
+gp,	.4935,	.7098,	.6256,	.8081,	.2119,	.2494,	.3472,	.3397,	.3450,	.6136,	
FBAR 4-7,	.3729,	.3885,	.4204,	.4305,	.3671,	.3157,	.3896,	.3853,	.4736,	.7244,	

Table 2.14

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17
Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR,	1984,	1985,
AGE		
2,	.0168,	.0112,
3,	.1196,	.2461,
4,	.3486,	.4226,
5,	.5363,	.8761,
6,	1.0100,	1.2069,
7,	2.1050,	1.4944,
8,	1.7238,	1.2004,
9,	1.3578,	1.2052,
+gp,	1.3578,	1.2052,
REFMEAN,	.6221,	.5275,

Table 9 Relative F at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	.2336,	.0104,	.0049,	.0027,	.0010,	.0135,	.0038,	.0006,	.0621,	.0875,
3,	.1334,	.0846,	.1184,	.1064,	.0587,	.1141,	.0648,	.0429,	.1080,	.1633,
4,	.5495,	.4486,	.3292,	.1918,	.2968,	.3328,	.5714,	.2086,	.2499,	.4521,
5,	.7924,	1.2185,	.4348,	.5620,	.4819,	1.1134,	1.0483,	.5893,	.7180,	.8430,
6,	1.1075,	.8911,	1.2331,	.9669,	.8280,	1.0173,	1.2044,	.9794,	.9048,	1.1205,
7,	1.5506,	1.4418,	2.0030,	2.2794,	2.3932,	1.5365,	1.1758,	2.2226,	2.1272,	1.5844,
8,	1.6084,	1.4919,	1.9159,	2.4943,	3.4520,	1.0945,	1.2494,	1.9721,	2.2655,	1.3852,
9,	1.2771,	1.2720,	1.4115,	1.5892,	1.7997,	1.1959,	1.1758,	1.4498,	1.5134,	1.2414,
+gp,	1.2771,	1.2720,	1.4115,	1.5892,	1.7997,	1.1959,	1.1758,	1.4498,	1.5134,	1.2414,
REFMEAN,	.5806,	.4914,	.6190,	.3747,	.1830,	.1697,	.2323,	.2335,	.2325,	.3007,

Table 2.14 (Continued)

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	MEAN

AGE											
2	.0885	.1172	.0480	.0247	.0199	.0094	.0463	.0294	.0034	.0054	.0127
3	.2691	.3235	.3068	.1424	.1405	.0933	.1955	.3558	.1141	.1108	.1936
4	.5002	.4824	.6147	.3502	.6557	.4133	.4738	.6671	.3804	.5352	.5276
5	1.2559	.6661	.9229	.8987	1.0604	.9962	.7781	.8033	.8894	1.1082	.9337
6	1.0172	1.1828	1.0729	1.1831	1.2218	1.1532	1.3813	1.0422	1.1622	1.2848	1.1631
7	1.2267	1.6686	1.3895	1.5680	1.0622	1.4373	1.3668	1.4874	1.5679	1.0717	1.3757
8	1.7262	2.1363	1.7314	1.4782	.7460	1.0671	1.5600	1.0546	1.7529	.9596	1.2557
9	1.3235	1.8270	1.4881	1.8773	.5771	.7902	.8913	.8816	.7285	.8470	.8190
+gp	1.3235	1.8270	1.4881	1.8773	.5771	.7902	.8913	.8816	.7285	.8470	
REFMEAN	.3729	.3885	.4204	.4305	.3671	.3157	.3896	.3853	.4736	.7244	

Table 2.15

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17
Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1984	1985
AGE		
2	87943	74599
3	53610	71252
4	39416	40745
5	28352	25979
6	14224	16627
7	7515	6213
8	3631	1661
9	1587	1017
+gp	1191	613
TOTAL	237468	238705

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
2	35690	36879	40146	44113	42742	60199	49990	31195	25606	34488
3	60718	25516	30040	32769	36079	34988	49174	40892	25536	20664
4	51235	46006	20040	22857	25780	29223	28097	39658	33146	20389
5	26693	30490	30215	13382	17416	19992	22612	20144	30926	25606
6	13399	13796	13716	18900	8876	13056	13550	14512	14373	21427
7	7202	5767	7290	5234	10772	6246	8994	8387	9453	9535
8	2313	2397	2325	1727	1824	5692	3940	5604	4087	4720
9	722	744	943	581	555	794	3870	2413	2895	1976
+gp	847	350	622	209	286	563	1282	2636	2951	1524
TOTAL	198819	161946	145336	139774	144332	170753	181510	165442	148973	140329

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

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST
AGE												
2	40610	32911	30633	26350	23655	16487	11877	7940	8312	4248	0	32857
3	27504	32169	25746	24579	21346	19226	13459	9550	6428	6794	3465	29385
4	16107	20368	23227	18528	18927	16598	15284	10211	6817	4986	5134	24641
5	14571	10944	13826	14686	13047	12181	11927	10404	6465	4661	2770	18384
6	16270	7469	6917	7679	8167	7237	7282	7212	6251	3474	1710	11485
7	12525	9116	3862	3607	3778	4269	4117	3481	3952	2951	1121	6379
8	4848	6490	3903	1763	1504	2094	2221	1979	1607	1540	1112	2901
9	2548	2085	2317	1543	764	936	1224	990	1079	574	629	1298
+gp	1526	1468	805	629	875	592	1410	377	1154	400	432	
TOTAL	136508	123020	111236	99365	92063	79622	68801	52145	42065	29628	16372	

Table 2.16

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17
Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1984	1985
AGE		
2	879	746
3	3217	4275
4	9460	9779
5	13892	12730
6	10241	11972
7	6613	5467
8	3449	1578
9	1587	1017
+gp	1191	613

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

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	357,	369,	401,	441,	427,	602,	500,	312,	256,	0,
3,	3643,	1531,	1802,	1966,	2165,	2099,	2950,	2454,	1532,	207,
4,	12296,	11042,	4810,	5486,	6187,	7014,	6743,	9518,	7955,	4078,
5,	13080,	14940,	14805,	6557,	8534,	9796,	11080,	9871,	15154,	12035,
6,	9647,	9933,	9876,	13608,	6391,	9400,	9756,	10449,	10348,	14356,
7,	6338,	5075,	6415,	4606,	9479,	5496,	7915,	7380,	8319,	8105,
8,	2197,	2277,	2208,	1641,	1733,	5408,	3743,	5324,	3882,	4059,
9,	722,	744,	943,	581,	555,	794,	3870,	2413,	2895,	1976,
+gp,	847,	350,	622,	209,	286,	563,	1282,	2636,	2951,	1524,

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

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
2,	0,	0,	0,	264,	237,	0,	0,	0,	0,	0,
3,	825,	1930,	1545,	737,	1281,	0,	269,	0,	64,	0,
4,	3866,	5907,	5807,	3891,	4543,	1162,	306,	511,	614,	349,
5,	8160,	4925,	7328,	6462,	6393,	4507,	3101,	3017,	2392,	1865,
6,	13016,	5676,	5118,	4992,	5880,	5717,	6408,	3534,	4751,	1945,
7,	11523,	8842,	3360,	2778,	3325,	4141,	3829,	3133,	3754,	2627,
8,	4799,	6490,	3474,	1763,	1429,	2053,	1998,	1940,	1575,	1509,
9,	2548,	2085,	2317,	1543,	764,	917,	1188,	951,	1079,	574,
+gp,	1526,	1468,	805,	629,	875,	592,	1410,	377,	1154,	400,

Table 2.17

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17
Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,	1985,
AGE		
2,	28234,	23947,
3,	40643,	54010,
4,	58306,	60264,
5,	60598,	55519,
6,	40033,	46791,
7,	35490,	29339,
8,	24275,	11103,
9,	11080,	7100,
+gp,	11578,	5957,
TOTALBIO,	310238,	294030,

Table 2.18

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17
Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,	1985,
AGE		
2,	282,	239,
3,	2439,	3241,
4,	13993,	14463,
5,	29693,	27204,
6,	28824,	33689,
7,	31231,	25818,
8,	23061,	10548,
9,	11080,	7100,
+gp,	11578,	5957,
TOTSPBIO,	152182,	128261,

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

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	115,	118,	129,	142,	137,	193,	160,	100,	82,	0,
3,	2762,	1161,	1366,	1490,	1641,	1592,	2237,	1860,	1161,	163,
4,	18187,	16331,	7114,	8113,	9153,	10376,	9974,	14076,	11766,	6219,
5,	27953,	31929,	31641,	14013,	18240,	20940,	23680,	21093,	32383,	26744,
6,	27148,	27954,	27792,	38294,	17987,	26460,	27456,	29401,	29120,	41365,
7,	29931,	23965,	30293,	21751,	44769,	25961,	37378,	34848,	39281,	37813,
8,	14687,	15224,	14764,	10969,	11589,	36160,	25024,	35588,	25954,	28332,
9,	5039,	5195,	6581,	4058,	3878,	5546,	27018,	16844,	20209,	13357,
+gp,	8239,	3404,	6045,	2036,	2777,	5474,	12468,	25633,	28695,	15085,
TOTSPBIO,	134061,	125281,	125725,	100866,	110170,	132702,	165397,	179443,	188651,	169080,

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

YEAR,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE										
2,	0,	0,	0,	85,	86,	0,	0,	0,	0,	0,
3,	597,	1319,	1353,	620,	1036,	0,	245,	0,	54,	0,
4,	5540,	8059,	8386,	6518,	7059,	1771,	542,	668,	1037,	522,
5,	16753,	9325,	15314,	14167,	16230,	10434,	7681,	6333,	5395,	4059,
6,	35770,	15989,	14977,	14264,	17926,	18990,	20440,	10757,	15735,	6182,
7,	54415,	39147,	14394,	12612,	14469,	15309,	16658,	12150,	15581,	10543,
8,	32086,	41589,	19381,	11602,	8861,	12617,	8946,	9331,	7235,	7094,
9,	17663,	16279,	19129,	14592,	6514,	8048,	9382,	5775,	7010,	3605,
+gp,	14834,	15893,	9961,	8111,	10559,	7388,	18647,	3754,	11235,	3938,
TOTSPBIO,	177659,	147600,	102896,	82572,	82739,	74557,	82541,	48769,	63282,	35943,

Table 2.19

Runtitle : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 21/04/2006 19:17

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,	87943,	310238,	152182,	74824,	.4917,	1.0002,	.6221,
1985,	74599,	294030,	128261,	75451,	.5883,	1.0000,	.5275,
1986,	35690,	290768,	134061,	68905,	.5140,	1.0001,	.5806,
1987,	36879,	255072,	125281,	60972,	.4867,	1.0001,	.4914,
1988,	40146,	231065,	125725,	59294,	.4716,	1.0001,	.6190,
1989,	44113,	196945,	100866,	40285,	.3994,	1.0000,	.3747,
1990,	42742,	211143,	110170,	28127,	.2553,	1.0002,	.1830,
1991,	60199,	247161,	132702,	24822,	.1871,	1.0003,	.1697,
1992,	49990,	289648,	165397,	41690,	.2521,	1.0001,	.2323,
1993,	31195,	303079,	179443,	52557,	.2929,	1.0000,	.2335,
1994,	25606,	303993,	188651,	54562,	.2892,	1.0000,	.2325,
1995,	34488,	285410,	169080,	57207,	.3383,	1.0001,	.3007,
1996,	40610,	251915,	177659,	61776,	.3477,	1.0001,	.3729,
1997,	32911,	213546,	147600,	63319,	.4290,	1.0003,	.3885,
1998,	30633,	183943,	102896,	51572,	.5012,	.9919,	.4204,
1999,	26350,	165054,	82572,	40732,	.4933,	1.0002,	.4305,
2000,	23655,	156172,	82739,	36715,	.4437,	.9999,	.3671,
2001,	16487,	146913,	74557,	29699,	.3983,	1.0004,	.3157,
2002,	11877,	153471,	82541,	40994,	.4966,	1.0181,	.3896,
2003,	7940,	100029,	48769,	34635,	.7102,	1.0001,	.3853,
2004,	8312,	97123,	63282,	32599,	.5151,	1.0001,	.4736,
2005,	4248,	62163,	35943,	30936,	.8607,	.9999,	.7244,
Arith. Mean,	34846,	215858,	118653,	48258,	.4437		.4016,
Units,	Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

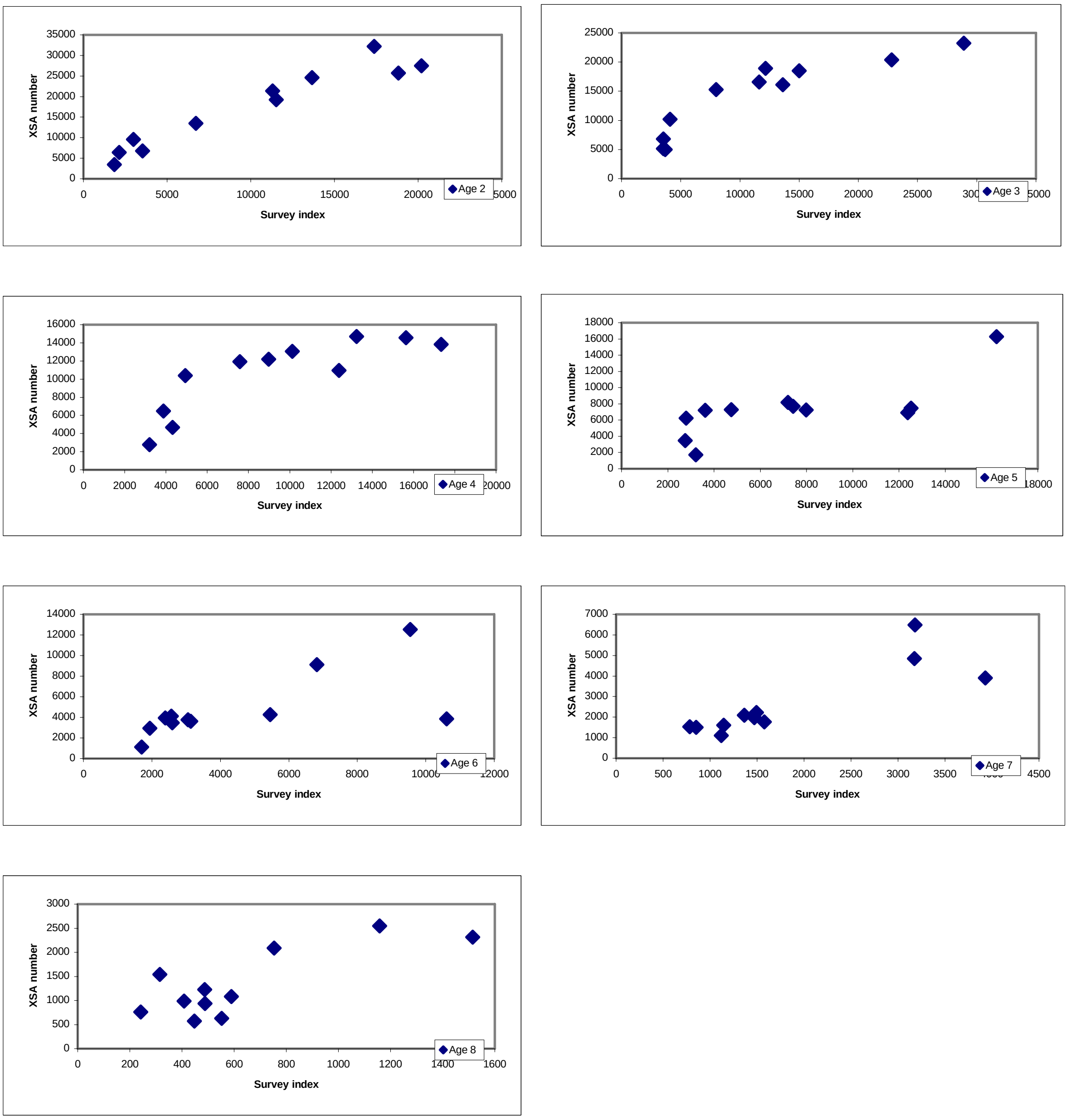


Figure 2.1 **Norwegian Coastal cod – Coastal acoustic survey vs XSA. Age (n) in survey=age (n+1) from XSA the year after because the surveys are conducted late autumn (1995-2004).**

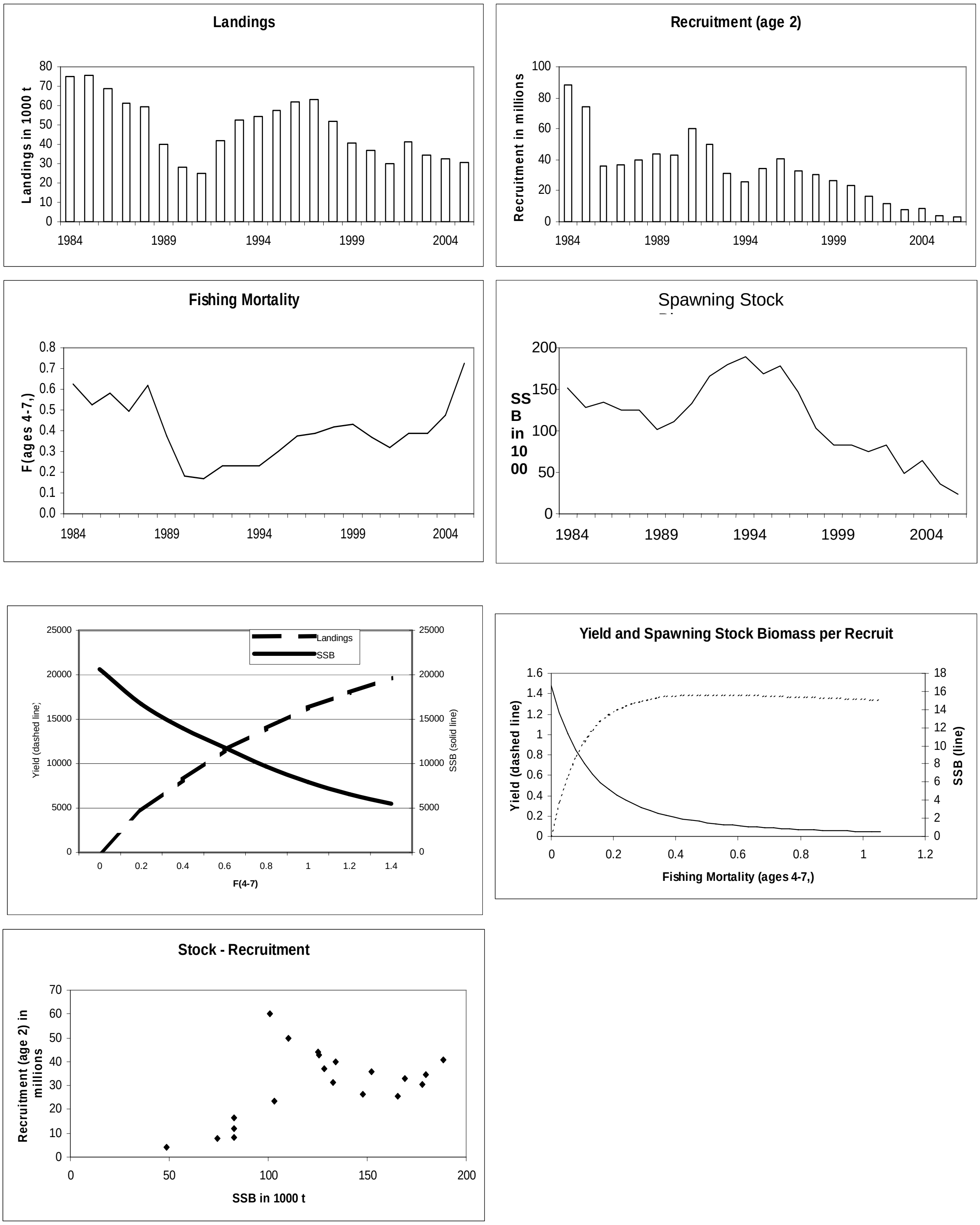
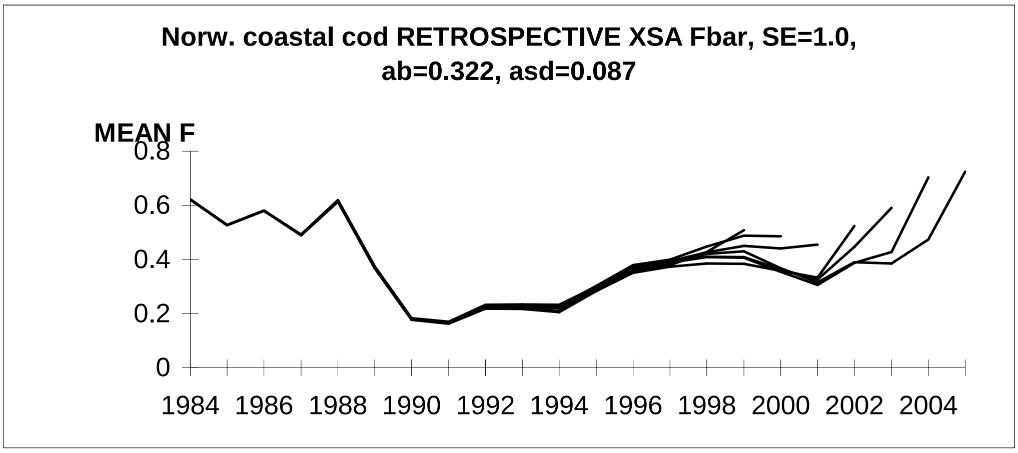
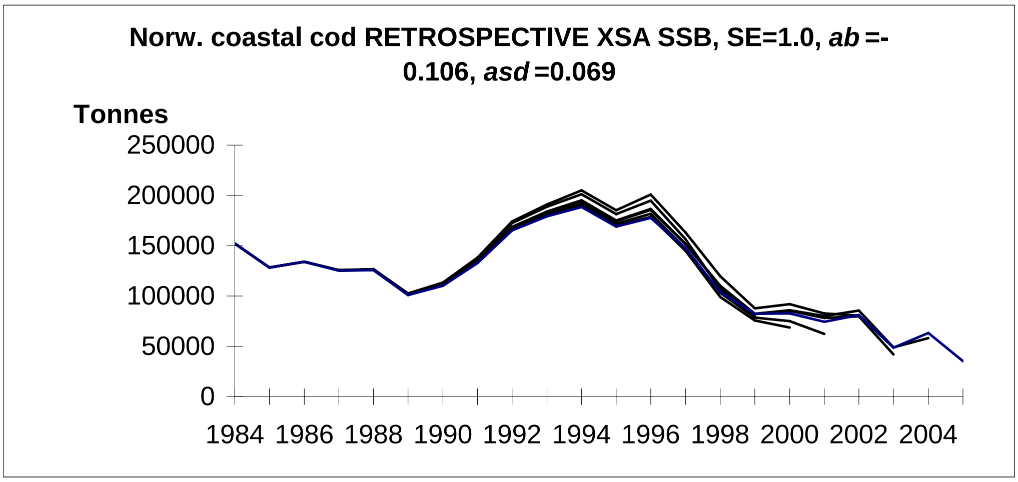


Figure 2.2 Norwegian Coastal cod: Historical landings, recruitment, fishing mortality and spawning stock biomass. Short term yield and spawning stock biomass. Long-term yield pr recruit and spawning stock biomass per recruit. Stock – recruitment.





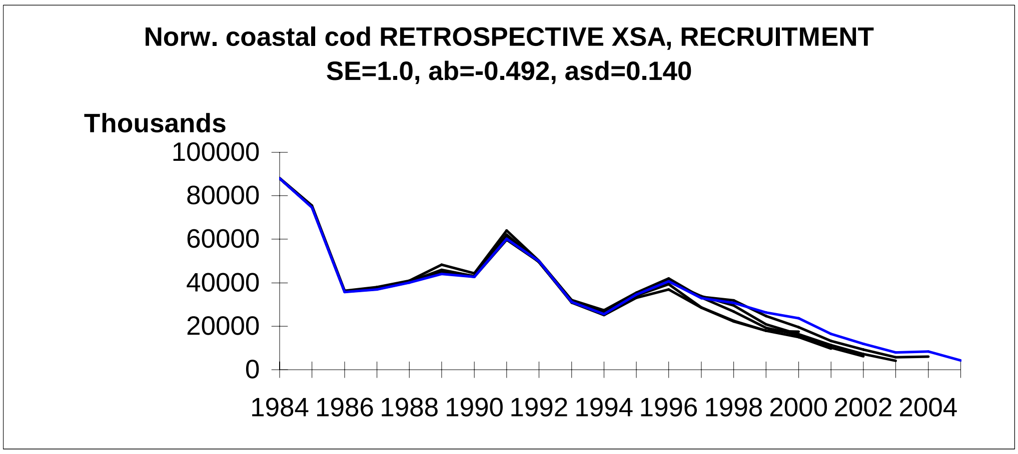


Figure 2.3 Norwegian coastal cod: Retrospective plots using XSA.with shrinkage SE=1.0.

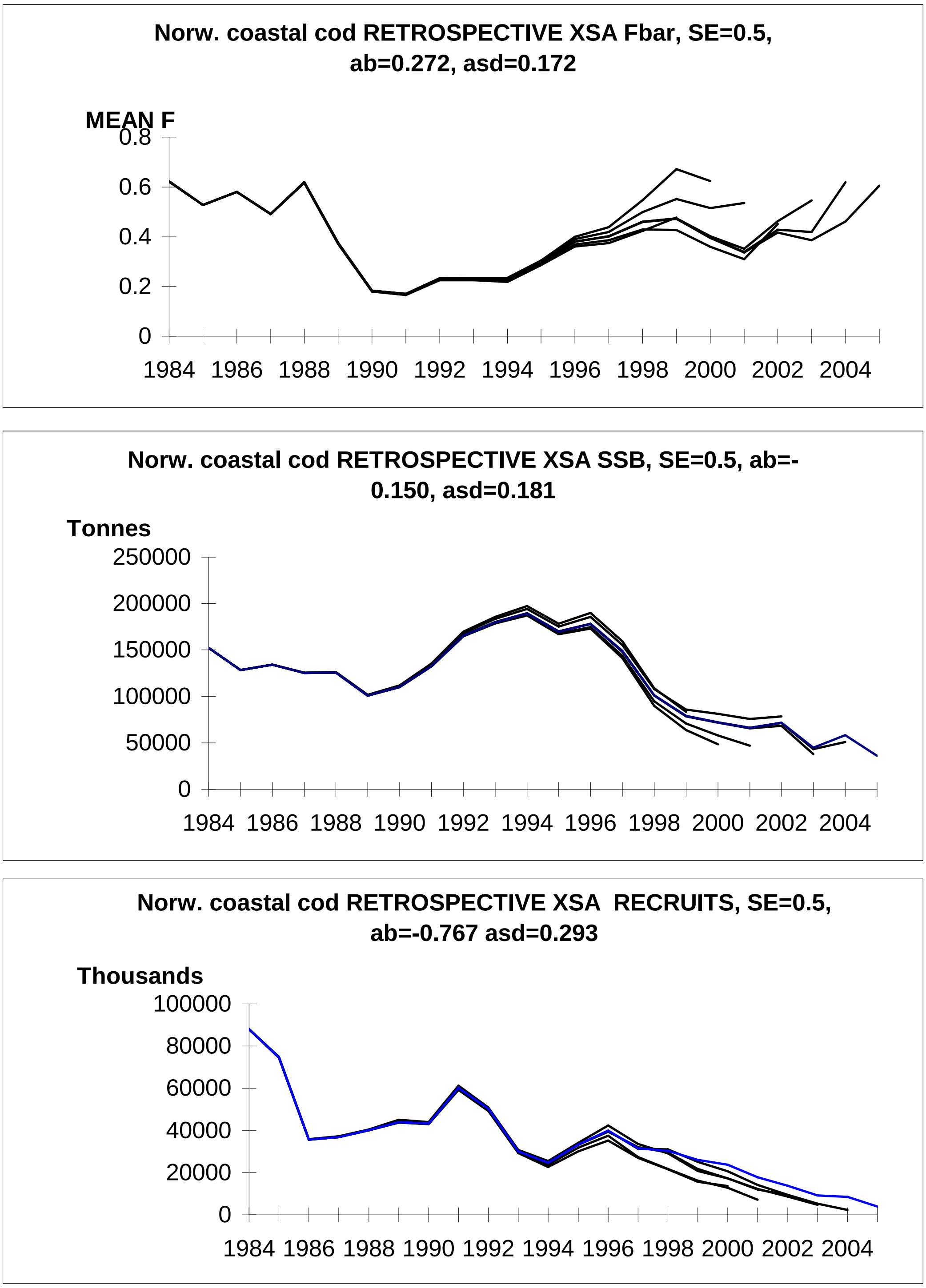


Figure 2.4 Norwegian coastal cod: Retrospective plots using XSA.with shrinkage SE=1.0.

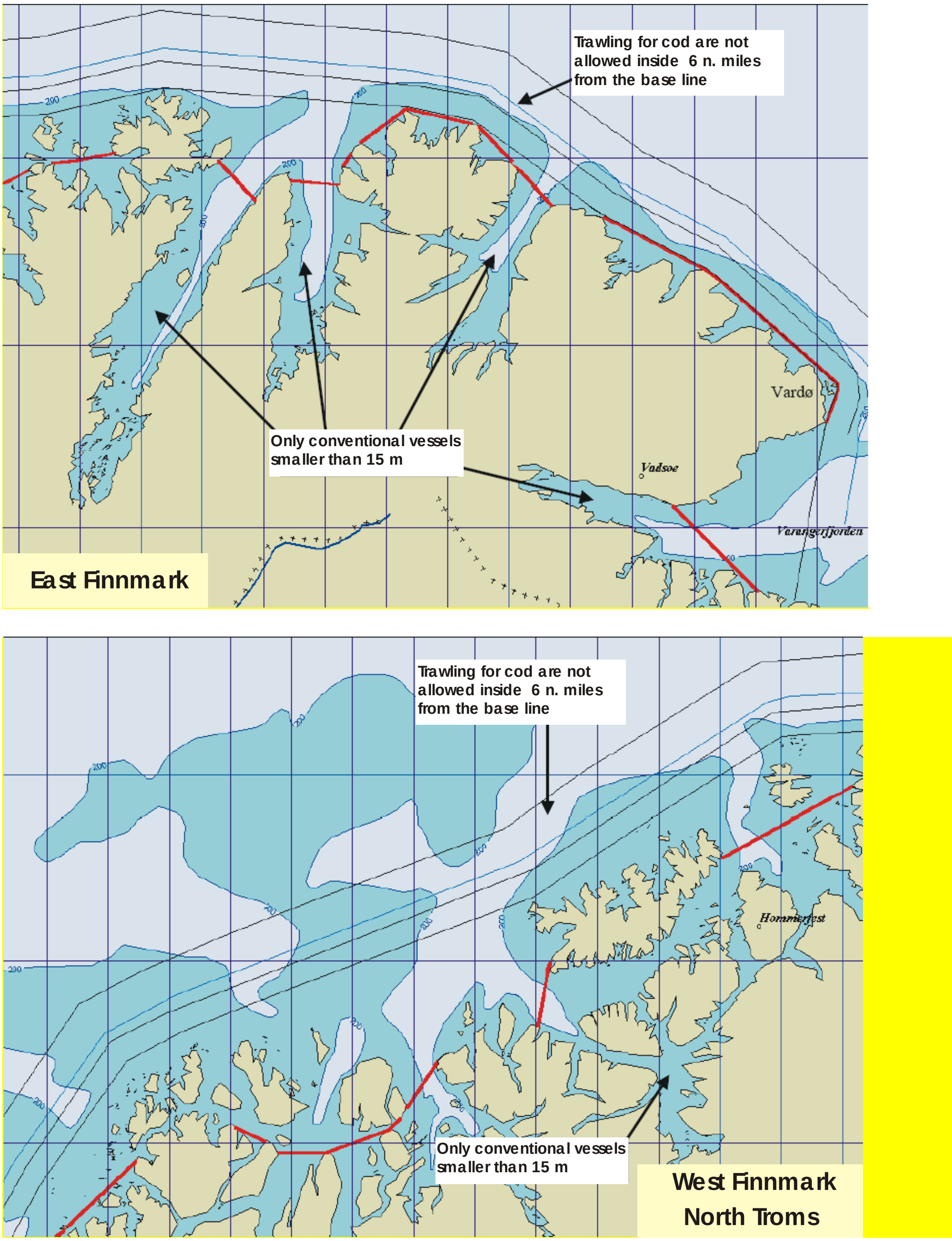
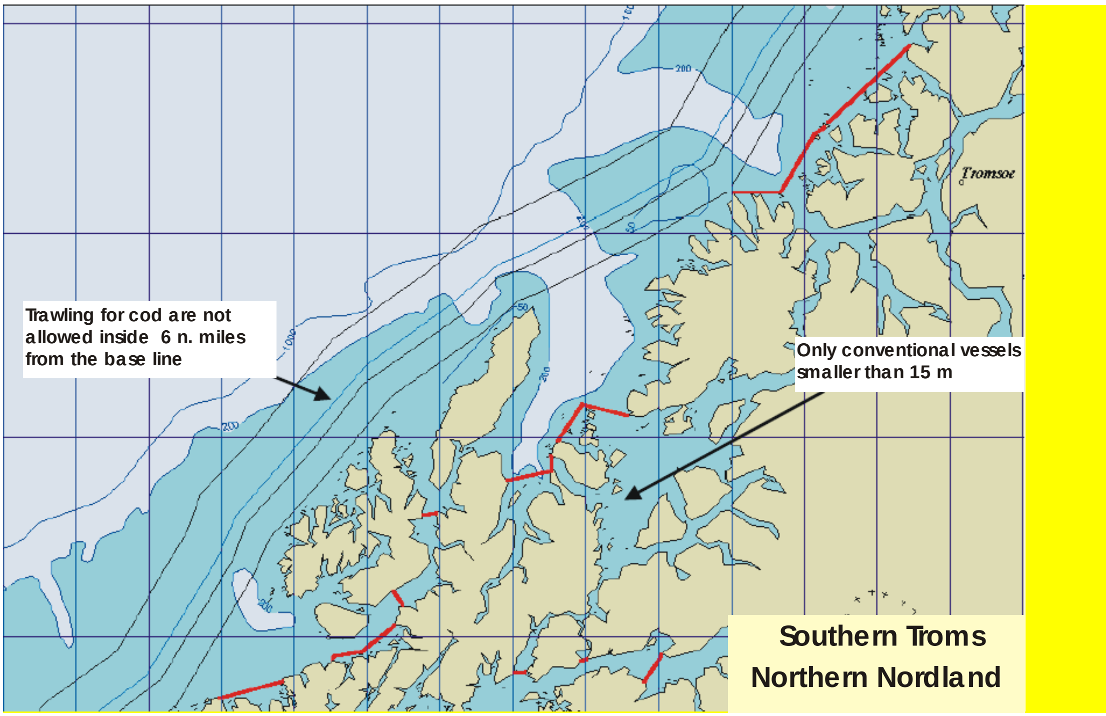


Figure 2.5 Map showing the new regulations for cod fishery near the coast of Norway



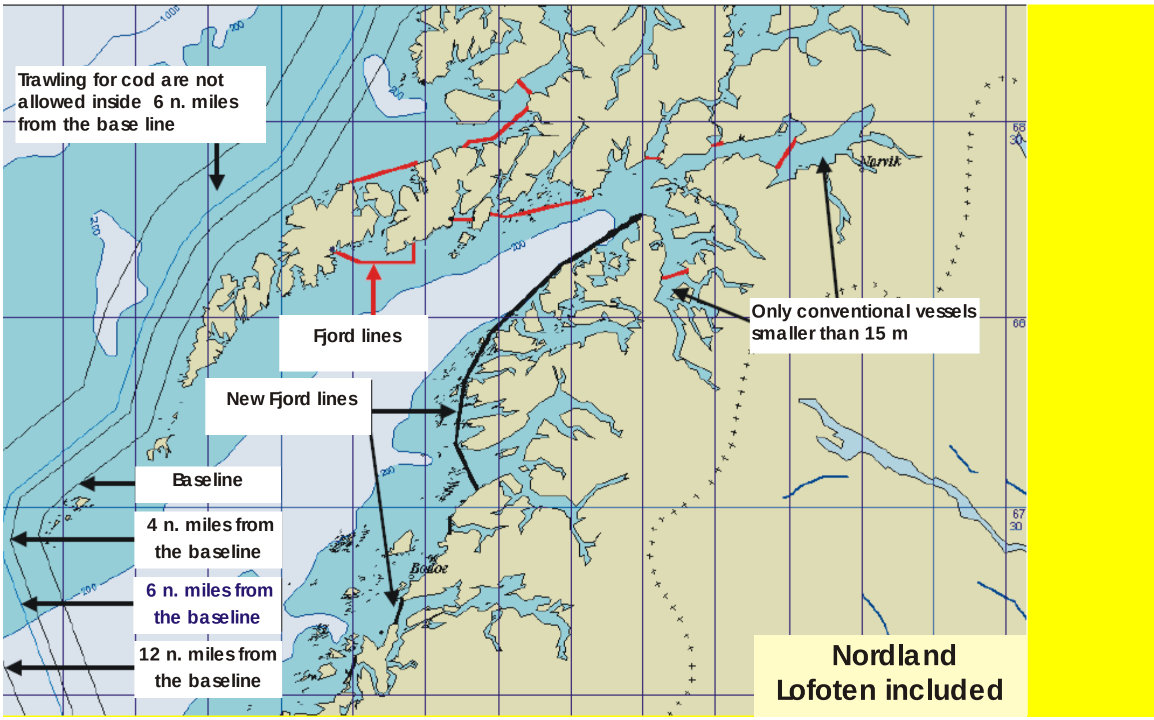
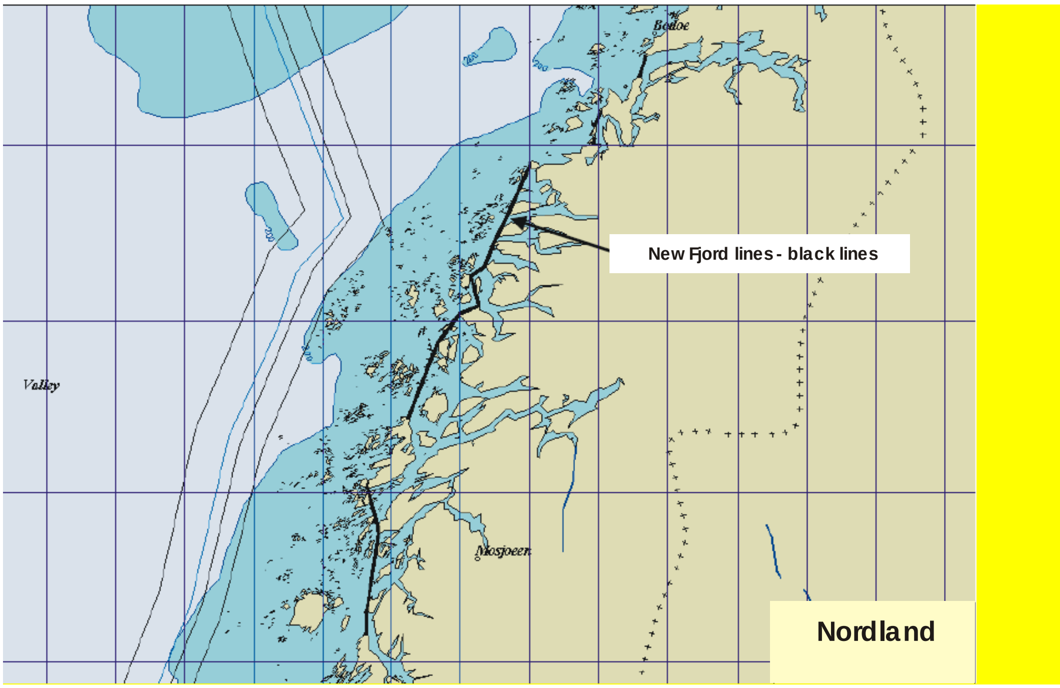


Figure 2.5 (Continued) Map showing the new regulations for cod fishery near the coast of Norway



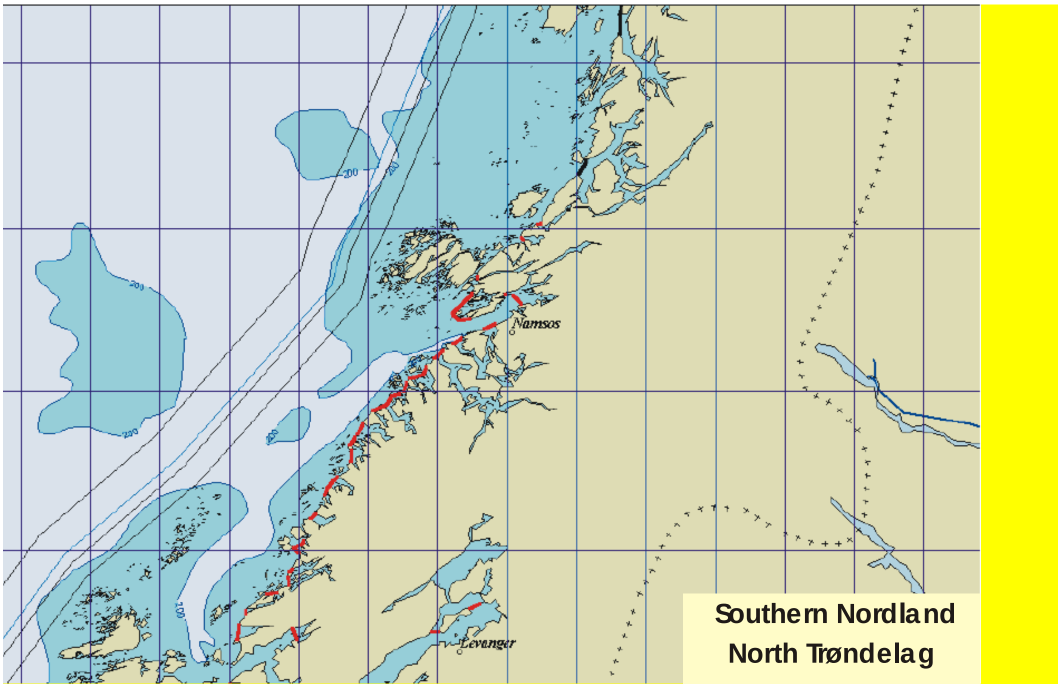


Figure 2.5 (Continued) Map showing the new regulations for cod fishery near the coast of Norway

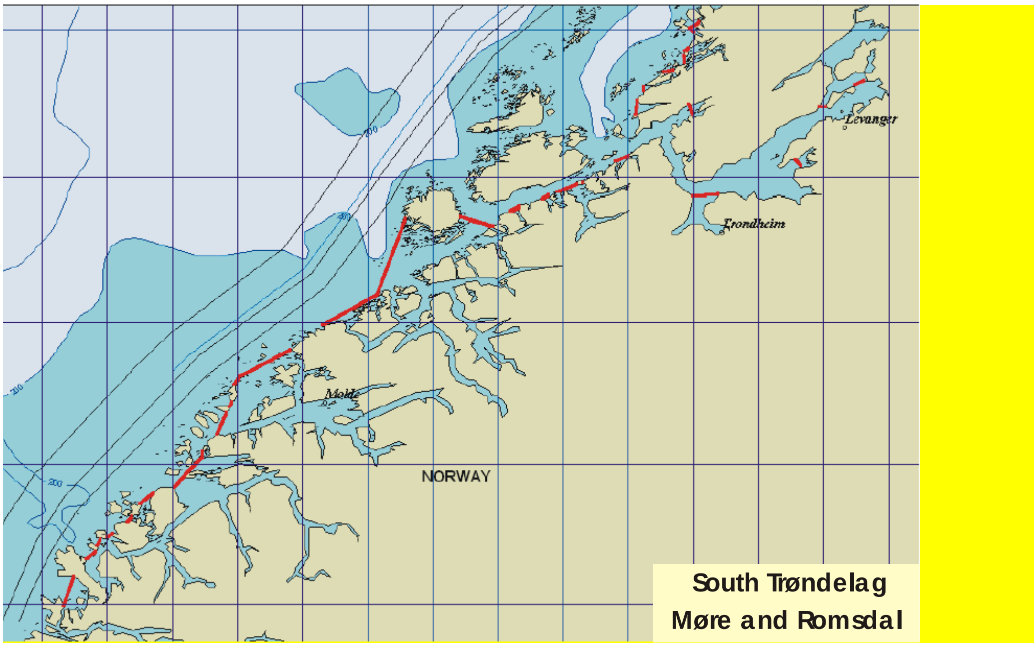


Figure 2.5 (Continued) Map showing the new regulations for cod fishery near the coast of Norway

3 North-East Arctic Cod (Sub-Areas I and II)

The assessment of this stock is on the observation list

3.1 Status of the fisheries

3.1.1 Historical development of the fisheries (Table 3.1a)

From a level of about 900,000 t in the mid-1970s, landings declined steadily to around 300,000 t in 1983-1985 (Table 3.1a). 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 2005 was 641,000 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 2006 (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 2004 amount to 489,445 t. The provisional official landings for 2005 are 475,276 t. Estimated unreported landings for 2004 was revised from 90,000 t used by the 2005 WG to 117,000 t. For 2005 an unreported catch of 166,000 t has been estimated. The methodology for estimating the unreported landings for 2004 and 2005 is described in WD4.

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) led to official landings of North-East Arctic cod of 489,445 t in 2004 and 475,276 t in 2005 (Table 3.1a). The coastal cod catches calculated this way in 2004 and 2005 were 13,951 t and 13,366 t, respectively. The catches of coastal cod calculated this way for the period 1960-2005 are given in Table 3.1b together with the coastal cod catches calculated based on otolith types as described in Section 2.

For the assessment the estimated 117,000 tonnes of unreported catches in 2004 and 166,000 tonnes in 2005 were added. All of these catches were assumed to be Northeast Arctic cod.

The landings by area, split into trawl and other gears, are given in Table 3.2 and the nominal landings by country are given in Table 3.3. Compared to 2004, the landings in 2005 increased in Division IIb, but decreased slightly in Sub-area I and in Division IIa (Table 3.1a).

3.1.3 Catch advice for 2005 and 2006

The mixed Norwegian-Russian Fisheries Commission agreed on a TAC of 506,000 t for 2005, including 21,000 t Norwegian coastal cod. The total reported catch of 488,462 t in 2005 was 17,358 t below the agreed TAC.

For 2006, the mixed Norwegian-Russian Fisheries Commission agreed on a TAC of 492,000 t, including 21,000 t Norwegian coastal cod.

The Working Group has no information on the size of expected unreported landings in 2006.

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)

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 2006 are given in Tables A2 and A3. More details on this survey are given in WD 23.

Before 2000 this survey was made without participation from Russian vessels, while in 2001-2005 Russian vessels have covered important parts of the Russian zone. In 2006, however, the survey was carried out only by Norwegian vessels.

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).

Joint ecosystem survey (formerly 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 since the 2000 Working Group. The series given for the Barents Sea for 1995-2004 covers ICES Division IIa and IIb and the north-western part of sub-area I, and thus includes the Svalbard area estimates. In 2004 and 2005, the Joint Ecosystem survey covered the entire Barents Sea. Survey estimates for the areas used in Table A5 can be calculated, but were not available to the Working Group.

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). Cod trawl-acoustic survey indices were revised using the data for 1994-2005 only (WD 21). Beforehand stratification of survey areas has been implemented using haul depth data. Then the abundance indices were calculated in four strata, using a trawl swept area method (Jakobsen et al., 1997). New swept area indices reflect Northeast Arctic cod stock dynamics more precisely as compared to the previous one - catch per hour trawling.

International 0-group survey

Abundance indices of 0-group cod from the International 0-group survey are provided in Tables 1.1-1.4. 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).

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 were presented at the 3rd International Symposium on otoliths (Australia, July 2004). It was shown, that bias in ageing made in different time periods cannot explain the appearance of the observed time trends in size at age of the Northeast Arctic cod population (Zuykova et al., WD12, 2005).

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 Barents Sea survey in February 2006 and the Russian autumn survey in 2005 show small changes in size-at-age compared to the previous year (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 1985-2006, Norwegian maturity at age ogives have been obtained by combining the Barents Sea and Lofoten surveys. 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 Norwegian maturity data since 1985 has been calculated by combining the observations from the Lofoten acoustic survey and the Barents Sea acoustic survey. In several earlier WG–reports it is said that the procedure for combining Norwegian and Russian maturity data is identical to the procedure used for combining Norwegian and Russian stock weights at age (the equation given in Section 3.3.2). This is literally true, but based on this it has been assumed that also the combination between Barents Sea and Lofoten was identical. This is not quite true. The data program used for combining the Norwegian maturity data keeps the total number of fish in each of the surveys as a weighting factor, but it does not necessarily keep the age (and length) composition as observed in the surveys. Some details of this procedure are given in the Appendix of Marshall et al. (1998). The main difference is that (within each survey) the maturation program weights each individual fish sampled according to the trawl catch rate, while in the survey estimate acoustic abundance by strata acts as a weighting factor. This year a WD (#19) on this topic was presented. Here the maturation from the two surveys was combined by the same method as used for combining stock weights from the two surveys. In addition some doubtful maturity observations (stages coded as uncertain) were excluded from the analysis. The analysis covered the years 1989-2006. In the years 1985-1988 another maturity scale was in use and some further work is required to recalculate for those years. Figure 3.2a compares the results. For most years and age groups the revisions were minor. These values (Table 3.5) were further combined with the Russian series and used in this year's assessment. Figure 3.2b shows the effect on last years' assessment of replacing the old data for 1989-2004 with these new ones.

3.2.5.1 Status of research on reproductive potential of NEA cod

Section 3.2.5 in the AFWG 2004 report lists a few maturity related topics for intersessional work. More details are discussed in a long maturity chapter in the 2003 AFWG report (3.2.5). A Russian-Norwegian project ("Optimal long-term harvest in the Barents Sea ecosystem") includes some of these topics, in particular the occurrence of skipped spawners. Gonads have been sampled for histological studies in both the Russian autumn survey and the joint winter survey in 2005 and 2006. In addition monthly sampling of gonads is made during 2006.

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.

Marshall et al. (2006) estimated female-only spawner biomass (FSB) and total egg production (TEP) for the Northeast Arctic cod stock over a 56-year time period. The proportion of females (FSB/SSB) varied between 24% and 68%, and the variation was systematic with length such that SSB became more female-biased as the mean length of spawners increased. Relative fecundity of the stock (TEP/SSB) varied between 115 and 355 eggs g^{-1} and was significantly, positively correlated with mean length of spawners. Both FSB and TEP gave a different interpretation of the recruitment response to reductions in stock size (overcompensatory) compared with that obtained using SSB (either compensatory or depensatory). There was no difference between SSB and FSB in the assessment of stock status; however, in recent years (1980–2001) TEP fell below the threshold level at which recruitment becomes impaired more frequently than did SSB. This suggests that using SSB as a measure of stock reproductive potential could lead to overly optimistic assessments of stock status.

3.3 Data used in the assessment

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

For 2004, the amount of unreported catches was increased from 90,000 tonnes to 117,000 tonnes, based on considerations presented in WD 4. No other revisions were made to the 2004 catches. For 2005, age compositions from all areas were available from Russia, Germany and Norway. Spain provided age compositions from Divisions IIa and IIb. 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 2004 and 2005 were distributed using total international trawl catch age distribution in Division IIb on half the unreported catch and total international trawl 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 (Table 3.9) were used in the XSA tuning.

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 the 2003 working group new estimates were presented for more recent years (WD 9, 2003). Estimated discarded by-catches in the shrimp fishery were presented in WD 1 and are given in Table 3.31a. These discard series should be further evaluated and considered for use in the assessment. From a high level in 1980s, these bycatches have now dropped to a fairly low level. It should be noted that the number of small cod (5-25 cm, i.e. ages 0-2 mainly) caught in bycatches from 1991 onwards are very low compared to the number of these age groups consumed by cod (Table 3.9). However, it is important to also have numbers for this by-catch in order to quantify all sources of mortality. More description of discards and unreported catches are given in the introduction section 1.4.1.

Hylen (2002) has extended the VPA back to 1932. This series should also be considered for use in the assessment and studies of reference points.

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

Catch weights

For 2005, 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. For the years 1946-1984 the 13+ weights are calculated year by year as a weighted mean of the former fixed values for older ages. For later years they are calculated from the average observed weight for age 11 in the years 1995-2006 increased by 1.58 kg for age 12 and 2x1.58 kg for age 13+.

For ages 1-11 stock weights at age a at the start of year y ($W_{a,y}$) for 1983-2006 (Table 3.12) were calculated as follows:

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

where

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

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

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

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

$W_{lof,a,y}$: 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 1985-2006.

3.3.5 Tuning data (Table 3.14)

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

	NAME	PLACE	SEASON	AGE	YEARS
Fleet 18	Russian bottom trawl surv.	Total area	Oct-Dec	3-8	1994-2005
Fleet 09	Russian trawl CPUE	Total area	All year	9-12	1985-2005
Fleet 15	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2006
Fleet 16	Joint acoustic survey	Barents Sea + Lofoten	Feb-Mar	3-11	1985-2006 (Table A14)

In the final run ages 12 in fleet 09 and ages 10 and 11 in fleet 16 were removed, and for fleet 18 age 9 was added. Fleet 18 is a recalculated series from Russian autumn survey. These changes are further commented in section 3.4.1. 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 2006 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 about 9,000 cod stomachs from the Barents Sea have been analysed annually in the period 1984-2005. 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 2005 as well as additional data for 2004. In addition, the age-length keys used for the second half of 2004 were revised (based on the ecosystem survey). 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. 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 (Johannessen et al., in prep.). 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.

3.3.8 Prediction data (Tables 3.23 and 3.28, Figure 3.2 and 3.11)

The input data to the short-term prediction with management option table (2006-2008) are given in Table 3.28. For 2006 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2006 onwards and stock weights in 2007 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 the 2003 working group. Then it was decided that for Catch Weights average annual increments by age were calculated for the period 1994-2001, and for Stock Weights average annual increments by age were calculated for the period 1995-2002. At the 2004 working group 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. The same argument was considered valid at the 2005 and 2006 working groups and only the 3 most recent values of annual increments were used for predicting stock weights. Figures 3.2c and 3.2d show how these predictions perform back in history. Evidently the fit is best over the period which is the basis for calculated Incr(a). The latest observations of stock weights are very close to those predicted, while the observed catch weights in 2005 is slightly below the predicted ones.

Last year the maturity ogive for the years 2005 and 2006 was predicted by using the 2002-2004 average. The 2003-2005 period also appears fairly stable, and an average over that period was applied. The exploitation pattern in 2006 and later years was set equal to the 2003-2005 average.

At the previous two WG meetings the reference F was also averaged over a three years period because there were no clear trend in F or documented fishing effort over those years. This year's assessment shows an increasing F since 2003, and also the available effort data shows an increase (Figure 3.11). It was therefore decided to use last year's (i.e. 2005) F value for the intermediate year in an $F_{status\ quo}$ prediction. Concerns were raised that this approach might give unrealistic low catch in 2006, compared to the agreed TAC plus expected overfishing. It was therefore decided to make an additional prediction with a catch constraint for 2006 equal to agreed TAC+ the average estimated overfishing in 2004 and 2005 (141,500 tonnes). It was also decided to make a forecast based on a 3-year average F to permit comparison to the procedure used by the two previous working groups.

The stock number at age in 2006 was taken from the final VPA (Table 3.23) for ages 4 and older. The recruitment at age 3 in year 2006 and later was estimated from surveys (section 3.3.6). Fig. 3.10 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 1984-2005. The recent 3 years average M was considered realistic as input for the years 2006-2008 in the prediction.

It is seen from Figure 3.10 that the level of cannibalism, particularly on age 1 cod, may be inversely related to the capelin abundance. Models for predicting cannibalism were presented in WD 10 (2004).

3.4 Methods used in the assessment.

The XSA was also this year used as the main assessment method. The assessment with Gadget is presented in section 3.10. Analysis made with the ADAPT assessment tool are presented in section 3.11 and results using ISVPA are presented and discussed in section 3.12. Results from the survey calibration method presented by Pennington and Nakken (WD 13) are given in Section 3.13 and a comparison of the results of all methods is given in Section 3.14.

3.4.1 VPA, tuning and sensitivity analysis

Since the assessments in August 2000, few changes in model settings and data choices have been made. The Quality Control Diagrams has indicated rather consistent assessments in the period 1999-2005, while this year’s assessment represents some downward revision of the stock.

This year a time series (1994-2005) was presented of stratified swept area estimates at age on the basis of the Russian autumn survey (WD 21). This series (labelled fleet 18) replaced the former average catch rate series from that survey (formerly labelled fleet 17). This revised series (for ages 3-8) was first applied for a rerun of the 2005 assessment, before the catch revision of the 2005 assessment was made (Table 3.15a). The new series showed considerably better diagnostics than the old version and got accordingly larger weights in the tuning.

After including the 2005 data the diagnostics of the first run were inspected. The diagnostics showed some high catchability residuals for age 12 in fleet 09 (Russian CPUE) and for age 10 and 11 in fleet 16 (the combined Barents Sea and Lofoten acoustic survey). This pattern was also commented on by the 2004 WG, but the data was kept in at that time. In addition, reviews of the previous two assessments have highlighted this issue. These age groups were removed one by one, and on basis of improved diagnostics (sees also ADAPT run, section 3.11) it was decided to not include the mentioned age groups for those fleets. In addition, age 9 from the new Russian series (fleet 18) was included and considered informative and useful. Figure 3.3a-c shows the residuals of the problematic series, and the residuals for the other age groups and surveys after the removal.

Figure 3.4 compares the estimated survivors (by end of 2005) and Fs before shrinkage in single fleet tunings. For the ages 3-8 there is a fair agreement between the single fleets, and the combined fleet (ALL, after shrinkage) are located in-between the individual fleet estimates. For age 9 the estimated survivors from the cpue series (fleet 9) is less than half compared to the estimates from the two surveys. For age 10 the fleet 9 is the only observation, but the combined value is somewhat increased by the extrapolated observations of the same cohort one year earlier. The internal consistency within surveys is illustrated in the plots from the “surba” program (Needle, 2003 and Needle, 2004) in Figure 3.5.

ACFM technical minutes have several times commented on the rather unconventional use of “stock size dependant catchability” (ssdq). For NEA cod, this is assumed for age groups 3-5. It is true that this choice involves more parameters to be estimated and a likely less precise parameter fit, in particular when the tuning is restricted to the latest 10 years. It is also observed that the influence of shrinkage is considerably higher for the age groups estimated by this q-assumption (table 3.15b). The 2005 WG argued for keeping this setting on the basis of compared retrospective patterns, and the ACFM reviewers agreed that without ssdq some problems might occur again as soon as some high survey values occur. The retrospective runs in last years report shows that the sensitivity to this choice was highest in the mid-1990s, a period with high survey estimates. The comparisons showed in Table 3.15b confirms that in the current situation with low or moderate survey estimates the assessment result is much less sensitive to these choices.

It is not clear whether this apparent stock size dependence in the surveys are real or caused by underreporting of catches. Underreporting would mean that the documented catches have been too small to confirm the abundance measured in the surveys. On the other hand, fish behaviour studies and comparative fishing have indicated that there might be a real tendency for higher escapement rate when fishing at low concentrations compared to high (Aglen *et al.* 1997).

The diagnostics (Table 3.16), at least for some of the fleets, show that the t-values for the log-log regression slopes are significantly different from 1 for some of the younger ages. Figure 3.6 shows XSA values vs. survey values for ages 3-6, for the 10 last years. Points indicating a line through the origin fulfils the assumption of stock size independent q. Cases indicating a large intercept or an asymptotic pattern would be better described by a stock size dependent q. Even in this short series there are several cases where the dependent version would be preferable. The problem is of course the parameter estimation with a short tuning series. Probably it is better to estimate relevant parameters at low precision than less relevant parameters with higher precision. For the above mentioned reasons the former setting with stock size dependant q for ages 3-5 was kept.

The WG discussed using a longer series. The earlier reason for limiting the series was a shift in survey coverage in 1993-1994. Following this argument the full series from 1994 should be utilised. The problematic issue now is illustrated by Figures 3.7-3.8 (details in WD 13). When surveys are scaled to the vpa in former years, the comparison between the vpa and the scaled survey shows a clear shift in 1998-1999. This reflects a shift in q which will influence the tuning. The tuning series for the final run was therefore (as in earlier assessments) constrained to 10 years (1996-2005) with a rather strong downweighting (“tricubic”) of the first 2-3 years. Table 3.15b includes results of a 15 year series for comparison. Table 3.15b also shows the effect of increased shrinkage. Compared with the final run both versions gave very similar biomass and reference F, while the age composition shifted slightly towards younger ages.

The reason for the indicated shift in q in 1998-1999 was discussed. One possible reason could be the inclusion of estimated underreporting from 2002 on, while underreporting or discarding might have been important also in earlier years. The retrospective plot (Figure 3.9) shows a shift in pattern around 2001, which could relate to this, but may also be caused by the shrinkage working in opposite direction for a decreasing stock compared to an increasing stock.

The effects of increasing unreported catch in 2004, and in 2005 adding 114,000 tonnes unreported catch (Reported from the Norwegian Directorate of Fisheries) and adding 166,000 tonnes unreported catch (WD 4) are shown in Table 3.15a.

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 was presented in Appendix 1 in the 2004 AFWG report. The conclusion was that it improves the assessment.

The following procedure was followed: As a starting point the number of cod consumed by cod was 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 (2005) 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 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 1984-2005 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, Figure 3.1)

The estimated F_{5-10} in 2005 is higher than the assumed F_{sq} in last year's prediction (0.74 vs. 0.57), while the spawning stock biomass in 2006 is estimated to be 517,000 t, which is well below last year's assessment (661,000 t). A more detailed comparison of this years' and last years' assessment is given in Section 3.9.

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 Figure 3.1.

Figure 3.9 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 431 millions for the 2003 year-class, 533 millions for the 2004 year-class and 546 millions for the 2005 year-class. A comparison of these results with the results of other recruitment models is given in Table 1.17.

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 $\mathbf{B}_{lim}$ = 220,000 t, $\mathbf{B}_{pa}$ = 460,000 t. (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).

Calculations of yield per recruit gave the following values: $F_{0.1}$ =0.12 and F_{max} =0.25.

3.6.3 Target reference points

The Russian-Norwegian Fishery Commission has requested an evaluation of the maximum sustainable yield (MSY) from the Barents Sea, taking into account species interactions and the influence from the environment. The work shall start with cod and gradually incorporate other species. A first step towards this is to study the MSY of cod in a single-species context (Kovalev and Bogstad, 2005). They studied the long-term yield of cod using the same biological model as used in the evaluation of the harvest control rule. Thus, mean weight at age in the stock was modelled as a function of total stock size, and mean weight at age in the catch and maturity at age was modelled as a function of mean weight at age in the stock. Cannibalism was included, and a stochastic segmented regression SSB-recruitment relationship was used. The results indicated that the long-term yield is fairly stable for a range of fishing mortalities between 0.25 and 0.6. It should be noted that there are few observations of biological parameters for low fishing mortalities and high stock sizes, so that the results for low Fs are more uncertain than those for higher Fs.

3.7 Short term forecast (Table 3.28-3.30)

Table 3.29 shows the short-term consequences over a range of F-values in 2007. The detailed outputs corresponding to F_{sq} in 2006 and F_{pa} in 2007 is given in Table 3.30a. In Figure 3.1 the catch level in 2007 and spawning stock biomass level in 2008 are plotted against the fishing mortality in 2007.

3.8 Three year 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. This rule was applied for the first time when setting quotas for 2004. The rule was somewhat amended at the 33rd session of The Joint Norwegian-Russian Fishery Commission in autumn 2004. The amended rule was evaluated by ICES in 2005 and found to be precautionary.

"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 utilization 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):

- *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 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 B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{pa} at B_{pa}, to F= 0 at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year, a year before and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.*

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).

3.8.2 Results

Tables 3.30a-b show output of the predictions for the time period (2006-2009) relevant for applying the agreed harvest control rule (HCR). Table 3.30a is based on F_{sq} (=F_{2005}=0.74) in 2006 and F=0.4 in the following years. The estimated SSB in 2007 is 441,000 tonnes. This is below B_{pa}, and in such a case the HCR specifies that the 10% constraint on annual TAC change is abandoned and that the 3 year average catch should be calculated by using an F reduced according to the ratio between SSB and B_{pa}. The HCR specifies that the 10% limit is abandoned if SSB is below B_{pa} in any of the relevant years (current year, quota year or the 2 following years), but it does not clearly specify the year to be used for calculating the reduction of F. In all the simulation work done by the WG to test the HCR the SSB in the quota year has been used as basis for reducing F (this means that the F for the 3 year prediction would be equal to 0.4 in all cases when SSB in the quota year is above B_{pa} regardless of what happens in the other years). According to this the F for calculating the 3 year average catch is F=0.4*441/460=0.38. Table 3.30b show the prediction for this reduced F.

The TAC in 2007 according to this rule is thus estimated to 366,000 tonnes, corresponding to F=0.49 in 2007. This catch forecast covers all catches. It is then implied that all types of catches are to be counted against this TAC. It also means that if any overfishing is expected to take place in 2007, the above calculated TAC should be reduced by the expected amount of overfishing.

The F_{sq} prediction above corresponds to a catch in 2006 of 551,000 tonnes, which is 80,000 tonnes above the agreed quota for 2006. In view of the 166,000 tonnes overfishing estimated for 2005 there could be reasons to believe that this prediction is overoptimistic. A prediction based on a catch in 2006 of 612,500 tonnes (agreed TAC+average estimated overfishing in 2004-2005) gives a further 10% lower SSB in 2007 (395,000 tonnes). Using an F_{sq} equal to the recent 3 year average F (F_{2006}= $F_{03\text{-}05}$=0.65, assuming there is no real trend in F) gives SSB in 2007 of 479,000 tonnes, which is above B_{pa}. This illustrates some of the uncertainty related to expected catch levels in 2006 (see table below).

F2006	BASIS	C2006	SSB2007	F IN 3 YR RULE	C2007	SSB2008	COMMENTS REGARDING HCR IN 2007
0.741	F06=F05	551	441	0.383	366	556	no 10% limit, F=0.4*441/460
0.862	C06=612	612	395	0.344	326	532	no 10% limit, F=0.4*395/460
0.649	F06=aver	500	479	0.4	424	524	catch =TAC06-10% (otherwise 390)

In all these cases the SSB in 2007 decreases compared to 2006.

Concerning the HCR, it should also be noted that it does not take into consideration possible assessment revisions from year to year. This may lead to unexpected results, as illustrated by the following example: This year, the predicted SSB in 2007 (441,000 t) is < B_{pa}, and thus the limit of 10% year-to-year-change is suspended when setting the TAC for 2007. The prediction also gives an increase of more than 10% in the TAC from 2007 to 2008 (from 366 to 425 thousand tonnes), which will be allowed because SSB < B_{pa} in 2007. However, if next year's assessment should show that the SSB in 2007 and following years all are > B_{pa}, this means that the TAC for 2008 then will be limited by the 10% year-to-year change, and thus may not increase by more than 10%. One of the intentions of the rule was that the 10% limit should not apply in the situation when the SSB increases from below B_{pa} in one year to above B_{pa} in next year, so that the TAC can be increased by more than 10% in such situations. This intention will thus not always be fulfilled.

The HCR evaluation performed last year found the HCR to be in agreement with the precautionary approach, provided that the assessment uncertainty, assessment error and implementation error are not greater than those calculated from historic data and used in the evaluation. It should be noted that an implementation error of 12% with a CV of 0.18 was used for all age groups. In 2002-2005, the implementation error has been in the 20-35% range. Thus, the assumptions made in the evaluation may be violated.

Stochastic medium-term predictions for the period 2006-2009, using the HCR, are given in Figure 3.11. The same uncertainty in stock assessment as in the HCR work (section 3.14 AFWG 2005) was used. It was decided not to apply any bias in the predictions, based on the rather consistent retrospective pattern in recent years. No implementation error was assumed. The uncertainty in the recruitment in 2007-2009 was assumed to be the same as the uncertainty in the assessment of age 3 fish. The recruitment in 2010 and 2011 (used when applying the 3-year rule in 2008 and 2009) was calculated using the stock-recruitment relationship used in the evaluation of the harvest control rule.

3.9 Comparison of this year's XSA assessment with last year's assessment.

The text table below compares this year's estimates with last year's estimate for the year 2005 for number at age, total biomass, spawning biomass and reference F-values, as well as reference F for the year 2004.

			2005									
Assessment yr (specification)	F(2004)	age3	age4	age5	age6	age7	age8	age9	age10	TSB	SSB	F(2005)
2005 WG	0.57	576*	234	305	150	103	48	17.6	4.6	1573	701	0.57**
2005 revised data***	0.60		273	289	133	87	46	16.0	5.4	1482	643	
2006 final	0.68	484	255	311	135	90	40	13.1	4.3	1443	595	0.74
Ratio 2006 final/ 2005 revised	1.13		0.93	1.08	1.02	1.03	0.87	0.82	0.80	0.97	0.93	
Ratio 2006 final/ 2005 WG	1.19	0.84	1.09	1.02	0.90	0.87	0.83	0.74	0.93	0.92	0.85	1.30

*estimated by rct3 **assuming three-year F_{sq} ***revised tuning fleet and revised landings

The final assessment values for ages 4-7 and 10 are fairly close to the 2005 assessment, while ages 3, 8 and 9 seem to have been overestimated in last year's assessment. The F in 2004 is revised up by 19%, (13% compared to the revised 2005 analysis). The SSB in 2005 is revised down by 15% and the estimated F for 2005 is 30% higher than the F_{sq} applied by last WG. The updated 2005 assessment (increased catch and revised fleet data) are in between the two others.

The new estimate of SSB in 2006 (517,000 tonnes) is 22% below the prediction from last year (661,000 tonnes). The downward revision of the SSB in 2006 is mainly explained by revised stock numbers. The observed maturation at age in 2006 is slightly lower than predicted last year, but explains only 2 % reduction of the SSB in 2006.

Retrospective plots of F, SSB and recruitment are shown in Figure 3.9. It is observed that with the current tuning settings and fleet inputs this pattern of downward revision of stock and upward revision of F occurs over the latest three year period when the stock decreases and F increases.

3.10 Assessment using Gadget

3.10.1 ntroduction

The Gadget modelling framework is described in Section 0.6. The biological Gadget model used for Northeast Arctic cod is described in Bogstad et al. (2004).

3.10.2 Stock assessment using Gadget

3.10.2.1 Model structure

A quarterly time step is used. The model is run for the period 1.quarter 1985- 1.quarter 2006. The cod stock is divided into an immature (ages 1-10, lengths 1-105 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 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	1994-2006	1-10	5-90 cm	Immature
Norwegian Winter acoustic	1	1985-1993	3-9	20-90 cm	Immature
Norwegian/Joint Winter acoustic	1	1994-2006	1-10	5-90 cm	Immature
Lofoten acoustic	1	1985-1989	5-12+	55-110 cm	Mature
Lofoten acoustic	1	1990-2006	5-12+	55-110 cm	Mature
Russian bottom trawl autumn	4	1994-2005	3-13	11-126 cm	Immature and mature

The Norwegian (2000-2005 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).

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 1985-2005 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 1985-2005 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. It was attempted to include those data in the likelihood function, using the SCAmounts and SCRatios function in Gadget. The runs presented here include consumption data in the likelihood function using SCRatios.

Differences between data used in XSA and in Gadget

It should be noted that there is some difference between the tuning series used in XSA and in Gadget. The earliest part of all the survey time series are downweighted in XSA. In Gadget, 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 Gadget. The Russian CPUE series (FLT09 in XSA) is not used in Gadget.

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. 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, Gadget 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.

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 Software and optimization algorithm

Model runs are now performed using Gadget version 2.1.02. 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 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

The results of the 1+ runs were not considered to be reliable. Thus the 3+ run with the same settings as in last year's Gadget assessment was chosen as the key run. The weighting factors for the individual components in the objective function were adjusted because the revised data from the Russian survey were on a different scale than those previously used. The weight given to each component is approximately the same as last year, however.

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. 3.13a-f, together with the XSA assessment and last year's key run. 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 90 000 tonnes in 1995. In general, the trends given by XSA and Gadget are very similar for the fishing mortality and stock biomass. Gadget shows the same overall trends for $F_{5\text{-}10}$ as XSA, but the curve given by Gadget is smoother. One reason for this may be that Gadget 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 fishing mortality ($F_{5\text{-}10}$) in 2004 was about the same in this year's assessment as in last year's assessment (0.67 vs. 0.68 last year), while the total stock biomass in 2005 increased from 1.1 million tonnes in the 2005 assessment to 1.4 million tonnes in this year's assessment.

It should be noted that the maturity parameters were not estimated this year and that the proportion mature at age in Gadget is markedly lower than in XSA. Runs with lower (and fixed) values of the maturation length gave small changes in the total biomass and fishing mortality for a rather wide range of values (75-97cm), while the spawning stock biomass of course increased with decreasing maturation length. The objective function was relatively little affected by the value of the maturation length. Data on proportion mature fish by length/age group in surveys and catches are available and need to be included to determine the proportion mature fish in a better way. At present it is only the survey indices and the assumptions about which surveys cover immature/mature/all fish that determine the maturation parameters.

Model/data fit

The total likelihood score is not comparable to last year's assessment, the weighting factors are changed and the Russian survey has been revised, as mentioned above.

The logarithm of the ratio between observed and modelled catches and survey indices by age are plotted in Fig. 3.15. The fit of the catch data is generally good, but the fit to the survey data is more variable.

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 3.14a-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 2000, and is thus labeled 2000. The retrospective pattern seems to be quite consistent back to 2000.

3.10.5 Reference points related to Gadget

In order to use Gadget 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 Gadget. It should be noted that it is somewhat difficult to extend Gadget 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.

Kvamme and Bogstad (2006) studied how the results of a yield-per-recruit analysis varied according to the choice of model structure. For Northeast Arctic cod, an age-structured model was compared to an age-length structured Gadget model. In a fishery large fish within a cohort are likely to enter the fishery earlier than the smaller fish of the same age. This results in a change in the mean weight at age of a year class of fish, depending on the fishing pressure and the selectivity of the fishery. An age-based approach may not capture this feature, and may thus give misleading yield-per-recruit calculations. In particular it may underestimate the benefits to be gained by delaying exploitation to older, larger, fish. Thus, YPR analyses should incorporate length structure. It was shown that moderate or high fishing pressures, with fishing on medium or small fish, would produce significant reductions in the mean weight at age of the stock. This translated to marked differences in the yield-per-recruit curves in the model in which length structure was included.

3.11 Assessment using ADAPT

3.11.1 ADAPT vs. XSA

Although the underlying cohort model used within ADAPT (Gavaris, 1988) and XSA (Darby and Flatman, 1994) is the same, there are several important differences. First, a statistical approach is used to estimate parameters within ADAPT, minimizing a statistical objective function, complete with estimates of the standard errors and bias (associated with the non-linear estimation) of the parameters. XSA is an iterative process, basically converging upon the average population trend inferred from the tuning data. Another important difference is that within ADAPT, shrinkage is not an option, whereas XSA permits two types of shrinkage: i) shrinkage towards the mean fishing mortality in recent years, and ii) shrinking the estimate of terminal year recruitment towards the time-series average. There are numerous other differences between ADAPT and XSA, but these are less fundamental than those noted above.

3.11.2 ADAPT Runs, NEA Cod

In addition to estimating stock size with XSA, VPA analyses using ADAPT software were explored for NEA cod. The model structure was selected independently from the XSA settings.

The catch at age matrix for NEA cod includes a plus group. Within ADAPT, there are two methods for specifying cohorts using F-constraints: “FRATIO” or “FIRST” (see Gavaris, 1988). All ADAPT results presented herein use the FRATIO method for F-constraints on the plus group. Using the FRATIO method, it is assumed that the fishing mortality for the plus group is proportional to the fishing mortality on the oldest “true age”. The constant of proportionality may be either fixed or estimated. The results presented below all have the FRATIO value fixed at 1.0, so that $F_{13+} = F_{12}$. To evaluate the influence of this assumption, an additional VPA run including estimation of the FRATIO parameter over all years was conducted, and differences in resulting estimates are imperceptible. This is not unexpected as the plus-group contains a very small proportion of the population.

Results are presented below for an ADAPT analysis with the following inputs and structure:

Catch at age, 1984-2005, ages 1-13+ (includes estimates of cannibalism at younger ages).

M=0.2 for all years, ages

Tuning Data:

Fleet 9 - Russian CPUE dataset, 1996-2005, ages 9-12

Fleet 15 - Joint Bottom Trawl Survey in Barents Sea, 1996-2005, ages 3-8

Fleet 16 - Joint Acoustic Survey in Barents Sea + Lofoten, 1996-2005, ages 3-11

Fleet 18 - Russian Bottom Trawl Survey, 1996-2005, ages 3-8 (in some of the outputs labelled fleet 17)

Estimation:

Survivors ages 4-13+ estimated for Jan 1 2006

FRATIO fixed at 1 over 1984-2005.

Catchabilities estimated for each index-age.

The parameter estimates from ADAPT (Table 3.34) indicate relatively large standard errors for the survivor estimates, with increasing CV for the older age groups. The relative bias is quite small except for the oldest age-classes of survivors. Residual analyses (Figures 3.16 and 3.17) indicate that the overall mean square error (0.145) is dominated by three index-ages: ages 10 and 11 from Fleet 16, and also age 12 from the Russian CPUE series (Fleet 18). Note that for each of these age groups there are many positive and negative residuals, which are large in magnitude (Fig. 3.17), as opposed to one outlier inflating the MSE. Further, there is an apparent increasing trend in the mean annual residual from the Russian trawl survey (Fleet 18). Evidence of year-effects can be seen in each of the tuning series.

3.11.3 Results

A summary table of VPA results (bias-corrected) from ADAPT (Table 3.35) reveals that the population is decreasing and fishing mortality has increased in the recent time period. Note that estimates of 2006 biomass and spawner biomass are generated using 3-year geometric means of the stock weights and maturities. The average fishing mortality in 2005 over ages 5-10 is 0.80, which is greater than the long-term average (0.74). Total biomass for 2006 (1.13 million t) is estimated to be the 5^{th} lowest in the 1984-2005 time series; however, due to increasing trends in maturity over the past decade, spawner biomass in 2006 (490,000 t) is estimated to be slightly above the long-term average (445,000 t).

3.11.4 Sensitivities

The robustness of the assessment was evaluated with respect to the trends inferred from each tuning fleet. Using XSA, this sensitivity is typically evaluated by single tuning fleet runs. In ADAPT, estimation within such an exercise can be problematic, particularly when there are tuning fleets with limited data. For example, consider the Russian CPUE series, having age 9 as the youngest age. Within ADAPT, one would have to manually fill survivor estimates at ages 1-9, and age 10 would be the youngest age group of the survivors which could be estimated. As such, within ADAPT, fleet effects are commonly investigated by a series of analyses which re-estimate the population size, excluding each fleet in turn from tuning data set. A plot of the estimated biomass and reference fishing mortality in 2005 from these analyses (Figure 3.18) indicates that the trends inferred from each fleet are quite similar.

3.11.5 Additional Run

A second analysis was considered which was identical in structure to the previous run. However, the input data set excludes the three poorly fitted index-age groups noted above: ages 10 and 11 from Fleet 16, and also age 12 from the Russian CPUE series (Fleet 18). Although the estimated trends in stock size are almost identical (Table 3.36-3.37, Figures 3.19 – 3.21), the diagnostics are much-improved: the overall MSE decreases to 0.080 (compared to 0.145 above), and the standard errors on the parameter (Table 3.37) estimates are reduced considerably; only the survivor estimates for age groups 11, 12, and 13+ have relative errors exceeding 20%. Residual patterns for index-ages used in both runs show similar patterns.

3.11.6 Retrospective Analysis

Using the second input dataset, a five-year retrospective analysis was conducted. Results (Fig 3.22) indicate that estimates of terminal year stock size and fishing mortality are generally stable, with some indications that the total and spawner biomass were over-estimates in assessment years 2003 and 2004.

3.11.7 Comparison to XSA Results

Comparison plots (Fig 3.23) of the final ADAPT run and the XSA run indicate near identical results, which implies that the XSA is insensitive to shrinkage settings and the weighting scheme applied (tapered time weighting). Note, however, that the final XSA run includes an additional age group in the tuning input file: age 9 of the revised Russian survey index. As in the previous figures, the 2006 biomass and spawner biomass values are computed using a three year geometric mean of stock weights and maturities. The differences in recruitment in the last two years are reflective of P-shrinkage in XSA.

3.12 Assessment using ISVPA

3.12.1 ISVPA vs. XSA

Both models are cohort methods of stock assessment but they have several important structural differences. In contrast to XSA, ISVPA (Vasilyev, 2005) is a separable cohort model.

Unknown parameters of XSA model are estimated by iterative procedure; convergence of this procedure is considered complete, if terminal fishing mortality coefficient estimates after two successive iterations are sufficiently close to each other. Such convergence of the calculations does not prove that the solution found is unique and has an unclear statistical meaning. Furthermore, convergence within XSA is usually not attained after 30 iterations but after a considerable increase in the number of iterations.

ISVPA estimates the unknown parameters by means of minimisation of a loss function with distinct statistical meaning.

For the XSA tuning, it is possible to use several age-disaggregated indices, such as CPUE series or the survey results. An imperative condition of using such indices is the availability of data for the terminal year. If any series is interrupted this index can not be used.

ISVPA can use auxiliary information in form of age-structured time series or time series without age structure (integral indices). The procedure used to estimate parameters permits time gaps in auxiliary data, even for the terminal year. Furthermore, the procedure allows estimation of parameters from catch-at-age data alone. Other advantages of this model include option to use principles of robust statistics to decrease the effect of data noise on results and the possibility to get unbiased estimates of the stock parameters.

3.12.2 Input data

The first ISVPA run for NEA cod was made with input data from AFWG-2005 for year interval 1985-2004 (Bulgakova and Vasilyev, WD# 9).

The results presented below use the same input data as used in the key run *SVPASA15/V15* (includes unreported landings) at AFWG-2006 except natural mortality (M) – this value is fixed at 0.2 for all ages and years. The analysis covers years 1980-2005, and the age groups 3-13+.

3.12.3 ISVPA run for NEA Cod

The first stage of ISVPA analysis consists of search for the most appropriate model settings. The user can divide the time-series into two sub-periods, and estimate constant selectivity patterns for each sub-period. For NEA cod, preliminary analyses indicated that the sub periods 1980-1991 and 1992-2005 were most appropriate.

It is also necessary to choose the most suitable type of loss function for the catch-at age matrix and for the each component of the loss function corresponding to each stock index. Loss functions, which may be used in the ISVPA, include the sum of squared logarithmic residuals (SSE), the median of distribution of squared logarithmic residuals (MDN), or the median of the absolute deviations of model residuals from their median value (AMD). The latter two options are more robust choices for the loss function (Vasilyev, 2005). The abundance at age data from survey can be used for the model tuning either as absolute number estimates (noted in table below and in figures as N&N) or as age proportions (P&P). Using P&P can remove the effect of possible inter-annual differences in the survey execution conditions. The logarithmical residuals of the age proportions can be weighted by the abundance estimates (P&Pwd) to give more statistical weight to more representative data (Vasilyev, 2003).

The indices chosen for tuning are shown in the text table below. The type of loss function applied to each component is indicated in the last column of the table. The last index of the spawning stock biomass (S92) is the CPUE of the Russia fleet taken from Table A1 for three sub-areas (Sub-area I, DivIIa and DivIIb) and weighted by the total catches from these areas. Table A1 also contains the CPUE of the Norwegian fleet. The dynamics of these two CPUE series (Figure 3.24) are similar since 1992, thus the Russian CPUE data is used in the run for 1992 onward. Note that these two indices are measured in different units.

Data series for ISVPA tuning

DATA INDEX	NAME	YEAR TUNING INTERVAL	AGE INTERVAL	SEASON	TYPE OF LOSSF
Fl 09	Russian trawl CPUE	1996-2005	9-11	All year	MDN;N&N
Fl 15	Joint bottom trawl survey	1996-2005	3-8	Feb-Mar	MDN;N&N
Fl 16	Joint acoustic survey	1996-2005	3-11	Feb-Mar	MDN;N&N
Fl 18	Russian bottom trawl survey	1994-2005	3-8	Oct-Dec	SSE;N&N
S92	Russian CPUE	1992-2005	Integral index	All year	SSE;N&N

3.12.4 Results

A series of calculations are carried out to determine suitable model options and suitable form of the loss function component for each index. Loss functions with a pronounced minimum in the loss profile were selected. The final profiles of these components are presented in Figure 3.25. Most of then have a well-defined minimum.

The ISVPA allows comparison signals from different variants of the same stock index. In previous years, AFWG has used the results of the Russian bottom trawl survey for tuning (fleet 17, FL 17). In 2006 Golovanov, Yaragina and Sokolov (WD# 21) presented a new time series for this index, using method based on estimates of the swept bottom trawls area. The new time series (FL 18) is used in XSA tuning instead of FL17. Comparison of the loss functions for FL 17 and FL 18 by means of ISVPA showed the new series has a more pronounced signal (see Figure 3.26) as the minimum of the loss function is more well-defined. Figure 3.27 shows the logarithmic residuals from ISVPA for the estimated catch at age matrix and for each of the five indices listed in the text table above.

The stock assessment results obtained by ISVPA are presented in Table 3.38 and Figures 3.28 and 3.29.

3.12.5 Comparison to XSA Results

The cod stock dynamics estimated from both models, XSA and ISVPA, are quite similar (Figure 3.28), however in the last 2 years, the ISVPA estimates of total stock biomass and SSB indicate smaller decreases compared to the XSA estimates. The estimated stock abundance and fishing mortality at age in the terminal year from the two models indicate notable differences for ages 3-6 (Figure 3.29).

The considerable difference in estimated recruitment (Figure 3.28) is caused by differences in the assumed natural mortality – XSA uses a natural mortality matrix, which includes estimates of cannibalism and ISVPA does not include cannibalism (M=0.2).

3.13 Survey calibration method

A “calibrated” prediction of stock numbers from the Joint bottom trawl survey against VPA numbers, using data from the period 1981-1995 to scale the survey series to absolute numbers, is given in Pennington and Nakken (WD13). The regression is done for ages 4-6 and 7+ separately. The results, using a regression method with intercept, are shown in Fig 3.7-3.8 and in the text table in Section 3.14. The figure shows that the survey calibration method gives comparable trends with the VPA for ages 4-6, but gives somewhat smaller stock sizes than the

VPA. For age 7+, the trends are also comparable, although the picture is more noisy. The downward revision of the age 7+ stock from the 2005 to the 2006 assessment year gives a better correspondence between the VPA and the survey calibration method this year than last year.

3.14 Comparison of results of different approaches

The text table below shows a comparison of stock size and fishing mortality for the different approaches.

METHOD	F 2005	SSB 2005	SSB 2006	TSB 2006	NUMBER AGE 4-6 1 JANUARY 2006	NUMBER AGE 7+ 1 JANUARY 2006
Final run (svpa)	0.74	595	517	1319	690	110
Gadget	0.89	373	263	997	509	86
ADAPT	0.73	605	515	1167	519	104
ISVPA	0.69	637	681	1474	647	137
Survey calibration - Pennington & Nakken					550	101

All methods confirm a high F in 2005. Gadget gave the highest F (0.89) while the others are in the range 0.69-0.74. The difference between Gadget and the others is larger for SSB than for TSB and stock numbers. The additional difference for SSB is caused by Gadget modeling lower maturation at age. Stock numbers ages 4-6 is higher for xsa than the others.

3.15 Precision in input data

Estimates of sampling error are to a large degree lacking or are incomplete for the input data used in the assessment. However, the uncertainty has been estimated for some parts of the input data:

For the Norwegian estimates of catch at age methods for estimating the precision have been developed, and the work is still in progress (Aanes and Pennington 2003, Hirst et al. 2004, Hirst et al. 2005). The methods are general and can in principle be used for the total catch, including all countries catches, and provide estimates both at age and at length groups. Typical error coefficients of variation are in the range 5-40% depending on age and year. It is evident that the estimates of the oldest fish are the most imprecise due to the low numbers in the catches and resulting small number of samples on these age groups.

For the Barents Sea winter survey, the sampling error is estimated per length group, but not per age group (WD23). Since the ages are sampled stratified per length groups in this survey, it is not straightforward to estimate the sampling error per age group. However, this is possible by for example using similar methods as for the catch data (see Hirst et al. 2004).

Aging error is another source of uncertainty, which causes increased uncertainty in addition to bias in the estimates: An estimated age distribution to appear smoother than it would have been in absence of aging error. Some data have been analysed to estimate the precision in aging (Aanes 2002). If the aging error is known, this can currently be taken into account for the estimation of catch at age described above.

Work on quantifying uncertainties also for other input data sets should be encouraged.

3.16 Answering 2005 ACFM comments:

The minutes of the review of the 2005 AFWG report contained a number of comments to the NEA cod assessment. Below, we answer these comments and describe how they have been taken into account (*in italics*):

This is a benchmark assessment (as this stock is on the "observation list") and there was a special request to evaluate the amended HCR. The WG are thanked and congratulated for the wide range of models and approaches they have investigated for this stock.

Does not require any action from the WG

As suggested by the WG, discrepancies between estimates of discards from two different methods should be clarified. More work is needed by the WG in this area.

Has not been addressed by the WG this year. Some additional discard estimates from the shrimp fishery were considered (WD 1)

Within the XSA the key question which arose was the influence of the Russian Survey fleet on the results. The estimates from this fleet are rather discrepant when compared with those from the other fleets, with the problem most apparent in the trends in catchability residuals for ages 6-8 since 2002. Although these estimates receive relatively little weight, it may still be better to exclude this fleet, or at least these ages for this fleet. The WG is asked to consider this and to investigate why this fleet produces these problems.

The Russian survey series has been revised, and the problem does no longer exist.

Within XSA, the use of catchability dependent on stock size for ages 3 to 6 is rather unconventional. The WG justifies this partly on the basis of improved retrospective pattern. While the retrospective performance with this setting was clearly better around 1992-1993, the differences over the more recent (and more relevant period) are rather small, and these settings may not be so relevant to the current stock situation. Experience from other areas suggests this catchability model may be most appropriate when there is one or more relatively strong year-class present in the younger ages of the stock, which does not appear to be the case for this stock at present. It is useful to look at this graphically (i.e. survey data vs. XSA stock numbers) to understand what form the catchability relationship might take. The WG is asked to consider this. Again!

The WG considered this (Section 3.4.1) and decided to continue using catchability dependent on stock size for ages 3 to 6

As a general point, it is useful if tables are clearly labelled within the report. With regard to this stock, the multiple tables of M and F (resulting from the iterative estimation of predation mortality) are confusing and would benefit from having much more informative captions. Similarly the Gadget output simply refers to results from a key run, without identifying either the stock or the model involved. As a minimum standard, table headings should identify both the stock and the content of the table. References to tables and figures in the section headings are in principle a good idea, but if being incomplete (e.g. Table 3.27 in section 3.3.8), this is adding to the confusion.

The Table and Figure headings have been changed to take these comments into account.

The use of a number of different approaches for this stock prompted a discussion of how they should be used and evaluated. Gadget provides a better representation of biological processes within the stock, but it has some instability (in terms of year-to-year changes in the estimated stock history) which makes it less suitable in contexts where reference points are defined on an absolute scale. It maybe that a relatively simple, robust tool like XSA is more suitable for routine use in an HCR context, with something like Gadget still having an important role in the investigation of any wider biological or ecosystem questions which may arise.

One important question where Gadget could be useful is the estimation of total landings. If Gadget could be used to provide independent estimates of total landings in recent years (e.g. by omitting the catch data for these years), this would be helpful in determining the true extent of the problem and in ground-truthing the existing estimates. The WG is encouraged to pursue this.

Estimation of total/unreported landings using Gadget is discussed in WD24

The HCR evaluation performed by the WG has gone a long way towards addressing the comments made in last year's review. The WG have done an impressive job in incorporating assessment bias, and general 'data nastiness' into the evaluation, as well as evaluating the effects of starting at different stages of the recruitment cycle, and evaluating the effectiveness in a recovery situation.

Does not require any action from the WG

Table 3.1a 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	163,109	222,052	51,829	115,000	551,990
2004	177,888	219,261	92,296	117,000	606,445
2005 [1]	159,573	194,644	121,059	166,000	641,276

[1] Provisional figures.

Table 3.1b Landings of Norwegian Coastal Cod in Sub-areas I and II

Year	Landings in '000 t As calculated from samples and reported to AFWG	By area and time of capture
1960	-	43
1961	-	32
1962	-	30
1963	-	40
1964	-	46
1965	-	24
1966	-	29
1967	-	33
1968	-	47
1969	-	52
1970	-	49
1971	-	*)
1972	-	*)
1973	-	*)
1974	-	*)
1975	-	*)
1976	-	*)
1977	-	*)
1978	-	*)
1979	-	*)
1980	-	40
1981	-	49
1982	-	42
1983	-	38
1984	74	33
1985	75	28
1986	69	26
1987	61	31
1988	59	22
1989	40	17
1990	28	24
1991	25	25
1992	42	35
1993	53	44
1994	55	48
1995	57	39
1996	62	32
1997	63	36
1998	52	29
1999	41	23
2000	37	19
2001	30	14
2002	41	20
2003	35	19
2004	33	14
2005	31	13
Average 1984-2005	48	27

*) No data

Table 3.2

	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	146.0	17.1	107.8	114.2	50.1	1.8
2004	154.4	23.5	100.3	118.9	88.8	3.5
2005 [1]	132.4	27.2	87.0	107.7	115.4	5.6

[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	19,427	2,921	7,026	4,732	191,977	7,924	8,711	182,160	5,963	6,149	436,990
2004	19,226	3,621	8,196	6,187	212,117	11,285	14,004	201,525	7,201	6,082	489,445
2005[1]	16,273	3,491	8,135	5,848	207,825	9,349	10,744	200,077	5,874	7,660	475,276

[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	10.68	21.66
2004	0.54	1.08	1.41	1.95	2.69	3.46	4.77	6.72	7.90	8.66	12.21	14.02	16.50	11.37
2005	0.58	0.92	1.38	1.86	2.61	3.54	4.57	6.41	8.24	9.89	11.04	14.08	11.81	20.08

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	2.40	3.41	4.86	6.28	7.55	11.10	13.41	12.12	14.51	
2004	0.30	0.57	1.09	1.55	2.37	3.20	4.73	6.92	8.41	9.77	11.08			
2005	0.33	0.65	0.98	1.50	2.10	3.08	4.31	5.81	8.42	10.37	13.56	14.13		

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	
2004 [2]	0.22	0.73	1.01	1.75	2.58	3.33	4.73	6.32	7.20	8.45	9.20	11.99	10.14	13.11
2005 [3]	0.57	0.77	1.13	1.66	2.33	3.36	4.38	5.92	6.65	7.26	10.01	11.14		

[1] Division IIa only

[2] IIa and IIb combined

[3] I,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		
2004 [1]	0.31	0.56	0.80	1.28	1.96	2.59	3.72	5.36	5.28	7.41		11.43		
2005 [1]		0.63	1.14	1.85	2.48	3.43	4.25	5.38	8.41	11.19	15.04	16.93		

[1] IIa and IIb combined

Iceland (Sub-area I)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
2005	0	1	5	24	62	85	95	98
2006	0	0	6	30	60	89	96	100

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	2	1	4	31	70	82	100	100
1990	2	1	4	22	58	81	100	100
1991	0	3	14	38	76	90	95	100
1992	0	2	21	53	87	97	100	100
1993	0	3	10	53	85	97	99	100
1994	1	0	16	37	63	88	98	100
1995	0	1	8	52	64	81	98	99
1996	0	0	3	30	70	82	100	100
1997	0	0	2	18	73	93	99	100
1998	0	1	3	15	47	76	94	100
1999	0	0	2	28	71	95	99	100
2000	0	0	8	30	77	82	100	100
2001	1	1	9	44	63	74	94	100
2002	0	1	6	43	68	85	93	100
2003	0	0	7	36	69	88	96	100
2004	0	1	10	55	82	91	99	99
2005	0	0	9	55	82	94	98	100
2006	0	0	6	44	70	90	97	100

revised data for 1989-2005

Table 3.6. Recruitment indices for NEA cod. Input for the RCT3-analysis.

```
NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,
9,21,2            (No. of surveys, No. of years, VPA Column No.),,
1985,   205,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1986,   173,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1987,   243,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1988,   412,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1989,   721,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1990,   896,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1991,   810,    -11,  -11, -11,    -11,     -11,     -11    -11, 296.5, 349.8
1992,   657,    -11,  -11, 699,    -11,     -11,   535.8, 577.2, 274.6, 166.2
1993,   437,    -11, 8332, 369, 1035.9,   858.3,   541.5, 292.9, 170.0,  92.9
1994,   713,  16066, 4719,1285, 5253.1,  2619.2,   707.6, 339.8, 238.0, 188.3
1995,   846,  57035, 3965,1353, 5768.5,  2396.0,  1045.1, 430.5, 396.0, 427.7
1996,   553,  26603, 3539, 896, 4815.5,  1623.5,   643.7, 632.9, 211.8, 150.0
1997,   608,  13714, 2768,1184, 2418.5,  3401.3,   340.1, 304.3, 235.2, 245.1
1998,   523,   3048,  401,1036,  484.6,   358.3,   248.3, 221.4, 191.1, 138.2
1999,   408,   2669,  377, 773,  128.8,   154.1,    76.6,  63.9,  88.3,  69.3
2000,   563,  14365, 2338,1356,  657.9,   629.9,   443.9, 215.1, 377.0, 303.4
2001,   335,   3216,  267, 268,   35.3,    18.2,    79.1,  61.5,  76.6,  33.6
2002,   483,  17979, 5175, 875, 2991.7,  1693.9,   235.4, 105.2, 246.9, 123.9
2003,   -11,   4895, 1584, 617,  328.5,   157.6,   224.6, 119.6, 118.1,  79.8
2004,   -11,  17704, 3239, -11,  824.3,   465.3,   288.4, 216.6,   -11,   -11
2005,   -11,  22980,  -11, -11,  862.7,   544.6,     -11,   -11,   -11,   -11
R-0      Russian Swept area trawl survey, area I+IIb,   age 0
R-1      Russian Swept area  trawl survey, area I+IIb,   age 1
R-2      Russian Swept area  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 :

rec2006n

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

Data for 9 surveys over 21 years : 1985 - 2005
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 = 1999

	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	.25	4.07	.21	.542	5	7.89	6.02	.371	.086
R-1	2.15	-10.75	2.50	.011	6	5.93	2.02	4.282	.001
R-2	.64	2.08	.21	.565	7	6.65	6.31	.268	.165
N-BST1	.32	3.95	.25	.529	6	4.87	5.48	.509	.046
N-BSA1	.43	3.27	.31	.410	6	5.04	5.43	.622	.031
N-BST2	.77	1.59	.33	.345	7	4.35	4.94	.768	.020
N-BSA2	1.63	-3.26	.64	.121	7	4.17	3.55	1.663	.004
N-BST3	.90	1.50	.10	.867	8	4.49	5.54	.199	.296
N-BSA3	.49	3.87	.10	.844	8	4.25	5.94	.161	.296
					VPA Mean =		6.31	.457	.057

Yearclass = 2000

	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	.25	4.06	.18	.709	6	9.57	6.43	.242	.135
R-1	.49	2.62	.59	.187	7	7.76	6.39	.753	.014
R-2	.85	.58	.28	.472	8	7.21	6.71	.369	.058
N-BST1	.22	4.75	.20	.673	7	6.49	6.16	.258	.119
N-BSA1	.29	4.35	.23	.601	7	6.45	6.19	.298	.089
N-BST2	.40	3.96	.24	.562	8	6.10	6.39	.290	.094
N-BSA2	.53	3.36	.31	.417	8	5.38	6.19	.393	.051
N-BST3	.66	2.86	.12	.834	9	5.93	6.76	.162	.198
N-BSA3	.46	4.01	.09	.895	9	5.72	6.65	.119	.198
					VPA Mean =		6.31	.424	.044

Yearclass = 2001

	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	.25	4.02	.17	.692	7	8.08	6.05	.238	.200
R-1	.47	2.71	.52	.195	8	5.59	5.36	.776	.019
R-2	.88	.36	.30	.401	9	5.59	5.26	.526	.041
N-BST1	.21	4.79	.19	.645	8	3.59	5.56	.327	.106
N-BSA1	.28	4.39	.22	.589	8	2.95	5.22	.438	.059
N-BST2	.39	3.98	.22	.565	9	4.38	5.71	.323	.108
N-BSA2	.52	3.44	.29	.417	9	4.14	5.57	.441	.058
N-BST3	.68	2.69	.19	.637	10	4.35	5.65	.295	.130
N-BSA3	.48	3.90	.14	.758	10	3.54	5.59	.237	.201
					VPA Mean =		6.33	.381	.078

Table 3.7 (Cont'd)

Yearclass = 2002

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
R-0	.31	3.45	.21	.700	8	9.80	6.48	.261	.088
R-1	.35	3.70	.37	.412	9	8.55	6.68	.462	.028
R-2	.62	2.15	.22	.635	10	6.78	6.33	.267	.084
N-BST1	.18	5.06	.16	.787	9	8.00	6.50	.197	.149
N-BSA1	.19	5.03	.18	.745	9	7.44	6.48	.220	.123
N-BST2	.36	4.18	.19	.717	10	5.47	6.16	.223	.119
N-BSA2	.43	3.92	.23	.615	10	4.67	5.94	.293	.069
N-BST3	.60	3.11	.17	.768	11	5.51	6.44	.198	.149
N-BSA3	.41	4.25	.13	.848	11	4.83	6.23	.152	.149
						VPA Mean =	6.30	.370	.044

Yearclass = 2003

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
R-0	.33	3.25	.23	.617	9	8.50	6.03	.290	.076
R-1	.37	3.51	.40	.340	10	7.37	6.22	.475	.028
R-2	.63	2.06	.22	.622	11	6.43	6.09	.262	.093
N-BST1	.19	4.98	.19	.692	10	5.80	6.06	.232	.118
N-BSA1	.20	4.96	.20	.670	10	5.07	5.98	.249	.103
N-BST2	.36	4.21	.17	.729	11	5.42	6.15	.203	.154
N-BSA2	.41	4.05	.22	.616	11	4.79	6.04	.268	.089
N-BST3	.62	2.98	.19	.711	12	4.78	5.96	.227	.123
N-BSA3	.41	4.25	.12	.847	12	4.39	6.05	.149	.159
						VPA Mean =	6.30	.333	.057

Yearclass = 2004

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
R-0	.33	3.25	.23	.614	9	9.78	6.45	.289	.116
R-1	.36	3.58	.39	.352	10	8.08	6.48	.473	.043
R-2									
N-BST1	.18	5.00	.19	.694	10	6.72	6.23	.228	.186
N-BSA1	.20	4.98	.20	.675	10	6.14	6.19	.239	.170
N-BST2	.35	4.24	.17	.738	11	5.67	6.24	.199	.242
N-BSA2	.41	4.08	.22	.624	11	5.38	6.28	.259	.144
N-BST3									
N-BSA3									
						VPA Mean =	6.30	.313	.099

Yearclass = 2005

Survey/ Series	Regression: Slope	Inter-cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
R-0	.33	3.24	.24	.611	9	10.04	6.54	.301	.188
R-1									
R-2									
N-BST1	.18	5.01	.19	.695	10	6.76	6.24	.231	.320
N-BSA1	.19	5.00	.20	.680	10	6.30	6.23	.239	.298
N-BST2									
N-BSA2									
N-BST3									
N-BSA3									
						VPA Mean =	6.30	.297	.194

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	344	5.84	.11	.12	1.32	409	6.01
2000	651	6.48	.09	.08	.71	564	6.34
2001	303	5.71	.11	.10	.82	335	5.82
2002	572	6.35	.08	.06	.54	484	6.18
2003	431	6.07	.08	.03	.13		
2004	533	6.28	.10	.03	.12		
2005	546	6.30	.13	.07	.25		

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	47	130	2348	31033	76175	67656	42122	11527	1801	529	223	120	21	9	5
2003	6	187	7263	20885	64447	71109	36706	14002	2887	492	142	97	21	43	1
2004	8	183	2090	38226	50826	68350	50838	18118	6239	1746	295	127	39	16	8
2005	11	453	5815	19768	113144	61665	44777	20553	6285	2348	562	100	21	24	7

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

YEAR	AGE						
	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	143	0	0	0	0	0
1990	0	126	28	0	0	0	0
1991	123	155	216	2	0	0	0
1992	4305	1036	156	4	0	0	0
1993	3833	20252	513	52	1	0	0
1994	8344	6947	647	134	54	8	0
1995	8327	15367	757	250	87	4	0
1996	9902	21695	1497	142	55	20	1
1997	2946	15956	1860	172	16	1	0
1998	79	4858	537	213	25	2	1
1999	592	1823	291	51	4	0	0
2000	1675	2235	172	37	14	4	0
2001	89	2254	114	24	12	2	1
2002	6851	472	395	43	6	1	0
2003	5331	4153	105	23	0	0	0
2004	4041	3165	469	19	11	1	0
2005	1064	1776	141	41	4	6	0

Table 3.10 Catch numbers at age

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

At 24/04/2006 17:43

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

YEAR	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
AGE											
3	4008	710	140	991	1281	24687	24099	47413	11473	3902	
4	10387	13192	3872	6808	10954	77924	120704	107659	155171	37652	
5	18906	43890	31054	35214	29045	64013	113203	112040	146395	201834	
6	16596	52017	55983	100497	45233	46867	73827	55500	100751	161336	
7	13843	45501	77375	83283	62579	37535	49389	22742	40635	84031	
8	15370	13075	21482	29727	30037	33673	20562	16863	10713	30451	
9	59845	19718	15237	13207	19481	23510	24367	10559	11791	13713	
10	22618	47678	9815	5606	9172	10589	15651	10553	8557	9481	
11	10093	31392	30041	8617	6019	4221	8327	5637	6751	4140	
12	9573	9348	7945	13154	4133	1288	3565	1752	2370	2406	
+gp	8137	18055	12595	7719	9862	4935	2158	797	1287	1350	
0 TOTALNUM		189376	294576	265539	304823	227796	329242	455852	391515	495894	550296
TONSLAND		706000	882017	774295	800122	731982	827180	876795	695546	826021	1147841
SOPCOF %		103	91	89	99	109	115	93	105	93	106

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

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	
AGE											
3	10614	17321	31219	32308	37882	45478	42416	13196	5298	15725	
4	24172	33931	133576	77942	97865	132655	170566	106984	45912	25999	
5	129803	27182	71051	148285	64222	123458	167241	205549	97950	78299	
6	250472	70702	40737	53480	67425	51167	89460	95498	58575	68511	
7	86784	87033	38380	18498	23117	38740	28297	35518	19642	25444	
8	51091	39213	35786	17735	8429	17376	21996	16221	9162	8438	
9	14987	17747	13338	23118	7240	5791	7956	11894	6196	3569	
10	7465	6219	10475	9483	11675	6778	2728	3884	3553	1467	
11	3952	3232	3289	3748	4504	5560	2603	1021	783	1161	
12	1655	1220	1070	997	1843	1682	1647	1025	172	131	
+gp	1906	819	433	513	682	1298	775	784	782	337	
0 TOTALNUM		582901	304619	379354	386107	324884	429983	535685	491574	248025	229081
TONSLAND		1343068	792557	769313	744607	622042	783221	909266	776337	437695	444930
SOPCOF %		105	100	112	93	104	110	124	102	103	129

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

At 24/04/2006 17:43

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	
AGE											
3	55937	34467	3709	2307	7164	7754	35536	294262	91855	45282	
4	55644	160048	174585	24545	10792	13739	45431	131493	437377	59798	
5	34676	69235	267961	238511	25813	11831	26832	61000	203772	226646	
6	42539	22061	107051	181239	137829	9527	12089	20569	47006	118567	
7	37169	26295	26701	79363	96420	59290	7918	7248	12630	29522	
8	18500	25139	16399	26989	31920	52003	34885	8328	4370	9353	
9	5077	11323	11597	13463	8933	12093	22315	19130	2523	2617	
10	1495	2329	3657	5092	3249	2434	4572	4499	5607	1555	
11	380	687	657	1913	1232	762	1215	677	2127	1928	
12	403	316	122	414	260	418	353	195	322	575	
+gp	156	279	240	190	180	216	476	195	296	283	
0 TOTALNUM		251976	352179	612679	574026	323792	170067	191622	547596	807885	496126
TONSLAND		483711	572605	1074084	1197226	933246	689048	565254	792685	1102433	829377
SOPCOF %		123	109	108	105	112	124	118	130	137	115

Table 3.10 (continued)

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

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
AGE											
3	85337	39594	78822	8600	3911	3407	8948	3108	6942	24634	
4	114341	168609	45400	77484	17086	9466	20933	19594	14240	45769	
5	79993	136335	88495	43677	81986	20803	19345	20473	18807	27806	
6	118236	52925	56823	31943	40061	63433	28084	17656	20086	19418	
7	47872	61821	25407	16815	17664	21788	42496	17004	15145	11369	
8	13962	23338	31821	8274	7442	9933	8395	18329	8287	3747	
9	4051	5659	9408	10974	3508	4267	2878	2545	5988	1557	
10	936	1521	1227	1785	3196	1311	708	646	783	768	
11	558	610	913	427	678	882	271	229	232	137	
12	442	271	446	103	79	109	260	74	153	36	
+gp	218	268	847	142	58	41	37	83	69	71	
0 TOTALNUM		465946	490951	339609	200224	175669	135440	132355	99741	90732	135312
TONSLAND		867463	905301	698715	440538	380434	399038	363730	289992	277651	307920
SOPCOF %		127	107	109	121	127	118	125	90	95	102

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	
AGE											
3	28968	13648	9828	5085	1911	4963	21835	10094	6531	4879	
4	70993	137106	22774	17313	7551	10933	36015	46182	59444	42587	
5	78672	98210	135347	32165	12999	16467	27494	63578	102548	115329	
6	25215	61407	54379	81756	17827	20342	23392	33623	59766	98485	
7	11711	13707	21015	27854	30007	19479	18351	14866	32504	32036	
8	4063	3866	3304	5501	6810	25193	13541	9449	10019	7334	
9	976	910	1236	827	828	3888	18321	6571	6163	3014	
10	726	455	519	290	179	428	2529	12593	3671	1725	
11	557	187	106	41	59	48	264	1749	7528	1174	
12	136	227	69	13	15	12	82	377	995	1920	
+gp	76	100	62	28	13	4	13	86	144	264	
0 TOTALNUM		222093	329823	248639	170873	78199	101757	161837	199168	289313	308747
TONSLAND		430113	523071	434939	332481	212000	319158	513234	581611	771086	739999
SOPCOF %		102	102	100	99	101	95	103	101	101	100

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

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
AGE											
3	7655	12827	31887	7501	4701	5044	2348	7263	2090	5815	
4	28782	36491	88874	77714	33094	35019	31033	20885	38226	19768	
5	80711	69633	48972	92816	93044	62139	76175	64447	50826	113144	
6	100509	83017	40493	31139	47210	62456	67656	71109	68350	61665	
7	54590	65768	34513	15778	12671	22794	42122	36706	50838	44777	
8	10545	28392	26354	15851	6677	5266	11527	14002	18118	20553	
9	2023	4651	6583	8828	4787	1773	1801	2887	6239	6285	
10	930	1151	965	1837	1647	1163	529	492	1746	2348	
11	462	373	197	195	321	343	223	142	295	562	
12	230	213	69	40	71	85	120	97	127	100	
+gp	894	383	117	72	26	35	36	65	63	52	
0 TOTALNUM		287331	302899	279024	251771	204249	196117	233570	218095	236918	275069
TONSLAND		732228	762403	592624	484910	414868	426471	535045	551990	606445	641276
SOPCOF %		101	100	101	100	100	100	100	100	100	100

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Table 3.11 Catch weights at age

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

At 24/04/2006 17:43

Table 2 Catch weights at age (kg)

YEAR	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
AGE										
3	0.35	0.32	0.34	0.37	0.39	0.4	0.44	0.4	0.44	0.32
4	0.59	0.56	0.53	0.67	0.64	0.83	0.8	0.76	0.77	0.57
5	1.11	0.95	1.26	1.11	1.29	1.39	1.33	1.28	1.26	1.13
6	1.69	1.5	1.93	1.66	1.7	1.88	1.92	1.93	1.97	1.73
7	2.37	2.14	2.46	2.5	2.36	2.54	2.64	2.81	3.03	2.75
8	3.17	2.92	3.36	3.23	3.48	3.46	3.71	3.72	4.33	3.94
9	3.98	3.65	4.22	4.07	4.52	4.88	5.06	5.06	5.4	4.9
10	5.05	4.56	5.31	5.27	5.62	5.2	6.05	6.34	6.75	7.04
11	5.92	5.84	5.92	5.99	6.4	7.14	7.42	7.4	7.79	7.2
12	7.2	7.42	7.09	7.08	7.96	8.22	8.43	8.67	10.67	8.78
+gp	8.146	8.848	8.43	8.218	8.891	9.389	10.185	10.238	9.68	10.077
0 SOPCOFAC	1.03	0.9143	0.8915	0.992	1.088	1.1483	0.9348	1.0485	0.9294	1.0634

Table 2 Catch weights at age (kg)

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.33	0.33	0.34	0.35	0.34	0.31	0.32	0.32	0.33	0.38
4	0.58	0.59	0.52	0.72	0.51	0.55	0.55	0.61	0.55	0.68
5	1.07	1.02	0.95	1.47	1.09	1.05	0.93	0.96	0.95	1.03
6	1.83	1.82	1.92	2.68	2.13	2.2	1.7	1.73	1.86	1.49
7	2.89	2.89	2.94	3.59	3.38	3.23	3.03	3.04	3.25	2.41
8	4.25	4.28	4.21	4.32	4.87	5.11	5.03	4.96	4.97	3.52
9	5.55	5.49	5.61	5.45	6.12	6.15	6.55	6.44	6.41	5.73
10	7.28	7.51	7.35	6.44	8.49	8.15	7.7	7.91	8.07	7.54
11	8	8.24	8.67	7.17	7.79	8.68	9.27	9.62	9.34	8.47
12	8.35	9.25	9.58	8.63	8.3	9.6	10.56	11.31	10.16	11.17
+gp	9.944	10.605	11.631	11.621	11.422	11.952	12.717	12.737	12.886	13.722
0 SOPCOFAC	1.0455	1.0004	1.1232	0.9305	1.0416	1.097	1.2356	1.0226	1.0277	1.2903

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

At 24/04/2006 17:43

Table 2 Catch weights at age (kg)

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.44	0.29	0.33	0.44	0.37	0.45	0.38	0.38	0.32	0.41
4	0.74	0.81	0.7	0.79	0.91	0.88	0.77	0.91	0.66	0.64
5	1.18	1.35	1.48	1.23	1.34	1.38	1.43	1.54	1.17	1.11
6	1.78	2.04	2.12	2.03	2	2.16	2.12	2.26	2.22	1.9
7	2.46	2.81	3.14	2.9	3	3.07	3.23	3.29	3.21	2.95
8	3.82	3.48	4.21	3.81	4.15	4.22	4.38	4.61	4.39	4.37
9	5.36	4.89	5.27	5.02	5.59	5.81	5.83	6.57	5.52	5.74
10	7.27	7.11	6.65	6.43	7.6	7.13	7.62	8.37	7.86	8.77
11	8.63	9.03	9.01	8.33	8.97	8.62	9.52	10.54	9.82	9.92
12	10.66	10.59	9.66	10.71	10.99	10.83	12.09	11.62	11.41	11.81
+gp	14.148	13.829	14.848	14.211	14.074	12.945	13.673	13.904	13.242	13.107
0 SOPCOFAC	1.2327	1.0911	1.0785	1.052	1.117	1.2405	1.1822	1.3003	1.366	1.152

Table 3.11 (continued)

Table 2 Catch weights at age (kg)

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
3		0.35	0.49	0.49	0.35	0.27	0.49	0.37	0.84	1.42	0.94
4		0.73	0.9	0.81	0.7	0.56	0.98	0.66	1.37	1.93	1.37
5		1.19	1.43	1.45	1.24	1.02	1.44	1.35	2.09	2.49	2.02
6		2.01	2.05	2.15	2.14	1.72	2.09	1.99	2.86	3.14	3.22
7		2.76	3.3	3.04	3.15	3.02	2.98	2.93	3.99	3.91	4.63
8		4.22	4.56	4.46	4.29	4.2	4.85	4.24	5.58	4.91	6.04
9		5.88	6.46	6.54	6.58	5.84	6.57	6.46	7.77	6.02	7.66
10		9.3	8.63	7.98	8.61	7.26	9.16	8.51	9.29	7.4	9.81
11		10.28	9.93	10.15	9.22	8.84	10.82	12.24	11.55	8.13	11.8
12		11.86	10.9	10.85	10.89	9.28	10.77	10.78	16.2	8.57	14.16
	+gp	13.544	13.668	13.177	14.344	14.448	13.932	14.041	17.034	8.609	14.008
0	SOPCOFAC	1.2688	1.0683	1.089	1.2139	1.2723	1.1809	1.2521	0.8953	0.9483	1.0182

Table 2 Catch weights at age (kg)

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
3		0.64	0.49	0.54	0.74	0.81	1.05	1.16	0.81	0.82	0.77
4		1.27	0.88	0.85	0.96	1.22	1.45	1.57	1.52	1.3	1.2
5		1.88	1.55	1.32	1.31	1.64	2.15	2.21	2.16	2.06	1.78
6		2.79	2.33	2.24	1.92	2.22	2.89	3.1	2.79	2.89	2.59
7		4.49	3.44	3.52	2.93	3.24	3.75	4.27	4.07	3.21	3.81
8		5.84	5.92	5.35	4.64	4.68	4.71	5.19	5.53	5.2	4.99
9		6.83	8.6	8.06	7.52	7.3	6.08	6.14	6.47	6.8	6.23
10		7.69	9.6	9.51	9.12	9.84	8.82	7.77	7.19	7.57	8.05
11		9.81	12.17	11.36	11.08	13.25	11.8	10.12	7.98	8.01	8.74
12		10.71	13.72	14.09	11.47	16.88	16.58	11.54	10.11	9.48	9.22
	+gp	12.051	13.38	16.706	16.484	11.617	16.69	14.332	14.183	11.978	12.319
0	SOPCOFAC	1.016	1.0224	1.0001	0.9879	1.0108	0.9521	1.027	1.0127	1.009	1.003

Table 2 Catch weights at age (kg)

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
3		0.79	0.67	0.68	0.63	0.572	0.66	0.723	0.672	0.72	0.693
4		1.11	1.04	1.05	1.01	1.036	1.05	1.133	1.119	1.13	1.081
5		1.61	1.53	1.62	1.54	1.609	1.62	1.56	1.827	1.607	1.566
6		2.46	2.22	2.3	2.34	2.344	2.51	2.306	2.499	2.429	2.205
7		3.82	3.42	3.3	3.21	3.341	3.51	3.52	3.575	3.274	3.263
8		5.72	5.2	4.86	4.29	4.476	4.78	4.784	5.039	4.725	4.443
9		6.74	7.19	6.87	6	5.724	6.04	6.2	6.355	6.712	6.228
10		8.04	7.73	9.3	6.73	7.523	7.54	7.659	8.196	7.984	8.187
11		9.28	8.61	10.3	10.08	8.021	9	9.14	10.711	9.192	9.724
12		10.4	11.07	15.05	13.88	12.478	10.48	8.197	11.958	12.024	11.496
	+gp	10.966	11.117	14.524	14.036	17.241	16.18	10.325	10.657	14.245	14.417
0	SOPCOFAC	1.0147	1.0004	1.0072	0.9967	1.0039	0.9994	1.0025	1.0014	1.0017	0.9993
1											

Table 3.12. Stock weights at age

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

At 24/04/2006 17:43

Table 3 Stock weights at age (kg)

YEAR	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
AGE										
3	0.35	0.32	0.34	0.37	0.39	0.4	0.44	0.4	0.44	0.32
4	0.59	0.56	0.53	0.67	0.64	0.83	0.8	0.76	0.77	0.57
5	1.11	0.95	1.26	1.11	1.29	1.39	1.33	1.28	1.26	1.13
6	1.69	1.5	1.93	1.66	1.7	1.88	1.92	1.93	1.97	1.73
7	2.37	2.14	2.46	2.5	2.36	2.54	2.64	2.81	3.03	2.75
8	3.17	2.92	3.36	3.23	3.48	3.46	3.71	3.72	4.33	3.94
9	3.98	3.65	4.22	4.07	4.52	4.88	5.06	5.06	5.4	4.9
10	5.05	4.56	5.31	5.27	5.62	5.2	6.05	6.34	6.75	7.04
11	5.92	5.84	5.92	5.99	6.4	7.14	7.42	7.4	7.79	7.2
12	7.2	7.42	7.09	7.08	7.96	8.22	8.43	8.67	10.67	8.78
+gp	8.146	8.848	8.43	8.218	8.891	9.389	10.185	10.238	9.68	10.077

Table 3 Stock weights at age (kg)

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.33	0.33	0.34	0.35	0.34	0.31	0.32	0.32	0.33	0.38
4	0.58	0.59	0.52	0.72	0.51	0.55	0.55	0.61	0.55	0.68
5	1.07	1.02	0.95	1.47	1.09	1.05	0.93	0.96	0.95	1.03
6	1.83	1.82	1.92	2.68	2.13	2.2	1.7	1.73	1.86	1.49
7	2.89	2.89	2.94	3.59	3.38	3.23	3.03	3.04	3.25	2.41
8	4.25	4.28	4.21	4.32	4.87	5.11	5.03	4.96	4.97	3.52
9	5.55	5.49	5.61	5.45	6.12	6.15	6.55	6.44	6.41	5.73
10	7.28	7.51	7.35	6.44	8.49	8.15	7.7	7.91	8.07	7.54
11	8	8.24	8.67	7.17	7.79	8.68	9.27	9.62	9.34	8.47
12	8.35	9.25	9.58	8.63	8.3	9.6	10.56	11.31	10.16	11.17
+gp	9.944	10.605	11.631	11.621	11.422	11.952	12.717	12.737	12.886	13.722

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

At 24/04/2006 17:43

Table 3 Stock weights at age (kg)

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.44	0.29	0.33	0.44	0.37	0.45	0.38	0.38	0.32	0.41
4	0.74	0.81	0.7	0.79	0.91	0.88	0.77	0.91	0.66	0.64
5	1.18	1.35	1.48	1.23	1.34	1.38	1.43	1.54	1.17	1.11
6	1.78	2.04	2.12	2.03	2	2.16	2.12	2.26	2.22	1.9
7	2.46	2.81	3.14	2.9	3	3.07	3.23	3.29	3.21	2.95
8	3.82	3.48	4.21	3.81	4.15	4.22	4.38	4.61	4.39	4.37
9	5.36	4.89	5.27	5.02	5.59	5.81	5.83	6.57	5.52	5.74
10	7.27	7.11	6.65	6.43	7.6	7.13	7.62	8.37	7.86	8.77
11	8.63	9.03	9.01	8.33	8.97	8.62	9.52	10.54	9.82	9.92
12	10.66	10.59	9.66	10.71	10.99	10.83	12.09	11.62	11.41	11.81
+gp	14.148	13.829	14.848	14.211	14.074	12.945	13.673	13.904	13.242	13.107

Table 3.12 (continued)

Table 3 Stock weights at age (kg)

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.35	0.49	0.49	0.35	0.27	0.49	0.37	0.37	0.42	0.413
4	0.73	0.9	0.81	0.7	0.56	0.98	0.66	0.92	1.16	0.875
5	1.19	1.43	1.45	1.24	1.02	1.44	1.35	1.6	1.81	1.603
6	2.01	2.05	2.15	2.14	1.72	2.09	1.99	2.44	2.79	2.81
7	2.76	3.3	3.04	3.15	3.02	2.98	2.93	3.82	3.78	4.059
8	4.22	4.56	4.46	4.29	4.2	4.85	4.24	4.76	4.57	5.833
9	5.88	6.46	6.54	6.58	5.84	6.57	6.46	6.17	6.17	7.685
10	9.3	8.63	7.98	8.61	7.26	9.16	8.51	7.7	7.7	10.117
11	10.28	9.93	10.15	9.22	8.84	10.82	12.24	9.25	9.25	14.29
12	11.86	10.9	10.85	10.89	9.28	10.77	10.78	10.85	10.85	12.731
+gp	13.544	13.668	13.177	14.344	14.448	13.932	14.041	12.988	13.033	14.311

Table 3 Stock weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.311	0.211	0.212	0.299	0.398	0.518	0.44	0.344	0.235	0.201
4	0.88	0.498	0.404	0.52	0.705	1.136	0.931	1.172	0.753	0.485
5	1.47	1.254	0.79	0.868	1.182	1.743	1.812	1.82	1.42	1.14
6	2.467	2.047	1.903	1.477	1.719	2.428	2.716	2.823	2.413	2.118
7	3.915	3.431	2.977	2.686	2.458	3.214	3.895	4.031	3.825	3.47
8	5.81	5.137	4.392	4.628	3.565	4.538	5.176	5.497	5.416	4.938
9	6.58	6.523	7.812	7.048	4.71	6.88	6.774	6.765	6.631	7.16
10	6.833	9.3	12.112	9.98	7.801	10.719	9.598	8.571	7.63	9.119
11	11.004	13.15	13.107	9.25	8.956	9.445	12.427	10.847	8.112	10.101
12	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731
+gp	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311

Table 3 Stock weights at age (kg)

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0.195	0.202	0.217	0.203	0.194	0.285	0.251	0.23	0.25	0.231
4	0.487	0.521	0.533	0.52	0.465	0.522	0.605	0.537	0.546	0.624
5	0.971	1.079	1.161	1.174	1.208	1.196	1.189	1.31	1.087	1.118
6	2.054	1.878	1.939	2.031	1.972	2.239	2.138	2.009	2.035	1.932
7	3.527	3.369	2.945	3.034	3.048	3.313	3.333	3.241	2.921	3.046
8	5.503	5.263	4.574	4.464	4.096	5.118	4.766	4.971	4.384	3.955
9	7.767	8.927	7.423	6.482	5.724	6.376	6.859	6.739	6.254	5.811
10	10.159	12.154	10.367	10.269	7.457	9.241	9.333	8.706	8.543	8.289
11	10.669	11.204	11.738	10.882	9.582	11.322	10.186	15.026	9.735	13.44
12	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731
+gp	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311

1

Table 3.13 Northeast Arctic cod. Proportion mature at age.

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

At 24/04/2006 17:43

Table 5 Proportion mature at age

YEAR	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
AGE										
3 0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0
5	0.01	0.01	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	0.03	0.03
7	0.06	0.06	0.07	0.09	0.09	0.1	0.08	0.07	0.08	0.07
8	0.11	0.13	0.13	0.17	0.23	0.24	0.22	0.19	0.16	0.13
9	0.18	0.16	0.25	0.29	0.35	0.4	0.41	0.4	0.37	0.26
10	0.44	0.42	0.47	0.54	0.52	0.58	0.63	0.64	0.68	0.53
11	0.65	0.75	0.73	0.79	0.79	0.72	0.82	0.84	0.87	0.83
12	0.86	0.91	0.91	0.88	0.95	0.85	0.92	0.94	0.93	0.92
+gp	0.96	0.95	0.97	0.97	0.97	0.96	0.97	0.97	0.96	0.97

Table 5 Proportion mature at age

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0.01	0	0	0.01	0	0
5	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0	0
6	0.03	0.03	0.03	0.04	0.06	0.06	0.05	0.03	0.03	0.01
7	0.06	0.06	0.06	0.12	0.1	0.12	0.15	0.07	0.13	0.06
8	0.12	0.09	0.1	0.34	0.19	0.31	0.34	0.28	0.37	0.2
9	0.14	0.12	0.1	0.49	0.45	0.65	0.61	0.42	0.66	0.55
10	0.41	0.22	0.3	0.67	0.69	0.91	0.81	0.81	0.89	0.73
11	0.67	0.6	0.5	0.84	0.77	0.98	0.92	0.98	0.95	0.99
12	0.91	0.82	0.82	0.87	0.85	0.98	0.97	0.98	0.99	0.98
+gp	0.96	0.97	0.97	1	0.99	1	1	1	1	1

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

At 24/04/2006 17:43

Table 5 Proportion mature at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3 0	0	0	0	0	0	0.01	0	0	0	
4	0	0	0	0	0.01	0	0.02	0	0	0
5	0.01	0	0.03	0	0	0.01	0.02	0	0	0.01
6	0.02	0.03	0.05	0.02	0.01	0.05	0.01	0.02	0.01	0.02
7	0.06	0.07	0.09	0.04	0.07	0.11	0.1	0.16	0.03	0.09
8	0.22	0.14	0.19	0.12	0.23	0.3	0.34	0.53	0.21	0.21
9	0.35	0.38	0.39	0.34	0.58	0.59	0.64	0.81	0.5	0.56
10	0.74	0.64	0.58	0.55	0.81	0.79	0.81	0.92	0.96	0.78
11	0.94	0.89	0.82	0.74	0.89	0.86	0.94	0.95	1	0.79
12	0.94	0.9	1	0.95	0.91	0.88	1	0.98	0.96	0.95
+gp	1	1	1	1	1	1	1	1	1	1

Table 3.13 (continued)

Table 5 Proportion mature at age

AGE	YEAR 1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	0	0	0	0	0	0	0	0.01	0	0
4	0	0	0	0	0	0	0.05	0.08	0.05	0.01
5	0	0.02	0	0	0	0.02	0.1	0.1	0.18	0.09
6	0.05	0.08	0.02	0.03	0.02	0.07	0.34	0.3	0.31	0.36
7	0.12	0.26	0.13	0.13	0.13	0.2	0.65	0.73	0.56	0.55
8	0.29	0.54	0.44	0.39	0.35	0.54	0.82	0.88	0.9	0.85
9	0.45	0.76	0.71	0.77	0.65	0.8	0.92	0.97	0.99	0.96
10	0.84	0.87	0.77	0.89	0.82	0.97	1	1	1	0.9
11	0.83	0.93	0.81	0.83	1	1	1	1	1	1
12	1	0.94	0.89	0.78	0.9	1	1	1	1	1
+gp	0.9	0.9	0.8	0.9	0.9	1	1	1	1	1

Table 5 Proportion mature at age

AGE	YEAR 1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	0	0	0	0.008	0.008	0.001	0.001	0	0.003	0
4	0.05	0.01	0.02	0.003	0.013	0.032	0.014	0.028	0.007	0.003
5	0.08	0.07	0.05	0.029	0.051	0.075	0.145	0.087	0.119	0.061
6	0.19	0.18	0.33	0.228	0.21	0.305	0.419	0.368	0.335	0.372
7	0.53	0.22	0.53	0.547	0.522	0.708	0.8	0.704	0.589	0.624
8	0.71	0.46	0.62	0.705	0.715	0.861	0.943	0.931	0.862	0.781
9	0.62	0.5	1	0.915	0.905	0.957	0.974	0.972	0.963	0.96
10	0.9	0.75	1	1	0.975	1	1	0.994	0.99	0.979
11	1	1	1	1	1	1	1	1	1	1
12	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

AGE	YEAR 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
3	0	0	0.001	0.002	0	0.003	0.002	0.001	0.001	0	
4	0	0	0.003	0.002	0.001	0.003	0.013	0.001	0.01	0.004	
5	0.019	0.012	0.026	0.014	0.071	0.065	0.084	0.088	0.091	0.068	
6	0.258	0.14	0.152	0.187	0.247	0.359	0.388	0.326	0.442	0.397	
7	0.631	0.607	0.472	0.544	0.643	0.624	0.683	0.672	0.726	0.716	
8	0.82	0.83	0.814	0.847	0.83	0.819	0.841	0.888	0.872	0.892	
9	0.975	0.946	0.957	0.965	0.978	0.952	0.951	0.957	0.976	0.967	
10	1	1	0.98	1	1	1	1	1	0.977	0.991	
11	1	1	1	1	1	1	1	1	1	1	
12	1	1	1	1	1	1	1	1	1	1	
	+gp	1	1	1	1	1	1	1	1	1	1
1											

Table 3.14

North-East Arctic cod (Sub-areas I and II) (run name: XSAASA01)
104
FLT09: Russian trawl catch and effort ages 9 - 11 (Catch: Thousa (Catch: Unknown) (Effort: Unknown)
1985 2005
1 1 0.00 1.00
9 11

0.70	291	77	30
1.52	87	59	22
2.10	127	95	37
2.75	442	215	53
2.12	140	47	11
1.11	204	49	14
1.56	791	71	16
2.50	3852	689	62
2.64	2019	1778	68
2.96	1237	595	167
3.88	684	345	146
3.73	364	164	34
4.92	488	99	34
6.77	559	88	34
6.39	882	171	0
4.25	742	185	25
3.50	235	95	35
3.15	336	61	18
2.34	319	83	19
3.47	710	262	56
3.54	588	203	57

FLT15: NorBarTrSur rev99 (Catch: Unknown) (Effort: Unknown)
1980 2005
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
1	621	981	247	155	45	11
1	1115	287	437	102	49	14

Table 3.14 (continued)

```
FLT16: NorBarLofAcSur rev99 (Catch: Unknown) (Effort: Unknown)
1984 2005
1 1 0.99 1.00
3 9
   1    1416     204     154     157      33      13      10
   1    1343     684     116      77      31       3       0
   1    2049     502     174      14      30       7       0
   1     355     578     109      40       3       0       1
   1     344     214     670     166      32       5       2
   1     206     262     269     668      73       6       3
   1     346     293     339     367     500      37       2
   1     658     215     184     284     254     824      43
   1    1911    1131     354     255     252     277     442
   1    4045    2175     895     225     119      94      39
   1    1598    2166    1040     290      44      43      30
   1     705     872     891     446      65      11       4
   1     517     497     422     499     205      22       5
   1    1826     424     338     340     247      49       7
   1     964     454     122     112     187      92      10
   1    1589    1457     493     129      69      52      12
   1    1716     816     573     198      24       8       6
   1    1122    1043     661     345      95      12       5
   1    1144    1315    1445     643     212      38       5
   1     928     327     451     468     222      88      22
   1     337     661      299     432     172      75      18
   1     591     157     381     169     155      88      24
FLT18: RusSweptArea rev05 (ages 3-9) (Catch: Unknown) ( (Catch:
Unknown) (Effort: Unknown)
1994 2005
1 1 0.90 1.00
3 9
1     1363  1309  1019  354   128   49    21
1     589   1065  1395  849   251   83    19
1     733   784   1035  773   348   132   19
1     1342  835   613   602   348   116   32
1     2028  1363  788   470   259   130   48
1     1587  2072  980   301   123   94    42
1     1839  1286  1786  773   114   52    23
1     1224  1557  1290  1061  304   50    14
1     980   1473  1473  896   600   182   29
1     1246  1057  1166  1203  535   241   40
1     329   1576  880   1111  776   279   93

1     1408  631   1832  744   605   244   88
```

Table 3.15a. NEAcod. Compared diagnostics and results for xsa with or without unreported catches added in 2005.Cannibalism is removed from the catch numbers in the table.

		90000 T unrep 04 2005 xsa	90000 T unrep 04 2005 rev fleet	117000T unrep 04 2005 rev fleet			official catch 05	114000 T unreported catch 05 F D data	166000 T unreported catch 05 WD4, 2006
TSB	2002	1699727	1664998	1676323	TSB	2002	1605015	1634046	1647081
	2003	1771101	1706842	1724607		2003	1626814	1677174	1699784
	2004	1712001	1615514	1639525		2004	1522857	1597872	1631482
	2005					2005	1369605	1478558	1527283
SSB	2002	526648	528045	530024	SSB	2002	501352	504627	506099
	2003	591917	587329	592476		2003	544770	553795	557846
	2004	721210	695162	706499		2004	634999	659559	670569
	2005					2005	532215	578674	599544
F(5-10)	2002	0.648	0.642	0.640	F(5-10)	2002	0.680	0.675	0.672
	2003	0.496	0.496	0.490		2003	0.543	0.532	0.527
	2004	0.574	0.580	0.599		2004	0.728	0.693	0.679
	2005					2005	0.618	0.707	0.746
N2004	age3	37418	34132	34618	N2005	age3	45326	47443	48407
N*10^-4	age4	42035	39768	40194	N*10^-4	age4	22762	24777	25581
	age5	23738	21585	21883		age5	28617	30565	31484
	age6	19804	17813	18141		age6	11844	13080	13632
	age7	11315	11010	11209		age7	7923	8724	9083
	age8	4110	3893	3960		age8	3586	3910	4054
	age9	1246	1330	1347		age9	1221	1297	1331
	age10	378	405	408		age10	412	431	440
F2004	age3	0.062	0.039	0.039	F2005	age3	0.116	0.113	0.112
	age4	0.206	0.126	0.131		age4	0.088	0.101	0.107
	age5	0.441	0.282	0.297		age5	0.387	0.493	0.540
	age6	0.782	0.515	0.539		age6	0.520	0.645	0.700
	age7	1.120	0.668	0.696		age7	0.621	0.737	0.787
	age8	1.108	0.687	0.705		age8	0.698	0.784	0.822
	age9	1.350	0.704	0.718		age9	0.670	0.717	0.738
	age10	1.199	0.624	0.641		age10	0.810	0.866	0.891
N2005	age3	53243	50797	51238	N2006	age3	44663	46943	47918
N*10^-4	age4	29582	26878	27267	N*10^-4	age4	33062	34682	35421
	age5	30576	28717	28873		age5	17070	18341	18827
	age6	15090	13324	13318		age6	15906	15279	15018
	age7	10352	8718	8668		age7	5764	5619	5543
	age8	4870	4622	4577		age8	3485	3420	3385
	age9	1782	1603	1602		age9	1460	1461	1459
	age10	470	539	538		age10	511	518	521
Catch	age3	198	198	209	Catch	age3	400	525	581
2004	age4	3609	3609	3822	2005	age4	1368	1786	1977
N*10^-4	age5	4805	4805	5082	N*10^-4	age5	7740	10195	11314
	age6	6483	6483	6835		age6	4306	5584	6167
	age7	4854	4854	5084		age7	3318	4114	4478
	age8	1751	1751	1812		age8	1631	1922	2055
	age9	608	608	624		age9	539	601	629
	age10	170	170	175		age10	207	226	235

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 18 Rus BT survey	Final run ALL Fleets	Gadget Keyrun	ALL Fleets	ALL Fleets	ALL Fleets	Red.surv. weights ALL Fleets	15 yr tuning 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
SS-ind.Q for age>		6	6	6	6	6		3	4	5	6	6
ages with fleet data		9 to 11	3 to 8	3 to 9	3 to 9	3 to 11		3 to 11	3 to 11	3 to 11	3 to 11	3 to 11
# of iterations to converg		>30	>30	>30	23	> 30		>30	>30	>30	>30	>30
age3	PshrinkW	**0.98**	**0.68**	**0.68**	**0.67**	**0.34**		*	0.15	**0.32**	**0.32**	0.23
	FshrinkW	0.02	0.03	0.03	0.03	0.02		0.04	0.03	0.02	0.08	0.03
age4	PshrinkW	**0.95**	**0.47**	**0.51**	**0.46**	0.25		*	*	0.24	0.24	0.16
	FshrinkW	0.05	0.03	0.03	0.03	0.01		0.02	0.02	0.01	0.05	0.02
age5	PshrinkW	**0.89**	**0.30**	**0.30**	**0.30**	0.13		*	*	*	0.12	0.11
	FshrinkW	0.11	0.04	0.04	0.04	0.02		0.02	0.02	0.02	0.06	0.02
age6	FshrinkW	**1.00**	0.06	0.06	0.06	0.02		0.03	0.03	0.02	0.08	0.02
age7	FshrinkW	**1.00**	0.07	0.08	0.06	0.03		0.03	0.03	0.03	0.09	0.03
age8	FshrinkW	**1.00**	0.09	0.10	0.08	0.03		0.03	0.03	0.03	0.12	0.03
age9	FshrinkW	0.23	0.18	0.09	0.08	0.04		0.04	0.04	0.04	0.13	0.03
age10	FshrinkW	0.17	**0.31**	0.20	0.14	0.07		0.07	0.07	0.06	0.22	0.07
age11	FshrinkW	0.12	**0.52**	0.23	**0.32**	0.08		0.08	0.08	0.08	0.27	0.09
age12	FshrinkW	0.12	**0.77**	**0.53**	**0.45**	0.08		0.08	0.08	0.08	**0.42**	0.11
N2005	age3	54813	51475	48410	55372	48407		42701	43315	48425	49943	46685
N*10^-4	age4	36620	30235	29412	30510	25581		13675	14357	24886	25771	20350
	age5	33399	33145	29928	34911	31484		32173	32572	32895	32666	31031
	age6	16394	14267	13050	14907	13632		12369	12418	13246	13976	13159
	age7	9351	8941	9247	9623	9083		8944	8960	9125	9158	9194
	age8	3837	3847	4393	4210	4054		4080	4076	4080	4032	4171
	age9	1054	1229	1486	1435	1331		1327	1326	1334	1306	1377
	age10	386	490	496	593	440		441	441	441	441	458
F2005	age 4	0.073	0.089	0.092	0.089	0.107		0.210	0.199	0.110	0.106	0.136
	age5	0.500	0.505	0.578	0.472	0.540		0.525	0.517	0.510	0.515	0.551
	age6	0.542	0.656	0.746	0.617	0.700		0.809	0.804	0.730	0.675	0.737
	age7	0.753	0.806	0.766	0.722	0.787		0.806	0.804	0.782	0.777	0.773
	age8	0.897	0.893	0.728	0.776	0.822		0.814	0.815	0.814	0.829	0.787
	age9	1.076	0.833	0.630	0.661	0.738		0.741	0.742	0.736	0.759	0.702
	age10	1.116	0.754	0.741	0.576	0.891		0.889	0.889	0.887	0.888	0.835
2005	F(5-10)	0.814	0.741	0.698	0.637	0.746		0.764	0.762	0.743	0.741	0.731
	F(4-8)	0.553	0.590	0.582	0.535	0.591		0.633	0.627	0.589	0.580	0.597
TSB2005	incl Age1-2	1669023	1580365	1559722	1681128	1527283		1413088	1425037	1533738	1547614	1490255
SSB2005	('000 T)	599809	591938	627088	646919	599544		587739	588614	599745	601063	605871
N2006	age3					47918		40024	40704	47736	44862	49000
N*10^-4	age4	40666	37933	35424	41124	35421		30749	31252	35436	36679	34011
	age5	27865	22637	21964	22863	18827		9079	9638	18258	18982	14544
	age6	16586	16378	13745	17824	15018		15582	15909	16174	15986	14648
	age7	7805	6064	5067	6587	5543		4509	4549	5228	5825	5156
	age8	3604	3268	3519	3827	3385		3271	3284	3419	3447	3476
	age9	1281	1290	1737	1587	1459		1481	1478	1481	1441	1555
	age10	294	437	648	607	521		518	517	523	501	559
Survivors	age3		355459	293878	441141	354211						
end of 05	age4		188044	174836	189630	188273						
direct	age5		164559	125701	184301	150182						
predic.	age6		59744	49129	65087	55432						
by the	age7		32396	34912	38254	33849						
survey	age8		12850	17739	16030	14592						
N*10^-3	age9	2681	4398	6720	6229	5212						
	age10	969	2060	2000	2982	1477						
F2005	age3		0.112	0.134	0.091	0.112						
	age4		0.107	0.114	0.106	0.107						
direct	age5		0.503	0.618	0.460	0.540						
predic.	age6		0.663	0.762	0.622	0.700						
by the	age7		0.811	0.770	0.722	0.787						
survey	age8		0.895	0.717	0.770	0.822						
	age9	1.138	0.830	0.613	0.649	0.738						
	age10	1.161	0.709	0.724	0.538	0.891						

Table 3.16. Northeast Arctic cod. Diagnostics for final XSA.

Lowestoft VPA Version 3.1

24/04/2006 15:46

Extended Survivors Analysis

Arctic Cod (run: XSAASA01/X01)

CPUE data from file fleet

Catch data for 22 years. 1984 to 2005. Ages 1 to 13.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT09: Russian trawl	1996	2005	9	11	0	1
FLT15: NorBarTrSur r	1996	2005	3	8	0.99	1
FLT16: NorBarLofAcSu	1996	2005	3	9	0.99	1
FLT18: RusSweptArea	1996	2005	3	9	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 = .00067

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	1.0767	0.2365	0.1123	0.1065	0.5402	0.6998	0.787	0.8217	0.7376	0.8909
Iteration 30	1.0767	0.2365	0.1123	0.1065	0.5402	0.6998	0.7871	0.8217	0.7377	0.891

Age	11	12
Iteration 29	0.7898	0.4063
Iteration 30	0.79	0.4065

Table 3.16. (Cont'd)

Regression weights

0.02	0.116	0.284	0.482	0.67	0.82	0.921	0.976	0.997	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	1.992	2.509	1.629	1.089	1.438	1.03	0.594	1.479	1.581	1.077
2	1.058	1.089	0.627	0.357	0.259	0.224	0.488	0.25	0.629	0.237
3	0.47	0.333	0.38	0.123	0.078	0.062	0.129	0.06	0.072	0.112
4	0.352	0.297	0.354	0.21	0.138	0.117	0.107	0.081	0.131	0.107
5	0.412	0.569	0.521	0.548	0.412	0.281	0.289	0.272	0.296	0.54
6	0.543	0.724	0.78	0.72	0.604	0.521	0.543	0.475	0.52	0.7
7	0.75	0.843	0.773	0.81	0.743	0.671	0.811	0.65	0.758	0.787
8	0.863	1.236	1.043	1.063	1.035	0.821	0.892	0.709	0.803	0.822
9	0.752	1.338	1.175	1.395	1.202	0.889	0.759	0.581	0.826	0.738
10	0.939	1.509	1.248	1.437	1.178	1.171	0.739	0.476	0.871	0.891
11	0.867	1.442	1.332	0.948	1.155	0.847	0.737	0.444	0.592	0.79
12	0.913	1.503	1.307	1.175	1.215	1.187	0.843	0.865	0.944	0.406

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1996	2.78E+07	2.54E+06	4.42E+05	3.14E+05	3.29E+05	2.68E+05	1.14E+05	2.02E+04	4.23E+03	1.69E+03
1997	1.92E+07	3.10E+06	7.21E+05	2.26E+05	1.81E+05	1.79E+05	1.28E+05	4.42E+04	6.97E+03	1.63E+03
1998	6.68E+06	1.28E+06	8.55E+05	4.23E+05	1.38E+05	8.37E+04	7.08E+04	4.50E+04	1.05E+04	1.50E+03
1999	3.04E+06	1.07E+06	5.59E+05	4.79E+05	2.43E+05	6.70E+04	3.14E+04	2.68E+04	1.30E+04	2.66E+03
2000	3.24E+06	8.36E+05	6.15E+05	4.05E+05	3.18E+05	1.15E+05	2.67E+04	1.14E+04	7.57E+03	2.63E+03
2001	3.87E+06	6.30E+05	5.28E+05	4.65E+05	2.89E+05	1.72E+05	5.16E+04	1.04E+04	3.33E+03	1.86E+03
2002	1.16E+06	1.13E+06	4.12E+05	4.06E+05	3.39E+05	1.78E+05	8.38E+04	2.16E+04	3.74E+03	1.12E+03
2003	5.94E+06	5.26E+05	5.69E+05	2.97E+05	2.99E+05	2.08E+05	8.49E+04	3.05E+04	7.24E+03	1.44E+03
2004	4.40E+06	1.11E+06	3.36E+05	4.39E+05	2.24E+05	1.87E+05	1.06E+05	3.63E+04	1.23E+04	3.32E+03
2005	2.98E+06	7.41E+05	4.84E+05	2.56E+05	3.15E+05	1.36E+05	9.08E+04	4.05E+04	1.33E+04	4.40E+03

Estimated population abundance at 1st Jan 2006

0.00E+00	8.31E+05	4.79E+05	3.54E+05	1.88E+05	1.50E+05	5.54E+04	3.38E+04	1.46E+04	5.21E+03

Taper weighted geometric mean of the VPA populations:

3.48E+06	8.59E+05	4.96E+05	3.71E+05	2.77E+05	1.50E+05	6.81E+04	2.47E+04	7.58E+03	2.20E+03

Standard error of the weighted Log(VPA populations) :

0.6198	0.3777	0.2551	0.2517	0.233	0.3559	0.506	0.5517	0.5741	0.5079

	AGE	
YEAR	11	12
1996	8.80E+02	4.25E+02
1997	5.40E+02	3.03E+02
1998	2.96E+02	1.05E+02
1999	3.52E+02	6.40E+01
2000	5.18E+02	1.12E+02
2001	6.63E+02	1.34E+02
2002	4.73E+02	2.33E+02
2003	4.37E+02	1.85E+02
2004	7.30E+02	2.30E+02
2005	1.14E+03	3.31E+02

Estimated population abundance at 1st Jan 2006

1.48E+03	4.22E+02

Taper weighted geometric mean of the VPA populations:

5.84E+02	1.79E+02

Table 3.16. (Cont'd)

Standard error of the weighted Log(VPA populations) :

	0.4123	0.5079

1

Log catchability residuals.

Fleet : FLT09: Russian trawl

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
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	0.23	-0.02	-0.67	-0.29	0.41	0.16	0.45	-0.04	-0.06	-0.39
10	0.46	-0.07	-0.51	-0.3	0.11	-0.02	-0.03	0.21	0.3	-0.25
11	-0.49	-0.05	0.19	99.99	-0.28	-0.12	-0.39	-0.09	0.15	-0.21

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	-3.5636	-3.5958	-3.5958
S.E(Log q)	0.3493	0.2484	0.2464

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	1.81	-2.26	-0.8	0.64	10	0.48	-3.56
10	1.06	-0.238	3.35	0.79	10	0.29	-3.6
11	1	-0.017	3.71	0.79	9	0.23	-3.72

1

Fleet : FLT15: NorBarTrSur r

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	-0.1	0.04	-0.13	-0.07	0.03	-0.04	0.23	0.05	-0.13	-0.05
4	0.28	0.24	-0.12	0	0	-0.01	0.03	0.09	0	-0.1
5	0.06	0.31	0.12	0.02	-0.11	-0.03	0.11	-0.04	-0.12	0.07
6	0.13	0.26	0.06	-0.19	-0.12	-0.08	0.1	0.28	-0.13	-0.06
7	-0.11	0.28	0.28	0.19	-0.31	-0.26	0.11	0.38	-0.26	0.01
8	0.17	-0.14	-0.16	0.38	0.1	-0.3	0.24	0.24	-0.27	-0.12
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									

Table 3.16. (Cont'd)

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	-6.246	-6.548	-6.8296
S.E(Log q)	0.168	0.2696	0.2618

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	0.7	1.299	7.9	0.82	10	0.13	-5.68
4	0.51	3.348	9.31	0.92	10	0.08	-5.93
5	0.64	1.688	8.34	0.84	10	0.11	-6.02

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	0.8	1.282	7.38	0.91	10	0.13	-6.25
7	0.88	0.571	7.12	0.83	10	0.25	-6.55
8	1	-0.013	6.82	0.82	10	0.29	-6.83

1

Fleet : FLT16: NorBarLofAcSu

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	0.02	0.19	-0.33	0.24	0.16	0.06	0.35	-0.13	-0.19	-0.21
4	0.19	0.44	-0.14	0.08	0.03	-0.03	0.18	0.01	-0.13	-0.09
5	-0.24	0.33	0.04	0.21	-0.04	0.06	0.31	-0.18	-0.09	-0.18
6	-0.13	0.08	-0.22	0.08	-0.15	-0.08	0.53	0	0.07	-0.38
7	-0.05	0.12	0.36	0.22	-0.74	-0.1	0.36	0.23	-0.14	-0.06
8	-0.47	-0.09	0.34	0.3	-0.75	-0.46	0.03	0.35	0.11	0.17
9	-0.35	0.07	-0.15	0.04	-0.3	0.03	-0.22	0.42	-0.06	0.06
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	-5.4197	-5.3313	-5.2905	-5.4421
S.E(Log q)	0.2906	0.346	0.386	0.2377

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	0.59	0.916	8.94	0.54	10	0.26	-6.03
4	0.34	2.674	10.52	0.79	10	0.14	-6.12
5	0.52	1.179	8.99	0.59	10	0.22	-5.75

Table 3.16. (Cont'd)

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	0.81	0.621	6.65	0.71	10	0.25	-5.42
7	0.75	1.195	6.81	0.84	10	0.25	-5.33
8	0.62	3.493	7.1	0.95	10	0.14	-5.29
9	0.94	0.325	5.65	0.87	10	0.25	-5.44

1

Fleet : FLT18: RusSweptArea

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	0.1	-0.18	-0.14	0.07	0.02	-0.02	0.15	-0.09	-0.17	0.15
4	0	0.33	0.07	0.14	-0.06	-0.08	0.01	0.08	-0.01	-0.1
5	-0.33	-0.1	0.37	0.04	0.24	-0.11	-0.13	-0.25	-0.22	0.4
6	-0.7	-0.37	0.19	-0.09	0.2	0.04	-0.15	-0.07	0	0.08
7	-0.65	-0.67	-0.44	-0.34	-0.32	-0.06	0.27	-0.01	0.24	0.17
8	0.09	-0.47	-0.55	-0.34	-0.11	-0.25	0.38	0.14	0.2	-0.03
9	-0.3	0.27	0.11	-0.02	-0.27	-0.24	0.25	-0.26	0.29	0.07
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	-4.4411	-4.2448	-4.1143	-4.1969
S.E(Log q)	0.1375	0.2728	0.2803	0.2458

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	0.46	2.174	9.78	0.79	10	0.15	-5.84
4	0.67	1.78	7.82	0.87	10	0.11	-5.38
5	0.99	0.026	4.95	0.44	10	0.29	-4.85

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	1.17	-0.832	3.18	0.85	10	0.17	-4.44
7	0.74	1.809	6.05	0.92	10	0.17	-4.24
8	0.92	0.359	4.59	0.83	10	0.28	-4.11
9	0.9	0.563	4.68	0.88	10	0.24	-4.2

1

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1	0	0	0	0	0	0
FLT15: NorBarTrSur r	1	0	0	0	0	0	0
FLT16: NorBarLofAcSu	1	0	0	0	0	0	0
FLT18: RusSweptArea	1	0	0	0	0	0	0

Table 3.16. (Cont'd)

P shrinkage mean	859249	0.38				0.875	1.055
F shrinkage mean	654910	1				0.125	1.24

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
830601	0.35	13.63	2	38.572	1.077

Age 2 Catchability dependent on age and year class strength

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1	0	0	0	0	0	0
FLT15: NorBarTrSur r	1	0	0	0	0	0	0
FLT16: NorBarLofAcSu	1	0	0	0	0	0	0
FLT18: RusSweptArea	1	0	0	0	0	0	0
P shrinkage mean	495843	0.26				0.939	0.229
F shrinkage mean	283342	1				0.061	0.372

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
479181	0.25	13.08	2	52.927	0.237

Age 3 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	0	0	0	0	0	0
FLT15: NorBarTrSur r	335721	0.3	0	0	1	0.213	0.118
FLT16: NorBarLofAcSu	288454	0.3	0	0	1	0.213	0.136
FLT18: RusSweptArea	411291	0.3	0	0	1	0.213	0.097
P shrinkage mean	371211	0.25				0.339	0.107
F shrinkage mean	501787	1				0.021	0.081

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
354211	0.14	0.07	5	0.488	0.112

1

Age 4 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	0	0	0	0	0	0
FLT15: NorBarTrSur r	168077	0.212	0.013	0.06	2	0.257	0.119
FLT16: NorBarLofAcSu	164845	0.226	0.052	0.23	2	0.228	0.121
FLT18: RusSweptArea	164893	0.212	0.034	0.16	2	0.257	0.121
P shrinkage mean	276757	0.23				0.245	0.074
F shrinkage mean	173204	1				0.013	0.115

Weighted prediction :

Table 3.16. (Cont'd)

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
188273	0.11	0.1	8	0.88	0.107

Age 5 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 trawl	1	0	0	0	0	0	0
FLT15: NorBarTrSur r	156555	0.175	0.021	0.12	3	0.295	0.523
FLT16: NorBarLofAcSu	129453	0.175	0.018	0.1	3	0.295	0.605
FLT18: RusSweptArea	162302	0.185	0.143	0.77	3	0.258	0.509
P shrinkage mean	150335	0.36				0.134	0.54
F shrinkage mean	294002	1				0.017	0.312

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
150182	0.1	0.05	11	0.519	0.54

1

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

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1	0	0	0	0	0	0
FLT15: NorBarTrSur r	56219	0.155	0.072	0.46	4	0.337	0.693
FLT16: NorBarLofAcSu	51445	0.156	0.149	0.95	4	0.328	0.738
FLT18: RusSweptArea	57670	0.161	0.074	0.46	4	0.314	0.68
F shrinkage mean	79026	1				0.021	0.537

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
55432	0.09	0.06	13	0.609	0.7

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1	0	0	0	0	0	0
FLT15: NorBarTrSur r	32715	0.149	0.028	0.19	5	0.344	0.806
FLT16: NorBarLofAcSu	33877	0.155	0.059	0.38	5	0.294	0.787
FLT18: RusSweptArea	34763	0.151	0.069	0.46	5	0.337	0.773
F shrinkage mean	37410	1				0.025	0.734

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
33849	0.09	0.03	16	0.325	0.787

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

Year class = 1997

Table 3.16. (Cont'd)

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1	0	0	0	0	0	0
FLT15: NorBarTrSur r	13699	0.159	0.076	0.48	6	0.36	0.858
FLT16: NorBarLofAcSu	15804	0.176	0.066	0.38	6	0.252	0.778
FLT18: RusSweptArea	14799	0.16	0.055	0.34	6	0.355	0.814
F shrinkage mean	13618	1				0.033	0.861

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14592	0.1	0.04	19	0.376	0.822

Age 9 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 trawl	3537	0.376	0	0	1	0.117	0.959
FLT15: NorBarTrSur r	5061	0.164	0.116	0.71	6	0.18	0.753
FLT16: NorBarLofAcSu	5846	0.194	0.052	0.27	7	0.307	0.679
FLT18: RusSweptArea	5554	0.173	0.039	0.23	7	0.361	0.705
F shrinkage mean	4171	1				0.035	0.86

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5212	0.11	0.05	22	0.435	0.738

Age 10 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	1201	0.249	0.077	0.31	2	0.376	1.018
FLT15: NorBarTrSur r	1696	0.185	0.059	0.32	6	0.115	0.812
FLT16: NorBarLofAcSu	1536	0.205	0.073	0.36	7	0.204	0.869
FLT18: RusSweptArea	1854	0.183	0.035	0.19	7	0.241	0.764
F shrinkage mean	1464	1				0.065	0.897

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1477	0.13	0.04	23	0.341	0.891

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

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	399	0.211	0.156	0.74	3	0.594	0.821
FLT15: NorBarTrSur r	446	0.2	0.098	0.49	6	0.06	0.761
FLT16: NorBarLofAcSu	563	0.223	0.086	0.39	7	0.125	0.643
FLT18: RusSweptArea	396	0.198	0.108	0.55	7	0.146	0.826
F shrinkage mean	445	1				0.075	0.763

Weighted prediction :

Table 3.16. (Cont'd)

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
422	0.15	0.05	24	0.338	0.79

1
Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	221	0.202	0.06	0.3	3	0.594	0.343
FLT15: NorBarTrSur r	137	0.231	0.041	0.18	6	0.056	0.508
FLT16: NorBarLofAcSu	137	0.24	0.072	0.3	7	0.123	0.508
FLT18: RusSweptArea	192	0.213	0.1	0.47	7	0.145	0.386
F shrinkage mean	68	1				0.082	0.849

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
180	0.15	0.08	24	0.518	0.406

Table 3.17 Northeast arctic cod.
Fishing mortality for XSA run down to age 1. Number of cod eaten by cod included in catch matrix

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

At 24/04/2006 15:47

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1984	1985
AGE		
1	0.2457	0.3591
2	0.0373	0.0577
3	0.0199	0.0533
4	0.1235	0.1701
5	0.3075	0.3763
6	0.6274	0.6051
7	1.1361	0.9248
8	1.2111	1.0189
9	1.2623	0.7786
10	0.9579	0.5057
11	1.0876	0.4205
12	1.0345	0.4665
+gp	1.0345	0.4665
0 FBAR 5	0.9171	0.7016

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.9368	0.5267	0.8044	0.2145	0.0961	0.1038	0.4685	2.5645	1.7162	1.8693
2	0.8027	0.8028	0.1102	0.002	0.0594	0.2381	0.1461	0.4488	0.6315	0.9361
3	0.1451	0.1137	0.0629	0.0327	0.0086	0.0185	0.0405	0.0788	0.2097	0.5518
4	0.2122	0.2285	0.127	0.1284	0.0622	0.0624	0.1266	0.096	0.2011	0.3038
5	0.4933	0.5097	0.3704	0.266	0.1342	0.1875	0.2205	0.3464	0.339	0.3381
6	0.7052	0.9363	0.5971	0.4016	0.231	0.321	0.4428	0.4597	0.6457	0.5773
7	0.948	1.1398	1.0446	0.7156	0.2504	0.4259	0.5396	0.5663	1.1681	0.891
8	1.0909	1.0143	0.9834	0.8892	0.3742	0.3451	0.5993	0.5977	0.9863	0.9433
9	0.8281	0.7784	1.1591	0.7166	0.3058	0.3805	0.4558	0.6665	1.0544	0.9618
10	1.112	1.3241	1.718	0.9855	0.3242	0.256	0.4586	0.6631	1.04	1.0199
11	0.8745	1.027	1.5371	0.5821	0.54	0.134	0.2482	0.6763	1.1613	1.2534
12	1.0045	1.1899	1.6497	0.7917	0.4352	0.1959	0.3556	0.6759	1.1137	1.1503
+gp	1.0045	1.1899	1.6497	0.7917	0.4352	0.1959	0.3556	0.6759	1.1137	1.1503
0 FBAR 5	0.8629	0.9504	0.9788	0.6624	0.27	0.3193	0.4528	0.55	0.8722	0.7886
1										

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

At 24/04/2006 15:47

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
1	1.9922	2.5094	1.6287	1.0893	1.4379	1.0302	0.594	1.4785	1.5815	1.0767	1.3789
2	1.0577	1.0885	0.6273	0.3572	0.2591	0.2243	0.4878	0.2495	0.6294	0.2365	0.3718
3	0.4697	0.3327	0.3798	0.1225	0.0782	0.0624	0.1288	0.0604	0.072	0.1123	0.0816
4	0.3521	0.2966	0.3537	0.2101	0.1382	0.1171	0.1068	0.081	0.1314	0.1065	0.1063
5	0.4118	0.569	0.5207	0.5476	0.4118	0.2806	0.2895	0.272	0.2961	0.5402	0.3694
6	0.5427	0.7244	0.7799	0.7205	0.6039	0.5211	0.5431	0.4754	0.5195	0.6998	0.5649
7	0.7498	0.843	0.7734	0.8099	0.7435	0.6706	0.8115	0.6499	0.7583	0.7871	0.7318
8	0.8626	1.2355	1.0433	1.0633	1.0355	0.821	0.8919	0.7093	0.8027	0.8217	0.7779
9	0.7517	1.3384	1.1746	1.3954	1.2016	0.8894	0.7586	0.5806	0.8255	0.7377	0.7146
10	0.9394	1.5086	1.2476	1.4373	1.1776	1.1715	0.7392	0.4761	0.8709	0.891	0.746
11	0.8674	1.4418	1.3316	0.9483	1.155	0.8473	0.7371	0.4443	0.5915	0.79	0.6086
12	0.9132	1.5026	1.3072	1.1752	1.215	1.1869	0.8433	0.8652	0.9445	0.4065	0.7387
+gp	0.9132	1.5026	1.3072	1.1752	1.215	1.1869	0.8433	0.8652	0.9445	0.4065	
0 FBAR 5	0.7097	1.0365	0.9233	0.9957	0.8623	0.7257	0.6723	0.5272	0.6788	0.7462	
1											

Table 3.18. Northeast Arctic cod. Stock number at age from XSA run down to age 1, with number of cod eaten by cod included in catch matrix

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

At 24/04/2006 15:47

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1984	1985
	AGE		
	1	211677	137712
	2	67035	135548
	3	40282	52873
	4	13543	32331
	5	7852	9800
	6	4763	4727
	7	2465	2082
	8	1304	648
	9	923	318
	10	140	214
	11	39	44
	12	26	11
	+gp	12	21
0	TOT/	350062	376329

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	1	175526	49253	82175	81730	151981	173646	306299	2424805	935989	2008062
	2	78736	56316	23815	30098	53996	113031	128153	156974	152784	137752
	3	104751	28886	20660	17463	24593	41659	72936	90659	82043	66518
	4	41043	74177	21109	15883	13838	19963	33481	57345	68601	54466
	5	22329	27180	48325	15222	11437	10646	15355	24153	42652	45934
	6	5507	11163	13366	27319	9552	8188	7226	10084	13985	24879
	7	2113	2227	3583	6023	14969	6207	4863	3800	5213	6003
	8	676	670	583	1032	2411	9540	3320	2321	1766	1327
	9	192	186	199	179	347	1358	5532	1493	1045	539
	10	120	69	70	51	71	209	760	2871	628	298
	11	106	32	15	10	16	42	133	393	1211	182
	12	24	36	9	3	5	7	30	85	164	310
	+gp	13	16	8	6	4	2	5	19	23	42
0	TOT/	431135	250212	213917	195018	283220	384500	578091	2775001	1306105	2346313
	1										

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

At 24/04/2006 15:47

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 84-**	AMST 84-**
	AGE													
	1	2776326	1919498	667932	303561	323902	387361	116442	594441	440312	297768	0	345432	691416
	2	253573	310036	127799	107280	83622	62965	113199	52635	110952	74146	83060	93347	112267
	3	44229	72095	85468	55877	61451	52836	41194	56902	33578	48407	47918	50109	55669
	4	31363	22640	42323	47861	40473	46528	40641	29652	43856	25581	35421	33347	37363
	5	32910	18056	13778	24328	31762	28860	33883	29904	22387	31484	18827	21752	24718
	6	26819	17850	8369	6702	11520	17227	17847	20769	18652	13632	15018	11610	13393
	7	11436	12761	7083	3141	2670	5156	8376	8488	10570	9083	5543	4983	5933
	8	2016	4424	4497	2676	1144	1039	2159	3046	3628	4054	3385	1759	2330
	9	423	697	1053	1297	757	333	374	724	1227	1331	1459	586	898
	10	169	163	150	266	263	186	112	144	332	440	521	192	348
	11	88	54	30	35	52	66	47	44	73	114	148	59	132
	12	42	30	10	6	11	13	23	19	23	33	42	20	43
	+gp	162	53	17	11	4	5	7	12	11	17	27		
0	TOT/	3179557	2378359	958509	553043	557629	602576	374303	796779	685601	506090	211371		
	1													

Table 3.19

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

At 24/04/2006 15:47

Table 4 Natural Mortality (M) at age

YEAR	1984	1985
AGE		
1	0.2	0.2
2	0.2	0.2
3	0.2	0.2
4	0.2	0.2
5	0.2	0.2
6	0.2	0.2
7	0.2	0.2
8	0.2	0.2
9	0.2	0.2
10	0.2	0.2
11	0.2	0.2
12	0.2	0.2
+gp	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	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

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

At 24/04/2006 15:47

Table 4 Natural Mortality (M) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	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 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	0.2457	0.0356	0.0006	0.0000	0.0000	0.0000
1985	0.3590	0.0562	0.0004	0.0000	0.0000	0.0000
1986	0.9368	0.8010	0.1123	0.0000	0.0000	0.0000
1987	0.5267	0.8017	0.0585	0.0000	0.0000	0.0000
1988	0.8044	0.1093	0.0087	0.0000	0.0000	0.0000
1989	0.2145	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0961	0.0590	0.0000	0.0000	0.0000	0.0000
1991	0.1038	0.2374	0.0052	0.0000	0.0000	0.0000
1992	0.4681	0.1450	0.0067	0.0000	0.0000	0.0000
1993	2.5645	0.4482	0.0660	0.0027	0.0022	0.0000
1994	1.7162	0.6312	0.1999	0.0954	0.0257	0.0046
1995	1.8693	0.9358	0.5413	0.2036	0.0111	0.0014
1996	1.9922	1.0571	0.4457	0.2318	0.0811	0.0060
1997	2.5094	1.0878	0.3096	0.0908	0.0101	0.0019
1998	1.6287	0.6254	0.3302	0.0782	0.0167	0.0098
1999	1.0893	0.3568	0.1067	0.0111	0.0000	0.0000
2000	1.4379	0.2588	0.0694	0.0414	0.0168	0.0006
2001	1.0302	0.2238	0.0515	0.0290	0.0077	0.0070
2002	0.5939	0.4876	0.1221	0.0178	0.0033	0.0001
2003	1.4785	0.2491	0.0459	0.0000	0.0000	0.0000
2004	1.5815	0.6292	0.0649	0.0286	0.0062	0.0003
2005	1.0767	0.2357	0.0983	0.0165	0.0261	0.0047

Table 3.21. Northeast Arctic cod. Final VPA

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
AGE										
3	0.0061	0.0018	0.0003	0.0023	0.002	0.0254	0.0225	0.0334	0.0199	0.0159
4	0.02	0.0249	0.0124	0.0209	0.0321	0.1612	0.1667	0.1325	0.1457	0.084
5	0.0532	0.1101	0.0751	0.1484	0.1167	0.2637	0.37	0.2299	0.2676	0.2859
6	0.0973	0.2024	0.1997	0.3662	0.2882	0.2787	0.5501	0.3125	0.3333	0.5297
7	0.1781	0.416	0.5201	0.5101	0.4096	0.4122	0.5311	0.3243	0.3969	0.5139
8	0.1932	0.2545	0.3536	0.3869	0.348	0.4046	0.4175	0.3469	0.2494	0.588
9	0.3125	0.4047	0.5286	0.3832	0.4741	0.5057	0.579	0.3932	0.4364	0.5805
10	0.2798	0.4405	0.3617	0.3766	0.5031	0.5149	0.7613	0.5364	0.6441	0.7645
11	0.3432	0.7827	0.5536	0.6259	0.9031	0.4585	1.026	0.698	0.8035	0.7621
12	0.312	0.6182	0.4604	0.5039	0.7111	0.4879	0.9056	0.6217	0.7304	0.7704
+gp	0.312	0.6182	0.4604	0.5039	0.7111	0.4879	0.9056	0.6217	0.7304	0.7704
0 FBAR 5	0.1857	0.3047	0.3398	0.3619	0.3566	0.3966	0.5348	0.3572	0.3879	0.5437
FBAR 4	0.1084	0.2016	0.2322	0.2865	0.2389	0.3041	0.4071	0.2692	0.2786	0.4003

Table 8 Fishing mortality (F) at age

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.027	0.024	0.0718	0.0535	0.0543	0.0562	0.0663	0.0313	0.0174	0.0226
4	0.1291	0.1128	0.2589	0.2564	0.2266	0.2717	0.3063	0.2366	0.1449	0.111
5	0.4568	0.2094	0.3626	0.5093	0.3477	0.4944	0.6498	0.742	0.3537	0.3909
6	0.69	0.4862	0.5517	0.5121	0.4607	0.5168	0.8279	1.0069	0.4854	0.4494
7	0.6129	0.5494	0.5357	0.5251	0.4363	0.5279	0.6094	0.9764	0.5787	0.4033
8	0.688	0.6287	0.4593	0.5111	0.4855	0.6931	0.6564	0.8798	0.7409	0.5303
9	0.6551	0.5463	0.4535	0.6141	0.4053	0.7389	0.8167	0.9416	1.0674	0.7389
10	0.738	0.6333	0.7388	0.686	0.7381	0.8379	0.9855	1.3731	0.8476	0.8074
11	0.8756	0.8584	0.8415	0.6511	0.8449	1.0011	0.9522	1.4366	1.2968	0.7617
12	0.8152	0.7529	0.799	0.6734	0.7981	0.9284	0.9756	1.4264	1.0883	0.7927
+gp	0.8152	0.7529	0.799	0.6734	0.7981	0.9284	0.9756	1.4264	1.0883	0.7927
0 FBAR 5	0.6401	0.5089	0.5169	0.5596	0.4789	0.6348	0.7576	0.9866	0.6789	0.5533
FBAR 4	0.5154	0.3973	0.4337	0.4628	0.3914	0.5008	0.61	0.7683	0.4607	0.377
1										

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.0398	0.0298	0.0251	0.023	0.0409	0.0214	0.0394	0.1959	0.2141	0.0837
4	0.1037	0.1525	0.2064	0.2292	0.1422	0.1028	0.1673	0.1996	0.4959	0.2106
5	0.2119	0.1814	0.4087	0.4792	0.4004	0.2285	0.2976	0.3536	0.5375	0.5211
6	0.3818	0.2026	0.4683	0.5382	0.568	0.2517	0.3849	0.3917	0.5078	0.7021
7	0.4713	0.432	0.4019	0.7725	0.6211	0.5144	0.3427	0.421	0.4451	0.705
8	0.5797	0.6844	0.5291	0.9302	0.8479	0.833	0.6583	0.7375	0.4863	0.7032
9	0.7183	0.8781	0.8041	1.1783	0.9682	0.9584	1.1338	0.9698	0.5192	0.6109
10	0.8182	0.885	0.8105	1.0769	1.09	0.7876	1.3393	0.7386	0.8842	0.7149
11	0.5024	1.2253	0.6772	1.5554	0.8533	0.8388	1.2904	0.7222	0.9905	0.9079
12	0.6634	1.0696	0.7458	1.3377	0.9829	0.8179	1.3377	0.7358	0.9492	0.8218
+gp	0.6634	1.0696	0.7458	1.3377	0.9829	0.8179	1.3377	0.7358	0.9492	0.8218
0 FBAR 5	0.5302	0.5439	0.5704	0.8292	0.7493	0.5956	0.6928	0.602	0.5633	0.6595
FBAR 4	0.3497	0.3306	0.4029	0.5899	0.5159	0.3861	0.3702	0.4207	0.4945	0.5684

Table 3.21. (continued)

Table 8	Fishing mortality (F) at age									
YEAF	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.166	0.1338	0.146	0.0489	0.0318	0.0252	0.0672	0.0208	0.0194	0.0533
4	0.3121	0.5671	0.2234	0.209	0.1296	0.1003	0.2121	0.205	0.1247	0.1716
5	0.48	0.7544	0.6703	0.3475	0.3562	0.23	0.3045	0.3308	0.3096	0.3788
6	0.5715	0.6857	0.8497	0.5478	0.6225	0.5163	0.5518	0.5033	0.6301	0.6078
7	0.6973	0.6763	0.8581	0.6643	0.6766	0.8475	0.7996	0.7821	1.135	0.9264
8	0.8908	0.9121	0.9296	0.7789	0.7123	1.0788	0.9846	1.0295	1.2083	1.0191
9	0.7746	1.2298	1.3057	1.0352	0.939	1.2764	1.1588	0.9701	1.2572	0.7818
10	0.46	0.7689	1.0301	0.9848	1.038	1.2299	0.7507	0.9203	0.9564	0.5088
11	0.6132	0.6231	1.8042	1.4314	1.4798	0.9557	0.9516	0.5853	1.081	0.4237
12	0.5389	0.6958	1.4375	1.2219	1.2775	1.1082	0.8607	0.759	1.0345	0.4665
+gp	0.5389	0.6958	1.4375	1.2219	1.2775	1.1082	0.8607	0.759	1.0345	0.4665
0 FBAR !	0.6457	0.8379	0.9406	0.7264	0.7241	0.8632	0.7583	0.756	0.9161	0.7038
FBAR 4	0.5904	0.7191	0.7062	0.5095	0.4994	0.5546	0.5705	0.5701	0.6815	0.6207

Table 8	Fishing mortality (F) at age									
YEAF	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.033	0.0555	0.0546	0.033	0.0087	0.0134	0.0341	0.0129	0.0098	0.0106
4	0.2133	0.2293	0.1277	0.1292	0.0627	0.0631	0.1276	0.0942	0.1065	0.1008
5	0.496	0.5104	0.371	0.2671	0.1352	0.1888	0.2226	0.3464	0.3153	0.3291
6	0.7078	0.9362	0.5974	0.4024	0.2324	0.3228	0.4449	0.4635	0.6434	0.5786
7	0.9487	1.1362	1.0411	0.7142	0.2518	0.4277	0.5417	0.5693	1.1663	0.8924
8	1.091	1.0143	0.9788	0.8851	0.3755	0.347	0.6013	0.601	0.9867	0.9446
9	0.8325	0.7841	1.1546	0.7134	0.3067	0.3823	0.4585	0.6697	1.0544	0.9633
10	1.1134	1.3245	1.7027	0.9791	0.3242	0.2572	0.4612	0.6669	1.0411	1.021
11	0.8774	1.0329	1.5282	0.581	0.5377	0.1345	0.2497	0.6797	1.1612	1.2497
12	1.0045	1.1899	1.6497	0.7917	0.4352	0.1959	0.3556	0.6759	1.1137	1.1503
+gp	1.0045	1.1899	1.6497	0.7917	0.4352	0.1959	0.3556	0.6759	1.1137	1.1503
0 FBAR !	0.8649	0.951	0.9743	0.6602	0.271	0.321	0.455	0.5528	0.8679	0.7882
FBAR 4	0.6914	0.7653	0.6232	0.4796	0.2115	0.2699	0.3876	0.4149	0.6436	0.5691

Table 8	Fishing mortality (F) at age										
YEAF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
3	0.024	0.0232	0.0497	0.0159	0.0089	0.011	0.0068	0.0146	0.0071	0.014	0.0119
4	0.121	0.2069	0.2766	0.2001	0.0974	0.0888	0.0896	0.0817	0.1035	0.09	0.0917
5	0.3325	0.5607	0.5053	0.5485	0.3964	0.2743	0.2877	0.2736	0.2915	0.5141	0.3598
6	0.5395	0.7241	0.7709	0.7206	0.6044	0.5159	0.5442	0.4774	0.521	0.6951	0.5645
7	0.7538	0.8457	0.7761	0.8113	0.7434	0.6718	0.8112	0.6509	0.7589	0.7871	0.7323
8	0.8665	1.2353	1.046	1.0642	1.0334	0.8193	0.8903	0.7105	0.8021	0.8217	0.7781
9	0.7575	1.3367	1.176	1.3917	1.2	0.8881	0.7562	0.5824	0.8261	0.7377	0.7154
10	0.9438	1.5061	1.2455	1.4313	1.174	1.1675	0.7394	0.4761	0.8702	0.891	0.7458
11	0.873	1.4403	1.3299	0.9509	1.1473	0.8472	0.7382	0.4472	0.5902	0.79	0.6091
12	0.9132	1.5026	1.3072	1.1752	1.215	1.1869	0.8433	0.8652	0.9445	0.4065	0.7387
+gp	0.9132	1.5026	1.3072	1.1752	1.215	1.1869	0.8433	0.8652	0.9445	0.4065	
0 FBAR !	0.6989	1.0348	0.92	0.9946	0.8586	0.7228	0.6715	0.5285	0.6783	0.7411	
FBAR 4	0.5227	0.7145	0.675	0.6689	0.575	0.474	0.5246	0.4388	0.4954	0.5816	
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	0.0328	0.2122	0.4933	0.7052
1987	0.0000	0.0011	0.0552	0.2285	0.5097	0.9363
1988	0.0000	0.0009	0.0542	0.1270	0.3704	0.5971
1989	0.0000	0.0009	0.0327	0.1284	0.2660	0.4016
1990	0.0000	0.0004	0.0086	0.0622	0.1342	0.2310
1991	0.0000	0.0007	0.0133	0.0624	0.1875	0.3210
1992	0.0004	0.0011	0.0338	0.1266	0.2205	0.4428
1993	0.0000	0.0006	0.0128	0.0933	0.3442	0.4597
1994	0.0000	0.0003	0.0098	0.1057	0.3133	0.6411
1995	0.0000	0.0003	0.0105	0.1002	0.3270	0.5759
1996	0.0000	0.0006	0.0240	0.1203	0.3307	0.5367
1997	0.0000	0.0007	0.0231	0.2058	0.5589	0.7225
1998	0.0000	0.0019	0.0496	0.2755	0.5040	0.7701
1999	0.0000	0.0004	0.0158	0.1990	0.5476	0.7205
2000	0.0000	0.0003	0.0088	0.0968	0.3950	0.6033
2001	0.0000	0.0005	0.0109	0.0881	0.2729	0.5141
2002	0.0001	0.0002	0.0067	0.0890	0.2862	0.5430
2003	0.0000	0.0004	0.0145	0.0810	0.2720	0.4754
2004	0.0000	0.0002	0.0071	0.1028	0.2899	0.5192
2005	0.0000	0.0008	0.0140	0.0900	0.5141	0.6951

Table 3.23. Stock number at age. Final VPA

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

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

	YEAF	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
	AGE										
	3	728139	425311	442592	468348	704908	1083753	1193111	1590377	641584	272778
	4	577860	592530	347574	362238	382556	575973	865011	955076	1259285	514924
	5	402060	463732	473210	281072	290427	303320	401364	599477	684912	891184
	6	197212	312115	340097	359415	198391	211595	190765	226975	389987	429102
	7	93323	146496	208708	228044	204032	121764	131099	90099	135956	228785
	8	96213	63939	79121	101579	112107	110900	66016	63110	53333	74845
	9	244722	64933	40588	45487	56484	64808	60583	35603	36525	34028
	10	101777	146581	35470	19586	25387	28785	32000	27799	19673	19329
	11	38117	62991	77255	20227	11003	12568	14083	12237	13311	8459
	12	39205	22142	23578	36361	8856	3651	6506	4133	4985	4880
	+gp	33324	42765	37377	21337	21133	13989	3938	1880	2707	2738
0	TOT/	2551952	2343535	2105569	1943694	2015284	2531108	2964476	3606766	3242259	2481052

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

	YEAF	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	AGE										
	3	439602	804781	496824	683690	789653	916842	728338	472064	338678	776941
	4	219807	350332	643259	378598	530599	612324	709603	558039	374580	272501
	5	387619	158175	256234	406511	239862	346346	382037	427678	360621	265306
	6	548181	200984	105033	145989	199996	138702	172949	163321	166726	207288
	7	206850	225110	101196	49529	71623	103298	67732	61876	48854	84015
	8	112048	91748	106395	48488	23986	37908	49883	30149	19083	22424
	9	34036	46105	40060	55027	23813	12084	15518	21185	10240	7448
	10	15591	14474	21860	20840	24380	13000	4726	5614	6764	2883
	11	7368	6103	6291	8550	8592	9541	4605	1444	1164	2373
	12	3232	2513	2118	2220	3650	3022	2871	1455	281	261
	+gp	3722	1687	857	1142	1351	2332	1351	1113	1278	670
0	TOT/	1978057	1902013	1780129	1800584	1917505	2195401	2139612	1743938	1328269	1642109

Table 3.23. (continued)
Run title : Arctic Cod (run: SVPASA15/V15)

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

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

	YEAF	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	1582560	1295416	164955	112039	197105	404774	1015319	1818949	523916	621616
	4	621906	1245195	1029477	131705	89647	154909	324399	799193	1224278	346265
	5	199663	458995	875269	685697	85743	63671	114439	224670	535936	610486
	6	146941	132256	313440	476187	347649	47037	41482	69576	129164	256342
	7	108284	82121	88421	160667	227600	161288	29940	23112	38504	63643
	8	45954	55340	43651	48433	60756	100131	78947	17401	12421	20199
	9	10803	21072	22854	21054	15642	21306	35642	33463	6815	6253
	10	2913	4313	7170	8373	5306	4863	6690	9391	10388	3320
	11	1053	1052	1457	2610	2335	1461	1811	1435	3673	3513
	12	907	522	253	606	451	815	517	408	571	1117
	+gp	351	461	498	278	312	421	697	408	525	550
0	TOT/	2721334	3296742	2547445	1647648	1032545	960676	1649883	2998007	2486189	1933304

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

	YEAF	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	613942	348054	638490	198490	137735	150868	151830	166831	397831	523673
	4	468089	425778	249276	451722	154747	109237	120444	116234	133783	319254
	5	229669	280485	197708	163230	300088	111295	80899	79769	77525	96695
	6	296843	116349	108004	82807	94414	172067	72401	48848	46916	46570
	7	104000	137232	47987	37806	39202	41481	84063	34138	24176	20455
	8	25746	42398	57130	16658	15929	16316	14551	30937	12785	6362
	9	8186	8650	13943	18463	6259	6397	4542	4451	9048	3127
	10	2779	3089	2070	3093	5368	2004	1461	1167	1381	2107
	11	1330	1436	1172	605	946	1557	480	565	381	435
	12	1160	590	631	158	118	176	490	152	258	106
	+gp	572	583	1198	218	87	66	70	170	116	209
0	TOT/	1752317	1364643	1317608	973250	754893	611465	531231	483261	704200	1018993

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

	YEAF	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	1038820	286370	204640	172781	242751	411780	720906	896029	810154	656754
	4	406348	735510	209192	157264	136870	197022	330919	566642	677943	537807
	5	220157	268786	478804	150743	113151	105246	151442	238469	421083	453586
	6	54207	109763	132093	270498	94491	80924	71339	99246	137778	245134
	7	20763	21867	35238	59508	148103	61321	47978	37432	51115	59006
	8	6632	6583	5747	10186	23854	94264	32734	22851	17344	13037
	9	1880	1824	1954	1768	3442	13416	54550	14689	10258	5294
	10	1171	669	682	504	709	2074	7495	28237	6156	2926
	11	1037	315	146	102	155	420	1313	3869	11867	1779
	12	233	353	92	26	47	74	301	837	1605	3042
	+gp	130	156	82	56	40	25	48	191	232	418
0	TOT/	1751376	1432196	1068670	823436	763613	966566	1419022	1908492	2145535	1978784

Table 3.24. Stock biomass at age. Final VPA

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
AGE										
3	254849	136099	150481	173289	274914	433501	524969	636151	282297	87289
4	340937	331817	184214	242699	244836	478058	692009	725857	969649	293507
5	446286	440545	596245	311990	374651	421615	533814	767331	862989	1007038
6	333289	468173	656387	596629	337265	397799	366270	438062	768275	742347
7	221176	313502	513421	570111	481515	309280	346101	253178	411947	629160
8	304996	186702	265846	328099	390132	383714	244919	234769	230934	294890
9	973994	237005	171279	185131	255308	316264	306548	180151	197233	166739
10	513974	668411	188345	103218	142673	149682	193600	176245	132792	136079
11	225651	367868	457348	121160	70420	89737	104495	90555	103693	60902
12	282275	164292	167165	257435	70497	30013	54844	35831	53190	42844
+gp	271456	378386	315087	175349	187892	131347	40110	19247	26204	27591
0 TOTAL	4168882	3692801	3665819	3065111	2830103	3141009	3407679	3557376	4039204	3488383

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	145069	265578	168920	239291	268482	284221	233068	151061	111764	295238
4	127488	206696	334495	272591	270606	336778	390282	340404	206019	185301
5	414753	161338	243423	597571	261449	363663	355294	410571	342590	273265
6	1003170	365792	201664	391251	425991	305145	294013	282545	310111	308859
7	597796	650567	297518	177809	242086	333654	205229	188104	158775	202475
8	476204	392683	447924	209470	116810	193710	250910	149537	94841	78931
9	188902	253117	224738	299899	145737	74320	101645	136428	65640	42675
10	113501	108698	160673	134210	206985	105953	36390	44408	54588	21740
11	58944	50286	54540	61300	66934	82819	42684	13894	10875	20098
12	26988	23247	20287	19159	30297	29013	30314	16454	2856	2911
+gp	37015	17892	9967	13275	15429	27875	17178	14173	16470	9201
0 TOTAL	3189831	2495895	2164149	2415826	2050805	2137149	1957006	1747579	1374529	1440693

1

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	696327	375671	54435	49297	72929	182148	385821	691201	167653	254863
4	460210	1008608	720634	104047	81578	136320	249787	727266	808024	221610
5	235602	619644	1295399	843407	114895	87866	163647	345992	627045	677639
6	261555	269803	664492	966659	695298	101599	87943	157241	286743	487049
7	266378	230760	277642	465934	682799	495154	96707	76038	123596	187748
8	175545	192584	183771	184531	252138	422555	345787	80219	54527	88269
9	57905	103040	120443	105690	87437	123791	207793	219854	37616	35894
10	21174	30662	47678	53839	40323	34676	50977	78601	81651	29113
11	9087	9500	13129	21742	20948	12590	17245	15127	36074	34848
12	9669	5524	2444	6492	4958	8822	6248	4742	6512	13192
+gp	4967	6369	7389	3953	4396	5449	9529	5674	6947	7206
0 TOTAL	2198418	2852164	3387455	2805591	2057698	1610969	1621485	2401955	2236387	2037430

Table 3.24 (continued)

	Table 12	Stock biomass at age (start of year)			Tonnes					
	YEAF	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	214880	170547	312860	69471	37188	73926	56177	61727	167089	216277
	4	341705	383200	201913	316206	86659	107052	79493	106936	155188	279347
	5	273307	401093	286676	202406	306090	160265	109213	127630	140320	155003
	6	596655	238515	232208	177208	162392	359620	144077	119188	130896	130862
	7	287041	452865	145879	119088	118389	123613	246304	130406	91385	83027
	8	108649	193334	254800	71461	66900	79133	61698	147262	58429	37111
	9	48132	55876	91184	121484	36552	42028	29340	27463	55823	24029
	10	25849	26656	16521	26635	38975	18354	12436	8986	10636	21316
	11	13669	14264	11898	5579	8362	16843	5870	5224	3521	6210
	12	13760	6427	6843	1720	1099	1899	5283	1645	2794	1346
	+gp	7750	7970	15783	3124	1256	924	979	2209	1514	2984
0	TOTAL	1931396	1950748	1576565	1114381	863862	983658	750871	738675	817596	957513

	Table 12	Stock biomass at age (start of year)			Tonnes					
	YEAF	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	323073	60424	43384	51661	96615	213302	317198	308234	190386	132008
	4	357586	366284	84514	81777	96493	223817	308085	664104	510491	260836
	5	323630	337058	378255	130845	133744	183443	274413	434013	597938	517088
	6	133728	224685	251373	399526	162430	196483	193758	280171	332459	519194
	7	81286	75026	104902	159839	364038	197086	186873	150889	195515	204752
	8	38530	33816	25242	47139	85039	427769	169430	125614	93933	64377
	9	12370	11896	15268	12462	16210	92305	369519	99371	68020	37904
	10	8004	6226	8256	5034	5534	22227	71932	242017	46968	26681
	11	11412	4142	1910	941	1389	3966	16313	41965	96264	17974
	12	2965	4496	1169	330	593	944	3826	10659	20436	38731
	+gp	1863	2226	1181	798	578	354	682	2733	3325	5986
0	TOTAL	1294447	1126278	915454	890352	962663	1561697	1912030	2359771	2155734	1825531

	Table 12	Stock biomass at age (start of year)			Tonnes					
	YEAF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	85284	144076	183557	112275	117976	149002	102290	129582	83687	111708
	4	150799	116632	223139	246308	186273	240336	243285	157511	237059	159134
	5	315336	192227	157998	282209	379277	341422	398399	387355	240560	348248
	6	542824	330182	159823	134273	224259	380730	376898	411981	374722	259917
	7	396325	422448	205118	93789	80256	168442	275069	271435	304268	272653
	8	108909	227858	201579	117147	46059	52463	101338	149240	156794	157921
	9	32235	60811	76499	82175	42430	20885	25372	48159	75540	76296
	10	16804	19363	15190	26731	19245	16891	10298	12378	27918	35884
	11	9207	5904	3395	3757	4881	7395	4743	6480	7039	15062
	12	5316	3757	1301	798	1390	1686	2918	2320	2874	4177
	+gp	23226	7594	2480	1614	572	780	984	1748	1603	2442
0	TOTAL	1686265	1530853	1230079	1101075	1102619	1380033	1541593	1578189	1512065	1443441
	1										

Table 3.25. Northeast Arctic cod. Spawning stock biomass at age

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	4463	4405	5962	3120	3747	4216	5338	7673	8630	10070
	6	9999	14045	19692	17899	10118	11934	10988	13142	23048	22270
	7	13271	18810	35939	51310	43336	30928	27688	17722	32956	44041
	8	33550	24271	34560	55777	89730	92091	53882	44606	36949	38336
	9	175319	37921	42820	53688	89358	126506	125685	72060	72976	43352
	10	226148	280733	88522	55738	74190	86815	121968	112796	90299	72122
	11	146673	275901	333864	95716	55632	64611	85686	76066	90213	50549
	12	242756	149506	152120	226543	66972	25511	50457	33681	49467	39416
	+gp	260598	359467	305634	170088	182256	126093	38907	18670	25156	26763
0	TOTSF	1112776	1165059	1019114	729879	615339	568705	520599	396417	429694	346919

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	2706	0	0	3404	0	0
	5	4148	1613	2434	5976	7843	3637	3553	4106	0	0
	6	30095	10974	6050	15650	25559	18309	14701	8476	9303	3089
	7	35868	39034	17851	21337	24209	40038	30784	13167	20641	12149
	8	57144	35341	44792	71220	22194	60050	85309	41870	35091	15786
	9	26446	30374	22474	146950	65582	48308	62004	57300	43323	23471
	10	46535	23914	48202	89921	142819	96417	29476	35970	48583	15870
	11	39492	30172	27270	51492	51539	81163	39269	13616	10332	19897
	12	24559	19063	16635	16668	25753	28433	29404	16125	2828	2853
	+gp	35534	17356	9668	13275	15274	27875	17178	14173	16470	9201
0	TOTSF	299823	207840	195377	432489	383479	404228	311678	208207	186570	102315
	1										

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

At 24/04/2006 17:43

Traditional vpa using file input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAF	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	0	0	0	0	0	0	3858	0	0	0
	4	0	0	0	0	816	0	4996	0	0	0
	5	2356	0	38862	0	0	879	3273	0	0	6776
	6	5231	8094	33225	19333	6953	5080	879	3145	2867	9741
	7	15983	16153	24988	18637	47796	54467	9671	12166	3708	16897
	8	38620	26962	34917	22144	57992	126766	117567	42516	11451	18536
	9	20267	39155	46973	35935	50714	73036	132988	178082	18808	20100
	10	15669	19624	27653	29611	32662	27394	41292	72313	78385	22708
	11	8542	8455	10766	16089	18644	10827	16210	14370	36074	27530
	12	9089	4972	2444	6167	4512	7763	6248	4647	6251	12532
	+gp	4967	6369	7389	3953	4396	5449	9529	5674	6947	7206
0	TOTSF	120722	129784	227215	151870	224482	311662	346511	332913	164491	142028

Table 3.25 (continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	0	0	0	0	0	0	0	617	0	0
	4	0	0	0	0	0	0	3975	8555	7759	2793
	5	0	8022	0	0	0	3205	10921	12763	25258	13950
	6	29833	19081	4644	5316	3248	25173	48986	35756	40578	47110
	7	34445	117745	18964	15481	15391	24723	160097	95196	51176	45665
	8	31508	104400	112112	27870	23415	42732	50592	129590	52586	31544
	9	21659	42466	64741	93543	23759	33622	26992	26639	55265	23068
	10	21713	23191	12721	23705	31960	17804	12436	8986	10636	19184
	11	11345	13266	9637	4630	8362	16843	5870	5224	3521	6210
	12	13760	6041	6090	1342	989	1899	5283	1645	2794	1346
	+gp	6975	7173	12626	2812	1130	924	979	2209	1514	2984
0	TOTSP	171238	341385	241536	174699	108253	166926	326133	327181	251087	193856

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	0	0	0	413	773	213	317	0	571	0
	4	17879	3663	1690	245	1254	7162	4313	18595	3573	783
	5	25890	23594	18913	3795	6821	13758	39790	37759	71155	31542
	6	25408	40443	82953	91092	34110	59927	81185	103103	111374	193140
	7	43081	16506	55598	87432	190028	139537	149498	106226	115158	127766
	8	27356	15555	15650	33233	60803	368309	159773	116947	80971	50278
	9	7669	5948	15268	11403	14670	88336	359912	96588	65503	36388
	10	7204	4670	8256	5034	5395	22227	71932	240564	46498	26121
	11	11412	4142	1910	941	1389	3966	16313	41965	96264	17974
	12	2965	4496	1169	330	593	944	3826	10659	20436	38731
	+gp	1863	2226	1181	798	578	354	682	2733	3325	5986
0	TOTSP	170729	121243	202589	234715	316414	704734	887541	775141	614827	528709

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	0	0	184	225	0	447	205	130	84	0
	4	0	0	669	493	186	721	3163	158	2371	637
	5	5991	2307	4108	3951	26929	22192	33466	34087	21891	23681
	6	140049	46225	24293	25109	55392	136682	146236	134306	165627	103187
	7	250081	256426	96816	51021	51604	105108	187872	182404	220899	195220
	8	89306	189122	164085	99224	38229	42967	85225	132525	136724	140866
	9	31429	57528	73209	79299	41497	19883	24129	46088	73727	73778
	10	16804	19363	14886	26731	19245	16891	10298	12378	27276	35561
	11	9207	5904	3395	3757	4881	7395	4743	6480	7039	15062
	12	5316	3757	1301	798	1390	1686	2918	2320	2874	4177
	+gp	23226	7594	2480	1614	572	780	984	1748	1603	2442
0	TOTSP	571408	588227	385426	292220	239925	354753	499238	552624	660115	594609

Table 3.26. Northeast Arctic cod. Summary Table.

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

At 24/04/2006 17:43

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	863862	108253	380434	3.5143	0.7241	0.4994
1981	150868	983658	166926	399038	2.3905	0.8632	0.5546
1982	151830	750871	326133	363730	1.1153	0.7583	0.5705
1983	166831	738675	327181	289992	0.8863	0.756	0.5701
1984	397831	817596	251087	277651	1.1058	0.9161	0.6815
1985	523673	957513	193856	307920	1.5884	0.7038	0.6207
1986	1038820	1294447	170729	430113	2.5193	0.8649	0.6914
1987	286370	1126278	121243	523071	4.3142	0.951	0.7653
1988	204640	915454	202589	434939	2.1469	0.9743	0.6232
1989	172781	890352	234715	332481	1.4165	0.6602	0.4796
1990	242751	962663	316414	212000	0.67	0.271	0.2115
1991	411780	1561697	704734	319158	0.4529	0.321	0.2699
1992	720906	1912030	887541	513234	0.5783	0.455	0.3876
1993	896029	2359771	775141	581611	0.7503	0.5528	0.4149
1994	810154	2155734	614827	771086	1.2542	0.8679	0.6436
1995	656754	1825531	528709	739999	1.3996	0.7882	0.5691
1996	437353	1686265	571408	732228	1.2814	0.6989	0.5227
1997	713245	1530853	588227	762403	1.2961	1.0348	0.7145
1998	845886	1230079	385426	592624	1.5376	0.92	0.675
1999	553079	1101075	292220	484910	1.6594	0.9946	0.6689
2000	608126	1102619	239925	414868	1.7292	0.8586	0.575
2001	522815	1380033	354753	426471	1.2022	0.7228	0.474
2002	407529	1541593	499238	535045	1.0717	0.6715	0.5246
2003	563398	1578189	552624	551990	0.9989	0.5285	0.4388
2004	334749	1512065	660115	606445	0.9187	0.6783	0.4954
2005	483585	1443441	594609	641276	1.0785	0.7411	0.5816
Arith. Mean	599557	2000580	389761	661121	2.3562	0.6475	0.4804
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)			

Table 3.27. Northeast Arctic cod. Summary table, no cannibalism included

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

At 26/04/2006 20:52

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRI 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	863862	108253	380434	3.5143	0.7241	0.4994
1981	150868	983658	166926	399038	2.3905	0.8632	0.5546
1982	151830	750871	326133	363730	1.1153	0.7583	0.5705
1983	166831	738675	327181	289992	0.8863	0.756	0.5701
1984	397595	817497	251087	277651	1.1058	0.9161	0.6815
1985	523470	957429	193856	307920	1.5884	0.7038	0.6207
1986	930297	1260696	170729	430113	2.5193	0.8649	0.6914
1987	270552	1122940	121243	523071	4.3142	0.951	0.7653
1988	202916	915089	202589	434939	2.1469	0.9743	0.6232
1989	172781	890352	234715	332481	1.4165	0.6602	0.4796
1990	242751	962663	316414	212000	0.67	0.271	0.2115
1991	408156	1559820	704733	319158	0.4529	0.321	0.2699
1992	700304	1901820	887516	513234	0.5783	0.455	0.3877
1993	759208	2295642	774555	581611	0.7509	0.553	0.4156
1994	516498	2022895	612305	771086	1.2593	0.8688	0.646
1995	306804	1689504	527931	739999	1.4017	0.7887	0.5735
1996	257833	1597022	570364	732228	1.2838	0.7014	0.5289
1997	491859	1473233	588138	762403	1.2963	1.0357	0.7181
1998	599816	1158889	385112	592624	1.5388	0.9211	0.6784
1999	475798	1079409	292175	484910	1.6597	0.9946	0.6698
2000	550749	1076552	239427	414868	1.7328	0.8594	0.5765
2001	488363	1358676	353812	426471	1.2054	0.7232	0.4748
2002	358593	1524006	499053	535045	1.0721	0.6716	0.5249
2003	518821	1566876	552606	551990	0.9989	0.5285	0.4389
2004	311357	1495774	659834	606445	0.9191	0.6785	0.4962
2005	461384	1432574	594128	641276	1.0794	0.7411	0.5816
Arith. Mean	568118	1988481	389631	661121	2.3566	0.6476	0.4808
0 Units	(Thousands)	(Tonnes	(Tonnes	(Tonnes)			

Table 3.28. Northeast Arctic cod. Short term prediction input

MFDP version 1a
Run: st7
Time and date: 12:46 26.04.2006
Fbar age range: 5-10

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	431000	0.2697	0	0	0	0.256	0.0136	0.745
4	353870	0.215	0.001	0	0	0.602	0.1047	1.129
5	187701	0.2108	0.06	0	0	1.201	0.4107	1.67
6	148587	0.2017	0.369	0	0	2.009	0.6443	2.294
7	54708	0.2	0.647	0	0	3.114	0.8358	3.399
8	33357	0.2	0.897	0	0	4.427	0.8881	5.034
9	14374	0.2	0.965	0	0	6.03	0.8165	6.443
10	5141	0.2	1	0	0	8.037	0.8512	7.935
11	1454	0.2	1	0	0	9.928	0.6952	9.404
12	416	0.2	1	0	0	15.784	0.8431	10.746
13	272	0.2	1	0	0	17.533	0.8431	12.647

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	533000	0.2697	0	0	0	0.242	0.0136	0.773
4	.	0.215	0.005	0	0	0.594	0.1047	1.126
5	.	0.2108	0.073	0	0	1.151	0.4107	1.639
6	.	0.2017	0.403	0	0	2.011	0.6443	2.385
7	.	0.2	0.696	0	0	2.973	0.8358	3.333
8	.	0.2	0.887	0	0	4.153	0.8881	4.838
9	.	0.2	0.969	0	0	5.827	0.8165	6.472
10	.	0.2	0.989	0	0	7.571	0.8512	7.883
11	.	0.2	1	0	0	10.355	0.6952	9.375
12	.	0.2	1	0	0	12.857	0.8431	10.844
13	.	0.2	1	0	0	17.533	0.8431	12.186

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	546000	0.2697	0	0	0	0.245	0.0136	0.773
4	.	0.215	0.005	0	0	0.596	0.1047	1.126
5	.	0.2108	0.073	0	0	1.16	0.4107	1.639
6	.	0.2017	0.403	0	0	1.971	0.6443	2.385
7	.	0.2	0.696	0	0	3.046	0.8358	3.333
8	.	0.2	0.887	0	0	4.16	0.8881	4.838
9	.	0.2	0.969	0	0	5.748	0.8165	6.472
10	.	0.2	0.989	0	0	7.849	0.8512	7.883
11	.	0.2	1	0	0	10.093	0.6952	9.375
12	.	0.2	1	0	0	12.401	0.8431	10.844
13	.	0.2	1	0	0	14.903	0.8431	12.186

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	606000	0.2697	0	0	0	0.245	0.0136	0.773
4	.	0.215	0.005	0	0	0.596	0.1047	1.126
5	.	0.2108	0.073	0	0	1.16	0.4107	1.639
6	.	0.2017	0.403	0	0	1.971	0.6443	2.385
7	.	0.2	0.696	0	0	3.046	0.8358	3.333
8	.	0.2	0.887	0	0	4.16	0.8881	4.838
9	.	0.2	0.969	0	0	5.748	0.8165	6.472
10	.	0.2	0.989	0	0	7.849	0.8512	7.883
11	.	0.2	1	0	0	10.093	0.6952	9.375
12	.	0.2	1	0	0	12.401	0.8431	10.844
13	.	0.2	1	0	0	14.903	0.8431	12.186

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	606000	0.2697	0	0	0	0.245	0.0136	0.773
4	.	0.215	0.005	0	0	0.596	0.1047	1.126
5	.	0.2108	0.073	0	0	1.16	0.4107	1.639
6	.	0.2017	0.403	0	0	1.971	0.6443	2.385
7	.	0.2	0.696	0	0	3.046	0.8358	3.333
8	.	0.2	0.887	0	0	4.16	0.8881	4.838
9	.	0.2	0.969	0	0	5.748	0.8165	6.472
10	.	0.2	0.989	0	0	7.849	0.8512	7.883
11	.	0.2	1	0	0	10.093	0.6952	9.375
12	.	0.2	1	0	0	12.401	0.8431	10.844
13	.	0.2	1	0	0	14.903	0.8431	12.186

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	606000	0.2697	0	0	0	0.245	0.0136	0.773
4	.	0.215	0.005	0	0	0.596	0.1047	1.126
5	.	0.2108	0.073	0	0	1.16	0.4107	1.639
6	.	0.2017	0.403	0	0	1.971	0.6443	2.385
7	.	0.2	0.696	0	0	3.046	0.8358	3.333
8	.	0.2	0.887	0	0	4.16	0.8881	4.838
9	.	0.2	0.969	0	0	5.748	0.8165	6.472
10	.	0.2	0.989	0	0	7.849	0.8512	7.883
11	.	0.2	1	0	0	10.093	0.6952	9.375
12	.	0.2	1	0	0	12.401	0.8431	10.844
13	.	0.2	1	0	0	14.903	0.8431	12.186

Input units are thousands and kg - output in tonnes

Table 3.29. Northeast Arctic cod. Management option table

1				
2006				
Biomass	SSB	FMult	FBar	Landings
1319102	517304	1	0.7411	550733

2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1226003	440626	0	0	0	1793635	787478
.	440626	0.1	0.0741	65456	1721570	735563
.	440626	0.2	0.1482	126916	1654115	687350
.	440626	0.3	0.2223	184657	1590945	642565
.	440626	0.4	0.2964	238935	1531760	600951
.	440626	0.5	0.3706	289987	1476280	562276
.	440626	0.6	0.4447	338034	1424246	526320
.	440626	0.7	0.5188	383280	1375420	492884
.	440626	0.8	0.5929	425915	1329580	461782
.	440626	0.9	0.667	466113	1286520	432843
.	440626	1	0.7411	504039	1246049	405908
.	440626	1.1	0.8152	539842	1207992	380832
.	440626	1.2	0.8893	573665	1172182	357478
.	440626	1.3	0.9634	605638	1138470	335722
.	440626	1.4	1.0375	635881	1106713	315448
.	440626	1.5	1.1117	664507	1076781	296550
.	440626	1.6	1.1858	691622	1048552	278927
.	440626	1.7	1.2599	717322	1021913	262488
.	440626	1.8	1.334	741697	996759	247149
.	440626	1.9	1.4081	764833	972992	232832
.	440626	2	1.4822	786807	950523	219462

Input units are thousands and kg - output in tonnes

Table 3.30a. Northeast Arctic cod. Single option prediction: Detailed tables
F=0.4 in 2007-2009
MFDP version 1a
Run: st7
Time and date: 12:46 26.04.2006
Fbar age range: 5-10

Year:	2006	F multiplie	1	Fbar:	0.7411				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136	5104	3803	431000	110336	0	0	0	0
4	0.1047	31711	35802	353870	213030	354	213	354	213
5	0.4107	57412	95878	187701	225429	11262	13526	11262	13526
6	0.6443	64601	148194	148587	298511	54829	110151	54829	110151
7	0.8358	28476	96789	54708	170361	35396	110223	35396	110223
8	0.8881	18055	90887	33357	147671	29921	132461	29921	132461
9	0.8165	7368	47471	14374	86675	13871	83642	13871	83642
10	0.8512	2708	21487	5141	41318	5141	41318	5141	41318
11	0.6952	668	6281	1454	14435	1454	14435	1454	14435
12	0.8431	218	2340	416	6566	416	6566	416	6566
13	0.8431	142	1801	272	4769	272	4769	272	4769
Total		216463	550733	1230880	1319102	152916	517304	152916	517304

Year:	2007	F multiplie	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3417	2641	533000	128986	0	0	0	0
4	0.0565	16066	18091	324670	192854	1623	964	1623	964
5	0.2217	46254	75810	257039	295852	18764	21597	18764	21597
6	0.3477	26973	64331	100821	202752	40631	81709	40631	81709
7	0.4511	21139	70457	63763	189567	44379	131939	44379	131939
8	0.4793	6755	32681	19418	80644	17224	71531	17224	71531
9	0.4407	3656	23663	11237	65475	10888	63445	10888	63445
10	0.4594	1750	13793	5201	39380	5144	38946	5144	38946
11	0.3752	513	4806	1797	18607	1797	18607	1797	18607
12	0.455	198	2150	594	7637	594	7637	594	7637
13	0.455	81	986	242	4250	242	4250	242	4250
Total		126803	309410	1317783	1226003	141287	440626	141287	440626

Year:	2008	F multiplie	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3500	2706	546000	133770	0	0	0	0
4	0.0565	19993	22513	404027	240800	2020	1204	2020	1204
5	0.2217	44533	72989	247473	287069	18066	20956	18066	20956
6	0.3477	44624	106429	166797	328756	67219	132489	67219	132489
7	0.4511	19296	64312	58202	177284	40509	123389	40509	123389
8	0.4793	11567	55962	33251	138325	29494	122694	29494	122694
9	0.4407	3203	20731	9844	56586	9539	54831	9539	54831
10	0.4594	1992	15701	5921	46474	5856	45963	5856	45963
11	0.3752	767	7195	2690	27150	2690	27150	2690	27150
12	0.455	337	3660	1011	12536	1011	12536	1011	12536
13	0.455	145	1767	434	6475	434	6475	434	6475
Total		149958	373964	1475650	1455223	176838	547687	176838	547687

Table 3.30a (Cont'd)

Year:		2009	F multiplie	0.5397	Fbar:	0.4				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073		3885	3003	606000	148470	0	0	0	0
4	0.0565		20481	23062	413881	246673	2069	1233	2069	1233
5	0.2217		55417	90829	307962	357235	22481	26078	22481	26078
6	0.3477		42963	102467	160589	316520	64717	127558	64717	127558
7	0.4511		31922	106396	96288	293294	67017	204133	67017	204133
8	0.4793		10558	51082	30351	126262	26922	111994	26922	111994
9	0.4407		5485	35499	16857	96896	16335	93892	16335	93892
10	0.4594		1745	13756	5187	40716	5130	40268	5130	40268
11	0.3752		874	8191	3062	30906	3062	30906	3062	30906
12	0.455		505	5479	1513	18767	1513	18767	1513	18767
13	0.455		251	3054	751	11189	751	11189	751	11189
Total			174087	442818	1642442	1686928	209997	666018	209997	666018

Year:		2010	F multiplie	1	Fbar:	0.7411				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136		7177	5548	606000	148470	0	0	0	0
4	0.1047		41165	46352	459363	273780	2297	1369	2297	1369
5	0.4107		96493	158152	315473	365948	23030	26714	23030	26714
6	0.6443		86884	207219	199841	393886	80536	158736	80536	158736
7	0.8358		48253	160828	92705	282378	64522	196535	64522	196535
8	0.8881		27178	131486	50213	208884	44539	185280	44539	185280
9	0.8165		7887	51046	15387	88445	14910	85704	14910	85704
10	0.8512		4679	36883	8883	69721	8785	68954	8785	68954
11	0.6952		1232	11553	2683	27077	2683	27077	2683	27077
12	0.8431		902	9779	1723	21364	1723	21364	1723	21364
13	0.8431		616	7502	1176	17527	1176	17527	1176	17527
Total			322466	826347	1753445	1897481	244200	789260	244200	789260

Year:		2011	F multiplie	1	Fbar:	0.7411				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136		7177	5548	606000	148470	0	0	0	0
4	0.1047		40908	46063	456496	272072	2282	1360	2282	1360
5	0.4107		102058	167273	333666	387052	24358	28255	24358	28255
6	0.6443		73672	175709	169452	333991	68289	134598	68289	134598
7	0.8358		44637	148775	85757	261216	59687	181807	59687	181807
8	0.8881		17810	86164	32905	136884	29187	121416	29187	121416
9	0.8165		8670	56113	16914	97224	16390	94210	16390	94210
10	0.8512		2933	23119	5568	43703	5507	43222	5507	43222
11	0.6952		1426	13370	3105	31336	3105	31336	3105	31336
12	0.8431		574	6221	1096	13591	1096	13591	1096	13591
13	0.8431		535	6516	1021	15222	1021	15222	1021	15222
Total			300400	734869	1711981	1740761	210922	665018	210922	665018

Input units are thousands and kg - output in tonnes

Table 3.30b. Single option prediction: Detailed tables
Harvest control rule applied in 2007. Same F in 2008-2009 as in 2007.
MFDP version 1a
Run: st8
Time and date: 13:23 26.04.2006

Fbar age range: 5-10

Year:	2006	F multiplie	1	Fbar:	0.7411				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136	5104	3803	431000	110336	0	0	0	0
4	0.1047	31711	35802	353870	213030	354	213	354	213
5	0.4107	57412	95878	187701	225429	11262	13526	11262	13526
6	0.6443	64601	148194	148587	298511	54829	110151	54829	110151
7	0.8358	28476	96789	54708	170361	35396	110223	35396	110223
8	0.8881	18055	90887	33357	147671	29921	132461	29921	132461
9	0.8165	7368	47471	14374	86675	13871	83642	13871	83642
10	0.8512	2708	21487	5141	41318	5141	41318	5141	41318
11	0.6952	668	6281	1454	14435	1454	14435	1454	14435
12	0.8431	218	2340	416	6566	416	6566	416	6566
13	0.8431	142	1801	272	4769	272	4769	272	4769
Total		216463	550733	1230880	1319102	152916	517304	152916	517304

Year:	2007	F multiplie	0.517	Fbar:	0.3831				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.007	3274	2531	533000	128986	0	0	0	0
4	0.0541	15408	17349	324670	192854	1623	964	1623	964
5	0.2123	44501	72937	257039	295852	18764	21597	18764	21597
6	0.3331	26011	62037	100821	202752	40631	81709	40631	81709
7	0.4321	20422	68068	63763	189567	44379	131939	44379	131939
8	0.4591	6529	31588	19418	80644	17224	71531	17224	71531
9	0.4221	3532	22856	11237	65475	10888	63445	10888	63445
10	0.4401	1691	13327	5201	39380	5144	38946	5144	38946
11	0.3594	495	4637	1797	18607	1797	18607	1797	18607
12	0.4359	192	2078	594	7637	594	7637	594	7637
13	0.4359	78	953	242	4250	242	4250	242	4250
Total		122132	298361	1317783	1226003	141287	440626	141287	440626

Year:	2008	F multiplie	0.517	Fbar:	0.3831				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.007	3354	2592	546000	133770	0	0	0	0
4	0.0541	19180	21597	404152	240874	2021	1204	2021	1204
5	0.2123	42947	70389	248062	287752	18109	21006	18109	21006
6	0.3331	43436	103594	168359	331835	67849	133730	67849	133730
7	0.4321	18916	63047	59060	179896	41105	125207	41105	125207
8	0.4591	11395	55127	33888	140974	30059	125044	30059	125044
9	0.4221	3157	20432	10045	57738	9733	55948	9733	55948
10	0.4401	1960	15455	6032	47343	5965	46822	5965	46822
11	0.3594	755	7078	2742	27680	2742	27680	2742	27680
12	0.4359	331	3592	1027	12736	1027	12736	1027	12736
13	0.4359	143	1741	443	6600	443	6600	443	6600
Total		145573	364644	1479809	1467197	179053	555977	179053	555977

Table 3.30b (Cont'd)

Year:	2009	F multiplier	0.517	Fbar:	0.3831				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.007	3722	2877	606000	148470	0	0	0	0
4	0.0541	19648	22124	414009	246749	2070	1234	2070	1234
5	0.2123	53460	87621	308790	358196	22542	26148	22542	26148
6	0.3331	41919	99976	162479	320245	65479	129059	65479	129059
7	0.4321	31587	105280	98622	300403	68641	209080	68641	209080
8	0.4591	10554	51061	31388	130576	27842	115821	27842	115821
9	0.4221	5510	35658	17530	100763	16987	97639	16987	97639
10	0.4401	1753	13816	5392	42322	5333	41857	5333	41857
11	0.3594	875	8207	3180	32098	3180	32098	3180	32098
12	0.4359	506	5482	1567	19438	1567	19438	1567	19438
13	0.4359	251	3059	778	11598	778	11598	778	11598
Total		169785	435161	1649736	1710858	214418	683972	214418	683972

Year:	2010	F multiplier	1	Fbar:	0.7411				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136	7177	5548	606000	148470	0	0	0	0
4	0.1047	41178	46366	459505	273865	2298	1369	2298	1369
5	0.4107	96753	158578	316321	366932	23091	26786	23091	26786
6	0.6443	87934	209722	202255	398644	81509	160654	81509	160654
7	0.8358	49540	165118	95177	289911	66244	201778	66244	201778
8	0.8881	28370	137252	52415	218045	46492	193406	46492	193406
9	0.8165	8323	53865	16237	93330	15734	90437	15734	90437
10	0.8512	4957	39072	9410	73860	9307	73047	9307	73047
11	0.6952	1306	12243	2843	28694	2843	28694	2843	28694
12	0.8431	951	10318	1818	22541	1818	22541	1818	22541
13	0.8431	650	7922	1242	18509	1242	18509	1242	18509
Total		327138	846004	1763222	1932801	250576	817221	250576	817221

Year:	2011	F multiplier	1	Fbar:	0.7411				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136	0	0	0	0	0	0	0	0
4	0.1047	40908	46063	456496	272072	2282	1360	2282	1360
5	0.4107	102089	167325	333769	387172	24365	28264	24365	28264
6	0.6443	73870	176181	169908	334889	68473	134960	68473	134960
7	0.8358	45176	150573	86793	264372	60408	184003	60408	184003
8	0.8881	18285	88462	33783	140535	29965	124655	29965	124655
9	0.8165	9050	58573	17656	101488	17109	98342	17109	98342
10	0.8512	3095	24396	5875	46117	5811	45610	5811	45610
11	0.6952	1511	14163	3289	33196	3289	33196	3289	33196
12	0.8431	608	6593	1161	14403	1161	14403	1161	14403
13	0.8431	564	6877	1078	16067	1078	16067	1078	16067
Total		295157	739206	1109809	1610310	213942	680859	213942	680859

Input units are thousands and kg - output in tonnes

Table 3.30c. Single option prediction: Detailed tables

Fbar age range: 5-10

Year:	2006	F multiplie	1.1636	Fbar:	0.8623				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0158	5933	4420	431000	110336	0	0	0	0
4	0.1218	36602	41324	353870	213030	354	213	354	213
5	0.4779	64833	108271	187701	225429	11262	13526	11262	13526
6	0.7497	71868	164865	148587	298511	54829	110151	54829	110151
7	0.9725	31329	106487	54708	170361	35396	110223	35396	110223
8	1.0334	19807	99707	33357	147671	29921	132461	29921	132461
9	0.9501	8115	52284	14374	86675	13871	83642	13871	83642
10	0.9905	2977	23620	5141	41318	5141	41318	5141	41318
11	0.8089	741	6966	1454	14435	1454	14435	1454	14435
12	0.981	239	2573	416	6566	416	6566	416	6566
13	0.981	157	1980	272	4769	272	4769	272	4769
Total		242600	612496	1230880	1319102	152916	517304	152916	517304

Year:	2007	F multiplie	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3417	2641	533000	128986	0	0	0	0
4	0.0565	16031	18050	323948	192425	1620	962	1620	962
5	0.2217	45468	74523	252674	290828	18445	21230	18445	21230
6	0.3477	25221	60151	94270	189576	37991	76399	37991	76399
7	0.4511	19024	63408	57384	170602	39939	118739	39939	118739
8	0.4793	5892	28504	16937	70337	15023	62389	15023	62389
9	0.4407	3162	20463	9717	56621	9416	54866	9416	54866
10	0.4594	1531	12068	4551	34455	4501	34076	4501	34076
11	0.3752	446	4182	1563	16188	1563	16188	1563	16188
12	0.455	177	1919	530	6816	530	6816	530	6816
13	0.455	71	859	211	3703	211	3703	211	3703
Total		120439	286769	1294785	1160538	129239	395369	129239	395369

Year:	2008	F multiplie	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3500	2706	546000	133770	0	0	0	0
4	0.0565	19993	22513	404027	240800	2020	1204	2020	1204
5	0.2217	44434	72827	246923	286431	18025	20909	18025	20909
6	0.3477	43866	104621	163964	323173	66077	130239	66077	130239
7	0.4511	18042	60133	54420	165763	37876	115371	37876	115371
8	0.4793	10410	50364	29925	124486	26543	110419	26543	110419
9	0.4407	2794	18082	8586	49354	8320	47824	8320	47824
10	0.4594	1722	13578	5120	40189	5064	39747	5064	39747
11	0.3752	672	6296	2354	23755	2354	23755	2354	23755
12	0.455	294	3184	879	10907	879	10907	879	10907
13	0.455	129	1567	385	5739	385	5739	385	5739
Total		145855	355868	1462583	1404366	167545	506114	167545	506114

Table 3.30c (Cont'd)

Year:	2009	F multiplie	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3885	3003	606000	148470	0	0	0	0
4	0.0565	20481	23062	413881	246673	2069	1233	2069	1233
5	0.2217	55417	90829	307962	357235	22481	26078	22481	26078
6	0.3477	42868	102240	160232	315817	64573	127274	64573	127274
7	0.4511	31380	104589	94653	288313	65878	200666	65878	200666
8	0.4793	9872	47762	28379	118057	25172	104716	25172	104716
9	0.4407	4936	31948	15171	87202	14701	84499	14701	84499
10	0.4594	1522	11998	4524	35513	4475	35122	4475	35122
11	0.3752	756	7083	2648	26727	2648	26727	2648	26727
12	0.455	442	4793	1324	16420	1324	16420	1324	16420
13	0.455	219	2672	657	9789	657	9789	657	9789
Total		171779	429980	1635431	1650216	203979	632525	203979	632525

Year:	2010	F multiplie	1	Fbar:	0.7411				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136	7177	5548	606000	148470	0	0	0	0
4	0.1047	41165	46352	459363	273780	2297	1369	2297	1369
5	0.4107	96493	158152	315473	365948	23030	26714	23030	26714
6	0.6443	86884	207219	199841	393886	80536	158736	80536	158736
7	0.8358	48146	160471	92499	281751	64379	196098	64379	196098
8	0.8881	26716	129253	49360	205337	43782	182134	43782	182134
9	0.8165	7375	47729	14387	82698	13941	80134	13941	80134
10	0.8512	4211	33193	7994	62746	7906	62056	7906	62056
11	0.6952	1075	10076	2340	23617	2340	23617	2340	23617
12	0.8431	780	8457	1490	18475	1490	18475	1490	18475
13	0.8431	539	6564	1029	15335	1029	15335	1029	15335
Total		320560	813012	1749774	1872042	240729	764667	240729	764667

Year:	2011	F multiplie	1	Fbar:	0.7411				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0136	7177	5548	606000	148470	0	0	0	0
4	0.1047	40908	46063	456496	272072	2282	1360	2282	1360
5	0.4107	102058	167273	333666	387052	24358	28255	24358	28255
6	0.6443	73672	175709	169452	333991	68289	134598	68289	134598
7	0.8358	44637	148775	85757	261216	59687	181807	59687	181807
8	0.8881	17770	85973	32832	136580	29122	121146	29122	121146
9	0.8165	8523	55160	16627	95573	16112	92610	16112	92610
10	0.8512	2742	21617	5206	40863	5149	40414	5149	40414
11	0.6952	1283	12032	2794	28201	2794	28201	2794	28201
12	0.8431	500	5426	956	11854	956	11854	956	11854
13	0.8431	465	5661	888	13227	888	13227	888	13227
Total		299736	729236	1710674	1729098	209636	653472	209636	653472

Input units are thousands and kg - output in tonnes

Table 3.30d. Single option prediction: Detailed tables

MFDP version 1a
Run: st13
Time and date: 14:48 26.04.2006
Fbar age range: 5-10

Year:	2006	F multiplie	1.1636	Fbar:	0.8623				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0158	5933	4420	431000	110336	0	0	0	0
4	0.1218	36602	41324	353870	213030	354	213	354	213
5	0.4779	64833	108271	187701	225429	11262	13526	11262	13526
6	0.7497	71868	164865	148587	298511	54829	110151	54829	110151
7	0.9725	31329	106487	54708	170361	35396	110223	35396	110223
8	1.0334	19807	99707	33357	147671	29921	132461	29921	132461
9	0.9501	8115	52284	14374	86675	13871	83642	13871	83642
10	0.9905	2977	23620	5141	41318	5141	41318	5141	41318
11	0.8089	741	6966	1454	14435	1454	14435	1454	14435
12	0.981	239	2573	416	6566	416	6566	416	6566
13	0.981	157	1980	272	4769	272	4769	272	4769
Total		242600	612496	1230880	1319102	152916	517304	152916	517304

Year:	2007	F multiplie	0.4639	Fbar:	0.3438				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0063	2939	2272	533000	128986	0	0	0	0
4	0.0486	13831	15574	323948	192425	1620	962	1620	962
5	0.1905	39653	64991	252674	290828	18445	21230	18445	21230
6	0.2989	22167	52868	94270	189576	37991	76399	37991	76399
7	0.3877	16824	56074	57384	170602	39939	118739	39939	118739
8	0.412	5219	25249	16937	70337	15023	62389	15023	62389
9	0.3788	2794	18085	9717	56621	9416	54866	9416	54866
10	0.3949	1354	10677	4551	34455	4501	34076	4501	34076
11	0.3225	393	3681	1563	16188	1563	16188	1563	16188
12	0.3911	157	1698	530	6816	530	6816	530	6816
13	0.3911	62	760	211	3703	211	3703	211	3703
Total		105393	251929	1294785	1160538	129239	395369	129239	395369

Year:	2008	F multiplie	0.4639	Fbar:	0.3438				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0063	3010	2327	546000	133770	0	0	0	0
4	0.0486	17268	19444	404444	241048	2022	1205	2022	1205
5	0.1905	39059	64018	248890	288713	18169	21076	18169	21076
6	0.2989	39774	94862	169148	333392	68167	134357	68167	134357
7	0.3877	16753	55839	57144	174060	39772	121146	39772	121146
8	0.412	9824	47529	31882	132628	28279	117641	28279	117641
9	0.3788	2641	17093	9184	52791	8899	51154	8899	51154
10	0.3949	1621	12780	5447	42755	5387	42285	5387	42285
11	0.3225	631	5912	2510	25338	2510	25338	2510	25338
12	0.3911	274	2969	927	11497	927	11497	927	11497
13	0.3911	121	1477	410	6117	410	6117	410	6117
Total		130978	324250	1475987	1442109	174544	531816	174544	531816

Year:	2009	F multiplie	0.4639	Fbar:	0.3438				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0063	3341	2583	606000	148470	0	0	0	0
4	0.0486	17690	19918	414308	246928	2072	1235	2072	1235
5	0.1905	48765	79925	310735	360453	22684	26313	22684	26313
6	0.2989	39179	93441	166616	328399	67146	132345	67146	132345
7	0.3877	30061	100193	102533	312316	71363	217372	71363	217372
8	0.412	9783	47330	31748	132073	28161	117149	28161	117149
9	0.3788	4972	32177	17289	99375	16753	96294	16753	96294
10	0.3949	1532	12079	5149	40411	5092	39966	5092	39966
11	0.3225	755	7076	3005	30328	3005	30328	3005	30328
12	0.3911	440	4767	1489	18463	1489	18463	1489	18463
13	0.3911	219	2665	741	11038	741	11038	741	11038
Total		156735	402155	1659612	1728253	218504	690502	218504	690502

Table 3.30e. Single option prediction: Detailed tables

MFDP version 1a
Run: st14
Time and date: 19:44 26.04.2006
Fbar age range: 5-10

Year:	2006	F multiplier	0.8762	Fbar:	0.6494				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0119	4476	3335	431000	110336	0	0	0	0
4	0.0917	27957	31563	353870	213030	354	213	354	213
5	0.3599	51470	85955	187701	225429	11262	13526	11262	13526
6	0.5645	58595	134416	148587	298511	54829	110151	54829	110151
7	0.7323	26057	88567	54708	170361	35396	110223	35396	110223
8	0.7782	16559	83357	33357	147671	29921	132461	29921	132461
9	0.7154	6736	43401	14374	86675	13871	83642	13871	83642
10	0.7458	2480	19675	5141	41318	5141	41318	5141	41318
11	0.6091	607	5710	1454	14435	1454	14435	1454	14435
12	0.7387	199	2142	416	6566	416	6566	416	6566
13	0.7387	130	1648	272	4769	272	4769	272	4769
Total		195266	499770	1230880	1319102	152916	517304	152916	517304

Year:	2007	F multiplier	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3417	2641	533000	128986	0	0	0	0
4	0.0565	16093	18121	325217	193179	1626	966	1626	966
5	0.2217	46857	76799	260393	299712	19009	21879	19009	21879
6	0.3477	28380	67687	106080	213327	42750	85971	42750	85971
7	0.4511	22894	76307	69057	205307	48064	142894	48064	142894
8	0.4793	7492	36244	21535	89435	19102	79329	19102	79329
9	0.4407	4081	26413	12542	73085	12154	70819	12154	70819
10	0.4594	1936	15260	5755	43568	5691	43089	5691	43089
11	0.3752	570	5341	1997	20674	1997	20674	1997	20674
12	0.455	216	2344	647	8323	647	8323	647	8323
13	0.455	90	1095	269	4718	269	4718	269	4718
Total		132026	328251	1336492	1280315	151308	478662	151308	478662

Year:	2008	F multiplier	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3500	2706	546000	133770	0	0	0	0
4	0.0565	19993	22513	404027	240800	2020	1204	2020	1204
5	0.2217	44608	73112	247890	287552	18096	20991	18096	20991
6	0.3477	45206	107817	168973	333045	68096	134217	68096	134217
7	0.4511	20302	67667	61238	186531	42622	129825	42622	129825
8	0.4793	12528	60609	36012	149810	31943	132882	31943	132882
9	0.4407	3552	22991	10918	62754	10579	60809	10579	60809
10	0.4594	2223	17526	6609	51875	6536	51304	6536	51304
11	0.3752	849	7961	2976	30038	2976	30038	2976	30038
12	0.455	375	4066	1123	13929	1123	13929	1123	13929
13	0.455	159	1937	476	7095	476	7095	476	7095
Total		153296	388903	1486242	1497199	184467	582294	184467	582294

Year:	2009	F multiplier	0.5397	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3885	3003	606000	148470	0	0	0	0
4	0.0565	20481	23062	413881	246673	2069	1233	2069	1233
5	0.2217	55417	90829	307962	357235	22481	26078	22481	26078
6	0.3477	43036	102640	160859	317054	64826	127773	64826	127773
7	0.4511	32339	107784	97544	297120	67891	206796	67891	206796
8	0.4793	11109	53746	31934	132847	28326	117836	28326	117836
9	0.4407	5940	38447	18257	104941	17691	101688	17691	101688
10	0.4594	1935	15255	5753	45155	5690	44658	5690	44658
11	0.3752	975	9143	3418	34498	3418	34498	3418	34498
12	0.455	559	6061	1674	20763	1674	20763	1674	20763
13	0.455	277	3379	831	12380	831	12380	831	12380
Total		175954	453350	1648114	1717137	214897	693703	214897	693703

Table 3.30f. Single option prediction: Detailed tables

MFDP version 1a
Run: st16
Time and date: 22:14 26.04.2006
Fbar age range: 5-10

Year:		2006	F multiplie	0.8762	Fbar:	0.6494			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0119	4476	3335	431000	110336	0	0	0	0
4	0.0917	27957	31563	353870	213030	354	213	354	213
5	0.3599	51470	85955	187701	225429	11262	13526	11262	13526
6	0.5645	58595	134416	148587	298511	54829	110151	54829	110151
7	0.7323	26057	88567	54708	170361	35396	110223	35396	110223
8	0.7782	16559	83357	33357	147671	29921	132461	29921	132461
9	0.7154	6736	43401	14374	86675	13871	83642	13871	83642
10	0.7458	2480	19675	5141	41318	5141	41318	5141	41318
11	0.6091	607	5710	1454	14435	1454	14435	1454	14435
12	0.7387	199	2142	416	6566	416	6566	416	6566
13	0.7387	130	1648	272	4769	272	4769	272	4769
Total		195266	499770	1230880	1319102	152916	517304	152916	517304

Year:		2007	F multiplie	0.697	Fbar:	0.5165			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0095	4408	3408	533000	128986	0	0	0	0
4	0.073	20621	23220	325217	193179	1626	966	1626	966
5	0.2863	58737	96270	260393	299712	19009	21879	19009	21879
6	0.4491	35017	83515	106080	213327	42750	85971	42750	85971
7	0.5826	27902	92998	69057	205307	48064	142894	48064	142894
8	0.619	9101	44028	21535	89435	19102	79329	19102	79329
9	0.5691	4980	32229	12542	73085	12154	70819	12154	70819
10	0.5933	2357	18580	5755	43568	5691	43089	5691	43089
11	0.4846	701	6567	1997	20674	1997	20674	1997	20674
12	0.5876	263	2855	647	8323	647	8323	647	8323
13	0.5876	109	1334	269	4718	269	4718	269	4718
Total		164197	405005	1336492	1280315	151308	478662	151308	478662

Year:		2008	F multiplie	0.5397	Fbar:	0.4			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3500	2706	546000	133770	0	0	0	0
4	0.0565	19951	22464	403164	240285	2016	1201	2016	1201
5	0.2217	43879	71918	243841	282855	17800	20648	17800	20648
6	0.3477	42378	101072	158402	312210	63836	125820	63836	125820
7	0.4511	18345	61145	55336	168552	38514	117313	38514	117313
8	0.4793	10984	53142	31576	131354	28007	116511	28007	116511
9	0.4407	3089	19993	9494	54572	9200	52881	9200	52881
10	0.4594	1955	15413	5813	45622	5749	45121	5749	45121
11	0.3752	743	6963	2603	26273	2603	26273	2603	26273
12	0.455	336	3645	1007	12487	1007	12487	1007	12487
13	0.455	139	1696	417	6213	417	6213	417	6213
Total		145300	360157	1457651	1414195	169149	524469	169149	524469

Year:		2009	F multiplie	0.5397	Fbar:	0.4			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0073	3885	3003	606000	148470	0	0	0	0
4	0.0565	20481	23062	413881	246673	2069	1233	2069	1233
5	0.2217	55299	90635	307303	356472	22433	26022	22433	26022
6	0.3477	42333	100964	158232	311875	63767	125686	63767	125686
7	0.4511	30315	101041	91442	278532	63644	193858	63644	193858
8	0.4793	10038	48566	28857	120043	25596	106478	25596	106478
9	0.4407	5209	33710	16008	92013	15512	89160	15512	89160
10	0.4594	1683	13266	5003	39268	4948	38836	4948	38836
11	0.3752	858	8041	3006	30340	3006	30340	3006	30340
12	0.455	489	5302	1465	18161	1465	18161	1465	18161
13	0.455	247	3009	740	11022	740	11022	740	11022
Total		170837	430598	1631936	1652869	203179	640797	203179	640797

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). The discard numbers applied correspond to method II (1946-1982) and IIIb (1983-1998) mentioned in Dingsør (2001).

	Estimated stock numbers (thousands)			Percent increase		
Year	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 3.31a. Numbers ('000) of NEA cod by length groups and total weight (tonnes) taken as bycatch in the Norwegian Barents sea shrimp fishery during 1983-2005.

FISH	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4	0	0	0	0	0	0	0	0	0	1	0	0
5	0	0	1	0	0	0	0	63	0	52	0	4
6	0	0	17	0	0	2	19	316	0	184	149	32
7	0	1	457	7	7	0	42	626	0	1066	101	187
8	863	2	744	36	6	8	111	546	4	644	134	201
9	20	2	1298	61	4	56	49	264	23	1687	934	375
10	293	45	1593	264	8	67	202	306	201	2401	1074	327
11	317	150	1260	161	15	74	2	142	438	2483	2148	278
12	598	191	1311	200	36	88	27	339	866	1762	1074	239
13	250	350	1984	235	80	76	17	421	859	1191	889	182
14	287	382	1776	178	99	92	11	405	903	886	472	148
15	709	460	3193	291	398	94	10	523	597	416	534	182
16	674	493	3476	453	619	54	66	184	707	403	335	265
17	1008	617	3670	441	451	39	95	253	1059	456	308	201
18	1196	596	4548	414	448	110	49	224	636	451	289	214
19	974	699	4044	437	195	188	36	294	689	333	338	158
20	673	754	3960	544	432	251	80	302	1163	248	555	99
21	555	598	4421	635	416	365	44	312	1067	140	450	54
22	384	577	3535	679	466	444	34	234	600	81	469	29
23	376	659	4163	910	935	610	48	152	641	106	504	34
24	88	479	6667	979	923	260	96	72	576	30	252	50
25	259	314	8678	1215	1415	468	82	38	698	28	307	24
>25	3589	4621	53581	9327	9627	9307	6014	2264	1547	0	0	0
Total	13112	11991	114376	17469	16577	12653	7135	8280	13276	15050	11314	3281
Tonnes	5335	4036	49261	8375	7607	10164	11592	5382	2197	287	405	92

Table 3.31a. (continued)

FISH	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
4	0	7	0	0	0	0	0	0	0	0	0
5	0	33	0	0	0	0	0	0	0	0	0
6	29	25	0	0	0	1	4	0	295	0	0
7	69	209	58	42	54	1	25	21	2697	598	0
8	26	225	209	404	24	4	129	61	1088	105	1
9	194	84	412	4224	115	21	346	182	117	31	5
10	531	62	651	11713	436	116	398	180	214	155	52
11	760	478	5711	13854	292	108	757	115	741	229	130
12	855	1238	4730	7008	332	222	1156	121	1523	234	198
13	709	2084	4443	5908	1243	1423	1302	108	2006	175	265
14	625	2374	2864	3906	1165	892	1289	168	1946	123	194
15	313	1687	2202	1827	1779	820	1117	146	1260	84	177
16	173	1162	982	1574	1372	741	889	139	647	67	139
17	94	934	460	1740	1148	249	851	180	333	62	82
18	88	690	190	915	634	219	672	176	131	68	39
19	19	450	247	1345	408	172	360	126	81	56	20
20	22	263	318	423	258	125	329	105	32	42	9
21	11	24	173	93	152	82	181	65	20	20	4
22	3	10	61	28	48	41	43	22	35	7	0
23	0	4	0	1	0	8	50	13	7	1	0
24	0	4	0	0	0	7	0	5	3	1	0
25	0	0	0	0	0	1	0	3	3	1	0
>25	0	0	0	0	0	0	0	0	0	0	0
Total	4521	12045	23711	55005	9461	5252	9898	1936	13180	2061	1317
Tonnes	86	343	497	980	309	159	294	63	233	37	33

Table 3.32a Northeast Arctic Cod. Likelihood components at end of Gadget key run.

Likelihood Component	Unweighted Likelihood		Weight	Weighted Likelihood
	Keyrun	2005 wg		Keyrun
rusnorfleetlik	416	383	40	16633
gillfleetlik	117	115	40	4664
wintersur-85-93	1707	1974	2	3415
wintersur-94-06	1213	1739	2	2426
acousticsur-85-93	1129	1142	2,5	2823
acousticsur-94-06	1532	1967	2,5	3829
lofotensur-85-89	86	76	5	430
lofotensur-90-06	674	586	5	3369
rustrawlsur-94-05	20934	1718	0,15	3140
bounds	0	0	1	0
scratios-85-05	76		40	3037
Total	27883	9700	140,15	43773

Table 3.32b Northeast Arctic Cod. Gadget parameter values and sensitivity (effect of parameter change on likelihood score).

Parameter	Value	- 5 %	+ 5 %
ba1ac.cbt	0,789	0,0531	0,0459
ba1ac.l50	77,719	0,0054	0,0064
ba1ac.slope	0,002	0,0008	0,0015
ba1tr.cbt	0,934	6,2874	6,1367
ba1tr.l50	22,399	0,0379	1,3005
ba1tr.slope	0,730	0,0000	0,0000
ba2ac.cbt	0,956	0,1055	0,0918
ba2ac.l50	58,058	0,0048	0,0054
ba2ac.slope	0,002	0,0006	0,0008
ba2tr.cbt	0,509	0,0874	0,0882
ba2tr.l50	17,907	0,1029	0,4285
ba2tr.slope	0,623	0,0001	0,0001
betabin	59,529	0,0066	0,0054
cann.m0	0,215	0,0465	0,0352
d_minage.1986	4,466	0,0610	0,0606
d_minage.1987	3,843	0,0162	0,0136
d_minage.1988	4,108	0,0132	0,0106
d_minage.1989	5,593	0,0052	0,0071
d_minage.1990	6,296	0,0083	0,0120
d_minage.1991	5,690	0,0247	0,0199
d_minage.1992	8,785	0,0754	0,0614
d_minage.1993	4,556	0,0335	0,0384
d_minage.1994	6,437	0,0725	0,0582
d_minage.1995	6,528	0,0401	0,0359
d_minage.1996	6,808	0,0359	0,0260
d_minage.1997	4,778	0,0486	0,0369
d_minage.1998	5,087	0,0656	0,0504
d_minage.1999	4,520	0,0191	0,0212
d_minage.2000	3,713	0,0162	0,0151
d_minage.2001	3,814	0,0155	0,0096
d_minage.2002	5,011	0,0127	0,0078
d_minage.2003	4,654	0,0261	0,0189
d_minage.2004	4,606	0,0035	0,0038
d_minage.2005	4,577	0,0128	0,0074
d_minage.2006	4,586	0,0042	0,0022
gil.1985	2,281	0,0047	0,0056
gil.1986	1,453	0,0037	0,0023
gil.1987	1,362	0,0030	0,0019
gil.1988	1,718	0,0021	0,0030
gil.1989	3,562	0,0037	0,0035
gil.1990	0,905	0,0016	0,0013
gil.1991	0,676	0,0028	0,0018
gil.1992	0,470	0,0020	0,0025
gil.1993	0,721	0,0034	0,0022
gil.1994	0,944	0,0031	0,0036
gil.1995	1,609	0,0065	0,0051
gil.1996	1,383	0,0054	0,0047

Parameter	Value	- 5 %	+ 5 %
gil.1997	1,771	0,0050	0,0070
gil.1998	1,868	0,0046	0,0054
gil.1999	2,006	0,0035	0,0040
gil.2000	2,440	0,0027	0,0035
gil.2001	1,902	0,0031	0,0026
gil.2002	1,324	0,0029	0,0025
gil.2004	0,820	0,0026	0,0017
gil.2005	0,822	0,0024	0,0014
gil.l50	82,667	4,7477	5,1479
gil.slope	0,037	0,2654	0,2508
growth.1985	7,526	0,1483	0,1587
growth.1986	7,579	0,2131	0,2264
growth.1987	7,727	0,1496	0,1540
growth.1988	7,114	0,0775	0,0800
growth.1989	12,065	0,1413	0,1474
growth.1990	11,894	0,1567	0,1628
growth.1991	12,058	0,2390	0,2419
growth.1992	6,652	0,0945	0,1025
growth.1993	9,483	0,3180	0,3281
growth.1994	9,843	0,3320	0,3338
growth.1995	9,831	0,2729	0,2729
growth.1996	9,619	0,1964	0,1781
growth.1997	10,203	0,2497	0,2221
growth.1998	10,427	0,2566	0,2321
growth.1999	10,967	0,2400	0,2195
growth.2000	12,982	0,3861	0,3671
growth.2001	10,602	0,2415	0,2351
growth.2002	11,468	0,2413	0,2286
growth.2003	10,689	0,1916	0,1810
growth.2004	10,031	0,1021	0,0985
growth.2005	10,424	0,0482	0,0434
imm.n_age3	50,410	0,0832	0,0696
imm.n_age4	34,651	0,0577	0,0568
imm.n_age5	8,294	0,0145	0,0091
imm.n_age6	3,595	0,0041	0,0049
imm.n_age7	1,288	0,0011	0,0015
imm.n_age8	0,261	0,0001	0,0002
imm.n_age9	0,180	0,0001	0,0002
l_minage.1986	32,685	3,5193	3,1331
l_minage.1987	30,976	0,9033	0,8211
l_minage.1988	31,650	0,7015	0,7128
l_minage.1989	31,352	0,2397	0,2594
l_minage.1990	31,948	0,3421	0,3399
l_minage.1991	37,751	1,0901	1,0985
l_minage.1992	38,146	1,0760	1,0882
l_minage.1993	33,394	2,3399	2,2304
l_minage.1994	27,799	0,9990	0,8158

Table 3.32b (continued)

Parameter	Value	- 5 %	+ 5 %
l_minage.1995	27,385	0,5859	0,4765
l_minage.1996	29,254	0,4441	0,3873
l_minage.1997	29,817	1,2498	1,2310
l_minage.1998	29,475	1,6296	1,6197
l_minage.1999	27,230	0,7681	0,7654
l_minage.2000	26,695	1,0260	1,0815
l_minage.2001	30,699	0,9972	0,9802
l_minage.2002	28,037	0,3902	0,3841
l_minage.2003	27,930	0,8178	0,7622
l_minage.2004	30,116	0,1738	0,1577
l_minage.2005	27,626	0,2636	0,2330
l_minage.2006	28,813	0,0739	0,0910
lof1ac.cbt	2,825	0,0046	0,0030
lof1ac.l50	104,226	0,0227	0,0278
lof1ac.slope	0,008	0,0025	0,0034
lof2ac.cbt	1,931	0,0417	0,0342
lof2ac.l50	67,477	0,1305	0,1761
lof2ac.slope	0,020	0,0026	0,0017
mat.n_age10	0,208	0,0003	0,0002
mat.n_age5	1,966	0,0012	0,0008
mat.n_age6	1,507	0,0012	0,0011
mat.n_age7	1,187	0,0014	0,0016
mat.n_age8	0,445	0,0005	0,0006
mat.n_age9	0,161	0,0002	0,0002
n_minage.1986	112,744	0,1589	0,1372
n_minage.1987	32,903	0,0396	0,0386
n_minage.1988	24,157	0,0362	0,0264
n_minage.1989	17,260	0,0217	0,0227
n_minage.1990	25,458	0,0335	0,0327
n_minage.1991	42,431	0,0562	0,0647
n_minage.1992	71,877	0,1110	0,0962
n_minage.1993	86,517	0,1320	0,1132
n_minage.1994	93,453	0,0875	0,0838
n_minage.1995	55,783	0,0632	0,0417
n_minage.1996	32,420	0,0460	0,0408
n_minage.1997	53,427	0,0850	0,0789
n_minage.1998	65,809	0,1057	0,1005
n_minage.1999	46,744	0,0640	0,0713
n_minage.2000	55,101	0,0801	0,0730
n_minage.2001	43,096	0,0650	0,0482
n_minage.2002	31,649	0,0399	0,0259
n_minage.2003	63,068	0,0403	0,0490
n_minage.2004	15,399	0,0079	0,0070
n_minage.2005	40,200	0,0115	0,0076
n_minage.2006	22,447	0,0022	0,0028
rusnor.1985	1,295	0,0235	0,0264
rusnor.1986	2,093	0,0436	0,0441

Parameter	Value	- 5 %	+ 5 %
rusnor.1987	3,461	0,0805	0,0674
rusnor.1988	2,966	0,0565	0,0519
rusnor.1989	2,064	0,0356	0,0347
rusnor.1990	0,728	0,0138	0,0148
rusnor.1991	0,717	0,0174	0,0179
rusnor.1992	0,822	0,0279	0,0252
rusnor.1993	1,260	0,0465	0,0391
rusnor.1994	1,772	0,0641	0,0596
rusnor.1995	1,875	0,0654	0,0569
rusnor.1996	2,087	0,0654	0,0561
rusnor.1997	2,996	0,0783	0,0721
rusnor.1998	3,535	0,0764	0,0705
rusnor.1999	3,362	0,0592	0,0544
rusnor.2000	2,294	0,0356	0,0399
rusnor.2001	1,791	0,0366	0,0383
rusnor.2002	1,451	0,0338	0,0372
rusnor.2003	1,290	0,0346	0,0289
rusnor.2004	1,592	0,0378	0,0294
rusnor.2005	2,088	0,0295	0,0325
rusnor.l50	52,901	15,8986	19,7581
rusnor.slope	0,049	0,4773	0,4827
rustr.cbt	33,558	0,0667	0,0529
rustr.l50	92,439	0,3613	0,4230
rustr.slope	0,009	0,0720	0,0850

Table 3.32c Northeast Arctic Cod. Fixed parameter values used in Gadget key run.

Parameter	Value	Parameter	Value
ba1ac.b0	1,000	imm.l_age9	90,000
ba1tr.b0	1,000	imm.n_age10	0,000
ba2ac.b0	1,000	lof1ac.b0	1,000
ba2tr.b0	1,000	lof2ac.b0	1,000
cann.breakpoint	1,120	mat.d_age10	5,437
cann.capelin	0,500	mat.d_age11	10,621
cann.hf	0,000	mat.d_age12	3,266
cann.leftslope	0,015	mat.d_age4	14,900
cann.m1	0,104	mat.d_age5	1,100
cann.m2	0,000	mat.d_age6	6,745
cann.m3	2,400	mat.d_age7	3,184
cann.other	0,500	mat.d_age8	5,107
cann.rightslope	0,228	mat.d_age9	3,065
growth.exponent	0,000	mat.l_age10	105,200
growth.ratio	0,741	mat.l_age11	114,000
imm.d_age10	8,700	mat.l_age12	114,000
imm.d_age3	5,100	mat.l_age4	51,000
imm.d_age4	4,100	mat.l_age5	59,600
imm.d_age5	4,900	mat.l_age6	71,100
imm.d_age6	5,300	mat.l_age7	79,000
imm.d_age7	5,400	mat.l_age8	88,200
imm.d_age8	8,700	mat.l_age9	97,300
imm.d_age9	8,700	mat.n_age11	0,040
imm.l_age10	90,000	mat.n_age12	0,030
imm.l_age3	40,600	mat.n_age4	0,000
imm.l_age4	48,700	maturation.l50	97,720
imm.l_age5	61,300	maturation.slope	0,012
imm.l_age6	71,100	other.level	10000,000
imm.l_age7	81,200	rustr.b0	1,000
imm.l_age8	85,700		

Table 3.33 Northeast Arctic Cod. Results from Gadget keyrun.

; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas 1

Total fishing mortality at age

Year / Age	1986	1987	1988	1989	1990	1991
3	0.0478	0.0511	0.0370	0.0393	0.0219	0.0406
4	0.2518	0.1808	0.1118	0.0930	0.0770	0.0823
5	0.4535	0.6773	0.3354	0.2193	0.1381	0.1755
6	0.6679	0.9786	0.7665	0.4174	0.1984	0.2293
7	0.8022	1.2192	0.9896	0.7197	0.2532	0.2676
8	0.9368	1.3780	1.2309	0.9766	0.3292	0.3070
9	1.0139	1.5114	1.4321	1.4135	0.3889	0.3654
10	1.0632	1.5654	1.5946	1.7847	0.4498	0.4018
11	1.1215	1.6066	1.6501	2.0996	0.4814	0.4281
12+	1.1271	1.6383	1.6987	2.2057	0.5073	0.4412
F 5-10	0.8229	1.2217	1.0582	0.9219	0.2929	0.2911

Total fishing mortality at age

Year / Age	1992	1993	1994	1995	1996	1997	1998
3	0.0613	0.0394	0.0577	0.0547	0.0683	0.0498	0.0482
4	0.1527	0.1493	0.1685	0.1478	0.1350	0.1877	0.2083
5	0.2188	0.2919	0.3644	0.3668	0.3361	0.4620	0.5170
6	0.3168	0.3567	0.5652	0.5316	0.5856	0.7695	0.8872
7	0.3572	0.4557	0.6271	0.7231	0.7016	1.0304	1.1487
8	0.3861	0.5049	0.7388	0.7974	0.8691	1.1583	1.3882
9	0.4139	0.5451	0.8004	0.9560	0.9274	1.3715	1.5037
10	0.4434	0.5815	0.8487	1.0478	1.0486	1.4343	1.7097
11	0.4564	0.6151	0.8787	1.0983	1.0998	1.5481	1.7587
12+	0.4651	0.6291	0.9070	1.1323	1.1362	1.6045	1.8565
F 5-10	0.3560	0.4560	0.6574	0.7371	0.7447	1.0377	1.1924

Total fishing mortality at age

Year / Age	1999	2000	2001	2002	2003	2004	2005	2003-2005
3	0.0278	0.0176	0.0212	0.0262	0.0290	0.0418	0.0435	0.0381
4	0.1875	0.1107	0.0889	0.1171	0.1016	0.1146	0.1858	0.1340
5	0.5055	0.3667	0.2835	0.2765	0.3060	0.3184	0.4167	0.3470
6	0.7909	0.6055	0.4974	0.4698	0.4419	0.5682	0.7141	0.5747
7	1.0877	0.7637	0.6440	0.6158	0.5557	0.6638	0.9417	0.7204
8	1.2981	0.9890	0.7551	0.7241	0.6547	0.7510	1.0247	0.8101
9	1.5392	1.2073	0.9294	0.7968	0.7281	0.8264	1.1043	0.8863
10	1.6314	1.4492	1.0634	0.8985	0.7667	0.8713	1.1616	0.9332
11	1.8089	1.5234	1.1730	0.9537	0.8117	0.8903	1.1890	0.9637
12+	1.8615	1.6713	1.2025	0.9948	0.8342	0.9120	1.2009	0.9824
F 5-10	1.1421	0.8969	0.6955	0.6302	0.5755	0.6665	0.8939	

Table 3.33 (continued)

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; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas  1
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Residual natural mortality (M1)

Year	1986	1987	1988	1989	1990	1991
Age						
3	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
5	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
7	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
9	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
11	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

Residual natural mortality (M1)

Year	1992	1993	1994	1995	1996	1997	1998
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	1999	2000	2001	2002	2003	2004	2005	2003-2005
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	1986	1987	1988	1989	1990	1991
Age						
3	0.0766	0.0930	0.0107	0.0035	0.0018	0.0005
4	0.0010	0.0045	0.0008	0.0002	0.0000	0.0001

Predation mortality (M2)

Year	1992	1993	1994	1995	1996	1997	1998
Age							
3	0.0032	0.0485	0.5147	0.5251	0.1258	0.0339	0.0080
4	0.0001	0.0038	0.0116	0.0229	0.0053	0.0025	0.0005

Predation mortality (M2)

Year	1999	2000	2001	2002	2003	2004	2005	2003-2005
Age								
3	0.0050	0.0032	0.0024	0.0201	0.1259	0.0810	0.1912	0.1327
4	0.0002	0.0001	0.0001	0.0002	0.0037	0.0052	0.0062	0.0050

Table 3.33 (continued)

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; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas  1
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Stock numbers (thousands) at age by Jan. 1

Year	1986	1987	1988	1989	1990	1991	1992
Age							
3	1127438	329030	241566	172598	254583	424308	718767
4	383981	815058	233239	188568	135395	203562	333399
5	238691	244165	554432	170619	140648	102633	153475
6	58073	124171	101537	324544	112178	100297	70504
7	25064	24382	38210	38627	175046	75316	65290
8	10161	9200	5898	11629	15398	111262	47185
9	2444	3260	1899	1410	3585	9071	67015
10	1047	773	600	375	283	1997	5244
11	544	249	121	96	49	141	1004
12+	179	193	72	30	12	31	91
Total	1847622	1550480	1177573	908496	837178	1028617	1461972

Stock numbers (thousands) at age by Jan. 1

Year	1993	1994	1995	1996	1997	1998	1999
Age							
3	865166	934533	557829	324197	534272	658090	467438
4	551695	648764	431677	255766	218599	402311	509339
5	234280	387566	443627	297962	181999	147967	267322
6	100957	143234	219938	251492	174228	93860	72234
7	42052	57857	66638	105800	114645	66079	31647
8	37397	21829	25302	26475	42947	33495	17152
9	26257	18481	8538	9333	9089	11041	6843
10	36535	14316	7488	2922	3109	1958	2036
11	2493	14872	4324	1916	752	536	264
12+	568	1351	5503	2633	1214	331	118
Total	1897400	2242802	1770864	1278495	1280853	1415669	1374392

Stock numbers (thousands) at age by Jan. 1

Year	2000	2001	2002	2003	2004	2005	2006
Age							
3	551006	430963	316488	630680	153993	401999	224471
4	370345	441852	344624	247403	442268	111515	260275
5	345639	271422	330964	250932	182318	321230	75349
6	132021	196108	167364	205513	151292	108534	173279
7	26817	58994	97641	85657	108156	70179	43509
8	8732	10230	25367	43187	40232	45593	22406
9	3834	2659	3937	10067	18372	15544	13397
10	1246	963	891	1486	4046	6698	4353
11	282	215	241	263	499	1270	1582
12+	50	58	69	97	130	211	369
Total	1439971	1413465	1287585	1475286	1101307	1082772	818988

Table 3.33 (continued)

```
; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas  1
```

Spawning stock biomass (tons) at Jan. 1

Year	1986	1987	1988	1989	1990	1991	1992
Age							
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	32529	28777	11712	1687	7662	15982	27448
6	51583	56609	38283	41751	22814	41331	51623
7	47653	42074	39591	33995	100298	63720	90519
8	35836	29986	17333	23581	29362	183988	108947
9	12384	17595	9328	6478	12875	33785	248091
10	5870	5138	4313	2582	1827	11515	32832
11	5846	2452	1164	966	466	1270	9377
12+	2388	2821	1006	416	170	378	1122
SSB total	194089	185451	122729	111455	175473	351968	569958

Spawning stock biomass (tons) at Jan. 1

Year	1993	1994	1995	1996	1997	1998	1999
Age							
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	40852	55536	38084	17351	9174	7720	12082
6	52937	89304	104039	98359	50785	24878	17402
7	65276	69429	94154	117683	118920	54870	23502
8	97440	60393	56903	71675	91208	74951	29417
9	102751	76418	38070	34848	40228	40141	24619
10	204968	69674	42363	16986	16961	12594	9815
11	23339	121692	38358	17143	7073	4798	2262
12+	6526	14471	60225	31051	16469	4966	1363
SSB total	594088	556917	472197	405095	350818	224918	120461

Spawning stock biomass (tons) at Jan. 1

Year	2000	2001	2002	2003	2004	2005	2006
Age							
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	17834	16107	15752	21308	10396	15665	4302
6	36014	71146	58597	73236	66958	39108	46186
7	19007	56088	111268	96870	117106	87861	39855
8	14980	17983	58320	114256	99872	105226	60141
9	12324	8978	13773	44697	85598	65845	59894
10	6720	4937	4901	8639	27160	44573	30056
11	2222	1872	2128	2518	4722	12477	17439
12+	584	612	812	1208	1651	2550	5155
SSB total	109685	177724	265550	362731	413463	373304	263027

Table 3.33 (continued)

```
; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas  1
```

Total stock biomass (tons) at Jan. 1

Year	1986	1987	1988	1989	1990	1991	1992
Age							
3	348854	85793	67490	48888	77793	204886	381680
4	354136	426525	120206	105441	110295	178904	386110
5	343864	318227	514615	154940	172197	164647	250274
6	149316	244821	188588	470272	193516	220164	193131
7	96364	81777	104471	102430	426415	217027	236705
8	52885	44765	25831	44624	60302	425983	216747
9	15636	21292	11544	8123	18990	50578	388870
10	8006	5774	4696	2867	2042	14014	39951
11	5846	2821	1260	1008	488	1334	10198
12+	2388	2821	1006	416	170	378	1122
Total	1377294	1234616	1039705	939009	1062208	1477914	2104790

Total stock biomass (tons) at Jan. 1

Year	1993	1994	1995	1996	1997	1998	1999
Age							
3	285499	195437	112447	79159	127901	153918	85602
4	481850	493099	288392	165748	138430	241660	293336
5	383210	564814	587247	347388	206374	160311	288435
6	221118	350027	459181	500926	312575	163466	119133
7	148889	177971	220983	309770	330879	175262	79414
8	172442	100194	102761	120343	169955	140475	61484
9	150800	105606	50641	49815	53991	59209	35442
10	258154	85118	49915	19735	20669	14687	12357
11	25663	136106	44365	19165	7828	5361	2466
12+	6526	14471	60225	31051	16469	4966	1363
Total	2134150	2222842	1976157	1643099	1385071	1119315	979032

Total stock biomass (tons) at Jan. 1

Year	2000	2001	2002	2003	2004	2005	2006
Age							
3	92876	109390	64056	124742	37744	76861	48424
4	189825	251004	222808	149513	244729	82646	154172
5	381912	309276	373555	336973	208502	421959	93668
6	234078	387263	327953	423267	329854	242969	322603
7	66618	171433	310415	276603	338325	239599	126298
8	32101	38757	112612	207995	184813	198760	107628
9	19107	13912	21481	63854	118099	92350	84786
10	8133	6234	6143	10882	32259	52099	35519
11	2526	2067	2390	2822	5289	13506	18757
12+	584	612	812	1208	1651	2550	5155
Total	1027760	1289948	1442225	1597858	1501266	1423300	997010

Table 3.33 (continued)

; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas 1

Weight (kg) in catch (Observed)

Year / Age	1986	1987
3	0.62	0.49
4	1.25	0.87
5	1.87	1.53
6	2.80	2.34
7	4.46	3.55
8	5.78	5.97
9	6.76	8.60
10	7.60	9.61
11	9.76	12.26
12+	10.63	13.77

Weight (kg) in catch (Observed)

Year / Age	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	0.53	0.74	0.83	1.03	1.15	0.76	0.83	0.80	0.80
4	0.83	0.92	1.22	1.43	1.56	1.44	1.27	1.22	1.09
5	1.29	1.26	1.61	2.11	2.22	2.07	1.97	1.73	1.59
6	2.22	1.86	2.13	2.80	3.14	2.71	2.89	2.55	2.41
7	3.52	2.86	3.15	3.58	4.31	4.05	3.41	3.81	3.82
8	5.28	4.58	4.57	4.61	5.24	5.44	5.33	5.02	5.83
9	7.92	7.51	7.26	5.99	6.16	6.40	6.91	6.18	6.91
10	9.01	9.09	9.85	8.78	7.89	7.13	7.67	8.03	8.16
11	11.21	11.40	13.54	11.82	10.32	7.99	8.06	8.84	9.65
12+	13.99	12.00	17.13	16.58	11.81	10.31	9.70	9.24	10.75

Weight (kg) in catch (Observed)

Year / Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2003-2005
3	0.67	0.61	0.62	0.55	0.66	0.73	0.72	0.79	0.71	0.74
4	0.99	0.98	1.00	1.00	1.02	1.15	1.17	1.27	1.11	1.18
5	1.45	1.54	1.48	1.56	1.58	1.62	1.90	1.81	1.61	1.77
6	2.13	2.22	2.25	2.29	2.48	2.44	2.62	2.66	2.32	2.53
7	3.34	3.22	3.16	3.29	3.48	3.70	3.72	3.44	3.43	3.53
8	5.26	4.83	4.30	4.45	4.75	4.98	5.15	4.80	4.58	4.84
9	7.28	6.88	6.03	5.71	5.99	6.48	6.45	6.74	6.36	6.52
10	7.83	9.39	6.86	7.52	7.42	7.88	8.35	8.01	8.27	8.21
11	8.57	10.75	11.01	7.71	8.67	9.22	10.58	9.13	9.95	9.88
12+	11.32	15.23	14.27	12.34	10.87	7.87	11.88	12.84	12.25	12.32

Table 3.33 (continued)

; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas 1

Weight (kg) in catch (Model)

Year	1986	1987
Age		
3	0.57	0.45
4	1.31	0.86
5	1.76	1.62
6	2.87	2.22
7	4.17	3.65
8	5.48	5.24
9	6.66	6.96
10	7.89	8.46
11	10.89	10.48
12+	13.39	15.65

Weight (kg) in catch (Model)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age									
3	0.53	0.70	0.88	1.06	1.14	0.66	0.60	0.60	0.66
4	0.85	0.96	1.39	1.48	1.61	1.48	1.15	1.09	1.06
5	1.30	1.31	1.72	2.14	2.11	2.06	1.96	1.71	1.59
6	2.18	1.82	2.19	2.69	3.15	2.63	2.80	2.63	2.41
7	3.00	3.04	2.93	3.41	4.02	3.96	3.49	3.88	3.49
8	4.65	4.21	4.53	4.43	5.01	5.03	5.07	4.70	5.14
9	6.33	6.07	5.87	6.21	6.23	6.16	6.23	6.57	5.98
10	8.17	7.97	7.77	7.61	8.15	7.53	7.51	8.04	8.12
11	9.83	10.20	9.90	9.55	9.69	9.75	8.82	9.43	9.68
12+	14.23	14.04	14.41	12.85	12.60	11.88	11.58	11.51	12.72

Weight (kg) in catch (Model)

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2003-2005
Age										
3	0.55	0.57	0.47	0.45	0.51	0.54	0.51	0.59	0.50	0.53
4	1.10	1.03	1.03	0.99	0.94	1.08	1.07	1.02	1.10	1.06
5	1.55	1.55	1.52	1.61	1.56	1.59	1.75	1.63	1.62	1.67
6	2.20	2.15	2.11	2.26	2.39	2.42	2.44	2.56	2.45	2.48
7	3.34	3.07	2.98	3.05	3.37	3.70	3.64	3.51	3.71	3.62
8	4.51	4.65	4.15	4.29	4.34	5.00	5.26	5.03	4.84	5.04
9	6.48	5.87	5.85	5.62	5.77	6.06	6.73	6.85	6.51	6.70
10	7.44	8.24	6.93	7.40	7.20	7.75	7.88	8.48	8.50	8.29
11	9.96	9.41	9.49	8.56	9.21	9.40	9.83	9.83	10.42	10.02
12+	14.17	15.48	12.79	12.43	11.16	12.44	12.67	13.04	12.74	12.81

Table 3.33 (continued)

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; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas  1
```

Weight (kg) in stock at Jan. 1

Year Age	1986	1987	1988
3	0.31	0.26	0.28
4	0.92	0.52	0.52
5	1.44	1.30	0.93
6	2.57	1.97	1.86
7	3.84	3.35	2.73
8	5.20	4.87	4.38
9	6.40	6.53	6.08
10	7.65	7.47	7.83
11	10.75	11.33	10.41
12+	13.34	14.62	13.97

Weight (kg) in stock at Jan. 1

Year Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	0.28	0.31	0.48	0.53	0.33	0.21	0.20	0.24	0.24
4	0.56	0.81	0.88	1.16	0.87	0.76	0.67	0.65	0.63
5	0.91	1.22	1.60	1.63	1.64	1.46	1.32	1.17	1.13
6	1.45	1.73	2.20	2.74	2.19	2.44	2.09	1.99	1.79
7	2.65	2.44	2.88	3.63	3.54	3.08	3.32	2.93	2.89
8	3.84	3.92	3.83	4.59	4.61	4.59	4.06	4.55	3.96
9	5.76	5.30	5.58	5.80	5.74	5.71	5.93	5.34	5.94
10	7.64	7.21	7.02	7.62	7.07	5.95	6.67	6.75	6.65
11	10.50	9.95	9.46	10.16	10.29	9.15	10.26	10.00	10.41
12+	13.86	14.19	12.21	12.33	11.49	10.71	10.94	11.79	13.57

Weight (kg) in stock at Jan. 1

Year Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2004-2006
3	0.23	0.18	0.17	0.25	0.20	0.20	0.25	0.19	0.22	0.22
4	0.60	0.58	0.51	0.57	0.65	0.60	0.55	0.74	0.59	0.63
5	1.08	1.08	1.10	1.14	1.13	1.34	1.14	1.31	1.24	1.23
6	1.74	1.65	1.77	1.97	1.96	2.06	2.18	2.24	1.86	2.09
7	2.65	2.51	2.48	2.91	3.18	3.23	3.13	3.41	2.90	3.15
8	4.19	3.58	3.68	3.79	4.44	4.82	4.59	4.36	4.80	4.59
9	5.36	5.18	4.98	5.23	5.46	6.34	6.43	5.94	6.33	6.23
10	7.50	6.07	6.53	6.47	6.89	7.32	7.97	7.78	8.16	7.97
11	10.00	9.34	8.96	9.61	9.92	10.73	10.60	10.63	11.86	11.03
12+	15.00	11.55	11.68	10.55	11.77	12.45	12.70	12.09	13.97	12.92

Table 3.33 (continued)

```
; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
stocks cod.imm cod.mat
areas  1
```

Proportion mature at age

Year	1986	1987	1988
Age			
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.078	0.067	0.013
6	0.356	0.210	0.169
7	0.496	0.524	0.360
8	0.690	0.674	0.680
9	0.775	0.835	0.813
10	0.693	0.824	0.904
11	1.000	1.000	1.000
12+	1.000	1.000	1.000

Proportion mature at age

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997
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	0.006	0.029	0.072	0.079	0.080	0.064	0.046	0.032	0.028
6	0.064	0.096	0.163	0.233	0.192	0.220	0.176	0.168	0.131
7	0.295	0.209	0.272	0.360	0.402	0.346	0.393	0.323	0.332
8	0.514	0.463	0.412	0.488	0.544	0.578	0.516	0.571	0.487
9	0.804	0.676	0.657	0.628	0.668	0.713	0.734	0.673	0.728
10	0.894	0.894	0.821	0.803	0.780	0.708	0.764	0.782	0.780
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	1998	1999	2000	2001	2002	2003	2004	2005	2006	2004-2006
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	0.029	0.026	0.029	0.034	0.027	0.044	0.030	0.022	0.030	0.0273
6	0.120	0.110	0.124	0.153	0.146	0.144	0.174	0.130	0.114	0.1392
7	0.278	0.263	0.244	0.298	0.327	0.319	0.318	0.348	0.279	0.3148
8	0.512	0.451	0.440	0.431	0.496	0.527	0.517	0.511	0.539	0.5222
9	0.640	0.683	0.628	0.632	0.618	0.688	0.711	0.698	0.693	0.7007
10	0.817	0.761	0.792	0.766	0.763	0.763	0.821	0.832	0.811	0.8211
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 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
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	1986	1987	1988	1989
Age				
3	25341	8415	5868	4280
4	69138	106339	19853	13276
5	71629	100983	130460	27311
6	23778	66045	46190	92315
7	11916	14925	20766	17182
8	5445	6084	3717	6485
9	1387	2276	1313	989
10	614	550	440	294
11	331	180	90	80
12+	109	140	54	25
Total	209688	305937	228750	162237

Model catch in numbers (thousands) at age

Year	1990	1991	1992	1993	1994	1995	1996	1997
Age								
3	3129	10841	21007	14906	11109	6842	6424	13679
4	6905	10751	28047	50486	65478	37534	23455	28717
5	12683	11421	18184	43888	85469	104004	66621	54514
6	14384	14509	11889	22721	46620	71362	89735	77194
7	28701	12822	12518	11875	20641	27958	43934	62235
8	3352	22116	9952	11680	9020	11540	13063	25320
9	932	2192	15435	8852	8209	4504	4848	5974
10	85	534	1316	13123	6697	4230	1665	2100
11	16	40	261	945	7169	2526	1129	530
12+	4	9	24	220	669	3284	1587	874
Total	70189	85237	118633	178696	261082	273784	252461	271137

Model catch in numbers (thousands) at age

Year	1998	1999	2000	2001	2002	2003	2004	2005
Age								
3	20462	8477	6208	6179	2936	4728	2096	4543
4	60643	70297	30162	29415	23740	12953	26567	10107
5	49045	87570	85521	54422	52111	40774	30605	63903
6	46075	33109	49460	64191	42747	46949	42048	33801
7	38300	17898	12061	23992	32229	24581	34734	27378
8	21843	10847	4760	4745	9850	14841	14734	19360
9	7557	4784	2394	1445	1679	3879	7466	7147
10	1437	1469	867	575	424	604	1738	3247
11	399	200	202	137	121	113	219	630
12+	253	91	38	38	36	43	59	106
Total	246013	234742	191671	185137	165872	149464	160266	170223

Table 3.33 (continued)

```
; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
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	1986	1987	1988	1989
Age				
3	24597	10450	9317	4902
4	59086	117698	19548	15828
5	71517	84253	117460	28904
6	23479	57239	48949	66506
7	10439	13074	19899	24993
8	3797	3568	3151	5186
9	888	867	1163	789
10	688	449	381	275
11	519	183	107	42
12+	134	204	68	14
Total	195143	287984	220041	147438

Observed catch in numbers (thousands) at age

Year	1990	1991	1992	1993	1994	1995	1996	1997
Age								
3	1315	3493	14276	7680	5558	4741	7034	10454
4	5807	8514	22802	37098	49632	35100	25574	32828
5	9870	12308	18685	54328	79314	95618	70969	63737
6	13786	15174	17113	28245	50230	79441	87253	75825
7	23668	14189	12899	11520	28770	28290	46081	60395
8	5151	18096	9543	7441	7676	6786	8729	22648
9	605	2701	12820	5183	4523	2495	1791	3191
10	125	264	1761	9806	2498	1433	808	814
11	47	37	192	1296	5464	808	357	352
12+	12	12	46	249	751	1664	174	146
Total	60386	74787	110136	162845	234417	256374	248771	270388

Observed catch in numbers (thousands) at age

Year	1998	1999	2000	2001	2002	2003	2004	2005
Age								
3	28160	8084	4266	4348	1547	4480	1369	3438
4	78268	72593	27993	30719	20480	12801	24289	11618
5	42650	81439	76991	53307	49756	38650	31696	64452
6	35602	27616	40926	53506	45010	44642	42084	35141
7	29462	13875	11508	20104	30600	25371	33879	28042
8	23799	14370	6318	4707	8910	10748	13674	14515
9	6133	7967	4563	1622	1343	2354	5072	4940
10	883	1812	1517	1063	402	389	1429	1933
11	174	210	261	275	145	113	232	450
12+	60	41	41	49	86	140	160	126
Total	245190	228007	174384	169700	158279	139688	153884	164655

Table 3.33 (continued)

; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
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	1986	1987	1988	1989
Age				
3	14444	3814	3083	2986
4	90568	91085	16845	12769
5	125752	163220	169329	35870
6	68216	146703	100607	168442
7	49641	54424	62388	52255
8	29818	31906	17277	27288
9	9241	15834	8316	5997
10	4847	4657	3595	2347
11	3601	1887	886	813
12+	1465	2200	772	354
Total	397591	515727	383098	309121
Total+	447691	573318	428693	349948

(+ Also includes: overfish-new otherfleet)

Model catch in biomass (tons) at age

Year	1990	1991	1992	1993	1994	1995	1996	1997
Age								
3	2757	11454	23937	9779	6709	4119	4251	7571
4	9596	15863	45219	74714	75083	40932	24869	31632
5	21854	24466	38313	90547	167709	177558	105676	84486
6	31478	38972	37437	59837	130739	187572	216279	169973
7	84090	43686	50349	47076	71936	108610	153480	207599
8	15172	97938	49895	58750	45711	54242	67100	114289
9	5473	13611	96135	54566	51128	29594	28973	38722
10	663	4067	10729	98857	50295	34017	13510	15616
11	157	385	2528	9207	63258	23834	10933	5283
12+	59	117	306	2611	7742	37813	20193	12379
Total	171299	250559	354849	505944	670309	698291	645264	687548
Total+	220485	325622	521179	621764	831451	822562	748182	772452

(+ Also includes: overfish-new otherfleet)

Model catch in biomass (tons) at age

Year	1998	1999	2000	2001	2002	2003	2004	2005
Age								
3	11722	3946	2783	3136	1581	2398	1235	2257
4	62193	72406	29859	27730	25608	13854	27117	11132
5	76146	133358	138038	84720	82751	71353	49774	103650
6	98871	69865	111940	153602	103535	114460	107443	82661
7	117662	53256	36753	80894	119178	89356	122048	101609
8	101582	45058	20400	20576	49270	78000	74048	93615
9	44346	28001	13466	8341	10170	26118	51133	46506
10	11839	10184	6417	4137	3286	4760	14746	27592
11	3756	1900	1728	1262	1136	1113	2156	6568
12+	3911	1161	469	418	445	542	764	1345
Total	532026	419135	361853	384817	396959	401953	450464	476933
Total+	592412	470381	417079	439297	545587	575761	643268	710309

(+ Also includes: overfish-new otherfleet)

Table 3.33 (continued)

```
; Gadget version 2.1.02 running on bare8645 Wed Apr 26 12:16:47 2006
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	1986	1987	1988	1989
Age				
3	15226	5086	4968	3624
4	73787	101978	16313	14598
5	133381	128842	151174	36498
6	65666	133719	108829	123969
7	46521	46379	69956	71372
8	21949	21314	16648	23732
9	5997	7454	9215	5923
10	5232	4318	3431	2496
11	5068	2247	1195	477
12+	1422	2810	947	168
Total	374248	454146	382675	282856
Total+	424348	511737	428270	323683

(+ Also includes: overfish-new otherfleet)

Observed catch in biomass (tons) at age

Year	1990	1991	1992	1993	1994	1995	1996	1997
Age								
3	1090	3597	16410	5869	4605	3802	5644	7034
4	7070	12153	35478	53248	62856	42832	27948	32452
5	15879	25920	41467	112199	156455	165865	112514	92423
6	29412	42533	53720	76633	144955	202254	210237	161292
7	74450	50742	55633	46655	98004	107761	175919	201478
8	23544	83487	49966	40484	40920	34062	50900	119086
9	4394	16169	78925	33172	31231	15421	12384	23228
10	1229	2314	13899	69911	19171	11505	6598	6372
11	632	437	1976	10359	44041	7145	3449	3012
12+	199	192	548	2563	7283	15370	1874	1650
Total	157898	237543	348022	451093	609520	606017	607465	648026
Total+	207084	312606	514352	566913	770662	730289	710383	732930

(+ Also includes: overfish-new otherfleet)

Observed catch in biomass (tons) at age

Year	1998	1999	2000	2001	2002	2003	2004	2005
Age								
3	17085	5037	2354	2860	1122	3247	1084	2442
4	76328	72744	27998	31436	23522	15016	30927	12857
5	65520	120373	120413	84341	80738	73619	57354	103559
6	79064	62170	93671	132679	109755	117057	111912	81584
7	94788	43800	37826	70012	113273	94438	116671	96246
8	114831	61825	28120	22370	44387	55339	65688	66457
9	42175	48013	26052	9711	8708	15172	34180	31430
10	8289	12422	11409	7887	3167	3247	11440	15992
11	1869	2313	2012	2384	1337	1195	2117	4476
12+	917	590	506	532	677	1663	2055	1543
Total	500866	429287	350362	364212	386685	379994	433427	416588
Total+	561252	480533	405588	418692	535313	553802	626231	649964

(+ Also includes: overfish-new otherfleet)

Table 3.34.

Table 3.xx - Estimated parameters from ADAPT
Shaded cells highlight relative errors/biases exceeding 25%

	Parameter	Estimate	StdErr	Bias	Relative Error	Relative Bias
Survivors						
	N[2006 4]	326226	125588	23223	38%	7%
	N[2006 5]	91268	28228	3853	31%	4%
	N[2006 6]	164862	54897	6669	33%	4%
	N[2006 7]	52311	20395	2586	39%	5%
	N[2006 8]	48845	18259	2236	37%	5%
	N[2006 9]	24086	9548	1314	40%	5%
	N[2006 10]	4743	2688	491	57%	10%
	N[2006 11]	329	318	128	97%	39%
	N[2006 12]	221	167	45	76%	20%
	N[2006 13]	91	66	15	72%	17%
Catchabilities (Fleet_age)						
	F09_9	0.0493	0.0065	0.0003	13%	1%
	F09_10	0.0509	0.0068	0.0004	13%	1%
	F09_11	0.0387	0.0053	0.0003	14%	1%
	F09_12	0.0202	0.0029	0.0002	14%	1%
	F15_3	0.0026	0.0003	0.0000	13%	1%
	F15_4	0.0021	0.0003	0.0000	13%	1%
	F15_5	0.0014	0.0002	0.0000	13%	1%
	F15_6	0.0009	0.0001	0.0000	13%	1%
	F15_7	0.0005	0.0001	0.0000	13%	1%
	F15_8	0.0004	0.0001	0.0000	14%	1%
	F16_3	0.0020	0.0003	0.0000	13%	1%
	F16_4	0.0018	0.0002	0.0000	13%	1%
	F16_5	0.0018	0.0002	0.0000	13%	1%
	F16_6	0.0020	0.0003	0.0000	13%	1%
	F16_7	0.0018	0.0002	0.0000	13%	1%
	F16_8	0.0018	0.0002	0.0000	13%	1%
	F16_9	0.0018	0.0002	0.0000	13%	1%
	F16_10	0.0024	0.0003	0.0000	15%	1%
	F16_11	0.0056	0.0009	0.0000	16%	1%
	F17_3	0.0029	0.0005	0.0000	18%	1%
	F17_4	0.0044	0.0008	0.0001	18%	1%
	F17_5	0.0064	0.0011	0.0001	18%	1%
	F17_6	0.0087	0.0015	0.0001	18%	1%
	F17_7	0.0098	0.0017	0.0001	18%	1%
	F17_8	0.0122	0.0022	0.0002	18%	1%

Fleet labeled “fleet 17” is fleet 18

Table 3.35.

Table 3.xx - Summary of ADAPT Estimates (First Run).

Year	Abundance 000s	Biomass tonnes	SSB tonnes	Mean F5-10	Mean F4-8	Recruits Age 3, 000s
1984	3475083	1005941	252275	0.910	0.681	396605
1985	3730674	1171621	193254	0.706	0.623	523814
1986	4262240	1422387	170000	0.864	0.697	1043684
1987	2479160	1167815	117500	0.965	0.773	286299
1988	2117383	972829	200688	1.031	0.636	204843
1989	1932175	943998	233093	0.705	0.491	172951
1990	2805228	1091402	316316	0.286	0.211	242767
1991	3808410	1773939	706947	0.328	0.268	412012
1992	5723995	2133395	892397	0.452	0.387	721249
1993	26823798	2714735	780398	0.547	0.415	897284
1994	12779643	2348153	619340	0.872	0.668	812303
1995	22859093	2187277	531903	0.783	0.612	657982
1996	30909865	2207913	568189	0.706	0.586	437590
1997	23025143	1897510	589325	1.031	0.734	714035
1998	9404491	1344816	387236	0.911	0.695	843884
1999	5465261	1196353	293578	0.984	0.670	554082
2000	5450024	1203438	241030	0.852	0.585	614093
2001	5900779	1472312	353185	0.716	0.485	524502
2002	3432781	1617088	497601	0.667	0.531	380592
2003	7464582	1654373	551281	0.535	0.445	553093
2004	6332320	1543724	659920	0.694	0.503	176038
2005	4497095	1369330	585097	0.804	0.632	394355
2006	4360690	1133612	490318			337363

Note: Biomass and spawner biomass in 2006 are computed using 3 year geometric mean of stock weights and maturities at age.

Table 3.36.

Table 3.xx - Estimated parameters from ADAPT (Second Run). Shaded cells highlight relative errors/biases exceeding 25%

	Parameter	Estimate	StdErr	Bias	Relative Error	Relative Bias
Survivors						
	N[2006 4]	290345	51193	4799	18%	1.7%
	N[2006 5]	83126	11556	828	14%	1.0%
	N[2006 6]	145963	20908	1404	14%	1.0%
	N[2006 7]	43800	6861	494	16%	1.1%
	N[2006 8]	35028	5507	408	16%	1.2%
	N[2006 9]	16817	2719	219	16%	1.3%
	N[2006 10]	5704	1128	99	20%	1.7%
	N[2006 11]	1729	532	56	31%	3.2%
	N[2006 12]	675	208	22	31%	3.3%
	N[2006 13]	325	128	11	39%	3.4%
Catchabilities (Fleet_age)						
	F09_9	0.0288	0.0027	0.0001	9%	0.3%
	F09_10	0.0275	0.0027	0.0001	10%	0.4%
	F09_11	0.0222	0.0025	0.0002	11%	0.7%
	F09_12	-				
	F15_3	0.0037	0.0003	0.0000	9%	0.3%
	F15_4	0.0030	0.0003	0.0000	9%	0.3%
	F15_5	0.0024	0.0002	0.0000	9%	0.3%
	F15_6	0.0019	0.0002	0.0000	9%	0.3%
	F15_7	0.0013	0.0001	0.0000	9%	0.3%
	F15_8	0.0010	0.0001	0.0000	9%	0.3%
	F16_3	0.0028	0.0003	0.0000	9%	0.3%
	F16_4	0.0026	0.0002	0.0000	9%	0.3%
	F16_5	0.0030	0.0003	0.0000	9%	0.3%
	F16_6	0.0041	0.0004	0.0000	9%	0.3%
	F16_7	0.0045	0.0004	0.0000	9%	0.3%
	F16_8	0.0042	0.0004	0.0000	9%	0.3%
	F16_9	0.0038	0.0004	0.0000	10%	0.3%
	F16_10	-				
	F16_11	-				
	F17_3	0.0032	0.0003	0.0000	9%	0.3%
	F17_4	0.004961	0.0005	0.0000	9%	0.3%
	F17_5	0.007234	0.0007	0.0000	9%	0.3%
	F17_6	0.0098	0.0009	0.0000	9%	0.3%
	F17_7	0.0103	0.0009	0.0000	9%	0.3%
	F17_8	0.0123	0.0011	0.0000	9%	0.3%

Fleet labeled “fleet 17” is fleet 18

Table 3.37.

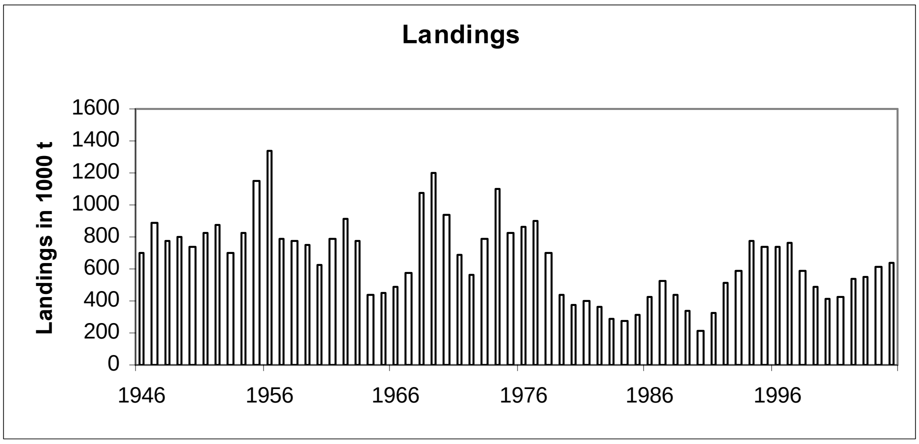
Table 3.xx - Summary of ADAPT Estimates (Second run).

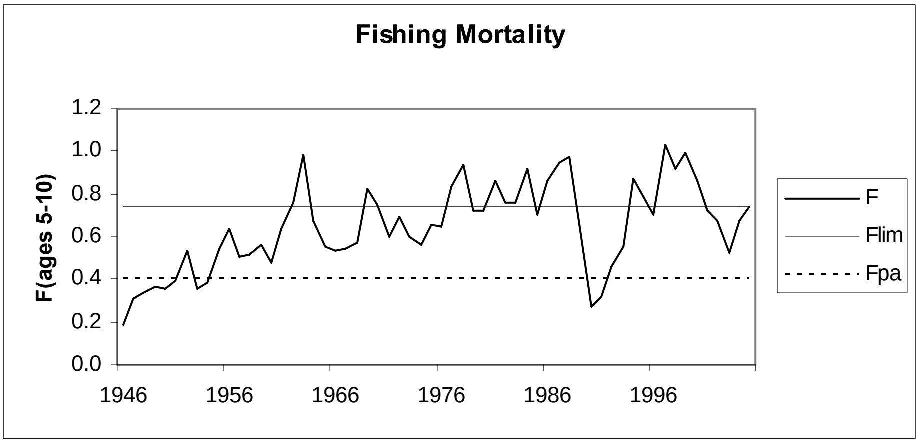
Year	Abundance 000s	Biomass tonnes	SSB tonnes	Mean F5-10	Mean F4-8	Recruits Age 3, 000s
1984	3475084	1005941	252275	0.910	0.681	396605
1985	3730675	1171621	193254	0.706	0.623	523814
1986	4262242	1422387	170000	0.864	0.697	1043685
1987	2479162	1167815	117500	0.965	0.773	286299
1988	2117386	972830	200688	1.031	0.636	204843
1989	1932183	944000	233094	0.705	0.491	172952
1990	2805249	1091405	316317	0.286	0.211	242768
1991	3808486	1773948	706949	0.328	0.268	412016
1992	5724149	2133414	892400	0.452	0.387	721260
1993	26824200	2714775	780402	0.547	0.415	897323
1994	12780545	2348228	619346	0.872	0.668	812364
1995	22862193	2187449	531917	0.783	0.612	658145
1996	30918524	2208360	568223	0.706	0.586	437966
1997	23034393	1898548	589401	1.031	0.734	715513
1998	9414921	1347045	387397	0.910	0.694	847711
1999	5476836	1200455	293984	0.981	0.668	555586
2000	5461898	1210223	242356	0.845	0.580	616116
2001	5915333	1483232	357364	0.704	0.477	526584
2002	3446694	1631667	505703	0.646	0.518	382180
2003	7484768	1673419	563893	0.511	0.433	556320
2004	6353223	1565559	675952	0.647	0.496	177416
2005	4518686	1396342	605306	0.732	0.623	400003
2006	4382942	1166684	515288			340508

Note: Biomass and spawner biomass in 2006 are computed using 3 year geometric mean of stock weights and maturities at age.

Table 3.38 Results of ISVPA for NEA cod

	R(3), 1000 t	Tot.Stock (in N)	TSB t	SSB t	f(year)	F(5-10)
1980	138558	806986	920556	110861	5.28	0.71
1981	146965	637634	1034356	166291	5.39	0.96
1982	143551	523234	760147	336594	5.21	0.81
1983	167074	475891	730860	328947	4.93	0.79
1984	367204	669705	799072	253451	5.68	0.91
1985	516945	977465	918079	192992	4.59	0.74
1986	1026710	1721120	1268048	172166	5.42	0.84
1987	267379	1493063	1167005	123164	5.82	1.02
1988	200698	1150922	1008253	220428	6.03	1.08
1989	168125	852665	948148	252482	4.58	0.82
1990	226521	752739	984301	337991	2.71	0.26
1991	398335	932276	1534845	712982	2.42	0.32
1992	752581	1430698	1915074	905539	3.28	0.46
1993	875311	1916332	2391815	791351	4.03	0.55
1994	583639	1972798	2161092	617808	5.45	0.91
1995	314319	1637405	1823903	552053	5.23	0.77
1996	248130	1280977	1720908	603439	4.72	0.69
1997	449257	1229847	1598389	650982	6.06	1.02
1998	554447	1273642	1187049	410778	5.82	0.84
1999	470187	1282839	1072032	297831	5.77	1.06
2000	553020	1391503	1069799	243960	5.34	0.88
2001	525582	1471488	1339483	349299	4.72	0.72
2002	438196	1452991	1499321	471588	4.51	0.71
2003	731483	1709571	1628421	531694	3.81	0.57
2004	227201	1434137	1633379	666988	4.61	0.68
2005	322841	1262009	1574910	636805	4.70	0.69


Landings
Landings in 1000 t
1600
1400
1200
1000
800
600
400
200
0
1946
1956
1966
1976
1986
1996


Fishing Mortality
F(ages 5-10)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1946
1956
1966
1976
1986
1996
F
Flim
Fpa


Recruitment (age 3)
Recruitment in billions
2
1.5
1
0.5
0
1946
1956
1966
1976
1986
1996

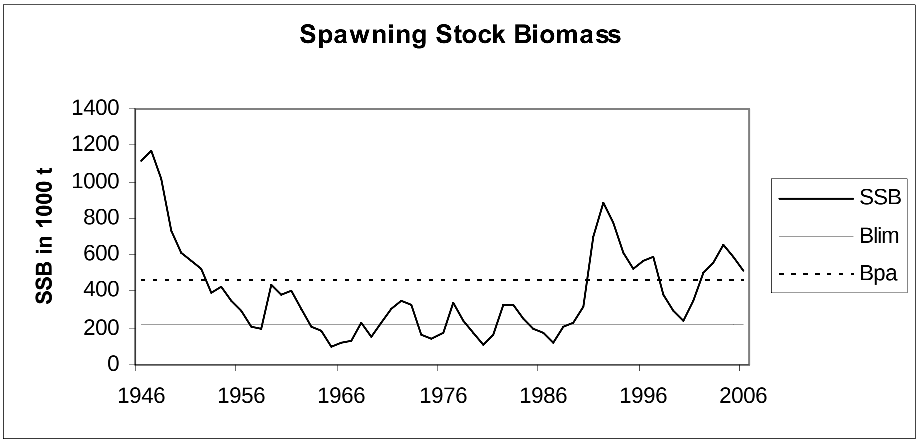
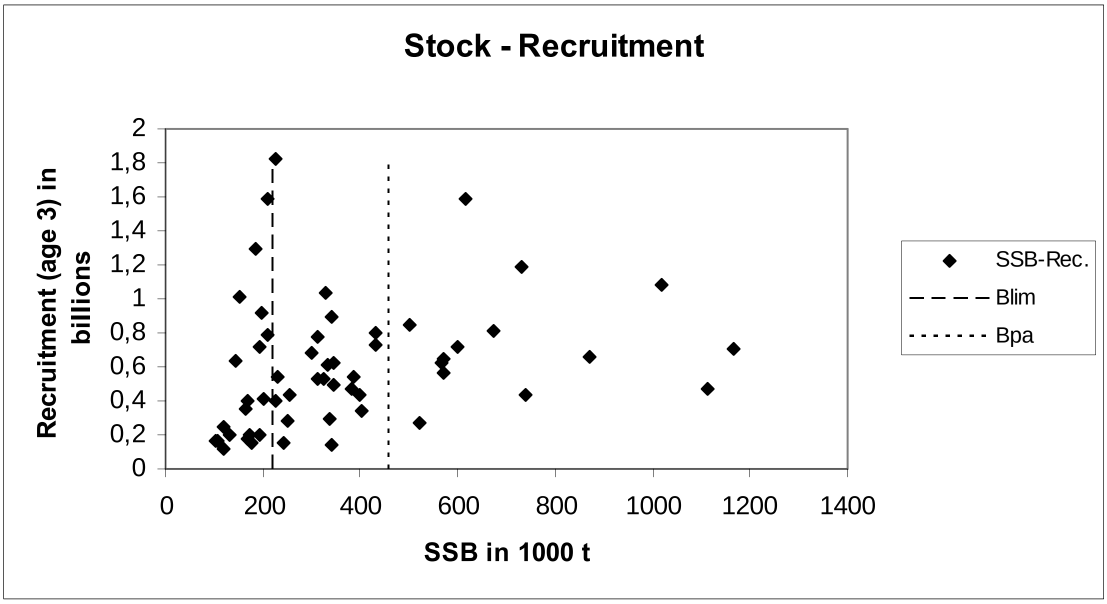
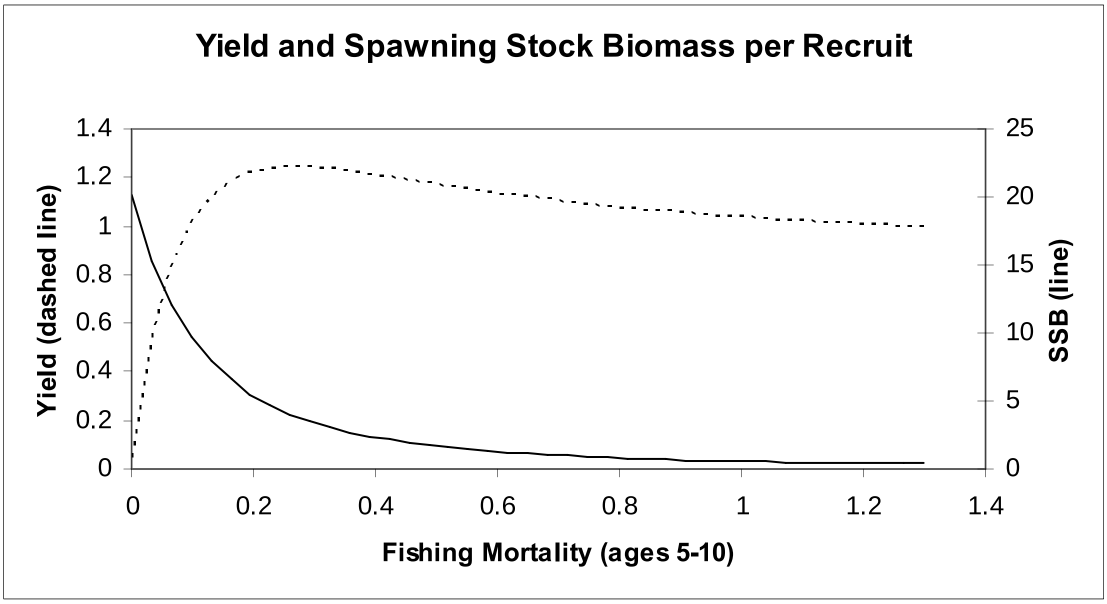

Spawning Stock Biomass
SSB in 1000 t
1400
1200
1000
800
600
400
200
0
1946
1956
1966
1976
1986
1996
2006
SSB
Blim
Bpa

Figure 3.1. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)





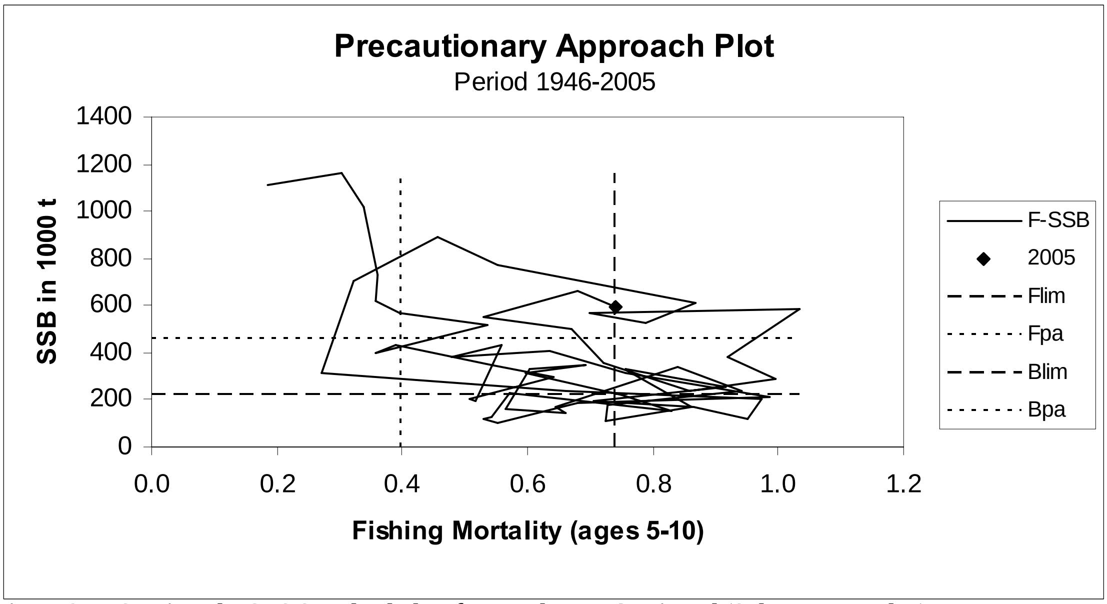


Figure 3.1. Continued. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)

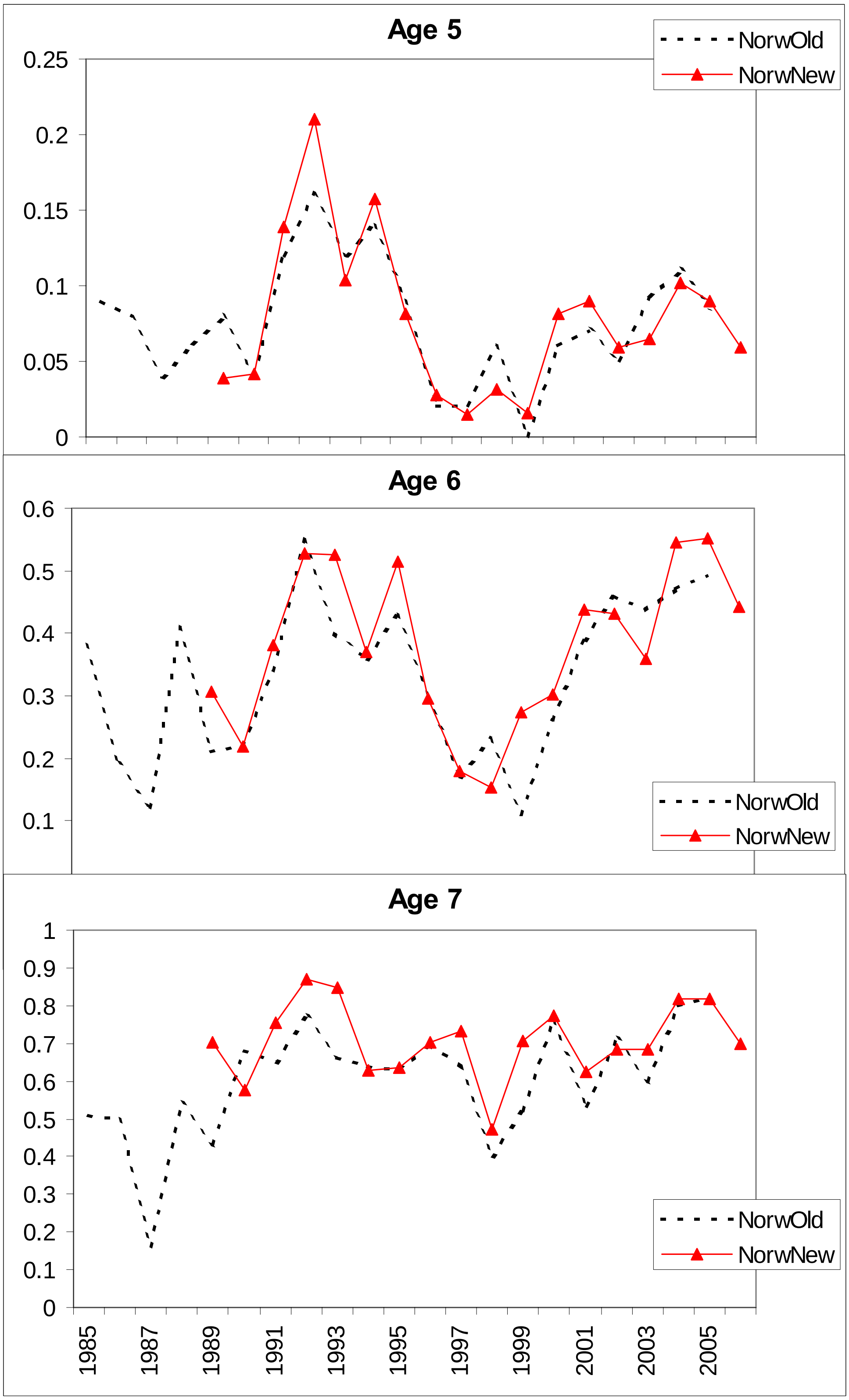


Figure 3.2 a. New and Old calculation of Maturity at age based on Norwegian data.

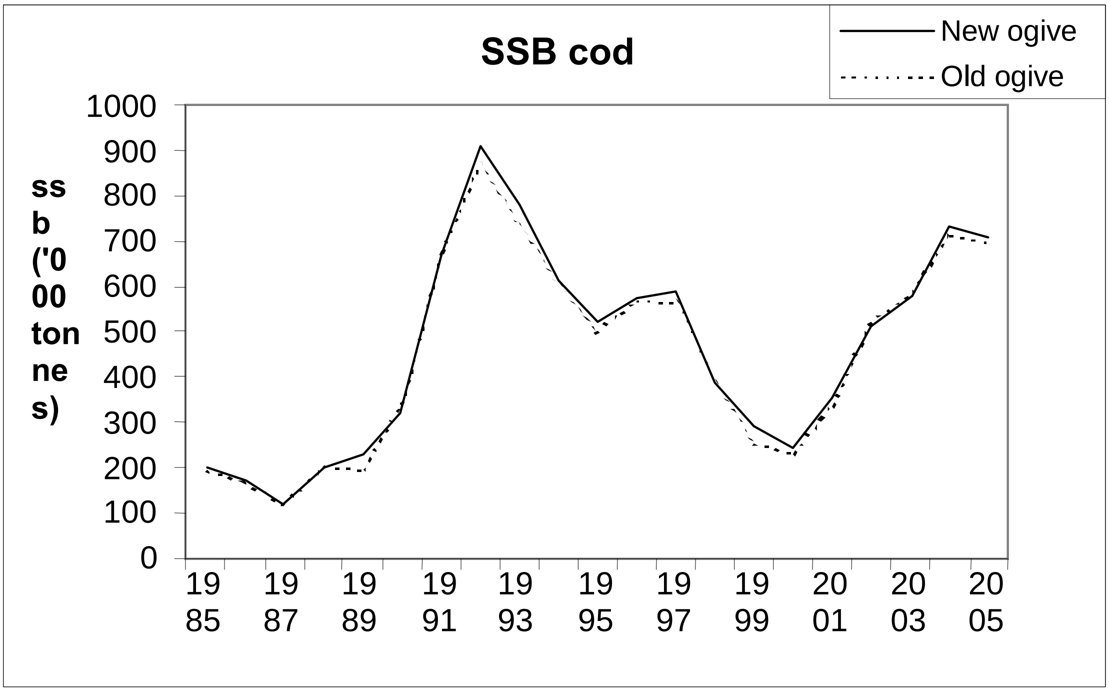


Figure 3.2 b. SSB calculated with new and old combined ogive (based on AFWG 05 stock numbers).

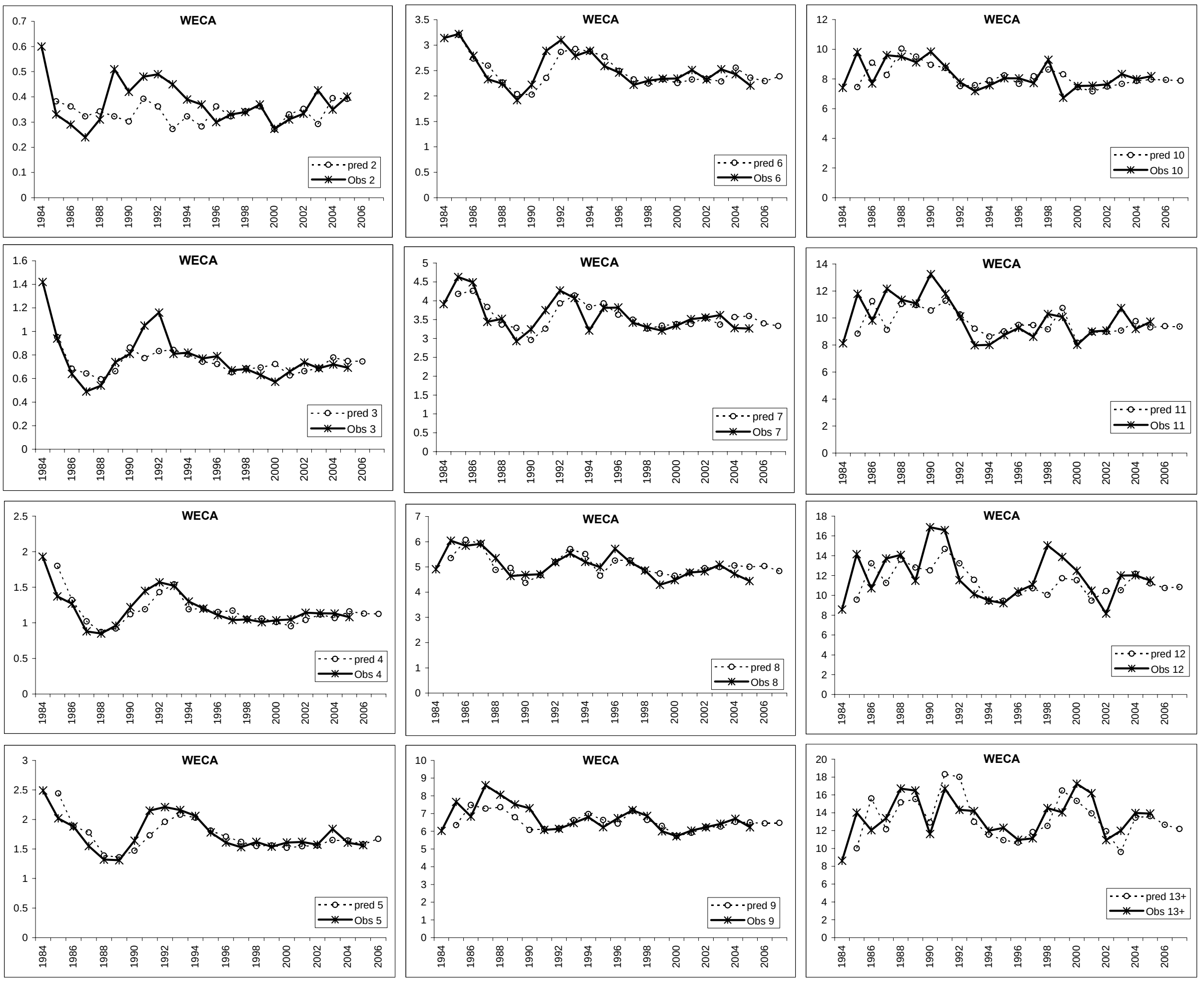


Figure. 3.2c . North-east Arctic cod. Weight in catch predictions.

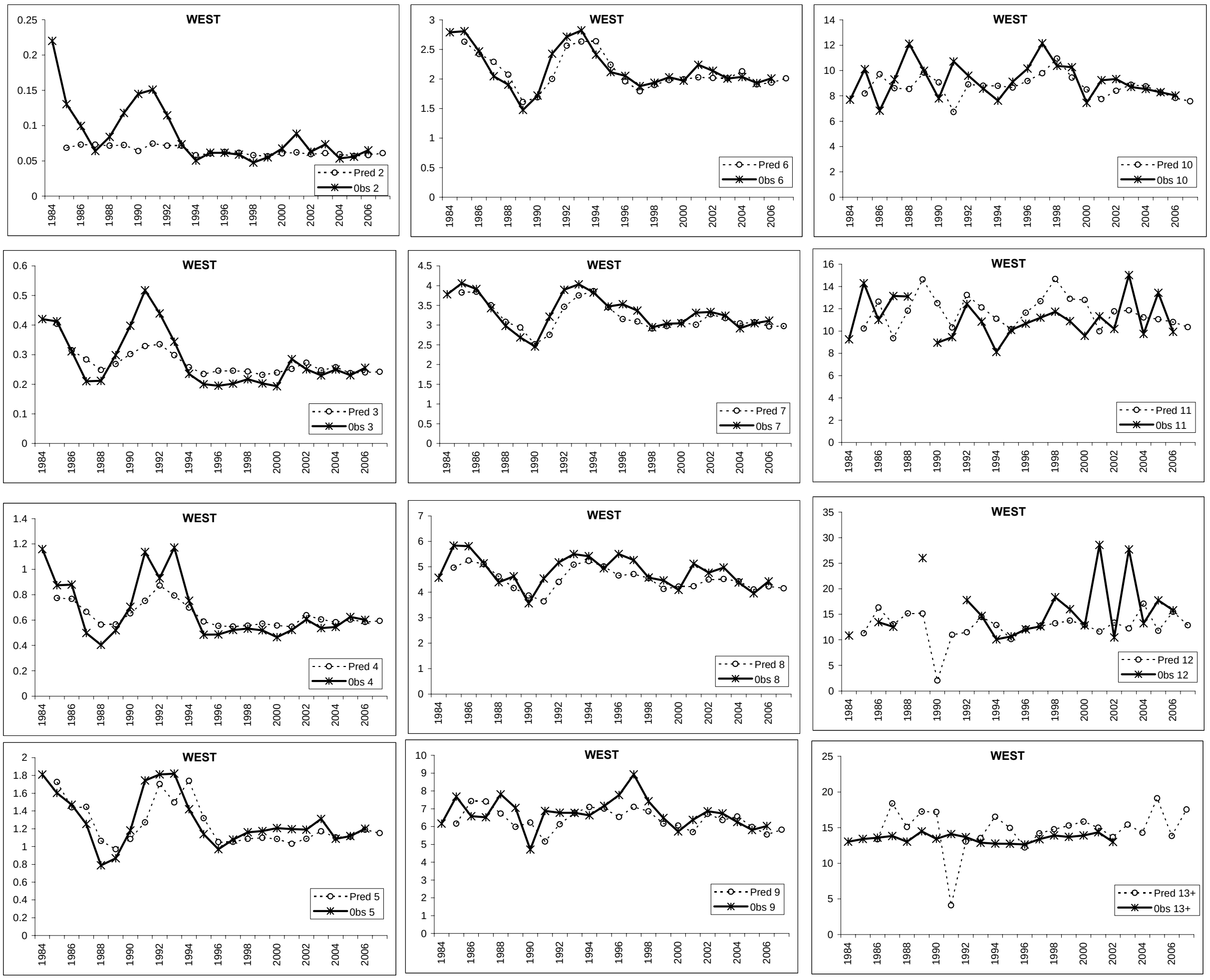


Figure 3.2d . North-east Arctic cod. Weight in stock predictions.

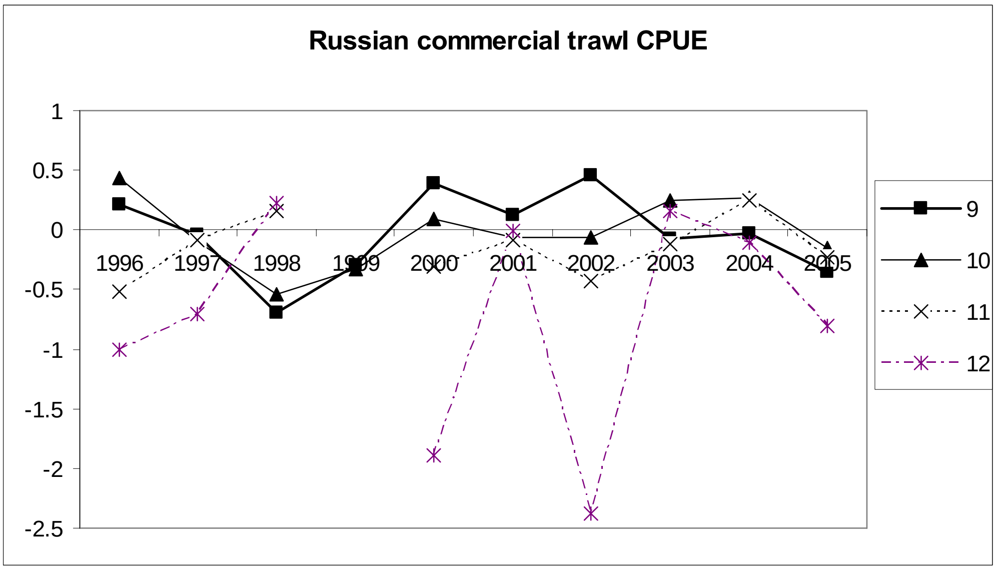


Figure 3.3 a. Residual log catchability of fleet 09 by ages in the initial 2006 XSA run

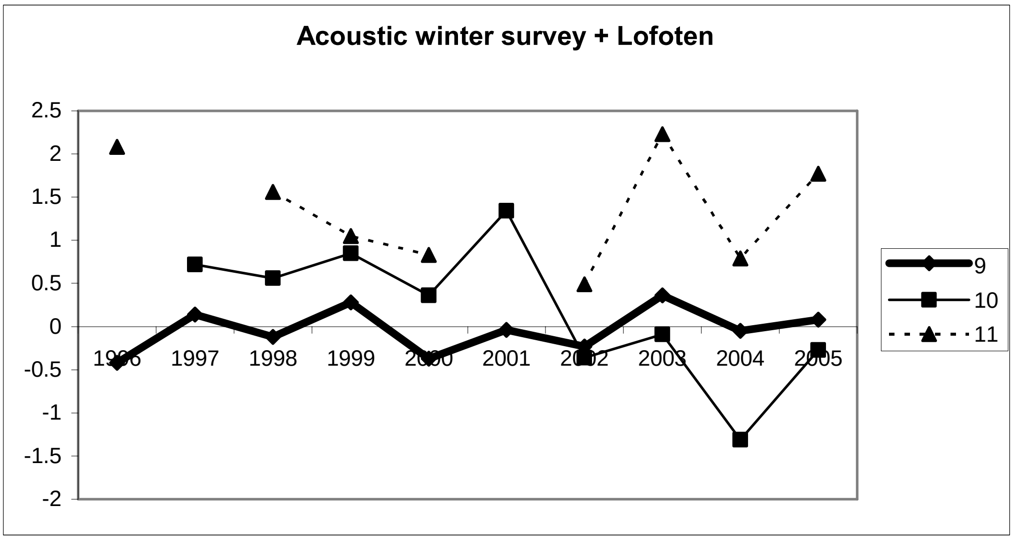


Figure 3.3 b. Residual log catchability of fleet 16 by ages in the initial 2006 XSA run

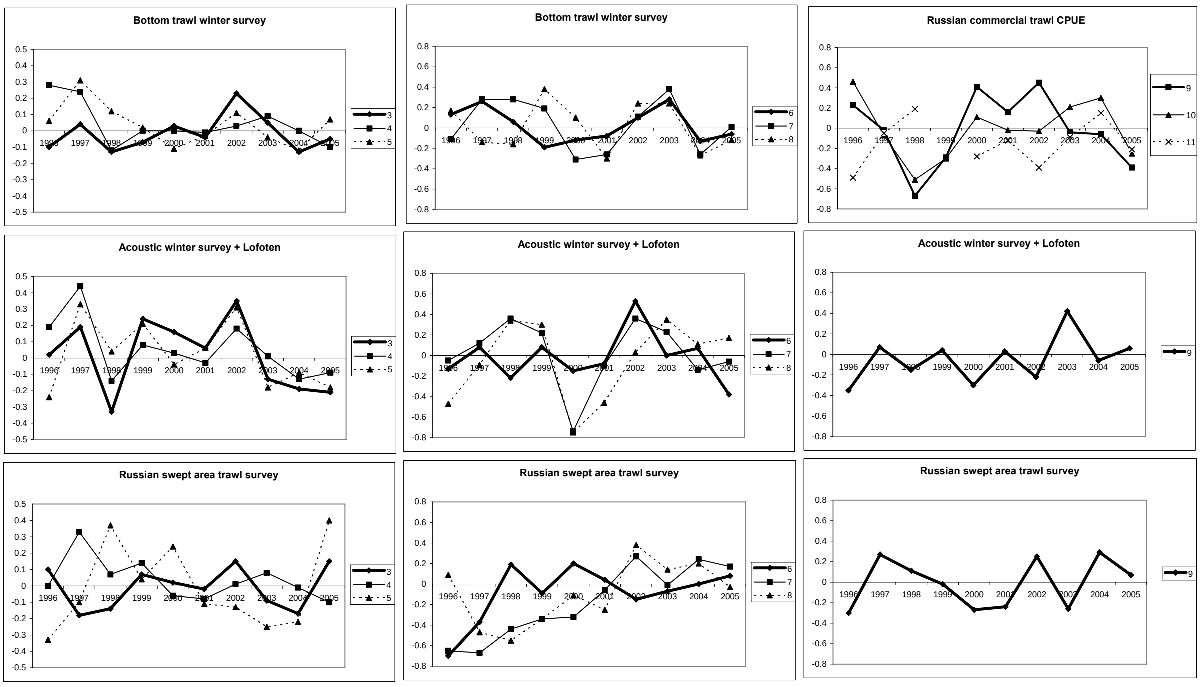


Figure 3.3 c. Residual log catchability by fleets and ages from the final XSA output in the 2006 assessment.

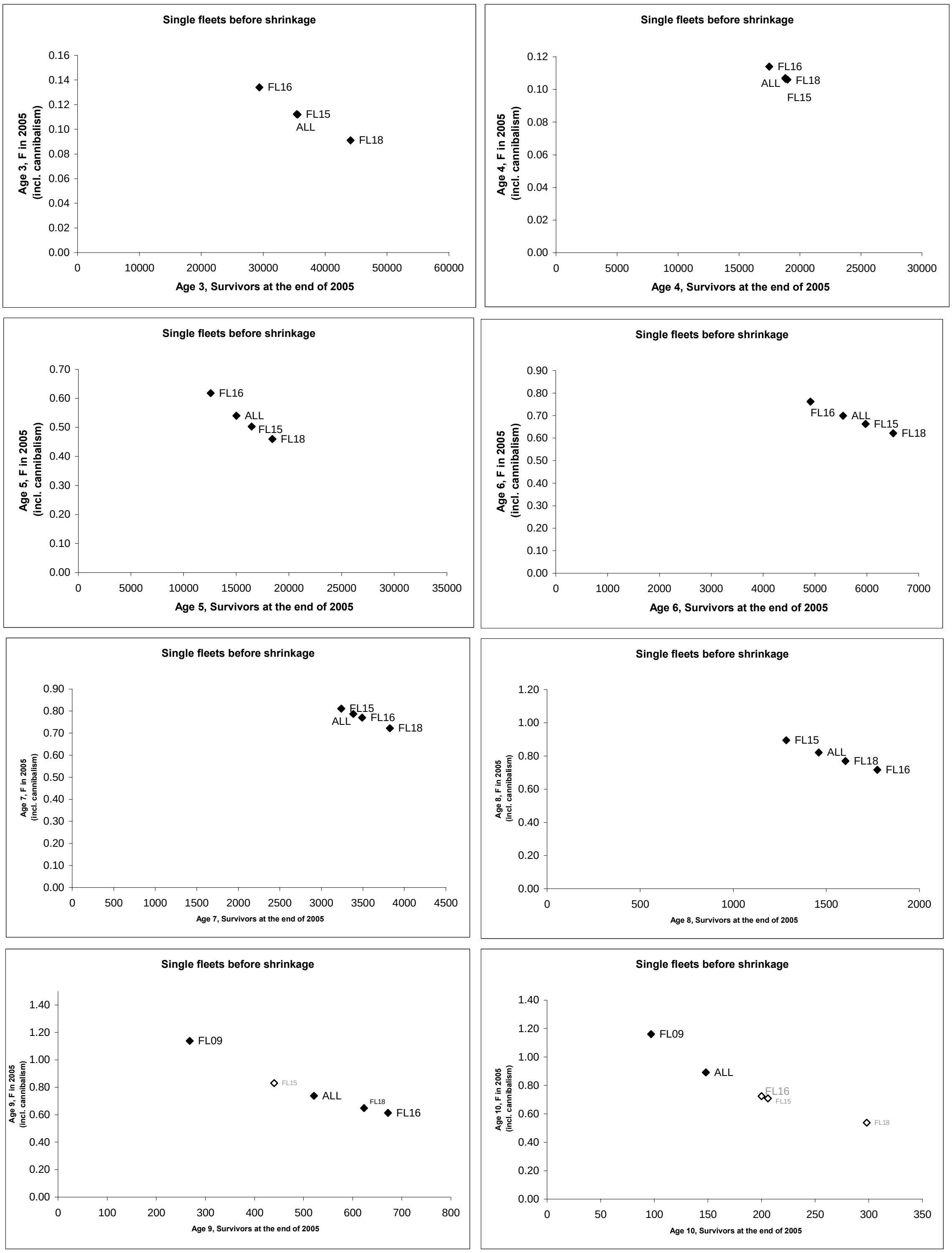


Figure 3.4. Single fleet tuning results before shrinkage by ages plotted against the final run (ALL) for 2005

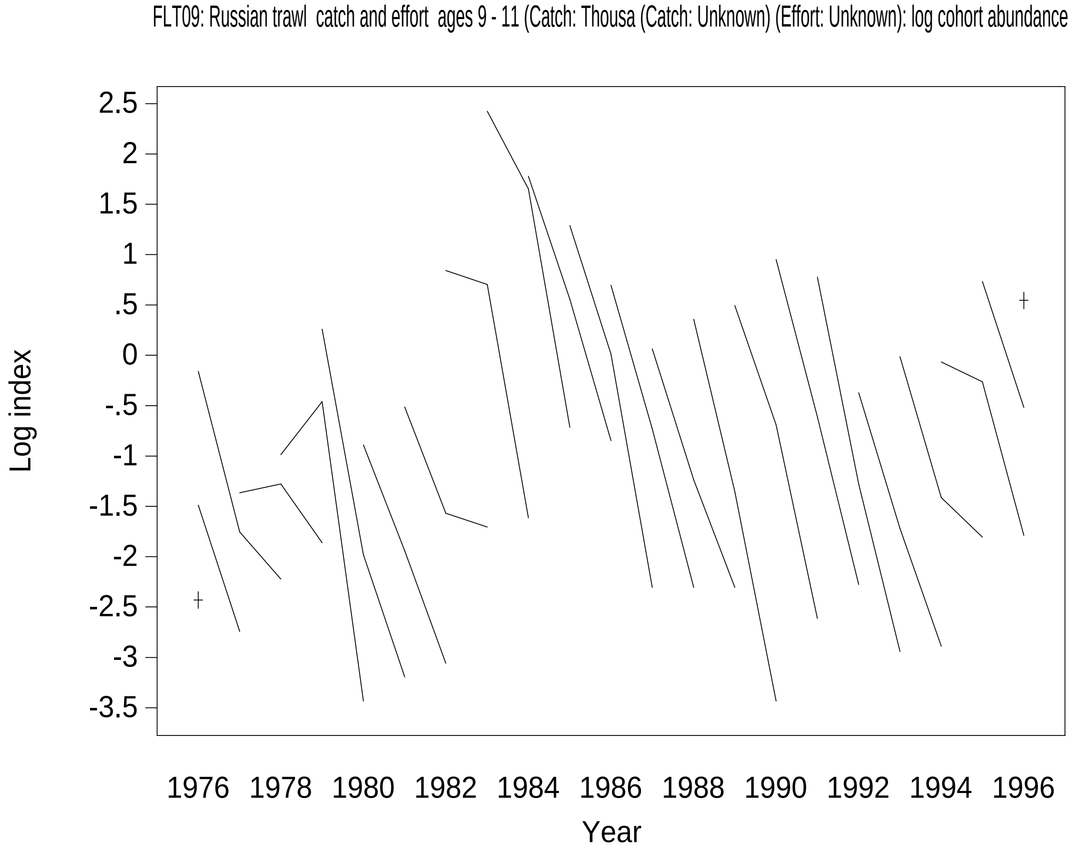


Figure 3.5. Standard SURBA plot for fleet 09.

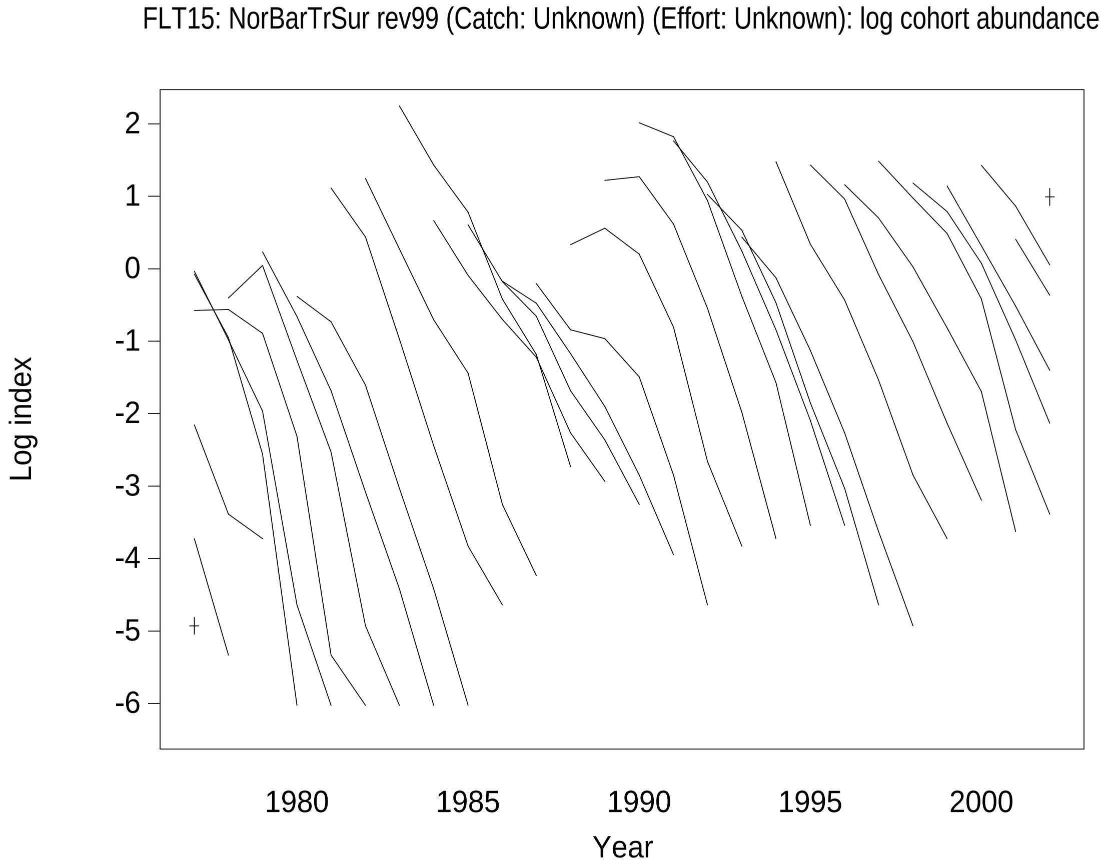


Figure 3.5 (continued). Standard SURBA plot for fleet 15.

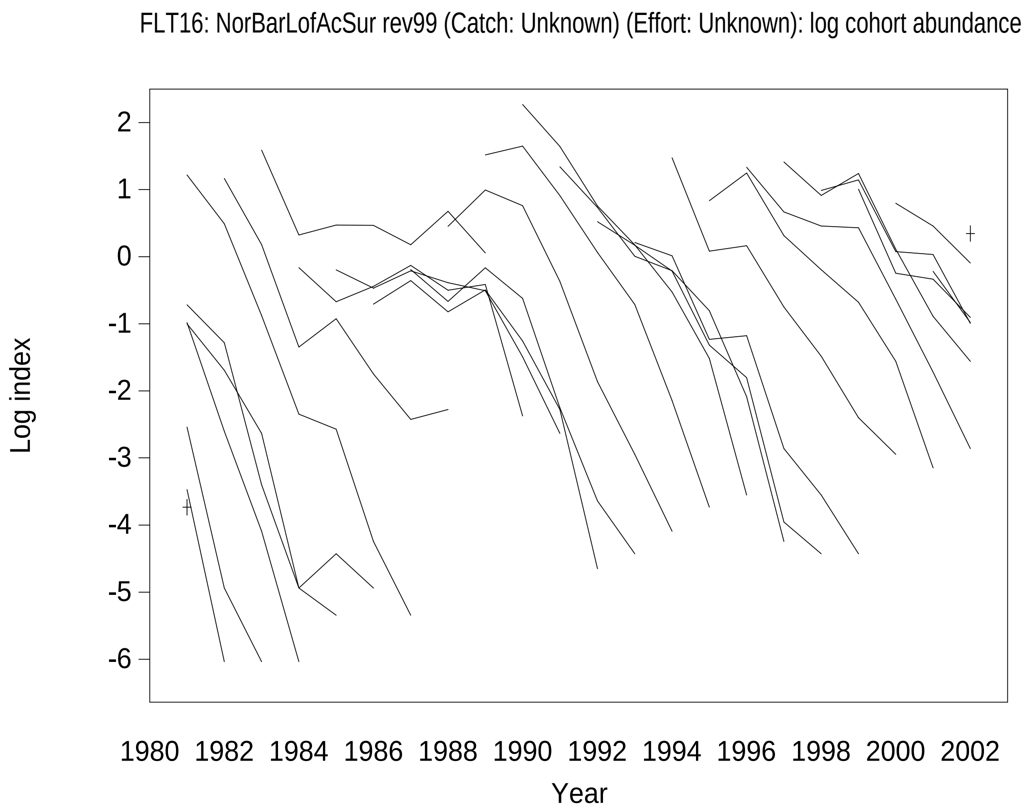


Figure 3.5 (continued). Standard SURBA plot for fleet 16.

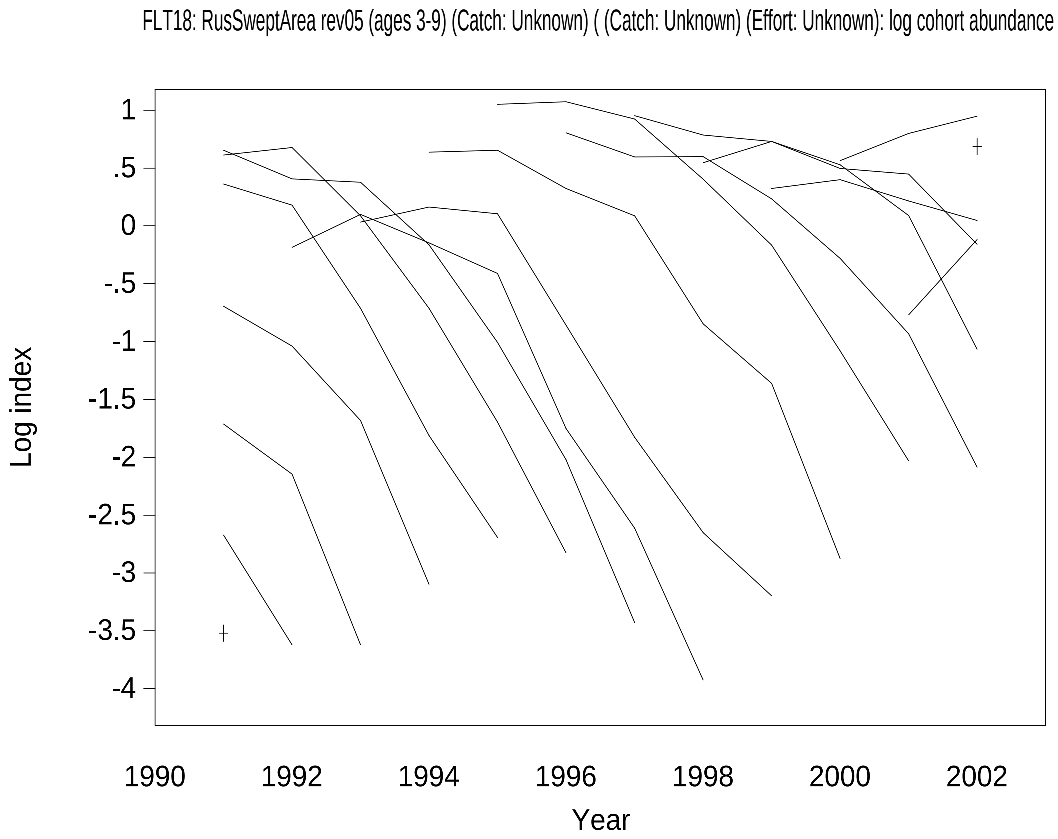


Figure 3.5 (continued). Standard SURBA plot for fleet 18.

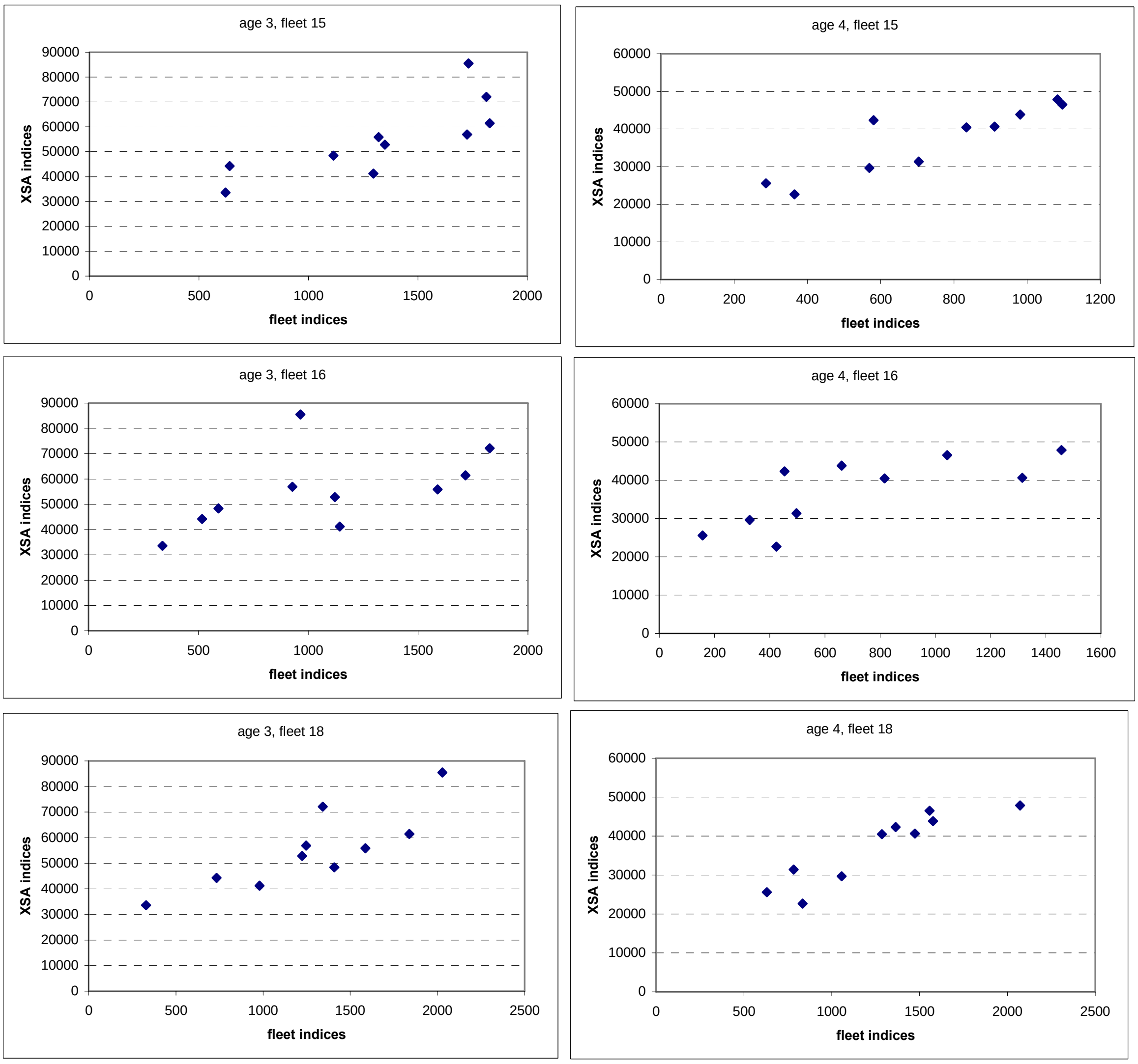


Figure 3.6. Fleet indices for ages 3 and 4 plotted against XSA indices in the 2006 assessment.

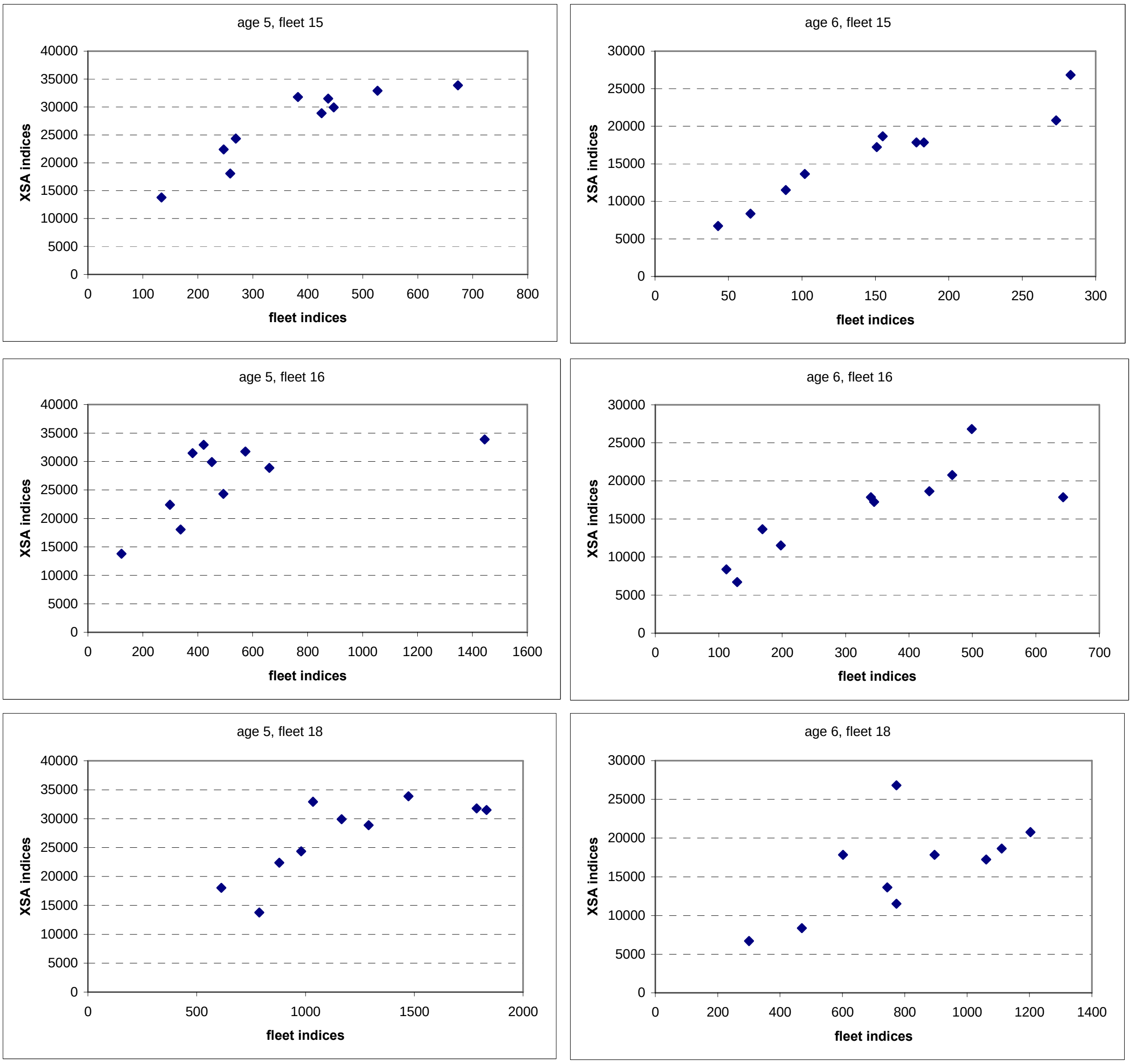


Figure 3.6 (continued). Fleet indices for ages 5 and 6 plotted against XSA indices in the 2006 assessment.

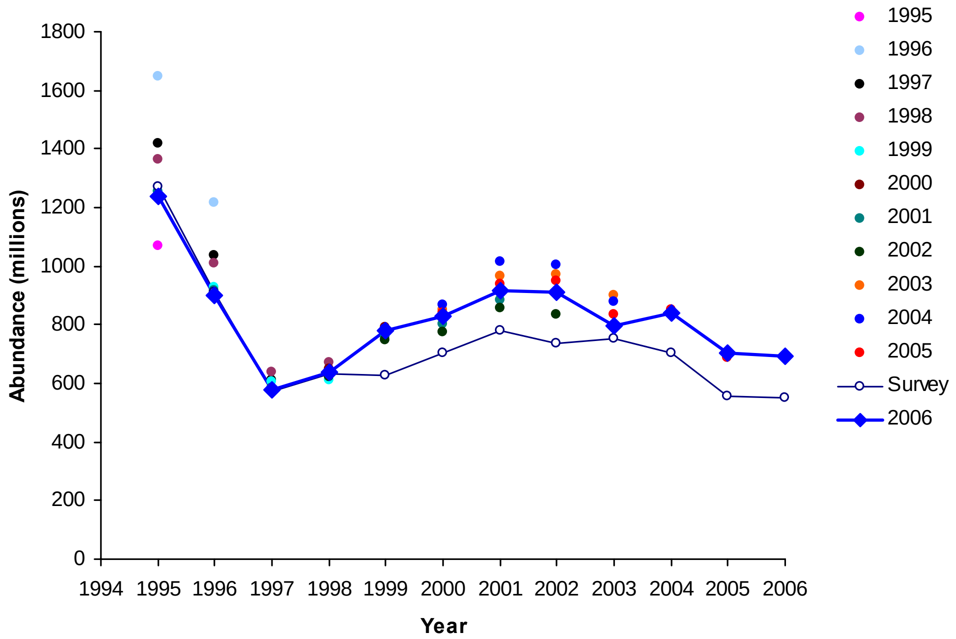


Figure 3.7. Calibrated survey estimates (Pennington and Nakken, WD13) compared to annual VPA estimates
Number of age 4-6 fish

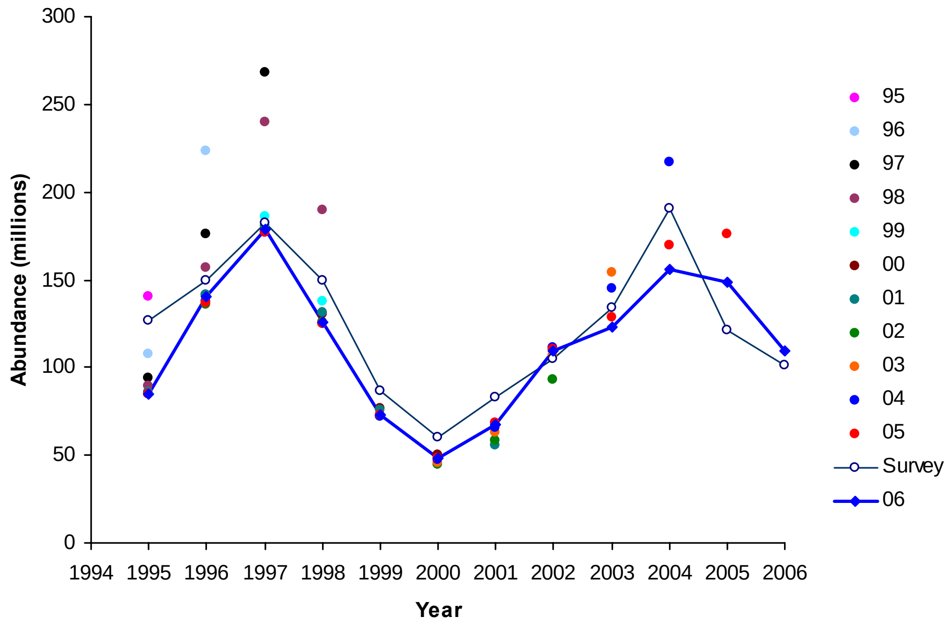


Figure 3.8. Calibrated survey estimates (Pennington and Nakken, WD13) compared to annual VPA estimates
Number of age 7+ fish

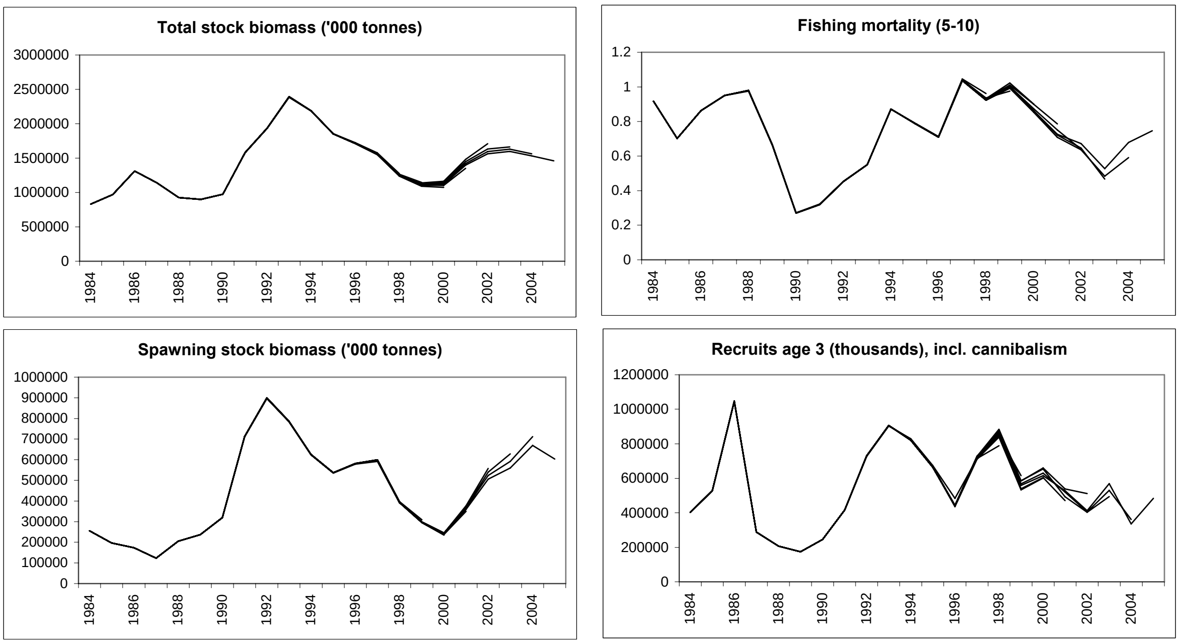


Figure 3.9. Retrospective plots with catchability dependent on stock size for ages < 6.

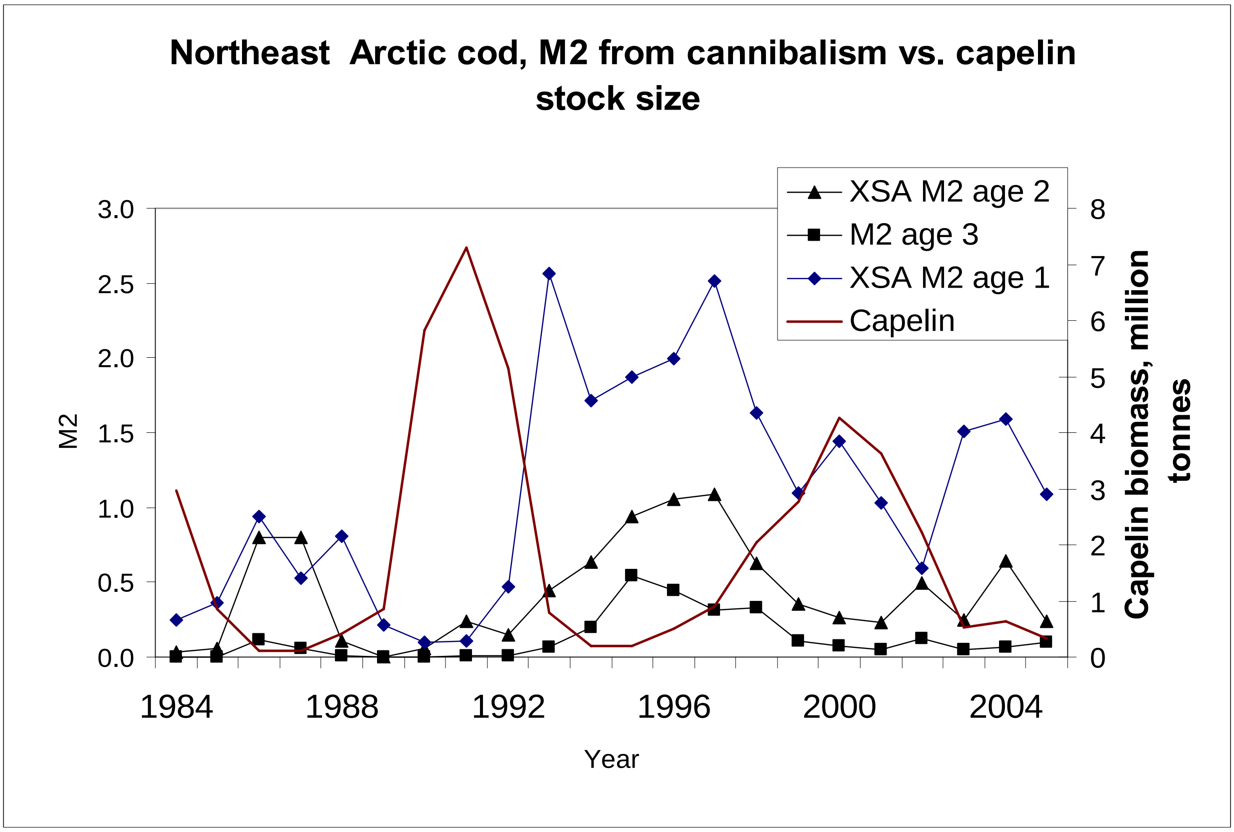
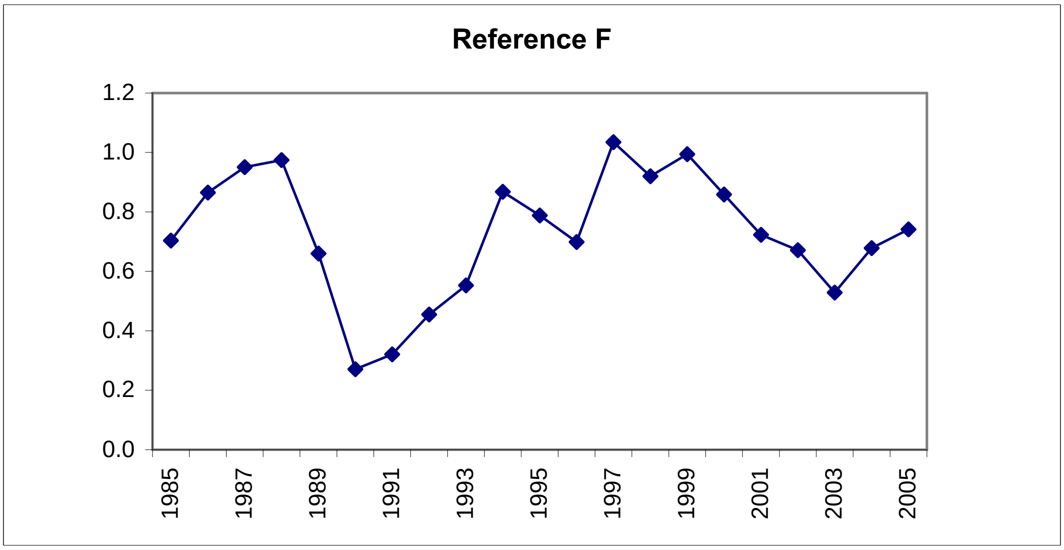
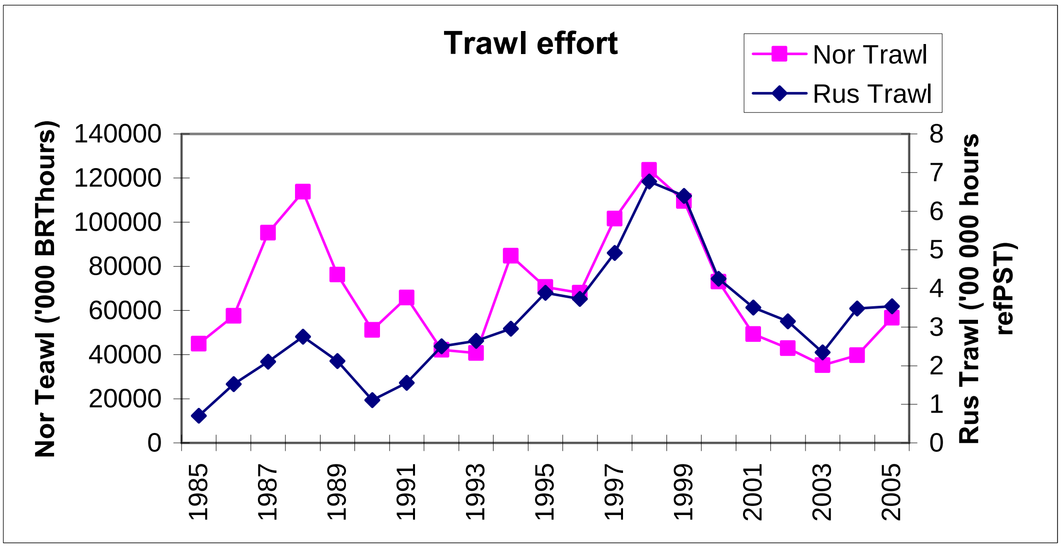
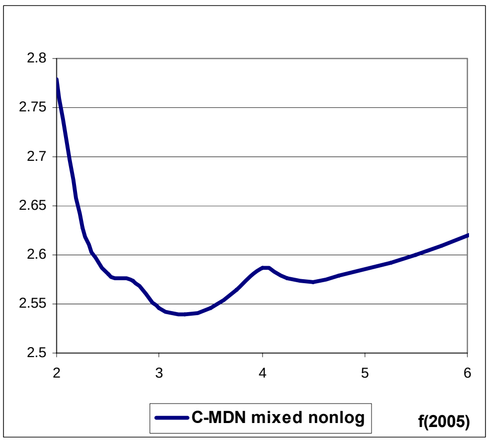


Figure 3.10. Northeast Arctic cod. Temporal trends of cod M2 (cannibalism mortality) for ages 1-3 vs. capelin stock size.







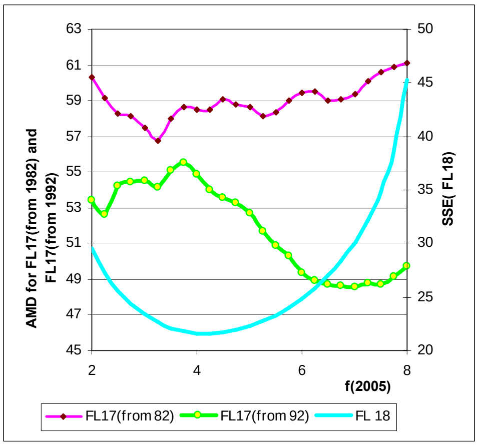
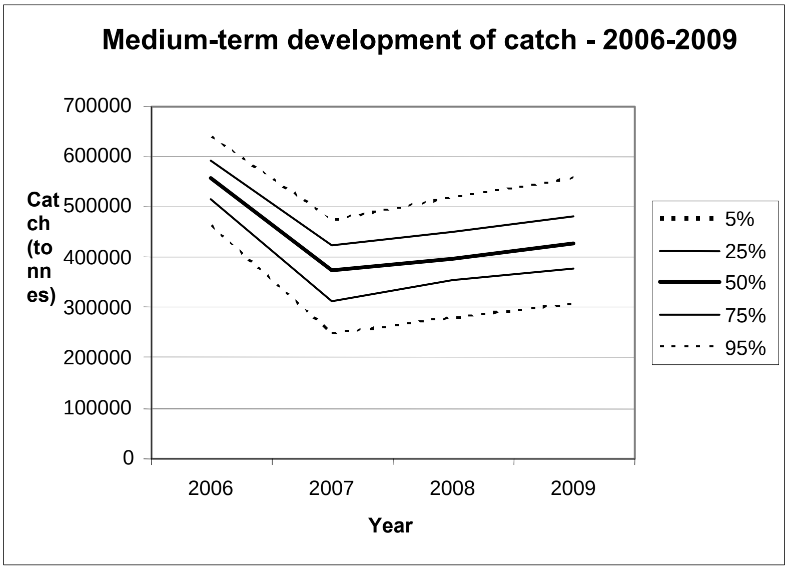
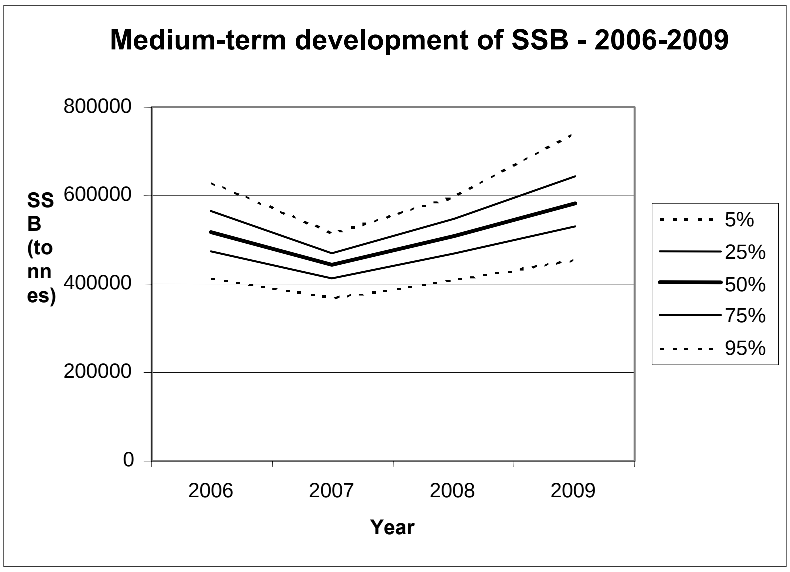


Figure 3 for 3.11

Figure 3.11. Fishing mortality (F_{5-10}) (top panel) and trawl efforts in 1985-2005 (bottom panel).





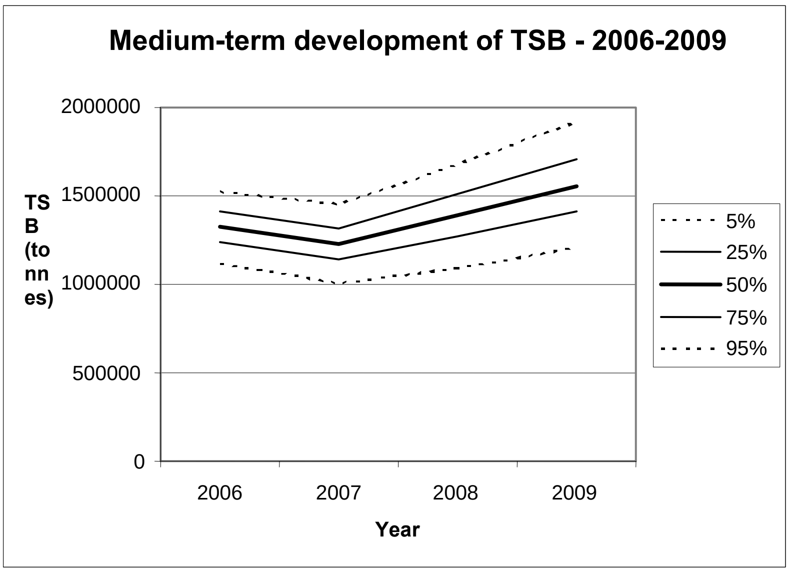


Figure 3.12. Stochastic medium-term projections of Catch, SSB and TSB

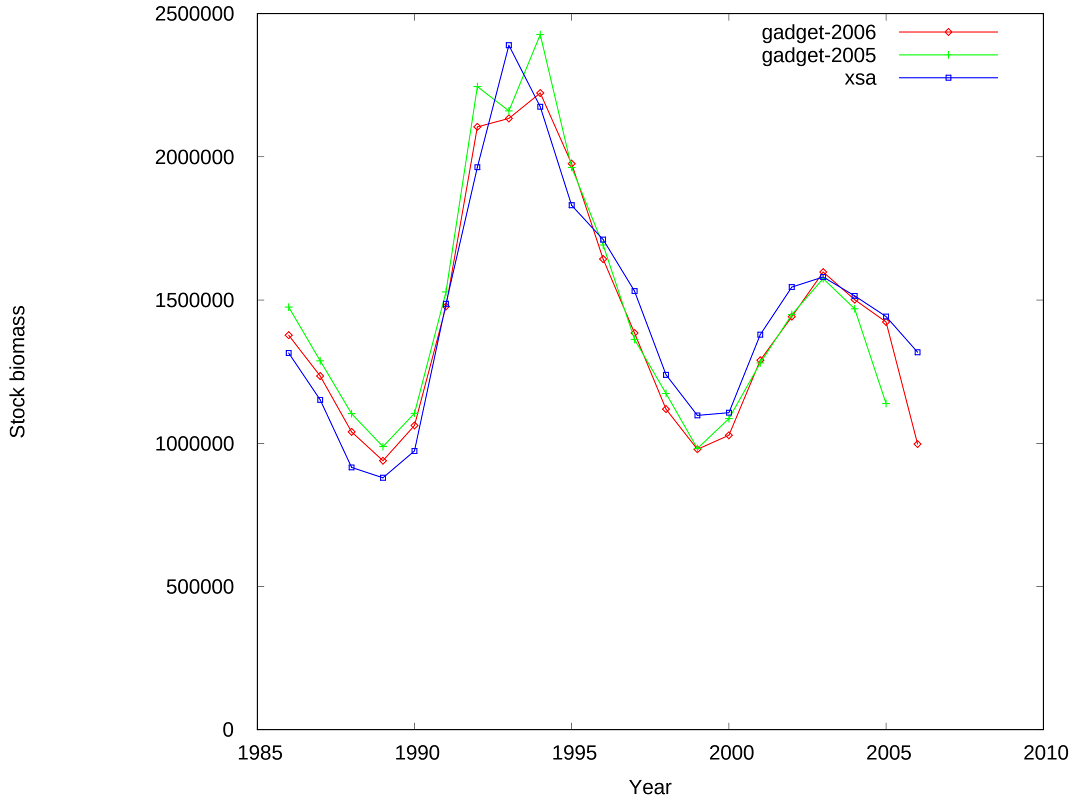


Figure 3.13a. Northeast Arctic Cod. Stock biomass in Gadget key run, last year's Gadget key run, and XSA.

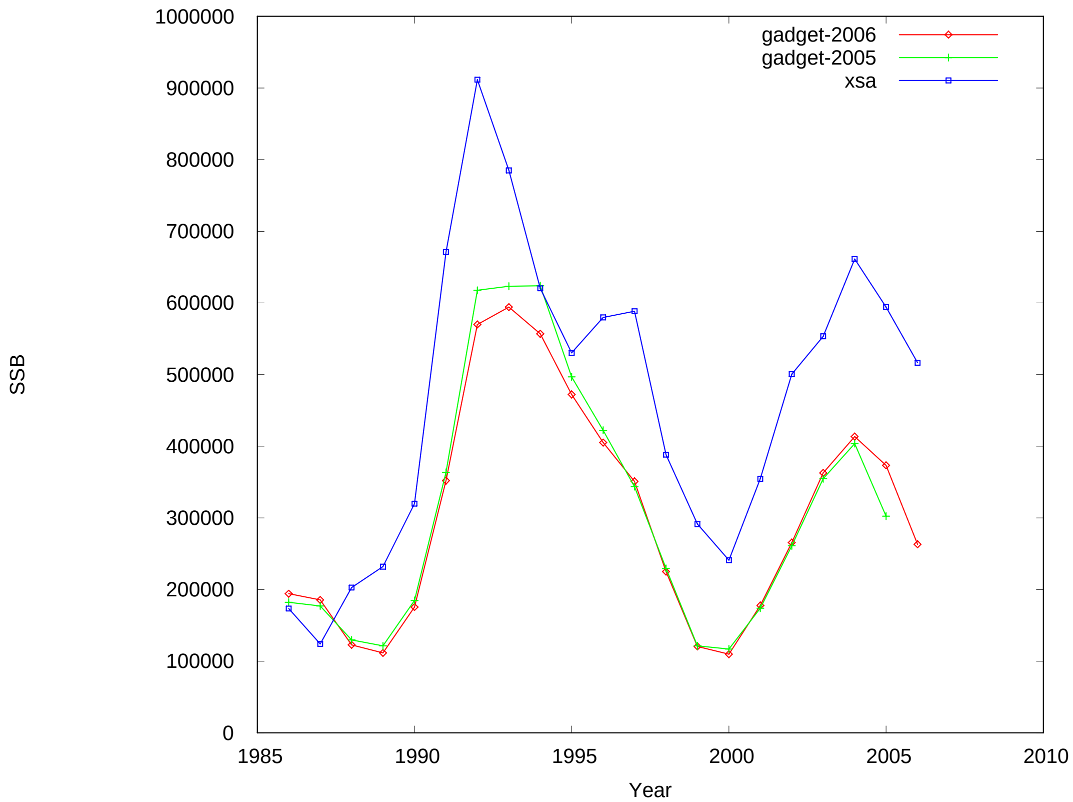


Figure 3.13b. Northeast Arctic Cod. Spawning stock biomass in Gadget key run, last year's Gadget key run, and XSA.

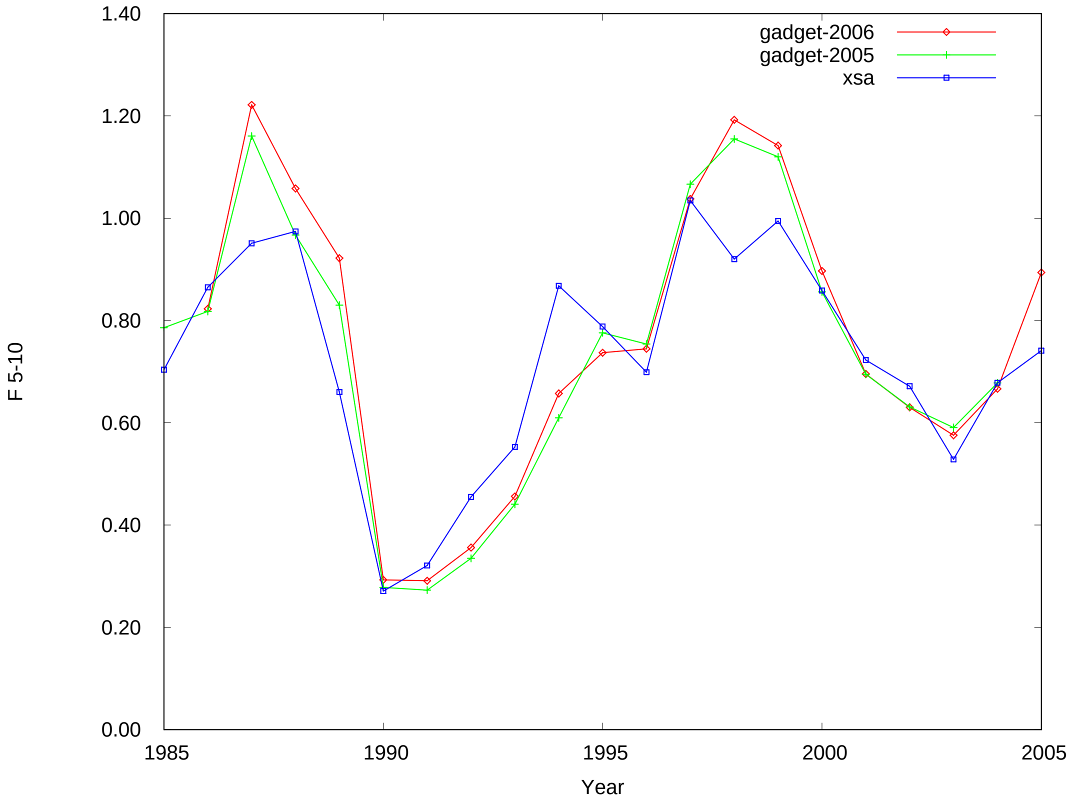


Figure 3.13c. Northeast Arctic Cod. F5-10 in Gadget key run, last year's Gadget key run, and XSA.

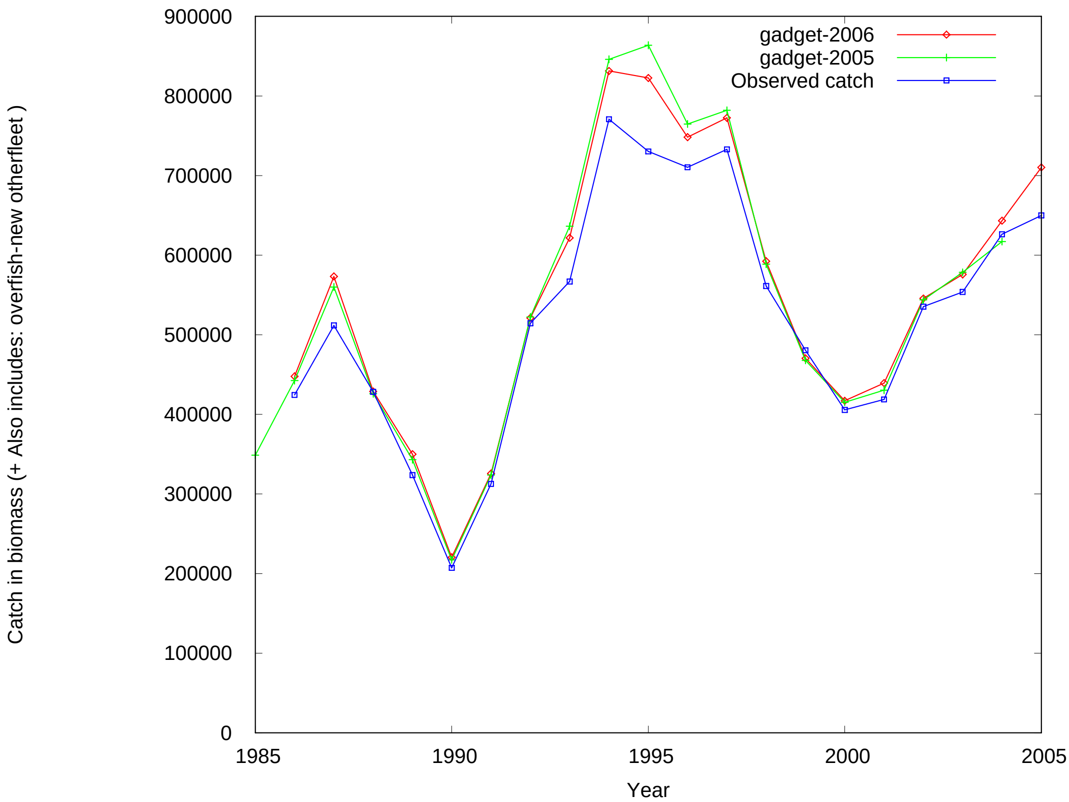


Figure 3.13d. Northeast Arctic Cod. Catch in biomass in Gadget key run, last year's Gadget key run, and XSA.

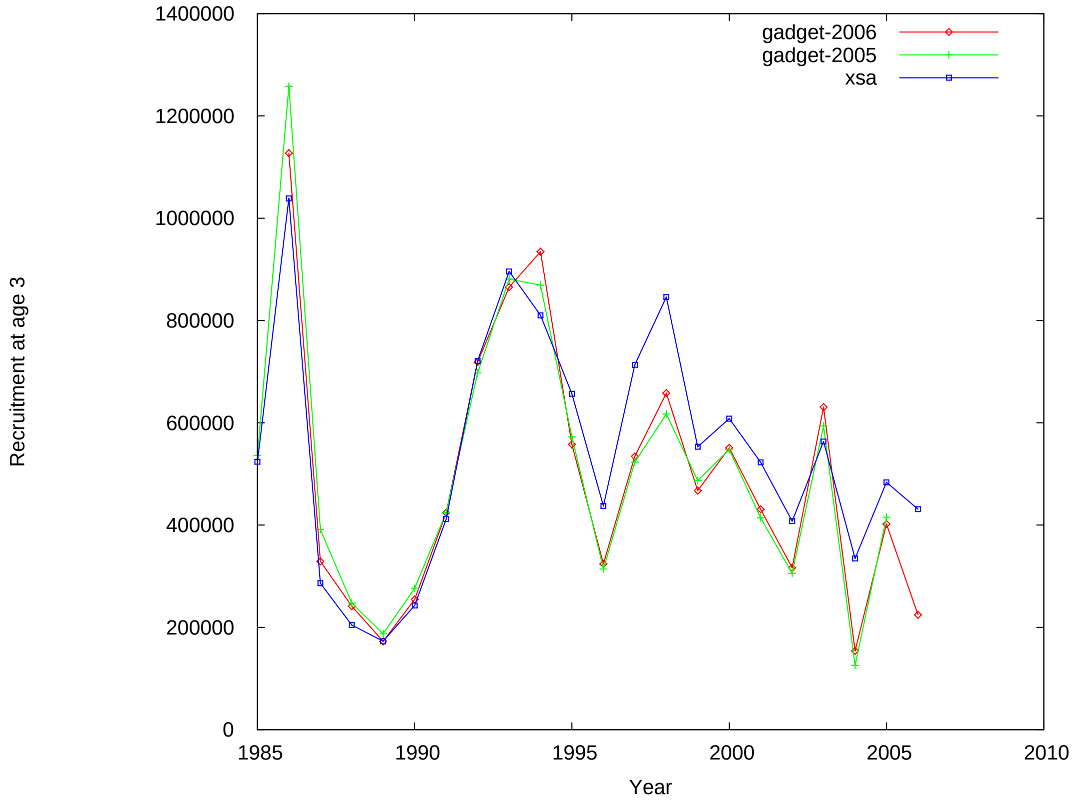


Figure 3.13e. Northeast Arctic Cod. Recruitment (number of 3 year olds) in Gadget key run, last year's Gadget key run, and XSA.

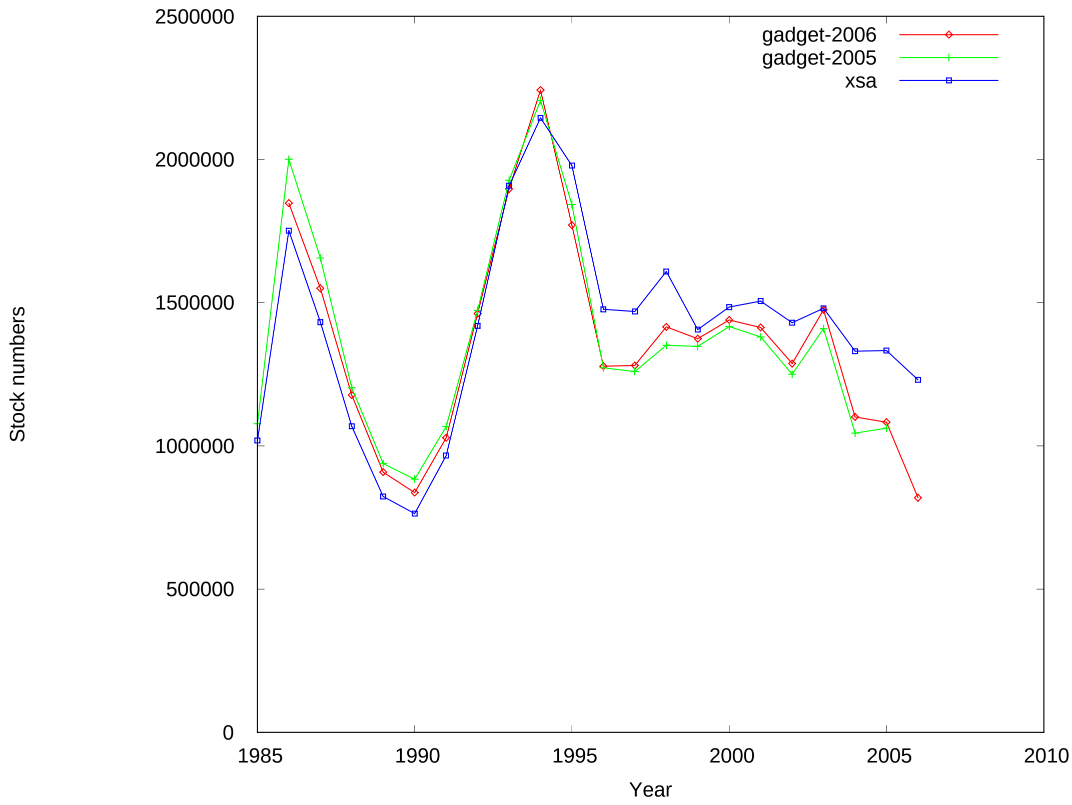


Figure 3.13f. Northeast Arctic Cod. Stock numbers in Gadget key run, last year's Gadget key run, and XSA.

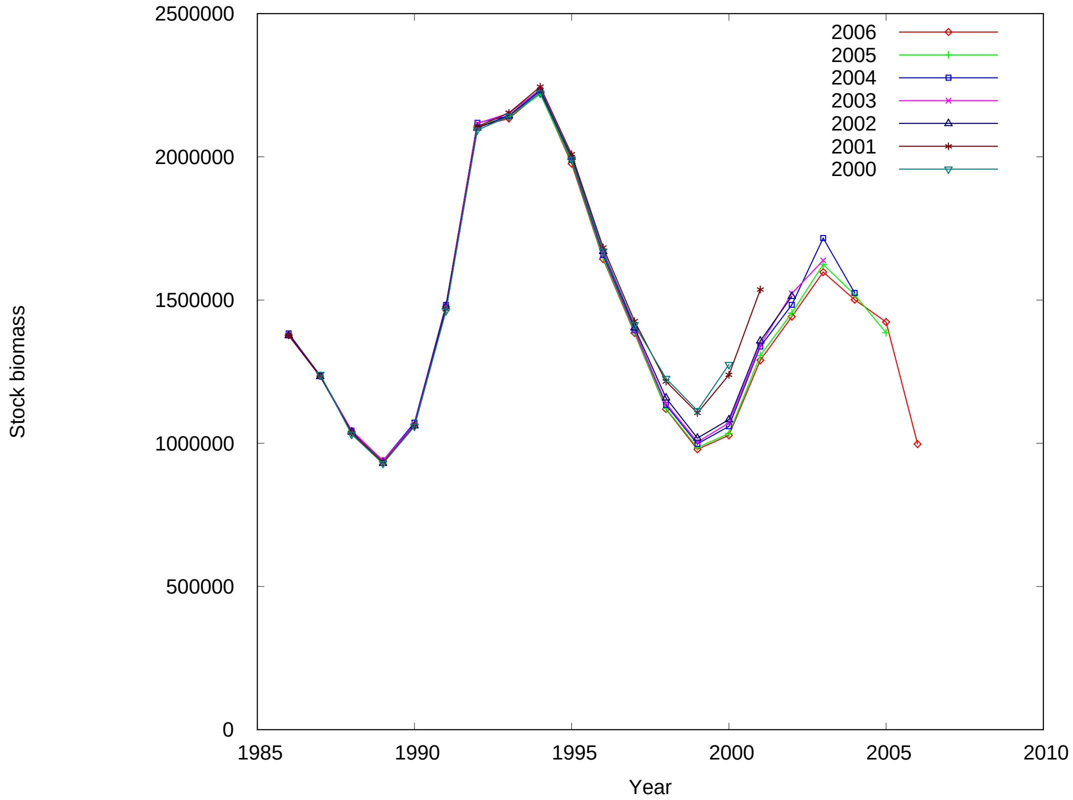


Figure 3.14a. Northeast Arctic Cod. Retrospective pattern for stock biomass in Gadget key run.

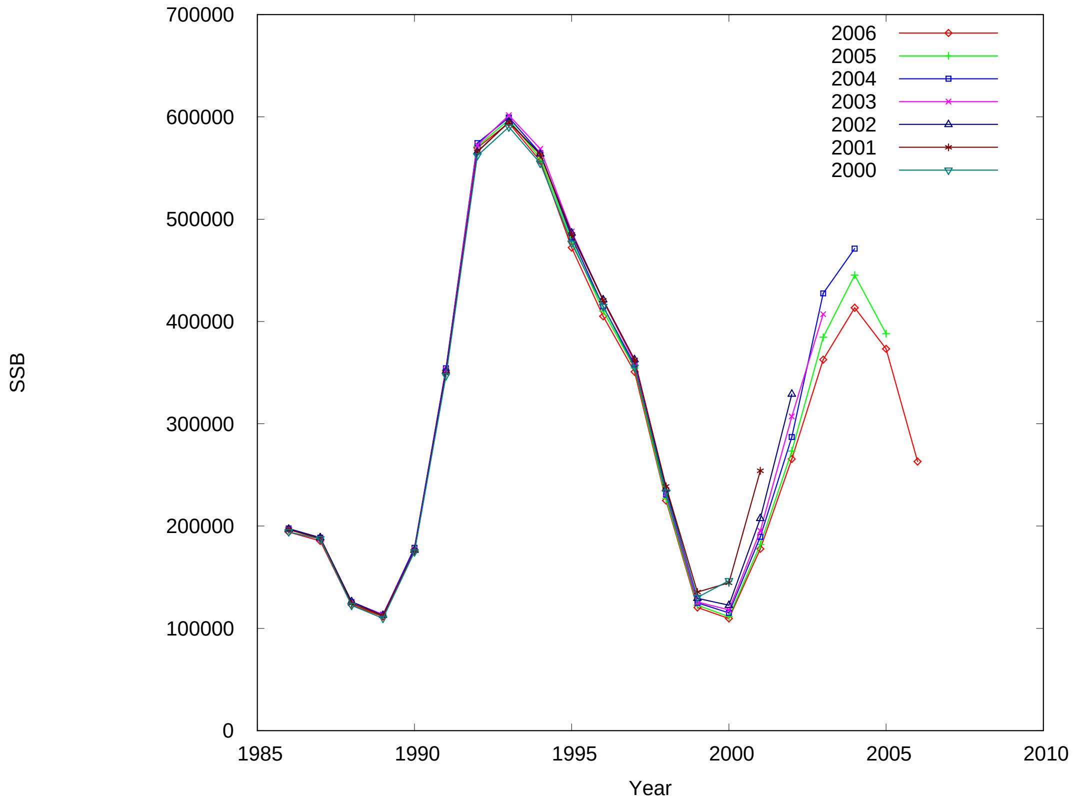


Figure 3.14b. Northeast Arctic Cod. Retrospective pattern for spawning stock biomass in Gadget key run.

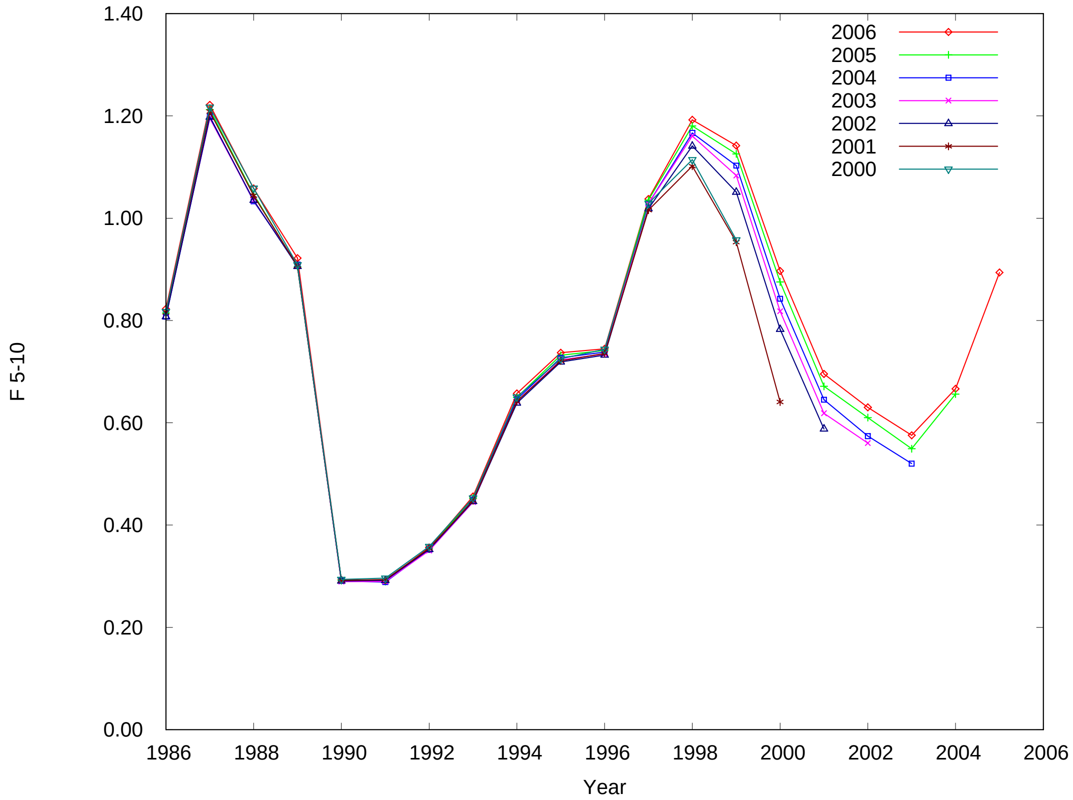


Figure 3.14c. Northeast Arctic Cod. Retrospective pattern for F5-10 in Gadget key run.

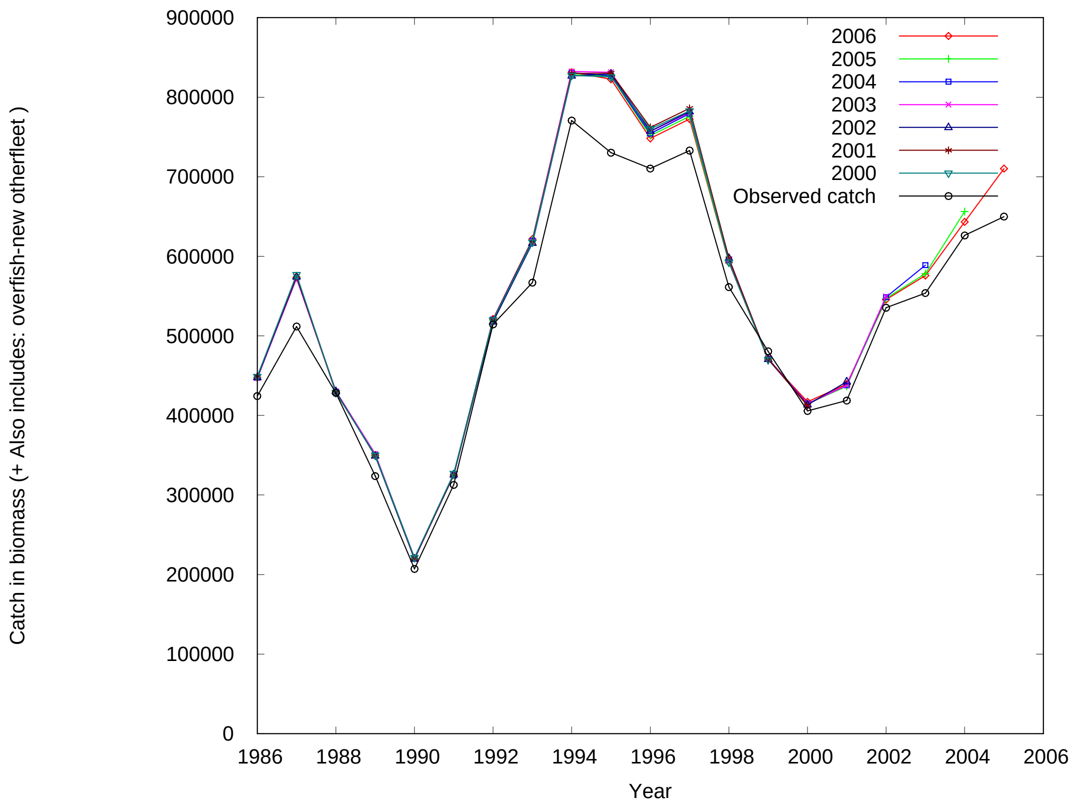


Figure 3.14d. Northeast Arctic Cod. Retrospective pattern for catch in biomass in Gadget key run.

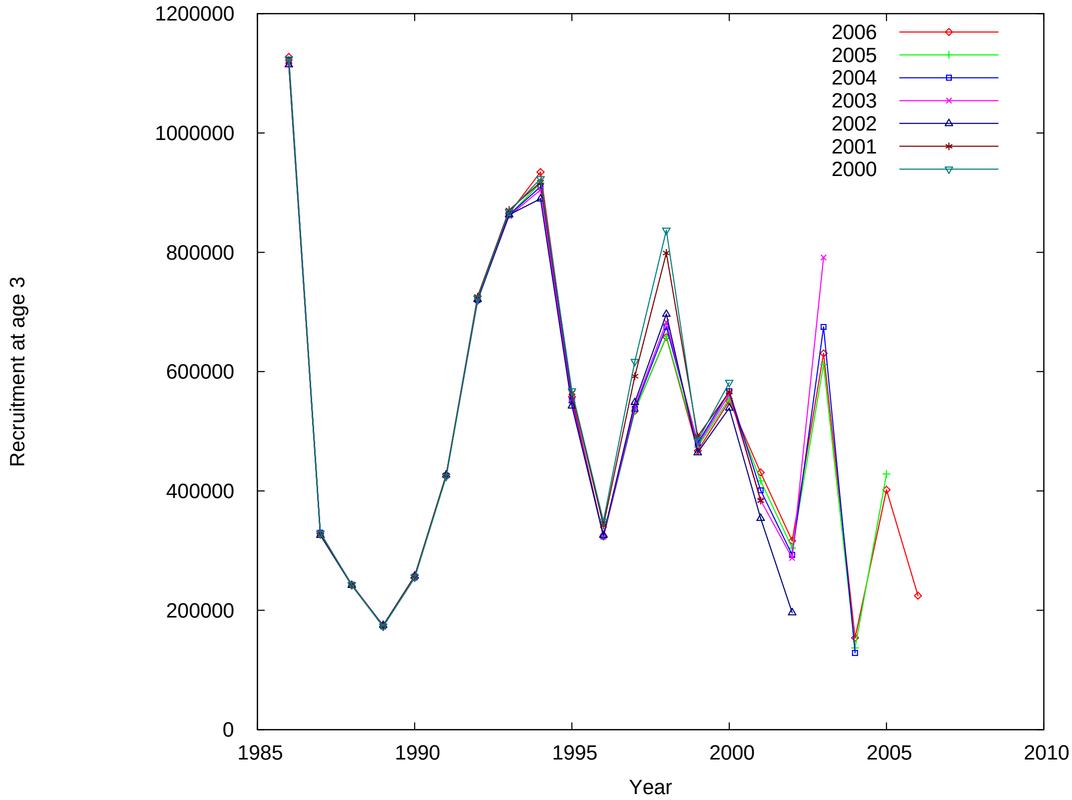


Figure 3.14e. Northeast Arctic Cod. Retrospective pattern for recruitment (number of 3 year olds) in Gadget key run.

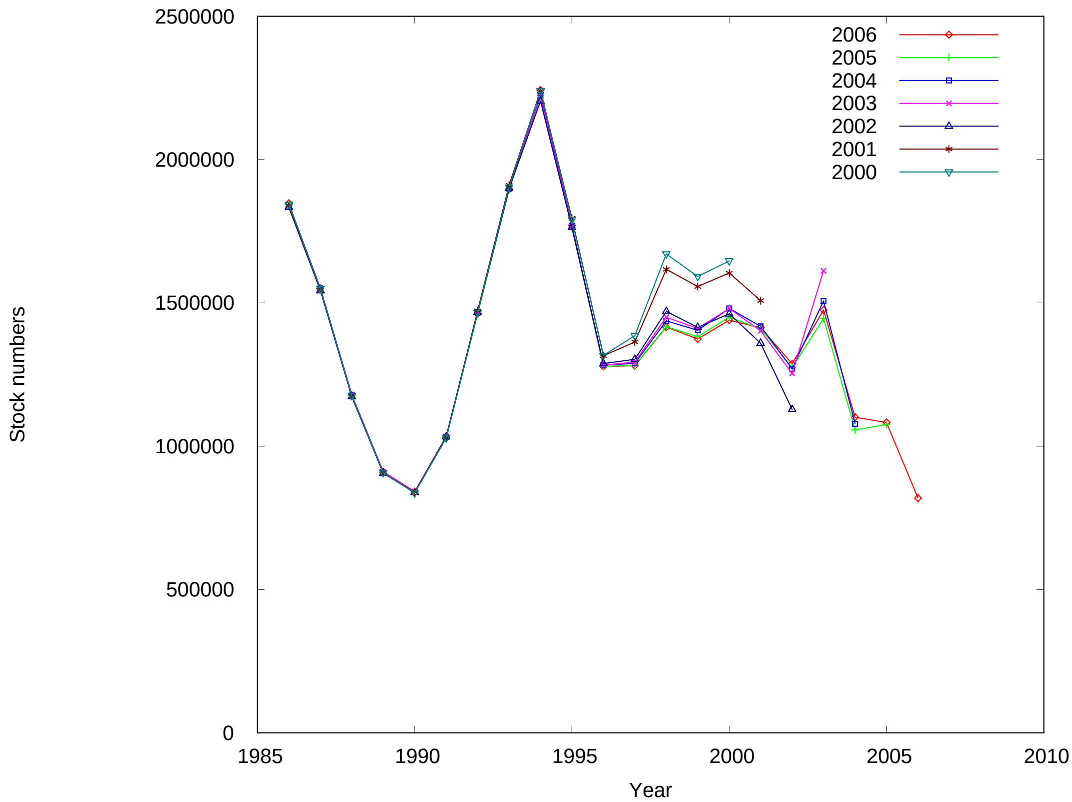


Figure 3.14f. Northeast Arctic Cod. Retrospective pattern for stock numbers in Gadget key run.

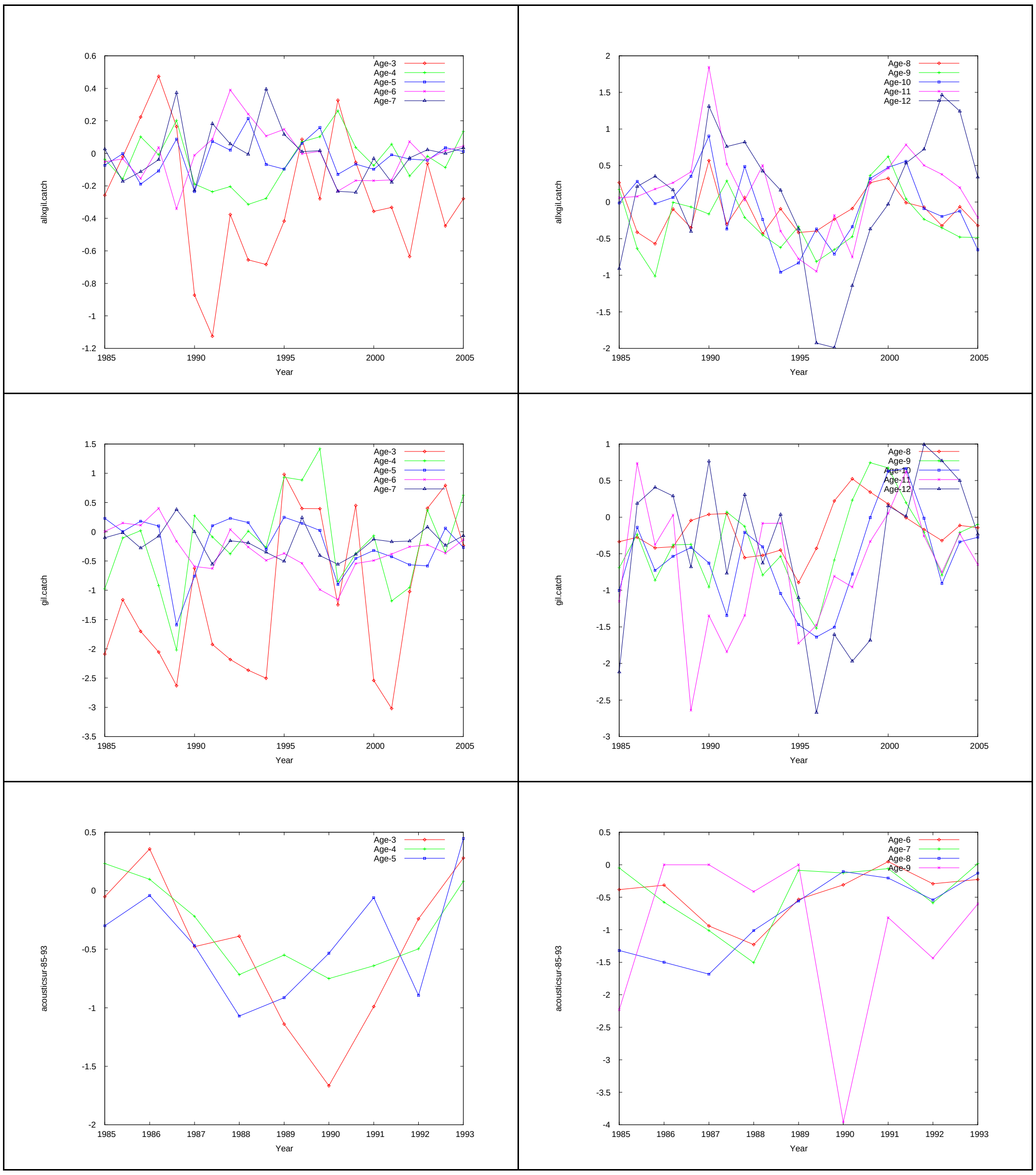


Figure 3.15. Northeast Arctic Cod.. Residual plots for Gadget. Log (observed/modelled) catches and survey indices.

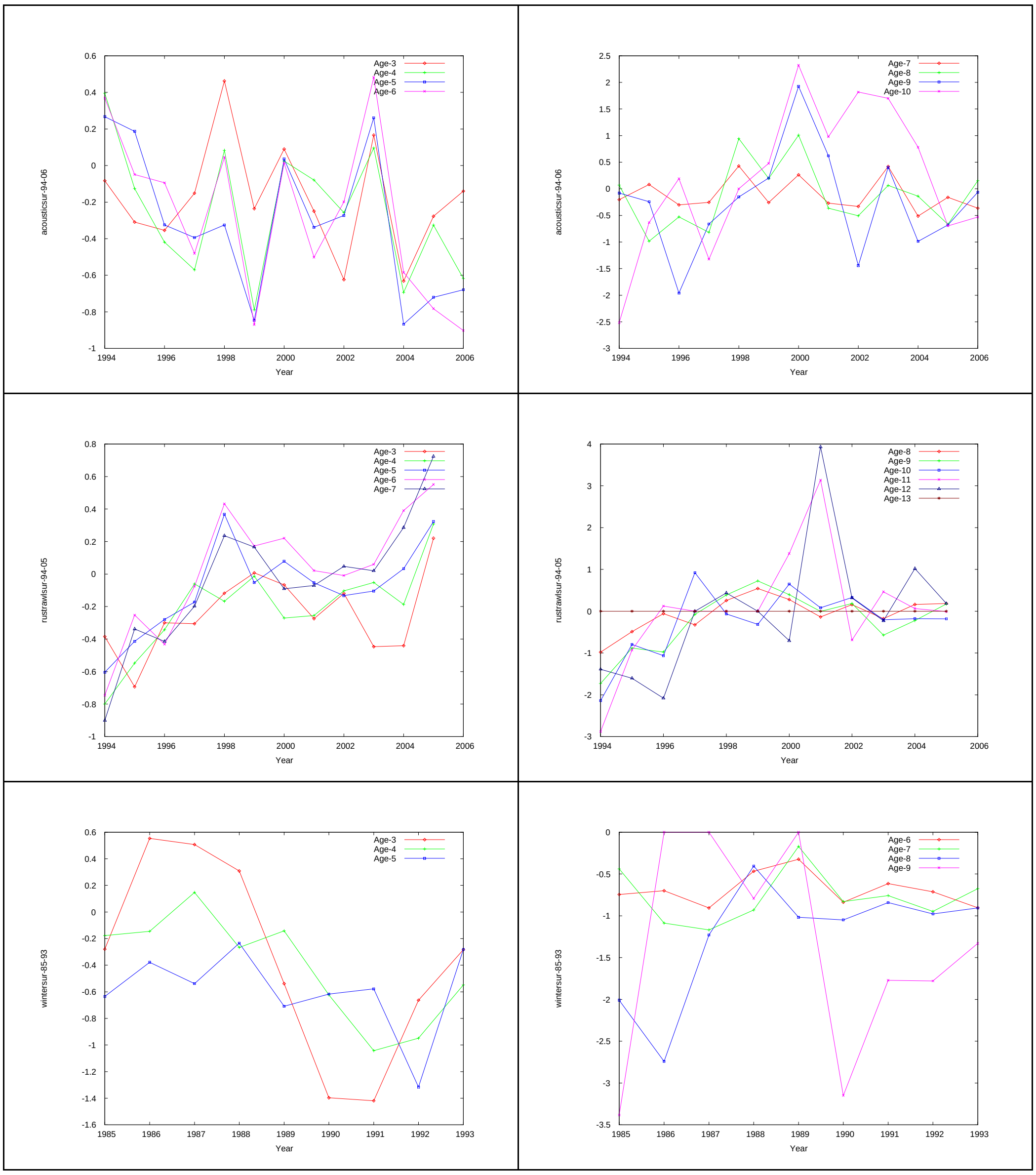


Figure 3.15 (continued). Northeast Arctic Cod.. Residual plots for Gadget. Log (observed/modelled) catches and survey indices.

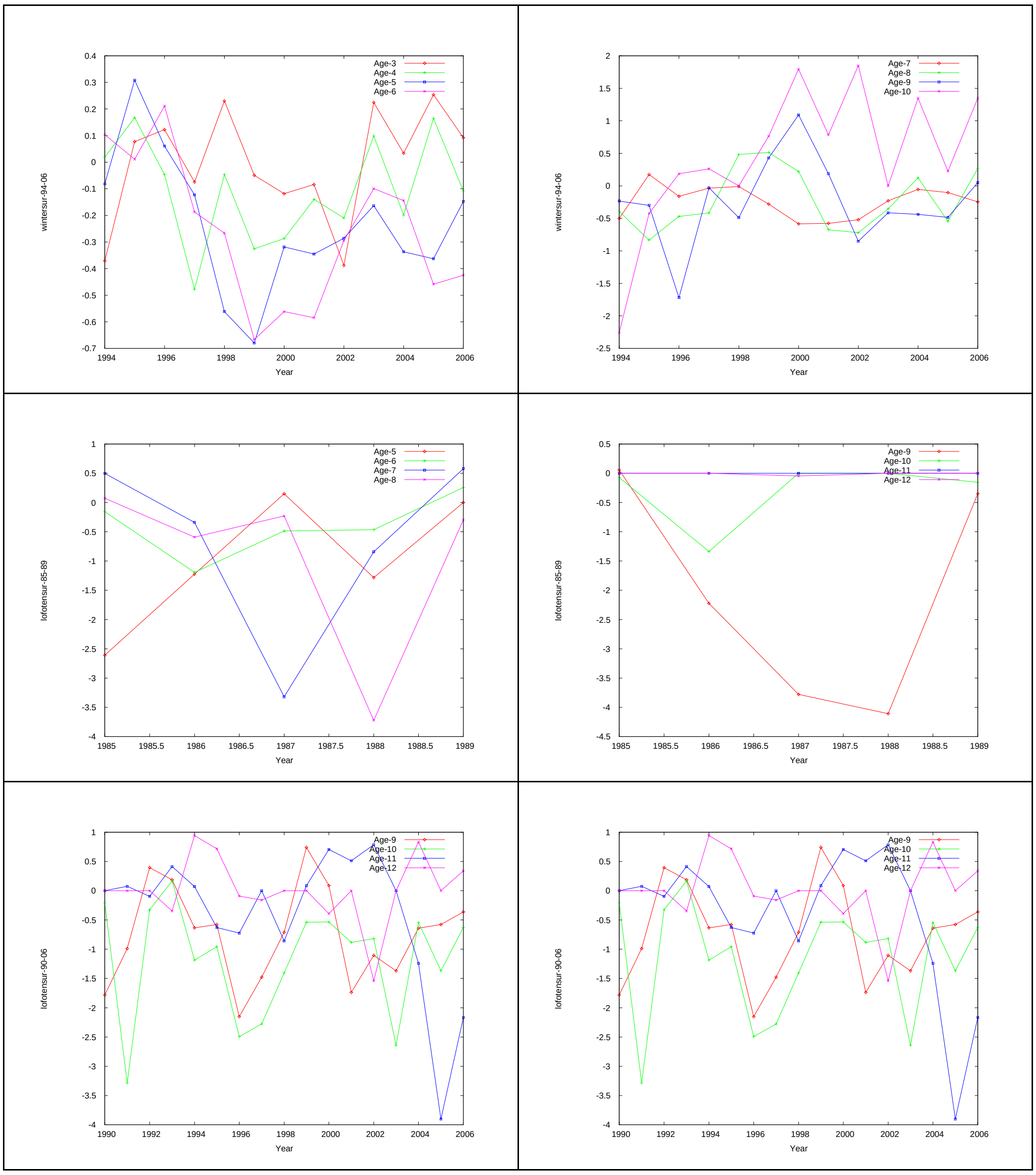


Figure 3.15 (continued). Northeast Arctic Cod.. Residual plots for Gadget. Log (observed/modelled) catches and survey indices.

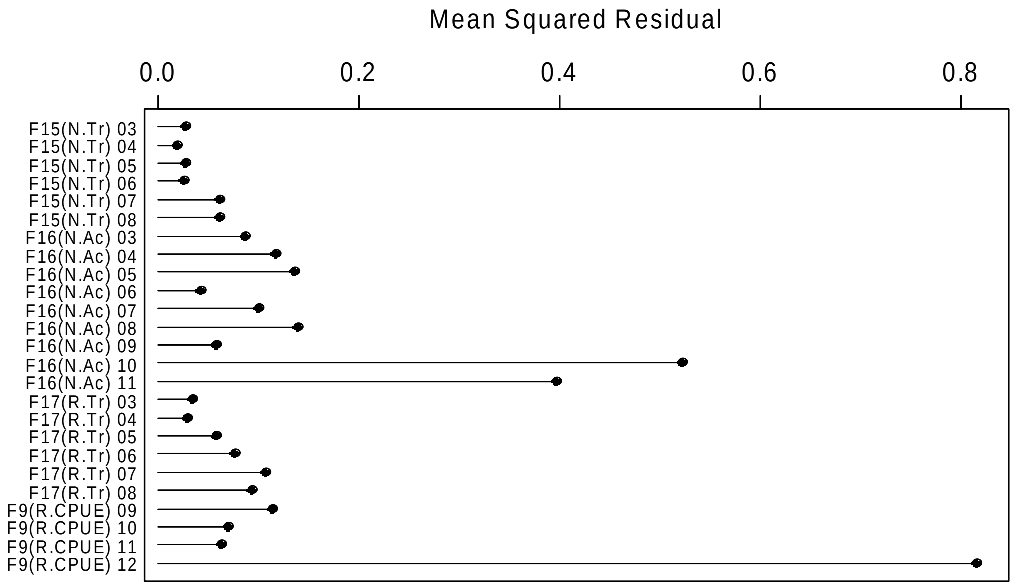
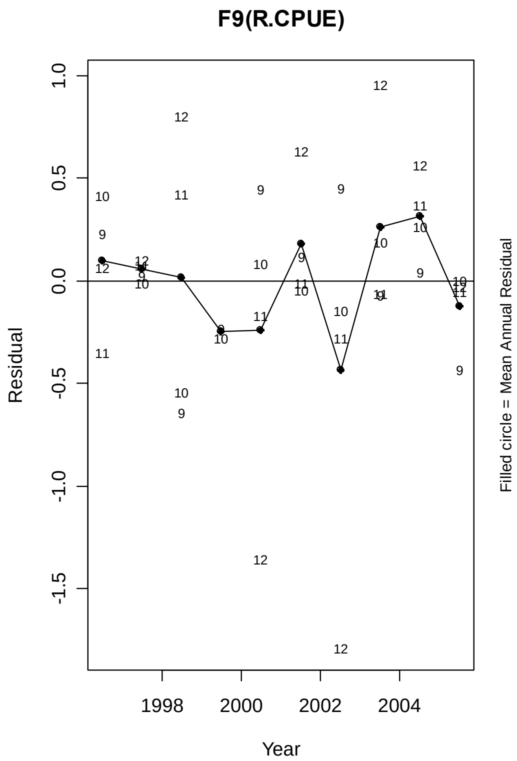
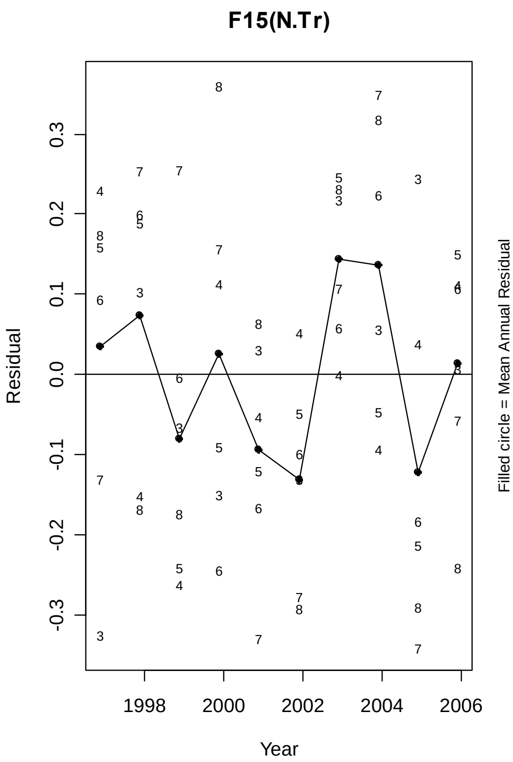


Figure. 3.16. Mean Squared Errors for each index-age, ADAPT first run. Fleet labeled "fleet 17" is fleet 18.


F9(R.CPUE)
Residual
Year
Filled circle = Mean Annual Residual


F15(N.Tr)
Residual
Year
Filled circle = Mean Annual Residual

Continued

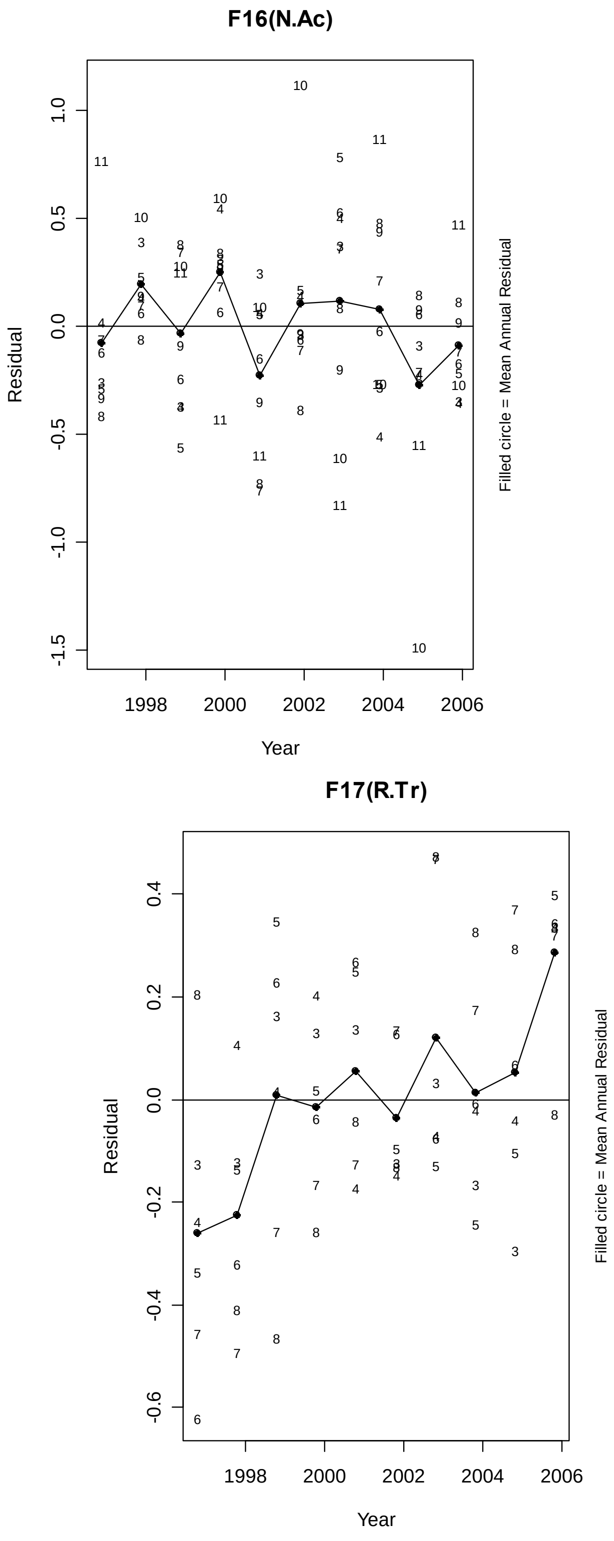


Figure 3.17. ADAPT Residuals, first run. Annual residuals identified by age-group. The solid circle for each year is the mean annual residual. Note that x-values in the plot corresponds to the year and month of each index. Fleet labeled "fleet 17" is fleet 18.

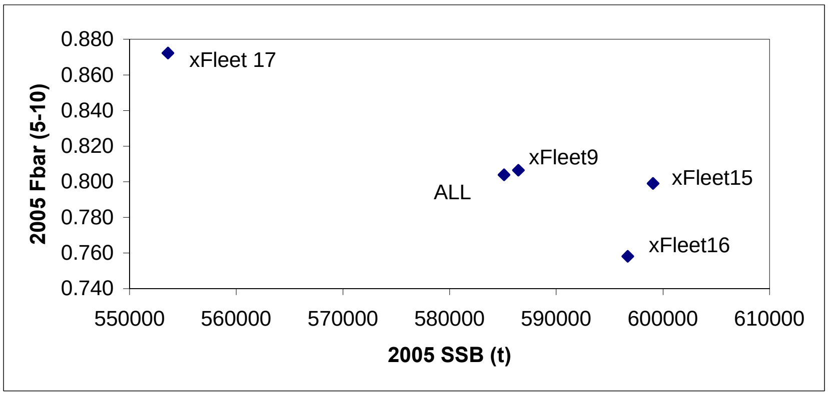


Figure 3.18 – ADAPT Sensitivity of terminal year average fishing mortality (ages 5-10) and spawner biomass to each tuning fleet. Note that fleet labeled "fleet 17" is fleet 18. The fleet named indicated in the plot refers to the fleet *excluded* from the tuning dataset, etc., and "All" is the result from the analysis including all tuning fleets.

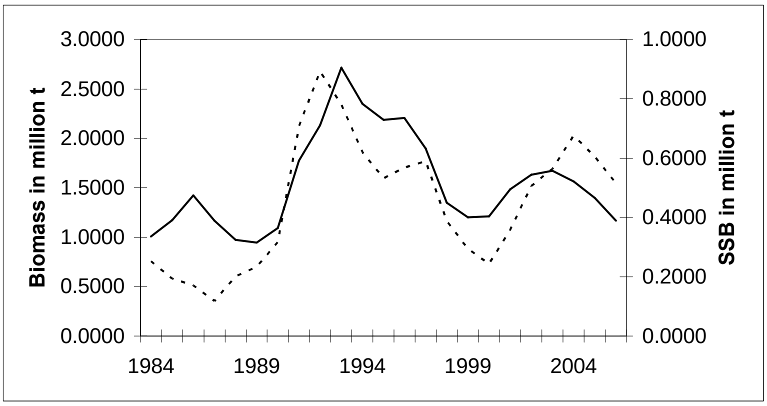


Figure 3.19. ADAPT Estimates of average fishing mortality (ages 5-10), second run.

Figure 3.20. ADAPT Estimates of average fishing mortality (ages 5-10), second run.

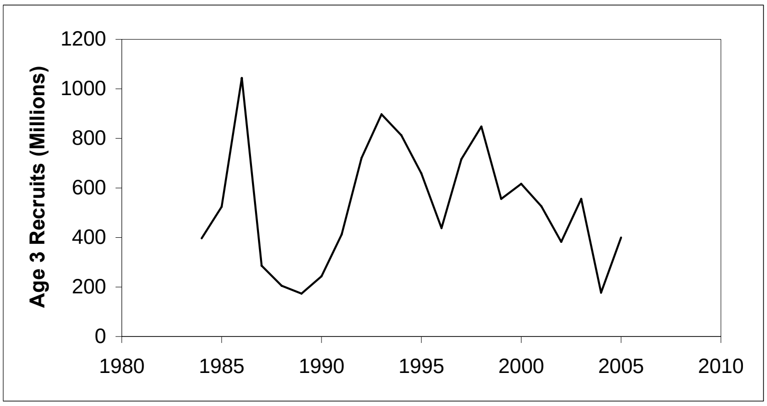


Figure 3.21. ADAPT Estimates of age 3 recruitment, second run

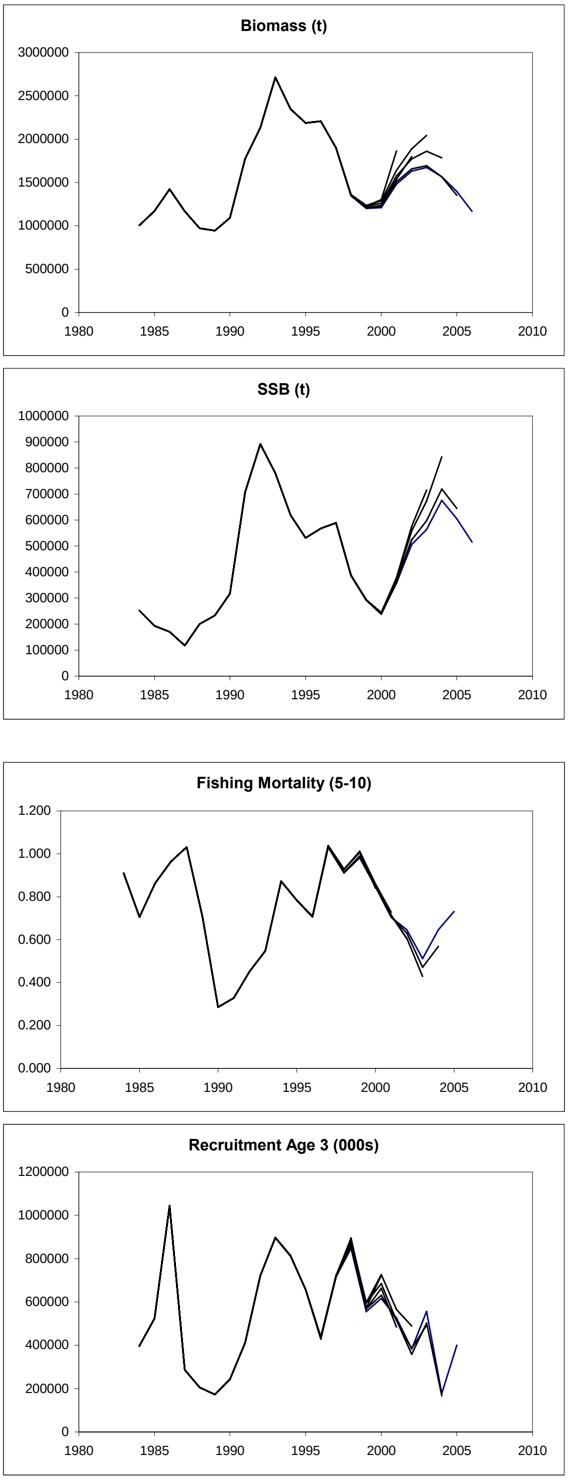


Figure 3.22. Retrospective analysis of ADAPT results (from second run).

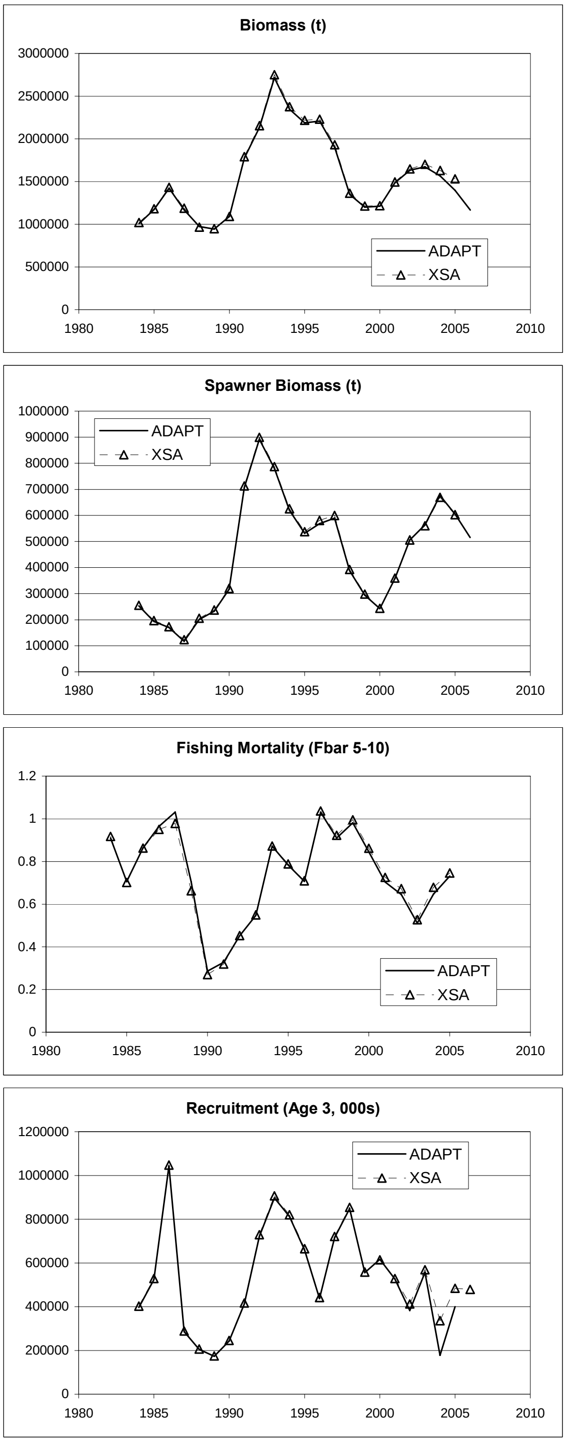


Figure 3.23. Comparison of ADAPT and XSA estimates.

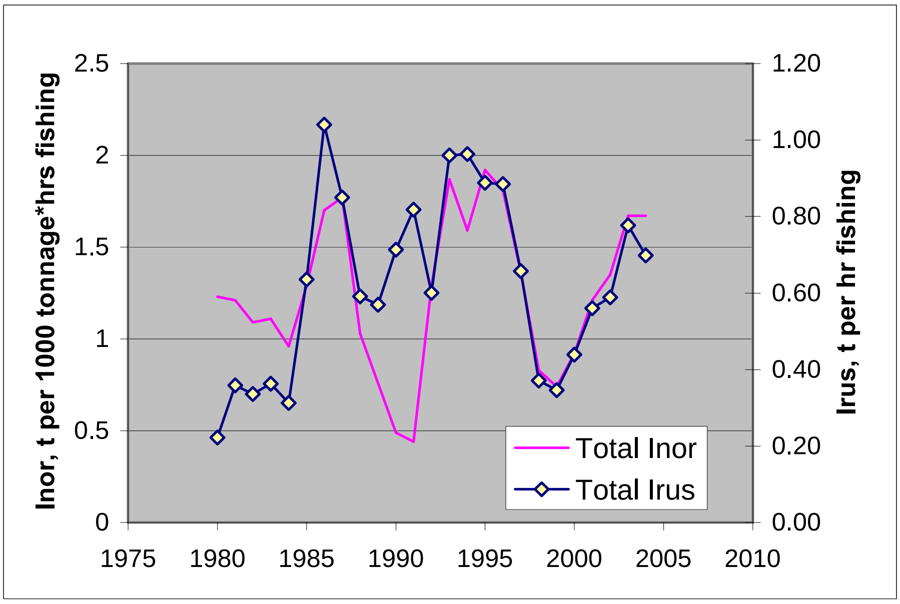


Figure 3. 24. Dynamics of two CPUE indices- for Norway fishery and for Russia fishery (Russia index is named in text as S92)

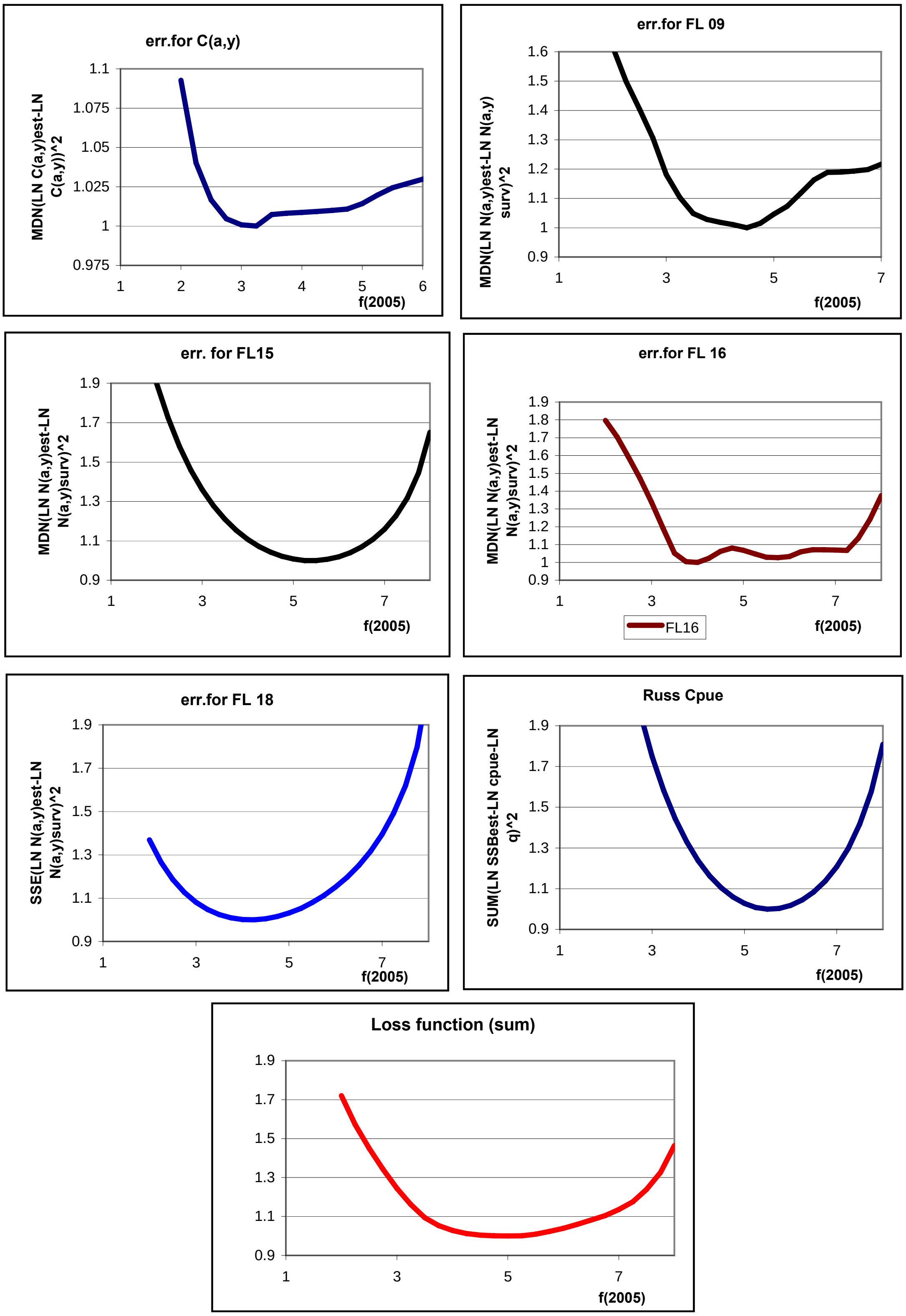


Figure 3. 25. Profiles of components of the loss function obtained by ISVPA model. Parameter f(y) on axis of abscissa is connected with F(a,y) by means of equality f(y)s(a)=1-exp[-F(a,y)]

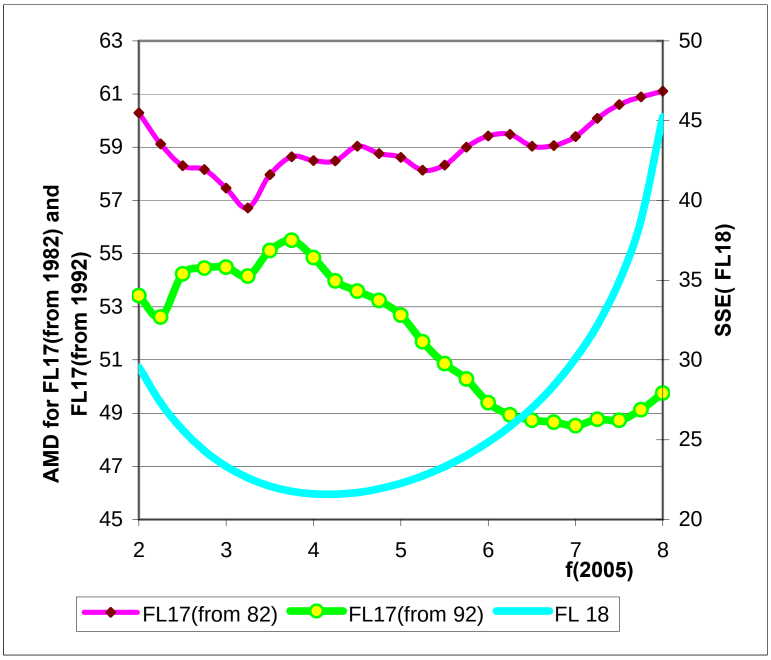


Figure 3. 26. Comparison profiles of loss function obtained for FL17 (two variants-for 1982-2004 and 1992-2004; no data for 2005) and for revised time series noted as FL 18 (for 1994-2005)

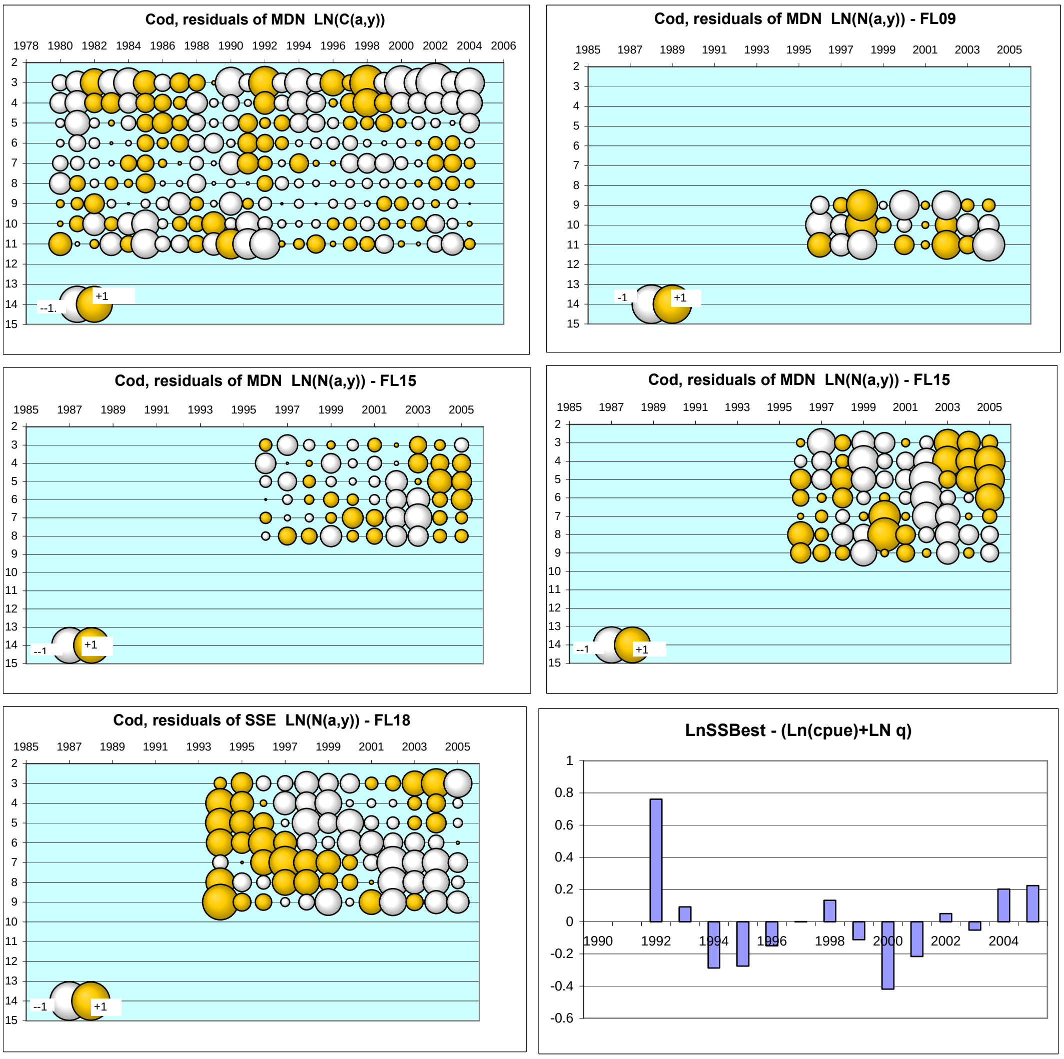


Figure 3. 27. Diagnostics of ISVPA run. Logarithmic residuals of "actual" and "theoretical" catch at age LN[C(a,y)], logarithmic residuals of "theoretical" and "survey index"abundance-at age LN(N(a,y)) for surveys FL09, FL15, Fl16 (for total stock) and FL18 (for spawning stock), and logarithmic residuals of the model estimates SSB and integral index – cpue of Russia fleet.

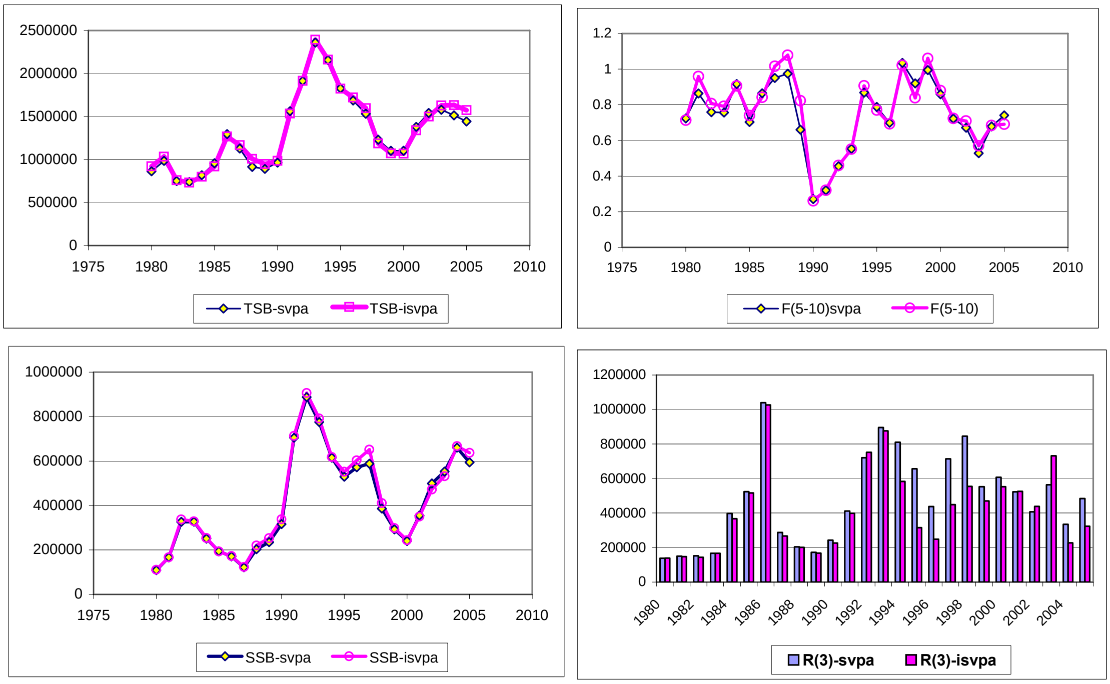
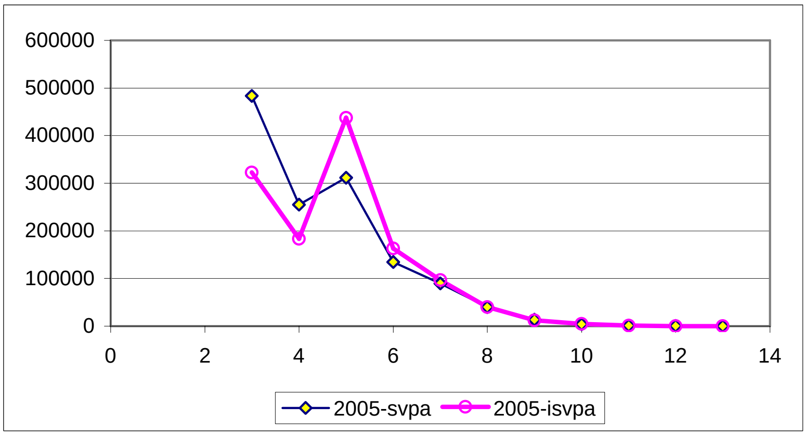


Figure 3.28. Comparison the results of XSA and ISVPA : cod total biomass dynamics, spawning stock biomass, Fbar(5-10) and recruitment in age 3



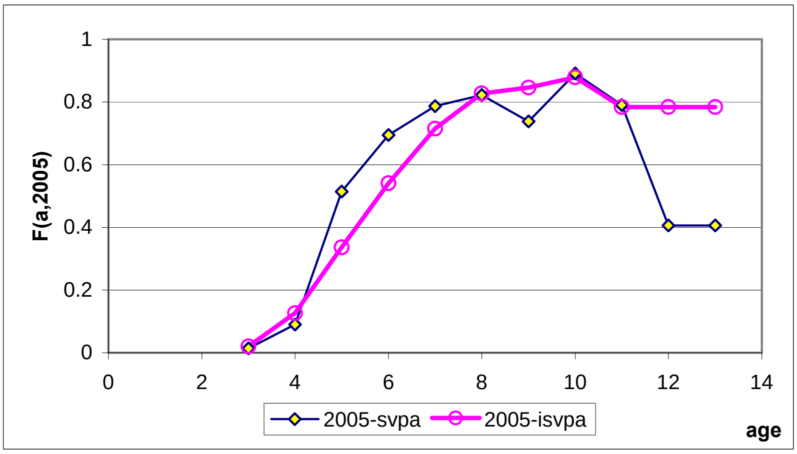


Figure 3.29. Comparison the cod stock abundance by age (up) and F(a) in the terminal year, obtained after svpa run of XSA and ISVPA

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			0.70			1.22		0.73	1.67
2004			0.48			0.78		0.84	1.67
2005[1]			0.45			0.62		0.81	1.23

[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.
[5]Spanish 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
2005	465.3	119.6	123.9	33.7	62.8	16.9	14.5	4.2	1.0	0.4	842.4
2006	544.6	216.6	79.8	59.1	15.5	25.6	8.8	4.5	1.4	0.5	956.5

[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
2005	824.3	224.6	246.9	62.1	98.1	24.7	15.5	4.5	1.1	0.4	1502.3
2006	862.7	288.4	118.1	111.5	28.7	43.7	10.2	4.9	1.4	0.6	1470.4

[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	2.30	19.11	16.50	6.49	0.83	0.31	0.47	0.01	46.02
2003	2.49	29.56	30.01	13.46	1.90	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
2005	4.33	13.26	28.97	13.07	6.51	1.55	0.06	0.16	67.91
2006	0.29	13.15	8.24	11.07	7.47	2.12	0.16	0.66	43.16

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 (1995-2004).
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
2004	122.5	71.8	35.2	82.6	15.7	12.0	5.6	0.8	0.6	346.9

Abundance indices (millions) from the Norwegian Bottom Trawl
survey in the Svalbard and Barents Sea area in July-August (1995-2004).
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
2004	285.2	142.0	67.3	113.0	24.8	22.7	12.4	4.1	2.0	673.5

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
2005	11.5	18.6	29.3	43.0	51.1	60.3	71.1	78.4
2006	12.2	19.9	31.3	42.1	53.5	60.8	68.9	77.7

[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
2005	13	57	230	705	1135	1817	2948	4081
2006	15	71	288	682	1366	1991	2959	4354

[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
2005	56.1	65.3	72.3	76.0	85.3	95.5	110.5	117.8
2006	56.8	63.8	72.6	77.5	82.9	88.3	89.3	116.3

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	24.50	27.70
2004	1.74	2.30	3.02	4.50	5.77	7.81	9.95	13.25
2005	1.57	2.39	3.20	3.71	5.79	8.52	16.27	18.63
2006	1.54	2.35	3.44	4.19	5.43	6.57	6.19	17.36

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
2004	375	35	170	85	345	194	229	167	49	19	1669
2005	112	48	65	154	70	214	68	47	17	8	803

[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. Abundance indices (millions)
from the Russian bottom trawl survey in the Barents Sea

Year	Age											
	0	1	2	3	4	5	6	7	8	9	10+	Total
			Total (Sub-area I and Division IIa and IIb)									
1994	16066	8332	699	1363	1309	1019	354	128	49	21	11	29351
1995	57035	4719	369	589	1065	1395	849	251	83	19	18	66392
1996	26603	3965	1285	733	784	1035	773	348	132	19	5	35682
1997	13714	3539	1353	1342	835	613	602	348	116	32	15	22509
1998	3048	2768	896	2028	1363	788	470	259	130	48	5	11803
1999	2669	401	1184	1587	2072	980	301	123	94	42	4	9457
2000	14365	377	1036	1839	1286	1786	773	114	52	23	9	21660
2001	3216	2338	773	1224	1557	1290	1061	304	50	14	5	11832
2002	17979	267	1356	980	1473	1473	896	600	182	29	8	25243
2003	4895	5175	268	1246	1057	1166	1203	535	241	40	9	15835
2004	17704	1584	875	329	1576	880	1111	776	279	93	23	25230
2005	22980	3239	617	1408	631	1832	744	605	244	88	28	32416

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
2004	9.8	19.6	29.3	38.4	49.1	60.0	70.5	80.0	91.0	98.0
2005	11.2	19.4	29.7	38.5	48.7	59.3	69.3	79.2	87.7	96.1

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
2004	6	55	231	543	1,079	1,798	2,977	4,110	5,822	8,061	12,442
2005	10	59	223	521	1,034	1,910	3,036	4,619	6,580	9,106	12,006

Table A14. Sum of acoustic abundance estimates (millions) in the Joint winter Barents Sea survey (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	4.3	1.7	0.2
1993	1074.0	494.7	357.2	191.1	113.1	35.4	25.5	25.2	27.7	44.2	4.9	0.8
1994	858.3	577.2	349.8	404.5	217.5	89.5	22.5	11.9	9.4	3.9	18.0	2.7
1995	2619.2	292.9	166.2	159.8	216.6	104.0	29.0	4.4	4.3	3.0	2.6	8.1
1996	2396.0	339.8	92.9	70.5	87.2	89.1	44.6	6.5	1.1	0.4	0.9	1.4
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	0.7	0.2	0.1
1999	358.3	304.3	150.0	96.4	45.4	12.2	11.2	18.7	9.2	1.0	0.2	0.2
2000	154.1	221.4	245.2	158.9	145.7	49.3	12.9	6.9	5.2	1.2	0.6	0.2
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
2005	465.3	119.6	123.9	33.7	66.1	29.9	43.2	17.2	7.5	1.8	0.1	0.2
2006	544.6	216.6	79.8	59.1	15.7	38.1	16.9	15.5	8.8	2.4	0.3	0.8

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. 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 2006 (Tables 4.1–4.3, Figure 4.1A)

The working group has made two important changes since last year's working group report concerning landings prior to 2006. These changes have been 1) to include unreported landings in the years 2002-2005, and 2) to include reported Norwegian landings of haddock from the Norwegian statistical areas 06 and 07 (i.e., between 62N and Lofoten) not previously included in the total landings of NEA haddock used as input for this stock assessment (Tables 4.1 – 4.3). The report from the Norwegian Directorate of Fisheries (www.fiskeridir.no) estimates the unreported landings of NEA haddock in 2005 to have been at least 36 300 tonnes above the agreed TAC. Earlier reports from the Norwegian Directorate estimating unreported landings of cod in 2002, 2003 and 2004 (see AFWG reports 2004 and 2005, and www.fiskeridir.no) have stipulated the unreported landings of haddock to compose about 20% of the total unreported landings of demersal fish from the Barents Sea/Svalbard areas. WD #4, which has evaluated the above report and analysed the same data according to well known statistical procedures (same as used for NEA cod), comes up with an estimate of unreported haddock landings in 2005 of 60 337 tonnes in addition to agreed TAC. However, the precision of this estimate is relatively much lower than for cod. The Working Group therefore decided to use the ratio between cod and haddock in the international reported landings from Sub-area I and Division IIb in 2002-2005 to estimate the proportion of cod and haddock in the unreported landings. Finally, the unreported landings of haddock these years are estimated by multiplying the proportion of haddock with the total unreported landings of both cod and haddock during the same time period. By doing this, unreported landings of 20 738 t, 28 946 t, 30 469 t and 40 284 t for 2002-2005, respectively, were included in the assessment in addition to the reported landings.

The reported landings of NEA haddock for 2005 amounted to 114 thousand tons, the agreed TAC was 117 thousand tons and unreported catches were estimated at 40 thousand tons. The reported catch by fishing area is given in Table 4.1 (see also Figure 4.1A). The catch numbers of NEA haddock since 1983 have slightly changed because the data were revised at WKHAD (ICES, 2006). The reported catch by area, broken down by trawl and other gears, is given in Table 4.2 and by country is given in Table 4.3.

4.1.3 Expected catches in 2006

ACFM recommended to set a TAC lower than 112 000 t for 2006. The TAC for 2006 on NEA haddock was set by applying the agreed harvest control rule. The agreed TAC for 2006 is 120 000 t. An additional Norwegian quota on haddock in the statistical areas 06 and 07 was set at 5 000 tons. The total reported landing in 2006 is expected to be equal to the agreed TAC. The unreported landings and Norwegian landings reported in statistical areas 06 and 07 are expected to be at the same level as in 2005 (40 000 and 5 000 tons correspondingly).

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 the last four years.

4.2.2 Survey results (Tables B1-B4, 4.11, 1.1-1.4.)

The overall picture seen in the surveys is summarized as follows: the yearclass 1997 seems to be poor while 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, 2004 and 2005 year classes seem to be well above average. The numbers of 8+ appear at low levels.

Norwegian bottom trawl and acoustic survey

Norway provided indices from the 2006 Barents Sea bottom trawl and acoustic survey in January-March (Table B1 and B3, 4.11). There was a reduced coverage of the Barents Sea in 1997-1998, but full coverage up to 2006. Due to less vessel time this year the coverage was less complete, so that the uncertainty, in particular regarding the age groups 2-3, is considered to be larger than in the preceding 5 years (WD 26).

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. For age group 2, the 2004 yearclass appears equally strong as the 1990 yearclass. The 2005 yearclass has the same potential. The yearclasses 1998 to 2001 have been observed as stronger than the 1992-1997 year classes, while the 2003 yearclass does not seem to be that strong. The 2005 yearclass seems to have the potential to become equally strong as well.

Russian bottom trawl and acoustic survey

Russia provided indices from the 2005 Barents Sea trawl and acoustic survey (Tables B2, B4a, and B4b, 4.11), 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 1.1 -1.4. There are two new versions of the area based indices, one which is corrected for catching efficiency (Table 1.3) and one without (Table 1.4). The four tables show slightly different pictures, but all tables indicate that the 2002-2005 are very strong yearclasses. While the 2005 logarithmic index is not calculated, the area based indices show even higher values for 2005 and the one corrected for catching efficiency is twice as high as the former record value.

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 are on average about the same as last year.

4.3 Summary of Report of the Workshop on Biological Reference Points for North East Arctic Haddock (WKHAD)

4.3.1 Introduction

The Terms of Reference points a), b) and c) for the workshop:

a) Review and revise input data used in assessing the North East Arctic haddock;

b) Propose biomass and fishing mortality reference points based on the most appropriate time period;

c) On the basis of the evaluation framework of management plans [...] evaluate the proposed and candidate HCRs in relation to long term yield and year-to-year stability in TACs taking into account the spasmodic recruitment observed for this stock;

The workshop recognized that there was not enough time during the meeting and the Terms of Reference where only partly addressed.

4.3.2 Revision of input data

4.3.2.1 Stock definition – Catches (Table 4.1)

The landings statistics of NEA Haddock were changed by including landings from Norwegian statistical areas 06 and 07 i.e., the areas between 62N and Lofoten. These landings were previously considered by Norway to have been taken from a separate Norwegian Coastal Haddock stock component. The workshop members believe there isn't sufficient biological information to support a separation of a coastal haddock stock from the Northeast Arctic haddock stock, and it was therefore decided to add these catches to NEA haddock landings back to 1983.

The total landings were thus in 1983-2005 increased with an average of around 5 000 t per year. The yearly landings from statistical areas 06 and 07 are given in Table 4.1.

4.3.2.2 Catch-at-age in numbers and weight in catch

The catch at age information has been changed due to the inclusion of landings mentioned above. The Norwegian catch at age information has also been changed by implementing a modeling approach to the estimation procedure. The new age distributions and weight at age were estimated using the software based on the method of Hirst et al. (2005). In this method, the three different types of available samples (age and weight samples, age and weight stratified by length groups and length samples) are modeled simultaneously using a previously developed Bayesian hierarchical model (Hirst et al. 2004).

4.3.2.3 Weight-at-age in the stock

Weight at age data has previously been rather ”noisy”. The current approach is as follows: Mean length at age is modeled using a von Bertalanffy model with L_∞ and T_0 parameters estimated over the whole time series and a separate K parameter for each year-class. Weight at age is estimated from a length weight relationship using the smoothed (modeled) length at age. Estimates were produced separately for the Russian autumn survey and the joint winter survey and was later combined as plain average.

4.3.2.4 Maturity-at-age

Previous assessments used relative frequencies per age groups observed during the Russian autumn survey from 1980 and onwards and a constant from 1950-1979. For the years 1980 and onwards the new series consists of predicted values using a logistic link function with age and length as explanatory variables from the joint winter survey combined with predicted proportions from the Russian autumn survey using:

$$Mat = \frac{1}{1 + e^{(-a*(age - age50\%)}}$$

The new series is based on the data from the Russian autumn survey and the joint winter survey. For the period 1950-1979 an average from both data series is used.

4.3.3 Reference points

4.3.3.1 B_{lim} and B_{pa}

B_{lim} was the only reference point that was investigated at the workshop. The WKHAD concluded that the stock-recruitment relationship was changed so much that the previous rationale could no longer be used. Spawning stock biomasses close to the lowest observed have produced high recruitment. Thus, B_{loss} was proposed as a candidate for B_{lim} and the average of the 3 lowest SSB’s is close to 50 000 t. Segmented regression was also carried out, but because of the noisy SSB recruitment relationship this did not result in a clear candidate. A conclusion on a B_{lim} was not made at the workshop.

4.3.3.2 F_{lim} and F_{pa}

The discussion on reference points on fishing mortality was quite limited, and no specific values were concluded.

4.3.3.3 Natural mortality

For the period from 1984 to 2005 actual data from predation for cod have been used while for the previous years (1950-1983) 0.2 have been used for all ages. This was changed so that the 0.2 values were replaced by the average natural mortality for 1984-2004 (age groups 1-6).

4.3.4 HCR evaluation

4.3.4.1 Limitations

We cite from the workshop report: “The evaluation is to a large extent based on simulations. All simulations have their limitations and shortcomings in how well they can mimic a fisheries system and these limitations influence the ability to make conclusions. The perception of the dynamics of the stock may be flawed. Such flaws can be related to incomplete knowledge of the system, biased information being used or the simulation itself lacking the degree of complexity needed [...]. The following list represents important factors, shortcomings or weaknesses not taken into account in the simulations made at this workshop:

1. Discarding and high grading is known to occur in fisheries that catch NEA haddock. There is a general discard ban in all the fisheries that catch NEA Haddock. There is very little information available that can be used to estimate the extent of discarding. Discarding may be a factor that reduces the ability of the simulation to mimic the "true" dynamics of fisheries system. All conclusions drawn from the simulations described in this report assumes none or negligible discarding/high-grading.

2. Not all landings of NEA Haddock are recorded. As for NEA cod unreported landings may (at least for some recent years) form a large part of the catches. The consequences of such a degree of implementation error (transshipping of cod and haddock) have not been a part of the simulations. All conclusions drawn are based on the assumption that the harvest control rule is implemented without such errors.

3. The spasmodic recruitment dynamics of NEA haddock is difficult to simulate (as for other haddock stocks). There is no clear SR-relationship for this stock and this makes it difficult to simulate the potential effect the current fishing has on future yields (only weak signs of reduced recruitment at low spawning stock levels). [...]"

4.3.4.2 Conclusion

The workshop concluded that: " the preliminary results [...] indicate that the HCR is in accordance with the precautionary approach as long as the assessment error is within the bounds used in the simulations and there is no assessment bias."

The workshop recommended that simulations including assessment bias should be made.

4.4 Data Used in the Assessment

During the Workshop on Biological Reference Points for Northeast Arctic Haddock (WKHAD) (ICES, 2006) several input data series were revised: the catch data, maturity-at-age and weight-at-age data. This is more thoroughly documented in the WKHAD report.

4.4.1 Estimates of unreported catches (Tables 4.1-4.3)

The assessment of unreported NEA haddock catches in 2002-2005 have been made on the assumption that the ratio of NEA cod and haddock in unreported catches is the same as in official international catches in ICES areas I and II b. Based on the agreed level of unreported cod catches in 2002-2005 and on the ratio of cod and haddock in the catches in these areas the unreported catches of haddock were estimated for the same period as for cod.

4.4.2 Catch-at-age (Table 4.4)

Total catches were changed in accordance with the WKHAD (see section 4.3.2.2) and section 4.4.1. Age and length compositions of the landings for 2005 were available from Norway and Russia in Subarea I and IIb, from Norway, Russia, and Germany in Division IIa. The unreported landings were distributed by ages using catch-at-age matrix for international trawl fleet from Sub-area I and Division IIb. The combined catch data were estimated by the SALLOC program (Patterson, 1998). The SOP check gave no deviation from the nominal catch of 2005.

4.4.3 Weight-at-age (Tables 4.5-4.6, Table B.6)

The mean weight-at-age in the catches were calculated by the SALLOC program (Patterson, 1998) and based on weights in the catches of Russia, Norway and Germany (Table 4.5). The data have been revised (see section 4.3.2.2). The weights-at-age in the catch in 2005 are showing a declining tendency for most ages.

Stock weights (Table 4.6) used from 1985 to 2006 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. The weight-at-age data are smoothed as described in 4.3.2.3.

4.4.4 Natural mortality (Table 4.7)

Natural mortality (Table 4.7) was set to 0.2+mortality from predation by cod (see Section 4.3.3.3). The proportion of F and M before spawning was set to zero. For the period from 1984 to 2005 actual data from predation for cod have been used while for the previous years (1950-1983) the 0.2 was replaced for all ages at the Svanhovd meeting by the average natural mortality for 1984-2005 (age groups 1-6).

4.4.5 Maturity-at-age (Table 4.7)

Maturity-at-age was changed in accordance with section 4.3.2.4. The series is shown in Table 4.7. The data indicate a slight reduction in the proportions mature at age from 2004 to 2005 and is thus still lower than historic averages.

4.4.6 Changes in data from last year (Table 4.12)

The changes made to this year's assessment compared to last year were mainly changes in the input data and are documented in the report of the workshop on biological reference points for Northeast Arctic haddock (ICES, 2006). The estimates of the unreported catches is described in section 4.1.2:

- The Russian catch-at-age data were slightly revised.
- The catches of haddock in Norwegian statistical areas 06 and 07 were added to the total catches in the assessment.
- The catch composition of the Norwegian catches was recalculated back to 1983.
- The combined catch data were calculated by the SALLOC program.
- Both the Russian and Norwegian maturity-at-age and weight-at-age data were modeled, smoothing the data. Previous, only Russian maturity-at-age data have been used, but this year these were combined with Norwegian data.
- Estimates of unreported landings were added to the reported catches for 2002-2005
- Natural mortality for 1950-1983 (0.2) was replaced by average natural mortality with predation by cod for 1984-2005 for age groups 1-6
- The retrospective performance of the XSA is illustrated in Figure 4.12

4.4.7 Data for tuning (Table 4.19, Fig.4.11)

The following surveys series (Table 4.9) are included in the data for tuning:

Name	Place	Season	Age	Year	prior weight
Russian bottom trawl	Total area	Autumn	1–7	1983–2005	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2006	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2006	1

The indices for the Russian BT survey in the 1990 and indices for 1996-year class were not used for tuning the XSA. Since the 2004 WG meeting the survey data before 1990 have not been used in the XSA run. This decision is based on the analysis of survey residuals and changes in some surveys methodology (See Figures 4.6-4.8, Section 4.5.1 in the 2002 and the 2004 reports).

4.4.8 Recruitment indices (Table 4.10)

The table with recruitment indices (Table 4.10) covers the year classes 1980 and later. Similar to XSA turning points from the 1990 Russian BT survey and indices of the 1996-year class were removed from recruitment estimation.

4.4.9 Prediction data (Table 4.11, Table 4.22)

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 4.22:

- The estimated recruitment from RCT for 2006-2008 and average for 2009 given in Table 4.11.
- The average fishing pattern observed in the 3 last years.
- Observed maturity for 2006, smoothed average maturity for the 1982-1985 and 1990-1993 yearclasses for 2007-2009Smoothed observed weights at age in the stock for 2006, average smoothed weights for the 1982-1985 and 1990-1993 yearclasses for 2007-2009.
- The average weights in the catch for the 1982-1985 and 1990-1993 yearclasses for 2006-2009.
- Natural mortality – average for the 3 last years (2003-2005)
- And stock numbers and fishing mortalities from the standard VPA.

4.5 Methods Used in the Assessment

4.5.1 VPA and tuning (Table 4.9)

The Extended Survivors Analysis (XSA) was used to tune the VPA to the available index series (Table 4.9). The settings used by the AFWG in 2005 were not changed:

- The tuning window is set to (1990-2005).
- The F shrinkage was giving a weight corresponding to SE=0.5

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 (1984–2005). 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	226.2	0.0	0.0	0.0	0.0	0.0
1990	145.5	38.7	3.7	0.0	0.0	0.0
1991	463.4	14.5	0.0	0.0	0.0	0.0
1992	2121.6	151.5	1.1	0.0	0.0	0.0
1993	1380.1	164.2	36.3	3.4	2.9	0.0
1994	1409.2	80.6	25.1	7.6	0.9	0.0
1995	2885.8	162.3	12.0	29.5	29.6	0.3
1996	1589.3	160.1	40.2	5.5	2.6	3.4
1997	897.2	35.2	25.2	1.7	0.8	0.5
1998	1535.6	28.7	2.0	3.0	0.5	0.0
1999	905.4	23.6	0.3	0.0	0.0	0.0
2000	1218.1	65.8	2.1	1.1	0.2	0.1
2001	556.7	53.2	5.0	0.1	0.0	0.0
2002	2377.0	230.5	38.3	2.4	0.4	0.2
2003	3473.2	218.6	38.9	12.4	1.2	0.0
2004	2512.3	216.3	33.6	10.3	4.2	0.3
2005	5030.0	298.7	96.6	11.9	2.2	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 4.9) was used in the final XSA.

4.5.2 Recruitment (Tables 4.10-4.11)

The recruiting year classes 2003-2005 were estimated using RCT3 (input given in Tables 4.10 and output given in Table 4.11). The indices for the 1996-year class were removed, as were the indices from the Russian 1990 BT survey. The tuning window was used for the period from 1990 to 2005.

4.6 Results of the Assessment

4.6.1 Fishing mortality and VPA (Tables 4.12-4.21 and Figures 4.1A-D)

The tuning diagnostics of the final XSA (predation included) are given in Table 4.12.

Proportion of M and F before spawning was set to 0 and given in Tables 4.13 and 4.14. Fishing mortality and relative fishing morality are given in Tables 4.15 and 4.16 respectively, while the stock numbers and spawning stock numbers, stock biomass at age and the spawning biomass at age of the final VPA are given in Tables 4.17, 4.18, 4.19 and 4.20. A summary of landings, fishing mortality, spawning stock biomass, and recruitment since 1950 is given in Table 4.21 and Figures 4.1A, 4.1B, 4.1C and 4.1D.

Assessment showed that F_{4-7} in 2005 increased considerably compared to fishing mortality in 2004, exceeded the F_{pa} and reached the highest level beginning from 1999. Fishing mortality in 2000-2002 was quite low relative to the 90^{th} and to the period 2003-2005.

The majority of the catches in 2005 still consisted of 1998, 1999 and 2000 yearclasses.

According to the assessment the spawning stock biomass reached in 2005 the maximum historical level although in 2006 the decreasing of SSB is expected.

The largest contribution to the total and spawning stock in 2005 was made by 1998 and 1999 yearclasses.

4.6.2 Recruitment (Tables 4.11, Figure 4.1C)

The strength of the recruiting yearclasses is given in the table below (numbers in millions at age 3). The numbers marked with * are XSA estimates, and the rest is RCT results (Table 4.11). The recruitment time series is shown in Figure 4.1C.

	Year of assessment		
Year Class	2004	2005	2006
2000	187*	197*	237*
2001	239	176*	219*
2002	384	295	313*
2003	159	156	183
2004		462	755
2005			521

4.6.3 Catch options for 2007-2008 (Tables 4.22 - 4.24)

The input to the prediction is given in Table 4.22.The estimated catch in 2005 corresponds to F=0.38 and the estimated spawning stock biomass is 250 000 t in the beginning of 2006. We have assumed landings in 2006 to be equal to the TAC (120 000) plus unreported catches on the level of 2005 (40 000 t) and plus an additional TAC decided by Norway for statistical areas 06, 07 (5 000 t). Thus, the corresponding F was used for 2006 (F=0.42).

The deterministic projection suggests a decrease in SSB to 221 000 t in the beginning of 2007 (table 4.23)

Fishing at $\mathbf{F}_{pa}$ in 2007 corresponds to total landings of 131 000 t, with a keeping of the SSB into the beginning of 2008 on the same level equal to 223 000 tons (table 4.24).

Fishing in period 2007-2009 with F which corresponds to agreed experimental harvest rule (F=0.35) is equal to total mean landings of 150 000 t in 2007 (the average yield for 2007-2009 is 160 000 t. but the 25 % limitation applied by the HCR restricts the TAC on 10 000 t). It leads to a slight decrease of the SSB in 2008 to 211 000 t.

4.6.4 Comparison with last year assessment (Fig.4.5)

This year assessment due to revision of biological and catch data shows considerable changes in total biomass, spawning biomass and fishing mortality in comparison with assessments of previous years.

Assessment of 2006 showed the fishing mortality for the whole period with changed catch data to be much lower compared to the last assessment, especially for the period from 1997 to 2002 for which the strongest impact of included unreported catches could be tracked.

Total biomass and spawning biomass in 2005 are on the highest ever observed level that conflicts somewhat with the assessment of 2004.

This caused some concern in the working group, keeping in mind that the inclusion of relative high estimates of unreported landings has the potential of changing the perception of the stock situation. The working group decided to make additional runs to estimate the effect of unreported catches including and revision of biological and catch data, in particular:

XSA run with unreported catches in 1998-2005 that were calculated on the same procedure as for 2002-2005 (to avoid «jumping» in catch data);

XSA run without unreported catches.

The dynamic and the level of fishing mortality, total and spawning stock biomass correlate well in all runs (including final run with unreported catches in 2002-2005).and show similar state and trends to increasing in 2005 compared with previous years (Fig.4.5).

4.7 Comments to the assessment and forecasts

This table reflects mainly 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 yearclass dependent changes in survey catchability. This year catches of haddock in Norwegian statistical areas 06 and were added to the NEA haddock. These include haddock of older ages compared to the landings of NEA haddock. Since the surveys don’t cover the coastal regions this indicates that the older ages are covered more poorly.
Correlated error structures	Year effects in a survey are quite common. 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	This year, estimates for unreported catches were provided for 2002-2005.	The estimates are considered quite uncertain (see WD# 4).
Predation on young yearclasses	The survival due to predation (to a large extent by cod) varies substantially from year to year.	The predictions of young yearclasses are very uncertain, escpecially for the 3-years HCR.
Sampling error	Estimation of catch at age is based on sampling catches. The uncertainty in the estimates caused by sampling can be considerable for some age groups in some years even if the total catch is known. The estimation of the abundance indices from surveys will also be affected by sampling error.	The effect of not taking sampling error into account when fitting models to data may introduce bias in the resulting estimates. This bias is likely to increase with sampling error.

4.7.1 Model uncertainty (Fig 4.6-4.7)

An analysis of model uncertainty requires a framework within which many candidate assessments and forecasts can be carried out quickly and efficiently. The FLR system (http://www.flr-project.org/doku.php) under development in the EU EFIMAS-COMMIT-FISBOAT cluster was used for this purpose. FLR consists of a number of data classes and methods coded in the R language (R Development Core Team 2005). A simple R script loops over all possible combinations of different XSA settings (Darby and Flatman 1994), running XSA and generating assessments for each one. The following list shows the settings used for the NEA haddock (the baseline settings is highlighted in **bold**):

1) F shrinkage = (**0.5**, 1.0, 1.5,)
2) Catchability (q) plateau = (7, 8, **9**)
3) Plus-group age = (9, 10, **11**)
4) All possible combinations of surveys: for example, with three surveys, the combinations are (1), (2), (3), (1,2), (2,3), (1,3), (**1,2,3**).

The method is still is the early stages of development, and needs to be explored further. For example, uncertainty in growth and recruitment is not yet incorporated. There is no account taken of parameter estimation uncertainty, and we have restricted the approach to a single assessment method (XSA) when it would be more appropriate to look at several. It may also be appropriate to weight the contributions of different parameters settings to the overall distributions. For example, although choosing F shrinkage in XSA is arbitrary to a certain extent, experience has shown that a low number (0.5) is more likely to induce biased advice than a high number (2.0) in a situation where there is a trend in mortality.

The results indicate that the choice of catchability plateau has little effect on the assessment whereas the other combinations are of importance.

4.7.2 Comparing survey trends with SSB estimates from the XSA (Fig.4.8-4.9)

The three different survey series used for tuning the XSA are compared in the following figures. Please note that the Norwegian acoustic and Norwegian BT survey indices are parts of the same cruise. All series are standardised to zero mean and unit standard deviation.

All surveys seem to track the different yearclasses quite well. The following figure is comparing the SSB survey index (Index X west X matprop). The surveys represent the SSB in the end of the year and the XSA SSB is shifted from the beginning of the year to the end. All series were standardised to zero mean and unit standard deviation before the plotting.

The assessment SSB is showing some of the trends that can be found in the surveys with a peak in SSB around 1995-1996. The last part of the XSA estimate series is somewhat higher than the 1995-1996 peak while the surveys are indicative of an SSB well below the period 1995-1996.

These differences are alarmingly high and represent ”conflicting signals”. The worrying part is that the last part of the XSA series and especially the latest point is very much determined by the surveys and some ”shrinkage”. There is nothing in the XSA diagnostics that indicate that F-shrinkage is the source of the problem. One problem is the impact of the 1996 yearclass that is determined completely by F-shrinkage. This yearclass is estimated to be stronger than the 1990 yearclass at age 10. Age 10 is the last true age in the XSA and the 1996 yearclass is 10 year in 2006.

The effect of including unreported landings for the last 4 years in the assessment is of course an increase in the XSA estimate of stock size, but it is difficult to assess if this is a part of the problem with conflicting signals.

The exploitation pattern is not very stable and could be a symptom of the underlying problems.

Conclusion

The assessment should be treated with some caution.

4.8 Biomass and fishing mortality reference points (Table 4.25, Figures 4.2–4.4, 4.10, 4.13–4.15)

One of the objectives for the Workshop on Biological Reference Points for Northeast Arctic Haddock, WKHAD, (ICES, 2006) was to revise the reference points for this stock. The biomass reference points previously adopted by ACFM for this stock are $\mathbf{B}_{lim}$=50,000 t and $\mathbf{B}_{pa}$ =80,000 t. The fishing mortality reference points are $\mathbf{F}_{lim}$=0.49 and $\mathbf{F}_{pa}$ =0.35 (Figure 4.4).

A plot of SSB versus recruitment is shown in Figure 4.2. Yield and SSB per recruit (YPR and SPR) are presented in Table 4.25 and Figure 4.3.

The rationale for $\mathbf{B}_{lim}$ was (ICES, 2005): *only poor recruitment has been observed from 4 years of SSB < 50 000 t and all moderate or large year classes have been produced at higher SSB.* Due to changes in biological data and catch-at-age made in this year assessment, the estimates of SSB and R are changed (Fig. 4.10). The lowest observed biomass (SSB at 1986) is now 47.6 thousand tons, which is much higher than the AFWG-2005 assessment made before revision of the data (27 thousand tons in year 1985). The average value of the 3 lowest spawning biomasses (1984, 1985, 1986) is very close to 48 thousand tons. The picture is now different in that spawning stock biomasses close to the lowest observed have produced high recruitment. Segmented regression was carried out at the workshop, but because of the SSB recruitment relationship this did not result in a clear candidate. $\mathbf{B}_{loss}$ was proposed as a candidate for $\mathbf{B}_{lim.}$ There was no consensus on this during the workshop and the decision was left to the AFWG 2006.

Due to time constrain and taking into account in general not very sufficient changes at SSB-R relationship there was no work done during the AFWG meeting on possible revision of NEA haddock BRPs. The WG has decided to analyze a possible changes in BRPs values later.

Nevertheless, there were some discussion on possible alternative candidates on Blim during the meeting. Their results summarized below.

$\mathbf{B}_{lim}$ discursion

A working document with the title ”Aspects of estimating yearclass strength” was presented to this year’s working group. The document focuses on some aspects of what determines the yearclass strength. The natural mortality estimated based on the estimates of consumption of young haddock by NEA cod in last year’s NEA Haddock assessment was used to calculate the survival from age 1 to age 3. The survival varied with a factor of more than 20 and the author claimed that one could not expect any useful relationship between recruitment and SSB at age 3 or older. R-SSB plots with recruiting age 1 and age 3 was compared (Fig.4.13-4.14).

It was argued that the 1983 and 1990 yearclasses became strong because survival from age 1 to age 3 was high, while the yearclass 1995, which seem to start as strong yearclass had been preyed rather heavily on.The estimates of natural mortality are considered rather uncertain, but are used as a part of the assessment. The WD concluded that the range of estimated survival from age 1 to age 3 indicates that predation from cod is an important factor for establishing yearclass strength. Based on the SSB-R plot with recruiting age 1, the WD suggested an alternative candidate for $\mathbf{B_{lim}}$, $\mathbf{B_{lim}}$ =100 000t, based on the following rationale: *Poor recruitment has only been observed at SSB < 100 000 t and higher SSB has only produced moderate or large year classes*.

On the other hand there is an evidence that assessed numbers of haddock at ages 1 and 2 based only on cod consumption estimations and they are less reliable. The comparisons of these estimates with survey indices shows that they are sometimes are considerably different (Fig. 4.15). For instance yearclasses 1983 and 1990, mentioned above were very abundant at age 1 and also at age 2 in accordance to survey and their VPA estimates are not valid. The same disagreement is observed for yearclass 1995. Their estimates by VPA at age 1 is very high but in survey at age 1 and 2 this yearclass is one of the weakest. The source of such disagreement could be a wrong estimations of haddock consumed by cod due to poor data sampling both by period of the year and by ages.

The two candidates for $\mathbf{B_{lim}}$ were not thoroughly discussed and no conclusion reached. The arguments in the (limited) discussion are summarized as follows:

Pro $B_{lim}=B_{loss}$

- Common ICES practice when no clear SSB-R relationship
- Keeps the same value as previous years since the difference at SSB-R relationship is not sufficient and no consensus was reached.
- Despite the previous rational for B_{lim} ("*only poor recruitment has been observed of SSB < 50 000 t*") is no relevant anymore the conceptually B_{loss} is relevant candidate on B_{lim} as for current SSB-R relationship at SSB<48 000 t "*the dynamics of the stock are unknown*" (ICES, 2003).

Contra $B_{lim}=B_{loss}$

- New perception of the stock. The revised data has increased the SSB levels for some years specially for years with lowest observed spawning biomass.
- Disagreement that common ICES practice is favourable practice.

Pro B_{lim}=100 000t

- The SSB-R plot, recruitment at age 1, indicates more certain relationship between the SSB and the recruitment level.
- Allows young haddock to play an important role as prey, taking into account ecosystem considerations.

Contra B_{lim}=100 000t

- The estimates of 1-year olds in VPA are based only on NEA cod consumption estimates and they are very uncertain. Yearclasses strength observed by survey could be considerably deferent to VPA estimates. This is specially true for two most abounded yearclasses 1983 and 1990 which are well recognized by survey results from age 1.
- When survival varies drastically, it is irrelevant to consider 1-year olds in a SSB-R relationship.
- The BRPs are established for regulation of fishery and it is more important to consider about recruitment to the fishable stock biomass. The processes influence on young haddock survival are still unknown. If survival is dependent on population density it could be wrong to use the stock-recruitment at age 1 relationship for fishery management purposes.

It was agreed that the rationale behind different B_{lim} candidates should be looked more carefully into.

Candidates for B_{pa} were consequently not discussed, but the Svanhovd workshop recommends estimating the factor B_{pa}/B_{lim} using the performance of the deterministic prediction in the same way as for NEA Cod.

There were no efforts in defining the fishing mortality reference points. It was agreed that these should relate to B_{lim}. Based on the evaluation of the harvest control rules, it was agreed that an F_{target}=0.35 is in accordance with the precautionary approach

4.9 Evaluation of the agreed harvest control rule (Tables 4.21–4.22)

At the 33rd meeting of the Joint Russian-Norwegian Fisheries Commission (JRNC) in November 2004, 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 utilization 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):

- *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 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 B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{pa} at B_{pa}, to F= 0 at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year, a year before and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.*
- *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).[1]"*

ICES set up a separate workshop (WKHAD) in March 2006 to revise input data, revise the reference points and to evaluate if the agreed HCR for haddock is in accordance with the precautionary approach and to suggest changes or modifications to the HCR if appropriate. A summary of the workshop report including some of the limitations in the evaluations/simulations can be found in Section 4.3. The workshop did not revise any of the reference points. The biomass reference points are most in need of a revision since the stock definitions has changed (including landings from Norwegian statistical areas 06 and 07) and with large revisions of the maturity ogives. The lack of revised limit reference points is to some extent limiting the working groups ability to conclude from the evaluation. Two candidate B_{lim} reference points has been presented to the working group, but with only limited discussion and no conclusion. See section 4.8 for a presentation of the candidate limit

1 This quotation is taken from point 5.1, in the Protocol of the 33rd session of The Joint Norwegian-Russian Fishery Commission and translated from Norwegian to English. For an accurate interpretation, please consult the text in the official languages of the Commission (Norwegian and Russian).

reference points. In this section the use of 50 000 t or 100 000 t SSB correspond to the two candidate B_{lim} reference points. 50 000 t is also equal to the previously defined B_{lim}. The evaluation is using F=0.49 as level to evaluate the fishing mortality. F=0.49 corresponds to the previously defined F_{lim}. The working group did not reach a conclusion whether the previously defined limit reference points could be used as current reference points in the lack of revised reference points.

Simulation made at WKHAD focused on evaluating the effect of replacing the target fishing mortality in the HCR (F=0.35) with F=0.25 or F=0.45. Both F=0.25 and F=0.35 performed well in keeping the SSB at safe levels, while F=0.45 gave an average realised F close to the previous F_{lim}. The effect of changing the TAC stability criteria to 10% and no TAC stability criteria at all was also explored at the workshop. The 10% criteria increased the likelihood of low SSB and the overall yield was also slightly lower than the other simulations. The 10% criteria was not considered to be precautionary.

This section describes further evaluations of the HCR. The working group discussed whether to include simulations of assessment bias or implementation error (TAC not restraining catches) or both. The working group concluded that the assessment bias is most likely entangled with implementation errors and choose to limit the evaluations to the latter. The evaluations presented in this section is conditional on and limited by the following:

a) The simulations were made assuming a ”hockey-stick” relationship between SSB and recruitment at age 3. This rather ”vague” relationship is identical to the one used during the haddock workshop (WKHAD). Recruitment variation was simulated assuming a lognormal error term corresponding to the observed history of residuals. Periodicity in recruitment caused by periodicity in cod predation was not a part of the simulations.

b) The weight at age in stock was simulated assuming density dependence based on a regression on historic observations. Both weight at age in the catch and proportions mature at age was linked to weight at age in the stock based on observed relationships in the historic series. Observed periodicity was not simulated. (The population parameter figures in the WKHAD report illustrate this periodicity.)

c) Exploitation patterns are known to change when strong yearclasses are entering the fishery. Difficulties in modelling such changes limited to assuming a fixed exploitation pattern.

d) The role of the haddock stock in the ecosystem (for example as prey for cod) did not play any role in the simulations/evaluations. Such considerations together with an ecosystem based approach to management is likely to influence how future simulations are to be set up including different performance criteria.

The simulations were set up with the following performance criteria:

The probability (%) that SSB shall fall below 50 000 t

The probability (%) that SSB shall fall below 100 000 t

The probability (%) that the fishing mortality exceed F=0.49

The probability (%) that an increase in TAC is limited by the 25% TAC constraint

The probability (%) that a reduction in TAC is limited by the 25% TAC constraint

The table below summarises the 6 different evaluations. The evaluations was set up to gain insight in:

1) How well is the agreed HCR performing in situations with an implementation of the same magnitude as the unreported landings included in the catches for 2002-2005?

2) What is the effect of replacing the 3-year rule in the prediction with a 1-year prediction?

3) What would be the effect of changing the trigger point (the size of SSB below which F is reduced linearly down to 0 at SSB=0) to a higher value? The previously defined B_{pa}=80 000 t used by the HCR as such a "trigger point".

Run no	Rule	TAC constr.	Trigger point	Impl. error	Intended F	Realised F	Catch (kt.)	SSB (kt.)	Prob. SSB<50kt	Prob. SSB<100kt	Prob. F>0.49	Prob. upper constr.	Prob. lower constr.
1	3-year	25 %	80	no	0.357	0.360	151	264	0	0	8	12	6
2	3-year	25 %	80	27 %	0.411	0.587	140	140	1	22	49	8	9
3	1-year	25 %	80	no	0.344	0.347	151	276	0	1	3	21	12
4	1-year	25 %	80	27 %	0.348	0.482	144	177	0	15	33	18	13
5	1-year	No	80	27 %	0.348	0.482	147	166	0	10	33	0	0
6	1-year	25 %	145	no	0.345	0.350	152	267	0	0	2	14	11

Please note that the columns labeled "Intended F", "Realised F", "Catch" and "SSB" are all average numbers and does not correspond to "stable levels".

All simulations showed negligible probabilities of SSB falling below 50 000 t.

Run number 2, 4 and 5 looked at the effect of an implementation error of 27%. The general effect of the implementation error was a probability of SSB falling below 100 000 t of 10% to 22% depending on other settings. The probability of fishing above F=0.49 for this level of implementation error was quite high (33%-49%).

Run number 1 and 3 illustrates the effect of replacing the current 3-year rule in the prediction (run 1) with a 1-year prediction (run 3). The performance relative to SSB is similar while the 1-year prediction has a lower probability of producing high fishing mortalities. Prob(F>0.49)=3% and Prob(F>0.49)=8%.The intention of the 3-year rule in the prediction is to increase year-to-year stability in TAC. 3-year predictions are more uncertain than 1-year predictions and the opposite could be the effect. This conclusion relies heavily on the prediction method used and is not the case when comparing run 1 and 3. The simulations represent a simplified world where 3-year predictions perform very well. If stability in fishing mortality were a criterion then a 1-year rule would perform better than a 3-year rule.

Run number 6 illustrates the performance of the HCR when the 80 000 t trigger point is replaced with the much higher 145 000 t. The performance relative to the probability of low SSB or high F is better than any of the other simulations, but only slightly better than run 3. The average yield is on a level comparable to all other runs. The result of this simulation depends on the assumed SSB-R relationship used and other likely assumptions may change the results.

Conclusion

Given the limitations and assumptions in these evaluations the results indicate that **the agreed HCR are not in accordance with the precautionary approach** because realised fishing mortalities have a relatively high probability of being above F_{lim}=0.49 (Probability=8%).

Replacing the 3-year rule in the prediction with a **1-year rule** will reduce the probability of high fishing mortalities to 3%. The results indicate that with this modification to the HCR it **will be in accordance with the precautionary approach**. The evaluation does not indicate that the 3-years rule increases the average yield and due to the uncertainties in 3-years predictions, the working group doubts that the rule will have a stabilizing effect on the annual yield compared to a 1-year rule.

Implementation errors of magnitudes corresponding to current estimates of unreported landings are considered harmful and cannot be a part of a fishery managed according to the precautionary approach.

4.10 Technical Minutes from ACFM

In spite of the fast the assessment have been classified as an update one members of working group decided to make several exploratory runs to evaluate and show the effect of the revision of biological and landings data in fishing mortality, total stock and spawning stock biomass dynamics.

The working group did not explore the catchability assumptions, predation mortality before 1984, the convergence problem or the suggestion on deleting older age groups. This is left for future consideration.

Because of lack of information the discards problem was not discussed on working group. This is left for future consideration

We note that ACFM addresses several shortcomings in the assessment and the working group was asked to explore these. The working group did add estimated unreported landings to the catches for the last four years in this year's assessment. The predation numbers were not modeled before 1984, but there was an attempt to analyze the impact of the varying predation on the youngest age groups on the stock recruitment relationship and B_{lim} (WD 25) based on data series from 1984. However there was no consensus in the group on whether the results were relevant for deciding the B_{lim} value.

The XSA was the only model used to assess the NEA haddock stock. The working group intends to run the assessment model by Sondre Aanes next year (model presented in a WD last year) and possibly other models as well to be able to sort out some of the problems with the haddock assessment.

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	[2] unreported	Total	[3] Norwegian statistical areas 06 and 07
1960	125 026	27 781	1 844	-	154 651	6 000
1961	165 156	25 641	2 427	-	193 224	4 000
1962	160 561	25 125	1 723	-	187 409	3 000
1963	124 332	20 956	936	-	146 224	4 000
1964	79 262	18 784	1 112	-	99 158	6 000
1965	98 921	18 719	943	-	118 583	6 000
1966	125 009	35 143	1 626	-	161 778	5 000
1967	107 996	27 962	440	-	136 398	3 000
1968	140 970	40 031	725	-	181 726	3 000
1969	89 948	40 306	566	-	130 820	2 000
1970	60 631	27 120	507	-	88 258	-
1971	56 989	21 453	463	-	78 905	-
1972	221 880	42 111	2 162	-	266 153	-
1973	285 644	23 506	13 077	-	322 227	-
1974	159 051	47 037	15 069	-	221 157	10 000
1975	121 692	44 337	9 729	-	175 758	6 000
1976	94 054	37 562	5 648	-	137 264	2 000
1977	72 159	28 452	9 547	-	110 158	2 000
1978	63 965	30 478	979	-	95 422	2 000
1979	63 841	39 167	615	-	103 623	6 000
1980	54 205	33 616	68	-	87 889	5 098
1981	36 834	39 864	455	-	77 153	4 767
1982	17 948	29 005	2	-	46 955	3 335
1983	5 837	16 859	1 904	-	24 600	3 112
1984	2 934	16 683	1 328	-	20 945	3 803
1985	27 982	14 340	2 730	-	45 052	3 583
1986	61 729	29 771	9 063	-	100 563	4 021
1987	97 091	41 084	16 741	-	154 916	3 194
1988	45 060	49 564	631	-	95 255	3 756
1989	29 723	28 478	317	-	58 518	4 701
1990	13 306	13 275	601	-	27 182	2 912
1991	17 985	17801	430	-	36 216	3 045
1992	30 884	28 064	974	-	59 922	5 634
1993	46 918	32 433	3 028	-	82 379	5 559
1994	76 748	50 388	8 050	-	135 186	6 311
1995	75 860	53 460	13 128	-	142 448	5 444
1996	112 749	61 722	3 657	-	178 128	5 126
1997	78 128	73 475	2 756	-	154 359	5 987
1998	45 640	53 936	1 054	-	100 630	6 338
1999	38 291	40 819	4 085	-	83 195	5 743
2000 .	25 931	39 169	3 844	-	68 944	4 536
2001	35 072	47 245	7 323	-	89 640	4 542
2002	40 721	42 774	12 567	20 738	116 800	6 898
2003	53 653	43 564	8 483	28 946	134 646	4 279
2004 [1]	64 873	47 483	12 146	30 469	154 971	3 743
2005 [1]	53 563	45 729	14 540	40 284	154 116	5 406

[1] Provisional figures, Norwegian catches on Russian quotas are included

[2] Uncertain figures

[3] included in total landings in region IIa

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		[2] unreported
Year	Trawl	Others	Trawl	Others	Trawl	Others	catches
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	3.6	2.2	8.7	8.2	0.2	1.7	-
1984	1.6	1.3	7.6	9.1	0.1	1.2	-
1985	24.4	3.5	6.2	8.1	0.1	2.6	-
1986	51.7	10.1	14.0	15.8	0.8	8.3	-
1987	79.0	18.1	23.0	18.1	3.0	13.8	-
1988	28.7	16.4	34.3	15.3	0.6	0.0	-
1989	20.0	9.7	13.5	15.0	0.3	0.0	-
1990	4.4	8.9	5.1	8.2	0.6	0.0	-
1991	9.0	8.9	8.9	8.9	0.2	0.2	-
1992	21.3	9.6	11.9	16.1	1.0	0.0	-
1993	35.3	11.6	14.5	17.9	3.0	0.0	-
1994	58.6	18.2	26.1	24.3	7.9	0.2	-
1995	63.9	12.0	29.6	23.8	12.1	1.0	-
1996	98.3	14.4	36.5	25.2	3.4	0.3	-
1997	57.4	20.7	44.9	28.6	2.5	0.3	-
1998	26.0	19.6	27.1	26.9	0.7	0.3	-
1999	29.4	8.9	19.1	21.8	4.0	0.1	-
2000	20.1	5.9	18.8	20.4	3.7	0.1	-
2001	28.4	6.7	23.4	23.8	7.0	0.3	-
2002	30.5	10.2	19.5	23.3	12.5	0.1	20.7
2003	42.7	10.9	21.9	21.7	8.1	0.4	28.9
2004 [1]	52.4	12.5	27.0	20.5	11.5	0.6	30.5
2005 [1]	38.5	15.0	24.9	20.9	13.0	1.6	40.3

[1] Provisional

[2] Uncertain figures

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.	[4] Norway	Poland	United Kingdom	Russia[2]	Others	[3] unreported catches	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	66 501	-	2 948	20 706	246	-	92 504
1981	381	414	22	2 402	63 435	**Spain**	1 682	13 400	-	-	81 736
1982	496	53	-	1 258	43 702	-	827	2 900	-	-	49 236
1983	428	-	1	729	22 364	139	259	680	-	-	24 600
1984	297	15	4	400	18 813	37	276	1 103	-	-	20 945
1985	424	21	20	395	21 272	77	153	22 690	-	-	45 052
1986	893	12	75	1 079	52 313	22	431	45 738	-	-	100 563
1987	464	7	83	3 105	72 419	59	563	78 211	5	-	154 916
1988	1 113	116	78	1 323	60 823	72	435	31 293	2	-	95 255
1989	1 217	-	26	171	36 451	1	590	20 062	-	-	58 518
1990	705	-	5	167	20 621	-	494	5 190	-	-	27 182
1991	1 117	-	**Greenld**	213	22 178	-	514	12 177	17	-	36 216
1992	1 093	151	1 719	387	36 238	38	596	19 699	1	-	59 922
1993	546	1215	880	1 165	40 978	76	1 802	35 071	646	-	82 379
1994	2 761	678	770	2 412	71 171	22	4 673	51 822	877	-	135 186
1995	2 833	598	1 097	2 675	76 886	14	3 111	54 516	718	-	142 448
1996	3 743	6	1 510	942	94 527	669	2 275	74 239	217	-	178 128
1997	3 327	540	1 877	972	103 407	364	2 340	41 228	304	-	154 359
1998	1 903	241	854	385	75 108	257	1 229	20 559	94	-	100 630
1999	1 913	64	437	641	48 182	652	694	30 520	92	-	83 195
2000	631	178	432	880	42 009	502	747	22 738	827	-	68 944
2001	1 210	324	553	554	49 067	1 497	1 068	34 307	1060	-	89 640
2002	1 564	297	858	627	52 247	1 505	1 125	37 157	682	20 738	96 062
2003	1 959	382	1 363	918	56 485	1 330	1 018	41 142	1103	28 946	105 700
2004 [1]	2 484	103	1 680	823	62 192	54	1 250	54 347	1569	30 469	124 502
2005 [1]	1 296	106	-	981	60 887	-	1 622	48 093	847	40 284	154 116

[1] Provisional figures, Norwegian catches on Russian quotas are included.

[2] USSR prior to 1991.

[3] Uncertain figures.

[4] Included landings in Norwegian statistical areas 06 and 07 (from 1983)

Table 4.4 Catch numbers at age (numbers, thousands spec.)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 1	Catch numbers at age			Numbers*10**-3		
YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	3189	65643	6012	64528	6563	1154
4	37949	9178	151996	13013	154696	10689
5	35344	18014	13634	70781	5885	176678
6	18849	13551	9850	5431	27590	4993
7	28868	6808	4693	2867	3233	28273
8	9199	6850	3237	1080	1302	1445
9	1979	3322	2434	424	712	271
10	1093	1182	606	315	319	100
+gp	2977	1348	880	1005	543	100
0 TOTAL	139447	125896	193342	159444	200843	223703
TONSLA	132125	120077	127660	123920	156788	202286
SOPCOF	61	80	56	68	66	64

Table 1	Catch numbers at age			Numbers*10**-3						
YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	16437	2074	1727	20318	39910	15429	39503	28466	22363	5936
4	5922	24704	5914	7826	70912	56855	30868	72736	49290	46356
5	14713	7942	31438	7243	13647	63351	48903	18969	30672	40201
6	127879	12535	5820	14040	7101	8706	33836	13579	5815	12631
7	3182	46619	12748	3154	6236	3578	3201	9257	3527	1679
8	8003	1087	17565	2237	1579	4407	1341	1239	2716	974
9	450	1971	822	5918	2340	788	1773	559	833	897
10	200	356	1072	285	2005	527	242	409	104	123
+gp	185	176	601	500	606	1434	756	375	633	802
0 TOTAL	176971	97464	77707	61521	144336	155075	160423	145589	115953	109599
TONSLA	213924	123583	112672	88211	154651	193224	187408	146224	99158	118578
SOPCOF	77	78	87	104	94	98	93	85	72	85

1

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 1	Catch numbers at age			Numbers*10**-3						
YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	26345	15907	657	1524	23444	1978	230942	70679	9685	10037
4	22631	41346	67632	1968	2454	24358	22315	260520	41706	14088
5	63176	13496	41267	44634	1906	1257	42981	24180	88120	33871
6	29048	25719	7748	19002	22417	918	3206	6919	5829	49711
7	5752	8872	15599	3620	8100	9279	1611	422	4138	2135
8	582	1616	5292	4937	2012	3056	6758	426	382	1236
9	438	218	655	1628	2016	826	2638	1692	618	92
10	189	175	182	316	740	1043	900	529	2043	131
+gp	242	271	286	109	293	534	1652	584	1870	934
0 TOTAL	148403	107620	139318	77738	63382	43249	313003	365951	154391	112235
TONSLA	161778	136397	181726	130820	88257	78905	266153	322226	221157	175758
SOPCOF	84	98	98	111	100	128	90	84	109	109

Table 4.4 Catch numbers at age (contin.)

Table 1	Catch numbers at age			Numbers*10**-3						
YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	13994	55967	47311	17540	627	486	883	1173	1271	29624
4	13454	22043	18812	35290	22878	2561	900	2636	1019	1695
5	6810	7368	4076	10645	21794	22124	3372	1360	1899	564
6	20796	2586	1389	1429	2971	10685	12203	2394	657	1009
7	40057	7781	1626	812	250	1034	2625	2506	950	943
8	1247	11043	2596	546	504	162	344	1799	2619	886
9	1350	311	6215	1466	230	162	75	267	352	1763
10	193	388	162	2310	842	72	80	37	87	588
+gp	1604	379	400	323	1460	963	649	292	77	281
0 TOTAL	99505	107866	82587	70361	51556	38249	21131	12464	8931	37353
TONSLA	137264	110158	95422	103623	87889	77153	46955	24600	20945	45052
SOPCOF	87	90	106	127	129	136	135	95	95	102

Table 1	Catch numbers at age			Numbers*10**-3						
YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	23113	5031	1439	2157	1015	4421	11571	13487	3374	2003
4	68429	87170	12478	4986	2580	3564	11567	19457	47821	16109
5	1565	64556	47890	16071	2142	2416	4099	13704	36333	72644
6	783	960	20429	25313	4046	3299	2642	4103	13264	19145
7	896	597	397	3198	6221	4633	2894	1747	2057	6417
8	393	376	178	147	840	3953	3327	1886	903	746
9	702	212	74	1	134	461	3498	2105	1453	361
10	1144	230	88	28	42	83	486	1965	2769	770
+gp	987	738	446	177	71	54	84	323	2110	1576
0 TOTAL	98012	159870	83419	52078	17091	22884	40168	58777	110084	119771
TONSLA	100563	154916	95255	58518	27182	36216	59922	82379	135186	142448
SOPCOF	95	101	100	102	98	96	102	100	99	98

Table 1	Catch numbers at age			Numbers*10**-3						
YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	1662	2280	1701	16839	1520	12971	6960	6496	6898	10575
4	6818	5633	11304	8039	29986	5230	46278	27043	18113	17547
5	36473	12603	9258	15365	6496	32049	11273	51599	36593	20332
6	73579	32832	8633	6073	5149	5279	22647	12927	42650	33535
7	13426	49478	13801	4466	2406	2941	2623	14900	5256	26533
8	2944	5636	19469	6355	1657	1137	1621	2156	5253	2653
9	573	778	2113	6204	1570	1161	498	1662	675	3946
10	365	245	330	647	1744	1169	470	1231	1541	995
+gp	1897	748	490	446	437	1204	1052	1391	96	1439
0 TOTAL	137737	110233	67099	64434	50965	63141	93422	119405	117075	117555
TONSLA	178128	154359	100630	83195	68944	89640	116800	134649	154975	154116
SOPCOF	98	95	99	98	97	101	99	98	100	100
1										

Table 4.5 Catch weights at age (kg)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 2 Catch weights at age (kg)

	YEAR	1950	1951	1952	1953	1954	1955
	AGE						
	3	0.768	0.768	0.768	0.768	0.768	0.768
	4	1.065	1.065	1.065	1.065	1.065	1.065
	5	1.353	1.353	1.353	1.353	1.353	1.353
	6	1.663	1.663	1.663	1.663	1.663	1.663
	7	1.921	1.921	1.921	1.921	1.921	1.921
	8	2.183	2.183	2.183	2.183	2.183	2.183
	9	2.463	2.463	2.463	2.463	2.463	2.463
	10	2.752	2.752	2.752	2.752	2.752	2.752
	+gp	3.177	3.177	3.177	3.177	3.177	3.177
0	SOPCO	0.6148	0.796	0.5603	0.6839	0.6614	0.6354

Table 2 Catch weights at age (kg)

	YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	AGE										
	3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768
	4	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065
	5	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353
	6	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663
	7	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921
	8	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183
	9	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463
	10	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752
	+gp	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177
0	SOPCO	0.7714	0.7831	0.8697	1.038	0.9368	0.9807	0.927	0.8514	0.7191	0.8484
	1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 2 Catch weights at age (kg)

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768
	4	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065
	5	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353
	6	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663
	7	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921
	8	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183
	9	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463
	10	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752
	+gp	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177
0	SOPCO	0.8391	0.9761	0.9781	1.1066	0.9988	1.2771	0.8971	0.8366	1.0914	1.0879

Table 4.5 Catch weights at age (contin.)

Table 2 Catch weights at age (kg)

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	1.033	1.218	0.835
	4	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.408	1.632	1.29
	5	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.71	2.038	1.816
	6	1.663	1.663	1.663	1.663	1.663	1.663	1.663	2.149	2.852	2.174
	7	1.921	1.921	1.921	1.921	1.921	1.921	1.921	2.469	2.845	2.301
	8	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.748	3.218	2.835
	9	2.463	2.463	2.463	2.463	2.463	2.463	2.463	3.069	3.605	3.253
	10	2.752	2.752	2.752	2.752	2.752	2.752	2.752	3.687	4.065	3.721
	+gp	3.177	3.177	3.177	3.177	3.177	3.177	3.177	4.516	4.667	4.416
0	SOPCO	0.8715	0.8969	1.0601	1.2702	1.2854	1.3583	1.3511	0.9535	0.9491	1.0242

Table 2 Catch weights at age (kg)

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	0.612	0.497	0.55	0.684	0.793	0.941	0.906	0.94	0.614	0.739
	4	1.064	0.765	0.908	0.84	1.172	1.281	1.263	1.204	0.906	0.808
	5	1.539	1.179	1.097	0.998	1.397	1.556	1.535	1.487	1.287	1.107
	6	1.944	1.724	1.357	1.176	1.624	1.797	1.747	1.748	1.602	1.556
	7	2.362	2.135	1.537	1.546	1.885	2.044	2.043	1.994	1.968	1.838
	8	2.794	2.551	1.704	1.713	2.112	2.079	2.2	2.237	2.059	2.234
	9	3.25	3.009	2.403	1.949	2.653	2.311	2.298	2.417	2.39	2.416
	10	3.643	3.414	2.403	2.14	3.102	2.788	2.494	2.654	2.545	2.602
	+gp	5.283	4.213	2.571	2.685	3.338	3.219	2.652	3.026	2.893	3.13
0	SOPCO	0.9508	1.0078	1.0045	1.023	0.9843	0.9639	1.0207	0.9969	0.9945	0.9759

Table 2 Catch weights at age (kg)

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	0.683	0.682	0.748	0.826	0.853	0.751	0.711	0.624	0.662	0.751
	4	0.868	1.028	0.974	1.079	1.186	1.104	1.012	0.866	0.91	0.916
	5	1.045	1.151	1.262	1.261	1.395	1.459	1.364	1.121	1.192	1.129
	6	1.363	1.369	1.433	1.485	1.588	1.709	1.64	1.349	1.512	1.345
	7	1.71	1.637	1.641	1.634	1.808	1.921	1.962	1.48	1.817	1.611
	8	1.886	1.856	1.863	1.798	1.989	2.182	2.088	1.927	2.092	2.044
	9	2.214	2.073	2.069	2.032	2.264	2.331	2.298	1.844	2.366	2.132
	10	2.37	2.5	2.335	2.237	2.415	2.609	2.449	2.034	2.68	2.406
	+gp	2.675	2.554	2.81	2.712	2.892	2.981	2.613	2.187	2.53	2.511
0	SOPCO	0.9832	0.9505	0.9888	0.9792	0.9741	1.0098	0.9909	0.9788	0.9956	0.9965
	1										

Table 4.6 Stock weights at age (kg)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 3 Stock weights at age (kg)

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	0.368	0.368	0.368	0.368	0.368	0.368
4	0.672	0.672	0.672	0.672	0.672	0.672
5	1.04	1.04	1.04	1.04	1.04	1.04
6	1.456	1.456	1.456	1.456	1.456	1.456
7	1.902	1.902	1.902	1.902	1.902	1.902
8	2.368	2.368	2.368	2.368	2.368	2.368
9	2.819	2.819	2.819	2.819	2.819	2.819
10	3.24	3.24	3.24	3.24	3.24	3.24
+gp	3.66	3.66	3.66	3.66	3.66	3.66

Table 3 Stock weights at age (kg)

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368
4	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672
5	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
6	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456
7	1.902	1.902	1.902	1.902	1.902	1.902	1.902	1.902	1.902	1.902
8	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368
9	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819
10	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
+gp	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66
1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 3 Stock weights at age (kg)

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368
4	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672
5	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
6	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456
7	1.902	1.902	1.902	1.902	1.902	1.902	1.902	1.902	1.902	1.902
8	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368	2.368
9	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819
10	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
+gp	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66

Table 4.6 Stock weights at age (contin.)

Table 3 Stock weights at age (kg)

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.368	0.368	0.368	0.368	0.454	0.606	0.634	0.527	0.393	0.379
4	0.672	0.672	0.672	0.672	0.871	0.802	1.05	1.1	0.927	0.701
5	1.04	1.04	1.04	1.04	1.164	1.305	1.212	1.557	1.632	1.393
6	1.456	1.456	1.456	1.456	1.676	1.589	1.77	1.656	2.091	2.195
7	1.902	1.902	1.902	1.902	2.286	2.123	2.026	2.243	2.113	2.626
8	2.368	2.368	2.368	2.368	3.105	2.728	2.562	2.461	2.707	2.565
9	2.819	2.819	2.819	2.819	3.301	3.498	3.148	2.984	2.882	3.151
10	3.24	3.24	3.24	3.24	3.527	3.681	3.857	3.539	3.383	3.283
+gp	3.66	3.66	3.66	3.66	3.952	3.889	4.03	4.183	3.901	3.755

Table 3 Stock weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.312	0.333	0.385	0.447	0.414	0.402	0.341	0.28	0.264	0.292
4	0.681	0.569	0.604	0.69	0.79	0.735	0.719	0.616	0.512	0.485
5	1.069	1.045	0.885	0.936	1.055	1.193	1.116	1.096	0.95	0.799
6	1.895	1.472	1.448	1.243	1.31	1.458	1.63	1.533	1.511	1.322
7	2.76	2.407	1.893	1.872	1.628	1.71	1.882	2.081	1.965	1.944
8	3.14	3.308	2.911	2.316	2.303	2.027	2.122	2.31	2.53	2.398
9	3.001	3.624	3.825	3.394	2.73	2.729	2.427	2.535	2.732	2.964
10	3.567	3.413	4.069	4.305	3.846	3.126	3.141	2.822	2.94	3.14
+gp	3.659	3.951	3.795	4.472	4.744	4.264	3.5	3.533	3.204	3.331

Table 3 Stock weights at age (kg)

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0.302	0.331	0.297	0.347	0.31	0.322	0.298	0.289	0.307	0.305
4	0.535	0.552	0.6	0.536	0.626	0.565	0.584	0.544	0.529	0.56
5	0.76	0.836	0.859	0.928	0.823	0.964	0.879	0.902	0.846	0.826
6	1.125	1.075	1.178	1.207	1.295	1.142	1.341	1.236	1.26	1.188
7	1.717	1.477	1.416	1.548	1.582	1.686	1.478	1.741	1.618	1.641
8	2.38	2.12	1.842	1.772	1.933	1.97	2.087	1.82	2.148	2.014
9	2.82	2.806	2.519	2.21	2.133	2.322	2.36	2.487	2.157	2.552
10	3.377	3.222	3.216	2.906	2.573	2.492	2.708	2.745	2.878	2.483
+gp	3.529	3.764	3.602	3.602	3.276	2.926	2.842	3.082	3.117	3.253
1										

Table 4.7 Natural mortality (M) at age

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 4 Natural Mortality (M) at age

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266
4	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291
5	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149
6	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022
7	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
9	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
+gp	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266
4	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291
5	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149
6	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022
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										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 4 Natural Mortality (M) at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266
4	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291
5	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149
6	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022
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 4.7 (contin.)

Table 4 Natural Mortality (M) at age

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.3266	0.2074	0.2
4	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2291	0.2	0.2
5	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2149	0.2	0.2
6	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	0.2022	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	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.6443	0.2	0.403	0.2	0.3214	0.2	0.2057	0.2599	0.2937	0.3412
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2248	0.217	0.3601
5	0.2	0.2	0.2023	0.2	0.2	0.2	0.2	0.2672	0.2111	0.3018
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2005	0.2078
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	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0.7107	0.4594	0.2349	0.2013	0.2221	0.2141	0.329	0.404	0.3773	0.5564
4	0.2954	0.2376	0.2485	0.2	0.2063	0.2011	0.2094	0.2606	0.2833	0.296
5	0.2235	0.2219	0.2179	0.2	0.2068	0.2	0.2077	0.2072	0.2324	0.2278
6	0.2217	0.2088	0.2	0.2	0.2037	0.2	0.2025	0.2	0.2033	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 4.8 Proportion mature at age

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 5 Proportion mature at age

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	0.025	0.025	0.025	0.025	0.025	0.025
4	0.097	0.097	0.097	0.097	0.097	0.097
5	0.309	0.309	0.309	0.309	0.309	0.309
6	0.632	0.632	0.632	0.632	0.632	0.632
7	0.857	0.857	0.857	0.857	0.857	0.857
8	0.953	0.953	0.953	0.953	0.953	0.953
9	0.986	0.986	0.986	0.986	0.986	0.986
10	0.996	0.996	0.996	0.996	0.996	0.996
+gp	0.999	0.999	0.999	0.999	0.999	0.999

Table 5 Proportion mature at age

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
4	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097
5	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309
6	0.632	0.632	0.632	0.632	0.632	0.632	0.632	0.632	0.632	0.632
7	0.857	0.857	0.857	0.857	0.857	0.857	0.857	0.857	0.857	0.857
8	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953
9	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986
10	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996
+gp	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 5 Proportion mature at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
4	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097	0.097
5	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309
6	0.632	0.632	0.632	0.632	0.632	0.632	0.632	0.632	0.632	0.632
7	0.857	0.857	0.857	0.857	0.857	0.857	0.857	0.857	0.857	0.857
8	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953
9	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986
10	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996
+gp	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999

Table 4.8 (contin.)

Table 5 Proportion mature at age

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.025	0.025	0.025	0.025	0.027	0.034	0.039	0.037	0.036	0.021
4	0.097	0.097	0.097	0.097	0.108	0.104	0.127	0.146	0.133	0.129
5	0.309	0.309	0.309	0.309	0.347	0.339	0.326	0.38	0.417	0.387
6	0.632	0.632	0.632	0.632	0.65	0.671	0.659	0.655	0.705	0.737
7	0.857	0.857	0.857	0.857	0.861	0.856	0.879	0.87	0.873	0.897
8	0.953	0.953	0.953	0.953	0.955	0.953	0.952	0.962	0.958	0.96
9	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.989	0.987
10	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.997
+gp	0.999	0.999	0.999	0.999	0.998	0.999	0.999	0.999	0.999	0.999

Table 5 Proportion mature at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.017	0.019	0.024	0.03	0.041	0.034	0.024	0.014	0.013	0.014
4	0.084	0.069	0.077	0.095	0.117	0.144	0.123	0.091	0.06	0.056
5	0.376	0.281	0.239	0.261	0.307	0.357	0.405	0.364	0.292	0.213
6	0.716	0.707	0.597	0.547	0.575	0.63	0.684	0.732	0.696	0.62
7	0.911	0.905	0.902	0.836	0.806	0.825	0.857	0.887	0.913	0.896
8	0.968	0.973	0.972	0.971	0.945	0.934	0.942	0.954	0.965	0.975
9	0.988	0.991	0.992	0.992	0.992	0.983	0.98	0.982	0.986	0.99
10	0.996	0.997	0.997	0.998	0.998	0.998	0.995	0.994	0.995	0.996
+gp	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.998	0.998

Table 5 Proportion mature at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0.017	0.023	0.029	0.037	0.025	0.026	0.02	0.016	0.018	0.019
4	0.058	0.07	0.09	0.107	0.129	0.093	0.096	0.079	0.066	0.073
5	0.202	0.208	0.241	0.291	0.33	0.369	0.295	0.305	0.263	0.229
6	0.504	0.486	0.493	0.551	0.618	0.663	0.701	0.625	0.636	0.584
7	0.858	0.77	0.753	0.757	0.811	0.855	0.881	0.901	0.863	0.867
8	0.969	0.956	0.916	0.908	0.909	0.936	0.954	0.964	0.971	0.958
9	0.993	0.991	0.987	0.974	0.97	0.971	0.98	0.986	0.99	0.992
10	0.997	0.998	0.997	0.996	0.992	0.991	0.991	0.994	0.996	0.997
+gp	0.999	0.999	0.999	0.999	0.999	0.998	0.997	0.997	0.998	0.999
1										

Table 4.9 Survey indicies used in tuning XSA

North-East Arctic haddock 2006
103
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7
1983 2005

age		1	2	3	4	5	6	7	8
	1	592	95	5	4	0.1	0	0	
	1	586	584	15	2	1	0.1	0	
	1	144	1343	900	4	1	1	0	
	1	14	107	363	164	1	0.1	0.1	
	1	9	17	83	225	57	0.1	0.1	
	1	3	7	17	40	76	8	0.1	
	1	18	24	4	14	41	81	11	
	1	0	0	0	0	0	0	0	
	1	429	176	62	9	3	6	18	
	1	282	1286	346	50	4	6	9	
	1	48	357	1985	356	48	8	4	
	1	49	58	442	1014	116	15	1	
	1	72	42	31	123	370	40	5	
	1	23	57	28	49	362	334	29	
	1	0	19	32	32	10	27	10	
	1	29	0	38	46	8	5	15	
	1	289	61	0	39	37	8	3	
	1	207	262	60	0	26	11	2	
	1	149	261	334	40	0	11	4	
	1	193	189	399	450	47	0	4	
	1	328	251	221	299	231	34	0	
	1	110	206	113	94	107	87	5	

FLT02: Norwegian acoustic, age 1-7, shifted
1980 2005

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
1	2090	2190	1020	360	400	90	0

Table 4.9 (contin.)

FLT04: Norwegian BT survey, age 1-8, shifted
1982 2005

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
1	4204	3465	1333	668	522	123	6	0

Table 4.10 North-East Arctic HADDOCK. Input data for recruitment prediction (RCT3).

NORTHEAST ARCTIC HADDOCK: recruits as 3 year-olds

8 16 2

'Year-class'	'VPA'	'RT1'	'RT2'	'NT2'	'NT3'	'NT4'	'RT0'	'NT1'	'NA1'
1990	688.9	42.9	128.6	1375.5	507.7	436.6	-11	2006	1890
1991	307.7	28.2	35.7	599	339.5	171.1	16.7	1659.4	1135
1992	99.8	4.8	5.8	228	53.6	48.1	16.4	727.9	947
1993	107.5	4.9	4.2	179.3	52.5	28	3.5	603.2	562
1994	119	7.2	5.7	263.6	86.1	33.2	9.1	1463.6	1379
1995	62.9	2.3	1.9	67.9	22.7	12.2	6.4	309.5	249
1996	277.1	-11	-11	-11	-11	-11	-11	-11	-11
1997	99.8	2.9	6.1	57.6	27.2	29.3	1.8	212.9	220
1998	438.4	28.9	26.2	452.2	296	185.3	10.7	1244.9	856
1999	346.9	20.7	26.1	460.3	314.7	182	11.7	847.2	1024
2000	219.1	14.9	18.9	534.7	317.4	102.7	15.1	1220.5	976
2001	229.4	19.3	25.1	513.1	188.1	133.3	20.8	1680.3	2062
2002	358.9	32.8	20.6	711.2	346.5	140.5	33.2	3332.1	2394
2003	-11	11	13.6	420.4	77.4	-11	19.8	715.9	752
2004	-11	79.2	-11	1313.1	-11	-11	50	4630.2	3364
2005	-11	-11	-11	-11	-11	-11	62	5141.3	2767

1990 RT was removed from XSA tuning

1996 yearclass 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 1

NT1 Norwegian bottom trawl survey age 1

NA1 Norwegian acoustic survey age 1

Table 4.11 NEA Haddock. Analysis by RCT3 ver.1

Yearclass	=	2002							
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series	cept	Error	Pts	Value	Value	Error	Weights		
RT1	0.84	3.16	0.19	0.944	11	3.52	6.11	0.237	0.247
RT2	0.72	3.32	0.22	0.925	11	3.07	5.54	0.26	0.206
NT2	0.89	0.22	0.43	0.76	11	6.57	6.03	0.534	0.049
NT3	0.7	1.86	0.28	0.879	11	5.85	5.95	0.351	0.113
NT4	0.71	2.17	0.17	0.953	11	4.95	5.68	0.206	0.329
RT0	1.81	0.94	1.08	0.296	10	3.53	7.32	1.505	0.006
NT1	1.38	-4.1	0.76	0.506	11	8.11	7.1	1.043	0.013
NA1	1.49	-4.75	0.89	0.424	11	7.78	6.84	1.168	0.01
VPA	Mean	=	5.27	0.695	0.029				

Yearclass	=	2003							
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series	cept	Error	Pts	Value	Value	Error	Weights		
RT1	0.81	3.21	0.18	0.943	12	2.48	5.22	0.216	0.4
RT2	0.76	3.25	0.25	0.903	12	2.68	5.29	0.287	0.227
NT2	0.87	0.32	0.41	0.773	12	6.04	5.56	0.477	0.082
NT3	0.69	1.9	0.27	0.887	12	4.36	4.91	0.317	0.186
NT4									
RT0	1.44	1.7	0.88	0.387	11	3.03	6.06	1.077	0.016
NT1	1.19	-2.88	0.7	0.531	12	6.57	4.92	0.829	0.027
NA1	1.31	-3.64	0.8	0.468	12	6.62	5.06	0.936	0.021
VPA	Mean	=	5.33	0.679	0.041				

Yearclass	=	2004							
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series	cept	Error	Pts	Value	Value	Error	Weights		
RT1	0.81	3.22	0.18	0.942	12	4.38	6.76	0.262	0.642
RT2									
NT2	0.86	0.34	0.41	0.767	12	7.18	6.54	0.544	0.149
NT3									
NT4									
RT0	1.42	1.75	0.88	0.392	11	3.93	7.33	1.251	0.028
NT1	1.17	-2.74	0.7	0.528	12	8.44	7.11	0.975	0.046
NA1	1.29	-3.48	0.79	0.467	12	8.12	7	1.067	0.039
VPA	Mean	=	5.33	0.672	0.097				

Yearclass	=	2005							
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series	cept	Error	Pts	Value	Value	Error	Weights		
RT1									
RT2									
NT2									
NT3									
NT4									
RT0	1.39	1.81	0.87	0.398	11	4.14	7.59	1.322	0.121
NT1	1.14	-2.58	0.7	0.525	12	8.55	7.19	1.013	0.206
NA1	1.26	-3.28	0.79	0.467	12	7.93	6.71	1.046	0.193
VPA	Mean	=	5.34	0.664	0.48				

Year	Weighted	Log	Int	Ext	Var	VPA	Log
Class	Average	WAP	Std	Std	Ratio	VPA	
Prediction	Error	Error					
2002	342	5.84	0.12	0.11	0.91	359	5.89
2003	183	5.21	0.14	0.08	0.33		
2004	755	6.63	0.21	0.2	0.93		
2005	521	6.26	0.46	0.53	1.33		

Table 4.12 Extended Survivors Analysis

Lowestoft VPA Version 3.1

25/04/2006 0:44

Extended Survivors Analysis

NEA Haddock (Final XSA AFWG06)

CPUE data from file fleet

Catch data for 56 years. 1950 to 2005. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: Russian BT su	1990	2005	1	7	0.9	1
FLT02: Norwegian aco	1990	2005	1	7	0.99	1
FLT04: Norwegian BT	1990	2005	1	8	0.99	1

Table 4.13

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 = .00199

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	0.0001	0.0034	0.0449	0.1504	0.2573	0.4666	0.6274	0.2992	0.2395	0.475
Iteration 30	0.0001	0.0034	0.0449	0.1504	0.2573	0.4664	0.6269	0.2989	0.2392	0.4744

1

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Table 4.12 (contin.)

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0	0	0.001	0	0	0	0	0	0	0
2	0.002	0.001	0.005	0.005	0.001	0.004	0.002	0.002	0.003	0.003
3	0.022	0.024	0.03	0.069	0.017	0.037	0.024	0.034	0.038	0.045
4	0.12	0.13	0.19	0.201	0.169	0.076	0.181	0.133	0.145	0.15
5	0.328	0.364	0.337	0.44	0.248	0.276	0.235	0.318	0.283	0.257
6	0.473	0.568	0.465	0.392	0.257	0.33	0.321	0.467	0.477	0.466
7	0.661	0.697	0.501	0.468	0.264	0.229	0.271	0.363	0.35	0.627
8	0.878	0.655	0.663	0.455	0.316	0.192	0.191	0.374	0.209	0.299
9	0.659	0.605	0.551	0.455	0.191	0.382	0.12	0.305	0.19	0.239
10	0.674	0.669	0.564	0.321	0.221	0.213	0.262	0.487	0.517	0.474

1

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8	9	10
1996	1.84E+06	3.19E+05	1.08E+05	6.99E+04	1.46E+05	2.18E+05	3.07E+04	5.57E+03	1.31E+03	8.23E+02
1997	1.43E+06	1.16E+05	1.20E+05	5.21E+04	4.61E+04	8.41E+04	1.09E+05	1.30E+04	1.89E+03	5.55E+02
1998	1.78E+06	3.75E+05	6.37E+04	7.40E+04	3.61E+04	2.57E+04	3.87E+04	4.44E+04	5.51E+03	8.46E+02
1999	1.68E+06	1.47E+05	2.80E+05	4.89E+04	4.77E+04	2.07E+04	1.32E+04	1.92E+04	1.87E+04	2.60E+03
2000	1.94E+06	5.61E+05	1.00E+05	2.14E+05	3.27E+04	2.51E+04	1.14E+04	6.76E+03	9.97E+03	9.73E+03
2001	1.29E+06	4.89E+05	3.99E+05	7.87E+04	1.47E+05	2.08E+04	1.59E+04	7.19E+03	4.04E+03	6.74E+03
2002	3.11E+06	5.49E+05	3.51E+05	3.11E+05	5.97E+04	9.13E+04	1.22E+04	1.03E+04	4.86E+03	2.26E+03
2003	4.10E+06	5.00E+05	2.39E+05	2.47E+05	2.10E+05	3.83E+04	5.41E+04	7.64E+03	6.99E+03	3.53E+03
2004	2.44E+06	5.99E+05	2.21E+05	1.54E+05	1.67E+05	1.24E+05	1.97E+04	3.08E+04	4.30E+03	4.22E+03
2005	5.11E+06	3.94E+05	3.18E+05	1.46E+05	1.00E+05	9.94E+04	6.30E+04	1.13E+04	2.05E+04	2.91E+03

Estimated population abundance at 1st Jan 2006

0.00E+00	7.57E+05	1.30E+05	1.74E+05	9.33E+04	6.19E+04	5.11E+04	2.76E+04	6.90E+03	1.32E+04

Taper weighted geometric mean of the VPA populations:

2.17E+06	3.55E+05	1.89E+05	1.23E+05	7.99E+04	4.46E+04	2.14E+04	9.96E+03	5.13E+03	2.47E+03

Standard error of the weighted Log(VPA populations) :

0.5558	0.6251	0.7129	0.787	0.8406	0.8796	0.8815	0.863	0.9723	1.0135

1

Log catchability residuals.

Fleet : FLT01: Russian BT su

Age	1990	1991	1992	1993	1994	1995
1	99.99	0.27	0.11	-0.13	-0.34	-0.43
2	99.99	0.22	0.3	0.19	0.07	-0.33
3	99.99	0.08	0.41	0.28	0.21	-0.22
4	99.99	-0.13	-0.08	0.61	0.15	-0.42
5	99.99	-0.22	-0.22	0.32	0.25	-0.25
6	99.99	-0.36	0.44	0.62	0.1	0.11
7	99.99	0.57	0.74	0.92	-0.36	0.41
8	No data for this fleet at this age					

Table 4.12 (contin.)

Age		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	1	-0.24	99.99	-0.22	0.39	0.21	0.15	-0.06	0.02	-0.14	0.29
	2	-0.21	-0.15	99.99	0.24	-0.17	-0.04	-0.06	0.21	-0.21	0.23
	3	-0.15	-0.31	0.3	99.99	0.11	-0.24	0.05	0.13	-0.21	-0.02
	4	0.1	0.06	0.01	0.29	99.99	-0.25	0.15	0.1	-0.22	-0.22
	5	0.69	-0.51	-0.43	0.36	0.39	99.99	0.17	0.01	-0.27	-0.31
	6	0.47	-0.45	-0.65	-0.12	-0.17	0.07	99.99	0.43	-0.01	-0.13
	7	1.32	-0.98	0.28	-0.29	-0.74	-0.41	-0.11	99.99	-0.29	0.38
	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	-7.4685
S.E(Log q)	0.6473

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	0.57	2.184	10.91	0.74	14	0.27	-8.05
2	0.66	2.864	9.2	0.89	14	0.22	-7.3
3	0.6	3.672	9.04	0.9	14	0.23	-6.93
4	0.7	2.716	8.24	0.91	14	0.26	-6.77
5	0.66	2.318	8.35	0.84	14	0.39	-6.85
6	0.77	1.678	7.78	0.86	14	0.38	-6.92

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	1.03	-0.099	7.4	0.62	14	0.7	-7.47
1							

Fleet : FLT02: Norwegian aco

Age		1990	1991	1992	1993	1994	1995
	1	0.65	0.3	0.37	0.34	0.35	0
	2	0.14	0.25	0.01	0.21	-0.05	-0.08
	3	0.25	-0.17	0.31	0.21	-0.14	0.16
	4	0.13	-0.39	-0.27	0.51	0.17	-0.03
	5	0.11	99.99	99.99	0.29	0.39	-0.11
	6	-0.15	99.99	99.99	99.99	0.06	0.26
	7	0.73	-0.87	99.99	99.99	99.99	99.99
	8	No data for this fleet at this age					

Age		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	1	-0.8	99.99	-0.48	0.36	0.06	-0.01	-0.17	0.03	-0.15	0.21
	2	-0.06	0.05	99.99	-0.01	-0.09	0.06	0.01	0	0.07	-0.15
	3	-0.07	0	-0.04	99.99	-0.12	-0.23	0.16	-0.05	0.21	-0.14
	4	-0.13	0.13	-0.07	0.53	99.99	-0.24	0.17	-0.14	-0.16	-0.22
	5	0.09	-0.03	0.07	0.44	-0.73	99.99	0.36	-0.04	-0.11	-0.34
	6	0.11	0.31	-0.31	0.33	-0.43	-0.19	99.99	0.61	-0.39	-0.18
	7	0.12	0.97	-0.27	0.08	99.99	99.99	99.99	99.99	99.99	-0.63
	8	No data for this fleet at this age									

Table 4.12 (contin.)

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	-6.6031
S.E(Log q)	0.6385

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	0.76	1.002	7.36	0.66	15	0.36	-5.07
2	0.68	5.842	7.69	0.97	15	0.1	-5.31
3	0.68	4.151	7.56	0.95	15	0.17	-5.36
4	0.68	2.864	7.46	0.9	15	0.28	-5.52
5	0.6	2.63	8.02	0.84	13	0.36	-5.8
6	0.68	2.065	7.84	0.84	12	0.37	-6.43

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	0.82	0.449	7.3	0.7	7	0.59	-6.6
1							

Fleet : FLT04: Norwegian BT

Age	1990	1991	1992	1993	1994	1995
1	0.56	0.36	0.04	0.19	-0.26	-0.19
2	-0.14	0.14	-0.38	0.11	0.08	-0.13
3	-0.2	-0.26	0.04	-0.16	0.02	0.33
4	0.35	-0.37	-0.42	-0.03	0.1	0.44
5	0.31	0.16	-0.04	-0.25	0.3	0.07
6	-0.38	-0.14	0.32	-0.14	0.32	0.4
7	1.16	0.39	-0.41	-0.52	99.99	0.96
8	99.99	1.3	-0.25	0.03	0.45	99.99

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.26	99.99	-0.54	0	0.07	0.21	0	0.02	0.1	0.23
2	0.09	0.09	99.99	-0.16	-0.12	0.05	0.23	0.01	0.08	-0.11
3	0.13	-0.02	-0.22	99.99	-0.09	-0.21	-0.03	0.03	0.27	0.07
4	0.2	0.19	-0.29	-0.03	99.99	-0.08	-0.39	-0.09	0.27	0.12
5	0.15	-0.04	0.09	0.04	-0.12	99.99	-0.12	-0.24	0.05	0.04
6	0.06	-0.09	-0.13	-0.08	-0.28	-0.12	99.99	0.46	-0.3	0.04
7	1.47	1.08	0.36	-0.33	-1.49	-0.75	-0.86	99.99	-0.16	0.6
8	0.15	1.03	0.26	0.44	-0.6	99.99	-1.15	0.03	99.99	-0.44

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	-7.3911	-7.7024
S.E(Log q)	0.9103	0.6694

Table 4.12 (contin.)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.72	1.665	7.52	0.79	15	0.26	-4.7
2	0.59	5.024	8.21	0.94	15	0.15	-5
3	0.68	3.911	7.4	0.94	15	0.18	-5.17
4	0.69	2.871	7.43	0.91	15	0.27	-5.53
5	0.52	8.25	8.57	0.97	15	0.16	-6.09
6	0.56	4.478	8.36	0.92	15	0.28	-6.57

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	0.56	2.766	8.53	0.83	14	0.39	-7.39
8	0.85	0.53	7.95	0.63	12	0.59	-7.7
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2004

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	1011712	0.33	0	0	1	0.288	0
FLT02: Norwegian aco	929754	0.422	0	0	1	0.177	0
FLT04: Norwegian BT	955805	0.31	0	0	1	0.329	0
P shrinkage mean	354798	0.63				0.081	0
F shrinkage mean	258542	0.5				0.126	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
757162	0.18	0.27	5	1.55	0

1

Age 2 Catchability dependent on age and year class strength

Year class = 2003

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	136462	0.212	0.185	0.87	2	0.324	0.003
FLT02: Norwegian aco	112633	0.235	0.001	0.01	2	0.265	0.004
FLT04: Norwegian BT	129473	0.212	0.103	0.48	2	0.324	0.003
P shrinkage mean	189308	0.71				0.029	0.002
F shrinkage mean	172441	0.5				0.059	0.003

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
130487	0.12	0.07	8	0.545	0.003

Table 4.12 (contin.)

Age 3 Catchability dependent on age and year class strength

Year class = 2002

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	162457	0.173	0.071	0.41	3	0.329	0.048
FLT02: Norwegian aco	170697	0.187	0.068	0.36	3	0.283	0.046
FLT04: Norwegian BT	184208	0.173	0.016	0.09	3	0.329	0.043
P shrinkage mean	122757	0.79				0.017	0.063
F shrinkage mean	259393	0.5				0.041	0.03

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
174253	0.1	0.04	11	0.421	0.045

1

Age 4 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	86993	0.15	0.1	0.67	4	0.327	0.16
FLT02: Norwegian aco	90437	0.158	0.099	0.63	4	0.298	0.155
FLT04: Norwegian BT	102804	0.15	0.063	0.42	4	0.327	0.137
P shrinkage mean	79948	0.84				0.013	0.173
F shrinkage mean	99271	0.5				0.035	0.142

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
93283	0.09	0.05	14	0.537	0.15

Age 5 Catchability dependent on age and year class strength

Year class = 2000

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	59003	0.142	0.088	0.62	5	0.311	0.268
FLT02: Norwegian aco	55529	0.147	0.061	0.42	5	0.291	0.283
FLT04: Norwegian BT	71964	0.135	0.052	0.38	5	0.349	0.225
P shrinkage mean	44645	0.88				0.012	0.341
F shrinkage mean	57591	0.5				0.037	0.274

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
61863	0.08	0.04	17	0.551	0.257

Table 4.12 (contin.)

1

Age 6 Catchability dependent on age and year class strength

Year class = 1999

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	51377	0.136	0.065	0.47	6	0.293	0.464
FLT02: Norwegian aco	49795	0.14	0.057	0.4	6	0.281	0.476
FLT04: Norwegian BT	51931	0.125	0.025	0.2	6	0.362	0.46
P shrinkage mean	21395	0.88				0.016	0.883
F shrinkage mean	67172	0.5				0.049	0.373

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51092	0.08	0.04	20	0.492	0.466

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

Year class = 1998

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	29057	0.141	0.094	0.67	7	0.288	0.602
FLT02: Norwegian aco	24476	0.145	0.113	0.78	7	0.275	0.684
FLT04: Norwegian BT	22755	0.128	0.08	0.62	7	0.347	0.72
F shrinkage mean	69401	0.5				0.091	0.297

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
27559	0.09	0.09	22	1.002	0.627

1

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

Year class = 1997

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	7122	0.138	0.104	0.76	7	0.293	0.29
FLT02: Norwegian aco	7090	0.142	0.152	1.07	6	0.255	0.292
FLT04: Norwegian BT	6357	0.13	0.118	0.91	8	0.371	0.32
F shrinkage mean	8174	0.5				0.081	0.258

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6897	0.08	0.07	22	0.789	0.299

Table 4.12 (contin.)

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

Year class = 1996

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	1	0	0	0	0	0	0
FLT02: Norwegian aco	1	0	0	0	0	0	0
FLT04: Norwegian BT	1	0	0	0	0	0	0
F shrinkage mean	13225	0.5				1	0.239

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13225	0.5	0	1	0	0.239

1

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1995

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	1625	0.145	0.093	0.65	7	0.271	0.441
FLT02: Norwegian aco	1377	0.154	0.191	1.24	6	0.223	0.503
FLT04: Norwegian BT	1313	0.134	0.064	0.48	8	0.353	0.522
F shrinkage mean	1882	0.5				0.153	0.391

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1485	0.1	0.06	22	0.61	0.474

1

Table 4.13 (Proportion of M before Spawning)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 6 Proportion of M before Spawning

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
+gp	0	0	0	0	0	0

Table 6 Proportion of M before Spawning

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0
1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 6 Proportion of M before Spawning

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 4.13 (contin.)

Table 6 Proportion of M before Spawning

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 6 Proportion of M before Spawning

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 6 Proportion of M before Spawning

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0
1										

Table 4.14 (Proportion of F before Spawning)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 7 Proportion of F before Spawning

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
+gp	0	0	0	0	0	0

Table 7 Proportion of F before Spawning

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

1

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 7 Proportion of F before Spawning

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 4.14 (contin.)

Table 7 Proportion of F before Spawning

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 7 Proportion of F before Spawning

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 7 Proportion of F before Spawning

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0
1										

Table 4.15 (Fishing mortality at age)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	0.0495	0.1279	0.1058	0.0652	0.0558	0.0229
4	0.5811	0.2142	0.5366	0.383	0.2399	0.1319
5	0.8188	0.6295	0.5805	0.5332	0.3066	0.4864
6	0.8118	0.9127	0.888	0.4895	0.4142	0.4686
7	1.157	0.8053	0.9961	0.7145	0.6139	1.0131
8	1.0055	1.0036	1.2502	0.6589	0.8609	0.6211
9	0.6504	1.4256	1.3695	0.5162	1.3582	0.43
10	0.946	1.0901	1.2251	0.6331	0.9584	0.6948
+gp	0.946	1.0901	1.2251	0.6331	0.9584	0.6948
0 FBAR 4- 7	0.8422	0.6404	0.7503	0.53	0.3936	0.525

Table 8 Fishing mortality (F) at age

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	0.1036	0.041	0.0259	0.0654	0.1842	0.1555	0.183	0.1108	0.0736	0.0609
4	0.1707	0.2441	0.1713	0.1706	0.3717	0.4778	0.5841	0.6648	0.3116	0.2343
5	0.2769	0.372	0.5745	0.3355	0.5152	0.6925	1.055	0.9304	0.6879	0.4646
6	0.8118	0.4068	0.521	0.5578	0.6525	0.7509	1.0608	1.0256	0.8702	0.6979
7	0.6249	0.8167	0.9643	0.6025	0.5207	0.8335	0.7002	1.0012	0.8437	0.6762
8	0.9345	0.4513	0.8693	0.4321	0.7026	0.8825	0.904	0.6536	0.9605	0.5955
9	0.3985	0.6298	0.743	0.8446	1.1478	0.9636	1.1812	1.3586	1.3821	1.0492
10	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374	1.0158	1.0779	0.7832
+gp	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374	1.0158	1.0779	0.7832
0 FBAR 4- 7	0.4711	0.4599	0.5578	0.4166	0.515	0.6887	0.85	0.9055	0.6784	0.5182
1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.1184	0.0559	0.0379	0.0919	0.1556	0.0213	0.2622	0.3096	0.206	0.2352
4	0.3782	0.3017	0.3877	0.166	0.2291	0.2631	0.3836	0.5901	0.334	0.5761
5	0.5917	0.4189	0.5746	0.494	0.246	0.1802	1.0622	0.9847	0.417	0.5126
6	0.743	0.5201	0.4589	0.5812	0.5034	0.1812	0.9487	0.4771	0.695	0.4457
7	0.8234	0.5329	0.7021	0.4049	0.5297	0.4031	0.5512	0.2977	0.5912	0.5984
8	0.5278	0.5805	0.7159	0.5022	0.4138	0.3894	0.5804	0.2726	0.4815	0.3499
9	0.5925	0.3839	0.4945	0.5015	0.3945	0.2977	0.6922	0.2768	0.7995	0.2019
10	0.6549	0.5027	0.6448	0.4733	0.4492	0.3649	0.6145	0.2825	0.6303	0.3844
+gp	0.6549	0.5027	0.6448	0.4733	0.4492	0.3649	0.6145	0.2825	0.6303	0.3844
0 FBAR 4- 7	0.6341	0.4434	0.5308	0.4115	0.377	0.2569	0.7364	0.5874	0.5093	0.5332

Table 4.15 (contin.)

Table 8 Fishing mortality (F) at age

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.2987	0.7007	0.3221	0.1337	0.0263	0.0459	0.0668	0.1641	0.1234	0.1195
4	0.6305	1.2539	0.6067	0.47	0.283	0.1553	0.1222	0.3172	0.226	0.2412
5	0.6352	0.9125	0.8742	0.8848	0.6195	0.5004	0.3222	0.2806	0.4053	0.1882
6	0.7037	0.538	0.4297	0.925	0.6759	0.7292	0.5816	0.4038	0.2142	0.3921
7	0.7989	0.6308	0.7891	0.4835	0.3981	0.531	0.392	0.2223	0.277	0.5389
8	0.872	0.5337	0.4453	0.6805	0.6353	0.4885	0.3364	0.5123	0.3811	0.4502
9	0.8092	0.5553	0.6613	0.4888	0.6961	0.4302	0.4407	0.4751	0.1753	0.4793
10	0.8375	0.5781	0.6381	0.5555	0.5825	0.4876	0.3922	0.4063	0.2782	0.4926
+gp	0.8375	0.5781	0.6381	0.5555	0.5825	0.4876	0.3922	0.4063	0.2782	0.4926
0 FBAR 4- 7	0.6921	0.8338	0.6749	0.6908	0.4941	0.479	0.3545	0.306	0.2806	0.3401

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.0611	0.0493	0.0321	0.0934	0.0331	0.0478	0.0623	0.0225	0.0127	0.0239
4	0.4404	0.4563	0.1659	0.1666	0.1542	0.1666	0.1698	0.1436	0.1078	0.0882
5	0.3668	0.9994	0.4913	0.3328	0.1001	0.2114	0.2933	0.3221	0.4414	0.252
6	0.4303	0.4031	1.0864	0.5273	0.1299	0.2201	0.3763	0.5361	0.6234	0.4471
7	0.7296	0.6905	0.2893	0.4766	0.235	0.2153	0.3057	0.4596	0.5694	0.7148
8	0.4526	0.7986	0.452	0.1649	0.2191	0.2302	0.2366	0.3348	0.4595	0.4166
9	0.7925	0.4733	0.351	0.004	0.2225	0.1795	0.3276	0.231	0.4674	0.336
10	0.6653	0.6631	0.3673	0.2166	0.2265	0.2089	0.2912	0.3093	0.537	0.4871
+gp	0.6653	0.6631	0.3673	0.2166	0.2265	0.2089	0.2912	0.3093	0.537	0.4871
0 FBAR 4- 7	0.4918	0.6373	0.5082	0.3758	0.1548	0.2034	0.2863	0.3654	0.4355	0.3755

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
3	0.0218	0.0242	0.0306	0.069	0.0172	0.0371	0.0237	0.0338	0.0385	0.0449	0.0391
4	0.1203	0.1303	0.1903	0.201	0.1692	0.0766	0.1817	0.1337	0.1455	0.1504	0.1432
5	0.328	0.3642	0.3373	0.4396	0.2488	0.2757	0.2357	0.3188	0.2838	0.2573	0.2867
6	0.4731	0.5661	0.4643	0.392	0.2575	0.33	0.3204	0.4657	0.4783	0.4664	0.4701
7	0.6602	0.6954	0.4997	0.4674	0.265	0.2299	0.2712	0.362	0.3498	0.6269	0.4462
8	0.8755	0.6531	0.6598	0.4539	0.3157	0.1928	0.1913	0.3742	0.2086	0.2989	0.2939
9	0.6594	0.605	0.5494	0.454	0.1912	0.3817	0.1209	0.3059	0.1913	0.2392	0.2454
10	0.6741	0.6685	0.5637	0.3214	0.2207	0.2127	0.2617	0.4871	0.5172	0.4744	0.4929
+gp	0.6741	0.6685	0.5637	0.3214	0.2207	0.2127	0.2617	0.4871	0.5172	0.4744	
0 FBAR 4- 7	0.3954	0.439	0.3729	0.375	0.2351	0.2281	0.2522	0.3201	0.3143	0.3753	
1											

Table 4.16 (Relative F at age)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

Table 9 Relative F at age

	YEAR	1950	1951	1952	1953	1954	1955
	AGE						
	3	0.0588	0.1997	0.141	0.1231	0.1418	0.0436
	4	0.69	0.3344	0.7151	0.7225	0.6095	0.2513
	5	0.9723	0.9829	0.7737	1.006	0.7788	0.9264
	6	0.9639	1.4252	1.1835	0.9235	1.0523	0.8926
	7	1.3738	1.2574	1.3276	1.348	1.5595	1.9297
	8	1.1939	1.5671	1.6664	1.2433	2.1871	1.183
	9	0.7723	2.2261	1.8253	0.974	3.4506	0.8191
	10	1.1233	1.7022	1.6328	1.1945	2.4348	1.3234
	+gp	1.1233	1.7022	1.6328	1.1945	2.4348	1.3234
0	REFMEA	0.8422	0.6404	0.7503	0.53	0.3936	0.525

Table 9 Relative F at age

	YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	AGE										
	3	0.2198	0.0891	0.0464	0.157	0.3577	0.2258	0.2153	0.1224	0.1084	0.1175
	4	0.3623	0.5308	0.3071	0.4094	0.7217	0.6938	0.6871	0.7342	0.4594	0.4521
	5	0.5878	0.8089	1.03	0.8054	1.0004	1.0055	1.2411	1.0275	1.0141	0.8964
	6	1.7233	0.8845	0.9341	1.3389	1.2669	1.0904	1.248	1.1327	1.2828	1.3467
	7	1.3266	1.7758	1.7288	1.4463	1.011	1.2103	0.8238	1.1057	1.2437	1.3048
	8	1.9839	0.9813	1.5585	1.0372	1.3641	1.2815	1.0636	0.7218	1.416	1.1491
	9	0.8459	1.3694	1.332	2.0275	2.2286	1.3993	1.3896	1.5004	2.0374	2.0247
	10	1.3986	1.3852	1.5576	1.5132	1.5486	1.309	1.1028	1.1218	1.589	1.5113
	+gp	1.3986	1.3852	1.5576	1.5132	1.5486	1.309	1.1028	1.1218	1.589	1.5113
0	REFMEA	0.4711	0.4599	0.5578	0.4166	0.515	0.6887	0.85	0.9055	0.6784	0.5182
	1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

Table 9 Relative F at age

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	0.1868	0.126	0.0715	0.2233	0.4128	0.0827	0.3561	0.5271	0.4044	0.4411
	4	0.5965	0.6805	0.7304	0.4033	0.6076	1.0242	0.5209	1.0046	0.6558	1.0805
	5	0.9331	0.9448	1.0825	1.2005	0.6525	0.7014	1.4424	1.6764	0.8187	0.9614
	6	1.1717	1.1729	0.8644	1.4122	1.3351	0.7054	1.2883	0.8123	1.3647	0.8358
	7	1.2987	1.2018	1.3227	0.984	1.4048	1.5691	0.7485	0.5068	1.1608	1.1223
	8	0.8324	1.3092	1.3486	1.2204	1.0975	1.5159	0.7881	0.464	0.9455	0.6563
	9	0.9344	0.8659	0.9315	1.2187	1.0463	1.1589	0.9399	0.4712	1.5698	0.3786
	10	1.0329	1.1337	1.2147	1.1501	1.1914	1.4205	0.8344	0.481	1.2376	0.7209
	+gp	1.0329	1.1337	1.2147	1.1501	1.1914	1.4205	0.8344	0.481	1.2376	0.7209
0	REFMEA	0.6341	0.4434	0.5308	0.4115	0.377	0.2569	0.7364	0.5874	0.5093	0.5332

Table 4.16 (contin.)

	Table 9	Relative F at age									
	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	0.4315	0.8403	0.4772	0.1936	0.0533	0.0959	0.1885	0.5363	0.4397	0.3513
	4	0.9111	1.5038	0.8989	0.6803	0.5728	0.3242	0.3447	1.0368	0.8053	0.7092
	5	0.9178	1.0943	1.2952	1.2808	1.2537	1.0447	0.9089	0.917	1.4442	0.5533
	6	1.0168	0.6453	0.6366	1.339	1.3678	1.5224	1.6406	1.3198	0.7634	1.1529
	7	1.1543	0.7566	1.1692	0.6999	0.8057	1.1087	1.1057	0.7264	0.987	1.5845
	8	1.2599	0.6401	0.6598	0.9851	1.2857	1.0198	0.9489	1.6746	1.3579	1.3237
	9	1.1692	0.6659	0.9798	0.7075	1.4087	0.8981	1.2432	1.5529	0.6248	1.4091
	10	1.2101	0.6933	0.9455	0.8041	1.1789	1.018	1.1064	1.328	0.9913	1.4483
	+gp	1.2101	0.6933	0.9455	0.8041	1.1789	1.018	1.1064	1.328	0.9913	1.4483
0	REFMEA	0.6921	0.8338	0.6749	0.6908	0.4941	0.479	0.3545	0.306	0.2806	0.3401

	Table 9	Relative F at age									
	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	0.1242	0.0774	0.0632	0.2486	0.2138	0.2351	0.2176	0.0615	0.0292	0.0638
	4	0.8955	0.716	0.3264	0.4432	0.9963	0.8193	0.5931	0.393	0.2476	0.235
	5	0.7458	1.5681	0.9666	0.8855	0.6463	1.0396	1.0244	0.8817	1.0135	0.6711
	6	0.875	0.6325	2.1377	1.4031	0.8391	1.0823	1.3145	1.4673	1.4315	1.1905
	7	1.4837	1.0834	0.5693	1.2682	1.5182	1.0589	1.068	1.258	1.3074	1.9034
	8	0.9204	1.2531	0.8893	0.4388	1.4151	1.132	0.8265	0.9164	1.055	1.1092
	9	1.6114	0.7427	0.6906	0.0105	1.437	0.8824	1.1443	0.6324	1.0734	0.8947
	10	1.3529	1.0405	0.7227	0.5763	1.4631	1.0272	1.0172	0.8466	1.2331	1.2971
	+gp	1.3529	1.0405	0.7227	0.5763	1.4631	1.0272	1.0172	0.8466	1.2331	1.2971
0	REFMEA	0.4918	0.6373	0.5082	0.3758	0.1548	0.2034	0.2863	0.3654	0.4355	0.3755

	Table 9	Relative F at age										
	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	MEAN **-**
	AGE											
	3	0.0552	0.055	0.082	0.1839	0.0732	0.1626	0.094	0.1057	0.1224	0.1197	0.1159
	4	0.3041	0.2968	0.5103	0.5361	0.7195	0.3359	0.7204	0.4176	0.4628	0.4008	0.4271
	5	0.8295	0.8297	0.9046	1.1721	1.0584	1.2091	0.9343	0.9962	0.9029	0.6857	0.8616
	6	1.1966	1.2895	1.2451	1.0454	1.0952	1.447	1.2703	1.4552	1.5216	1.2429	1.4066
	7	1.6698	1.584	1.3399	1.2464	1.1269	1.008	1.075	1.131	1.1127	1.6706	1.3048
	8	2.2143	1.4878	1.7693	1.2103	1.3426	0.8451	0.7584	1.1693	0.6637	0.7965	0.8765
	9	1.6677	1.378	1.4733	1.2106	0.8134	1.6736	0.4792	0.9557	0.6085	0.6374	0.7339
	10	1.7049	1.5228	1.5116	0.857	0.9387	0.9326	1.0375	1.5219	1.6454	1.2642	1.4772
	+gp	1.7049	1.5228	1.5116	0.857	0.9387	0.9326	1.0375	1.5219	1.6454	1.2642	
0	REFMEA	0.3954	0.439	0.3729	0.375	0.2351	0.2281	0.2522	0.3201	0.3143	0.3753	
	1											

Table 4.17 (Stock number at age (start of year) Numbers*10-3)**

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

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

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	77272	638726	70010	1195377	141491	59702
4	95289	53048	405437	45433	807829	96525
5	69250	42380	34053	188543	24636	505406
6	36948	24631	18216	15372	89234	14625
7	45596	13404	8078	6123	7697	48176
8	15745	11738	4905	2442	2454	3411
9	4518	4716	3523	1150	1035	849
10	1941	1930	928	733	562	218
+gp	5287	2201	1348	2339	957	218
0 TOTAL	351847	792775	546498	1457515	1075895	729130

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

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	195297	60502	79183	375610	276631	125057	275511	317127	368923	117619
4	42091	127020	41892	55660	253799	165972	77220	165505	204765	247254
5	67275	28221	79133	28070	37323	139180	81855	34244	67703	119240
6	250665	41142	15692	35936	16188	17984	56170	22991	10894	27450
7	7478	90933	22377	7613	16806	6886	6934	15885	6735	3728
8	14321	3277	32898	6985	3412	8175	2450	2818	4779	2372
9	1501	4605	1709	11292	3712	1384	2769	812	1200	1497
10	452	825	2009	665	3973	964	432	696	171	247
+gp	418	408	1126	1168	1201	2624	1350	638	1040	1609
0 TOTAL	579499	356934	276018	522998	613045	468227	504692	560717	666210	521014

1

Run title : NEA Haddock (SVPA AFWG06)

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	275591	342616	20669	20293	189870	110174	1165364	308558	60651	55782
4	79834	176594	233718	14355	13353	117224	77803	646749	163316	35607
5	155565	43495	103858	126127	9670	8445	71657	42161	285086	93002
6	60443	69443	23077	47158	62077	6099	5689	19981	12704	151552
7	11159	23489	33725	11915	21545	30656	4157	1800	10130	5180
8	1552	4010	11287	13682	6507	10386	16772	1961	1094	4592
9	1070	750	1837	4517	6779	3522	5761	7686	1223	553
10	429	485	418	917	2240	3741	2141	2361	4771	450
+gp	550	750	657	316	887	1915	3930	2606	4367	3208
0 TOTAL	586194	661633	429246	239281	312928	292163	1353275	1033863	543341	349927

Table 4.17 (contin.)

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

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	63022	127806	199658	163672	28274	12677	15985	9045	12097	289608
4	31806	33724	45751	104368	103289	19866	8734	10785	5537	8690
5	15917	13464	7654	19835	51875	61893	13526	6147	6246	3616
6	44931	6803	4361	2576	6605	22521	30268	7905	3745	3410
7	79287	18160	3245	2318	834	2745	8874	13823	4313	2475
8	2331	29201	7912	1207	1170	459	1321	4909	9062	2677
9	2649	798	14020	4150	500	508	230	773	2408	5068
10	370	966	375	5925	2084	204	270	121	393	1654
+gp	3078	943	926	829	3614	2731	2193	958	348	791
0 TOTAL	243391	231865	283901	304879	198245	123604	81402	54467	44149	317989

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	527501	115249	55245	26639	36419	104409	211791	688917	307725	99836
4	210404	260548	89817	35753	19865	25549	81492	161997	519450	226503
5	5590	110899	135168	62295	24780	13939	17707	56301	112074	375396
6	2453	3172	33424	67557	36565	18357	9238	10813	31232	58366
7	1886	1306	1735	9234	32643	26290	12060	5191	5179	13701
8	1182	744	536	1064	4694	21128	17354	7273	2684	2399
9	1397	616	274	279	739	3087	13741	11215	4260	1388
10	2569	518	314	158	228	484	2112	8108	7288	2186
+gp	2217	1661	1591	999	385	315	365	1333	5553	4473
0 TOTAL	755199	494713	318104	203978	156318	213558	365861	951147	995445	784248

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

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 50-**	AMST 50-**
AGE													
3	107490	119013	63298	278592	99319	395569	348370	237215	219200	313386	0	123432	216075
4	69292	51671	73381	48540	212607	78178	307715	244838	153115	144640	171768	79948	139508
5	144669	45728	35765	47318	32504	146057	59223	208109	165064	99728	92559	46054	79987
6	215759	83344	25447	20526	24962	20608	90763	38013	122984	98501	61399	22162	38446
7	30320	107696	38400	13096	11355	15738	12130	53805	19535	62208	50586	10447	18445
8	5489	12827	43988	19075	6719	7133	10239	7573	30672	11273	27210	4713	7896
9	1295	1872	5465	18618	9920	4012	4816	6923	4264	20384	6845	2199	3722
10	812	548	837	2583	9681	6708	2242	3494	4175	2884	13138	983	1814
+gp	4221	1674	1243	1781	2426	6909	5019	3948	260	4170	3594		
0 TOTAL	579348	424375	287824	450128	409491	680912	840518	803917	719270	757174	427099		

1

Table 4.18 (Spawning stock number at age (spawning time) Numbers*10-3)**

Run title : NEA Haddock (SVPA AFWG06)

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

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	1932	15968	1750	29884	3537	1493
4	9243	5146	39327	4407	78359	9363
5	21398	13095	10522	58260	7612	156170
6	23351	15567	11513	9715	56396	9243
7	39076	11487	6923	5248	6597	41287
8	15005	11186	4675	2328	2339	3251
9	4454	4650	3473	1134	1020	838
10	1933	1922	924	730	560	217
+gp	5282	2199	1346	2337	956	218

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

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	4882	1513	1980	9390	6916	3126	6888	7928	9223	2940
4	4083	12321	4064	5399	24619	16099	7490	16054	19862	23984
5	20788	8720	24452	8674	11533	43007	25293	10581	20920	36845
6	158420	26002	9917	22711	10231	11366	35500	14530	6885	17348
7	6409	77930	19177	6525	14403	5902	5942	13613	5772	3195
8	13648	3123	31352	6656	3252	7791	2335	2686	4554	2260
9	1480	4541	1685	11134	3660	1364	2730	801	1183	1476
10	451	822	2001	663	3957	961	430	693	170	246
+gp	418	407	1125	1166	1200	2622	1349	637	1039	1607

1

Run title : NEA Haddock (SVPA AFWG06)

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	6890	8565	517	507	4747	2754	29134	7714	1516	1395
4	7744	17130	22671	1392	1295	11371	7547	62735	15842	3454
5	48070	13440	32092	38973	2988	2610	22142	13028	88091	28738
6	38200	43888	14584	29804	39233	3855	3595	12628	8029	95781
7	9563	20130	28902	10211	18464	26272	3562	1542	8681	4439
8	1479	3822	10757	13039	6201	9898	15984	1869	1043	4376
9	1056	739	1812	4454	6684	3473	5680	7578	1206	546
10	428	483	416	914	2231	3726	2133	2351	4752	448
+gp	549	750	656	316	886	1914	3926	2603	4363	3205

Table 4.18 (contin.)

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

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	1576	3195	4991	4092	763	431	623	335	435	6082
4	3085	3271	4438	10124	11155	2066	1109	1575	736	1121
5	4918	4160	2365	6129	18001	20982	4410	2336	2604	1400
6	28397	4299	2756	1628	4293	15112	19947	5178	2641	2513
7	67949	15563	2781	1987	718	2350	7800	12026	3765	2220
8	2221	27829	7540	1150	1118	437	1258	4723	8681	2570
9	2612	787	13824	4092	493	501	227	762	2381	5002
10	369	962	373	5902	2076	203	269	121	392	1649
+gp	3074	942	925	828	3606	2728	2191	957	348	790

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	8968	2190	1326	799	1493	3550	5083	9645	4000	1398
4	17674	17978	6916	3397	2324	3679	10024	14742	31167	12684
5	2102	31163	32305	16259	7608	4976	7171	20493	32726	79959
6	1756	2242	19954	36954	21025	11565	6318	7915	21737	36187
7	1718	1182	1565	7720	26310	21689	10335	4605	4728	12276
8	1144	724	521	1033	4436	19734	16348	6938	2590	2339
9	1380	610	272	277	733	3035	13466	11013	4201	1374
10	2559	516	313	158	227	483	2102	8059	7251	2177
+gp	2215	1660	1589	998	385	315	365	1331	5542	4464

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

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	1827	2737	1836	10308	2483	10285	6967	3795	3946	5954
4	4019	3617	6604	5194	27426	7271	29541	19342	10106	10559
5	29223	9511	8619	13769	10726	53895	17471	63473	43412	22838
6	108743	40505	12545	11310	15426	13663	63625	23758	78218	57525
7	26015	82926	28915	9913	9209	13456	10687	48478	16859	53934
8	5319	12263	40293	17320	6107	6676	9768	7300	29783	10800
9	1286	1856	5394	18134	9622	3895	4720	6826	4222	20221
10	810	547	835	2573	9603	6648	2222	3473	4158	2875
+gp	4217	1673	1242	1779	2423	6895	5004	3936	260	4166
1										

Table 4.19 (Stock biomass at age with SOP (start of year) Tonnes)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

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

YEAR	1950	1951	1952	1953	1954	1955
AGE						
3	17483	187107	14434	300867	34440	13961
4	39368	28377	152644	20882	359062	41217
5	44278	35085	19842	134111	16946	333995
6	33074	28547	14860	15308	85935	13531
7	53317	20294	8608	7966	9684	58224
8	22922	22126	6508	3956	3843	5133
9	7830	10583	5564	2218	1929	1522
10	3867	4978	1685	1625	1204	448
+gp	11897	6413	2764	5856	2316	507
0 TOTALBI	234035	343510	226907	492788	515360	468537

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

YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
AGE										
3	55438	17435	25342	143483	95370	45132	93990	99356	97628	36720
4	21819	66842	24483	38826	159780	109377	48105	94688	98950	140959
5	53969	22984	71573	30303	36364	141949	78918	30320	50633	105205
6	281525	46909	19870	54313	22081	25678	75817	28499	11406	33906
7	10971	135439	37014	15031	29946	12845	12226	25722	9211	6015
8	26159	6078	67750	17169	7570	18984	5378	5682	8138	4764
9	3263	10167	4189	33043	9804	3825	7236	1949	2433	3581
10	1131	2093	5660	2238	12059	3065	1298	1919	398	678
+gp	1181	1169	3584	4436	4117	9420	4581	1988	2738	4995
0 TOTALBI	455457	309115	259464	338842	377090	370274	327549	290123	281535	336825
1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	85096	123074	7440	8264	69789	51778	384722	94992	24359	22332
4	45015	115840	153621	10675	8963	100602	46903	363585	119775	26030
5	135751	44156	105648	145160	10045	11217	66855	36682	323576	105220
6	73842	98697	32864	75984	90278	11341	7431	24338	20187	240047
7	17809	43610	62741	25078	40930	74463	7093	2864	21027	10717
8	3084	9269	26143	35855	15389	31409	35630	3885	2828	11829
9	2532	2063	5066	14091	19088	12680	14568	18125	3761	1697
10	1167	1533	1325	3290	7248	15480	6223	6398	16871	1586
+gp	1688	2681	2352	1282	3242	8953	12904	7979	17444	12775
0 TOTALBI	365984	440923	397200	319679	264971	317924	582329	558847	549828	432233

Table 4.19 (contin.)

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

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	20213	42184	77893	76506	16499	10435	13693	4545	4512	112422
	4	18628	20326	32593	89086	115636	21641	12391	11313	4872	6240
	5	14427	12559	8439	26202	77614	109712	22150	9126	9674	5160
	6	57015	8884	6731	4764	14228	48610	72386	12483	7433	7665
	7	131430	30979	6543	5601	2452	7915	24290	29563	8649	6657
	8	4811	62019	19862	3630	4671	1700	4574	11520	23282	7032
	9	6509	2018	41899	14860	2123	2412	980	2199	6587	16357
	10	1046	2807	1288	24385	9448	1021	1409	410	1263	5563
	+gp	9817	3097	3592	3852	18357	14428	11940	3823	1289	3041
0	TOTALBI	263895	184872	198840	248885	261027	217874	163812	84982	67562	170136

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	156490	38677	21365	12181	14841	40457	73718	192295	80790	28448
	4	136241	149407	54493	25236	15447	18101	59807	99479	264486	107201
	5	5682	116793	120162	59648	25733	16029	20171	61513	105881	292700
	6	4420	4705	48615	85903	47149	25798	15369	16524	46930	75297
	7	4949	3168	3300	17683	52310	43334	23167	10769	10120	25992
	8	3530	2482	1568	2520	10641	41281	37590	16748	6753	5615
	9	3986	2248	1054	970	1985	8121	34041	28342	11575	4015
	10	8715	1781	1283	696	862	1459	6772	22808	21308	6697
	+gp	7713	6616	6065	4571	1798	1294	1304	4694	17695	14541
0	TOTALBI	331726	325877	257905	209408	170765	195874	271940	453172	565538	560506

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

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	31916	37445	18588	94659	29993	128618	102868	67099	66996	95245
	4	36448	27112	43533	25476	129650	44602	178067	130363	80639	80713
	5	108099	36338	30376	42997	26059	142175	51583	183727	139026	82085
	6	238647	85164	29640	24259	31489	23765	120604	45986	154274	116606
	7	51185	151200	53763	19850	17499	26794	17765	91684	31467	101723
	8	12844	25849	80115	33098	12651	14189	21174	13489	65593	22624
	9	3591	4994	13613	40288	20612	9406	11262	16853	9157	51835
	10	2697	1680	2662	7351	24264	16879	6017	9388	11961	7135
	+gp	14645	5990	4427	6281	7741	20412	14134	11910	807	13518
0	TOTALBI	500072	375772	276717	294258	299957	426842	523473	570498	559922	571484
	1										

Table 4.20 (Spawning stock biomass with SOP (spawning time) Tonnes)

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

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

	YEAR	1950	1951	1952	1953	1954	1955
	AGE						
	3	437	4678	361	7522	861	349
	4	3819	2753	14806	2026	34829	3998
	5	13682	10841	6131	41440	5236	103204
	6	20903	18042	9391	9675	54311	8552
	7	45693	17392	7377	6827	8299	49898
	8	21845	21086	6202	3770	3663	4891
	9	7720	10435	5486	2187	1902	1500
	10	3851	4958	1678	1618	1200	447
	+gp	11885	6407	2761	5850	2314	506
0	TOTSPBI(	129835	96591	54193	80914	112615	173346

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

	YEAR	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	AGE										
	3	1386	436	634	3587	2384	1128	2350	2484	2441	918
	4	2116	6484	2375	3766	15499	10610	4666	9185	9598	13673
	5	16677	7102	22116	9364	11236	43862	24386	9369	15646	32508
	6	177924	29647	12558	34326	13955	16229	47916	18011	7209	21429
	7	9402	116071	31721	12882	25664	11008	10477	22044	7894	5155
	8	24930	5792	64566	16362	7214	18091	5125	5415	7755	4541
	9	3218	10024	4131	32581	9666	3772	7135	1922	2399	3531
	10	1126	2085	5637	2229	12010	3052	1293	1912	397	675
	+gp	1180	1168	3581	4431	4113	9410	4577	1986	2735	4990
0	TOTSPBI(	237959	178808	147317	119527	101742	117163	107925	72327	56073	87420
	1										

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Traditional vpa using file input for terminal F

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

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	2127	3077	186	207	1745	1294	9618	2375	609	558
	4	4366	11236	14901	1035	869	9758	4550	35268	11618	2525
	5	41947	13644	32645	44854	3104	3466	20658	11335	99985	32513
	6	46668	62376	20770	48022	57055	7167	4696	15382	12758	151710
	7	15262	37374	53769	21492	35077	63815	6078	2454	18020	9185
	8	2939	8834	24914	34170	14666	29933	33955	3703	2695	11273
	9	2497	2034	4995	13893	18821	12502	14364	17871	3709	1674
	10	1162	1527	1320	3276	7219	15418	6199	6373	16803	1580
	+gp	1686	2679	2350	1280	3238	8944	12891	7971	17426	12762
0	TOTSPBI(	118656	142781	155850	168231	141794	152299	113010	102730	183624	223779

Table 4.20 (contin.)

	Table 15	Spawning stock biomass with SOP (spawning time)			Tonnes					
	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	505	1055	1947	1913	445	355	534	168	162	2361
	4	1807	1972	3162	8641	12489	2251	1574	1652	648	805
	5	4458	3881	2608	8097	26932	37192	7221	3468	4034	1997
	6	36034	5614	4254	3011	9248	32617	47702	8176	5240	5649
	7	112635	26549	5607	4800	2111	6775	21351	25720	7550	5972
	8	4585	59105	18929	3459	4460	1620	4354	11082	22304	6751
	9	6418	1989	41312	14652	2093	2378	967	2168	6514	16144
	10	1041	2795	1283	24287	9410	1017	1403	408	1258	5546
	+gp	9807	3094	3589	3848	18320	14413	11928	3819	1288	3038
0	TOTSPBI(	177290	106054	82690	72707	85509	98619	97033	56662	49000	48262

	Table 15	Spawning stock biomass with SOP (spawning time)			Tonnes					
	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	2660	735	513	365	608	1376	1769	2692	1050	398
	4	11444	10309	4196	2397	1807	2606	7356	9053	15869	6003
	5	2136	32819	28719	15568	7900	5722	8169	22391	30917	62345
	6	3165	3326	29023	46989	27111	16253	10513	12096	32663	46684
	7	4509	2867	2976	14783	42162	35750	19854	9552	9240	23289
	8	3417	2415	1524	2447	10055	38557	35409	15977	6517	5474
	9	3938	2228	1045	962	1969	7982	33360	27831	11413	3975
	10	8680	1776	1279	695	861	1456	6738	22671	21201	6670
	+gp	7705	6609	6059	4566	1796	1293	1303	4689	17659	14512
0	TOTSPBI(	47654	63084	75335	88773	94269	110996	124473	126953	146530	169351

	Table 15	Spawning stock biomass with SOP (spawning time)			Tonnes					
	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	543	861	539	3502	750	3344	2057	1074	1206	1810
	4	2114	1898	3918	2726	16725	4148	17094	10299	5322	5892
	5	21836	7558	7321	12512	8599	52463	15217	56037	36564	18797
	6	120278	41390	14612	13367	19460	15756	84543	28741	98118	68098
	7	43916	116424	40484	15026	14192	22909	15651	82607	27156	88194
	8	12446	24712	73385	30053	11500	13281	20200	13004	63690	21674
	9	3566	4949	13436	39241	19993	9133	11037	16617	9066	51421
	10	2688	1676	2654	7321	24070	16728	5963	9331	11913	7113
	+gp	14631	5984	4423	6274	7733	20372	14092	11874	805	13504
0	TOTSPBI(	222018	205453	160771	130023	123022	158133	185854	229583	253842	276503
	1										

Table 4.21 Summary

Run title : NEA Haddock (SVPA AFWG06)

At 27/04/2006 16:30

Table 17 Summary (with SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 4- 7
1950	77272	234035	129835	132125	1.0176	0.6148	0.8422
1951	638726	343510	96591	120077	1.2432	0.796	0.6404
1952	70010	226907	54193	127660	2.3557	0.5603	0.7503
1953	1195377	492788	80914	123920	1.5315	0.6839	0.53
1954	141491	515360	112615	156788	1.3922	0.6614	0.3936
1955	59702	468537	173346	202286	1.167	0.6354	0.525
1956	195297	455457	237959	213924	0.899	0.7714	0.4711
1957	60502	309115	178808	123583	0.6912	0.7831	0.4599
1958	79183	259464	147317	112672	0.7648	0.8697	0.5578
1959	375610	338842	119527	88211	0.738	1.038	0.4166
1960	276631	377090	101742	154651	1.52	0.9368	0.515
1961	125057	370274	117163	193224	1.6492	0.9807	0.6887
1962	275511	327549	107925	187408	1.7365	0.927	0.85
1963	317127	290123	72327	146224	2.0217	0.8514	0.9055
1964	368923	281535	56073	99158	1.7684	0.7191	0.6784
1965	117619	336825	87420	118578	1.3564	0.8484	0.5182
1966	275591	365984	118656	161778	1.3634	0.8391	0.6341
1967	342616	440923	142781	136397	0.9553	0.9761	0.4434
1968	20669	397200	155850	181726	1.166	0.9781	0.5308
1969	20293	319679	168231	130820	0.7776	1.1066	0.4115
1970	189870	264971	141794	88257	0.6224	0.9988	0.377
1971	110174	317924	152299	78905	0.5181	1.2771	0.2569
1972	1165364	582329	113010	266153	2.3551	0.8971	0.7364
1973	308558	558847	102730	322226	3.1366	0.8366	0.5874
1974	60651	549828	183624	221157	1.2044	1.0914	0.5093
1975	55782	432233	223779	175758	0.7854	1.0879	0.5332
1976	63022	263895	177290	137264	0.7742	0.8715	0.6921
1977	127806	184872	106054	110158	1.0387	0.8969	0.8338
1978	199658	198840	82690	95422	1.154	1.0601	0.6749
1979	163672	248885	72707	103623	1.4252	1.2702	0.6908
1980	28274	261027	85509	87889	1.0278	1.2854	0.4941
1981	12677	217874	98619	77153	0.7823	1.3583	0.479
1982	15985	163812	97033	46955	0.4839	1.3511	0.3545
1983	9045	84982	56662	24600	0.4342	0.9535	0.306
1984	12097	67562	49000	20945	0.4275	0.9491	0.2806
1985	289608	170136	48262	45052	0.9335	1.0242	0.3401
1986	527501	331726	47654	100563	2.1103	0.9508	0.4918
1987	115249	325877	63084	154916	2.4557	1.0078	0.6373
1988	55245	257905	75335	95255	1.2644	1.0045	0.5082
1989	26639	209408	88773	58518	0.6592	1.023	0.3758
1990	36419	170765	94269	27182	0.2883	0.9843	0.1548
1991	104409	195874	110996	36216	0.3263	0.9639	0.2034
1992	211791	271940	124473	59922	0.4814	1.0207	0.2863
1993	688917	453172	126953	82379	0.6489	0.9969	0.3654
1994	307725	565538	146530	135186	0.9226	0.9945	0.4355
1995	99836	560506	169351	142448	0.8411	0.9759	0.3755
1996	107490	500072	222018	178128	0.8023	0.9832	0.3954
1997	119013	375772	205453	154359	0.7513	0.9505	0.439
1998	63298	276717	160771	100630	0.6259	0.9888	0.3729
1999	278592	294258	130023	83195	0.6399	0.9792	0.375
2000	99319	299957	123022	68944	0.5604	0.9741	0.2351
2001	395569	426842	158133	89640	0.5669	1.0098	0.2281
2002	348370	523473	185854	116800	0.6285	0.9909	0.2522
2003	237215	570498	229583	134649	0.5865	0.9788	0.3201
2004	219200	559922	253842	154975	0.6105	0.9956	0.3143
2005	313386	571484	276503	154116	0.5574	0.9965	0.3753
Arith. Mean	217869	347516	129338	123942	1.0633		.4830
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

1

Table 4.22
PREDICTION WITH MANAGEMENT OPTION TABLE: INPUT DATA

MFDP version 1a
Run: 1
Time and date: 19:47 27.04.2006
Fbar age range: 4-7

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	183000	0.4459	0.018	0	0	0.32	0.0391	0.684
4	171768	0.28	0.076	0	0	0.555	0.1432	0.898
5	92559	0.2225	0.244	0	0	0.871	0.2867	1.155
6	61399	0.2011	0.542	0	0	1.166	0.4701	1.451
7	50586	0.2	0.829	0	0	1.555	0.4462	1.78
8	27210	0.2	0.958	0	0	2.031	0.2939	2.058
9	6845	0.2	0.988	0	0	2.412	0.2454	2.293
10	13138	0.2	0.997	0	0	2.945	0.4929	2.475
11	3594	0.2	0.999	0	0	2.794	0.4929	2.754

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	755000	0.4459	0.017	0	0	0.318	0.0391	0.684
4	.	0.28	0.071	0	0	0.579	0.1432	0.898
5	.	0.2225	0.244	0	0	0.897	0.2867	1.155
6	.	0.2011	0.548	0	0	1.256	0.4701	1.451
7	.	0.2	0.802	0	0	1.639	0.4462	1.78
8	.	0.2	0.93	0	0	2.035	0.2939	2.058
9	.	0.2	0.978	0	0	2.431	0.2454	2.293
10	.	0.2	0.994	0	0	2.82	0.4929	2.475
11	.	0.2	0.998	0	0	3.196	0.4929	2.754

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	521000	0.4459	0.017	0	0	0.318	0.0391	0.684
4	.	0.28	0.071	0	0	0.579	0.1432	0.898
5	.	0.2225	0.244	0	0	0.897	0.2867	1.155
6	.	0.2011	0.548	0	0	1.256	0.4701	1.451
7	.	0.2	0.802	0	0	1.639	0.4462	1.78
8	.	0.2	0.93	0	0	2.035	0.2939	2.058
9	.	0.2	0.978	0	0	2.431	0.2454	2.293
10	.	0.2	0.994	0	0	2.82	0.4929	2.475
11	.	0.2	0.998	0	0	3.196	0.4929	2.754

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	219000	0.4459	0.017	0	0	0.318	0.0391	0.684
4	.	0.28	0.071	0	0	0.579	0.1432	0.898
5	.	0.2225	0.244	0	0	0.897	0.2867	1.155
6	.	0.2011	0.548	0	0	1.256	0.4701	1.451
7	.	0.2	0.802	0	0	1.639	0.4462	1.78
8	.	0.2	0.93	0	0	2.035	0.2939	2.058
9	.	0.2	0.978	0	0	2.431	0.2454	2.293
10	.	0.2	0.994	0	0	2.82	0.4929	2.475
11	.	0.2	0.998	0	0	3.196	0.4929	2.754

Table 4.23

PREDICTION WITH MANAGEMENT OPTION TABLE FOR 2006-2008

MFDP version 1a

Run: 5

preMFDP Index file 26.04.2005

Time and date: 00:38 28.04.2006

Fbar age range: 4-7

2006				
Biomass	SSB	FMult	FBar	Landings
505269	249844	1.2547	0.4223	165284

2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
633367	221094	0	0	0	858704	311082
.	221094	0.1	0.0337	14517	844574	300982
.	221094	0.2	0.0673	28588	830914	291263
.	221094	0.3	0.101	42229	817708	281908
.	221094	0.4	0.1346	55457	804937	272903
.	221094	0.5	0.1683	68287	792584	264233
.	221094	0.6	0.2019	80733	780634	255887
.	221094	0.7	0.2356	92811	769072	247850
.	221094	0.8	0.2692	104533	757881	240110
.	221094	0.9	0.3029	115914	747049	232655
.	221094	1	0.3366	126965	736561	225475
.	221094	1.1	0.3702	137699	726405	218557
.	221094	1.2	0.4039	148127	716567	211893
.	221094	1.3	0.4375	158261	707037	205470
.	221094	1.4	0.4712	168110	697802	199282
.	221094	1.5	0.5048	177686	688851	193317
.	221094	1.6	0.5385	186999	680174	187567
.	221094	1.7	0.5721	196057	671761	182024
.	221094	1.8	0.6058	204870	663602	176679
.	221094	1.9	0.6394	213446	655687	171526
.	221094	2	0.6731	221794	648007	166556

Input units are thousands and kg - output in tonnes

Table 4.24

Prediction single option table for period 2006-2009

MFDP version 1a

Run: 1

Time and date: 19:47 27.04.2006

Fbar age range: 4-7

Year:	2006	F multiplier:	1.2547	Fbar:	0.4223				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0491	7081	4843	183000	58560	3294	1054	3294	1054
4	0.1797	24741	22217	171768	95331	13054	7245	13054	7245
5	0.3597	25238	29150	92559	80619	22584	19671	22584	19671
6	0.5898	25026	36313	61399	71591	33278	38802	33278	38802
7	0.5598	19838	35311	50586	78661	41936	65210	41936	65210
8	0.3687	7652	15748	27210	55264	26067	52942	26067	52942
9	0.3079	1653	3789	6845	16510	6763	16312	6763	16312
10	0.6184	5548	13732	13138	38691	13099	38575	13099	38575
11	0.6184	1518	4180	3594	10042	3590	10032	3590	10032
Total		118295	165284	610099	505269	163666	249844	163666	249844

Year:	2007	F multiplier:	1.04	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0407	24309	16627	755000	240090	12835	4082	12835	4082
4	0.1489	13510	12132	111556	64591	7920	4586	7920	4586
5	0.2982	25211	29119	108470	97298	26467	23741	26467	23741
6	0.4889	18261	26497	51709	64947	28337	35591	28337	35591
7	0.464	9440	16803	27840	45630	22328	36595	22328	36595
8	0.3056	5676	11682	23661	48151	22005	44780	22005	44780
9	0.2552	3159	7243	15407	37455	15068	36631	15068	36631
10	0.5126	1510	3737	4119	11616	4094	11546	4094	11546
11	0.5126	2706	7452	7381	23590	7366	23542	7366	23542
Total		103782	131292	1105145	633367	146421	221094	146421	221094

Year:	2008	F multiplier:	1.04	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0407	16775	11474	521000	165678	8857	2817	8857	2817
4	0.1489	56206	50473	464126	268729	32953	19080	32953	19080
5	0.2982	16885	19502	72647	65164	17726	15900	17726	15900
6	0.4889	22759	33023	64446	80944	35316	44357	35316	44357
7	0.464	8795	15654	25936	42510	20801	34093	20801	34093
8	0.3056	3438	7076	14331	29164	13328	27123	13328	27123
9	0.2552	2926	6709	14271	34692	13957	33929	13957	33929
10	0.5126	3583	8867	9773	27560	9714	27395	9714	27395
11	0.5126	2067	5693	5639	18023	5628	17987	5628	17987
Total		133433	158471	1192168	732463	158280	222679	158280	222679

Year:	2009	F multiplier:	1.04	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0407	7051	4823	219000	69642	3723	1184	3723	1184
4	0.1489	38786	34830	320277	185441	22740	13166	22740	13166
5	0.2982	70249	81137	302243	271112	73747	66151	73747	66151
6	0.4889	15243	22117	43161	54211	23652	29708	23652	29708
7	0.464	10961	19510	32325	52980	25924	42490	25924	42490
8	0.3056	3203	6592	13351	27170	12417	25268	12417	25268
9	0.2552	1772	4063	8643	21012	8453	20550	8453	20550
10	0.5126	3318	8213	9052	25527	8998	25374	8998	25374
11	0.5126	2771	7630	7558	24154	7543	24106	7543	24106
Total		153353	188915	955611	731249	187197	247997	187197	247997

Table 4.25 Yield per recruit. Input data and results.

MFYPR version 2a
Run: 1
NEA Haddock
Time and date: 18:11 27.04.2006
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.446	0.019	0	0	0.300	0.039	0.679
4	0.280	0.073	0	0	0.544	0.143	0.897
5	0.222	0.229	0	0	0.858	0.287	1.147
6	0.201	0.584	0	0	1.228	0.470	1.402
7	0.200	0.867	0	0	1.667	0.446	1.636
8	0.200	0.958	0	0	1.994	0.294	2.021
9	0.200	0.992	0	0	2.399	0.245	2.114
10	0.200	0.997	0	0	2.702	0.493	2.373
11	0.200	0.999	0	0	3.151	0.493	2.409

Weights in kilograms

MFYPR version 2a
Run: 1
Time and date: 18:11 27.04.2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJa	SSBJan	SpwnNosS	SSBSpwn
0	0	0	0	4.2594	6.0387	2.0946	4.8031	2.0946	4.8031
0.1	0.0337	0.0882	0.1517	3.8265	4.8547	1.6839	3.646	1.6839	3.646
0.2	0.0673	0.1502	0.2469	3.524	4.0646	1.4025	2.881	1.4025	2.881
0.3	0.101	0.1968	0.3105	3.2983	3.5017	1.1969	2.3415	1.1969	2.3415
0.4	0.1346	0.2335	0.3549	3.1222	3.0818	1.0399	1.9435	1.0399	1.9435
0.5	0.1683	0.2634	0.387	2.9802	2.7578	0.9162	1.6401	0.9162	1.6401
0.6	0.2019	0.2883	0.4109	2.8627	2.501	0.8162	1.4028	0.8162	1.4028
0.7	0.2356	0.3095	0.4289	2.7636	2.2932	0.734	1.2135	0.734	1.2135
0.8	0.2692	0.3278	0.4429	2.6788	2.1222	0.6652	1.06	0.6652	1.06
0.9	0.3029	0.3439	0.4539	2.6052	1.9794	0.6071	0.9337	0.6071	0.9337
1	0.3366	0.3581	0.4626	2.5406	1.8587	0.5574	0.8288	0.5574	0.8288
1.1	0.3702	0.3709	0.4697	2.4834	1.7555	0.5146	0.7406	0.5146	0.7406
1.2	0.4039	0.3824	0.4755	2.4323	1.6664	0.4773	0.6659	0.4773	0.6659
1.3	0.4375	0.3928	0.4802	2.3863	1.589	0.4447	0.6022	0.4447	0.6022
1.4	0.4712	0.4024	0.4842	2.3446	1.521	0.4159	0.5474	0.4159	0.5474
1.5	0.5048	0.4112	0.4875	2.3067	1.461	0.3905	0.4999	0.3905	0.4999
1.6	0.5385	0.4193	0.4904	2.2719	1.4077	0.3678	0.4586	0.3678	0.4586
1.7	0.5721	0.4269	0.4928	2.2399	1.36	0.3475	0.4225	0.3475	0.4225
1.8	0.6058	0.4339	0.4949	2.2104	1.3172	0.3293	0.3907	0.3293	0.3907
1.9	0.6394	0.4406	0.4968	2.1829	1.2784	0.3129	0.3627	0.3129	0.3627
2	0.6731	0.4468	0.4984	2.1573	1.2433	0.298	0.3378	0.298	0.3378

Reference	F multiplier	Absolute F
Fbar(4-7)	1	0.3366
FMax	>=1000000	
F0.1	0.6212	0.2091
F35%SPR		
R	0.4849	0.1632

Weights in kilograms

North-East Arctic haddock (Sub-areas I and II)

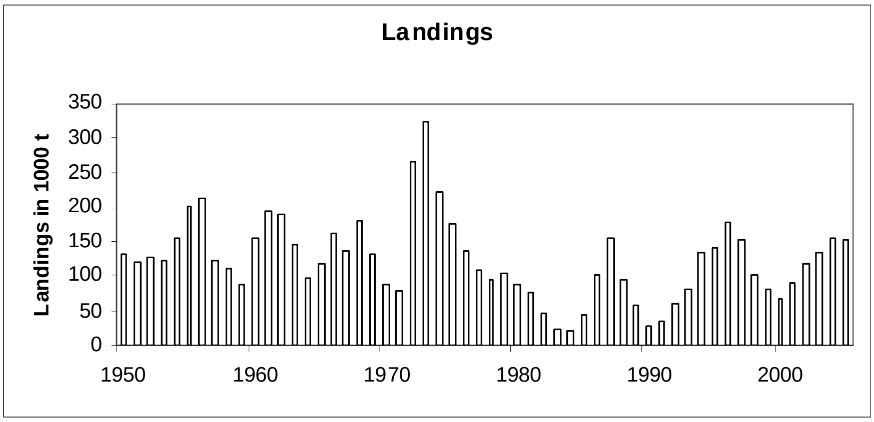


Figure 4.1 A Landings of Northeast Arctic Haddock

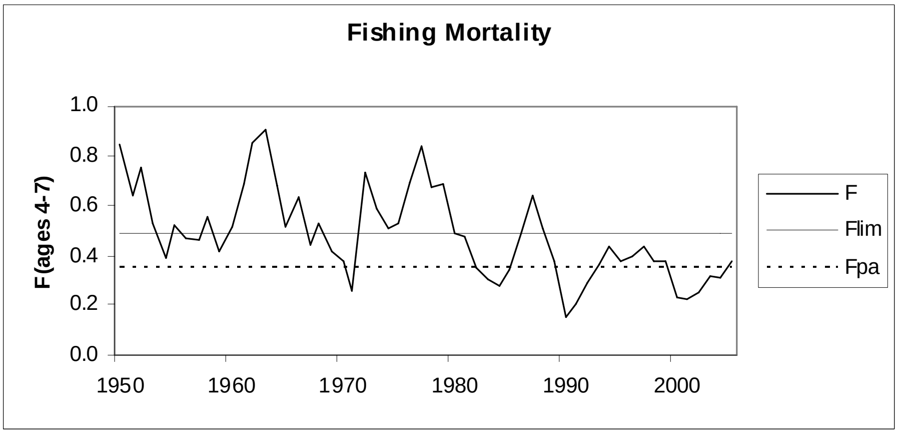


Figure 4.1 B Fishing mortality of Northeast Arctic Haddock

Figure 4.1C Recruitment of Northeast Arctic Haddock

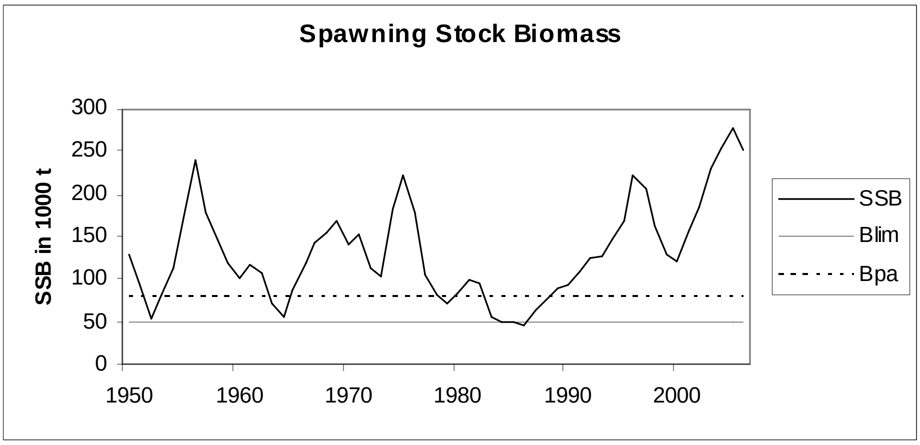


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock

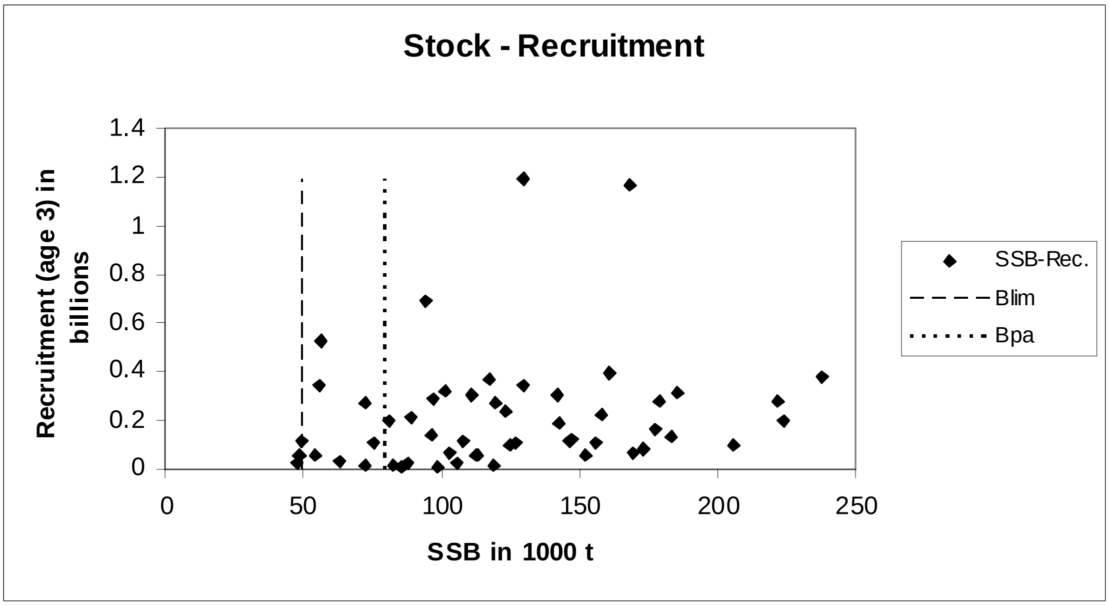


Figure 4.2 Northeast Arctic haddock

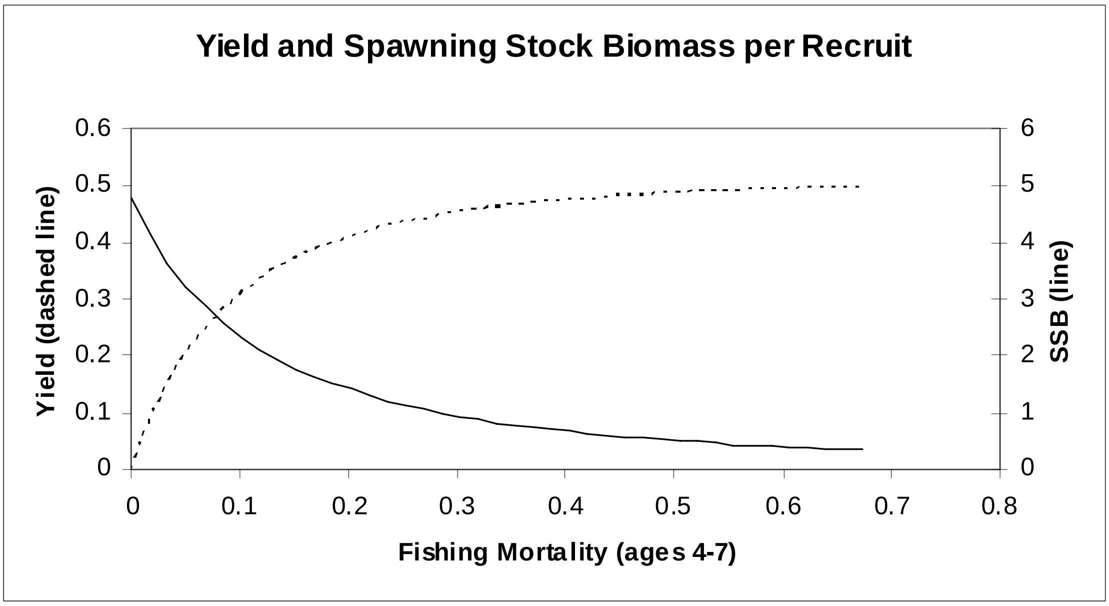


Figure 4.3 Northeast Arctic haddock

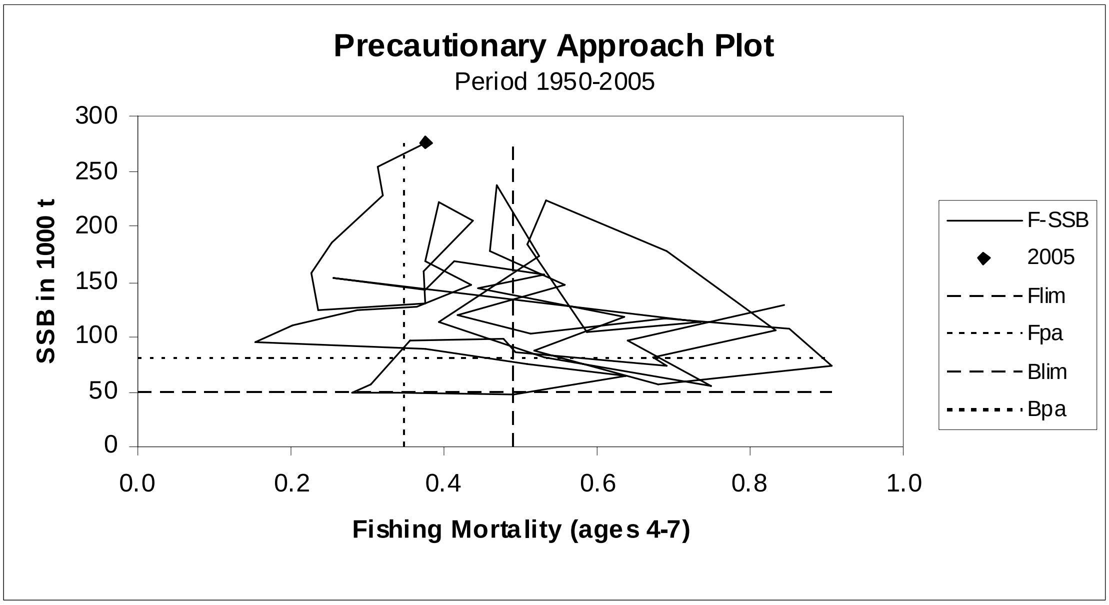


Figure 4.4 Northeast Arctic haddock

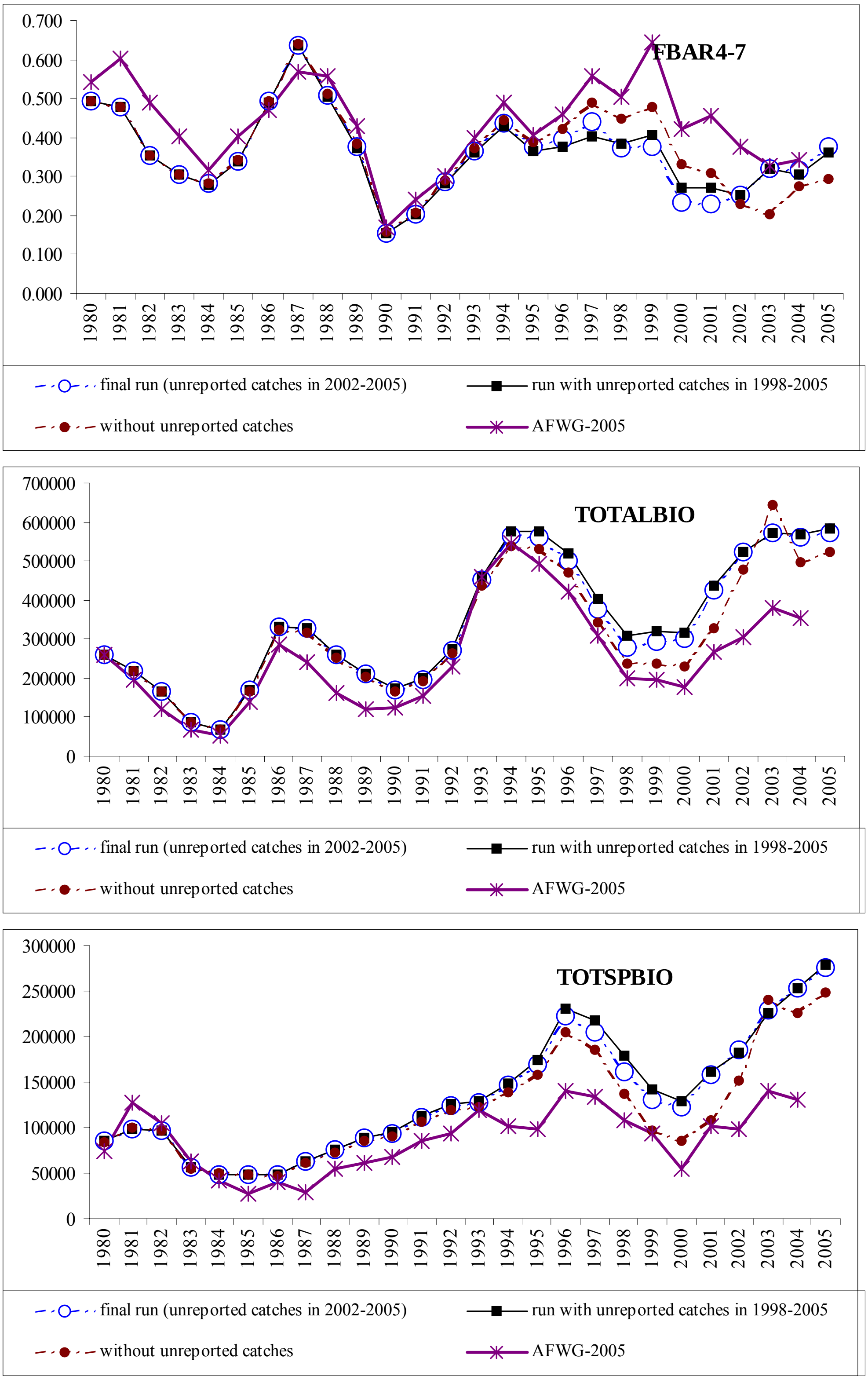


Figure 4.5 NEA haddock. Dynamics of F_{bar}, total and spawning stock biomass in according with assessment with various biological and landings input data

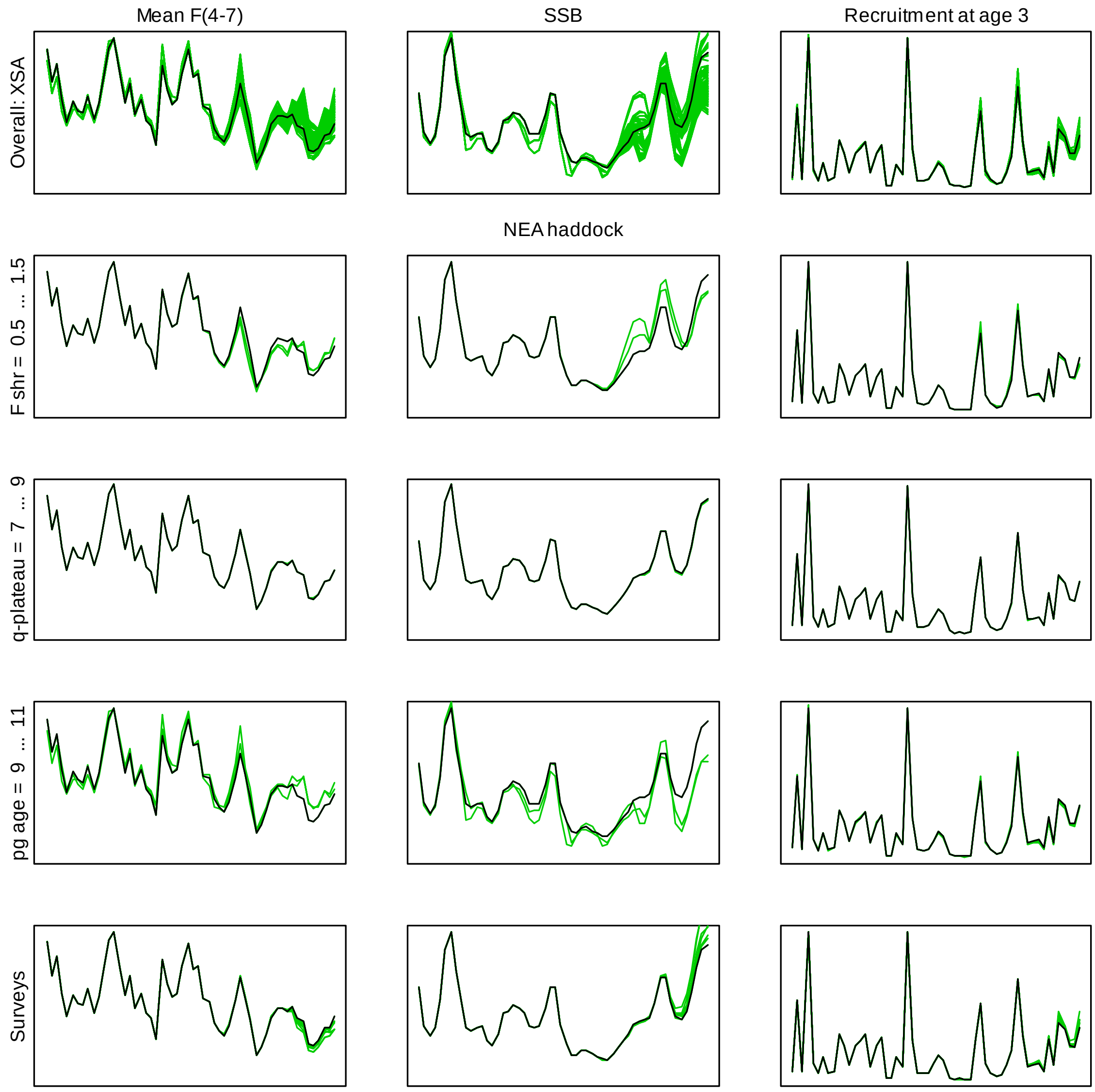


Figure 4.6. NEA haddock. Time-series plots showing the effect on the assessment of varying user-defined XSA run settings. The black line shows the baseline assessment from AFWG

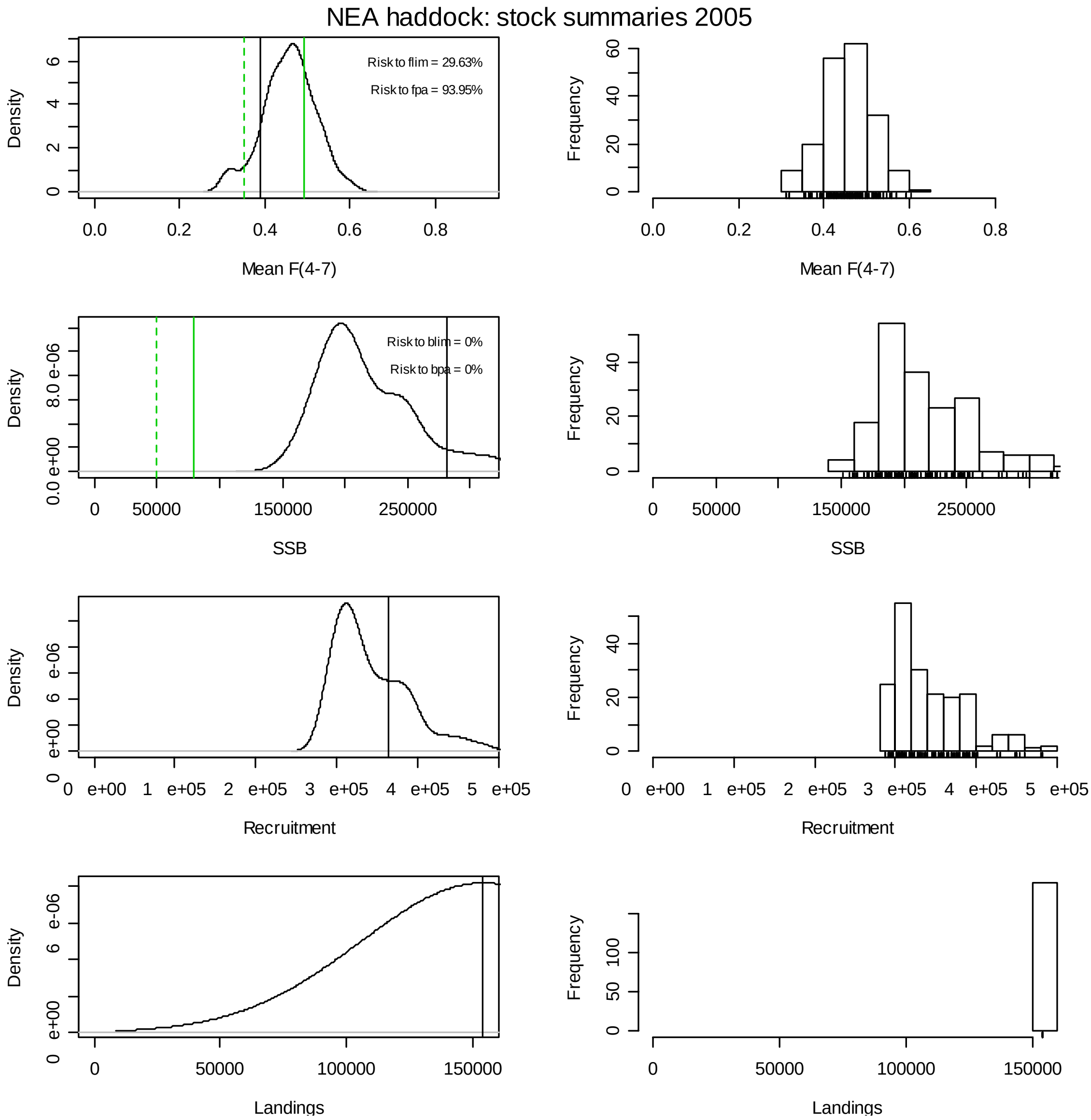


Figure 4.7. NEA haddock. Summary of distributions of assessment estimates in the final assessment year (left: density plots, right: histograms). Green vertical lines show reference points, black vertical lines show the baseline assessment. The estimated probability of being above F-reference points (and below biomass reference points) is also given.

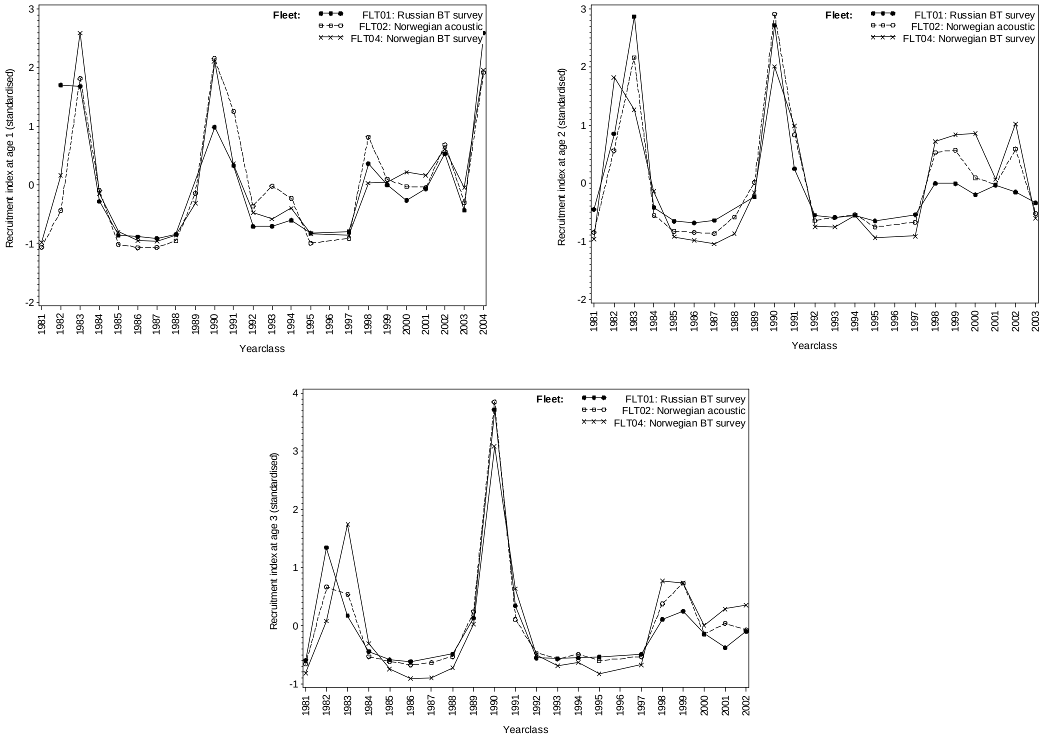


Figure 4.8 NEA haddock. Survey indices for age 1-3 used for tuning the XSA

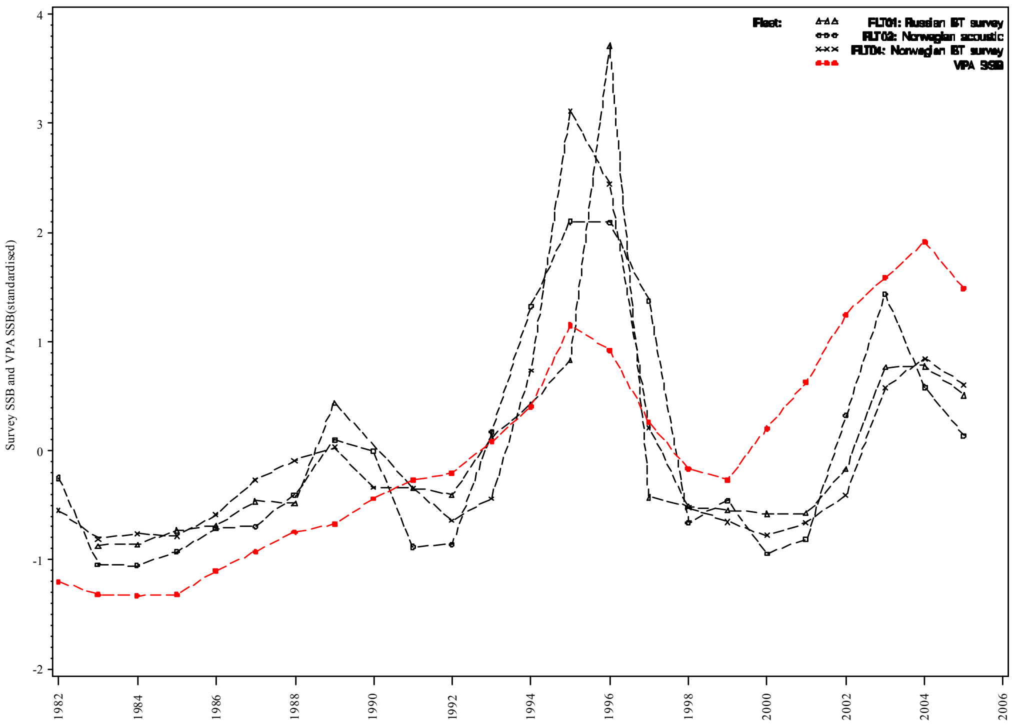


Figure 4.9 NEA haddock. Comparing survey SSB trends with SSB estimates from the XSA

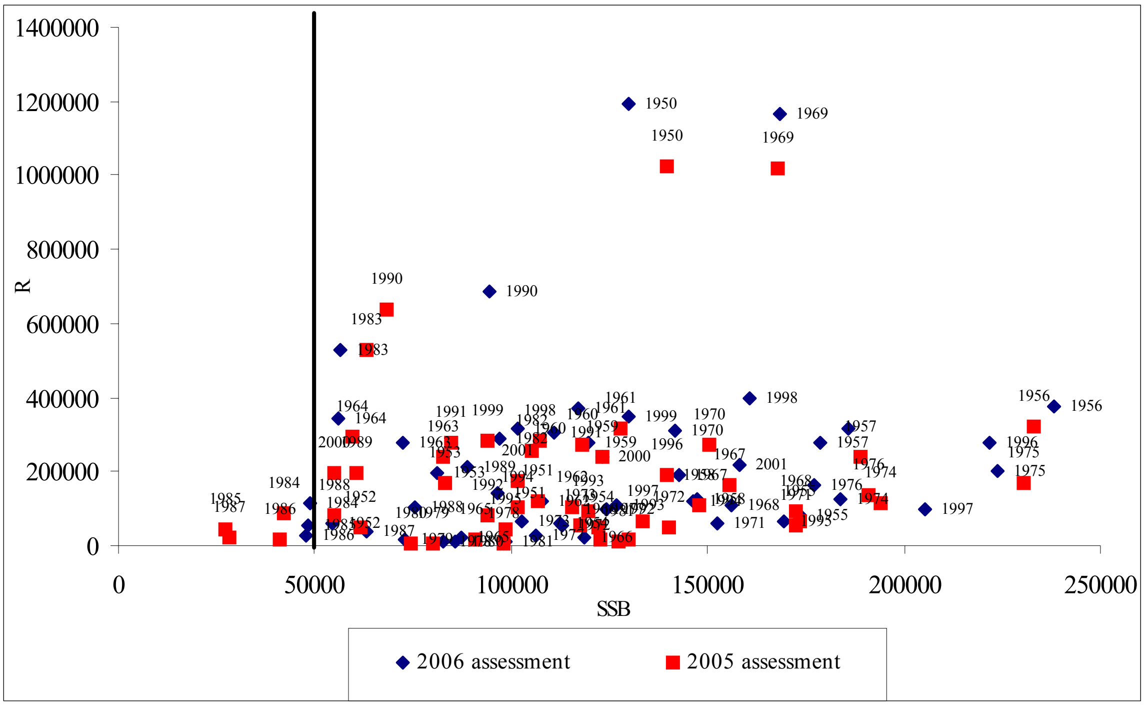
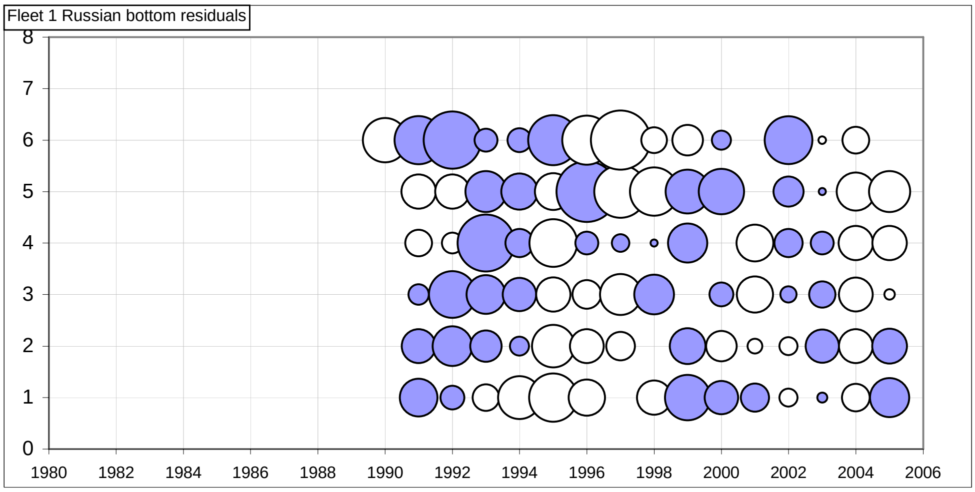


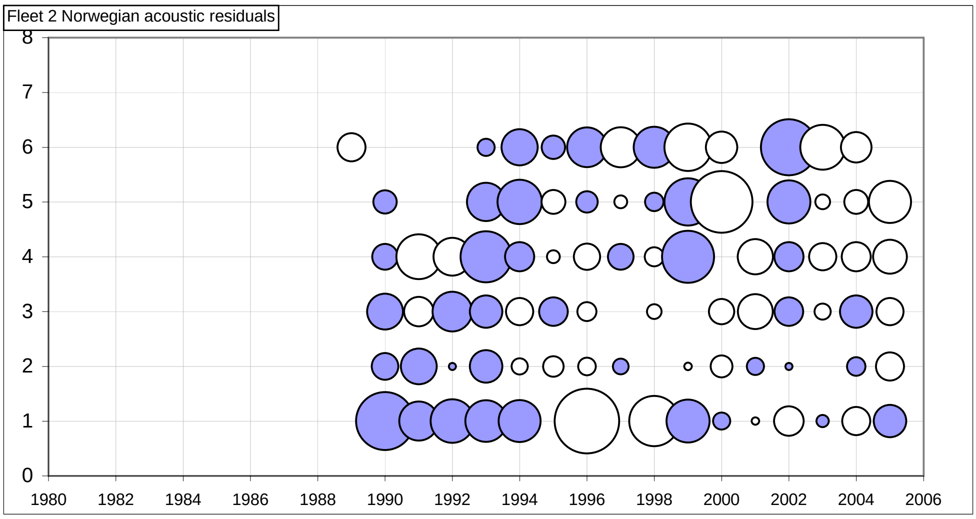
Figure 4.10 NEA haddock. Stock-recruitment relationship plot in 2005 («old») and 2006 («new») data

NEA Haddock, combined fleets, shrinkage 0.5, reduce data Residuals

Russian BT su min -0.98 st. error 0.356 max 1.32



Norwegian Acou su min -0.87 st. error 0.310 max 0.97



Norwegian BT su min -1.49 st. error 0.414 max 1.47

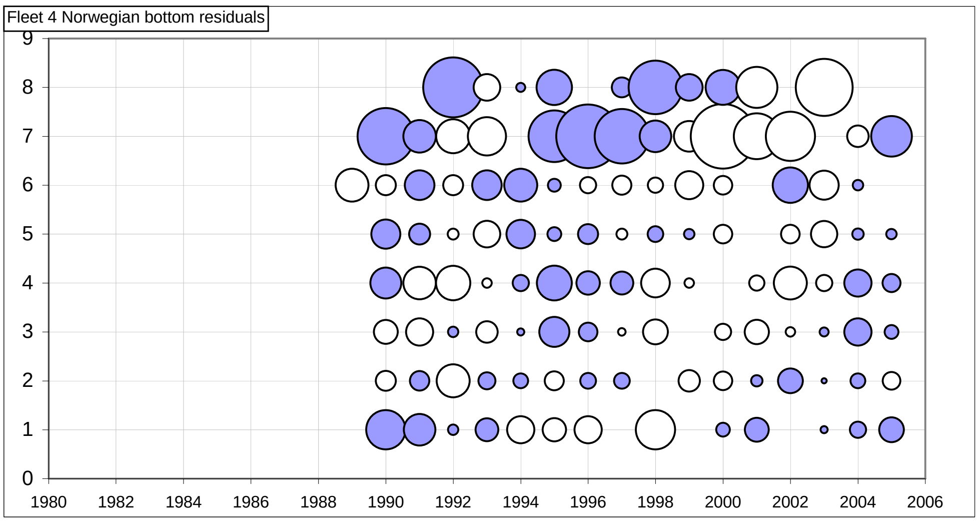


Figure 4.11. NEA Haddock, Log catchability residuals plot, fleets combined, with shrinkage 0.5

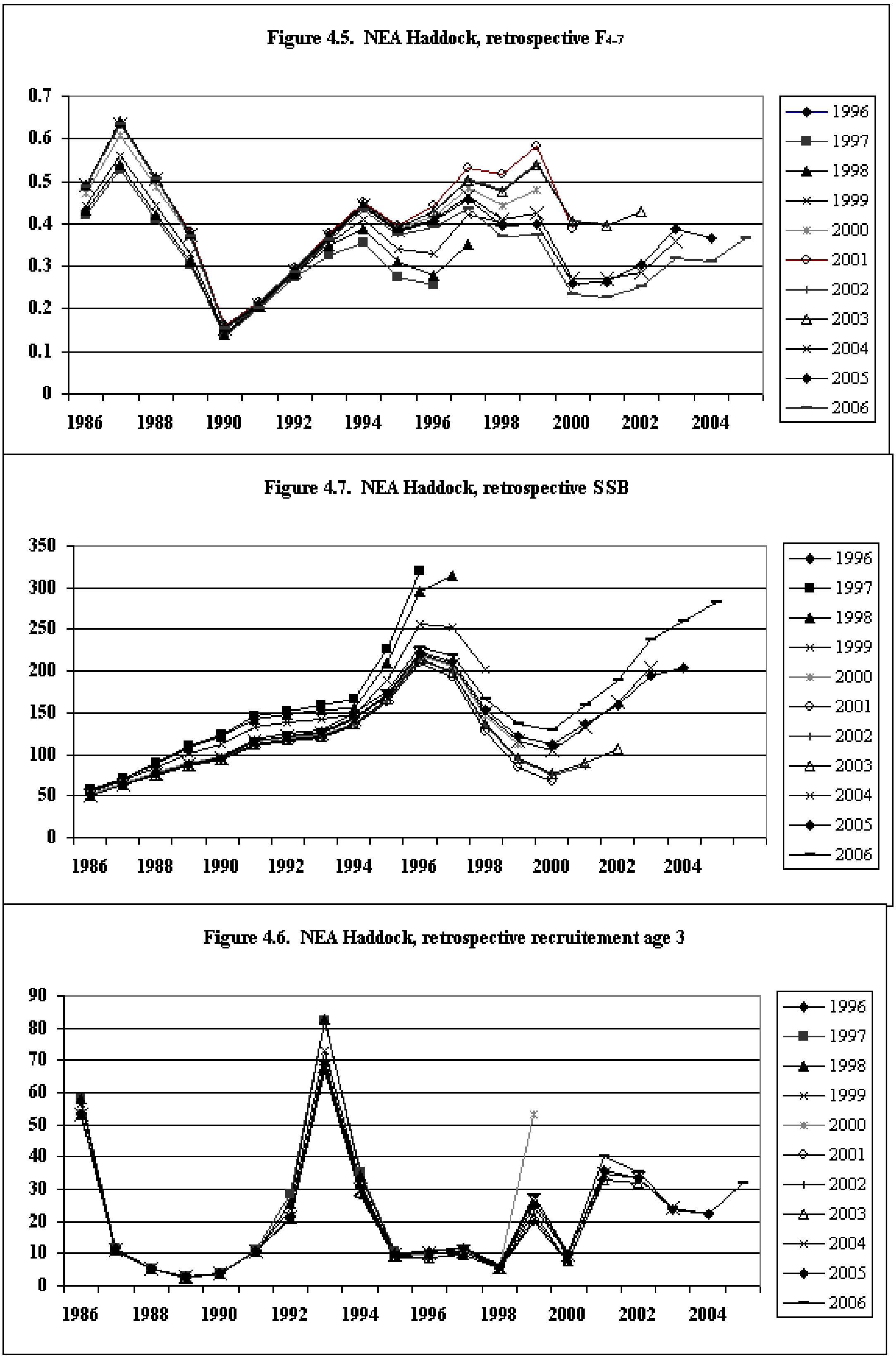


Figure 4.12 NEA Haddock. Retrospective plots with shrinkage 0.5

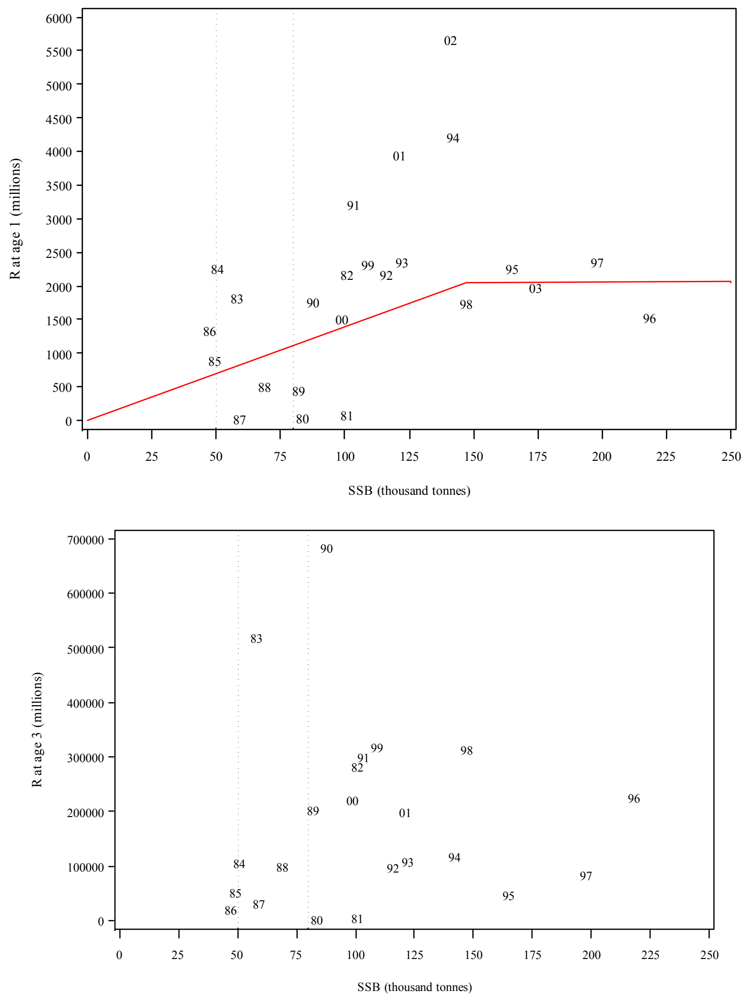


Figure 4.13 NEA Haddock. Stock – recruitment relationship plot for age 1 (left) and for age 3 (right)

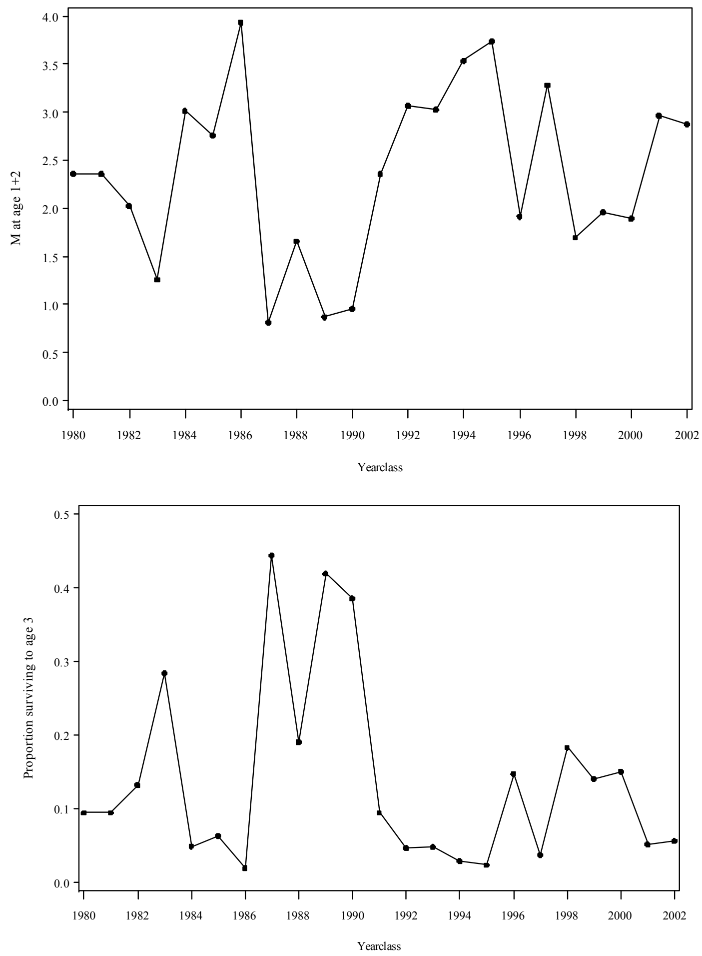
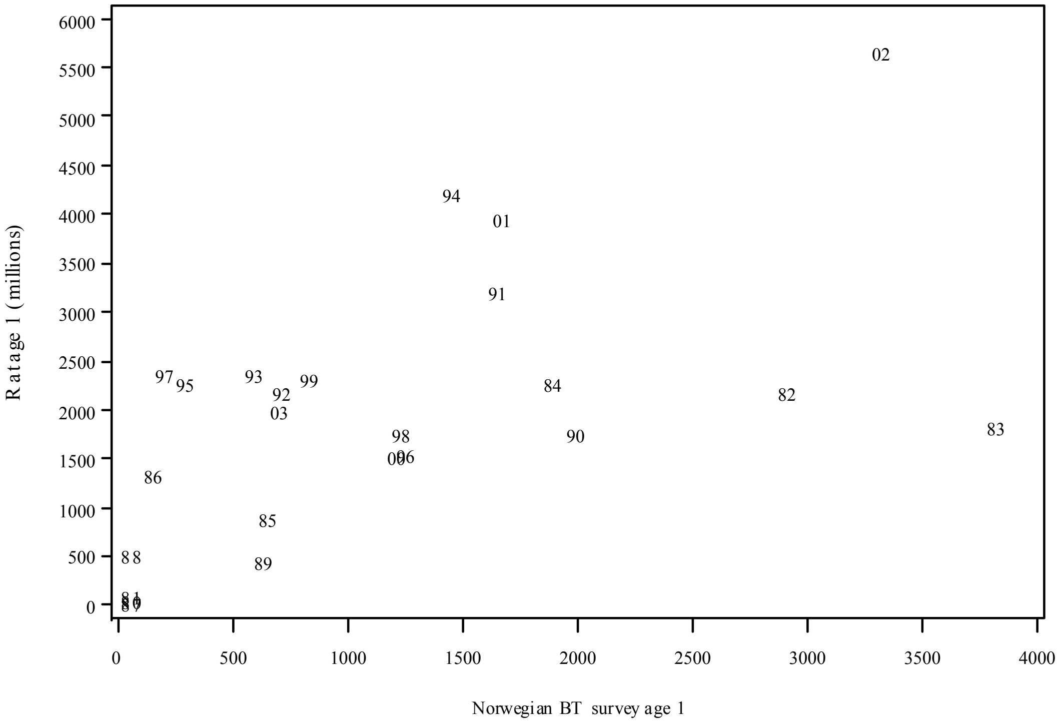


Figure 4.14 NEA Haddock. Natural mortality of yearclasses at age 1+2 (left) and proportion surviving to age 3 (right)



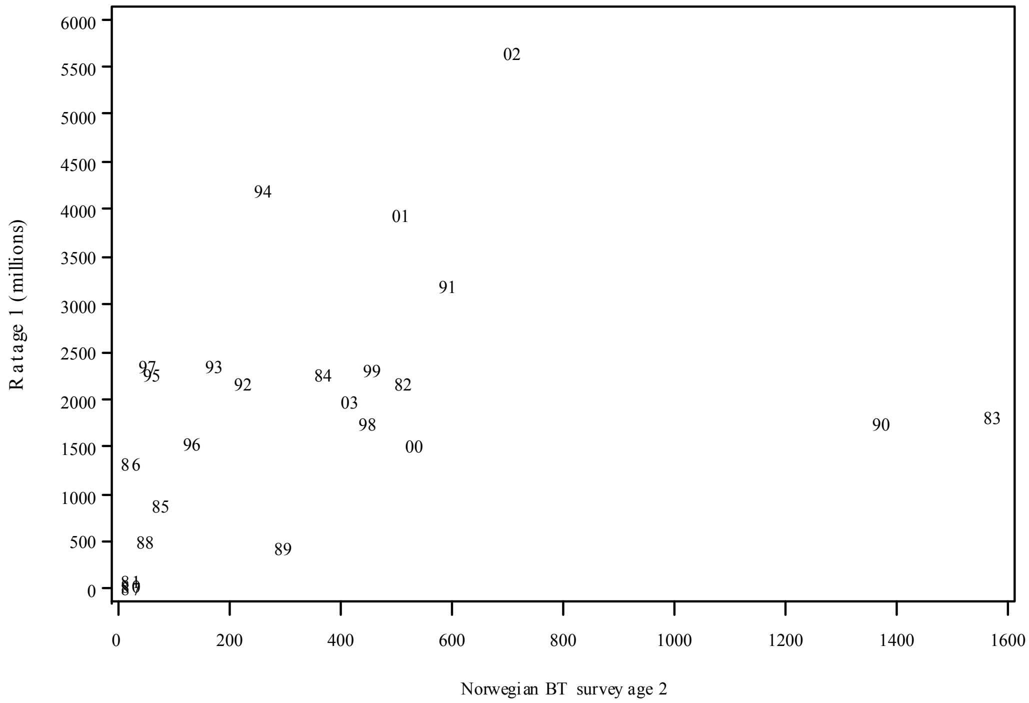


Figure 4.15 NEA Haddock. Estimated recruitment at ages 1 and 2 versus the age 1 index from the Norwegian bottom trawl survey (from WD#25)

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
2005	4630.2	420.4	346.5	133.3	66.8	52.2	12.3	0.6	0.2	0	5662.4
2006	5141.3	1313.1	77.4	140.5	48.2	19.6	15.2	3.1	0.1	0.3	6758.8

[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).

	Age											
Year	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
2004	47.9	12	27.9	18.6	12.8	16.1	12.4	0.8	0.3	0.1		148.9
2005	62.7	109.6	20.7	34.4	12.4	6.5	7.1	2.5	0.1	0.1		256.1
						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
2004	100.2	32.8	18.1	4.5	5.5	7.2	8.1	0.7	1.1	0.3		178.4
2005	61.6	23.9	4.6	10.9	2.1	2.7	5.3	2.9	0.5	0.2		114.6

Table B2 (continued)

Year	Age 0	1	2	3	4	5	6	7	8	9	Older	Total
						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
2004	34.9	5.6	6.4	1.3	2.6	1.8	2.9	0.1	0.2	0.1		56
2005	60.9	43.5	4.1	10.3	4.1	2.7	3.6	2.2	0.1	0.3		131.7
						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
2004	50.0	11.0	20.6	11.3	9.4	10.7	8.7	0.5	0.4	0.2		122.8
2005	62	79.2	13.6	24	8.6	4.8	5.7	2.4	0.1	0.2		200.7

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
2005	3364	209	219	102	36	40	9	+	+	0	3979
2006	2767	804	54	86	30	12	9	2	+	+	3764

[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 1985-2005 (old method). Index of number of fish at age.

	Age										
Year	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
2004	3164	472	421	176	143	154	151	10	21	5	4722
2005	7156	2521	271	476	172	114	154	79	5	7	10956

[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 1996-2005 (new method). Index of number of fish at age.

	Age											
Year	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
2004	8529	1141	342	116	54	55	44	3	4	1	1	10289
2005	17782	2903	123	205	62	33	38	16	1	1	+	21165

[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			
	2005	15.1	20.8	30.0	36.6	41.5	47.9	51.9			
	2006	14.7	22.6	31.3	37.8	43.2	48.0	50.8			
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
	2004	14.4	23.1	30.4	37.7	44.2	49.4	56.4	61.6	66.4	69.1
	2005	14.9	23.5	30.0	36.9	44.8	49.9	54.7	59.2	65.9	66.6

[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.

Norway

Year	Age 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
2005	29	84	253	469	699	1 054	1 378
2006	26	107	303	540	821	1 111	1 332

Russia

Year	Age 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	-
2004	24	87	253	518	846	1 130	1 571	1 959	2 633	3 366	
2005	27	115	259	511	933	1 289	1 670	2 079	2 833	2 965	-

[1] Lengths adjusted to account for limited area coverage.

[2] Limited area coverage.

5 Northeast Arctic Saithe (Sub-areas I and II)

An update assessment is presented for this stock. General information is located in the Quality Handbook Stock Annex.

5.1 The Fishery (Tables 5.1.1-5.1.2, Figure 5.1.1)

Currently the main fleets targeting saithe include trawl, purse seine, gillnet, hand line and Danish seine. Landings of saithe were highest in 1970-1976 with an average of 238,000 t and a maximum of 274,000 t in 1974. 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 70,000-122,000 t. An increasing trend was seen after 1990 to 171,348 t in 1996. Since then the annual landings have been between 136,000 and 176,000 t.

There is known to be a discarding problem in the saithe fishery. Undocumented observations and comparisons of people having taken scientific samples from commercial trawlers for many years indicate a substantial discarding in certain areas and seasons. The total discarding of saithe in this fishery may amount to about 20-30%. There are also records of discard in the purse seine fishery. In 2005 this fleet had problems finding saithe of suitable size, and areas were closed due to a too high percentage of undersized fish. Therefore the minimum landing size was reduced from 42 to 40 cm north of Lofoten (the same size as south of Lofoten) in the second half of the year. The purse seine fleet was thereby able to target the recruiting relatively strong 2002-year class (3 year olds) without getting a too high percentage of undersized fish. At the moment it is not possible to estimate the total level of discarding and use the information quantitatively in the assessment.

5.1.1 ICES advice applicable to 2005 and 2006

The advice from ICES for 2005 was as follows:

Exploitation boundaries in relation to precautionary limits: *In order to harvest the stock within precautionary limits fishing mortality should be kept below Fpa. This corresponds to landings of less than 215 000 t in 2005. Take account of Sebastes marinus by-catch.*

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: *The current estimated fishing mortality (0.18) is just above the lowest fishing mortality that would lead to high long-term yields (F0.1=0.12). There will be no gain in the long-term yield to have fishing mortalities above F0.1 (0.12). Fishing at such lower mortalities would lead to higher SSB, and, therefore, lower risks of fishing outside precautionary limits*.

The advice from ICES for 2006 was as follows:

Exploitation boundaries in relation to precautionary limits: *In order to harvest the stock within precautionary limits, fishing mortality should be kept below F_{pa}. This corresponds to landings of less than 202 000 t in 2006. Take account of Sebastes marinus by-catch.*

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: *The current estimated fishing mortality (0.21) is just above the lowest fishing mortality that would lead to high long-term yields ($F_{0.1}$=0.15).*

5.1.2 Management applicable in 2005 and 2006

Management of Northeast Arctic saithe is by TAC and technical measures. Norwegian authorities set the TACs for 2005 and 2006 to 215,000 t and 193,500 t, respectively. The

Institute of Marine Research, Bergen, Norway, advised a TAC for both years at 2004 level in order to stabilize catches and spawning stock development.

5.1.3 The fishery in 2005 and expected landings in 2006

Provisional figures show that the landings in 2005 were approximately 176,000 t, which is about 40,000 t. lower than the level expected by the WG last year (215,000 t).

Official landings in 2006 are expected to be around the TAC of 193,500 t, which is 10 % lower than the 2005 TAC. The saithe prices have so far been much higher in 2006 than in the previous years. One may therefore also experience increased problems with discard of small and less paid saithe, as well as of the largest fish due to processing problems on some trawlers.

5.2 Commercial catch-effort data and research vessel surveys

5.2.1 Fishing Effort and Catch-per-unit-effort (Tables 5.2.1-5.2.3, Figure 5.2.1-5.2.2)

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 numbers of vessels catching more than 100 tonnes annually have been regarded as a more representative and stable measure of effort in the purse seine fishery. These numbers have been raised to the total purse seine catch (Table 5.2.1). There was an increase in purse seine effort in 2003, a decrease in 2004 and a new increase in 2005. This variations may be explained both by better availability of schooling saithe in some years with strong recruiting year classes and by transfer of quota, allowing for a longer fishing season.

In the Norwegian trawl CPUE indices all days with 20% or more saithe in the catches from vessels larger than the median length were include. First all CPUE observations for each quarter were averaged, and then a yearly index were calculated by averaging over the year. There was an increase in the total CPUE from 1999 to 2003 (Table 5.2.2 A), when it reached the highest level in the time series going back to 1980. In 2004 the total CPUE was almost exactly the same as in 2003, while there was about a 30 % increase from 2004 to 2005. This was caused by an increase in the quarter one CPUE (Figure 5.2.1). This increase started already in 2003, but was most pronounced in 2005. The increase may be explained by increased availability and catchability of saithe in spawning areas of Norwegian spring spawning herring, where the saithe feeds on herring during quarter one. A similar increase is not seen in the other areas and quarters. In quarter four 2005 the trawl catches were small because most of the quota already was taken and no logbook data are available. Annual CPUE was also calculated without quarter one data (Figure 5.2.2, Table 5.2.2 B). This CPUE series shows much less variations over the last four years. The total CPUE index was finally divided on age groups applying yearly catch in numbers and weight at age data from the trawl fishery.

In 2005 German freezer trawler CPUE data was made available for the WG (Table 5.2.3). The data come from one trawler only fishing in the first quarter of the year. Analyses performed by the 2005 WG showed that the CPUE data did not track weak and strong year classes very well and showed some very strong year effects. There were strong age effects on selectivity for most age groups. In the combined tuning this fleet got the lowest scaled weights and the WG decided not to apply the series in the analysis.

5.2.2 Survey results (Table 5.2.4)

Autumn 2003 the saithe- and coastal cod surveys were combined (Berg *et al*., WD 11 2004). However, until new time series can be established, the estimation of abundance indices is done very much in the same way as before and the results should be comparable. The total index for

2005 (Berg *et al*., WD 14) decreased by over 30 % compared to 2004, and was at about the same level as in 2002-2003. Only age group 3 (2002 year class) was above average level, while older fish (6+) were at about average level.

5.2.3 Recruitment indices

Good recruitment indices are crucial for reliable predictions. Attempts at establishing year class strength at age 0 or 1 have so far failed. The accuracy of the survey recruitment indices varies from year to year according to the extent to which 2 - 3 year old saithe have migrated out from the near coast areas and become available to the acoustic saithe survey on the banks. An observer program for establishing a 0-group index series started in 2000 (Borge and Mehl, WD 21 2002. However, these observations do not seem to pick up the year class strength very well, and the program will be evaluated in the near future.

5.3 Data used in the Assessment

5.3.1 Catch numbers at age (Table 5.3.1)

The allocation of biological samples of catch numbers, mean length and mean weight at age from the Norwegian fishery in 2004 was updated, and the total Norwegian landings by numbers were adjusted to the official total catch reported to ICES. This revision resulted in minor changes in catch numbers-at-age and weight-at-age. Age composition data for 2005 was available from Norway, Russia (Division 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 5.3.2)

Constant weights 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. There have been relatively small changes in individual weight at age since 2003, but with some variations for age groups 7+.

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 5.3.4)

A constant maturity ogive was used until the 2005 WG, when these estimates were evaluated. In the last period the maturity at age had decreased somewhat, and the WG decided to use a 3-year running average for the period from 1985 and onwards (2-year average for the first and last year). New analyses were only available back to 1985. Table 5.3.4 presents the 3-year running average maturity ogives.

5.3.5 Tuning data (Table 5.3.5)

Until the 2005 WG the tuning was based on three data series: CPUE from Norwegian purse seine and Norwegian trawl and indices from a Norwegian acoustic survey. The 2005 WG found rather large and variable log q residuals and large S.E. log q for the purse seine fleet, strong year effects and in the combined tuning the fleet got low scaled weights. The WG decided to not include the purse seine tuning fleet in the final analysis and the following two fleets were used:

- Fleet 12: CPUE data from the Norwegian trawl fisheries (start 1994, age groups 4 to 8)
- Fleet 13: Indices from the Norwegian acoustic survey (start 1994, age groups 3 to 7).

As mentioned in section 5.2.3 there was about a 30 % increase in total trawl CPUE from 2004 to 2005. A few exploratory runs, with and without quarter one CPUE trawl data were performed to analyze the effect of the increase in CPUE on the assessment.

5.4 Exploratory runs

The settings of the different runs are shown in Table 5.4.1.

5.4.1 XSA runs based on data until 2004 (Table 5.4.1)

Based on the update of Norwegian catch statistics and allocations of biological samples, a SPALY (Same Procedure As Last Year) XSA (run 1) was performed, giving similar results as in the 2004 assessment. $F_{4\text{-}7}$ in 2004 was the same as in last assessment (0.21), and SSB 1 Jan. 2004 only increased a little from 595,000 t to 607,000 t.

5.4.2 XSA runs based on data with 2005 included (Table 5.4.1, Figure 5.4.1).

SPALY 2005-data run

A SPALY (Same Procedure As Last Year) XSA run with 2005 data included was performed first (run 2). The results showed that $F_{4\text{-}7}$ in 2004 was reduced from 0.21 to 0.15 compared with the SPALY run based on data until 2004 (run 1). $F_{4\text{-}7}$ in 2005 was estimated to 0.16. The estimate of SSB 1 Jan. 2004 increased from 607,000 t to about 834,000 t, while SSB 1 Jan. 2005 was estimated to 675,000 t. The changes may to a large extent be explained by the increase in total annual CPUE from 2004 to 2005.

Singe fleet tuning runs

3 single fleet tuning runs were performed; one with the Norwegian trawl CPUE calculated over all quarters (Table 5.2.2A) (run 3), one with the CPUE calculated over quarter 2-4 (Table 5.2.2B) (run 4) and one with the Norwegian acoustic survey (run 5). Figure 5.4.1 compares estimates of SSB and $F_{4\text{-}7}$ in 2005 from the three single fleet XSA-runs as well as from two combined tuning runs (SPALY run and a run with trawl CPUE calculated over quarter 2-4 (run 6)). The single fleet tuning runs based on the total annual CPUE and on the survey gives the lowest $F_{4\text{-}7}$ and highest SSB in the last assessment year (2005). The SSB estimates are about 50 % above the 2005 WG result. The single fleet tuning runs based on CPUE calculated over quarter 2-4 gives a higher $F_{4\text{-}7}$ and a much lower SSB in 2005 compared to the two other single fleet tuning runs. The SPALY combined run results in a $F_{4\text{-}7}$ about in the middle of the results of the three single fleet tuning runs and a SSB at about the same level as the run with CPUE calculated over quarter 2-4. The combined run with trawl CPUE calculated over quarter 2-4 (run 6) gives about the same $F_{4\text{-}7}$ as the single fleet tuning runs based on CPUE calculated over quarter 2-4 and the lowest SSB of all the runs based on 2005 data, but the estimate of SSB at 1 Jan. 2004 is still considerably higher than the 2005 WG estimate (782,000 t. compared to 607,000 t.).

Figure 5.4.2 present S.E. log q for the different age groups 4-7 in the three fleets used in the single fleet tuning runs. The single fleet tuning runs based on CPUE calculated over quarter 2-4 has slightly lower S.E. log q for most age groups compared to the run with CPUE calculated over the whole year, while the run based on the survey has much lower S.E. log q for age group 4, somewhat lower for age group 5 and 7 and much higher for age group 6. The latter was at the 2005 WG explained by a large increase in availability and/or catchability of this age group in 1997-98.

Based on the changes in the quarter one trawl CPUE the last years and on the results of the single fleet tuning runs, the WG decided to base the final run on the CPUE calculated over quarter 2-4 and on the acoustic survey (Table 5.3.5):

Fleet 12: CPUE data from the Norwegian trawl fisheries quarter 2-4 (start 1994, age groups 4 to 8)

Fleet 13: Indices from the Norwegian acoustic survey on saithe (start 1994, age groups 3 to 7).

This is identical with run 6 above.

5.5 Final assessment run (Tables 5.5.1–5.5.7, Figure 5.5.1–5.5.3)

Extended Survivors Analysis (XSA) was used for the final assessment with settings shown in Table 5.4.1 (run 6). The settings for this update assessment are the same as in the 2005 assessment since diagnostics of initial runs were similar to last year's. Full tuning fleet diagnostics are given in Table 5.5.1, and Figure 5.5.1 presents log q residuals for the two fleets, Figure 5.5.2 shows scaled weights and Figure 5.5.3a-b shows plots of the tuning indices versus stock numbers from the XSA.

5.5.1 Fishing mortalities and VPA (Tables 5.5.2–5.5.7, Figure 5.5.4)

The fishing mortality (F_{4-7}) in 2004 was 0.17, which is lower than the value of 0.21 from last year's assessment. The fishing mortality (F_{4-7}) in 2005 was 0.19, i.e. a little above the corresponding figure for 2004 but well below the F_{pa} of 0.35. 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 5.5.4. A couple of retrospective XSA analyses with a natural mortality of 0.1 and 0.02, respectively, were performed, but they both showed the same retrospective picture as the final run.

The XSA-estimates of the 2002-2003 year classes are not considered to be valid and these estimates are therefore shaded (Tables 5.5.3 and 5.5.5). The summary table (Table 5.5.7) presents the recalculated recruitment figures and total biomass. The 1996-year class was well represented in the catches over several years, and still appear to be above average in the current assessment, while the 1997-year class seems to be weak and the 1998-year class is of about average strength. As in 2003 and 2004 the 1999-year class is one of the dominating in the catches, and also in the present assessment appear to be almost as strong as the 1992-year class. The 2000-year class seems to be well below average strength and the 2001-year class about at average strength, while the 2002-year class had the highest catch number in the catches in 2005 and at present seems to be strong. No information is available on recent year classes.

The total biomass (ages 3+) has been at a stable and high level above the long-term (1960-2005) mean since 1995. Likewise, the SSB has been above the long-term mean since 1996 and above B_{pa} since 1994 (Tables 5.5.5-5.5.7).

5.5.2 Recruitment (Table 5.3.1, Figure 5.1.1)

Estimates of the recruiting year classes up to the 2001-year class (4 year olds) from the XSA were accepted. Catches of age group 3 have to a large extent declined to low levels in recent years (Table 5.3.1). Until the 2005 WG RCT3-runs were conducted to estimate the corresponding year classes, with 2 and 3 year olds from the acoustic survey as input together with VPA numbers. These estimates were, however, strongly weighted towards the mean value of the input XSA-numbers, which due to the short survey time series also contained year classes that are still not converged. It has therefore been stated several times in the ACFM Technical Minutes that it would be more transparent to use the long-term GM (geometric mean) recruitment.

The GM recruitment 1960-2004 is 169 million 3 year olds, and this value is used for the 2002-year class. The value is somewhat lower to the GM recruitment 1994-2003 (203 million 3 year olds), a period where the SSB has been well above B_{pa}. Preliminary data from the Norwegian 0-group observer program indicate slightly above average recruitment since 2000. This time series is still too short to use in recruitment models together with converged XSA-data.

5.6 Reference points

Due to the change of Fbar from 3-6 to 4-7 and age at recruitment from 2 to 3, the lim and pa reference points were re-estimated at the 2005 WG. The lim reference points were estimated according to the new methodology outlined in ICES CM 2003/ACFM:15, while the pa reference point estimation was based on the old procedure (ICES CM 1998/ACFM:10).

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 an examination of the stock-recruitment plot ACFM reduced the B_{pa} to 150,000 t (ICES 1998).

At the 2005 WG parameter values, including the change-point, were computed using segmented regression on the 1960-2000 time series of SSB-recruitment pairs. The maximum likelihood estimate of the spawning stock biomass at which recruitment is impaired was 136,055 t, and B_{lim} was set at 136,000 t. Applying the “magic formula” $B_{pa} = B_{lim} \exp(1.645*\sigma)$, with a value of 0.3 for σ, gave a B_{pa} of 222,863 t, rounded to 220,000 t. This new B_{pa} for Northeast Arctic saithe was accepted by ACFM.

5.6.2 Fishing mortality reference points (Tables 5.6.1, 5.7.1, Figure 5.1.1)

Yield and SSB per recruit were based on the parameters in Table 5.7.1 and are presented in Table 5.6.1. $F_{0.1}$ and F_{max} were estimated to be 0.14 and 0.32, respectively, which is very close to the values as obtained last year. The plot of SSB versus recruitment is shown in Figure 5.1.1. The values of F_{low}, F_{med} and F_{high} obtained by the 2002 WG were 0.11, 0.34 and 0.69, respectively. In 1998 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).

At the 2005 WG F_{lim} was set on the basis of B_{lim} (ICES CM 2003/ACFM:15). The functional relationship between spawner-per-recruit and F gave the F associated with the R/SSB slope derived from the B_{lim} estimate obtained from the segmented regression. R/SSB = 1.27 from the B_{lim} estimation gave SSB/R = 0.7874 and a $F_{lim} = 0.58$. Applying the “magic formula” $F_{pa} = F_{lim} \exp(-1.645*\sigma)$, gave a F_{pa} of 0.35. This new F_{pa} for Northeast Arctic saithe was accepted by ACFM.

5.7 Predictions

5.7.1 Input data (Table 5.7.1)

The input data to the predictions based on results from the final XSA-analysis are given in Table 5.7.1. The stock number at age in 2006 was taken from the XSA for age 5 (2001 year class) and older. The recruitment at ages 3 in the last assessment year (2005) was calculated as the long-term GM (geometric mean) recruitment 1960-2004 (Section 5.5.2), and the corresponding numbers at age 4 in the intermediate year (2006) was calculated applying a natural mortality of 0.2 and the F value estimated by XSA (as recommended by the ACFM reviewers in 2004). The GM age 3 recruitment of 169 million was also used for the 2003 and subsequent year classes. The natural mortality is the same as were used in the assessment. For the exploitation pattern the average of 2003-2005 has been used. For weight at age in stock and catch the average of the last three years in the XSA was used. For maturity at age the average of the 2004-2005 annual determinations was applied, which is the same as applied for 2005 in the assessment.

5.7.2 Catch options for 2007 (short term predictions) (Table 5.7.2-5.7.3)

The management option table (Table 5.7.2) shows that the expected catch of 193,500 t in 2006 will increase the fishing mortality compared to 2005 from 0.19 to 0.24, which are well below the F_{pa} of 0.35. A catch in 2007 corresponding to $F_{status\ quo}$ level of 0.17 will give 135,000 t, while the catch corresponding to F_{pa} in 2007 is about 247,000 t. The SSB is expected to decrease from about 650,000 t in the beginning of 2006 to 604,000 t in the beginning of 2007, which is well above the prediction made by last year's working group for a catch in 2006 corresponding to F_{pa}. At $F_{sstatus\ quo}$ in 2007 SSB is estimated to remain at this level, while at F_{pa} it will decrease to about 500,000 t at the beginning of 2008. This predicted reduction in SSB may be explained by a higher fishing mortality (F_{pa}) and incoming year classes of average strength. Table 5.7.3 presents detailed output for fishing at F_{pa} in 2007.

Autumn 2004 the Norwegian Directorate of Fishery suggested a management strategy for Northeast Arctic saithe:

- At spawning stock levels above the precautionary approach level (B_{pa} = 220 000 tonnes), the TAC is based on the average of the TACs that a fishing mortality of 0.30 for reference ages 4-7 years would imply the next three years.
- The TAC should not be changed by more than +/- 10% from year to year
- If the spawning stock falls below Bpa the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from 0.30 at B_{pa} to F=0 at SSB equal to zero. At such low SSB-levels there should be no limitation on the year-to-year variation in TAC.

The strategy was sent for a public hearing, but it is not yet adopted or fully tested and evaluated. If this strategy should be applied now, the corresponding TAC for 2007, 2008 and 2009 at F = 0.30 would be 217,624 t, 190,322 t and 175,221 t, respectively. The final average TAC for 2007 would then be 194,392 t.

5.7.3 Medium term simulations (Figure 5.7.1-5.7.2)

The ACFM review group did not consider the medium term analyses reliable as the results were mainly driven by the assumption of mean recruitment and ignoring the bias in the assessment. The WG followed the advise from the ACFM Technical Minutes and use the long-term GM (geometric mean) recruitment and the problem with bias in the assessment was not resolved. However, the WG made medium-term simulations just to illustrate a couple of scenarios made under specific assumptions, one fishing at F_{pa} and the other following the new management strategy proposed by the Norwegian Directorate of Fishery.

The input data were the same as used for the short-term predictions (Table 5.7.1). At F_{pa} the catch will decrease to about 170,000 t in 2010, and the SSB will be reduced to about 400,000 t (Figure 5.7.1A-B). Following the suggested management strategy, the catch will decrease to slightly below 170,000 t in 2010, while the SSB will be reduced to about 470,000 t (Figure 5.7.1A-B).

5.8 Comparison of the present and last year's assessment

The current assessment estimated the total stock to be about 13 % higher and SSB 15 % higher in 2005, compared to the previous assessment. The F in 2004 was estimated to be somewhat lower than in the previous assessment, and the realized F in 2005 is much lower than the predicted one since almost 20 % of the quota was not taken.

	Total stock (3+) by 1 January 2005	SSB by 1 January 2005	F_{4-7} in 2005	F_{4-7} in 2004
WG 2005	885448	599348	0.32 (prediction)	0.21
WG 2006	1004822	689993	0.19	0.17

5.9 Comments on the assessment and the forecast

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 problems 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. Even if the present assessment is an update assessment, the WG decided to change the basis for calculating annual trawl CPUE due to rather large changes in CPUE in quarter one the last three years.

5.10 Response to ACFM technical minutes

The review group noted that *the total discarding should be investigated with the aim of including this type of information in the assessment data should discarding practices persist*. The WG has information about persisting discarding both in the trawl and purse seine fishery. However, so far it has not been possible to get any data that may be used in the assessment.

The review group further commented that *the final assessment included several changes in settings, and it would be important to include results of the SPALY (Same Procedure As Last Year) assessment in the graphical comparisons*. The WG changed the basis for calculating annual trawl CPUE. SPALY results were therefore included in Figure 5.4.1.

The reviewers found *the final assessment to have significant diagnostic problems with very noisy indices, some with conflicting trends and very strong "reverse" retrospective pattern, and that this needed to be addressed by exploring the reasons for the retrospective patterns*. In previous retrospective analysis carried out fleet by fleet saithe (Mehl and Fotland,WD 15 2003) and with a range of different XSA parameter settings (ICES CM 2005/ACFM:20), all runs showed the same trends. During the present WG a couple of retrospective XSA analyses with alternative natural mortalities were performed, but they both showed the same retrospective picture as the other runs. The reasons for the retrospective patterns are probably complex, and since the same "reverse" retrospective pattern also have been observed for other saithe stock, there should be some joint effort to look into the problem.

The reviewers requested additional *information on the performance of alternative models and discussion of their respective diagnostics*. The WG noticed this for the next benchmark assessment. It was further noticed that *the working group should explore the possibility of using less data-demanding methods in this assessment, e.g. production models, taking into account the diagnostic problems and retrospective pattern*.

Table 5.1.1

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 [2]	136 402
2002	520 [2]	1048	1138 [2]	2 642 [6]	143 840	-	118	5 402	37 [2]	345	75	81 [2]	155 246
2003	561 [2]	848	929 [2]	2 763 [6]	150 244	-	143	3 893	13 [2]	265		98 [2]	159 757
2004	708 [2]	188 [2]	891 [2]	2 161 [6]	147 933	-	105	9 192	87	522	21	333 [2]	162 140
2005 [1]	1 192 [2]	348 [2]	817 [2]	2 048 [6]	162 001	-	343	8 362	24	629		365 [2]	176 129

[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 5.1.2 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	16.1	168.4 [4]
1996	46.9	72.8	31.6	20.1	171.3
1997	44.4	56.1	24.4	18.8	143.6
1998	44.4	58.1	27.6	23.2	153.3
1999	39.2	57.9	29.7	23.6	150.4
2000	28.3	54.6	29.6	23.5	135.9
2001	28.1	58.3	28.2	21.7	136.4
2002	27.4	75.9	30.4	21.5	155.2
2003	43.3	72.2	25.2	19.0	159.8
2004	41.8	72.0	26.9	21.3	162.1
2005 [1]	42.1	90.4	25.5	18.2	176.1

[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 5.2.1 Northeast Arctic saithe. Catches splitted on vessels with annual catch < 100 t and > 100 t, and number of vessels with catch > 100 t scaled by total purse seine catch

	No. of vessels with catch			% vessels with catch		Annual catch (t) from vessel with catch			Catch in % by vessel		Catch per vessel by vessel		Effort (No.) vessel>100(t) scaled to total catch
Year	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	
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	185	108	293	63 %	37 %	3 098.0	40 250.0	43 348.0	7 %	93 %	16.7	372.7	116.3
2004	194	71	265	73 %	27 %	2 905.0	38 892.0	41 797.0	7 %	93 %	15.0	547.8	76.3
2005 [1]	221	101	322	69 %	31 %	2 642.0	39 400.0	42 042.0	6 %	94 %	12.0	390.1	107.8
Mean	142.6	85.9	228.6	60 %	40 %	3 035.3	32 782.7	35 818.0	9 %	91 %	22.9	390.3	94.8

Table 5.2.2 Northeast Arctic saithe. Norwegian trawl CPUE by agegroup (Catch in numbers per trawlhour)
A. All quarters included in the calculatons

Year	Agegroup									Total CPUE (kg/h)
	effort	3	4	5	6	7	8	9	10	Quarter 1-4
1994	1	5.0	123.8	417.1	259.1	35.8	8.0	2.5	4.9	856
1995	1	41.7	223.0	309.5	336.3	53.4	8.8	0.3	2.3	975
1996	1	23.0	114.4	152.9	222.3	293.2	33.6	7.2	0.7	847
1997	1	16.0	42.4	220.6	224.7	289.0	181.9	19.2	1.9	996
1998	1	3.2	33.0	55.3	244.1	93.0	56.5	16.3	7.6	509
1999	1	15.6	37.7	106.2	80.5	186.4	42.7	31.3	9.0	509
2000	1	6.6	72.4	77.4	145.2	112.4	151.0	57.1	64.5	687
2001	1	7.9	47.0	257.5	185.4	175.1	74.2	105.7	50.7	904
2002	1	10.1	76.1	123.7	385.2	86.8	89.2	40.8	75.9	888
2003	1	5.7	149.8	228.6	151.7	218.8	141.1	116.8	72.3	1085
2004	1	3.7	9.1	222.7	165.6	212.5	266.4	85.6	117.6	1083
2005 [1]	1	25.8	103.6	149.4	464.7	243.9	140.9	208.2	93.1	1429

[1] Provisional figures.

B. Quarter 2-4 included in the calculatons

Year	Agegroup									Total CPUE (kg/h)
	effort	3	4	5	6	7	8	9	10	Quarter 2-4
1994	1	5.1	126.0	424.3	263.6	36.4	8.1	2.6	5.0	871
1995	1	39.5	211.0	292.9	318.3	50.5	8.3	0.3	2.1	923
1996	1	21.3	105.9	141.5	205.7	271.3	31.1	6.7	0.6	784
1997	1	15.2	40.4	210.1	214.0	275.3	173.3	18.3	1.8	948
1998	1	3.2	32.4	54.3	239.5	91.2	55.5	16.0	7.5	499
1999	1	16.1	39.0	109.8	83.2	192.8	44.2	32.4	9.3	527
2000	1	7.4	81.2	86.8	162.7	126.0	169.2	64.0	72.3	770
2001	1	8.5	50.9	278.8	200.7	189.5	80.3	114.4	54.8	978
2002	1	10.2	76.4	124.3	387.1	87.2	89.6	41.0	76.3	892
2003	1	4.8	127.2	194.1	128.8	185.8	119.8	99.2	61.4	921
2004	1	3.2	7.7	190.4	141.5	181.7	227.7	73.2	100.5	926
2005 [1]	1	14.8	59.6	86.0	267.6	140.4	81.1	119.9	53.6	823

[1] Provisional figures.

Table 5.2.3 Northeast Arctic saithe. German freezer trawl CPUE (kg/h) and catch in numbers by age group

Year	Agegroup													
	CPUE	3	4	5	6	7	8	9	10	11	12	13	14	15
1995 [1]	314	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	746	0	7	12	42	39	5	0	0	1	0	1	0	0
1997	1148	0	2	45	43	58	23	1	0	0	0	0	0	0
1998	828	0	8	6	14	6	10	2	1	0	0	0	0	0
1999	779	0	5	28	46	82	26	27	3	1	0	0	0	0
2000	1208	0	30	16	61	42	67	18	20	5	2	1	0	1
2001	922	1	49	140	61	21	6	6	1	0	0	0	0	0
2002 [1]	876	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	839	0	46	38	70	114	22	25	11	14	11	9	3	1
2004	866	0	0	10	58	57	73	21	13	8	8	7	7	4
2005	907	0	1	5	64	41	29	36	15	6	6	10	4	3

[1] No age based data available

Table 5.2.4 Northeast Arctic saithe. Acoustic abundance indices from Norwegian surveys in October-November.
In 1985 - 1991 the area coverage was incomplete. Numbers in millions.

Year	Age									
	2	3	4	5	6/6+	7	8	9	10+	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	35.1	87.1	108.9	41.4	8.1	0.7	1.0	0.5	1.0	283.8
1995	38.4	166.1	86.5	46.5	16.5	2.4	0.0	0.0	1.0	357.5
1996	48.8	122.6	207.4	31.7	15.1	4.0	0.5	0.0	0.0	430.0
1997	5.5	38.0	184.8	79.8	50.6	9.6	1.2	0.0	0.3	369.8
1998	44.0	96.7	202.6	69.3	84.3	6.6	3.8	0.7	0.1	508.1
1999	61.1	233.8	72.9	62.2	21.0	19.2	5.9	1.4	0.4	477.8
2000	164.8	142.5	176.3	11.6	11.5	8.0	4.0	1.0	2.0	521.7
2001	104.7	275.9	45.9	53.8	5.6	6.1	3.2	3.4	1.9	500.5
2002	25.5	230.2	92.6	18.9	10.6	2.2	0.9	0.8	1.2	382.9
2003	31.0	87.5	151.7	26.1	6.2	6.4	1.2	0.7	1.3	312.1
2004	152.2	212.4	118.7	49.1	19.2	4.7	3.0	3.1	3.1	565.5
2005	22.2	228.1	67.2	20.3	16.5	7.7	2.2	1.7	0.9	366.7

Table 5.3.1 Catch numbers at age

Run title : North-East Arctic saithe
At 19/04/2006 14:05

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

YEAR	1960	1961	1962	1963	1964	1965
AGE						
3	10509	17824	37266	42050	9001	37115
4	13083	9131	11131	28925	59601	5001
5	13545	12506	4421	5888	13154	26300
6	5064	3799	8290	4650	2718	10142
7	4883	1332	2427	3861	3472	2861
8	2401	968	1024	1099	2655	2110
9	1315	520	938	1075	1251	2733
10	743	405	451	697	1221	699
+gp	1525	1229	1728	1777	3559	3593
0 TOTALNUM	53068	47714	67676	90022	96632	90554
TONSLAND	133515	105951	120707	148627	197426	185600
SOPCOF %	129	142	123	122	121	115

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	22392	29664	25196	77333	43540	77019	65178	76296	36782	60832
4	54537	24836	18384	11949	62846	59280	52389	25206	44027	11691
5	13124	35956	5101	16939	13987	26961	29146	26911	15671	16366
6	12899	4125	8282	4747	16189	9556	10186	16031	20419	4436
7	4652	5616	787	4798	5122	9592	5616	7114	12148	7808
8	1374	2916	1913	1126	7950	2901	3547	3935	4802	6789
9	933	1413	900	1711	2504	4352	1865	2871	3258	2914
10	965	1397	577	675	3697	2195	2140	2610	2505	2350
+gp	2900	3493	1166	511	2799	5490	3149	3924	3821	4140
0 TOTALNUM	113776	109416	62306	119789	158634	197346	173216	164898	143433	117326
TONSLAND	203788	181326	110247	140060	264924	241272	214334	213859	274121	233453
SOPCOF %	112	96	119	98	101	80	85	82	104	115

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

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	125030	99049	48969	61963	40796	83954	34733	17244	41466	48917
4	30576	34317	27685	23328	36644	21822	65052	23768	33233	11974
5	7947	10140	12476	14122	9211	21528	13060	32700	12064	7189
6	8712	2062	4534	4400	6379	3619	8212	3226	11204	5279
7	3435	4332	1468	2901	3200	2550	1054	3008	1135	3740
8	3212	1456	1848	963	1338	2008	1251	1177	1772	775
9	2679	1606	938	1356	147	369	461	760	560	878
10	1724	963	976	438	730	279	263	247	557	134
+gp	2880	1134	2150	1192	1629	629	448	760	897	701
0 TOTALNUM	186195	155059	101044	110663	100074	136758	124534	82890	102888	79587
TONSLAND	242486	182817	154464	164180	144554	175516	168034	156936	158786	107183
SOPCOF %	108	107	115	122	99	102	103	106	105	100

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	22115	17869	8126	12550	23792	68681	44608	22614	7058	17178
4	12895	49829	35847	19285	16930	13630	33266	61398	35593	52109
5	6062	4339	32827	33233	9054	5752	5982	30848	49248	40145
6	4525	3118	4560	18479	10238	4883	5408	3716	18999	30451
7	2805	3490	2328	1751	7341	3877	4748	1744	2053	4177
8	1399	755	1219	350	1076	2381	3173	1366	723	483
9	351	620	966	176	160	383	1461	1018	421	125
10	454	257	320	187	112	61	286	790	278	259
+gp	285	797	102	204	269	179	442	146	655	293
0 TOTALNUM	50891	81074	86295	86215	68972	99827	99374	123640	115028	145220
TONSLAND	70458	92391	114242	122310	95848	107326	127516	153584	146544	168378
SOPCOF %	101	104	100	105	102	101	105	101	98	100

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

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	10510	11789	3091	9655	9175	3833	6614	2335	991	26264
4	54886	11698	16215	12236	22767	7979	17554	50447	6111	14514
5	18499	35011	11946	22872	7747	27071	11592	13374	33548	9156
6	18357	13567	31818	10347	10676	8802	25702	7008	10441	22197
7	17834	13452	8376	18930	6123	7147	5323	9467	7321	10268
8	2849	7058	5539	3374	8303	3158	4284	5411	8133	5458
9	485	812	2873	3343	2530	4706	2390	3497	2742	6727
10	214	55	727	2290	2652	1943	3443	2492	3026	2695
+gp	474	146	394	597	1219	1942	2392	4102	5336	2459
0 TOTALNUM	124108	93588	80979	83644	71192	66581	79294	98133	77649	99738
TONSLAND	171348	143629	153327	150373	135945	136402	155246	159757	162140	176129
SOPCOF %	100	100	100	100	101	100	100	100	100	100

Table 5.3.2 Catch weight at age
Run title : North-East Arctic saithe
At 19/04/2006 14:05

Table 2 Catch weights at age (kg)

	YEAR	1960	1961	1962	1963	1964	1965
	AGE						
	3	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
	5	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
	7	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
	9	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
	+gp	8.03	8.039	7.924	7.851	7.781	7.959
0	SOPC(	1.2863	1.4159	1.2326	1.2169	1.2138	1.1472

Table 2 Catch weights at age (kg)

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	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	8.106	7.994	7.716	7.479	7.404	7.052	7.477	7.385	7.217	7.127
0	SOPC(	1.1222	0.9593	1.1889	0.9829	1.0067	0.8017	0.8492	0.8246	1.0407	1.1549

Table 2 Catch weights at age (kg)

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	0.71	0.71	0.71	0.71	0.79	0.73	0.77	1.05	0.71	0.75
	4	1.11	1.11	1.11	1.11	1.27	1.4	1.12	1.33	1.26	1.33
	5	1.63	1.63	1.63	1.63	2.03	2.05	2.02	1.86	2.02	2.07
	6	2.33	2.33	2.33	2.33	2.55	2.76	2.61	2.8	2.7	2.63
	7	3.16	3.16	3.16	3.16	3.29	3.3	3.27	4	3.88	3.28
	8	4.03	4.03	4.03	4.03	4.34	4.38	3.91	4.18	4.47	3.96
	9	4.87	4.87	4.87	4.87	5.15	5.95	4.69	5.33	5.36	4.54
	10	5.63	5.63	5.63	5.63	5.75	6.39	5.63	5.68	6.06	5.55
	+gp	7.32	7.394	7.527	7.809	6.937	6.841	7.558	8.665	7.19	8.012
0	SOPC(	1.0845	1.0695	1.1465	1.2199	0.9879	1.0237	1.0323	1.0564	1.051	1.0011

Table 2 Catch weights at age (kg)

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	0.59	0.53	0.62	0.74	0.71	0.68	0.67	0.61	0.52	0.56
	4	1.22	0.84	0.87	0.95	1	1.05	1.01	0.99	0.76	0.79
	5	1.97	1.66	1.31	1.4	1.45	1.85	1.92	1.65	1.24	1.19
	6	2.3	2.32	2.43	1.78	2.09	2.39	2.28	2.46	2.12	1.71
	7	2.87	2.97	3.87	2.96	2.49	3.08	2.77	2.85	3.22	2.87
	8	3.72	4	5.38	3.73	3.75	3.35	3.2	3.03	3.83	3.78
	9	4.3	4.72	5.83	4.62	3.9	4.48	3.73	3.71	4.69	4.06
	10	4.69	5.44	5.36	4.67	6.74	4.66	6.35	4.49	5.31	5.3
	+gp	6.597	6.904	7.448	7.19	6.27	6.58	7.63	6.29	5.97	7.56
0	SOPC(	1.0079	1.0384	1.0023	1.0484	1.0226	1.0085	1.0517	1.0106	0.9848	0.999

Table 2 Catch weights at age (kg)

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	0.59	0.62	0.68	0.67	0.6	0.75	0.69	0.66	0.71	0.59
	4	0.82	0.95	1	1.05	1.03	1.12	1.01	0.91	1.03	0.91
	5	1.33	1.24	1.48	1.45	1.63	1.54	1.5	1.42	1.37	1.45
	6	1.84	1.72	1.87	1.93	2.1	2.04	1.97	1.9	1.9	2.04
	7	2.48	2.35	2.58	2.27	2.67	2.6	2.54	2.54	2.42	2.25
	8	3.73	3.1	3.07	2.97	3.14	3.14	3.25	2.59	2.99	3.12
	9	4.32	4.19	4.13	3.61	3.81	3.63	3.77	3.49	3.45	3.5
	10	5.34	5.79	5.44	4.1	4.41	4.54	4.31	3.75	3.73	3.99
	+gp	7.07	7.44	8.07	5.58	6.13	5.36	5.62	4.9	4.9	5.61
0	SOPC(	1.0018	1.0011	1.0014	1.0009	1.0053	1.001	1.0013	1.0018	1.0026	1.0037

Table 5.3.4. NEA saithe. 3-year running average maturity ogive 1985-2005.

	Age group									
Year	2	3	4	5	6	7	8	9	10	11+
1985	0.00	0.00	0.04	0.76	0.87	0.92	1.00	1.00	1.00	1.00
1986	0.00	0.00	0.03	0.76	0.89	0.95	1.00	1.00	1.00	1.00
1987	0.00	0.00	0.03	0.63	0.88	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.00	0.09	0.56	0.74	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.00	0.16	0.56	0.64	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.00	0.17	0.66	0.62	0.91	1.00	1.00	1.00	1.00
1991	0.00	0.00	0.12	0.72	0.75	0.90	1.00	1.00	1.00	1.00
1992	0.00	0.00	0.05	0.64	0.84	0.89	1.00	1.00	1.00	1.00
1993	0.00	0.00	0.03	0.54	0.91	0.98	1.00	1.00	1.00	1.00
1994	0.00	0.00	0.09	0.50	0.85	0.97	1.00	1.00	1.00	1.00
1995	0.00	0.00	0.14	0.53	0.81	0.90	0.98	1.00	1.00	1.00
1996	0.00	0.00	0.14	0.50	0.73	0.84	0.97	1.00	1.00	1.00
1997	0.00	0.00	0.11	0.42	0.59	0.74	0.82	1.00	1.00	1.00
1998	0.00	0.00	0.08	0.27	0.53	0.69	0.76	1.00	1.00	1.00
1999	0.00	0.00	0.04	0.28	0.54	0.72	0.75	1.00	1.00	1.00
2000	0.00	0.00	0.05	0.27	0.70	0.81	0.88	1.00	1.00	1.00
2001	0.00	0.00	0.05	0.38	0.78	0.94	0.93	1.00	1.00	1.00
2002	0.00	0.00	0.07	0.45	0.86	0.94	0.96	1.00	1.00	1.00
2003	0.00	0.00	0.09	0.46	0.87	0.95	0.93	1.00	1.00	1.00
2004	0.00	0.00	0.13	0.55	0.84	0.92	0.90	1.00	1.00	1.00
2005	0.00	0.00	0.18	0.57	0.81	0.90	0.85	1.00	1.00	1.00

Table 5.3.5 Tuning data sets applied in final XSA run (flt12 CPUE from Quarter 2,3,4)

```
North-East Arctic saithe (Sub-areas I and II)
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FLT12: Nor new trawl revised 2006 (Catch: Unknown) (Effort:
Unknown)
1994 2005
1 1 0.00 1.00
4  8
   1   126.0   424.3   263.6    36.4     8.1
   1   211.0   292.9   318.3    50.5     8.3
   1   105.9   141.5   205.7   271.3    31.1
   1    40.4   210.1   214.0   275.3   173.3
   1    32.4    54.3   239.5    91.2    55.5
   1    39.0   109.8    83.2   192.8    44.2
   1    81.2    86.8   162.7   126.0   169.2
   1    50.9   278.8   200.7   189.5    80.3
   1    76.4   124.3   387.1    87.2    89.6
   1   127.2   194.1   128.8   185.8   119.8
   1     7.7   190.4   141.5   181.7   227.7
   1    59.6    86.0   267.6   140.4    81.1

FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort:
Unknown)
1994 2005
1 1 0.75 0.85
3  7
   1    87.1   108.9    41.4     8.1     0.7
   1   166.1    86.5    46.5    16.5     2.4
   1   122.6   207.4    31.7    15.1     4.0
   1    38.0   184.8    79.8    50.6     9.6
   1    96.7   202.6    69.3    84.3     6.6
   1   233.8    72.9    62.2    21.0    19.2
   1   142.5   176.3    11.6    11.5     8.0
   1   275.9    45.9    53.8     5.6     6.1
   1   230.2    92.6    18.9    10.6     2.2
   1    87.5   151.7    26.1     6.2     6.4
   1   212.4   118.7    49.1    19.2     4.7
   1   228.1    67.2    20.3    16.5     7.7
```

Table 5.4.1. Data and parameter settings of exploratory and final XSA-runs

Run No.	1	2	3	4	5	6
Ass. type	SPALY	SPALY	SFT	SFT	SFT	FINAL
Catch data	1960-04	1960-05	1960-05	1960-05	1960-05	1960-05
Age range	3-11+	3-11+	3-11+	3-11+	3-11+	3-11+
F bar	4-7	4-7	4-7	4-7	4-7	4-7
Fleet 12 Norw. trawl	1994-04 age 4-8 Q1-4	1994-05 age 4-8 Q1-4	1994-05 age 4-8 Q1-4	1994-05 age 4-8 Q2-4		1994-05 age 4-8 Q2-4
Fleet 13 ac. survey	1994-04 age 3-7	1994-05 age 3-7			1994-05 age 3-7	1994-05 age 3-7
Time series weights	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y
Power model	No	No	No	No	No	No
Catchability (q) plateau	8	8	8	8	8	8
Survivor est. shrunk tow. Mean of	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages
SE of mean	0.5	0.5	0.5	0.5	0.5	0.5
Min. fleet SE for pop. Est.	0.3	0.3	0.3	0.3	0.3	0.3
Prior weight.	None	None	None	None	None	None

Table 5.5.1. Tuning diagnostics

Lowestoft VPA Version 3.1
19/04/2006 14:05
Extended Survivors Analysis

North-East Arctic saithe

CPUE data from file flt-12-13.dat

Catch data for 46 years. 1960 to 2005. Ages 3 to 11.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
FLT12: Nor new trawl	1994	2005	4	8	0	1
FLT13: Norway Ac Sur	1994	2005	3	7	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 73 iterations

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	0.074	0.066	0.026	0.034	0.071	0.022	0.022	0.024	0.006	0.044
4	0.213	0.111	0.122	0.135	0.106	0.082	0.13	0.232	0.08	0.122
5	0.231	0.205	0.158	0.253	0.119	0.178	0.164	0.138	0.238	0.164
6	0.25	0.266	0.291	0.199	0.18	0.192	0.256	0.141	0.152	0.245
7	0.352	0.293	0.26	0.282	0.173	0.175	0.17	0.141	0.215	0.22
8	0.325	0.228	0.188	0.158	0.191	0.127	0.151	0.262	0.173	0.246
9	0.761	0.144	0.136	0.165	0.171	0.158	0.134	0.178	0.205	0.211
10	0.352	0.172	0.185	0.153	0.191	0.192	0.166	0.201	0.23	0.319

XSA population numbers (Thousands)

YEAR / AGE	3	4	5	6	7	8	9	10
1996	1.63E+05	3.16E+05	9.90E+04	9.18E+04	6.65E+04	1.13E+04	1.01E+03	7.96E+02
1997	2.03E+05	1.24E+05	2.09E+05	6.43E+04	5.86E+04	3.83E+04	6.71E+03	3.85E+02
1998	1.34E+05	1.56E+05	9.06E+04	1.39E+05	4.04E+04	3.58E+04	2.50E+04	4.76E+03
1999	3.15E+05	1.07E+05	1.13E+05	6.33E+04	8.52E+04	2.55E+04	2.43E+04	1.78E+04
2000	1.47E+05	2.49E+05	7.65E+04	7.18E+04	4.25E+04	5.27E+04	1.78E+04	1.69E+04
2001	1.99E+05	1.12E+05	1.83E+05	5.57E+04	4.91E+04	2.93E+04	3.56E+04	1.23E+04
2002	3.37E+05	1.59E+05	8.47E+04	1.26E+05	3.76E+04	3.37E+04	2.11E+04	2.49E+04
2003	1.10E+05	2.70E+05	1.15E+05	5.89E+04	7.97E+04	2.60E+04	2.38E+04	1.51E+04
2004	1.71E+05	8.83E+04	1.75E+05	8.17E+04	4.19E+04	5.67E+04	1.64E+04	1.63E+04
2005	6.69E+05	1.39E+05	6.67E+04	1.13E+05	5.74E+04	2.76E+04	3.90E+04	1.09E+04

Estimated population abundance at 1st Jan 2006

0.00E+00	5.24E+05	1.01E+05	4.64E+04	7.24E+04	3.77E+04	1.77E+04	2.59E+04

Taper weighted geometric mean of the VPA populations:

2.23E+05	1.54E+05	1.02E+05	6.49E+04	3.50E+04	1.83E+04	9.64E+03	4.65E+03

Standard error of the weighted Log(VPA populations) :

0.5585	0.5055	0.5993	0.7122	0.9	1.1515	1.3993	1.5998

Log catchability residuals.

Fleet : FLT12: Nor new trawl

Age	1994	1995
3	No data for this fleet at this age	
4	0.45	1.31
5	0.61	0.46
6	1.09	0.17
7	1.17	-0.13
8	0.32	0.5

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	No data for this fleet at this age									
4	-0.03	-0.1	-0.55	0.02	-0.11	0.21	0.29	0.32	-1.44	0.17
5	0.14	-0.22	-0.76	-0.24	-0.14	0.18	0.13	0.27	-0.13	0
6	-0.08	0.32	-0.33	-0.64	-0.1	0.37	0.24	-0.16	-0.38	-0.03
7	0.3	0.42	-0.33	-0.32	-0.1	0.17	-0.34	-0.35	0.3	-0.27
8	-0.06	0.4	-0.69	-0.6	0.04	-0.15	-0.17	0.43	0.25	-0.03

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

Age	4	5	6	7	8
Mean Log	-7.7709	-6.4825	-5.8023	-5.5431	-5.5871
S.E(Log q)	0.6381	0.3436	0.4154	0.4152	0.384

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
4	0.6	1.413	9.48	0.59	12	0.36	-7.77
5	0.81	0.826	7.47	0.69	12	0.28	-6.48
6	1.51	-0.887	3.02	0.26	12	0.63	-5.8
7	1.57	-2.241	2.62	0.65	12	0.55	-5.54
8	1.14	-0.993	4.98	0.86	12	0.44	-5.59

Fleet : FLT13: Norway Ac Sur

Age	1994	1995
3	-0.53	-0.46
4	-0.36	-0.18
5	-0.25	0.08
6	0.29	-0.22
7	0.63	0.09
8	No data for this fleet at this age	

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	0.17	-1.23	0.09	0.12	0.42	0.74	0.03	0.18	0.62	-0.65
4	-0.01	0.73	0.6	-0.04	-0.02	-0.59	-0.2	-0.15	0.6	-0.39
5	0.08	0.23	0.89	0.64	-0.76	-0.05	-0.34	-0.34	-0.05	-0.03
6	-0.16	1.42	1.18	0.5	-0.24	-0.69	-0.82	-0.69	0.12	-0.28
7	-0.63	0.32	0.3	0.63	0.37	-0.05	-0.8	-0.51	-0.12	0.06
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	3	4	5	6	7
Mean Log	-7.1422	-6.9851	-7.7791	-8.1955	-8.6456
S.E(Log q)	0.5718	0.43	0.4515	0.7217	0.471

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	1.98	-1.538	2.09	0.23	12	1.06	-7.14
4	1.38	-0.784	5.11	0.34	12	0.6	-6.99
5	0.87	0.373	8.27	0.51	12	0.41	-7.78
6	0.95	0.07	8.34	0.21	12	0.73	-8.2
7	1.21	-0.791	8.21	0.61	12	0.58	-8.65
1							

Terminal year survivor and F summaries :

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

Year class = 2002

Fleet	I:	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	1	0	0	0	0	0	0
FLT13: Norway Ac Sur	274611	0.598	0	0	1	0.4	0.083
F shrinkage mean	806540	0.5				0.6	0.029

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
523889	0.38	0.83	2	2.174	0.044

1

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

Year class = 2001

Fleet	I:	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	119736	0.668	0	0	1	0.155	0.104
FLT13: Norway Ac Sur	97834	0.36	0.484	1.35	2	0.533	0.126
F shrinkage mean	97548	0.5				0.312	0.126

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
100852	0.27	0.21	4	0.778	0.122

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

Year class = 2000

Fleet	I:	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	34342	0.317	0.59	1.86	2	0.376	0.216
FLT13: Norway Ac Sur	60389	0.287	0.198	0.69	3	0.443	0.129
F shrinkage mean	45281	0.5				0.181	0.168

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
46361	0.2	0.21	6	1.094	0.164

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

Year class = 1999

Fleet	I:	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	69643	0.259	0.095	0.37	3	0.457	0.253
FLT13: Norway Ac Sur	65032	0.272	0.059	0.22	4	0.36	0.269
F shrinkage mean	98823	0.5				0.183	0.185

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
72436	0.18	0.07	8	0.419	0.245

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

Year class = 1998

Fleet	E	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	35143	0.223	0.171	0.77	4	0.474	0.235
FLT13: Norway Ac Sur	37649	0.24	0.165	0.69	5	0.387	0.221
F shrinkage mean	48392	0.5				0.139	0.176

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
37729	0.16	0.1	10	0.659	0.22

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

Year class = 1997

Fleet	E	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	18984	0.198	0.081	0.41	5	0.55	0.231
FLT13: Norway Ac Sur	13389	0.241	0.165	0.69	5	0.309	0.314
F shrinkage mean	24801	0.5				0.141	0.182

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17699	0.15	0.1	11	0.649	0.246

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

Year class = 1996

Fleet	E	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	27796	0.2	0.124	0.62	5	0.54	0.198
FLT13: Norway Ac Sur	19959	0.246	0.153	0.62	5	0.298	0.266
F shrinkage mean	32912	0.5				0.162	0.17

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
25879	0.15	0.1	11	0.636	0.211

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

Year class = 1995

Fleet	E	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nor new trawl	7121	0.2	0.162	0.81	5	0.501	0.294
FLT13: Norway Ac Sur	3915	0.246	0.185	0.75	5	0.278	0.484
F shrinkage mean	9992	0.5				0.221	0.218

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6500	0.16	0.15	11	0.907	0.319

Table 5.5.2

Run title : North-East Arctic saithe
At 19/04/2006 14:05

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1960	1961	1962	1963	1964	1965
AGE						
3	0.1412	0.2383	0.2772	0.1747	0.108	0.1562
4	0.1843	0.1755	0.2297	0.3606	0.4012	0.0805
5	0.5007	0.2695	0.1204	0.1825	0.276	0.3093
6	0.2407	0.2519	0.2882	0.1797	0.1198	0.3557
7	0.3847	0.0915	0.253	0.2108	0.1978	0.1786
8	0.4184	0.1206	0.0942	0.1734	0.2195	0.1772
9	0.3585	0.1479	0.1645	0.1355	0.3055	0.369
10	0.3832	0.177	0.1849	0.1771	0.2248	0.2795
+gp	0.3832	0.177	0.1849	0.1771	0.2248	0.2795
0 FBAR 4	0.3276	0.1971	0.2228	0.2334	0.2487	0.231

Table 8 Fishing mortality (F) at age

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0.1876	0.1886	0.2041	0.3402	0.188	0.3511	0.5893	0.4905	0.6669	0.5962
4	0.3616	0.3278	0.1709	0.1406	0.5146	0.4216	0.4299	0.4766	0.5911	0.459
5	0.3131	0.4319	0.1024	0.2354	0.2432	0.4348	0.3782	0.411	0.6231	0.4556
6	0.2447	0.1522	0.1649	0.1307	0.3709	0.261	0.2894	0.3693	0.637	0.3552
7	0.2736	0.1595	0.0391	0.1356	0.2034	0.3929	0.2409	0.3373	0.5334	0.5379
8	0.1219	0.2757	0.0747	0.0721	0.348	0.1697	0.2451	0.2654	0.4017	0.656
9	0.1106	0.1777	0.1274	0.0885	0.2271	0.3262	0.1569	0.321	0.3673	0.4563
10	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635	0.3429	0.5166	0.496
+gp	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635	0.3429	0.5166	0.496
0 FBAR 4	0.2983	0.2679	0.1193	0.1606	0.333	0.3776	0.3346	0.3986	0.5961	0.4519

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0.9054	0.786	0.6157	0.4447	0.5173	0.4113	0.4036	0.2139	0.7554	0.7853
4	0.6942	0.6807	0.524	0.6834	0.5184	0.5846	0.6568	0.5371	0.8243	0.5076
5	0.661	0.5207	0.5675	0.5606	0.6404	0.6683	0.8688	0.8444	0.5813	0.4129
6	0.4704	0.3522	0.467	0.3991	0.5357	0.5632	0.5853	0.5405	0.81	0.5471
7	0.5163	0.4538	0.4574	0.6257	0.5721	0.4246	0.3134	0.4399	0.3683	0.7108
8	0.4431	0.4306	0.3556	0.6249	0.6731	0.8956	0.3812	0.6971	0.5068	0.4642
9	0.592	0.4163	0.5508	0.4825	0.1766	0.3908	0.5214	0.4221	0.8813	0.5098
10	0.541	0.4379	0.4833	0.543	0.5238	0.5936	0.5384	0.5939	0.6352	0.5333
+gp	0.541	0.4379	0.4833	0.543	0.5238	0.5936	0.5384	0.5939	0.6352	0.5333
0 FBAR 4	0.5855	0.5019	0.504	0.5672	0.5666	0.5602	0.6061	0.5905	0.646	0.5446

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0.1169	0.1238	0.1165	0.231	0.4554	0.36	0.124	0.085	0.0352	0.0481
4	0.4848	0.4173	0.3902	0.4435	0.5589	0.5169	0.2962	0.251	0.1871	0.3896
5	0.5257	0.2962	0.539	0.7773	0.3857	0.3721	0.4507	0.4952	0.3279	0.3332
6	0.4992	0.5701	0.5843	0.6755	0.584	0.3711	0.729	0.5656	0.6578	0.3468
7	0.6399	0.9413	1.2068	0.4657	0.6315	0.4571	0.7628	0.5493	0.7198	0.2875
8	0.6408	0.3491	1.0994	0.5624	0.5891	0.4289	0.8659	0.5143	0.4631	0.3608
9	0.3957	0.6658	1.0581	0.4356	0.5474	0.4289	0.5132	0.7758	0.2918	0.1328
10	0.5447	0.5693	0.9072	0.5883	0.5521	0.4145	0.6704	0.585	0.4959	0.2939
+gp	0.5447	0.5693	0.9072	0.5883	0.5521	0.4145	0.6704	0.585	0.4959	0.2939
0 FBAR 4	0.5374	0.5562	0.6801	0.5905	0.54	0.4293	0.5597	0.4653	0.4731	0.3393

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
3	0.0742	0.0662	0.0258	0.0344	0.0713	0.0215	0.022	0.0237	0.0064	0.0444	0.0248
4	0.2134	0.1105	0.1221	0.1351	0.1064	0.0818	0.1299	0.2317	0.0796	0.1224	0.1446
5	0.2314	0.2049	0.1576	0.2533	0.1186	0.178	0.164	0.1382	0.2379	0.1644	0.1802
6	0.2496	0.2655	0.291	0.1991	0.1795	0.1921	0.2561	0.141	0.1523	0.2447	0.1794
7	0.3517	0.2927	0.2605	0.2816	0.1734	0.1753	0.1702	0.1408	0.2148	0.2202	0.1919
8	0.325	0.2278	0.1875	0.1583	0.1915	0.127	0.1512	0.2617	0.1727	0.2461	0.2269
9	0.7612	0.1435	0.1361	0.165	0.1709	0.1579	0.1338	0.1776	0.2048	0.2113	0.1979
10	0.3524	0.172	0.1849	0.153	0.1909	0.1921	0.1659	0.2013	0.2299	0.3186	0.2499
+gp	0.3524	0.172	0.1849	0.153	0.1909	0.1921	0.1659	0.2013	0.2299	0.3186	
0 FBAR 4	0.2615	0.2184	0.2078	0.2173	0.1445	0.1568	0.18	0.1629	0.1712	0.1879	

Table 5.5.3
Run title : North-East Arctic saithe
At 19/04/2006 14:05

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1960	1961	1962	1963	1964	1965
	AGE						
	3	88173	92920	170143	289935	97186	283653
	4	85921	62681	59948	105582	199330	71425
	5	38001	58508	43057	39010	60271	109269
	6	26165	18857	36586	31252	26611	37443
	7	16897	16840	12001	22453	21379	19328
	8	7761	9416	12582	7630	14890	14362
	9	4823	4181	6833	9375	5252	9788
	10	2580	2759	2953	4746	6703	3168
	+gp	5253	8334	11260	12044	19432	16183
0	TOT/	275574	274496	355364	522026	451054	564620

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

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	144689	190738	150801	296371	280751	287484	161777	217484	83523	149692
	4	198653	98200	129322	100667	172674	190463	165682	73476	109025	35101
	5	53953	113296	57927	89245	71607	84508	102299	88246	37350	49425
	6	65664	32298	60225	42811	57741	45971	44794	57383	47899	16400
	7	21479	42090	22711	41814	30755	32626	28991	27458	32476	20741
	8	13236	13376	29379	17882	29893	20546	18033	18655	16044	15597
	9	9850	9593	8313	22322	13622	17281	14197	11554	11713	8790
	10	5541	7220	6576	5992	16728	8887	10210	9936	6862	6641
	+gp	16565	17951	13243	4518	12585	22073	14934	14828	10361	11585
0	TOT/	529629	524762	478496	621623	686356	709838	560918	519020	355252	313972

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	231999	201094	117719	190763	111633	275151	115586	98957	86434	99373
	4	67514	76813	75019	52071	100117	54484	149310	63206	65416	33246
	5	18160	27610	31838	36370	21524	48812	24862	63383	30243	23488
	6	25657	7677	13430	14778	16999	9288	20484	8538	22306	13845
	7	9413	13123	4420	6893	8118	8146	4330	9341	4072	8125
	8	9916	4599	6825	2290	3018	3751	4362	2591	4926	2307
	9	6627	5212	2448	3916	1004	1261	1254	2439	1057	2430
	10	4560	3001	2814	1155	1979	689	698	610	1309	358
	+gp	7538	3503	6140	3111	4370	1535	1177	1854	2083	1855
0	TOT/	381384	342633	260652	311346	268762	403116	322064	250920	217845	185026

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	221602	169535	81658	67246	71879	251043	422639	306582	225795	404569
	4	37098	161422	122635	59503	43701	37321	143392	305664	230546	178479
	5	16385	18705	87074	67970	31267	20460	18223	87299	194701	156550
	6	12725	7930	11388	41587	25578	17407	11547	9507	43562	114847
	7	6559	6324	3671	5198	17328	11678	9834	4560	4421	18474
	8	3268	2832	2020	899	2671	7544	6053	3755	2156	1762
	9	1187	1410	1635	551	419	1214	4022	2085	1838	1111
	10	1195	654	593	465	292	199	647	1971	786	1124
	+gp	742	2007	186	501	693	578	987	360	1833	1263
0	TOT/	300760	370819	310861	243920	193829	347445	617344	721784	705639	878179

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

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 60-**	AMST 60-**
	AGE													
	3	162515	203444	134109	315131	147297	198813	336619	110396	171136	668888	0	168888	189657
	4	315689	123546	155899	107002	249271	112295	159306	269615	88272	139217	523889	103374	122903
	5	98976	208802	90566	112967	76534	183485	84720	114545	175096	66742	100852	56053	70261
	6	91847	64296	139273	63340	71794	55651	125730	58874	81681	113001	46361	30003	40182
	7	66475	58588	40365	85237	42496	49120	37599	79683	41861	57427	72436	16337	23492
	8	11346	38288	35796	25469	52658	29253	33749	25967	56673	27648	37729	8577	13394
	9	1006	6712	24962	24295	17800	35600	21092	23755	16364	39041	17699	4661	8314
	10	796	385	4760	17837	16867	12284	24888	15107	16285	10917	25879	2551	5126
	+gp	1750	1016	2568	4631	7715	12218	17215	24742	28560	9892	12389		
0	TOT/	750401	705077	628297	755909	682432	688719	840918	722685	675926	1132772	837234		

Table 5.5.4

Run title : North-East Arctic saithe
At 19/04/2006 14:05

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1960	1961	1962	1963	1964	1965
AGE						
3	0	0	0	0	0	0
4	859	627	599	1056	1993	714
5	20901	32179	23681	21455	33149	60098
6	22240	16028	31098	26564	22619	31827
7	16559	16503	11761	22004	20952	18941
8	7761	9416	12582	7630	14890	14362
9	4823	4181	6833	9375	5252	9788
10	2580	2759	2953	4746	6703	3168
+gp	5253	8334	11260	12044	19432	16183

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

YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	1987	982	1293	1007	1727	1905	1657	735	1090	351
5	29674	62313	31860	49085	39384	46480	56264	48535	20543	27184
6	55815	27453	51191	36389	49080	39076	38075	48776	40714	13940
7	21049	41248	22256	40978	30140	31973	28412	26909	31826	20326
8	13236	13376	29379	17882	29893	20546	18033	18655	16044	15597
9	9850	9593	8313	22322	13622	17281	14197	11554	11713	8790
10	5541	7220	6576	5992	16728	8887	10210	9936	6862	6641
+gp	16565	17951	13243	4518	12585	22073	14934	14828	10361	11585

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	675	768	750	521	1001	545	1493	632	654	1330
5	9988	15185	17511	20003	11838	26847	13674	34861	16634	17851
6	21809	6526	11415	12561	14449	7895	17412	7258	18960	12045
7	9225	12861	4331	6755	7955	7983	4243	9154	3990	7475
8	9916	4599	6825	2290	3018	3751	4362	2591	4926	2307
9	6627	5212	2448	3916	1004	1261	1254	2439	1057	2430
10	4560	3001	2814	1155	1979	689	698	610	1309	358
+gp	7538	3503	6140	3111	4370	1535	1177	1854	2083	1855

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	1113	4843	11037	9521	7429	4479	7170	9170	20749	24987
5	12453	11784	48761	38063	20637	14731	11663	47141	97351	82971
6	11326	6978	8427	26616	15859	13055	9699	8652	37028	93026
7	6231	6324	3671	5198	15768	10510	8752	4469	4289	16627
8	3268	2832	2020	899	2671	7544	6053	3755	2156	1727
9	1187	1410	1635	551	419	1214	4022	2085	1838	1111
10	1195	654	593	465	292	199	647	1971	786	1124
+gp	742	2007	186	501	693	578	987	360	1833	1263

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

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	44197	13590	12472	4280	12464	5615	11151	24265	11475	25059
5	49488	87697	24453	31631	20664	69724	38124	52691	99805	38043
6	67049	37935	73815	34204	50256	43408	108128	51220	68612	91531
7	55839	43355	27852	61371	34422	46173	35343	75699	38512	51684
8	11006	31397	27205	19102	46339	27205	32399	24149	51006	23501
9	1006	6712	24962	24295	17800	35600	21092	23755	16364	39041
10	796	385	4760	17837	16867	12284	24888	15107	16285	10917
+gp	1750	1016	2568	4631	7715	12218	17215	24742	28560	9892

Table 5.5.5

Run title : North-East Arctic saithe

At 19/04/2006 14:05

Terminal Fs derived using XSA (With F shrinkage)

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1960	1961	1962	1963	1964	1965
	AGE						
	3	62603	65973	120802	205854	69002	201394
	4	95372	69576	66543	117196	221257	79282
	5	61942	95368	70183	63586	98241	178108
	6	60964	43936	85246	72817	62003	87243
	7	53395	53214	37924	70952	67559	61076
	8	31275	37946	50706	30748	60005	57880
	9	23490	20363	33278	45655	25578	47668
	10	14524	15534	16625	26719	37736	17837
	+gp	42179	66999	89226	94556	151201	128799
0	TOTAL	445745	468910	570532	728082	792583	859287

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	102729	135424	107069	210424	199333	204113	114862	154414	59301	106281
	4	220505	109002	143548	111741	191669	211414	183907	81559	121018	38962
	5	87943	184672	94421	145470	116720	137749	166747	143840	60881	80563
	6	152998	75254	140323	99749	134536	107113	104371	133702	111605	38212
	7	67874	133004	71766	132132	97187	103098	91613	86767	102623	65541
	8	53339	53906	118396	72064	120468	82800	72671	75178	64656	62856
	9	47968	46718	40485	108710	66337	84157	69137	56270	57040	42809
	10	31196	40649	37021	33734	94177	50032	57485	55938	38634	37392
	+gp	134275	143497	102186	33793	93178	155656	111662	109506	74774	82569
0	TOTAL	898826	922127	855213	947816	1113606	1136132	972456	897174	690533	555183

Terminal Fs derived using XSA (With F shrinkage)

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	164719	142777	83580	135442	88190	200860	89002	103905	61368	74530
	4	74941	85262	83271	57799	127148	76277	167227	84065	82425	44217
	5	29600	45004	51896	59283	43694	100064	50222	117893	61091	48620
	6	59781	17888	31291	34432	43347	25635	53464	23907	60225	36412
	7	29746	41470	13966	21781	26708	26880	14158	37363	15798	26649
	8	39962	18533	27504	9230	13100	16429	17054	10831	22018	9134
	9	32272	25384	11921	19069	5169	7501	5881	13000	5663	11030
	10	25674	16898	15844	6505	11378	4401	3931	3462	7934	1989
	+gp	55175	25902	46214	24293	30317	10502	8894	16066	14977	14862
0	TOTAL	511871	419117	365488	367833	389052	468550	409834	410493	331499	267441

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	130745	89854	50628	49762	51034	170710	283168	187015	117413	226558
	4	45259	135594	106693	56528	43701	39187	144826	302608	175215	140998
	5	32278	31051	114066	95157	45338	37851	34989	144043	241430	186294
	6	29269	18397	27674	74024	53459	41603	26327	23388	92351	196388
	7	18823	18783	14207	15386	43146	35968	27239	12997	14237	53022
	8	12156	11326	10868	3354	10018	25274	19370	11377	8256	6662
	9	5105	6653	9533	2545	1636	5437	15004	7735	8621	4509
	10	5603	3560	3179	2170	1967	926	4109	8851	4173	5957
	+gp	4895	13856	1385	3604	4347	3803	7533	2266	10944	9551
0	TOTAL	284133	329074	338233	302531	254644	360760	562563	700280	672641	829939

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	95884	126135	91194	211137	88378	149110	232267	72862	121506	394644
	4	258865	117369	155899	112352	256749	125771	160899	245350	90920	126688
	5	131638	258914	134038	163803	124751	282567	127080	162654	239882	96775
	6	168999	110589	260441	122246	150768	113528	247688	111860	155193	230522
	7	164859	137682	104142	193488	113465	127712	95501	202395	101303	129211
	8	42321	118694	109894	75644	165345	91853	109685	67254	169452	86263
	9	4345	28121	103091	87706	67816	129226	79519	82906	56455	136643
	10	4252	2227	25896	73133	74381	55769	107269	56649	60743	43557
	+gp	12375	7563	20721	25839	47295	65488	96746	121236	139942	55491
0	TOTAL	883538	907295	1005315	1065348	1088949	1141025	1256654	1123167	1135396	1299793

Table 5.5.6

Run title : North-East Arctic saithe

At 19/04/2006 14:05

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1960	1961	1962	1963	1964	1965
	AGE						
	3	0	0	0	0	0	0
	4	954	696	665	1172	2213	793
	5	34068	52452	38601	34972	54033	97959
	6	51820	37346	72459	61894	52703	74156
	7	52327	52150	37165	69533	66207	59854
	8	31275	37946	50706	30748	60005	57880
	9	23490	20363	33278	45655	25578	47668
	10	14524	15534	16625	26719	37736	17837
	+gp	42179	66999	89226	94556	151201	128799
0	TOTSF	250637	283486	338725	365249	449676	484948

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	2205	1090	1435	1117	1917	2114	1839	816	1210	390
	5	48369	101570	51931	80009	64196	75762	91711	79112	33484	44310
	6	130048	63966	119275	84787	114356	91046	88715	113647	94864	32480
	7	66516	130344	70330	129489	95243	101036	89781	85032	100571	64230
	8	53339	53906	118396	72064	120468	82800	72671	75178	64656	62856
	9	47968	46718	40485	108710	66337	84157	69137	56270	57040	42809
	10	31196	40649	37021	33734	94177	50032	57485	55938	38634	37392
	+gp	134275	143497	102186	33793	93178	155656	111662	109506	74774	82569
0	TOTSF	513916	581740	541059	543703	649873	642603	583002	575498	465234	367034

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	749	853	833	578	1271	763	1672	841	824	1769
	5	16280	24752	28543	32605	24032	55035	27622	64841	33600	36951
	6	50814	15205	26598	29268	36845	21790	45445	20321	51192	31678
	7	29151	40641	13687	21346	26173	26343	13875	36616	15482	24517
	8	39962	18533	27504	9230	13100	16429	17054	10831	22018	9134
	9	32272	25384	11921	19069	5169	7501	5881	13000	5663	11030
	10	25674	16898	15844	6505	11378	4401	3931	3462	7934	1989
	+gp	55175	25902	46214	24293	30317	10502	8894	16066	14977	14862
0	TOTSF	250078	168167	171143	142893	148286	142763	124375	165979	151690	131929

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	1358	4068	9602	9045	7429	4702	7241	9078	15769	19740
	5	24532	19562	63877	53288	29923	27253	22393	77783	120715	98736
	6	26049	16189	20479	47376	33144	31202	22114	21283	78499	159074
	7	17882	18783	14207	15386	39263	32372	24243	12737	13810	47720
	8	12156	11326	10868	3354	10018	25274	19370	11377	8256	6528
	9	5105	6653	9533	2545	1636	5437	15004	7735	8621	4509
	10	5603	3560	3179	2170	1967	926	4109	8851	4173	5957
	+gp	4895	13856	1385	3604	4347	3803	7533	2266	10944	9551
0	TOTSF	97579	93998	133130	136767	127727	130969	122006	151110	260787	351815

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	36241	12911	12472	4494	12837	6289	11263	22082	11820	22804
	5	65819	108744	36190	45865	33683	107376	57186	74821	136733	55162
	6	123369	65248	138034	66013	105538	88552	213012	97318	130362	186723
	7	138481	101885	71858	139311	91906	120050	89771	192275	93199	116290
	8	41051	97329	83519	56733	145504	85423	105298	62547	152507	73323
	9	4345	28121	103091	87706	67816	129226	79519	82906	56455	136643
	10	4252	2227	25896	73133	74381	55769	107269	56649	60743	43557
	+gp	12375	7563	20721	25839	47295	65488	96746	121236	139942	55491
0	TOTSF	425935	424027	491781	499094	578960	658172	760063	709834	781759	689993

Table 5.5.7

Run title : North-East Arctic saithe

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1960	88173	445745	250637	133515	0.5327	0.3276
1961	92920	468910	283486	105951	0.3737	0.1971
1962	170143	570532	338725	120707	0.3564	0.2228
1963	289935	728082	365249	148627	0.4069	0.2334
1964	97186	792583	449676	197426	0.439	0.2487
1965	283653	859287	484948	185600	0.3827	0.231
1966	144689	898826	513916	203788	0.3965	0.2983
1967	190738	922127	581740	181326	0.3117	0.2679
1968	150801	855213	541059	110247	0.2038	0.1193
1969	296371	947816	543703	140060	0.2576	0.1606
1970	280751	1113606	649873	264924	0.4077	0.333
1971	287484	1136132	642603	241272	0.3755	0.3776
1972	161777	972456	583002	214334	0.3676	0.3346
1973	217484	897174	575498	213859	0.3716	0.3986
1974	83523	690533	465234	274121	0.5892	0.5961
1975	149692	555183	367034	233453	0.6361	0.4519
1976	231999	511871	250078	242486	0.9696	0.5855
1977	201094	419117	168167	182817	1.0871	0.5019
1978	117719	365488	171143	154464	0.9025	0.504
1979	190763	367833	142893	164180	1.149	0.5672
1980	111633	389052	148286	144554	0.9748	0.5666
1981	275151	468550	142763	175516	1.2294	0.5602
1982	115586	409834	124375	168034	1.351	0.6061
1983	98957	410493	165979	156936	0.9455	0.5905
1984	86434	331499	151690	158786	1.0468	0.646
1985	99373	267441	131929	107183	0.8124	0.5446
1986	221602	284133	97579	70458	0.7221	0.5374
1987	169535	329074	93998	92391	0.9829	0.5562
1988	81658	338233	133130	114242	0.8581	0.6801
1989	67246	302531	136767	122310	0.8943	0.5905
1990	71879	254644	127727	95848	0.7504	0.54
1991	251043	360760	130969	107326	0.8195	0.4293
1992	422639	562563	122006	127516	1.0452	0.5597
1993	306582	700280	151110	153584	1.0164	0.4653
1994	225795	672641	260787	146544	0.5619	0.4731
1995	404569	829939	351815	168378	0.4786	0.3393
1996	162515	883538	425935	171348	0.4023	0.2615
1997	203444	907295	424027	143629	0.3387	0.2184
1998	134109	1005315	491781	153327	0.3118	0.2078
1999	315131	1065348	499094	150373	0.3013	0.2173
2000	147297	1088949	578960	135945	0.2348	0.1445
2001	198813	1141025	658172	136402	0.2072	0.1568
2002	336619	1256654	760063	155246	0.2043	0.18
2003	110396	1123167	709834	159757	0.2251	0.1629
2004	171136	1135396	781759	162140	0.2074	0.1712
2005	168937	1004822	689993	176129	0.2553	0.1879
Arith. Mean	188803	696558	366504	160153	0.6021	0.3815
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 5.6.1 Yield per recruit
MFYPR version 2a
Run: 000
Time and date: 15:30 22.04.2006
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	13.3058	3.3527	11.1363	3.3527	11.1363
0.1250	0.0217	0.0922	0.2612	5.0572	11.3321	2.9135	9.2025	2.9135	9.2025
0.2500	0.0435	0.1640	0.4378	4.6998	9.8548	2.5753	7.7629	2.5753	7.7629
0.3750	0.0652	0.2218	0.5600	4.4125	8.7127	2.3064	6.6564	2.3064	6.6564
0.5000	0.0870	0.2695	0.6461	4.1756	7.8068	2.0872	5.7843	2.0872	5.7843
0.6250	0.1087	0.3097	0.7075	3.9763	7.0732	1.9047	5.0827	1.9047	5.0827
0.7500	0.1305	0.3441	0.7515	3.8058	6.4687	1.7504	4.5086	1.7504	4.5086
0.8750	0.1522	0.3739	0.7831	3.6580	5.9634	1.6181	4.0320	1.6181	4.0320
1.0000	0.1740	0.4002	0.8058	3.5284	5.5355	1.5033	3.6315	1.5033	3.6315
1.1250	0.1957	0.4234	0.8220	3.4136	5.1693	1.4028	3.2914	1.4028	3.2914
1.2500	0.2175	0.4442	0.8333	3.3111	4.8529	1.3140	2.9997	1.3140	2.9997
1.3750	0.2392	0.4629	0.8410	3.2189	4.5771	1.2351	2.7475	1.2351	2.7475
1.5000	0.2610	0.4798	0.8459	3.1355	4.3349	1.1643	2.5278	1.1643	2.5278
1.6250	0.2827	0.4953	0.8489	3.0596	4.1207	1.1007	2.3351	1.1007	2.3351
1.7500	0.3045	0.5094	0.8503	2.9901	3.9301	1.0430	2.1650	1.0430	2.1650
1.8750	0.3262	0.5224	0.8505	2.9263	3.7596	0.9906	2.0141	0.9906	2.0141
2.0000	0.3480	0.5345	0.8499	2.8675	3.6063	0.9427	1.8795	0.9427	1.8795
2.1250	0.3697	0.5456	0.8486	2.8130	3.4678	0.8988	1.7589	0.8988	1.7589
2.2500	0.3915	0.5560	0.8468	2.7623	3.3420	0.8585	1.6503	0.8585	1.6503
2.3750	0.4132	0.5657	0.8446	2.7152	3.2274	0.8213	1.5522	0.8213	1.5522
2.5000	0.4350	0.5747	0.8421	2.6711	3.1226	0.7868	1.4632	0.7868	1.4632

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.174
FMax	1.8415	0.3204
F0.1	0.8081	0.1406
F35%SPR	0.9146	0.1591

Weights in kilograms

Table 5.7.1 Prediction input data

MFDP version 1a
Run: 000
Time and date: 09:54 15.04.2006
Fbar age range: 4-7

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	168937.5	0.2	0	0	0	0.653333	0.02481	0.653333
4	132307	0.2	0.18	0	0	0.95	0.144557	0.95
5	100852	0.2	0.57	0	0	1.413333	0.180173	1.413333
6	46361	0.2	0.81	0	0	1.946667	0.179363	1.946667
7	72436	0.2	0.9	0	0	2.403333	0.1919	2.403333
8	37729	0.2	0.85	0	0	2.9	0.226853	2.9
9	17699	0.2	1	0	0	3.48	0.19787	3.48
10	25879	0.2	1	0	0	3.823333	0.249913	3.823333
11	12389	0.2	1	0	0	5.136667	0.249913	5.136667

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	168937.5	0.2	0	0	0	0.653333	0.02481	0.653333
4	.	0.2	0.18	0	0	0.95	0.144557	0.95
5	.	0.2	0.57	0	0	1.413333	0.180173	1.413333
6	.	0.2	0.81	0	0	1.946667	0.179363	1.946667
7	.	0.2	0.9	0	0	2.403333	0.1919	2.403333
8	.	0.2	0.85	0	0	2.9	0.226853	2.9
9	.	0.2	1	0	0	3.48	0.19787	3.48
10	.	0.2	1	0	0	3.823333	0.249913	3.823333
11	.	0.2	1	0	0	5.136667	0.249913	5.136667

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	168937.5	0.2	0	0	0	0.653333	0.02481	0.653333
4	.	0.2	0.18	0	0	0.95	0.144557	0.95
5	.	0.2	0.57	0	0	1.413333	0.180173	1.413333
6	.	0.2	0.81	0	0	1.946667	0.179363	1.946667
7	.	0.2	0.9	0	0	2.403333	0.1919	2.403333
8	.	0.2	0.85	0	0	2.9	0.226853	2.9
9	.	0.2	1	0	0	3.48	0.19787	3.48
10	.	0.2	1	0	0	3.823333	0.249913	3.823333
11	.	0.2	1	0	0	5.136667	0.249913	5.136667

Input units are thousands and kg - output in tonnes

Table 5.7.2 Short term prediction

MFDP version 1a
Run: 000
000MFDP Index file 15.04.2006
Time and date: 15:20 22.04.2006
Fbar age range: 4-7

2006				
Biomass	SSB	FMult	FBar	Landings
976528	650829	1.4015	0.2439	193500

2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
923127	604398	0	0	0	1072133	737623
.	604398	0.125	0.0217	18327	1051754	719893
.	604398	0.25	0.0435	36215	1031872	702613
.	604398	0.375	0.0652	53674	1012474	685770
.	604398	0.5	0.087	70716	993547	669352
.	604398	0.625	0.1087	87351	975081	653350
.	604398	0.75	0.1305	103590	957062	637751
.	604398	0.875	0.1522	119441	939479	622545
.	604398	1	0.174	134917	922322	607723
.	604398	1.125	0.1957	150025	905580	593274
.	604398	1.25	0.2175	164774	889242	579189
.	604398	1.375	0.2392	179175	873298	565458
.	604398	1.5	0.261	193236	857738	552072
.	604398	1.625	0.2827	206966	842552	539021
.	604398	1.75	0.3045	220371	827731	526299
.	604398	1.875	0.3262	233462	813266	513895
.	604398	2	0.348	246246	799147	501802
.	604398	2.125	0.3697	258730	785366	490011
.	604398	2.25	0.3915	270922	771915	478515
.	604398	2.375	0.4132	282829	758785	467307
.	604398	2.5	0.435	294459	745968	456378

Input units are thousands and kg - output in tonnes

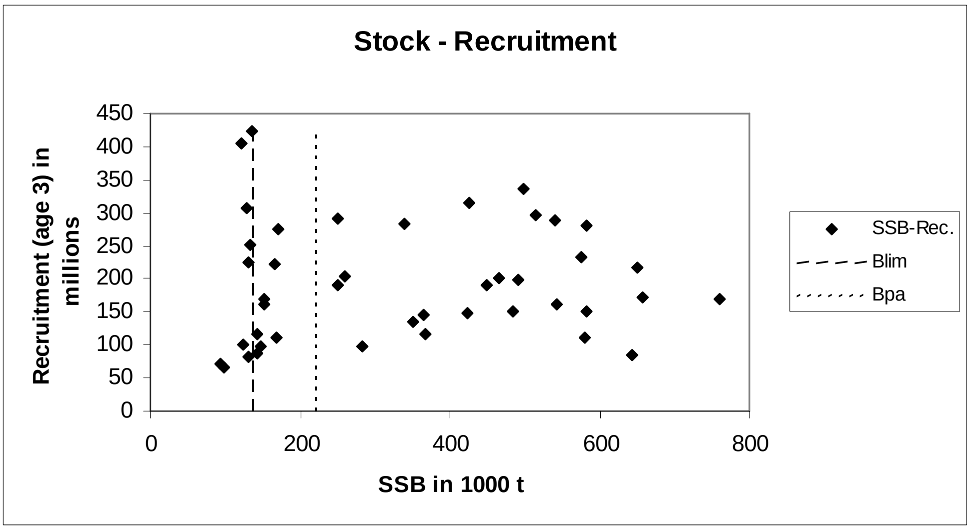
Table 5.7.3. Detailed short term projection output
MFDP version 1a
Run: fpa med
Time and date: 11:15 23.04.2006
Fbar age range: 4-7

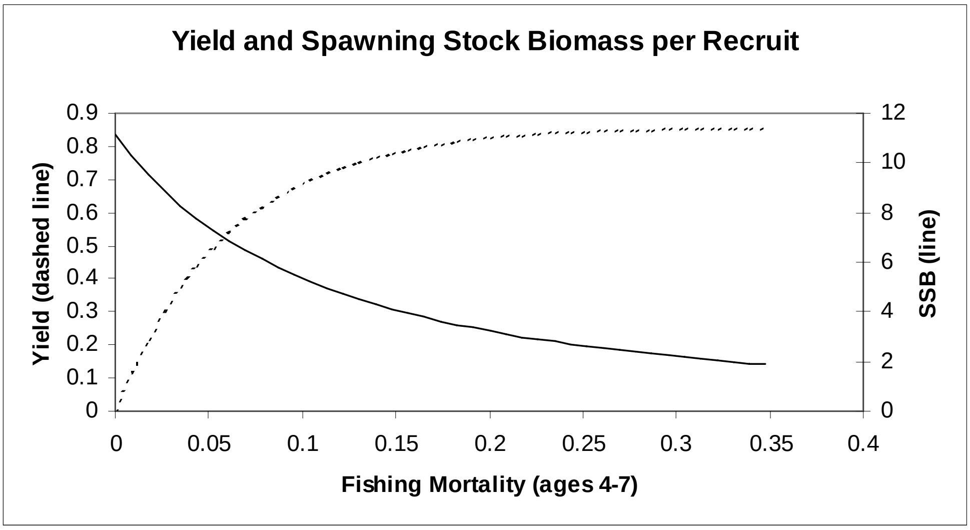
Year:		2006	F multiplier	1.4015	Fbar:	0.2439				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0348	5236	3421	168937	110372	0	0	0	0
	4	0.2026	22067	20963	132307	125692	23815	22624	23815	22624
	5	0.2525	20484	28951	100852	142537	57486	81246	57486	81246
	6	0.2514	9379	18258	46361	90249	37552	73102	37552	73102
	7	0.269	15552	37376	72436	174088	65192	156679	65192	156679
	8	0.3179	9363	27152	37729	109414	32070	93002	32070	93002
	9	0.2773	3903	13583	17699	61593	17699	61593	17699	61593
	10	0.3503	6971	26654	25879	98944	25879	98944	25879	98944
	11	0.3503	3337	17143	12389	63638	12389	63638	12389	63638
Total			96292	193500	614589	976528	272082	650829	272082	650829

Year:		2007	F multiplier	2.0115	Fbar:	0.35				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0499	7460	4874	168937	110372	0	0	0	0
	4	0.2908	30697	29163	133587	126908	24046	22843	24046	22843
	5	0.3624	24520	34655	88457	125020	50421	71261	50421	71261
	6	0.3608	17714	34483	64144	124867	51957	101142	51957	101142
	7	0.386	8623	20724	29520	70947	26568	63852	26568	63852
	8	0.4563	15164	43975	45320	131428	38522	111714	38522	111714
	9	0.398	6733	23432	22477	78219	22477	78219	22477	78219
	10	0.5027	3965	15160	10981	41985	10981	41985	10981	41985
	11	0.5027	7970	40941	22073	113381	22073	113381	22073	113381
Total			122847	247406	585497	923127	247044	604398	247044	604398

Input units are thousands and kg - output in tonnes

Figure 5.1.1 North-East Arctic saithe (Sub-areas I and II)





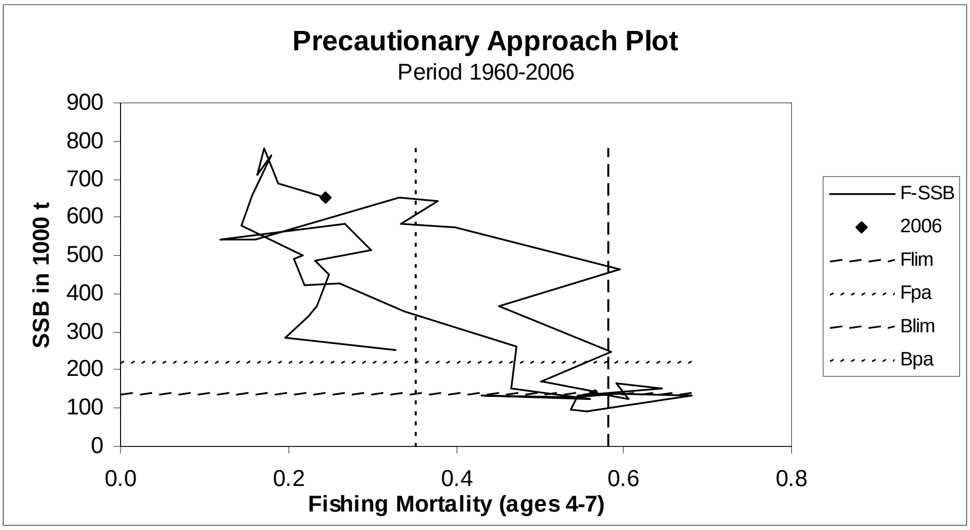


Figure 5.1.1 (continued)

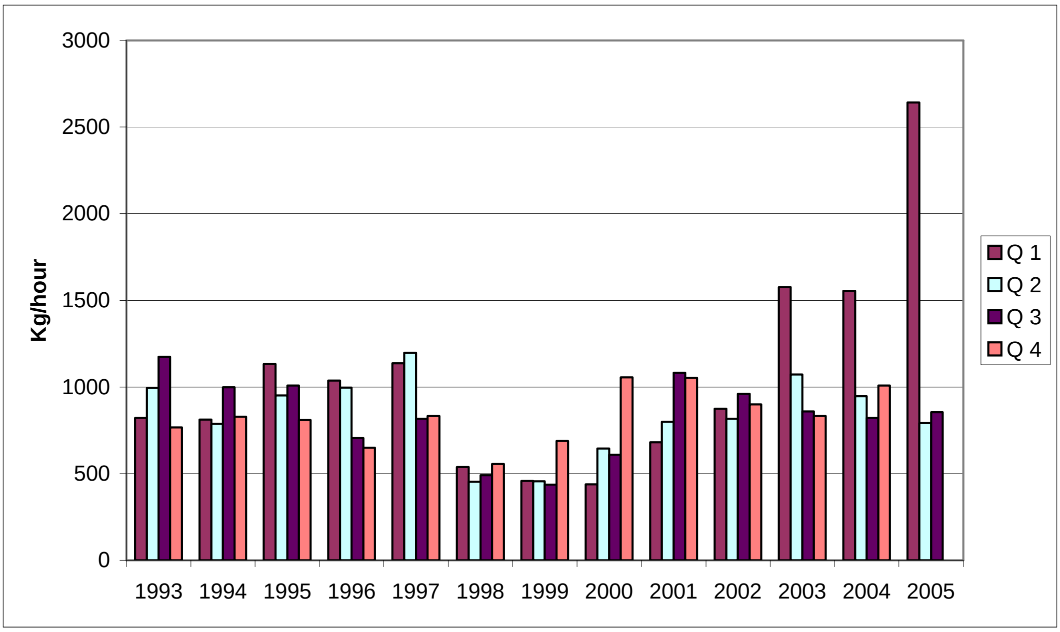


Figure 5.2.1. Noregian trawl CPUE by year and quarter 1993-2005

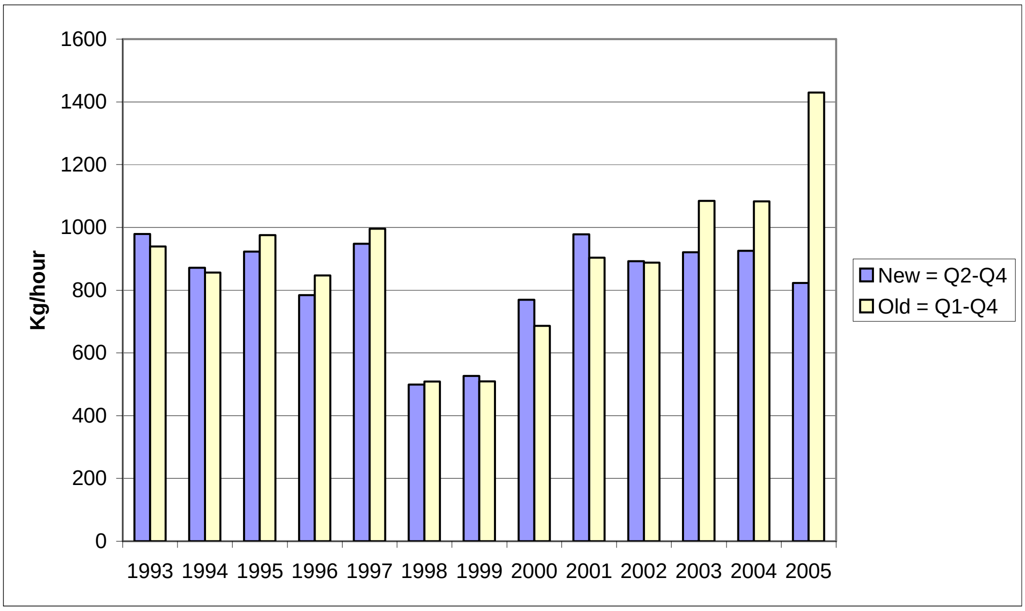


Figure 5.2.2. Norwegian trawl CPUE by year, averaged over quarter 1-4 (old) and over quarter 2-4 (new)

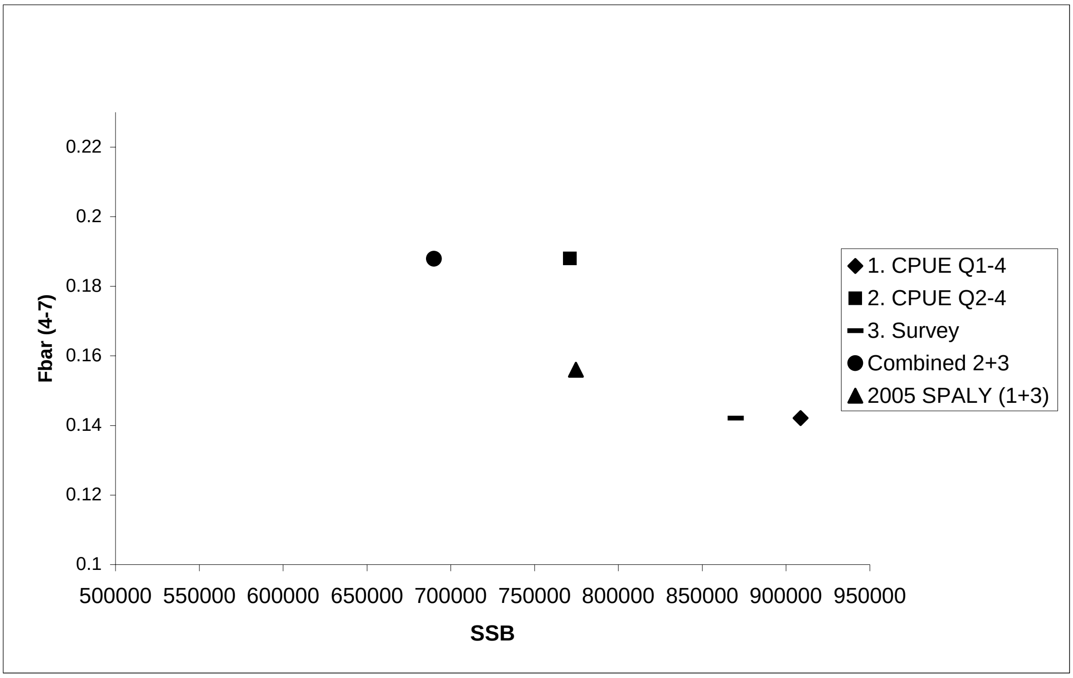


Figure 5.4.1 Comparison of SSB and F4-7 in 2005 from single fleet and combined XSA runs

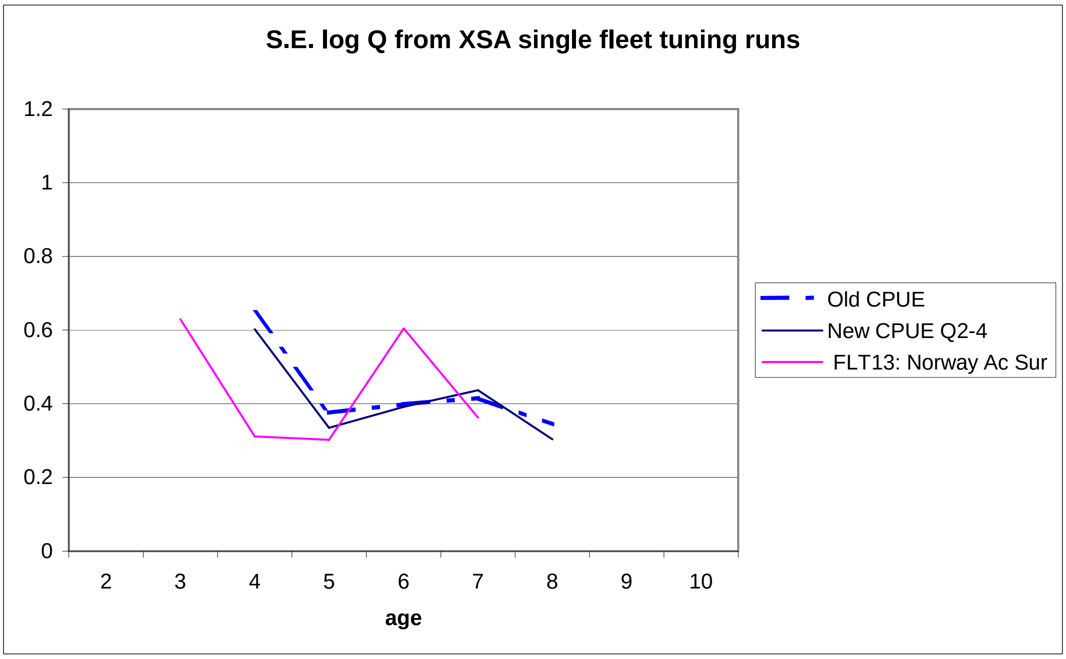
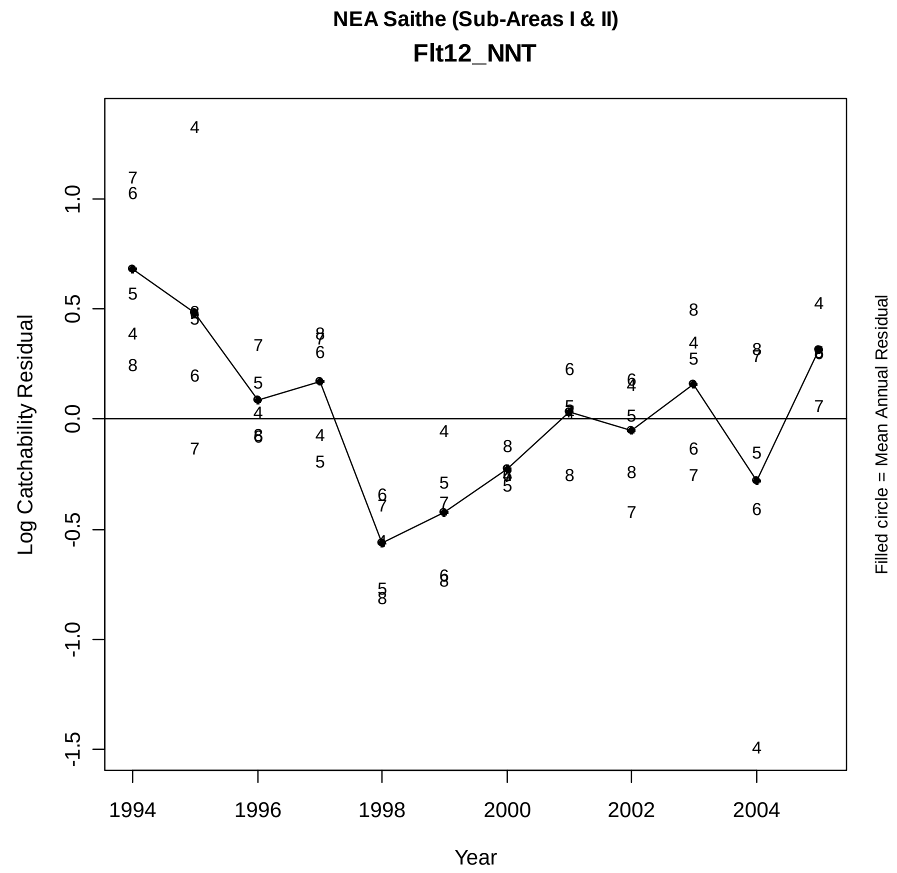


Figure 5.4.2. S.E. log catchability from three XSA single fleet tuning runs



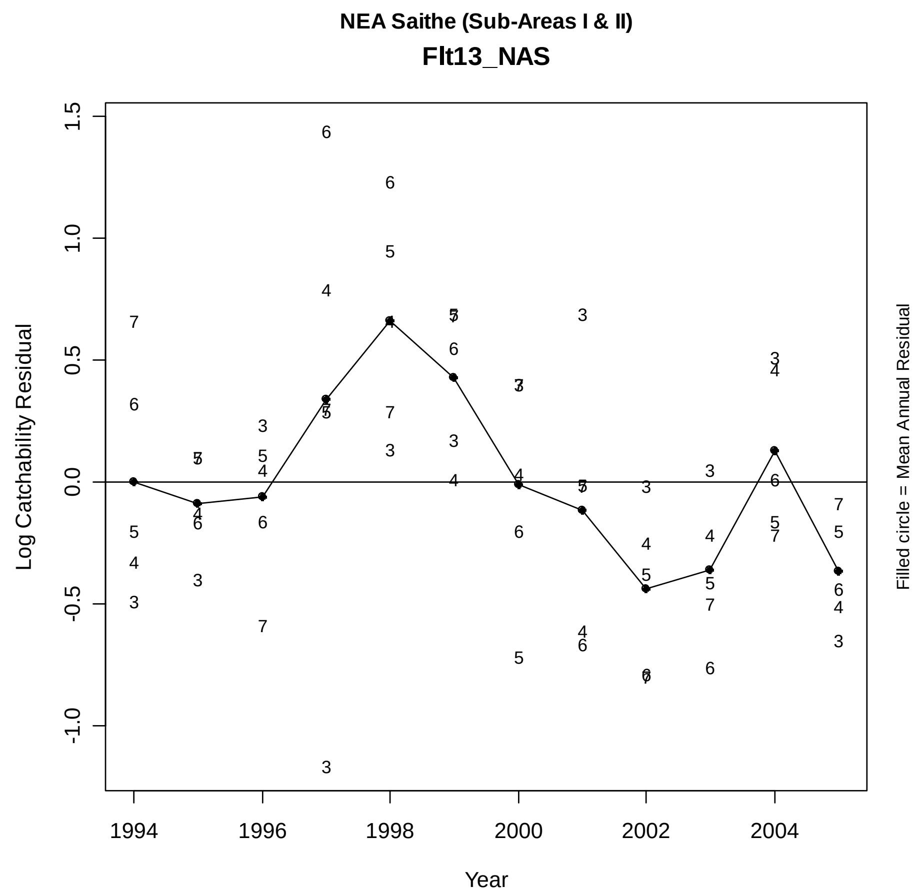


Figure 5.5.1 Final run log Q residuals.

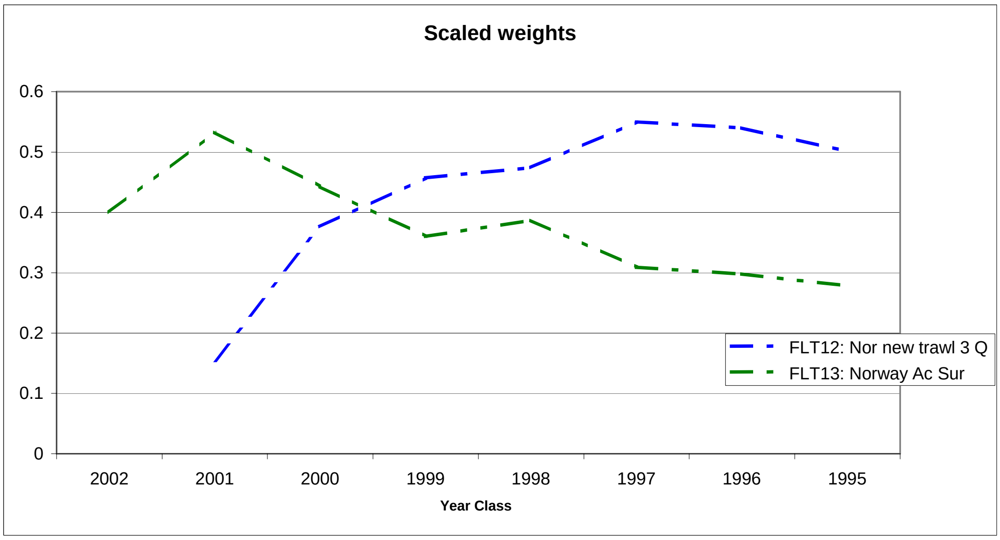


Figure 5.5.2 Scaled weights at age from final XSA run with 2 fleets.

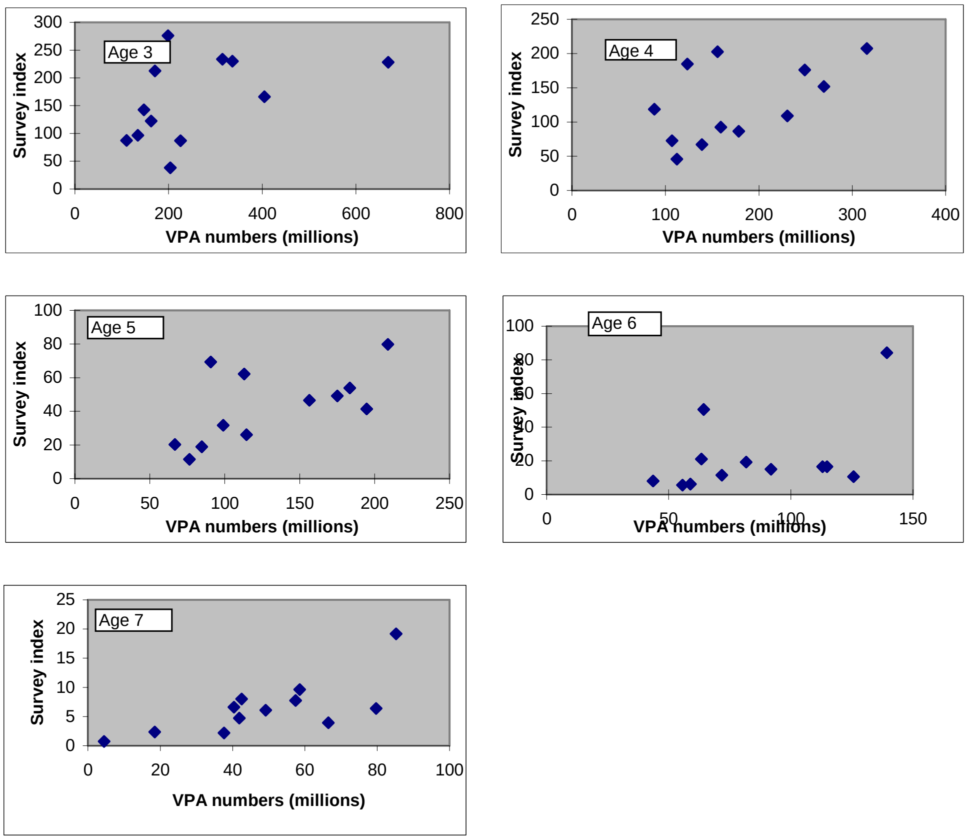


Figure 5.5.3A. North-East Arctic Saithe - Acoustic survey vs VPA

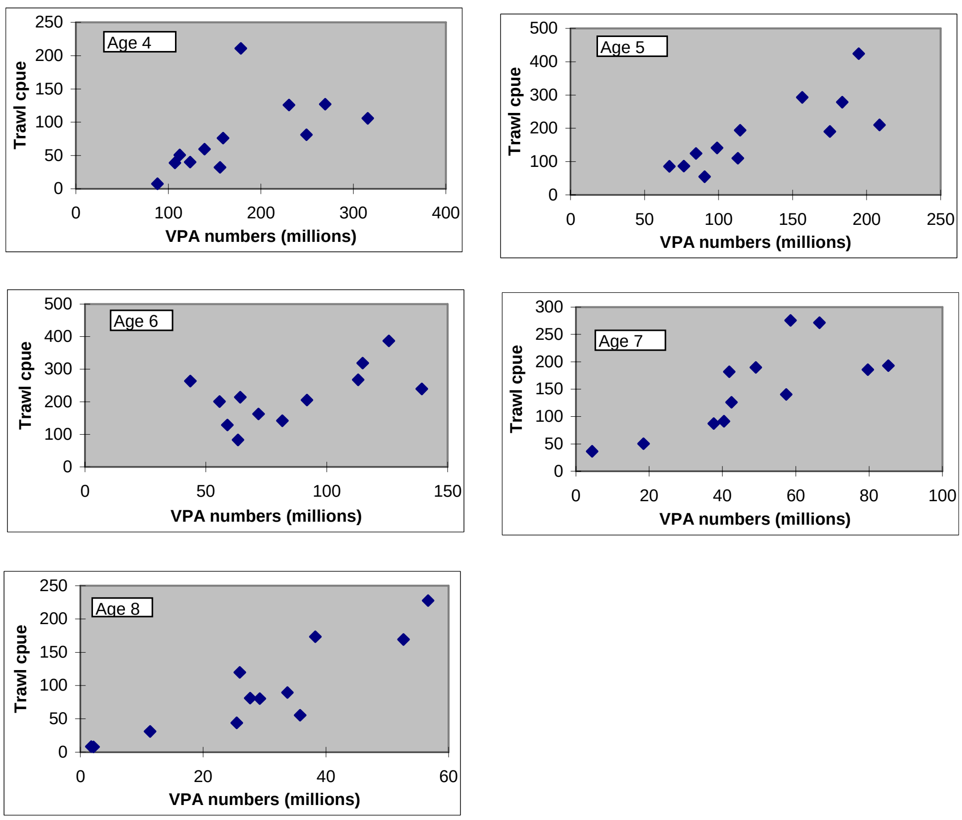


Figure 5.5.3B. North-East Arctic Saithe - Norwegian trawl vs VPA

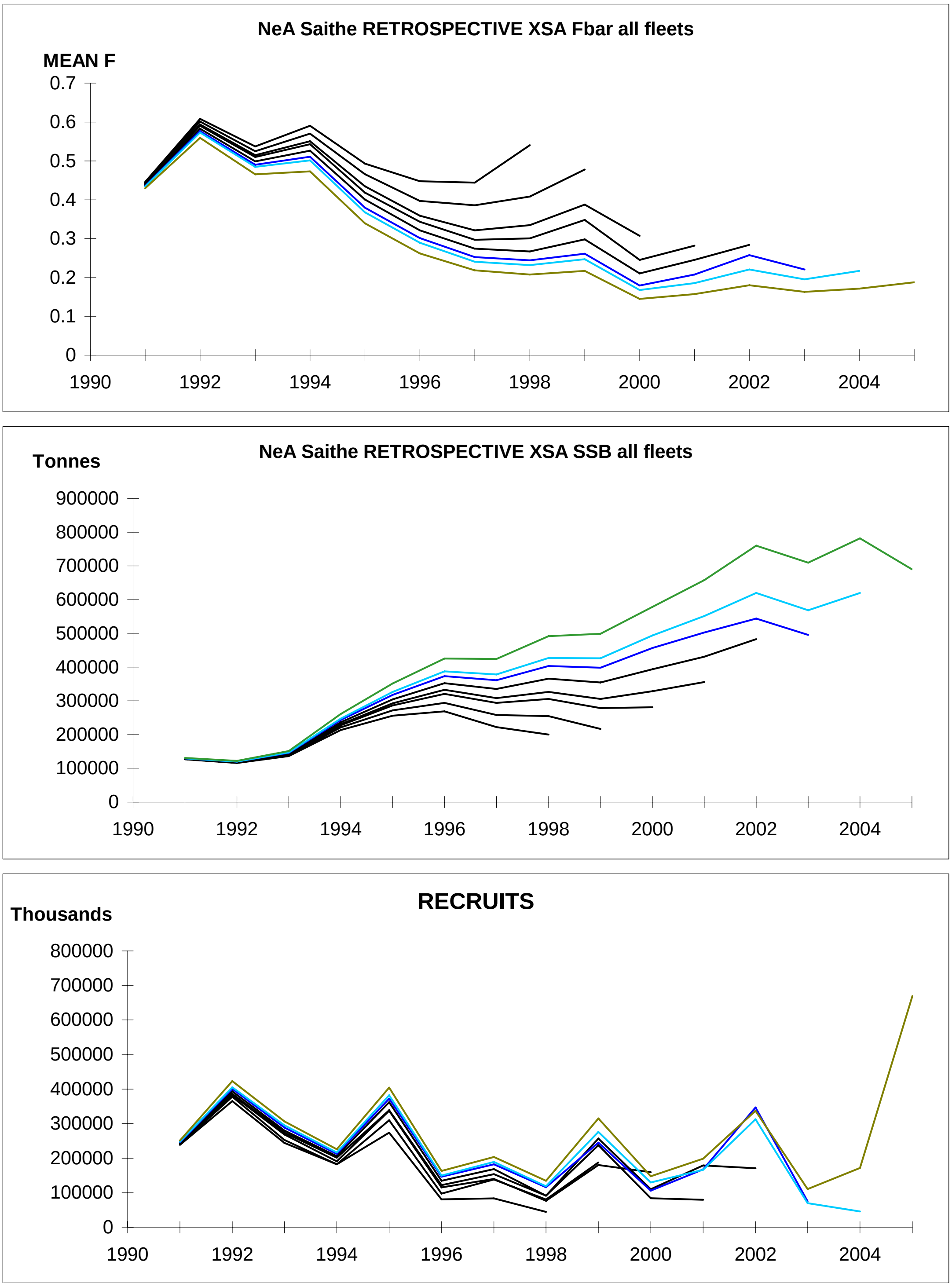
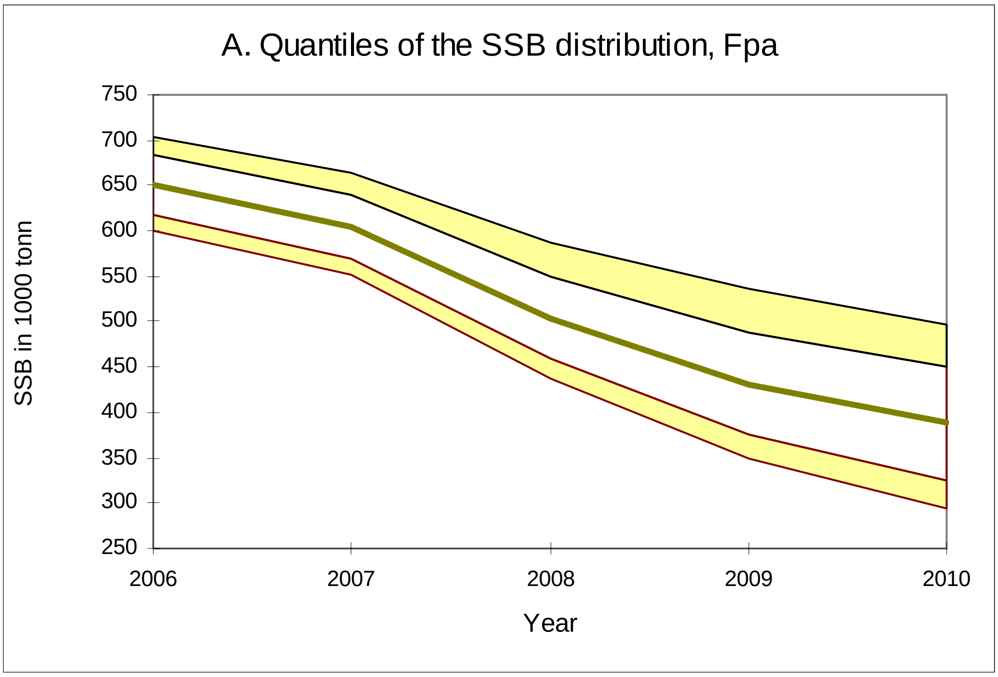


Figure 5.5.4 NeA Saithe RETROSPECTIVE XSA SSB all fleets



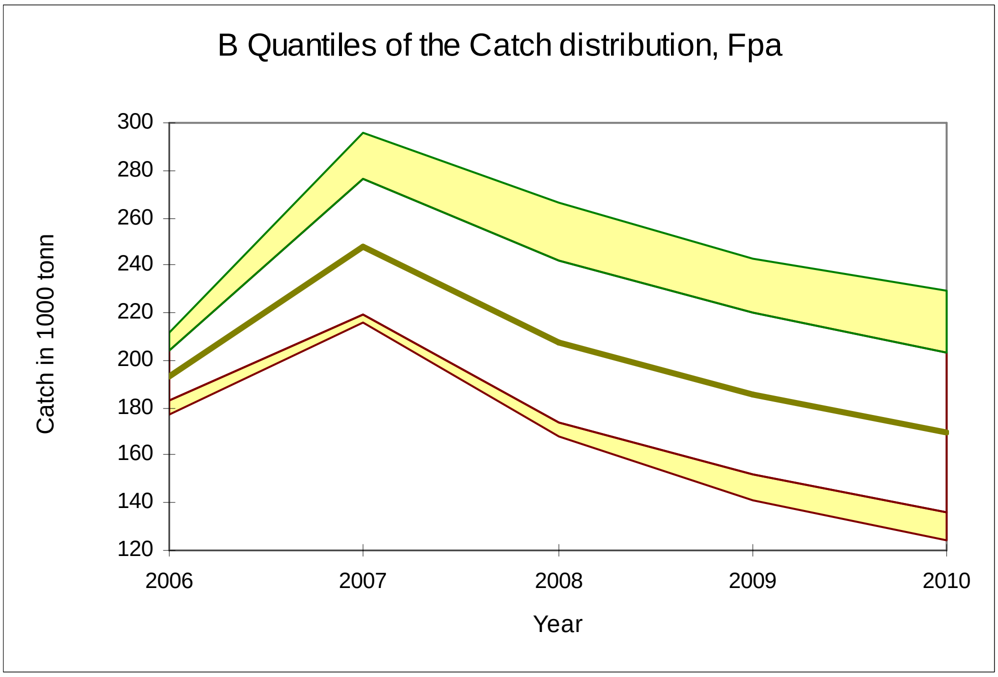
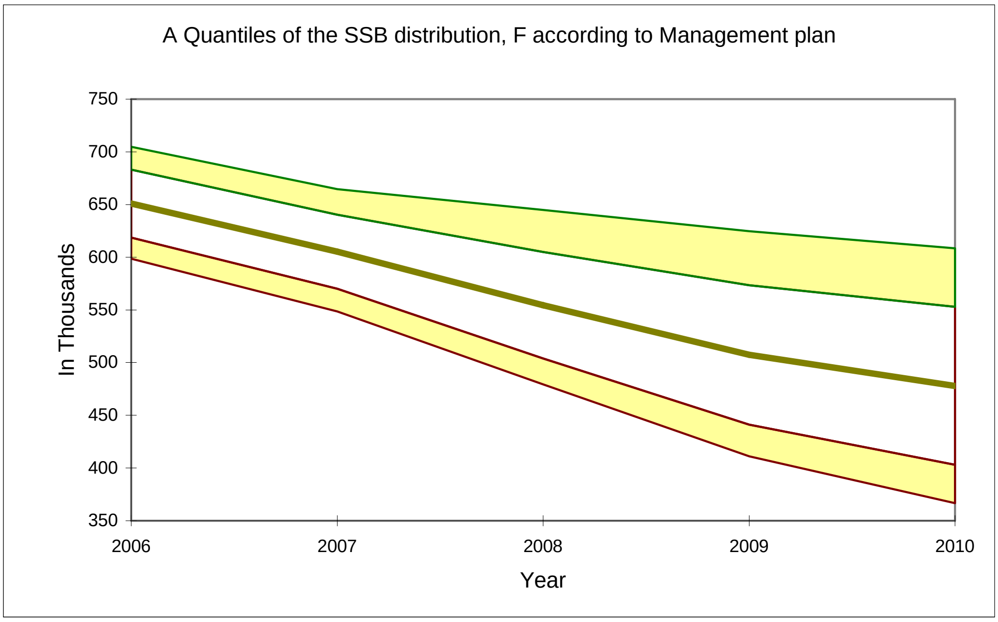


Figure 5.7.1A-b. Quantiles of SSB and catch distribution from mediumterm risk analyses



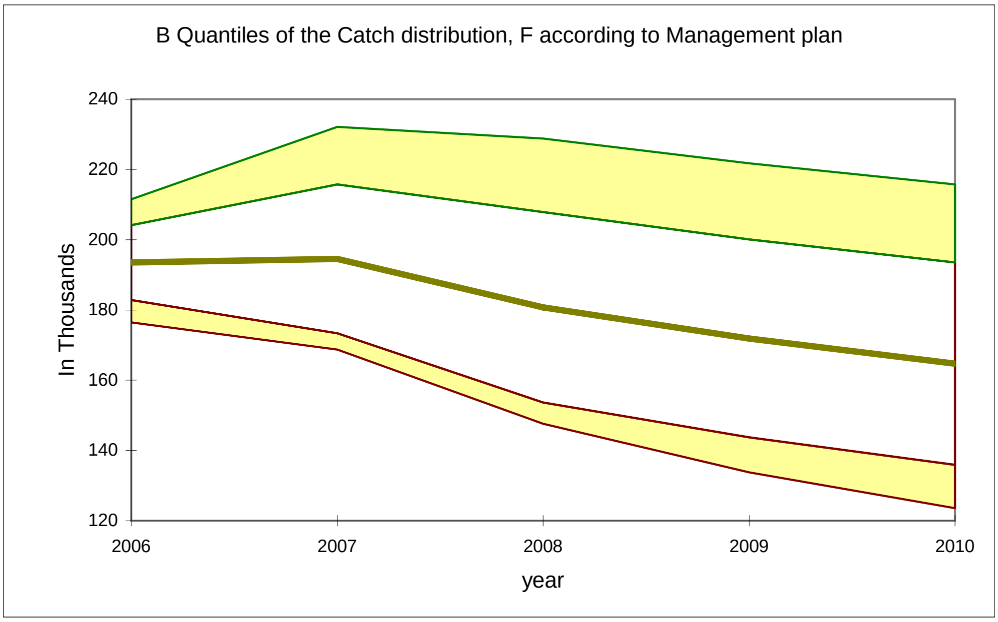


Figure 5.7.2A-b. Quantiles of SSB and catch distribution from mediumterm risk analyses

6 *Sebastes mentella* (Deep-sea redfish) in Sub-areas I and II

ACFM considers any analytical assessments for this stock to be experimental. Since ACFM considers it not necessary to assess this stock every year since the status of the stock can clearly be deducted from the surveys, no analytical assessment has been made.

6.1 Status of the Fisheries

6.1.1 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 15% redfish (both species together) in round weight as bycatch per haul and on board at any time.

6.1.2 Bycatch in other fisheries (Tables D9-D10, Figures 6.2-6.4.)

For the second time, reported landings of *S. mentella* taken in the pelagic Russian fishery for blue whiting and herring in the Norwegian Sea were reported to the working group. Of a total Russian catch of 5,023 tonnes in 2005, 3,299 tonnes (66%) were reported taken as bycatch in these pelagic fisheries. Information about geographic positions, catch rates, depth and length distribution were provided by Russian observers on board (Table D9 and Figure 6.2.). Germany reported 8.5 t, 40.4 t, 1.8 t and 19.6 t *S. mentella* as bycatch in their pelagic fisheries in the Norwegian Sea during 2002-2005, respectively.

The working group believes that similar bycatches of *S. mentella* may have been taken by other national fleets, but then either discarded or put together with the target species into meal production. Other nations than Russia and Germany are requested to collate and present data on redfish taken as bycatch in their pelagic fisheries in the Norwegian Sea.

Numbers and weights of the redfish (fully dominated by *S. mentella*) taken as by-catch in the Norwegian shrimp fishery in the Barents Sea during two decades were presented to last year's AFWG. The results show that shrimp trawlers removed significant numbers of juvenile redfish during the beginning of the 1980's with a peak during 1985 amounting to about 200 millions individuals (Table D10, Figures 6.3. and 6.4.). As sorting grids became mandatory in 1993, by-catches of redfish reduced drastically during the 1990's. From 1 January 2006, the maximum bycatch of redfish juveniles in the international shrimp fisheries in the northeast Arctic has been reduced from ten to three redfish per 10 kg shrimp.

6.1.3 Landings prior to 2006 (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 1965-2005 are also shown in Figure 6.1.

The total landings show a continuous decrease 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 2,471 t in 2003 due to stronger regulations enforced. An increase in 2004 and 2005 are mainly caused by Russia, and explained by the pelagic bycatches in their blue whiting and herring fisheries.

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 191 t in 2005 (Table D2).

6.1.4 Expected landings in 2006

There will be no directed fishery for *S. mentella* in 2006, and all the current regulations will be continued in 2006. Based on the present regulations, and reports from the first months in 2006, the total landings of *S. mentella* for 2006 are expected to be maximum **7,000 t,** also taking possible bycatches in the pelagic blue whiting and herring fisheries into account.

6.2 Data used in the Assessment

No analytical assessment was attempted for this stock this year. All input data sets were, however, updated up to and including 2005.

6.2.1 Catch at age (Table 6.5)

Catch at age for 2001-2004 was revised according to new catch data. Age data for 2005 for *S. mentella* were available from Norway for all areas, and from Russia in Division IIb. Russian catch-at-length from Sub-area I was converted to catch-at-age by using the Norwegian age-length key from Sub-area I. Since the *S. mentella* caught as bycatch in the Norwegian Sea were mature and relative large fish, these fishes were regarded resembling the *S. mentella* inhabiting the southern part of Division IIa more than the northern part. Russian total catch-at-length in Division IIa, incl. the pelagic bycatches, was hence converted to catch-at-age by using the Norwegian age-length key from Division IIa (southern part). The available length distribution from Germany catches in Division IIa was converted to catch-at-age by using the Norwegian age-length key from Division IIa (southern part). Other countries were assumed to have the same relative age distribution and mean weight as Norway.

6.2.2 Weight at age (Table 6.6)

Catch weight-at-age data for 2005 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.

6.2.3 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 2002-2004, when no survey was conducted, a weighted (by sample size) average of the 2000 and 2001 data was used.

6.2.4 Survey results (Tables 1.1, 1.4, D3–D7, Figures 6.5–6.9)

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, now part of the Ecosystem survey (Table 1.1 and Figure 6.5a, b). A new method to calculate the 0-group series has been adopted (Figure 6.5b). These new indices are calculated by the method of stratified sample mean, and this method allows for confidence limits to be calculated (Anon. 2005). When the new method has been carefully scrutinized and compared to previous methods, the new indices are meant to replace the "Area Index" after a short period of overlap between the two methods.
2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December from 1978–2005 in fishing depths of 100–900 m (Table D3, Figure 6.6).
3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1986–2005 in fishing depths of 100–500 m (swept area down to 800 m). Data disaggregated by age only for the years 1992–2005 (Table D4a,b).
4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2006 (joint with Russia since 2000, Russian vesssel did not take part in survey in 2006) in fishing depths of 100–500 m (swept area down to 800 m). Data disaggregated by age only for the years 1992–2005 (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 6.7a,b.

1) The Norwegian survey initially designed for redfish and Greenland halibut is now part of the ecosystem survey and covers the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen during August 1996-2005 from less than 100 m to 800 m depth (Table D6, Figures 6.8-6.9). This survey includes survey no. 3 above.
2) 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, and although the 2001-2005 year classes are among the lowest on record, a slow increase is observed since 2002.

Results from the Norwegian ecosystem survey (Table D6 and Figures 6.8-6.9) confirm the stock development as interpreted from the 0-group survey (Figure 6.5), i.e., relative strong 1988-1990 year classes, followed by weaker 1991-1995 year classes, and very weak year classes since 1996 onwards. A clear and sudden decrease of *S. mentella* for ages 9 and older (i.e., larger than about 28 cm) after the autumn 2002 survey is observed. It is likely that this decrease is related to the increase of *S. mentella* observed in the pelagic fisheries in the Norwegian Sea. This decrease is also seen in Figure 6.7a and b.

In the Russian bottom trawl survey the most recent estimates are among the lowest observed (Table D3, Figure 6.6). The overall picture of the relative strength of the year classes is 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 6.7) 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 1.5, 1.6).

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. The survey has unfortunately not been run since 2001.

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 is still very low.

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, it is of crucial importance that the 1987–1990 year classes (approx. 34–39 cm) which currently have recruited more than 80% to the spawning stock are protected. Unfortunately it is necessary to note, that quite probably these year classes are caught as bycatch in the Norwegian Sea during blue whiting and herring fisheries.

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

Since ACFM considers it not necessary to assess this stock every year as long as the status of the stock can clearly be deducted from the surveys, no experimental analytical assessment has been attempted.

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. This should include the Norwegian Sea.

6.5 Biological reference points

Until an analytical assessment will be available and used as basis for reference points calculations for this stock, candidate reference points for the biomass could be set at the average biomass level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. ACFM is supporting this suggestion and states that 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).

6.6 Management advice

The stock is in a very poor situation and this situation is expected to remain for a considerable period irrespective current management actions. Year-classes recruit to the SSB at old age (e.g. 10 years old) and surveys indicate failure of recruitment over a long time period.

The measures introduced in 2003 should be continued, i.e. there should be no directed trawl fishery on this stock and the area closures and low by-catch 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. Recruitment failure has been observed in surveys for more than a decade. In this connection it is of vital importance that the juvenile age classes be given the strongest protection from being caught as by-catch in any fishery, e.g., 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. In addition to long-existing bycatch regulations of the shrimp fishery, regulations to prevent future bycatches in the pelagic trawl fisheries for blue whiting, herring and mackerel in the Norwegian Sea seem necessary. Concerning the shrimp fishery, the sorting grid is not capable of sorting out all the small redfish, and closure of areas should therefore be a necessary and important regulation.

As long as the recruitment of new year classes is very poor, it is of crucial importance and urgent that the 1987–1990 year classes (approx. 34–39 cm) which currently have recruited more than 80% 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 and further improved by the 33rd Fishery Commission. However, it is probably these year classes which at present are taken as bycatch in the Norwegian Sea pelagic fisheries, and which need to be better protected.

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. This should further include the Norwegian Sea.

6.7 Response to ACFM technical minutes

ACFM considers it not necessary to assess the stock every year, and that updating of the tables and figures would be sufficient. The working group takes this into account.

The working group plan to update the unreported bycatch information annually from all fisheries, also the pelagic fisheries in the Norwegian Sea and the shrimp fisheries.

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	-	74	16	198	17	4
2002	41	15	75	58	99	18	4
2003	5	-	64	22	32	8	5
2004	10	-	52	13	10	4	3
2005[1]	6	5	204	37	33	39	4

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	13,937	5	179	3,775	90		120[5]	18,418
2002	2,152	8	242	3,904	190	**Sweden**	188[5]	6,993
2003	1,214	7	44	952	47	-	124[5]	2,525
2004	1,312	42	235	2,879	257	1	76[5]	4,894
2005[1]	1,781	-	114	5,023	163	**Netherl** -7	95	7,511

[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	-	-	-	6	292	-	-	298
2004	-	-	-	2	355	-	-	357
2005[1]	-	-	-	3	327	-	-	330

[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	63[2]	12[2]	161[2]	17[2]	4[2]	13,636
2002	37[2]	54[2]	59[2]	18[2]	4[2]	1,937
2003	58[2]	18[2]	17[2]	8[2]	5[2]	1,017
2004	17[2]	8[2]	4[2]	4[2]	3[2]	1,028
2005[1]	18[2]	32[2]	17[2]	38[2]	4[2]	1,103

YEAR	SWEDEN	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]	16,827
2002		124[2]	2,615	8[2]	41[2]	157[2, 6]	5,055
2003		17[2]	448	8[2]	5[2]	102[2, 6]	1,704
2004	1[2]	86[2]	2,081	7[2]	10[2]	18[2, 6]	3,268
2005[1]	-	71[2]	3,307	20[2]	4[2]	15[2, 6]	4,629

[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	-	-	11[2]	4[2]	37[2]	-	-
2002	-	-	38[2]	4[2]	40[2]	-	-
2003	-	-	6[2]	4[2]	15[2]	-	-
2004	-	-	35[2]	5[2]	6[2]	-	-
2005[1]	**Netherl** -7	-	186[2]	5[2]	17[2]	1[2]	-

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	293	5[2]	74[2]	763	72[2]	Estonia	25[2, 7]	1,284
2002	210	8[2]	118[2]	702	182[2]	15[8]	31[2, 7]	1,348
2003	191	7	27[2]	212	39[2]	-	22[2, 7]	523
2004	282	42[2]	149[2]	443	250[2]	-	58[2, 7]	1,270
2005[1]	675	-	43[2]	1,389	143[2]	5	80[2, 7]	2,553

[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 Sebastes mentella. Catch numbers at age

NUMBERS*10**-3															
YEAR	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
AGE															
6	1653	1873	159	738	662	223	125	37	9	1	117	2	6	11	5
7	5453	2498	159	730	941	634	533	882	83	24	372	40	37	24	40
8	7994	1898	174	722	1279	1699	1287	2904	441	390	542	252	103	103	108
9	6781	1622	512	992	719	1554	1247	4236	1511	1235	976	572	93	138	327
10	8226	1780	2094	2561	740	1236	1297	3995	2250	2460	925	709	132	400	521
11	5344	1531	3139	2734	1230	1078	1244	2741	3262	2149	1712	532	220	589	554
12	6227	2108	2631	3060	2013	1146	876	1877	1867	1816	2651	1382	383	852	350
13	9880	2288	2308	1535	4297	1413	1416	1373	1454	1205	2660	1893	390	505	1394
14	10824	2258	2987	2253	3300	1865	1784	1277	1447	1001	1911	1617	434	1256	1115
15	4049	2506	1875	2182	2162	880	1217	1595	1557	993	1773	855	466	941	2917
16	2105	2137	1514	3336	1454	621	537	1117	1418	932	1220	629	512	852	994
17	9603	1512	1053	1284	757	498	1177	784	1317	505	714	163	199	812	1151
18	6522	677	527	734	794	700	342	786	658	596	814	237	231	490	897
+gp	19299	9258	6022	3257	2404	2247	3568	6241	3919	5705	16234	4082	1192	1840	3616
TOTALNUM	**103960**	**33946**	**25154**	**26118**	**22752**	**15794**	**16650**	**29845**	**21193**	**19012**	**32621**	**12965**	**4398**	**8813**	**13989**
TONSLAND	48727	15590	12866	12721	10284	8075	8597	14045	11209	10075	18418	6993	2524	4894	7511

Table 6.6 Sebastes mentella. Catch weights at age

YEAR	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
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	0.09	0.13	0.14
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	0.17	0.17
8	0.21	0.26	0.25	0.24	0.19	0.25	0.25	0.23	0.22	0.22	0.20	0.22	0.22	0.22	0.21
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	0.27	0.29
10	0.34	0.31	0.33	0.34	0.28	0.42	0.33	0.33	0.33	0.31	0.30	0.34	0.33	0.33	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	0.38	0.39	0.38	0.38
12	0.42	0.38	0.44	0.4	0.37	0.47	0.46	0.43	0.44	0.42	0.39	0.43	0.43	0.43	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	0.43	0.44
14	0.51	0.43	0.5	0.45	0.47	0.67	0.51	0.54	0.53	0.51	0.48	0.52	0.50	0.50	0.52
15	0.58	0.43	0.57	0.49	0.53	0.69	0.55	0.59	0.56	0.56	0.53	0.56	0.54	0.55	0.56
16	0.59	0.45	0.58	0.55	0.58	0.71	0.6	0.61	0.62	0.62	0.59	0.57	0.59	0.58	0.56
17	0.58	0.52	0.62	0.58	0.66	0.74	0.66	0.64	0.66	0.63	0.62	0.60	0.57	0.61	0.59
18	0.59	0.57	0.65	0.67	0.71	0.74	0.65	0.66	0.67	0.67	0.65	0.59	0.62	0.64	0.61
+gp	0.7	0.67	0.662	0.79	0.806	0.847	0.787	0.753	0.805	0.774	0.70	0.73	0.74	0.70	0.68

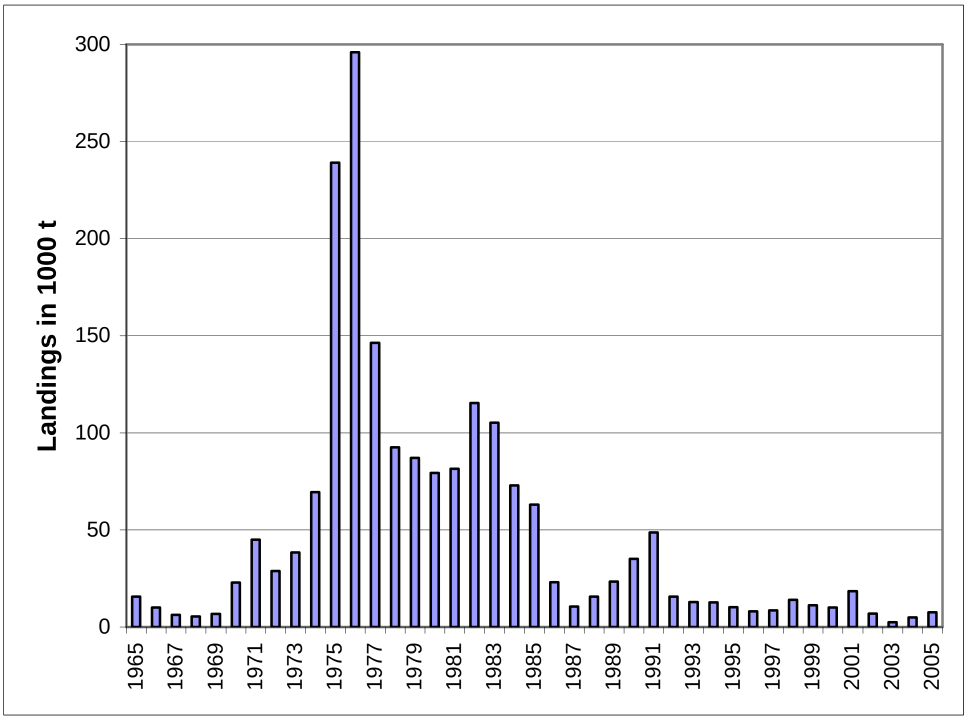


Figure. 6.1. Sebastes mentella in Sub-areas I and II. Total international landings 1965-2005 (thousand tonnes).

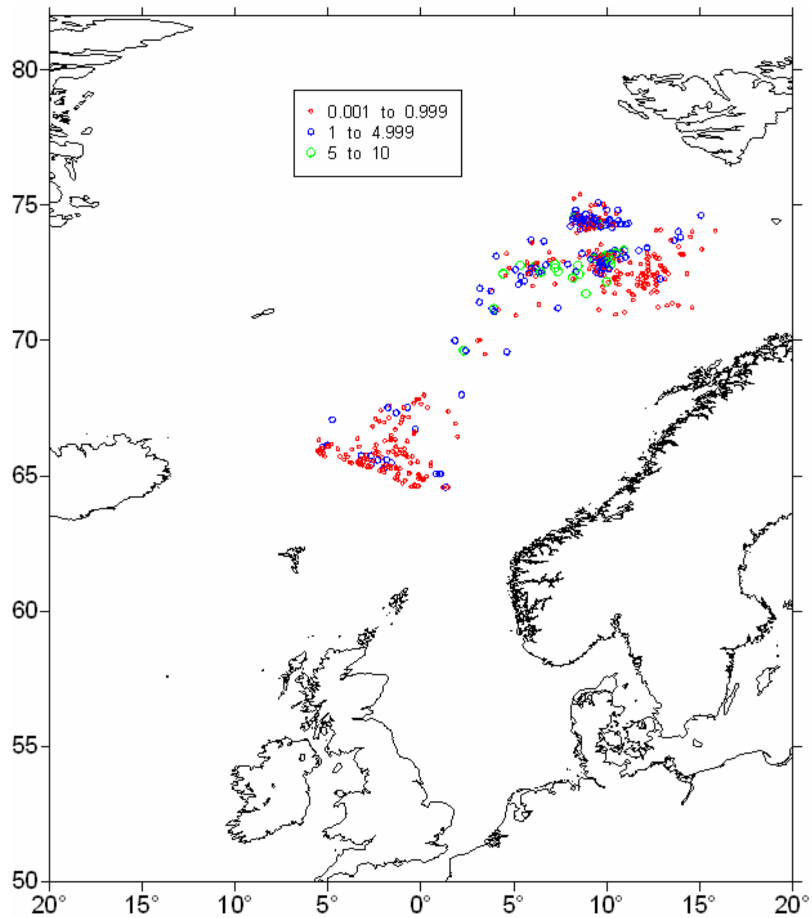


Figure. 6.2. Map showing the geographical positions and catch per day (tonnes) of Russian pelagic trawl hauls from which length samples of *S. mentella* were collected (see Table D9).

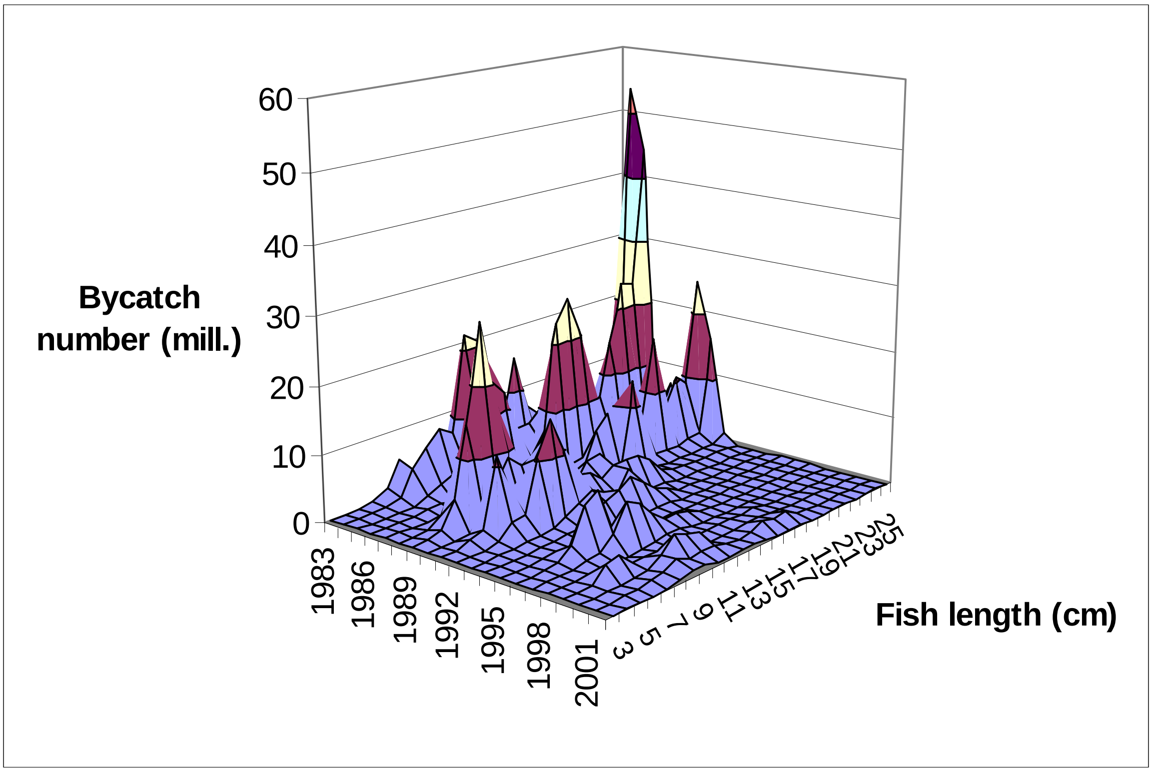


Figure 6.3. Redfish by-catch by year and length group (same data as in Table D10). (Data not yet available for 2002-2205).

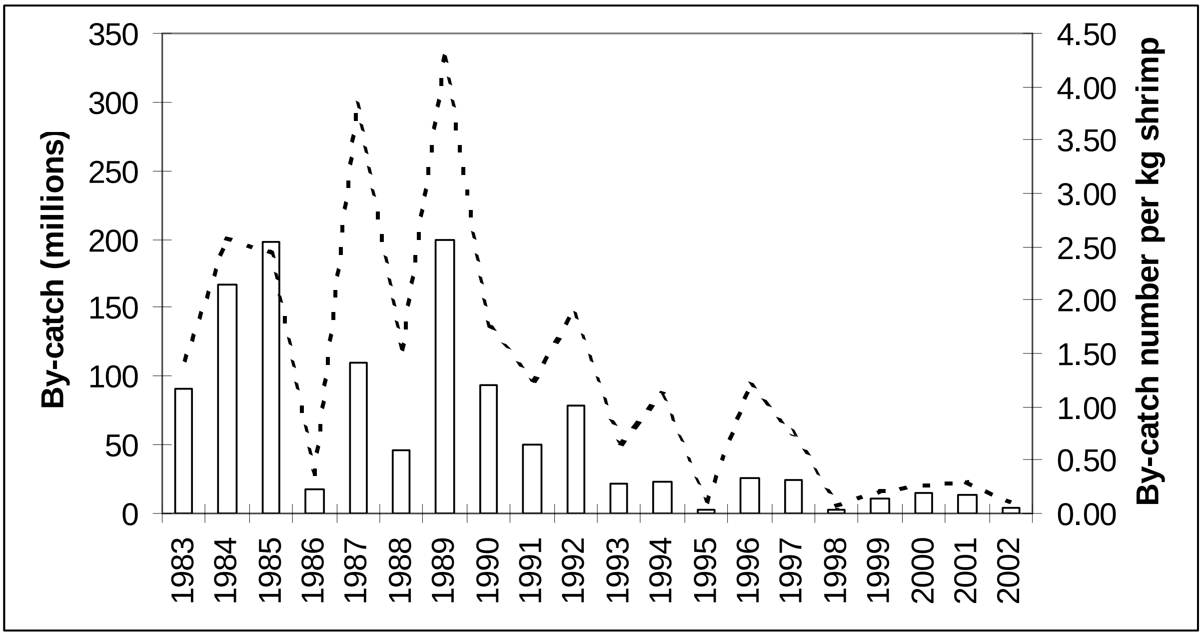


Figure 6.4. Total number of redfish caught by year in the Norwegian shrimp fishery (columns) and bycatch number per kg shrimp (line). (Data not yet available for 2003-2205).

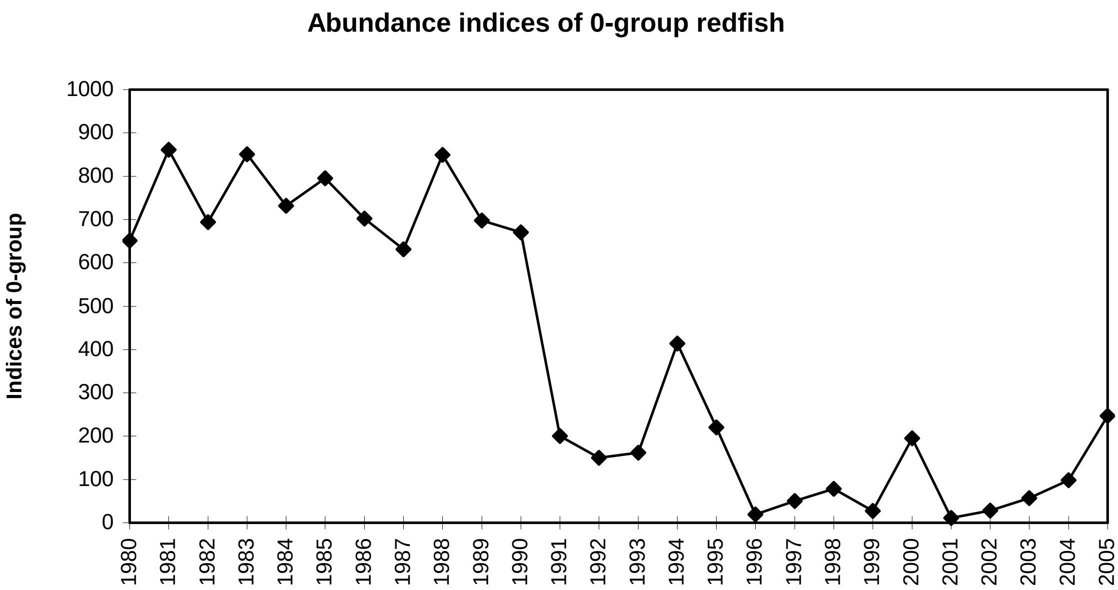


Figure 6.5a. Abundance indices of 0-group redfish (believed to be mostly *S.mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2005. (ref. Table 1.1)

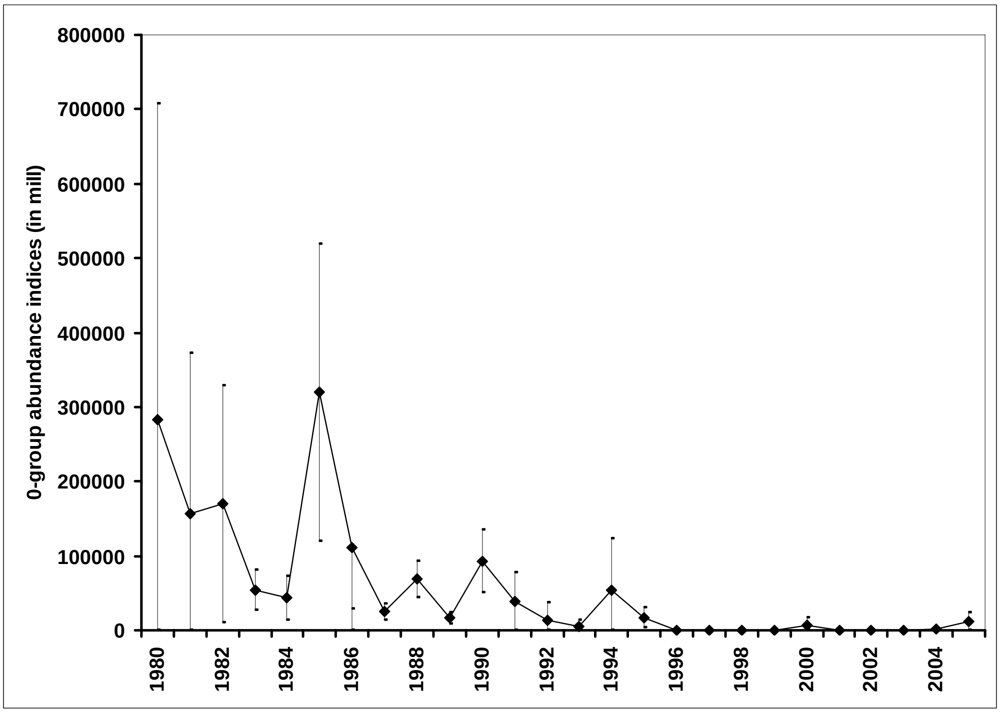


Figure 6.5b. Abundance indices (in millions) with 95% confidence limits of 0-group redfish (believed to be mostly *S.mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2005, as calculated by the new method, and not corrected for catching efficiency. (ref. Table 1.4)

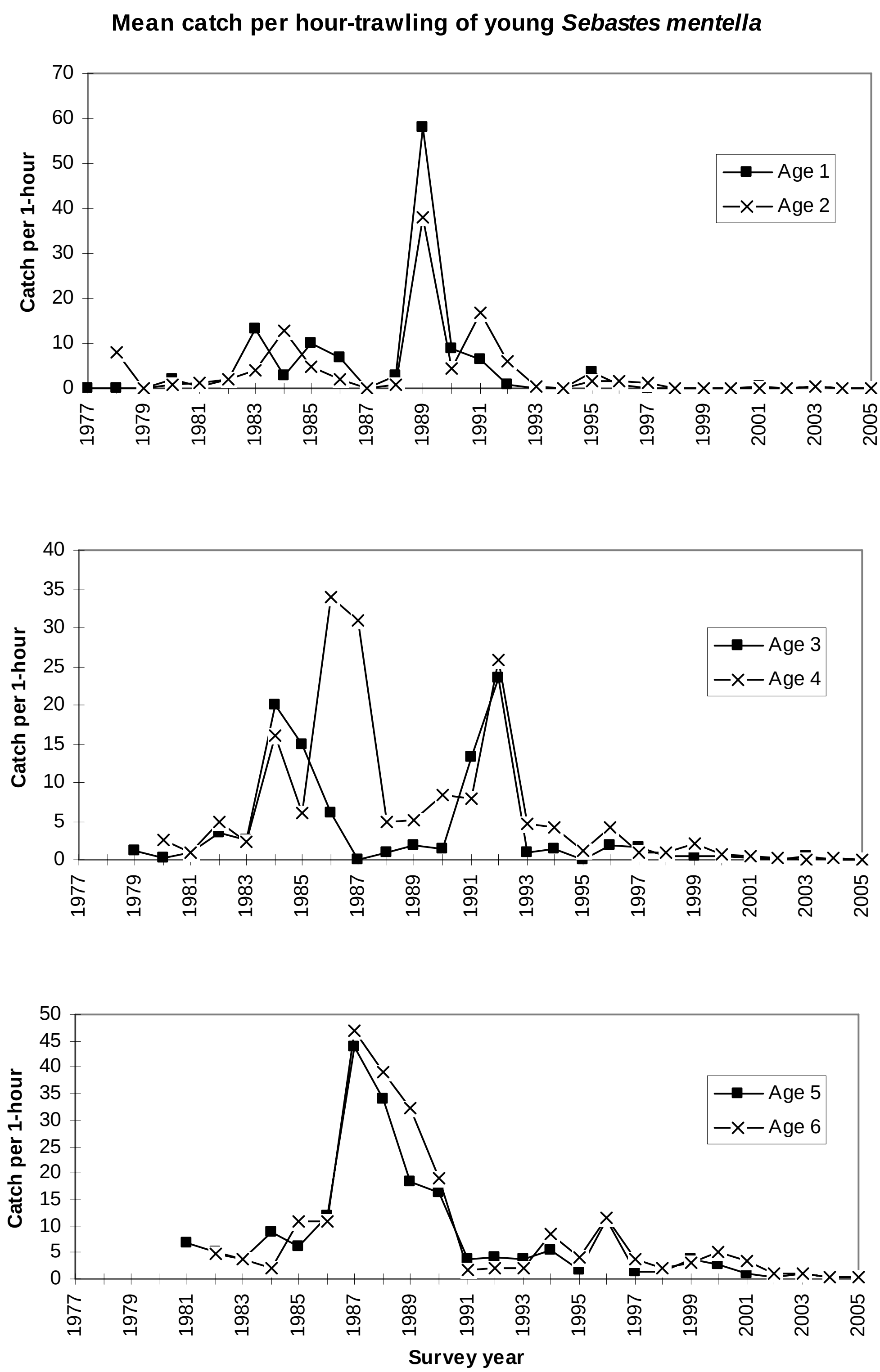
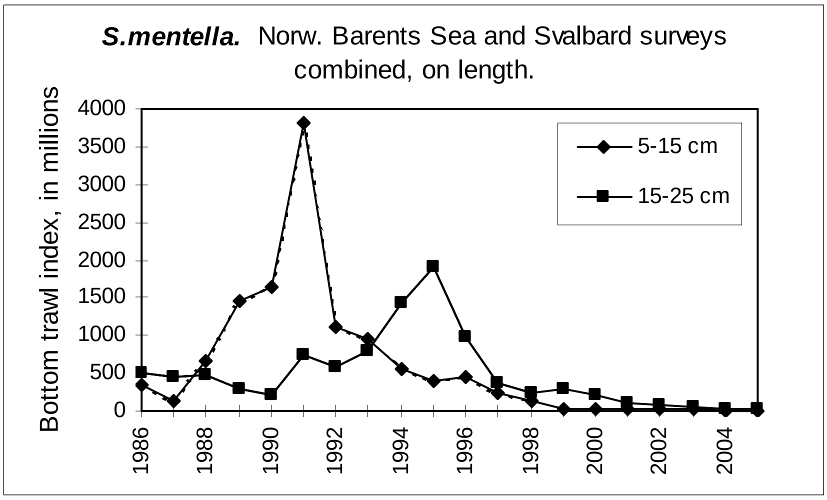


Figure 6.6. Catch (numbers of specimens) per hour trawling of different ages of Sebastes mentella in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D3).



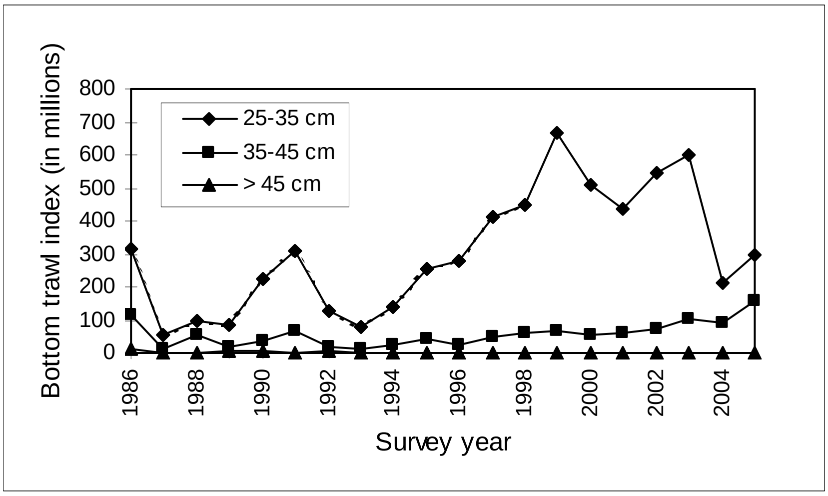
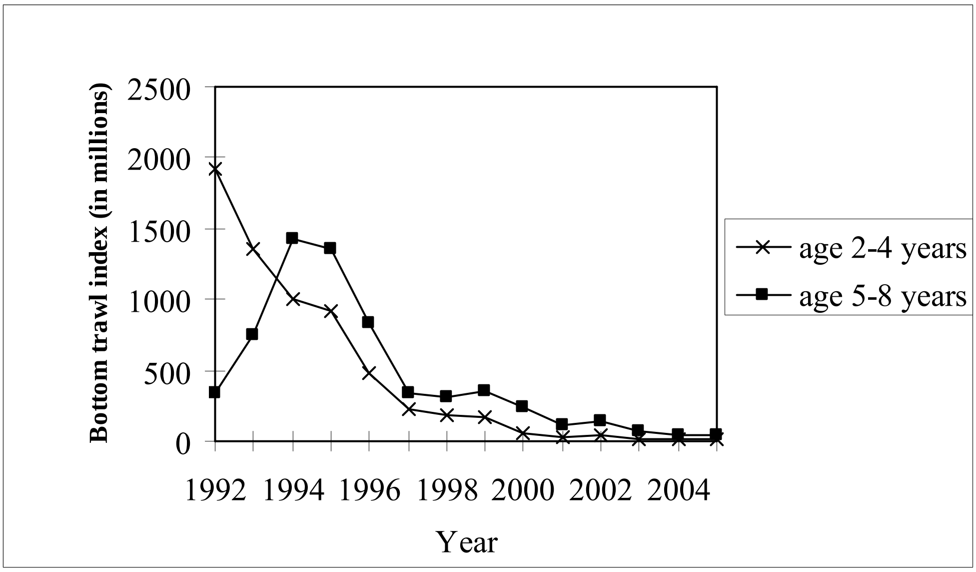


Figure 6.7a. Sebastes mentella. Abundance indices (on length) when combining the Norwegian bottom trawl surveys 1986-2005 at Svalbard (summer/fall) and in the Barents Sea (winter).



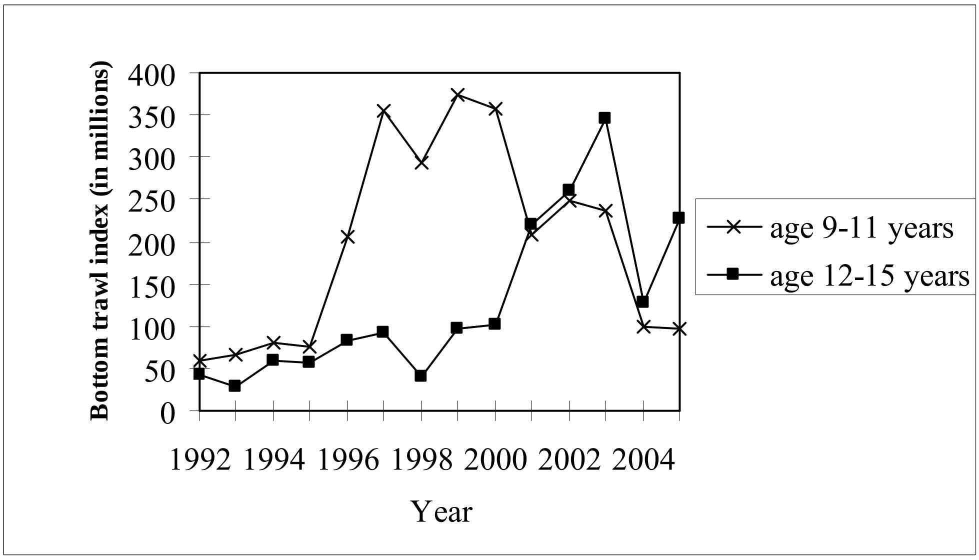


Figure 6.7b. Sebastes mentella. Abundance indices (on age) when combining the Norwegian bottom trawl surveys 1992-2005 at Svalbard (summer/fall) and in the Barents Sea (winter).

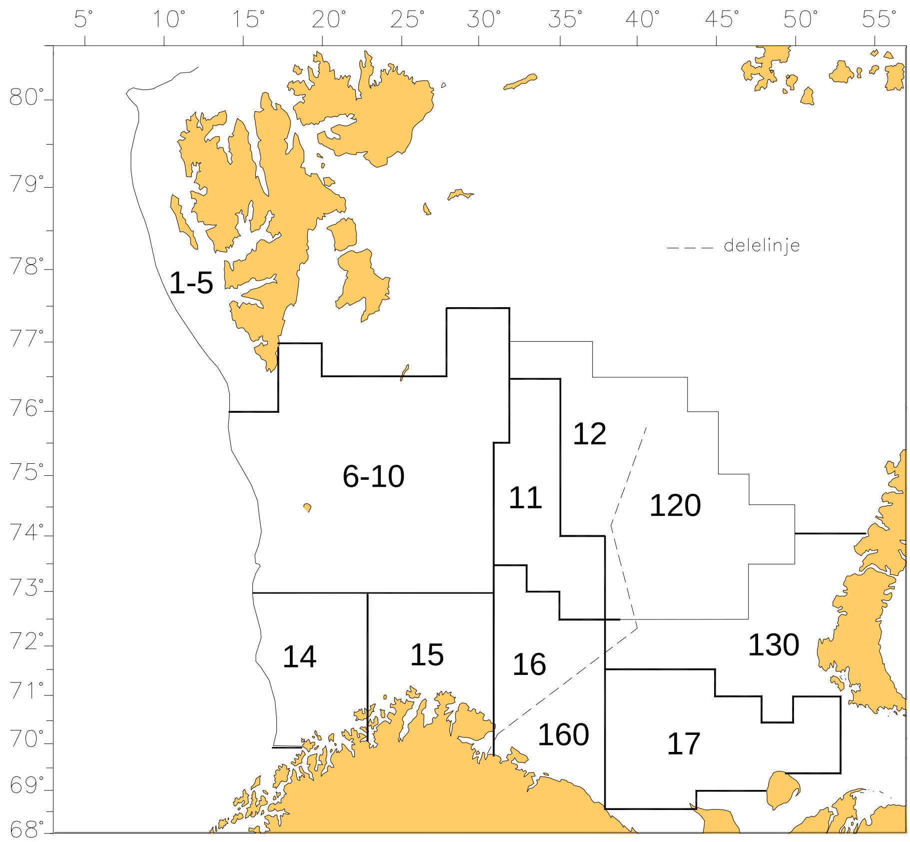
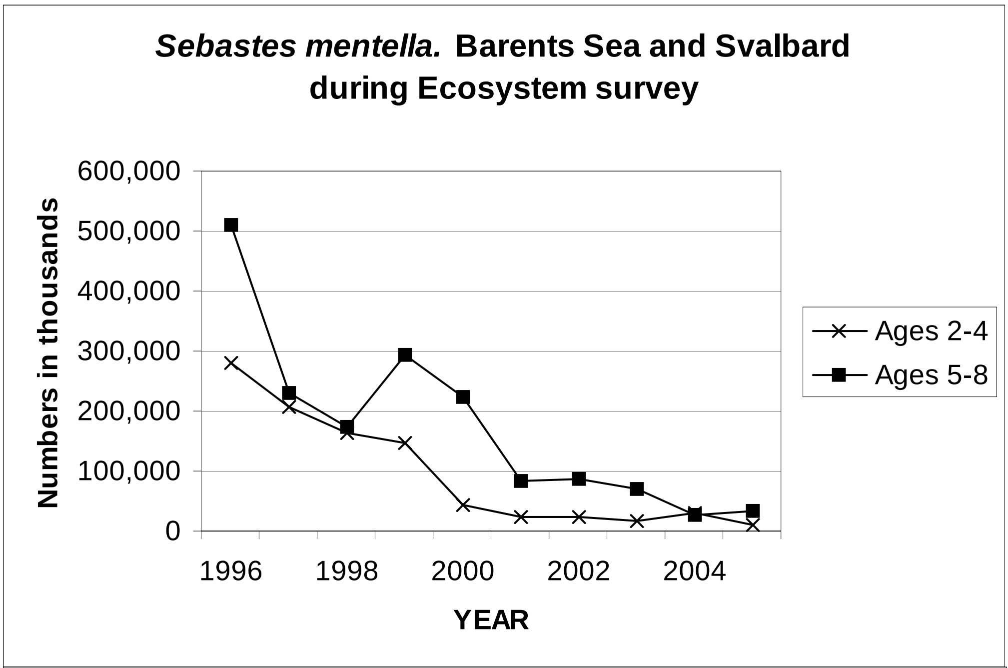


Figure 6.8. Survey regions and subareas in the ecosystem survey in the Barents Sea and adjacent areas in August-September 1996-2005 covered by the standard 1800 Campelen research trawl shallower than ca. 500 m. Subareas 1-10 are further depth stratified. The Svalbard region comprises these ten subareas, 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 D6).



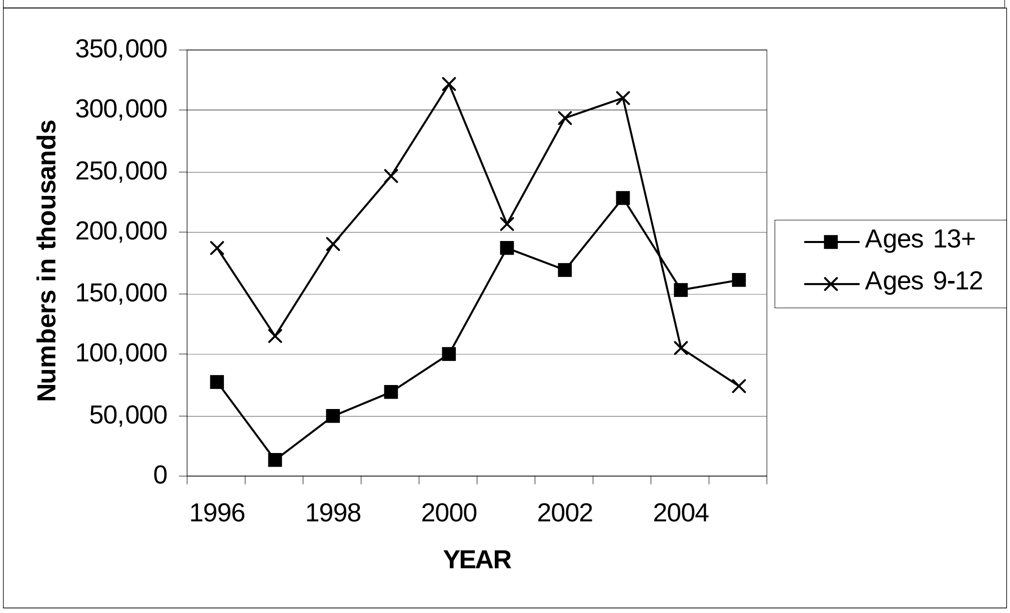


Figure 6.9. Sebastes mentella. Abundance indices (on age) from the Ecosystem survey in August-September 1996-2005 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (ref. Table D6).

Table D1 REDFISH (S.mentella and S.marinus) 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	-	-	111[3]	46	436	34	3	5	-	23,071	5	186	4,738	91	ESTONIA	239[6]	28,965
2002	-	-	135[3]	89	141	49	44	4	-	10,713	8[3]	276	4,736	193[2]	15	234[6]	16,637
2003	SWED	-	173[3]	31	154	44[3]	9	5[3]	89	8,091[1]	7	50	1,431	47	-	258[6]	10,389
2004	1	-	64[3]	17[3]	78	24[3]	40	3	33	7,658[1]	42	240	3,601	260	-	146[6]	12,206
2005[1]	-	-	241[3]	46[3]	106	75[3]	25	4[3]	55	8,385	-	170	5,637	171	5	147[6]	15,068

[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 (S.mentella and S.marinus) 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	SWEDEN	UK (ENG. & 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	370	-	4	21	1,113	68	681	2,868
1999	3	52	1	-	58	-	39	16	862	67	465	1,563
2000	5	41	-	224	19	-	28	19	443	132	486	1,397
2001	4	96	-	272	13	-	19	+	421	80	458	1,363
2002	2	40	2	98	11	-	7	+	241		524[3]	925
2003	1	71	2	26	2	32	-	-	474		463[3]	1,071
2004	+	42	3	26	1	5	-	-	287		214[3]	578
2005[1]	2	n.a.	n.a.	10	1	n.a.	-	-	85		93[3]	191

[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

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	2.1
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	3.1	3.3	1.8	1.2
1995	2.8	1.0	1.1	0.4	2.2	2.6	3.5	3.4	2.9	1.2	1.0	
1996[2]	+	0.1	0.1	0.4	0.7	1.1	1.0	1.4	1.0	0.8		
1997	-	-	+	0.4	0.5	0.3	0.9	0.6	1.0			
1998	-	0.1	0.2	0.3	0.2	1.1	0.5	0.7				
1999	0.1	-	0.1	+	0.1	0.3	0.5					
2000	-	0.6	0.1	0.5	0.3	0.3						
2001	-	0.1	0.4	-	0.1							
2002[3]	0.1	0.5	0.1	-								
2003	-	-	0.1									
2004	-	0.2										
2005	-											

(1976–1983 published in "Annales Biologiques").

[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 1986-2005 (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
2004	0	2	7	6	14	78	53	2	0	163
2005	1	1	6	11	19	93	63	1	0	196

[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 1992-2005 (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
2004	1	1	3	3	1	4	2	9	9	18	15	17	19	9	113
2005	1	1	2	3	3	6	9	15	14	16	14	21	22	25	152

[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 1986-2006 (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
2005	+	6.3	7.3	10.7	28.4	153.4	86.6	3.9	0.2	296.8
2006	98.8	1.9	9.8	14.6	22.7	102.8	81.9	2.7	0.7	336.0

[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 1992-2005 (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
2005	0	4	3	3	6	6	11	15	23	14	21	40	35	49	229

[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 ecosystem survey in August-September 1996-2005 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (numbers in thousands) (ref. Figure 6.9).**

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
2004	9068	10837	9008	7292	2510	7896	8193	15268	25544	29654	35249	21142	39581	25976	66792	314030
2005	1310	4406	5241	5031	5722	8740	13452	20672	16207	19353	17430	32028	37564	34815	57103	279072

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																							
2004	No Data																							
2005	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

Table D9. Length distributions (by sex) of S. mentella caught as bycatch in the Russian pelagic fisheries for blue whiting and herring in the Norwegian Sea in summer and autumn 2005 (see also Figure 6.2).

Date	Position	Depth of sea, m	Depth of trawling, m	Sex	Length, cm														Sum	Mean length, cm
					19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46		
21.06.2005	65058N	3000	120	M									1		1				2	37.5
	03001W			F										1	1				2	38.5
04.08.2005	65041N	3000	300	M							1	10	21	32	12				76	36.7
	01020W			F								2	5	6	7	2			22	37.7
06.09.2005	66034N	3000	310	M						1	2	18	46	34	5				106	35.9
	00023W			F							1	11	9	3	4	1			39	36.1
08.09.2005	72037N	1800	20	M							1	9	8	3	1				22	35.0
	04004E			F								5	4	8	1				18	36.1
09.09.2005	73001N	1500	265	M						2	19	57	26	12	2				118	34.1
	04042E			F						2	11	31	33	25	11	4			117	35.5
14.09.2005	73003N	2000	280	M						5	15	27	14	8	1				70	33.7
	10020E			F						1	9	26	26	22	6				90	35.2
15.09.2005	72049N	2000	330	M						3	21	23	19	1					67	33.3
	09031E			F						2	12	25	24	12	5				80	34.7
16.09.2005	72050N	2000	340	M						3	18	31	14	5	1				72	33.6
	09011E			F						2	14	39	29	15	4				103	34.5
17.09.2005	73042N	1350	330	M						2	10	18	3	2					35	33.1
	13039E			F						2	9	31	22	3					67	34.0
18.09.2005	73028N	1350	330	M							16	23	7	3					49	33.4
	13053E			F						2	12	37	16	2	2				71	33.8
20.09.2005	72052N	1500	310	M							1								1	31.5
	13044E			F							1	1							2	32.5
22.09.2005	74006N	2000	300	M						1	2	5	1						9	32.8
	11053E			F							2		1						3	32.8
09.08.2005	65023N	3200	100	M									5	8	12	6	3	1	35	39.3
	03004W			F									6	23	13	6			48	38.3
13.08.2005	64041N	2750	310	M								2	5	6	7				20	37.3
	00019W			F									2	2	1				5	37.1
17.08.2005	73009N	1700	350	M								2	5						7	34.9
	12011E			F								1				1			2	37.5
21.08.2005	72024N	2100	300	M									2	2					4	36.5
	10019E			F									2	3		1			6	37.5
18.09.2005	72049N	2500	300	M						12	21	44	59	25	6				167	34.5
	07013E			F					4	11	18	35	44	16	7				135	34.2
20.09.2005	72049N	2500	350	M					1	19	31	39	54	15	6				165	33.9
	07054E			F					1	6	17	25	48	30	8				135	35.0
21.09.2005	72040N	2500	350	M					1	4	19	59	65	23	8				179	34.7
	05057E			F					2	3	22	29	39	23	2	1			121	34.5

Table D10. Estimated number (millions) of redfish caught in the shrimp fishery by length group and year. Sum and estimated catch weight (000 tonnes) are given at the bottom rows. (Data not yet available for 2002-2005).

L(cm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	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	0.27	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5	0.06	0.00	0.00	0.00	0.00	0.23	1.03	0.08	0.91	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.07	0.00	0.17	0.00
6	0.53	0.10	0.01	0.10	0.00	1.85	4.56	0.17	1.64	0.64	0.16	0.09	0.12	0.21	0.01	0.00	2.15	0.06	0.30	0.00
7	1.80	0.94	0.21	0.42	0.01	5.97	14.79	2.76	11.44	2.56	0.47	0.24	0.31	1.81	0.40	0.00	2.69	0.15	0.57	0.09
8	5.37	4.64	0.93	0.44	0.02	3.55	28.90	6.24	5.89	2.94	0.41	0.20	0.17	6.81	0.60	0.00	0.83	0.39	0.73	0.45
9	1.70	7.10	2.12	0.09	0.02	1.01	17.81	9.19	1.88	10.42	0.80	0.64	0.05	8.30	2.75	0.07	0.65	1.61	1.91	0.88
10	3.79	9.35	2.80	0.03	0.09	1.42	8.68	7.22	1.11	15.29	1.49	0.53	0.06	2.37	6.40	0.22	0.66	3.96	1.13	0.82
11	0.62	7.96	3.13	0.25	0.08	0.60	5.70	7.50	2.31	10.14	2.81	2.01	0.08	1.71	5.38	0.65	0.44	3.13	1.34	0.31
12	1.64	22.25	10.82	0.28	2.00	0.50	5.47	10.65	2.57	5.56	4.04	3.08	0.06	2.34	3.36	0.72	0.16	2.63	1.35	0.22
13	1.46	20.66	15.24	1.00	1.34	0.52	2.19	5.90	2.88	5.31	2.88	3.92	0.14	0.94	1.71	0.84	0.47	0.43	0.82	0.45
14	2.68	4.11	12.64	1.15	1.78	0.42	2.48	3.18	5.72	3.65	1.83	5.25	0.33	0.16	1.52	0.41	0.41	0.34	0.43	0.55
15	3.07	2.04	6.26	2.39	7.04	0.46	1.80	1.73	5.91	4.76	4.79	3.50	0.41	0.13	1.09	0.18	0.59	0.41	0.71	0.41
16	6.08	0.33	6.63	3.90	23.00	1.57	1.31	0.82	2.31	5.15	0.81	1.84	0.35	0.03	0.28	0.09	0.62	0.69	1.64	0.18
17	15.13	2.74	8.29	2.91	26.45	2.17	6.82	1.08	1.70	4.95	0.51	1.24	0.14	0.02	0.27	0.02	0.34	0.61	1.10	0.11
18	6.60	0.17	0.42	1.33	21.11	4.33	8.92	0.83	0.63	3.52	0.47	0.13	0.02	0.06	0.00	0.00	0.76	0.35	1.34	0.03
19	4.72	2.23	3.05	0.56	7.13	5.65	8.03	13.78	0.41	1.46	0.27	0.04	0.01	0.05	0.00	0.00	0.23	0.36	0.28	0.01
20	3.22	6.55	6.04	0.32	3.43	6.46	4.13	0.68	0.41	0.61	0.11	0.00	0.00	0.11	0.00	0.00	0.09	0.16	0.27	0.00
21	3.23	5.82	5.53	0.11	1.27	2.93	6.21	1.17	0.22	0.30	0.04	0.00	0.00	0.07	0.00	0.00	0.01	0.05	0.00	0.00
22	3.83	3.43	6.79	0.10	2.89	2.15	18.24	0.81	0.17	0.37	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.15	0.00	0.00
23	3.47	3.63	14.78	0.33	1.27	1.38	6.61	0.94	0.26	0.15	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.02	0.00	0.00
24	1.60	4.96	23.90	0.20	1.70	1.12	10.72	1.29	0.50	0.27	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
25	1.54	3.86	23.48	0.29	2.15	0.83	9.19	1.59	0.26	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
>25	18.95	53.87	44.56	1.60	7.41	0.96	24.98	16.22	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	91	167	198	18	110	46	199	94	51	78	22	23	2	25	24	3	11	15	14	5
000T	9.0	17.8	25.5	1.3	8.8	3.3	16.7	6.8	1.3	2.2	0.7	0.7	0.1	0.3	0.4	0.1	0.2	0.4	0.5	0.1

7 *Sebastes marinus* (Golden redfish) in Subareas I and II

ACFM considers the analytical assessments for this stock to be experimental for time being. The status of the stock can clearly be deducted from the surveys.

7.1 Status of the Fisheries

7.1.1 Recent regulations of the fishery

A description of the historical development of the fishery and regulations 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 currently legal to have up to 15% 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 has been enforced in all fisheries except trawl. For 2006 this moratorium will be during April-May and September, a change from 20 April-19 June in 2005 and 1-31 May in 2004. When fishing for other species (also during the moratorium) it is allowed to have up to 15% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday.

7.1.2 Landings prior to 2006 (Tables 7.1–7.4, D1 & D2, Figures 7.1–7.2)

Nominal catches of *S. marinus* by country for Sub-areas I and II combined, and for each Sub-area and Division are presented in Tables 7.1- 7.4. The total landings for both *S. marinus* and *S. mentella* are presented 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 figures for *S. marinus* in 2004 and 2005 of 7,312 t and 7,557 t, respectively, are the lowest since the mid-1940ies (!). The time series of *S. marinus* landings is given in Figure 7.1 and shows a long-term (1908-2005) mean of 17,140 t.

The Norwegian landings are presented by gear and month in Figure 7.2. This shows that the limited moratorium for conventional gears during 20 April-19 June 2005 may have lead to a 200 t decrease in the landings during April-June compared to the year before. For the whole 2005, the landings by conventional gears decreased by about 600 t while the trawl landings increased by about 225 t.

The AFWG received catch data on *S. marinus* caught as bycatch in the pelagic trawl fishery for herring and blue whiting in the Norwegian Sea. Of a total reported Russian catch of 722 tonnes in 2004, 117 tonnes were caught as bycatch in these fisheries. In 2005 this pelagic catch decreased to 15 tonnes of a total of 614 tonnes. Germany also reported bycatch of redfish from their pelagic fisheries in the Norwegian Sea during 2002-2005, but everything as *S. mentella*. Other nations than Russia and Germany are therefore requested to collate and present data on redfish taken as bycatch in their pelagic fisheries in the Norwegian Sea. For other pelagic fishing fleets, however, it is likely that bycatches of redfish are either not reported or put together with the target species in the fishmeal production.

The bycatch estimates of redfish (*Sebastes* spp.) in the Norwegian Barents Sea shrimp fisheries during 1983-2002 (WD #18 at AFWG2005) are completely dominated by *S. mentella*, and hence will influence the *S. marinus* to a much lesser extent. However, it probably put an extra mortality on the *S. marinus* in the coastal areas before the sorting grid was enforced in 1990. From 1 January 2006, the maximum bycatch of redfish juveniles in the international shrimp fisheries in the northeast Arctic has been reduced from ten to three redfish per 10 kg shrimp.

Information describing the splitting of the redfish landings by species and area is given in the Quality handbook.

7.1.3 Expected landings in 2006

On the basis of reports from the first months of the year, a legal by-catch of 15% in all trawl fisheries, and an assumed effect of the regulations for the other gears, the Norwegian landings in 2006 are not expected to decrease by more than about 500 t compared to 2005, leading to a total Norwegian catch of about 6,000 t. The Russian catch is expected to increase to about 800 t due to higher bycatches in the first months of the year. On this basis landings of at least **7,000 t** are expected in 2006.

7.2 Data Used in the Assessment

7.2.1 Catch-per-unit-effort (Table D11, Figures 7.3 and D1)

The CPUE-series for *S. marinus* from Norwegian 32-50 meter freezer trawlers is presented from 1992 onwards (Table D11). Only data from days with more than 10% *S. marinus* in the catches (in weight) are included in the annual averages. Mean CPUEs with standard errors together with number of vessel days meeting the 10% criterion are presented in Table D11 and Figure 7.3. Results from the analyses of the CPUEs for factory trawlers, including all days with redfish in the catches in addition to the 10% criterion, are shown in Figure D1. To what extent a double-trawl has been reported used is also shown in this figure.

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 7.3 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 since the criterion for defining it to be a *S. marinus* vessel-day since 2003 (due to regulations) have not been more than 20% or 15% (since 2004) *S. marinus* in each trawl haul. In 2005 a slight increase in numbers of vessel-days led to a further decrease in the catch-rates. With some variation, the average annual catch-rates have decreased from an average level of 350 kg/trawl hour during mid 1990ies to less 150 kg/h in 2003-2005, i.e., less than 40% of the former recent level.

7.2.2 Catch at age (Table 7.5)

Catch at age data for 2001-2004 were revised. Age composition data for 2005 were only provided by Norway, accounting for 87% 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. German catch-at-length from Division IIa was converted to catch-at-age by using the Norwegian age-length key for Division IIa (southern part). 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 7.5.

7.2.3 Weight at Age (Table 7.6).

Weight-at-age data for ages 7–24+ were available from the Norwegian landings in 2005.

7.2.4 Maturity at age (Figure 7.9)

A maturity ogive has previously not been available for *S. marinus,* and knife-edge maturity at age 15 (age 15 as 100% mature) has hence been assumed. This year, the Gadget model modelled the maturity based on maturation data (by length and age) collected from Norwegian surveys and landings (Figure 7.9). This analysis shows that at age 11 about 50% of the fish are mature.

7.2.5 Survey results (Tables D12a,b–D13a,b–D14, Figures 7.4a,b–7.5a,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 1986–2006 (joint with Russia since 2000) in fishing depths of 100–500 m. Length compositions for the years 1986–2006 are shown in Table D12a and Fig 7.4a. Age compositions for the years 1992–2005 are shown in Table D12b and Figure 7.4b. This survey covers important nursery areas for the stock.

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2005 in fishing depths of 100–500 m (depths down to 800 m incl. in the swept area). Length compositions for the years 1985–2005 and age compositions for the years 1992–2005 are shown in Table D13a and D13b, 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 7.5a,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 1995-2005 from Finnmark to Møre (Table D14).

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. The surveys in 2005 and 2006 confirm the historic low abundance and poor recruitment.

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) since the mid 1990-ies. 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 D14).

7.3 Assessment by use of the GADGET (Fleksibest) model

Description of the model

ACFM has previously recommended the Working Group to investigate possible alternative methods to conventional catch-at-age analyses. The GADGET (FLEKSIBEST) model is closely related to the BORMICON model that currently is used by the ICES North-Western WG on *S. marinus* (Björnsson and Sigurdsson 2003). The functioning of a Gadget model, including parameter estimation, is described in Bogstad et al. (2004b). The model used on this stock was for the first time presented to ACFM last year (AFWG 2005, WD #17). The main model period has been considered to be from 1990, with earlier years acting as a lead-in period to the model. The *S. marinus* has been modelled with a single-species, single-area model, with mature and immature fish considered (at the AFWG 2006 for the first time) as two population groups. The fish were modelled in 1cm length categories. The age and length ranges were defined as 3-30+ and 1-59+ cm, respectively.

The *S. marinus* was considered to have Von Bertanlanffy growth, with “sensible” initial parameters being provided. These were K=0.11, L-inf=50.2, and t0=0.08 (Nedreaas 1990). The length-weight relationship w=0.000015*l^3.0 (where w is in kilogram and l in cm) was used and kept constant between seasons and years.

There has been no cannibalism or modelled predation – mortality has been exclusively due to fishing and residual natural mortality was set initially at 0.1. Recruitment was handled as a number of recruits estimated per year, and no attempt at closure of the life cycle was attempted. “Sensible” initial recruitment values were provided from trial XSA-runs previously done by the Arctic Fisheries WG. Although a maturity ogive has been modelled (Figure 7.9), a knife-edged maturity at age 15 has been used for estimating the spawning stock.

Each parameter may be estimated during the modelling process, but “sensible” starting values were required. For each parameter a range of possible values was also required. This should be the absolute maximum range the parameters can reach, as the model will not search values outside this range. Where detailed knowledge is available the ranges may be set quite tight, which will improve efficiency during optimisation. In other cases lack of knowledge will dictate a wide range of possible values.

For each of the following parameters both an initial estimate and a likely range were needed. For the selectivities it was enough to give the range from which the fleet goes from almost no catch to maximum selectivity (assuming the L50 style curve). An L50 and slope parameters for the fleets were then estimated .

- Two growth parameters *
- Annual recruitment – one per year
- Four parameters governing commercial selectivity (two per fleet)
- Several parameters per survey governing selectivity (two or three per fleet) **
- Initial population numbers for mature and immature fish
- Natural mortality (initially 0.1)

  * There was an additional growth parameter governing the distribution of actual growths around the calculated mean growth for fish in each length cell. This is a purely estimated parameter and no initial value need be provided.

  ** The exact number will depend on the form of the selectivity chosen.

Data used for tuning are:

- Quarterly length distribution of the landings from two commercial fishing fleets
- Quarterly age-length keys from the same fishing fleets
- Length disaggregated survey indices from the Norwegian Barents Sea bottom trawl survey (February) from 1990–2005 (joint with Russia since 2000) (Table D12a).
- Age-length keys from the Barents Sea bottom trawl survey (Table D12b).

The fishing was handled as two main, and two subsidiary fleets. The Norwegian trawl- and gillnet fleets were both fully modelled, with estimated selectivity for each, accounting for about 70-80% of the total catch in tonnes. The amount fished in each time step of one quarter of the year was input from catch data as a fixed amount. No account of possible errors in the catch-in-tons data was made. Two additional fleets have been considered; the international trawl fleet and a fleet made up by combining all other minor Norwegian fishing methods. Both these fleets have quarterly catch-in-tons specified, and have used the same selectivity as the

Norwegian trawl fleet. In addition to catch-in-tons, quarterly catch-in-numbers-at-length and age-length keys have been used. The format of the selectivity (L50) was selected and assumed to remain constant over time for each fleet. In order to account for possible errors in age reading the data was split into age-length keys, and purely length based distributions. Both data sets were input into the model, with weights set so that each gave an approximately equal contribution to the overall likelihood score.

Survey data was used as age-length keys giving the distribution within a single year, and as a purely length based survey index giving year to year variations in numbers by length. Prior to 1992 only length and weight data were recorded; after that data on annual age readings (and hence age-length data) are also available. The time period 1990-2005 was used, and the age-length key for 1992 was also used as age-length key for 1990-1991.

Changes made to the model and in input data compared with last year's Working Group:

- the stock has this year been modelled as two stock components, i.e., one immature and one mature part. Input data for doing this have been the proportions mature/immature *S. marinus* both at age and length as collected and classified from Norwegian commercial landings and surveys.
- two new years (2004 and 2005) with catch data, i.e., quarterly catch in numbers at length and catch in numbers at age for each of the two fleets
- two new years (2004 and 2005) with survey data

Optimization of the model and the likelihood components employed

For the survey a likelihood function was selected. The format of the selectivity (straight line, L50 or dome shaped) was also selected, using L50 for the survey and allowing the model sufficient freedom during optimisation that it could approximate a flat selectivity if that best fitted the data. Gadget was allowed to freely select the survey selectivity. After optimisation the model selected a suitability curve that was flat, with a selectivity of one, for all lengths in the stock. This can been seen as supporting the assumption that the survey indices represent a measure of the stock unbiased by selectivity. This more flexible model was then adopted as the standard one presented here (Figure 7.6).

By conducting several experiments a number of assumptions on the model structure were tested. In the standard version a parameter or group of parameters were assumed to be known, in an alternative run the model was allowed to optimize those parameters to best fit the data. In this way it could be determined if the initial assumption was reasonable, and if the model was capable of estimating the parameter(s) in question.

The sensitivity plots for the redfish model parameters are given in Figure 7.7. In each case a single parameter has been varied in steps up to +/-50% (5% steps, with 1% between +/-5% for better plotting). No optimisation was carried out on these plots - it is a straight "how much would the result have changed if this one parameter was different". All of the optimized parameters are displayed here. Some were optimized to zero, or very close to it (in which case varying the parameter by +/-50% obviously has no effect and would give a flat curve). These zero or near zero parameters are: immature redfish of ages 22 to 26, and initial numbers of mature redfish of age 7 and 11. It should be stressed that these are at an optimum, but that the sensitivity technique used here to produce the graphs (of using percentage changes to the reference value) is not informative for these parameters. Initial numbers of redfish between age27 and 30 have not been optimised (these caused problems when optimising them, probably due to the lack of data in the years before they enter the plus group), and are also not displayed. Also not displayed are initial numbers of mature redfish of ages 3 to 6 (these were fixed at zero), and the purely internal “betabinomial” parameter, which controls distribution of growth into length classes around the computed mean growth. In several cases the line does not span the full +/-50% range, this is because these changes would have placed the parameter outside the pre-set bounds. In no case does a non-zero parameter lie on its bounds – this is purely an issue when conducting sensitivity tests.

It can be seen that all of the non-zero parameters are at a definite optimum - though some are very flat. Noting the scale of the likelihood sensitivities it is evident that some parameters are *much* more important than others (growth parameters, fleet selectivity especially). Some parameters are also asymmetric - this typically indicates a situation where reducing that parameter (while keeping all others fixed) would tend to lead to stock extinction.

Figure 7.8 shows the comparison of observed and modelled survey indices.

The weighting of different components in a likelihood function is a clear problem in any model combining multiple data sources, and needs to be addressed in a wider fisheries assessment context in order for researchers to make best use of all the available data. This work is ongoing in a number of places (Gadget specific work is currently being done in Bergen and Reykjavik). The scheme employed here is based on a pragmatic approach to allow all data sets to have an influence on the model solution. Weights are assigned such that in the final weighted likelihood score: (1) fleet and survey data have approximately equal influence, and (2) all fleet data sets have approximately equal influence, and all survey data sets have approximately equal influence. This avoids any one data set having a disproportionately high or low influence. Where a likelihood component has been split into a mature and immature component the weighting for each part of the data set has assigned so that the combined mature and immature components have the same contribution as a single data set for all mature and immature individuals.

The likelihood components employed are as described below. The contribution each score makes to the overall likelihood value is given. This "contribution" is the weighted score for each component divided by the total weighted sum. Note that the first two components are mechanistic ones required for the optimisation process: at a valid solution both should give zero contribution to the overall score. The length distributions in the winter survey have been split into a survey index and a length distribution component, this in effect gives a higher weight to the survey length distributions than to the survey index level by length. For the survey index components an additional internal parameter is estimated in the regression process.

- Bounds component – sets bounds on parameters during estimation, purely internal component. Contribution: 0%
- Understocking – prevents selecting models with insufficient fish to match catch data, purely internal component. Contribution: 0%
- Age-length keys in the trawl for all fish – multinomial. Contribution: 13.5%
- Length distribution in the trawl fleet for immature fish – multinomial. Contribution: 8.1%
- Length distribution in the trawl fleet for mature fish – multinomial. Contribution: 7.7%
- Age-length keys in the gillnet for all fish – multinomial. Contribution: 13.1%
- Length distribution in the gillnet fleet for immature fish – multinomial. Contribution: 4.7%
- Length distribution in the gillnet fleet for mature fish – multinomial. Contribution: 6.0%
- Age-length keys in the survey – multinomial. Contribution: 22.2%
- Length distribution in the winter survey, immature fish – multinomial. Contribution: 5.4%

- Survey index in the winter survey, immature fish – log-linear regression fit, estimating intercept , fixing slope at 1. Contribution: 5.6%
- Length distribution in the winter survey, mature fish – multinomial. Contribution: 7.0%
- Survey index in the winter survey, mature fish – log-linear regression fit, estimating intercept, fixing slope at 1. Contribution: 6.6%

Fleet contribution: 53.2%
Survey contribution: 46.7%

Assessment results using the Gadget model

The text table below compares the results from this year's Gadget model with last year's. The main reason for the downscaling of the stock is considered to be the addition of two more years with data (data which show an even poorer stock situation than last year, and including fish that were 15-20 years old and thus still have an impact on the estimation of the stock back to 1990), and the addition of maturation data which enabled the model to treat the stock as one immature and one mature component.

	Total stock (3+) by 1 January 1990	Mean weight in stock 1990 (kg)	SSB (15+) by 1 January 1990	Total stock (3+) by 1 January 2003	Mean weight in stock 2003 (kg)	SSB (15+) by 1 January 2003
WG 2005	232 628	0.41	89 322	101 686	0.69	66 121
WG 2006	179 313	0.39	64 019	71 013	0.71	38 927

The most important conclusions to be drawn from the current assessment using the Gadget model are:

- The L50s for the trawl- and gillnet fleets were estimated to 35 cm and 37 cm, respectively, whereas the survey is estimated to have a flat selectivity for all fish in the model (Figure 7.6).
- The recruitment to the stock is very poor or almost absent (Figure 7.11).
- Average fishing mortalities for ages 12-19 have during 1990-2005 been within the range of 0.1-0.2 (Table 7.7 and Figure 7.10).
- According to the model the total stock biomass (3+) of *S. marinus* has decreased from about 180.000 tonnes around 1990 to less than 60.000 tonnes in 2005 (Figure 7.12, Table 7.8).
- The spawning stock biomass (15+) of *S. marinus* has decreased from about 64.000 tonnes in 1990 to 37.000 tonnes in 2005 (Figure 7.12, Table 7.8).
- A maximum exploitation rate of 5% has been suggested sustainable for long lived species like *Sebastes* spp. when the stocks show no sign of reduced reproductive potential (ref. pelagic redfish in the Irminger Sea and for several rockfishes in the Pacific). Based on the selection curves for the fleets, a reasonable classification of the fishable biomass would be the 15+ and mature biomass. A corresponding 5% harvest of this would yield less than 2.000 tonnes.

7.4 State of the stock

Presently this stock is 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 and surveys indicate failure of recruitment over a long period.

The new analytical assessment using the Gadget model confirms the poor stock situation, and quantifies the serious development of this stock during the last decade. It is also meant to be an aid for managers to better quantify necessary stronger regulations.

Clearly the stock has at present a reduced reproductive potential. In order to turn this negative development, no directed fishery should be conducted on this stock until an increase in the number of juveniles has been detected in surveys, and an improved stock situation is confirmed by the assessment.

7.5 Comments on the Assessment

All present available information confirms last years' evaluation of stock status.

Gadget is capable of modeling the maturation process explicitly, by calculating the probability of a fish of given characteristics becoming mature in any given time step. Data on the maturity of sampled fish was available and used in this year's assessment, and it has therefore been possible to replace the knife-edge ogive with a fully modeled maturation process. This is considered to have improved the current model, and also provided a comparison to the knife-edged ogive. The mature stock biomass has also this year been presented including ages 15+ only.

The current model assumes constant selectivity through time. It may be possible to extend this to allow for varying selectivity. The model may also be used for comparing modeled mean length at age with the actual data as a contribution to the age reading validation.

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 assessment methods.

7.6 Biological reference points

Until an analytical assessment can be accepted and used as basis for reference points calculations for this stock, candidate reference points for the biomass could be set at the average biomass level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. ACFM is supporting this suggestions and states that U-type reference points could be developed provided that a sufficient long time series demonstrating a dynamic range is available. Also the reference point should be expressed in biomass units (SSB or fishable stock), and work has hence been initiated to present the survey time series also in biomass units (also as SSB and fishable stock).

7.7 Management advice

ICES considers that the area closures and low bycatch limits should be retained, but stronger regulations than those recently enforced are needed given the continued decline in SSB and recruitment. The current measures are insufficient measures to stop the stock from declining to such low levels that any *S. marinus* fisheries in future will be difficult to conduct.

More stringent protective measures should be implemented. No directed fishery should be conducted on this stock at the moment, and the percent legal bycatch should be set as low as possible for other fisheries to continue.

7.8 Response to ACFM Technical Minutes (ACFM TM *in italics*)

An assessment was attempted using GADGET. As this is the first time that this approach is used for this redfish stock and as we have no information about the stability of the results year *after year (robustness to yearly fluctuation in the data), the reviewers consider this application as exploratory.*

The last year's approach to use GADGET was considered to be exploratory. This year more effort have been put in to e.g., investigate sensitivity to model assumptions. In addition, the use of a biologically detailed model such as GADGET has made it possible this year to model maturation directly, giving more insight into the dynamics of the species.

RG asked if diagnostics had been discussed as little documentation had been presented in the report on the model results and associated diagnostics. The reviewers discussed the sensitivity plots and noted that, for some of the parameters, the likelihood is not concave and there is no optimum suggesting that there is no information in the data to estimate these parameters. Some recruitment estimates, in particular, exhibit that pattern.

All parameters estimated are, in fact, concave at the optimum – although some are very flat there is a distinct optimum in all cases. A result of the comparison between model and data over all years is that any parameter affecting the stock in all or most years will be more "significant" than one only affecting a few years of model population. It is thus inevitable that some parameters will have more steeply sloping likelihood surfaces than others. In particular the recruitment in recent years is still poorly constrained, this is a result of the limited data concerning the development of those year classes, and would likely be a problem for any modelling approach. Nevertheless, the sensitivity plots also show improvement for these recruitment parameters compared to last year.

Also, some curves are bimodal suggesting that there are local minima. Selectivity parameters, in particular, fit in that category. It is also apparent that there are difficulties associated with the determination of starting values for the parameters ("sensible starting values are required").

The model does have the potential to produce multiple "optima" - especially for parameters producing "unrealistic" stock levels. In practice this occurs for parameter values which produce stock extinction for cases where the data suggests stock extinction does not occur. The likelihood components are not designed for this case, and this relates to the requirement for "sensible" starting values. The likelihood components are designed to compare small differences between model results and observed data. It is not clear how such likelihood components would behave when comparing radically different data sets, such as data on a relatively healthy stock against a model with parameters indicating near extinction. Optimisation in Gadget uses a two step approach (a wide area search Simulated Annealing, followed by a step-wise Hooke & Jeeves algorithm). In practice the use of Simulated Annealing as part of the optimisation routine means that such starting values are not absolutely required, as these multiple optima have much higher likelihood scores than biologically realistic ones. However such starting parameters do significantly improve optimisation times, both directly and by allowing for reasonable bounds to places on parameter space to be searched.

From these observations arises the concern that the model is over-specified (over-parameterized).

Gadget models the biological processes involved. Parameter requirements are thus, to some extent, determined by the biology of the stock. This will typically result in a higher number of parameters than if a "curve fitting" model were employed. To some extent this increase in parameters is offset by the imposition of biological realism into the model.

Work is ongoing to reduce the number of parameters by replacing annual estimates of recruitment with a time-dependant function. This approach, when completed, will significantly reduce the number of parameters to be estimated. However a biologically-detailed model will always require more parameters than a statistical one. The approach taken to reducing the parameters involved has been submitted to the Fisheries Research journal, and is currently under review (Subbey *et al*. 2006).

From these observations, it is unclear how the model can arrive at "estimating" some of the parameters. It is unclear what is done when the parameters are undetermined…. .

If there are parameters which are not well covered by the data then these will be estimated externally to the model and input as fixed parameters. However, for some parameters (especially the number of recruits in recent years) there is no good way to identify correct values, and the approach is to allow Gadget to estimate these – the resulting likelihood surfaces are shallow, but do contain a genuine optimum. Further, the sensitivity analyses conducted provide a measure of the reliability of the estimated values.

Also, when a complex objective function is used for parameter estimation, weighting is an issue that need to be carefully considered. It is unclear how this weighting was determined and how different weighting schemes could influence the outcome or results.

This is a clear problem in any model combining multiple data sources, and needs to be addressed in a wider fisheries assessment context in order for researchers to make best use of all the available data. This work is ongoing in a number of places (Gadget specific work is currently being done in Bergen and Reykjavik). The scheme employed here is described in chapter 7.3, and the contribution each parameter makes to the overall likelihood value is given.

It is also unclear how the survey catchabilities are determined and used in the model (only the sensitivity to the selectivity parameters are presented implying that the catchabilities may not be estimated but considered as a "nuisance" parameter or a parameter of convenience internally determined).

In general, the catchability in the redfish survey is often taken to be uniform. In this model survey catchability was estimated by allowing the model to freely estimate the parameters governing an S-Shaped suitability curve. In practice the model estimated parameter values producing an essentially flat curve for all lengths at which the stock existed – in other words reducing the selectivity to a uniform distribution. This may be taken as supporting evidence for an assumption of constant catchability which has been used in the final model runs. The survey selectivity sensitivity plots have thus not been presented.

The model looks promising and confirms the trends in stock. For such a model to be used for the provision of catch advice, reference points (limit and precautionary) would be required. Further word is needed in that direction.

The Gadget model is meant to be an aid for scientists to better define any reference points which will be very useful for necessary long-term management plans. Although the status of the stock can clearly be understood from the surveys at present, the need for getting suitable reference points, a management plan and harvest control rules in a rebuilding phase of the stock are all important reasons for developing and approving an analytical assessment model.

The WG needs more years of experience with this model to assess how stable its results are year after year. Also, a retrospective analysis should be done to assess internal consistency of repeated annual assessments. In short, there is a need to investigate the stability of the approach.

The WG agrees that more years of experience are needed. This year the WG is illustrating year over year comparisons by presenting a text table in chapter 7.3 which compares some of this year's GADGET results with last year's.

The likelihood function should be described and included when reporting on the results of GADGET so that we can fully evaluate how the model operates.

A description of the likelihood components is given in chapter 7.3 in this years report.

The results of the model could also be compared with those of a regular SURBA which doesn't make assumptions about an underlying stock dynamics.

No information has been provided in the output about exploitation rates. This is likely available and would be of interest if the method is proven to be of value for providing advice on this stock.

The exploitation rates (fishing mortalities) estimated by Gadget are this year presented in Table 7.7 and Figure 7.10.

In summary, a species like S. marinus is typically difficult to assess through age- or length-disaggregated data because time series are typically too short in relation to their lifespan. Under these conditions, it is even more important to be parsimonious in the number of parameters that are to be estimated. Before establishing this approach as a mainstream method for this redfish stock, we need to convince ourselves that the parameters are well determined and that the approach offers some stability in its year-to-year application.

There is certainly a lack of data covering multiple life cycles of the stock. This would principally affect any attempt to model a closed life cycle, but also poses problems for other aspects of the model. On the other hand the long life span involved means that there is a very high resolution of data in comparison to the life of the fish – far higher than would be available for shorter lived stocks such as capelin, or even cod. It is not clear that the lack of long-term data outweighs this higher resolution – especially as long as closure of the life cycle is not attempted.

The reviewers also suggest that simpler approaches, such as production analyses or production models, be explored as an alternative way to assess this stock.

There is certainly potential to investigate other models. In general having multiple models should be seen as a positive goal, especially as a discrepancy between different models can be used to highlight areas where the models may be having problems, and which require further investigation.

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	37	30	238	17	-	1	-
2002	60	31	42	31	3	-	-
2003	109	8	122	36	4	-	89
2004	12	4	68	20	30	-	33
2005[1]	37	9	72	36	19	-	48
Year	Norway	Portugal	Russia[3]	Spain	UK (Eng. & Wales)	UK (Scotl)	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	9,134	7	963	1		119[4]	10,547
2002	8,561	34	832	3		46[4]	9,643
2003	6,877[1]	6	479	-		134[4]	7,864
2004	6,346[1]	5	722	3		69[4]	7,312
2005[1]	6,605	56	614	8		52[4]	7,557

1 Provisional figures.

2 Includes former GDR prior to 1991.

3 USSR prior to 1991.

4UK(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(Scotl)	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	4	11[2]	-	-	1,053	128	France	16[6]	1,212
2002	15	5[2]	-	-	693	220	1[2]	9[2,6]	943
2003	15	-	1	-	818[1]	140	-	4[2,6]	978
2004	-	-	-	-	1,178[1]	213	-	12[2,6]	1,403
2005[1]	-	-	-	-	1,551	61	1[2]	4[2,6]	1,617

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.

6UK(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 (Scotl.)	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	33[2]	30[2]	227[2]	17[2]	1[2]	-	8,002	6[2]	612	1[2]	Iceland	103[2, 6]	9,031
2002	45[2]	30[2]	37[2]	31[2]	-	-	7,761	18[2]	192	2[2]	3[2]	32[2, 6]	8,151
2003	94[2]	9[2]	122[2]	35[2]	-	89[2]	5,991[1]	6[2]	264		4[2]	130[2, 6]	6,743
2004	12[2]	4[2]	68[2]	20[2]	-	33[2]	5,077[1]	5[2]	396	3[2]	30[2]	58[2, 6]	5,705
2005[1]	37[2]	9[2]	60[2]	36[2]	-	48[2]	4,831	56[2]	265	8[2]	19[2]	48[2,6]	5,416

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.
6UK(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 (Scotl.)	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[2]	223	-	-	-	303
2002	-	-	-	107	16[2]	420	1[2]		5[2,7]	549
2003	-	-	-	68[1]	-	75	-		-	143
2004	-	-	-	91[1]	-	113	-		-	204
2005[1]	-	13[2]	-	223	-	288	-		-	523

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.
7UK(E&W)+UK(Scot.)

Table 7.5. *Sebastes marinus.* Catch numbers at age.

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE														
7	5	0	46	60	9	9	28	78	4	23	14	22	19	46
8	22	24	7	85	119	98	51	593	13	23	36	25	48	67
9	78	193	292	230	313	156	206	855	70	44	71	30	47	111
10	114	359	640	672	361	321	470	572	245	199	143	44	67	89
11	394	406	816	908	879	686	721	1006	902	347	414	204	202	172
12	549	1036	1930	1610	1234	1065	968	1230	958	482	686	360	279	180
13	783	1022	2096	2038	1638	1781	1512	1618	1782	1120	1199	707	513	400
14	1718	1523	2030	2295	2134	2276	1736	1480	1409	1342	1943	1692	599	830
15	3102	2353	1601	1783	1675	2172	1582	1612	2121	1674	1377	1342	688	797
16	2495	1410	2725	1406	1614	1848	1045	1239	2203	1653	1274	1074	975	1019
17	2104	1655	2668	785	1390	1421	1277	1407	1715	1243	1196	940	1073	1039
18	1837	1678	1409	563	952	851	970	1558	753	568	388	482	799	770
19	998	745	617	670	679	804	1018	1019	483	119	313	368	443	358
20	858	716	733	593	439	608	846	394	458	183	99	146	169	195
21	688	534	514	419	560	511	443	197	132	154	104	84	186	218
22	547	528	256	368	334	205	764	459	230	112	117	52	110	142
23	268	576	177	250	490	334	486	174	224	135	113	18	81	147
+gp	3110	3482	1508	3232	3135	2131	3389	2131	895	254	253	69	191	266
TOTALNUM	**19670**	**18240**	**20065**	**17967**	**17955**	**17277**	**17512**	**17622**	**14597**	**9675**	**9740**	**7659**	**6489**	**6846**
TONSLAND	16185	16651	18120	15616	18043	17511	19155	18986	14460	10547	9643	7864	7313	7558

Table 7.6. *Sebastes marinus.* Catch weights at age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE														
7	0.18	0.20	0.25	0.33	0.22	0.23	0.37	0.14	0.19	0.15	0.17	0.19	0.21	0.16
8	0.29	0.33	0.37	0.43	0.49	0.51	0.21	0.26	0.24	0.26	0.25	0.22	0.26	0.21
9	0.48	0.36	0.38	0.64	0.56	0.53	0.47	0.44	0.32	0.45	0.33	0.31	0.36	0.34
10	0.42	0.43	0.49	0.61	0.65	0.74	0.62	0.57	0.44	0.55	0.42	0.39	0.45	0.43
11	0.50	0.51	0.51	0.59	0.71	0.72	0.67	0.69	0.53	0.58	0.54	0.49	0.51	0.51
12	0.59	0.51	0.64	0.65	0.81	0.78	0.77	0.78	0.64	0.67	0.67	0.58	0.59	0.57
13	0.58	0.64	0.74	0.74	0.84	0.80	0.77	0.86	0.73	0.80	0.72	0.69	0.68	0.66
14	0.65	0.64	0.76	0.79	0.88	0.86	0.85	1.04	0.84	0.89	0.84	0.84	0.80	0.80
15	0.65	0.76	0.86	0.84	0.96	0.91	1.05	1.07	0.96	1.01	0.98	0.96	0.96	0.91
16	0.71	0.86	0.95	0.92	1.00	0.99	0.96	1.12	1.11	1.14	1.09	1.05	1.07	1.00
17	0.82	0.89	1.03	1.12	1.02	1.16	1.25	1.18	1.25	1.33	1.20	1.29	1.22	1.15
18	0.84	0.98	1.07	1.01	1.01	1.18	1.28	1.71	1.32	1.43	1.30	1.36	1.34	1.32
19	0.94	1.00	1.11	1.01	1.00	1.21	1.30	1.09	1.53	1.62	1.44	1.65	1.57	1.47
20	1.02	1.03	1.16	1.21	1.03	1.34	1.23	1.18	1.06	1.60	1.78	1.74	1.67	1.52
21	1.03	1.21	1.15	1.14	1.04	1.28	1.87	1.04	1.29	1.47	1.68	2.09	1.75	1.75
22	1.15	1.03	1.13	1.09	1.14	1.54	1.46	1.34	1.32	2.00	1.88	1.85	2.09	1.95
23	1.27	1.20	1.02	1.30	1.09	1.19	1.73	1.18	1.12	2.70	2.12	2.30	1.90	2.27
+gp	1.27	1.14	1.36	1.01	1.16	1.29	1.29	1.34	1.20	2.31	1.84	2.38	2.04	2.29

Table 7.7. *Sebastes marinus.* Fishing mortalities as estimated by Gadget.

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
7	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.003	0.002	0.003	0.002	0.002	0.003
8	0.022	0.009	0.008	0.008	0.009	0.008	0.009	0.009	0.011	0.011	0.009	0.007	0.007	0.006	0.006	0.007
9	0.042	0.029	0.018	0.018	0.020	0.017	0.021	0.021	0.025	0.026	0.021	0.016	0.016	0.013	0.014	0.016
10	0.057	0.048	0.042	0.034	0.038	0.033	0.039	0.040	0.046	0.049	0.040	0.030	0.030	0.025	0.026	0.030
11	0.077	0.061	0.060	0.065	0.061	0.053	0.063	0.064	0.074	0.079	0.064	0.049	0.049	0.041	0.042	0.048
12	0.099	0.077	0.072	0.084	0.098	0.075	0.090	0.092	0.106	0.113	0.092	0.072	0.070	0.059	0.061	0.069
13	0.125	0.094	0.086	0.097	0.117	0.107	0.118	0.120	0.139	0.148	0.122	0.095	0.091	0.078	0.080	0.090
14	0.153	0.112	0.101	0.111	0.131	0.123	0.152	0.146	0.170	0.183	0.150	0.117	0.112	0.096	0.098	0.109
15	0.182	0.131	0.115	0.125	0.146	0.134	0.167	0.176	0.197	0.214	0.177	0.138	0.131	0.113	0.113	0.126
16	0.212	0.151	0.130	0.138	0.159	0.145	0.179	0.189	0.226	0.241	0.200	0.156	0.147	0.127	0.127	0.140
17	0.241	0.170	0.145	0.152	0.172	0.155	0.190	0.199	0.238	0.268	0.219	0.171	0.160	0.139	0.138	0.151
18	0.255	0.188	0.159	0.164	0.185	0.165	0.199	0.208	0.248	0.278	0.238	0.184	0.171	0.149	0.146	0.160
19	0.268	0.197	0.172	0.176	0.196	0.174	0.209	0.216	0.256	0.287	0.245	0.195	0.179	0.157	0.153	0.167
20	0.280	0.205	0.178	0.186	0.206	0.182	0.217	0.223	0.264	0.295	0.251	0.200	0.187	0.163	0.159	0.172
21	0.291	0.212	0.183	0.191	0.216	0.189	0.224	0.229	0.270	0.301	0.256	0.203	0.190	0.168	0.163	0.176
22	0.301	0.219	0.188	0.195	0.220	0.195	0.230	0.235	0.276	0.307	0.261	0.206	0.192	0.170	0.166	0.179
23	0.309	0.225	0.193	0.199	0.223	0.198	0.235	0.240	0.281	0.312	0.265	0.209	0.195	0.172	0.167	0.181
24	0.316	0.230	0.197	0.203	0.226	0.200	0.237	0.243	0.285	0.317	0.268	0.212	0.196	0.173	0.168	0.182
25	0.322	0.234	0.200	0.206	0.229	0.203	0.239	0.245	0.288	0.320	0.271	0.214	0.198	0.174	0.169	0.183
26	0.326	0.238	0.203	0.208	0.232	0.204	0.241	0.247	0.290	0.323	0.273	0.215	0.199	0.175	0.170	0.183
27	0.330	0.240	0.205	0.210	0.234	0.206	0.243	0.248	0.291	0.324	0.275	0.217	0.200	0.176	0.171	0.184
28	0.332	0.242	0.207	0.212	0.235	0.207	0.244	0.249	0.292	0.325	0.276	0.218	0.201	0.177	0.171	0.184
29	0.334	0.244	0.208	0.213	0.237	0.209	0.245	0.250	0.293	0.326	0.277	0.218	0.202	0.177	0.172	0.185
30	0.336	0.245	0.210	0.216	0.239	0.211	0.247	0.252	0.295	0.329	0.279	0.219	0.203	0.178	0.173	0.186
age12-19	0.192	0.140	0.123	0.131	0.151	0.135	0.163	0.168	0.198	0.216	0.180	0.141	0.133	0.115	0.114	0.126

Table 7.8. *Sebastes marinus.* Stock numbers, biomass and mean weight as estimated by GADGET.

	TOTAL STOCK, AGES 3+				MATURE STOCK, AGES 15+				IMMATURE STOCK, AGE 3-14		
year	**number**	**mean weight**	**biomass**		**number**	**mean weight**	**biomass**		**number**	**mean weight**	**biomass**
1990	460385	0.39	179313		61385	1.04	64019		399000	0.29	115294
1991	445503	0.39	174439		58503	1.03	60273		387000	0.30	114166
1992	428739	0.40	171865		58739	1.02	59828		370000	0.30	112037
1993	398785	0.42	168190		58785	1.02	59773		340000	0.32	108417
1994	362788	0.45	162134		54788	1.03	56538		308000	0.34	105596
1995	326252	0.48	155013		52252	1.04	54581		274000	0.37	100432
1996	294003	0.50	147250		50003	1.06	53037		244000	0.39	94213
1997	260580	0.52	136638		45580	1.08	49276		215000	0.41	87362
1998	228505	0.55	124673		44505	1.07	47756		184000	0.42	76918
1999	195466	0.56	110168		41466	1.07	44249		154000	0.43	65918
2000	166269	0.59	97609		38269	1.07	40827		128000	0.44	56782
2001	140237	0.61	85608		34237	1.07	36667		106000	0.46	48941
2002	118809	0.66	78264		35647	1.07	38016		83162	0.48	40248
2003	99947	0.71	71013		36364	1.07	38927		63583	0.50	32087
2004	83550	0.76	63650		36092	1.08	38983		47458	0.52	24667
2005	69274	0.82	56667		33587	1.10	37101		35688	0.55	19566
	Stock, ages 7+					**Stock, ages 3-6**					
year	**number**	**mean weight**	**biomass**		**number**	**mean weight**	**biomass**				
1990	279000	0.59	163577		182000	0.09	15935				
1991	275000	0.58	160209		171000	0.08	14445				
1992	268000	0.59	157944		160000	0.09	13642				
1993	256000	0.60	154438		143000	0.10	13715				
1994	251000	0.60	151062		112000	0.10	11378				
1995	242000	0.60	146369		84735	0.10	8859				
1996	230000	0.61	140923		63675	0.10	6191				
1997	209000	0.63	132012		51994	0.09	4783				
1998	184000	0.65	120308		43901	0.09	4022				
1999	158000	0.67	106435		37239	0.10	3597				
2000	137000	0.69	94560		29106	0.10	2929				
2001	118000	0.70	83130		21786	0.10	2241				
2002	105000	0.73	76874		14104	0.11	1605				
2003	91837	0.76	69985		8111	0.13	1029				
2004	79289	0.80	63068		4262	0.14	582				
2005	67938	0.83	56497		1337	0.13	170				

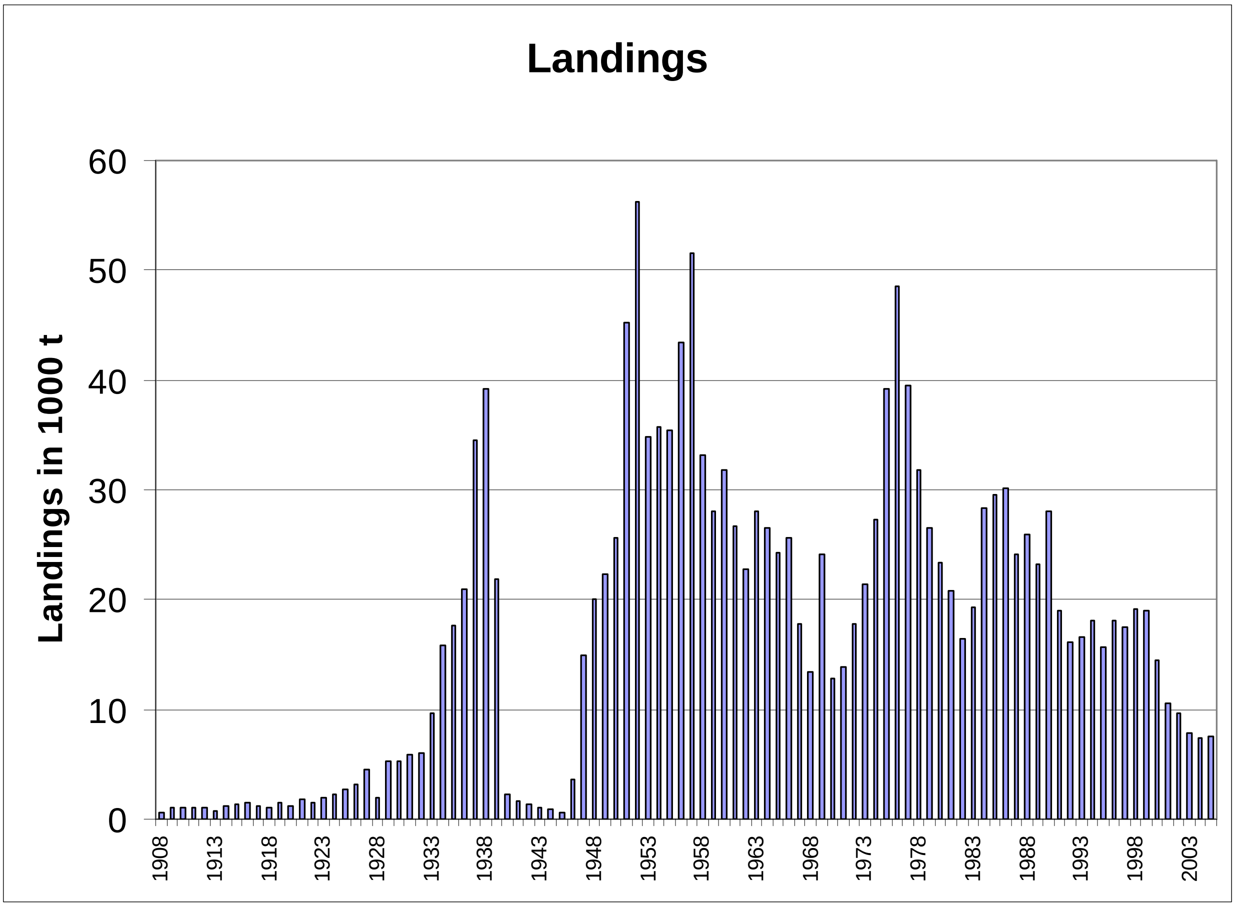


Figure 7.1. *Sebastes marinus* in Sub-areas I and II. Total international landings 1965-2005 (in thousand tonnes).

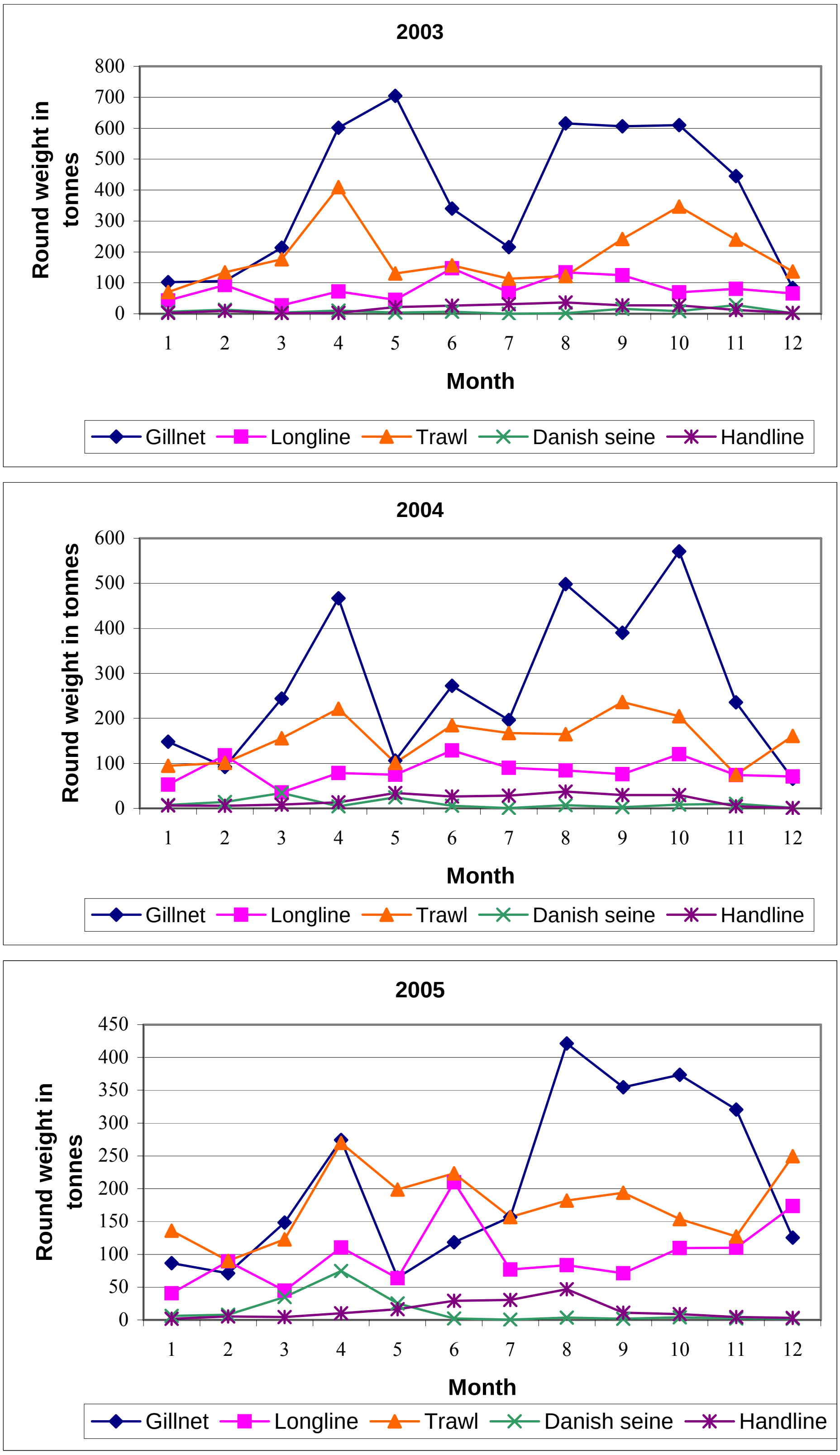


Figure 7.2. Illustration of the seasonality in the different Norwegian *S. marinus* fisheries, also illustrating how the current regulations are working.

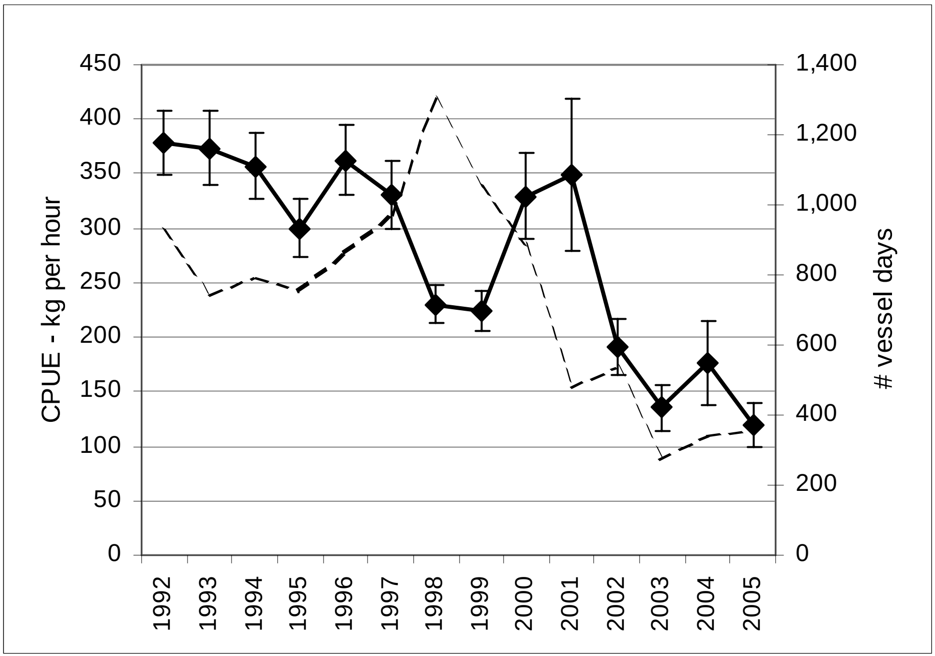
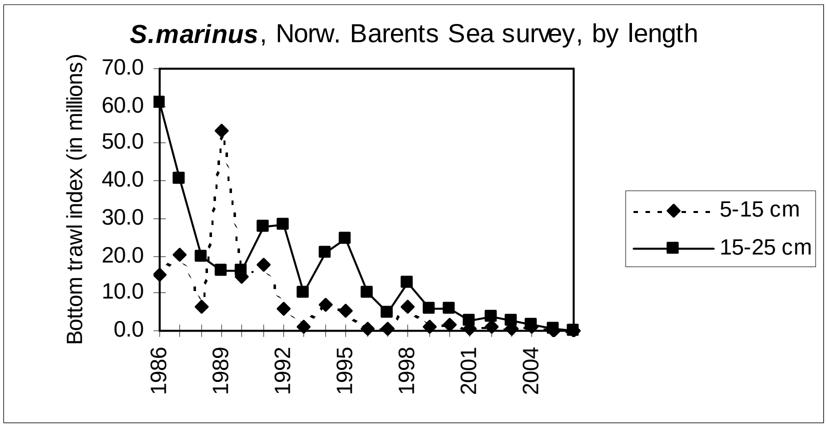


Figure 7.3. *Sebastes marinus*. Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery, and numbers of vessel days (stippled curve) meeting the criterium of minimum 10% *S. marinus* in the catch per day. The figure is an illustration of the data given in Table D11.



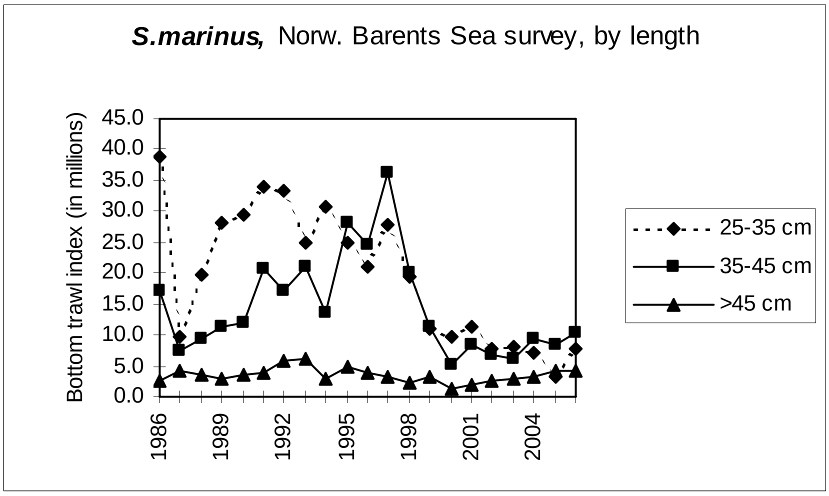
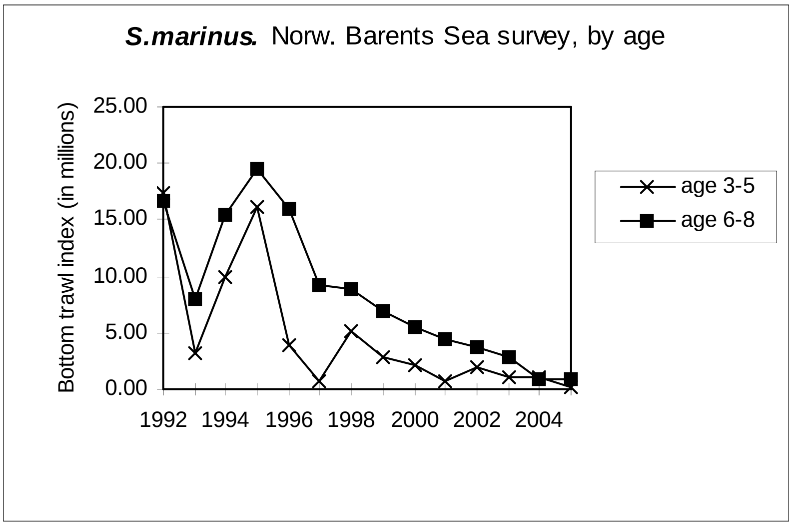


Figure 7.4a. Sebastes marinus. Abundance indices (by length) from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2006 (ref. Table D12a).



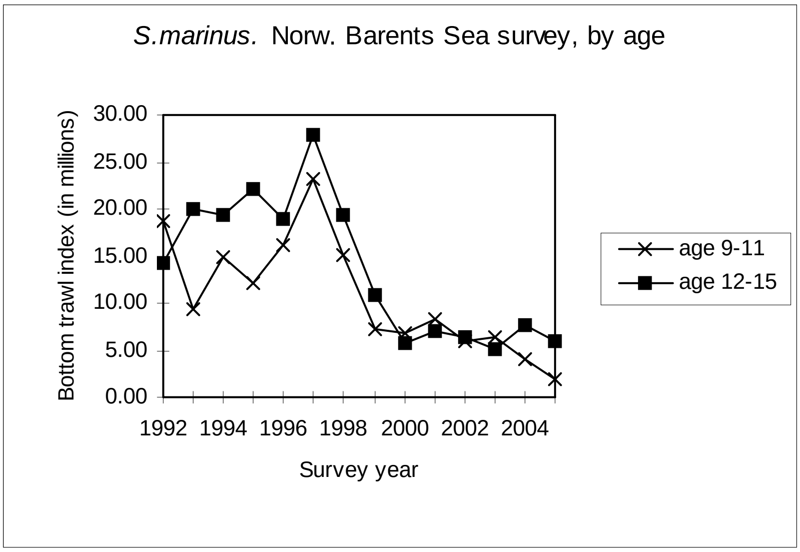
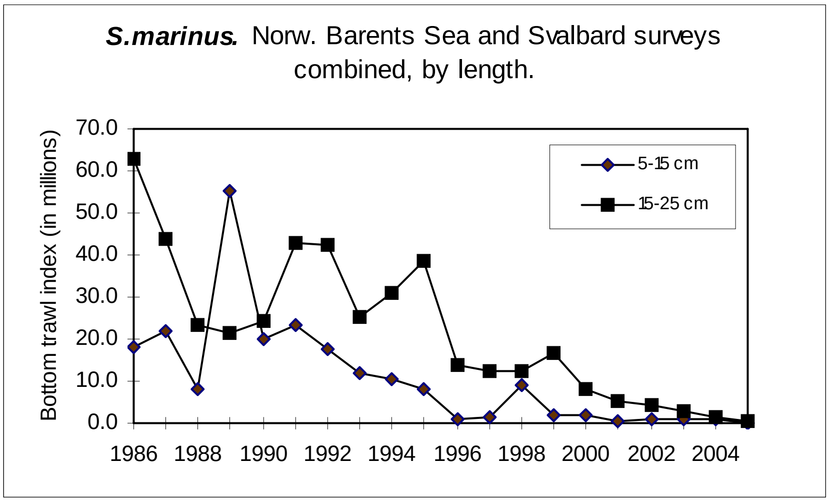


Figure 7.4b. Sebastes marinus. Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2005 in the Barents Sea (ref. Table D12b).



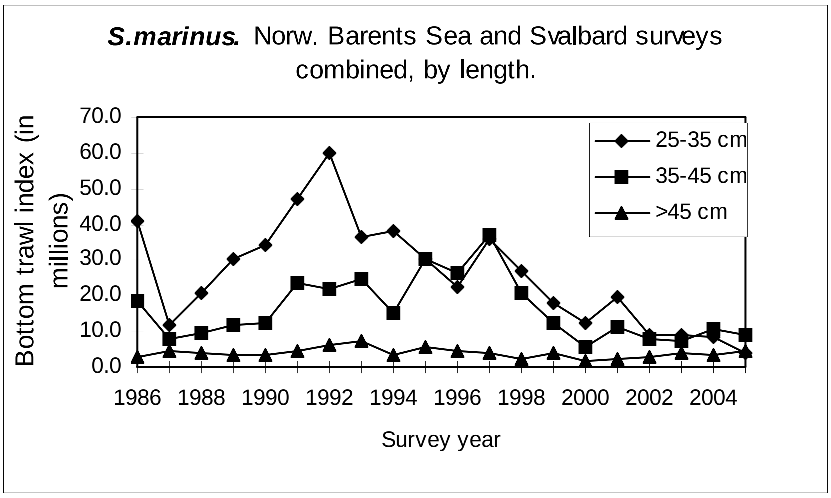
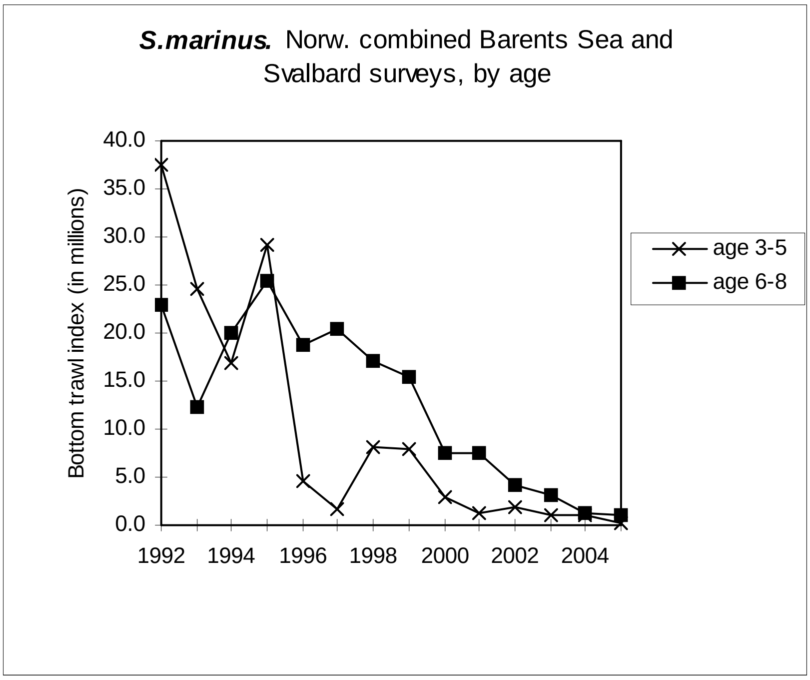


Figure 7.5a. Sebastes marinus. Abundance indices (by length) when combining the Norwegian bottom trawl surveys 1986-2005 in the Barents Sea (winter) and at Svalbard (summer/fall).



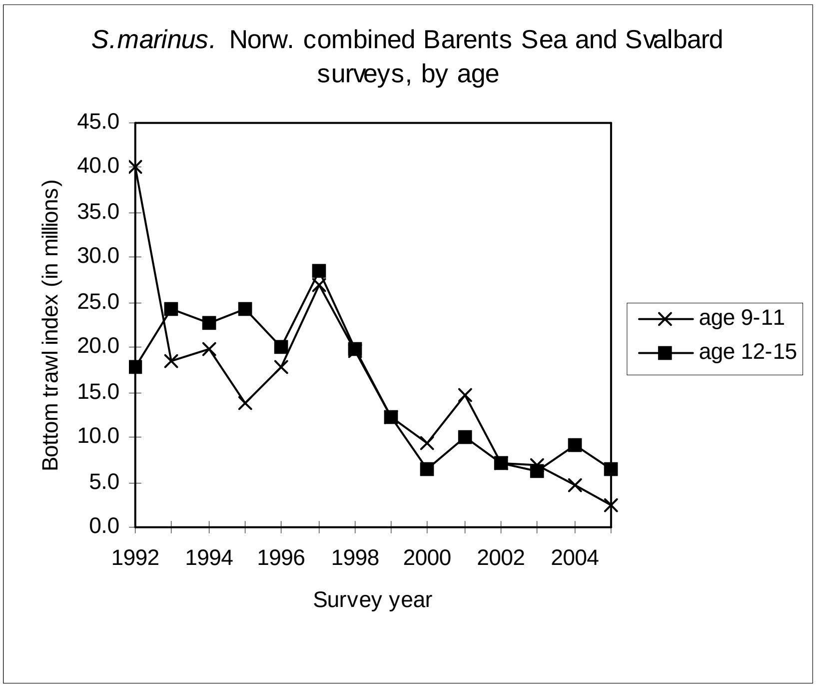


Figure 7.5b. Sebastes marinus. Abundance indices (by age) when combining the Norwegian bottom trawl surveys 1992-2005 in the Barents Sea (winter) and at Svalbard (summer/fall).

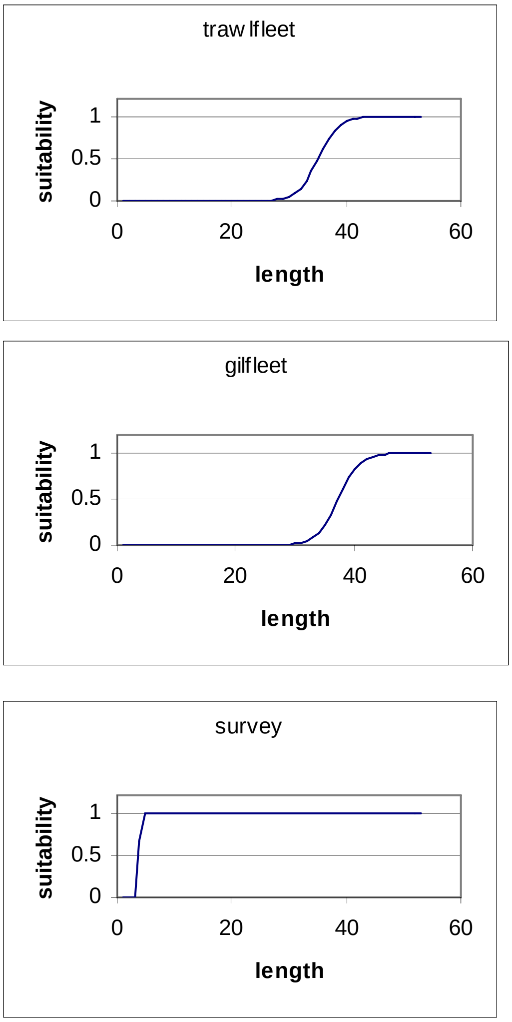


Figure 7.6. Selection curves for the trawl- and gillnet fleets as well as the bottom trawl survey as modelled by Gadget.

Figure 7.7. Sensitivity plots for the *S. marinus* model parameters. In each case a single parameter has been varied in steps up to +/-50% (5% steps, with 1% between +/-5% for better plotting). Note that the plots scale each parameter separately.

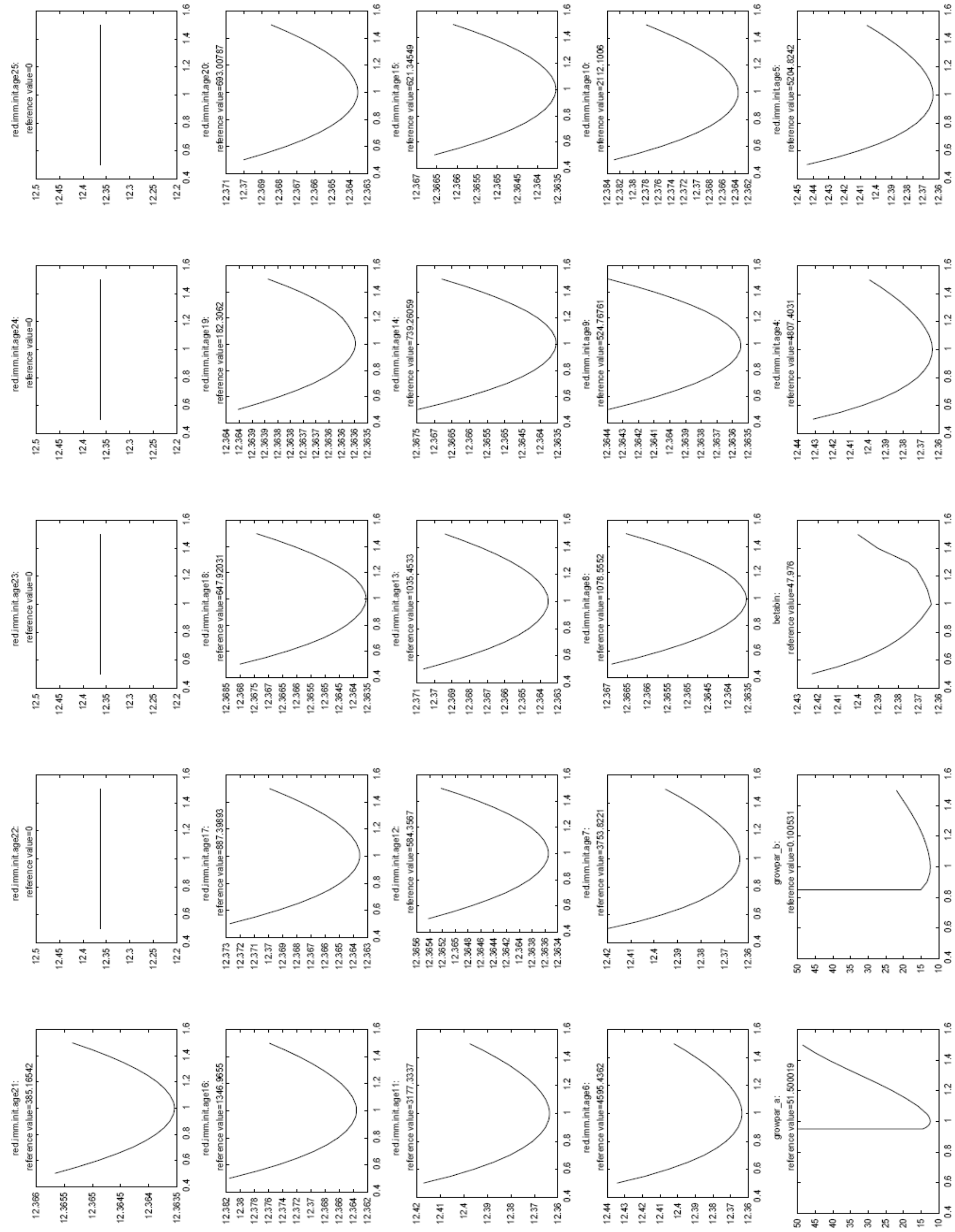


Figure 7.7, continued

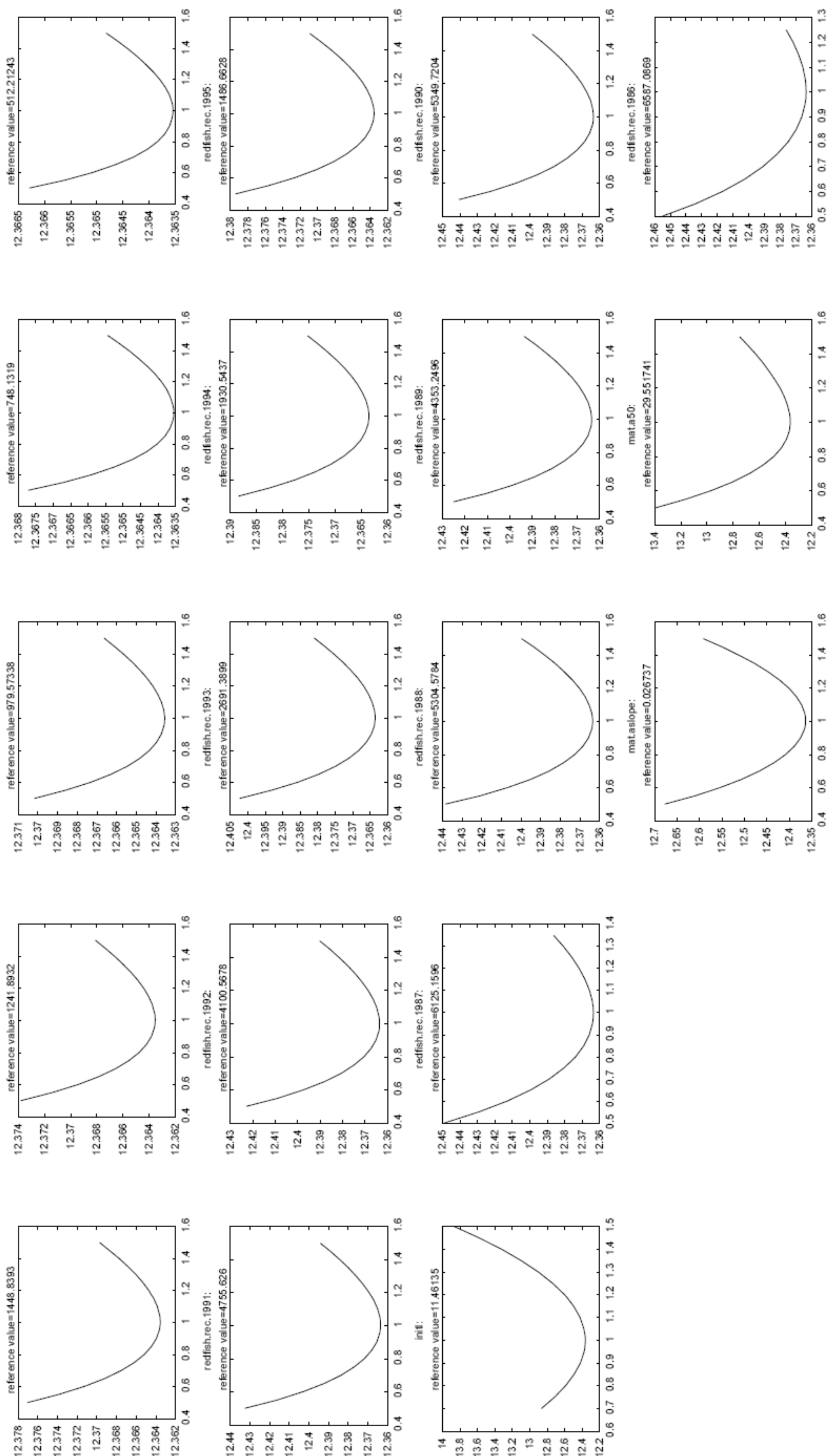


Figure 7.7, continued

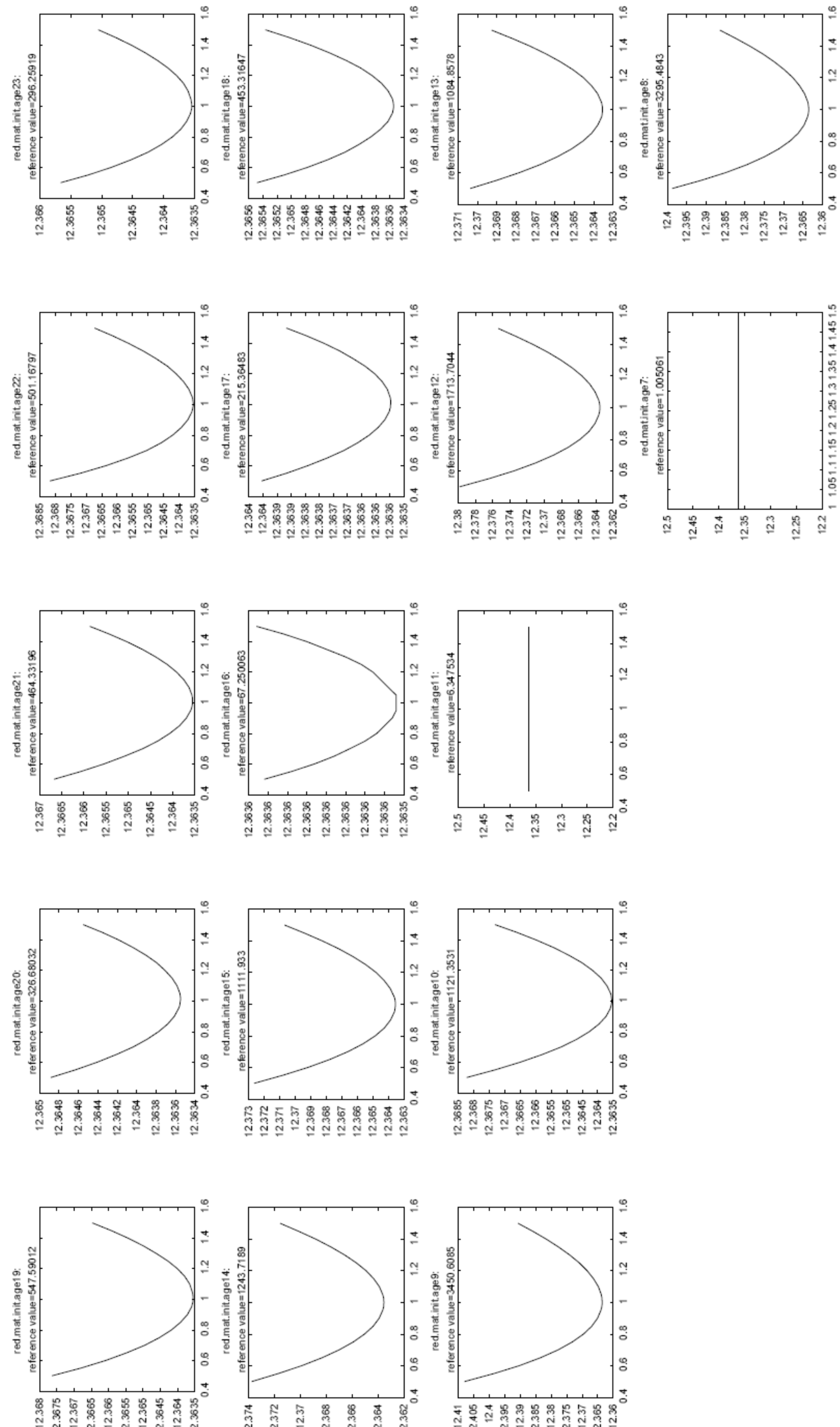
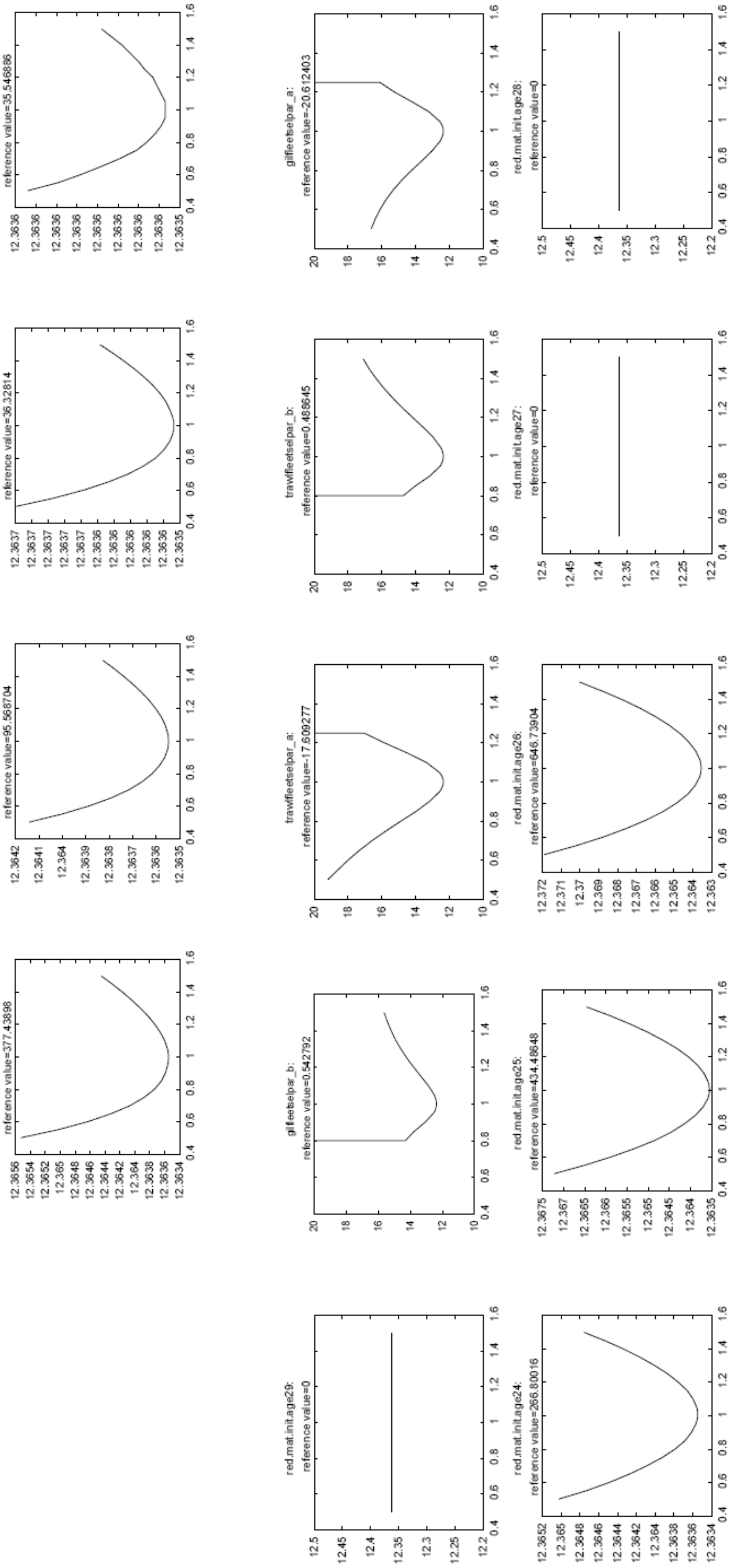


Figure 7.7, continued.



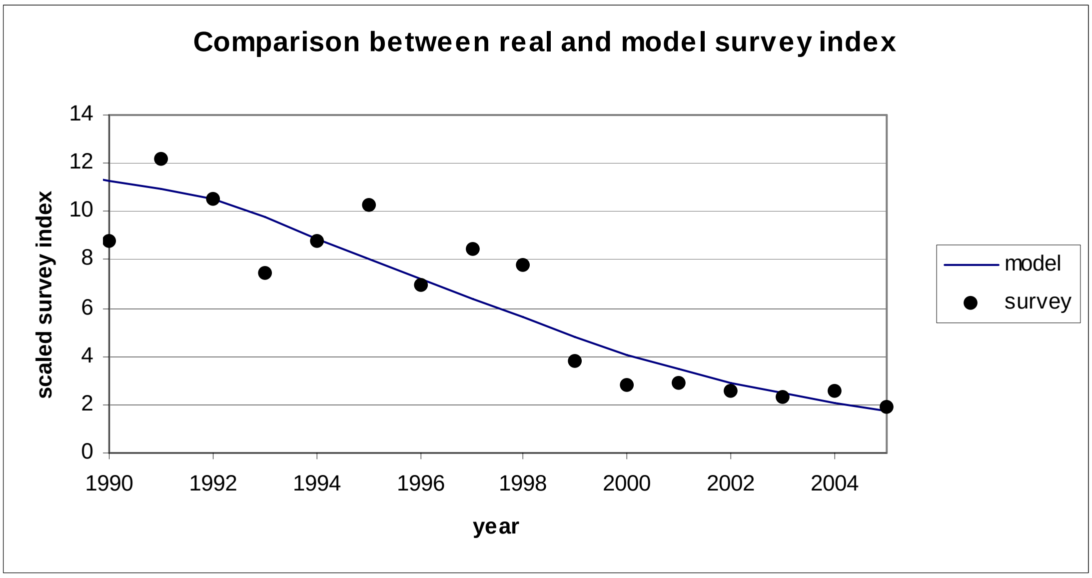


Figure 7.8. Results from the Gadget assessment. The Figure shows comparison of observed and modelled survey indices (total number scaled to sum=100 during the time period).

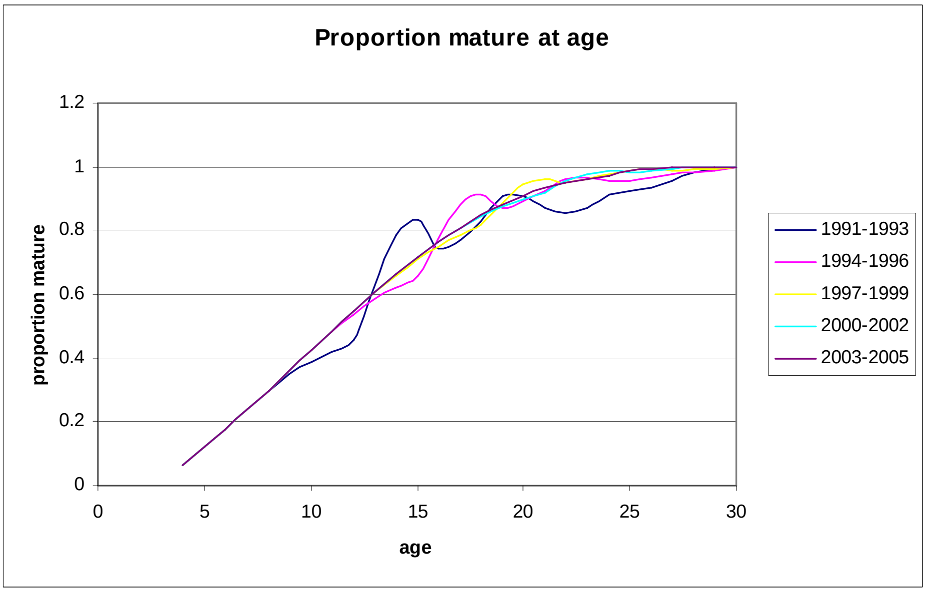


Figure 7.9. *Sebastes marinus*. Estimates of maturity at age by Gadget. Input data have been proportions of *S. marinus* mature both at age and length as collected and classified from Norwegian commercial landings and surveys. Fewer data together with being the beginning of the modelled time period have caused the more varying pattern for 1991-1996.

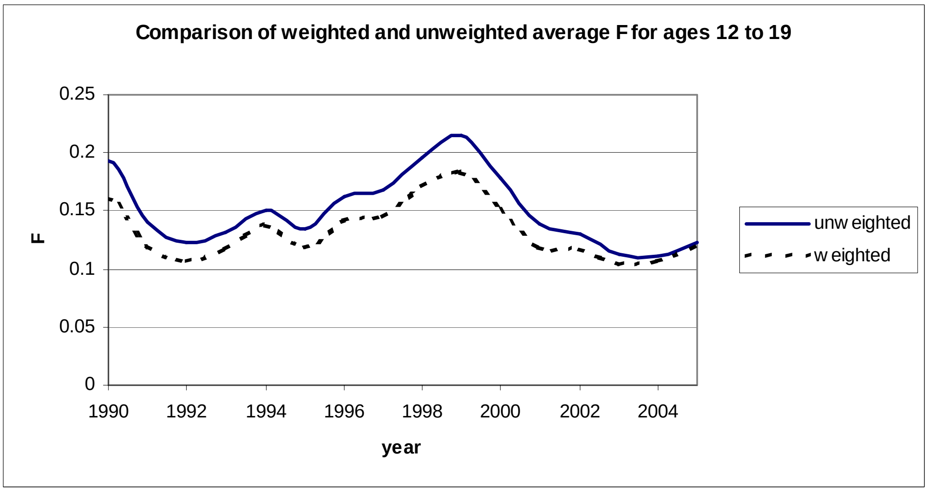


Figure 7.10. ***Sebastes marinus.*** **Weighted (by stock numbers at age) and unweighted average fishing mortality for ages 12-19 as estimated by Gadget.**

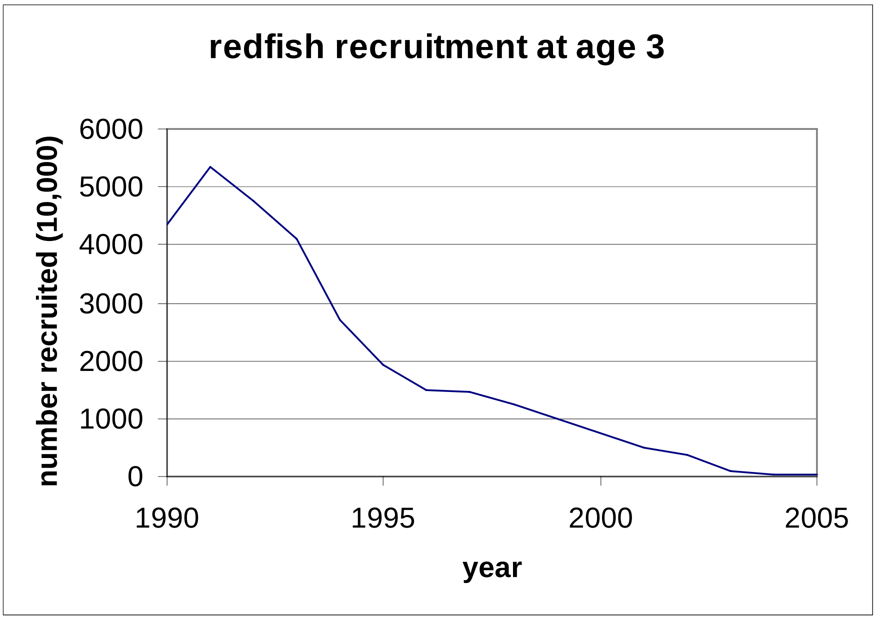


Figure 7.11. ***Sebastes marinus.*** **Estimates of recruitment at age 3 (in numbers) by Gadget.**

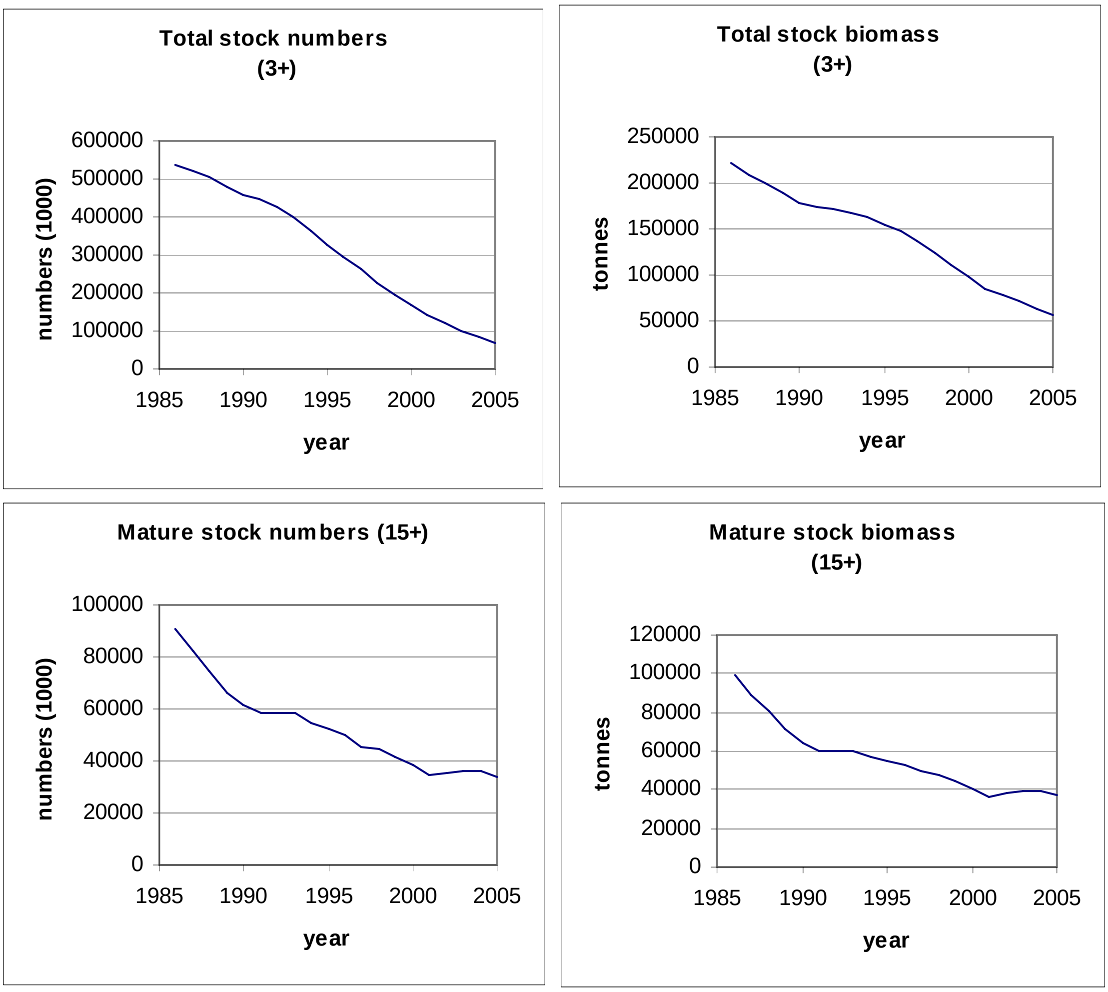


Figure 7.12. ***Sebastes marinus.*** **Stock numbers (in thousands) and biomass (in tonnes) for the total stock (3+) (upper panel), and the fishable and mature stock (15+) (lower panel), as estimated by Gadget.**

Table D11. *Sebastes marinus*. Effort (vessel days) and catch per unit effort (kg per trawl hour) with 2 x st.error for Norwegian freezer trawlers (32-50 meters long).[1]

Year	Number of vessel days meeting the 10% requirement	Mean CPUE per year (kg/hour)	2 x standard error of the mean
1992	926	378	29.4
1993	743	374	34.4
1994	793	357	30.1
1995	754	300	26.7
1996	864	363	32.1
1997	972	331	31.9
1998	1 303	230	17.2
1999	1 054	224	18.8
2000	884	330	39.9
2001	481	349	70.5
2002	536	192	26.0
2003	276	136	21.4
2004	343	176	38.7
2005[2]	360	119	20.0

1 Only including days with more than 10% *S. marinus* in the catches. Only including areas with low mixing of *S. mentella.*

2 Provisional figures.

Table D12a. ***Sebastes marinus*. Abundance indices (on length) from the bottom trawl surveys in the Barents Sea in the winter 1986-2006 (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	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
2005	+	0.1	0.2	0.4	1.1	2.0	3.7	4.6	4.3	16.4
2006	0.0	0.0	0.0	0.2	2.5	5.4	6.1	4.1	4.2	22.5

1 - Adjusted indices to account for not covering the Russian EEZ in Subarea I

Table D12b. ***Sebastes marinus* in Sub-areas I and II. Norwegian bottom trawl indices (on age) from the annual Barents Sea survey in February 1992-2005 (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	13,520
2005	39	85	107	110	321	524	669	497	697	820	1,517	1,905	1,653	8,944

Table D13a. ***Sebastes marinus*** **in Division IIb. Abundance indices (on length) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1985-2005 (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
2004	0	0	10	50	650	740	670	430	190	2,740
2005	0	45	0	30	315	384	307	159	274	1,513

1 - Old trawl equipment (bobbins gear and 80 meter sweep length)

Table D13b. ***Sebastes marinus*** **in Sub-areas I and II. Norwegian bottom trawl survey indices (on age) in the Svalbard area (Division IIb) in summer/fall 1992-2005 (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
2004	0	0	0	+	+	20	360	120	430	160	410	360	370	200	2,430
2005	0	45	0	0	0	30	48	228	138	187	194	93	105	109	1,177

Table D14. *Sebastes marinus.* Mean catch rates (N/nm2) of *Sebastes marinus* from Norwegian Coastal Surveys in 1995-2005 within 100-350 m depth. Catch rates for the total area.

	Total										
Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
0-4	0	0	0	0	0	0	0	0	0	0	0
5-9	41	34	4	0	0	0	0	0	0	2	0
10-14	118	87	9	0	19	2	2	0	1	3	5
15-19	59	124	12	4	242	13	11	0	3	10	3
20-24	54	151	64	12	160	7	14	2	22	36	29
25-29	38	67	112	16	34	10	22	6	50	76	50
30-34	69	210	96	17	43	30	15	29	51	45	51
35-39	214	415	178	110	151	160	83	259	213	340	182
40-44	157	209	190	96	117	155	160	213	185	258	146
45-49	21	64	45	18	15	30	30	26	37	19	39
50-54	2	0	2	3	4	4	2	4	4	3	1
55-59	1	0	1	0	2	0	0	1	0	1	0
60-64	0	0	0	0	0	0	0	0	0	0	0
Total	775	1361	715	277	786	411	340	538	568	793	506
Measured	1026	1233	599	287	459	503	326	326	812	866	696
# trawls	94	84	95	87	102	99	80	96	95	83	87
# trawl with species	61	60	57	40	42	50	41	38	59	52	56

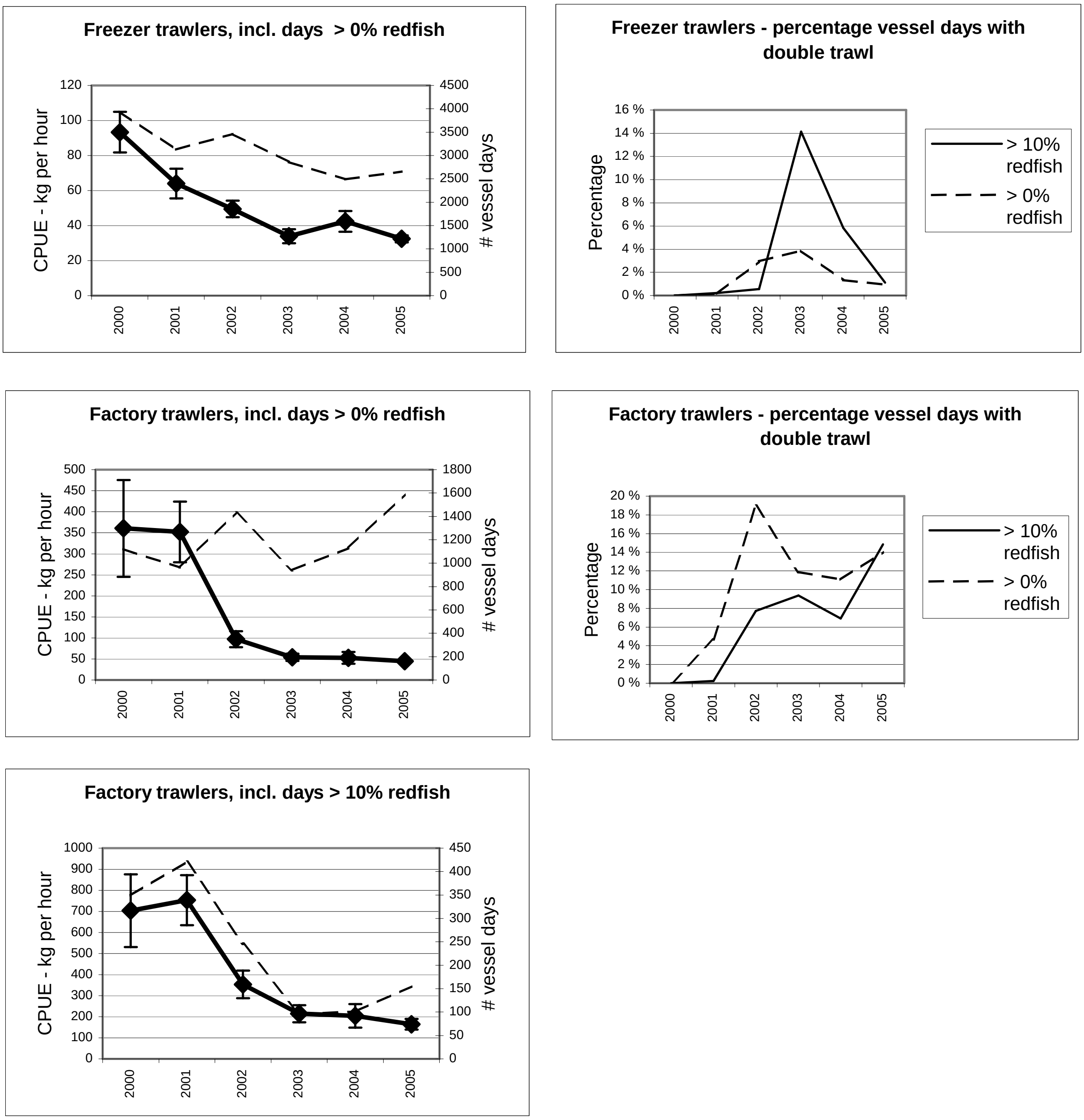


Figure D1. *Sebastes marinus.* Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery presented for two trawler categories, i.e., freezer trawlers 32-50 meters and factory trawlers above 54 meters, and two criteria for which vessel days to use, i.e., only vessel days with minimum 10% *S. marinus* in the total catch per day or incl. all vessel days where *S. marinus* were caught. In the left panel, the numbers of vessel days (stippled curve) meeting the criterium of minimum % *S. marinus* in the catch per day are shown. The right panel shows how the use of double trawl has developed. The figure is meant to be a supplement to Figure 7.3.

8 Greenland halibut in subareas I and II

An update assessment is presented for this stock. The schedule for this stock was to conduct a benchmark assessment, but the working group decided by correspondence that this was to early considering all the research activity going on to improve the assessment. General information is located in the Quality Handbook Stock Annex.

8.1 Status of the fisheries

8.1.1 Landings prior to 2006 (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 2004 is 18,800 t, which is close to that used in the previous assessment (18,762 t). The preliminary estimate of the total catch for 2005 is 18,806 t. This is quite similar to the projected catch for 2005 estimated by the Working Group during its 2005 meeting (19,000 t). The bycatch criteria for Norwegian vessels in the NEEZ was changed by Norwegian authorities in the beginning of 2004 and the bycatch is now only limited by a catch retention limit onboard the vessel at any time. This has caused an huge increase in the Norwegian trawl catch in 2004-2005.

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 catch in 2005 is the lowest observed since 1985. 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. No catch was reported from this area in 2005. 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 ICES advice applicable to 2005 and 2006

The advice from ICES for 2005 was as follows:

Exploitation boundaries in relation to precautionary limits: *The stock has remained at a relatively low size in the last 25 years at catch levels of 15 000-25 000 t. In order to increase the SSB, catches should be kept well below that range. Catches should not increase above the recent average of 13 000 t for 2005 to allow for continued increase in the spawning stock.*

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: *The current estimated fishing mortality (0.21) is above fishing mortalities that would lead to high long-term yields (F0.1=0.06, Fmax =0.14). This indicates that long-term yield will increase at Fs well below the historic values. Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.*

The advice from ICES for 2006 was as follows:

Exploitation boundaries in relation to precautionary limits: *The stock has remained at a relatively low size in the last 25 years at catch levels of 15 000–25 000 t. In order to increase the SSB, catches should be kept well below that range. Catches for 2006 should not increase above the recent average of 13 000 t as advised in 2004, to allow for continued increase in the spawning stock.*

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: *The current estimated fishing mortality is above fishing mortalities that would lead to high long-term yields. This indicates that long-term yield will increase at Fs well below the historic values. Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of reducing stock productivity.*

8.1.3 Management applicable in 2005 and 2006

Target Greenland halibut fishery is forbidden since 1992. Management of Greenland halibut is by bycatch regulations and a limited coastal Norwegian fishery using longline and gillnet. From 2001 the bycatch regulations in each haul was not to exceed 12% in each haul and 7% of the landed catch. From early 2004 the Norwegian Department of Fisheries decided that for Norwegian vessels in the NEEZ allowable bycatch at any time on board and by landing should not exceed 7 %. In addition, the annual catch for each trawler are not allowed to exceed 4 % of the sum of the vessels quota on cod, haddock and saithe, and limited by a maximum annual catch of 40 t pr. vessel.

The Norwegian conventional fleet, vessels smaller than 28 m, are allowed to conduct a limited target fishery with longlines and gillnets in a limited area in approximately one month each year. For these vessels the TAC is set to 10, 12 and 14 t, dependent of size of the vessel. This fishery is supposed to keep the total catch at a level which these vessels landed historically (ca. 2,500 t).

The 30. Session of the joint Russian-Norwegian Fisheries Commission in 2001 stated that both the Russian and the Norwegian party could catch up to 1,500 t of Greenland halibut for research and surveillance purposes in 2002. This research quota was increased in the commission meeting the year after to 3,000 t for each party, and has been at this level until 2005. For the year 2006 this research quota was again increased to 4,500 t to each party (34. Session of the joint R-N Fisheries Commission in 2005). Most of this quota has been landed, i.e. 6,000 t of the catch in 2005 was from research and surveillance purposes. If this development continues the catch in 2006 will probably reach 9,000 t, in comparison with a catch recommendation from ICES of less than 13,000 t in total.

8.1.4 Expected landings in 2006

The total Norwegian catch in 2006 is expected to be at the same level as in 2005, about 13,500 t. In addition 6,000 t is expected to be caught by Russian vessels and 500 t by other countries. Consequently the official landings in 2006 are expected to be 20,000 t. Discards is not regarded as a problem but it is believed that there may be additional landings that are not reported. The catches from Division IVa are expected to be maintained at a low level (below 500 t).

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 2001 covered 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). With exception of the Norwegian Greenland halibut survey all these surveys from 2004 are conducted as one major joint survey between Norway and Russia. 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 assessment.

The Norwegian Combined Survey Index (Table E5) indicates an increase in the total stock during the last five 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 four last years when younger age groups were more abundant. That indicates that the catchability of younger ages (i.e. those primarily from northern surveys) is 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). 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. Observations on the main spawning grounds in 2003 were conducted three weeks later than usual because access to NEEZ was obtained too late. The number of trawl stations was also insufficient due to the same reason. It was considered therefore imprudent to use the 2002 and 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 from 2002 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, but the 2006 total estimate was the second highest in the series.

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 1.1. The increase in 0-group abundance after 1996 seems to have stopped. The index in 2003 and 2005 are well below average.

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 1800 kg/h with the highest value in 2005 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series shows the highest value in 2003. In 2004-2005 a significant decline was observed (Table 8.6) and this was probably caused by the reduced fishing period, only October and November.

8.2.3 Age readings

In the current assessment, the problem of low abundance of the Greenland halibut at age 9 in the Norwegian data was not so apparent in the last survey year. 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. The work addressing this problem is still in progress.

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 2004 were updated using revised catch figures and revised Norwegian age composition. Catch-at-age data for 2005 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.

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 2005 (Table 8.8) was calculated as a simple mean 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 1984–2005, 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 and 2004-2005 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 1992–2005 for ages 5–14.

Fleet 7: Russian trawl survey from 1992-2005 for ages 5-14. The 2002 and 2003 data was not included in this series due to the problems mentioned in section 8.2.1

Fleet 8: Norwegian Combined Survey from 1996-2005 for ages 5-15.

The software XXSA.exe were used because the VPA95.exe did not produce complete diagnostics output (see Introduction).

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 (Figure 8.1, Tables 8.7-8.10)

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 2006 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 prosecuted 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 49,000 by 2004, wich is the highest value estimated since 1976 and equal to long-term average for the whole period 1964-2005.

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 0.25. The high catch in 1999 resulted in an increase in fishing mortality to 0.35 but since then has declined to 0.17-0.18 by 2002 and 2003, the lowest value estimated for the last 20 years. Due to the increased catch in 2004-2005 the fishing mortality again slightly raised (0.21-0.23) but remained lower than average.

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 1990-2004 average is about 83% of the average during the 1980's. The estimate for 2005 is the highest after 1974 and close to long-term average.

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 2006

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 year assessment stock size and SSB for 2005 have increased while fishing mortality remained at the same level.

	TOTAL STOCK (5+) BY 1 JANUARY 2005	SSB BY 1 JANUARY 2005	F6-10 IN 2005	F6-10 IN 2004
WG 2005	97261	41730	0.23*	0.23
WG 2006	101839	46280	0.23	0.21

*prediction

8.8 Comments to the assessment (Figures 8.3 – 8.4)

The assessment was classified as an update assessment. The current assessment was using the same catch matrix, surveys series and settings as in the previous year with updated data for 2004 and new data for 2005. Fishing mortalities tend to be overestimated while SSB tends to be underestimated in the assessment year as illustrated by the retrospective plots in Figure 8.3.

The assessment is considered to be still uncertain due to the age-reading and survey data quality problems. Nevertheless the assessment may be accepted as indicative for stock trends. Although many aspects of the assessment remain uncertain, most fishery independent indices of stock size indicate positive trends in recent years (Figure 8.4).

The working group have stated in several previous reports that catches above the mean after 1992 (ca. 13,000 t) reduces the stocks ability to rebuild. The high catch in 2004-2005 and expected catch of 2006 will most likely lead to reduction in the spawning stock size, as in the period 1983 to 1990.

8.9 Response to ACFM technical minutes

The main remarks were that the age reading is still the problem for the stock and aging validation should be done. Due to the age reading problems, significant differences in growth rates for males and females and certain XSA diagnostic problems, it had been recommend to explore the possibility of using for Greenland halibut assessment length structured assessment tools or production models.

During the March (2006) meeting, the Norwegian and Russian scientists developed a new 3-year joint research program aimed at improvement of methods for assessment of Greenland halibut. This program includes all items mentioned in the ACFM technical minutes. In the frame of the program planned to put efforts to solve the age reading and survey data quality problems and also to examine the alternative assessment tools including Gadget, production models, etc. Some work in these directions have already been done (e.g. Albert, et al., WD8#2005, Howell, WD26#2006). Unfortunately more time is needed before any firm conclusions can be drawn. However, Norway has decided to change their age reading method from this year (2006).

A full assessment should not be conducted before the results from the research program is available.

Table 8.1. GREENLAND HALIBUT in Sub-areas I and II. Nominal catch (t) by countries (Sub-area I, Divisions IIa and IIb combined) as officially reported to ICES.

Year	Denmark	Estonia	Faroe Isl.	France	Fed. Rep. Germany	Greenl.	Iceland	Ireland	Lithuania	Norway	Poland	Portugal	Russia[3]	Spain	UK (Engl. & Wales)	UK (Scotland)	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	2,564	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	0	0	0	45	15	0	16	1	0	9,083	3	37	4,568	375[2]	111	43	14,297
2001	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	459	2	18	14	0	1	0	8,347[2]	5	19	4,384	230[2]	41	58	13,578
2004[1]	0	0	0	0	9	0	9	0	0	13,840[2]	1	50	4,662	186[2]	43	0	18,800
2005[1]	0	170	0	32	8	0	0	0	0	13,425[3]	0	23	4883	660[3]	29	18	19,248

[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	France	Greenland	Iceland	Ireland	Norway	Poland	Russia[3]	Spain	UK (E & W)	UK (Scot.)	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	-	-	-	-	-	-	-	2,039	-	482	-	+	-	2,521
1990	-	7	-	-	-	-	-	1,304	-	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	-[2]	+	-	857
1998	-	47	+	-	-	23	-	859	-	491	-[2]	2	-	1,422
1999	-	91	-	-	13	7	-	1,101	-	1,203	-[2]	+	-	2,415
2000	-	-	+	-	-	16	-	1,021	+	1,169	-[2]	1	-	2,206
2001	-	-	-	-	-	9	-	925[2]	+	951	-[2]	2	-	1,887
2002[1]	-	-	3	-	-	+	-	791[2]	-	1,167	-[2]	+	-	1,961
2003[1]	-	48	+	+	2	+	1	949	1	735	+[2]	+	+	1,736
2004[1]	-	-	-	-	-	+	-	812	-	633	-[2]	3	-	1,449
2005[1]	-	-	-	1	-	-	-	575	-	595	-[2]	3	-	1,174

[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	Fed. Rep. Germ.	France	Greenland	Iceland	Ireland	Norway	Poland	Portugal	Russia[5]	Spain	UK (E & W)	UK (Scot.)	Total
1984	-	-	265	138	-		-	3,703	-	-	5,459	-	1	-	9,566
1985	-	-	254	239	-		-	4,791	-	-	6,894	-	2	-	12,180
1986	-	6	97	13	-		-	6,389	-	-	5,553	-	5	1	12,064
1987	-	-	75	13	-		-	5,705	-	-	4,739	-	44	10	10,586
1988	-	177	150	67	-		-	7,859	-	-	4,002	-	56	2	12,313
1989	-	67	104	31	-		-	8,050	-	-	4,964	-	6	-	13,222
1990	-	133	12	49	-		-	8,233	-	-	1,246[2]	-	1	-	9,674
1991	1,400	314	21	119	-		-	11,189	-	-	305[2]	-	+	1	13,349
1992	-	16	1	108	13[4]		-	3,586	-	15[3]	58	-	1	-	3,798
1993	-	29	14	78	8[4]		-	7,977	-	17	210	-	2	-	8,335
1994	-	-	33	47	3[4]		4	6,382	-	26	67	+	14	-	6,576
1995	-	-	30	174	12[4]		2	6,354	-	60	227	-	83	2	6,944
1996	-	-	34	219	123[4]		-	9,508	-	55	466	4	278	57	10,744
1997	-	-	23	253	-[4]		-	5,702	-	41	334	1[2]	21	25	6,400
1998	-	-	16	67	-[4]		1	6,661	-	80	530	5[2]	74	41	7,475
1999	-	-	20	-	25[4]		2	13,064	-	33	734	1[2]	63	45	13,987
2000	-	-	10	43	-[4]		+	7,536	-	18	690	1[2]	65	43	8,406
2001	-	-	49	122	-[4]	9	1	8,740	-	13	726	5[2]	56	30	9,751
2002[1]	-	-	9	7	22[4]	4	-	5,780[2]	-	3	849	-[2]	12	28	6,714
2003[1]	-	390	5	2	12[4]	+	+	6,778[2]	+	10	1,762	14[2]	5	58	9,036
2004[1]	-	-	4	-	-[4]	9	-	11,633[2]	-	24	810	4[2]	1	-	12,485
2005[1]	-	-	3	31	-[4]	-	-	11,756[2]	-	11	1406	+	5	18	13,230

[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 Isl.	France	Fed. Rep. Germ.	Ireland	Lithuania	Norway	Poland	Portugal	Russia[4]	Spain	UK (E&W)	UK (Scot.)	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	1,022	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	-	-	-	2	5	-	-	526	3	19	2,709	374[2]	46	-	3,685
2001	-	-	-	+	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]	+	+	21	-	13	-	-	620[2]	4	9	1,887	216	35	+	2,805
2004[1]	-	-	-	-	5	-	-	1,395[2]	1	26	3,219	182[2]	39	-	4,866
2005[1]	-	170	-	-	5	-	-	1,094[3]	-	12	2,882	660[2]	21	-	4,844

[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	Danish seine	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	6 049		13 578
2004	2 290	7 135	8 778	599	18 801
2005	1 842	7 539	9 420	447	19 248

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	-	-	-	-	-
2004	0.63 [13]	-	1.16	1.79	-	-	-	-	-
2005	0.61 [12]	-	1.30	2.29	-	-	-	-	-

[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.**

[13] **Based on fishery from october-november only.**

Table 8.7

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	372	253	170	156	114	1064	526	80	1109	212	917
6	1480	853	563	332	283	2420	2792	4486	3521	1117	2519
7	2808	1735	1106	623	452	3208	10464	12712	9605	3923	6204
8	5674	3868	2715	2006	1976	6288	18562	12283	6438	3515	3838
9	4951	4203	4054	3237	3923	4921	10034	6130	2775	2551	1834
10	3981	3799	2499	2409	2950	4431	6671	4339	1734	1919	1942
11	1853	1799	1284	1718	2234	2381	2517	2703	1368	1536	1622
12	1018	1002	783	871	792	812	1250	1660	1234	1127	1338
13	364	372	246	315	146	229	616	1044	675	716	734
14	251	282	261	155	43	100	1104	300	200	251	531
+gp	76	50	28	19	7	30	281	143	80	126	216
0 TOTALNUM	22828	18216	13709	11841	12920	25884	54817	45880	28739	16993	21695
TONSLAND	40391	34751	26321	24267	26168	43789	89484	79034	43055	29938	37763
SOPCOF %	100	100	101	100	100	103	94	104	98	92	98

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	840	830	2037	1897	2218	731	1896	1304	1543	915	1219
6	2337	2982	3255	3589	3155	1138	1917	1494	1864	3698	2874
7	6520	5824	4200	4118	2727	1665	1919	1276	1851	3350	2561
8	4118	5002	2524	2365	1234	1341	933	1208	2287	1938	1548
9	2265	3000	1610	1509	495	944	484	1493	1491	1064	972
10	1654	1350	1104	946	319	473	448	1258	1228	1191	1037
11	1857	915	1062	934	296	511	482	838	713	602	614
12	1536	1212	858	438	243	275	380	502	488	340	363
13	1122	698	595	349	103	242	384	324	247	171	161
14	600	526	384	147	45	145	150	108	201	132	120
+gp	368	358	180	112	51	78	62	46	64	71	63
0 TOTALNUM	23217	22697	17809	16404	10886	7543	9055	9851	11977	13472	11532
TONSLAND	38172	36074	28827	24617	17312	13284	15018	16789	22147	21883	19945
SOPCOF %	88	93	101	105	104	109	107	100	98	100	99

Table 8.7 (Continued)

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

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	1672	1212	907	2080	2139	3312	1098	1140	631	846	1034
6	3335	2972	2540	4453	5163	3889	1195	1088	708	992	2083
7	2712	3572	3141	3655	4642	4716	1069	1608	1252	1719	3795
8	1531	1746	2096	1657	1932	2355	778	1118	817	990	1426
9	1128	752	1182	801	1221	1031	360	140	310	405	262
10	997	828	860	318	499	1284	600	976	642	726	655
11	530	362	481	228	264	774	188	444	416	461	270
12	434	202	313	126	314	673	150	144	330	371	132
13	314	186	133	120	42	177	79	36	88	154	29
14	305	63	140	140	96	266	89	20	39	56	22
+gp	239	7	47	28	44	517	56	4	3	8	1
0 TOTALNUM	13197	11902	11840	13606	16356	18994	5662	6718	5236	6728	9709
TONSLAND	22875	19112	19587	20138	23183	33320	8602	11933	9226	11734	14347
SOPCOF %	98	101	100	103	102	105	95	102	99	101	101

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

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE									
5	330	359	433	380	441	277	397	290	442
6	921	1116	1905	735	1347	921	1025	1016	1099
7	1822	2466	3955	1926	2338	1475	1827	2316	2007
8	953	1464	1810	1464	1325	983	928	1392	1803
9	342	527	914	743	788	631	632	1087	959
10	822	924	1905	1318	1140	1097	1045	778	1017
11	231	237	380	457	519	563	520	675	631
12	150	122	237	330	372	301	311	607	634
13	18	15	67	49	115	132	77	199	383
14	41	29	42	37	54	59	107	155	246
+gp	1	15	7	14	12	42	26	105	333
0 TOTALNUM	5631	7274	11655	7453	8451	6481	6895	8620	9554
TONSLAND	9410	11893	19517	14437	16307	13161	13578	18800	19248
SOPCOF %	99	100	102	101	100	100	100	102	97

Table 8.8

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

Table 2 Catch weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	0.42	0.42	0.42	0.42	0.42	0.42	0.567	0.567	0.567	0.567	0.567
6	0.64	0.64	0.64	0.65	0.66	0.64	0.737	0.737	0.737	0.737	0.737
7	0.9	0.9	0.91	0.93	0.96	0.91	1.079	1.079	1.079	1.079	1.079
8	1.2	1.22	1.24	1.27	1.31	1.25	1.421	1.421	1.421	1.421	1.421
9	1.63	1.66	1.7	1.71	1.74	1.64	1.848	1.848	1.848	1.848	1.848
10	2.26	2.23	2.22	2.2	2.19	2.25	2.281	2.281	2.281	2.281	2.281
11	3.11	3	2.94	2.84	2.79	2.99	2.887	2.887	2.887	2.887	2.887
12	3.74	3.49	3.39	3.3	3.19	3.63	3.247	3.247	3.247	3.247	3.247
13	4.57	4.4	4.38	4.27	4.27	4.68	4.303	4.303	4.303	4.303	4.303
14	5.01	4.91	4.84	4.88	5	5.38	4.931	4.931	4.931	4.931	4.931
+gp	5.94	5.89	5.88	5.8	5.99	5.99	5.794	5.841	6.037	6.006	5.964
0 SOPCOFAC	0.9986	1.0046	1.0054	1.0024	0.9994	1.0262	0.9436	1.0434	0.9752	0.9231	0.9825

Table 2 Catch weights at age (kg)

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	0.567	0.567	0.567	0.567	0.900	0.702	0.660	0.69	0.75	0.63	0.6
6	0.737	0.737	0.737	0.737	1.200	0.872	0.840	0.84	1.04	0.96	0.89
7	1.079	1.079	1.079	1.079	1.500	1.141	1.150	1.03	1.34	1.18	1.2
8	1.421	1.421	1.421	1.421	1.800	1.468	1.560	1.31	1.57	1.53	1.85
9	1.848	1.848	1.848	1.848	2.200	1.778	2.040	1.74	1.97	2.31	2.59
10	2.281	2.281	2.281	2.281	2.600	2.302	2.570	2.24	2.73	2.87	3.18
11	2.887	2.887	2.887	2.887	3.000	2.664	2.980	2.77	3.29	3.46	3.62
12	3.247	3.247	3.247	3.247	3.500	3.046	3.430	3.37	4.22	3.77	3.95
13	4.303	4.303	4.303	4.303	4.100	3.368	4.130	4.32	4.71	3.99	4.48
14	4.931	4.931	4.931	4.931	4.800	4.285	4.680	5.35	6.08	4.35	4.25
+gp	5.91	5.923	6.027	5.906	6.176	5.346	5.999	5.833	6.122	4.525	4.825
0 SOPCOFAC	0.8805	0.9255	1.0095	1.0485	1.0364	1.0894	1.068	1.0038	0.9783	1.0009	0.9858

Table 8.8 (Continued)

Table 2 Catch weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0.62	0.709	0.74	0.76	0.71	0.77	0.68	0.79	0.72	0.73	0.77
6	0.92	1.003	0.962	1.03	1.06	1.05	0.97	1.02	0.94	0.94	0.97
7	1.28	1.266	1.249	1.32	1.29	1.38	1.27	1.35	1.27	1.25	1.31
8	1.9	1.683	1.626	1.8	1.7	1.75	1.76	1.88	1.72	1.74	1.74
9	2.48	2.482	2.164	2.42	2.1	2.2	2.21	2.46	2.19	2.09	2.24
10	3.11	2.982	2.897	3.13	2.61	2.6	2.56	2.67	2.52	2.51	2.59
11	3.35	3.547	3.406	3.37	2.87	2.79	3.11	3.43	2.97	2.95	3.29
12	3.72	3.8	3.661	4.05	3.45	3.28	3.59	4.29	3.29	3.34	4.02
13	4	4.56	4.247	4.29	3.72	3.89	3.83	5.08	3.84	3.83	4.75
14	4.18	5.002	4.187	4.5	4.09	4.38	4.25	6.33	4.95	4.98	6.24
+gp	4.526	5.953	4.463	4.72	4.52	5.29	4.8	8.91	6.68	8.15	6.09
0 SOPCOFAC	0.9782	1.0116	0.9973	1.0346	1.0204	1.047	0.9519	1.0183	0.9937	1.0095	1.0066

Table 2 Catch weights at age (kg)

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE									
5	0.77	0.73	0.7	0.76	0.74	0.69	0.715	0.702	0.669
6	0.94	0.93	0.95	0.97	1.03	0.94	1.05	0.994	0.952
7	1.28	1.3	1.27	1.33	1.39	1.36	1.428	1.404	1.306
8	1.64	1.61	1.55	1.63	1.75	1.68	1.748	1.797	1.653
9	2.07	2.12	2.00	2.11	2.29	2.18	2.318	2.397	2.131
10	2.59	2.57	2.46	2.61	2.68	2.68	2.615	2.767	2.544
11	3.3	3.25	3.22	3.35	3.33	3.19	3.043	3.196	2.848
12	4.01	3.91	3.85	3.97	3.92	3.89	3.694	3.768	3.334
13	4.83	4.9	4.61	4.97	4.81	4.46	4.566	4.208	3.734
14	5.95	5.66	5.84	5.82	5.81	5.25	5.568	4.929	4.384
+gp	6.26	4.91	5.98	7.22	7.41	6.32	6.365	6.618	5.791
0 SOPCOFAC	0.9851	0.9983	1.0172	1.0055	1.0014	1.000	0.996	1.0181	0.966

Table 8.9

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

Table 5 Proportion mature at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	0	0	0	0	0	0	0	0	0	0	0
6	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
7	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
8	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
9	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
10	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
11	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
12	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 5 Proportion mature at age

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	0	0	0	0	0	0	0	0	0	0	0
6	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
7	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
8	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.18	0.18	0.19
9	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.6	0.61	0.65
10	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.82	0.83	0.85
11	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.96	0.97	0.97
12	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 8.9 (Continued)

Table 5 Proportion mature at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0	0	0	0	0	0	0	0.01	0.01	0.01	0
6	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0
7	0.03	0.02	0.01	0.02	0.02	0.04	0.06	0.08	0.07	0.08	0.07
8	0.24	0.22	0.21	0.18	0.17	0.15	0.28	0.32	0.34	0.29	0.25
9	0.74	0.66	0.53	0.49	0.51	0.54	0.66	0.68	0.69	0.58	0.58
10	0.91	0.9	0.87	0.8	0.77	0.77	0.86	0.83	0.81	0.79	0.88
11	0.99	0.95	0.89	0.89	0.91	0.89	0.87	0.88	0.95	0.96	0.97
12	0.98	0.98	0.98	1.000	1.000	1.000	1.000	0.94	0.94	0.89	0.94
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 5 Proportion mature at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE									
5	0	0	0	0	0.01	0.02	0.02	0	0
6	0	0	0	0.01	0.03	0.04	0.04	0.02	0.03
7	0.07	0.04	0.02	0.03	0.06	0.09	0.09	0.12	0.09
8	0.21	0.1	0.07	0.1	0.19	0.26	0.26	0.38	0.34
9	0.53	0.45	0.33	0.37	0.49	0.63	0.63	0.74	0.74
10	0.85	0.82	0.66	0.63	0.65	0.72	0.72	0.93	0.92
11	0.94	0.92	0.86	0.87	0.84	0.91	0.91	0.95	0.97
12	0.94	1	0.99	0.96	0.96	0.96	0.96	0.97	0.99
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.98	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.98	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 8.10.

Lowestoft VPA Version 3.1

26/04/2006 16:45

Extended Survivors Analysis

Arctic Green.halibut (run: 2006/1)

CPUE data from file fleet

Catch data for 42 years. 1964 to 2005. Ages 5 to 15.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT04: Norw. Exp. CP	1992	2005	5	14	0.38	0.44
FLT07: Russ.Surv. ne	1992	2005	5	14	0.75	0.92
FLT08: Norw.Comb.Sur	1996	2005	5	14	0.55	0.72

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 :

Terminal year survivor estimates shrunk towards the mean F of the final 2 years.
S.E. of the mean to which the estimates are shrunk = .500

Oldest age survivor estimates for the years 1964 to 2005
shrunk towards1.000 * the mean F of ages 9 - 13

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

Minimum standard error for population estimates from each cohort age = .300

Individual fleet weighting not applied

Tuning converged after 42 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	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
5	0.062	0.017	0.021	0.032	0.026	0.031	0.017	0.028	0.017	0.019
6	0.166	0.069	0.071	0.143	0.066	0.113	0.081	0.075	0.089	0.081
7	0.409	0.203	0.25	0.361	0.199	0.289	0.166	0.215	0.228	0.24
8	0.339	0.159	0.237	0.277	0.207	0.193	0.179	0.141	0.238	0.263
9	0.12	0.119	0.118	0.215	0.165	0.155	0.126	0.158	0.232	0.243
10	0.654	0.629	0.507	0.742	0.514	0.387	0.316	0.298	0.282	0.333
11	0.564	0.475	0.347	0.379	0.366	0.368	0.316	0.229	0.302	0.366
12	0.586	0.672	0.467	0.658	0.626	0.542	0.356	0.272	0.43	0.485
13	0.218	0.135	0.118	0.477	0.253	0.434	0.352	0.136	0.265	0.501
14	0.499	0.51	0.315	0.523	0.498	0.459	0.392	0.506	0.416	0.572

Table 8.10 (Continued)

XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12	13	14
1996	1.85E+04	1.46E+04	1.22E+04	5.35E+03	2.49E+03	1.47E+03	6.75E+02	3.21E+02	1.60E+02	6.04E+01
1997	2.08E+04	1.50E+04	1.07E+04	6.98E+03	3.28E+03	1.90E+03	6.59E+02	3.31E+02	1.54E+02	1.11E+02
1998	1.83E+04	1.76E+04	1.20E+04	7.49E+03	5.12E+03	2.50E+03	8.71E+02	3.53E+02	1.45E+02	1.16E+02
1999	1.49E+04	1.54E+04	1.41E+04	8.05E+03	5.09E+03	3.92E+03	1.30E+03	5.30E+02	1.90E+02	1.11E+02
2000	1.61E+04	1.24E+04	1.15E+04	8.45E+03	5.25E+03	3.53E+03	1.61E+03	7.65E+02	2.36E+02	1.02E+02
2001	1.54E+04	1.35E+04	1.00E+04	8.12E+03	5.92E+03	3.83E+03	1.82E+03	9.58E+02	3.52E+02	1.58E+02
2002	1.81E+04	1.28E+04	1.04E+04	6.46E+03	5.76E+03	4.36E+03	2.24E+03	1.08E+03	4.80E+02	1.96E+02
2003	1.54E+04	1.53E+04	1.02E+04	7.58E+03	4.65E+03	4.37E+03	2.74E+03	1.41E+03	6.53E+02	2.90E+02
2004	1.81E+04	1.29E+04	1.23E+04	7.08E+03	5.67E+03	3.42E+03	2.79E+03	1.87E+03	9.22E+02	4.91E+02
2005	2.48E+04	1.53E+04	1.01E+04	8.40E+03	4.80E+03	3.87E+03	2.22E+03	1.78E+03	1.05E+03	6.09E+02

Estimated population abundance at 1st Jan 2006

	0.00E+00	2.09E+04	1.21E+04	6.85E+03	5.56E+03	3.24E+03	2.39E+03	1.32E+03	9.42E+02	5.47E+02

Taper weighted geometric mean of the VPA populations:

	1.72E+04	1.36E+04	1.01E+04	6.45E+03	4.12E+03	2.86E+03	1.42E+03	7.48E+02	3.23E+02	1.71E+02

Standard error of the weighted Log(VPA populations) :

	0.1887	0.2054	0.2563	0.3071	0.3727	0.3932	0.5126	0.6304	0.7221	0.7491

1

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992	1993	1994	1995
5	0.2	0.78	0.52	0.65
6	-0.23	0.03	0.15	-0.13
7	-0.52	0.06	0.08	0.08
8	-0.2	0.16	0.26	0.26
9	-1.45	-1.42	-0.92	0.28
10	-0.44	0.09	0.29	0.75
11	-0.22	-0.14	-0.21	0.19
12	0.1	-0.2	-0.83	0.16
13	-0.36	-0.06	-0.77	-0.21
14	-1.3	-0.25	-0.56	0.08

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
5	0.9	0.8	-0.69	-0.28	0.24	-0.45	-0.36	-0.09	-0.19	-0.82
6	0.71	0.12	-0.22	-0.13	0.03	-0.07	-0.17	-0.08	-0.02	0.06
7	0.31	0.01	-0.01	-0.2	0.29	-0.15	0.22	-0.07	-0.21	-0.04
8	0.15	-0.23	-0.13	-0.22	-0.19	0.33	-0.08	-0.51	0.06	0.46
9	-0.22	-0.01	-0.2	-1.14	0.11	0.34	0.31	0.68	0.68	0.89
10	0	0.47	-1.06	0.19	0.35	-0.14	-0.07	0.16	-0.43	-0.03
11	-0.67	0.5	-1.02	-1.15	-1.17	-0.8	-0.79	-0.4	-0.39	-0.2
12	-0.77	0.44	-0.91	0.49	-0.16	-0.15	-0.69	-0.01	-0.06	0.33
13	99.99	0.07	99.99	-0.7	0.25	-0.92	-1.67	-0.28	-0.28	0.21
14	-0.23	-0.14	99.99	-0.14	99.99	-0.52	-0.07	-0.19	-0.06	0.05

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	-4.9782	-4.0297	-3.2328	-3.6938	-4.5404	-3.6012	-3.6012	-3.6012	-3.6012	-3.6012
S.E(Log q)	0.5779	0.2263	0.2004	0.2857	0.7282	0.4443	0.7375	0.503	0.7352	0.3819

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	2.59	-0.612	-2.63	0.02	14	1.54	-4.98
6	1.01	-0.021	3.99	0.44	14	0.24	-4.03
7	0.93	0.306	3.66	0.67	14	0.19	-3.23
8	1.24	-0.684	2.45	0.45	14	0.37	-3.69
9	0.53	1.597	6.32	0.55	14	0.36	-4.54
10	1.26	-0.57	2.47	0.34	14	0.58	-3.6
11	1.28	-0.72	3.24	0.41	14	0.66	-4.12
12	0.87	0.621	4.12	0.72	14	0.43	-3.75
13	1.01	-0.026	4	0.59	12	0.64	-4.01
14	0.91	0.737	3.94	0.89	12	0.28	-3.82

Fleet : FLT07: Russ.Surv. ne

Age	1992	1993	1994	1995
5	1.86	0.72	0.02	-0.48
6	0.93	0.63	0.22	-0.16
7	0.53	0.55	0.05	0.03
8	0.35	0.33	0.07	0.32
9	-0.61	-0.05	0.02	0.33
10	-0.42	0	0.28	0.22
11	0.38	-0.13	-0.45	-0.04
12	0.29	0.4	-0.03	0.08
13	-0.43	-0.31	-0.4	-0.28
14	-4.92	0.73	0.53	-1.75

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
5	-0.35	-1.01	-0.23	-0.28	0.22	0.76	99.99	99.99	-0.02	-0.13
6	-0.01	-0.55	-0.46	-0.5	-0.11	0.73	99.99	99.99	0.21	-0.17
7	0.09	-0.25	-0.28	-0.51	-0.17	0.43	99.99	99.99	-0.01	0.08
8	0.18	-0.03	0.04	-0.09	0.08	-0.3	99.99	99.99	-0.12	-0.28
9	0.76	-0.14	0.16	0.05	0.12	-0.34	99.99	99.99	0	-0.4
10	-0.84	-0.01	0.19	0.1	0.19	0.11	99.99	99.99	0.08	-0.14
11	-0.65	0.31	0.73	-0.23	0.53	0.08	99.99	99.99	-0.09	-0.13
12	-0.87	-0.41	0.55	0.22	0.55	0.78	99.99	99.99	0.04	0.04
13	-0.4	0.43	0.4	0.62	-0.83	1.08	99.99	99.99	0.08	-0.12
14	-0.35	-0.34	-0.3	-0.22	0.43	0.45	99.99	99.99	0.6	0.13

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	-0.4866	0.5226	0.9491	1.1411	0.7002	0.3781	0.3781	0.3781	0.3781	0.3781
S.E(Log q)	0.6363	0.4651	0.3167	0.2149	0.3401	0.3059	0.4079	0.4897	0.5809	1.2321

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	-0.82	-2.666	17.33	0.23	12	0.39	-0.49
6	-1.87	-2.899	28.26	0.12	12	0.63	0.52
7	3.75	-2.487	-28.87	0.1	12	0.93	0.95
8	1.89	-3.207	-9.98	0.64	12	0.28	1.14
9	1.48	-1.134	-4.98	0.43	12	0.49	0.7
10	0.78	1.03	1.44	0.75	12	0.24	0.38
11	1.08	-0.245	-1	0.57	12	0.46	0.42
12	0.86	0.649	0.45	0.75	12	0.41	0.53
13	0.98	0.084	-0.29	0.64	12	0.6	0.43
14	0.88	0.245	0.46	0.35	12	1.13	0.18
1							

Fleet : FLT08: Norw.Comb.Sur

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
5	0.19	-0.18	-0.32	-0.27	0.09	-0.12	0.01	0.3	-0.02	0.29
6	0.26	0.11	-0.4	-0.05	-0.09	0.07	-0.05	0.08	0.04	0.08
7	0.26	0	0.1	-0.13	-0.19	0.18	0.17	0.12	-0.04	-0.41
8	0.44	-0.41	-0.23	0.23	-0.15	0.01	0.15	0	0.06	-0.08
9	-0.04	-0.49	-0.72	-0.43	0.37	-0.27	0.41	0.44	0.11	0.42
10	0.71	0.26	0.23	0.3	-0.36	0.05	-0.34	-0.04	-0.31	-0.24
11	0.01	-0.04	-0.03	-0.46	-1.04	-0.79	-0.23	-0.86	-0.85	-0.26
12	0.17	0.33	0.67	0.69	-0.39	-0.17	0.09	-0.19	0.07	-0.09
13	-0.46	-1.18	-3.03	-0.03	-0.68	-0.69	-0.21	-0.33	-0.07	-0.21
14	0.13	0.03	0.24	0.14	-0.68	-0.27	-0.18	-0.51	0.14	-0.45

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	-0.185	0.3592	0.9922	0.511	-0.0829	0.7884	0.7884	0.7884	0.7884	0.7884
S.E(Log q)	0.2222	0.1667	0.2056	0.2269	0.4344	0.3405	0.6438	0.3756	1.1243	0.3657

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	0.73	0.755	2.81	0.51	10	0.17	-0.18
6	1.89	-0.869	-9.19	0.12	10	0.32	0.36
7	1.16	-0.204	-2.64	0.18	10	0.25	0.99
8	5.47	-1.501	-42.6	0.02	10	1.16	0.51
9	0.78	0.473	1.96	0.38	10	0.35	-0.08
10	3.34	-2.869	-21.5	0.17	10	0.83	0.79
11	1.98	-2.426	-7.78	0.46	10	0.62	0.31
12	1.47	-2.038	-4.45	0.72	10	0.45	0.89
13	0.61	1.844	2.23	0.75	10	0.47	0.13
14	1.13	-0.736	-1.4	0.81	10	0.38	0.63
1							

Table 8.10 (Continued)

Terminal year survivor and F summaries :

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	9198	0.603	0	0	1	0.136	0.044
FLT07: Russ.Surv. ne	18440	0.669	0	0	1	0.111	0.022
FLT08: Norw.Comb.Sur	27913	0.3	0	0	1	0.551	0.015
F shrinkage mean	17719	0.5				0.202	0.023

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20903	0.22	0.22	4	0.992	0.019

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	12286	0.269	0.1	0.37	2	0.297	0.08
FLT07: Russ.Surv. ne	10777	0.395	0.071	0.18	2	0.137	0.09
FLT08: Norw.Comb.Sur	12477	0.212	0.048	0.22	2	0.473	0.079
F shrinkage mean	11928	0.5				0.093	0.082

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12123	0.15	0.03	7	0.235	0.081

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	6615	0.2	0.014	0.07	3	0.326	0.248
FLT07: Russ.Surv. ne	7734	0.276	0.056	0.2	2	0.176	0.216
FLT08: Norw.Comb.Sur	6605	0.174	0.209	1.2	3	0.428	0.248
F shrinkage mean	7491	0.5				0.07	0.222

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6855	0.12	0.07	9	0.628	0.24

Table 8.10 (Continued)

Age 8 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
FLT04: Norw. Exp. CP	5905	0.168	0.179	1.06	4	0.336	0.249
FLT07: Russ.Surv. ne	4682	0.224	0.13	0.58	2	0.204	0.305
FLT08: Norw.Comb.Sur	5465	0.152	0.034	0.23	4	0.403	0.267
F shrinkage mean	7974	0.5				0.058	0.19

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5555	0.1	0.07	11	0.729	0.263

Age 9 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
FLT04: Norw. Exp. CP	3214	0.165	0.137	0.83	5	0.313	0.244
FLT07: Russ.Surv. ne	2698	0.22	0.206	0.93	3	0.218	0.285
FLT08: Norw.Comb.Sur	3472	0.146	0.085	0.58	5	0.407	0.228
F shrinkage mean	4117	0.5				0.062	0.196

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3242	0.1	0.07	14	0.736	0.243

Age 10 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
FLT04: Norw. Exp. CP	2236	0.158	0.146	0.92	6	0.306	0.352
FLT07: Russ.Surv. ne	2438	0.211	0.155	0.73	4	0.216	0.327
FLT08: Norw.Comb.Sur	2417	0.138	0.063	0.46	6	0.415	0.33
F shrinkage mean	2793	0.5				0.063	0.291

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2386	0.09	0.06	17	0.654	0.333

Table 8.10 (Continued)

Age 11 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
FLT04: Norw. Exp. CP	1186	0.16	0.095	0.6	7	0.287	0.401
FLT07: Russ.Surv. ne	1400	0.196	0.106	0.54	5	0.247	0.349
FLT08: Norw.Comb.Sur	1287	0.139	0.103	0.74	7	0.389	0.375
F shrinkage mean	1917	0.5				0.077	0.267

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1323	0.09	0.06	20	0.634	0.366

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

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	1095	0.163	0.101	0.62	8	0.278	0.43
FLT07: Russ.Surv. ne	801	0.189	0.067	0.36	6	0.234	0.551
FLT08: Norw.Comb.Sur	852	0.141	0.094	0.67	8	0.396	0.525
F shrinkage mean	1391	0.5				0.092	0.353

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
942	0.1	0.06	23	0.634	0.485

Age 13 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
FLT04: Norw. Exp. CP	508	0.175	0.08	0.46	9	0.269	0.531
FLT07: Russ.Surv. ne	460	0.195	0.102	0.52	7	0.249	0.573
FLT08: Norw.Comb.Sur	444	0.147	0.08	0.54	9	0.354	0.588
F shrinkage mean	1596	0.5				0.128	0.201

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
547	0.11	0.1	26	0.925	0.501

Table 8.10 (Continued)

Age 14 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	282	0.187	0.076	0.41	10	0.302	0.593
FLT07: Russ.Surv. ne	294	0.183	0.068	0.37	8	0.196	0.574
FLT08: Norw.Comb.Sur	261	0.163	0.091	0.56	10	0.374	0.628
F shrinkage mean	482	0.5				0.127	0.387

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
296	0.11	0.06	29	0.517	0.572

Table 8.11

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 8 Fishing mortality (F) at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	0.0094	0.0053	0.0032	0.0024	0.0019	0.0207	0.0139	0.0027	0.0363	0.0074	0.0378
6	0.0484	0.0255	0.0138	0.0072	0.0051	0.0484	0.0659	0.1491	0.151	0.0442	0.1079
7	0.1146	0.0699	0.0397	0.018	0.0116	0.0691	0.2864	0.4473	0.511	0.237	0.3447
8	0.2531	0.216	0.1411	0.0891	0.0694	0.2081	0.6556	0.6021	0.4033	0.3335	0.3623
9	0.4566	0.2848	0.3476	0.2356	0.2381	0.2332	0.5603	0.4392	0.2444	0.2597	0.2744
10	0.7003	0.7254	0.2583	0.3382	0.3302	0.435	0.5339	0.4739	0.1999	0.2516	0.3041
11	0.6375	0.7606	0.5421	0.2684	0.5685	0.4571	0.4457	0.4037	0.2511	0.2585	0.3298
12	0.5666	0.8214	0.8585	0.8373	0.1802	0.3905	0.4362	0.5627	0.3063	0.3191	0.3546
13	0.4065	0.391	0.4515	1.0092	0.2945	0.0686	0.5465	0.7562	0.4414	0.2765	0.3347
14	0.5568	0.6004	0.4943	0.5409	0.3237	0.3182	0.5074	0.5302	0.2898	0.2741	0.3208
+gp	0.5568	0.6004	0.4943	0.5409	0.3237	0.3182	0.5074	0.5302	0.2898	0.2741	0.3208
0 FBAR 6-10	0.3146	0.2643	0.1601	0.1376	0.1309	0.1988	0.4204	0.4223	0.3019	0.2252	0.2787

Table 8 Fishing mortality (F) at age

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	0.041	0.0413	0.0973	0.1046	0.1294	0.0433	0.1214	0.0771	0.0917	0.0569	0.0682
6	0.1211	0.1895	0.2135	0.2346	0.2396	0.0859	0.1448	0.1258	0.1429	0.311	0.2406
7	0.4197	0.4666	0.4176	0.4305	0.2658	0.1815	0.1933	0.1284	0.2143	0.3869	0.3475
8	0.3818	0.6251	0.3558	0.4142	0.2074	0.1911	0.1388	0.1696	0.3357	0.3436	0.2925
9	0.3558	0.5001	0.3927	0.3521	0.1333	0.2293	0.0925	0.324	0.3079	0.2429	0.273
10	0.4017	0.3509	0.3249	0.398	0.1094	0.1723	0.1532	0.3461	0.4551	0.4074	0.373
11	0.5023	0.3824	0.4848	0.4738	0.1957	0.2424	0.2519	0.4462	0.3179	0.3979	0.3585
12	0.5617	0.6829	0.7082	0.3551	0.2024	0.2657	0.2704	0.4255	0.4788	0.2324	0.4192
13	0.5355	0.5074	0.818	0.6673	0.1238	0.3005	0.6807	0.3676	0.3613	0.2877	0.1554
14	0.474	0.4874	0.549	0.4516	0.1533	0.2429	0.2909	0.3837	0.386	0.315	0.3171
+gp	0.474	0.4874	0.549	0.4516	0.1533	0.2429	0.2909	0.3837	0.386	0.315	0.3171
0 FBAR 6-10	0.336	0.4264	0.3409	0.3659	0.1911	0.172	0.1445	0.2188	0.2912	0.3384	0.3053

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Table 8.11 (Continued)

Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0.095	0.0696	0.0434	0.1143	0.1726	0.3301	0.1187	0.0993	0.0377	0.0522	0.0622
6	0.2541	0.2306	0.1928	0.292	0.4294	0.5073	0.1791	0.1568	0.0783	0.0727	0.1665
7	0.3541	0.4462	0.3833	0.4394	0.5288	0.842	0.237	0.3661	0.2573	0.2611	0.4085
8	0.3406	0.3825	0.4836	0.3373	0.4138	0.529	0.292	0.393	0.3025	0.3142	0.339
9	0.3392	0.2634	0.4564	0.3231	0.4208	0.3824	0.1322	0.0735	0.1685	0.2274	0.1205
10	0.4685	0.4222	0.5114	0.1994	0.323	1.0193	0.3783	0.589	0.5217	0.692	0.6537
11	0.3126	0.2905	0.4377	0.2302	0.2393	1.1622	0.3585	0.5031	0.5063	0.8472	0.5641
12	0.437	0.1773	0.4135	0.1829	0.5347	1.6141	0.6825	0.4841	0.8314	1.1489	0.5861
13	0.7409	0.3187	0.1607	0.2589	0.0809	0.6218	0.7957	0.3188	0.5836	1.2138	0.2178
14	0.4621	0.2956	0.3979	0.2397	0.3211	0.9678	0.7007	0.4427	0.6397	0.8818	0.4988
+gp	0.4621	0.2956	0.3979	0.2397	0.3211	0.9678	0.7007	0.4427	0.6397	0.8818	0.4988
0 FBAR 6-10	0.3513	0.349	0.4055	0.3182	0.4232	0.656	0.2437	0.3157	0.2657	0.3135	0.3376

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE										
5	0.0173	0.0214	0.0318	0.0257	0.0314	0.0166	0.0282	0.0175	0.0194	0.0217
6	0.0687	0.0709	0.1429	0.0658	0.1135	0.0805	0.0747	0.089	0.0808	0.0815
7	0.2035	0.25	0.3606	0.1989	0.2895	0.1659	0.2147	0.2278	0.2403	0.2276
8	0.1593	0.2365	0.2774	0.2067	0.1935	0.1791	0.1415	0.2382	0.2632	0.2143
9	0.1193	0.1176	0.2151	0.1654	0.155	0.1257	0.1584	0.2317	0.2425	0.2109
10	0.6287	0.5071	0.7422	0.5144	0.3866	0.3163	0.298	0.2818	0.3332	0.3043
11	0.4748	0.3469	0.3792	0.3664	0.3678	0.3158	0.2293	0.3018	0.3663	0.2991
12	0.6718	0.4667	0.6575	0.6259	0.5421	0.356	0.2723	0.43	0.4852	0.3959
13	0.135	0.118	0.4772	0.2528	0.4342	0.352	0.1359	0.2649	0.5007	0.3005
14	0.5102	0.3154	0.523	0.4982	0.4593	0.3916	0.5064	0.4162	0.5719	0.4982
+gp	0.5102	0.3154	0.523	0.4982	0.4593	0.3916	0.5064	0.4162	0.5719	
0 FBAR 6-10	0.2359	0.2364	0.3476	0.2302	0.2276	0.1735	0.1775	0.2137	0.232	

Table 8.12

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

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

	YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE											
	5	42840	51686	57828	70443	64280	55932	41112	31550	33555	31061	26642
	6	33792	36528	44251	49616	60486	55221	47154	34898	27081	27852	26538
	7	27961	27712	30648	37565	42397	51798	45284	37995	25875	20042	22937
	8	27353	21461	22243	25353	31755	36072	41607	29268	20909	13360	13611
	9	14559	18279	14883	16626	19961	25498	25214	18591	13796	12024	8238
	10	8521	7938	11833	9049	11307	13541	17381	12393	10314	9300	7983
	11	4237	3641	3307	7867	5554	6995	7544	8771	6641	7269	6224
	12	2537	1928	1465	1656	5177	2707	3812	4158	5042	4447	4831
	13	1175	1239	730	534	617	3721	1577	2121	2039	3195	2782
	14	634	673	721	400	168	395	2990	786	857	1128	2085
	+gp	190	118	77	49	27	118	756	372	341	564	844
0	TOTAL	163799	171203	187987	219156	241727	251998	234430	180902	146450	130242	122714

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

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE											
	5	22540	22098	23687	20591	19700	18601	17875	18933	18988	17818	19929
	6	22080	18621	18250	18498	15963	14898	15332	13626	15086	14911	14487
	7	20504	16836	13260	12688	12591	10813	11767	11418	10342	11255	9403
	8	13986	11599	9088	7517	7100	8308	7762	8348	8644	7184	6580
	9	8154	8217	5343	5480	4276	4966	5906	5815	6064	5318	4385
	10	5389	4917	4290	3105	3317	3221	3399	4635	3620	3836	3590
	11	5069	3104	2980	2668	1795	2559	2333	2510	2822	1977	2197
	12	3852	2640	1822	1580	1430	1270	1729	1561	1383	1767	1143
	13	2917	1891	1148	773	953	1005	838	1135	878	737	1206
	14	1713	1470	980	436	341	725	641	365	677	527	476
	+gp	1044	993	456	330	386	388	264	155	214	282	249
0	TOTAL	107248	92386	81303	73665	67852	66755	67845	68500	68717	65613	63645

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
	5	19878	19443	23000	20764	14547	12697	10575	13000	18387	17920	18488
	6	16022	15558	15610	18954	15942	10536	7856	8083	10131	15240	14639
	7	9803	10696	10633	11079	12183	8931	5461	5653	5948	8063	12197
	8	5718	5922	5892	6238	6145	6179	3312	3708	3374	3958	5345
	9	4227	3501	3477	3127	3832	3497	3134	2129	2155	2146	2488
	10	2873	2592	2316	1896	1948	2165	2053	2363	1702	1567	1471
	11	2128	1548	1463	1195	1337	1214	673	1211	1129	870	675
	12	1321	1340	996	813	817	906	327	404	630	585	321
	13	647	735	966	567	582	412	155	142	215	236	160
	14	888	265	460	708	377	462	190	60	89	103	60
	+gp	692	29	153	141	172	887	119	12	7	15	3
0	TOTAL	64196	61628	64966	65482	57882	47888	33854	36766	43766	50703	55847

Table 8.12 (Continued)

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

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 64-**	AMST 64-**
AGE												
5	20761	18308	14922	16136	15387	18122	15371	18053	24762	0	22941	25885
6	14953	17563	15425	12442	13535	12835	15341	12862	15269	20903	19059	21896
7	10668	12016	14082	11509	10027	10400	10192	12253	10128	12123	14452	17266
8	6977	7491	8054	8451	8119	6461	7583	7078	8398	6855	9578	12201
9	3278	5121	5090	5253	5916	5759	4649	5666	4800	5555	6205	8009
10	1898	2504	3919	3533	3832	4360	4371	3415	3868	3242	4177	5256
11	659	871	1298	1606	1818	2241	2735	2793	2218	2386	2362	3068
12	331	353	530	765	958	1083	1406	1872	1778	1323	1343	1796
13	154	145	190	236	352	480	653	922	1048	942	689	1006
14	111	116	111	102	158	196	290	491	609	547	390	598
+gp	3	59	18	38	35	139	70	330	818	693		
0 TOTAL	59792	64548	63639	60070	60137	62076	62663	65734	73694	54568		

Table 8.13

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE											
	5	17993	21708	24288	29586	26998	23491	23311	17889	19026	17612	15106
	6	21627	23378	28321	32250	39921	35341	34752	25719	19959	20527	19559
	7	25165	24941	27890	34936	40701	47136	48861	40997	27919	21626	24749
	8	32824	26182	27581	32199	41599	45090	59123	41590	29712	18984	19341
	9	23731	30343	25301	28430	34732	41817	46595	34355	25495	22220	15223
	10	19258	17701	26270	19908	24761	30467	39646	28267	23526	21213	18208
	11	13178	10923	9724	22341	15494	20915	21779	25322	19172	20985	17969
	12	9488	6728	4965	5463	16515	9828	12376	13501	16370	14438	15687
	13	5368	5452	3196	2281	2634	17415	6786	9127	8772	13746	11970
	14	3175	3306	3491	1952	838	2128	14746	3875	4226	5565	10283
	+gp	1131	697	452	282	163	707	4378	2171	2060	3388	5034
0	TOTALBIO	172936	171359	181480	209627	244355	274335	312353	242814	196238	180303	173128

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE											
	5	12780	12529	13430	11675	17730	13058	11797	13064	14241	11225	11957
	6	16273	13723	13450	13633	19156	12991	12879	11446	15689	14315	12894
	7	22124	18166	14308	13690	18887	12337	13532	11761	13858	13281	11284
	8	19874	16483	12914	10681	12780	12196	12109	10936	13571	10991	12172
	9	15069	15186	9874	10128	9407	8830	12049	10118	11947	12285	11358
	10	12292	11216	9784	7083	8624	7415	8735	10381	9883	11010	11417
	11	14634	8960	8603	7702	5385	6817	6954	6952	9284	6839	7953
	12	12508	8572	5918	5129	5004	3870	5929	5261	5835	6663	4514
	13	12551	8136	4939	3325	3908	3385	3462	4904	4136	2942	5402
	14	8448	7247	4831	2150	1638	3106	2998	1954	4113	2291	2023
	+gp	6168	5883	2747	1949	2382	2076	1581	902	1311	1275	1200
0	TOTALBIO	152723	126103	100799	87145	104900	86081	92024	87679	103867	93117	92173

Table 12 Stock biomass at age (start of year) Tonnes

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
	5	12324	13785	17020	15780	10328	9777	7191	10270	13238	13082	14235
	6	14740	15604	15017	19523	16898	11063	7620	8245	9524	14326	14200
	7	12548	13541	13281	14625	15716	12325	6935	7632	7554	10079	15978
	8	10864	9966	9581	11229	10447	10814	5829	6972	5803	6887	9301
	9	10483	8689	7524	7567	8047	7693	6926	5237	4718	4485	5573
	10	8934	7728	6708	5934	5085	5630	5256	6310	4290	3933	3811
	11	7129	5489	4981	4028	3837	3387	2092	4152	3352	2565	2221
	12	4915	5092	3647	3291	2819	2971	1173	1735	2073	1956	1290
	13	2587	3350	4102	2433	2167	1603	594	722	824	904	759
	14	3714	1327	1925	3186	1541	2025	809	381	440	513	377
	+gp	3130	175	685	666	777	4694	570	107	45	119	17
0	TOTALBIO	91367	84747	84471	88261	77662	71981	44996	51762	51862	58848	67761

Table 8.13 (Continued)

Table 12 Stock biomass at age (start of year) Tonnes

		1997	1998	1999	2000	2001	2002	2003	2004	2005
YEAR		1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
	5	15986	13365	10445	12263	11386	12504	10990	12673	16565
	6	14056	16334	14653	12069	13942	12064	16108	12785	14536
	7	13655	15620	17884	15307	13937	14145	14555	17203	13227
	8	11443	12061	12484	13775	14208	10855	13256	12719	13881
	9	6785	10857	10180	11084	13547	12554	10777	13582	10230
	10	4917	6435	9641	9221	10270	11686	11430	9450	9841
	11	2174	2832	4179	5379	6054	7148	8324	8926	6316
	12	1325	1379	2041	3036	3756	4214	5195	7053	5926
	13	742	712	877	1175	1693	2139	2982	3879	3913
	14	658	654	649	592	918	1030	1616	2419	2669
+gp		17	292	110	276	259	878	446	2187	4734
0 TOTALBIO		71758	80542	83144	84175	89969	89216	95678	102874	101839

Table 8.14

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE											
	5	0	0	0	0	0	0	0	0	0	0	0
	6	649	701	850	968	1198	1060	1043	772	599	616	587
	7	755	748	837	1048	1221	1414	1466	1230	838	649	742
	8	6893	5498	5792	6762	8736	9469	12416	8734	6240	3987	4062
	9	15900	20330	16952	19048	23270	28018	31218	23018	17082	14888	10200
	10	16562	15223	22592	17121	21295	26201	34096	24310	20233	18243	15659
	11	12914	10704	9529	21895	15184	20496	21343	24816	18789	20565	17609
	12	9298	6594	4866	5354	16185	9631	12129	13231	16043	14150	15373
	13	5368	5452	3196	2281	2634	17415	6786	9127	8772	13746	11970
	14	3175	3306	3491	1952	838	2128	14746	3875	4226	5565	10283
	+gp	1131	697	452	282	163	707	4378	2171	2060	3388	5034
0	TOTSPBIO	72644	69254	68557	76709	90723	116540	139620	111283	94880	95795	91519

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE											
	5	0	0	0	0	0	0	0	0	0	0	0
	6	488	412	403	409	575	390	386	343	471	573	516
	7	664	545	429	411	567	370	406	353	416	398	451
	8	4174	3461	2712	2243	2684	2561	2543	2296	2443	1978	2313
	9	10096	10174	6616	6786	6302	5916	8073	6779	7168	7494	7383
	10	10571	9646	8415	6091	7417	6377	7512	8928	8104	9138	9704
	11	14341	8781	8431	7548	5278	6681	6815	6813	8913	6634	7714
	12	12258	8401	5799	5026	4904	3792	5810	5156	5718	6530	4469
	13	12551	8136	4939	3325	3908	3385	3462	4904	4136	2942	5402
	14	8448	7247	4831	2150	1638	3106	2998	1954	4113	2291	2023
	+gp	6168	5883	2747	1949	2382	2076	1581	902	1311	1275	1200
0	TOTSPBIO	79760	62686	45322	35938	35653	34654	39586	38430	42791	39253	41174

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
	5	0	0	0	0	0	0	0	103	132	131	0
	6	442	156	150	195	169	111	76	82	95	143	0
	7	376	271	133	292	314	493	416	611	529	806	1118
	8	2607	2192	2012	2021	1776	1622	1632	2231	1973	1997	2325
	9	7757	5735	3988	3708	4104	4154	4571	3561	3256	2601	3233
	10	8130	6956	5836	4747	3916	4335	4520	5237	3475	3107	3353
	11	7058	5215	4433	3585	3491	3015	1820	3654	3184	2463	2154
	12	4817	4990	3574	3291	2819	2971	1173	1631	1949	1740	1212
	13	2587	3350	4102	2433	2167	1603	594	722	824	904	759
	14	3714	1327	1925	3186	1541	2025	809	381	440	513	377
	+gp	3130	175	685	666	777	4694	570	107	45	119	17
0	TOTSPBIO	40618	30366	26838	24124	21074	25022	16182	18320	15902	14525	14548

Table 8.14 (Continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE									
	5	0	0	0	0	114	125	110	0	0
	6	0	0	0	121	418	362	322	256	436
	7	956	625	358	459	836	1414	1601	2064	1190
	8	2403	1206	874	1377	2699	3365	4507	4833	4720
	9	3596	4886	3359	4101	6638	8286	7759	10050	7570
	10	4179	5277	6363	5809	6676	9232	10059	8788	9054
	11	2043	2606	3594	4680	5085	6505	7658	8479	6127
	12	1246	1379	2021	2914	3606	4045	5039	6842	5867
	13	742	712	877	1175	1693	2117	2922	3802	3913
	14	658	654	649	592	918	1030	1584	2370	2669
	+gp	17	292	110	276	259	878	446	2187	4734
0	TOTSPBIO	15840	17636	18205	21504	28942	37359	42007	49671	46280
	1									

Table 8.15

Run title : Arctic Green.halibut (run: 2006/1)

At 26/04/2006 16:47

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA with final year & oldest age shrinkage.

	RECRUITS Age 5	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 6-10
1964	42840	172936	72644	40391	0.556	0.3146
1965	51686	171359	69254	34751	0.5018	0.2643
1966	57828	181480	68557	26321	0.3839	0.1601
1967	70443	209627	76709	24267	0.3164	0.1376
1968	64280	244355	90723	26168	0.2884	0.1309
1969	55932	274335	116540	43789	0.3757	0.1988
1970	41112	312353	139620	89484	0.6409	0.4204
1971	31550	242814	111283	79034	0.7102	0.4223
1972	33555	196238	94880	43055	0.4538	0.3019
1973	31061	180303	95795	29938	0.3125	0.2252
1974	26642	173128	91519	37763	0.4126	0.2787
1975	22540	152723	79760	38172	0.4786	0.336
1976	22098	126103	62686	36074	0.5755	0.4264
1977	23687	100799	45322	28827	0.636	0.3409
1978	20591	87145	35938	24617	0.685	0.3659
1979	19700	104900	35653	17312	0.4856	0.1911
1980	18601	86081	34654	13284	0.3833	0.172
1981	17875	92024	39586	15018	0.3794	0.1445
1982	18933	87679	38430	16789	0.4369	0.2188
1983	18988	103867	42791	22147	0.5176	0.2912
1984	17818	93117	39253	21883	0.5575	0.3384
1985	19929	92173	41174	19945	0.4844	0.3053
1986	19878	91367	40618	22875	0.5632	0.3513
1987	19443	84747	30366	19112	0.6294	0.349
1988	23000	84471	26838	19587	0.7298	0.4055
1989	20764	88261	24124	20138	0.8348	0.3182
1990	14547	77662	21074	23183	1.1001	0.4232
1991	12697	71981	25022	33320	1.3316	0.656
1992	10575	44996	16182	8602	0.5316	0.2437
1993	13000	51762	18320	11933	0.6514	0.3157
1994	18387	51862	15902	9226	0.5802	0.2657
1995	17920	58848	14525	11734	0.8079	0.3135
1996	18488	67761	14548	14347	0.9862	0.3376
1997	20761	71758	15840	9410	0.5941	0.2359
1998	18308	80542	17636	11893	0.6744	0.2364
1999	14922	83144	18205	19517	1.0721	0.3476
2000	16136	84175	21504	14437	0.6714	0.2302
2001	15387	89969	28942	16307	0.5634	0.2276
2002	18122	89216	37359	13161	0.3523	0.1735
2003	15371	95678	42007	13578	0.3232	0.1775
2004	18053	102874	49671	18800	0.3785	0.2137
2005	24762	101839	46280	19248	0.4159	0.232
Arith. Mean	25672	120439	48756	25225	0.5801	0.2866
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

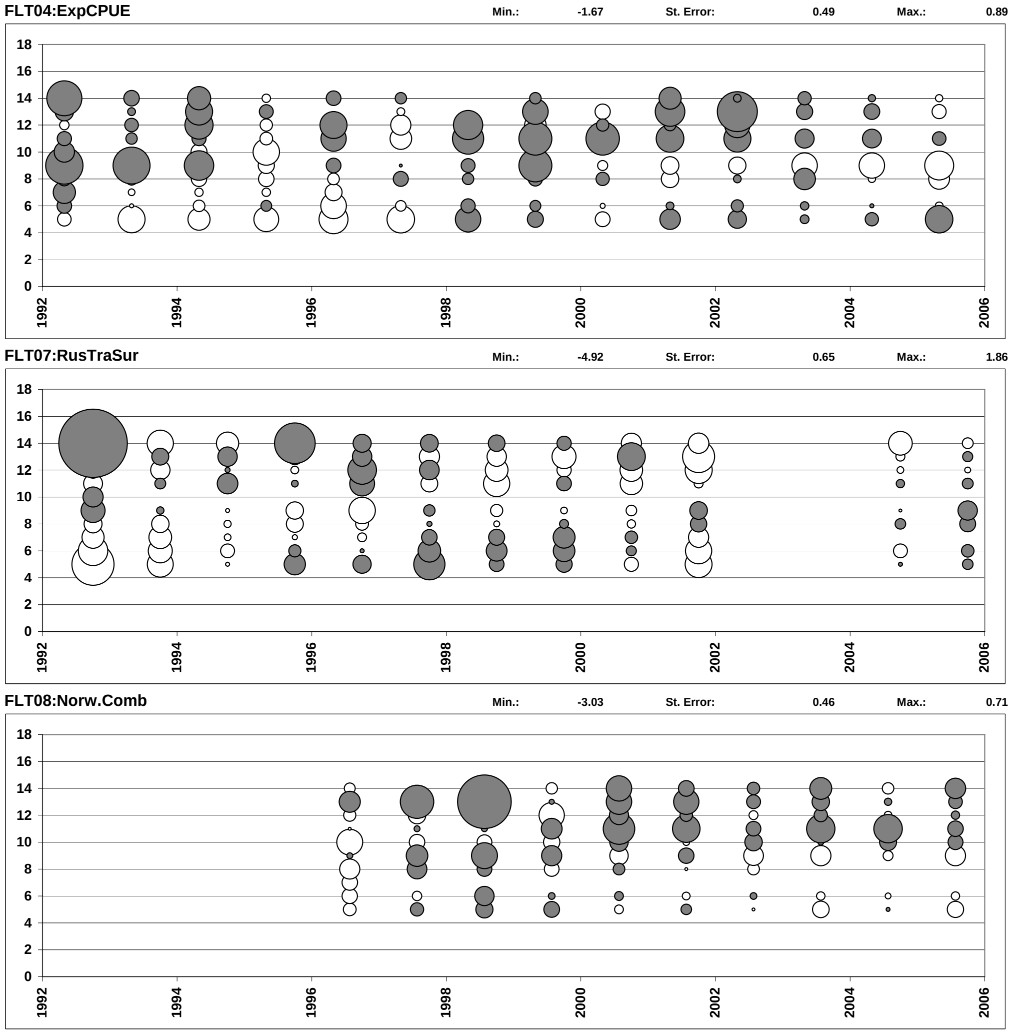

Figure 8.1. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.

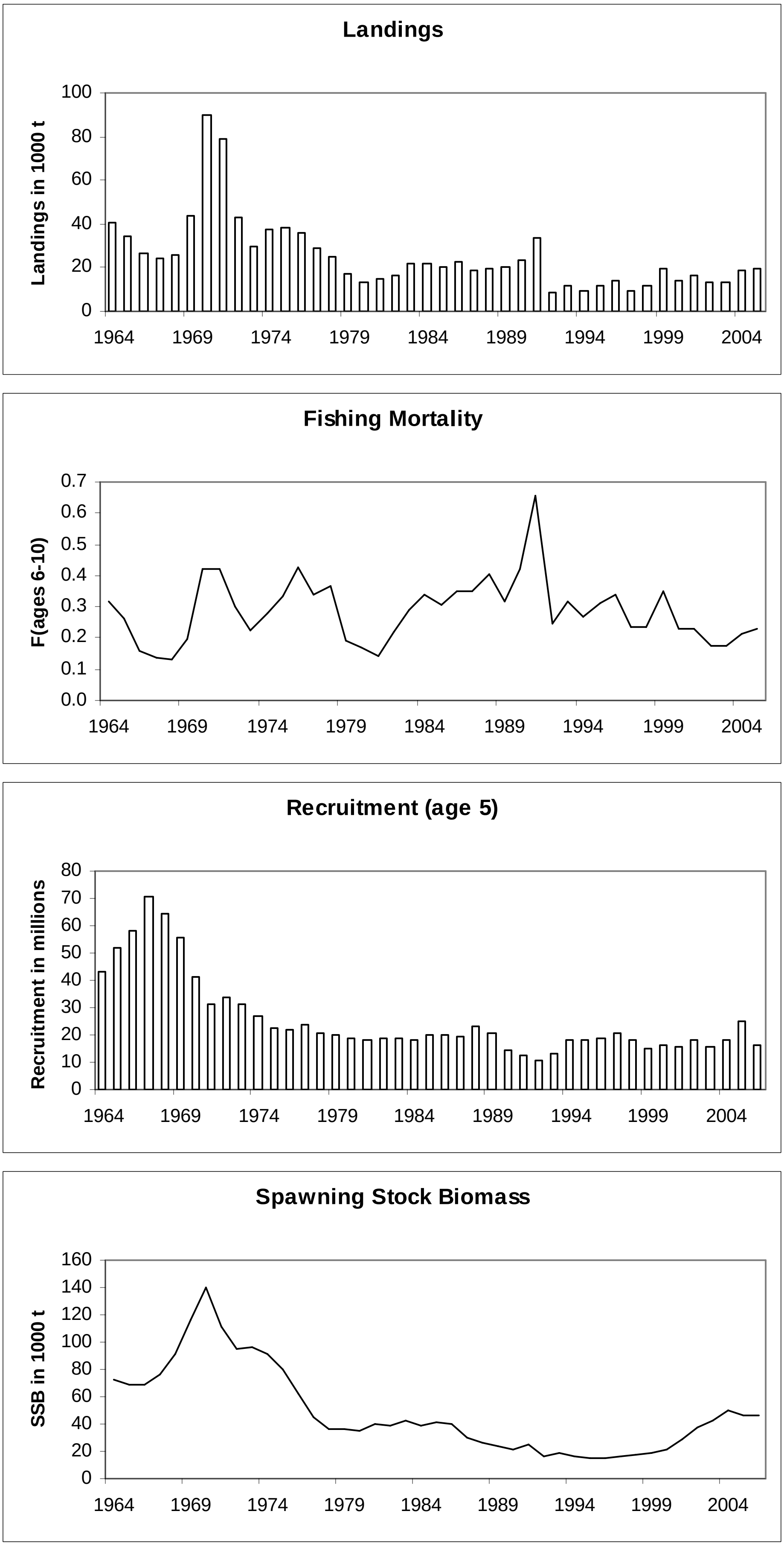

Figure 8.2. Historical landings, recruitment, fishing mortality and spawning stock biomass.

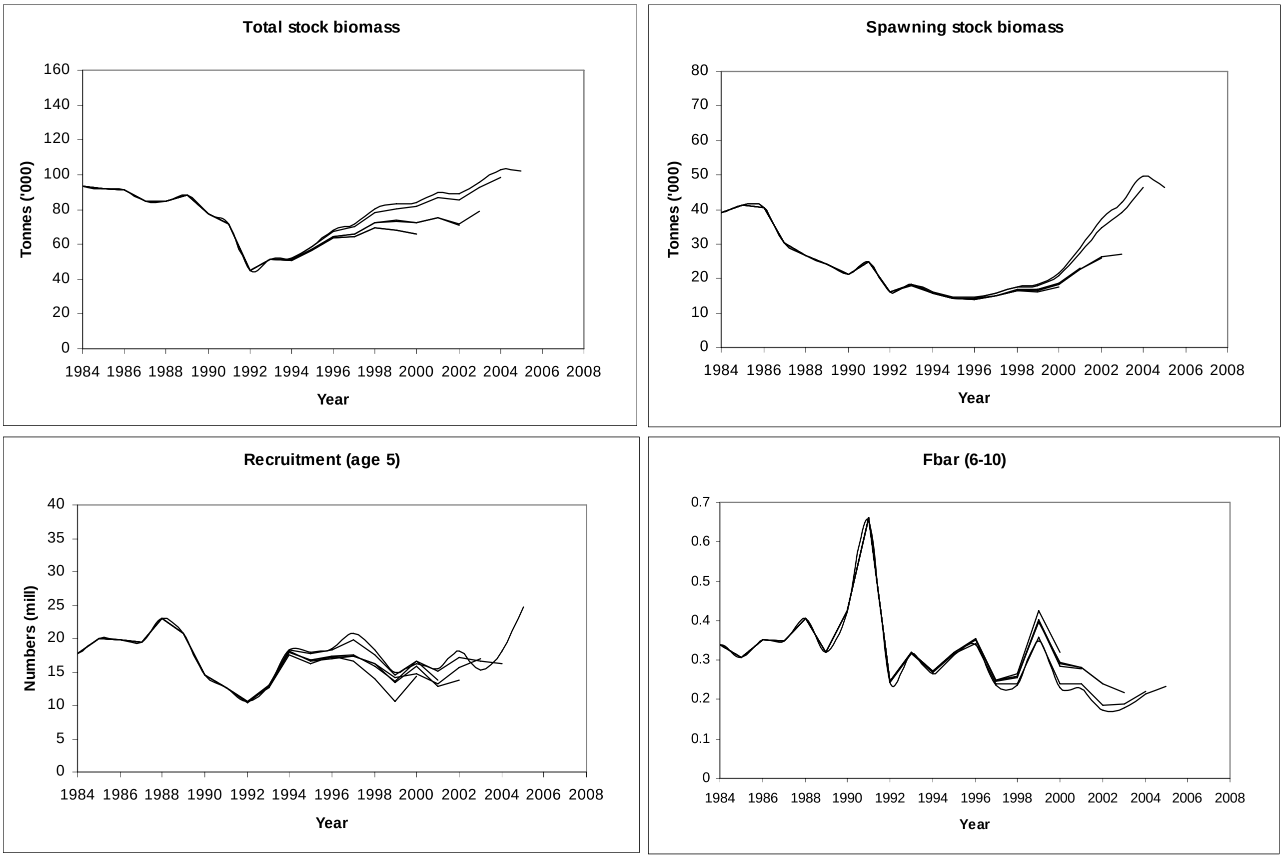

Figure 8.3. Retrospective plots.

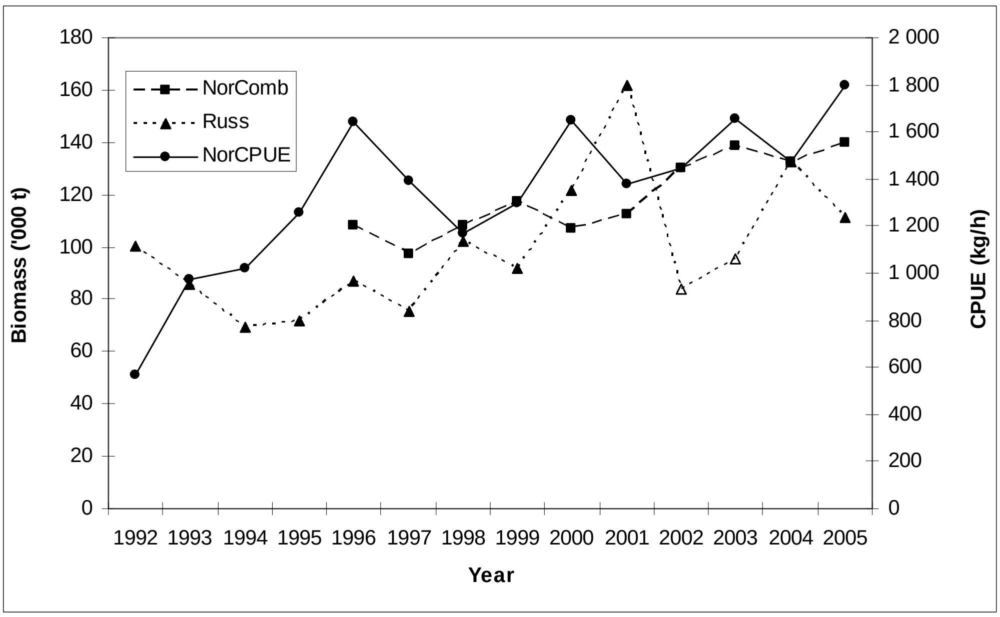

Figure 8.4. Biomass estimates from the tuning series used in the assessment. Years with open symbols in the Russian series excluded from the tuning.

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										20 100
1982	0.7					No age data					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.

Not updated, new ecosystem survey

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.

Not updated, new ecosystem survey

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
2004	0	5	328	3 637	6 962	12 909	20 674	8 692	3 771	3 908	1 663	2 886	1 276	865	641	68 217
2005	3	24	2 036	9 170	10 195	13 477	8 785	7 683	4 611	4 388	2 500	2 250	995	401	693	67 210

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	Age						Total
Year	1	2	3	4	5	6+	
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
2004[1]	15 257	28 540	48 286	12 598	3 562	1 153	109 396
2005[1]	138 248	23 689	25 989	32 052	6 735	893	227 606

B	Age						Total
Year	1	2	3	4	5	6+	
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				
2004[1]	23 560	47 023	77 374	14 081	3 719	1 232	166 989
2005[1]	253 127	40 975	40 231	40 858	6 955	893	383 039

[1] From 2004 part of the new joint ecosystem survey.

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 (from 2004 two of them are part of the joint ecosystem survey covering the whole Barents Sea) combined to one index (in thousands).

A: Old strata system used B: Ecosystem survey combined with Norw. GrHal survey

A	Age															Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
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
2004	17 233	29 072	50 471	17 112	13 233	16 459	24 970	9 753	4 568	4 170	1 963	3 042	1 460	865	726	195 096
2005	153 834	29 173	32 072	46 345	24 680	20 381	14 189	9 919	5 261	4 929	2 709	2 392	1 242	540	776	348 443

B	Age															Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
2004	16 513	37 564	56 050	12 858	11 967	18 047	25 933	10 060	4 974	4 413	2 151	3 600	1 276	865	641	206 912
2005	182 754	40 350	40 139	40 760	25 334	21 739	15 320	10 504	5 594	5 131	2 967	2 494	1 249	686	758	395 780

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
2004	3 305	8 342	9 461	21 834	22 876	14 187	8 331	3 776	2 544	1 745	1031	811	966	99 209
2005	2 096	7 668	11 657	17 933	20 555	14 140	4 658	3 264	1 844	1 585	789	554	420	87 164

[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 1997-2004.

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
2004	153 859	135 631	320 485	283 965
2005	144 573	134 566	317 320	313 459

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	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
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	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
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
2005	259	300	2 318	1 512	4 106	3 554	5 373	2 072	862	278	372	305	824	22 135
2006	45	46	1 119	5 518	6 912	5 640	1 353	603	562	321	365	61	115	22 660

[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 1992-2005. 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	2004	2005
1														
2														
3	0.1			0.1		0.0	0.0	0.0					0.1	0.2
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	1.4	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	8.9	5.4
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	18.9	20.4
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	31.3	25.4
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	14.8	21.5
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	9.5	8.2
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	4.7	6.5
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	4.0	3.1
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	3.5	4.0
13	0.5	0.4	0.2	0.3	0.0	0.3		0.2	0.6	0.3	0.2	1.2	1.5	2.1
14	0.2	0.2	0.1	0.2	0.1	0.2		0.2	0.0	0.2	0.4	0.5	0.9	1.0
15	0.1					0.0		0.0	0.0	0.2	0.1	0.0	0.4	0.5

	Mean individual weight (kg)													
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0.26			0.40		0.39							0.27	0.24
4	0.50	0.53	0.52	0.47	0.48	0.45	0.41	0.51	0.50	0.60	0.44	0.48	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	0.65	0.64
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	0.88	0.84
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	1.17	1.14
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	1.43	1.40
9	2.00	2.28	2.23	2.03	2.00	1.87	2.26	2.18	1.90	1.84	1.69	1.97	1.73	1.67
10	2.46	2.65	2.55	2.50	2.50	2.34	2.54	2.38	2.40	2.30	2.31	2.37	2.14	2.26
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	2.34	2.62
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	2.77	2.87
13	4.44	5.18	5.01	4.62		4.52		5.07	4.47	3.68	5.20	4.28	2.92	2.98
14	6.00	6.44	6.29	5.59		5.47		5.60	6.00	5.74	5.59	4.74	3.89	3.30
15	5.22								8.79	5.52	7.03	9.17	4.65	3.32

'Table E9 (Continued) GREENLAND HALIBUT in Sub-areas I and II. Results from a research program using trawlers in a limited commercial fishery 1992-2005. All areas combined. Spring and autumn combined in 1992-1993, otherwise only spring-data.

CPUE (N) on age														
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0			1	0	0	0	0	0	0	0	0	1	2
4	19	30	26	7	7	11	2	7	14	12	7	19	15	24
5	80	176	198	219	286	298	59	72	132	63	81	90	96	70
6	97	130	191	220	463	275	229	214	208	201	176	229	203	263
7	109	191	215	294	521	366	400	369	524	284	447	322	337	328
8	56	87	90	107	127	121	139	135	150	244	130	101	159	278
9	7	5	8	26	19	31	40	15	55	78	75	86	102	106
10	29	52	47	64	29	60	18	90	104	73	92	116	51	84
11	12	22	19	19	7	23	7	9	11	18	23	43	43	40
12	7	7	5	11	3	10	3	17	13	17	12	32	38	52
13	2	3	2	3	0	4	0	2	7	3	2	12	16	27
14	1	1	1	2	1	2	0	2	0	2	4	5	10	13
15	0			0	0	0	0	0	0	2	1	0	4	6

CPUE (kg) on age														
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0			0	0	0	0	0	0	0	0	0	0	1
4	10	16	13	3	4	5	1	3	7	7	3	9	6	11
5	57	134	145	153	211	207	45	53	91	41	56	61	63	44
6	93	127	182	207	435	243	220	197	204	189	164	229	179	220
7	140	254	276	364	641	423	476	461	645	318	543	411	396	373
8	99	162	161	183	211	189	249	221	236	361	181	169	228	389
9	14	11	18	53	38	59	91	32	105	143	127	169	177	176
10	70	138	121	161	73	141	46	215	250	167	213	275	109	189
11	38	75	65	64	23	68	25	30	33	54	74	138	101	104
12	28	30	20	40	11	33	11	64	53	66	48	113	105	150
13	9	15	8	13	0	16	0	9	32	11	9	52	48	79
14	5	9	5	11	0	13		10	2	10	24	23	38	43
15	2			0	0	0		0	3	11	4	4	20	20

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
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	1.37	1.39
CPUE (kg round weight per trawlhour)**	567	973	1020	1255	1640	1393	1169	1294	1647	1377	1449	1657	1475	1795
CPUE (Number fish per trawlhour)**	420	705	803	973	1464	1201	899	931	1220	998	1050	1055	1077	1291
Catch (in tonnes)	695	862	811	368	436	274	272	269	295	297	288	298	304	292

***) Preliminary**

*** *) 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	Green-land	Ire-land	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	-	+	122	576
2004[1]	-	-	-	-	-	-	413	-	90	-	503
2005[1]	-	-	2	-	-	-	58	-	4	-	64

[1] Provisional figures

9 Barents Sea Capelin

9.1 Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between Russia (former USSR) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. In recent years no autumn fishery has taken place, except for a small Russian experimental fishery. The fishery was closed from 1 May to 15 August until 1984. After 1984, the fishery was closed from 1 May to 1 September. A minimum landing size of 11 cm has been in force for several years. From the autumn of 1986 to the winter of 1991, from the autumn 1993 to the winter 1999, and in 2004-2005, no commercial fishery took place.

9.2 Catch Statistics (Table 9.1)

The international catch by country and season in the years 1965-2006 is given in Table 9.1. No commercial catches were taken during 2005and spring 2006.

9.3 Stock Size Estimates

9.3.1 Larval and 0-group estimates in 2005 (Table 9.2)

Norwegian larval surveys based on Gulf III plankton samples have been carried out in June each year since 1981. The estimated total number of larvae is shown in Table 9.2. These larval abundance estimates do not show a high correlation with year class strength at age one, but should reflect the amount of larvae produced each year (Gundersen and Gjøsæter, 1998). The year 1986 was exceptional, in that no larvae were found. This may have been due to late spawning that year, and eggs may have hatched after the survey was carried out. Also in other years some spawning is known to have taken place during the summer, and offspring from such late spawning is not reflected in the larval abundance estimates in Table 9.2. Since 1997, permission has not been granted to enter the Russian EEZ during the larval survey or permission has been granted so late that it could not be employed to good purpose, and consequently the total larval distribution area has not been covered. The estimate of $8.8 \cdot 10^{12}$ larvae in 2005 is close to the average for the period 1981-2004. A swept volume index (Dingsør, 2005) of abundance of 0-group capelin in August-September is given in Table 9.2 (see also general description, chapter 1). This index is calculated both without correction and with correction for catching efficiency correspondingly (Anon. 2005). Both 0-group indices indicate that the abundance of 0-group is below average.

9.3.2 Acoustic stock size estimates in 2005 (Table 9.3-9.4)

Two Russian and three Norwegian vessels jointly carried out the 2005 acoustic survey as part of an ecosystem-survey during autumn (Anon., 2005). The geographical coverage of the total stock was considered complete. However, it was noted (Anon, 2005) that in the eastern areas of the Barents Sea considerable amounts of capelin was detected in the trawl when no acoustic registrations were made, possibly because capelin was distributed over the transducer and/or near to the sea floor. This indicates that the acoustic estimate is an underestimate. The results from the survey are given in Table 9.3, and are compared to previous years' results in Table 9.4. The stock size was estimated at 0.32 million tonnes. About 50% (0.17 mill t) of the stock biomass consisted of maturing fish (> 14 cm).

9.3.3 Other surveys and information from 2005-2006

During a joint Norwegian-Russian bottom fish survey during February-March 2005 capelin observations were also made. Very scattered distributions of capelin were found in central and south-eastern areas of the Barents Sea. In all areas capelin were sampled as bycatch only. Acoustic estimation was not possible.

During the Norwegian bottom fish survey during February-March 2006 maturing capelin were detected in the southern Barents Sea and along the Norwegian coast from about 15º-30º E. An acoustic estimation of the prespawning capelin was made, indicating that in the order of 0.4 million tonnes of capelin were going to spawn during winter 2006. This amount is considerably more than the prognosis given during autumn 2005 based on the autumn acoustic survey. There are considerable sources of error to acoustic estimates of capelin during the winter period. Reliable estimates have never been obtained at this time of the year, but normally such estimates have been underestimates, and the main reason has been considered to be insufficient coverage of the prespawning fish migrating towards the coast. However, experiments made during recent years (Jørgensen and Olsen, 2004) have shown that the TS for capelin is dependent on depth. Consequently, the TS applied during acoustic surveys (19.1 log L –74.0 DB) may be too low in situations where capelin is found in more shallow distributions than is normally found during autumn. This would lead to overestimation when capelin is found in typical migrating schools in near surface waters.

Based on this information it is not possible to conclude whether the autumn estimate is an underestimate, the spring estimate is an overestimate, or both.

9.4 Historical stock development (Tables 9.5-9.11)

An overview of the development of the Barents Sea capelin stock in the period 1996-2005 is given in Tables 9.5-9.11. The methods and assumptions used for constructing the tables are explained in Appendix A to ICES CM1995/Assess: 9. In that report, the complete time series back to 1973 can also be found. It should be noted that several of the assumptions and parameter values used in constructing these tables differ from those used in the assessment. For instance, in the assessment model the M-values for immature capelin are calculated using new estimates of the length at maturity and M-values for mature capelin are calculated taking the predation by cod into account. This will also affect the estimates of spawning stock biomass given in the stock summary table (Table 9.11). It should be noted that these values, coming from a deterministic model cannot directly be compared to those coming from the probabilistic assessment model (Bifrost, Gjøsæter *et al.* 2002) used for this stock. However, as a crude overview of the development of the Barents Sea capelin stock the tables may be adequate.

Estimates of stock in number by age group and total biomass for the period are shown in Table 9.5. Catch in numbers at age and total landings are shown for the spring and autumn seasons in Tables 9.6 and 9.7. Natural mortality coefficients by age group for immature and mature capelin are shown in Table 9.8. Stock size at 1 January in numbers at age and total biomass is shown in Table 9.9. Spawning stock biomass per age group is shown in Table 9.10. Table 9.11 gives an aggregated summary for the entire period 1973-2005.

9.5 Reference points

A B_{lim} (SSB_{lim}) management approach has been suggested for this stock (Gjøsæter et al. 2002). In 2002, the Mixed Russian-Norwegian Fishery Commission agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 t of capelin should be allowed to spawn. Consequently, 200 000 t was used as a B_{lim}. There is clearly also a need for a target biomass reference point for capelin, and calculations of B_{target} are also in progress.

9.6 Stock assessment autumn 2005

As decided by the Arctic Fisheries Working Group at its 2005 meeting (ICES 2005), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk. In accordance with this, the assessment was made on board R/V "G.O. Sars" at the end of the autumn survey, and reported directly to ACFM autumn meeting in October 2005.

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2006 was made using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL). The projection was based on a maturation and predation model with parameters estimated by the model Bifrost and data on cod abundance and size at age from the 2005 Arctic Fisheries Working Group. The methodology is described in "Stock assessment methodology for the Barents Sea capelin", WD1 to the capelin assessment meeting in autumn 2005 (WD 8 to AFWG 2006).

Probabilistic prognoses for the maturing stock from October 1 2005 until April 1 2006 were made, with a CV of 0.20 on the abundance estimate. With no catch, the estimated mean spawning stock size in 2006 is 72,000 tonnes. The simulations also indicate that with no catch, the probability for the spawning stock in 2006 to be below 200 000 t the $\mathbf{B}_{\mathrm{lim}}$ value used by ACFM in recent years is > 95 %.

Capelin recruitment in 2006 could be seriously negatively affected by the large stock of young herring now found in the Barents Sea. The abundance of young herring in the Barents Sea is expected to be high also in 2006 (ICES 2006), for a more detailed analysis of this, see in WD1 to the capelin assessment meeting in autumn 2005 (WD # to AFWG 2006)

9.7 Regulation of the fishery for 2006

During its Autumn 2005 meeting, the Mixed Russian-Norwegian Fishery Commission decided that no fishing should take place on Barents Sea capelin for the winter season 2006.

9.8 Management advice for the fishery in 2007

Since the assessment of the stock is directly based on the acoustic survey conducted annually in September-October, and the main fishing season does not begin until January, advice for this stock must be given during the autumn ACFM meeting and the TAC must be set by the Mixed Norwegian-Russian Fishery Commission during its meeting in November-December. As previously decided by the Arctic Fisheries Working Group, the assessment of Barents Sea capelin is left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who will meet in Kirkenes in October 2006 and reported directly to the 2006 ACFM autumn meeting.

9.9 Predicting the capelin stock 1.5 year ahead

9.9.1 Introduction

Previously, the CapTool model gave a prognosis for the mature part of the stock from the survey in September in year *Y* until the spawning next spring (1 April year *Y+1*). In 2002, this model was enhanced, by including a prognosis of the immature part of the capelin stock up to 1 October in year *Y+1*, to be able to give a forecast of the spawning stock at 1 April in year *Y+2*. This prognosis was made by repeating the first step but basing the calculations on the stock prognosis by 1 October year *Y+1* instead of the survey. As a by-product of this model enhancement, a prognosis of the total stock at 1 January year *Y+2* is produced.

The method for predicting the stock by 1 October in year *Y+1* from the stock at 1 October in year *Y* was evaluated by Bogstad et al. (2005a). In 18 out of the 23 years the observed stock sizes are within the 90% confidence interval of the predictions. It is found that there is a tendency for overestimating stock size in periods when the stock decreases and vice versa. The ratio between predicted and observed stock sizes is variable and some times quite high for stock sizes below one million tonnes (collapsed stock size) but varies between about 0.5 and 1.5 and is unrelated to stock size for larger stock sizes. The model can be further improved by relating capelin growth to capelin stock size, prey abundance or environmental conditions (Bogstad et al. 2005b).

9.9.2 Methodology

The 1.5-year prognosis is based on a number of assumptions, of which the most important are:

- The parameters in the maturation function (needed to split the total stock measured in autumn into an immature and a mature part) were estimated based on data from the time series 1972-1980, a period where the natural mortality was rather constant.
- Annual values of the natural mortality of immature capelin is estimated together with the parameters in the maturation function (because these are interdependent) from survey data. For prognostic runs, natural mortality for immature capelin is drawn randomly from historic values. Natural mortality of mature capelin during the autumn period is set equal to that of immature capelin.
- The natural mortality of mature capelin during the period 1 January to 1 April is estimated from the predicted consumption by cod, in the same way as for 0.5 year prognostic runs.
- Total spawning mortality is assumed.
- The recruitment (number of one-year-olds in year *Y+1*) is estimated from a regression between the number of 1-group of capelin and the 0-group index (see section 9.9.3)
- The length growth and weight-at-length in prognostic runs are randomly drawn from the time series for the period 1981-2005. The length distribution of age 1 capelin in year *Y+1* is drawn at random from the time series of length distributions of 1-year-olds. The individual growth in length (cm/year) for each age group is calculated from values obtained by comparing the mean length at age of immature capelin one year with the mean length at age of the total stock next year. The length growth is implemented by shifting the distribution of immature capelin upwards with the number of 0.5cm length intervals, which corresponds to the growth in length, for each age group and year.
- The capelin length-weight relationship for use in the 1-year prediction is drawn randomly from historical data for the period 1981-2005.
- No weight increase during winter (1 October to 1 April) is assumed.
- Zero catch is assumed.

9.9.3 Recruitment (Figure 9.1)

Gundersen and Gjøsæter (1998) established a linear regression between the logarithms of the 0-group area based indices and the logarithm of the 1-group acoustic abundance 1 year later. The period after 1981 was chosen. The reason for this is that before 1981, the coverage of 1-group capelin during the acoustic survey was incomplete (Gjøsæter et al., 1998). This regression has been annually updated with new data, and used in the predictions of capelin stock size. Revised 0-group indices from Anon. (2005) are now available for the period 1980-2005. Using these indices (without or with correction for length-dependent selectivity in the trawl), we found that a linear regression gave better fit than a log-log regression. The new regressions, using data from the 1981-2004 year classes, are shown in Fig. 9.1. They both gave the same coefficient of determination (0.5), and since the index series without correction for length-dependent selectivity is at present considered as the official one, that series was used in the further calculations. To include uncertainty into the prognosis for 1-group capelin, the replicates of capelin of age 1 in 2006 were constructed by bootstrapping. From the 24 pairs of 0-group/1-group data from the year classes 1981-2004 24 new pairs of data were drawn at random with equal probability. These data were used in a new regression, and from the new regression the number of 1-year-old capelin in 2006 was calculated from the 0-group value in 2005. This procedure was repeated 1000 times. In order to avoid bias, the regressions were forced through the origin.

9.9.4 Results (Table 9.12, Figure 9.2)

The prognoses are given in Table 9.12 and in Figure 9.2. The stock size will, according to this prognosis remain at a low level during 2006, and the SSB in 2007 will also be low.

9.10 Sampling

The sampling from scientific surveys of capelin in 2005 and winter 2006 is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Capelin larval survey, May-June 2005	7	372	119
Acoustic survey autumn 2005 (Norway)	338	10155	2600
Acoustic survey autumn 2005 (Russia)	220	12470	1077
Russian bottom fish survey, November 2005	14	3526	150
Norwegian capelin investigations winter 2006	227	6840	2232

Table 9.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	156	20	704	31	195	226	929
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	1	1
1998	0	0	0	0	0	1	1	1
1999	50	32	0	82	0	23	23	105
2000	279	95	8	382	0	28	28	410
2001	376	180	8	564	0	11	11	575
2002	398	228	17	643	0	16	16	659
2003	180	93	9	282	0	0	0	282
2004	0	0	0	0	0	0	0	0
2005[1]	1	0	0	1	0	0	0	1
2006	0	0	0	0				

Table 9.2 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group indices (10^{12}) in August-September.

Year	Larval abundance	New 0-group Index (10^{12} ind.)[1]	
		without K eff	with K eff
1980	-	217.5	809.2
1981	9.7	110.1	428.3
1982	9.9	181.1	611.7
1983	9.9	100.8	332.3
1984	8.2	73.2	168.7
1985	8.6	24.2	73.4
1986	0.0	13.5	56.5
1987	0.3	.6	2.3
1988	0.3	28.8	92.1
1989	7.3	258.7	881.8
1990	13.0	36.0	115.2
1991	3.0	55.9	164.8
1992	7.3	.1	.3
1993	3.3	.3	.8
1994	0.1	9.2	21.0
1995	0.0	.6	2.1
1996	2.4	47.1	143.8
1997	6.9	57.6	196.0
1998	14.1	35.9	88.0
1999	36.5	88.9	295.0
2000	19.1	39.4	140.1
2001	10.7	5.2	19.9
2002	22.4	20.7	21.9
2003	11.9	130.7	458.9
2004	2.5	20.7	69.3
2005	8.8	47.3	154.7
Average	8.6	61.7	205.7

Table 9.3. Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September 2005. Based on TS value 19.1 log L –74.0 dB, corresponding to σ = 5.0 · 10^7 · $L^{1.91}$.

Length (cm)			Age/Year class				Sum	Biomass	Mean
			1	2	3	4+	(10^6)	(10^3 t)	weight (g)
			2004	2003	2002	2001-			
6.5	-	7.0	797				797	0.8	1.0
7.0	-	7.5	1559				1559	1.6	1.0
7.5	-	8.0	2148				2148	3.5	1.6
8.0	-	8.5	1592				1592	1.6	1.0
8.5	-	9.0	1687				1687	2.0	1.2
9.0	-	9.5	1745				1745	4.6	2.7
9.5	-	10.0	2457	3			2460	8.1	3.3
10.0	-	10.5	4030	5			4035	16.9	4.2
10.5	-	11.0	4542	72			4613	22.2	4.8
11.0	-	11.5	3169	3			3172	17.6	5.5
11.5	-	12.0	2555	326			2880	17.7	6.1
12.0	-	12.5	453	405			858	6.5	7.6
12.5	-	13.0	86	1287	10		1382	12.0	8.7
13.0	-	13.5	0	1346	21		1367	13.8	10.1
13.5	-	14.0	85	1710	39		1834	21.1	11.5
14.0	-	14.5	12	1783	56		1851	24.5	13.2
14.5	-	15.0	21	1843	99	4	1966	30.4	15.5
15.0	-	15.5		1746	202	2	1950	33.5	17.2
15.5	-	16.0		1138	530	1	1668	32.2	19.3
16.0	-	16.5		762	333	13	1109	24.5	22.1
16.5	-	17.0		452	209	31	693	16.8	24.3
17.0	-	17.5		98	153	4	255	7.2	28.3
17.5	-	18.0		44	85	2	131	3.7	28.6
18.0	-	18.5		2	25	10	37	1.2	33.5
18.5	-	19.0				1	1	0.0	34.3
19.0	-	19.5				1	1	0.0	37.3
TSN (10^6)			26938	13025	1762	69	41794		
TSB (10^3 t)			99.6	185.9	36.8	1.7		324.0	
Mean length (cm)			9.9	14.4	16.0	16.8	11.5		
Mean weight (g)			3.7	14.3	20.8	25.8			7.8
SSN (10^6)			33	7868	1692	69	9662		
SSB (10^3 t)			0.5	136.0	36.0	1.7		174.3	

Based on TS value: 19.1 log L - 74.0, corresponding to σ = 5.0 · 10^{-7} · $L^{1.9}$

Table 9.4 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass and biomass of the maturing component. Stock in numbers (unit:10^9) and stock and maturing stock biomass (unit:10^3 tonnes) are given at 1. October.

Year	Stock in numbers (10^9)						Stock in weight (10^3 t)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290
2003	82	10	11	1	0	104	533	280
2004	51	25	6	1	0	82	628	294
2005	27	13	2	0	0	42	324	174

Table 9.5Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. August, back-calculated from the survey in September-October.

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	88.9	111.8	188.4	171.4	474.7	128.0	62.0	111.7	62.5	32.9
2	12.5	44.2	76.5	111.5	116.8	246.6	94.2	13.0	30.3	16.4
3	2.2	2.2	12.1	27.9	35.9	33.0	60.2	14.5	6.9	2.5
4	0.1	0.1	0.7	0.9	0.8	1.2	0.7	1.9	0.8	0.1
5	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.0
Sum	103.7	158.3	277.8	311.7	628.4	408.8	217.1	141.1	100.6	51.9
Biomass	467	866	1860	2580	3840	3480	2145	700	724	389

Table 9.6 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the spring season.

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.2	0.5	0.4	0.0	0.0	0.0
3	0.0	0.0	0.0	1.6	5.5	7.6	10.0	2.1	0.0	0.0
4	0.0	0.0	0.0	1.2	8.4	12.1	14.2	10.8	0.0	0.0
5	0.0	0.0	0.0	0.1	1.0	2.2	0.7	1.4	0.0	0.0
Sum	0.0	0.0	0.0	3.0	15.1	22.5	25.3	14.3	0.0	0.0
Landings	0	0	0	78	386	557	635	282	0	0

Table 9.7 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the autumn season.

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.9	0.9	0.4	0.3	0.0	0.0	0.0
3	0.0	0.0	0.0	0.2	0.4	0.2	0.6	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.1	1.6	1.5	0.6	0.9	0.0	0.0	0.0
Landings	0	1	1	23	28	11	16	0	0	0

Table 9.8 Barents Sea CAPELIN. Natural mortality coefficients (per month) for immature fish (Mimm), used for the whole year, and for mature fish (per season) (Mmat) used January to March, by age group and average for age groups 1-5.

	1996		1997		1998		1999		2000	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.041	0.122	0.062	0.185	0.026	0.077	0.047	0.142	0.028	0.083
2	0.041	0.122	0.062	0.185	0.026	0.077	0.047	0.142	0.028	0.083
3	0.041	0.122	0.062	0.185	0.071	0.212	0.025	0.074	0.026	0.079
4	0.050	0.149	0.014	0.041	0.071	0.212	0.025	0.074	0.026	0.079
5	0.050	0.149	0.014	0.041	0.071	0.212	0.025	0.074	0.026	0.079
Avr	0.043	0.133	0.042	0.127	0.053	0.158	0.034	0.101	0.027	0.080

Table 9.8 (Continued)

	2001		2002		2003		2004		2005	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.060	0.180	0.019	0.056	0.152	0.456	0.100	0.300	0.100	0.300
2	0.060	0.180	0.019	0.056	0.152	0.456	0.100	0.300	0.114	0.342
3	0.040	0.120	0.091	0.273	0.140	0.421	0.100	0.300	0.180	0.540
4	0.040	0.120	0.091	0.273	0.140	0.421	0.100	0.300	0.180	0.540
5	0.040	0.120	0.091	0.273	0.140	0.421	0.100	0.300	0.180	0.540
Avr	0.048	0.144	0.062	0.186	0.145	0.435	0.100	0.300	0.151	0.452

Table 9.9 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. January.

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	118.2	172.0	225.5	238.5	576.1	194.7	70.5	323.8	126.0	66.3
2	5.7	72.5	82.2	165.8	135.3	413.3	94.6	85.4	6.1	18.4
3	6.5	10.2	32.5	67.3	88.1	100.9	182.6	38.2	7.2	4.2
4	1.4	1.8	1.6	8.5	24.7	31.1	27.0	0.4	0.9	0.5
5	0.3	0.1	0.1	0.5	0.8	0.7	0.9	0.0	0.0	0.0
Sum	132.2	256.6	341.9	480.6	824.9	740.6	375.7	447.8	140.2	89.4
Biomass	313	779	1240	2456	3571	4558	3490	2151	430	450

Table 9.10 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0	0	0	0	0	0	0	0	0	0
2	3	1	1	2	24	5	0	192	27	98
3	71	175	217	650	819	943	733	567	117	63
4	24	49	34	193	472	539	267	0	19	8
5	7	2	2	10	0	0	6	0	0	1
Sum	105	228	254	856	1315	1487	1007	759	163	170

Table 9.11 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1 year old fish, unit:10^9) and stock biomass ('000 t) given at 1. August. Spawning stock ('000 t) at time of spawning (1. April). Landings ('000 t) are the sum of the total landings in the two fishing seasons within the year indicated.

Year	Stock biomass August 1	Maturing biomass survey Oct. 1	Recruit-ment Age 1, August 1	Spawning stock biomass, assessment model	Landings
1965					224
1966					389
1967					409
1968					537
1969					680
1970					1314
1971					1392
1972	5831	2182			1592
1973	6630	1350	1140	33	1336
1974	7121	907	737	*	1149
1975	8841	2916	494	*	1439
1976	7584	3200	433	253	2587
1977	6254	2676	830	22	2987
1978	6119	1402	855	*	1916
1979	6576	1227	551	*	1783
1980	8219	3913	592	*	1648
1981	4489	1551	466	316	1986
1982	4205	1591	611	106	1760
1983	4772	1329	612	100	2358
1984	3303	1208	183	109	1477
1985	1087	285	47	*	868
1986	157	65	9	*	123
1987	107	17	46	34	0
1988	361	200	22	*	0
1989	771	175	195	84	0
1990	4901	2617	708	92	0
1991	6647	2248	415	643	929
1992	5371	2228	396	302	1123
1993	991	330	3	293	586
1994	259	94	30	139	0
1995	189	118	8	60	0
1996	467	248	89	60	0
1997	866	312	112	85	1
1998	1860	931	188	94	1
1999	2580	1718	171	382	106
2000	3840	2099	475	599	414
2001	3480	2019	128	626	568
2002	2145	1290	62	496	651
2003	700	280	112	427	282
2004	724	293	63	94	0
2005	389	174	33	122	1
Average	3466	1270	328	223	844

Table 9.12 Prognosis for capelin biomass, thousand tonnes:

Date	Median	5%	95%
1 October 2006 immature	532	320	792
1 October 2006 maturing	131	13	386
1 January 2007 maturing	122	7	399
1 April 2007 spawning	60	3	201

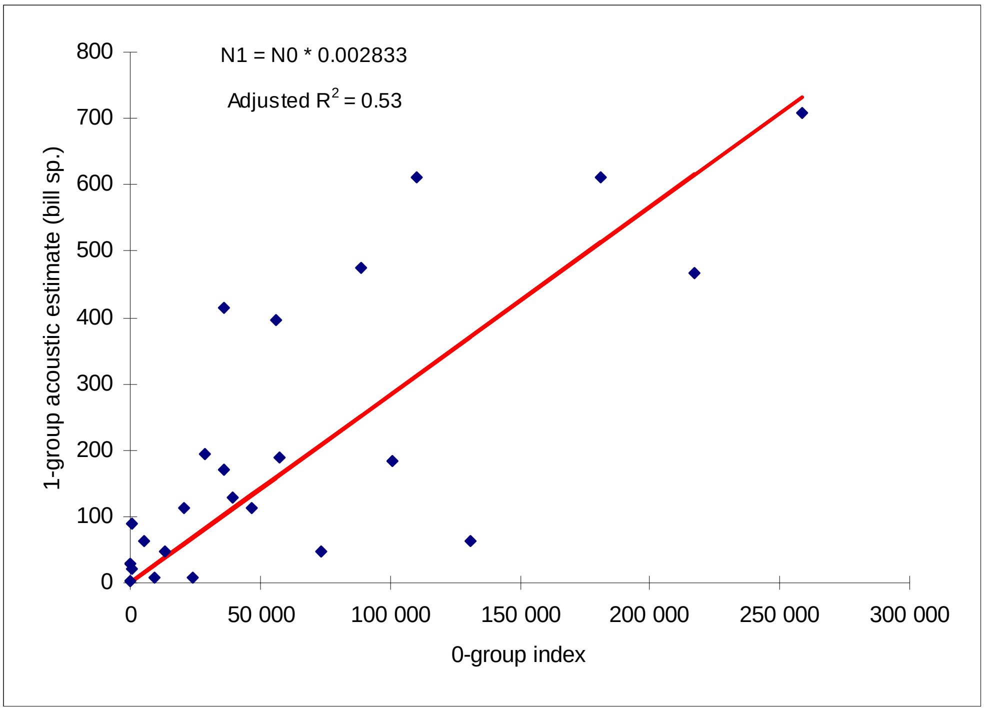

Figure 9.1. Regression of abundance of capelin at age 0 (0-group index without K_{eff}) and age 1 (acoustic estimate) of year classes 1981-2004. The regression line is forced through the origin, to avoid systematic overestimation of weak year classes.

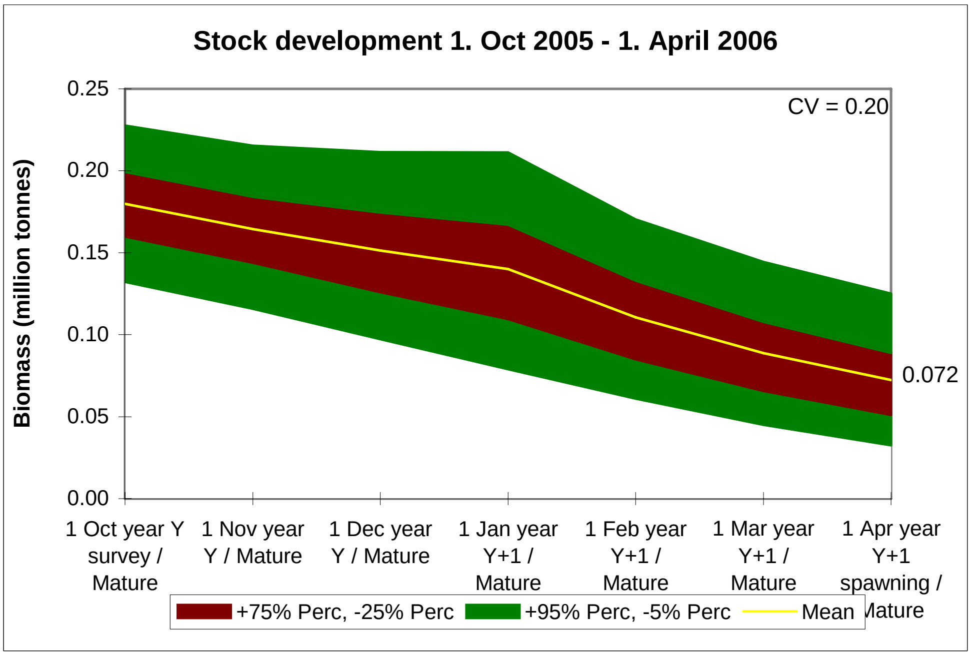

Figure 9.2. Capelin prognosis from 1 Oct 2005 to 1 Apr 2006 with no catch during the period.

10 Working documents

WD#	Title	Authors
1.	Cod bycatches in the Barents Sea shrimp fishery during 1983-2005	Ajiad, A., Aglen, A., Nedreaas K. and Kvamme, C.
2.	Short status of the results from the Norwegian-Russian cod and haddock comparative age readings	Nedreaas K.H. and Yaragina N.A.
3.	Some results from the annual Norwegian-Russian cod comparative age readings	Yaragina N.A. and Nedreaas K.H.
4.	Evaluation of 'Status report for 2005- "Russian cod and haddock fishing/reloading at sea"'	S. Aanes and K. Nedreaas
5.	Some information about unreported landings of cod fished in the Barents Sea 'loop-hole', and the Norwegian Coast Guard inspections and reactions in 2005	Nedreaas, K.H.
6.	Estimated bycatch of haddock (Melanogrammus aeglefinus) and Greenland halibut (Reinhardtius hippoglossoides) in the Barents Sea shrimp fishery during 2000-2005	Kvamme, C., Ajiad, A., Aglen, A., and Nedreaas K.
7.	The Barents Sea capelin stock	Gjøsæter, H., Bogstad, B., Røttingen, B.
8.	Stock assessment methodology for the Barents Sea capelin.doc	Anon. (Assessment group on BS Capelin autumn 2005)
9.	Northeast Arctic cod stock assessment by means of ISVPA model	Bulgakova T. and Vasilyev D.
10.	Management Strategies for Northeast Arctic Saithe - should predation on herring be taken into account?	Mehl, S., Røttingen, I. and Sandberg, P.
11.	The Spanish NE Arctic Cod Fishery in 2005	Casas, J. M. and H. Murua
12.	Spanish bottom trawl survey *Fletán ártico 2005* in the slope of Svalbard area, ICES Division IIb	Paz, X., C. González and E. Román
13.	Timely Evaluation of Stock Status Based on Scientific Surveys	Pennington, M. and Nakken, O.
14.	Acoustic abundance of saithe, coastal cod and juvenile herring Finnmark – Møre Autumn 2005	Aglen, A., Berg, E., Mehl, S. and Sunnanå, K.
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19.	New combination of maturity observations of cod in the Lofoten survey and Barents Sea winter survey	Aglen, A.
20.	Cod Consume Capelin	Johannesen, E., Johansen, G. O., Bogstad, B., Mehl, S., Tjelmeland, S. and Dolgov, A.
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Annex 2: Recommendations

Establishment of a permanent multispecies working group

The Study Group on Multispecies Assessments in the North Sea (SGMSNS) met at ICES headquarters 20-25 February 2006. The report from SGMSNS became publicly available just before the start of the AFWG meeting. Some of the conclusions and recommendations of SGMSNS are highly relevant to the work of AFWG, and thus AFWG would like to comment on some of these.

SGMSNS advises that a permanent and wide-ranging Working Group on Multispecies Assessment (WGMA) be established to meet annually, with the first meeting in San Sebastian for 5-7 days in autumn 2007. AFWG strongly supports this initiative, and the date and site suggested for the first meeting is suitable.

AFWG suggests some changes/addition to the ToRs suggested by SGMSNS. A more suitable name for the new group could be Working Group on Multispecies Assessment Methods (WGMAM), as we believe that the working group should focus on methodological aspects, but leave use of multispecies models in annual assessments and management advice to the assessment working groups.

We suggest the following terms of reference for the first meeting:

a) Examine the status of multispecies modelling efforts throughout the ICES region, i.e. Bay of Biscay, Mediterranean Sea, Iceland, Barents Sea, North Sea, Baltic Sea (based e.g. on results from the EU-funded BECAUSE project), as well as in other areas;

b) Evaluation of region-specific stomach sampling survey designs and preparation of standardized guidelines and operation manuals.

c) Collate an overview of existing stomach contents data for those of the areas mentioned in (a) where such an overview does not already exist.

d) Investigate the potential implications of a decline in forage fish for dependent predators (fish, marine mammals, seabirds), and the implications for prey stocks of recovering fish predator populations.

e) Investigate precautionary reference points and harvest control rules in a multispecies context

Annex 3: Quality Handbook ANNEX:cod-coastal

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:	27-04-06…

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: 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: Average of the three last years.

Weight at age in the catch: Average of the three last years.

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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Annex 4: Quality Handbook ANNEX:_afwg-ghl-arct

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), with the highest concentrations from 500 to 800 m depth between Norway and Bear Island, which is also regarded as the main spawning area (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 (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 (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

None

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Annex 5: Quality Handbook ANNEX:__afwg-saithe

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North-East Arctic Saithe
Working Group:	Arctic Fisheries Working Group
Date:	26.04.2006

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 purse seine and trawl fisheries accounting for 60% in 2000 have dominated the fishery. 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. Landings of saithe were highest in 1970-1976 with an average of 238,000 t and a maximum of 274,000 t in 1974. Catches declined sharply after 1976 to about 160,000 t in the years 1978-1984. 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. Another decline followed and from 1985 to 1991 the landings ranged from 70,000-122,000 t. An increasing trend was seen after 1990 to 171,348 t in 1996. Since then the annual landings have been between 136,000 and 162,000 t. In recent years quotas have regulated the purse seine and trawl fisheries 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. In the 1996-2004 assessments, an ogive based on analyses of spawning rings in otholiths for the period 1973-1994 was applied for all years. The analysis showed a lower maturation in the last part of the period, and some extra weight was given to this part when an average ogive was calculated. Before the 2005 WG a large number of otholiths with missing information on spawning rings were re-read, and new analyses were done for the period 1985-2004. The average for the period 1985-2004 is presented in the text table below together with the ogive applied until 2005.

AGE GROUP	2	3	4	5	6	7	8	9	10	11+
Until 2005	0	0	0.01	0.55	0.85	0.98	1	1	1	1
1985-2004	0	0	0.08	0.51	0.76	0.90	0.94	1	1	1

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. Before the 2005 WG the 6+ group from the Norwegian acoustic survey was split into individual age groups 6 – 9 by rerunning the original acoustic abundance estimates. This was only possible to do for the years back to 1994

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.

Autumn 2003 the saithe- and coastal cod surveys were combined. However, until new time series can be established, the estimation of abundance indices is done very much in the same way as before and the results should be comparable.

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.

The quality and performance of the purse seine tuning fleet has been discussed several times in the WG. The effort, measured as number of vessels participating, has been highly variable from year to year. This has been partly taken care of by only including vessels with total catch > 100 tonnes. However, with a restricting and changing TAC and transfer of quota, the CPUE may change much from year to year without really reflecting trends in the saithe availability. This is also reflected in the tuning diagnostics of exploratory runs. There are rather large and variable log q residuals and large S.E. log q for all age groups except age 4, which is the dominant age group in the purse seine landings in many years. And even the S.E. log q for age 4 is higher than in the Norwegian trawl CPUE and acoustic survey indices single fleet tunings. There are strong year effects, and in the combined tuning the purse seine series get low scaled weights. Mainly based on this the 2005 WG decided to not include the purse seine tuning fleet in the further and final analysis.

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, first averaging all CPUE observations for each month, and then averaging over the year calculated a yearly index. The CPUE indices were splitted on age groups by quarterly weight, length and age data from the trawl fishery. From 2003, first averaging all CPUE observations for each quarter, and then averaging over the year calculate a yearly index. There was an increase in the total CPUE from 1999 to 2003, when it reached the highest level in the time series going back to 1980. In 2004 the total CPUE was almost exactly the same as in 2003, while there was about a 30 % increase from 2004 to 2005. This was caused by an increase in the quarter one CPUE. This increase started already in 2003, but was most pronounced in 2005. The increase may be explained by increased availability and catchability of saithe in spawning areas of Norwegian spring spawning herring, where the saithe feeds on herring during quarter one. A similar increase was not seen in the other areas and quarters. AT the 2005 WG annual CPUE was also calculated without quarter one data. This CPUE series showed much less variations over the last four years, and the WG decided to use a CPUE time series averaged over quarters 2-4 for tuning. 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. Based on exploratory runs done at the 2005 WG, the age span was set to 4-8.

B.5. Other relevant data

None.

C. Historical Stock Development

Until the 2005 assessment age 2 was applied as recruitment age in the XSA runs, projections and calculations of reference points. Since the mid 1990's there has been almost no catch of 2 year olds, and this age group should in theory be fully protected by the new minimum landing size. 2-year-old saithe, mainly inhabiting the fjords and more coastal areas, are represented in the survey, but highly variable from year to year. The saithe is normally not fully recruited to the survey before at age 3 and in some years at age 4. It is therefore difficult to estimate good recruitment indices, even at age 2. This especially effects the projections. Retrospective XSA analyses showed that applying age 3 as recruitment age implies that one may include more years in the last part of the recruitment time series. The 2005 WG therefore decided to apply age 3 as recruitment age.

Until the 2005 assessment age group 3-6 was the reference age group for Fbar and has been applied in the projections and calculations of fishing mortality reference points. Before the mid 1990's 3 year old fish made up a significant part of the landings, and age group 3-6 contributed about 80 %. Since the mid 1990's there has been a marked reduction in the landings of 3 year olds, and age group 4-7 contributes more than age group 3-6. This is partly related to transference of quota from purse seine to conventional gears and partly to better price for larger saithe. In 1999 the minimum landing size was increased, and most of the 3-year-old fish will be below this size the whole year. The 2005 WG therefore decided to apply age group 4-7 as reference age group for Fbar. The fishing mortality PA-reference points therefore were re-calculated

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	3 – 11+	Yes
Canum	Catch at age in numbers	1960 – last data year	3 – 11+	Yes
Weca	Weight at age in the commercial catch	1960 – last data year	3 – 11+	Yes/No - constant at age from 1960 - 1979
West	Weight at age of the spawning stock at spawning time.	1960 – last data year	3 – 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	3 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1960 – last data year	3 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1960 – last data year	3 – 11+	No – constant ogive 1960-1984, three year running average since 1985
Natmor	Natural mortality	1960 – last data year	3 – 11+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 13	Norway ac survey extended 2005	1994 – last data year	3 – 7
Tuning fleet 12	Nor new trawl quarter 2-4	1994 – last data year	4 - 8

For analysis of alternative procedures see WG reports from AFWG 1997-2002.

D. Short-Term Projection

Model used: Age structured
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 3 in the last data year is estimated using the long-term geometric mean, and numbers at age 4 in the intermediate year is calculated applying a natural mortality of 0.2 and the F value estimated by XSA.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: Constant ogive 1960-1984, three year running average since 1985

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.
Exploitation pattern: The average of the last three years, scaled by the Fbar (4-7) 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 3 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Model used: Age structured
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: Same as in the short-term projections.

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 3 is used

Uncertainty models used: @RISK for Excel, Latin Hyper cubed, 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 3, see recruitment below)

- Natural mortality: Set to 0.2 for all ages in all years

- Maturity: Constant ogive 1960-1984, three year running average since 1985

- 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 (4-7) to the level of the last year if there is a trend

- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

- Stock recruitment model used: specified as a PERT distribution (as special form of the beta distribution) with a *minimum* and *maximum* value as specified. The shape parameter is calculated from the defined *most likely* value.
RiskPertAlt(*arg1type, arg1value, arg2type,arg2value, arg3type,arg3value*). Specifies a PERT distribution with three arguments of the type *arg1type to arg3type*. These arguments can be either a *percentile* between 0 and 1 or "*min", "m. likely"* or *"max"*.
Examples: *RiskPertAlt(2%; 50; 50%; 60; 98%; 70) specifies a PERT distribution with a* minimum *of 50 and a most likely value of 60 and a 98th percentile of 70*

F. Long-Term Projections

Not done

G. Biological Reference Points

Due to the change of Fbar from 3-6 to 4-7 and age at recruitment from 2 to 3, the **lim** and **pa** reference points were re-estimated at the 2005 WG. The **lim** reference points were estimated according to the new methodology outlined in ICES CM 2003/ACFM:15. Saithe retrospective XSA-analyses show that in later years there have been an overestimation of F and underestimation of SSB in the assessment year. The trend may have been the opposite in earlier years, but the length of the tuning series do not allow for long enough retrospective analysis to verify this. The new methodology (ICES CM 2003/ACFM:15) does not give any advise on how to deal with such situations. The **pa** reference point estimation was therefore based on the old procedure, applying the "magic formula" $\mathbf{B}_{pa} = \mathbf{B}_{lim}\ \exp(1.645*\sigma)$ and $\mathbf{F}_{pa}=\mathbf{F}_{lim}*\exp(-1.645*\sigma)$, where σ is a measure of the uncertainty of F estimates (ICES CM 1998/ACFM:10). For NEA saithe a value of 0.3 was applied in both estimates.

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 (ICES 1996/Assess: 4). 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).

At the 2005 WG parameter values, including the change-point ($\mathbf{S^*} = \mathbf{B}_{lim}$), slope in the origin ($\hat{\alpha}$) and recruitment plateau (**R***), were computed using segmented regression on the 1960-2000 time series of SSB-recruitment pairs. The values are presented in the text table below. Applying the "magic formula" $\mathbf{B}_{pa} = \mathbf{B}_{lim}\ \exp(1.645*\sigma)$, gives a $\mathbf{B}_{pa}$ of 223,392 t, rounded to 220,000 t. The WG proposed this as the new $\mathbf{B}_{pa}$ for Northeast Arcic saithe.

From algorithm in Julious (2001)		
S*	$\hat{\alpha}$	R*
136378	1.27	173200

$F_{0.1}$ and F_{max} are estimated by the MFDP yield per recruit routine, and increased from 0.08 to 0.15 and from 0.14 to 0.3 for $F_{0.1}$ and F_{max}, respectively, in the 1999 - 2005 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).

ICES CM 2003/ACFM:15 proposed that $\mathbf{F}_{lim}$ should be set on the basis of $\mathbf{B}_{lim,}$ and $\mathbf{F}_{lim}$ should be derived deterministically as the fishing mortality that will on average (i.e. with a 50% probability) drive the stock to the biomass limit. The functional relationship between spawner-per-recruit and F will then give the F associated with the R/SSB slope derived from the $\mathbf{B}_{lim}$ estimate obtained from the segmented regression. At the 2005 WG arithmetic means of proportion mature 1960-2004, weight in stock and weight in catch 1980-2004 (weights were constant before 1980), natural mortality and fishing pattern 1960-2004 were used for calculating the spawner-per-recruit function using ICES Secretariat yield-per-recruit software. R/SSB = 1.27 from the $\mathbf{B}_{lim}$ estimation gives SSB/R = 0.7874 and a $\mathbf{F}_{lim}$ = 0.58. Applying the "magic formula" $F_{pa} = F_{lim}$ exp(-1.645*σ), gives a F_{pa} of 0.35. The 2005 WG proposed this as the new F_{pa} for Northeast Arcic saithe.

H. Other Issues

None.

I. References

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Annex 6: Quality Handbook ANNEX:afwg-smr

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: 28.04.2006

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. During 2003 and 2004, when fishing for other species it was 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 2005 this percentage has been reduced to 15%.

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 April 2004 there were no regulations of the other gears/fleets than trawl fishing for *S. marinus*. Since then, different limited moratoriums have been enforced in all fisheries except trawl. These have been 1-31 May in 2004, 20 April-19 June in 2005 and during April-May and September in 2006. When fishing for other species (also during the moratorium) it is allowed for these fleets to have up to 15% (in 2004, 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.

From 1 January 2006, the maximum bycatch of redfish (both *S. mentella and S. marinus*) juveniles in the international shrimp fisheries in the northeast Arctic has been reduced from ten to three redfish per 10 kg shrimp.

A.3. Ecosystem aspects

None

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 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. 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[2]				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] 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 (age 15 as 100% mature) has been used for this stock. Since 2006 a maturity ogive has been modelled and estimated by the GADGET model.

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 1986–2006 in fishing depths of 100–500 m. Data are available on length for the years 1986–2006, and on age for the years 1992–2005. This survey covers important nursery areas for the stock

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2005 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 1995-2005 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 together with data on vessel days (i.e., effort) meeting the 10% criterion.

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

Since WG2005, experimental analytical assessments have been conducted on this stock using GADGET, and results presented for the years 1990 – last year. Input data and model settings will after the first two experimental years be included in the Quality Handbook.

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 biomass 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 biomass estimates for the same size groups in the same surveys/years. The survey series are at present only available in numbers.

Annex 7: Quality Handbook ANNEX: *S. mentella*

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: 28.04.06

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 2005 the bycatch percentage has been reduced to 15% (both species together).

From 1 January 2000 until 31 December 2005 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. Since 1 January 2006 this by-catch criterion has been reduced to 3 juvenile redfish (both *S.marinus*, *S. mentella* and *S. viviparus*) per 10 kg shrimp.

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 <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. 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, Russian and German input files are Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. 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 (since 2004 part of the Ecosystem 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 (since 2004 part of the Ecosystem survey) 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 2002-2004) 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.

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	1965-2005	6-19+	yes
Canum	Catch at age in numbers	1965-2005[1]	6-19+	yes
Weca	Weight at age in the commercial catch	1965-2005	6-19+	yes
West	Weight at age of the spawning stock at spawning time.	1965-2005	6-19+	yes
Mprop	Proportion of natural mortality before spawning	1965-2005	6-19+	Constant=0
Fprop	Proportion of fishing mortality before spawning	1965-2005	6-19+	Constant=0
Matprop	Proportion mature at age	1965-2005	6-19+	1965-1975, const. 1976-1983, const. 1984-variable
Natmor	Natural mortality	1965-2005	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	1991-2005	6-8
Tuning fleet 2	FLT13 Rus acous	1995-2001	6-14
Tuning fleet 3	FLT14 Norw bottom	1996-2005	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 8: Quality Handbook ANNEX:_NEA Cod

Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock: North-East Arctic Cod

Working Group: ArcticFisheries Working Group (AFWG)

Date: .

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	x	x		x
Spain	x				
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]					

[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)
10) 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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Annex 9: Quality Handbook ANNEX:NEA Haddock

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 (AFWG)

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

H References

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Annex 10: Review Report Arctic Fisheries Working Group (RGAF)

The review took place at ICES headquarters, Copenhagen on 22-24th May 2006.

Present were:

Max Cardinale	Sweden	
Mark Dickey-Collas	The Netherlands	
Reidar Toresen	Norway	
Yuri Kovalev	The Russian Federation	(Chair of AFWG)

1 General Comments

The reviewers thank the AFWG for the report that generally described the methods and the issues well. It was clear that a large amount of work had gone into the preparation of the report. Some reviewers commented that they enjoyed reviewing a relatively data rich report. Yuri Kovalev is thanked for his presentations and explanations which assisted the reviewers greatly throughout the review.

There still appeared to be confusion between the WG and the review group as to what is required for an update, benchmark or exploratory assessment. The review group and the WG also had differing expectations from assessments on the observation list. The review group used the Guidelines for Review groups, circulated by the ICES secretariat as the basis for reviewing the assessments.

The review used only the draft AFWG report, and many of errors were corrected as the review progressed, hence some of the comments below may not be relevant to the final version of the AFWG report.

Sadly, the whole report gave the impression that XSA was the best model to use in all cases. In fact by always comparing the results from other models to XSA, is gave the impression that XSA was the "truth" and the creditability of the other models was based on whether they could replicate the XSA results. Care should be taken to not over play the importance of one assessment model over the others, particularly when carrying out benchmark assessments but the reviewers acknowledge that consistency between assessments is important. Criteria for the choice of model should be made prior to the benchmark assessment and should be stock and data quality specific (e.g. coping with inaccurate catch statistics, the lowest retrospective bias, the most precise estimates of F or SSB etc).

1.1 Structure and format of the Report.

The AFWG report has an unusual format, with tables and figures followed by "annex" tables. This should be made clear in the introduction. Many tables and figures were not numbered according to the order in which they appeared in the text, this caused problems to the reader. Many table and figure legends were unclear, non-existent and/or did not have the relevant stock heading.

1.1.1 Chapter 1 Ecosystem Considerations

This is an important and informative chapter, particularly sections 1.3.7 and 1.5. The reviewers found this approach very useful and acknowledge that the AFWG considers the ecosystem approach to be very important in the provision of advice. However the readability could be improved. Next year the WG should try to reduce the size of this chapter, by pulling out the key points and issues. As presently written the chapter appears repetitive and drifting. The value of this important chapter will be increased by making it easier to read, and it should remain focused on key issues for the ecosystem and fisheries.

1.2 Chapter 2. Norwegian Coastal cod in sub-area I and II.

This chapter provides strong and clear evidence that Norwegian coastal cod is in a depleted state and that recent recruitment has been very low. It also provides strong evidence that under/misreporting of catches is a growing problem for this stock. The under/misreporting has important implications for the quality of the assessment and the ability to provide advice.

Although the absolute level of the stock is unknown due to the dimension and variability of recreational catches, it is apparent that the stock is over exploited. The y/r analysis although not informative for estimating F_{max} is consistent with the information derived from other cod stocks that the long-term fishing mortality (i.e. $F_{0.1}$) should be in the range of 0.1-0.3 for NCC cod.

The chapter was described as a benchmark assessment. The reviewers felt that the work described appeared to be an update assessment. This stock is now on the ACFM observation list. Observation list stocks, are just that- under observation. A full bench mark assessment is not required every year for stocks on the observation list. It is not productive to label a stock assessment as a benchmark and then provide an update assessment.

With regard to this chapter as a benchmark assessment:

Sadly this stock assessment did not match expectations as a bench mark. There was no clear focus described for the benchmark assessment. The objectives and evaluation criteria were not given.

The catch statistics in the tables and model output agree. Comments by the previous reviewers were addressed.

The WG has paid much attention to catch and removals from the stock. This was well covered in the report and problems were clearly highlighted, although basic analysis of the trends in terms of log catch ratios and the coherence of cohort signals would have been productive. The surveys were described but the quality of the data was only broadly mentioned in a qualitative manner, although the occurrence of small year effects in the survey residuals in XSA were discussed. CPUE series are not used in the assessment so hence none need to be evaluated. Sampling levels were not presented or evaluated, other than the number of otoliths collected to determine stock identity.

The WG did not explore which assessment models were most suitable to assess this stock, in terms of the characteristics of the fishery and the fish. XSA was assumed to be the “correct” assessment model. There was no analysis of diagnostics from the XSA runs. The use of ADAPT to compare with XSA was good but no other techniques or methods were considered, and both ADAPT and XSA are VPA based. XSA assumes that catches are exact and considering the issues about the quality of the catch data (i.e. dimension and variability of recreational catches) this assumption does not hold for NCC cod. ADAPT suggested that there were problems with consistency in cohorts in the catch data, so early exploration of log catch ratios would have proved useful. In the XSA runs, apart from the sensitivity to two values of shrinkage no other models assumptions were explored. There was no investigation sensitivity of parameter estimates to data been evaluated and presented (e.g. bootstrap analysis) and no estimates of the level of uncertainty in the stock estimates?

Retrospective analysis was carried out and evaluated and it is clear that the final assessment is acceptable to show the historic stock development and the relative current status of the stock.

There are no short or medium term projections and the reviewers consider this decision appropriate. The historic performance of the stock assessment has not been discussed.

If the chapter is taken to be an update assessment, then:

The labels of the figures and tables do not correspond to their order of appearance in the text. With no predictions for this stock, the end of chapter 2.1.2 is poorly described and seems to contradict the decision not to do predictions.

Some tables are not labelled with the stock, or with any description or legend (e.g. 2.8 to 2.18).

The actual method for stock separation using otoliths is not described, in annex 2, as suggested.

Possibilities for additional investigations:

Due to the fragmented nature of the Norwegian coast, where this stock is assessed as a single unit, a map of the distribution of NCC cod in both catches and surveys in comparisons with the occurrence of NEA cod (i.e. % of occurrence and density in the different areas) could represent useful information for assessing the stock. This is particularly important when considering that the status of different sub-units of the stock could be significantly different in respect to a general condition of over exploitation. That information is also very useful for managers for establishing areas of particular interest for this stock at a more detailed spatial level than used before.

Thus further investigations into the spatial nature of the separation of NEA and Norwegian coastal cod, and discussions about stock unity could be useful. A map of the proportions of each of the 2 cod stocks by quarter would be instructive.

1.3 Chapter 3. North East Arctic cod in sub areas I and II

This chapter highlights very well the current problem in providing advice on NEA cod, in that there is growing evidence for underreporting of catch which may be increasing in magnitude to beyond that included in the evaluation of the HCR as implementation error. It is difficult to predict the development of the stock in the short term as the scale and trend in catch misreporting is unknown for 2006, and this lack of information will erode the quality of the advice. This is particularly pertinent as the estimated spawning biomass close to the trigger biomass of the HCR.

The catch statistics in the tables and model outputs agree. Comments by the previous reviewers were addressed. Sampling levels were not presented or evaluated.

The chapter is strengthened by the use of a range of stock assessment models. All models used show similar dynamics in the stock, although all models use catches as exact or quasi-exact entities. XSA assumes that catches are exact and considering the issues highlighted above this assumption does not hold for NEA cod. The survey based method (using 1 survey only) did show a slightly different perception of the state of the stock with an apparent rescaling in recent years, but the trends were similar. The reviewers were concerned about the comparisons as autocorrelation between XSA and the survey based method would exist in the most recent 3-4 years.

The reviewers agreed with the WG analysis of catchability dependent on stock size, but perhaps as mentioned by the WG, the increase in catchability with stock size might be the results of increased discard instead of a real increase (i.e. density mechanisms) of the catchability of the stock. Although the WG pointed to studies in the field that suggest that catchabilities do change dependent on stock size.

The reviewers however felt that the criticism from last year's review about the clarity of the iterative process to determine the effect of cannibalism was still justified. In chapter 3 it is unclear which results come from the preparatory XSA runs and which from the final SVPA, that incorporates the cannibalism into estimates of natural mortality. Also, the matrix of M for the final SVPA was missing, but added during the review. The reviewers noted that the description of incorporating cod predation into the haddock assessment was more clear.

The WG should state clearly how the use of two separation methods (to distinguish between NEA and coastal cod) impacts on the catch estimates of both stocks. This is well tabulated (Table 3.1), but not that well described. Also the fact that some cod will be counted twice-once within each stock may impact on the quality of the advice. The reviewers would like to see a sensitivity analysis to this phenomenon.

Move most of chapter 3.2.5 into the stock annex.

References to figures appear incorrect, note in section 3.7, reference to 3.1.

Labels of Figure 3.5 are unclear.

1.4 Chapter 4. North East Arctic haddock (sub areas I and II)

Update Assessment.

General comments

The chapter was well written. The data and what was done with them was well described and the methods were generally transparent.

The assessment of NEA Haddock was supposed to be an update assessment, - but substantial changes and revisions of much of the data and time series had been carried out. When such huge changes are made in the input data, a somewhat more thorough investigation of the assessment should be made. The reviewers were not clear whether to review this stock assessment as benchmark or update. Considering the extensive revision of the data, the reviewers suggest that **this stock should be a candidate for a bench mark assessment next year**.

The changes in the time series that definitely impacted the assessment were the reworking of mean weights, the new maturity ogive and the addition of unreported catches and the addition of catches from areas which has not been in the assessment earlier (Statistical areas 06 and 07). These added catches represent some 25 % of the total catches in 2005.

Even though this was only an update assessment, a simple exploratory analysis of log catch ratios to look for consistency in the new catch matrix would have been appropriate. An investigation of cohort consistency by using regressions between age groups and years, within the catch at age matrix, and between this matrix and the numbers at age in the abundance indices should also be made next year.

We acknowledge the revision of the data, and this revision will probably lead to better assessments of haddock in the future, but at this point some sensitivity analyses, saying something about how the various parts of the added or changed data affect the assessment should be made. A SPALY run was carried out by WKHAD and it should have been shown again in this chapter.

The assessment

The input tables for the assessment seem to need some quality checking. There is no description or table of sampling levels. Due to the patchy and partial incorporation of cod predation into natural mortality Table 4.7 shows some strange phenomena in accuracy. There was some very accurate numbers of natural mortality (up to 4 decimal places) while most of the estimates were to just 1 decimal place (0.2). The accurate numbers and the 0,2 values should not be mixed in the same table. In Table 4.9 there is a mismatch between year range given in the heading, and the number of years with data. The year 2005 is not there, and the same comment goes for all the fleets (The final version of the report should have this corrected the input files for the runs were correct). Table 4.13 and 4.14 contains only zero values.

The maturity ogive on older fish should be replaced by 1, as the empirical data suggest 100% mature for fish aged 8 and older, whereas smoothing has created an asymptote effect slightly below 1.

The signals of the abundance indices used in the assessment are quite consistent showing the same overall trend. Figure 4.9 does suggest a problem however, as comparison of the survey based SSBs and XSA SSBs shows that this trend is not similarly matched in the most recent years, and indicates that perhaps the catchabilities have changed across the whole series. If this was true, it should be reflected in the residuals of survey estimate to XSA numbers. However this does not appear to be the case (Table 4.12). This needs further investigation and must be addressed next year.

The log catchability residuals of the various fleets are not very high, but there seems to be some year effects. However, the retrospective runs show strong patterns of overestimations of SSB when the stock is decreasing, and underestimating the stock when it is increasing. This indicates that a big problem with this stock is the difficulty of tracing the changes and it may be explained by the spasmodic recruitment pattern for haddock.

In the assessment, there is high weight on shrinkage. There are also indications of high bias, which is mentioned throughout the chapter by the WG. This has been investigated by the WG in the past, but in the next benchmark assessment, the WG should look again into the problem of bias introduced by this high shrinkage. The only rational that appears to be given for this use of high shrinkage appears to be “it is the same as it was done in the past”.

Metrics for retrospective bias must be included in the analysis.

An analysis of the model uncertainty was done (FLR analysis). The analysis is well described in the report and Figures 4.6 and 4.7 are very useful. As described and showed in the report only a limited group of settings were tested. However, it is demonstrated that the assessment is sensitive to the abundance index fleets and the combination of these, the number of age groups in the plus group and the shrinkage level. We note that the choice of plus group has a large effect on the SSB and this may well be caused by the effect of strong cohorts still dominating the plus group. At the next benchmark assessment, the reviewers recommend that this plus group effect is investigated. Although the choice of settings for the XSA sensitivity analysis was arbitrary and “man-made” it is clear that the final deterministic estimates of F and recruitment were close to the central tendency of the settings in XSA, the SSB is to the extreme (see Figure 4.7). In the future, the analysis should be done also on the uncertainty in growth and recruitment (as the WG also suggests in the report).

The fact that the unreported catches represent some 25 % of the total catch and that the catch statistics is very uncertain, lead the reviewers to think about other methods than XSA, not assuming the catches to be true and reliable. The reviewers would also like to see other assessment methods investigated on this stock (although the strong cohort effects may make separable models inappropriate) and recommend this for the next benchmark. The WG also state that exploration with different models is required.

The under reporting of catches is a problem, and there is an increasing trend as for the NEA Cod. The problem seems to be as great for haddock as for cod, in terms of proportion of the total catch (about 25%). There is probably also a discarding problem in the demersal fishery in the Barents Sea, and the WG should look into this problem in the future, as requested by last year's reviewers.

Summary

Much of the exploratory work was carried out by WKHAD, and that report was not fully available to the reviewers. The estimates of F and recruitment appear fairly robust to changes in most of the model settings, but the SSB estimate in recent years appears very sensitive to model assumptions.

The reviewers were concerned about the apparent contradiction between the survey signals in Fig 4.9 and the residuals in the XSA run. These differences could not be explained.

As a basis for advice, the reviewers note that the perception of the stock as being moderately exploited is clear from both the old data and the new data (Figure 4.5). The trend in the survey indices agree with the assessment that the SSB is relatively high for the time series, but the reviewers were not convinced that the absolute values of SSB in the most recent years were well estimated.

Evaluation of HCR

The dynamics of the stock within the evaluation should not be invalidated by the worries about the estimate of SSB in recent years. The perception of the recruitment to SSB relationship will vary, depending on whether the new or old data series are used, and this was discussed by the WG. However the trigger points were still considered appropriate by the WG, the reviewers did not feel able to comment on these.

The reviewers broadly supported the findings of the WG, and thought that the methods used to evaluate the HCR were appropriate. The reviewers also agreed with the WG that the evaluation suggests that the 3 year rule is not precautionary, whereas the 1 year rule may be precautionary. However the evaluations showed that implementation error (as seen in recent years) has a strong effect on the assessment quality, and thus results in even the 1 year rule being non-precautionary. The reviewers feel that the proposed rule, but on a 1 year basis with no implementation error is precautionary. But under the current regime of under reporting catch, the proposed HCR is not precautionary.

1.5 Chapter 5. North East Arctic saithe (sub areas I and II)

The assessment of saithe was an update assessment.

No real SPALY assessment was made.

A very small change was done to the data and the change was well explained in the report.

There were no tables or descriptions of sampling levels and the adequacy of coverage. Some of the comments by last year reviewers were addressed, but as an update assessment not all comments should be addressed.

The abundance indices by fleets were not shown in Figures in the WG report. This should be done in order for the reader to be able to evaluate the consistency in trends. The dropping of a fleet, without full sensitivity testing is outside the remit of an update assessment.

As is generally known for this stock, the retrospective bias in this stock assessment is still very strong. This has been investigated by previous AFWGs. The SSB tends to be underestimated, while the Fs are overestimated. There does not seem to be any convergence in this pattern. At the next benchmark assessment, the WG should look into the retrospective pattern again and try to explain why this pattern is so strong for such a long time. Metrics for retrospective bias must be included in the analysis.

Review why there is an apparent conflict between catch and surveys at the next benchmark assessment.

The comments from last years review of the saithe, although not expected to be dealt with during this years assessment are still valid. These are, investigating the discarding problems , investigate the noisy indices some with conflicting trends and finally to try other assessment models.

Also in the next bench mark, the reviewers would like to WG to consider the appropriateness of "traditional" stock assessment models when the estimated Fs are much smaller than the assumed natural mortality (M).

1.6 Chapter 6. *Sebastes mentella* (Deep-sea redfish) in sub-areas I and II

The reviewers agreed with the approached used by AFWG and with the previous comments by ACFM. The reviewers look forward to the improved estimates of bycatch of *Sebastes mentella*, as promised by the working group.

The current methods (use of surveys) do provide a basis for advice on *Sebastes mentella*.

The catch statistics in the tables agree. Comments by the previous reviewers were addressed. Sampling levels were not presented or evaluated.

Stock labels were absent from some figures and table captions. This must be addressed.

1.7 Chapter 7. *Sebastes marinus* (Golden redfish) in sub-areas I and II

The reviewers agreed with the approached used by AFWG and with the previous comments by ACFM.

The assessment method development with Gadget was encouraging, and the reviewers were pleased to see that many of the concerns of the previous reviewers with regard to the Gadget development had been addressed by the WG. Although the use of simpler models or SURBA has still not been considered by the WG.

The current methods (of surveys) do provide a basis for advice on *Sebastes marinus.*

The catch statistics in the tables agree. Sampling levels were not presented or evaluated.

Stock labels were absent from some figures captions (Figs 7.2, 7.6). This must be addressed.

1.8 Chapter 8. Greenland halibut

The reviewers agreed with last year's ACFM comment that this assessment was useful as an indicator of trends in the stock.

The stock assessment was treated as an update assessment although it was originally scheduled as a benchmark. While the reasons for this were well explained throughout the report, a better summary of the rationale behind this decision should have been giving at the start of the chapter (i.e. 4.1.1). The reviewers look forward to a benchmark assessment on

Greenland halibut in a few years time when the age reading problems have been successfully resolved. The reviewers are aware that even if the age reading methods are agreed by all parties, the existing time series will probably not be compatible with the newly developed one.

The matrix of the tuning fleet was missing in the assessment tables; this was fixed during the review. The catch statistics in the tables agree. Comments by the previous reviewers were addressed.

The assessment is tuned by a number of surveys. The WG has made an attempt to combine different surveys in a single tuning index. This gives a better diagnostics than the previous year, although it is still very difficult to follow year classes. This is probably due to age reading problems mainly, together with issue related to changes in distribution and catchability of different segments of the stocks (i.e. sexes, young and adults, etc).

The scientific quota is supposed to reach the value of about 9000 t in 2006. This will correspond to about 2/3 of the advised catches (13000 t). Considering the poor stock situation, it seems advisable that catch for scientific purposes should be reduced as much as possible. The proportions of scientific quota devoted to the surveys used to construct the tuning indices and the proportion devoted to the observer programmes on commercial fleets should be tabulated in the report, to ensure that the fishery independent indices remain as such. The reviewers considered that there may also be the opportunity to coordinate better the research effort on Greenland halibut.

In the retrospective plots, metrics on bias and variability are missing and should be included; also the stock name is missing in several figures (8.1, 8.3, 8.4 etc) and must be included in all figures and table captions.

The figures in Table E7 are not clear and should be better specified, i.e. what is meant by biomass and abundance.

In table E9, although weight at age shows a substantial variation, there is a tendency of the weight at age to decrease in the last 5 years. This could be due to sampling problems related to the distribution of the different sexes but also to a real decrease of the weight at age in the stock that would be indicative of other problems. The WG should comment on this in the next report.

The catches observed in the northern part of IVa were not included in the total catch due to the rationale that they belong to a separate stock. This should be justified better in the text by citing the rational and evidence for this decision.

1.9 Chapter 8. Barents Sea Capelin

The current method used to project forward the biomass of capelin was considered a reasonable method which was transparent and sound. However the expertise within review group was not great enough to allow a full and comprehensive review of those methods. The reviewers considered that a group with greater relevant expertise and more time should be convened to assess the methodology. The tables were updated.