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19–28 April 2005

Murmansk, Russia

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer
H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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0.1 Participants

Erik Berg	Norway
Bjarte Bogstad	Norway
Vladimir Borisov (part-time)	Russia
Tatiana Bulgakova (part-time)	Russia
Jose Miguel Casas	Spain
Guzman Diez	Spain
Konstantin Drevetnyak	Russia
Anatoly Filin	Russia
Åge Fotland	Norway
Sergey Golovanov	Russia
Harald Gjøsæter	Norway
Kjellrun Hiis Hauge (part-time)	Norway
Åge Høines	Norway
Yuri Kovalev (Chair)	Russia
Yuri Lepesevich	Russia
Sigbjørn Mehl	Norway
Kjell H. Nedreaas	Norway
Kåre Nolde Nielsen (observer)	Norway
Dmitry Prozorkevich	Russia
Alexey Russkih	Russia
Rüdiger Schöne	Germany
Mikhail Shevelev (part-time)	Russia
Oleg Smirnov	Russia
Jan Erik Stiansen	Norway
Ekaterina Volkovinskaya (translater)	Russia
Nikolay Ushakov	Russia
Natalia Yaragina	Russia
Sondre Aanes	Norway
Morten Nygaard Åsnes	Norway

The meeting was observed by a scientific observer working on research project Boundary Negotiations in Mandated Science (BNIMS), funded by the Norwegian Research Council.

0.2 Terms of Reference

At its October 2004 meeting ACFM decided the following:

The **Arctic Fisheries Working Group** [AFWG] (Chair: Y. Kovalev, Russia) will meet in Murmansk, Russia from 19–28 April 2005 to:

a) assess the status of and provide management options for the year 2006 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. 2ACFM01.

AFWG will report by 3 May 2005 for the attention of ACFM.

C.Res. 2ACFM01

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, WGNPBW, AFWG, HAWG, NWWG, and WGPAND will, in addition to the tasks listed by individual group, in 2005:

(1) for stocks where it is considered relevant, review limit reference points (and come forward with new ones where none exist) and develop proposals for management

strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) – following the guidelines from SGMS (2005) and AMAWGC (2004 and 2005);

(2) comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans;

(3) based on input from WGRED incorporate (where appropriate) existing knowledge on important environmental drivers for stock productivity and management into assessment and prediction, and important impacts of fisheries on the ecosystem;

(4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;

(5) where misreporting is considered significant provide information on its distribution on fisheries and the methods used to obtain the information;

(6) provide for each stock information on discards (its distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessment;

(7) provide on a national basis an overview of the sampling of the basic assessment data for the stocks considered;

(8) provide specific information on possible deficiencies in the 2005 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.

0.3 General comment

WGNPBW has been moved from spring to autumn and Barents Sea capelin moved to AFWG from this year.

0.4 Management strategy for NEA cod and haddock

In 2004 ICES evaluated HCR for cod and stated that the rule was incomplete in the last part. It was amended by ICES for performing the evaluation. The amended HCR was considered by ICES as consistent with the precautionary approach. At the 33rd Session of The Joint Norwegian-Russian Fishery Commission the HCR was amended for rebuilding situations and ICES was requested to evaluate the new rule and provide an advice in accordance to it. The evaluation of the harvest control rule is given in Section 3.14.

The evaluation of the harvesting strategy for haddock requested in 2003 was postponed. AFWG decided to initiate a special Study Group in the beginning of 2006 for evaluation of the HCR and biological reference points for NEA haddock.

The request from Norway in 2005 content the following: "… we request assessment of the Northeast Arctic Haddock stock, and comments upon aspects of the agreed experimental harvest rule in relation to the recruitment situation for this stock, and catch options according to the experimental harvest control rule and to an exploitation equal to Fpa level". The requested comments to HCR could be found in Section 4.7.

0.5 Unreported landings

ICES received an official letter from the Norwegian ICES delegate including a report with information about unreported landings of cod in the Barents Sea and Svalbard areas according to comprehensive investigations conducted by the Norwegian Directorate of Fisheries with assistance from the Norwegian Coast Guard. Besides, a number of WDs relevant to the issue were presented at the AFWG meeting. ICES did also receive a report from World Wildlife Fund (WWF) in Russia about illegal fishing in the Barents Sea. This report indicates unreported landings of cod in the Barents Sea. By use of other and independent methods, the WWF-Russia report supports assumptions made in the report referred to above.

Similar to last year and based on the information available, the AFWG thus decided to include unreported landings of cod in the assessment for 2002-2004. The AFWG has revised the amount of unreported landings for 2003 according to updated and more complete information, and included new data for 2004.

The current situation with actual catches of cod much exceeding those reported officially to ICES raises great concern. AFWG 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 33rd 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.

0.6 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*. WD24 2004 WG). During the present meeting, in addition to the above Norwegian report on unreported landings in 2003 (updated) and 2004, an ICES paper (Sokolov, 2004) estimating cod discard in the Russian bottom trawl fishery in the Barents Sea in 1983-2002 was available to the group. The discard was found to be highly variable over this time period and affected mainly age groups 3 and 4, and on average, 6 million individuals, mostly age groups 3 and 4 (30-45 cm), were annually discarded. On average, this composes about 6% of the total number of cod caught. Ajiad *et al*. (WD 18) presents preliminary results on the total redfish by-catch in the Norwegian shrimp fishery during 1983-2003 based on data from the Norwegian commercial shrimp landing statistics, data from the Norwegian fishery surveillance agency and the scientific shrimp surveys. All in all, the total effect of the discarding is still very unclear and requires more work before it can be included in the assessments.

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 (Zuykova *et al*., WD 12; Nedreaas and Yaragina, WD 21). 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 about 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., 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 precision, there are strong evidences of low accuracy of the age estimates.

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.

0.7 Inadequacies in available software

The AFWG have found a bug in the XSA tuning diagnostics output. When running the XSA using the software VPA95.exe with three tuning fleets in the Greenland halibut assessment, the diagnostics table did only print the t-values of the regression statistics for the three fleets. All other values were zero. Other diagnostics seemed all right, and all combinations running with two tuning fleets or run fleet by fleet were also all right. This was interpreted as a bug since the program obviously did perform the regression since it produced the t-values. The software XXSA.exe produced complete diagnostics output file and all other results were identical.

0.8 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.

For NEA cod, Gadget has been used as a supplementary model to XSA for some years. Gadget is now a complete assessment model which provides the same kind of output (assessment, retrospective analysis, prognosis, diagnostics) as e.g. XSA. Although questions concerning choice of likelihood functions and appropriate aggregation level for model/data comparisons need further study, it may be time to give the results from Gadget more weight. The use of several assessment models for the same stock is increasingly common in several assessment working groups. A comprehensive analysis of the performance of XSA and Gadget for cod should be presented to the 2006 AFWG meeting.

A project is currently underway to construct a multi-area, multi-species (cod, capelin, herring, minke whale) model for the Barents Sea using the Gadget modelling framework (see http://www.hafro.is/gadget), with the 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 new 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.

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

This 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 analytical 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.

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

A second meeting of SGASAM was held in March 2005 (ICES CM 2005/D:01).

0.9 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.

0.10 Scientific Presentations

WD 1 (presented by J.E. Stiansen) describes the present and expected situation of the Barents Sea ecosystem. The working document includes relevant factors on climatic conditions, phytoplankton, zooplankton, fish relations, marine mammals and bottom fauna.

WD 3 (presented by B. Bogstad) describes the status of joint Norwegian-Russian work on evaluation of the modified harvest control rule for Northeast Arctic cod given by the Joint Norwegian-Russian Fisheries Commission in 2004. The population model used is the same as in last year’s assessment, but now assessment bias as well as implementation error and bias is included explicitly. Also, both long-term simulations and studies of the performance of harvest control rule in a rebuilding situation are addressed.

WD 7 (presented by S. Mehl) describes analyses of Northeast Arctic saithe stomachs sampled during the survey along the Norwegian coast north of 62º N in October - November 1998-2003. 6 000 stomachs were sampled of and on average 35 - 40 % of the stomachs were empty. In the smallest size group (20-39 cm), krill was the dominating prey item in all sub-areas, while in the larger size groups fish dominated. In the northern sub-areas, herring was the most important fish prey, followed by Norway pout, haddock, and blue whiting. Cod only occurred sporadically. In the southern sub-areas, Norway pout was the dominating fish prey, followed by blue whiting and haddock. Herring was scarce and no cod was found. The importance of fish was highest in north, while in south the importance of crustaceans increased. The size of the fish prey increased with increasing predator size. Preliminary consumption estimates for quarter four show that krill was the single most important prey species; followed by Norway pout, herring, blue whiting and haddock. The consumption estimates are quite variable from sub-area to sub-area and year to year, and may only partly reflect the consumption and predation pressure of the Northeast Arctic saithe stock.

WD 8 (presented by Å. Høines) describes the status of work addressing the ageing of Greenland halibut. Serious problems with the present ageing technique for Greenland halibut were identified. Tag-recaptures, length-frequency analyses, and morphometric analyses of otoliths, all indicate that the present ageing method grossly underestimate age of older individuals. It is concluded that current age data are not suitable for making age structured assessments of the stock. A refined ageing method is presented, but more validation should be done before age-structured assessments are again warranted. In the meantime alternative approaches should be applied, e.g. traffic light evaluation scheme.

WD 12 (presented by N. Yaragina) describes the study was based on analysis of 646 cod otoliths from Institute of Marine Research (IMR) collection, which were selected randomly by five decades (the 1940-1980-s). As observed temporal trends in maturity-at-age and weight-at-age of the Northeast Arctic cod stock require determinations of their cause(s), Norwegian and Russian marine research institutes have therefore investigated the possibility if that biases in age reading (if any) have contributed to the long-term trends observed in stock productivity (growth, maturation rate, fecundity). The method of cod ageing of both Institutes (IMR and PINRO) is similar in principle. The age interpretation method did not drift through time (Rollefsen, 1933; Mankevich, 1966). Due to the study, there are some differences in age determinations of the Northeast Arctic cod by various generations of readers in different time periods. They have a tendency to diminish the age by modern readers compared to historic data for age groups of 5 - 7 years old. For age groups of 8, 9 and 10-years-old there is a opposite tendency: the age assigned to fish by specialists of the previous generation is one year less, but deviations are not significant. Bias in ageing made in different time periods cannot explain the appearance of the observed time trends of biological characteristics of the Northeast Arctic cod population. Moreover, the revision of historic data of age reading made by the present readers would lead to the strengthening of the observed tendencies.

WD 14 (presented by T. Bulgakova) is the development of the stochastic simulation model presented at the AFWG in 2004. This model works on the retrospective period of the NEA cod dynamics and is used both for testing of different HCR and the cod recruitment forecasting. This year an attempt to include the uncertainty into the catch implementation in the simulations is made for the variant of HCR approved by the 33 session of the Joint Russian- Norwegian Fisheries Commission.

WD 15 (presented by G.G.Novikov) describes the status of research conducted within the joint Russian-Norwegian project studied cod population structure in the Norwegian, Barents and White seas. Samples were collected during spawning period both in fjords and in the open sea. Results from the research support differentiation of cod into ecological forms, “oceanic” and “coastal” ones by the structure of otoliths, however give no grounds to conclude about reproductive isolation of these forms. No great genetic differences between local groups were found as well.

WD 16 (presented by A. Pedchenko and O. Titov) is describes oceanographic conditions, hydrochemical situation and distribution of zooplankton in 2004 as well as prediction of water temperature for 2005-2006. It also gives prediction of capelin and cod abundance based on hydrochemical indices in the bottom layer based on proposed prediction models in which in addition to biological factors the other factors are taken into consideration influencing the abundance of capelin year classes, such as change of climate. One of experiments on application of the ecosystem approach to prediction of the Barents Sea capelin and NEA cod recruitment abundance was a method with the use of data on physical and chemical status of environment as indices of long-term variations of the Barents Sea ecosystem as a single whole.

WD 17 (presented by K.H. Nedreaas) describes the modelling and assessment of *Sebastes marinus* using the Gadget model for the time period (1986)1990-2004. This was a contribution to ACFM’s previous recommendation to investigate possible alternative methods to conventional catch-at-age analyses. 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 results are given in the WD and in the current report (Section 7).

WD 18 (presented by K.H. Nedreaas) provides estimated numbers and weights of the redfish taken as by-catch in the Norwegian shrimp fishery in the Barents Sea during two decades. The results have shown that shrimp trawlers removed significant numbers of juvenile redfish during the beginning of the 80’s with a peak during 1985 amounting to about 200 millions individuals. As sorting grids became mandatory in 1993, by-catches of redfish reduced drastically during the 90’s. The by-catch of the redfish in relation to the shrimp catches and redfish landings were discussed.

WD19 (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 21 (presented by K.H. Nedreaas) describes the status of the PINRO - IMR’s routine exchange program of cod and haddock otoliths 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 increasing of the percentage of overlapped age readings over the whole time period both for cod and haddock. But differences in age reading varies by years, i.e. they increased to 30% for cod in recent period (2003). The percentage of haddock age readings showing a different result averaged about 10% at present. All in all, the effort invested by PINRO and IMR in harmonizing the age readings among the readers has given positive results.

WD 23 (presented by K.H. Nedreaas) describes the recreational - and the tourist fishing in Norway, who has the right to fish, and what kind of regulations that exist for these activities. Except a smaller quantity of the recreational catch which is sold and reported (and included in the statistics), most of it is unreported. The working document summarizes two recent reports (in Norwegian) about these fishing activities, and present a likely estimate of the quantities caught. Altogether, the unreported cod fished in the Norwegian recreational fishery and by the tourists, may account for about 10.000 tonnes coastal cod and 2.500 tonnes North-East Arctic cod per year. More information and improved statistical analyses are necessary before this information is suitable for inclusion in the analytical assessment.

WD 24 (presented by A. Russkikh) an attempt has been made to improve method in estimating inputs for predictions of NEA haddock. It was established empirically and supplemented statistical tests that “cohort” method which use as predictor means weight of same yearclasses in previous year gives best results in predictions weight at age in stock for youngest age groups and in predictions weight at age in catch for all age groups in short-term projection procedure.

WD 25 (presented by S. Aanes) describes a stochastic age structured model. The input data are estimates of catch at age and indices of abundance, and the model is fitted to data for Northeast Arctic cod. The mortality processes are modelled as stochastic processes and natural mortality is estimated, as well as the variance components in the processes describing the temporal and random variability. In addition the input data are uncertain, and the uncertainty in the input data is estimated. The model fit is evaluated by simulations. Estimates of the abundance and mortality for the period 1985-2004 is presented and is in agreement with existing estimates.

0.11 Time of Next Meeting

The Working Group proposes the dates of April 19 – 28, 2006 for its next meeting.

1 Ecosystem considerations

Fisheries effects, environmental effects and interactions within and between different levels in the food chain influence the population dynamics of all commercial fish stocks in the Barents Sea. The understanding of the term ‘ecosystem’ is somewhat differing between science fields. In this chapter both the physical environment and human activity are considered as part of the ecosystem.

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 are 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.

The general circulation pattern 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.

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 biomass has shown large variation among years in the Barents Sea. 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). The observations showed that after cooling the abundance of *Th. raschii* increases and of *Th. inermis* – decreases, while after the number of warm years, on the contrary, 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 of the Themisto species, *T. libellula*, is mainly restricted to the mixed Atlantic and Arctic water masses. A very high abundance of *T. libellula* is recorded close to the Polar Front.

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. The last few years there has in addition been an increase of blue whiting migrating into the Barents Sea. The composition and distribution of species in the Barents Sea depends considerably on the position of the polar front. 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, capelin and herring are key species in this system. Cod prey on capelin, herring and cod, while herring prey on capelin larvae. Cod is the most important predator fish species in the Barents Sea, and feeds on a large range of prey, including the larger zooplankton species, most of the available fish species and shrimp. Capelin feeds on the zooplankton production near the ice edge and is usually the most important prey species in the Barents Sea, serving as a major transporter of biomass from the northern Barents Sea to the south (von Quillfeldt and Dommasnes, in prep.). Herring, as a prey for cod, is the only other prey item with similar abundance and energy content as capelin. At the same time herring is also a major predator on zooplankton.

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. Marine mammals are significant ecosystem components. 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).

1.2 State and expected situation of the ecosystem

1.2.1 Climate (Figures 1.2-1.4)

Sampling

The variability in the physical conditions in the Barents Sea is monitored regularly in three sections, as well as area coverage surveys in August/September and January/March and use of large hydrodynamical numerical models. The three sections are:

1) The Fugløya-Bear Island section (operated by IMR), situated at the entrance where the inflow of Atlantic water from the Norwegian Sea takes place, and representing the western part of the Barents Sea. Monitored regular by hydrographical observations 6 times a year since 1977 (august observations from 1964), and by continuous current measurements since August 1997.

2) The Vardø-N section (operated by IMR), most representative for the Atlantic branch going into the Hopen Trench, *i.e.* the central part of the Barents Sea. Monitored regular by hydrographical observations 4 times a year since 1977 (august observations from 1953).

3) The Kola section (operated by PINRO), most representative for the Atlantic branch going eastwards parallel to the coastline, *i.e.* the southern part of the Barents Sea. Monitored regular by hydrographical observations since 1900. The values are given quarterly for the period 1900-1921 and monthly for the period 1921-present. (In periods where observations were lacking the values are interpolated).

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. 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 (Stiansen *et al.*, WD1, Titov *et al.*, WD16). Although the 1990s decade was warm, it still was only the third warmest decade in the 20th century (Ingvaldsen *et al.* 2002b).

In 2004 the temperature in the Barents Sea was well above the long-term average throughout the whole year, and this transferred into the beginning of 2005. The anomalies were highest in the southern part (Figure 1.3). In the beginning of 2004 anomalies were +0.5°C and increased to long-term maximum values in the summer and early autumn 2004, with anomalies of more than +1°C (Figure 1.4). After a small decrease the beginning of 2005 were again at anomalies above +1°C (Titov *et al.*, WD16). The development in the western (Figure 1.2) and central part of the Barents Sea followed the same development as in the southern part, but with smaller anomalies (Stiansen *et al.*, WD1). This indicates that most of the warm water that entered through the western entrance in 2004 and beginning of 2005 was channelled into the Atlantic branch running parallel to the coast (Stiansen *et al.*, WD1). Bottom temperature anomalies from survey data in August/September (Titov *et al.*, WD16) also indicate that the warming of the whole Barents Sea reaches all the way to the bottom.

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 (Stiansen *et al.*, WD1).

Since 1998 the bottom layer oxygen level have been low in the southern Barents Sea. This situation continued throughout 2004 (Titov *et al.*, WD16).

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 outflow from the Barents Sea. The outflow area may at times be much wider than earlier believed, stretching from 73^{o}30'N south to 72^{o}N. This phenomenon is not only a short time feature; it might be present for a whole month. These patterns are most likely caused by horizontal pressure gradients caused by a change in sea-level between the Barents Sea and the Arctic or the Norwegian Sea by accumulation of water and/or by an atmospheric low or high (Stiansen *et al.*, WD1).

During 2003 there were a continuous decrease in the inflow throughout the whole year, and around New Year (2003-2004) the inflow was at the lowest observed for wintertime (Figure 1.2). In the first half of 2004 the inflow slightly increased again, but were still at a low level. Monthly values show that for the first 4 months of 2004 the volume flux shifted between above to below the long-term mean. In April and May, which are the period where zooplankton and fish larvae usually are advected into the Barents Sea from the Norwegian Sea, the flux was about or slightly less than average. In the summer the flux was below the average. Observations for the rest of 2004 will not be available until the current meters are recovered in late summer 2005. However, a wind driven modelled of the inflow (Stiansen *et al.*, WD 1) show an increased inflow in November and December 2004. This is a consequence of weather conditions with many strong low pressures in the area (Stiansen *et al.*, WD1).

Earlier it has been believed that the temperature and the volume transport varied in a similar manner; that is that high temperature was linked to high volume transport and lower temperature was linked to reduced inflow of Atlantic water. However, Figure 1.2 shows that there seems to be no correlation between the fluxes and the temperature of the inflowing water. In fact, in periods the temperature increase while the volume flux decreases, and high positive anomalies observed in 2004 are not due to an increased inflow, as we did believe earlier. This shows that in the Fugløya-Bear Island section the temperature is independent of the volume flux into the Barents Sea. The reason is simply that while the temperature of the inflowing water depends on the temperatures upstream in the Norwegian Sea, the volume flux depends mainly on the local wind field (Stiansen *et al.*, WD1).

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 2004 the ice coverage in the Barents Sea was low, with a strong decease in ice from 2003 (Stiansen *et al.*, WD1, Titov *et al.*, WD16). In the same period, the temperatures increased while the amount of inflowing water decreased. This indicates that the ice cover is more dependant on the temperature of the incoming water that of the amount (Stiansen *et al.*, WD1).

Climate effect on plankton (phyto-, zoo- and ichtyoplankton)

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

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

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

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

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 March 2005 allow for a six-month forecast until September 2005 (Stiansen *et al.*, WD1). The predictions indicates that the temperatures in the southern Barents Sea will be about 0.5°C above average from April to June, followed by an even warmer period (0.7°C above average) period from July to September. This is in accordance with a model (Titov *et al.*, WD16) based on harmonic analysis of the Kola section temperature time series (Figure 1.3). This model also predicts that the temperature will decrease in 2006, but still be above average.

Based upon the prognosis together with the record high temperatures in the western Barents Sea and high temperatures in the Norwegian Sea during late 2004 and beginning of 2005, it is expected that the temperatures in the southern Barents Sea will be high also during 2005. Especially the first half of the year is expected to be warm, partly as an effect of the strong low-pressure activity in November-January leading to large inflow to the south western Barents Sea. Later on the temperature anomalies are likely to become smaller, but still well above the long-term average.

The ice conditions in 2005 are expected to be low, similar to 2004, due to the expected high temperature in 2005.

1.2.2 Phytoplankton

Sampling

The phytoplankton situation in the Barents Sea is covered on a regular basis both during the survey coverage in August-October and in the standard sections Fugløya-Bjørnøya 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 observations, the primary production is simulated using numerical models.

Current situation

In March no production was measured at the western entrance and there were still winter values of chlorophyll. In April the spring bloom had started and the values of chlorophyll were particularly high in the upper parts of the coastal water close to the Norwegian coast, but also extending into Atlantic water. In June, the chlorophyll layer was mainly found in the upper 30-40 m along the entire section but also at that time with a maximum close to the Norwegian coast. In August the lower values of chlorophyll near the surface indicated that the phytoplankton had started to sink (Stiansen *et al.*, WD1).

Model simulations of the primary production (Stiansen *et al.*, WD1) showed that there was considerable interannual variation in timing of the spring bloom at the Fugløya-Bjørnøya section. Even though we suspect the model to produce the bloom somewhat too early in the year, we expect the trends to be correct. The model results showed that the peak of the bloom may vary with about three weeks from year to year and in 2004 the results indicates that the bloom was relatively early. The bloom was earliest close to the coast at the western entrance. Also 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 Central Bank and the Svalbard Bank. Some of these banks are very shallow and may act as retention areas for water masses. 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.

Expected situation

Based on the expected warm temperature, especially during the spring, it is expected a similar phytoplankton situation in 2005 as in 2004. 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.

1.2.3 Zooplankton (Figures 1.5-1.6)

Sampling

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

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

Current situation

In autumn-winter most of the production has taken place and the zooplankton biomass can be expressed as the overwintering population of zooplankton. According to the data from August/October survey there was a marked increase in zooplankton biomass during the period 1991-1994. Though the biomass has decreased from 1994 to present, the average biomass values during 1995 to 2004 are still higher than in the 1988-1992 period. In 2004 the zooplankton biomass was slightly above the average level, with a slight increase from 2003 to 2004 (Stiansen *et al.*, WD1). The high temperatures may have lead to increasing growth rates of zooplankton. In addition, increased advection may also have lead to high zooplankton abundance in the Barents Sea.

By the beginning of 2004 the abundance of krill (euphausids) fund was 1.7 times higher in the southern area and 1.5 times higher in the north-western areas than long-term mean value. Growth of average values of krill abundance compared to 2003 was registered in the western and coastal areas, whereas in the central and eastern areas a considerable decrease of small crustaceans number occurred (Titov *et al.*, WD16).

Trophic interactions

Possible reasons for the large year-to-year variations (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 young herring and young blue whiting. Herring have increased considerably the last years, due to strong year classes of 2002 and 2004. Herring is mostly found in the southern areas. The last few years the blue whiting entered the western Barents Sea in large numbers. How much impact herring and blue whiting have on the zooplankton biomass is not clear, but in the present low levels of the capelin stock they may constitute a major role on the grazing pressure.

The results from long-term investigations of macroplankton in autumn-winter indicate that the abundance of euphausiids (Figure 1.5), as well as the distribution and specific composition, is affected by interannual dynamics. This leads to changes in the feeding conditions of fish (cod in particular). According to Ponomarenko (1973, 1984) interannual changes of euphausiid abundance determined the survival rate of cod yearlings. Adult cod feeding on euphausiids in summer influences seasonal dynamics of their fatness (Orlova *et al*. 1998). The role of euphausiids for cod feeding increases in the years when capelin stock is at a low level (Ponomarenko and Yaragina 1990).

Expected situation

Based on the biomass information we have from 2004, the zooplankton production in 2005 is expected to be at a medium high level with a slightly increase from 2004, providing good feeding conditions for capelin, herring and other juvenile fish.

1.2.4 Fish (Tables 1.1-1.6, Figure 1.6)

Trophic relations

Cod, capelin and herring are key species among fish in the Barents Sea ecosystem. Cod prey on capelin, herring and cod, while herring prey on capelin larvae. 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 1.3 and 1.4). 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. 1.1 and 1.2) have a strong effect on growth, maturation and fecundity of cod, as well as on cod recruitment because of cannibalism.

Capelin is a key species because it feeds on the zooplankton production near the ice edge and is usually the most important prey species in the Barents Sea, serving as a major transporter of biomass from the northern Barents Sea to the south (von Quillfeldt and Dommasnes, in prep.). 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 predated by cod. Capelin also is important prey for predatory fishes as well as for several species of marine mammals and birds.

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 enter the Barents Sea, the recruitment to the capelin stock is poor and in the following years the capelin stock collapses. 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, as is currently the case. In this way, the herring impact both the capelin stock (directly) and the cod stock (indirectly).

Haddock is also a common species, and migrates partly out of the Barents Sea. It is a predator on smaller organisms including bottom fauna. The stock has large natural variations in stock size.

Saithe is common in coastal water. The smaller individuals feed on zooplankton, but larger saithe is known to be a predator on fish. 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. Fishing on these two species is severely restricted in order to rebuild the stock. 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 much of the Barents Sea.

In warm years there may be considerable quantities of blue whiting coming in with the Atlantic water in the western part of the Barents Sea. This has been the situation the last few years. 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. The present low stock of capelin is at the moment far outnumbered by these species, with young herring as the present dominant stock. 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. Therefore the competitive effect for food by blue whiting on the other three species for the local zooplankton production is assumed to be low. However, advected zooplankton biomass from the Norwegian Sea is an important mechanism for supplying the local production in the whole Barents Sea. It may therefore be an indirect effect of blue whiting feeding on the other species as a filter on the advected biomass passing on the way further into the Barents Sea. This may again reduce the local production since fewer adults reach new production areas. Another uncertainty is how large impact fish in general have on the plankton production. At present we do not know how strong impact the grazing pressure by fish has on the zooplankton stock. There are, however, indications of a possible inverse relationship between capelin and zooplankton biomass (Figure 1.6, Dalpadado *et al.* 2002).

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, WD9) 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.

Predation by fish species

<u>NEA cod</u>

The diet of cod is a good indicator of the state of the Barents Sea ecosystem. Table 1.3 -1.4 shows the diet of cod in the period 1984-2004, calculated from data on stomach content, gastric evacuation rate and number of cod by age. The data for cod stomach content are taken from the Joint IMR-PINRO stomach content database. The consumption calculations show that the total consumption by cod in 2003 and 2004 was about 4.5 million tonnes according to calculation IMR and about 3,2 million tonnes according to calculation PINRO (Dolgov, WD 10). The consumption per cod for the various age groups was also approximately the same in both years (Table 1.5 – 1.6). Capelin was also in 2004 the most important prey item for cod, followed by crustaceance and polar cod (Table 1.3-1.4). The proportion of capelin in the diet of cod decreased from 2002 to 2004, but not as much as the decrease in the abundance estimate of capelin should indicate. This phenomenon was, however also observed during the previous capelin collapse. Cod cannibalism is now at a low level.

<u>Haddock</u>

Food composition of haddock consists mainly of benthic organisms (Dolgov, WD9). Totally the mean weight percent of polychaets, mollusks and echinoderms was up to 40 %. Zooplankton importance was not too high, the portions of hyperiids and euphausiids do not exceed 1,8 and 19,0 % by weight respectively. Capelin was rather important prey species for haddock, its mean portion was 17,3 % by weight. The importance of other fishes was less 5 % by weight. There was not revealed any clear changes in the food composition of haddock from various length groups. The total food biomass yearly consumed by haddock varied from 348 thousand tonnes to 1268 thousand tonnes (mean value - 736 thousand tonnes). Among the commercially important species, capelin was consumed in the largest numbers.

<u>Greenland halibut</u>

The food composition of Greenland halibut consisted of more than 50 prey species in the period 1980-1990 (Dolgov, WD 9). Based on the quantitative data cephalopods (squids, octopuses) were dominated in the Greenland halibut feeding (18 % by weight, as well as fish, mainly capelin (10 % by weight) and herring (8 % by weight). The biggest portion of stomach content (approximately 34 % by weight) constituted by fisheries wastes (heads, guts etc).

The decreasing of the importance of small prey species (shrimp, capelin) and the increasing of the portion of larger fishes were observed with the increasing of the length of Greenland halibut. The specimens with length less 30-35 cm mainly fed on capelin and other small non-target fishes. Cephalopods were dominant in the feeding of fishes with 35-50 cm length (up to 35 % by weight). From 30 cm length the portion of the fisheries wastes sharply increased. The largest specimens (length more than 65-70 cm) had the big portion of cod and haddock in the diet.

The total food consumption by Greenland halibut in 1990-2003 varied from 143 to 187 thousand tonnes (mean value - 174 thousand tonnes). The bulk of consumed biomass consisted of cephalopods. The cannibalism level was very low – up to 0,7 thousand tonnes (mean value - 0,3 thousand tonnes per year). Totally the commercially important invertebrats and fishes consisted of 18 to 61 % of the total consumed biomass (mean value - 38 %).

<u>Long rough dab</u>

Analysis of long rough dab food composition has shown that this species is a typical ichthyobenthophage, main food of which are benthos (ophiura, polychaetes etc.) and different fish species (Dolgov, WD 9). With the long rough dab growth, importance of benthos reduced and portion of fish food increased. When 25 cm body length had been reached, polar cod and cod, and then capelin and juvenile redfish occurred in the long rough dab food, and the largest individuals (40 cm and longer) were observed to feed on their own juveniles and juvenile haddock.

Mean annual food consumption by the population of long rough dab was estimated at 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.

<u>Saithe</u>

Capelin was prevailed in saithe feeding totally (7-65 % by weight)(Dolgov, WD 9) Euphausiids and herring were second important prey species for saithe - 1-16 and 2-23 % by weight, respectively. Additional prey species were various fishes, including cod, saithe and haddock juveniles, and also blue whiting, Norway pout, polar cod and sandeel. Other prey species, including hyperiids and northern shrimp, occurred in insignificant amounts. The changes in food composition of saithe from different length groups were revealed. Main tendency was a decreasing of small zooplancton (copepods, hyperiids and euphausiids) and increasing of weight percent of fishes. The fishes occurred in a saithe feeding when it was 25 cm of length, but fishes predominated in saithe with the length more than 35 cm. Saithe started to consume of small fish species (capelin and herring) with reaching to length 30-35 cm, larger fishes (cod, haddock and blue whiting) were consumed only by saithe with length more than 45-50 cm.

Along the Norwegian coast north of 62º investigations in the period October - November 1998-2003 showed that fish was the dominating prey group for saithe (Mehl, WD 7), followed by crustaceans. In the smallest size group (20-39 cm), krill was the dominating prey item in all sub-areas, while in the larger size groups fish dominated. In the northern sub-areas, herring was the most important fish prey, followed by Norway pout, haddock, and blue whiting. Cod only occurred sporadically, but in numbers that may influence coastal cod recruitment. In the southern sub-areas, Norway pout was the dominating fish prey, followed by blue whiting and haddock. Herring was scarce and no cod was found. The importance of fish was highest in north, while in south the importance of crustaceans increased. The size of the fish prey increased with increasing predator size. Preliminary consumption estimates for quarter four show that krill was the single most important prey species, followed by Norway pout, herring, blue whiting and haddock. The consumption estimates are quite variable from sub-area to sub-area and year to year, and may only partly reflect the consumption and predation pressure of the Northeast Arctic saithe stock.

Blue whiting

Data given indicate that fish (all in all, about 76% by weight) and zooplankton (around 20% by weight) dominated the diet of blue whiting at autumn-winter period (Dolgov, WD 9). However, zooplankton is the most important prey at young ages (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 intensity of feeding was quite high, with a mean index of stomach fullness of about 19 %. 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 when the latter reached a length of about 27 cm. The fish predating blue whiting constitutes about 30 % of the total biomass. Cod juveniles occurred in the stomachs of blue whiting with a length of approximately 25 cm. The maximum size of fish consumed by blue whiting did not exceed 16-17 cm.

Skates

Thorny skate stomach contents consisted primarily of fish and large crustaceans, shrimps and crabs (Dolgov, WD 9). Of more than 18 species of fish identified, young cod (*Gadus morhua*) (12.5% by mass) and capelin (*Mallotus villosus*) (6.1% by mass) were the most prevalent. Demersal crustaceans were represented mainly by northern shrimp (*Pandalus borealis*) (9.5% by mass). The importance of small food items (*Gammaridea*, *Euphausiidae* and Polychaeta) reduced with increasing length of skate, whereas the importance of large crustaceans and fish increased. 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 (31% by mass) and *Gammaridae* (14% by mass). Northern shrimp (26% by mass) and fisheries waste (10% by mass) were also major components of their diets. Fish (mostly capelin and young cod) occurred in small quantities. Small individuals of round skate (<35-cm TL) consumed exclusively benthos (Polychaeta and *Gammaridae*), and only those of the 36–40-cm TL-group and larger fed on bigger prey. The largest skates (51–55-cm TL-group) had a high proportion of small benthic organisms (<30–40%). Arctic skate stomach contents consisted mainly of fish (~90% by mass), including herring (*Clupea harengus*), capelin and redfish (*Sebastes spp*). The portion of northern shrimp was also comparatively high (8.3% by mass), whereas that of fisheries waste did not exceed 2%. Blue skate stomach contents consisted largely of fish (~70% by mass), with young cod and haddock (*Melanogrammus aeglefinus*), redfish, and long rough dab (*Hippoglossoides platessoides limandoides*) prevalent. Fisheries waste was another important food source (25% by mass). Spinytail skate stomach contents were dominated by fish (90% by mass), 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.

Expected situation.

Which consequences will the collapse of the capelin stock in 2003-2004 imply 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 in 1987-1988 at least 77 000 harp seals 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.

Although the amount of herring in cod stomachs increased during the two 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 for a longer period of time, from 2002 up to at least 2007, since the 2002-year class of herring is very strong, as is probably also the 2004-year class. We will thus probably get a situation, which 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.

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, will have alternative fish prey available, as in the mid-1990s. It is thus most likely that the consequences of this capelin collapse will be modest and fairly similar to those in the mid-1990s. 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.

1.2.5 Marine mammals (Table 1.7, Figure 1.7)

Sampling

During summer/autumn 2004 the vessels' observations were carried out of sea mammals on board of R/V "F. Nansen" (PINRO) and Norwegian R/V "J. Hjort" and of some Russian fishing vessels leased for expeditions. Parallel with vessels investigations, the complex aircraft study (transect airborne survey) of distribution of sea mammals in the Barents Sea was performed onboard of the aircraft-laboratory AN-26 "Arktika". The aim of investigations was to study the distribution pattern of main studied species of sea mammals over the Barents Sea in the investigated period, to determine a mechanism and reasons of distribution, and, if possible, to give qualitative assessment of sea mammals number in the studied areas of the Barents Sea (Anon. 2005).

Distribution and abundance

Minke whale was the most frequent species of the large cetaceans. As for the frequency of occurrence, humpback whale was comparable with minke whale at present. The species composition of the registered concentrations of dolphins consisted of white-beaked and common dolphins and harbour porpoises. It should be mentioned that white-beaked dolphin occurred over the entire surveyed area, whereas common dolphin was predominantly registered in the western part. White-beaked dolphin was the most frequently occurred in the Barents Sea species among small cetaceans.

According to observations, cetaceans and pinnipeds were widely distributed in the current year over the entire surveyed area. Migrations of cetaceans in the Barents Sea became more prolonged both in time of presence in the sea and distance. The increase of occurrence in the Barents Sea of rare for this area species (pilot whale, sei whale, fin whale, sperm whale and bottle-nose dolphin), which were usually registered as single individuals, was observed. Concentrating of sea mammals (humpback whales and dolphins) at sites of food objects aggregation was more dense and prolonged than in 2003.

From 2003 to 2004 some changes in distribution of marine mammals were evident. In 2003 the fin, humpback and minke whales were mainly observed in the northern part of the sampling area, in association with capelin and polar cod. In 2004 (Figure 1.7) these species were also observed in the southern part of the sampling area, thus overlapping with capelin and polar cod in the north and herring and blue whiting in the south. Both herring and capelin were more abundant in 2003 than in 2004, while polar cod was more abundant in 2004 than in 2003. Hence, there are no obvious reasons for the southward displacement of the baleen whales.

A character of the revealed distribution of sea 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.

In March an airborne estimation of pups of harp seals was conducted. Preliminary results show that the abundance of the White Sea populations of harp seals in last years is stabilized or some decreased.

Predation by mammals

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

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

Analysis of consumptions of marine mammals in the Barents Sea for 2004 are not yet available.

1.2.6 Main conclusions

Climate

- The temperature in the whole Barents Sea was high in 2004, especially in the late summer and autumn. The heating was strongest in the southern part, with temperature anomalies between 0.5 and 1 °C. In the northern part the conditions were still higher than normal and followed the same development, but with smaller anomalies.
- Inflow of Atlantic waters was low in the first part of 2004.
- The temperature in 2005 is expected to remain high with a small reduction in the autumn.
- The ice concentration in 2004 was low. Similar conditions are expected in 2005.

Phytoplankton

- Model results indicate that spring bloom in 2004 was early.

- The phytoplankton situation in 2005 is expected to be similar to 2004. However, this prediction is highly uncertain due to the dependence on the rapid changing local water column stability.

Zooplankton

- The zooplankton biomass in 2004 was slightly above average.

- In 2005 the biomass is expected to increase slightly from 2004, to a medium high level.

Fish

- Capelin was at a low level in 2004, and is expected to remain at low level in 2005.

- Young herring is presently at a high level. The 2002 year class is strong and the 2004 year-class may also be strong. In 2005 the majority of the 2002 year class is expected to migrate out of the Barents Sea in summer/autumn, while the 2004 year class will remain.

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

- Blue whiting is abundant in the western areas in 2004, mostly individuals at age 1-4 which feed on zooplankton. However, in biomass older individuals which feed on fish constitutes about 30 %.

- Blue whiting abundance in the Barents Sea is expected to remain high in 2005.

- The effect of blue whiting on the zooplankton abundance, and thereby as a feeding competitor for other pelagic species, is not explored. However, there may be an indirect effect on local zooplankton production through filtering of advected zooplankton from the Norwegian Sea, thereby affecting growth of the other species.

Mammals

- In 2004 marine mammals were widely distributed in the Barents Sea

- Distribution of sea mammals in 2004 in the Barents Sea was determined by both high temperatures (earlier spring migration) and decrease of food availability (capelin). Main concentrations of whales and dolphins were found at sites with polar cod and herring aggregation.

1.3 Impact of the fisheries on the ecosystem

1.3.1 General description of the fisheries and mixed fisheries (Tables 1.8-1.9)

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 2004, catches slightly less than 0.9 million tonnes are reported from the stocks of cod, haddock, saithe, redfish, and Greenland halibut, which is an increase of about 10% compared to 2003. An additional catch of about 100 000 tonnes was taken from other demersal stocks, including crustaceans, not assessed at present. The major pelagic stocks are capelin, herring, and polar cod. There was no fishery for capelin in the area in 2004 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 1.8.

A description of the major fisheries in the Barents Sea is summarised by species in Table 1.8.

The demersal fisheries are highly mixed, usually with a clear target species dominating, and with low linkage to the pelagic fisheries (Table 1.9). 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). A 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. The available data has not yet been gathered and compiled for a quantitative analysis.

Estimates on unreported catches on cod in 2002 - 2004 indicate that this is a considerable problem. Unreported landings are estimated at 90 000, 115 000 and 90 000 tonnes in 2002, 2003 and 2004, respectively, *i.e.* 20% in addition to official landing statistics (Table 3.1a). 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.

1.3.2 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*., in press.) 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.

1.3.3 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.
- 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.

1.4 Ecosystem impact on commercial fish stocks

As shown by stock assessments and fisheries statistics, the biomass 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 also it should be remembered, that abundance fluctuations are an adaptive response of a population to environmental impact.

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 oceanographic conditions, which govern the formation of primary biological production and feeding conditions for fish as well as the survival of their progeny, an important factor, that influences the abundance dynamics of commercial species, is inter-specific trophic relations.

1.4.1 Recruitment (Tables 1.10-1.13)

New 0-group indices

A new type of 0-group fish abundance indices for the main commercial species for the period 1980-2004 has been calculated (Anon. 2005). The new indices are calculated with and without a correction factor for length-dependent catchability. Since these correction factors are not yet validated, the indices without length-dependent correction is considered as the official series. This new method is considered to better reflect the total abundance, allows to calculate confidence limits, and makes better use of the total data than the indices (area-based and logarithmic) used hitherto. The preparation of the data is explained and analysed in detail in (Dingsør 2005). When the results have been carefully scrutinized and compared to previous traditional methods, this method is meant to replace the methods used up to now after a short period of overlap between the two methods.

The old 0-group indices are given in Tables 1.10 and 1.11, while the new series are given in Tables 1.12A and 1.12B. The choice of 0-group indices for use in this year's assessment is described in each stock chapter.

Recruitment models

Predictions of the recruitment in fish stocks are essential for future harvesting of the fish stocks. Traditionally prediction methods have not included effects of climate variability. Multiple linear regression models can be used to incorporate both climate and fish parameters. Especially interesting are the cases where there exists a time lag between the predictor and response variables as this gives the opportunity to make a prediction. In the recent years several such models have been developed for different species (Bulgakova, WD20, Stiansen *et al.*, WD1, Titov *et al.*, WD16), which easily can be incorporated in the assessment projections. Prognosis estimates from these models are shown in Table 1.13, together with estimates from the assessment.

The recruitment estimates from XSA/RCT3 and from Gadget are also given in Table 1.13. There is relatively good correspondence between the various methods concerning recruitment in 2005 and 2006, while there are large discrepancies for 2007. It was decided to use the 'traditional' RCT3 estimates in the predictions of cod recruitment.

1.4.2 Growth (Tables 1.14-1.15, Figures 1.8-1.10)

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.

Prognosis of cod growth in the Barents Sea is given by the STOCOBAR model (Filin 2002). This model is used to calculate mean weight of fish at age 2-10 in the beginning of the year based on input data on food supply, temperature and size of cod abundance. Model parameters were estimated based on historical data for 1984-2002, using stomach data from the Russian-Norwegian database, mean annual temperature data in the Kola Section, estimated biomass of capelin and data on abundance and mean weight-at-age cod from the AFWG 2004 assessment.

The forecast of cod growth rate was made for 2004-2007 with 2003 taken as a starting year. Observed data from the start of 2003 were used in the forecast of mean weight at age. The mean weight of a cod aged 1 for 2006 and 2007 was calculated as a mean over the 3 previous years. In the prognosis the forecasts of mean annual temperature in the Kola Section for 2005-2006 was used as input data, together with the prognosis of capelin biomass in 2005 and 2006 (section 9.9).

The results of forecasting the growth rate of cod aged 2-8 are presented in Table 1.14. In general, the results showed that is not expected pronounced changes in growth rate of fish in 2005-2006. According to results for 2005-2007 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.

Effects of capelin and temperature on maturation of cod

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. Bivariate plots of these two variables for Northeast Arctic cod show that there is a clear distinction between the 1946-1979 and 1985-2001 time periods (Figure 1.8). In the earlier time period cod were maturing more slowly for their weight-at-age.

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

Estimates of weight-at-length were multiplied by the Russian liver condition index at length (Yaragina and Marshall 2000) to derive estimates of liver weight in grams for cod at a standard length (see Marshall *et al.* 2004 for details of this calculation). This analysis indicated that for the 1985-2001 there is a consistently significant, positive relationship between liver weight and proportion mature (Figure 1.10). For two length classes (midpoints 72.5 and 82.5 cm) there are significant correlations between liver weight and proportion mature for the earlier time period as well. This result confirms that the magnitude of stored energy is positively correlated with proportion mature. Furthermore, these derived estimates of liver weight are, positively correlated with capelin stock biomass over the entire 1946-2001 time period (Figure 1.11) ($n = 54$, $r^2 = 0.44$, $p < 0.001$ Marshall *et al.* 2004).

To investigate whether temperature had any effect on the relationship between liver weights and proportion mature average temperature values for July through December were calculated using the Kola section time series. The mean temperature of the last six months in the preceding year was did not explain a significant amount of variability in the proportion mature-at-length in models that use liver weight to represent the bioenergetic status (Table 1.15). Thus, variability in temperature does not appear to impact the proportion mature of cod.

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

1.4.3 Natural mortality (Table 1.16)

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 (Kovalev 2004). Using this approach the predicted natural mortality coefficient for cod including cannibalism seems to be higher compared to "the standard" prediction sec. 3.3.8

For age 3 the level of natural mortality tend to increase from 0.3 in 2004 to 0.47 in 2007 and for age 4 from 0.23 to 0.29. Values for the years 2004 to 2007 are given in the text table below:

	M2 AGE 3	M2 AGE 4
	by regression	
2004	0.30	0.23
2005	0.39	0.26
2006	0.42	0.27
2007	0.47	0.29
	values used in assessment	
2005-2007	0.2674	0.2116

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

1.4.4 Expected stock parameters based on qualitative analysis of ecosystem impact factors (Table 1.17)

An alternative approach for looking at the future development of the commercial fish stocks development 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 1.17.

1.5 Answers to short term considerations from WGRED

The Working Group on Regional Ecosystem Descriptions identified three specific environmental factors relevant for the AFWG. The AFWG 2005 is asked to consider these concerns:

Blue whiting in the Barents Sea

In 2004 1400 Kt of blue whiting has been recorded in the Barents Sea. This is the highest observed in the area. AFWG is asked to consider the impact of blue whiting on the Barents Sea ecosystem and whether there is enough knowledge to incorporate it into assessments of concern.

As described in chapter 1.2.4, there have been Russian investigations on stomach contents in the Barents Sea since the mid 80s (Dolgov, WD 9). Stomach contents of Blue whiting are sampled in 1998-2000 and 2003, about 1500 all together. The data indicate zooplankton is the most important prey at young ages (age < 5), which is the dominant part of the stock present in the Barents Sea. When blue whiting reaches a length of about 27 cm (5 years old), fish seems to be the dominant part the diet. This means that about one third of the biomass observed probably has fish as main prey. The fish prey was dominated by pelagic species (*i.e.* polar cod, capelin, haddock, saithe and redfish).

How much impact herring and blue whiting have on the zooplankton biomass is not clear, but the competitive effect is assumed to be low. However, advected zooplankton biomass from the Norwegian Sea is an important mechanism for supplying the local production in the whole Barents Sea. It may therefore be an indirect effect of blue whiting feeding on the other species as a filter on the advected biomass passing on the way further into the Barents Sea. This may again reduce the local production since fewer adults reach new production areas.

Blue whiting is observed in stomach contents of other species like cod, haddock and Greenland halibut (Dolgov, WD 9 and 10), however it is not likely that blue whiting is important prey for any of the fish stocks in the Barents Sea. It seems for example that the percentage of blue whiting in the cods' diet has decreased from 2001 to 2003.

Juvenile herring

AFWG is asked to address the additional risk to the Barents Sea capelin stock due to the strong year classes of juvenile Norwegian Spring Spawning herring in the Barents Sea. The 2002- and 2004 year classes are considered strong.

The working group is well aware of the effect strong year classes of herring have on the recruitment of capelin. This is not incorporated into the calculations of recruits, but there is ongoing work in order to handle this effect.

Capelin and cod

Capelin dependent growth effects are not implemented in the prediction of the cod stock. However, there is ongoing work on quantifying such effects in order to incorporate it.

The Barents Sea capelin stock level is still considered low. Capelin is the main prey for Northeast Arctic cod in periods when capelin is abundant, thus capelin stock levels have shown to affect the growth of cod. At present there is considerable alternative prey available, like herring, polar cod and juvenile fish. It is thus not expected that the low capelin stock will affect the cod growth markedly.

A possible implicit growth effect due to the large biomass of juvenile herring, which feed on capelin, has not been examined.

The cod-capelin relationship is already built into the basis for advice on Barents Sea capelin.

Cod and haddock

The predation of Northeast Arctic cod on Northeast Arctic haddock is implemented in the haddock assessment.

Table 1.1. Capelin stock history from 1973 and prognosis for capelin biomass in 2005. 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*		740	272	

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

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

Year	Prognosis (1+ capelin biomass) Available at AFWG in this year	Survey estimate (1+ capelin biomass)
1999	4.0	2.8
2000	3.8	4.3
2001	4.1	3.6
2002	3.4	2.2
2003	2.0	0.5
2004	1.7	0.6
2005	0.7	

TABLE 1.3. THE NORTH-EAST ARCTIC COD STOCK'S CONSUMPTION OF VARIOUS PREY SPECIES IN 1984-2004 (1000 TONNES), BASED ON NORWEGIAN CONSUMPTION CALCULATIONS.

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Total
1984	506	27	112	436	722	78	15	22	50	364	0	0	2332
1985	1157	169	57	155	1619	183	3	32	47	225	0	1	3649
1986	665	1223	108	142	835	133	141	83	110	313	0	0	3754
1987	680	1084	67	191	229	32	205	25	4	324	1	0	2843
1988	407	1236	317	129	339	8	92	9	3	223	0	4	2767
1989	725	800	241	132	580	3	32	8	10	232	0	0	2765
1990	1447	136	83	194	1593	7	6	19	15	243	0	85	3828
1991	1076	65	75	188	2901	8	12	26	20	312	7	10	4702
1992	1016	102	158	373	2457	332	97	55	106	189	20	2	4906
1993	783	253	715	315	3047	164	278	286	71	100	2	2	6018
1994	670	563	704	518	1087	147	582	225	49	79	0	1	4624
1995	855	982	516	363	630	116	254	393	116	194	1	0	4420
1996	639	631	1158	340	538	47	104	536	69	96	0	10	4168
1997	431	384	520	311	905	5	112	340	41	36	0	56	3142
1998	432	369	471	328	719	89	152	154	32	9	0	13	2768
1999	401	152	285	263	1791	137	232	63	26	16	1	32	3400
2000	424	176	480	478	1836	57	207	80	54	8	0	39	3838
2001	766	180	368	296	1861	77	271	69	53	6	1	163	4110
2002	385	89	270	226	1908	74	272	112	125	1	0	236	3698
2003	576	277	493	231	2117	199	274	116	166	3	0	78	4531
2004	759	626	410	251	1352	101	556	74	81	1	8	116	4336

TABLE 1.4. THE NORTH-EAST ARCTIC COD STOCK'S CONSUMPTION OF VARIOUS PREY SPECIES IN 1984-2004 (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	557	223	235	227	1101	144	368	84	165	6	14	74	3196

TABLE 1.5 CONSUMPTION PER COD BY COD AGE GROUP (KG/YEAR), BASED ON NORWEGIAN CONSUMPTION CALCULATIONS.

Year/Age	1	2	3	4	5	6	7	8	9	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	12.157
1999	0.163	0.505	1.093	2.718	3.720	5.446	6.970	9.189	11.031	12.036	12.139
2000	0.170	0.499	1.244	2.462	4.254	5.656	7.980	9.429	12.750	13.539	13.579
2001	0.171	0.455	1.309	2.440	3.685	5.304	7.555	11.328	13.731	14.444	14.763
2002	0.192	0.551	1.183	2.444	3.386	4.724	6.181	9.056	10.406	11.745	11.100
2003	0.209	0.652	1.285	2.401	4.003	5.983	8.477	10.537	13.063	13.878	14.578
2004	0.160	0.591	1.163	2.726	4.044	6.040	7.867	11.701	14.632	15.555	16.553

TABLE 1.6 CONSUMPTION PER COD BY COD AGE GROUP (KG/YEAR), BASED ON RUSSIAN CONSUMPTION CALCULATIONS.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13+
1984	0.262	0.893	1.612	2.748	3.848	5.486	6.990	8.563	10.574	13.166	12.437	14.282	15.272
1985	0.295	0.752	1.656	2.683	4.264	6.601	8.242	9.743	10.975	14.447	16.499	16.061	17.343
1986	0.179	0.515	1.461	3.467	4.956	5.913	6.477	8.156	9.766	11.455	12.500	13.577	14.772
1987	0.145	0.431	0.844	1.561	3.078	4.346	7.279	9.683	12.703	14.482	15.014	15.115	16.377
1988	0.183	0.704	1.075	1.627	2.392	4.387	8.208	9.978	10.867	16.536	14.352	15.765	12.361
1989	0.282	0.910	1.468	2.207	3.244	4.799	6.581	8.725	11.134	15.799	15.950	17.909	14.023
1990	0.288	1.007	1.696	2.694	3.278	3.833	5.584	6.871	10.716	11.428	12.660	15.053	16.064
1991	0.241	0.936	2.670	4.473	6.038	7.846	9.590	11.542	14.970	19.294	17.509	20.109	22.109
1992	0.178	0.969	2.475	2.866	3.995	5.138	6.724	7.414	8.754	12.304	13.518	13.744	14.908
1993	0.133	0.476	1.512	2.865	3.944	5.108	7.372	8.945	10.343	11.600	14.067	14.893	15.922
1994	0.180	0.512	1.212	2.402	3.517	5.359	7.560	10.001	11.818	12.896	13.554	15.902	16.806
1995	0.194	0.497	0.962	1.819	3.204	4.847	7.332	9.688	13.835	15.247	15.892	17.306	18.290
1996	0.170	0.498	1.028	1.916	3.075	4.189	6.987	10.212	12.185	13.426	13.669	14.968	15.738
1997	0.119	0.341	0.992	1.908	2.668	3.503	4.954	7.980	12.174	21.523	19.738	20.974	23.744
1998	0.232	0.528	1.081	2.016	2.823	4.089	5.469	7.346	9.586	13.012	13.570	14.540	15.762
1999	0.261	0.431	1.128	2.490	3.676	5.222	6.398	8.220	9.194	13.364	14.327	15.918	17.109
2000	0.186	0.545	1.288	2.551	4.384	6.557	8.813	10.483	11.495	15.101	16.026	18.770	20.330
2001	0.150	0.413	1.163	2.109	3.425	5.562	6.825	10.214	12.371	14.997	16.773	17.473	19.788
2002	0.252	0.677	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	18.788	17.929	19.056
2004	0.213	0.612	1.253	2.283	3.389	4.890	7.055	10.244	13.920	19.780	21.025	19.853	21.146

Table 1.7. 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 1.8. 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 2004 (TONNES)	AS BY-CATCH IN FLEET(S)	LOCATION	AGREEMENTS AND REGULATIONS
Capelin	PS, TP	seasonal	0	TR, TS	Northern coastal areas to south of 74°N	bilateral agreement, Norway and Russia
Coastal cod	GN, LL, HL, DS	all year	32599	TS, PS, DS, TP	Norwegian coast line	Q, MS, MCS, MBU, MBN, C, RS, RA
Cod	TR, GN, LL, HL	all year	580000	TS, PS, TP, DS	North of 62°N, Barents Sea, Svalbard	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Wolffish[1]	LL	all year	21081	TR, (GN), (HL)	North of 62°N, Barents Sea, Svalbard	Q, MB
Haddock	TR, GN, LL, HL	all year	116293	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	161916	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[2]	LL, GN	Seasonal	18762	TR	deep shelf and at the continental slope	Q, MS, RS, RG, MBH, MBL
Sebastes mentella	No directed fishery	all year	4914	TR	deep shelf and at the continental slope	C, SG, MB
Sebastes marinus	GN, LL,HL	all year	7293	TR	Norwegian coast	SG, MB MCS, MBU, C
Shrimp	TS	all year	41800[3]		Spitsbergen, Barents Sea, Coastal	ED, EF, SG, C, MCS

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

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

[3]The total catch in 2003

Table 1.9. 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 1.10. Abundance indices of 0-group fish in the Barents Sea and adjacent waters in 1965-2004. 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	-	157	70	472	9	72
1978	40	192	110	-	107	144	460	35	76
1979	660	129	95	-	23	302	980	22	69
1980	502	61	68	-	79	247	651	12	108
1981	570	65	30	-	149	93	861	38	95
1982	393	136	107	-	14	50	694	17	150
1983	589	459	219	-	48	39	851	16	80
1984	320	559	293	-	115	16	732	40	70
1985	110	742	156	-	60	334	795	36	86
1986	125	434	160	-	111	366	702	55	755
1987	55	102	72	-	17	155	631	41	174
1988	187	133	86	-	144	120	949	8	72
1989	1330	202	112	-	206	41	698	5	92
1990	324	465	227	-	144	48	670	2	35
1991	241	766	472	-	90	239	200	1	28
1992	26	1159	313	-	195	118	150	3	32
1993	43	910	240	188	171	156	162	11	55
1994	58	899	282	120	50	448	414	20	272
1995	43	1069	148	73	6	0	220	15	66
1996	291	1142	196	378	59	484	19	5	10
1997	522	1077	150	390	129	453	50	13	42
1998	428	576	593	524	144	457	78	11	28
1999	722	194	184	242	116	696	27	13	66
2000	303	870	417	213	76	387	195	28	81
2001	221	212	394	77	110	146	11	32	86
2002	327	1055	412	315	179	588	28	34	173
2003	630	694	705	277	164	337	57	9	58
2004	288	983	977	639	62	355	98	29	35
1985-2004	338	614	286		115	266	387	20	110
1965-2004	289	482	221				371	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 1.11. 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.

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 1.12A. New abundance indices (in millions) for 0-group fish with 95% confidence limits, corrected for catching efficiency

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	1078218	737682	1418753	490	257	724	450	276	624	124	33	215	28	0	63	0	0	0	193438	0	470287
1981	571088	304965	837211	427	304	550	106	43	169	50	0	115	0	0	0	3992	1843	6141	71870	28005	115735
1982	815597	203572	1427623	3924	2893	4955	3282	2416	4148	1065	292	1837	285	0	685	4	0	9	4073	0	9022
1983	443024	231573	654474	21932	11101	32764	5823	4310	7337	162656	38606	286707	445	138	751	1406	0	3256	81606	0	175202
1984	224880	137399	312360	27952	8486	47418	4973	3455	6491	24257	1735	46778	1149	395	1903	164	0	417	41402	9961	72842
1985	97915	968	194861	89166	43308	135023	3265	2079	4450	40187	8180	72195	41	6	75	117143	32088	202197	10925	0	22226
1986	75297	6625	143968	14676	10058	19294	2971	1759	4183	149	41	258	6	0	14	106360	35672	177049	27425	1268	53583
1987	3070	629	5511	1670	774	2566	1162	713	1611	66	0	149	7	0	16	102246	0	236750	1016	426	1605
1988	122766	22343	223190	4034	2344	5725	2438	856	4020	83138	28337	137939	33	13	54	4535	87	8983	62627	0	134372
1989	1175685	936027	1415342	3792	2302	5282	917	635	1199	23520	10937	36104	17	0	36	2681	0	5708	229206	30819	427594
1990	153597	103466	203728	31241	17864	44618	3757	2773	4742	10566	828	20304	33	3	64	4478	1107	7848	411733	0	917105
1991	219759	98508	341009	56288	41328	71249	19053	14647	23459	361027	137974	584080	10	5	16	834254	381210	1287299	497155	0	1424609
1992	465	0	991	226558	123246	329871	6000	4031	7969	118159	68004	168315	366	170	563	78143	0	156929	131280	19166	243394
1993	1034	215	1854	127006	70300	183713	3634	2523	4745	437573	3197	871950	1259	0	3036	158293	39655	276931	111155	18321	203989
1994	27983	2590	53376	110467	58920	162013	6228	3583	8872	174920	0	365301	7	0	15	1894327	862068	2926585	72569	0	160334
1995	2756	0	6324	346940	163909	529971	1596	816	2375	19094	7574	30614	562	250	874	0	0	0	350	18	681
1996	191767	98491	285044	380135	252053	508217	3026	2302	3750	758043	359092	1156994	609	251	968	970882	605523	1336240	65658	0	163364
1997	261351	113055	409647	423915	315457	532373	2655	1812	3497	624380	230666	1018094	498	239	757	434902	237937	631866	101768	8170	195365
1998	117380	64377	170384	31667	21006	42329	16465	11148	21781	632685	365795	899574	181	93	269	23638	11670	35605	137102	0	311064
1999	393331	200244	586419	5629	1503	9755	3224	1267	5181	49279	18559	79998	297	149	445	1731729	1103565	2359893	41141	6680	75603
2000	186841	7492	366191	152259	81350	223169	14944	9358	20530	626908	30754	1223062	1219	632	1805	1416626	814987	2018265	320585	212329	428840
2001	26526	4354	48698	6699	1315	12084	6659	4632	8685	13657	2453	24862	53	0	119	0	0	0	218690	0	480295
2002	29182	16813	41552	45457	29288	61625	5245	3467	7024	124280	18213	230346	632	372	891	129539	76206	182871	378438	70970	685906
2003	611818	314101	909536	131830	76270	187389	45461	25018	65903	256458	92865	420051	3810	0	9996	131767	68293	195241	22204	1648	42760
2004	74158	16665	131651	100968	72516	129420	45805	30977	60633	1065883	728730	1403037	6353	3574	9132	416803	183222	650384	4003	1102	6904

Table 1.12B. New abundance indices (in millions) with 95% confidence limits, without correction for catching efficiency.

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	289 233	198 151	380 314	84	48	120	89	55	123	7	2	12	376 831	0	942 891
1981	146 857	79 240	214 473	65	45	86	19	9	29	5	0	11	208 676	0	495 518
1982	241 500	60 673	422 327	665	478	851	716	521	911	66	15	116	225 937	14 158	437 716
1983	134 397	72 378	196 416	5 302	2 324	8 280	1 816	1 193	2 440	43 773	16 434	71 112	71 452	35 908	106 997
1984	97 638	60 528	134 748	7 874	2 533	13 214	1 713	1 169	2 256	5 677	2 093	9 261	57 458	18 739	96 177
1985	32 255	0	65 111	20 151	10 163	30 139	923	530	1 316	10 478	1 852	19 104	425 744	159 729	691 758
1986	18 025	891	35 160	2 493	1 718	3 267	630	364	896	12	0	24	147 650	0	304 931
1987	799	178	1 421	223	113	333	170	102	239	3	0	6	32 904	17 801	48 007
1988	38 435	7 967	68 904	702	402	1 002	524	207	840	11 928	4 488	19 368	91 515	58 459	124 571
1989	344 987	273 551	416 424	957	549	1 365	234	160	307	5 484	1 876	9 092	21 354	10 223	32 485
1990	48 054	32 584	63 525	8 821	4 733	12 909	1 519	1 117	1 920	6 054	0	12 658	123 980	67 925	180 034
1991	74 506	33 789	115 223	14 776	10 663	18 889	5 281	3 954	6 608	105 890	55 508	156 271	51 494	0	104 059
1992	154	0	330	60 728	33 084	88 371	2 237	1 600	2 874	52 097	30 012	74 182	18 413	0	48 719
1993	343	96	590	35 890	19 228	52 552	1 623	1 098	2 148	90 769	5 517	176 021	7 623	0	18 569
1994	12 316	1 206	23 425	35 683	18 494	52 872	2 586	1 367	3 806	25 224	0	54 145	71 465	0	164 239
1995	819	0	1 882	119 472	60 293	178 651	720	366	1 074	2 267	814	3 720	22 022	4 497	39 546
1996	62 740	32 285	93 194	94 377	62 348	126 406	1 422	1 062	1 782	78 827	39 355	118 298	37	11	62
1997	76 780	32 845	120 714	90 747	66 917	114 576	834	576	1 093	62 444	28 017	96 870	196	0	395
1998	47 841	30 786	64 895	9 065	5 747	12 382	7 990	4 985	10 996	106 103	58 716	153 490	995	12	1 978
1999	118 474	64 831	172 117	1 819	201	3 436	1 539	503	2 575	22 033	2 821	41 245	54	20	88
2000	52 507	787	104 227	34 816	18 597	51 035	3 927	2 510	5 344	66 280	4 456	128 104	10 051	0	22 542
2001	6 950	852	13 047	1 309	250	2 367	2 688	1 724	3 652	1 136	202	2 070	8	2	14
2002	27 629	15 510	39 748	25 504	14 781	36 227	2 464	1 699	3 228	31 326	16 289	46 363	176	29	324
2003	174 219	90 750	257 687	25 464	14 899	36 028	11 524	5 974	17 073	41 866	23 187	60 546	257	0	549
2004	22 688	3 525	41 851	29 893	21 856	37 931	26 775	17 806	35 744	185 326	131 597	239 055	1 366	0	2 807

Table 1.13. Overview of available recruitment models prognoses (section 1.4.1) together with the 2005 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	2005 Prognoses	2006 Prognoses	2007 Prognoses	Unit
WD1	Barents Sea capelin	Recruits (age 1)	1	November	173			$*10^9$
WD16	Barents Sea capelin	Recruits (age 1)	1	Before assessment	201	16		$*10^9$
WD1	NEA cod	0-group, log (age 0)	2	November	0.98	0.90		
WD16	NEA cod	Recruits (age 3)	4	Before assessment	616	555	951	$*10^6$
WD20	NEA cod	Recruits (age 3)	3	Before assessment	711	703	532	$*10^6$
WD1	NEA cod	Recruits (age 3)	2 (3 [1])	November (March [1])	723	501	644 [1]	$*10^6$
WD1	NEA cod	Recruits (age 3)	1 (2 [1])	November (March [1])	461	495 [1]		$*10^6$
WD1	NEA cod	Recruits (age 3)	0 (1 [1])	November (March [1])	627 [1]			$*10^6$
Gadget Assessment 2005	NEA cod	Recruits (age 3)	1	At assessment	416			$*10^6$
RCT3 Assessment 2005	NEA cod	Recruits (age 3)	3	At assessment	576	478	574	$*10^6$
RCT3 Assessment 2004	NEA cod	Recruits (age 3)	3	At assessment	604	455		$*10^6$
WD1	Norwegian spring spawning herring	Recruits (age 3)	3	November	9.9	15.8	26.8	$*10^9$

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

Table 1.14 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 1.15. Significance levels of temperature and interaction terms in the model: $M_l = LW_l + Temp + LW_l \times Temp$ where M_l is the proportion mature at length, LW_l is liver weight at length and Temp is the average temperature from July through December in the previous year. The pre time period is 1946 to 1979 and the post time period is 1985 to 2001.

TIME PERIOD	LENGTH	R^2	pLW_L	P(TEMP)	$P(LW_L$ X TEMP)
post	72.5	0.47	0.394	0.336	0.29
pre	72.5	0.27	0.283	0.441	0.393
post	82.5	0.43	0.448	0.583	0.579
pre	82.5	0.13	0.852	0.99	0.972
post	92.5	0.54	0.199	0.291	0.296
pre	92.5	0.07	0.868	0.875	0.78
post	102.5	0.62	0.062	0.119	0.107
pre	102.5	0.14	0.847	0.949	0.758

Table 1.16 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	0.0034	0.0035	0.0038	0.0038	0.0041
1990	0.0000	0.0000	0.0000	0.0007	0.0010	0.0010	0.0172	0.0178	0.0185	0.0186	0.0182
1991	0.0000	0.0005	0.0000	0.0003	0.0032	0.0020	0.0219	0.0227	0.0232	0.0235	0.0237
1992	0.0000	0.0021	0.0037	0.0128	0.0249	0.0475	0.0117	0.0157	0.0230	0.0230	0.0228
1993	0.0000	0.0413	0.0368	0.0515	0.0536	0.1129	0.0498	0.0796	0.0798	0.0798	0.0816
1994	0.0000	0.0038	0.0916	0.0347	0.0284	0.0778	0.1245	0.1331	0.2679	0.2694	0.2663
1995	0.0069	0.0811	0.0744	0.1101	0.0925	0.1114	0.1382	0.2528	0.2539	0.2545	0.2558
1996	0.0000	0.1490	0.2548	0.2059	0.1321	0.1265	0.1839	0.2058	0.2411	0.2421	0.2417
1997	0.0000	0.0720	0.0767	0.1139	0.1588	0.1559	0.2336	0.2247	0.2849	0.2761	0.2801
1998	0.0000	0.0134	0.0272	0.0417	0.1038	0.0974	0.1085	0.1488	0.2706	0.2711	0.2717
1999	0.0000	0.0000	0.0049	0.0137	0.0147	0.0342	0.0618	0.1112	0.1969	0.1939	0.1846
2000	0.0000	0.0000	0.0286	0.0148	0.0134	0.0266	0.0496	0.0563	0.2711	0.2689	0.2717
2001	0.0000	0.0159	0.0116	0.0082	0.0131	0.0241	0.0497	0.0370	0.3231	0.3187	0.3208
2002	0.0000	0.0371	0.0597	0.0151	0.0187	0.0274	0.0624	0.0630	0.1567	0.1551	0.1567
2003	0.0000	0.0197	0.0191	0.0195	0.0193	0.0183	0.0464	0.1012	0.2219	0.2265	0.2238
2004	0.0000	0.0050	0.0147	0.0179	0.0104	0.0178	0.0402	0.0282	0.0880	0.0890	0.0884
Average	0.0004	0.0212	0.0339	0.0319	0.0378	0.0534	0.0731	0.0876	0.1459	0.1455	0.1454

Table 1.17. Qualitative analysis of effects of ecosystem impact factors on some stocks in the Barents Sea in 2005.

Commercial species	Stock parameters	Ecosystem parameters									Total expectation
		Temperature of water	Zooplankton biomass	Capelin biomass	Herring biomass	Polar cod biomass	Blue whiting biomass	Cod biomass	Harp seal abundance	Whales abundance	
NEA Cod	Abundance at age 0+	++	++	+	– –	?	–	+ –	?	?	H
	Cannibalism	++	– –	++	– –	–	–	+	+	+	H
	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 values of biological parameters.
++ large positive influence of ecosystem parameter on biological parameters;
+ positive influence of ecosystem parameters on biological parameters;
+ − Influence of ecosystem parameter on biological parameter without clear positive or negative effects;
− negative influence of ecosystem parameters on biological parameters;
− − large negative influence of ecosystem parameter on biological parameter;
? knowledge are not available.

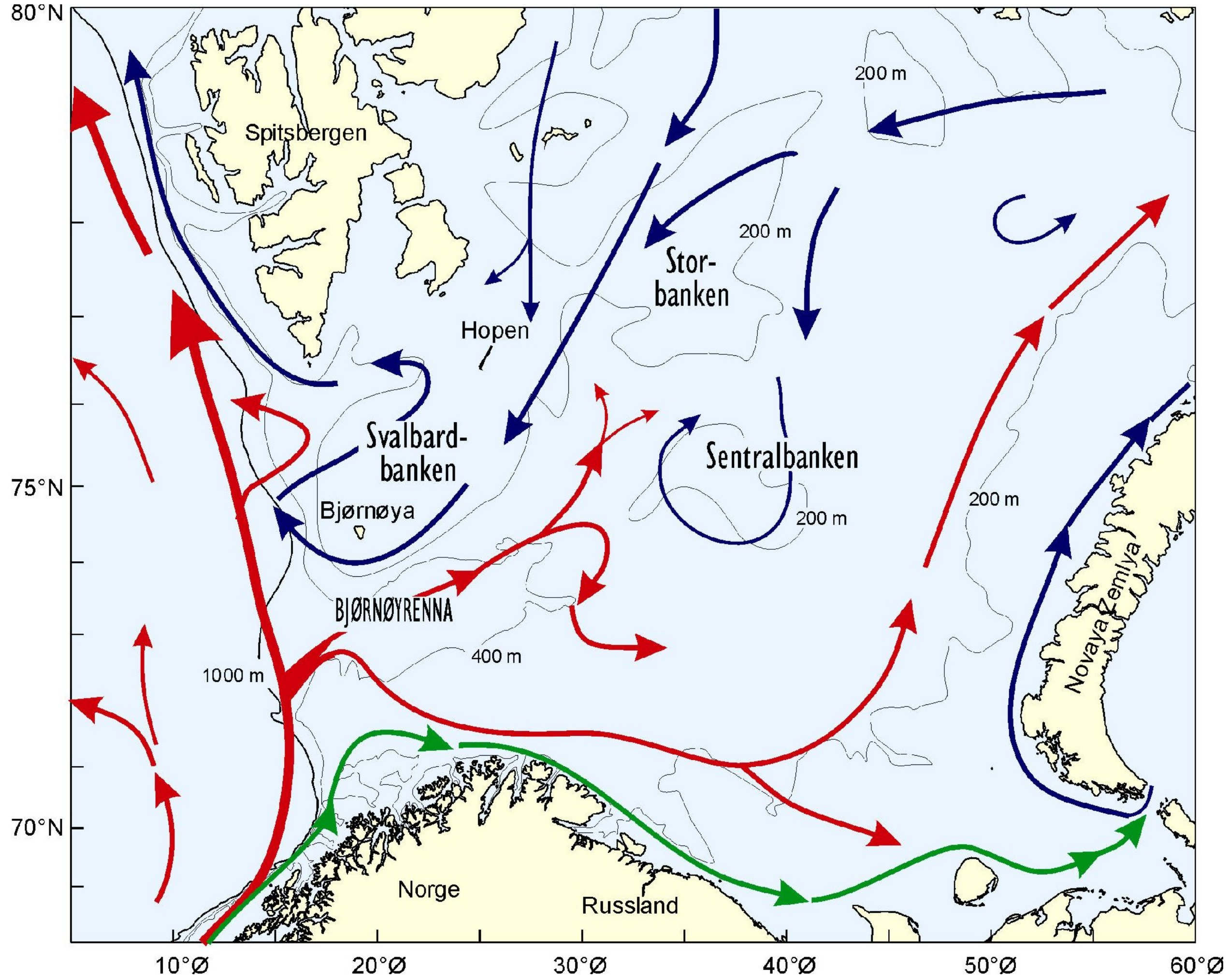


Figure 1.1. The main features of the circulation and bathymetry of the Barents Sea. Red arrows: Atlantic water. Blue arrows: Arctic water. Green arrows: Coastal water (Stiansen et al., WD1.).

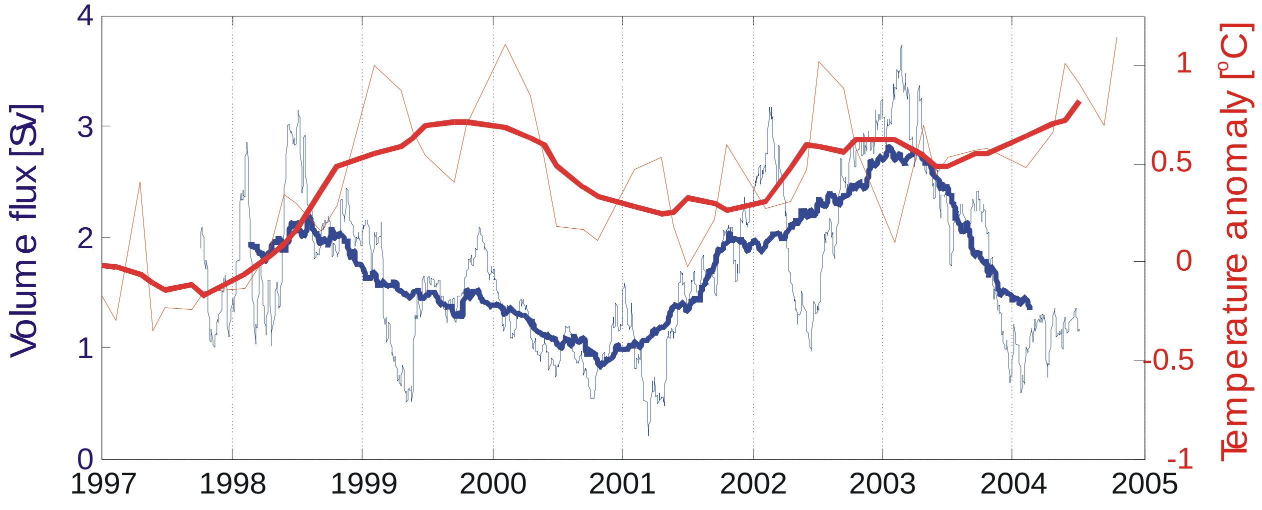


Figure 1.2. Temperature and inflow of Atlantic water at the western entrance. The blue lines show Atlantic water volume flux across the section Norway-Bear Island. Time series are 3 and 12 months running means. The red lines show temperature anomalies the section Fugløya – Bear Island section. Time series are actual values and 12 months running means (Stiansen et al., WD1).

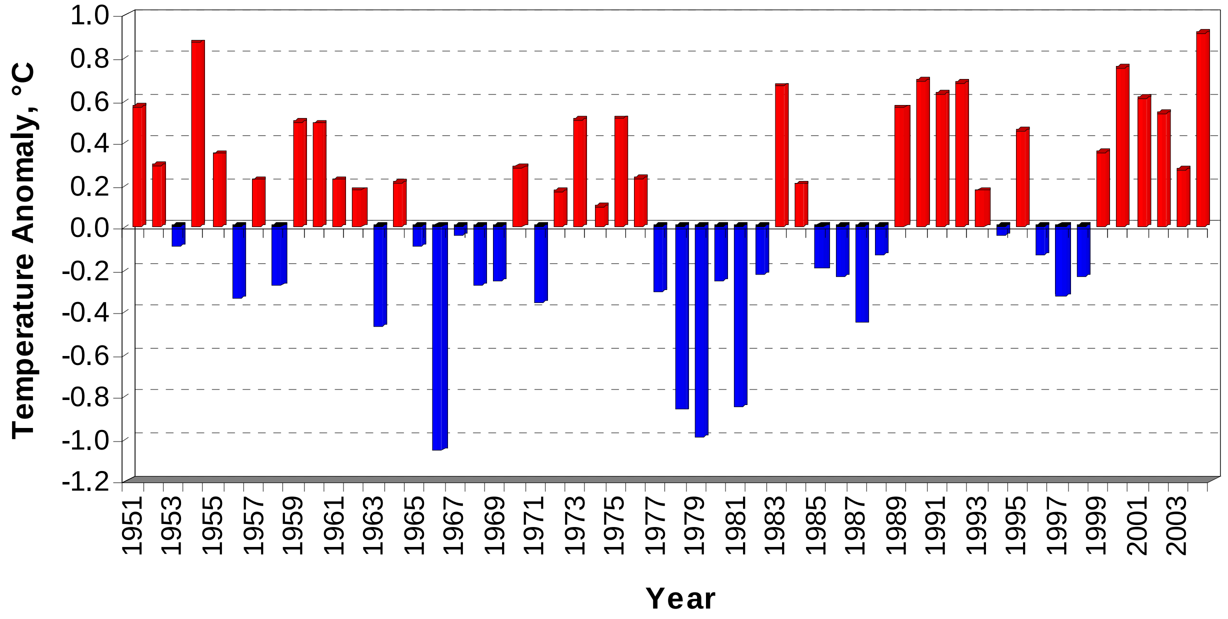


Figure 1.3. Average annual temperature anomalies in the 0-200 m layer in the Kola section (Titov et al., WD16)

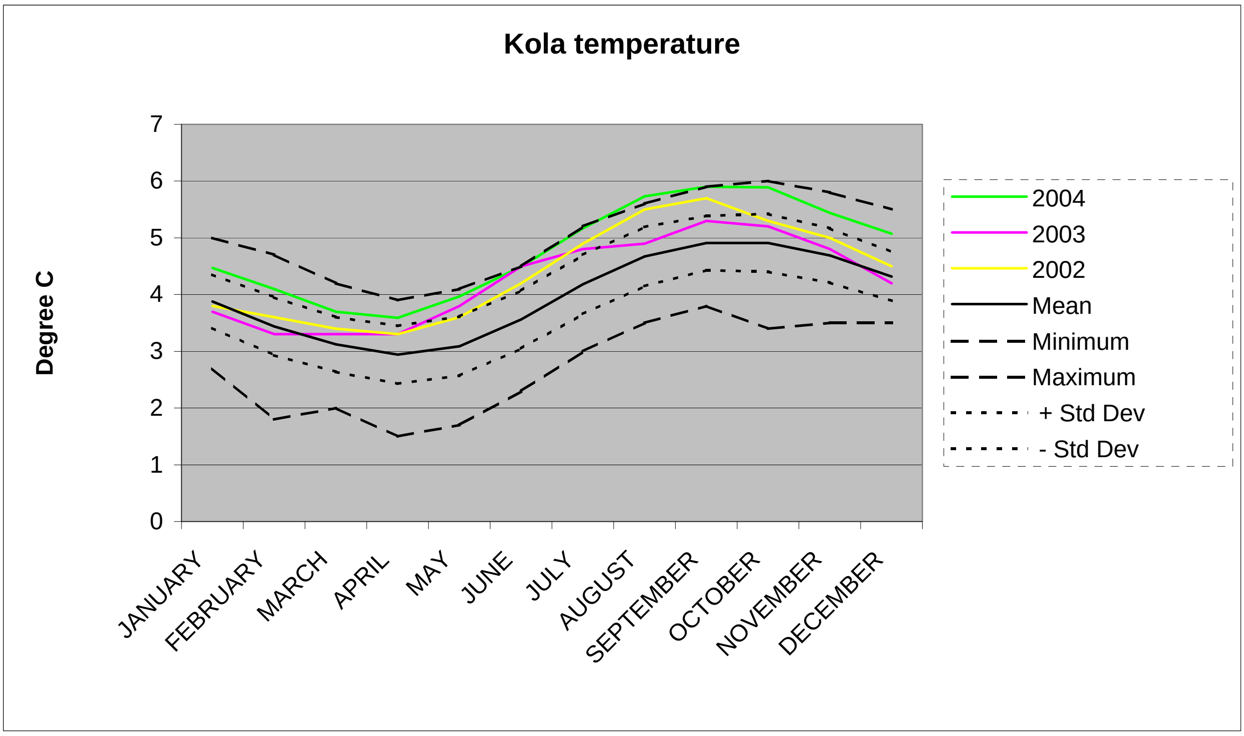


Figure 1.4. Southern Barents Sea seasonal temperature development. The figure shows the Kola section monthly temperature statistics (long-term seasonal mean, minimum, maximum and standard deviations) for the period 1921-1999, together with the values for 2002-2004, given for each calendar month for the 0-200 m depth interval (redrawn from Titov et al., WD16)

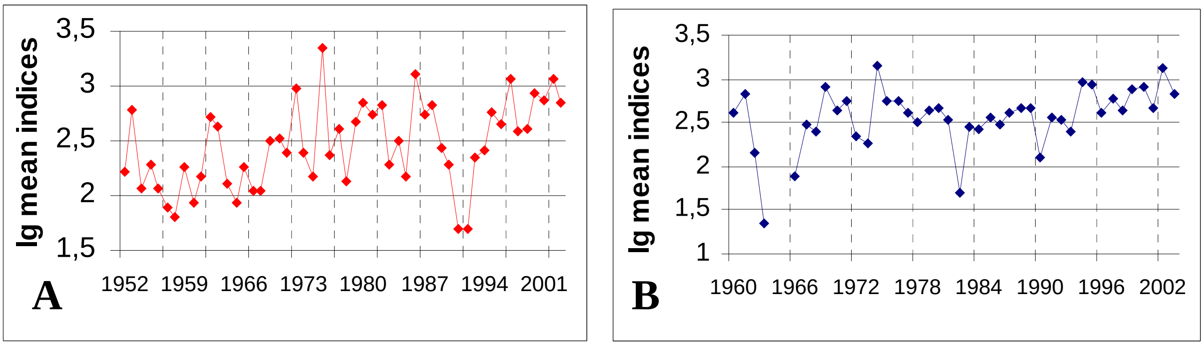


Figure 1.5. Krill abundance indices from the Russian macroplankton survey in the southern (A) and in the northwestern sea (B).

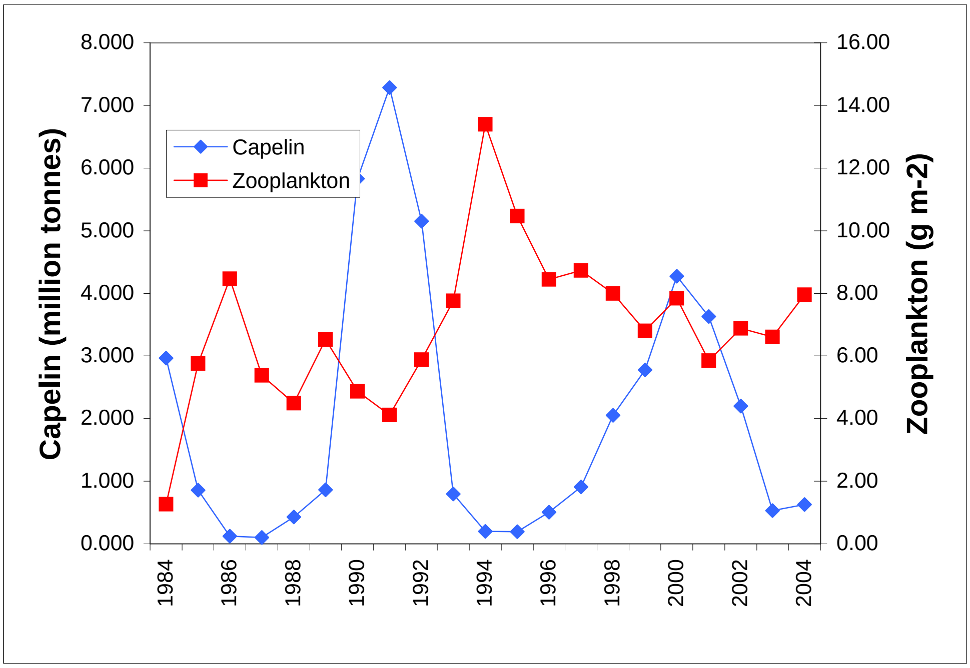


Figure 1.6. Average zooplankton biomass (g m^{-2}) together with biomass of one year old and older capelin (million tonnes) during 1984 – 2004, in the Barents Sea (from Dalpadado et al. 2002, updated with data for 2001-2004).

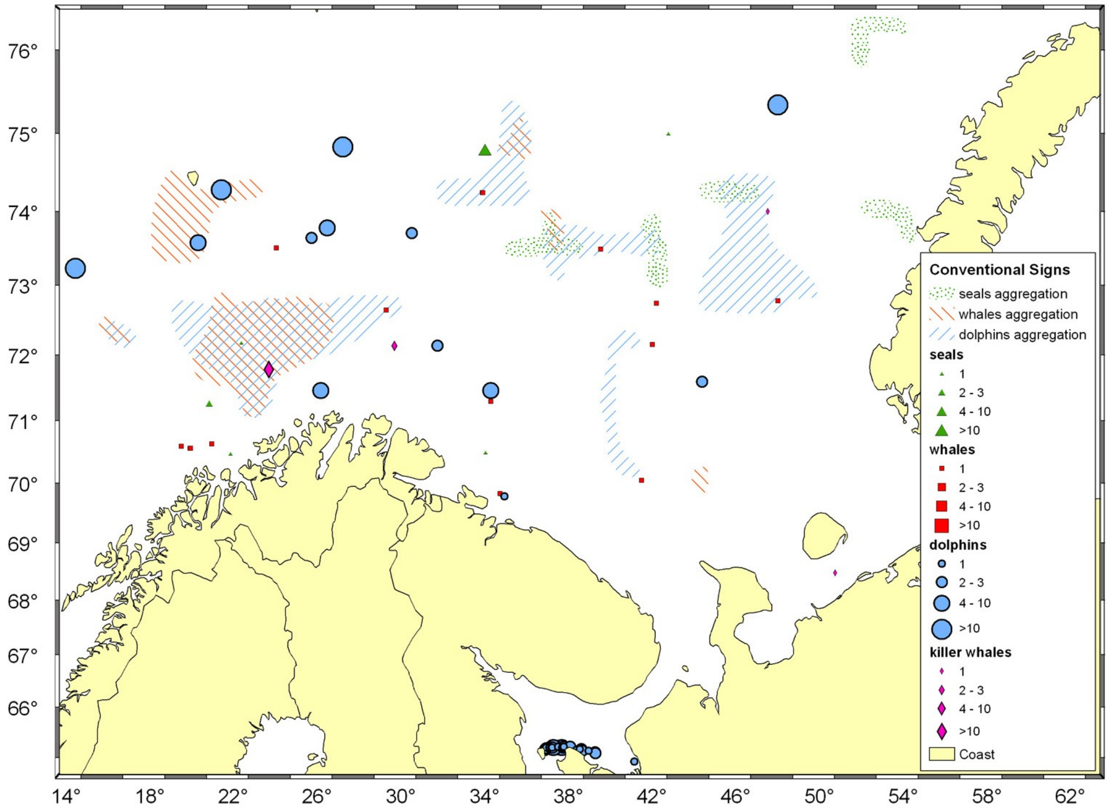


Figure 1.7. Distribution of marine mammals in the Barents Sea in August 2004 according to ship- and airborne observations.

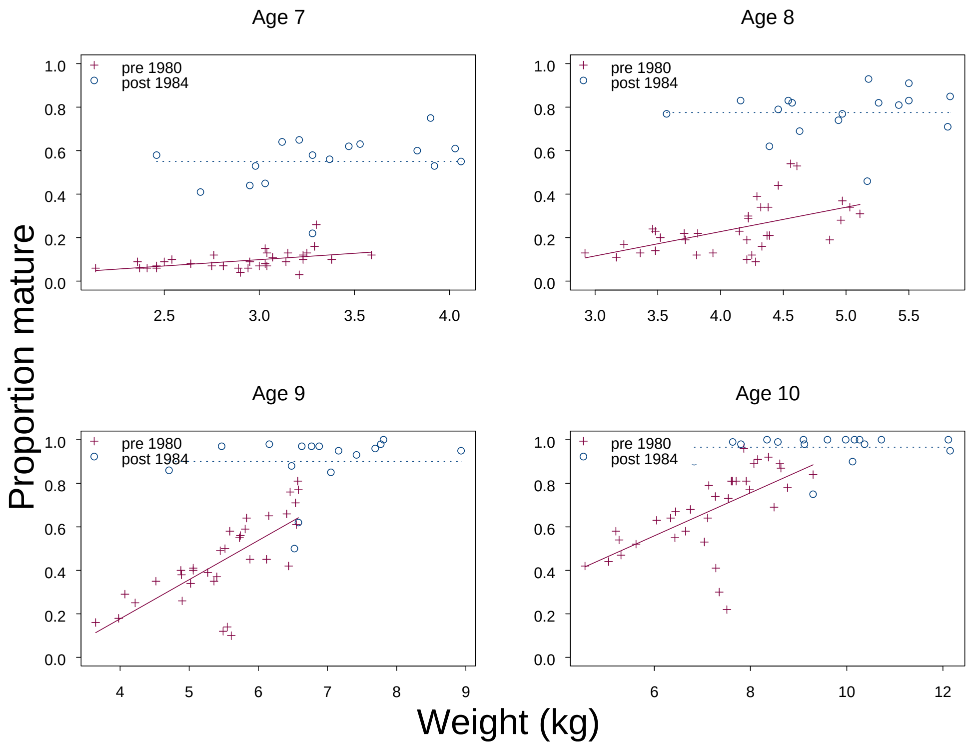


Figure 1.8. Bivariate relationships between cod weight at age (kg) and proportion of mature fish in two time periods (1946-1979 and 1984-2001).

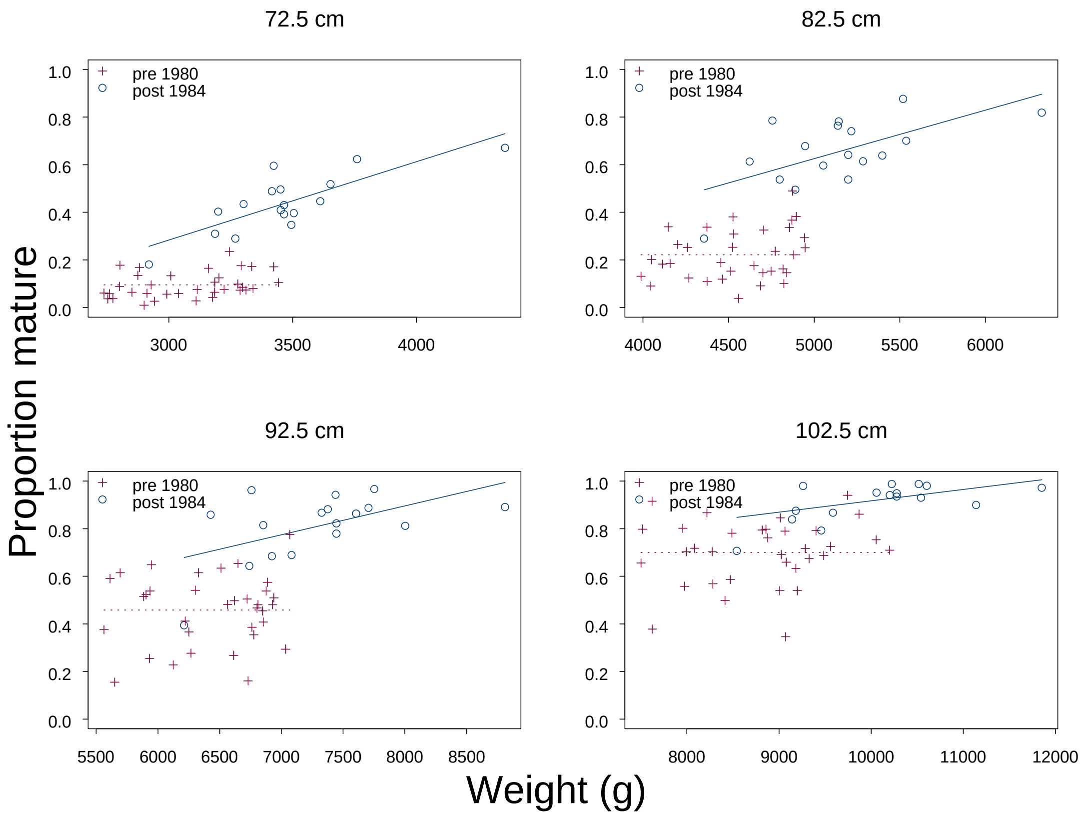


Figure 1.9. Bivariate relationships between cod weight (g) at 4 different lengths and proportion of mature fish in two time periods (1946-1979 and 1984-2001).

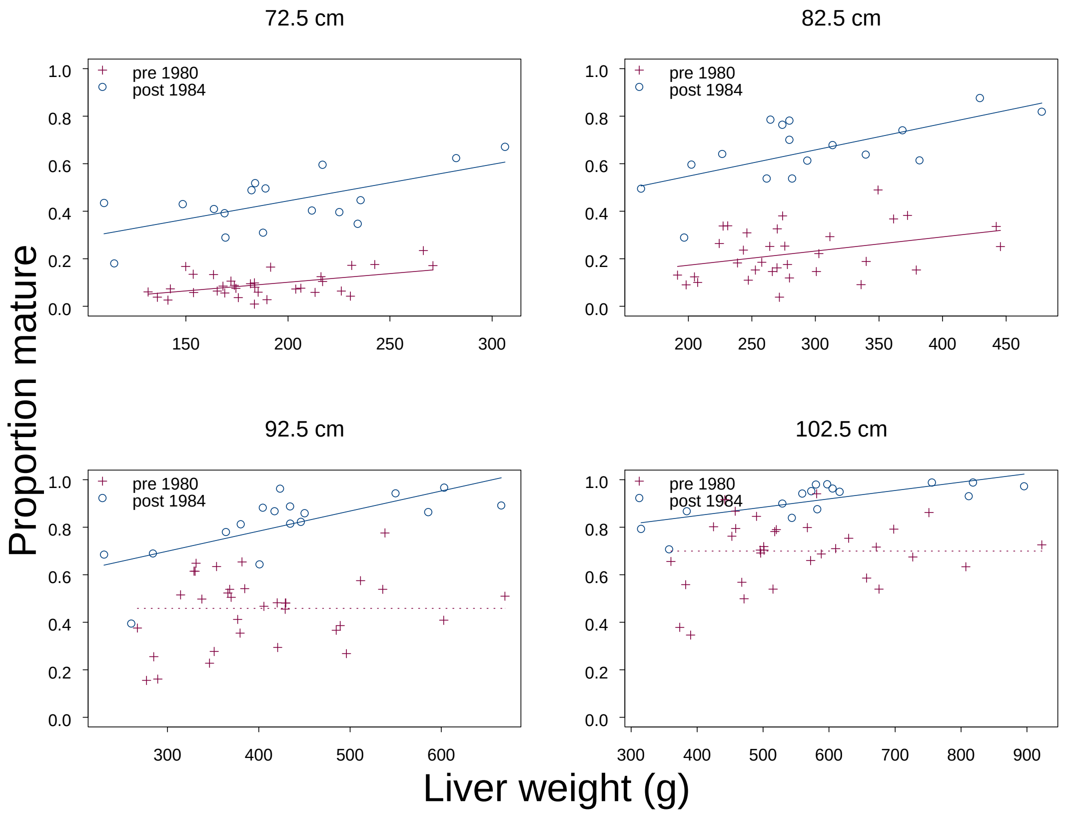


Figure 1.10. Bivariate relationships between cod liver weight at 4 different lengths and proportion of mature fish in two time periods (1946-1979 and 1984-2001).

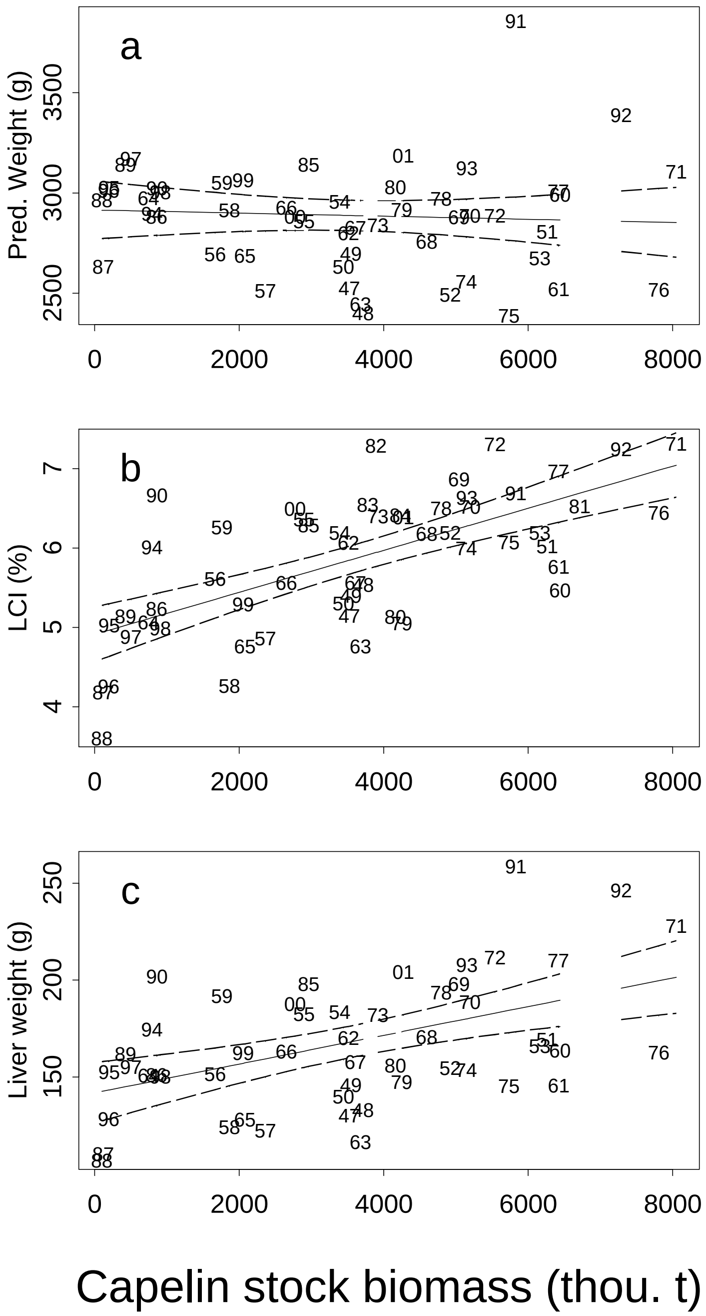


Figure 1.11. Bivariate relationships between capelin stock biomass (thousand t) and a) predicted weight of cod at 70 cm (g); b) liver condition index of the 61-70 cm length class of cod (%); and c) estimated liver weight of cod at 70 cm (g). Observations are denoted by year. Solid line indicates the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

2 Norwegian coastal cod in sub-areas I and II

2.1 Status of the Fisheries

2.1.1 Landings prior to 2005 (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 2003 reported to the Working Group is 34,635 t and the provisional figure for 2004 is 32,599 t (Tables 2.9, 2.19, Figure 2.2). The landings in 2004 decreased compared with 2003. However, the landings were higher than expected. The landings decreased in all areas except for the Lofoten area 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 2004 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 15,438 otoliths were collected from the commercial catches (Table 2.1.A) separated into quarter of catch and fishing gear. Approximately 22 % of the otoliths were classified as coastal cod.

2.1.2 Expected landings in 2005 (Figure 2.4)

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. To achieve a reduction in landings of coastal cod new technical regulations were adopted in 2004 and extended in 2005 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 2.4). 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 2004. 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 2005. 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 2005 accurate. The working group therefore assume a status quo fishing mortality in 2005, which will result in landings of 22,877 tonnes using the same exploitation pattern as in the period 2002-2004, scaled to the 2004 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 and 2004 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. In addition, a new bottom trawl time series based on fixed stations from the Norwegian coastal survey is under preparation and will hopefully be ready before next year’s assessment.

The trawl-acoustic coastal survey in 2004 estimated a total survey biomass of NCC of about 31,000 t (21 million fish) from Varanger to Stadt at 62^o 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). More than 67% of the total coastal biomass was distributed from the Russian border to 67^o N and about 33% south of 67^o

N (Norwegian statistical areas 06 and 07). 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^o N) nearly all otoliths collected were of the NCC type, which is similar to the results of the 1995-2003 surveys.

The numbers of NCC per age groups from all the coastal surveys is given in Table 2.7. The total numbers was almost unchanged in 2004 compared with the 2003 survey. For age groups 2-4 the numbers increased and for age groups 6-9 the numbers decreased from 2003 to 2004. The Norwegian 2005 coastal survey (October-November) will be conducted in a similar way as the previous one (2004) to further extend the time series for NCC over its distribution area.

2.2.2 Age reading and stock separation

Age readings of the cod both from the surveys and from the catches, are done the same way as for the NEA cod. A total of 2505 cod otoliths were sampled during the 2004 survey, and separated into NCC type (1721) and NEA cod (784). 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 about 95 % accuracy in the estimates (Berg *et al*., in press).

As in previous years, NCC was found throughout the survey area. The 2004 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^o N (Norwegian statistical areas 06 and 07). Although the proportion is lower, there is significant biomass of NCC north of 67^o N. It must be emphasised that the Norwegian coastal surveys have been conducted in August-November, and there may be more 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 1995-2003. The number of cod estimated in the southernmost area increased from 2003 to 2004. This is the main reason why the weight-at-age (weighted average) from the trawl-acoustic survey in 2004 was higher for most ages (except for age 2, 8 and 9) compared with the 2003 survey. The weight-at-age for NCC is however, well above the present level for NEA cod.

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 year on average for the surveyed area in 2004 (Tables 2.6, 2.12). There are some variations between the different areas. The 2004 data show that the average M_{50} is at a lower age as that found in the 2003 survey. The main reason for the lower age at maturation might be the increased number of cod estimated in the southern area, where cod is growing faster and reaches M_{50} at younger age. However, the survey is conducted in the period October/November. In this period the maturity ogive can be difficult to define exactly and might influence the estimation of maturity-at-age and hence the estimation of SSB. In addition, the average M_{50} for the 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 1984-2003 is given in Table 2.9. The exploitation pattern in 2004 was similar to that observed last year.

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 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. Institute of Marine Research in cooperation with the Directorate of Fisheries and relevant tourist organizations plans also to conduct an annual research on estimation of 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. Weight-at-age in 2004 was slightly higher for most ages (except for age 2 and 9) compared with 2003 (see 2.2.3). Weight-at-age for age 8 was very low and assumed to be wrong due to low sample size and therefore recalculated by using an average annual increase from age 7 to 8 for the three earlier years. The weight-at-age in the catch is given in Table 2.10. Weight at age in the catch increased from 2003 to 2004 caused by a relative higher proportion cod caught in the southernmost area where weight at age is somewhat higher compared with further north.

2.3.3 Natural mortality

A fixed natural mortality of 0.2 was used.

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

The maturity ogive data in 2004 is obtained from the Norwegian coastal survey (Tables 2.6, 2.12). The proportion mature at age has decreased the latest years for ages 3-6 (ref. chapter 2.2.4) (Table 2.12).

2.3.5 Tuning data (Table 2.7)

In previous assessments (until 2002) the acoustic indices (age 2-9) 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 2004 and in this year's assessment.

2.4 Data screening and exploratory runs

2.4.1 Survey data (Figures 2.5, 2.6, 2.7, 2.8, 2.9, 2.10)

The acoustic survey tuning data were screened using SURBA (version 2.20) to examine for year, age and cohort effects. Survey catchability and weighting factors by age were all set to 1.0 with a smoother parameter rho = 2.0. Mean-standardised survey indices by year class and by year show quite good internal consistency in tracking weak and strong year classes (Figure 2.5, 2.6), but with some strong year-effects especially in 1997 where the index for all year-classes are high than the year before (Figure 2.5). The empirical catch curves show that the survey has low catchability at age 2 and age 7 and older causing domed catch curves (Figure 2.9). In 2004 there seems to have been an increase in catchability of age groups 2-5, and a decrease for older ages (Figure 2.8). There is a clear temporal downward trend in F over the time series (Figure 2.7) and mean $F_{4\text{-}7}$ varies between about 0.3 and 0.7 (Figure 2.7). During the whole time period SSB shows a substantially downward trend (Figure 2.7). A consist retrospective pattern for F, SSB and recruitment is shown in Figure 2.10.

2.4.2 Exploratory runs

2.4.2.1 XSA; SE shrinkage changed from 1.0 to 0.5 (Figures 2.3, 2.11)

Previously a SE of 1.0 has been preferred for coastal cod. An exploratory XSA with the "default" value of SE of 0.5 was done during the WG. The retrospective pattern in F, SSB and recruitment was however somewhat worse (Figure 2.11) than using shrinkage=1.0 (Figure 2.3). Both SSB and total stock biomass for the final year was lower when using 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.

2.4.2.2 XSA; Number of years used in shrinkage changed fro 2 to 4 (Figure 2.12)

In the latest assessments the number of year used for shrinkage has been set to 2. The WG made an exploratory XSA run using 4 year as basis for the shrinkage. Only small changes in SSB, total biomass and recruitment in 2003 and 2004 was observed (see Table below). The retrospective pattern for SSB, total biomass and recruitment is very close to those observed for when using 2 year as basis for the shrinkage (Figure 2.12). The WG therefore found no strong reasons for changing the setting and decided to continue to apply 2 year as basis for the shrinkage.

2.4.2.3 XSA; Catchability for some ages set to be dependent of stock size

Several exploratory XSA runs were performed setting the catchability dependent of stock size increasing the age-span one year at the time. However, the XSA was very unstable for all these settings and the retrospective pattern for F, SSB and recruitment was very bad. The results are therefore not shown in the table below. The previous used catchability independent of stock size for all ages was therefore preferred.

2.4.2.3.1 ICA; Settings as close as possible to the settings used in XSA (Tables 2.24, 2.25)

One ICA run was performed with the same input files as to the XSA final run. The parameter settings were as close to the XSA settings as possible, and settings are presented in Table 2.24. The run was done with weighting of abundance manual with a value of 1. The results of the run with manual weighting came close to the XSA for the SSB. The total stock biomass was about 10% higher, and the $F_{4\text{-}7}$ was considerable lower in the ICA run (see table below). Hence the survivors in 2005 were higher in the ICA run. The recruits in 2003 was at the same level as in the XSA-run, while the recruits in 2004 was considerable lower in the ICA run. The summary output is presented in Table 2.25.

ASSESSMENT / SETTINGS	F (4-7) 2003	F (4-7) 2004	TOTAL BIOM. 2003	TOTAL BIOM. 2004	SSB 2003	SSB 2004	RECRUITS 2003	RECRUITS 2004
XSA - As last year	0.4275	0.7029	90 733	82 971	49 111	58 357	5 740	6 066
XSA - SE 0.5	0.4192	0.6195	86 639	75 225	43 176	50 805	5 212	2 278
XSA - 4 year shrinkage	0.4183	0.6808	92 915	85 714	50 621	60 466	5 939	6 391
ICA	0.3720	0.3964	100 637	94 580	50 048	63 004	5 490	1 140

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 significant 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 were obtained after examining the diagnostics of the mean log catchabilities from several exploratory XSA-runs in 2003 when changing this setting with one age at the time.

3. The survivors estimate was shrunk towards the mean F of the final 2 years since the exploitation pattern has changed the last few years (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).

The XSA converged after 102 iterations. The log catchability residuals were positive for all ages in 2004, while they were negative for all ages below 8 for the 2003 survey. The Norwegian coastal survey in 2003 and 2004 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 2004 might still suffer from this. At next WG a bottom trawl index based on fixed trawl stations extending back to 1995 will be presented. The mean log catchabilities has slightly increased for age 8, and decreased for ages 6 and younger in this year's assessment. This is probably the main reason to the observed retrospective pattern in 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 ages 4-7 fishing mortality in 2004 were estimated to be 0.70 (Table 2.13). This is the highest observed level and well above the level in 2003 (0.43). Fishing mortalities tend to be overestimated while SSB tends to be underestimated in the assessment year as illustrated by the retrospective plots in Figure 2.3. If the retrospective pattern is continued the estimated $F_{4\text{-}7}$ in 2004 is supposed to somewhat to high. However, the fishing mortality has increased substantially since 2000.

In 1990 and 1991 the lowest F-values was estimated (0.18 and 0.17). The fishing mortality was quite stable in the period 1996-2002 at a level varying from 0.30-0.40, but has for the last two years increased. The total biomass of the stock in the period from 1984-2004 has been between 83,000 t and 310,000 t (Tables 2.17, 2.19). In 2004 the biomass was estimated to be the lowest observed and about half the biomass in 2000. The spawning stock biomass has been between 49,000 t and 194,000 t (Tables 2.18, 2.19, Figure 2.2). The lowest observed SSB was estimated in 2003. However, the maturity ogive was probably to low in 2003 causing an increase in SSB from 2003-2004. Except for this, the SSB has declined from 1996 to present but were quite stable in the period 1999-2002. The decline both in the total stock biomass and the SSB seems to be accelerating, and will continue to decline unless the fishing mortality is substantially reduced.

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

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

Both the survey estimates of abundance in 2004 (age 1-4, Table 2.7), the XSA-estimate (age 2 and 3, Tables 2.15, 2.19) and result from the RCT3 (Table 2.20) indicate lower than average year-classes from 1997-2003. These eight year-classes are the lowest seven observed in the time series. The 2001 year-class is the lowest observed in the time series, and the RCT estimate of the 2003 year class is only slightly better than the 2001 year-class. Since 2002 the SSB has decreased further with approximately 30 % and the probability of weak year classes the next few years is assumed 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 1995-2004 show a steeply declining stock. For ages 2-8 the survey indices and the XSA estimates are well correlated (Figure 2.1). It therefore seems like the survey and the XSA assessment reflect the changes in the stock number quite well. There is a general trend towards decreasing catchability with increasing age.

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

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

Assessment year	F_{4-7} year 2003	SSB year 2003	Total stock biomass 2003	Recruits age 2 year 2003
2004	0.62	37,642	68,726	4,117
2005	0.43	49,111	90,733	5,740

2.7.3 Uncertainties in the assessment

- The landings of Coastal cod is severely underestimated (see 2.3.1). Although it certainly has been unreported catches for a long period, there are no available data for years other than 2003. 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.

- The Norwegian coastal survey is the only survey covering the distribution area of the stock. The survey is conducted in the period October/November. In this period the maturity ogive can be difficult to define exactly and might influence the estimation of maturity-at-age and hence the estimation of SSB.

- The catches and survey indices are estimated by separating between coastal cod and Northeast Arctic cod by inspection of the otoliths. The precision and accuracy of the method 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*., in press).
- 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 and 2004 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 and 2004 might still suffer from this.

The observed substantially level of unreported landings of coastal cod (WD 23) increase the uncertainty of the absolute level of both the total stock, SSB, recruitment and fishing mortality considerably. Assuming the amount of unreported landings have fluctuated together 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 4 last and lowest observed year classes are all produced by the 4 last and lowest observed SSB. The recruitment is therefore clearly impaired at the SSB levels observed the last few years.

2.8 Prediction data (Tables 2.20, 2.21, 2.22)

The input data to the short-term prediction with management option table (2005-2007) are given in Table 2.21. Weight at age in the stock decreased and the age-at-maturation (M_{50}) increased in 2003. However, in 2004 these parameters where almost back at the level observed in the period before 2003. For 2005-2007 the weight-at-age in stock and maturity-at-age were therefore set to the average in the period 2002-2004. There have been some variations without any trend in weight-at-age in catch in recent years. Weight at age was therefore set to the average in the period 2002-2004.

The recruitment (age 2) in 2004 was estimated using RCT3 with C regression and without shrinkage towards the mean since SSB has been steadily declining and is present at the lowest observed level. Shrinkage towards the mean would therefore probably overestimate the recruitment radically. A run using P-regression was also tried. However, this gave also recruitment at the same level as using shrinkage and well above the three latest observed year classes (year classes 2000-2002). Estimated number at age 1 from the Norwegian coastal survey was used as recruitment index, and the index in the 2004 survey was therefore used to estimate the 2003 year-class (age 2 in 2005). The recruitment in 2005 was estimated to 7.5 million in 2005 (Table 2.20). Since the SSB has been declining substantially since 2002 and the last survey do not indicate any increased recruitment, the recruitment in 2006-2007 is supposed to be no higher than the average of the three last year classes estimated by the XSA (6.5 million). However, the recruiting year classes will not influence the SSB in 2006 and 2007 since hardly any of these are mature in 2007. It must be emphasized that the regression diagnosis is not very good (R^2=0.39). The reason for the bad R^2 is mainly caused by the 1994 year-class. As 1-year old in the survey this year class was observed as very weak. The exploitation pattern is calculated using the average fishing mortality (age 4-7) from

2002 to 2004 scaled to the fishing mortality (age 4-7) in 2004. The scaling was used since there has been a trend towards fishing at older ages in recent years.

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

The total stock biomass and the SSB were further reduced during 2004 (respectively 29% and close to 32%). The management option table (2.22) shows that the expected catch of 22,877 t in 2005 (assuming F status quo) will give an unchanged fishing mortality (F_{2004}=0.70). The total stock biomass and the SSB will be further reduced during 2005 and the total stock biomass and SSB in 2006 will be 43,406 t. and 26,113. The status quo catch in 2006 is 15,442 t, and leads to a further decrease of the total stock biomass. In 2007 the total stock biomass and the SSB will be 34,487 t. and 17,444 t., which is far less than half of the level in 2004. The SSB will not be rebuilt to the 2005 level even if the fishing mortality in 2006 is set to zero (Table 2.22). A catch of 6,000 t (F=0.22) brings the SSB up to the level in 2006 (Table 2.22, Figure 2.2).

2.9 Reference points

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 levels of the 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 4 last and lowest observed year classes are all produced by the 4 last and lowest observed SSB. The recruitment is therefore clearly impaired at the SSB levels observed the last few years. At present, the SSB is well below the level where recruitment is impaired and below any $\mathbf{B}_{lim}$ 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. In case the fishing mortality is 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 and at the beginning of 2006 will be 26,000 t assuming F status quo in 2005. In that sense, SSB in 2006 will be well below any $\mathbf{B}_{lim}$ candidate, and the probability of further recruitment failure is likely to be very high. This being the case, the SSB should be rebuilt to a level where recruitment is not impaired before fishing is resumed.

2.11 Response to ACFM technical minutes

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

“Explore alternative models and input data”

- The WG has explored the survey data with SURBA
- The WG has tried ICA as an assessment tool.

“Information on discarding”

- The WG has explored the available data. The misreported landings seem to be quite high and the assessment suffers from this. However, it has not been possible to recalculate historical catch-at-age.

“Splitting between Northeast Arctic cod and coastal cod based on otoliths should be discussed”

- A scientific paper estimating the accuracy and precision is now in press (Berg *et al*.). The results indicate about 95 % accuracy in the estimates.

“The input table to RCT is missing and there is a difference in R-square in XSA and RCT”

- Input table is included in the report. The difference in R-square is reel. The input to RCT is age 1 in the survey (year n) and age 2 in the assessment (year n+1). Figure 2.1 compares age 2-8 in the survey and age 3-9 in the assessment the year after. Age 1 in the survey is therefore not included in Figure 2.1.

Table 2.1.A Number of otoliths sampled from commercial catches in the period 1985-2004. CC=coastal cod, NEAC=Northeast Arctic cod.

YEAR	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		TOTAL		
Year	CC	NEAC	CC	NEAC	CC	NEAC	CC	NEAC	CC	NEAC	% CC
1985	1 451	3 852	777	1 540	1 277	1 767	1 966	730	5 471	7 889	41
1986	940	1 594	1 656	2 579	0	0	669	966	3 265	5 139	39
1987	1 195	2 322	937	3 051	638	1 108	1 122	1 137	3 892	7 618	34
1988	257	546	160	619	87	135	55	44	559	1 344	29
1989	556	1 387	72	374	65	501	97	663	790	2 925	21
1990	731	2 974	61	689	252	97	265	674	1 309	4 434	23
1991	285	1 168	92	561	77	96	279	718	733	2 543	22
1992	152	619	281	788	79	82	272	672	784	2 161	27
1993	314	1 098	172	1 046	0	0	310	541	796	2 685	23
1994	317	1 605	179	923	21	31	126	674	643	3 233	17
1995	188	1 591	232	1 682	2 095	1 057	752	1 330	3 267	5 660	37
1996	861	5 486	591	1 958	1 784	1 076	958	2 256	4 194	10 776	28
1997	1 106	5 429	367	2 494	1 940	894	1 690	1 755	5 103	10 572	33
1998	608	4 930	552	1 342	489	1 094	2 999	2 217	4 648	9 583	33
1999	1 277	4 702	493	2 379	202	717	961	1 987	2 933	9 785	23
2000	1 283	4 918	365	2 112	386	1 295	472	1 668	2 506	9 993	20
2001	1 102	5 091	352	2 295	126	786	432	983	2 012	9 155	18
2002	823	5 818	321	1 656	503	831	897	1 355	2 544	9 660	21
2003	821	4 197	445	2 850	790	936	1 112	1 286	3 168	9 269	25
2004	1 511	7 539	758	2 565	532	685	531	1 317	3 332	12 106	22

Table 2.1.B Estimated survey number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2004.

	AGE										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	426	888	770	745	464	206	96	58	45	50	3748
04 West Finnmark/Tromsø	1895	1858	1709	1141	736	725	213	205	42	15	8539
05 Lofoten/Vesterålen	50	67	182	265	164	66	67	55	4	9	929
00 Vestfjord	728	237	305	649	250	437	100	24	4	1	2735
06 Nordland	107	431	606	1090	983	435	256	103		35	4046
07 Møre	11	60	125	430	162	72	50	3	4		917
Total	3217	3541	3696	4320	2758	1940	783	448	98	110	20914

Table 2.2 Estimated survey biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2004.

Age											
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	26	247	460	825	809	547	277	189	135	154	3668
04 West Finnmark/Troms	217	664	1390	1607	1589	2227	823	742	231	123	9612
05 Lofoten/Vesterålen	5	33	252	557	428	310	428	445	21	92	2571
00 Vestfjord	71	91	315	1159	722	2254	354	54	23	5	5049
06 Nordland	8	185	477	2036	1977	1163	915	326		684	7772
07 Møre	1	49	193	1210	566	399	211	24	44		2697
Total	329	1269	3087	7394	6089	6901	3009	1779	454	1058	31370

Table 2.3 Estimated survey spawning stock number (x1000) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2004.

	Age										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark		13	81	135	312	172	89	58	45	50	953
04 West Finnmark/Troms		25	63	424	576	691	207	205	42	15	2248
05 Lofoten/Vesterålen			29	72	143	58	67	55	4	9	435
00 Vestfjord			47	390	211	409	100	24	4	1	1186
06 Nordland			50	467	643	435	256	103	0	35	1990
07 Møre			12	126	135	72	50	0	4	0	400
Total	0	37	283	1613	2020	1837	769	445	98	110	7212

Table 2.4 Estimated survey spawning stock biomass (tonnes) of Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2004.

	Age										
Area	1	2	3	4	5	6	7	8	9	10+	Total
03 East Finnmark	0	3	49	149	544	456	256	189	135	154	1935
04 West Finnmark/Troms	0	9	51	597	1243	2122	798	742	231	123	5917
05 Lofoten/Vesterålen	0	0	40	151	374	272	428	445	21	92	1822
00 Vestfjord	0	0	48	695	611	2113	354	54	23	5	3904
06 Nordland	0	0	40	873	1292	1163	915	326	0	684	5293
07 Møre	0	0	19	356	471	399	211	0	44	0	1501
Total	0	12	247	2820	4535	6526	2963	1755	454	1058	20372

Table 2.5 Weight (gram)-at-age (year) for Norwegian Coastal cod from the Norwegian coastal survey during the autumn 2004.

	Age									
Area	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	69	291	680	1208	1910	2677	2869	3804	2392	3951
04 West Finnmark/Troms	84	328	788	1573	2237	3339	3991	4436	5985	8150
05 Lofoten/Vesterålen	91	433	1272	1866	2433	3880	4367	9276	2900	
00 Vestfjord	87	421	1090	1780	2767	3484	4927	1817		
06 Nordland	91	428	755	1733	2035	3029	3884	3493		19620
07 Møre	14	1079	1529	2480	3704	5019	6808		10322	
Weighted average	83	352	834	1690	2255	3312	4150	4594	4383	9733

Table 2.6 Percent mature at age for Norwegian Coastal cod at age from the Norwegian coastal survey during the autumn 2004.

Age										
Area	1	2	3	4	5	6	7	8	9	10+
03 East Finnmark	0	0	1	11	18	67	83	92	100	100
04 West Finnmark/Troms	0	0	1	4	37	78	95	97	100	100
05 Lofoten/Vesterålen	0	0	0	16	27	88	88	100	100	100
00 Vestfjord	0	0	0	15	60	85	94	100	100	100
06 Nordland	0	0	0	8	43	65	100	100	100	
07 Møre	0	0	0	10	29	83	100	100		100
Weighted average	0	0	1	9	37	76	95	98	100	100

Table 2.7 Estimated survey numbers at age (x1000) of Norwegian Coastal cod from the coastal surveys from 1995-2004.

	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

Table 2.8

Lowestoft VPA Version 3.1

22/04/2005 14:46

Extended Survivors Analysis

Norwegian Coastal Cod,COMBSEX,PLUSGROUP

CPUE data from file c:\VPA\DATA\2005\COASt-9.TUN

Catch data for 21 years. 1984 to 2004. Ages 2 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
Norw. Coast. survey ,	1995,	2004,	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 102 iterations

Regression weights

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

Fishing mortalities

Age,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004
2,	.026,	.033,	.045,	.019,	.011,	.009,	.004,	.023,	.016,	.002
3,	.047,	.099,	.125,	.127,	.059,	.055,	.036,	.096,	.182,	.076
4,	.136,	.180,	.184,	.256,	.147,	.229,	.141,	.231,	.343,	.254
5,	.257,	.467,	.247,	.380,	.382,	.378,	.295,	.334,	.417,	.653
6,	.322,	.386,	.457,	.422,	.492,	.441,	.349,	.489,	.463,	.925
7,	.470,	.428,	.667,	.579,	.602,	.370,	.441,	.499,	.487,	.981
8,	.372,	.628,	.732,	.771,	.626,	.230,	.313,	.579,	.367,	.612
9,	.357,	.415,	.677,	.491,	.922,	.207,	.199,	.314,	.315,	.298

XSA population numbers (Thousands)

	AGE							
YEAR ,	2,	3,	4,	5,	6,	7,	8,	9,
1995 ,	3.49E+04,	2.13E+04,	2.04E+04,	2.53E+04,	2.23E+04,	9.64E+03,	5.18E+03,	2.05E+03,
1996 ,	4.09E+04,	2.79E+04,	1.67E+04,	1.46E+04,	1.60E+04,	1.32E+04,	4.93E+03,	2.92E+03,
1997 ,	3.35E+04,	3.24E+04,	2.07E+04,	1.14E+04,	7.50E+03,	8.93E+03,	7.05E+03,	2.15E+03,
1998 ,	3.19E+04,	2.62E+04,	2.34E+04,	1.41E+04,	7.29E+03,	3.89E+03,	3.75E+03,	2.78E+03,
1999 ,	2.46E+04,	2.56E+04,	1.89E+04,	1.48E+04,	7.88E+03,	3.92E+03,	1.78E+03,	1.42E+03,
2000 ,	1.95E+04,	1.99E+04,	1.98E+04,	1.34E+04,	8.28E+03,	3.94E+03,	1.76E+03,	7.81E+02,
2001 ,	1.32E+04,	1.58E+04,	1.54E+04,	1.29E+04,	7.50E+03,	4.37E+03,	2.23E+03,	1.14E+03,
2002 ,	9.19E+03,	1.07E+04,	1.25E+04,	1.10E+04,	7.84E+03,	4.33E+03,	2.30E+03,	1.33E+03,
2003 ,	5.74E+03,	7.35E+03,	7.98E+03,	8.13E+03,	6.43E+03,	3.94E+03,	2.15E+03,	1.05E+03,
2004 ,	6.07E+03,	4.63E+03,	5.02E+03,	4.64E+03,	4.38E+03,	3.31E+03,	1.98E+03,	1.22E+03,

Table 2.8 (continued)

Estimated population abundance at 1st Jan 2005

0.00E+00,	4.96E+03,	3.51E+03,	3.19E+03,	1.98E+03,	1.42E+03,	1.02E+03,	8.80E+02,

Taper weighted geometric mean of the VPA populations:

2.04E+04,	1.92E+04,	1.72E+04,	1.37E+04,	9.32E+03,	5.72E+03,	3.04E+03,	1.56E+03,

Standard error of the weighted Log(VPA populations) :

.7556,	.6766,	.5618,	.4964,	.4506,	.4740,	.4983,	.5320,

Log catchability residuals.

Fleet : Norw. Coast. survey

Age ,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004
2 ,	.21,	-.09,	.19,	-.10,	-.03,	.22,	.07,	-.37,	-.24,	.20
3 ,	.05,	.34,	.45,	.00,	-.24,	-.04,	-.19,	-.42,	-.12,	.30
4 ,	.21,	.21,	.34,	.00,	-.14,	-.24,	-.23,	-.38,	-.08,	.42
5 ,	.08,	.54,	.60,	-.01,	-.09,	.11,	-.44,	-.52,	-.41,	.33
6 ,	-.21,	-.17,	1.09,	-.13,	-.18,	.31,	-.41,	-.34,	-.24,	.30
7 ,	-.01,	-.36,	.44,	.29,	-.32,	-.04,	.01,	.04,	-.12,	.07
8 ,	.05,	-.13,	.30,	-.61,	-.25,	.15,	-.02,	-.02,	.25,	.25

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,	-.5750,	-.2993,	-.2072,	-.1629,	-.2192,	-.5655,	-1.0890,
S.E(Log q),	.2097,	.2790,	.2741,	.3991,	.4495,	.2376,	.2785,

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,	.92,	.835,	1.28,	.94,	10,	.20,	-.58,
3,	.94,	.413,	.87,	.86,	10,	.28,	-.30,
4,	1.15,	-.685,	-1.24,	.73,	10,	.33,	-.21,
5,	1.02,	-.066,	-.05,	.54,	10,	.44,	-.16,
6,	1.32,	-.665,	-2.63,	.37,	10,	.62,	-.22,
7,	1.03,	-.160,	.32,	.79,	10,	.26,	-.57,
8,	1.03,	-.159,	.86,	.75,	10,	.31,	-1.09,

Terminal year survivor and F summaries :

Age 2 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 ,	6044.,	.300,	.000,	.00,	1,	.917,	.002
F shrinkage mean ,	549.,	1.00,,,,				.083,	.020

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
4956.,	.29,	.69,	2,	2.401,	.002

Table 2.8 (continued)

```
Age  3   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 ,      3623.,   .212,       .266,   1.25,   2,  .953,     .074

   F shrinkage mean  ,      1846.,   1.00,,,,                         .047,     .140

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3511.,       .21,      .21,    3,   1.015,   .076


 Age  4   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 ,      3208.,   .174,       .238,   1.37,   3,  .958,     .252

   F shrinkage mean  ,      2753.,   1.00,,,,                         .042,     .288

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3187.,       .17,      .19,    4,   1.112,   .254


 Age  5   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 ,      1883.,   .163,       .151,    .93,   4,  .935,     .676

   F shrinkage mean  ,      3961.,   1.00,,,,                         .065,     .378

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1976.,       .17,      .16,    5,    .956,   .653


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

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Norw. Coast. survey ,      1300.,   .158,       .146,    .93,   5,  .908,     .981

   F shrinkage mean  ,      3520.,   1.00,,,,                         .092,     .480

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1424.,       .17,      .18,    6,   1.080,   .925
```

Table 2.8 (continued)

Age 7 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 ,	932.,	.151,	.080,	.53,	6,	.915,	1.037
F shrinkage mean ,	2636.,	1.00,,,,				.085,	.497

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1018.,	.16,	.14,	7,	.878,	.981

Age 8 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
Norw. Coast. survey ,	861.,	.151,	.097,	.64,	7,	.938,	.621
F shrinkage mean ,	1215.,	1.00,,,,				.062,	.477

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
880.,	.15,	.09,	8,	.598,	.612

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

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Norw. Coast. survey ,	810.,	.150,	.075,	.50,	7,	.936,	.277
F shrinkage mean ,	210.,	1.00,,,,				.064,	.801

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
743.,	.15,	.15,	8,	.942,	.298

Table 2.9

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

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

YEAR,	1984,
AGE	
2,	829,
3,	3478,
4,	6954,
5,	7278,
6,	6004,
7,	4964,
8,	2161,
9,	819,
+gp,	624,
TOTALNUM,	33111,
TONSLAND,	74824,
SOPCOF %,	100,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	396,	4095,	170,	110,	41,	7,	125,	40,	4,	332,
3,	7848,	4095,	940,	1921,	1159,	349,	607,	665,	369,	573,
4,	7367,	12662,	8236,	3343,	1434,	1233,	1452,	3160,	1706,	1693,
5,	8699,	8906,	12430,	6451,	2299,	1330,	3114,	4422,	2343,	4302,
6,	7085,	5750,	4427,	6626,	5197,	1129,	1873,	2992,	2684,	2467,
7,	3066,	3868,	2649,	4687,	2720,	3456,	1297,	1945,	3072,	3337,
8,	705,	1270,	1127,	1461,	949,	773,	873,	898,	1871,	1514,
9,	433,	342,	313,	497,	236,	141,	132,	837,	627,	777,
+gp,	264,	407,	149,	333,	86,	73,	94,	279,	690,	798,
TOTALNUM,	35863,	41395,	30441,	25429,	14121,	8491,	9567,	15238,	13366,	15793,
TONSLAND,	75451,	68905,	60972,	59294,	40285,	28127,	24822,	41690,	52557,	54562,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
2,	810,	1193,	1326,	554,	252,	156,	44,	192,	81,	12,
3,	896,	2376,	3438,	2819,	1322,	971,	505,	893,	1107,	306,
4,	2345,	2480,	3150,	4786,	2346,	3664,	1837,	2331,	2094,	1017,
5,	5188,	4930,	2258,	4023,	4263,	3807,	2974,	2822,	2506,	2011,
6,	5546,	4647,	2490,	2272,	2773,	2671,	1998,	2742,	2158,	2394,
7,	3270,	4160,	3935,	1546,	1602,	1104,	1409,	1538,	1374,	1874,
8,	1455,	2082,	3312,	1826,	751,	326,	542,	915,	598,	820,
9,	557,	898,	959,	975,	774,	132,	187,	325,	258,	285,
+gp,	433,	543,	684,	343,	320,	152,	119,	377,	99,	307,
TOTALNUM,	20500,	23309,	21552,	19144,	14403,	12983,	9615,	12135,	10275,	9026,
TONSLAND,	57207,	61776,	63319,	51572,	40732,	36715,	29699,	40994,	34635,	32599,
SOPCOF %,	100,	100,	100,	99,	100,	100,	100,	102,	100,	100,

Table 2.10

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Table 2 Catch weights at age (kg)

YEAR,	1984,
AGE	
2,	.2480,
3,	.6190,
4,	1.1490,
5,	1.7340,
6,	2.3250,
7,	3.4860,
8,	4.8450,
9,	5.6080,
+gp,	8.8400,
SOPCOFAC,	1.0002,

Table 2 Catch weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	.2140,	.2270,	.3310,	.2460,	.3000,	.3450,	.1640,	.1680,	.2410,	.2540,
3,	.7120,	.5250,	.6730,	.6340,	.6610,	1.1740,	.9220,	.5560,	.6450,	.8050,
4,	1.4150,	1.0800,	1.1200,	1.1700,	1.8360,	1.5150,	1.6080,	1.3590,	1.7100,	1.4760,
5,	2.0360,	1.7060,	1.6930,	1.7270,	2.1700,	1.6780,	2.1080,	2.2670,	2.5910,	2.0970,
6,	2.7370,	2.2560,	2.3590,	2.3280,	2.4480,	2.7080,	2.5070,	2.9570,	3.5880,	3.2870,
7,	4.0120,	3.3530,	3.7430,	3.2560,	4.3910,	3.8980,	3.4690,	3.9030,	4.3660,	4.0950,
8,	6.1160,	4.8380,	5.3260,	4.7000,	4.8990,	6.5150,	4.9760,	5.3170,	5.8990,	5.5920,
9,	6.4600,	5.8380,	6.1290,	5.4500,	6.6610,	7.2990,	5.7340,	4.5580,	6.4940,	7.2170,
+gp,	10.7550,	7.0530,	11.6230,	8.2020,	11.6080,	13.9240,	11.0590,	7.0320,	7.5090,	8.3310,
SOPCOFAC,	1.0000,	1.0001,	1.0001,	1.0001,	1.0000,	1.0002,	1.0003,	1.0001,	1.0000,	1.0000,

Table 2.10 (Continued)

Table 2 Catch weights at age (kg)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2,	.3020,	.2740,	.2770,	.3760,	.4670,	.5150,	.1640,	.4910,	.9440,	.8240,
3,	.7100,	.9210,	.9700,	.9780,	1.1550,	1.3050,	.9520,	1.1790,	1.5520,	1.3740,
4,	1.3350,	1.4640,	1.5540,	1.5180,	1.6330,	2.2720,	1.6370,	1.8000,	2.1460,	1.9200,
5,	1.8420,	1.9790,	1.9700,	2.2810,	2.1710,	2.5550,	2.8810,	2.4850,	3.0820,	2.7550,
6,	2.4670,	2.5160,	2.8970,	3.1250,	3.2490,	3.2830,	3.4240,	3.8600,	3.5940,	3.5290,
7,	4.1910,	3.4610,	3.7160,	3.9000,	4.0950,	4.5040,	4.0380,	4.7600,	4.9530,	4.2810,
8,	5.7780,	4.8660,	4.8290,	5.5200,	5.0130,	5.4000,	5.3970,	5.1950,	5.7360,	5.3480,
9,	6.3760,	5.3910,	6.3490,	6.3330,	6.0180,	6.3790,	7.2080,	5.5070,	6.4770,	6.1600,
+gp,	9.9030,	8.8540,	9.2670,	9.3370,	6.2550,	6.4200,	6.8810,	9.1830,	9.6860,	6.7130,
SOPCOFAC,	1.0001,	1.0001,	1.0003,	.9919,	1.0002,	.9999,	1.0004,	1.0181,	1.0001,	1.0001,

Table 2.11

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Table 3 Stock weights at age (kg)

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

Table 3 Stock weights at age (kg)

AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,	.3210,
3,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,	.7580,
4,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,	1.4790,
5,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,	2.1370,
6,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,	2.8140,
7,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,	4.7220,
8,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,	6.6850,
9,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,	6.9800,
+gp,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,	9.7230,

Table 3 Stock weights at age (kg)

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2,	.3900,	.2520,	.2400,	.3720,	.3230,	.3650,	.3960,	.4280,	.3840,	.3520,
3,	.7910,	.7240,	.6830,	.8830,	.8410,	.8090,	.9660,	.8950,	.7360,	.8340,
4,	1.5250,	1.4330,	1.3640,	1.4560,	1.6750,	1.5540,	1.5240,	1.7410,	1.3090,	1.6900,
5,	2.2220,	2.0530,	1.8930,	2.1070,	2.1920,	2.5390,	2.3140,	2.4330,	2.0990,	2.2550,
6,	2.8810,	2.7480,	2.8160,	2.9500,	2.8570,	3.0490,	3.3200,	3.1330,	3.0440,	3.3120,
7,	4.6650,	4.7220,	4.4260,	4.3190,	4.5400,	4.3520,	3.6950,	4.2730,	3.8780,	4.1500,
8,	6.9790,	6.6850,	6.4060,	5.6250,	6.5790,	6.2030,	6.1440,	4.3970,	4.8100,	4.5940,
9,	6.7590,	6.9320,	7.8050,	8.3230,	9.4540,	8.5270,	8.7680,	7.7590,	6.0750,	6.4940,
+gp,	9.8970,	9.7230,	10.8270,	12.4680,	12.9020,	12.0660,	12.4680,	12.9920,	9.9540,	9.7330,

Table 2.12

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Table 5 Proportion mature at age

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

Table 2.12 (Continued)

Table 5 Proportion mature at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
3,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
4,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,	.2400,
5,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,	.4900,
6,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,	.7200,
7,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,	.8800,
8,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
2,	.0000,	.0000,	.0000,	.0000,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,
3,	.0100,	.0300,	.0600,	.0600,	.0300,	.0600,	.0000,	.0200,	.0000,	.0100,
4,	.2000,	.2400,	.2900,	.2500,	.2100,	.2400,	.0700,	.0200,	.0500,	.0900,
5,	.4700,	.5600,	.4500,	.5300,	.4400,	.4900,	.3700,	.2600,	.2900,	.3700,
6,	.6700,	.8000,	.7600,	.7400,	.6500,	.7200,	.7900,	.8800,	.4900,	.7600,
7,	.8500,	.9200,	.9700,	.8700,	.7700,	.8800,	.9700,	.9300,	.9000,	.9500,
8,	.8600,	.9900,	1.0000,	.8900,	1.0000,	.9500,	.9800,	.9000,	.9800,	.9800,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9800,	.9700,	.9600,	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 22/04/2005 14:47

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1984,
AGE	
2,	.0105,
3,	.0744,
4,	.2168,
5,	.3336,
6,	.6282,
7,	1.3094,
8,	1.0723,
9,	.8446,
+gp,	.8446,
FBAR 4- 7,	.6220,

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	.0059,	.1347,	.0050,	.0030,	.0010,	.0002,	.0022,	.0009,	.0001,	.0140,
3,	.1297,	.0771,	.0413,	.0724,	.0396,	.0104,	.0192,	.0146,	.0101,	.0251,
4,	.2228,	.3188,	.2194,	.2022,	.0709,	.0539,	.0545,	.1318,	.0472,	.0587,
5,	.4620,	.4598,	.5982,	.2674,	.2085,	.0870,	.1873,	.2337,	.1365,	.1611,
6,	.6365,	.6427,	.4376,	.7618,	.3591,	.1497,	.1699,	.2766,	.2171,	.2083,
7,	.7881,	.8997,	.7078,	1.2373,	.8501,	.4322,	.2570,	.2678,	.5102,	.4593,
8,	.6330,	.9333,	.7323,	1.1828,	.9287,	.6256,	.1825,	.2848,	.4475,	.5120,
9,	.6356,	.7410,	.6245,	.8715,	.5917,	.3256,	.2001,	.2672,	.3298,	.3373,
+gp,	.6356,	.7410,	.6245,	.8715,	.5917,	.3256,	.2001,	.2672,	.3298,	.3373,
FBAR 4- 7,	.5274,	.5802,	.4907,	.6172,	.3722,	.1807,	.1672,	.2275,	.2278,	.2219,

Table 8 Fishing mortality (F) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	FBAR
AGE											
2,	.0260,	.0328,	.0447,	.0194,	.0114,	.0089,	.0037,	.0234,	.0157,	.0022,	.0138,
3,	.0475,	.0990,	.1248,	.1265,	.0588,	.0554,	.0359,	.0965,	.1820,	.0759,	.1181,
4,	.1356,	.1796,	.1845,	.2562,	.1474,	.2293,	.1410,	.2308,	.3427,	.2536,	.2757,
5,	.2566,	.4668,	.2470,	.3798,	.3823,	.3781,	.2951,	.3343,	.4168,	.6528,	.4680,
6,	.3220,	.3857,	.4572,	.4220,	.4925,	.4406,	.3489,	.4886,	.4632,	.9248,	.6255,
7,	.4700,	.4277,	.6671,	.5791,	.6018,	.3703,	.4411,	.4985,	.4872,	.9805,	.6554,
8,	.3718,	.6284,	.7319,	.7715,	.6262,	.2296,	.3130,	.5795,	.3666,	.6116,	.5192,
9,	.3574,	.4147,	.6774,	.4910,	.9216,	.2069,	.1995,	.3135,	.3152,	.2981,	.3089,
+gp,	.3574,	.4147,	.6774,	.4910,	.9216,	.2069,	.1995,	.3135,	.3152,	.2981,	
FBAR4-7,	.2960,	.3650,	.3889,	.4093,	.4060,	.3546,	.3065,	.3880,	.4275,	.7029,	

Table 2.14

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR,	1984,
AGE	
2,	.0168,
3,	.1196,
4,	.3486,
5,	.5363,
6,	1.0100,
7,	2.1051,
8,	1.7238,
9,	1.3579,
+gp,	1.3579,
REFMEAN,	.6220,

Table 9 Relative F at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	.0111,	.2322,	.0103,	.0049,	.0027,	.0010,	.0133,	.0039,	.0006,	.0630,
3,	.2460,	.1329,	.0841,	.1174,	.1063,	.0575,	.1150,	.0642,	.0444,	.1129,
4,	.4225,	.5494,	.4470,	.3276,	.1906,	.2982,	.3261,	.5793,	.2072,	.2646,
5,	.8761,	.7924,	1.2190,	.4333,	.5603,	.4813,	1.1201,	1.0274,	.5992,	.7262,
6,	1.2069,	1.1076,	.8916,	1.2343,	.9649,	.8286,	1.0165,	1.2161,	.9534,	.9390,
7,	1.4945,	1.5506,	1.4424,	2.0048,	2.2842,	2.3919,	1.5373,	1.1772,	2.2402,	2.0702,
8,	1.2004,	1.6085,	1.4923,	1.9165,	2.4956,	3.4623,	1.0916,	1.2518,	1.9648,	2.3078,
9,	1.2052,	1.2771,	1.2725,	1.4121,	1.5898,	1.8018,	1.1968,	1.1744,	1.4482,	1.5201,
+gp,	1.2052,	1.2771,	1.2725,	1.4121,	1.5898,	1.8018,	1.1968,	1.1744,	1.4482,	1.5201,
REFMEAN,	.5274,	.5802,	.4907,	.6172,	.3722,	.1807,	.1672,	.2275,	.2278,	.2219,

Table 9 Relative F at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	MEAN 02-04
AGE											
2,	.0877,	.0898,	.1150,	.0474,	.0280,	.0250,	.0121,	.0602,	.0368,	.0031,	.0334,
3,	.1604,	.2711,	.3209,	.3091,	.1448,	.1561,	.1171,	.2487,	.4258,	.1080,	.2608,
4,	.4581,	.4922,	.4742,	.6260,	.3631,	.6468,	.4600,	.5947,	.8017,	.3608,	.5857,
5,	.8668,	1.2789,	.6350,	.9279,	.9416,	1.0664,	.9626,	.8614,	.9751,	.9287,	.9217,
6,	1.0876,	1.0569,	1.1755,	1.0312,	1.2130,	1.2426,	1.1383,	1.2592,	1.0836,	1.3156,	1.2195,
7,	1.5875,	1.1719,	1.7153,	1.4149,	1.4823,	1.0443,	1.4391,	1.2847,	1.1396,	1.3949,	1.2731,
8,	1.2558,	1.7218,	1.8819,	1.8851,	1.5424,	.6476,	1.0210,	1.4932,	.8576,	.8701,	1.0737,
9,	1.2071,	1.1362,	1.7415,	1.1998,	2.2699,	.5835,	.6508,	.8080,	.7374,	.4241,	.6565,
+gp,	1.2071,	1.1362,	1.7415,	1.1998,	2.2699,	.5835,	.6508,	.8080,	.7374,	.4241,	
REFMEAN	.2960,	.3650,	.3889,	.4093,	.4060,	.3546,	.3065,	.3880,	.4275,	.7029,	

Table 2.15

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,
AGE	
2,	87985,
3,	53628,
4,	39423,
5,	28356,
6,	14225,
7,	7515,
8,	3631,
9,	1587,
+gp,	1191,
TOT,	237540,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	74904,	35906,	37302,	40441,	45637,	43021,	62064,	49493,	31262,	26443,
3,	71286,	60967,	25692,	30387,	33011,	37327,	35216,	50701,	40486,	25591,
4,	40759,	51262,	46211,	20184,	23140,	25978,	30245,	28283,	40909,	32813,
5,	25985,	26705,	30513,	30382,	13500,	17648,	20153,	23449,	20297,	31950,
6,	16630,	13403,	13806,	13735,	19037,	8973,	13246,	13683,	15197,	14498,
7,	6214,	7205,	5771,	7298,	5250,	10884,	6325,	9150,	8495,	10014,
8,	1661,	2313,	2399,	2328,	1734,	1837,	5784,	4005,	5731,	4176,
9,	1017,	722,	745,	944,	584,	561,	805,	3946,	2466,	3000,
+gp,	613,	848,	350,	623,	210,	288,	570,	1307,	2695,	3058,
TOT,	239069,	199332,	162789,	146321,	142104,	146518,	174409,	184017,	167538,	151542,

Table 2.15 (Continued)

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 84-**
AGE												
2,	34935,	40871,	33489,	31875,	24618,	19503,	13153,	9191,	5740,	6066,	0,	34410,
3,	21350,	27870,	32383,	26219,	25596,	19927,	15826,	10729,	7351,	4627,	4956,	30712,
4,	20434,	16669,	20668,	23402,	18915,	19760,	15437,	12500,	7976,	5017,	3511,	25733,
5,	25333,	14608,	11403,	14071,	14830,	13364,	12863,	10976,	8125,	4636,	3187,	19112,
6,	22265,	16047,	7499,	7293,	7880,	8284,	7497,	7840,	6433,	4385,	1976,	11976,
7,	9638,	13211,	8933,	3887,	3915,	3943,	4366,	4330,	3938,	3314,	1424,	6713,
8,	5179,	4932,	7052,	3753,	1783,	1756,	2229,	2299,	2153,	1981,	1018,	3040,
9,	2049,	2924,	2154,	2777,	1421,	781,	1143,	1335,	1055,	1222,	880,	1367,
+gp,	1581,	1753,	1517,	967,	578,	894,	724,	1538,	402,	1308,	1537,	
TOT,	142763,	138884,	125098,	114244,	99535,	88211,	73236,	60738,	43174,	32555,	18489,	

Table 2.16

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,
AGE	
2,	880,
3,	3218,
4,	9462,
5,	13894,
6,	10242,
7,	6613,
8,	3449,
9,	1587,
+gp,	1191,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	749,	359,	373,	404,	456,	430,	621,	495,	313,	264,
3,	4277,	3658,	1542,	1823,	1981,	2240,	2113,	3042,	2429,	1535,
4,	9782,	12303,	11091,	4844,	5554,	6235,	7259,	6788,	9818,	7875,
5,	12733,	13085,	14951,	14887,	6615,	8648,	9875,	11490,	9946,	15655,
6,	11974,	9650,	9940,	9889,	13707,	6461,	9537,	9851,	10942,	10439,
7,	5468,	6340,	5078,	6422,	4620,	9578,	5566,	8052,	7476,	8812,
8,	1578,	2198,	2279,	2212,	1647,	1745,	5495,	3805,	5445,	3967,
9,	1017,	722,	745,	944,	584,	561,	805,	3946,	2466,	3000,
+gp,	613,	848,	350,	623,	210,	288,	570,	1307,	2695,	3058,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
2,	0,	0,	0,	0,	246,	195,	0,	0,	0,	0,
3,	213,	836,	1943,	1573,	768,	1196,	0,	215,	0,	46,
4,	4087,	4001,	5994,	5851,	3972,	4742,	1081,	250,	399,	452,
5,	11907,	8181,	5131,	7458,	6525,	6548,	4759,	2854,	2356,	1715,
6,	14918,	12837,	5699,	5397,	5122,	5965,	5922,	6899,	3152,	3333,
7,	8192,	12154,	8665,	3382,	3015,	3470,	4235,	4027,	3544,	3149,
8,	4454,	4883,	7052,	3340,	1783,	1668,	2184,	2069,	2110,	1941,
9,	2049,	2924,	2154,	2777,	1421,	781,	1120,	1295,	1012,	1222,
+gp,	1581,	1753,	1517,	967,	578,	894,	724,	1538,	402,	1308,

Table 2.17

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,
AGE	
2,	28248,
3,	40656,
4,	58317,
5,	60606,
6,	40036,
7,	35492,
8,	24277,
9,	11081,
+gp,	11579,
TOTALBIO,	310291,

Table 2.17 (Continued)

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	24045,	11526,	11975,	12982,	14649,	13812,	19929,	15889,	10035,	8488,
3,	54036,	46216,	19475,	23035,	25022,	28299,	26702,	38435,	30687,	19398,
4,	60285,	75822,	68350,	29854,	34224,	38428,	44746,	41835,	60501,	48530,
5,	55531,	57072,	65210,	64930,	28850,	37720,	43081,	50115,	43373,	68276,
6,	46799,	37720,	38852,	38653,	53571,	25254,	37284,	38507,	42762,	40797,
7,	29343,	34023,	27252,	34461,	24789,	51403,	29875,	43210,	40112,	47285,
8,	11105,	15465,	16038,	15564,	11590,	12282,	38678,	26775,	38313,	27913,
9,	7102,	5041,	5199,	6592,	4076,	3915,	5617,	27543,	17214,	20937,
+gp,	5959,	8242,	3406,	6055,	2046,	2803,	5544,	12711,	26201,	29736,
TOTALBIO,	294204,	291127,	255757,	232126,	198818,	213916,	251456,	295020,	309197,	311362,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
2,	13626,	10300,	8039,	11761,	7953,	7118,	5211,	4005,	2204,	2136,
3,	16889,	20179,	22123,	22963,	21530,	16120,	15295,	9776,	5411,	3859,
4,	31165,	23888,	28198,	33798,	31689,	30704,	23536,	22157,	10442,	8479,
5,	56296,	29993,	21592,	29408,	32512,	33927,	29777,	27188,	17056,	10455,
6,	64154,	44099,	21124,	21340,	22518,	25256,	24900,	25007,	19583,	14524,
7,	44965,	62388,	39548,	16651,	17779,	17157,	16138,	18836,	15271,	13756,
8,	36149,	32972,	45189,	20941,	11735,	10892,	13701,	10293,	10358,	9100,
9,	13849,	20269,	16816,	22927,	13433,	6656,	10024,	10542,	6407,	7936,
+gp,	15645,	17044,	16426,	11965,	7454,	10790,	9026,	20337,	4001,	12727,
TOTALBIO,	292738,	261131,	219056,	191754,	166603,	158617,	147607,	148141,	90733,	82971,

Table 2.18

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,
AGE	
2,	282,
3,	2439,
4,	13996,
5,	29697,
6,	28826,
7,	31233,
8,	23063,
9,	11081,
+gp,	11579,
TOTSPBIO,	152196,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	240,	115,	120,	130,	146,	138,	199,	159,	100,	85,
3,	3242,	2773,	1169,	1382,	1501,	1698,	1602,	2306,	1841,	1164,
4,	14468,	18197,	16404,	7165,	8214,	9223,	10739,	10040,	14520,	11647,
5,	27210,	27965,	31953,	31816,	14137,	18483,	21110,	24556,	21253,	33455,
6,	33695,	27158,	27973,	27830,	38571,	18183,	26845,	27725,	30789,	29374,
7,	25822,	29940,	23982,	30326,	21814,	45235,	26290,	38025,	35298,	41611,
8,	10550,	14692,	15236,	14785,	11010,	11668,	36744,	25436,	36397,	26518,
9,	7102,	5041,	5199,	6592,	4076,	3915,	5617,	27543,	17214,	20937,
+gp,	5959,	8242,	3406,	6055,	2046,	2803,	5544,	12711,	26201,	29736,
TOTSPBIO,	128288,	134124,	125442,	126081,	101516,	111346,	134690,	168502,	183614,	194527,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
2,	0,	0,	0,	0,	80,	71,	0,	0,	0,	0,
3,	169,	605,	1327,	1378,	646,	967,	0,	196,	0,	39,
4,	6233,	5733,	8177,	8449,	6655,	7369,	1648,	443,	522,	763,
5,	26459,	16796,	9716,	15586,	14305,	16624,	11018,	7069,	4946,	3868,
6,	42983,	35279,	16054,	15792,	14637,	18184,	19671,	22006,	9596,	11038,
7,	38220,	57397,	38362,	14487,	13690,	15098,	15654,	17517,	13744,	13068,
8,	31088,	32642,	45189,	18638,	11735,	10347,	13427,	9264,	10151,	8918,
9,	13849,	20269,	16816,	22927,	13433,	6656,	9824,	10226,	6151,	7936,
+gp,	15645,	17044,	16426,	11965,	7454,	10790,	9026,	20337,	4001,	12727,
TOTSPBIO,	174646,	185765,	152068,	109221,	82634,	86106,	80266,	87057,	49111,	58357,

Table 2.19

Run title : Norwegian Coastal Cod,COMBSEX,PLUSGROUP
At 22/04/2005 14:47

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,	87985,	310291,	152196,	74824,	.4916,	1.0002,	.6220,
1985,	74904,	294204,	128288,	75451,	.5881,	1.0000,	.5274,
1986,	35906,	291127,	134124,	68905,	.5137,	1.0001,	.5802,
1987,	37302,	255757,	125442,	60972,	.4861,	1.0001,	.4907,
1988,	40441,	232126,	126081,	59294,	.4703,	1.0001,	.6172,
1989,	45637,	198818,	101516,	40285,	.3968,	1.0000,	.3722,
1990,	43021,	213916,	111346,	28127,	.2526,	1.0002,	.1807,
1991,	62064,	251456,	134690,	24822,	.1843,	1.0003,	.1672,
1992,	49493,	295020,	168502,	41690,	.2474,	1.0001,	.2275,
1993,	31262,	309197,	183614,	52557,	.2862,	1.0000,	.2278,
1994,	26443,	311362,	194527,	54562,	.2805,	1.0000,	.2219,
1995,	34935,	292738,	174646,	57207,	.3276,	1.0001,	.2960,
1996,	40871,	261131,	185765,	61776,	.3325,	1.0001,	.3650,
1997,	33489,	219056,	152068,	63319,	.4164,	1.0003,	.3889,
1998,	31875,	191754,	109221,	51572,	.4722,	.9919,	.4093,
1999,	24618,	166603,	82634,	40732,	.4929,	1.0002,	.4060,
2000,	19503,	158617,	86106,	36715,	.4264,	.9999,	.3546,
2001,	13153,	147607,	80266,	29699,	.3700,	1.0004,	.3065,
2002,	9191,	148141,	87057,	40994,	.4709,	1.0181,	.3880,
2003,	5740,	90733,	49111,	34635,	.7052,	1.0001,	.4275,
2004,	6066,	82971,	58357,	32599,	.5586,	1.0001,	.7029,
Arith. Mean,	35900,	224887,	125026,	49083,	.4176		.3943,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 2.20a Input to RCT3 analysis program

```
NORWEGIAN COASTAL COD: recruits as 2 year-olds
1, 10, 2         'No. of Surveys, NUMBER OF YEARS, COLUMN NR. FOR THE VPA'

1994     40871 28707
1995     33489 1756
1996     31875 30694
1997     24618 14455
1998     19503 6850
1999     13153 9587
2000     9191        8366
2001     5740        1329
2002     6066        2084
2003     -11         3217
Norwegian coastal survey
```

Table 2.20b Analysis by RCT3 ver3.1 of data from file : ncc-inn1.txt

```
NORWEGIAN COASTAL COD: recruits as 2 year-olds

 Data for    1 surveys over   10 years :  1994 - 2003

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

 Forecast/Hindcast variance correction used.

 Yearclass =   2003

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Norweg    1.02    .66   1.00   .387      9   8.08    8.93    1.227    1.000

                                        VPA Mean =    9.71     .746     .000


 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std    Ratio             VPA
          Prediction           Error   Error

 2003        7566      8.93    1.23     .00      .00
```

Table 2.21 Prediction with management option table: Input data

YEAR: 2005

Age	Stock Size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	7566	0.2	0.00	0	0	0.388	0.0191	0.753
3	4956	0.2	0.01	0	0	0.822	0.1641	1.368
4	3511	0.2	0.05	0	0	1.580	0.3829	1.955
5	3187	0.2	0.31	0	0	2.262	0.6499	2.774
6	1976	0.2	0.71	0	0	3.163	0.8687	3.661
7	1424	0.2	0.93	0	0	4.100	0.9102	4.665
8	1018	0.2	0.95	0	0	4.600	0.7211	5.426
9	880	0.2	0.98	0	0	6.776	0.4290	6.048
10+	1537	0.2	1.00	0	0	10.893	0.4290	8.527
Unit	Thousands	-	-	-	-	Kg	-	Kg

YEAR: 2006

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	6457	0.2	0.00	0	0	0.388	0.0191	0.753
3	.	0.2	0.01	0	0	0.822	0.1641	1.368
4	.	0.2	0.05	0	0	1.580	0.3829	1.955
5	.	0.2	0.31	0	0	2.262	0.6499	2.774
6	.	0.2	0.71	0	0	3.163	0.8687	3.661
7	.	0.2	0.93	0	0	4.100	0.9102	4.665
8	.	0.2	0.95	0	0	4.600	0.7211	5.426
9	.	0.2	0.98	0	0	6.776	0.4290	6.048
10+	.	0.2	1.00	0	0	10.893	0.4290	8.527
Unit	Thousands	-	-	-	-	Kg	-	Kg

YEAR: 2007

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	6457	0.2	0.00	0	0	0.388	0.0191	0.753
3	.	0.2	0.01	0	0	0.822	0.1641	1.368
4	.	0.2	0.05	0	0	1.580	0.3829	1.955
5	.	0.2	0.31	0	0	2.262	0.6499	2.774
6	.	0.2	0.71	0	0	3.163	0.8687	3.661
7	.	0.2	0.93	0	0	4.100	0.9102	4.665
8	.	0.2	0.95	0	0	4.600	0.7211	5.426
9	.	0.2	0.98	0	0	6.776	0.4290	6.048
10+	.	0.2	1.00	0	0	10.893	0.4290	8.527
Unit	Thousands	-	-	-	-	Kg	-	Kg

Basis;	Weight in catch 2005-2007	-	Average weight in catch 2002-2004
	Weight in stock 2005-2007	-	Average weight in stock 2002-2004
	Maturity ogive 2005-2007	-	Average maturity ogive 2002-2004
	Exploit. Pattern 2005-2007	-	Average 2002-2004 scaled to 2004

Table 2.22 Prediction with management option table

Year: 2005					Year: 2006					Year: 2007	
F	Reference	Stock	Sp.stock	Catch in	F	Reference	Stock	Sp.stock	Catch in	Stock	Sp.stock
Factor	F	biomass	biomass	weight	Factor	F	biomass	biomass	weight	biomass	Biomass
1	0.7029	59 243	39 427	22 877	0	0	43 406	26 113	0	51 003	30 346
					0.1	0.0703	43 406	26 113	1 970	48 890	28 663
					0.2	0.1406	43 406	26 113	3 828	46 898	27 083
					0.3	0.2109	43 406	26 113	5 582	45 019	25 601
					0.4	0.2812	43 406	26 113	7 237	43 246	24 209
					0.5	0.3515	43 406	26 113	8 801	41 573	22 901
					0.6	0.4218	43 406	26 113	10 280	39 993	21 672
					0.7	0.4920	43 406	26 113	11 678	38 499	20 517
					0.8	0.5623	43 406	26 113	13 002	37 087	19 430
					0.9	0.6326	43 406	26 113	14 255	35 751	18 407
					1	0.7029	43 406	26 113	15 442	34 487	17 444
					1.1	0.7732	43 406	26 113	16 568	33 290	16 538
					1.2	0.8435	43 406	26 113	17 636	32 156	15 683
					1.3	0.9138	43 406	26 113	18 649	31 081	14 878
					1.4	0.9841	43 406	26 113	19 612	30 061	14 119
					1.5	1.0544	43 406	26 113	20 526	29 094	13 403
					1.6	1.1247	43 406	26 113	21 395	28 176	12 728
					1.7	1.1950	43 406	26 113	22 222	27 303	12 090
					1.8	1.2653	43 406	26 113	23 009	26 474	11 488
					1.9	1.3356	43 406	26 113	23 759	25 686	10 919
					2	1.4059	43 406	26 113	24 473	24 937	10 382
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Basis for 2005: Status quo fishing mortality

Table 2.23 Catch options for 2006 with corresponding total stock biomasses and spawning stock biomasses in 2007.

Basis: F(2005) =F_{sq} = 0.7029; Landings(2005) = 22, 877 t, SSB(2006) = 26,113 t.

F(2006)	Basis	Catch 2006 (t)	Total stock biomass 2007 (t)	SSB 2007 (t)
0	0*F_{sq}	0	51 003	30 346
0.0703	0.1*F_{sq}	1 970	48 890	28 663
0.1406	0.2*F_{sq}	3 828	46 898	27 083
0.2812	0.4*F_{sq}	7 237	43 246	24 209
0.4218	0.6*F_{sq}	10 280	39 993	21 672
0.5623	0.8*F_{sq}	13 002	37 087	19 430
0.7029	1.0*F_{sq}	15 442	34 487	17 444

Table 2.24. ICA parameter settings.

PARAMETER	SETTING
No years for separable constraint	3
Reference age for separable constraint	5
Selection pattern model	Constant
Default weighting	Yes
Model for catchability relationship	Linear
AWeighting of abundance indices relative to catch-at-age data	Manual = 1
Shrink the final population	Yes
Numbers of years to shrink	2
S.E. of mean	1.0

Table 2.25 Coastal cod STOCK SUMMARY ICA run with manual weighting

Year	Recruits Age 2 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 7	SoP (%)
1984	90950	347690	179261	74824	0.4174	0.5781	100
1985	90020	328937	148491	75451	0.5081	0.4431	100
1986	50210	334359	156264	68905	0.4410	0.4694	100
1987	45040	317658	160199	60972	0.3806	0.3970	100
1988	42290	307476	173802	59294	0.3412	0.4516	100
1989	46150	271785	152158	40285	0.2648	0.2583	99
1990	45990	293185	174688	28127	0.1610	0.1164	100
1991	64020	335168	207278	24822	0.1198	0.1232	100
1992	55770	385598	249653	41690	0.1670	0.2009	100
1993	30380	401088	267445	52557	0.1965	0.2093	99
1994	26170	361276	237723	54562	0.2295	0.2090	100
1995	34510	315931	192986	57207	0.2964	0.2675	100
1996	40940	279911	203465	61776	0.3036	0.3427	100
1997	32740	244456	177944	63319	0.3558	0.3486	100
1998	31610	209494	126026	51572	0.4092	0.4218	99
1999	25240	188162	104936	40732	0.3882	0.4076	100
2000	22570	155279	81940	36715	0.4481	0.3563	99
2001	17330	150587	78964	29699	0.3761	0.3048	100
2002	13460	152961	84041	40994	0.4878	0.3823	101
2003	5490	100637	50048	34635	0.6920	0.3720	100
2004	1140	94580	63004	32599	0.5174	0.3964	100

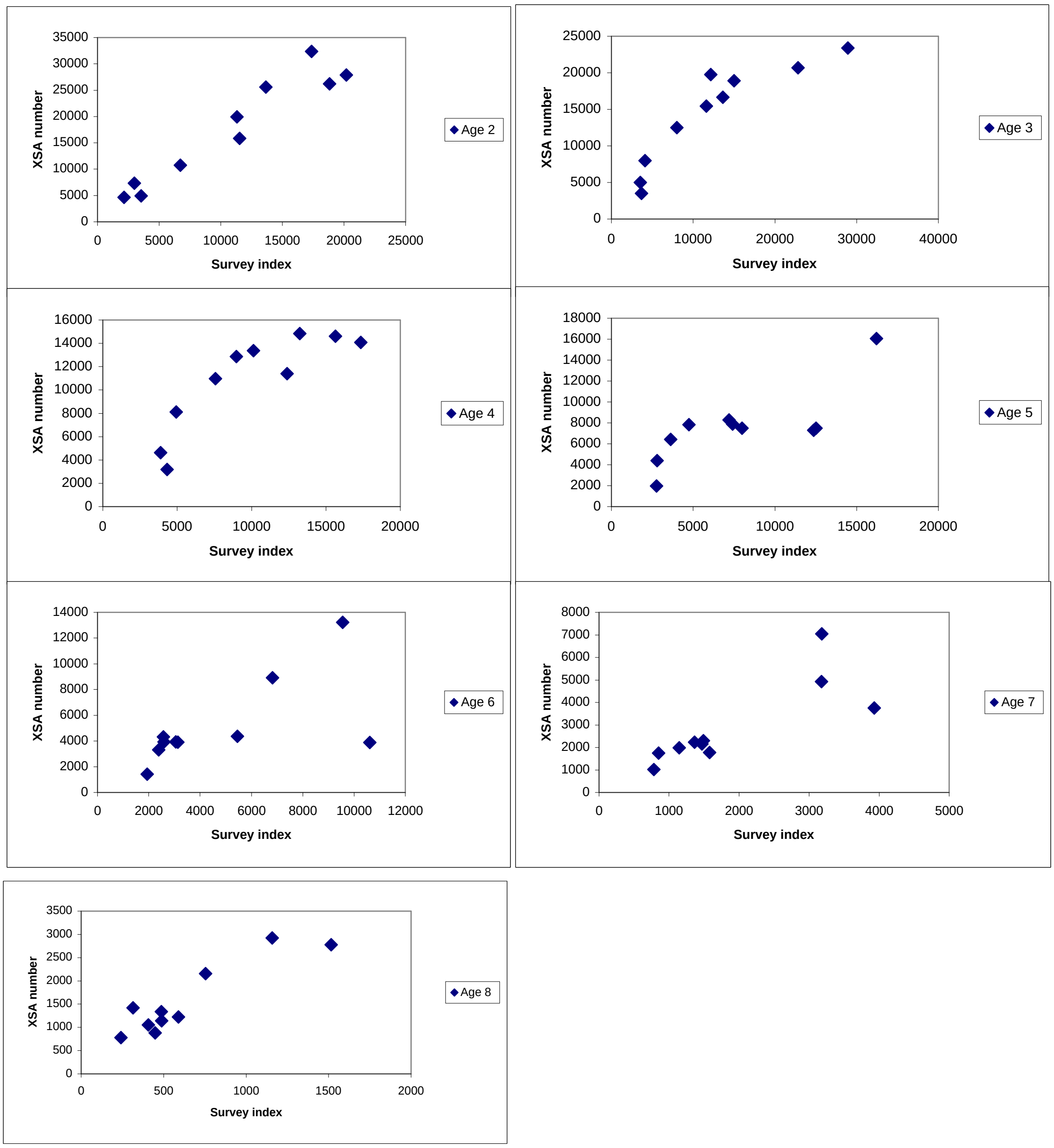


Figure 2.1 **Norwegian Coastal cod – Coastal acoustic survey vs XSA. Age (n) in survey=age (n+1) from XSA the year after because the surveys are conducted late autumn (1995-2004).**

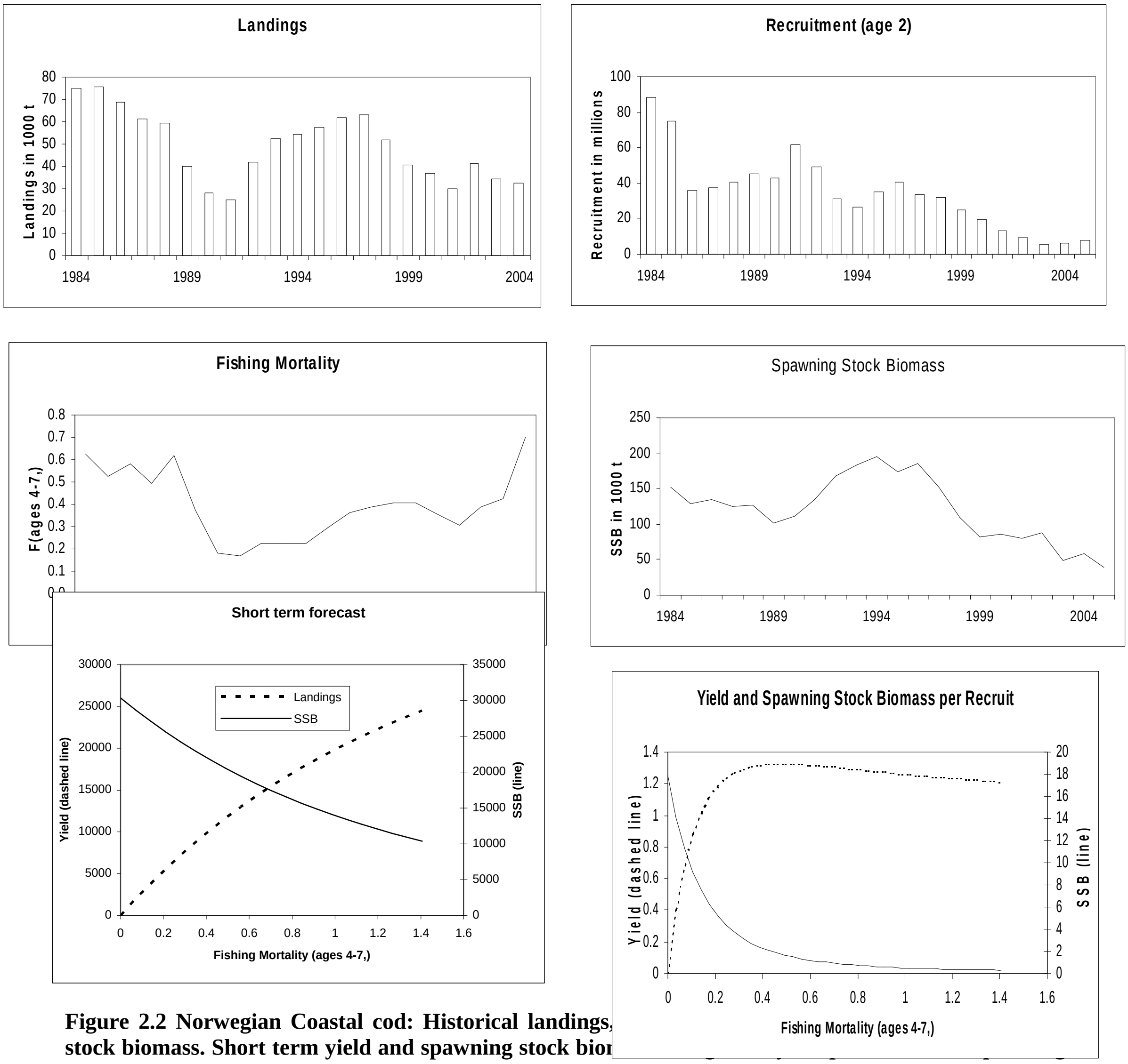
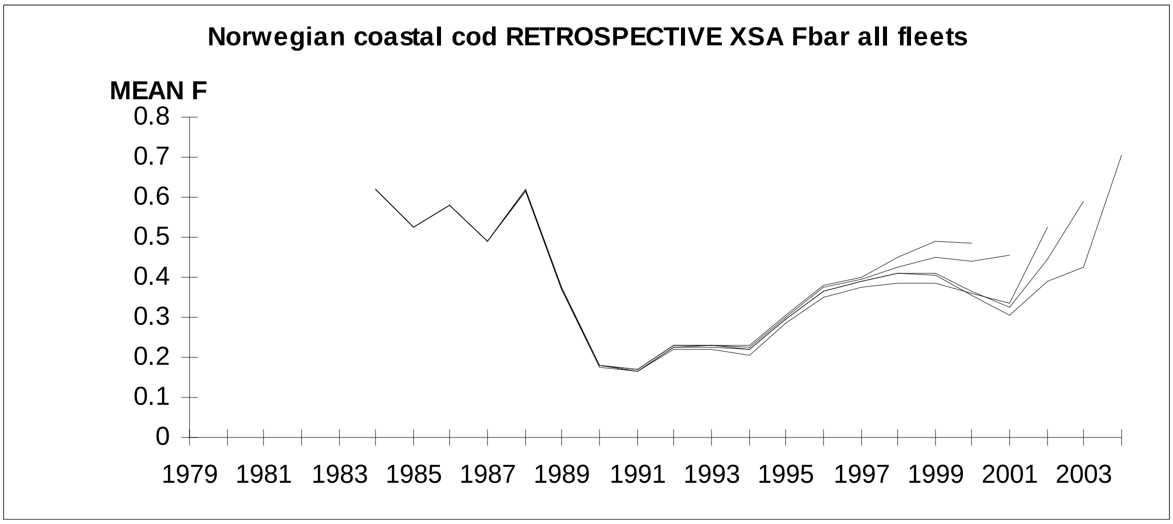
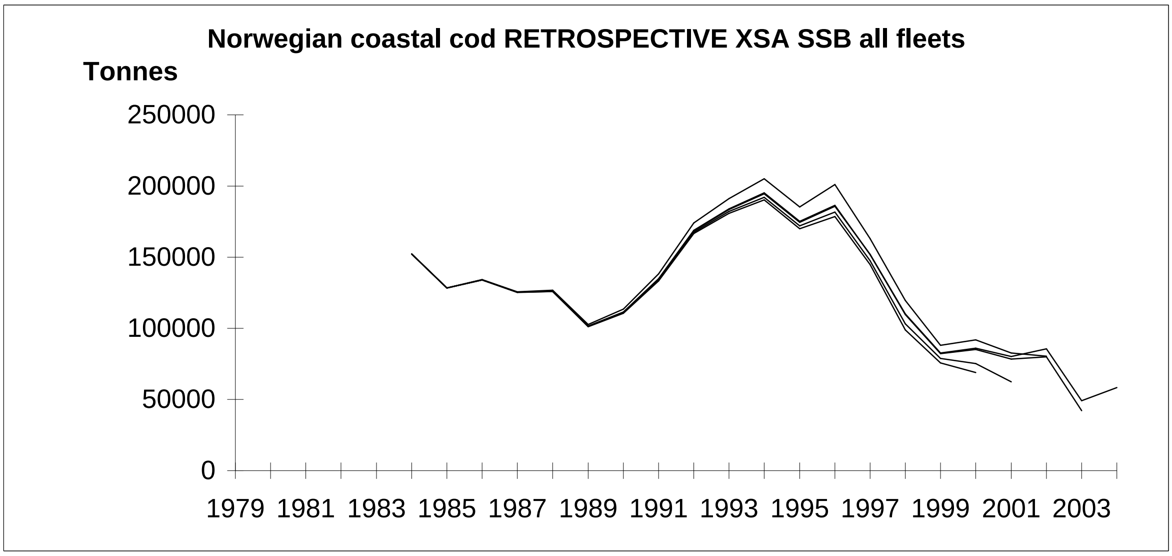


Figure 2.2 Norwegian Coastal cod: Historical landings, stock biomass. Short term yield and spawning stock bior stock biomass per recruit.





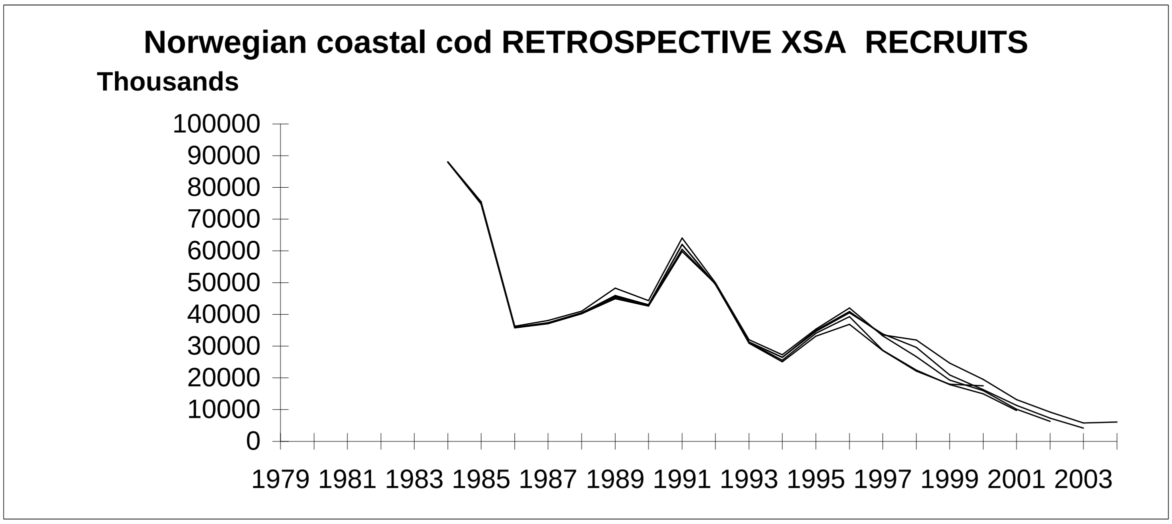


Figure 2.3 Norwegian coastal cod: Retrospective plots using XSA.with shrinkage SE=1.0.

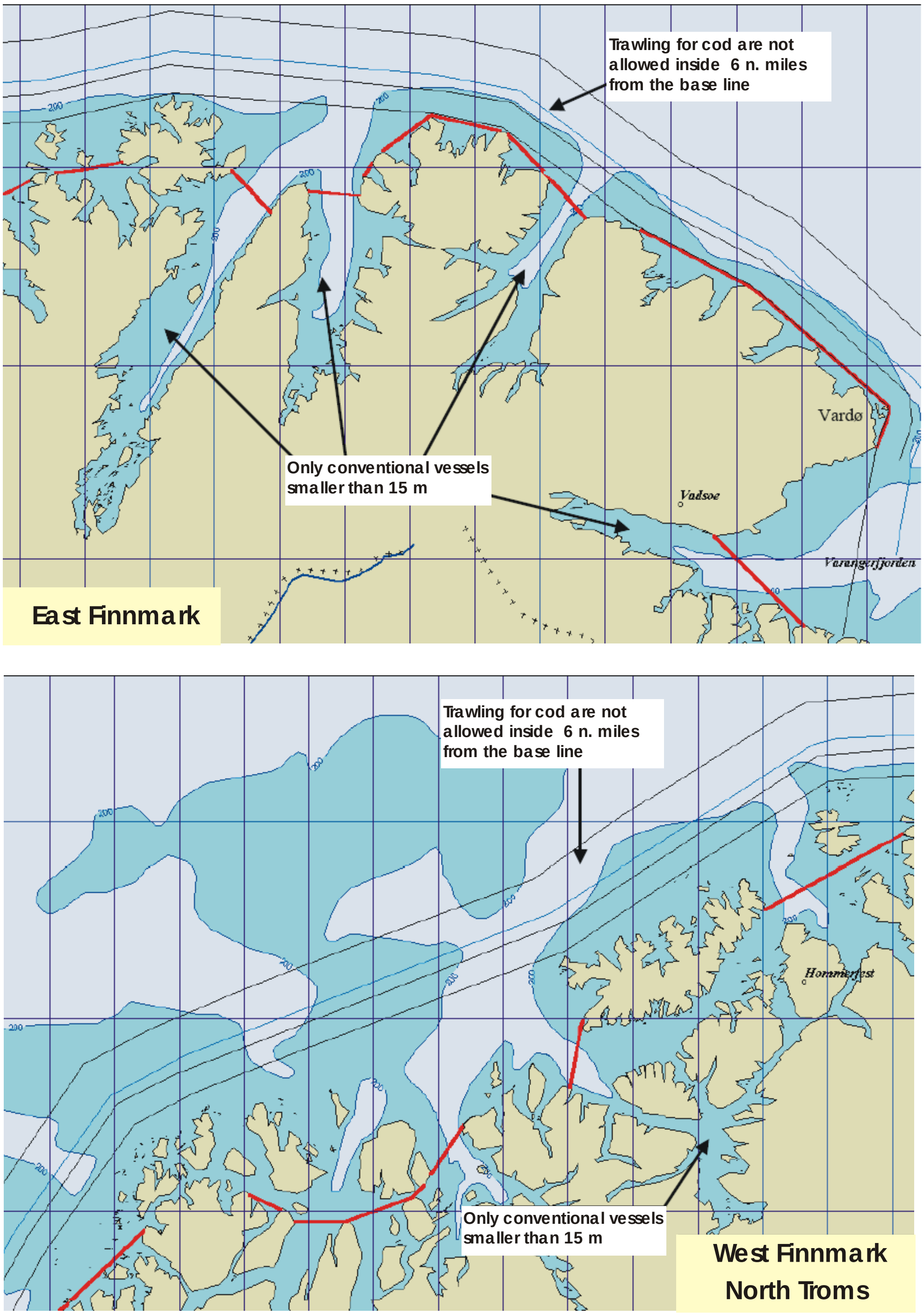
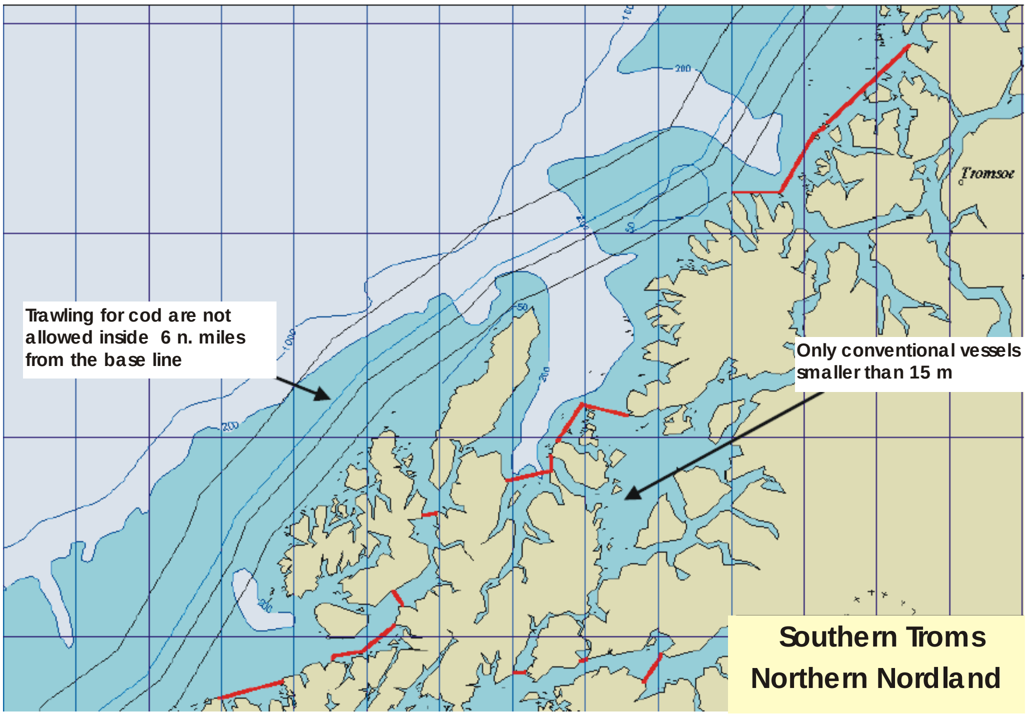


Figure 2.4 Map showing the new regulations for cod fishery near the coast of Norway



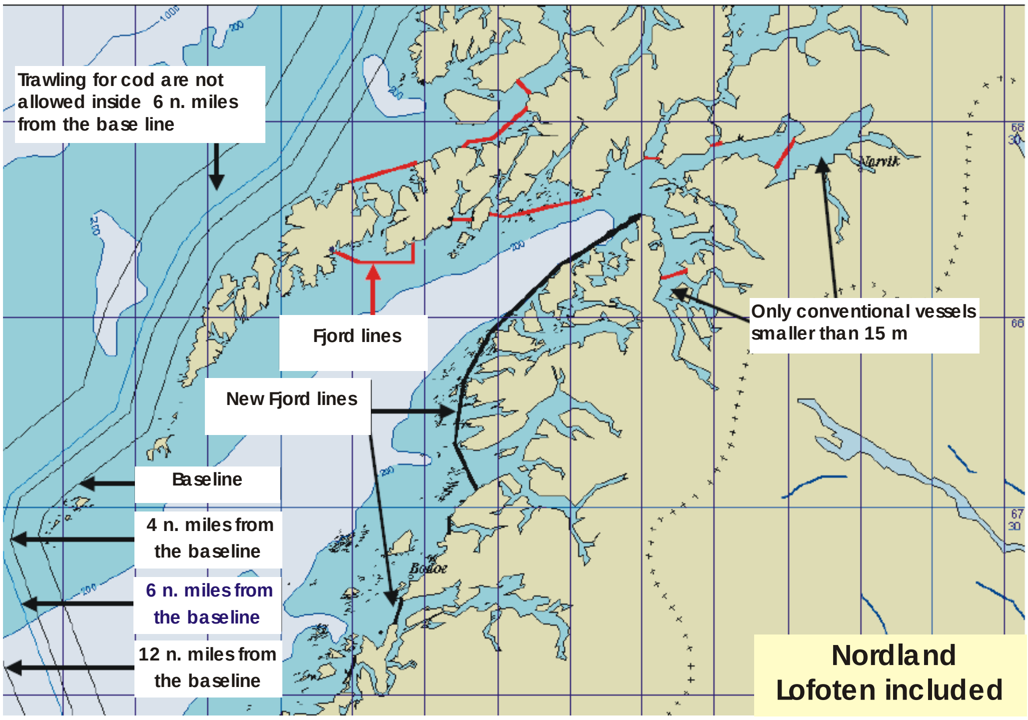
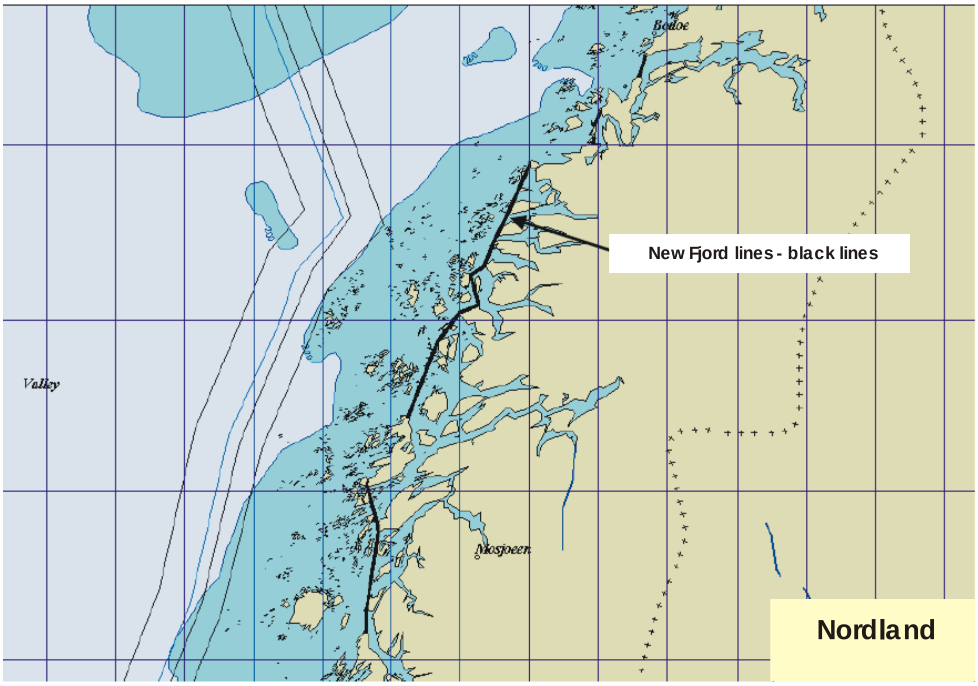


Figure 2.4 (Continued) Map showing the new regulations for cod fishery near the coast of Norway



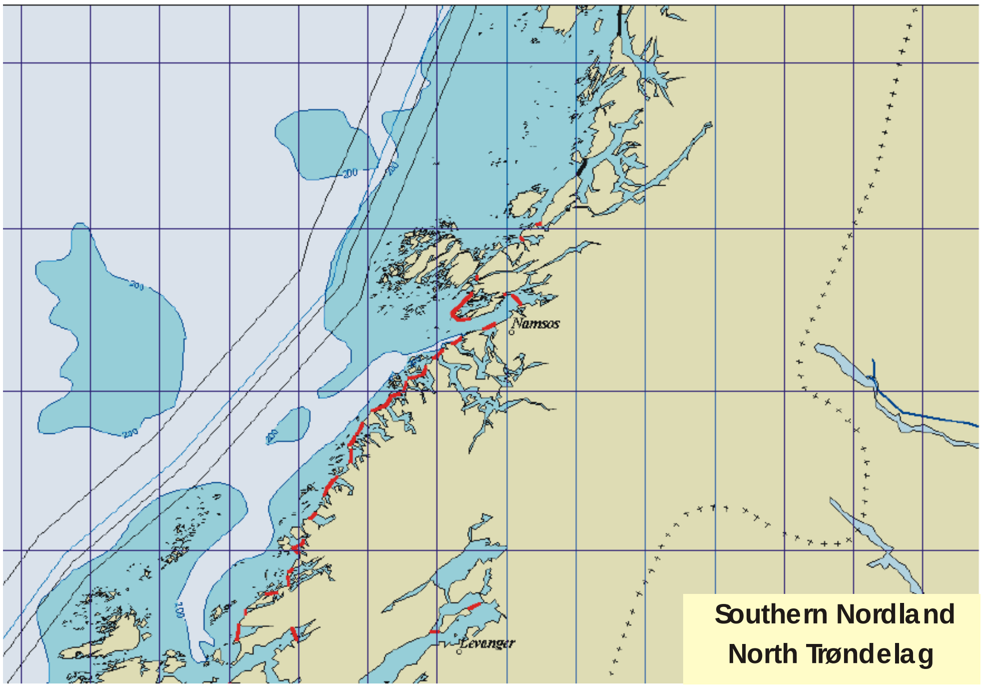


Figure 2.4 (Continued) Map showing the new regulations for cod fishery near the coast of Norway

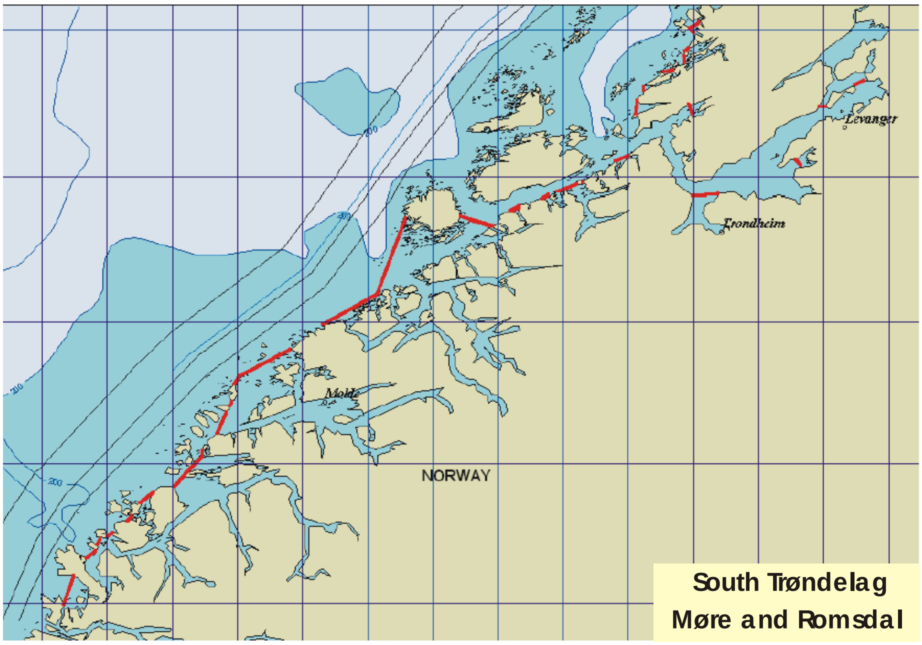


Figure 2.4 (Continued) Map showing the new regulations for cod fishery near the coast of Norway

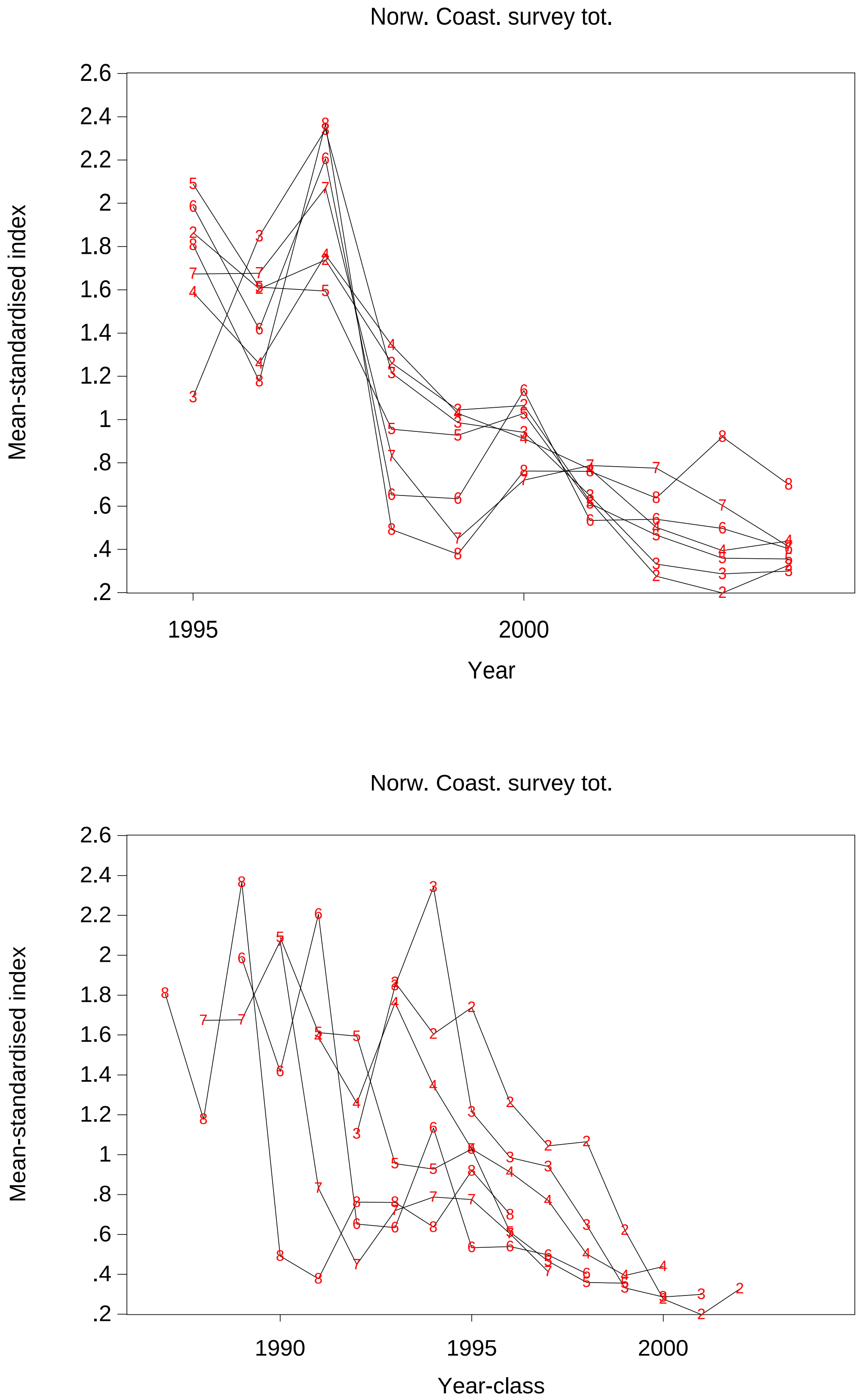


Figure 2.5 Norwegian coastal cod - SURBA ouput. Mean standardised index by year (upper panel) and year-classes (lower panel)

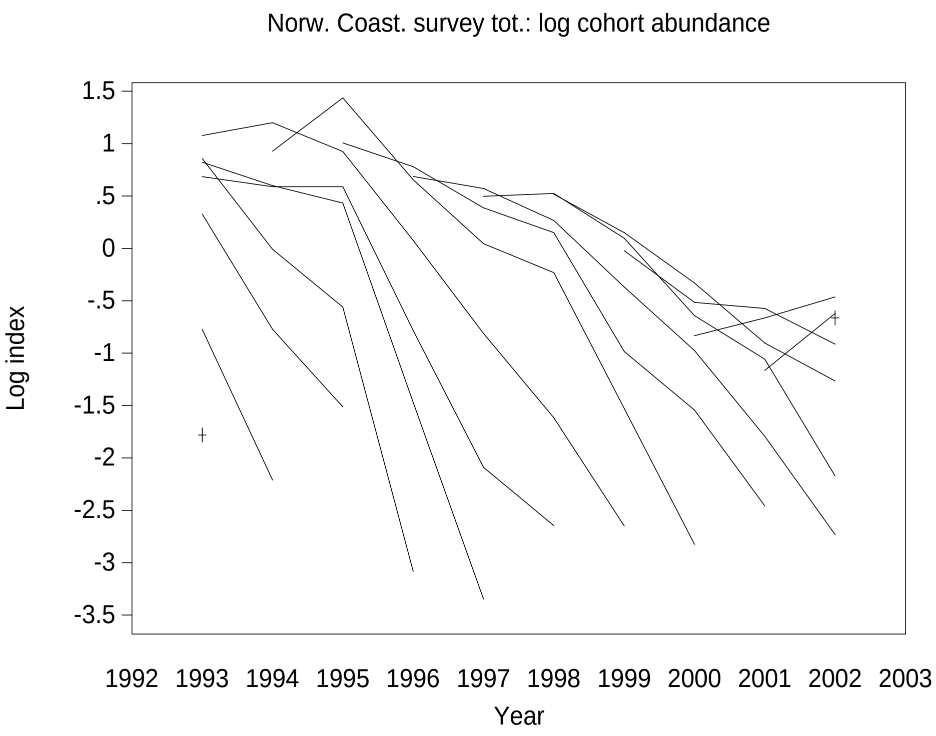


Figure 2.6 Norwegian coastal cod - SURBA ouput. Log cohort abundance index.

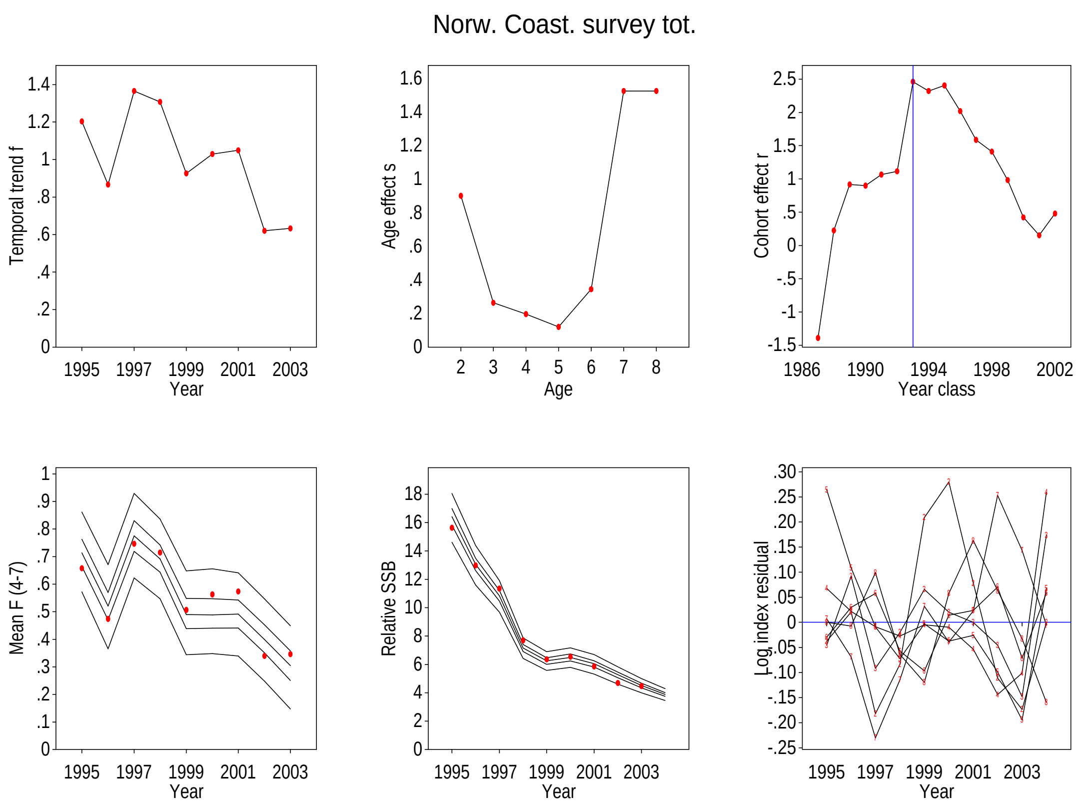


Figure 2.7 Norwegian coastal cod - SURBA ouput. Trends in F, SSB and log index rediuals.

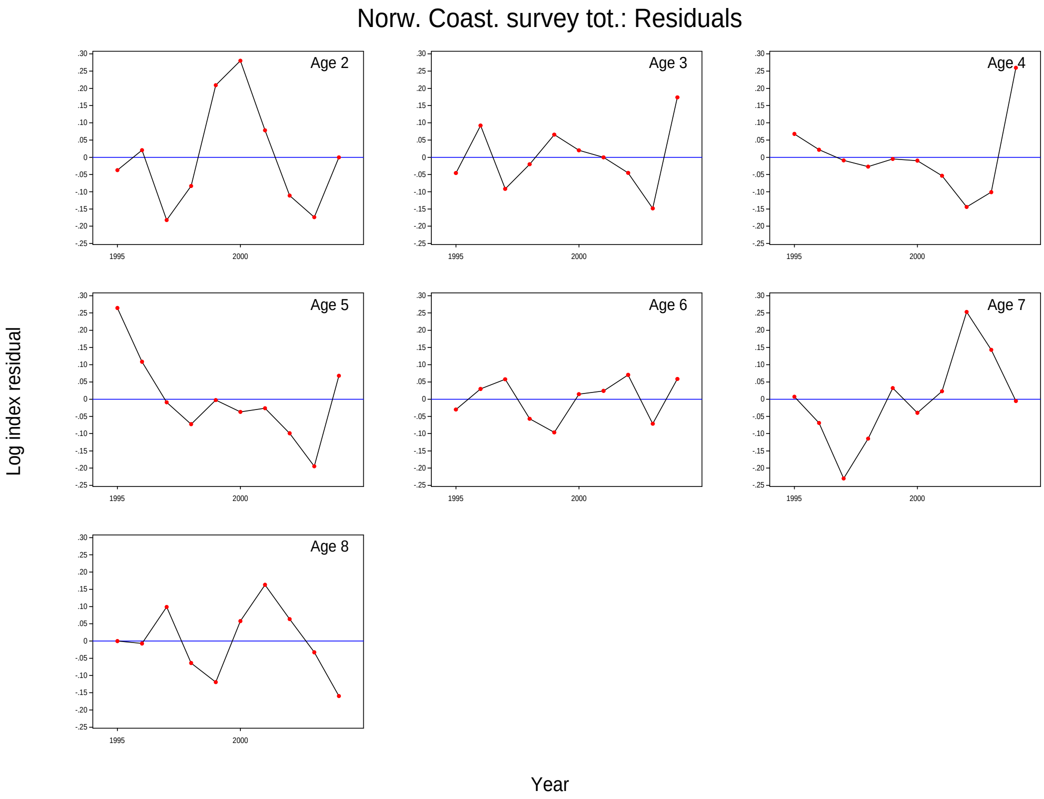


Figure 2.8 Norwegian coastal cod - SURBA ouput. Trends in log index rediuals by age.

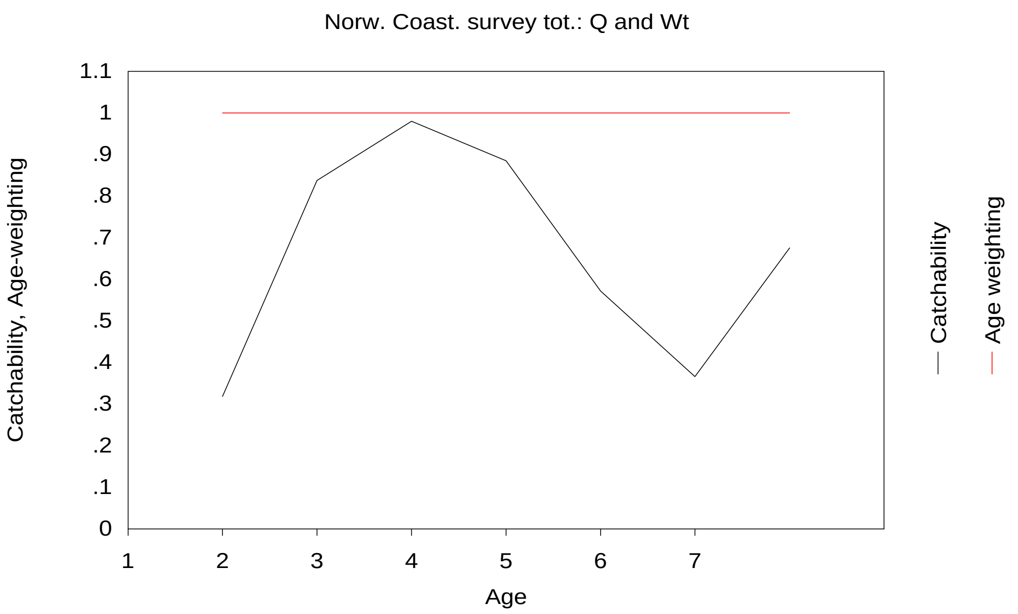


Figure 2.9 Norwegian coastal cod - SURBA ouput. Catchability by age.

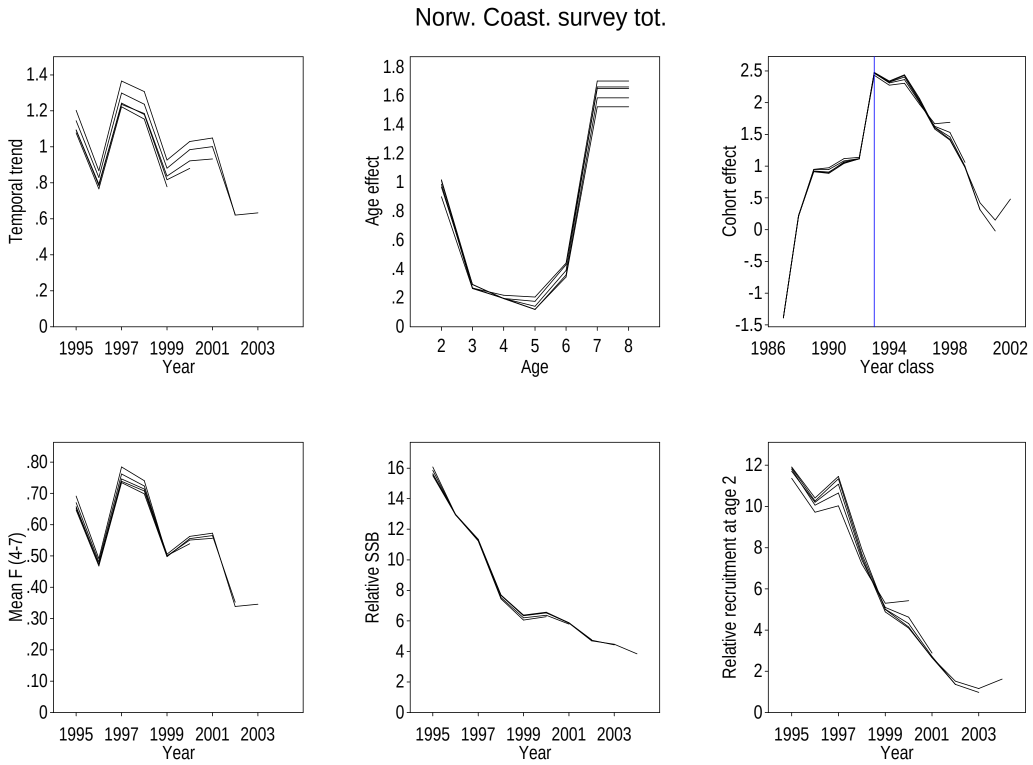


Figure 2.10 Norwegian coastal cod - SURBA ouput. Temporal trend in F, age effect and cohort effect (upper panel). Retrospective pattern of F, SSB and recruitment (age 2) (lower panel).

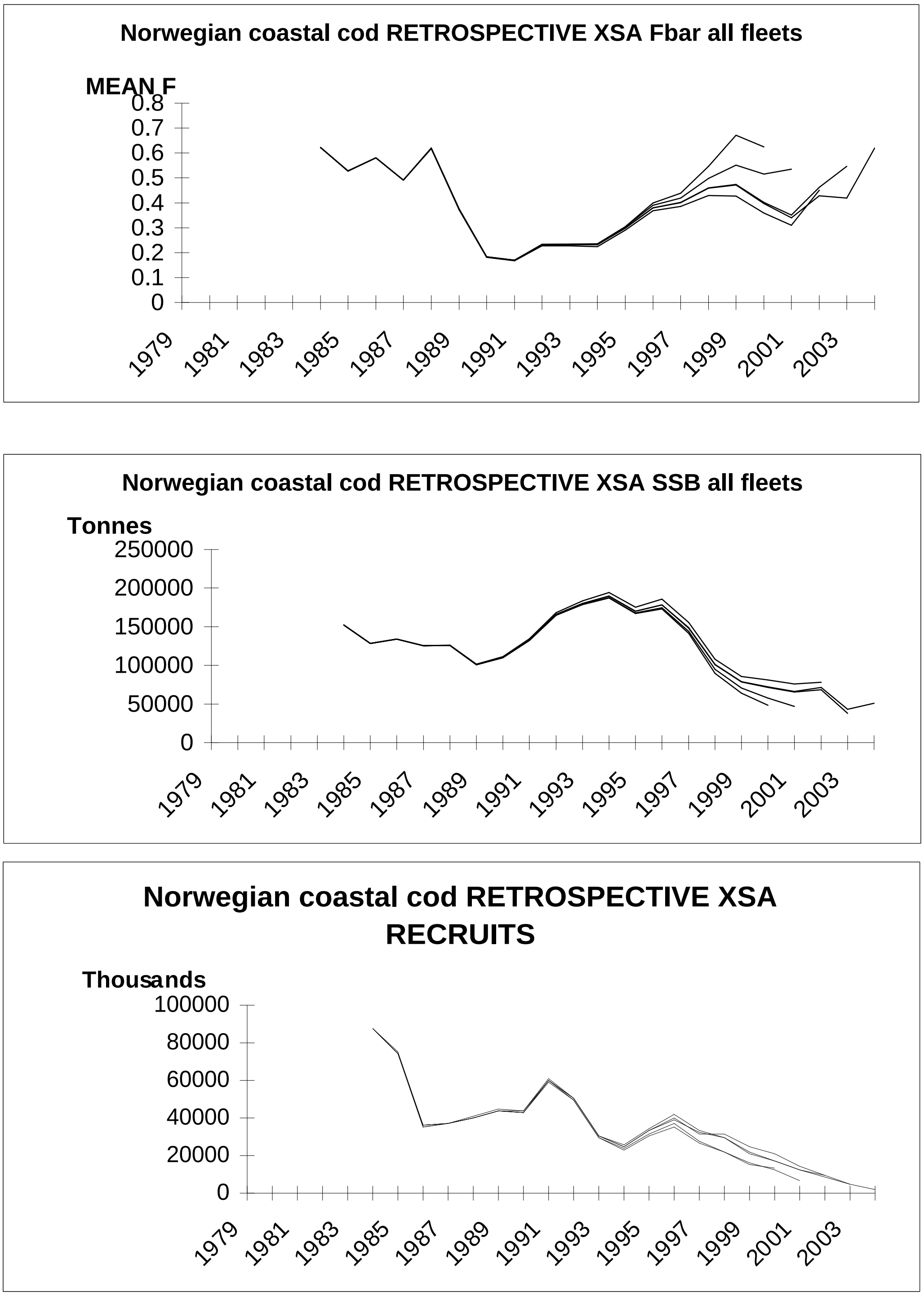
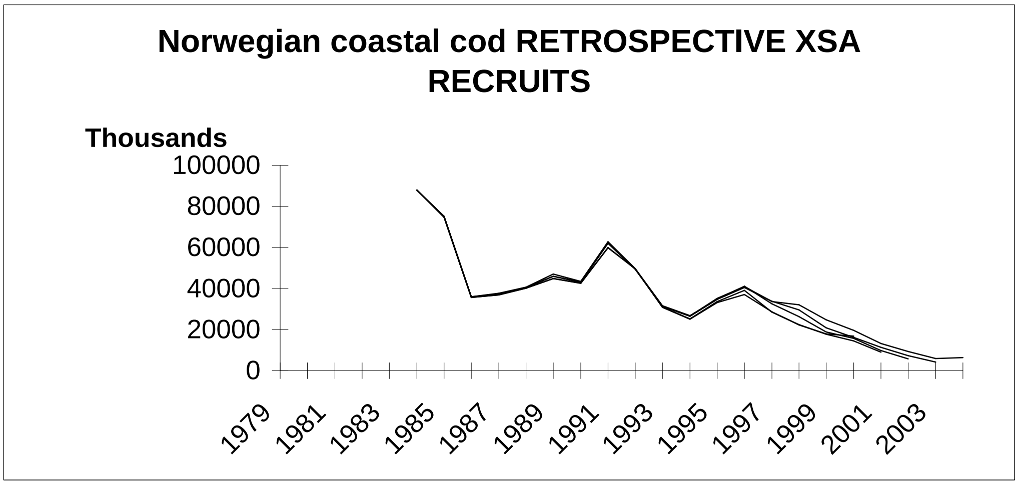
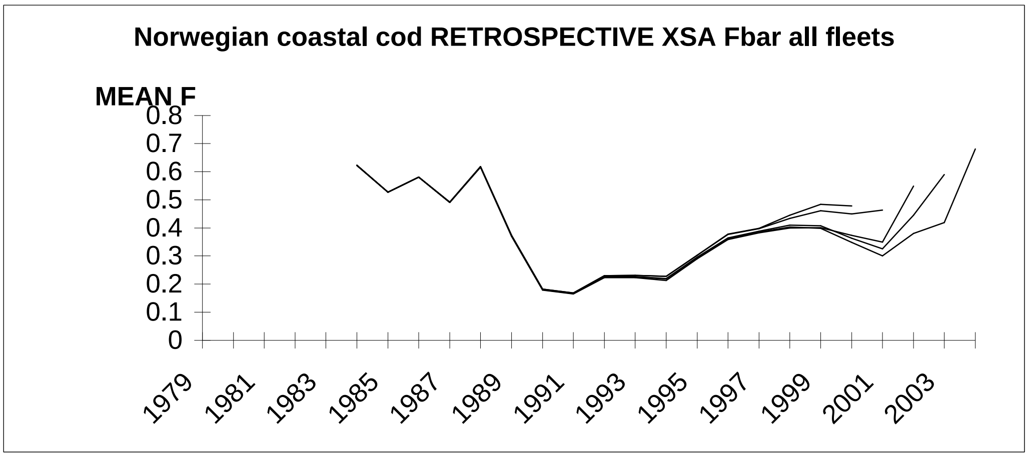


Figure 2.11 Norwegian coastal cod: Exploratory run: Retrospective plots using XSA with shrinkage 0.5.





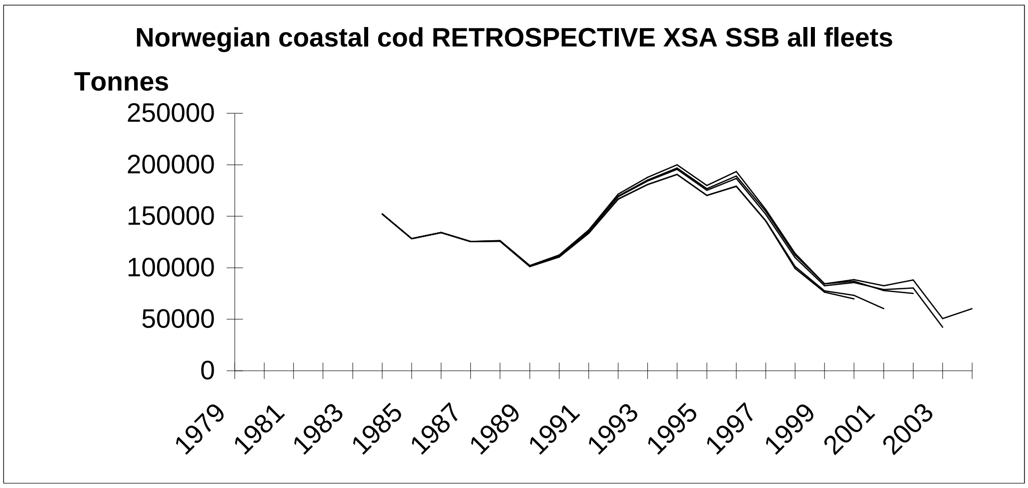


Figure 2.12 Norwegian coastal cod: Exploratory run: Retrospective plots using XSA with shrinkage 1.0. Survivor estimates shrunk towards the mean using 4 years for shrinkage.

3 North-East arctic cod (Sub-Areas I And II)

3.1 Status of the fisheries

3.1.1 Historical development of the fisheries (Table 3.1a)

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 2004 was about 580,000 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 2005 (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 2003 amount to 455,534 t. The provisional official landings for 2004 are 503,396 t. Unreported landings of 115,000 t for 2003 and 90,000 t for 2004 have been estimated.

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

The historical practise (considering catches between 62ºN and 67ºN for the whole year and catches between 67ºN and 69ºN for the second half of the year to be Norwegian coastal cod) lead to official landings of North-East Arctic cod of 436,990 t in 2003 and 489,445 t in 2004 (Table 3.1a). The coastal cod catches calculated this way in 2003 and 2004 were 18,544 t and 13,951 t, respectively. The catches of coastal cod calculated this way for the period 1960-2004 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 115,000 tonnes of unreported catches in 2003 and 90,000 tonnes in 2004 were added.

The landings by area, split into trawl and other gears, is given in Table 3.2 and the nominal landings by country is given in Table 3.3. Compared to 2003, the landings in 2004 increased in Sub-area I and Division IIb, but decreased slightly in Division IIa (Table 3.1a).

3.1.3 Catch advice for 2004 and 2005

The mixed Norwegian-Russian fisheries commission agreed on a TAC of 506,000 t for 2004, including 20,000 t Norwegian coastal cod. The total reported catch of 503,396 t in 2004 was 2,604 t below the agreed TAC.

For 2005, the mixed Norwegian-Russian fisheries commission agreed on a TAC of 506,000 t, including 21,000 t Norwegian coastal cod.

The Working Group has no information on the size of expected unreported landings in 2005. Based on available information, the amount of unreported landings in 2005 may decrease.

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 2005 are given in Tables A2 and A3. More details on this survey are given in Aglen (WD 26).

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

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

Lofoten acoustic survey on spawners

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

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, the Joint Ecosystem survey covered the entire Barents Sea.

Russian autumn survey

Abundance estimates from the Russian autumn survey (November-December) are given in Table A10 (acoustic estimates) and Table A11 (bottom trawl estimates). The Russian autumn survey did not cover the Norwegian economical zone in 2002. The indices obtained were adjusted assuming the area distribution to be equal to the 1998-2001 average. The 2003 and 2004 surveys were conducted with complete area coverage. The 2002 and 2003 year classes abundance was estimated to below average, the 2004 year class – to average in the latest survey.

International 0-group survey

Abundance indices of 0-group cod from the International 0-group survey are provided in Tables 1.10-1.12 (see comments in Section 1.4.1 about revision of 0-group indices). 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).

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

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

Both the joint winter survey in 2005 and the Russian autumn survey in 2004 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 1985-2005, Norwegian maturity-at-age ogives were obtained by combining the Barents Sea and Lofoten surveys according to the method described in Marshall *et al*. (1998). Russian maturity ogives from the autumn survey are available from 1984 until present. The Norwegian maturity ogives tend to give a higher percent mature at age compared to the Russian ogives, which is consistent with the generally higher growth rates observed in cod sampled by the Norwegian surveys. The approach used is consistent with the approach used to estimate the weight at age in the stock (described in Section 3.3.2). The percent mature at age for the Russian and Norwegian surveys have been arithmetically averaged for all years, except 1982-1983 when only Norwegian observations were used and 1984 when only Russian observations were used.

The 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 weighs each individual fish sampled according to the trawl catch rate, while in the survey estimate acoustic abundance by strata acts as a weighting factor. The 2005 WG decided to use the Norwegian values from the “standard” maturation program and combine those with Russian observations in the usual way. The weighting method should be reviewed before the next WG, and the time series updated accordingly.

Section 3.2.5 in WG 2004 lists a few maturity related topics for intersessional work. More details are discussed in a long maturity chapter in the 2003 WG report (3.2.5). A Russian-Norwegian project ("Optimal long-term harvest in the Barents Sea ecosystem") includes some of these topics, and hopefully some analysis will be available rather soon.

3.2.5.1 Status of research on reproductive potential of NA cod

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

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

3.2.5.2 Potential causes of interannual variation in maturity ogives

The maturity ogives used for the medium-term stock projections have a considerable impact on the forecasted SSB values. Average values are used, however, it would be advantageous to identify factors contributing to variation in maturity ogives. There is a positive relationship between weight-at-age and maturity-at-age for age-classes 8 to 10 (Figure 1.8), and between weight-at-length and maturity-at-length (Fig 1.9). Liver weight estimates (g) of cod (derived from the Russian liver condition index and age/length keys described in Marshall *et al*., 2004) show a significant, positive relationship with the proportion of mature fish for three length groups for the time period 1984 to 2001 (Figure 1.10)(Marshall, presentation for ICES Symposium Cod and Climate, Bergen May 2004). This result confirms that the magnitude of stored energy is positively correlated with the proportion mature. A decrease of maturity rates may occur in the short-term particularly given the low capelin biomass. However, the abundance of other fish prey is high and consumption per cod is at an average level.

Bogstad *et al*. (WD3, 2004) found the maturity-at-age to be correlated with the total stock biomass. However, their analysis was based on the whole time series (1946-2002), while the correlation between weight at age and maturity-at-age is clearly different between the 1946-1979 and 1985-2001 periods (Section 1.4.2). Thus, it may be worthwhile to look at density-dependence of maturation for those periods separately.

Possible future work on projecting maturity ogives includes establishing a method for predicting liver weights in the upcoming year. This research can take advantage of the links between capelin stock biomass and liver condition (Yaragina and Marshall, 2000).

3.3 Data used in the assessment

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

For 2003, age compositions for all areas were available from Russia, Norway, Germany and Spain. Length measurements were reported from Portuguese catches. On this basis Portuguese catches were distributed by use of the age composition in the Russian catches. Unreported catches in 2003 were distributed using total international catch age distribution in Division IIb on half the unreported catch and total international catch age distribution in Sub-area I on the other half. For 2004, age compositions from all areas were available from Russia and Norway. Germany and 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 2003 and 2004 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. Also, the 2002 catches were distributed using the total international trawl catch age distribution in Sub-area I. This caused a slight revision, as previously the total international (i.e. all gears combined) catch age distribution in Sub-area I was used.

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

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). The results in the overlapping years of these two studies differ considerably. The discrepancies should be clarified before these time series are used in the assessment. More references about discards and unreported catches are given in the introduction section.

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

Catch weights

For 2004, the mean weight at age in the catch (Table 3.11) was calculated as a weighted average of the weight at age in the catch for Norway, Russia, Germany and Spain. The weight at age in the catch for these countries is given in Table 3.4.

Stock weights

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

For ages 1-11 stock weights at age a at the start of year y ($W_{a,y}$) for 1983-2005 (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 1985-2005.

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 17	Russian bottom trawl surv.	Total area	Oct-Dec	3-8	1982-2004
Fleet 09	Russian trawl CPUE	Total area	All year	9-12	1985-2004
Fleet 15	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2005
Fleet 16	Joint acoustic survey	Barents Sea + Lofoten	Feb-Mar	3-11	1985-2005 (Table A14)

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 2005 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:

- Tapered time weighting power 3 over 10 years
- Catchability dependent of stock size for ages less than 6
- F of the 2 oldest age groups used in F shrinkage
- 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 9,000 cod stomachs from the Barents Sea have been analysed annually in the period 1984-2004. 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 2004 as well as additional data for 2003. In addition, the age-length keys used for the second half of 2002 were revised. The Barents Sea was divided into three areas (west, east and north) and the consumption by cod was calculated from the average stomach content of each prey group by area, half-year and cod age group.

The number of cod predators at age is taken from the VPA, and thus an iterative procedure has to be applied (Section 3.4.2). It was assumed that the mature part of the cod stock is found outside the Barents Sea for three months during the first half of the year. There were very few samples of the stomach contents of cod in the spawning areas. Thus, consumption by cod in the spawning period was omitted from the calculations. It is believed that the cod generally eats very little during spawning, although some predation by cod on herring has been observed close to the spawning areas. The geographical distribution of the cod stock by season is based on Norwegian survey data. The total number of cod ages 0–6 (million) consumed is given in Table 3.9. Alternative calculations of the number of cod consumed by cod, giving somewhat different results, were presented in Dolgov (WD 10).

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 (2005-2007) are given in Table 3.28. For 2005 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2005 onwards and Stock weights in 2006 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 working group and only the 3 most recent values of annual increments were used for predicting stock weights. Figures 3.2a and 3.2b show how these predictions perform back in history. Evidently the fit is best over the period which is the basis for calculated Incr(a).

The predictions of cod weight at age using the method given in Section 1.4.2 give results, which are in fairly good agreement with the predictions using the Brander method as described above.

Last year the maturity ogive for the years 2005 and 2006 was predicted by using the 2002-2004 average. The 2003-2005 period now appears rather stable, and an average over that period was applied. The exploitation pattern in 2005 and later years was set equal to the 2002-2004 average. The reference F was also averaged over the same period. There did not seem to be a clear trend in F over this 3-year period.

The stock number at age in 2005 was taken from the final VPA (Table 3.23) for ages 4 and older. The recruitment at age 3 in year 2005 and later was estimated from surveys (section 3.3.6). Figure 3.11 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 1984-2004. It is seen 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). High correlation was observed between the cod SSB and cannibalism mortality 3 years later. The group felt that this should be further explored, especially for a better understanding of the cause/ effect leading to such a relationship (section 1). This method gave a higher M for 2004 than the value calculated from stomach data. For the current prediction the 2002-2004 average natural mortality was used.

3.4 Methods used in the assessment

The XSA was also this year used as the main assessment method. The assessment with Gadget (formerly Fleksibest) is presented in section 3.10. The survey calibration method presented by Pennington and Nakken (WD 19) and the time series approach presented by Aanes (WD25) are presented in Section 3.11. A comparison of the results of these methods is given in Section 3.12.

3.4.1 VPA, tuning and sensitivity analysis

In the assessments in August 2000, several changes in model settings and data choices were made, and since then the retrospective analysis has considerably improved. The Quality Control Diagrams now indicate rather consistent assessments since 1999.

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

The present assessment applies the same fleets and age groups as used since the 2000 assessment, with the exception that Norwegian trawl CPUE has been left out since the 2002 assessment and that in the 2003 assessment, the ages were mis-specified in fleet 17.

Comparisons with individual surveys are shown in Figure 3.3. Figures 3.4-3.7 show fleet-wise plots from the “surba” program (Needle, 2003 and Needle, 2004). Figure 3.8 shows residuals of log catchability from a run based on the settings and fleet data described above (and cannibalism “tuned” as described in section 3.4.2). High catchability residuals (Figure 3.8), discrepancies compared to other fleets (Figure 3.3) and internal inconsistencies (Figures 3.4-3.7) are observed for age 12 in fleet 09, ages 10 and 11 in fleet 16 and ages 6,7 and 8 in fleet 17. The effect of removing such fleet data was studied in last year’s assessment. The XSA diagnostics improved, but the effect on the results was relatively small. Thus, it was decided not to repeat that exercise in this year’s assessment.

Here fleet 15 is rather parallel to the VPA, but tend to be somewhat below for ages 5-8, while the other fleets fluctuates around the VPA. The mortality trends for the surveys as seen from the “surba” analysis (Figures 3.4-3.7) are quite noisy, but an observed declining trend over the latest years is in general agreement with the recent mortality trends in the VPA.

Table 3.15b compares single fleet runs (with original data) with the final run. Figure 3.9 shows that $F_{4\text{-}8}$ follows better the expected “F-Biomass curve” than $F_{5\text{-}10}$ does.. It is noticed that the final run gives a somewhat lower F and higher SSB compared to 3 of the 4 single fleet runs (Figure 3.9). The final run does, however, gives a slightly higher F and considerably lower SSB than the single fleet run with the Russian bottom trawl survey (fleet 17). Since shrinkage works differently on single fleet runs than on a combined run, the fleet predictions before shrinkage (the 2004 values of F and survivors at age taken from the XSA diagnostics of single fleet runs) was examined.

Table 3.15b also shows the effect of changing ages for stock size dependent catchabilities (less than age 3, 4, 5 and 7, compared to 6 in “final run”). The current assessment is very little sensitive to this choice, while in the mid-1990s this choice was quite critical. This point is illustrated by a retrospective analysis with stock size dependent catchabilities for ages less than 3, shown in Figure 3.10a. This analysis shows a very bad pattern in the mid-1990s. An increased tuning window (15 yrs compared to 10) increased $F_{5\text{-}10}$ by 10% and reduced SSB by 5%. The earlier part of the survey series show larger discrepancies between surveys (Figure 3.3) and larger internal residuals (bubble plots, Figures 3.4-3.7). Thus an increased time window may introduce a bias. The 2000 working group observed a considerably worse retrospective pattern when the tuning window was increased.

The tuning appears to not to be very sensitive to the level of shrinkage. Increasing the F and population shrinkage (reducing minimum SE for shrinkage values from 1.0 to 0.5) lead to 10% increase in $F_{5\text{-}10}$ and 6% reduced SSB. Such a result should be expected since the assessment does not indicate a trend in F in the last 3 years, but some reduction in the 2 years prior to that (5 years are included in the shrinkage). The argument for keeping low shrinkage is that the assessment should be able to pick up recent trends in the surveys. One more reason for being restrictive towards changes in settings and choices of data is that the PA reference points for this stock is based on a retrospective run with fixed settings and input data.

The 2001 year class was estimated by calculating the weighted mean of the Fs estimated for this year class by the XSA for each survey, but without taking the shrinkage into account (Table 3.16). The scaled weights in the XSA diagnostics were used as weighting factors. This gave an abundance of 297 million at age 3 in 2004, which is close to the RCT3 estimate (286 million) for this year class at age 3.

The effects of adding unreported catch in 2002-2004 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 were estimated from the stock estimates in the last assessment. Then the number consumed was added to the catches used for tuning. The resulting stock then lead to new estimates of consumption. This procedure was repeated until the revision of consumed numbers for the latest year (2004) 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 1984-2004 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 2004 is lower than the assumed F_{sq} in last year’s prediction (0.57 vs. 0.63), while the spawning stock biomass in 2005 is estimated to be 701,000 t, which is below last year’s assessment (794,000 t).

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

Figure 3.10a 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 576 millions for the 2002 year-class, 478 millions for the 2003 year-class and 574 millions for the 2004 year-class. A comparison of these results with the results of other recruitment models is given in Table 1.8.

3.6 Reference points

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

3.6.1 Biomass reference points (Figure 3.1)

The values adopted by ACFM in 2003 are $\mathbf{B}_{lim}$ = 220,000 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, in prep.)

3.7 Catch options (Table 3.29-3.30)

Catch options are presented in Table 3.29. The detailed outputs corresponding to F_{sq} in 2005 and F_{pa} in 2006 is given in Table 3.30. It should be noted that the difference between the catch corresponding to F_{sq} (595,000 t) and the TAC for 2005 (485,000 t) is 110,000 t. This difference is higher than the amount of unreported catches estimated for 2004.

In Figure 3.1 the catch level in 2006 and spawning stock biomass level in 2007 are plotted against the fishing mortality in 2006.

3.8 Medium-term forecasts and management scenarios

3.8.1 Adopted harvesting strategy

At the 31st session of The Joint Norwegian-Russian Fishery Commission in autumn 2002, the Parties agreed on a new harvest control rule (section 3.14). 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 this year, see section 3.14.

3.8.2 Results

Table 3.30 shows output of the predictions (over the period 2005-2008) used to calculate the TAC, which corresponds to the agreed harvest control rule.

The catch in 2006 according to this rule is estimated to 471,000 tonnes, corresponding to F=0.45 in 2006. This catch forecast covers all catches. It is then implied that all types of catches are to be included in this amount.

Stochastic medium-term predictions for the period 2005-2008, using the HCR, are given in Figure 3.12. The same uncertainty in stock assessment as in the HCR work (section 3.14) 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 2006-2008 was assumed to be the same as the uncertainty in the assessment of age 3 fish. The recruitment in 2009 and 2010 (used when applying the 3-year rule in 2007 and 2008) 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 2004 for number at age, total biomass, spawning biomass and reference F-values, as well as reference F for the year 2003.

		2004										
Assessment yr (specification)	F(2003)	age3	age4	age5	age6	age7	age8	age9	age10	TSB	SSB	F(2004)
2004	0.46	276*	392	247	197	143	54	15.6	3.6	1749	851	0.63**
2005 final (added C 02,03,04)	0.50	297	419	236	197	112	41	12.3	3.7	1583	714	0.57
Ratio 2005 final/ 2004	1.09	1.08	1.07	0.96	1.00	0.78	0.76	0.79	1.03	0.91	0.84	0.89

*estimated by rct3 **assuming F_{sq}

The final assessment values for ages 3-6 and 10 are fairly close to the 2004 assessment, while ages 7-9 seem to have been overestimated in last year's assessment. The new estimate of SSB in 2005 (701,000 tonnes) is below the prediction from last year (794,000 tonnes).

Retrospective plots of F, SSB and recruitment are shown in Figure 3.10b. Here the pattern for F_{4-8} is shown for comparison. This shows less between year revision than the F_{5-10}, particularly some years back in time. This is most likely caused by some sampling noise associated with the age groups 9 and 10, which in some years are rather scarce in some fishing fleets and survey fleets.

3.10 Alternative assessment methods (Gadget/Fleksibest)

3.10.1 Introduction

A description of the mathematical formulations used in Fleksibest is given in Frøysa *et al*. (2002). Fleksibest is a length-structured extension of the type of age structured assessment models sometimes termed 'statistical catch at age analysis' (Fournier and Archibald, 1982; Deriso *et al*., 1985). As last year, a complete assessment including a medium-term prediction is presented for comparison with the XSA assessment. 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. The biological model used in described in Bogstad *et al*. (2004b).

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 2005. 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	1994-2005	1-10	5-90 cm	Immature
Norwegian Winter acoustic	1	1985-1993	3-9	20-90 cm	Immature
Norwegian/Joint Winter acoustic	1	1994-2005	1-10	5-90 cm	Immature
Lofoten acoustic	1	1985-1989	5-12+	55-110 cm	Mature
Lofoten acoustic	1	1990-2005	5-12+	55-110 cm	Mature
Russian bottom trawl autumn	4	1985-1993 and 1995-2004	1-8	6-106 cm	Immature and mature

In previous Gadget assessments, the Russian survey was shifted one age group, as was also the case in XSA assessments for cod in 2003 (see section 3.4.1).

The Norwegian (from 2000 Joint) winter survey in the Barents Sea (bottom trawl and acoustic indices) was split into two time periods because of the change of gear and increase in area coverage in 1994 (Jakobsen *et al*., 1997). The Lofoten acoustic survey was split into two periods because of the change of echosounder in 1990 (Korsbrekke, 1997). The 1994 data from the Russian bottom trawl survey gave extremely high residuals and were removed. The XSA also indicates a bad fit for this survey in 1994.

Catch data

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

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

Data for 1985-2004 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 1985-2004 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 function in Gadget. The results were not considered reliable, and thus the runs presented here do not include consumption data in the likelihood function. The reason for this will be investigated.

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 older 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 2.0.07. 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.

3.10.2.6 Results from the assessment

Choice of key run

Since the consumption data could not be included in the objective function this year, the results of the 1+ runs were not considered to be reliable. Thus the 3+ run with the same weighting and settings as in last year's Gadget assessment was chosen as the key run.

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 Figure 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 130 000 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_{5-10} 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.

Compared to last year's Gadget results, the results obtained this year give a somewhat more pessimistic view of the status of the stock. The fishing mortality (F_{5-10}) in 2003 increased from 0.56 in last year's assessment to 0.59 in this year's assessment, while the total stock biomass in 2004 decreased from 1.5 million tonnes in the 2004 assessment to 1.3 million tonnes in this year's assessment.

Model/data fit

The total likelihood score decreased somewhat compared to last year's assessment, probably because the error in the age distribution in the Russian survey was corrected.

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

3.10.3 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 1999, and is thus labeled 1999. The retrospective pattern seems to be quite consistent back to 1999.

3.10.4 Use of Gadget for predictions

Gadget is well suited for prognosis, because the length-dependence of population dynamics processes makes it easy to get consistency between the values of weight, maturity and mortality at age. In the prognosis runs with Gadget for the period 2005-2007, the same values as in the key run were used for most parameters. The growth parameter was set to the average of the 2001-2003 values, and the weight at length was set equal to the 2004 values. The mean length of age 3 fish in 2006 and 2007 was set approximately equal to the 2005 value. The distribution of the catch taken by each of the two fleets was set equal to the 2004 value. The recruitment at age 3 in 2006 and 2007 is set to the values obtained from the RCT3 analysis. This is consistent with the assumptions made in the medium-term prognosis based on the XSA run (see Section 3.3.8).

The values of recruitment, catch weight, stock weight, maturity, natural mortality and fishing mortality at age for a prediction with fishing mortality equal to the average for the period 2002-

2004 ($F_{5\text{-}10}$=0.63) are given in Table 3.34. This is comparable to the usual prediction input table (Table 3.28). The management option table for the Gadget prediction is given in Table 3.35.

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

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

3.10.4.1 Comments to the prognosis

The prognosis shows that fishing with F=0.63 in 2005 and 2006 will cause the total stock biomass to stabilize at about 1.1 million tonnes.

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 (2005) 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 yield 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. It was estimated that changing the fishing pattern to target older, larger, fish would produce a 20% increase in yield per recruit.

3.11 Other approaches to estimating current stock size

3.11.1 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 (WD19). The regression is done for ages 4-6 and 7 separately. The results, using a regression with intercept, are shown in the text table in Section 3.12. The table shows that the survey calibration method gives comparable trends to the XSA for ages 4-6, but for age 7+ the method shows a stronger decline from 2004 to 2005 compared to the XSA.

3.11.2 Time series analysis

Model description

In Aanes *et al*. (WD 25) a stochastic age structured model is presented and fitted to data for cod. The model fits in the state-space framework, i.e. the population is a hidden process where the signal (input data) from the process are uncertain due to sampling error and process error. Such models have increasingly appeared in the literature during the last decades, whereas examples of practical use can be found for demersal stocks in the North Sea and in Icelandic Waters under the name Time Series Analysis (TSA). The major difference in the model presented in WD 25 compared to the TSA models is that the natural mortality is explicitly modelled as a separate stochastic process, where the parameters are estimated. A brief description follows: The total mortality is split into fishing and natural mortality. The components of mortality are both modelled as stochastic processes: the mean fishing mortality is modelled as a separable model, where the effort follows a random walk. Deviation from separability is allowed since only the mean follows the separable model, with a variance that is estimated. The natural mortality follows a lognormal distribution, is independent from year to year, but correlated within year across all ages. The recruits at age 3 year and the abundance at age the first year are parameters (the initial values) and are estimated. Given the mortality rates and the initial values, the population is given by the process. The estimated catch at age is assumed to be independent identically lognormally distributed. Two components are estimated: one for the young fish (3-10 yrs) and one for the old fish (11-15yrs) since the precision for the oldest fish is lower due to low sample sizes and aging error. The survey indices are also assumed to be independent identically distributed lognormal, and the catchability is age-specific, not restricted by any functional form. The model is specified as a Bayesian model, and all parameters are given vague prior distributions. The parameters are estimated by Markov Chain Monte Carlo methods, i.e. sampling from the posterior distribution of the parameters. Therefore the entire distribution of the estimates is obtained and thus provides estimates of the uncertainty of both the abundances and the population parameters.

Results

The error coefficient of variation for the input data are estimated approximately to 27% for the estimates of catch at age ages 3-10, 103% for the estimates of catch at age ages 11-15, 38% for the catch per tow index (see WD 25) from the Norwegian survey in the Barents Sea, and 250% for the acoustic index from the survey in Lofoten. Due to the estimated low precision for the latter, it is given very low weight in the model fitting, and its influence on the other estimates is very small. In summary, the results are in agreement with the estimates provided by both XSA and Gadget: The temporal dynamics is similar, and the levels of the estimates are similar. The main difference is that the mean population size is estimated higher. This is mainly because the natural mortality is estimated higher (average 0.35). It should also be noticed that the temporal dynamics in the natural mortality is large, resulting in larger temporal fluctuations in the estimates of abundance. The annual estimates of the error coefficient of variation are between 20-35%. The model predicts the spawning stock abundance to decrease from 2004 to 2005.

3.12 Comparison of results of different approaches

The text table below shows a comparison between number at age 4-6 and 7+, respectively, for the different approaches.

METHOD	NUMBER AGE 4-6 1 JANUARY 2005	NUMBER AGE 7+ 1 JANUARY 2005
XSA	684	175
Gadget	517	129
Survey calibration - Pennington & Nakken (with intercept, adjusted numbers in brackets)	557(631)	121(110)
Time series analysis - Aanes	643	190

For the Pennington & Nakken method, the calibration using the data for the period 1981-1995 seems to give a bias. The numbers in brackets are corrected with the mean ratio for the years 1996-2004 of XSA 2005 number/calibration method number. It should be noted that the time series method estimates M at an average of 0.35, while the other methods are based on an M=0.2.

For age 4-6, the main difference between the XSA and Gadget is the estimate of the 2001 year class. The difference between the different methods is relatively larger for age 7+. Underestimation of these age groups in the XSA has also been a problem historically, see section 3.14.

3.13 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. in press*). 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 (Aglen, WD26). Since the ages are sampled stratified per length groups in this survey, it is not straight forward 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).

The error in the input data can also be estimated by fitting the data to models that explicitly model the error structure including parameters to be estimated (Aanes *et al*., WD 25). However, such estimates may be confounded with process error in addition to sampling error.

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.

3.14 Evaluation of harvest control rule

3.14.1 Introduction

The new harvest control rule was proposed by Mixed Norwegian-Russian Fisheries Commission (MRNC) for NEA cod and NEA haddock in November 2002.

ICES evaluated a harvest control rule for Northeast Arctic Cod in spring 2004. ICES regarded the harvest control rule to be consistent with the Precautionary Approach, provided adequate measures to ensure rebuilding of the stock in cases when SSB falls below B_{pa}. At the meeting of the Mixed Norwegian-Russian Fisheries Commission (MRNC) in October 2004 the harvest control rule was amended by including such pre-agreed measures for a rebuilding situation. ICES is requested to consider if this amendment is satisfactory with regard to the Precautionary Approach. ICES is further requested to give advice on levels of catch and effort for 2006 consistent with the agreed amended harvest control rule for North East Arctic Cod.

The amended harvest control rule (HCR) is as follows:

"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). "

3.14.2 Overview of previous work

At the 31st meeting of the Mixed Russian-Norwegian Fisheries Commission in November 2002, a harvest control rule for Northeast Arctic cod was suggested. The evaluation of this harvest control rule (hereafter called the MRNC-2002-rule) was carried out by AFWG in 2004 (ICES, 2004), and evaluated by ACFM that year. The MRNC-2002-rule did not describe how the TAC should be calculated if SSB < B_{pa}, and was thus incomplete. In 2004, AFWG explored several ways of determining the TAC if SSB < B_{pa}. Based on the MRNC-2002-rule, a complete HCR, describing how the TAC should be calculated at all SSB levels, was suggested by AFWG. AFWG evaluated this rule (hereafter called the AFWG-2004-rule) and found it to be precautionary. The 2004 AFWG report (ICES, 2004) also includes the evaluation by ACFM. ACFM stated that the AFWG-2004-rule is consistent with the precautionary approach. ACFM did, however, have a number of comments concerning the evaluation.

Since the amended HCR given above (hereafter called the MRNC-2004-rule) is not identical with the AFWG-2004-rule, a new evaluation is required. Here, we will evaluate the MRNC-2004-rule taking the comments made by ACFM in their 2004 evaluation of the AFWG-2004-rule and recommendations from SGMAS (ICES, 2005) into account. We will also utilize the work done on recovery strategies done by the Basic Document Working Group (BDWG, Bjordal *et al*. 2004) in September 2004.

3.14.3 General considerations for evaluation of harvest control rules

Evaluation of HCRs is usually done using simulation models for the population(s) in question. The scope, nature and quality standards of simulation models that may be used in order to evaluate HCRs are discussed e.g. by Skagen *et al*. (2003) and described by SGMAS (ICES, 2005). SGMAS (Section 4.4) also gives guidelines for evaluation of management strategies

Important issues for evaluation of harvest control rules are:

- Choice of population model
- Inclusion of uncertainty in population model

- Use of long-term and/or medium-term simulations
- Choice of initial values for simulations
- Choice of harvest control rules for use in the evaluation (constant F rules, how to reduce F when SSB<B_{pa} , limit on year-to-year variation in catch etc.)
- Performance measures for harvest control rules (yield, stock size, F, probability of SSB<B_{lim}, annual variation in catches etc.)

These issues are addressed below.

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

Two WDs addressed this issue: WD3 and WD14.

3.14.4.1 Long-term stochastic simulation (WD3)

3.14.4.1.1 Population model used

Bogstad *et al*. (2004a) used a biologically detailed population model for cod for use in the evaluation. In that model, recruitment is modelled using a segmented regression approach, as well as a periodic term and a term including the mean weight of spawning fish. Growth and maturation is modelled as density dependent, and cod cannibalism can also be included. Assessment error and uncertainty in the stock/recruitment relationship is included. Catch is implemented by first calculating the catch at age from the perceived stock using the fishing mortality derived from the harvest control rule and the given exploitation pattern. This catch at age is then applied to the actual stock. The general modelling approach taken is the same as described by Skagen *et al*. (2003).

The chosen population model was:

- Density-dependent weight at age in stock (average for 1946-2002 used for age groups where density-dependence was not found)
- Weight at age in catch is a function of weight at age in stock
- A spawning stock-recruitment model, including cyclic variation and uncertainty. (In 2004 the model also included an estimated relationship between mean weight in the spawning stock and the resulting recruitment.
- Time series (1946-2002) average used for maturation for age groups without density-dependent model
- Cannibalism not modelled directly because stock-recruitment relationship is based on a time series of spawning stock and recruitment (1946-present) where cannibalism is not included.
- Implementation of catch: First, the catch at age is calculated from the perceived stock using the fishing mortality derived from the harvest control rule and the given exploitation pattern. This catch at age is then applied to the actual stock.
- Exploitation pattern: 2000-2002 average used for all years.
- No uncertainty in weight at age, maturity-at-age or natural mortality at age

In 2004 a "reality check" of the model was made, with F_{5-10}=0.65, 50% maximum year-to-year-change in TAC and no assessment error. This F is equal to the average fishing mortality for the period 1946-2002. The stock sizes and catches from that simulation were somewhat above the historic average, but they do indicate that the model performs reasonably well at this level of fishing mortality. It should be noted that the historic exploitation pattern would give a lower yield than the present exploitation pattern, which is used in the simulations.

3.14.4.1.2 Software used

Considering various tools for evaluating harvest control rules mentioned by SGMAS in 2005 (ICES 2005), the simulations were carried out using the PROST software for stochastic projections (Åsnes, WD2). PROST was especially developed for this purpose because existing software for harvest control rule simulations such as WGMTERM, STPR and CS5 do not incorporate the 3-year averaging process (hereafter called the '3-year-average-rule') for setting TAC given by the agreed decision rule. However, PROST is intended as a general tool for stochastic projections.

3.14.4.1.3 Mathematical formulation of the MRNC-2004-rule

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

The rule can then be described in the following way:

If SSB(y) > B_{pa} then

if SSB(y-1) > B_{pa} and SSB(y+1) > B_{pa} and SSB(y+2) > B_{pa}

F(y) set by 3-year rule(0.40, 10)

else

F(y) set by 3-year rule(0.40, unconstrained)

else

F(y) set by 3-year rule ($0.40\frac{SSB(y)}{B_{pa}}$,unconstrained)

SSB(y+1) and SSB(y+2) in this calculation is derived using F=0.40 in years y and y+1.

For a fairly low fishing mortality such as F=0.40, SSB seldom falls below B_{pa}, and the difference between the MRNC-2004-rule and the AFWG-2004-rule should be very small. This was confirmed by making a run with the MRNC-2004-rule and the same settings as Run1 in the AFWG 2004 report. Those two runs gave almost identical results.

3.14.4.1.4 Changes in 2005 evaluation compared to 2004

In this evaluation, we will take into account the comments made by ACFM in 2004.

Thus, we make the following changes:

- Assessment and implementation error and bias are modelled explicitly as percentages of stock overestimation and level of overfishing.
- The assessment bias and error are modelled as age-dependent, with no correlation between age groups. The pattern used is based on an historical analysis. Two approaches were used to estimate the pattern. First, the bias in the number at age in the period 1987-2001 was calculated by comparing the estimated number at age in the year when the assessment was carried out, to the number at age from the 2004 assessment (Year-by-year method). The mean and standard deviation of this ratio was calculated for each age group. Second, the retrospective VPA-runs were compared to the assessment in 2004, to estimate the bias (Retrospective method). Data from 1990 to 2003 were used; the calculated relative bias and corresponding standard deviations were calculated. It was found that the results for the older age groups were somewhat noisy, and therefore, the values for age 9 was applied also for the older age groups,

including the +group. It was decided to apply for all age groups normal distributed errors around the mean values for the age group with the largest σ, truncated at ± 2.0σ. The two approaches are compared in the text table below:

METHOD	AGE	3	4	5	6	7	8	9	10	11	12	13
Year-by-year method	Bias	0.91	0.92	0.99	1.02	1.13	1.33	1.52	1.57	1.77	1.86	1.86
	St. dev	0.41	0.28	0.24	0.33	0.36	0.45	0.45	0.83	1.01	0.79	0.79
Retrospective method	Bias	0.94	0.96	1.00	1.03	1.15	1.21	1.30	1.30	1.30	1.30	1.30
	St. dev	0.43	0.20	0.21	0.19	0.31	0.40	0.62	0.62	0.62	0.62	0.62

Because the assessment methodology and settings have varied considerably during the period, it was decided to base the analysis on the estimated bias and variance from the retrospective runs. A bootstrap approach based on historical data would have been preferable, but due to time constraints, this could not be implemented.

- Implementation error and bias is modelled using the same percentage for all age groups. To explore the amount of bias and error to introduce, the relation between catch and quota for the period 1987-2003 was fitted to a normal distribution (Unreported catches were added to the catch statistics for the years 1990-1994 and 2002-2003) (Figure 3.16). The fit was considered acceptably good for the purpose and the estimated parameters were $\mu = 1.12$ and $\sigma = 0.20$. Thus, it was decided to include a bias of 12% with normally distributed error with a CV of 0.18 truncated at ± 2.0σ for all age groups.
- As mentioned under the paragraph "default model", the option of including an estimated relationship between mean weight in the spawning stock and the resulting recruitment in the recruitment model was turned off, since inspection of model diagnostics raised some doubt whether this option is biologically plausible when combined with the cyclic "Ockam" S/R relationship used.
- In addition, we tested the performance of the rule in a situation where stock rebuilding is needed. Two situations were simulated; one where the recruitment cycle was near its maximum during the years immediately following the start of the simulation (labelled "high recruitment" in tables 3.37-3.41), and one where the cycle was near its minimum (labelled "low recruitment" in tables 3.37-3.41). In both cases an increased natural mortality on the youngest age groups (M_3=0.7, M_4=0.4) was assumed.

Some issues explored last year are not addressed this year; they are only handled in the way described by the MRNC-2004-rule:

- % year- to year variation allowed
- How to reduce F when SSB(y) < B_{pa}

3.14.4.1.5 Long-term simulations

The various settings used in long-term simulations are described in the text table below, and the results of the simulations are described in Table 3.36.

Run No.	F	M ages 3 and 4 (High: 0.7& 0.4, Low: 0.2& 0.2)
1	0.40	Low
2	0.40	High

In both runs the realised F (when assessment and implementation errors have been taken into account) is around 0.6, but the total stock and the spawning stock are at a much higher level in run 1, and consequently the catches taken is also much higher in this simulation. SSB falls below B_{lim} in 0.00 and 0.11% of the years for run 1 and 2, respectively. The proportion of years the SSB is below B_{pa} is also low for run 1, while for run 2 this happens in almost half of the years.

3.14.4.1.6 Consequences of the rule in a period of recovery

In their 2004 evaluation of the harvest control rule (included in ICES, 2004), ACFM stated: *"... the plan needs to include pre-agreed measures to ensure rebuilding in cases when the SSB estimates fall below B_{pa}."* Such measures are included in the MRNC-2004-rule as well as in the AFWG-2004-rule. However, we consider that in order to evaluate consequences of such rebuilding measures, there is also need for medium term simulations of the NEA cod stock with initial stock levels below B_{pa}.

Medium-term simulations using the MRNC-2004-rule were carried out in order to explore this.

To study the performance of the rule in a stock recovery situation we made runs starting in 1985, when the total stock size was 957 000 tonnes and the SSB was 193 000 t, i.e. below B_{lim}. 1985 was chosen because it was a year with a fairly low stock size as well as a year when the stock was not dominated by a single year class. However, since we apply a cyclic recruitment function, and since the performance of the rule might be different in a situation where week or strong year classes enter the stock in the beginning of the period, we made runs covering both these situations. Technically, this was done by shifting the period of the cycle so that the start of the period either corresponded to a maximum or a minimum of the recruitment cycle.

For 1985, the weight at age in the stock and in the catch, maturity-at-age, natural mortality at age, fishing pattern and F were set to the same values as used in the assessment made by the ICES Arctic Fisheries Working Group in 2004.

For 1986 and later years, the following values were used:

Recruitment at age 3: For the recruitment in 1986 and later years, the stock-recruitment relationship from the evaluation of HCRs made by AFWG in 2004 was used.

Weight, maturity and natural mortality at age: the models used by AFWG in the 2004 HCR evaluation were used. This was done because these models were considered valid also at low stock size, since they were based on data from the entire time series, which contain several years with low stock abundance. The natural mortality for the two youngest age groups was set to 0.7 and 0.4, respectively, reflecting high cannibalism. This might seem unrealistic in a situation where the stock is at a low level and the recruitment level is low. However, this can be regarded as a worst-case scenario.

The fishing pattern was set equal to the 1985 pattern. Uncertainty in initial stock size and future stock assessments was included in the same way as in the long-term simulations described above. 2000 simulations were performed in each case.

The results of the simulations are given in Tables 3.37-3.41. The probability of SSB being above B_{lim} is very low for the first two years for both runs. However, from the third year and onwards, both runs gave 1.0 probability for this to happen. The probability for the SSB to be above B_{pa} is zero during the first two years, but then increases during the next three years. They are higher for the high-recruitment run, but vary somewhat with varying strength of the incoming year classes.

3.14.4.2 Stochastic simulations based on historical data (WD 14)

3.14.4.2.1 Model description

WD14 describes a stochastic simulation model, which is intended for testing and comparing various harvest control rules for the NEA cod stock. This model is an enhanced version of the model described earlier by Bulgakova (2003, 2004). The model is applied for the period 1980-2007, and weight-at-age, maturity at age, natural mortality at age and the exploitation pattern is taken from AFWG run for the cod in 2004. This allows for reducing the model output uncertainty and for testing model feasibility. The recruitment is described by a Ricker-type function, which depends on spawning biomass, the population fecundity index and on the index of inflow of

Atlantic waters, and the model parameters are updated in 2005. The recruitment model allows for 75% of uncertainty.

300 stochastic simulations are run in each case. The uncertainty in initial stock size and in the recruitment model is taken into consideration. The catch implementation uncertainty is included now in the following way. For each year TAC is estimated according to chosen HCR, then the random deviation applied to TAC gives the catch value for the same year and F_{rec} is calculated related to this catch.

To evaluate the area of possible differences between TAC and catch, the real data series of catch and TAC for 1987-2003 were analysed. The Frequency distribution of LN(Catch/TAC) is built (Figure 3.16). This distribution is built on 17 points and may be used only as preliminary one for simulation catch values. As the first step we assume this distribution of difference looks like a log-normal one and μ=0.0967, SE=0.186. The model allows testing of different harvest control rules.

3.14.4.2.2 Mathematical formulation of the harvest control rule

The new version of the harvest control rule approved by the 33rd meeting of the Mixed Norway Russian Fishery Commission is tested:

Let y be the year, which the TAC should be estimated for.

If SSB(y)<=Bpa, $F(y) = \frac{SSB(y) - B_{\lim}}{B_{pa} - B_{\lim}} Fpa$ (B_{lim}=0)

(F(y) is a linear function of SSB and is reduced to zero with SSB);

If SSB(y)>Bpa, F(y) is calculated by 3-years rule

if SSB<Bpa at least The new version of the harvest control rule approved by the 33rd meeting of the Mixed Norway in one of years (y-1), (y+1) or (y+2), catch variations do not restricted by Cvar% limit.

Else (if SSB>=Bpa in all consecutive years),this limit is used.

This new rule is denoted below as MRNC-5. Two cases are considered: Cvar=10% and Cvar=15%.

The performance measures for the different HCRs considered were:

- Average catch during the period
- Probability of SSB< 220 000 t or F > F_{lim}=0.74.
- Realised percentage of year-to-year changes in TAC

3.14.4.2.3 Results

The MRNC-5 scheme is considered precautionary for both Cvar values (10 and 15%) if the uncertainty in catch implementation is not incorporated. This rule is very close to the rule JRNC-3 considered in the 2004 WG report.

Introduction of the uncertainty in catches by the method described above makes this rule non-precautionary. When Cvar =15% taken, the confidence intervals became wider (Figure 3. 17) and the risk probability p(SSB<220000 t) in one of the years equals to 8%, risk in fishery mortality p(F>F_{lim}=0.74) reaches28% (Figure 3.18). When Cvar is set at 10% the risk increases.

Besides, when the confidence intervals of SSB and of catches are so wide, the problem of catch variation constraint becomes senseless.

In the same time the traditional precautionary ICES scheme after incorporation the noise in catches according to the same distribution was found to be precautionary for F=0.4 (risk SSB<B_{lim} is less than 0.5%) (Figure 3.19), but if F_{pa}=0.6 taken, the risk increases up to 2.5%.

3.14.4.3 Comparison of the approaches

The two approaches are quite different, since one (3.14.4.1) is based on long-term prognoses from a population model and the other (3.14.4.2) is based on the actual development of the stock from 1980 onwards. One problem with the latter is that it starts with the very strong 1975 year class in the stock, which could render the results not applicable in a general situation. In addition, assessment bias and uncertainty is not implemented in this model. The working group therefore, chose to base its conclusions on the long-term prognoses method presented in chapter 3.14.4.1.

3.14.4.4 Conclusions

The studies presented indicate that the amended HCR proposed by the Commission in 2004 (MRNC-2004-rule) is 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.

According to the simulations made, the amended HCR will help rebuild the stock to above B_{lim} level within three years, disregarding the recruitment situation in the starting year.

It should be noted that the conclusions drawn here is based on a risk level of 5%. They will hold also for higher risk levels. The risk level to use should be decided by managers. If lower risk levels than 5% is preferred, the harvest control rule should be evaluated against that level.

3.15 Answering 2004 ACFM comments:

The minutes of the review of the 2004 AFWG report contained a substantial number of comments to the NEA cod assessment. Below, we answer these comments and describe how they have been taken into account (*in italics*):

3.15.1 ACFM comments concerning the assessment:

“This is a benchmark assessment since the stock is on the observation list. The assessment was accepted. The review group appreciated that the WG came with estimates of unreported landings and investigated the effect of these on the assessment. However, the validity of the procedure used was questioned. The review group is of the opinion that such evaluation should be carried out within a statistical framework for instance AMCI which can be set up to estimate catches, also for the period 1990- 1994. It was noted that Flexibest estimates of catches in this period and later is higher than the reported catch.”

The changes in survey methodology in the period 1990-1994 makes survey-based estimates of catches in this period difficult. Gadget (Fleksibest) is a statistical framework which could be used to estimate unreported catches.

“If the underreporting only occurred in the years where estimates where available this causes no problems to the assessment. If underreporting also existed in preceding or intermediate years and no estimates are available, this may cause a serious problem to the assessment. It is noted that the assessment indicates a declining trend in F in recent years where the problems with the catch data are known to exist. The analyses of the individual surveys separately by SURBA come up with same signals with regard to recent trends in F and SSB and support the overall results of the XSA assessment. It is strongly recommended to try alternative assessment models on this stock.”

Several assessment approaches are tried for this stock (XSA, Gadget, two additional approaches)

"Comparison of tables 3.26 and 3.27 summary with or without cannibalism is confusing because cannibalism was not included in the whole time series presented. The effect of including cannibalism on the presented final results of the assessment is not presented clear. The WG is asked to demonstrate the change to the assessment of including cannibalism on the estimates of fishing mortality, SSB and recruitment."

The effect of including cannibalism in the assessment is discussed in WD9 (AFWG 2004), which was also included in last years' report. The conclusion was that it improves the assessment.

"Most of the cannibalism mortality takes place before the age of recruitment used in the assessment. It is recognised that survey estimates of age groups younger than the youngest age used in the assessment are affected and would have to be corrected for cannibalism before being used as predictors of recruitment."

No such corrections were applied this year. A consistent methodology for combining recruitment indices and cannibalism estimates in predictions of recruitment has not yet been established. Gadget may be able to provide such a methodology.

"The configuration of the XSA assessment includes the use of a power function (P-shrinkage) for ages less than 6 year old. The review group notes that the slopes and t-values etc. give no strong argument to include power function in assessment."

This comment has been addressed in Section 3.4.1. It was concluded that removing the power function for ages less than 6 gives a very bad retrospective pattern in the 1990s.

"Comparison of this years assessment with that of last year show that they are consistent. The differences are well explained by changes in previous years data and corrections for errors."

Does not require any action from the WG

"It was noted that there was a considerable decline in weight at age in the Norwegian survey for some age groups (eg age group 3). This was not evident in the Russian survey (compare tables A7 and A9)."

Does not require any action from the WG

"An output table of the predictions (over 3 years) was missing to justify the TAC which would have been set using the harvest control rule. Such a table was provided by the chair and is attached to the minutes."

Table 3.30 has now been expanded to take this into account.

"The results of Flexibest results were compared with those of XSA. There is a difference in the XSA and Flexibest SSB estimates for 2003, but this due to way maturity was modelled. The forecasts were compared as well (long discussion on this). It was noted that the yield forecast from Gadget is somewhat lower than XSA, particularly so for status quo forecast. However, the difference was lesser for F-values below Fpa. Also, in order to use this model for providing management advice, reference points would need to be recalculated. It would be difficult to extend Gadget to the time period when survey data are not available. The WG notes that such an extension will require assumptions about the selection pattern of the various fishing fleets backwards in time. The Review Group accepted XSA as the basis for the forecast."

Does not require any action from the WG

3.15.2 ACFM comments concerning HCR:

"The WG carried out an evaluation of the adopted harvest control rule for cod using a new simulation programme (PROST). The reviewers complimented the Working Group for this exercise. The chair of the WG was complemented for the clear presentation how the evaluation had been done. A lot of progress has been made in how to conduct such an evaluation. It would be helpful for similar exercises in the future that ICES provides a document with guidelines based on the experience from this group."

Does not require any action from the WG

"In the simulation, cyclic processes observed in recruitment, stock size dependent weight at age and maturation were modelled and compared to the observed trends. All observed and assumed relationships have been taken [into] account, including assessment uncertainty but not possible bias in assessment. Although the current assessment shows no retrospective bias presently, it was a big problem in the past it and it may occur in the future again e.g. in periods of large changes in the stock or fishery. It is recommended to test the robustness of the rule with respect to different levels of bias."

The WG made an evaluation of retrospective bias and uncertainty in the assessment, and have included both in the runs this year.

"It was noted that the present Fpa, in the way it was derived, takes into account the recent bias in the assessments, but bias may increase in the future for unknown reasons as has been observed in many other stocks."

See comment above.

"In principle the rule is incomplete because it does not specify how the reduction in TAC will be done when the stock falls below Bpa. In practice, while fishing at Fpa the occurrence of this situation in the simulations was less than 1% so it did not matter. While testing a number of assumed possible actions the rule for these actions would lead to a very low probability of SSB below Bpa in any year. The test runs assume either 1) that the fishing mortality will be reduced proportionally to zero when SSB is between Bpa and Blim or 2) that the TAC is set according to Fpa ignoring the 10% constraint on flexibility in TAC between successive years. Another assumption would be that the 10% constraint on the TAC would be maintained if SSB<Bpa. Such an option would likely be the default option when no agreement on the additional measures can be achieved."

The Norwegian Russian Fishery Commission in 2004 suggested an amended rule including actions to be taken when SSB falls below B_{pa}. This rule is complete and has been tested in the runs this year.

"The evaluation should have taken account for implementation error (non compliance with the management rules). Given the existence of underreporting at present, this is important."

The WG made an evaluation of the implementation error comparing agreed TAC with catches (including assumed unreported catches added by the WG) for a 17-year period. The implementation bias and uncertainty found in that analysis was included in the evaluation runs this year.

"It was noted that estimation of future recruitment in the model is different from common practice in the WG. The WG would estimate recruitment based on (survey) indices while the model estimates it from the S/R function. In most predictions a certain percentage of the catch contains of "assumed" recruitment, in other words recruitment estimated from a S/R function or mean. It would be relevant to demonstrate how much of the predicted catch in the 3 year rule is made up by 'assumed' year classes."

It is not clear to the WG what is meant by this comment. Since the evaluation is based on long-term simulations (e.g. 100 years) into the future, there is no other way of estimating recruitment than using the S/R function.

"It is not clear in Table 3.36 what the last 4 columns represent."

The heading row of table 3.36 was inadequate. This part of the table gave a synopsis of what parts of the rule decided TAC when the SSB was above B_{pa}, either the unmodified 3-year-rule, the rule preventing more than 10% increase of TAC from one year to the next, or the rule preventing more than 10% decrease of TAC from one year to the next. The last column gave the probability that SSB was below the B_{pa} in any of the three years determining the TAC in a given year.

"The output presents the results of the last 80 years of a simulation with rule over 100 years having already achieved an increase of the stock comparable with high historical observations. It would have been also interesting to see the results of the years immediate after the implementation of the rule because these would reflect the kind of action, which is required by managers in the recent medium term. This information was provided by the chairman of the WG and is attached to the minutes (see Appendix)."

Does not require any action from the WG.

"The rule has not been tested as a tool to rebuild the stock. Simulations of the rule would have to be done from a poor stock situation in order to do this. The rule is expected to bring the stock in a situation not observed historically and biological responses are extrapolated."

The rule has been tested in a rebuilding situation this year, based on the estimated stock size in a given year (1985) when the stock was at al low level (below B_{lim}), and taking into account the possibilities of either rich or poor recruitment in the years following.

"All simulations indicate that the risk of bringing the stock below Blim is very low. This would also have been expected when the PA reference points are chosen correctly. The probability of bringing the stock below Bpa is also low. This implies that the situations where other management decisions have to be taken are rare. In particular the omission of assuming bias in the assessment and implementation error (for instance by implementing an F of 20% or 40% higher than intended) should be further investigated before the rule can be considered in accordance with the Precautionary Approach. Also testing the performance of the HCR to rebuild the stock in poor situations should be further investigated."

See comments above.

"The rule was also tested with F=0.5 instead of F_{pa}(0.4). This leads to high probability of $SSB<B_{pa}$ (40%). The analyses support the choice of the value Fpa to be consisted with B_{pa}. The F =0.5 run can be considered as an implementation error or an assessment error of 20%. What really matters is that the stock does not drop below Blim."

See comments above.

Table 3.1a North-East Arctic COD. Total catch (t) by fishing
(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 [1]	177 888	219 261	92 296	90 000	579 445

[1] Provisional figures.

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

	Landings in '000 t	
Year	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
Average 1984-2004	49	28

*) No data

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

	Sub-area I		Division IIa		Division IIb	
Year	Trawl	Others	Trawl	Others	Trawl	Others
1967	238.0	84.8	38.7	90.0	121.1	-
1968	588.1	54.4	44.2	118.3	269.2	-
1969	633.5	45.9	119.7	135.9	262.3	-
1970	524.5	79.4	90.5	153.3	85.6	-
1971	253.1	59.4	74.5	245.1	56.9	-
1972	158.1	38.9	49.9	285.4	33.0	-
1973	459.0	33.7	39.4	172.4	88.2	-
1974	677.0	46.5	41.0	83.2	254.7	-
1975	526.3	35.4	33.7	86.6	147.4	-
1976	466.5	60.2	112.3	124.9	103.5	-
1977	471.5	66.7	100.9	156.2	110.0	-
1978	360.4	57.9	117.0	146.2	17.3	-
1979	161.5	33.7	114.9	120.5	8.1	-
1980	133.3	35.4	83.7	115.6	12.5	-
1981	91.5	45.1	77.2	167.9	17.2	-
1982	44.8	51.8	65.1	171.0	21.0	-
1983	36.6	28.2	56.6	143.7	24.9	-
1984	24.5	29.8	46.9	150.7	25.6	-
1985	72.4	40.2	60.7	112.8	21.5	-
1986	109.5	48.1	116.3	86.4	69.8	-
1987	126.3	19.8	167.9	77.5	129.9	1.7
1988	149.1	17.6	122.0	88.0	58.2	0.2
1989	144.4	19.5	68.9	81.2	19.1	0.1
1990	51.4	10.9	47.4	52.1	24.5	0.8
1991	58.9	12.1	73.0	84.0	40.0	1.2
1992	103.7	20.5	79.7	92.8	85.6	0.9
1993	165.1	30.7	155.5	113.9	66.3	0.2
1994	312.1	41.3	165.8	140.6	84.3	1.9
1995	218.1	33.3	174.3	143.3	160.3	10.7
1996	248.9	32.7	137.1	159.0	147.7	6.8
1997	235.6	37.7	150.5	176.2	154.7	7.6
1998	219.8	31.0	127.0	130.4	82.7	1.7
1999	133.3	25.7	101.9	115.0	107.2	1.8
2000	111.7	25.5	105.4	98.8	72.2	1.3
2001	119.1	23.5	83.1	102.8	95.4	2.5
2002	147.4	37.4	83.4	105.6	69.9	1.3
2003	146.0	17.1	107.8	114.2	50.1	1.8
2004 [1]	154.4	23.5	100.3	118.9	88.8	3.5

[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 [1]	19 226	3 621	8 196	6 187	212 117	11 285	14 004	201 525	7 201	6 082	489 445

[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

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			

Table 3.4 (continued)

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	19.20
2003	0.22	0.44	1.04	1.71	2.31	3.27	4.93	6.17	7.77	9.61	9.99	12.29	13.59	
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

[1] Division IIa only
[2] IIa and IIb combined

Spain (Division IIb)

Year	Age													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994	0.43	1.08	1.38	2.32	2.47	2.68	3.46	5.20	7.04	6.79	7.20	8.04	10.46	15.35
1995	0.42	0.51	0.98	1.99	3.41	4.95	5.52	8.62	9.21	11.42	9.78	8.08		
1996		0.66	1.12	1.57	2.43	3.17	3.59	4.44	5.48	6.79	8.10			
1997 [1]	0.51	0.65	1.22	1.68	2.60	3.39	4.27	6.67	7.88	11.34	13.33	10.03	8.69	
1998	0.47	0.74	1.15	1.82	2.44	3.32	3.71	5.00	7.26					
1999 [1]	0.21	0.69	1.06	1.69	2.50	3.32	4.72	5.76	6.77	7.24	7.63			
2000 [1]	0.23	0.61	1.24	1.75	2.47	3.12	4.65	6.06	7.66	10.94	11.40	7.20		
2001	0.23	0.64	1.25	1.95	2.86	3.55	4.95	6.46	8.50	11.07	13.09			
2002	0.16	0.55	1.00	1.48	2.17	3.29	4.47	5.35	8.29	12.23	9.01	12.16	15.23	
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		

[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	10.17	10.08		
1996 [2]			1.55	1.81	2.42	3.61	6.30	6.47	7.83	7.91	8.93	9.38	10.91	
1997 [2]			1.93	2.17	3.07	4.17	4.89	6.46		12.27	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

Norway

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1985	-	1	9	38	51	85	100	79
1986	3	7	8	19	50	67	36	80
1987	-	0	4	12	16	31	19	-
1988	-	2	6	41	54	45	100	100
1989	-	1	8	21	43	79	87	100
1990	-	1	4	22	68	93	91	100
1991	-	5	12	34	65	84	99	100
1992	-	1	16	55	77	94	100	100
1993	-	3	12	40	66	94	98	99
1994	-	1	14	36	64	79	98	100
1995	-	1	9	43	63	73	96	98
1996	-	-	2	30	70	84	100	100
1997	-	-	2	17	64	92	100	89
1998	-	1	6	23	40	77	90	100
1999	-	-	-	11	52	83	83	100
2000	-	-	6	26	76	83	99	100
2001	-	1	7	39	53	64	100	100
2002	-	1	5	46	71	89	97	100
2003	0	0	9	44	60	86	90	100
2004	0	0	11	47	80	92	99	100
2005	0	0	9	49	82	95	99	100

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

```
NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,
9,20,2             (No. of surveys, No. of years, VPA Column No.),,
1985,   205,   6,    2,   4,    -11,     -11,     -11,  -11,    -11,   -11
1986,   173,   1,    1,   3,    -11,     -11,     -11,  -11,    -11,   -11
1987,   243,   1,    1,   1,    -11,     -11,     -11,  -11,    -11,   -11
1988,   412,   1,    1,   4,    -11,     -11,     -11,  -11,    -11,   -11
1989,   721,   1,    3,   8,    -11,     -11,     -11,  -11,    -11,   -11
1990,   896,   4,    4,  44,    -11,     -11,     -11,  -11,    -11,   -11
1991,   811,   4,    8,  15,    -11,     -11,     -11   -11,  296.5, 349.8
1992,   660,  32,    3,  13,    -11,     -11,   535.8, 577.2, 274.6, 166.2
1993,   439,   3,    4,   6, 1035.9,   858.3,   541.5, 292.9, 170.0,  92.9
1994,   720,  12,    8,  10, 5253.1,  2619.2,   707.6, 339.8, 238.0, 188.3
1995,   843,  30,   13,  26, 5768.5,  2396.0,  1045.1, 430.5, 396.0, 427.7
1996,   569,  10,    7,  27, 4815.5,  1623.5,   643.7, 632.9, 211.8, 150.0
1997,   623,  16,    6,  18, 2418.5,  3401.3,   340.1, 304.3, 235.2, 245.1
1998,   546,   2,    4,  12,  484.6,   358.3,   248.3, 221.4, 191.1, 138.2
1999,   430,   1,    1,  13,  128.8,   154.1,    76.6,  63.9,  88.3,  69.3
2000,   546,   6,    7,  20,  657.9,   629.9,   443.9, 215.1, 377.0, 303.4
2001,   430,   2,    1,   3,   35.3,    18.2,    79.1,  61.5,  76.6,  33.6
2002,   -11,  14,    5,  10, 2991.7,  1693.9,   235.4, 105.2, 246.9, 123.9
2003,   -11,   8,    2, -11,  328.5,   157.6,   224.6, 119.6,    -11,   -11
2004,   -11,  16,  -11, -11,  824.3,   465.3,     -11,   -11,    -11,   -11
R-0      Russian Bottom trawl survey, area I+IIb,   age 0
R-1      Russian Bottom trawl survey, area I+IIb,   age 1
R-2      Russian Bottom trawl survey, area I+IIb,   age 2
N-BST1     Norwegian Barents Sea, Bottom trawl survey, age 1
N-BSA1     Norwegian Barents Sea Acoustic survey age 1
N-BST2     Norwegian Barents Sea, Bottom trawl survey, age 2
N-BSA2     Norwegian Barents Sea Acoustic survey age 2
N-BST3     Norwegian Barents Sea, Bottom trawl survey, age 3
N-BSA3     Norwegian Barents Sea Acoustic survey age 3
```

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

Analysis by RCT3 ver3.1 of data from file :
rec2005.txt

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

Data for 9 surveys over 20 years : 1985 - 2004

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 = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
R-0	1.05	4.33	1.01	.239	12	2.83	7.30	1.228	.007
R-1	1.10	4.51	.51	.559	12	1.95	6.65	.596	.030
R-2	.74	4.50	.41	.661	12	2.94	6.67	.482	.046
N-BST1	.40	3.17	.20	.757	4	7.79	6.29	.321	.104
N-BSA1	.59	2.02	.12	.892	4	8.13	6.84	.234	.196
N-BST2	1.18	-1.24	.24	.592	5	5.83	5.64	.514	.041
N-BSA2	3.05	-12.10	1.13	.060	5	5.72	5.36	1.789	.003
N-BST3	.92	1.42	.12	.836	6	5.46	6.42	.162	.268
N-BSA3	.46	4.05	.10	.889	6	5.51	6.58	.130	.268
					VPA Mean =		6.27	.538	.037

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
R-0	.97	4.39	.93	.244	13	1.10	5.46	1.103	.011
R-1	1.07	4.53	.47	.554	13	1.61	6.26	.546	.045
R-2	.72	4.52	.38	.654	13	2.56	6.37	.442	.069
N-BST1	.40	3.19	.18	.716	5	6.19	5.67	.398	.085
N-BSA1	.60	1.91	.23	.595	5	5.88	5.42	.590	.039
N-BST2	1.13	-.82	.40	.275	6	5.52	5.45	.753	.024
N-BSA2	2.95	-11.30	1.06	.052	6	5.40	4.64	1.784	.004
N-BST3	.91	1.45	.11	.837	7	5.26	6.23	.148	.335
N-BSA3	.47	3.97	.11	.837	7	4.94	6.29	.144	.335
					VPA Mean =		6.30	.500	.054

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction				---------I
R-0	.93	4.53	.88	.230	14	.69	5.17	1.075	.012
R-1	1.05	4.56	.44	.543	14	.69	5.29	.566	.044
R-2	.71	4.54	.36	.644	14	2.64	6.41	.411	.083
N-BST1	.31	3.98	.25	.503	6	4.87	5.51	.520	.052
N-BSA1	.43	3.29	.32	.386	6	5.04	5.45	.634	.035
N-BST2	.80	1.41	.35	.297	7	4.35	4.89	.829	.020
N-BSA2	1.65	-3.38	.65	.110	7	4.17	3.52	1.699	.005
N-BST3	.88	1.64	.10	.849	8	4.49	5.58	.206	.330
N-BSA3	.47	3.99	.10	.849	8	4.25	5.98	.152	.351
					VPA Mean =		6.32	.457	.067

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.80	4.85	.75	.259	15	1.95	6.39	.858	.012
R-1	.93	4.81	.43	.519	15	2.08	6.75	.499	.037
R-2	.73	4.45	.36	.596	15	3.04	6.68	.425	.051
N-BST1	.21	4.81	.20	.640	7	6.49	6.18	.264	.132
N-BSA1	.28	4.42	.23	.569	7	6.45	6.22	.303	.100
N-BST2	.40	4.00	.25	.512	8	6.10	6.41	.304	.099
N-BSA2	.52	3.43	.32	.386	8	5.38	6.21	.397	.058
N-BST3	.63	3.02	.13	.809	9	5.93	6.76	.167	.229
N-BSA3	.44	4.16	.09	.895	9	5.72	6.65	.113	.229
					VPA Mean =		6.32	.422	.052

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.73	4.96	.65	.269	16	1.10	5.76	.766	.024
R-1	.90	4.83	.41	.484	16	.69	5.45	.518	.053
R-2	.74	4.40	.36	.544	16	1.39	5.42	.467	.065
N-BST1	.21	4.87	.19	.638	8	3.59	5.61	.316	.143
N-BSA1	.27	4.47	.21	.574	8	2.95	5.28	.430	.077
N-BST2	.40	3.98	.23	.505	9	4.38	5.72	.347	.119
N-BSA2	.50	3.53	.29	.399	9	4.14	5.61	.437	.075
N-BST3	.69	2.63	.22	.558	10	4.35	5.65	.331	.130
N-BSA3	.47	3.94	.16	.704	10	3.54	5.61	.260	.212
					VPA Mean =		6.34	.378	.100

Yearclass = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.62	5.17	.53	.315	17	2.71	6.86	.624	.019
R-1	.76	5.10	.36	.499	17	1.79	6.46	.413	.044
R-2	.65	4.65	.35	.515	17	2.40	6.22	.399	.048
N-BST1	.16	5.24	.18	.669	9	8.00	6.52	.218	.159
N-BSA1	.18	5.15	.22	.572	9	7.44	6.51	.266	.106
N-BST2	.32	4.45	.20	.605	10	5.47	6.22	.235	.137
N-BSA2	.39	4.22	.23	.519	10	4.67	6.02	.292	.088
N-BST3	.55	3.42	.19	.633	11	5.51	6.47	.228	.145
N-BSA3	.37	4.49	.16	.712	11	4.83	6.28	.190	.189
					VPA Mean =		6.33	.343	.064

Yearclass = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.55	5.32	.46	.347	17	2.20	6.52	.528	.041
R-1	.68	5.22	.32	.511	17	1.10	5.97	.387	.077
R-2									
N-BST1	.16	5.26	.17	.675	9	5.80	6.17	.214	.251
N-BSA1	.18	5.18	.21	.579	9	5.07	6.08	.269	.160
N-BST2	.32	4.49	.19	.615	10	5.42	6.21	.232	.213
N-BSA2	.38	4.26	.23	.528	10	4.79	6.08	.285	.142
N-BST3									
N-BSA3									
					VPA Mean =		6.34	.315	.116

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.47	5.46	.38	.392	17	2.83	6.79	.466	.084
R-1									
R-2									
N-BST1	.15	5.28	.17	.682	9	6.72	6.32	.209	.419
N-BSA1	.17	5.21	.21	.587	9	6.14	6.28	.257	.276
N-BST2									
N-BSA2									
N-BST3									
N-BSA3									
					VPA Mean =		6.35	.288	.221

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	675	6.52	.10	.09	.77	624	6.44
1998	470	6.15	.12	.09	.67	546	6.30
1999	326	5.79	.12	.13	1.14	431	6.07
2000	670	6.51	.10	.08	.65	546	6.30
2001	286	5.66	.12	.09	.51	431	6.07
2002	576	6.36	.09	.06	.42		
2003	478	6.17	.11	.05	.20		
2004	574	6.35	.14	.08	.33		

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	7	174	1980	36094	48054	64832	48541	17505	6079	1700	286	124	38	16	8

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	144	0	0	0	0	0
1990	0	126	28	0	0	0	0
1991	123	153	215	2	0	0	0
1992	4305	1029	155	4	0	0	0
1993	3833	20305	513	52	1	0	0
1994	8344	6949	647	134	54	8	0
1995	8327	15406	759	253	87	4	0
1996	9939	21772	1503	143	56	20	1
1997	2949	16012	1874	177	17	1	0
1998	80	4853	535	210	25	2	1
1999	596	1848	302	54	5	0	0
2000	1715	2288	173	37	14	4	0
2001	92	2331	115	24	12	2	1
2002	7233	515	455	43	6	1	0
2003	5158	4354	110	24	0	0	0
2004	3039	3704	246	10	6	0	0

Table 3.10 Catch numbers at age

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

At 26/04/2005 10:40

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

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

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

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	3902,	10614,	17321,	31219,	32308,	37882,	45478,	42416,	13196,	5298,
4,	37652,	24172,	33931,	133576,	77942,	97865,	132655,	170566,	106984,	45912,
5,	201834,	129803,	27182,	71051,	148285,	64222,	123458,	167241,	205549,	97950,
6,	161336,	250472,	70702,	40737,	53480,	67425,	51167,	89460,	95498,	58575,
7,	84031,	86784,	87033,	38380,	18498,	23117,	38740,	28297,	35518,	19642,
8,	30451,	51091,	39213,	35786,	17735,	8429,	17376,	21996,	16221,	9162,
9,	13713,	14987,	17747,	13338,	23118,	7240,	5791,	7956,	11894,	6196,
10,	9481,	7465,	6219,	10475,	9483,	11675,	6778,	2728,	3884,	3553,
11,	4140,	3952,	3232,	3289,	3748,	4504,	5560,	2603,	1021,	783,
12,	2406,	1655,	1220,	1070,	997,	1843,	1682,	1647,	1025,	172,
+gp,	1350,	1906,	819,	433,	513,	682,	1298,	775,	784,	782,
0 TOTALNUM,	550296,	582901,	304619,	379354,	386107,	324884,	429983,	535685,	491574,	248025,
TONSLAND,	1147841,	1343068,	792557,	769313,	744607,	622042,	783221,	909266,	776337,	437695,
SOPCOF %,	106,	105,	100,	112,	93,	104,	110,	124,	102,	103,

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

At 26/04/2005 10:40

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	15725,	55937,	34467,	3709,	2307,	7164,	7754,	35536,	294262,	91855,
4,	25999,	55644,	160048,	174585,	24545,	10792,	13739,	45431,	131493,	437377,
5,	78299,	34676,	69235,	267961,	238511,	25813,	11831,	26832,	61000,	203772,
6,	68511,	42539,	22061,	107051,	181239,	137829,	9527,	12089,	20569,	47006,
7,	25444,	37169,	26295,	26701,	79363,	96420,	59290,	7918,	7248,	12630,
8,	8438,	18500,	25139,	16399,	26989,	31920,	52003,	34885,	8328,	4370,
9,	3569,	5077,	11323,	11597,	13463,	8933,	12093,	22315,	19130,	2523,
10,	1467,	1495,	2329,	3657,	5092,	3249,	2434,	4572,	4499,	5607,
11,	1161,	380,	687,	657,	1913,	1232,	762,	1215,	677,	2127,
12,	131,	403,	316,	122,	414,	260,	418,	353,	195,	322,
+gp,	337,	156,	279,	240,	190,	180,	216,	476,	195,	296,
0 TOTALNUM,	229081,	251976,	352179,	612679,	574026,	323792,	170067,	191622,	547596,	807885,
TONSLAND,	444930,	483711,	572605,	1074084,	1197226,	933246,	689048,	565254,	792685,	1102433,
SOPCOF %,	129,	123,	109,	108,	105,	112,	124,	118,	130,	137,

Table 3.10 (continued)

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	45282,	85337,	39594,	78822,	8600,	3911,	3407,	8948,	3108,	6942,
4,	59798,	114341,	168609,	45400,	77484,	17086,	9466,	20933,	19594,	14240,
5,	226646,	79993,	136335,	88495,	43677,	81986,	20803,	19345,	20473,	18807,
6,	118567,	118236,	52925,	56823,	31943,	40061,	63433,	28084,	17656,	20086,
7,	29522,	47872,	61821,	25407,	16815,	17664,	21788,	42496,	17004,	15145,
8,	9353,	13962,	23338,	31821,	8274,	7442,	9933,	8395,	18329,	8287,
9,	2617,	4051,	5659,	9408,	10974,	3508,	4267,	2878,	2545,	5988,
10,	1555,	936,	1521,	1227,	1785,	3196,	1311,	708,	646,	783,
11,	1928,	558,	610,	913,	427,	678,	882,	271,	229,	232,
12,	575,	442,	271,	446,	103,	79,	109,	260,	74,	153,
+gp,	283,	218,	268,	847,	142,	58,	41,	37,	83,	69,
0 TOTALNUM,	496126,	465946,	490951,	339609,	200224,	175669,	135440,	132355,	99741,	90732,
TONSLAND,	829377,	867463,	905301,	698715,	440538,	380434,	399038,	363730,	289992,	277651,
SOPCOF %,	115,	127,	107,	109,	121,	127,	118,	125,	90,	95,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	24634,	28968,	13648,	9828,	5085,	1911,	4963,	21835,	10094,	6531,
4,	45769,	70993,	137106,	22774,	17313,	7551,	10933,	36015,	46182,	59444,
5,	27806,	78672,	98210,	135347,	32165,	12999,	16467,	27494,	63578,	102548,
6,	19418,	25215,	61407,	54379,	81756,	17827,	20342,	23392,	33623,	59766,
7,	11369,	11711,	13707,	21015,	27854,	30007,	19479,	18351,	14866,	32504,
8,	3747,	4063,	3866,	3304,	5501,	6810,	25193,	13541,	9449,	10019,
9,	1557,	976,	910,	1236,	827,	828,	3888,	18321,	6571,	6163,
10,	768,	726,	455,	519,	290,	179,	428,	2529,	12593,	3671,
11,	137,	557,	187,	106,	41,	59,	48,	264,	1749,	7528,
12,	36,	136,	227,	69,	13,	15,	12,	82,	377,	995,
+gp,	71,	76,	100,	62,	28,	13,	4,	13,	86,	144,
0 TOTALNUM,	135312,	222093,	329823,	248639,	170873,	78199,	101757,	161837,	199168,	289313,
TONSLAND,	307920,	430113,	523071,	434939,	332481,	212000,	319158,	513234,	581611,	771086,
SOPCOF %,	102,	102,	102,	100,	99,	101,	95,	103,	101,	101,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	4879,	7655,	12827,	31887,	7501,	4701,	5044,	2348,	7263,	1980,
4,	42587,	28782,	36491,	88874,	77714,	33094,	35019,	31033,	20885,	36094,
5,	115329,	80711,	69633,	48972,	92816,	93044,	62139,	76175,	64447,	48054,
6,	98485,	100509,	83017,	40493,	31139,	47210,	62456,	67656,	71109,	64832,
7,	32036,	54590,	65768,	34513,	15778,	12671,	22794,	42122,	36706,	48541,
8,	7334,	10545,	28392,	26354,	15851,	6677,	5266,	11527,	14002,	17505,
9,	3014,	2023,	4651,	6583,	8828,	4787,	1773,	1801,	2887,	6079,
10,	1725,	930,	1151,	965,	1837,	1647,	1163,	529,	492,	1700,
11,	1174,	462,	373,	197,	195,	321,	343,	223,	142,	286,
12,	1920,	230,	213,	69,	40,	71,	85,	120,	97,	138,
+gp,	264,	894,	383,	117,	72,	26,	35,	36,	65,	62,
0 TOTALNUM,	308747,	287331,	302899,	279024,	251771,	204249,	196117,	233570,	218095,	225271,
TONSLAND,	739999,	732228,	762403,	592624,	484910,	414868,	426471,	535045,	551990,	579445,
SOPCOF %,	100,	101,	100,	101,	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 26/04/2005 10:40

Table 2 Catch weights at age (kg)

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,	1953,	1954,
AGE									
3,	.3500,	.3200,	.3400,	.3700,	.3900,	.4000,	.4400,	.4000,	.4400,
4,	.5900,	.5600,	.5300,	.6700,	.6400,	.8300,	.8000,	.7600,	.7700,
5,	1.1100,	.9500,	1.2600,	1.1100,	1.2900,	1.3900,	1.3300,	1.2800,	1.2600,
6,	1.6900,	1.5000,	1.9300,	1.6600,	1.7000,	1.8800,	1.9200,	1.9300,	1.9700,
7,	2.3700,	2.1400,	2.4600,	2.5000,	2.3600,	2.5400,	2.6400,	2.8100,	3.0300,
8,	3.1700,	2.9200,	3.3600,	3.2300,	3.4800,	3.4600,	3.7100,	3.7200,	4.3300,
9,	3.9800,	3.6500,	4.2200,	4.0700,	4.5200,	4.8800,	5.0600,	5.0600,	5.4000,
10,	5.0500,	4.5600,	5.3100,	5.2700,	5.6200,	5.2000,	6.0500,	6.3400,	6.7500,
11,	5.9200,	5.8400,	5.9200,	5.9900,	6.4000,	7.1400,	7.4200,	7.4000,	7.7900,
12,	7.2000,	7.4200,	7.0900,	7.0800,	7.9600,	8.2200,	8.4300,	8.6700,	10.6700,
+gp,	8.1460,	8.8480,	8.4300,	8.2180,	8.8910,	9.3890,	10.1850,	10.2380,	9.6800,
0 SOPCOFAC,	1.0300,	.9143,	.8915,	.9920,	1.0880,	1.1483,	.9348,	1.0485,	.9294,

Table 2 Catch weights at age (kg)

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	.3200,	.3300,	.3300,	.3400,	.3500,	.3400,	.3100,	.3200,	.3200,	.3300,
4,	.5700,	.5800,	.5900,	.5200,	.7200,	.5100,	.5500,	.5500,	.6100,	.5500,
5,	1.1300,	1.0700,	1.0200,	.9500,	1.4700,	1.0900,	1.0500,	.9300,	.9600,	.9500,
6,	1.7300,	1.8300,	1.8200,	1.9200,	2.6800,	2.1300,	2.2000,	1.7000,	1.7300,	1.8600,
7,	2.7500,	2.8900,	2.8900,	2.9400,	3.5900,	3.3800,	3.2300,	3.0300,	3.0400,	3.2500,
8,	3.9400,	4.2500,	4.2800,	4.2100,	4.3200,	4.8700,	5.1100,	5.0300,	4.9600,	4.9700,
9,	4.9000,	5.5500,	5.4900,	5.6100,	5.4500,	6.1200,	6.1500,	6.5500,	6.4400,	6.4100,
10,	7.0400,	7.2800,	7.5100,	7.3500,	6.4400,	8.4900,	8.1500,	7.7000,	7.9100,	8.0700,
11,	7.2000,	8.0000,	8.2400,	8.6700,	7.1700,	7.7900,	8.6800,	9.2700,	9.6200,	9.3400,
12,	8.7800,	8.3500,	9.2500,	9.5800,	8.6300,	8.3000,	9.6000,	10.5600,	11.3100,	10.1600,
+gp,	10.0770,	9.9440,	10.6050,	11.6310,	11.6210,	11.4220,	11.9520,	12.7170,	12.7370,	12.8860,
0 SOPCOFAC,	1.0634,	1.0455,	1.0004,	1.1232,	.9305,	1.0416,	1.0970,	1.2356,	1.0226,	1.0277,

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

At 26/04/2005 10:40

Table 2 Catch weights at age (kg)

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	.3800,	.4400,	.2900,	.3300,	.4400,	.3700,	.4500,	.3800,	.3800,	.3200,
4,	.6800,	.7400,	.8100,	.7000,	.7900,	.9100,	.8800,	.7700,	.9100,	.6600,
5,	1.0300,	1.1800,	1.3500,	1.4800,	1.2300,	1.3400,	1.3800,	1.4300,	1.5400,	1.1700,
6,	1.4900,	1.7800,	2.0400,	2.1200,	2.0300,	2.0000,	2.1600,	2.1200,	2.2600,	2.2200,
7,	2.4100,	2.4600,	2.8100,	3.1400,	2.9000,	3.0000,	3.0700,	3.2300,	3.2900,	3.2100,
8,	3.5200,	3.8200,	3.4800,	4.2100,	3.8100,	4.1500,	4.2200,	4.3800,	4.6100,	4.3900,
9,	5.7300,	5.3600,	4.8900,	5.2700,	5.0200,	5.5900,	5.8100,	5.8300,	6.5700,	5.5200,
10,	7.5400,	7.2700,	7.1100,	6.6500,	6.4300,	7.6000,	7.1300,	7.6200,	8.3700,	7.8600,
11,	8.4700,	8.6300,	9.0300,	9.0100,	8.3300,	8.9700,	8.6200,	9.5200,	10.5400,	9.8200,
12,	11.1700,	10.6600,	10.5900,	9.6600,	10.7100,	10.9900,	10.8300,	12.0900,	11.6200,	11.4100,
+gp,	13.7220,	14.1480,	13.8290,	14.8480,	14.2110,	14.0740,	12.9450,	13.6730,	13.9040,	13.2420,
0 SOPCOFAC,	1.2903,	1.2327,	1.0911,	1.0785,	1.0520,	1.1170,	1.2405,	1.1822,	1.3003,	1.3660,

Table 3.11 Catch weights at age (continued)

Table 2 Catch weights at age (kg)

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	.4100,	.3500,	.4900,	.4900,	.3500,	.2700,	.4900,	.3700,	.8400,	1.4200,
4,	.6400,	.7300,	.9000,	.8100,	.7000,	.5600,	.9800,	.6600,	1.3700,	1.9300,
5,	1.1100,	1.1900,	1.4300,	1.4500,	1.2400,	1.0200,	1.4400,	1.3500,	2.0900,	2.4900,
6,	1.9000,	2.0100,	2.0500,	2.1500,	2.1400,	1.7200,	2.0900,	1.9900,	2.8600,	3.1400,
7,	2.9500,	2.7600,	3.3000,	3.0400,	3.1500,	3.0200,	2.9800,	2.9300,	3.9900,	3.9100,
8,	4.3700,	4.2200,	4.5600,	4.4600,	4.2900,	4.2000,	4.8500,	4.2400,	5.5800,	4.9100,
9,	5.7400,	5.8800,	6.4600,	6.5400,	6.5800,	5.8400,	6.5700,	6.4600,	7.7700,	6.0200,
10,	8.7700,	9.3000,	8.6300,	7.9800,	8.6100,	7.2600,	9.1600,	8.5100,	9.2900,	7.4000,
11,	9.9200,	10.2800,	9.9300,	10.1500,	9.2200,	8.8400,	10.8200,	12.2400,	11.5500,	8.1300,
12,	11.8100,	11.8600,	10.9000,	10.8500,	10.8900,	9.2800,	10.7700,	10.7800,	16.2000,	8.5700,
+gp,	13.1070,	13.5440,	13.6680,	13.1770,	14.3440,	14.4480,	13.9320,	14.0410,	17.0340,	8.6090,
0 SOPCOFAC,	1.1520,	1.2688,	1.0683,	1.0890,	1.2139,	1.2723,	1.1809,	1.2521,	.8953,	.9483,

Table 2 Catch weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	.9400,	.6400,	.4900,	.5400,	.7400,	.8100,	1.0500,	1.1600,	.8100,	.8200,
4,	1.3700,	1.2700,	.8800,	.8500,	.9600,	1.2200,	1.4500,	1.5700,	1.5200,	1.3000,
5,	2.0200,	1.8800,	1.5500,	1.3200,	1.3100,	1.6400,	2.1500,	2.2100,	2.1600,	2.0600,
6,	3.2200,	2.7900,	2.3300,	2.2400,	1.9200,	2.2200,	2.8900,	3.1000,	2.7900,	2.8900,
7,	4.6300,	4.4900,	3.4400,	3.5200,	2.9300,	3.2400,	3.7500,	4.2700,	4.0700,	3.2100,
8,	6.0400,	5.8400,	5.9200,	5.3500,	4.6400,	4.6800,	4.7100,	5.1900,	5.5300,	5.2000,
9,	7.6600,	6.8300,	8.6000,	8.0600,	7.5200,	7.3000,	6.0800,	6.1400,	6.4700,	6.8000,
10,	9.8100,	7.6900,	9.6000,	9.5100,	9.1200,	9.8400,	8.8200,	7.7700,	7.1900,	7.5700,
11,	11.8000,	9.8100,	12.1700,	11.3600,	11.0800,	13.2500,	11.8000,	10.1200,	7.9800,	8.0100,
12,	14.1600,	10.7100,	13.7200,	14.0900,	11.4700,	16.8800,	16.5800,	11.5400,	10.1100,	9.4800,
+gp,	14.0080,	12.0510,	13.3800,	16.7060,	16.4840,	11.6170,	16.6900,	14.3320,	14.1830,	11.9780,
0 SOPCOFAC,	1.0182,	1.0160,	1.0224,	1.0001,	.9879,	1.0108,	.9521,	1.0270,	1.0127,	1.0090,

Table 2 Catch weights at age (kg)

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	.7700,	.7900,	.6700,	.6800,	.6300,	.5720,	.6600,	.7230,	.6720,	.7220,
4,	1.2000,	1.1100,	1.0400,	1.0500,	1.0100,	1.0360,	1.0500,	1.1330,	1.1190,	1.1310,
5,	1.7800,	1.6100,	1.5300,	1.6200,	1.5400,	1.6090,	1.6200,	1.5600,	1.8270,	1.6090,
6,	2.5900,	2.4600,	2.2200,	2.3000,	2.3400,	2.3440,	2.5100,	2.3060,	2.4990,	2.4320,
7,	3.8100,	3.8200,	3.4200,	3.3000,	3.2100,	3.3410,	3.5100,	3.5200,	3.5750,	3.2780,
8,	4.9900,	5.7200,	5.2000,	4.8600,	4.2900,	4.4760,	4.7800,	4.7840,	5.0390,	4.7290,
9,	6.2300,	6.7400,	7.1900,	6.8700,	6.0000,	5.7240,	6.0400,	6.2000,	6.3550,	6.7160,
10,	8.0500,	8.0400,	7.7300,	9.3000,	6.7300,	7.5230,	7.5400,	7.6590,	8.1960,	7.9870,
11,	8.7400,	9.2800,	8.6100,	10.3000,	10.0800,	8.0210,	9.0000,	9.1400,	10.7110,	9.1810,
12,	9.2200,	10.4000,	11.0700,	15.0500,	13.8800,	12.4780,	10.4800,	8.1970,	11.9580,	12.0280,
+gp,	12.3190,	10.9660,	11.1170,	14.5240,	14.0360,	17.2410,	16.1800,	10.3250,	10.6570,	13.9660,
0 SOPCOFAC,	1.0030,	1.0147,	1.0004,	1.0072,	.9967,	1.0039,	.9994,	1.0025,	1.0014,	1.0013,

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Table 3.12. Stock weights at age

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

At 26/04/2005 10:40

Table 3 Stock weights at age (kg)

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,	1953,	1954,
AGE									
3,	.3500,	.3200,	.3400,	.3700,	.3900,	.4000,	.4400,	.4000,	.4400,
4,	.5900,	.5600,	.5300,	.6700,	.6400,	.8300,	.8000,	.7600,	.7700,
5,	1.1100,	.9500,	1.2600,	1.1100,	1.2900,	1.3900,	1.3300,	1.2800,	1.2600,
6,	1.6900,	1.5000,	1.9300,	1.6600,	1.7000,	1.8800,	1.9200,	1.9300,	1.9700,
7,	2.3700,	2.1400,	2.4600,	2.5000,	2.3600,	2.5400,	2.6400,	2.8100,	3.0300,
8,	3.1700,	2.9200,	3.3600,	3.2300,	3.4800,	3.4600,	3.7100,	3.7200,	4.3300,
9,	3.9800,	3.6500,	4.2200,	4.0700,	4.5200,	4.8800,	5.0600,	5.0600,	5.4000,
10,	5.0500,	4.5600,	5.3100,	5.2700,	5.6200,	5.2000,	6.0500,	6.3400,	6.7500,
11,	5.9200,	5.8400,	5.9200,	5.9900,	6.4000,	7.1400,	7.4200,	7.4000,	7.7900,
12,	7.2000,	7.4200,	7.0900,	7.0800,	7.9600,	8.2200,	8.4300,	8.6700,	10.6700,
+gp,	8.1460,	8.8480,	8.4300,	8.2180,	8.8910,	9.3890,	10.1850,	10.2380,	9.6800,

Table 3 Stock weights at age (kg)

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	.3200,	.3300,	.3300,	.3400,	.3500,	.3400,	.3100,	.3200,	.3200,	.3300,
4,	.5700,	.5800,	.5900,	.5200,	.7200,	.5100,	.5500,	.5500,	.6100,	.5500,
5,	1.1300,	1.0700,	1.0200,	.9500,	1.4700,	1.0900,	1.0500,	.9300,	.9600,	.9500,
6,	1.7300,	1.8300,	1.8200,	1.9200,	2.6800,	2.1300,	2.2000,	1.7000,	1.7300,	1.8600,
7,	2.7500,	2.8900,	2.8900,	2.9400,	3.5900,	3.3800,	3.2300,	3.0300,	3.0400,	3.2500,
8,	3.9400,	4.2500,	4.2800,	4.2100,	4.3200,	4.8700,	5.1100,	5.0300,	4.9600,	4.9700,
9,	4.9000,	5.5500,	5.4900,	5.6100,	5.4500,	6.1200,	6.1500,	6.5500,	6.4400,	6.4100,
10,	7.0400,	7.2800,	7.5100,	7.3500,	6.4400,	8.4900,	8.1500,	7.7000,	7.9100,	8.0700,
11,	7.2000,	8.0000,	8.2400,	8.6700,	7.1700,	7.7900,	8.6800,	9.2700,	9.6200,	9.3400,
12,	8.7800,	8.3500,	9.2500,	9.5800,	8.6300,	8.3000,	9.6000,	10.5600,	11.3100,	10.1600,
+gp,	10.0770,	9.9440,	10.6050,	11.6310,	11.6210,	11.4220,	11.9520,	12.7170,	12.7370,	12.8860,

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

At 26/04/2005 10:40

Table 3 Stock weights at age (kg)

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	.3800,	.4400,	.2900,	.3300,	.4400,	.3700,	.4500,	.3800,	.3800,	.3200,
4,	.6800,	.7400,	.8100,	.7000,	.7900,	.9100,	.8800,	.7700,	.9100,	.6600,
5,	1.0300,	1.1800,	1.3500,	1.4800,	1.2300,	1.3400,	1.3800,	1.4300,	1.5400,	1.1700,
6,	1.4900,	1.7800,	2.0400,	2.1200,	2.0300,	2.0000,	2.1600,	2.1200,	2.2600,	2.2200,
7,	2.4100,	2.4600,	2.8100,	3.1400,	2.9000,	3.0000,	3.0700,	3.2300,	3.2900,	3.2100,
8,	3.5200,	3.8200,	3.4800,	4.2100,	3.8100,	4.1500,	4.2200,	4.3800,	4.6100,	4.3900,
9,	5.7300,	5.3600,	4.8900,	5.2700,	5.0200,	5.5900,	5.8100,	5.8300,	6.5700,	5.5200,
10,	7.5400,	7.2700,	7.1100,	6.6500,	6.4300,	7.6000,	7.1300,	7.6200,	8.3700,	7.8600,
11,	8.4700,	8.6300,	9.0300,	9.0100,	8.3300,	8.9700,	8.6200,	9.5200,	10.5400,	9.8200,
12,	11.1700,	10.6600,	10.5900,	9.6600,	10.7100,	10.9900,	10.8300,	12.0900,	11.6200,	11.4100,
+gp,	13.7220,	14.1480,	13.8290,	14.8480,	14.2110,	14.0740,	12.9450,	13.6730,	13.9040,	13.2420,

Table 3.12. Stock weights at age (continued)

Table 3 Stock weights at age (kg)

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	.4100,	.3500,	.4900,	.4900,	.3500,	.2700,	.4900,	.3700,	.3700,	.4200,
4,	.6400,	.7300,	.9000,	.8100,	.7000,	.5600,	.9800,	.6600,	.9200,	1.1600,
5,	1.1100,	1.1900,	1.4300,	1.4500,	1.2400,	1.0200,	1.4400,	1.3500,	1.6000,	1.8100,
6,	1.9000,	2.0100,	2.0500,	2.1500,	2.1400,	1.7200,	2.0900,	1.9900,	2.4400,	2.7900,
7,	2.9500,	2.7600,	3.3000,	3.0400,	3.1500,	3.0200,	2.9800,	2.9300,	3.8200,	3.7800,
8,	4.3700,	4.2200,	4.5600,	4.4600,	4.2900,	4.2000,	4.8500,	4.2400,	4.7600,	4.5700,
9,	5.7400,	5.8800,	6.4600,	6.5400,	6.5800,	5.8400,	6.5700,	6.4600,	6.1700,	6.1700,
10,	8.7700,	9.3000,	8.6300,	7.9800,	8.6100,	7.2600,	9.1600,	8.5100,	7.7000,	7.7000,
11,	9.9200,	10.2800,	9.9300,	10.1500,	9.2200,	8.8400,	10.8200,	12.2400,	9.2500,	9.2500,
12,	11.8100,	11.8600,	10.9000,	10.8500,	10.8900,	9.2800,	10.7700,	10.7800,	10.8500,	10.8500,
+gp,	13.1070,	13.5440,	13.6680,	13.1770,	14.3440,	14.4480,	13.9320,	14.0410,	12.9880,	13.0330,

Table 3 Stock weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	.4100,	.3100,	.1900,	.2100,	.3000,	.4000,	.5180,	.4400,	.3440,	.2350,
4,	.8800,	.8800,	.5100,	.4000,	.5200,	.7100,	1.1360,	.9310,	1.1720,	.7530,
5,	1.6000,	1.4700,	1.2800,	.7900,	.8700,	1.1800,	1.7430,	1.8120,	1.8200,	1.4200,
6,	2.8100,	2.4700,	1.9400,	1.9000,	1.4800,	1.7200,	2.4280,	2.7160,	2.8230,	2.4130,
7,	4.0600,	3.9200,	3.2800,	2.9800,	2.6900,	2.4600,	3.2140,	3.8950,	4.0310,	3.8250,
8,	5.8300,	5.8100,	5.1700,	4.3900,	4.6300,	3.5700,	4.5380,	5.1760,	5.4970,	5.4160,
9,	7.6900,	6.5800,	6.5200,	7.8100,	7.0500,	4.7100,	6.8800,	6.7740,	6.7650,	6.6310,
10,	10.1200,	6.8300,	9.3000,	12.1100,	9.9800,	7.8000,	10.7190,	9.5980,	8.5710,	7.6300,
11,	14.2900,	11.0000,	13.1500,	13.1100,	9.2500,	8.9600,	9.4450,	12.4270,	10.8470,	8.1120,
12,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,
+gp,	13.4130,	13.5870,	13.8260,	13.0180,	14.4790,	13.4230,	14.1000,	13.6620,	12.8870,	12.7540,

Table 3 Stock weights at age (kg)

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	.2010,	.1950,	.2020,	.2170,	.2030,	.1940,	.2850,	.2500,	.2300,	.2400,
4,	.4850,	.4870,	.5210,	.5330,	.5200,	.4650,	.5220,	.6040,	.5370,	.4800,
5,	1.1400,	1.0310,	1.0790,	1.1610,	1.1740,	1.2080,	1.1940,	1.1890,	1.3100,	1.1120,
6,	2.1180,	2.0540,	1.8780,	1.9390,	2.0310,	1.9720,	2.2310,	2.1380,	2.0090,	2.0540,
7,	3.4700,	3.5250,	3.3690,	2.9450,	3.0340,	3.0480,	3.3060,	3.3330,	3.2410,	2.9720,
8,	4.9380,	5.5030,	5.2630,	4.5740,	4.4640,	4.0960,	5.0500,	4.7670,	4.9710,	4.5670,
9,	7.1600,	7.7670,	8.9270,	7.4230,	6.4820,	5.7240,	6.3760,	6.8590,	6.7390,	6.6010,
10,	9.1190,	10.1590,	12.1540,	10.3670,	10.2690,	7.4570,	9.1150,	9.3340,	8.7060,	8.7600,
11,	10.1010,	10.6690,	10.8230,	11.7380,	10.8820,	9.5820,	11.2720,	10.1860,	15.0260,	10.9000,
12,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,	10.8500,
+gp,	12.7270,	12.6340,	13.3770,	13.8960,	13.6970,	13.9000,	14.3510,	12.9950,	12.9950,	12.9950,

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Table 3.13

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

At 26/04/2005 10:40

Table 5 Proportion mature at age

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,	1953,	1954,
AGE									
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0600,	.0600,	.0700,	.0900,	.0900,	.1000,	.0800,	.0700,	.0800,
8,	.1100,	.1300,	.1300,	.1700,	.2300,	.2400,	.2200,	.1900,	.1600,
9,	.1800,	.1600,	.2500,	.2900,	.3500,	.4000,	.4100,	.4000,	.3700,
10,	.4400,	.4200,	.4700,	.5400,	.5200,	.5800,	.6300,	.6400,	.6800,
11,	.6500,	.7500,	.7300,	.7900,	.7900,	.7200,	.8200,	.8400,	.8700,
12,	.8600,	.9100,	.9100,	.8800,	.9500,	.8500,	.9200,	.9400,	.9300,
+gp,	.9600,	.9500,	.9700,	.9700,	.9700,	.9600,	.9700,	.9700,	.9600,

Table 5 Proportion mature at age

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,	.0100,	.0000,
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0300,	.0100,	.0100,	.0100,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0400,	.0600,	.0600,	.0500,	.0300,	.0300,
7,	.0700,	.0600,	.0600,	.0600,	.1200,	.1000,	.1200,	.1500,	.0700,	.1300,
8,	.1300,	.1200,	.0900,	.1000,	.3400,	.1900,	.3100,	.3400,	.2800,	.3700,
9,	.2600,	.1400,	.1200,	.1000,	.4900,	.4500,	.6500,	.6100,	.4200,	.6600,
10,	.5300,	.4100,	.2200,	.3000,	.6700,	.6900,	.9100,	.8100,	.8100,	.8900,
11,	.8300,	.6700,	.6000,	.5000,	.8400,	.7700,	.9800,	.9200,	.9800,	.9500,
12,	.9200,	.9100,	.8200,	.8200,	.8700,	.8500,	.9800,	.9700,	.9800,	.9900,
+gp,	.9700,	.9600,	.9700,	.9700,	1.0000,	.9900,	1.0000,	1.0000,	1.0000,	1.0000,

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

At 26/04/2005 10:40

Table 5 Proportion mature at age

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0200,	.0000,	.0000,
5,	.0000,	.0100,	.0000,	.0300,	.0000,	.0000,	.0100,	.0200,	.0000,	.0000,
6,	.0100,	.0200,	.0300,	.0500,	.0200,	.0100,	.0500,	.0100,	.0200,	.0100,
7,	.0600,	.0600,	.0700,	.0900,	.0400,	.0700,	.1100,	.1000,	.1600,	.0300,
8,	.2000,	.2200,	.1400,	.1900,	.1200,	.2300,	.3000,	.3400,	.5300,	.2100,
9,	.5500,	.3500,	.3800,	.3900,	.3400,	.5800,	.5900,	.6400,	.8100,	.5000,
10,	.7300,	.7400,	.6400,	.5800,	.5500,	.8100,	.7900,	.8100,	.9200,	.9600,
11,	.9900,	.9400,	.8900,	.8200,	.7400,	.8900,	.8600,	.9400,	.9500,	1.0000,
12,	.9800,	.9400,	.9000,	1.0000,	.9500,	.9100,	.8800,	1.0000,	.9800,	.9600,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.13 (continued)

Table 5 Proportion mature at age

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0500,	.0800,	.0500,
5,	.0100,	.0000,	.0200,	.0000,	.0000,	.0000,	.0200,	.1000,	.1000,	.1800,
6,	.0200,	.0500,	.0800,	.0200,	.0300,	.0200,	.0700,	.3400,	.3000,	.3100,
7,	.0900,	.1200,	.2600,	.1300,	.1300,	.1300,	.2000,	.6500,	.7300,	.5600,
8,	.2100,	.2900,	.5400,	.4400,	.3900,	.3500,	.5400,	.8200,	.8800,	.9000,
9,	.5600,	.4500,	.7600,	.7100,	.7700,	.6500,	.8000,	.9200,	.9700,	.9900,
10,	.7800,	.8400,	.8700,	.7700,	.8900,	.8200,	.9700,	1.0000,	1.0000,	1.0000,
11,	.7900,	.8300,	.9300,	.8100,	.8300,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	.9500,	1.0000,	.9400,	.8900,	.7800,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	.9000,	.9000,	.8000,	.9000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,
4,	.0100,	.0500,	.0100,	.0200,	.0000,	.0100,	.0400,	.0100,	.0300,	.0100,
5,	.0900,	.0800,	.0700,	.0500,	.0500,	.0500,	.0600,	.1200,	.0900,	.1100,
6,	.3600,	.1900,	.1800,	.3300,	.1800,	.2100,	.2800,	.4300,	.3000,	.3300,
7,	.5500,	.5300,	.2200,	.5300,	.4100,	.5800,	.6500,	.7500,	.6100,	.6000,
8,	.8500,	.7100,	.4600,	.6200,	.6900,	.7700,	.8300,	.9300,	.9100,	.8100,
9,	.9600,	.6200,	.5000,	1.0000,	.8500,	.8600,	.9700,	.9700,	.9700,	.9700,
10,	.9000,	.9000,	.7500,	1.0000,	1.0000,	.9800,	1.0000,	1.0000,	.9900,	.9900,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,
12,	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,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,	.0100,	.0100,	.0000,	.0060,
5,	.0700,	.0200,	.0200,	.0400,	.0100,	.0600,	.0500,	.0800,	.1010,	.0930,
6,	.3300,	.2600,	.1400,	.1900,	.1000,	.2200,	.3400,	.4000,	.3650,	.4030,
7,	.6200,	.6300,	.5600,	.4400,	.4500,	.6400,	.5800,	.7000,	.6280,	.7170,
8,	.7400,	.8300,	.8200,	.8200,	.7900,	.8300,	.7700,	.8600,	.8790,	.8760,
9,	.9500,	.9800,	.9500,	.9300,	.8800,	.9700,	.9800,	.9800,	.9270,	.9790,
10,	.9800,	1.0000,	.9500,	.9800,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9820,
11,	1.0000,	1.0000,	.9500,	1.0000,	1.0000,	1.0000,	.9700,	1.0000,	1.0000,	1.0000,
12,	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,

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 - 14 (Catch: Thousa (Catch: Unknown) (Effort: Unknown)
1985 2004
1 1 0.00 1.00
9 13

0.70	291	77	30	6	0
1.52	87	59	22	3	1
2.10	127	95	37	11	2
2.75	442	215	53	12	3
2.12	140	47	11	0	0
1.11	204	49	14	2	0
1.56	791	71	16	4	1
2.50	3852	689	62	10	0
2.64	2019	1778	68	13	2
2.96	1237	595	167	40	5
3.88	684	345	146	21	1
3.73	364	164	34	10	0
4.92	488	99	34	10	0
6.77	559	88	34	13	1
6.39	882	171	0	0	0
4.25	742	185	25	1	0
3.50	235	95	35	7	0
3.15	336	61	18	1	0
2.34	319	83	19	9	1
3.47	710	262	56	12	0

FLT15: NorBarTrSur rev99 (Catch: Unknown) (Effort: Unknown)
1980 2004
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

Table 3.14 (continued)

FLT16: NorBarLofAcSur rev99 (Catch: Unknown) (Effort: Unknown)
1984 2004
1 1 0.99 1.00
3 11

1	1416	204	154	157	33	12	10	5	0
1	1343	684	116	77	31	3	0	4	1
1	2049	502	174	14	30	7	0	0	0
1	355	578	109	40	3	0	1	0	0
1	344	214	670	166	32	5	2	0	1
1	206	262	269	668	73	6	3	0	0
1	346	293	339	367	500	37	2	2	0
1	658	215	184	284	254	824	44	16	2
1	1911	1131	354	255	252	277	445	47	7
1	4045	2175	895	225	119	94	44	175	26
1	1598	2166	1040	290	44	43	36	22	80
1	705	872	891	446	65	11	7	8	13
1	517	497	422	499	205	22	5	0	8
1	1826	424	338	340	247	49	8	2	0
1	964	454	122	112	187	92	11	2	1
1	1589	1457	493	129	69	52	16	4	1
1	1716	816	573	198	24	8	6	3	1
1	1122	1043	661	345	95	12	5	6	0
1	1144	1315	1445	643	212	38	5	1	1
1	928	327	451	468	222	88	22	2	7
1	337	661	299	432	172	75	18	1	2

FLT17: RusSurCatch/hr rev00 (ages 1-8) (Catch: Unknown) ((Catch: Unknown) (Effort: Unknown)
1982 2004
1 1 0.90 1.00
3 8

1	76	94	58	32	11	4
1	73	48	20	7	11	2
1	93	49	30	12	5	3
1	397	181	45	17	6	1
1	286	140	50	14	2	1
1	402	78	34	8	2	1
1	73	193	33	10	2	1
1	91	109	161	131	55	29
1	29	65	78	96	43	11
1	48	58	66	83	71	7
1	90	45	48	26	23	9
1	526	377	117	45	32	19
1	404	383	366	120	42	13
1	235	247	105	23	7	2
1	101	126	86	36	9	1
1	83	62	37	18	5	1
1	334	97	37	16	7	1
1	475	162	31	12	8	2
1	219	169	58	8	3	1
1	372	206	115	22	3	1
1	144	241	252	117	52	12
1	293	175	202	175	60	23
1	43	201	94	100	63	19

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

		official catch	unrep. catch added
TSB	2001	1386956	1524632
	2002	1484586	1699727
	2003	1576578	1771101
	2004	1573669	1712001
SSB	2001	316268	339858
	2002	456344	526648
	2003	526920	591917
	2004	681155	721210
F(5-10)	2001	0.7722	0.7131
	2002	0.6442	0.6483
	2003	0.4623	0.4958
	2004	0.5387	0.5741
N2004	age3	24804	37418
N*10^-4	age4	37936	42035
	age5	21093	23738
	age6	18449	19804
	age7	10865	11315
	age8	3977	4110
	age9	1204	1246
	age10	307	378
F2004	age3	0.0522	0.0354
	age4	0.1087	0.1184
	age5	0.2273	0.2532
	age6	0.3829	0.4491
	age7	0.5376	0.6427
	age8	0.5614	0.6362
	age9	0.7112	0.7747
	age10	0.8119	0.6885
N2005	age3	50736	53243
N*10^-4	age4	16702	29582
	age5	27939	30576
	age6	12558	15090
	age7	10241	10352
	age8	5286	4870
	age9	1840	1782
	age10	488	470
Catch	age3	1142	1179
2004	age4	3536	4247
N*10^-4	age5	3881	4805
	age6	5310	6483
	age7	4088	4854
	age8	1546	1751
	age9	554	608
	age10	155	170

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

		FLT 09 Rus trawl CPUE	FLT 15 Joint BT survey	FLT 16 Joint+Lof Ac survey	FLT 17 Rus BT survey	Final run ALL Fleets	Gadget Keyrun	ALL Fleets	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	1.0	0.5	1.0
SS-ind.Q for age>		6	6	6	6	6	2	3	4	5	7	6	6
ages with fleet data		9 to 12	3 to 8	3 to 11	3 to 8	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12	3 to 12
# of iterations to converg		22	28	>30	>30	> 30		33	> 40	>40	>40	27	30
age3	PshrinkW	**0.96**	**0.66**	**0.80**	**0.57**	**0.47**		*	**0.44**	**0.46**	**0.48**	**0.44**	**0.33**
	FshrinkW	0.04	0.03	0.04	0.04	0.02		0.04	0.02	0.02	0.02	0.08	0.03
age4	PshrinkW	**0.94**	**0.41**	**0.44**	0.25	0.18		*	*	0.18	0.19	0.18	0.14
	FshrinkW	0.07	0.03	0.04	0.04	0.01		0.02	0.02	0.01	0.01	0.06	0.02
age5	PshrinkW	**0.87**	0.21	0.21	0.10	0.07		*	*	*	0.08	0.08	0.07
	FshrinkW	0.13	0.03	0.04	0.03	0.01		0.02	0.02	0.02	0.01	0.05	0.02
age6	FshrinkW	**1.00**	0.05	0.05	0.05	0.02		0.02	0.02	0.02	0.02	0.07	0.02
age7	FshrinkW	**1.00**	0.07	0.08	0.07	0.03		0.03	0.03	0.03	0.03	0.11	0.03
age8	FshrinkW	**1.00**	0.09	0.09	0.12	0.04		0.04	0.04	0.04	0.04	0.15	0.04
age9	FshrinkW	0.24	0.17	0.11	**0.53**	0.06		0.06	0.06	0.06	0.06	0.20	0.07
age10	FshrinkW	0.12	**0.38**	0.17	**0.79**	0.06		0.06	0.06	0.06	0.06	**0.22**	0.09
age11	FshrinkW	0.07	**0.59**	**0.31**	**0.89**	0.06		0.06	0.06	0.06	0.06	**0.24**	0.10
age12	FshrinkW	0.16	**0.80**	**0.44**	**0.97**	0.13		0.13	0.13	0.13	0.13	**0.40**	**0.22**
N2004	age3	446620	398140	407990	487160	374540	125699	159320	360260	366010	370460	336800	314870
N*10^-3	age4	361280	403880	363500	517990	420440	440333	400870	438580	420530	414230	407600	409380
	age5	219320	219140	212860	312490	237480	174652	205410	224420	230940	234020	226890	225930
	age6	161690	169960	181970	323330	198150	138280	191660	202490	201180	188900	188640	192020
	age7	101150	102420	105430	187620	113070	104090	116140	118540	116160	109050	107860	108980
	age8	32380	33210	42400	64630	41150	40505	40330	41640	41510	39940	36820	38790
	age9	11190	12410	12130	11460	12460	16843	12530	12570	12530	12390	11860	12090
	age10	3670	3050	3480	2940	3770	3823	3780	3790	3780	3770	3450	3210
F2004	age 4	0.20	0.1235	0.14	0.10	0.12	0.11	0.12	0.11	0.12	0.12	0.12	0.12
	age5	0.40	0.2775	0.29	0.19	0.25	0.32	0.30	0.27	0.26	0.26	0.27	0.27
	age6	0.84	0.5474	0.50	0.25	0.45	0.58	0.47	0.44	0.44	0.48	0.48	0.47
	age7	1.09	0.7419	0.71	0.34	0.64	0.67	0.62	0.60	0.62	0.68	0.69	0.68
	age8	1.31	0.8734	0.61	0.36	0.64	0.76	0.65	0.62	0.63	0.66	0.75	0.69
	age9	1.32	0.7791	0.81	0.88	0.77	0.84	0.77	0.77	0.77	0.78	0.84	0.81
	age10	1.03	0.9547	0.78	1.02	0.69	0.89	0.69	0.69	0.69	0.69	0.79	0.88
2004	F(5-10)	0.69	0.70	0.62	0.51	0.57	0.68	0.58	0.56	0.57	0.59	0.63	0.63
	F(4-8)	0.53	0.51	0.45	0.24	0.42	0.49	0.43	0.41	0.41	0.44	0.46	0.45
TSB2004	incl Age1-2	1520545	1553076	1607546	2448922	1712451	1469565	1602985	1731378	1720571	1667105	1623187	1638018
SSB2004	('000 T)	620073	632116	687499	1069637	721311	403615	716243	738026	731687	699383	676412	687694
N2005	age3					532580	415643	451890	531930	530550	525690	516470	550070
N*10^-3	age4	355000	315300	323400	388140	295980	95129	119770	284410	289360	292800	265090	247230
	age5	257360	292240	259190	385310	305810	318510	289780	320720	306020	300760	295280	296740
	age6	136080	135940	130800	212200	150950	103227	124700	140310	145770	148170	142280	141500
	age7	73720	80490	90330	205730	103570	63168	98250	107150	106150	96020	95790	98550
	age8	38900	39930	42390	109410	48660	43385	51170	53140	51180	45340	44390	45130
	age9	10670	11350	18880	36990	17850	15482	17180	18260	18160	16860	14310	15920
	age10	3660	4660	4430	3880	4700	6051	4760	4790	4760	4640	4210	4400
Survivors	age3		230987	190531	311654	295980							
end of 04	age4		320596	255660	414078	305810							
direct	age5		135595	127751	221641	150950							
predic.	age6		80868	91158	214226	103570							
by the	age7		40022	42527	117062	48660							
survey	age8		11452	20024	44043	17850							
	age9	3734	5026	4586	4694	4700							
	age10	1565	996	1402	699	1552							
F2004	age3		0.045	0.054	0.034	0.035							
	age4		0.113	0.14	0.089	0.118							
direct	age5		0.278	0.293	0.179	0.253							
predic.	age6		0.545	0.497	0.242	0.448							
by the	age7		0.741	0.709	0.319	0.643							
survey	age8		0.868	0.583	0.307	0.635							
	age9	0.91	0.739	0.788	0.776	0.775							
	age10	0.68	0.934	0.741	1.163	0.689							

Table 3.16. Diagnostics for final XSA.

Lowestoft VPA Version 3.1

26/04/2005 7:03

Extended Survivors Analysis

Arctic Cod (run: XSAASA01/X01)

CPUE data from file fleet

Catch data for 21 years. 1984 to 2004. Ages 1 to 13.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT09: Russian trawl,	1985,	2004,	9,	12,	.000,	1.000
FLT15: NorBarTrSur r,	1984,	2004,	3,	8,	.990,	1.000
FLT16: NorBarLofAcSu,	1984,	2004,	3,	11,	.990,	1.000
FLT17: RusSurCatch/h,	1984,	2004,	3,	8,	.900,	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 10 years

Catchability analysis :

Catchability dependent on stock size for ages < 6

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

Catchability independent of age for ages >= 10

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 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 = .00032

Final year F values

Age	1,	2,	3,	4,	5,	6,	7,	8,	9,	10
Iteration 29,	1.4535,	.3436,	.0354,	.1184,	.2531,	.4488,	.6433,	.6353,	.7748,	.6888
Iteration 30,	1.4535,	.3436,	.0354,	.1184,	.2531,	.4488,	.6433,	.6352,	.7748,	.6888

Age	11,	12
Iteration 29,	.5126,	.7765
Iteration 30,	.5126,	.7764

Regression weights

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

Fishing mortalities

Age,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004
1,	1.867,	1.991,	2.504,	1.610,	1.081,	1.470,	1.033,	.586,	1.669,	1.453
2,	.934,	1.053,	1.095,	.610,	.358,	.253,	.221,	.592,	.233,	.344
3,	.555,	.469,	.339,	.375,	.125,	.075,	.060,	.122,	.065,	.035
4,	.305,	.352,	.300,	.351,	.210,	.133,	.112,	.102,	.077,	.118
5,	.338,	.412,	.569,	.519,	.544,	.411,	.271,	.279,	.258,	.253
6,	.577,	.543,	.724,	.779,	.718,	.597,	.519,	.515,	.450,	.449
7,	.891,	.750,	.843,	.773,	.807,	.738,	.656,	.807,	.592,	.643
8,	.943,	.863,	1.235,	1.045,	1.062,	1.027,	.808,	.849,	.702,	.635
9,	.961,	.751,	1.342,	1.174,	1.402,	1.196,	.871,	.734,	.526,	.775
10,	1.022,	.938,	1.505,	1.261,	1.436,	1.197,	1.154,	.706,	.447,	.689
11,	1.257,	.872,	1.436,	1.319,	.978,	1.151,	.887,	.710,	.410,	.513
12,	1.157,	.920,	1.533,	1.287,	1.139,	1.337,	1.199,	.941,	.796,	.776

Table 3.16 (continued)

```
1
 XSA population numbers (Thousands)

                                A
 YEAR ,  1,        2,       3,            4,          5,         6,       7,     8,         9,           10,

 1995 , 2.01E+07, 1.38E+06, 6.68E+05, 5.45E+05, 4.59E+05, 2.49E+05, 6.00E+04, 1.33E+04, 5.39E+03, 2.98E+03,
 1996 , 2.78E+07, 2.54E+06, 4.44E+05, 3.14E+05, 3.29E+05, 2.68E+05, 1.14E+05, 2.02E+04, 4.23E+03, 1.69E+03,
 1997 , 1.93E+07, 3.11E+06, 7.27E+05, 2.27E+05, 1.81E+05, 1.79E+05, 1.28E+05, 4.42E+04, 6.96E+03, 1.63E+03,
 1998 , 6.72E+06, 1.29E+06, 8.51E+05, 4.24E+05, 1.38E+05, 8.38E+04, 7.09E+04, 4.49E+04, 1.05E+04, 1.49E+03,
 1999 , 3.11E+06, 1.10E+06, 5.74E+05, 4.79E+05, 2.45E+05, 6.72E+04, 3.15E+04, 2.68E+04, 1.29E+04, 2.66E+03,
 2000 , 3.50E+06, 8.65E+05, 6.29E+05, 4.15E+05, 3.18E+05, 1.16E+05, 2.68E+04, 1.15E+04, 7.58E+03, 2.61E+03,
 2001 , 4.15E+06, 6.58E+05, 5.50E+05, 4.78E+05, 2.97E+05, 1.73E+05, 5.24E+04, 1.05E+04, 3.37E+03, 1.88E+03,
 2002 , 1.27E+06, 1.21E+06, 4.32E+05, 4.24E+05, 3.50E+05, 1.86E+05, 8.40E+04, 2.23E+04, 3.83E+03, 1.15E+03,
 2003 , 5.95E+06, 5.77E+05, 5.48E+05, 3.13E+05, 3.13E+05, 2.17E+05, 9.08E+04, 3.07E+04, 7.80E+03, 1.51E+03,
 2004 , 5.32E+06, 9.17E+05, 3.75E+05, 4.20E+05, 2.37E+05, 1.98E+05, 1.13E+05, 4.11E+04, 1.25E+04, 3.77E+03,

 Estimated population abundance at 1st Jan 2005

    , 0.00E+00, 1.02E+06, 5.33E+05, 2.96E+05, 3.06E+05, 1.51E+05, 1.04E+05, 4.87E+04, 1.79E+04, 4.70E+03,

 Taper weighted geometric mean of the VPA populations:

    , 4.17E+06, 9.49E+05, 5.31E+05, 4.01E+05, 2.71E+05, 1.52E+05, 6.53E+04, 2.35E+04, 7.03E+03, 1.99E+03,

 Standard error of the weighted Log(VPA populations) :

    ,.7403,    .4372,    .2511,    .2033,    .2799,    .4297,    .5654,    .5741,    .5434,    .4249,

                                AGE
 YEAR ,     11,          12,

 1995 ,    1.81E+03, 3.09E+03,
 1996 ,    8.77E+02, 4.23E+02,
 1997 ,    5.41E+02, 3.00E+02,
 1998 ,    2.97E+02, 1.05E+02,
 1999 ,    3.45E+02, 6.50E+01,
 2000 ,    5.19E+02, 1.06E+02,
 2001 ,    6.45E+02, 1.34E+02,
 2002 ,    4.85E+02, 2.18E+02,
 2003 ,    4.67E+02, 1.95E+02,
 2004 ,    7.88E+02, 2.54E+02,

 Estimated population abundance at 1st Jan 2005

    ,     1.55E+03, 3.86E+02,

 Taper weighted geometric mean of the VPA populations:

    ,     5.19E+02, 1.60E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .3249,    .5384,

 Log catchability residuals.

 Fleet : FLT09: Russian trawl

  Age  ,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994
     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 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
    10 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
    11 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
    12 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99

  Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
     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 ,   .64,   .21,  -.04,  -.70,  -.30,   .39,   .11,   .39,  -.17,  -.12
    10 ,   .66,   .49,  -.04,  -.48,  -.27,   .15,  -.02,  -.05,   .18,   .12
    11 ,   .39,  -.46,  -.03,   .20, 99.99,  -.26,  -.05,  -.40,  -.14,   .07
    12 , -2.13,  -.93,  -.63,   .27, 99.99, -1.82,   .03, -2.39,   .15,  -.23
```

Table 3.16 (continued)

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

Age ,	9,	10,	11,	12
Mean Log q,	-3.5398,	-3.6200,	-3.6200,	-3.6200,
S.E(Log q),	.3468,	.2228,	.2494,	1.3750,

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,	1.71,	-1.763,	-.21,	.59,	10,	.50,	-3.54,
10,	.91,	.417,	3.99,	.82,	10,	.22,	-3.62,
11,	.96,	.120,	3.85,	.70,	9,	.23,	-3.74,
12,	1.18,	-.115,	4.20,	.10,	9,	1.48,	-4.35,

Fleet : FLT15: NorBarTrSur r

Age ,	1984
3 ,	99.99
4 ,	99.99
5 ,	99.99
6 ,	99.99
7 ,	99.99
8 ,	99.99
9 ,	No data for this fleet at this age
10 ,	No data for this fleet at this age
11 ,	No data for this fleet at this age
12 ,	No data for this fleet at this age

Age ,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
6 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
7 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
8 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
9 ,	No data for this fleet at this age									
10 ,	No data for this fleet at this age									
11 ,	No data for this fleet at this age									
12 ,	No data for this fleet at this age									

Age ,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004
3 ,	-.03,	-.06,	.04,	-.12,	-.07,	.02,	-.05,	.20,	.11,	-.18
4 ,	.18,	.28,	.10,	-.16,	.07,	-.03,	.01,	-.01,	-.06,	.06
5 ,	.28,	.15,	.33,	.06,	.03,	-.06,	-.02,	.17,	-.04,	-.22
6 ,	.11,	.16,	.29,	.09,	-.16,	-.10,	-.05,	.07,	.25,	-.23
7 ,	.04,	-.06,	.33,	.33,	.24,	-.27,	-.24,	.15,	.30,	-.40
8 ,	-.10,	.21,	-.10,	-.12,	.42,	.13,	-.29,	.21,	.27,	-.53
9 ,	No data for this fleet at this age									
10 ,	No data for this fleet at this age									
11 ,	No data for this fleet at this age									
12 ,	No data for this fleet at this age									

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

Age ,	6,	7,	8
Mean Log q,	-6.2793,	-6.5942,	-6.8703,
S.E(Log q),	.1835,	.3076,	.3395,

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,	.64,	1.336,	8.35,	.77,	10,	.15,	-5.69,
4,	.72,	1.432,	7.84,	.86,	10,	.09,	-5.85,
5,	.75,	.954,	7.67,	.78,	10,	.17,	-6.08,

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,	.87,	.769,	7.01,	.89,	10,	.17,	-6.28,
7,	.93,	.273,	6.89,	.80,	10,	.32,	-6.59,
8,	1.07,	-.236,	6.64,	.72,	10,	.40,	-6.87,

Table 3.16 (continued)

Fleet : FLT16: NorBarLofAcSu

Age	1984
3	99.99
4	99.99
5	99.99
6	99.99
7	99.99
8	99.99
9	99.99
10	99.99
11	99.99
12	No data for this fleet at this age

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
11	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
12	No data for this fleet at this age									

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-.17	.02	.15	-.34	.19	.11	.01	.29	-.09	-.29
4	-.15	.15	.36	-.20	.18	.00	-.03	.20	-.19	-.12
5	-.22	-.25	.31	.00	.20	-.05	.02	.29	-.25	-.20
6	-.14	-.14	.07	-.23	.07	-.17	-.09	.46	-.08	-.07
7	-.37	.00	.17	.41	.25	-.71	-.09	.39	.15	-.27
8	-.56	-.36	.02	.45	.41	-.65	-.37	.07	.44	-.08
9	-.03	-.33	.23	-.03	.36	-.29	.02	-.25	.32	-.11
10	.98	99.99	.67	.52	.81	.30	1.28	-.47	-.30	-1.67
11	2.19	2.05	99.99	1.50	1.01	.77	99.99	.40	2.09	.41
12	No data for this fleet at this age									

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

Age	6	7	8	9	10	11
Mean Log q	-5.4097	-5.3746	-5.3994	-5.4643	-5.6802	-5.6802
S.E(Log q)	.2299	.3898	.4148	.2593	1.0219	1.3557

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	.55	1.020	9.19	.55	10	.25	-5.97
4	.49	1.186	9.49	.56	10	.20	-5.94
5	.55	1.211	8.82	.62	10	.24	-5.75

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	.91	.367	5.97	.81	10	.23	-5.41
7	.79	.878	6.59	.80	10	.31	-5.37
8	.65	2.216	7.01	.91	10	.21	-5.40
9	.86	.741	5.93	.87	10	.23	-5.46
10	3.54	-.645	.81	.02	9	3.84	-5.68
11	3.41	-.634	.91	.02	8	2.71	-4.66

1

Fleet : FLT17: RusSurCatch/h

Age	1984
3	99.99
4	99.99
5	99.99
6	99.99
7	99.99
8	99.99
9	No data for this fleet at this age
10	No data for this fleet at this age
11	No data for this fleet at this age
12	No data for this fleet at this age

Table 3.16 (continued)

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	.02	.06	-.56	-.15	.29	-.13	.21	.10	.12	-.28
4	.26	.11	-.42	-.49	-.18	-.08	-.02	.27	.18	.09
5	-.47	-.22	-.03	.21	-.45	-.42	-.02	.29	.26	.07
6	-1.04	-.70	-.81	-.12	-.25	-1.31	-.77	.82	1.01	.54
7	-.52	-1.05	-1.65	-.80	.18	-.71	-1.45	1.07	.93	.81
8	-.09	-1.28	-1.71	-1.91	-.68	-.56	-.68	1.10	1.29	.74
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									

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

Age	6	7	8
Mean Log q	-7.5123	-7.5015	-7.6254
S.E(Log q)	.8957	1.0857	1.1603

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	.40	1.280	10.96	.52	10	.27	-7.63
4	1.12	-.217	6.73	.41	10	.27	-7.42
5	.60	.785	9.48	.47	10	.33	-7.44

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	.51	1.072	9.67	.53	10	.45	-7.51
7	.56	.925	9.08	.51	10	.62	-7.50
8	.75	.352	8.24	.31	10	.95	-7.63

1

Terminal year survivor and F summaries :

Age 1 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.	.000	.000	.00	0	.000	.000
FLT15: NorBarTrSur r	1.	.000	.000	.00	0	.000	.000
FLT16: NorBarLofAcSu	1.	.000	.000	.00	0	.000	.000
FLT17: RusSurCatch/h	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	948840.	.44				.840	1.508
F shrinkage mean	1476640.	1.00				.160	1.182

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1018624.	.40	13.83	2	34.538	1.453

Table 3.16 (continued)

```
1
 Age  2   Catchability dependent on age and year class strength

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT16: NorBarLofAcSu,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT17: RusSurCatch/h,         1.,   .000,       .000,    .00,   0,  .000,     .000

   P shrinkage mean  ,    531384.,    .25,,,,                        .941,     .344

   F shrinkage mean  ,    551907.,   1.00,,,,                        .059,     .333

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    532579.,       .24,    13.19,    2,  54.146,   .344

 Age  3   Catchability dependent on age and year class strength

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,    246529.,   .300,       .000,    .00,   1,  .208,     .042
 FLT16: NorBarLofAcSu,    221415.,   .342,       .000,    .00,   1,  .160,     .047
 FLT17: RusSurCatch/h,    224370.,   .359,       .000,    .00,   1,  .145,     .046

   P shrinkage mean  ,    401487.,    .20,,,,                        .469,     .026

   F shrinkage mean  ,    113932.,   1.00,,,,                        .019,     .089

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    295984.,       .14,      .19,    5,   1.412,   .035

 Age  4   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,    333544.,   .212,       .026,    .12,   2,  .269,     .109
 FLT16: NorBarLofAcSu,    274511.,   .212,       .014,    .06,   2,  .269,     .131
 FLT17: RusSurCatch/h,    339942.,   .212,       .016,    .07,   2,  .269,     .107

   P shrinkage mean  ,    271070.,    .28,,,,                        .180,     .133

   F shrinkage mean  ,    282960.,   1.00,,,,                        .014,     .127

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    305809.,       .11,      .04,    8,    .370,   .118

 Age  5   Catchability dependent on age and year class strength

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,    144727.,   .175,       .121,    .70,   3,  .316,     .263
 FLT16: NorBarLofAcSu,    143180.,   .175,       .157,    .90,   3,  .316,     .265
 FLT17: RusSurCatch/h,    170723.,   .184,       .035,    .19,   3,  .282,     .227

   P shrinkage mean  ,    151954.,    .43,,,,                        .073,     .252

   F shrinkage mean  ,    102125.,   1.00,,,,                        .013,     .355

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    150952.,       .10,      .06,   11,    .579,   .253
```

Table 3.16 (continued)

```
1
 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,     93855.,   .154,       .053,    .34,   4,  .380,     .486
 FLT16: NorBarLofAcSu,     99399.,   .154,       .091,    .59,   4,  .380,     .464
 FLT17: RusSurCatch/h,    134512.,   .190,       .041,    .21,   4,  .223,     .362

   F shrinkage mean  ,     77303.,   1.00,,,,                        .018,     .565

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    103574.,       .09,      .05,   13,    .568,   .449


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

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,     47259.,   .150,       .130,    .87,   5,  .423,     .657
 FLT16: NorBarLofAcSu,     47928.,   .155,       .095,    .62,   5,  .372,     .650
 FLT17: RusSurCatch/h,     55264.,   .197,       .161,    .82,   5,  .178,     .585

   F shrinkage mean  ,     41092.,   1.00,,,,                        .027,     .727

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     48659.,       .10,      .07,   16,    .681,   .643


1
 Age  8   Catchability constant w.r.t. time and dependent on age

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FLT15: NorBarTrSur r,     16005.,   .162,       .143,    .89,   6,  .458,     .688
 FLT16: NorBarLofAcSu,     20021.,   .172,       .086,    .50,   6,  .368,     .583
 FLT17: RusSurCatch/h,     21849.,   .224,       .155,    .69,   6,  .135,     .545

   F shrinkage mean  ,     10868.,   1.00,,,,                        .039,     .899

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     17854.,       .11,      .08,   19,    .693,   .635


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

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,      4164.,   .373,       .000,    .00,   1,  .191,     .842
 FLT15: NorBarTrSur r,      5391.,   .186,       .061,    .33,   6,  .229,     .703
 FLT16: NorBarLofAcSu,      4768.,   .202,       .090,    .44,   7,  .472,     .767
 FLT17: RusSurCatch/h,      5006.,   .289,       .306,   1.06,   6,  .051,     .741

   F shrinkage mean  ,      3434.,   1.00,,,,                        .058,     .956

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4700.,       .14,      .06,   21,    .405,   .775
```

Table 3.16 (continued)

1

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

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,      1617.,   .241,       .128,    .53,   2,  .470,     .669
 FLT15: NorBarTrSur r,      1564.,   .199,       .086,    .43,   6,  .127,     .685
 FLT16: NorBarLofAcSu,      1650.,   .217,       .201,    .93,   8,  .321,     .659
 FLT17: RusSurCatch/h,      1126.,   .387,       .386,   1.00,   6,  .021,     .861

   F shrinkage mean  ,       897.,   1.00,,,,                        .061,     .999

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1552.,       .15,      .08,   23,    .542,   .689


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

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,       444.,   .198,       .071,    .36,   3,  .685,     .459
 FLT15: NorBarTrSur r,       305.,   .227,       .045,    .20,   6,  .062,     .614
 FLT16: NorBarLofAcSu,       311.,   .247,       .084,    .34,   9,  .189,     .605
 FLT17: RusSurCatch/h,       271.,   .542,       .172,    .32,   6,  .008,     .670

   F shrinkage mean  ,       198.,   1.00,,,,                        .056,     .835

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       386.,       .16,      .05,   25,    .355,   .513


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

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT09: Russian trawl,        87.,   .210,       .044,    .21,   4,  .707,     .832
 FLT15: NorBarTrSur r,       112.,   .265,       .027,    .10,   6,  .030,     .693
 FLT16: NorBarLofAcSu,       114.,   .301,       .273,    .91,   9,  .134,     .685
 FLT17: RusSurCatch/h,        77.,   .695,       .140,    .20,   6,  .003,     .902

   F shrinkage mean  ,       135.,   1.00,,,,                        .125,     .606

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        96.,       .20,      .07,   26,    .340,   .776



1
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Table 3.17

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

At 26/04/2005 7:03

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1984,
AGE	
1,	.2458,
2,	.0373,
3,	.0199,
4,	.1235,
5,	.3075,
6,	.6274,
7,	1.1361,
8,	1.2111,
9,	1.2623,
10,	.9579,
11,	1.0876,
12,	1.0345,
+gp,	1.0345,
0 FBAR 5-10,	.9171,
FBAR 4- 8,	.6811,

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
1,	.3591,	.9368,	.5267,	.8044,	.2166,	.0961,	.1027,	.4656,	2.5644,	1.7153,
2,	.0577,	.8028,	.8028,	.1102,	.0020,	.0594,	.2370,	.1444,	.4481,	.6300,
3,	.0533,	.1451,	.1137,	.0629,	.0327,	.0086,	.0183,	.0405,	.0790,	.2096,
4,	.1701,	.2122,	.2285,	.1270,	.1284,	.0622,	.0624,	.1265,	.0963,	.2014,
5,	.3763,	.4933,	.5097,	.3704,	.2660,	.1342,	.1875,	.2205,	.3467,	.3392,
6,	.6051,	.7052,	.9364,	.5972,	.4016,	.2310,	.3210,	.4428,	.4597,	.6458,
7,	.9248,	.9480,	1.1398,	1.0446,	.7156,	.2505,	.4259,	.5398,	.5663,	1.1680,
8,	1.0189,	1.0910,	1.0143,	.9834,	.8893,	.3743,	.3452,	.5994,	.5979,	.9862,
9,	.7786,	.8281,	.7784,	1.1591,	.7167,	.3059,	.3806,	.4560,	.6668,	1.0552,
10,	.5057,	1.1120,	1.3241,	1.7180,	.9856,	.3243,	.2561,	.4588,	.6636,	1.0408,
11,	.4205,	.8745,	1.0270,	1.5372,	.5821,	.5401,	.1341,	.2483,	.6767,	1.1634,
12,	.4665,	1.0045,	1.1899,	1.6497,	.7918,	.4353,	.1959,	.3558,	.6764,	1.1152,
+gp,	.4665,	1.0045,	1.1899,	1.6497,	.7918,	.4353,	.1959,	.3558,	.6764,	1.1152,
0 FBAR 5-10,	.7016,	.8629,	.9504,	.9788,	.6625,	.2700,	.3194,	.4529,	.5501,	.8725,
FBAR 4- 8,	.6190,	.6899,	.7657,	.6245,	.4802,	.2104,	.2684,	.3858,	.4134,	.6681,

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

At 26/04/2005 7:03

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	FBAR **-**
AGE											
1,	1.8666,	1.9909,	2.5044,	1.6100,	1.0811,	1.4705,	1.0330,	.5856,	1.6692,	1.4535,	1.2361,
2,	.9336,	1.0525,	1.0946,	.6105,	.3584,	.2530,	.2205,	.5919,	.2328,	.3436,	.3894,
3,	.5546,	.4692,	.3390,	.3752,	.1247,	.0747,	.0600,	.1221,	.0645,	.0354,	.0740,
4,	.3047,	.3523,	.2999,	.3510,	.2101,	.1332,	.1123,	.1023,	.0766,	.1184,	.0991,
5,	.3383,	.4116,	.5688,	.5195,	.5439,	.4107,	.2707,	.2790,	.2580,	.2531,	.2634,
6,	.5773,	.5428,	.7242,	.7787,	.7180,	.5967,	.5193,	.5153,	.4505,	.4488,	.4715,
7,	.8913,	.7498,	.8435,	.7729,	.8073,	.7383,	.6556,	.8073,	.5918,	.6433,	.6808,
8,	.9430,	.8634,	1.2354,	1.0447,	1.0617,	1.0270,	.8085,	.8489,	.7015,	.6352,	.7286,
9,	.9613,	.7512,	1.3422,	1.1743,	1.4020,	1.1960,	.8709,	.7336,	.5260,	.7748,	.6782,
10,	1.0222,	.9383,	1.5051,	1.2606,	1.4357,	1.1974,	1.1536,	.7056,	.4471,	.6888,	.6138,
11,	1.2565,	.8724,	1.4360,	1.3193,	.9776,	1.1506,	.8866,	.7095,	.4096,	.5126,	.5439,
12,	1.1572,	.9197,	1.5334,	1.2869,	1.1385,	1.3370,	1.1993,	.9408,	.7960,	.7764,	.8377,
+gp,	1.1572,	.9197,	1.5334,	1.2869,	1.1385,	1.3370,	1.1993,	.9408,	.7960,	.7764,	
0 FBAR 5-10,	.7889,	.7095,	1.0365,	.9251,	.9948,	.8610,	.7131,	.6483,	.4958,	.5740,	
FBAR 4- 8,	.6109,	.5840,	.7344,	.6933,	.6682,	.5812,	.4733,	.5106,	.4157,	.4198,	

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Table 3.18 Stock number at age

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

At 26/04/2005 7:03

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1984,
AGE	
1,	211668,
2,	67034,
3,	40282,
4,	13543,
5,	7852,
6,	4763,
7,	2465,
8,	1304,
9,	923,
10,	140,
11,	39,
12,	26,
+gp,	12,
0 TOTAL,	350052,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
1,	137711,	175524,	49254,	82176,	81895,	151888,	173229,	305491,	2429610,	936482,
2,	135540,	78735,	56314,	23815,	30099,	53994,	112958,	127988,	157005,	153097,
3,	52873,	104745,	28885,	20658,	17464,	24594,	41657,	72970,	90697,	82117,
4,	32331,	41043,	74172,	21108,	15882,	13838,	19963,	33488,	57372,	68617,
5,	9800,	22329,	27179,	48321,	15221,	11436,	10646,	15355,	24159,	42661,
6,	4727,	5507,	11163,	13366,	27315,	9551,	8187,	7226,	10084,	13984,
7,	2082,	2113,	2227,	3583,	6023,	14966,	6207,	4862,	3800,	5214,
8,	648,	676,	670,	583,	1032,	2411,	9538,	3319,	2320,	1766,
9,	318,	192,	186,	199,	179,	347,	1358,	5530,	1492,	1045,
10,	214,	120,	69,	70,	51,	71,	209,	760,	2870,	627,
11,	44,	106,	32,	15,	10,	16,	42,	133,	393,	1210,
12,	11,	24,	36,	9,	3,	5,	7,	30,	85,	164,
+gp,	21,	13,	16,	8,	6,	4,	2,	5,	19,	23,
0 TOTAL,	376319,	431125,	250204,	213912,	195179,	283121,	384005,	577157,	2779908,	1307006,

1

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

At 26/04/2005 7:03

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	GMST 84-**	AMST 84-**
AGE													
1,	2009727,	2778264,	1929795,	672105,	311315,	349714,	414937,	126652,	594618,	532236,	0,	340447,	701444,
2,	137948,	254466,	310648,	129124,	109993,	86458,	65803,	120924,	57736,	91717,	101862,	97150,	116418,
3,	66759,	44402,	72723,	85124,	57415,	62928,	54963,	43213,	54777,	37454,	53258,	50175,	56025,
4,	54520,	31391,	22739,	42422,	47890,	41495,	47811,	42379,	31314,	42044,	29598,	33737,	38000,
5,	45931,	32913,	18070,	13794,	24452,	31778,	29737,	34986,	31324,	23748,	30581,	21469,	24559,
6,	24880,	26813,	17854,	8376,	6718,	11621,	17254,	18573,	21670,	19815,	15095,	11291,	13051,
7,	6002,	11436,	12757,	7085,	3148,	2682,	5239,	8404,	9083,	11307,	10357,	4852,	5805,
8,	1328,	2015,	4424,	4493,	2678,	1150,	1050,	2227,	3069,	4115,	4866,	1713,	2296,
9,	539,	423,	696,	1053,	1294,	758,	337,	383,	780,	1246,	1785,	580,	908,
10,	298,	169,	163,	149,	266,	261,	188,	115,	151,	377,	470,	195,	358,
11,	181,	88,	54,	30,	35,	52,	64,	49,	47,	79,	155,	60,	136,
12,	309,	42,	30,	11,	7,	11,	13,	22,	20,	25,	39,	20,	44,
+gp,	42,	162,	53,	17,	11,	4,	5,	6,	13,	13,	14,		
0 TOTAL,	2348463,	3182584,	2390005,	963782,	565221,	588911,	637401,	397932,	804600,	764176,	248082,		

1

Table 3.19.

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

At 26/04/2005 10:40

Table 4 Natural Mortality (M) at age

YEAR,	1946,	1947,	1948,	1949,	1950,	1951,	1952,	1953,	1954,
AGE									
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

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

At 26/04/2005 10:40

Table 4 Natural Mortality (M) at age

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 3.19 (continued)

Table 4 Natural Mortality (M) at age

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2006,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	.2004,	.3108,	.2580,	.2087,	.2000,	.2000,	.2050,	.2066,	.2660,	.3996,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2030,	.2956,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2026,	.2259,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2047,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	.7441,	.6453,	.5160,	.5256,	.3094,	.2662,	.2495,	.3156,	.2493,	.2294,
4,	.4046,	.4321,	.2946,	.2764,	.2115,	.2393,	.2268,	.2171,	.2000,	.2178,
5,	.2112,	.2810,	.2104,	.2164,	.2000,	.2164,	.2071,	.2033,	.2000,	.2000,
6,	.2015,	.2060,	.2020,	.2097,	.2000,	.2005,	.2065,	.2001,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

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

YEAR	M2 AGE 1	M2 AGE 2	M2 AGE 3	M2 AGE 4	M2 AGE 5	M2 AGE 6
1984	0.2435	0.0351	0.0006	0.0000	0.0000	0.0000
1985	0.3583	0.0555	0.0004	0.0000	0.0000	0.0000
1986	0.5068	0.7908	0.1108	0.0000	0.0000	0.0000
1987	0.5205	0.7947	0.0580	0.0000	0.0000	0.0000
1988	0.7998	0.1087	0.0087	0.0000	0.0000	0.0000
1989	0.2148	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0480	0.0587	0.0000	0.0000	0.0000	0.0000
1991	0.1023	0.2356	0.0050	0.0000	0.0000	0.0000
1992	0.4640	0.1412	0.0066	0.0000	0.0000	0.0000
1993	2.5640	0.4471	0.0660	0.0030	0.0026	0.0000
1994	1.7148	0.6291	0.1996	0.0956	0.0259	0.0047
1995	1.8666	0.9333	0.5441	0.2047	0.0112	0.0015
1996	1.9909	1.0519	0.4454	0.2321	0.0810	0.0060
1997	2.5044	1.0938	0.3160	0.0946	0.0104	0.0020
1998	1.6099	0.6086	0.3258	0.0766	0.0164	0.0097
1999	1.0808	0.3580	0.1096	0.0117	0.0000	0.0000
2000	1.4700	0.2525	0.0663	0.0398	0.0167	0.0005
2001	1.0326	0.2199	0.0496	0.0282	0.0076	0.0072
2002	0.5853	0.5912	0.1157	0.0173	0.0033	0.0001
2003	1.6689	0.4633	0.0494	0.0000	0.0000	0.0000
2004	1.4532	0.3432	0.0372	0.0176	0.0000	0.0000

Table 3.21

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

At 26/04/2005 10:40

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,
AGE									
3,	.0061,	.0018,	.0003,	.0023,	.0020,	.0254,	.0225,	.0334,	.0199,
4,	.0200,	.0249,	.0124,	.0209,	.0321,	.1612,	.1667,	.1325,	.1457,
5,	.0532,	.1101,	.0751,	.1484,	.1167,	.2637,	.3700,	.2299,	.2676,
6,	.0973,	.2024,	.1997,	.3662,	.2882,	.2787,	.5501,	.3125,	.3333,
7,	.1781,	.4160,	.5201,	.5101,	.4096,	.4122,	.5311,	.3243,	.3969,
8,	.1932,	.2545,	.3536,	.3869,	.3480,	.4046,	.4175,	.3469,	.2494,
9,	.3125,	.4047,	.5286,	.3832,	.4741,	.5057,	.5790,	.3932,	.4364,
10,	.2798,	.4405,	.3617,	.3766,	.5031,	.5149,	.7613,	.5364,	.6441,
11,	.3432,	.7827,	.5536,	.6259,	.9031,	.4585,	1.0260,	.6980,	.8035,
12,	.3120,	.6182,	.4604,	.5039,	.7111,	.4879,	.9056,	.6217,	.7304,
+gp,	.3120,	.6182,	.4604,	.5039,	.7111,	.4879,	.9056,	.6217,	.7304,
0 FBAR 5-10,	.1857,	.3047,	.3398,	.3619,	.3566,	.3966,	.5348,	.3572,	.3879,
FBAR 4- 8,	.1084,	.2016,	.2322,	.2865,	.2389,	.3041,	.4071,	.2692,	.2786,

Table 8 Fishing mortality (F) at age

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	.0159,	.0270,	.0240,	.0718,	.0535,	.0543,	.0562,	.0663,	.0313,	.0174,
4,	.0840,	.1291,	.1128,	.2589,	.2564,	.2266,	.2717,	.3063,	.2366,	.1449,
5,	.2859,	.4568,	.2094,	.3626,	.5093,	.3477,	.4944,	.6498,	.7420,	.3537,
6,	.5297,	.6900,	.4862,	.5517,	.5121,	.4607,	.5168,	.8279,	1.0069,	.4854,
7,	.5139,	.6129,	.5494,	.5357,	.5251,	.4363,	.5279,	.6094,	.9764,	.5787,
8,	.5880,	.6880,	.6287,	.4593,	.5111,	.4855,	.6931,	.6564,	.8798,	.7409,
9,	.5805,	.6551,	.5463,	.4535,	.6141,	.4053,	.7389,	.8167,	.9416,	1.0674,
10,	.7645,	.7380,	.6333,	.7388,	.6860,	.7381,	.8379,	.9855,	1.3731,	.8476,
11,	.7621,	.8756,	.8584,	.8415,	.6511,	.8449,	1.0011,	.9522,	1.4366,	1.2968,
12,	.7704,	.8152,	.7529,	.7990,	.6734,	.7981,	.9284,	.9756,	1.4264,	1.0883,
+gp,	.7704,	.8152,	.7529,	.7990,	.6734,	.7981,	.9284,	.9756,	1.4264,	1.0883,
0 FBAR 5-10,	.5437,	.6401,	.5089,	.5169,	.5596,	.4789,	.6348,	.7576,	.9866,	.6789,
FBAR 4- 8,	.4003,	.5154,	.3973,	.4337,	.4628,	.3914,	.5008,	.6100,	.7683,	.4607,

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

At 26/04/2005 10:40

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	.0226,	.0398,	.0298,	.0251,	.0230,	.0409,	.0214,	.0394,	.1959,	.2141,
4,	.1110,	.1037,	.1525,	.2064,	.2292,	.1422,	.1028,	.1673,	.1996,	.4959,
5,	.3909,	.2119,	.1814,	.4087,	.4792,	.4004,	.2285,	.2976,	.3536,	.5375,
6,	.4494,	.3818,	.2026,	.4683,	.5382,	.5680,	.2517,	.3849,	.3917,	.5078,
7,	.4033,	.4713,	.4320,	.4019,	.7725,	.6211,	.5144,	.3427,	.4210,	.4451,
8,	.5303,	.5797,	.6844,	.5291,	.9302,	.8479,	.8330,	.6583,	.7375,	.4863,
9,	.7389,	.7183,	.8781,	.8041,	1.1783,	.9682,	.9584,	1.1338,	.9698,	.5192,
10,	.8074,	.8182,	.8850,	.8105,	1.0769,	1.0900,	.7876,	1.3393,	.7386,	.8842,
11,	.7617,	.5024,	1.2253,	.6772,	1.5554,	.8533,	.8388,	1.2904,	.7222,	.9905,
12,	.7927,	.6634,	1.0696,	.7458,	1.3377,	.9829,	.8179,	1.3377,	.7358,	.9492,
+gp,	.7927,	.6634,	1.0696,	.7458,	1.3377,	.9829,	.8179,	1.3377,	.7358,	.9492,
0 FBAR 5-10,	.5533,	.5302,	.5439,	.5704,	.8292,	.7493,	.5956,	.6928,	.6020,	.5633,
FBAR 4- 8,	.3770,	.3497,	.3306,	.4029,	.5899,	.5159,	.3861,	.3702,	.4207,	.4945,

Table 3.21(continued)

Table 8 Fishing mortality (F) at age

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	.0837,	.1660,	.1338,	.1460,	.0489,	.0318,	.0252,	.0672,	.0208,	.0194,
4,	.2106,	.3121,	.5671,	.2234,	.2090,	.1296,	.1003,	.2121,	.2050,	.1247,
5,	.5211,	.4800,	.7544,	.6703,	.3475,	.3562,	.2300,	.3045,	.3308,	.3096,
6,	.7021,	.5715,	.6857,	.8497,	.5478,	.6225,	.5163,	.5518,	.5033,	.6301,
7,	.7050,	.6973,	.6763,	.8581,	.6643,	.6766,	.8475,	.7996,	.7821,	1.1350,
8,	.7032,	.8908,	.9121,	.9296,	.7789,	.7123,	1.0788,	.9846,	1.0295,	1.2083,
9,	.6109,	.7746,	1.2298,	1.3057,	1.0352,	.9390,	1.2765,	1.1588,	.9701,	1.2572,
10,	.7149,	.4600,	.7689,	1.0301,	.9848,	1.0380,	1.2299,	.7508,	.9203,	.9564,
11,	.9079,	.6132,	.6231,	1.8042,	1.4314,	1.4798,	.9557,	.9516,	.5854,	1.0810,
12,	.8218,	.5389,	.6958,	1.4375,	1.2219,	1.2775,	1.1082,	.8607,	.7590,	1.0346,
+gp,	.8218,	.5389,	.6958,	1.4375,	1.2219,	1.2775,	1.1082,	.8607,	.7590,	1.0346,
0 FBAR 5-10,	.6595,	.6457,	.8379,	.9406,	.7264,	.7241,	.8632,	.7583,	.7560,	.9161,
FBAR 4- 8,	.5684,	.5904,	.7191,	.7062,	.5095,	.4994,	.5546,	.5705,	.5701,	.6815,

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	.0533,	.0330,	.0555,	.0546,	.0330,	.0087,	.0134,	.0341,	.0129,	.0098,
4,	.1717,	.2133,	.2294,	.1277,	.1292,	.0627,	.0631,	.1276,	.0942,	.1065,
5,	.3788,	.4960,	.5105,	.3712,	.2671,	.1352,	.1889,	.2226,	.3464,	.3153,
6,	.6078,	.7079,	.9363,	.5975,	.4027,	.2324,	.3229,	.4449,	.4635,	.6435,
7,	.9264,	.9487,	1.1364,	1.0414,	.7144,	.2521,	.4277,	.5420,	.5693,	1.1663,
8,	1.0192,	1.0910,	1.0144,	.9790,	.8856,	.3757,	.3475,	.6013,	.6015,	.9867,
9,	.7818,	.8325,	.7842,	1.1548,	.7138,	.3070,	.3827,	.4595,	.6698,	1.0566,
10,	.5088,	1.1134,	1.3246,	1.7031,	.9796,	.3246,	.2576,	.4619,	.6695,	1.0413,
11,	.4237,	.8774,	1.0330,	1.5285,	.5814,	.5383,	.1347,	.2502,	.6815,	1.1728,
12,	.4665,	1.0046,	1.1899,	1.6500,	.7921,	.4357,	.1962,	.3562,	.6781,	1.1208,
+gp,	.4665,	1.0046,	1.1899,	1.6500,	.7921,	.4357,	.1962,	.3562,	.6781,	1.1208,
0 FBAR 5-10,	.7038,	.8649,	.9510,	.9745,	.6605,	.2712,	.3212,	.4554,	.5533,	.8683,
FBAR 4- 8,	.6208,	.6914,	.7654,	.6234,	.4798,	.2116,	.2700,	.3877,	.4150,	.6437,

Table 8 Fishing mortality (F) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	FBAR **-**
AGE											
3,	.0105,	.0239,	.0231,	.0497,	.0154,	.0086,	.0105,	.0064,	.0151,	.0075,	.0097,
4,	.1008,	.1208,	.2063,	.2756,	.1999,	.0947,	.0861,	.0855,	.0767,	.1005,	.0876,
5,	.3292,	.3326,	.5596,	.5044,	.5447,	.3959,	.2648,	.2769,	.2584,	.2529,	.2627,
6,	.5787,	.5398,	.7241,	.7684,	.7181,	.5970,	.5145,	.5159,	.4516,	.4481,	.4719,
7,	.8929,	.7539,	.8465,	.7763,	.8053,	.7380,	.6563,	.8067,	.5921,	.6433,	.6807,
8,	.9447,	.8676,	1.2361,	1.0485,	1.0648,	1.0147,	.8065,	.8469,	.7021,	.6352,	.7281,
9,	.9634,	.7575,	1.3418,	1.1783,	1.4033,	1.2023,	.8482,	.7312,	.5271,	.7748,	.6777,
10,	1.0266,	.9442,	1.5065,	1.2625,	1.4414,	1.2085,	1.1745,	.6695,	.4482,	.6888,	.6022,
11,	1.2506,	.8853,	1.4421,	1.3314,	.9891,	1.1757,	.9165,	.7493,	.3770,	.5126,	.5463,
12,	1.1871,	.9151,	1.5763,	1.3135,	1.1797,	1.3730,	1.2850,	1.0221,	.8948,	.7764,	.8978,
+gp,	1.1871,	.9151,	1.5763,	1.3135,	1.1797,	1.3730,	1.2850,	1.0221,	.8948,	.7764,	
0 FBAR 5-10,	.7892,	.6993,	1.0358,	.9230,	.9963,	.8594,	.7108,	.6412,	.4966,	.5739,	
FBAR 4- 8,	.5692,	.5229,	.7145,	.6746,	.6666,	.5681,	.4657,	.5064,	.4162,	.4160,	

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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	0.0192	0.1235	0.3075	0.6275
1985	0.0001	0.0015	0.0529	0.1702	0.3763	0.6052
1986	0.0000	0.0017	0.0324	0.2123	0.4934	0.7056
1987	0.0000	0.0011	0.0548	0.2287	0.5100	0.9365
1988	0.0000	0.0009	0.0542	0.1270	0.3709	0.5977
1989	0.0000	0.0009	0.0327	0.1284	0.2661	0.4025
1990	0.0000	0.0004	0.0086	0.0622	0.1343	0.2311
1991	0.0000	0.0007	0.0133	0.0623	0.1872	0.3210
1992	0.0004	0.0011	0.0331	0.1265	0.2205	0.4427
1993	0.0000	0.0006	0.0128	0.0933	0.3441	0.4597
1994	0.0000	0.0003	0.0097	0.1056	0.3132	0.6411
1995	0.0000	0.0003	0.0105	0.1000	0.3270	0.5758
1996	0.0000	0.0006	0.0238	0.1202	0.3306	0.5368
1997	0.0000	0.0007	0.0230	0.2052	0.5585	0.7223
1998	0.0000	0.0018	0.0494	0.2744	0.5030	0.7689
1999	0.0000	0.0004	0.0152	0.1984	0.5439	0.7182
2000	0.0000	0.0003	0.0084	0.0934	0.3940	0.5961
2001	0.0000	0.0005	0.0104	0.0841	0.2631	0.5122
2002	0.0001	0.0002	0.0063	0.0849	0.2757	0.5152
2003	0.0000	0.0008	0.0151	0.0765	0.2577	0.4504
2004	0.0000	0.0002	0.0075	0.1006	0.2529	0.4481

Table 3.23 Stock number at age

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

At 26/04/2005 10:40

Traditional vpa using file input for terminal F

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

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

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

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	272778,	439602,	804781,	496824,	683690,	789653,	916842,	728338,	472064,	338678,
4,	514924,	219807,	350332,	643259,	378598,	530599,	612324,	709603,	558039,	374580,
5,	891184,	387619,	158175,	256234,	406511,	239862,	346346,	382037,	427678,	360621,
6,	429102,	548181,	200984,	105033,	145989,	199996,	138702,	172949,	163321,	166726,
7,	228785,	206850,	225110,	101196,	49529,	71623,	103298,	67732,	61876,	48854,
8,	74845,	112048,	91748,	106395,	48488,	23986,	37908,	49883,	30149,	19083,
9,	34028,	34036,	46105,	40060,	55027,	23813,	12084,	15518,	21185,	10240,
10,	19329,	15591,	14474,	21860,	20840,	24380,	13000,	4726,	5614,	6764,
11,	8459,	7368,	6103,	6291,	8550,	8592,	9541,	4605,	1444,	1164,
12,	4880,	3232,	2513,	2118,	2220,	3650,	3022,	2871,	1455,	281,
+gp,	2738,	3722,	1687,	857,	1142,	1351,	2332,	1351,	1113,	1278,
0 TOTAL,	2481052,	1978057,	1902013,	1780129,	1800584,	1917505,	2195401,	2139612,	1743938,	1328269,

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

At 26/04/2005 10:40

Traditional vpa using file input for terminal F

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	776941,	1582560,	1295416,	164955,	112039,	197105,	404774,	1015319,	1818949,	523916,
4,	272501,	621906,	1245195,	1029477,	131705,	89647,	154909,	324399,	799193,	1224278,
5,	265306,	199663,	458995,	875269,	685697,	85743,	63671,	114439,	224670,	535936,
6,	207288,	146941,	132256,	313440,	476187,	347649,	47037,	41482,	69576,	129164,
7,	84015,	108284,	82121,	88421,	160667,	227600,	161288,	29940,	23112,	38504,
8,	22424,	45954,	55340,	43651,	48433,	60756,	100131,	78947,	17401,	12421,
9,	7448,	10803,	21072,	22854,	21054,	15642,	21306,	35642,	33463,	6815,
10,	2883,	2913,	4313,	7170,	8373,	5306,	4863,	6690,	9391,	10388,
11,	2373,	1053,	1052,	1457,	2610,	2335,	1461,	1811,	1435,	3673,
12,	261,	907,	522,	253,	606,	451,	815,	517,	408,	571,
+gp,	670,	351,	461,	498,	278,	312,	421,	697,	408,	525,
0 TOTAL,	1642109,	2721334,	3296742,	2547445,	1647648,	1032545,	960676,	1649883,	2998007,	2486189,

Table 3.23 (continued)

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	621616	613942	348054	638490	198490	137735	150868	151830	166828	397819
4	346265	468089	425778	249276	451722	154747	109237	120444	116234	133781
5	610486	229669	280485	197708	163230	300088	111295	80899	79768	77524
6	256342	296843	116349	108003	82807	94414	172067	72401	48848	46916
7	63643	104000	137232	47987	37806	39202	41481	84063	34138	24176
8	20199	25746	42398	57130	16658	15929	16316	14551	30937	12785
9	6253	8186	8650	13943	18463	6259	6397	4542	4451	9048
10	3320	2779	3089	2070	3093	5368	2004	1461	1167	1381
11	3513	1330	1436	1172	605	946	1557	480	565	381
12	1117	1160	590	631	158	118	176	490	152	257
+gp	550	572	583	1198	218	87	66	70	170	116
0 TOTAL	1933303	1752317	1364643	1317608	973250	754893	611464	531230	483257	704184

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	523638	1036924	286228	204599	172779	242750	411793	721139	896056	810607
4	319244	406318	735243	209189	157231	136869	197021	330995	566889	677964
5	96694	220148	268762	478585	150741	113124	105245	151441	238531	421152
6	46570	54205	109756	132074	270319	94489	80902	71339	99245	137764
7	20455	20762	21866	35232	59492	147957	61320	47960	37431	51115
8	6362	6631	6582	5746	10181	23841	94144	32733	22837	17343
9	3127	1880	1824	1954	1767	3438	13406	54452	14688	10246
10	2107	1171	669	682	504	709	2071	7486	28157	6155
11	435	1037	315	146	102	155	419	1310	3862	11802
12	106	233	353	92	26	47	74	300	835	1599
+gp	209	130	156	82	56	40	25	48	191	231
0 TOTAL	1018945	1749441	1431754	1068381	823199	763419	966419	1419202	1908722	2145978

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 46-**	AMST 46-**
AGE													
3	659633	439076	719501	843002	568929	623467	545725	429971	546256	296504	0	498058	608330
4	538273	310148	224856	419681	474198	411132	473652	420783	311603	419329	233963	378857	461204
5	453506	324725	178420	136258	241661	314261	294397	346391	310924	236277	305014	260329	314569
6	245132	264181	175814	82608	66274	114763	170360	183655	214293	196595	150221	148656	180754
7	58987	112352	125315	69638	31063	26462	51697	82838	89755	111692	102827	72755	91298
8	13037	19775	43281	44008	26233	11367	10357	21957	30272	40650	48060	32192	43778
9	5293	4150	6799	10295	12627	7405	3374	3785	7708	12282	17634	13626	24292
10	2916	1654	1593	1455	2595	2541	1822	1183	1492	3725	4633	5377	12932
11	1779	855	527	289	337	503	621	461	496	780	1532	2030	6669
12	2991	417	289	102	63	103	127	203	178	278	383	740	3400
+gp	411	1621	520	173	113	38	52	61	120	125	152		
0 TOTAL	1981957	1478954	1476914	1607509	1424092	1512041	1552184	1491288	1513097	1318239	864417		

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Table 3.24

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

At 26/04/2005 10:40

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

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

YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
AGE										
3,	87289,	145069,	265578,	168920,	239291,	268482,	284221,	233068,	151061,	111764,
4,	293507,	127488,	206696,	334495,	272591,	270606,	336778,	390282,	340404,	206019,
5,	1007038,	414753,	161338,	243423,	597571,	261449,	363663,	355294,	410571,	342590,
6,	742347,	1003170,	365792,	201664,	391251,	425991,	305145,	294013,	282545,	310111,
7,	629160,	597796,	650567,	297518,	177809,	242086,	333654,	205229,	188104,	158775,
8,	294890,	476204,	392683,	447924,	209470,	116810,	193710,	250910,	149537,	94841,
9,	166739,	188902,	253117,	224738,	299899,	145737,	74320,	101645,	136428,	65640,
10,	136079,	113501,	108698,	160673,	134210,	206985,	105953,	36390,	44408,	54588,
11,	60902,	58944,	50286,	54540,	61300,	66934,	82819,	42684,	13894,	10875,
12,	42844,	26988,	23247,	20287,	19159,	30297,	29013,	30314,	16454,	2856,
+gp,	27591,	37015,	17892,	9967,	13275,	15429,	27875,	17178,	14173,	16470,
0 TOTALBIO,	3488383,	3189831,	2495895,	2164149,	2415826,	2050805,	2137149,	1957006,	1747579,	1374529,

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

At 26/04/2005 10:40

Traditional vpa using file input for terminal F

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
3,	295238,	696327,	375671,	54435,	49297,	72929,	182148,	385821,	691201,	167653,
4,	185301,	460210,	1008608,	720634,	104047,	81578,	136320,	249787,	727266,	808024,
5,	273265,	235602,	619644,	1295399,	843407,	114895,	87866,	163647,	345992,	627045,
6,	308859,	261555,	269803,	664492,	966659,	695298,	101599,	87943,	157241,	286743,
7,	202475,	266378,	230760,	277642,	465934,	682799,	495154,	96707,	76038,	123596,
8,	78931,	175545,	192584,	183771,	184531,	252138,	422555,	345787,	80219,	54527,
9,	42675,	57905,	103040,	120443,	105690,	87437,	123791,	207793,	219854,	37616,
10,	21740,	21174,	30662,	47678,	53839,	40323,	34676,	50977,	78601,	81651,
11,	20098,	9087,	9500,	13129,	21742,	20948,	12590,	17245,	15127,	36074,
12,	2911,	9669,	5524,	2444,	6492,	4958,	8822,	6248,	4742,	6512,
+gp,	9201,	4967,	6369,	7389,	3953,	4396,	5449,	9529,	5674,	6947,
0 TOTALBIO,	1440693,	2198418,	2852164,	3387455,	2805591,	2057698,	1610969,	1621485,	2401955,	2236387,

Table 3.24 (continued)

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	254863,	214880,	170547,	312860,	69471,	37188,	73925,	56177,	61726,	167084,
4,	221610,	341705,	383200,	201913,	316206,	86659,	107052,	79493,	106935,	155186,
5,	677639,	273307,	401093,	286676,	202406,	306090,	160265,	109213,	127629,	140319,
6,	487049,	596655,	238515,	232207,	177208,	162392,	359620,	144077,	119188,	130896,
7,	187748,	287041,	452865,	145879,	119088,	118389,	123613,	246304,	130406,	91385,
8,	88269,	108649,	193334,	254800,	71461,	66900,	79133,	61698,	147262,	58429,
9,	35894,	48132,	55876,	91184,	121484,	36552,	42028,	29340,	27463,	55823,
10,	29113,	25849,	26656,	16521,	26635,	38975,	18354,	12436,	8986,	10636,
11,	34848,	13669,	14264,	11898,	5579,	8362,	16843,	5870,	5224,	3521,
12,	13192,	13760,	6427,	6843,	1720,	1099,	1899,	5283,	1645,	2794,
+gp,	7206,	7750,	7970,	15783,	3124,	1256,	924,	979,	2209,	1513,
0 TOTALBIO,	2037430,	1931396,	1950748,	1576565,	1114381,	863861,	983657,	750870,	738673,	817587,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	214691,	321447,	54383,	42966,	51834,	97100,	213309,	317301,	308243,	190493,
4,	280935,	357560,	374974,	83676,	81760,	97177,	223816,	308156,	664394,	510507,
5,	154710,	323618,	344016,	378082,	131145,	133486,	183442,	274412,	434127,	598036,
6,	130861,	133887,	212927,	250940,	400073,	162521,	196430,	193756,	280169,	332424,
7,	83047,	81388,	71720,	104992,	160035,	363975,	197081,	186803,	150886,	195513,
8,	37092,	38529,	34032,	25227,	47139,	85112,	427227,	169424,	125534,	93930,
9,	24045,	12370,	11890,	15263,	12460,	16193,	92233,	368858,	99364,	67941,
10,	21322,	8001,	6226,	8254,	5032,	5528,	22196,	71850,	241334,	46961,
11,	6210,	11408,	4142,	1911,	940,	1389,	3961,	16284,	41889,	95740,
12,	1147,	2527,	3831,	996,	281,	505,	804,	3256,	9063,	17354,
+gp,	2797,	1768,	2151,	1074,	807,	541,	348,	650,	2456,	2952,
0 TOTALBIO,	956857,	1292503,	1120291,	913379,	891506,	963528,	1560846,	1910750,	2357461,	2151852,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	132586,	85620,	145339,	182931,	115493,	120953,	155532,	107493,	125639,	71161,
4,	261062,	151042,	117150,	223690,	246583,	191176,	247246,	254153,	167331,	201278,
5,	516997,	334791,	192515,	158195,	283711,	379627,	351510,	411859,	407310,	262740,
6,	519190,	542628,	330178,	160176,	134602,	226313,	380073,	392653,	430515,	403807,
7,	204684,	396042,	422187,	205085,	94246,	80656,	170911,	276098,	290897,	331949,
8,	64375,	108822,	227787,	201292,	117106,	46559,	52303,	104669,	150483,	185650,
9,	37900,	32233,	60696,	76419,	81848,	42388,	21512,	25963,	51942,	81071,
10,	26594,	16800,	19360,	15083,	26643,	18947,	16607,	11040,	12987,	32633,
11,	17967,	9125,	5700,	3394,	3668,	4816,	7003,	4695,	7449,	8504,
12,	32447,	4524,	3135,	1106,	678,	1114,	1378,	2207,	1935,	3021,
+gp,	5233,	20478,	6950,	2402,	1541,	522,	750,	793,	1553,	1626,
0 TOTALBIO,	1819036,	1702104,	1530998,	1229774,	1106118,	1113070,	1404825,	1591624,	1648042,	1583439,

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Table 3.25

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

At 26/04/2005 10:40

Traditional vpa using file input for terminal F

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

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

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

	YEAR,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,
	AGE										
	3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	4,	0,	0,	0,	0,	0,	2706,	0,	0,	3404,	0,
	5,	10070,	4148,	1613,	2434,	5976,	7843,	3637,	3553,	4106,	0,
	6,	22270,	30095,	10974,	6050,	15650,	25559,	18309,	14701,	8476,	9303,
	7,	44041,	35868,	39034,	17851,	21337,	24209,	40038,	30784,	13167,	20641,
	8,	38336,	57144,	35341,	44792,	71220,	22194,	60050,	85309,	41870,	35091,
	9,	43352,	26446,	30374,	22474,	146950,	65582,	48308,	62004,	57300,	43323,
	10,	72122,	46535,	23914,	48202,	89921,	142819,	96417,	29476,	35970,	48583,
	11,	50549,	39492,	30172,	27270,	51492,	51539,	81163,	39269,	13616,	10332,
	12,	39416,	24559,	19063,	16635,	16668,	25753,	28433,	29404,	16125,	2828,
	+gp,	26763,	35534,	17356,	9668,	13275,	15274,	27875,	17178,	14173,	16470,
0	TOTSPBIO,	346919,	299823,	207840,	195377,	432489,	383479,	404228,	311678,	208207,	186570,

1

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

At 26/04/2005 10:40

Traditional vpa using file input for terminal F

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

	YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
	AGE										
	3,	0,	0,	0,	0,	0,	0,	0,	3858,	0,	0,
	4,	0,	0,	0,	0,	0,	816,	0,	4996,	0,	0,
	5,	0,	2356,	0,	38862,	0,	0,	879,	3273,	0,	0,
	6,	3089,	5231,	8094,	33225,	19333,	6953,	5080,	879,	3145,	2867,
	7,	12149,	15983,	16153,	24988,	18637,	47796,	54467,	9671,	12166,	3708,
	8,	15786,	38620,	26962,	34917,	22144,	57992,	126766,	117567,	42516,	11451,
	9,	23471,	20267,	39155,	46973,	35935,	50714,	73036,	132988,	178082,	18808,
	10,	15870,	15669,	19624,	27653,	29611,	32662,	27394,	41292,	72313,	78385,
	11,	19897,	8542,	8455,	10766,	16089,	18644,	10827,	16210,	14370,	36074,
	12,	2853,	9089,	4972,	2444,	6167,	4512,	7763,	6248,	4647,	6251,
	+gp,	9201,	4967,	6369,	7389,	3953,	4396,	5449,	9529,	5674,	6947,
0	TOTSPBIO,	102315,	120722,	129784,	227215,	151870,	224482,	311662,	346511,	332913,	164491,

Table 3.25 (continued)

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	617,	0,
4,	0,	0,	0,	0,	0,	0,	0,	3975,	8555,	7759,
5,	6776,	0,	8022,	0,	0,	0,	3205,	10921,	12763,	25257,
6,	9741,	29833,	19081,	4644,	5316,	3248,	25173,	48986,	35756,	40578,
7,	16897,	34445,	117745,	18964,	15481,	15391,	24723,	160097,	95196,	51176,
8,	18536,	31508,	104400,	112112,	27870,	23415,	42732,	50592,	129590,	52586,
9,	20100,	21659,	42466,	64741,	93543,	23759,	33622,	26992,	26639,	55265,
10,	22708,	21713,	23191,	12721,	23705,	31960,	17804,	12436,	8986,	10636,
11,	27530,	11345,	13266,	9637,	4630,	8362,	16843,	5870,	5224,	3521,
12,	12532,	13760,	6041,	6090,	1342,	989,	1899,	5283,	1645,	2794,
+gp,	7206,	6975,	7173,	12626,	2812,	1130,	924,	979,	2209,	1513,
0 TOTSPBIO,	142028,	171238,	341385,	241536,	174699,	108253,	166926,	326132,	327180,	251086,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	3173,	0,	0,
4,	2809,	17878,	3750,	1674,	0,	972,	8953,	3082,	19932,	5105,
5,	13924,	25889,	24081,	18904,	6557,	6674,	11006,	32929,	39071,	65784,
6,	47110,	25438,	38327,	82810,	72013,	34130,	55001,	83315,	84051,	109700,
7,	45676,	43136,	15778,	55646,	65614,	211106,	128103,	140102,	92041,	117308,
8,	31528,	27356,	15654,	15640,	32526,	65537,	354598,	157564,	114236,	76083,
9,	23083,	7669,	5945,	15263,	10591,	13926,	89466,	357792,	96383,	65903,
10,	19190,	7201,	4669,	8254,	5032,	5417,	22196,	71850,	238921,	46492,
11,	6210,	11408,	4142,	1911,	940,	1389,	3961,	16284,	41889,	94782,
12,	1147,	2527,	3831,	996,	281,	505,	804,	3256,	9063,	17354,
+gp,	2797,	1768,	2151,	1074,	807,	541,	348,	650,	2456,	2952,
0 TOTSPBIO,	193474,	170270,	118329,	202171,	194362,	340196,	674435,	869997,	738043,	601464,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	0,	2237,	0,	0,	2472,	2542,	0,	1208,
5,	36190,	6696,	3850,	6328,	2837,	22778,	17576,	32949,	41138,	24435,
6,	171333,	141083,	46225,	30433,	13460,	49789,	129225,	157061,	157138,	162734,
7,	126904,	249506,	236425,	90237,	42411,	51620,	99128,	193269,	182683,	238008,
8,	47638,	90322,	186785,	165059,	92514,	38644,	40274,	90015,	132274,	162629,
9,	36005,	31588,	57661,	71070,	72026,	41116,	21081,	25444,	48150,	79369,
10,	26062,	16800,	18392,	14782,	26643,	18947,	16607,	11040,	12987,	32046,
11,	17967,	9125,	5415,	3394,	3668,	4816,	6793,	4695,	7449,	8504,
12,	32447,	4524,	3135,	1106,	678,	1114,	1378,	2207,	1935,	3021,
+gp,	5233,	20478,	6950,	2402,	1541,	522,	750,	793,	1553,	1626,
0 TOTSPBIO,	499779,	570123,	564839,	387048,	255778,	229345,	335284,	520014,	585309,	713578,

1

Table 3.26

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

At 26/04/2005 10:40

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-10,	FBAR 4- 8,
1946,	728139,	4168882,	1112776,	706000,	.6344,	.1857,	.1084,
1947,	425311,	3692801,	1165059,	882017,	.7571,	.3047,	.2016,
1948,	442592,	3665819,	1019114,	774295,	.7598,	.3398,	.2322,
1949,	468348,	3065111,	729879,	800122,	1.0962,	.3619,	.2865,
1950,	704908,	2830103,	615339,	731982,	1.1896,	.3566,	.2389,
1951,	1083753,	3141009,	568705,	827180,	1.4545,	.3966,	.3041,
1952,	1193111,	3407679,	520599,	876795,	1.6842,	.5348,	.4071,
1953,	1590377,	3557376,	396417,	695546,	1.7546,	.3572,	.2692,
1954,	641584,	4039204,	429694,	826021,	1.9223,	.3879,	.2786,
1955,	272778,	3488383,	346919,	1147841,	3.3087,	.5437,	.4003,
1956,	439602,	3189831,	299823,	1343068,	4.4795,	.6401,	.5154,
1957,	804781,	2495895,	207840,	792557,	3.8133,	.5089,	.3973,
1958,	496824,	2164149,	195377,	769313,	3.9376,	.5169,	.4337,
1959,	683690,	2415826,	432489,	744607,	1.7217,	.5596,	.4628,
1960,	789653,	2050805,	383479,	622042,	1.6221,	.4789,	.3914,
1961,	916842,	2137149,	404228,	783221,	1.9376,	.6348,	.5008,
1962,	728338,	1957006,	311678,	909266,	2.9173,	.7576,	.6100,
1963,	472064,	1747579,	208207,	776337,	3.7287,	.9866,	.7683,
1964,	338678,	1374529,	186570,	437695,	2.3460,	.6789,	.4607,
1965,	776941,	1440693,	102315,	444930,	4.3486,	.5533,	.3770,
1966,	1582560,	2198418,	120722,	483711,	4.0068,	.5302,	.3497,
1967,	1295416,	2852164,	129784,	572605,	4.4120,	.5439,	.3306,
1968,	164955,	3387455,	227215,	1074084,	4.7272,	.5704,	.4029,
1969,	112039,	2805591,	151870,	1197226,	7.8832,	.8292,	.5899,
1970,	197105,	2057698,	224482,	933246,	4.1573,	.7493,	.5159,
1971,	404774,	1610969,	311662,	689048,	2.2109,	.5956,	.3861,
1972,	1015319,	1621485,	346511,	565254,	1.6313,	.6928,	.3702,
1973,	1818949,	2401955,	332913,	792685,	2.3811,	.6020,	.4207,
1974,	523916,	2236387,	164491,	1102433,	6.7021,	.5633,	.4945,
1975,	621616,	2037430,	142028,	829377,	5.8395,	.6595,	.5684,
1976,	613942,	1931396,	171238,	867463,	5.0658,	.6457,	.5904,
1977,	348054,	1950748,	341385,	905301,	2.6518,	.8379,	.7191,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,	.7062,
1979,	198490,	1114381,	174699,	440538,	2.5217,	.7264,	.5095,
1980,	137735,	863861,	108253,	380434,	3.5143,	.7241,	.4994,
1981,	150868,	983657,	166926,	399038,	2.3905,	.8632,	.5546,
1982,	151830,	750870,	326132,	363730,	1.1153,	.7583,	.5705,
1983,	166828,	738673,	327180,	289992,	.8863,	.7560,	.5701,
1984,	397819,	817587,	251086,	277651,	1.1058,	.9161,	.6815,
1985,	523638,	956857,	193474,	307920,	1.5915,	.7038,	.6208,
1986,	1036924,	1292503,	170270,	430113,	2.5261,	.8649,	.6914,
1987,	286228,	1120291,	118329,	523071,	4.4205,	.9510,	.7654,
1988,	204599,	913379,	202171,	434939,	2.1513,	.9745,	.6234,
1989,	172779,	891506,	194362,	332481,	1.7106,	.6605,	.4798,
1990,	242750,	963528,	340196,	212000,	.6232,	.2712,	.2116,
1991,	411793,	1560846,	674435,	319158,	.4732,	.3212,	.2700,
1992,	721139,	1910750,	869997,	513234,	.5899,	.4554,	.3877,
1993,	896056,	2357461,	738043,	581611,	.7880,	.5533,	.4150,
1994,	810607,	2151852,	601464,	771086,	1.2820,	.8683,	.6437,
1995,	659633,	1819036,	499779,	739999,	1.4807,	.7892,	.5692,
1996,	439076,	1702104,	570123,	732228,	1.2843,	.6993,	.5229,
1997,	719501,	1530998,	564839,	762403,	1.3498,	1.0358,	.7145,
1998,	843002,	1229774,	387048,	592624,	1.5311,	.9230,	.6746,
1999,	568929,	1106118,	255778,	484910,	1.8958,	.9963,	.6666,
2000,	623467,	1113070,	229345,	414868,	1.8089,	.8594,	.5681,
2001,	545725,	1404825,	335284,	426471,	1.2720,	.7108,	.4657,
2002,	429971,	1591624,	520014,	535045,	1.0289,	.6412,	.5064,
2003,	546256,	1648042,	585309,	551990,	.9431,	.4966,	.4162,
2004,	296504,	1583439,	713578,	579445,	.8120,	.5739,	.4160,
Arith. Mean ,	601993,	2013815,	384076,	660999,	2.3911,	.6430,	.4763,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 3.27 Summary, no cannibalism included

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

At 4/05/2005 13:51

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-10,	FBAR 4- 8,
1946,	728139,	4168882,	1112776,	706000,	.6344,	.1857,	.1084,
1947,	425311,	3692801,	1165059,	882017,	.7571,	.3047,	.2016,
1948,	442592,	3665819,	1019114,	774295,	.7598,	.3398,	.2322,
1949,	468348,	3065111,	729879,	800122,	1.0962,	.3619,	.2865,
1950,	704908,	2830103,	615339,	731982,	1.1896,	.3566,	.2389,
1951,	1083753,	3141009,	568705,	827180,	1.4545,	.3966,	.3041,
1952,	1193111,	3407679,	520599,	876795,	1.6842,	.5348,	.4071,
1953,	1590377,	3557376,	396417,	695546,	1.7546,	.3572,	.2692,
1954,	641584,	4039204,	429694,	826021,	1.9223,	.3879,	.2786,
1955,	272778,	3488383,	346919,	1147841,	3.3087,	.5437,	.4003,
1956,	439602,	3189831,	299823,	1343068,	4.4795,	.6401,	.5154,
1957,	804781,	2495895,	207840,	792557,	3.8133,	.5089,	.3973,
1958,	496824,	2164149,	195377,	769313,	3.9376,	.5169,	.4337,
1959,	683690,	2415826,	432489,	744607,	1.7217,	.5596,	.4628,
1960,	789653,	2050805,	383479,	622042,	1.6221,	.4789,	.3914,
1961,	916842,	2137149,	404228,	783221,	1.9376,	.6348,	.5008,
1962,	728338,	1957006,	311678,	909266,	2.9173,	.7576,	.6100,
1963,	472064,	1747579,	208207,	776337,	3.7287,	.9866,	.7683,
1964,	338678,	1374529,	186570,	437695,	2.3460,	.6789,	.4607,
1965,	776941,	1440693,	102315,	444930,	4.3486,	.5533,	.3770,
1966,	1582560,	2198418,	120722,	483711,	4.0068,	.5302,	.3497,
1967,	1295416,	2852164,	129784,	572605,	4.4120,	.5439,	.3306,
1968,	164955,	3387455,	227215,	1074084,	4.7272,	.5704,	.4029,
1969,	112039,	2805591,	151870,	1197226,	7.8832,	.8292,	.5899,
1970,	197105,	2057698,	224482,	933246,	4.1573,	.7493,	.5159,
1971,	404774,	1610969,	311662,	689048,	2.2109,	.5956,	.3861,
1972,	1015319,	1621485,	346511,	565254,	1.6313,	.6928,	.3702,
1973,	1818949,	2401955,	332913,	792685,	2.3811,	.6020,	.4207,
1974,	523916,	2236387,	164491,	1102433,	6.7021,	.5633,	.4945,
1975,	621616,	2037430,	142028,	829377,	5.8395,	.6595,	.5684,
1976,	613942,	1931396,	171238,	867463,	5.0658,	.6457,	.5904,
1977,	348054,	1950748,	341385,	905301,	2.6518,	.8379,	.7191,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,	.7062,
1979,	198490,	1114381,	174699,	440538,	2.5217,	.7264,	.5095,
1980,	137735,	863861,	108253,	380434,	3.5143,	.7241,	.4994,
1981,	150868,	983657,	166926,	399038,	2.3905,	.8632,	.5546,
1982,	151830,	750870,	326132,	363730,	1.1153,	.7583,	.5705,
1983,	166828,	738673,	327180,	289992,	.8863,	.7560,	.5701,
1984,	397582,	817487,	251086,	277651,	1.1058,	.9161,	.6815,
1985,	523434,	956773,	193474,	307920,	1.5915,	.7038,	.6208,
1986,	929970,	1259347,	170270,	430113,	2.5261,	.8649,	.6914,
1987,	270548,	1117312,	118329,	523071,	4.4205,	.9510,	.7654,
1988,	202876,	913017,	202171,	434939,	2.1513,	.9745,	.6234,
1989,	172779,	891506,	194362,	332481,	1.7106,	.6605,	.4798,
1990,	242750,	963528,	340196,	212000,	.6232,	.2712,	.2116,
1991,	408112,	1558939,	674435,	319158,	.4732,	.3212,	.2700,
1992,	700267,	1900315,	869893,	513234,	.5900,	.4554,	.3878,
1993,	759035,	2292769,	737396,	581611,	.7887,	.5536,	.4157,
1994,	516472,	2018620,	599103,	771086,	1.2871,	.8692,	.6461,
1995,	307144,	1682181,	499125,	739999,	1.4826,	.7898,	.5736,
1996,	258129,	1611185,	569026,	732228,	1.2868,	.7017,	.5291,
1997,	493784,	1472047,	564729,	762403,	1.3500,	1.0368,	.7181,
1998,	600509,	1159689,	386620,	592624,	1.5328,	.9241,	.6780,
1999,	489243,	1083994,	255778,	484910,	1.8958,	.9963,	.6674,
2000,	567583,	1087735,	228946,	414868,	1.8121,	.8602,	.5695,
2001,	511169,	1383975,	334455,	426471,	1.2751,	.7112,	.4664,
2002,	383183,	1574591,	519866,	535045,	1.0292,	.6413,	.5066,
2003,	515876,	1641055,	585309,	551990,	.9431,	.4966,	.4162,
2004,	292337,	1580747,	713568,	579445,	.8120,	.5739,	.4160,
Arith. Mean ,	570915,	2001972,	383961,	660999,	2.3914,	.6432,	.4767,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 3.28 Short term prediction input

MFDP version 1a
Run: pre
Time and date: 18:42 26.04.2005
Fbar age range: 5-10

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	576000	0.2674	0	0	0	0.225	0.0179	0.699
4	233963	0.2116	0.004	0	0	0.547	0.1543	1.132
5	305014	0.2011	0.066	0	0	1.12	0.4643	1.684
6	150221	0.2	0.367	0	0	1.908	0.8316	2.378
7	102827	0.2	0.718	0	0	3.083	1.1905	3.474
8	48060	0.2	0.899	0	0	4.294	1.2805	4.609
9	17634	0.2	0.97	0	0	5.889	1.184	6.246
10	4633	0.2	0.991	0	0	7.924	1.049	8.24
11	1532	0.2	1	0	0	10.083	0.9404	9.509
12	383	0.2	1	0	0	12.222	1.583	10.653
13	152	0.2	1	0	0	17.672	1.583	13.558

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	478000	0.2674	0	0	0	0.226	0.0179	0.692
4	.	0.2116	0.003	0	0	0.537	0.1543	1.096
5	.	0.2011	0.086	0	0	1.264	0.4643	1.679
6	.	0.2	0.378	0	0	1.917	0.8316	2.443
7	.	0.2	0.688	0	0	2.962	1.1905	3.406
8	.	0.2	0.885	0	0	4.37	1.2805	4.785
9	.	0.2	0.959	0	0	5.277	1.184	6.107
10	.	0.2	0.991	0	0	7.134	1.049	7.746
11	.	0.2	1	0	0	9.612	0.9404	9.74
12	.	0.2	1	0	0	15.679	1.583	11.009
13	.	0.2	1	0	0	13.545	1.583	12.153

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	574000	0.2674	0	0	0	0.23	0.0179	0.692
4	.	0.2116	0.003	0	0	0.532	0.1543	1.091
5	.	0.2011	0.086	0	0	1.177	0.4643	1.643
6	.	0.2	0.378	0	0	2.06	0.8316	2.438
7	.	0.2	0.688	0	0	2.946	1.1905	3.471
8	.	0.2	0.885	0	0	4.285	1.2805	4.717
9	.	0.2	0.959	0	0	5.692	1.184	6.283
10	.	0.2	0.991	0	0	6.6	1.049	7.607
11	.	0.2	1	0	0	8.457	0.9404	9.246
12	.	0.2	1	0	0	10.934	1.583	11.24
13	.	0.2	1	0	0	17.001	1.583	12.509

Input units are thousands and kg - output in tonnes

Table 3.29 Management option table

MFDP version 1a
Run: fin4
preMFDP Index file
26.04.2005
Time and date: 19:27 26.04.2005
Fbar age range: 5-10

2005				
Biomass	SSB	FMult	FBar	Landings
1572573	701319	1	0.57	596418

2006					2007	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1528291	661283	0	0	0	2148427	1076680
.	661283	0.1	0.057	70801	2072234	1018091
.	661283	0.2	0.114	137927	2000158	962981
.	661283	0.3	0.171	201594	1931954	911131
.	661283	0.4	0.228	262002	1867391	862341
.	661283	0.5	0.285	319343	1806254	816420
.	661283	0.6	0.342	373793	1748338	773192
.	661283	0.7	0.399	425519	1693455	732490
.	661283	0.8	0.456	474679	1641427	694159
.	661283	0.9	0.513	521419	1592085	658054
.	661283	1	0.57	565877	1545274	624037
.	661283	1.1	0.627	608184	1500847	591982
.	661283	1.2	0.684	648460	1458664	561769
.	661283	1.3	0.741	686821	1418597	533285
.	661283	1.4	0.798	723373	1380524	506426
.	661283	1.5	0.855	758219	1344331	481094
.	661283	1.6	0.912	791453	1309910	457196
.	661283	1.7	0.969	823164	1277161	434646
.	661283	1.8	1.026	853437	1245990	413363
.	661283	1.9	1.083	882349	1216306	393271
.	661283	2	1.14	909977	1188028	374299

Input units are thousands and kg - output in tonnes

Table 3.30 Single option prediction: Detailed tables

MFDP version 1a
Run: fin5
Time and date: 19:44 26.04.2005
Fbar age range: 5-10

Year:	2005	F multiplie	1	Fbar:	0.57				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Ja	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.01	5030	3516	576000	129600	0	0	0	0
4	0.088	17791	20139	233963	127978	936	512	936	512
5	0.265	64607	108798	305014	341616	20131	22547	20131	22547
6	0.474	51801	123184	150221	286622	55131	105190	55131	105190
7	0.679	46451	161371	102827	317016	73830	227617	73830	227617
8	0.73	22840	105270	48060	206370	43206	185526	43206	185526
9	0.675	7933	49547	17634	103847	17105	100731	17105	100731
10	0.597	1906	15708	4633	36712	4591	36381	4591	36381
11	0.536	581	5527	1532	15447	1532	15447	1532	15447
12	0.902	209	2230	383	4681	383	4681	383	4681
13	0.902	83	1126	152	2686	152	2686	152	2686
Total		219233	596418	1440419	1572573	216997	701319	216997	701319

Year:	2006	F multiplie	0.7011	Fbar:	0.40				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Ja	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.007	2931	2028	478000	108028	0	0	0	0
4	0.0617	23562	25824	436465	234382	1309	703	1309	703
5	0.1858	26715	44854	173393	219169	14912	18849	14912	18849
6	0.3323	49315	120476	191379	366874	72341	138678	72341	138678
7	0.476	26491	90229	76563	226778	52675	156023	52675	156023
8	0.5118	15633	74802	42694	186571	37784	165115	37784	165115
9	0.4732	6531	39882	18962	100064	18185	95961	18185	95961
10	0.4186	2294	17773	7351	52442	7285	51970	7285	51970
11	0.3758	597	5810	2088	20070	2088	20070	2088	20070
12	0.6324	315	3468	734	11506	734	11506	734	11506
13	0.6324	76	927	178	2407	178	2407	178	2407
Total		154459	426074	1427806	1528291	207491	661283	207491	661283

Year:	2007	F multiplie	0.7011	Fbar:	0.40				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Ja	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.007	3519	2435	574000	132020	0	0	0	0
4	0.0617	19612	21397	363289	193270	1090	580	1090	580
5	0.1858	51165	84065	332092	390872	28560	33615	28560	33615
6	0.3323	30345	73982	117763	242591	44514	91699	44514	91699
7	0.476	38886	134975	112386	331088	77321	227789	77321	227789
8	0.5118	14259	67258	38942	166864	34463	147675	34463	147675
9	0.4732	7216	45338	20952	119260	20093	114370	20093	114370
10	0.4186	3019	22964	9672	63833	9585	63259	9585	63259
11	0.3758	1131	10461	3960	33491	3960	33491	3960	33491
12	0.6324	504	5664	1174	12836	1174	12836	1174	12836
13	0.6324	170	2129	397	6742	397	6742	397	6742
Total		169827	470667	1574625	1692868	221157	732056	221157	732056

Year:	2008	F multiplie	0.7011	Fbar:	0.40				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Ja	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.007	3679	2546	600000	138000	0	0	0	0
4	0.0617	23551	25694	436251	232086	1309	696	1309	696
5	0.1858	42587	69971	276415	325340	23772	27979	23772	27979
6	0.3323	58119	141693	225545	464623	85256	175627	85256	175627
7	0.476	23928	83055	69155	203731	47579	140167	47579	140167
8	0.5118	20930	98728	57162	244939	50588	216771	50588	216771
9	0.4732	6582	41353	19111	108779	18327	104319	18327	104319
10	0.4186	3336	25374	10687	70532	10591	69898	10591	69898
11	0.3758	1489	13763	5210	44064	5210	44064	5210	44064
12	0.6324	956	10743	2227	24346	2227	24346	2227	24346
13	0.6324	293	3668	683	11615	683	11615	683	11615
Total		185449	516588	1702446	1868055	245541	815482	245541	815482

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 3.32a Likelihood components at end of keyrun

Likelihood Component	Unweighted Likelihood		Weight	Weighted Likelihood	
	Keyrun	2004 wg		Keyrun	2004 wg
rusnorfleetlik	383	379	40	15332	15168
gillfleetlik	115	107	40	4600	4276
wintersur-85-93	1974	1838	0.5	987	919
wintersur-94-05	1739	1472	0.5	870	736
acousticsur-85-93	1142	1183	0.5	571	592
acousticsur-94-05	1967	1802	0.5	984	901
lofotensur-85-89	76	77	10	761	769
lofotensur-90-05	586	536	10	5859	5356
rustrawlsur-85-04	1718	1880	2	3436	3760
bounds	0	0	1	0	0
Total	9700	9274	105	33393	32477

Table 3.32b Parameter values and sensitivity (effect of parameter change on likelihood score)

Parameter	Value	-5 %	5 %
ba1ac.cbt	0.67206821	0.015	0.011
ba1ac.l50	51.734418	0.000	0.001
ba1ac.slope	0.001571989	0.000	0.000
ba1tr.cbt	0.93161906	2.119	2.032
ba1tr.l50	21.680921	0.002	0.032
ba1tr.slope	0.43982332	0.000	0.000
ba2ac.cbt	0.91963807	0.024	0.028
ba2ac.l50	15.918935	0.000	0.000
ba2ac.slope	0.001		0.001
ba2tr.cbt	0.53811194	0.029	0.028
ba2tr.l50	17.831218	0.017	0.066
ba2tr.slope	0.5	0.000	
betabin	59.151138	0.007	0.006
cann.high	0.000232877	0.024	0.020
cann.m0	0.000385384	0.049	0.042
cann.noncod	0.000410581	0.015	0.020
d_minage.1986	4.458308	0.068	0.060
d_minage.1987	4.0168192	0.021	0.017
d_minage.1988	3.7610991	0.023	0.004
d_minage.1989	5.8350726	0.011	0.006
d_minage.1990	6.7382377	0.011	0.021
d_minage.1991	5.9101026	0.021	0.028
d_minage.1992	7.4331547	0.050	0.050
d_minage.1993	5.2455124	0.053	0.043
d_minage.1994	6.7470805	0.089	0.045
d_minage.1995	5.7929156	0.037	0.032
d_minage.1996	6.2450475	0.030	0.032
d_minage.1997	4.0735628	0.028	0.030
d_minage.1998	4.8331142	0.050	0.053
d_minage.1999	5.3878531	0.057	0.023
d_minage.2000	4.1731823	0.022	0.018
d_minage.2001	4.1567537	0.017	0.012
d_minage.2002	5.2121487	0.006	0.009
d_minage.2003	5.4889592	0.013	0.015
d_minage.2004	4.892599	0.001	0.003
d_minage.2005	4.3194412	0.003	0.002
gil.1985	2.4093985	0.007	0.007
gil.1986	1.5649873	0.002	0.005
gil.1987	1.3817556	0.005	0.002
gil.1988	1.5927	0.004	0.003
gil.1989	3.2438216	0.004	0.006

Parameter	Value	-5 %	5 %
gil.1990	0.89143211	0.002	0.002
gil.1991	0.64524613	0.002	0.004
gil.1992	0.40286991	0.004	0.002
gil.1993	0.69875218	0.002	0.005
gil.1994	0.767469	0.004	0.004
gil.1995	1.7682678	0.005	0.009
gil.1996	1.3717509	0.003	0.009
gil.1997	1.8119579	0.003	0.013
gil.1998	1.7714016	0.010	0.004
gil.1999	1.9247651	0.007	0.003
gil.2000	2.2786993	0.004	0.004
gil.2001	1.9523881	0.003	0.005
gil.2002	1.3304493	0.005	0.002
gil.2003	1.0107938	0.002	0.004
gil.2004	0.83275267	0.001	0.005
gil.l50	82.540735	6.208	6.606
gil.slope	0.03754628	0.351	0.319
growth.1985	7.7430567	0.212	0.220
growth.1986	6.9412359	0.245	0.247
growth.1987	7.8812046	0.236	0.226
growth.1988	6.5775282	0.092	0.106
growth.1989	11.374966	0.189	0.199
growth.1990	11.637133	0.215	0.214
growth.1991	12.726779	0.332	0.329
growth.1992	5.4753274	0.073	0.085
growth.1993	11.080549	0.458	0.458
growth.1994	7.7881429	0.211	0.195
growth.1995	11.590397	0.426	0.353
growth.1996	8.9171904	0.176	0.154
growth.1997	11.528016	0.337	0.316
growth.1998	9.0641495	0.206	0.217
growth.1999	11.471132	0.332	0.284
growth.2000	11.573629	0.323	0.301
growth.2001	10.671247	0.242	0.253
growth.2002	11.070967	0.165	0.211
growth.2003	10.787101	0.114	0.154
growth.2004	7.7673942	0.016	0.024
imm.n_age3	53.620469	0.106	0.078
imm.n_age4	35.177029	0.064	0.078
imm.n_age5	9.490729	0.023	0.016
imm.n_age6	3.4775276	0.005	0.007

Table 3.32b (continued)

Parameter	Value	-5 %	5 %
imm.n_age7	1.0662892	0.001	0.002
imm.n_age8	0.2369717	0.000	0.000
imm.n_age9	0.16419497	0.000	0.000
l_minage.1986	33.483434	3.821	3.317
l_minage.1987	32.061017	1.220	0.939
l_minage.1988	33.199807	0.858	0.985
l_minage.1989	31.541844	0.336	0.294
l_minage.1990	31.608556	0.409	0.372
l_minage.1991	37.553404	1.164	1.135
l_minage.1992	39.396907	1.662	1.531
l_minage.1993	32.662454	1.899	1.750
l_minage.1994	29.418811	0.994	0.744
l_minage.1995	27.452176	0.643	0.534
l_minage.1996	31.038123	0.554	0.545
l_minage.1997	30.290982	1.500	1.449
l_minage.1998	31.549895	1.868	1.852
l_minage.1999	28.645641	0.917	0.747
l_minage.2000	28.753975	1.025	0.923
l_minage.2001	32.014513	0.894	0.804
l_minage.2002	29.307827	0.289	0.268
l_minage.2003	28.465832	0.338	0.353
l_minage.2004	31.388035	0.057	0.045
l_minage.2005	28.079588	0.044	0.056
lof1ac.cbt	1.8886184	0.007	0.012
lof1ac.l50	83.416198	0.045	0.037
lof1ac.slope	0.010206756	0.002	0.002
lof2ac.cbt	1.8111972	0.095	0.093
lof2ac.l50	66.746001	0.335	0.376
lof2ac.slope	0.020014145	0.006	0.004
mat.n_age10	0.18118425	0.001	0.000
mat.n_age5	0.8782933	0.001	0.000
mat.n_age6	1.5069947	0.003	0.001
mat.n_age7	1.3139261	0.002	0.004
mat.n_age8	0.41275383	0.002	0.000
mat.n_age9	0.16682424	0.000	0.001
rusnor.1985	1.293143	0.042	0.024
rusnor.1986	2.0118967	0.052	0.063
rusnor.1987	3.2869365	0.103	0.090
rusnor.1988	2.7601423	0.074	0.071
rusnor.1989	1.9180288	0.041	0.053
rusnor.1990	0.68840894	0.020	0.018

Parameter	Value	-5 %	5 %
rusnor.1991	0.67916132	0.021	0.024
rusnor.1992	0.79219476	0.043	0.023
rusnor.1993	1.2443314	0.063	0.040
rusnor.1994	1.6814992	0.071	0.076
rusnor.1995	1.9694404	0.066	0.091
rusnor.1996	2.1034052	0.094	0.065
rusnor.1997	3.0615891	0.111	0.086
rusnor.1998	3.3806436	0.103	0.084
rusnor.1999	3.2986422	0.081	0.066
rusnor.2000	2.2001914	0.060	0.039
rusnor.2001	1.7861807	0.047	0.049
rusnor.2002	1.4497998	0.056	0.034
rusnor.2003	1.3053795	0.034	0.043
rusnor.2004	1.6971474	0.043	0.033
rusnor.l50	53.07729	19.857	25.241
rusnor.slope	0.04897575	0.639	0.600
rustr.cbt	0.20177205	0.030	0.027
rustr.l50	47.986741	0.178	0.325
rustr.slope	0.04189914	0.008	0.004
maturation.l50	97.722397	1.074	
maturation.slope	0.0120928	0.123	0.105
n_minage.1986	125.79735	0.170	0.161
n_minage.1987	39.153582	0.049	0.048
n_minage.1988	24.755726	0.033	0.039
n_minage.1989	18.735993	0.031	0.024
n_minage.1990	27.642765	0.040	0.041
n_minage.1991	42.495358	0.090	0.049
n_minage.1992	69.751912	0.126	0.101
n_minage.1993	88.103742	0.122	0.136
n_minage.1994	86.914486	0.091	0.085
n_minage.1995	57.262517	0.056	0.053
n_minage.1996	31.40019	0.053	0.039
n_minage.1997	52.316816	0.105	0.071
n_minage.1998	61.738658	0.126	0.086
n_minage.1999	48.691478	0.071	0.075
n_minage.2000	54.772349	0.075	0.067
n_minage.2001	41.427944	0.052	0.039
n_minage.2002	30.581685	0.018	0.020
n_minage.2003	59.38915	0.009	0.021
n_minage.2004	12.569921	0.001	0.001
n_minage.2005	41.564343	0.002	0.001

Table 3.32c Fixed parameter values used in keyrun

Name	Value	Name	Value
growth.exponent	0	mat.n_age12	0.03
cann.p1	2.219829	mat.l_age4	51
cann.p3	5.702254	mat.l_age5	59.6
cann.p2	0.643658	mat.l_age6	71.1
cann.m1	0.104	mat.l_age7	79
cann.m2	0.000112	mat.l_age8	88.2
cann.m3	2.4	mat.l_age9	97.3
cann.hf	0	mat.l_age10	105.2
imm.n_age10	0	mat.l_age11	114
imm.l_age3	40.6	mat.l_age12	114
imm.l_age4	48.7	mat.d_age4	14.9
imm.l_age5	61.3	mat.d_age5	1.1
imm.l_age6	71.1	mat.d_age6	6.74503
imm.l_age7	81.2	mat.d_age7	3.184107
imm.l_age8	85.7	mat.d_age8	5.107078
imm.l_age9	90	mat.d_age9	3.064587
imm.l_age10	90	mat.d_age10	5.437319
imm.d_age3	5.1	mat.d_age11	10.62126
imm.d_age4	4.1	mat.d_age12	3.265886
imm.d_age5	4.9	other.level	10000
imm.d_age6	5.3	ba1tr.b0	1
imm.d_age7	5.4	ba2tr.b0	1
imm.d_age8	8.7	lof1ac.b0	1
imm.d_age9	8.7	lof2ac.b0	1
imm.d_age10	8.7	ba1ac.b0	1
growth.ratio	0.740864	ba2ac.b0	1
mat.n_age4	0	rustr.b0	1
mat.n_age11	0.04		

Table 3.33 Results from the keyrun

; Gadget version 2.0.07 running on ress8645.imr.no Wed Apr 27 16:06:54 2005
stocks cod.imm cod.mat
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Total fishing mortality at age

Year / Age	1985	1986	1987	1988	1989	1990
3	0.0725	0.0458	0.0573	0.0398	0.0398	0.0203
4	0.1722	0.2492	0.1910	0.1246	0.0948	0.0692
5	0.3720	0.4367	0.6355	0.3192	0.2136	0.1330
6	0.5184	0.6533	0.9162	0.7042	0.3820	0.1876
7	0.7065	0.7909	1.1607	0.9056	0.6531	0.2368
8	0.8957	0.9327	1.3098	1.1365	0.8760	0.3097
9	1.0283	1.0192	1.4420	1.2994	1.2847	0.3675
10	1.1940	1.0741	1.5002	1.4384	1.5712	0.4339
11	1.2101	1.1346	1.5440	1.4891	1.8272	0.4628
12+	1.2281	1.1404	1.5751	1.5305	1.9187	0.4887
F 5-10	0.7858	0.8178	1.1607	0.9672	0.8301	0.2781

Total fishing mortality at age

Year / Age	1991	1992	1993	1994	1995	1996	1997
3	0.0389	0.0522	0.0377	0.0522	0.0463	0.0588	0.0481
4	0.0755	0.1457	0.1431	0.1680	0.1569	0.1485	0.2135
5	0.1606	0.2038	0.2806	0.3686	0.3698	0.3390	0.4873
6	0.2185	0.2984	0.3384	0.5318	0.5729	0.5879	0.7704
7	0.2525	0.3417	0.4383	0.5806	0.7520	0.7353	1.0470
8	0.2870	0.3656	0.4934	0.6767	0.8257	0.8800	1.2216
9	0.3419	0.3876	0.5300	0.7332	1.0066	0.9302	1.4084
10	0.3771	0.4126	0.5634	0.7674	1.1294	1.0511	1.4645
11	0.4055	0.4236	0.5974	0.7886	1.1837	1.1081	1.5868
12+	0.4173	0.4316	0.6119	0.8098	1.2218	1.1387	1.6503
F 5-10	0.2729	0.3350	0.4407	0.6097	0.7761	0.7539	1.0665

Total fishing mortality at age

Year / Age	1998	1999	2000	2001	2002	2003	2004	2002-2004
3	0.0498	0.0371	0.0208	0.0260	0.0250	0.0311	0.0361	0.0307
4	0.2201	0.1979	0.1279	0.0965	0.1347	0.1129	0.1111	0.1196
5	0.5410	0.5123	0.3689	0.2856	0.2841	0.3277	0.3213	0.3110
6	0.8715	0.7974	0.5962	0.4949	0.4666	0.4522	0.5818	0.5002
7	1.0915	1.0639	0.7496	0.6439	0.6149	0.5639	0.6742	0.6177
8	1.3256	1.2464	0.9474	0.7626	0.7245	0.6680	0.7612	0.7179
9	1.4759	1.4817	1.1245	0.9287	0.8007	0.7448	0.8417	0.7957
10	1.6247	1.6185	1.3490	1.0538	0.8948	0.7873	0.8885	0.8569
11	1.6618	1.7484	1.4553	1.1818	0.9461	0.8305	0.9088	0.8951
12+	1.7488	1.7933	1.5524	1.2367	0.9944	0.8530	0.9296	0.9257
F 5-10	1.1550	1.1200	0.8559	0.6949	0.6309	0.5907	0.6781	

Table 3.33 (continued)

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Residual natural mortality (M1)

Year	1985	1986	1987	1988	1989	1990
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	1991	1992	1993	1994	1995	1996	1997
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	1998	1999	2000	2001	2002	2003	2004	2002-2004
Age								
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
6	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
12+	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

Predation mortality (M2)

Year	1985	1986	1987	1988	1989	1990
Age						
3	0.0080	0.1497	0.1856	0.0331	0.0155	0.0038
4	0.0036	0.0213	0.0489	0.0109	0.0047	0.0009

Predation mortality (M2)

Year	1991	1992	1993	1994	1995	1996	1997
Age							
3	0.0016	0.0032	0.0388	0.3265	0.5188	0.1247	0.0419
4	0.0009	0.0012	0.0087	0.0461	0.1038	0.0266	0.0098

Predation mortality (M2)

Year	1998	1999	2000	2001	2002	2003	2004	2002-2004
Age								
3	0.0054	0.0032	0.0029	0.0032	0.0107	0.0681	0.0426	0.0405
4	0.0017	0.0008	0.0006	0.0011	0.0020	0.0116	0.0128	0.0088

Table 3.33 (continued)

Stock numbers (thousands) at age by Jan. 1

Year Age	1985	1986	1987	1988	1989	1990	1991
3	536205	1257974	391536	247557	187360	276428	424954
4	351770	405051	847039	251429	188433	145146	220935
5	103690	241576	253025	545571	179771	139659	110789
6	49845	58458	126503	108392	323152	118617	100062
7	23802	24289	24821	41189	43817	180373	80486
8	6497	9613	9004	6354	13625	18662	116522
9	3310	2172	3095	1988	1669	4644	11209
10	1812	969	683	610	448	382	2645
11	400	449	230	114	114	73	190
12+	300	170	163	68	33	19	47
Total	1077631	2000719	1656097	1203270	938421	884002	1067838

Stock numbers (thousands) at age by Jan. 1

Year Age	1992	1993	1994	1995	1996	1997	1998
3	697519	881037	869145	572625	314002	523168	617387
4	334124	540285	668198	487270	266440	213985	391470
5	167582	236174	380032	441654	307386	183109	140134
6	77220	111822	145499	211607	242837	177360	91668
7	65830	46892	65096	69465	96478	109958	67046
8	51186	38290	24741	29663	26663	37780	31567
9	71591	29073	19129	10272	10589	9046	9112
10	6649	40143	16164	8381	3309	3517	1892
11	1355	3238	16545	5271	1974	847	584
12+	129	795	1812	6816	2966	1311	348
Total	1473184	1927748	2206359	1843024	1272645	1260081	1351207

Stock numbers (thousands) at age by Jan. 1

Year Age	1999	2000	2001	2002	2003	2004	2005
3	486915	547723	414279	305817	593891	125699	415643
4	478320	382892	437952	329427	241600	440333	95129
5	256760	321057	275672	325223	235258	174652	318510
6	66741	125911	181732	169565	200228	138280	103227
7	31382	24611	56787	90690	87026	104090	63168
8	18424	8866	9521	24419	40137	40505	43385
9	6865	4338	2815	3636	9687	16843	15482
10	1734	1308	1182	954	1375	3823	6051
11	277	250	249	294	281	454	1178
12+	140	59	58	76	117	141	195
Total	1347557	1417015	1380246	1250101	1409599	1044819	1061969

Table 3.33 (continued)

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Spawning stock biomass (tons) at Jan. 1

Year	1985	1986	1987	1988	1989	1990	1991
Age							
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	33903	28008	13241	2430	7712	15597
6	0	41665	56223	40474	42514	24555	41352
7	0	46892	38129	42046	37630	99137	67268
8	0	35964	28869	17704	26731	34000	182728
9	0	11074	16736	9638	7390	15932	39743
10	0	5598	4477	4350	3021	2399	14578
11	0	4851	2249	1086	1121	673	1710
12+	0	2266	2376	944	454	254	562
SSB total	0	182212	177066	129481	121291	184662	363537

Spawning stock biomass (tons) at Jan. 1

Year	1992	1993	1994	1995	1996	1997	1998
Age							
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	30922	37196	63304	30988	20477	9163	10227
6	55359	54459	94708	101668	96208	50523	27973
7	95246	67842	78725	93856	120257	111600	57522
8	120460	99290	68451	62420	73543	87912	72724
9	260780	111334	82885	43366	39050	39935	37923
10	40748	215050	80176	46546	19233	18646	12464
11	12493	29284	136273	45807	18108	7857	5302
12+	1603	8836	19462	72177	35315	17917	5340
SSB total	617612	623291	623984	496827	422190	343551	229473

Spawning stock biomass (tons) at Jan. 1

Year	1999	2000	2001	2002	2003	2004	2005
Age							
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	11427	20421	18712	18607	24179	11987	8634
6	17959	37742	66078	62353	74307	68332	27172
7	24289	19446	54139	102693	97952	115410	69734
8	30381	15902	17170	56034	103844	99205	88934
9	24115	13587	9351	12885	42344	77272	58409
10	9102	7058	5713	5075	7923	25405	36699
11	2371	2094	2104	2499	2615	4260	10675
12+	1604	688	640	885	1387	1744	2196
SSB total	121246	116938	173906	261030	354552	403615	302453

Table 3.33 (continued)

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Total stock biomass (tons) at Jan. 1

Year	1985	1986	1987	1988	1989	1990	1991
Age							
3	0	417430	113343	78944	54400	83255	203144
4	0	379074	448219	142397	112887	115153	188353
5	0	352268	324641	521604	171042	174063	172058
6	0	154306	245003	201884	469546	205322	220818
7	0	93927	83656	111840	114526	428764	230256
8	0	49800	43040	28244	51092	70771	432901
9	0	13940	19696	11942	9665	23776	60416
10	0	7483	5031	4682	3361	2754	17934
11	0	4851	2570	1177	1165	706	1821
12+	0	2266	2376	944	454	254	562
Total	0	1475344	1287576	1103657	988138	1104821	1528262

Total stock biomass (tons) at Jan. 1

Year	1992	1993	1994	1995	1996	1997	1998
Age							
3	394154	277585	214946	112559	88349	128532	174106
4	399195	464426	538383	290435	180976	139994	262110
5	275730	372788	599571	547505	364809	208263	168022
6	211704	233102	370448	438428	495483	311489	170647
7	246394	158714	204148	221805	304285	313775	183084
8	239121	175029	115098	114418	123808	157264	136557
9	413806	163794	113570	58310	56628	53624	53634
10	50021	273656	97892	54554	22537	22941	14516
11	13670	32427	153253	53174	20241	8712	5955
12+	1603	8836	19462	72177	35315	17917	5340
Total	2245397	2160357	2426769	1963365	1692431	1362511	1173970

Total stock biomass (tons) at Jan. 1

Year	1999	2000	2001	2002	2003	2004	2005
Age							
3	106132	116026	119805	70673	127646	34985	82583
4	286683	226814	260650	234441	154375	252187	58425
5	281868	378227	320444	381608	332297	209228	321493
6	113217	234279	355760	337264	416830	315521	179422
7	79112	64444	163347	287333	278468	329328	186402
8	64178	33327	36041	107878	190354	184423	169956
9	34933	21359	14398	19868	60526	107182	83454
10	11048	8610	7328	6377	9929	30197	43264
11	2590	2323	2331	2845	2954	4770	11590
12+	1604	688	640	885	1387	1744	2196
Total	981364	1086098	1280744	1449172	1574766	1469565	1138783

Table 3.33 (continued)

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Weight (kg) in catch (Observed)
Year      1985  1986
Age
  3       0.91  0.62
  4       1.30  1.25
  5       1.96  1.87
  6       3.18  2.80
  7       4.63  4.46
  8       6.04  5.78
  9       7.66  6.76
 10       9.80  7.60
 11      11.82  9.76
 12+     14.32 10.63


Weight (kg) in catch (Observed)
Year      1987  1988  1989  1990  1991  1992  1993  1994  1995
Age
  3       0.49  0.53  0.74  0.83  1.03  1.15  0.76  0.83  0.80
  4       0.87  0.83  0.92  1.22  1.43  1.56  1.44  1.27  1.22
  5       1.53  1.29  1.26  1.61  2.11  2.22  2.07  1.97  1.73
  6       2.34  2.22  1.86  2.13  2.80  3.14  2.71  2.89  2.55
  7       3.55  3.52  2.86  3.15  3.58  4.31  4.05  3.41  3.81
  8       5.97  5.28  4.58  4.57  4.61  5.24  5.44  5.33  5.02
  9       8.60  7.92  7.51  7.26  5.99  6.16  6.40  6.91  6.18
 10       9.61  9.01  9.09  9.85  8.78  7.89  7.13  7.67  8.03
 11      12.26 11.21 11.40 13.54 11.82 10.32  7.99  8.06  8.84
 12+     13.77 13.99 12.00 17.13 16.58 11.81 10.31  9.70  9.24


Weight (kg) in catch (Observed)
Year      1996  1997  1998  1999  2000  2001  2002  2003  2004   2002-2004
Age
  3       0.80  0.67  0.61  0.62  0.55  0.66  0.73  0.72  0.76      0.74
  4       1.09  0.99  0.98  1.00  1.00  1.02  1.15  1.17  1.17      1.16
  5       1.59  1.45  1.54  1.48  1.56  1.58  1.62  1.90  1.70      1.74
  6       2.41  2.13  2.22  2.25  2.29  2.48  2.44  2.62  2.55      2.54
  7       3.82  3.34  3.22  3.16  3.29  3.48  3.70  3.72  3.41      3.61
  8       5.83  5.26  4.83  4.30  4.45  4.75  4.98  5.15  4.80      4.98
  9       6.91  7.28  6.88  6.03  5.71  5.99  6.48  6.45  6.73      6.55
 10       8.16  7.83  9.39  6.86  7.52  7.42  7.88  8.35  7.98      8.07
 11       9.65  8.57 10.75 11.01  7.71  8.67  9.22 10.58  9.09      9.63
 12+     10.75 11.32 15.23 14.27 12.34 10.87  7.87 11.88 12.79     10.85
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Table 3.33 (continued)

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Weight (kg) in catch (Model)

Year	1985	1986
Age		
3	0.94	0.58
4	1.31	1.31
5	2.31	1.76
6	3.54	2.93
7	4.77	4.18
8	6.19	5.43
9	7.51	6.67
10	10.46	7.95
11	13.38	10.91
12+	13.25	13.42

Weight (kg) in catch (Model)

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age									
3	0.50	0.55	0.71	0.90	1.09	1.07	0.72	0.63	0.59
4	0.87	0.90	0.97	1.38	1.50	1.63	1.44	1.19	1.10
5	1.61	1.32	1.35	1.73	2.13	2.12	2.07	1.98	1.70
6	2.20	2.18	1.82	2.19	2.71	3.12	2.60	2.86	2.62
7	3.68	2.98	2.99	2.86	3.41	4.09	3.87	3.50	3.81
8	5.17	4.72	4.11	4.39	4.34	5.04	5.04	5.07	4.55
9	6.79	6.27	6.10	5.69	6.05	6.15	6.11	6.39	6.37
10	8.36	8.01	7.83	7.79	7.41	8.03	7.36	7.61	7.99
11	10.45	9.75	9.93	9.72	9.56	9.51	9.49	8.82	9.29
12+	15.62	14.13	13.82	13.84	12.59	12.69	11.57	11.55	11.20

Weight (kg) in catch (Model)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2002-2004
Age										
3	0.66	0.56	0.59	0.58	0.50	0.57	0.58	0.58	0.61	0.59
4	1.07	1.14	1.05	1.06	1.08	0.99	1.15	1.12	1.04	1.10
5	1.62	1.59	1.62	1.54	1.65	1.61	1.63	1.83	1.64	1.70
6	2.46	2.22	2.23	2.17	2.31	2.37	2.47	2.47	2.61	2.51
7	3.68	3.36	3.13	3.01	3.15	3.33	3.67	3.63	3.49	3.60
8	5.22	4.75	4.76	4.07	4.35	4.33	4.96	5.18	4.93	5.02
9	5.97	6.51	6.34	5.79	5.56	5.66	6.04	6.64	6.70	6.46
10	8.10	7.36	8.43	7.30	7.39	6.92	7.60	7.82	8.32	7.91
11	9.89	9.87	9.50	9.53	9.05	8.97	9.06	9.58	9.67	9.44
12+	12.81	14.32	15.75	12.70	12.61	11.65	12.24	12.11	12.63	12.33

Table 3.33 (continued)

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Weight (kg) in stock at Jan. 1

Year	1985	1986	1987
Age			
3		0.33	0.29
4		0.94	0.53
5		1.46	1.28
6		2.64	1.94
7		3.87	3.37
8		5.18	4.78
9		6.42	6.36
10		7.72	7.37
11		10.80	11.17
12+		13.33	14.58

Weight (kg) in stock at Jan. 1

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age									
3	0.32	0.29	0.30	0.48	0.57	0.32	0.25	0.20	0.28
4	0.57	0.60	0.79	0.85	1.19	0.86	0.81	0.60	0.68
5	0.96	0.95	1.25	1.55	1.65	1.58	1.58	1.24	1.19
6	1.86	1.45	1.73	2.21	2.74	2.08	2.55	2.07	2.04
7	2.72	2.61	2.38	2.86	3.74	3.38	3.14	3.19	3.15
8	4.45	3.75	3.79	3.72	4.67	4.57	4.65	3.86	4.64
9	6.01	5.79	5.12	5.39	5.78	5.63	5.94	5.68	5.35
10	7.68	7.50	7.21	6.78	7.52	6.82	6.06	6.51	6.81
11	10.32	10.22	9.68	9.59	10.09	10.01	9.26	10.09	10.25
12+	13.88	13.77	13.39	11.95	12.43	11.11	10.74	10.59	11.91

Weight (kg) in stock at Jan. 1

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2003-2005
Age										
3	0.25	0.28	0.22	0.21	0.29	0.23	0.21	0.28	0.20	0.23
4	0.65	0.67	0.60	0.59	0.60	0.71	0.64	0.57	0.61	0.61
5	1.14	1.20	1.10	1.18	1.16	1.17	1.41	1.20	1.01	1.21
6	1.76	1.86	1.70	1.86	1.96	1.99	2.08	2.28	1.74	2.03
7	2.85	2.73	2.52	2.62	2.88	3.17	3.20	3.16	2.95	3.10
8	4.16	4.33	3.48	3.76	3.79	4.42	4.74	4.55	3.92	4.40
9	5.93	5.89	5.09	4.92	5.11	5.46	6.25	6.36	5.39	6.00
10	6.52	7.67	6.37	6.58	6.20	6.68	7.22	7.90	7.15	7.42
11	10.29	10.20	9.35	9.29	9.36	9.68	10.51	10.51	9.84	10.29
12+	13.67	15.34	11.45	11.66	11.03	11.64	11.86	12.37	11.26	11.83

Table 3.33 (continued)

```
; Gadget version 2.0.07 running on ress8645.imr.no Wed Apr 27 16:06:54 2005
stocks cod.imm cod.mat
areas  1
```

Proportion mature at age

Year	1985	1986	1987
Age			
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.085	0.080	0.063
6	0.302	0.269	0.208
7	0.552	0.501	0.454
8	0.635	0.736	0.675
9	0.504	0.778	0.858
10	1.000	0.708	0.823
11	1.000	1.000	1.000
12+	1.000	1.000	1.000

Proportion mature at age

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
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	0.015	0.008	0.030	0.066	0.079	0.072	0.074	0.038	0.036
6	0.168	0.065	0.097	0.164	0.227	0.181	0.221	0.186	0.164
7	0.358	0.292	0.204	0.270	0.367	0.387	0.339	0.387	0.350
8	0.628	0.509	0.456	0.402	0.489	0.548	0.569	0.501	0.569
9	0.812	0.766	0.668	0.646	0.621	0.665	0.722	0.722	0.661
10	0.916	0.893	0.867	0.811	0.794	0.769	0.705	0.759	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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2003-2005
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	0.028	0.039	0.026	0.035	0.038	0.031	0.052	0.036	0.015	0.0343
6	0.127	0.133	0.122	0.134	0.156	0.149	0.148	0.187	0.117	0.1509
7	0.323	0.276	0.274	0.263	0.305	0.327	0.316	0.321	0.346	0.3277
8	0.519	0.507	0.440	0.451	0.445	0.500	0.524	0.509	0.498	0.5105
9	0.727	0.680	0.673	0.615	0.634	0.629	0.690	0.708	0.677	0.6918
10	0.769	0.811	0.793	0.791	0.750	0.752	0.765	0.823	0.824	0.8039
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000
12+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000

Table 3.33 (continued)

```
; Gadget version 2.0.07 running on ress8645.imr.no Wed Apr 27 16:06:54 2005
stocks cod.imm cod.mat
areas  1
fleets  allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm
        gilfleet-cod.mat
```

Model catch in numbers (thousands) at age

Year	1985	1986	1987	1988
Age				
3	27700	28382	11251	6558
4	43914	69245	104658	22861
5	26305	69735	98570	122173
6	17174	23566	64288	46427
7	10715	11464	14772	21157
8	3511	5152	5798	3832
9	1968	1241	2112	1307
10	1183	574	477	426
11	263	276	163	81
12+	199	104	117	49
Total	132932	209741	302205	224870

Model catch in numbers (thousands) at age

Year	1989	1990	1991	1992	1993	1994	1995	1996
Age								
3	4291	3090	10344	19330	15739	11581	7186	7059
4	13185	6575	10655	26943	49469	64126	38396	25301
5	27908	12072	11318	18660	42734	84427	100858	68198
6	85064	14374	13848	12382	24123	45298	72475	86929
7	18113	27687	13000	12177	12876	21960	30078	41598
8	7066	3833	21762	10292	11806	9605	13902	13298
9	1114	1146	2552	15515	9629	7998	5622	5518
10	333	112	670	1560	14114	7042	4979	1890
11	90	23	52	328	1204	7383	3232	1170
12+	27	6	13	32	302	828	4267	1792
Total	157190	68918	84213	117219	181995	260247	280994	252752

Model catch in numbers (thousands) at age

Year	1997	1998	1999	2000	2001	2002	2003	2004
Age								
3	14839	21932	12705	7816	7587	3440	5512	1905
4	31237	62040	69223	35865	31352	25907	13849	26529
5	56954	48124	84890	79871	55510	52483	40164	30893
6	78604	44514	30746	46649	59086	43132	46225	41027
7	60316	37765	17509	10946	23040	29894	25081	35287
8	23022	20131	11379	4709	4442	9487	13908	15523
9	6030	6204	4706	2599	1527	1558	3775	7155
10	2400	1359	1248	878	701	452	567	1715
11	605	425	207	175	159	146	122	208
12+	956	260	106	42	38	40	52	66
Total	274961	242753	232718	189551	183442	166539	149255	160307

Table 3.33 (continued)

```
; Gadget version 2.0.07 running on ress8645.imr.no Wed Apr 27 16:06:54 2005
stocks cod.imm cod.mat
areas  1
fleets  allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm
        gilfleet-cod.mat
```

Observed catch in numbers (thousands) at age

Year	1985	1986	1987	1988
Age				
3	19823	24597	10450	9317
4	41151	59086	117698	19548
5	24948	71517	84253	117460
6	16753	23479	57239	48949
7	10561	10439	13074	19899
8	3508	3797	3568	3151
9	1432	888	867	1163
10	713	688	449	381
11	134	519	183	107
12+	38	134	204	68
Total	119061	195143	287984	220041

Observed catch in numbers (thousands) at age

Year	1989	1990	1991	1992	1993	1994	1995	1996
Age								
3	4902	1315	3493	14276	7680	5558	4741	7034
4	15828	5807	8514	22802	37098	49632	35100	25574
5	28904	9870	12308	18685	54328	79314	95618	70969
6	66506	13786	15174	17113	28245	50230	79441	87253
7	24993	23668	14189	12899	11520	28770	28290	46081
8	5186	5151	18096	9543	7441	7676	6786	8729
9	789	605	2701	12820	5183	4523	2495	1791
10	275	125	264	1761	9806	2498	1433	808
11	42	47	37	192	1296	5464	808	357
12+	14	12	12	46	249	751	1664	174
Total	147438	60386	74787	110136	162845	234417	256374	248771

Observed catch in numbers (thousands) at age

Year	1997	1998	1999	2000	2001	2002	2003	2004
Age								
3	10454	28160	8084	4266	4348	1547	4480	1369
4	32828	78268	72593	27993	30719	20480	12801	24289
5	63737	42650	81439	76991	53307	49756	38650	31696
6	75825	35602	27616	40926	53506	45010	44642	42084
7	60395	29462	13875	11508	20104	30600	25371	33879
8	22648	23799	14370	6318	4707	8910	10748	13674
9	3191	6133	7967	4563	1622	1343	2354	5072
10	814	883	1812	1517	1063	402	389	1429
11	352	174	210	261	275	145	113	232
12+	146	60	41	41	49	86	140	160
Total	270388	245190	228007	174384	169700	158279	139688	153884

Table 3.33 (continued)

; Gadget version 2.0.07 running on ress8645.imr.no Wed Apr 27 16:06:54 2005
stocks cod.imm cod.mat
areas 1
fleets allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm gilfleet-cod.mat

Model catch in biomass (tons) at age

Year	1985	1986	1987	1988
Age				
3	26152	16541	5609	3588
4	57595	90902	90920	20578
5	60782	122747	158432	160825
6	60755	69119	141204	101148
7	51149	47867	54388	63083
8	21742	27978	29953	18071
9	14787	8273	14339	8191
10	12374	4561	3985	3412
11	3520	3012	1702	789
12+	2639	1402	1823	691
Total	311495	392401	502355	380374
Total+	348724	442501	559946	425969

(+ Also includes: overfish-new otherfleet)

Model catch in biomass (tons) at age

Year	1989	1990	1991	1992	1993	1994	1995	1996
Age								
3	3037	2767	11246	20728	11299	7282	4234	4677
4	12846	9051	15956	43997	71096	76012	42078	27182
5	37615	20844	24085	39483	88324	167222	171579	110459
6	154852	31539	37581	38611	62755	129551	190163	214143
7	54198	79286	44392	49766	49798	76833	114636	153197
8	29063	16843	94360	51891	59504	48659	63249	69396
9	6797	6527	15437	95460	58866	51092	35788	32939
10	2606	870	4966	12520	103891	53581	39802	15313
11	898	221	497	3125	11425	65118	30030	11572
12+	369	86	166	406	3498	9561	47795	22958
Total	302281	168033	248686	355987	520456	684911	739354	661835
Total+	343108	217219	323749	522317	636276	846053	863626	764753

(+ Also includes: overfish-new otherfleet)

Model catch in biomass (tons) at age

Year	1997	1998	1999	2000	2001	2002	2003	2004
Age								
3	8368	13046	7352	3917	4349	2012	3204	1154
4	35575	64851	73072	38773	30928	29797	15506	27696
5	90413	78161	130871	131481	89258	85684	73339	50738
6	174283	99486	66611	107783	140044	106413	114208	106928
7	202443	118136	52692	34485	76789	109659	90995	123284
8	109368	95739	46358	20471	19217	47038	72016	76452
9	39268	39324	27258	14444	8637	9413	25052	47973
10	17654	11455	9106	6489	4850	3437	4435	14262
11	5968	4034	1971	1588	1426	1327	1171	2011
12+	13684	4090	1350	535	443	485	631	834
Total	697024	528321	416640	359965	375941	395263	400557	451332
Total+	781928	588707	467886	415191	430421	543891	578410	617134

(+ Also includes: overfish-new otherfleet)

Table 3.33 (continued)

; Gadget version 2.0.07 running on ress8645.imr.no Wed Apr 27 16:06:54 2005
stocks cod.imm cod.mat
areas 1
fleets allxgilfleet-cod.imm allxgilfleet-cod.mat gilfleet-cod.imm gilfleet-cod.mat

Observed catch in biomass (tons) at age

Year	1985	1986	1987	1988
Age				
3	17948	15226	5086	4968
4	53604	73787	101978	16313
5	48903	133381	128842	151174
6	53331	65666	133719	108829
7	48851	46521	46379	69956
8	21169	21949	21314	16648
9	10971	5997	7454	9215
10	6993	5232	4318	3431
11	1580	5068	2247	1195
12+	547	1422	2810	947
Total	263894	374248	454146	382675
Total+	301123	424348	511737	428270

(+ Also includes: overfish-new otherfleet)

Observed catch in biomass (tons) at age

Year	1989	1990	1991	1992	1993	1994	1995	1996
Age								
3	3624	1090	3597	16410	5869	4605	3802	5644
4	14598	7070	12153	35478	53248	62856	42832	27948
5	36498	15879	25920	41467	112199	156455	165865	112514
6	123969	29412	42533	53720	76633	144955	202254	210237
7	71372	74450	50742	55633	46655	98004	107761	175919
8	23732	23544	83487	49966	40484	40920	34062	50900
9	5923	4394	16169	78925	33172	31231	15421	12384
10	2496	1229	2314	13899	69911	19171	11505	6598
11	477	632	437	1976	10359	44041	7145	3449
12+	168	199	192	548	2563	7283	15370	1874
Total	282856	157898	237543	348022	451093	609520	606017	607465
Total+	323683	207084	312606	514352	566913	770662	730289	710383

(+ Also includes: overfish-new otherfleet)

Observed catch in biomass (tons) at age

Year	1997	1998	1999	2000	2001	2002	2003	2004
Age								
3	7034	17085	5037	2354	2860	1122	3247	1047
4	32452	76328	72744	27998	31436	23522	15016	28479
5	92423	65520	120373	120413	84341	80738	73619	53781
6	161292	79064	62170	93671	132679	109755	117057	107498
7	201478	94788	43800	37826	70012	113273	94438	115502
8	119086	114831	61825	28120	22370	44387	55339	65639
9	23228	42175	48013	26052	9711	8708	15172	34131
10	6372	8289	12422	11409	7887	3167	3247	11410
11	3012	1869	2313	2012	2384	1337	1195	2110
12+	1650	917	590	506	532	677	1663	2047
Total	648026	500866	429287	350362	364212	386685	379994	421642
Total+	732930	561252	480533	405588	418692	535313	557847	587444

(+ Also includes: overfish-new otherfleet)

Table 3.34 Gadget equivalent to standard prediction input table (3.28)

YEAR: 2005

Age	Stock size	Natural Mortality	Maturity ogive	Prop.Of F bef.spaw.	Prop.Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	415643	0.246	0.000	0	0	0.200	0.023	0.550
4	95129	0.210	0.000	0	0	0.610	0.108	1.090
5	318510	0.2	0.015	0	0	1.010	0.240	1.520
6	103227	0.2	0.117	0	0	1.740	0.456	2.200
7	63168	0.2	0.346	0	0	2.950	0.648	3.420
8	43385	0.2	0.498	0	0	3.920	0.733	4.440
9	15482	0.2	0.677	0	0	5.390	0.832	5.950
10	6051	0.2	0.824	0	0	7.150	0.924	7.820
11	1178	0.2	1.000	0	0	9.840	0.970	9.580
12+	195	0.2	1.000	0	0	11.260	0.992	11.800
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2006

Age	Stock size	Natural Mortality	Maturity ogive	Prop.Of F bef.spaw.	Prop.Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	478000	0.243	0.000	0	0	0.200	0.023	0.550
4	317627	0.209	0.000	0	0	0.600	0.103	1.070
5	69262	0.2	0.027	0	0	1.180	0.296	1.650
6	204280	0.2	0.097	0	0	1.690	0.442	2.160
7	53457	0.2	0.264	0	0	2.630	0.605	3.100
8	27030	0.2	0.530	0	0	4.240	0.753	4.770
9	17061	0.2	0.673	0	0	5.410	0.830	5.960
10	5680	0.2	0.791	0	0	6.850	0.908	7.630
11	1800	0.2	1.000	0	0	10.060	0.965	9.810
12+	425	0.2	1.000	0	0	11.730	0.990	12.290
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2007

Age	Stock size	Natural Mortality	Maturity ogive	Prop.Of F bef.spaw.	Prop.Of M bef.spaw.	Weight in stock	Exploit pattern	Weight in catch
3	574000	0.242	0.000	0	0	0.200	0.023	0.550
4	366445	0.209	0.000	0	0	0.600	0.102	1.070
5	232440	0.2	0.025	0	0	1.160	0.290	1.630
6	42022	0.2	0.133	0	0	1.920	0.492	2.360
7	107325	0.2	0.245	0	0	2.570	0.592	3.050
8	23889	0.2	0.448	0	0	3.810	0.712	4.350
9	10420	0.2	0.706	0	0	5.790	0.844	6.340
10	6283	0.2	0.792	0	0	6.880	0.903	7.660
11	1683	0.2	1.000	0	0	9.970	0.950	9.570
12+	690	0.2	1.000	0	0	12.170	0.982	12.730
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Table 3.35 Management options table from Gadget

Year: 2005					Year: 2006					Year: 2007	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.6388	1138785	302454	463811	0.0000	0.0000	1123082	269812	0	1670837	491418
.	.	.	.	.	0.0878	0.0518	.	269812	47206	1618764	464591
.	.	.	.	.	0.1756	0.1041	.	269812	92609	1568556	438869
.	.	.	.	.	0.2634	0.1572	.	269812	136254	1520164	414222
.	.	.	.	.	0.3512	0.2113	.	269812	178188	1473545	390621
.	.	.	.	.	0.4390	0.2663	.	269812	218454	1428652	368037
.	.	.	.	.	0.5268	0.3222	.	269812	257098	1385441	346442
.	.	.	.	.	0.6146	0.3793	.	269812	294163	1343867	325807
.	.	.	.	.	0.7024	0.4373	.	269812	329693	1303887	306105
.	.	.	.	.	0.7902	0.4966	.	269812	363730	1265457	287309
.	.	.	.	.	0.8780	0.5570	.	269812	396315	1228536	269392
.	.	.	.	.	0.9658	0.6188	.	269812	427492	1193082	252326
.	.	.	.	.	1.0536	0.6819	.	269812	457300	1159052	236086
.	.	.	.	.	1.1414	0.7464	.	269812	485781	1126407	220646
.	.	.	.	.	1.2292	0.8124	.	269812	512973	1095106	205980
.	.	.	.	.	1.3170	0.8802	.	269812	538916	1065108	192064
.	.	.	.	.	1.4048	0.9497	.	269812	563650	1036376	178872
.	.	.	.	.	1.4926	1.0211	.	269812	587212	1008871	166380
.	.	.	.	.	1.5804	1.0947	.	269812	609639	982554	154565

Table 3.36 Results of long-term simulations

Run No.	Realised F	Catch	TSB	SSB	Recruits	% years SSB<Blim	% years SSB<B_{pa}	Average year-to-year % change in TAC
1	0.61	921	3155	761	689	0.00	3.81	17
2	0.56	490	1895	452	689	0.11	48.53	22

Table 3.37 Mean SSB (1000 tonnes) in 1986-1990 for different runs.

Run no.	Mean SSB 1986	Mean SSB 1987	Mean SSB 1988	Mean SSB 1989	Mean SSB 1990
Low recruitment	173730	181096	453602	411426	485809
High recruitment	173357	176586	441973	446824	640728

Table 3.38 Probability of SSB> B_{pa} in 1986-1990 for different runs.

Run no.	P(SSB > B_{pa}) 1986	P(SSB > B_{pa}) 1987	P(SSB > B_{pa}) 1988	P(SSB > B_{pa}) 1989	P(SSB > B_{pa}) 1990
Low recruitment	0.00	0.00	0.44	0.19	0.58
High recruitment	0.00	0.00	0.35	0.40	0.94

Table 3.39 Probability of SSB> B_{lim} in 1986-1990 for different runs.

Model	P(SSB > B_{lim}) 1986	P(SSB > B_{lim}) 1987	P(SSB > B_{lim}) 1988	P(SSB > B_{lim}) 1989	P(SSB > B_{lim}) 1990
Low recruitment	0.00	0.01	1.00	1.00	1.00
High recruitment	0.00	0.00	1.00	1.00	1.00

Table 3.40 Mean catches (1000 tonnes) in 1986-1990 for different runs

Model	Mean catch 1986	Mean catch 1987	Mean catch 1988	Mean catch 1989	Mean catch 1990
Low recruitment	119938	171849	356674	350897	372113
High recruitment	129442	185734	401360	417611	426942

Table 3.41 Mean realized F values in 1986-1990 for different runs

Model	Mean F 1986	Mean F 1987	Mean F 1988	Mean F 1989	Mean F 1990
Low recruitment	0.39	0.38	0.67	0.62	0.60
High recruitment	0.43	0.42	0.69	0.61	0.57

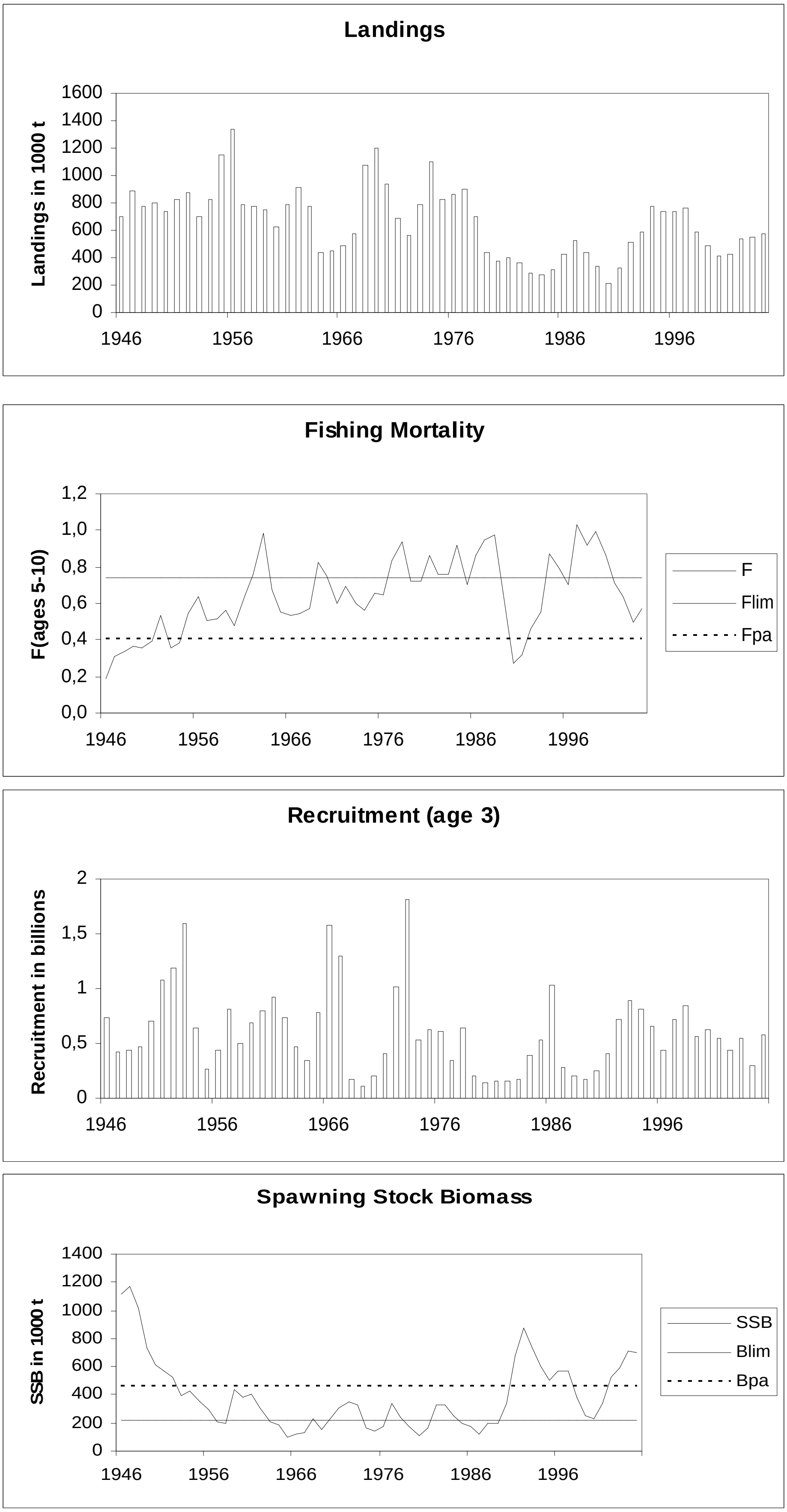
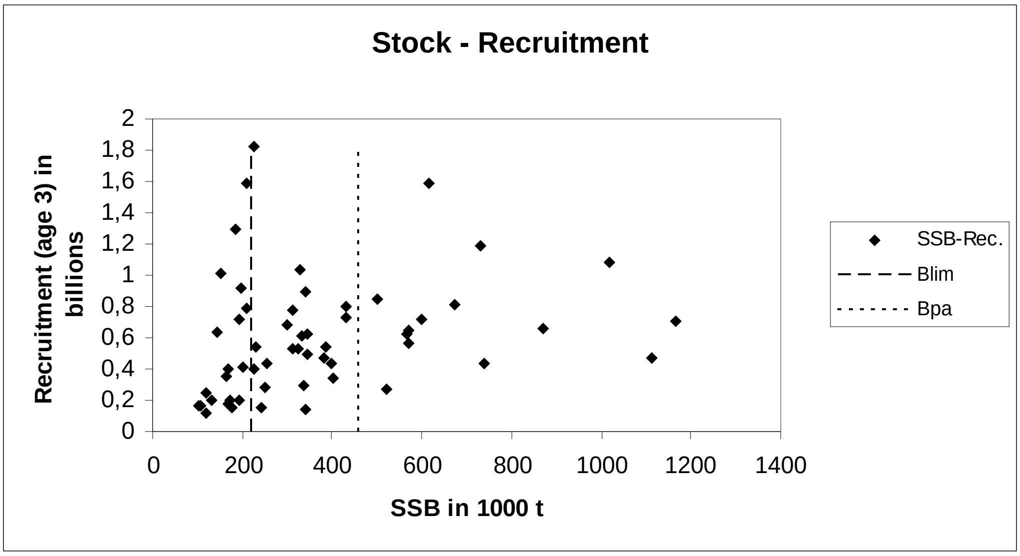
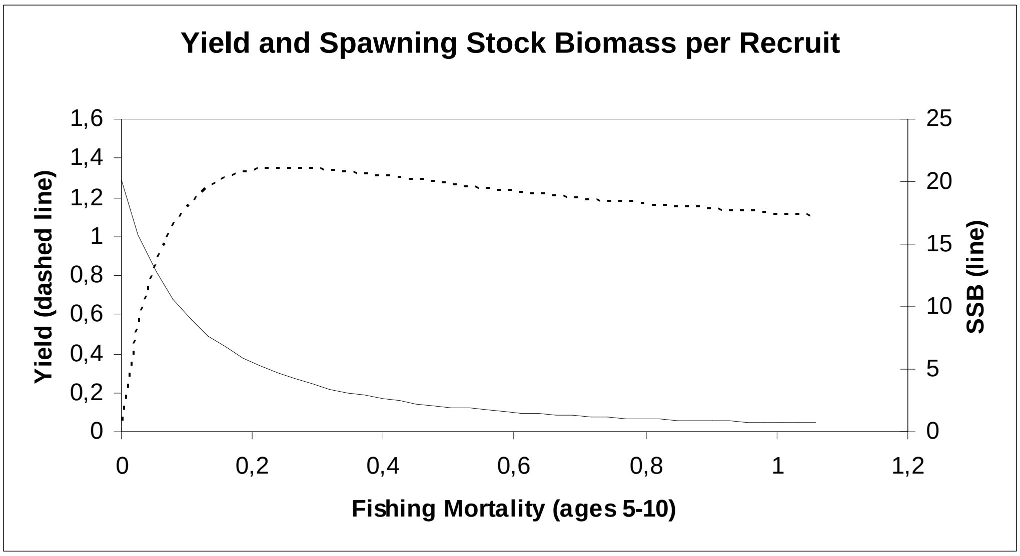


Figure 3.1. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)





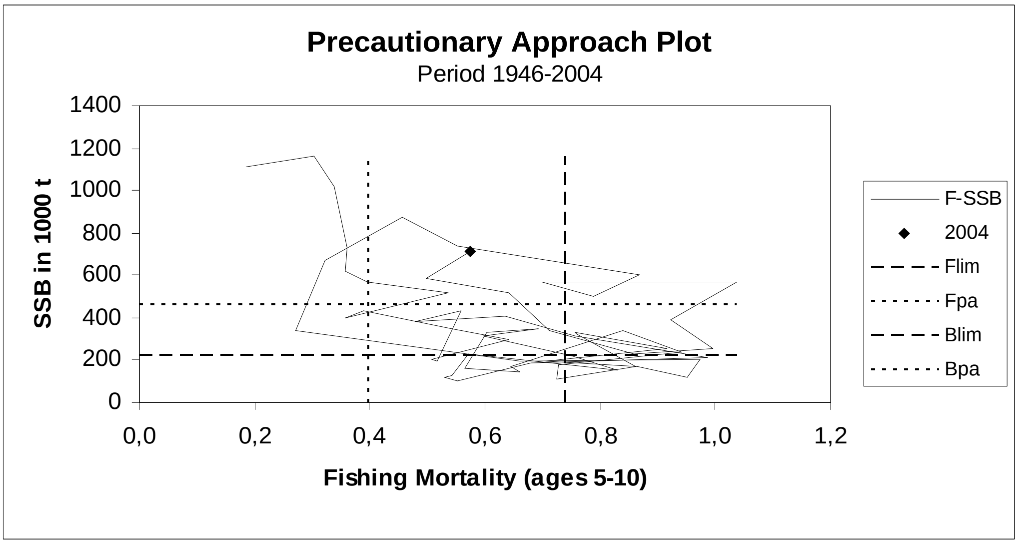


Figure 3.1. Continued. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)

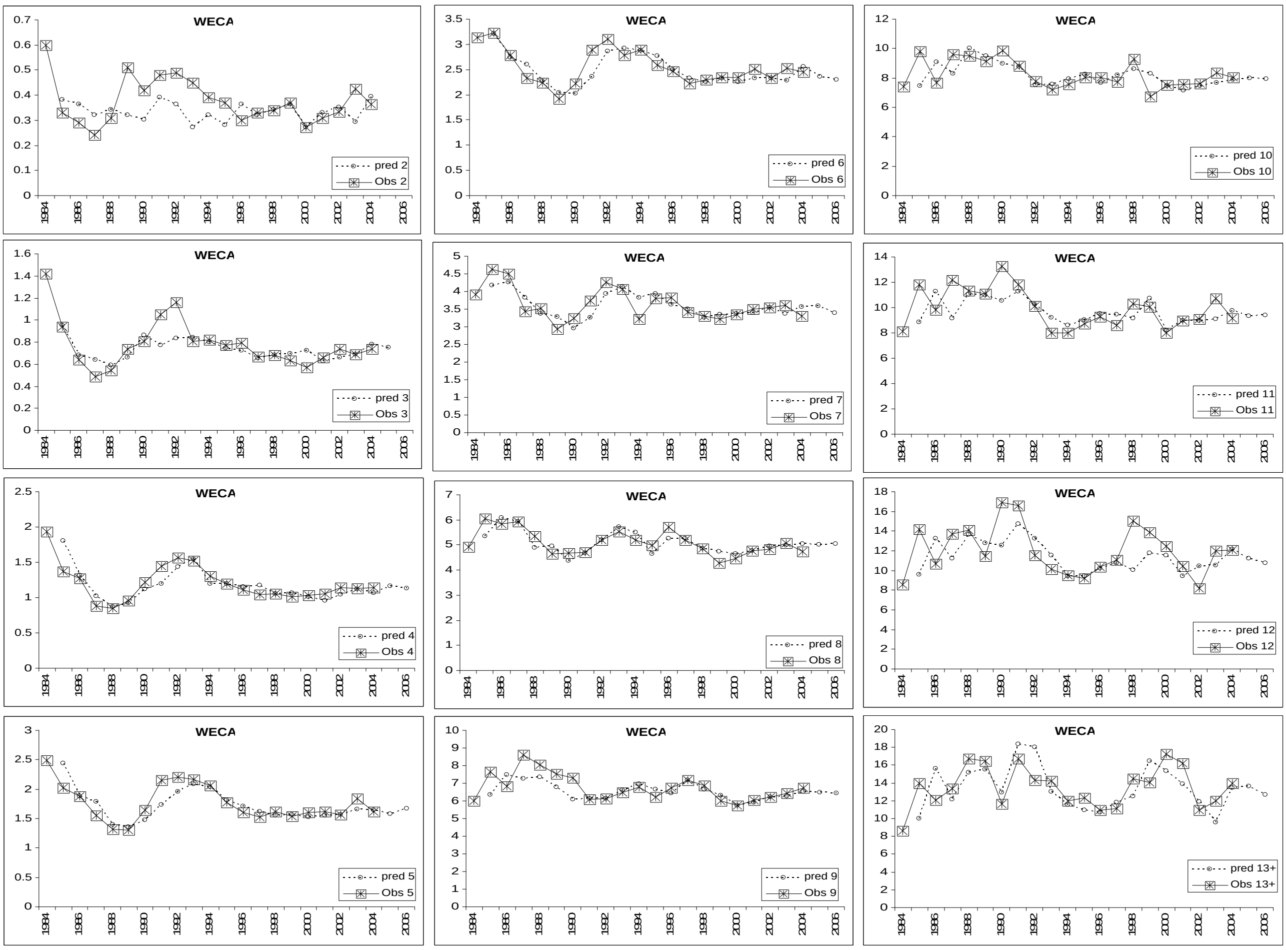


Figure 3.2a . North-east arctic cod. Weight in catch predictions.

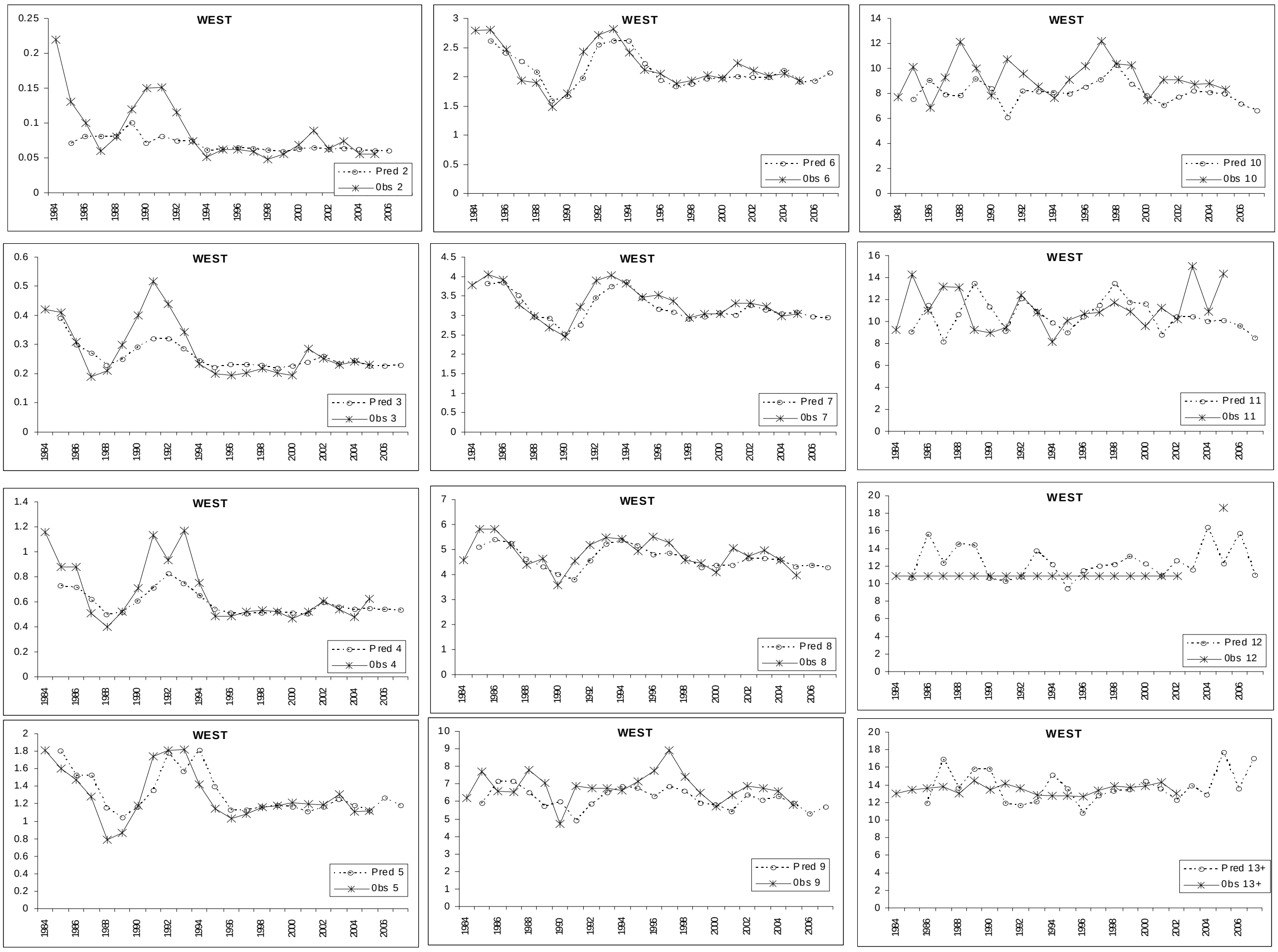


Figure 3.2b . North-east arctic cod. Weight in stock predictions.

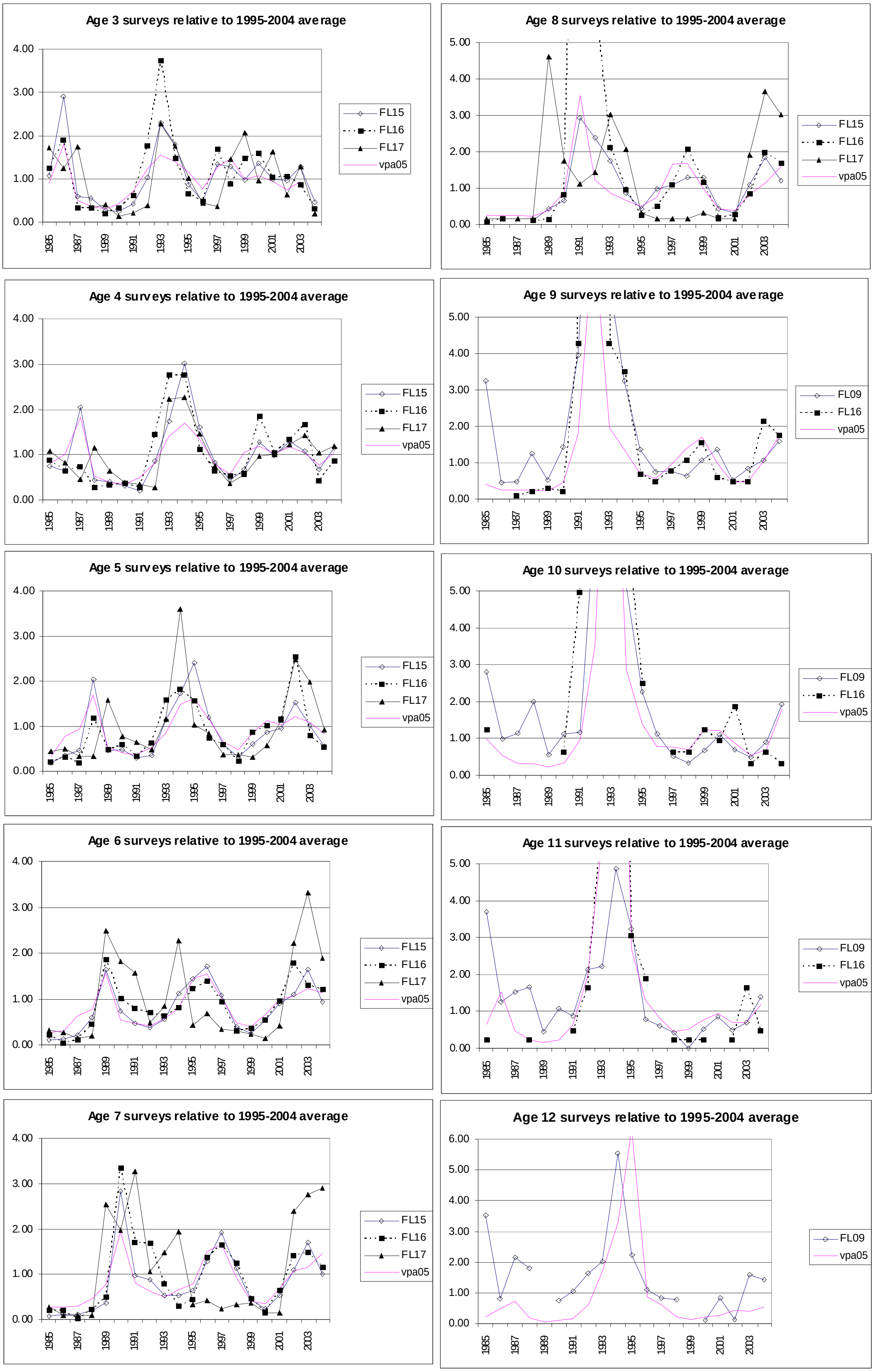


Figure 3.3. Single fleet tuning results by ages, plotted relative to 1994-2004 average values. Years and ages as specified in the tuning input.

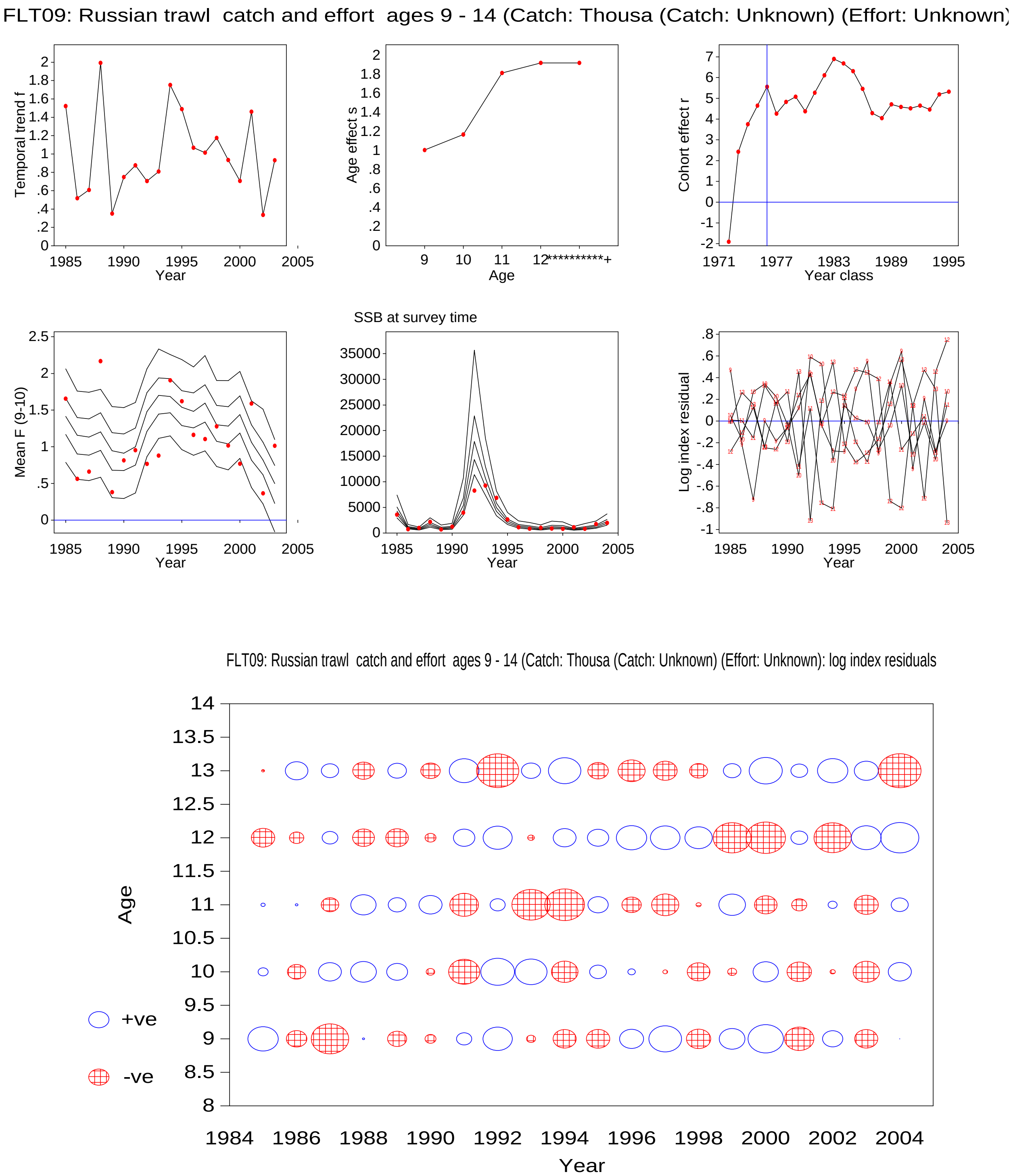
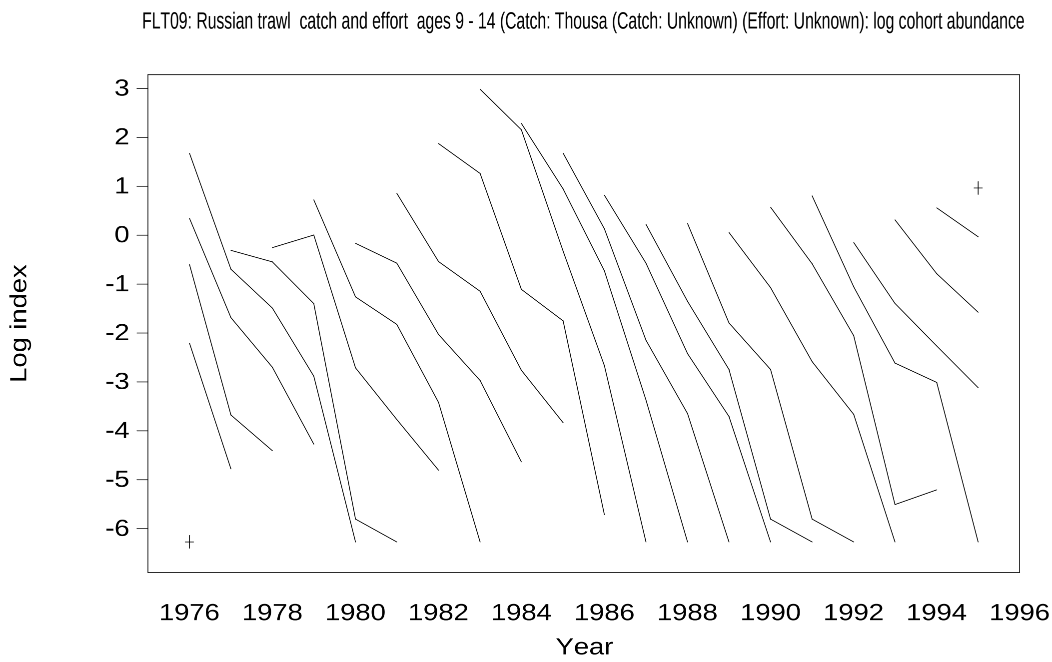


Figure 3.4. Standard SURBA plots for fleet 09



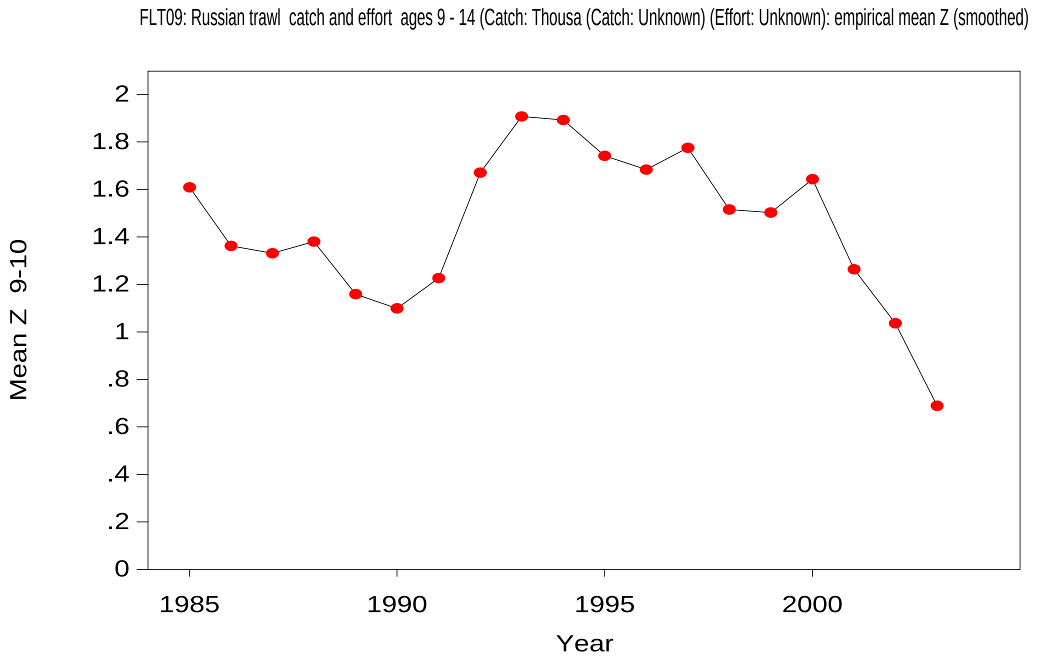


Figure 3.4 (continued). Standard SURBA plots for fleet 09.

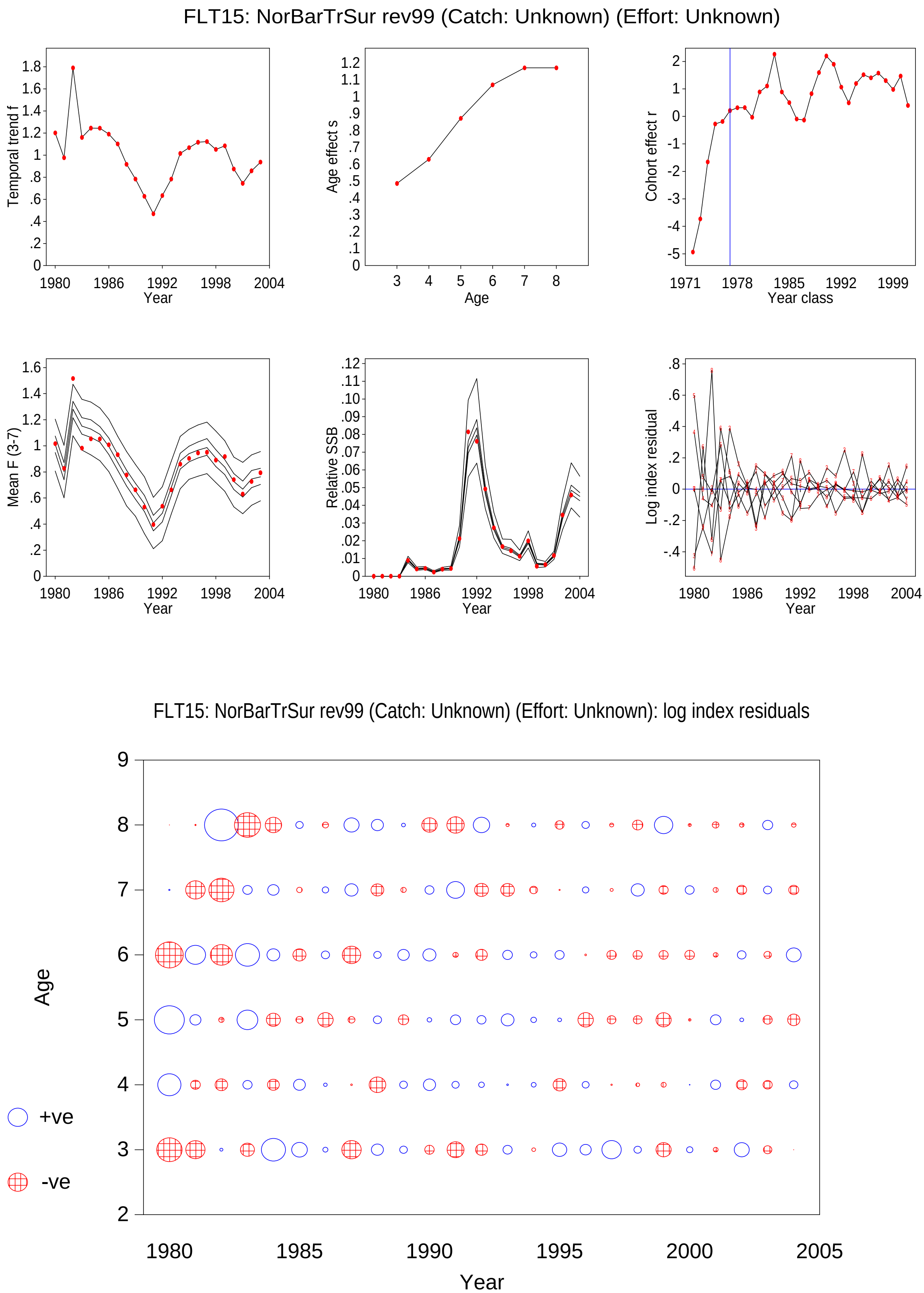


Figure 3.5. Standard SURBA plots for fleet 15.

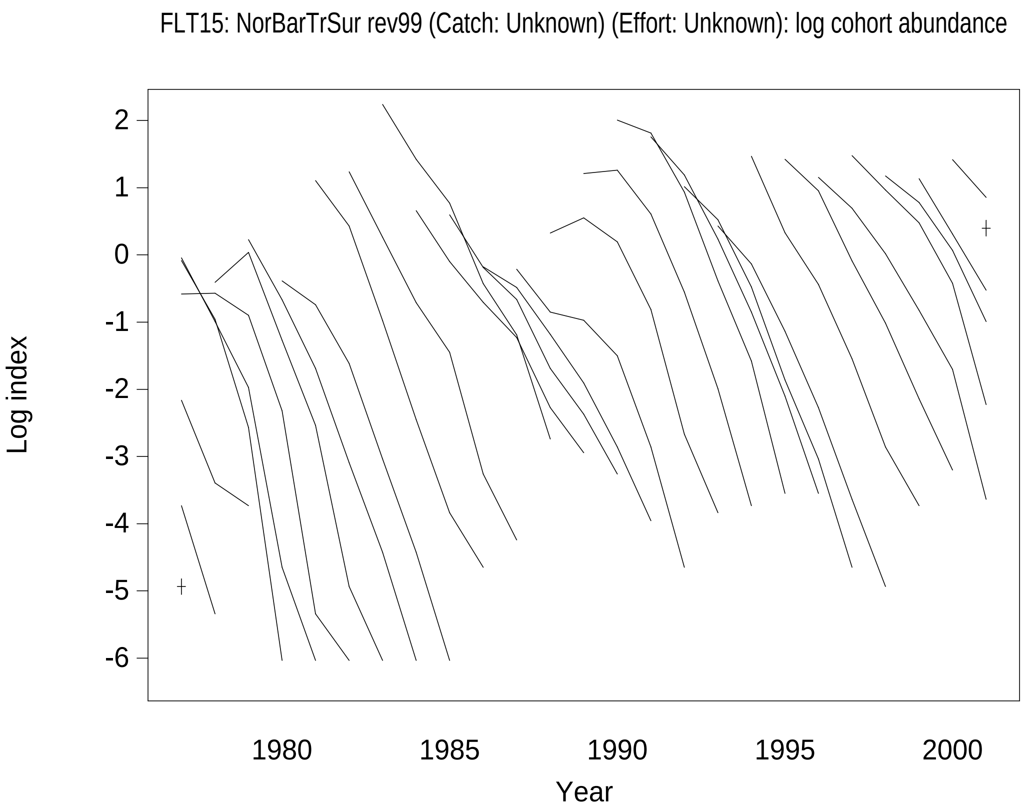


Figure 3.5 (continued). Standard SURBA plots for fleet 15.

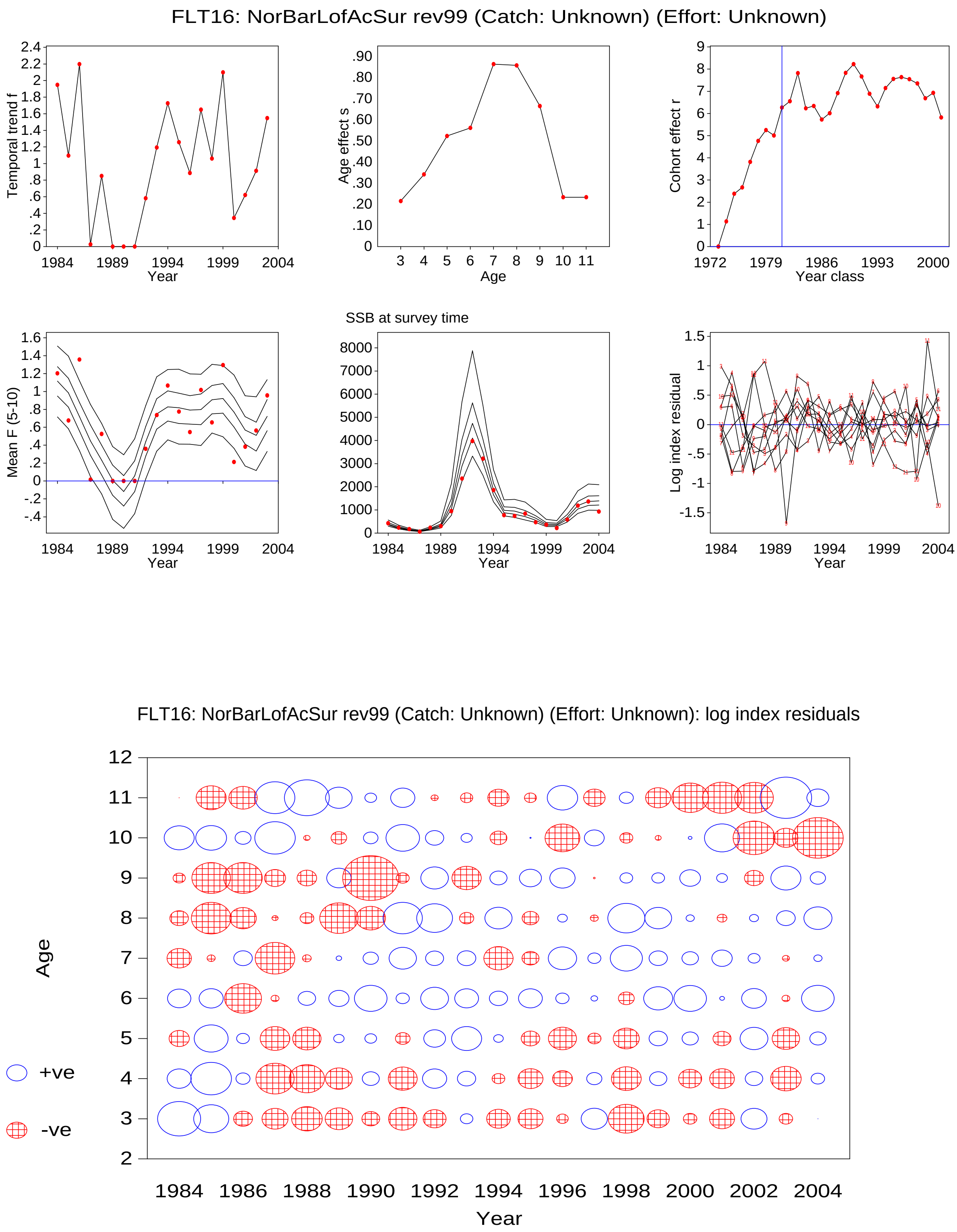
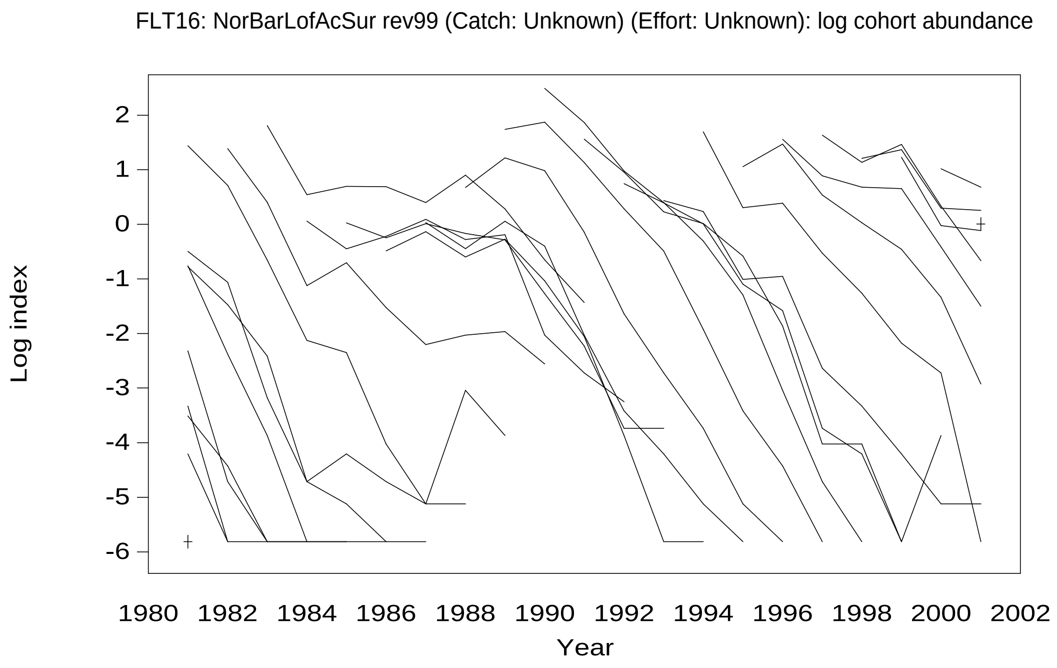


Figure 3.6. Standard SURBA plots for fleet 16.



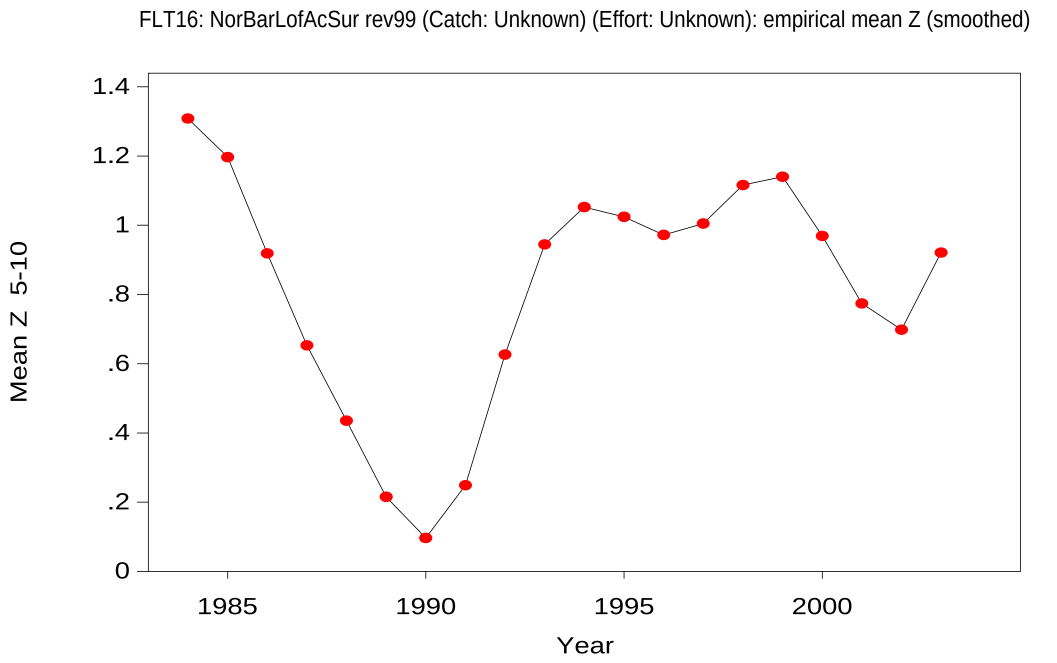


Figure 3.6 (continued). Standard SURBA plots for fleet 16.

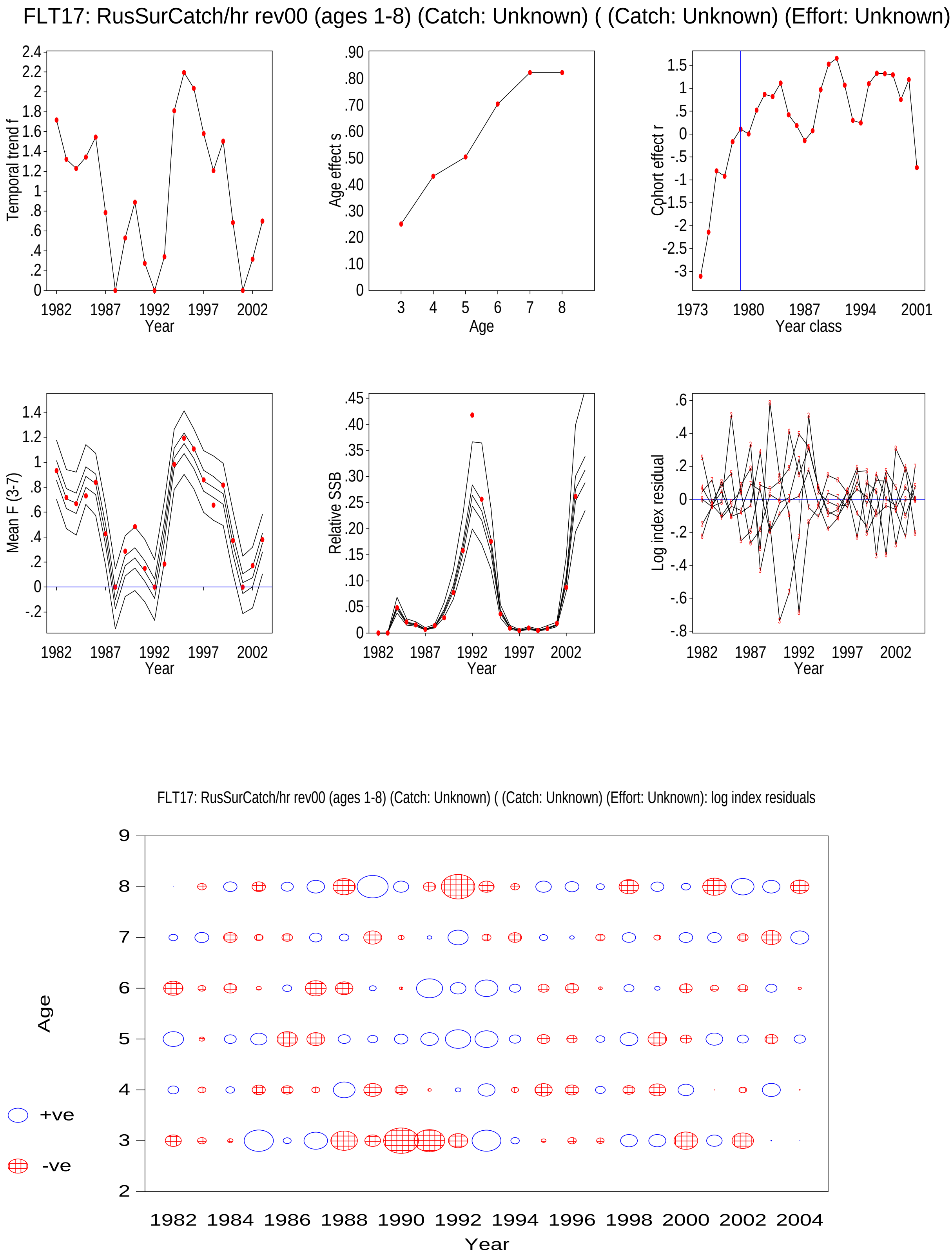


Figure 3.7. Standard SURBA plots for fleet 17.

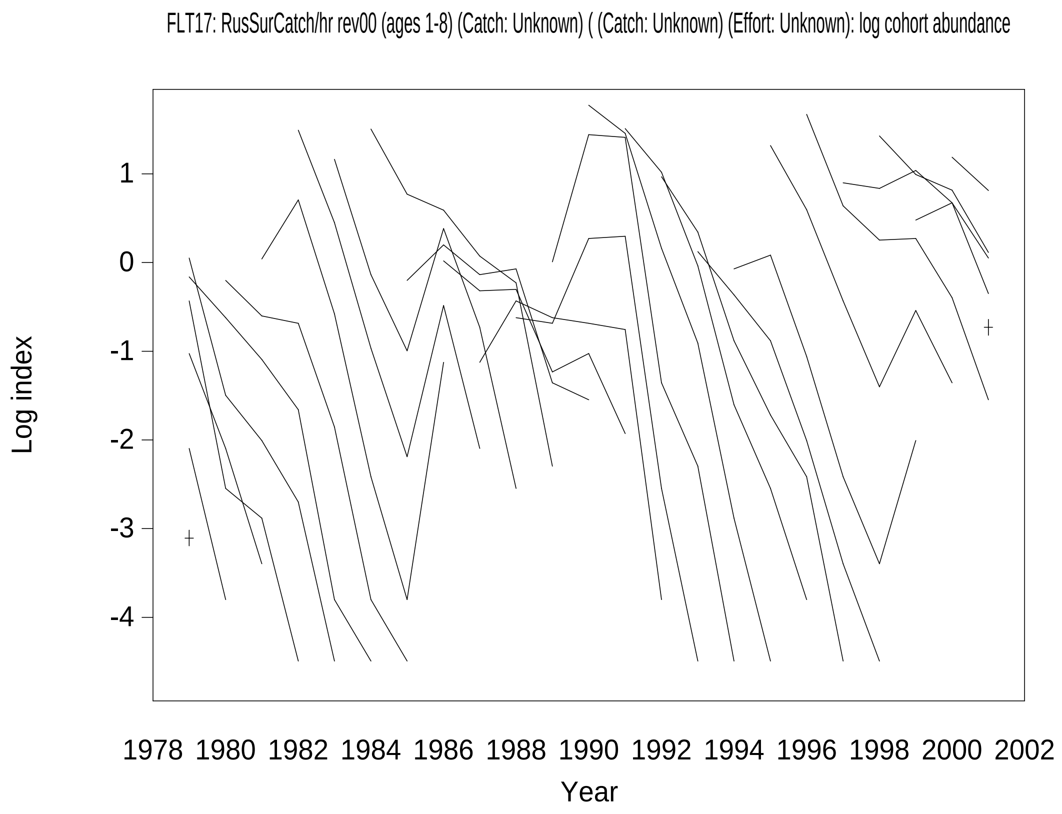


Figure 3.7 (continued). Standard SURBA plots for fleet 17.

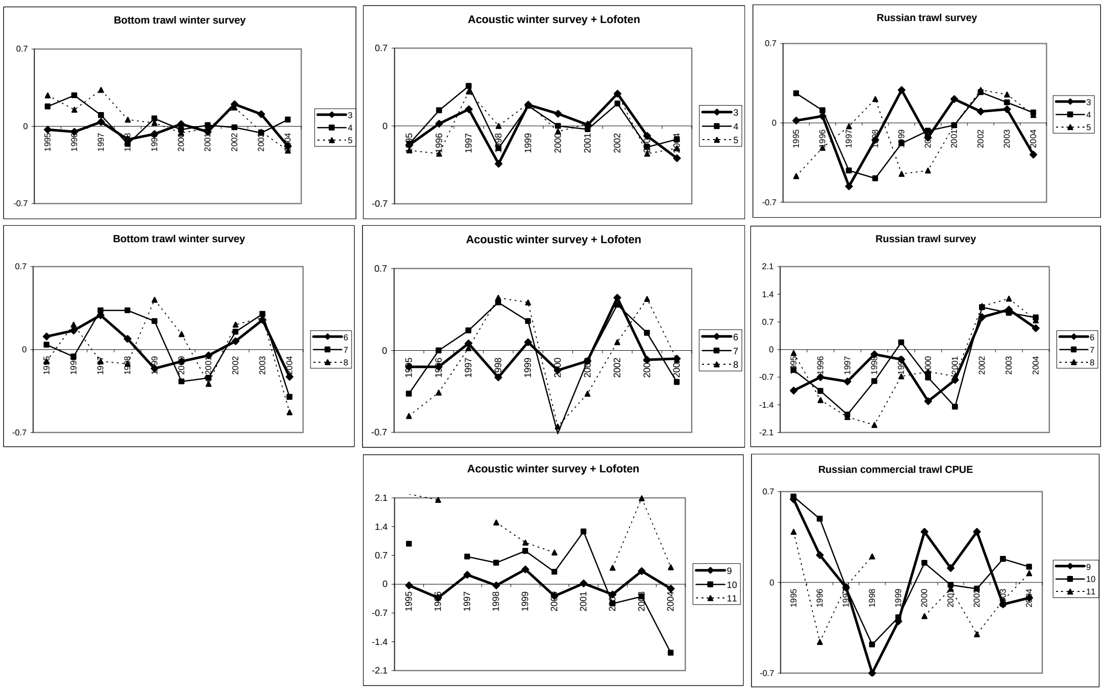
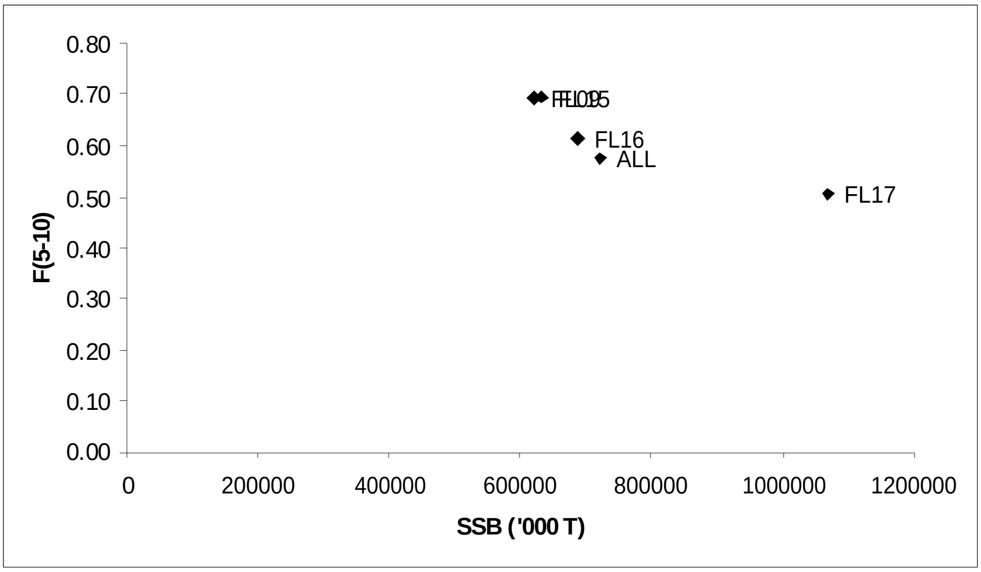


Figure 3.8. North-east arctic cod. Residual log catchability by fleet and age from the XSA output in the 2005 assessment.



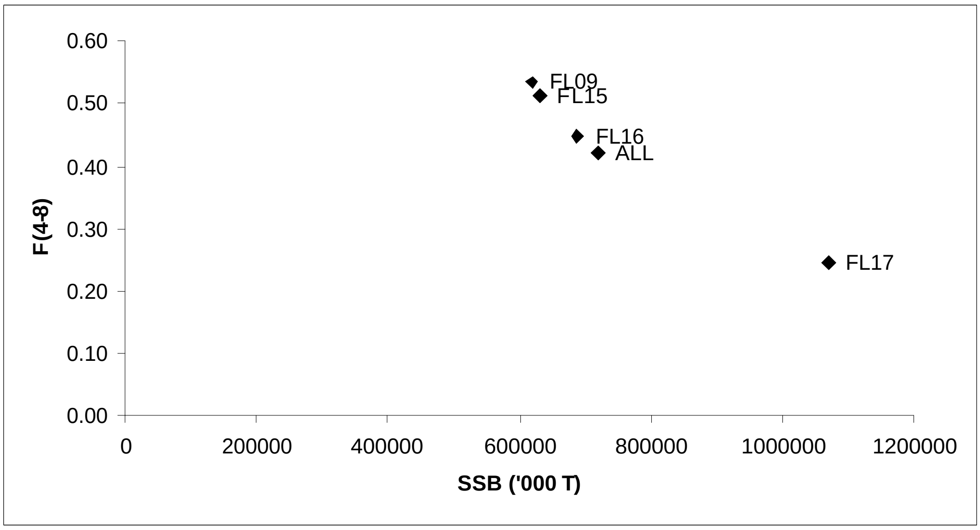


Figure 3.9. Single fleet tuning results, used as the final run.

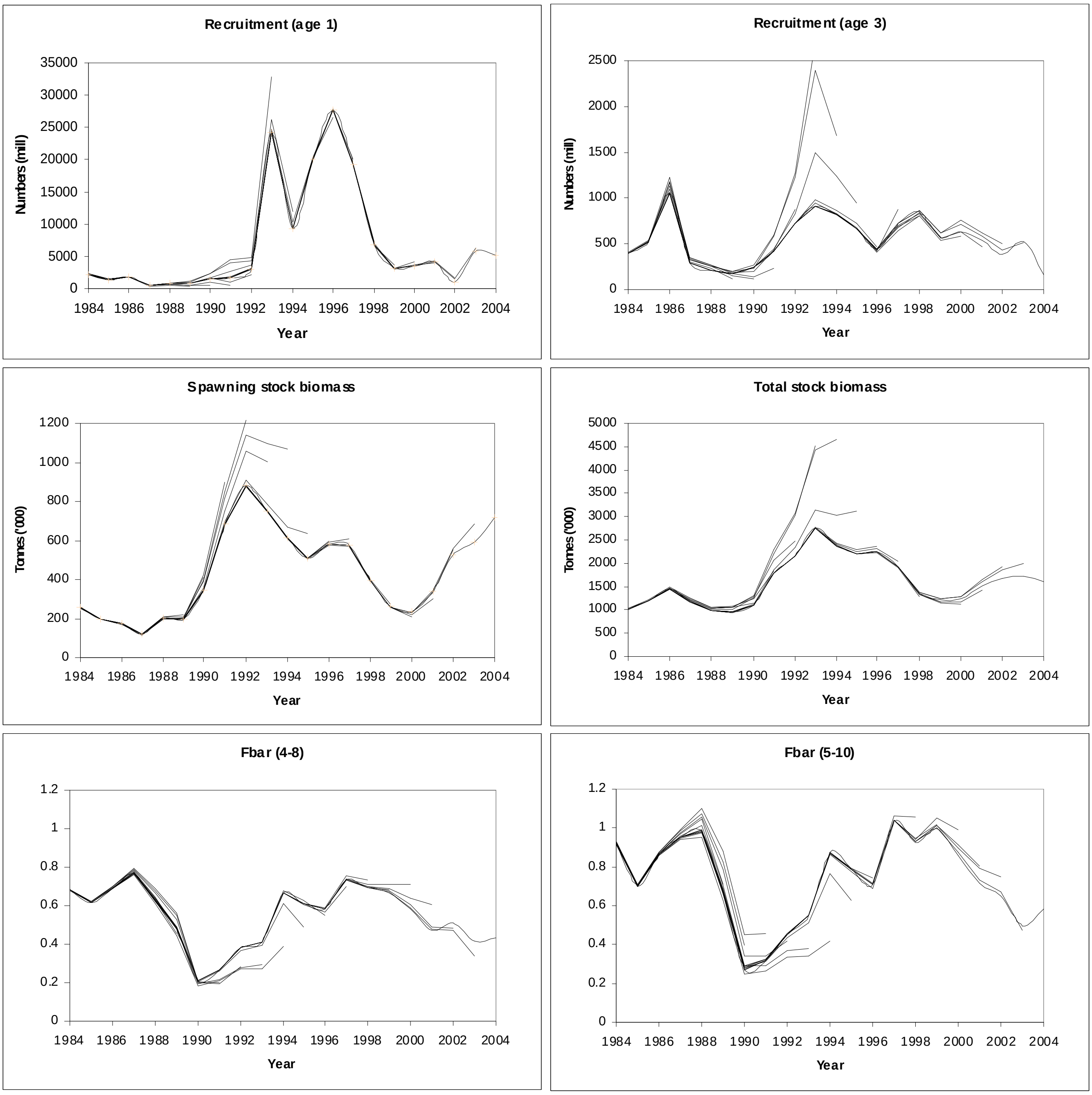


Figure 3.10 a. Retrospective plots with catchability dependent on stock size for ages < 3.

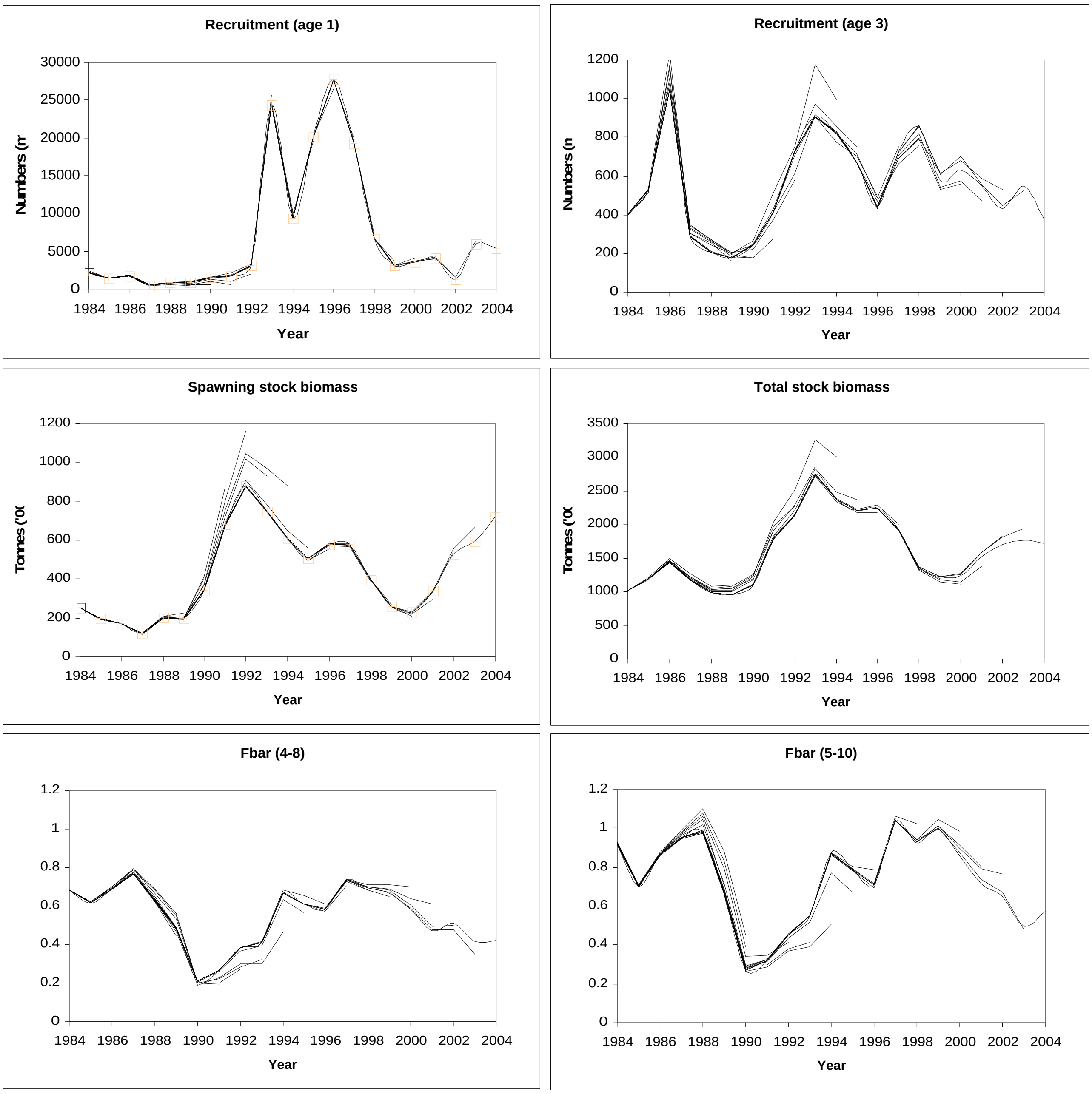


Figure 3.10 b. Retrospective plots with catchability dependent on stock size for ages < 6.

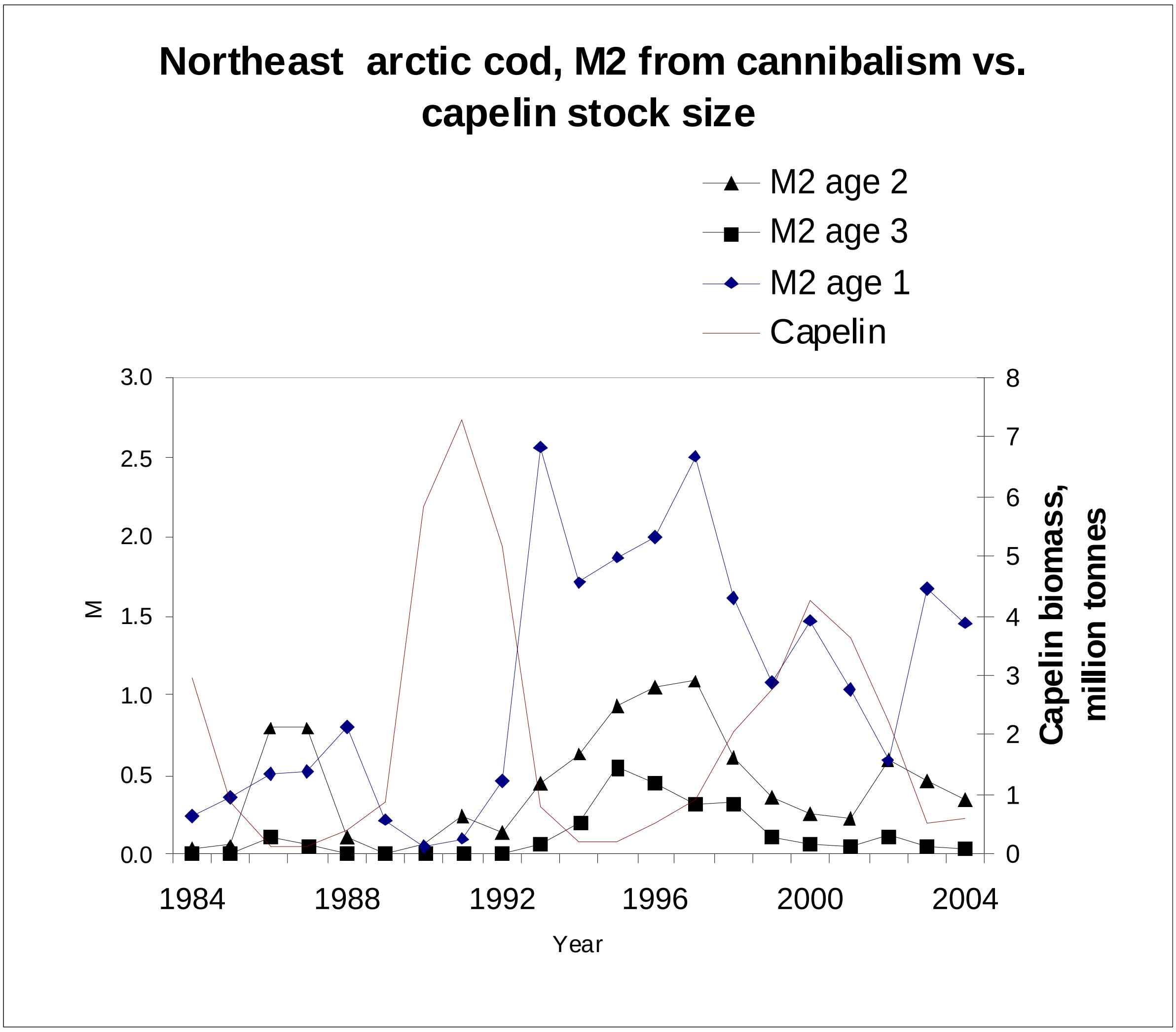
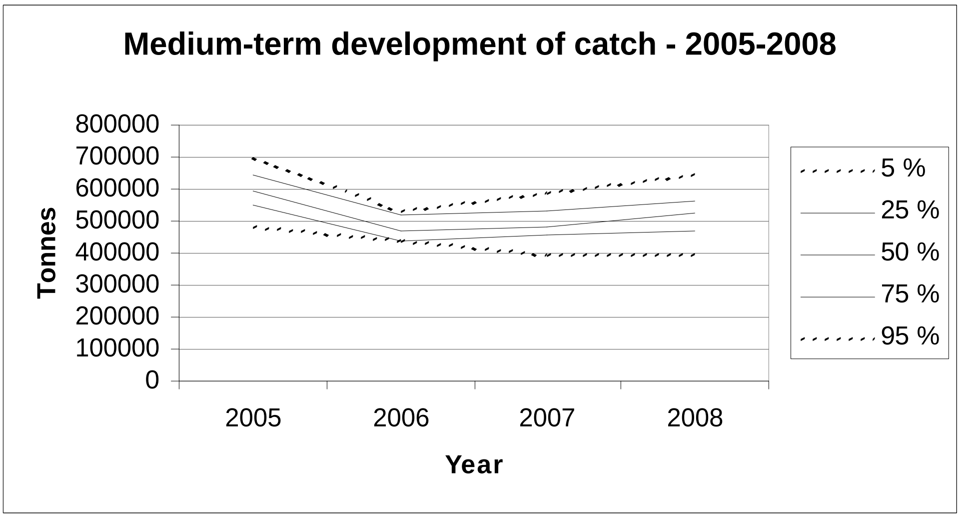
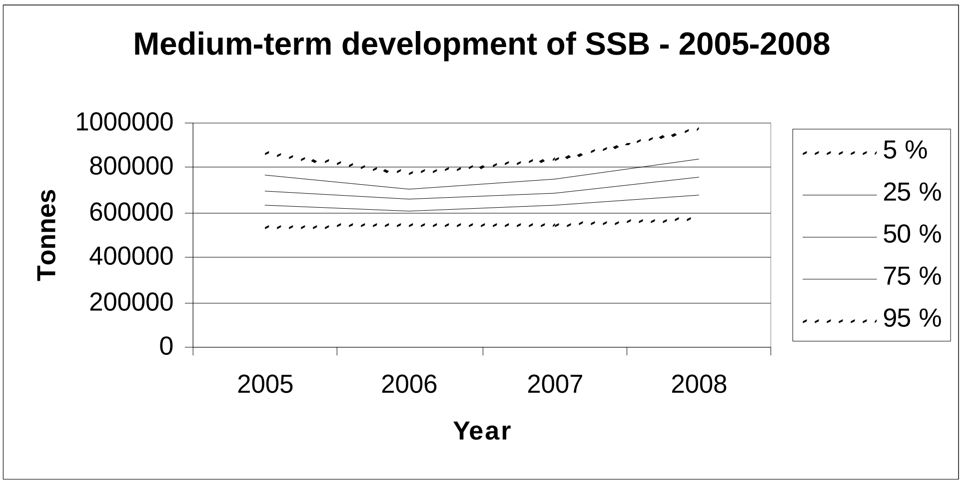


Figure 3.11. North-east arctic cod. Temporal trends in cod M2 by ages 1-3 from cannibalism and capelin stock size.





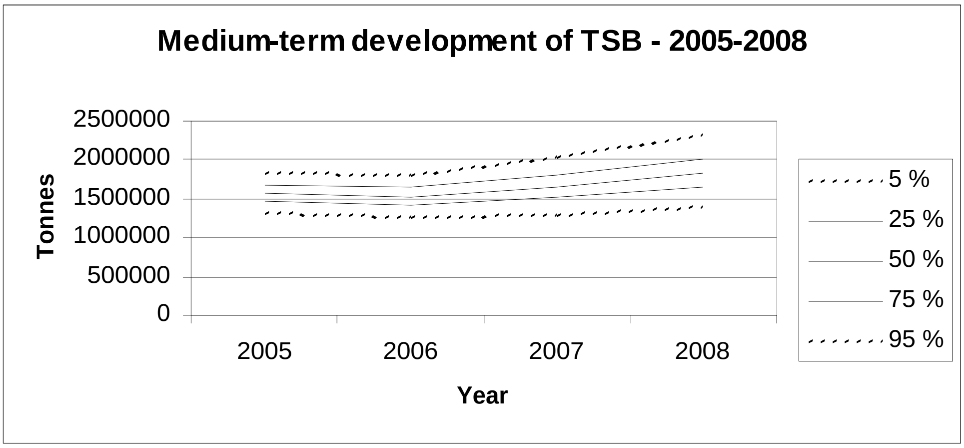


Figure 3.12 Stochastic medium-term projections of Catch, SSB and TSB.

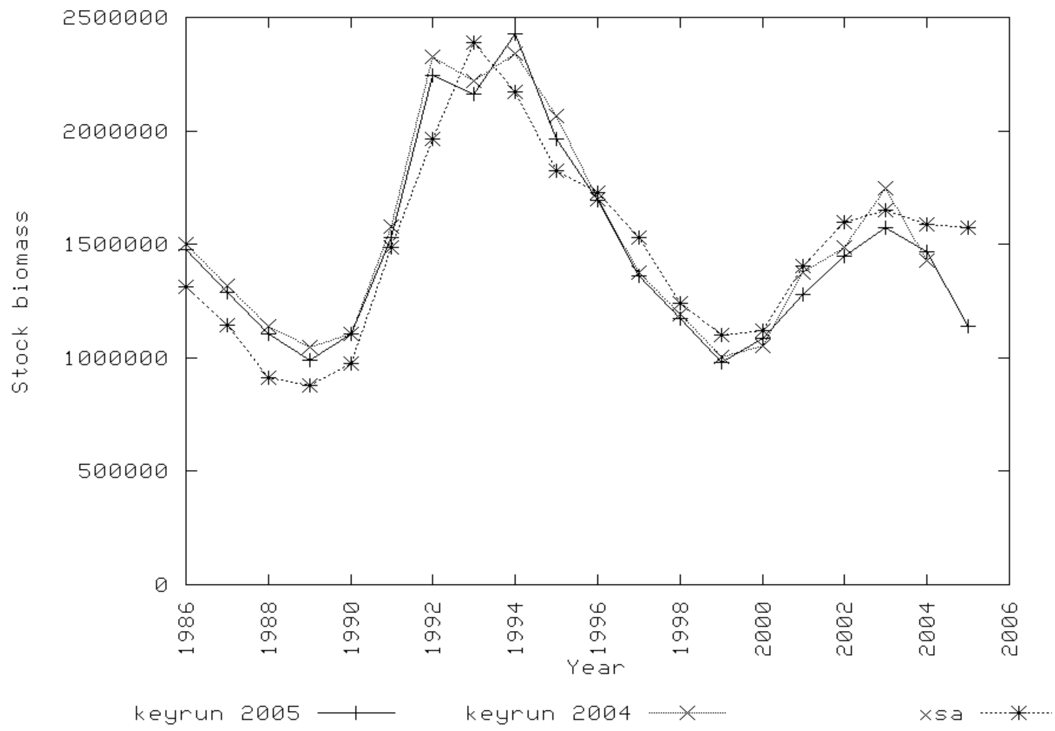


Figure 3.13a stock biomass in keyrun, last years keyrun, and XSA

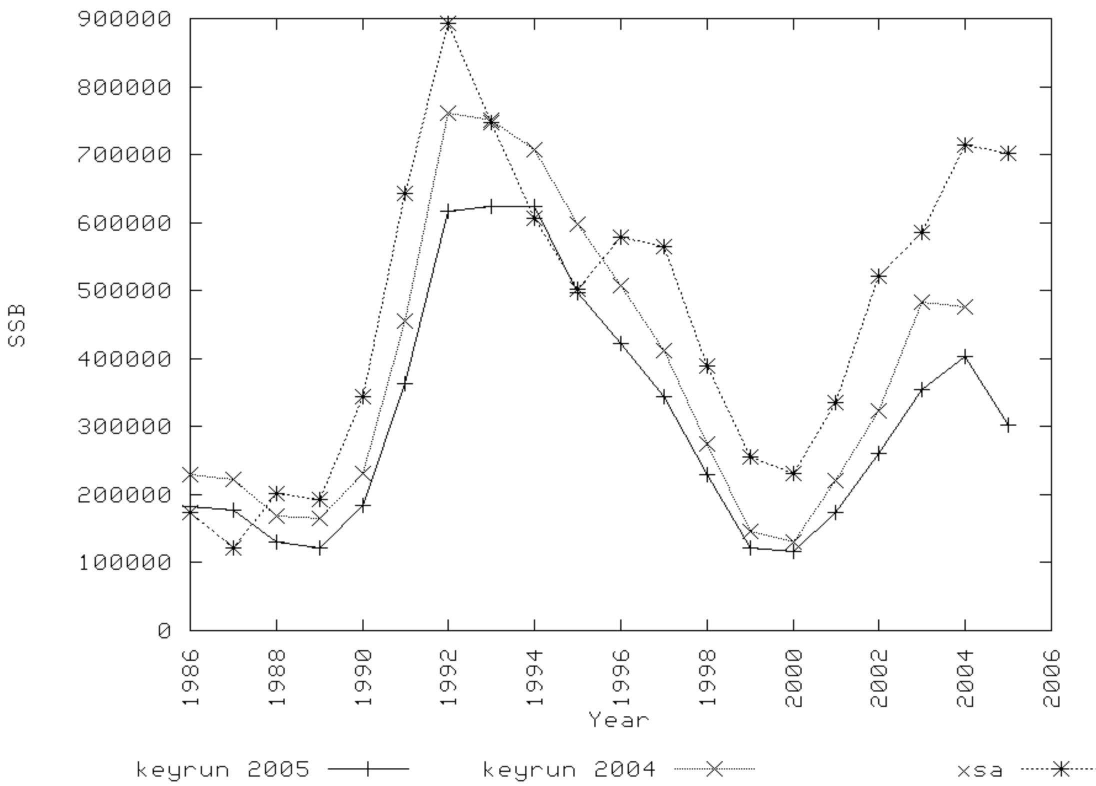


Figure 3.13b ssb in keyrun, last years keyrun, and XSA

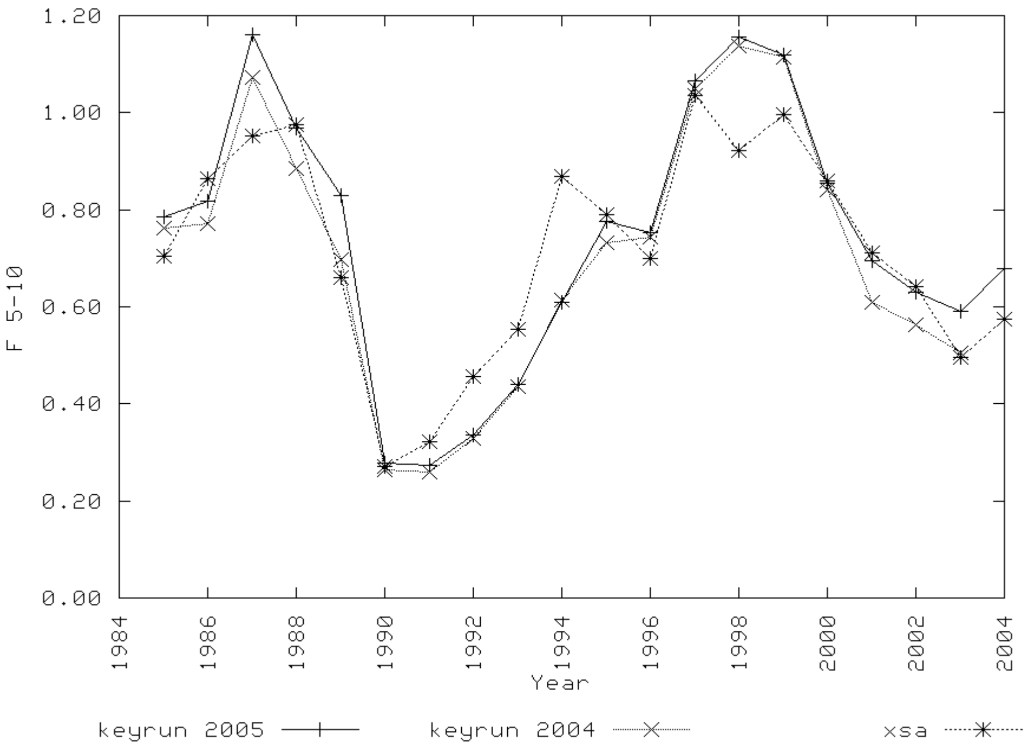


Figure 3.13c F5-10 in keyrun, last years keyrun, and XSA

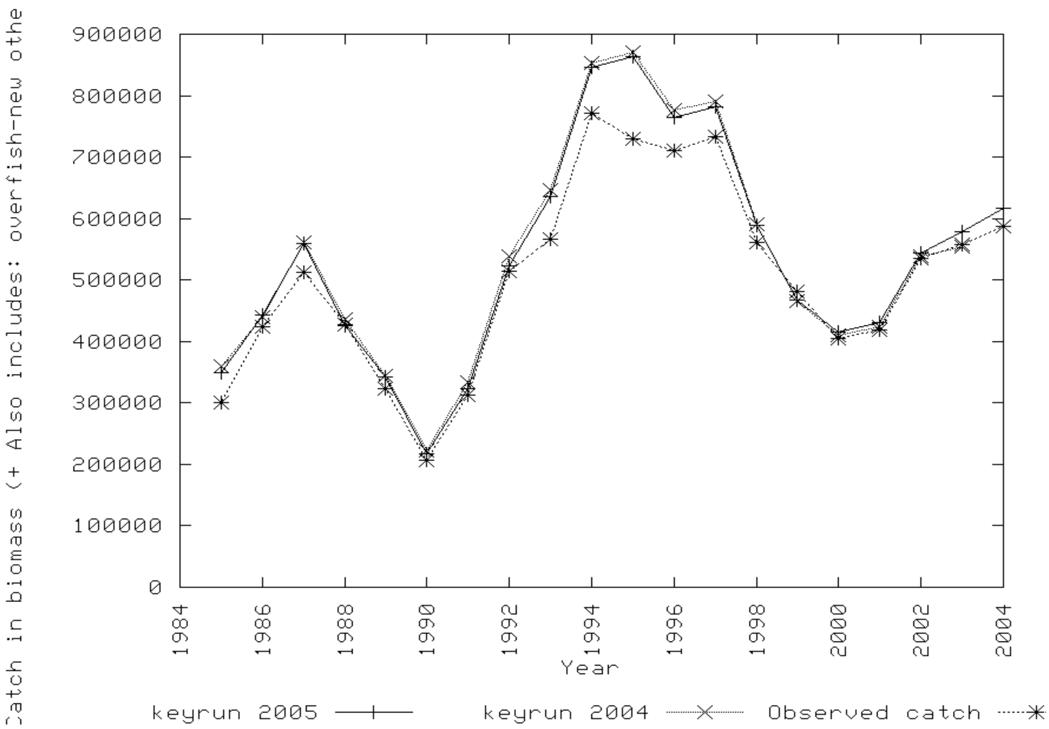


Figure 3.13d Catch in biomass in keyrun, last years keyrun, and observed catches

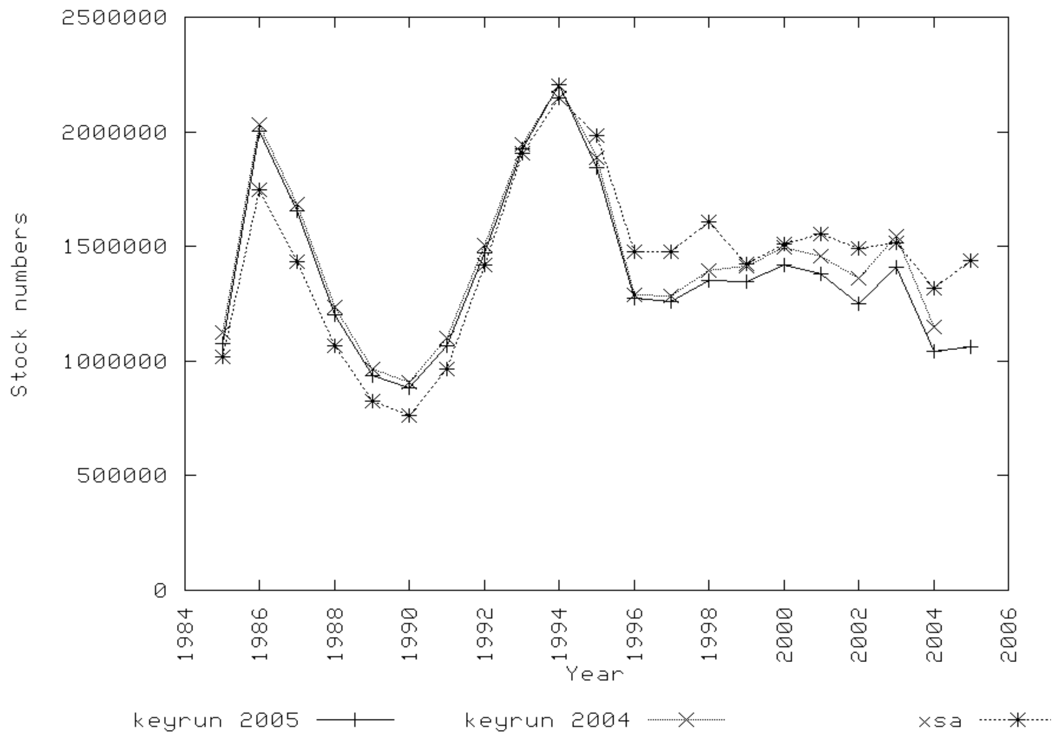


Figure 3.13e Recruitment (number of 3 year old) in keyrun, last years keyrun, and XSA

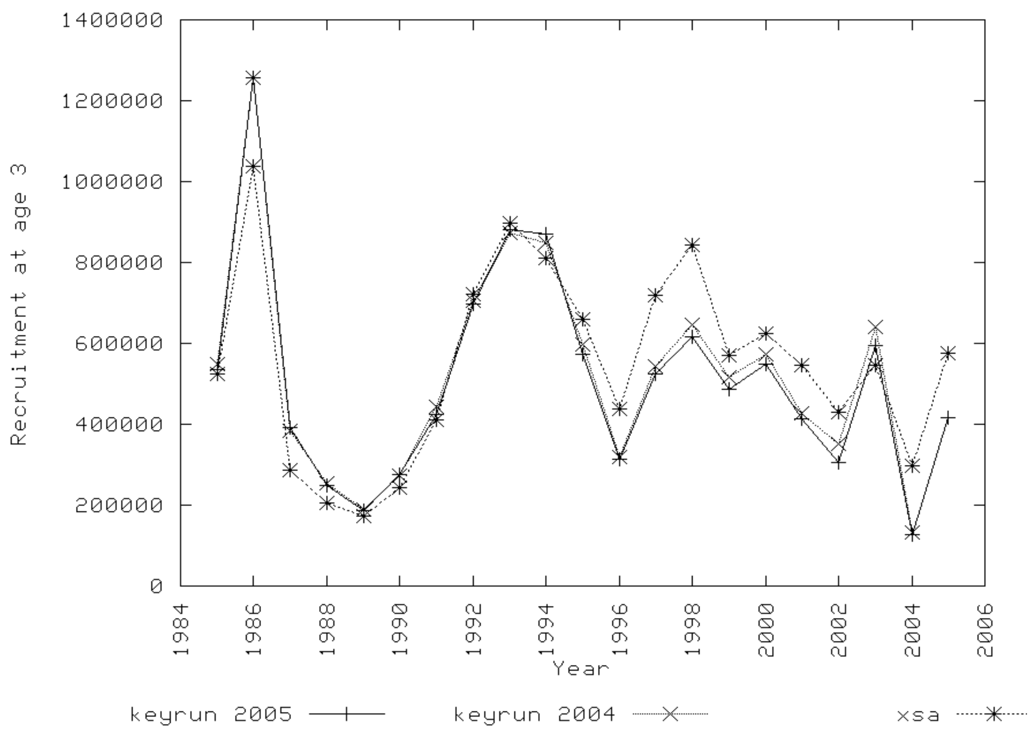


Figure 3.13f Stock numbers in keyrun, last years keyrun, and XSA

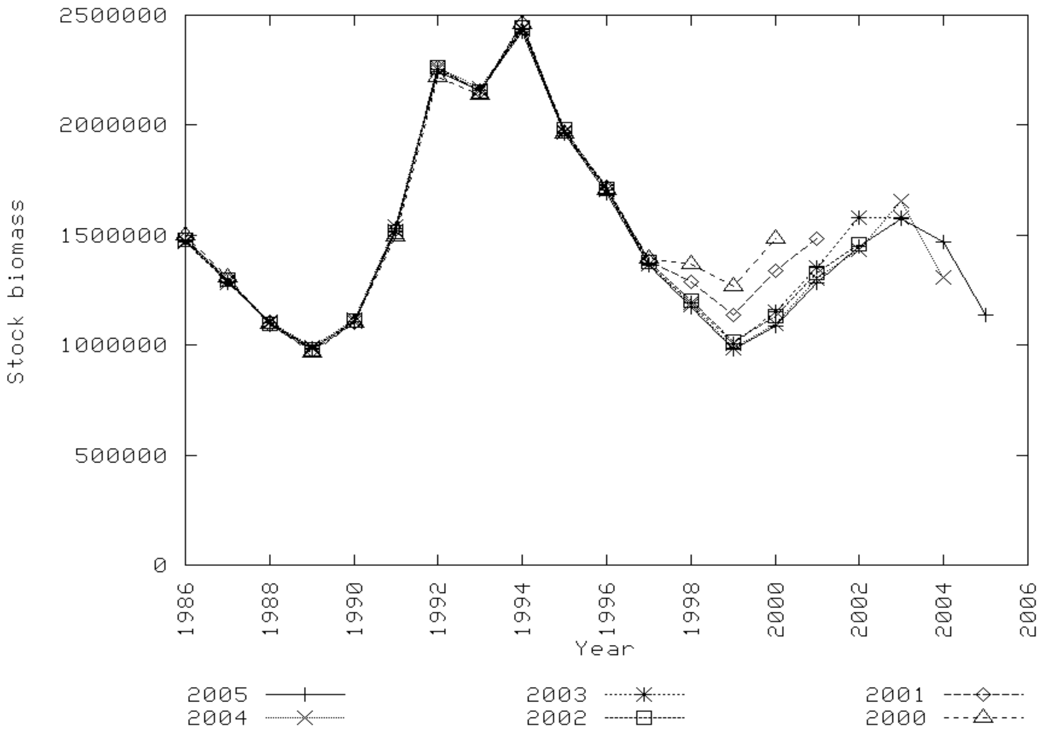


Figure 3.14a Retrospective pattern for stock biomass in keyrun

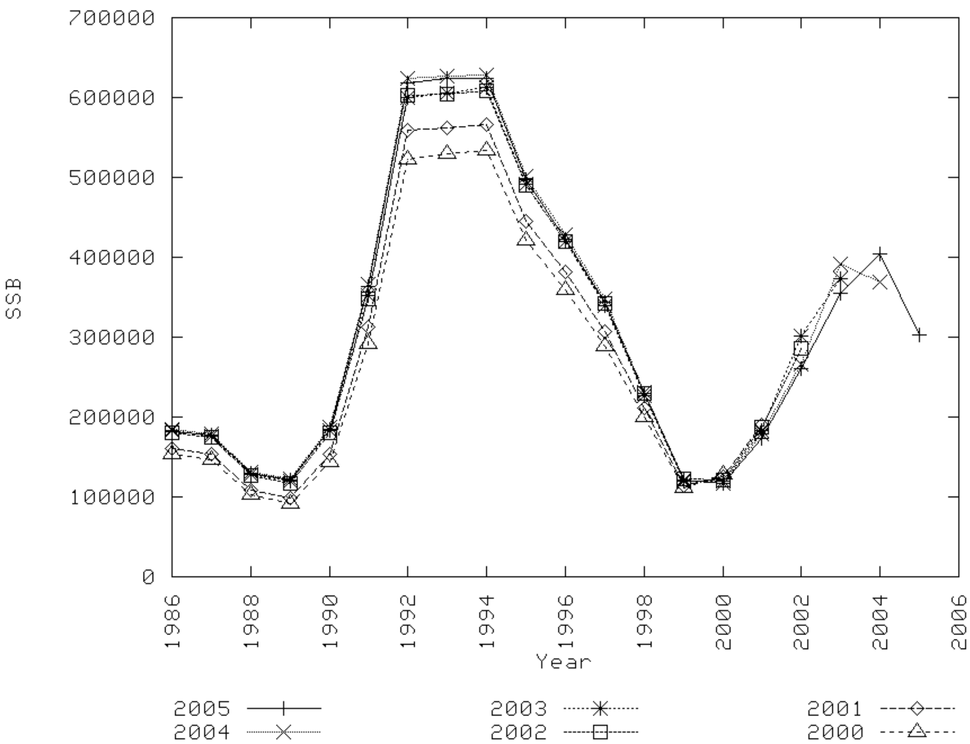


Figure 3.14b Retrospective pattern for SSB in keyrun

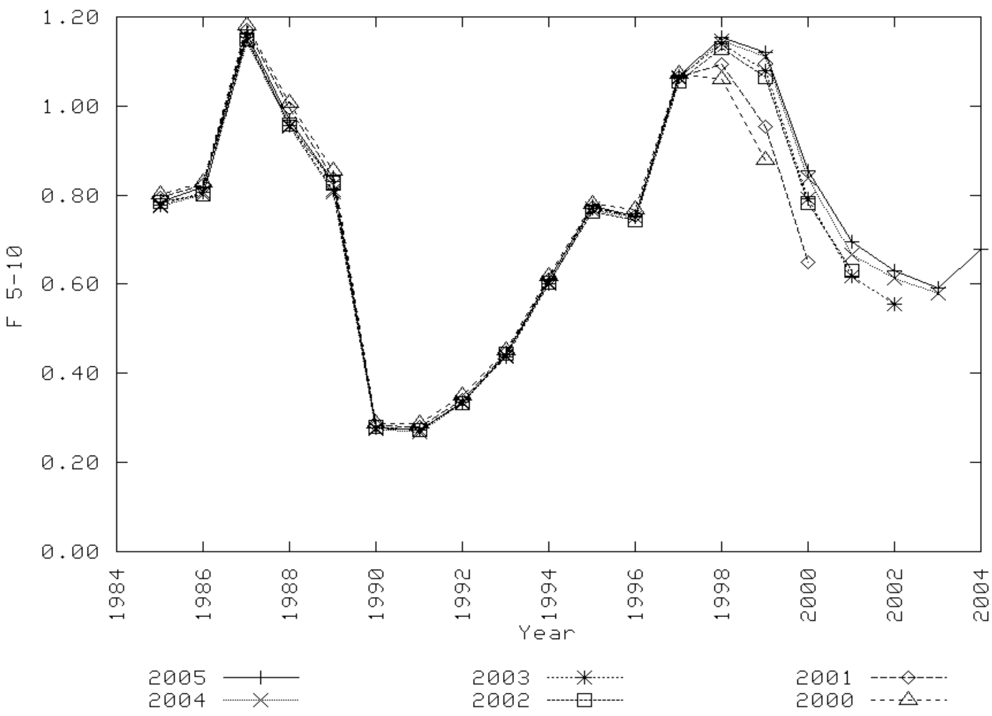


Figure 3.14c Retrospective pattern for F5-10 in keyrun

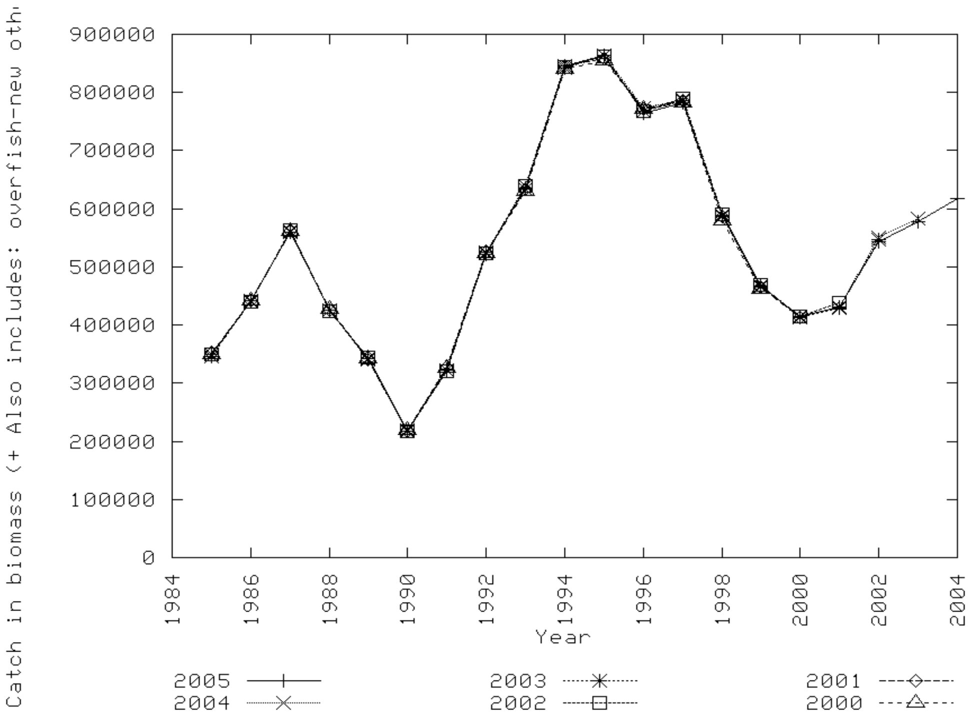


Figure 3.14d Retrospective pattern for Catch in biomass in key run

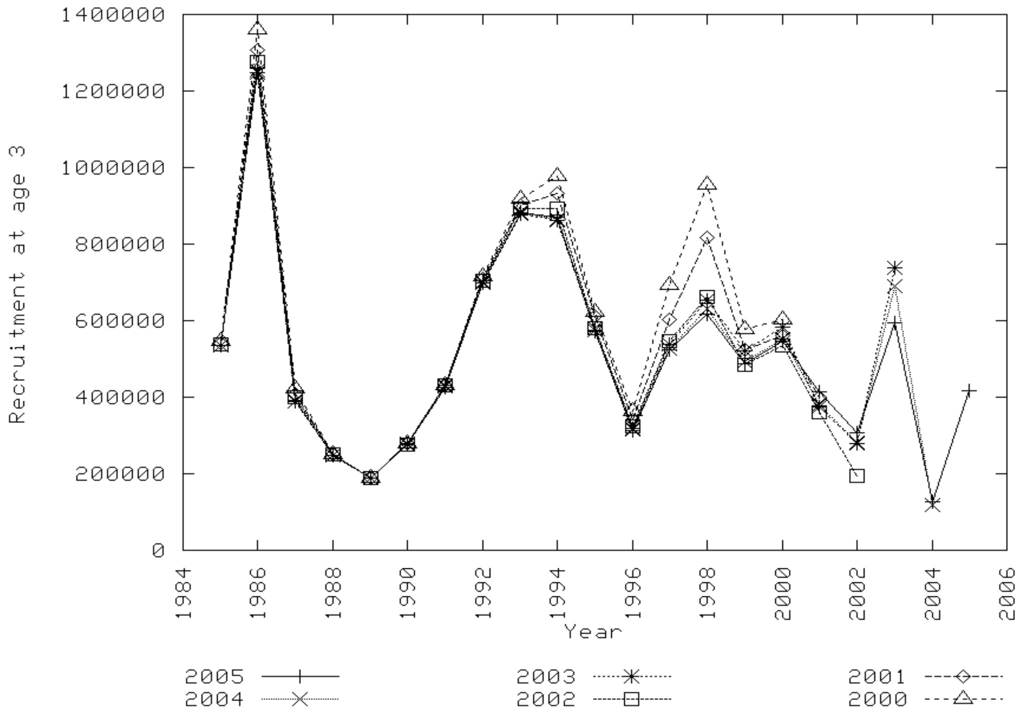


Figure 3.14e Retrospective pattern for recruitment in keyrun

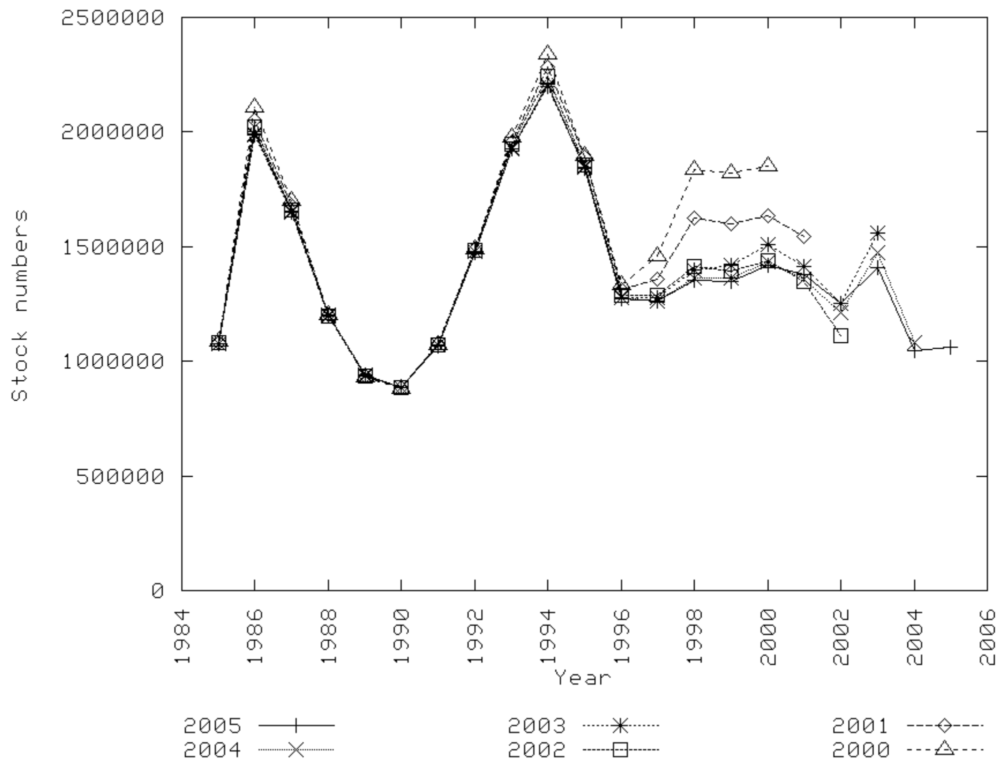


Figure 3.14f Retrospective pattern for stock numbers in keyrun

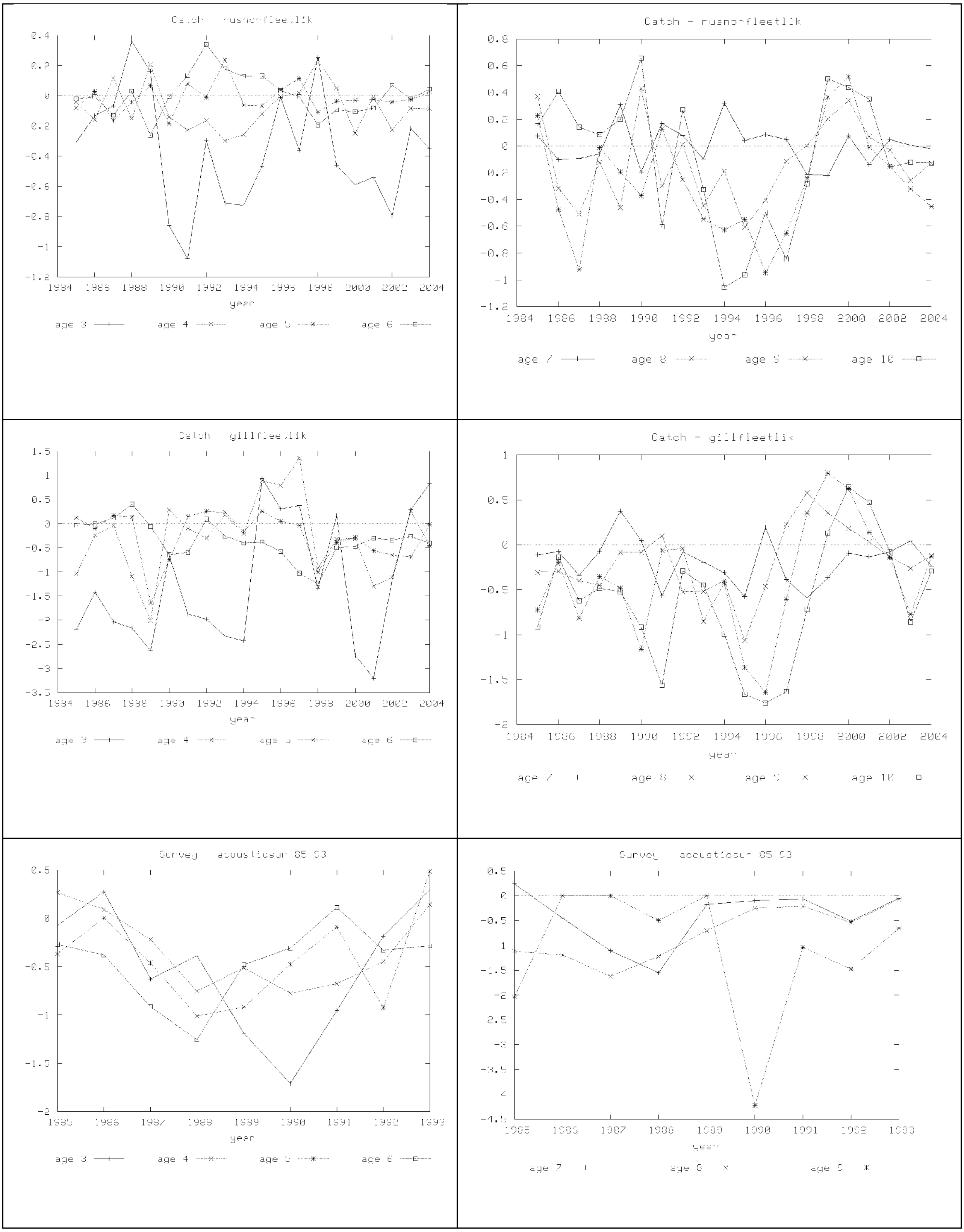


Fig 3.15. Residual plots for Gadget. Log (observed/modelled) catches and survey indices.

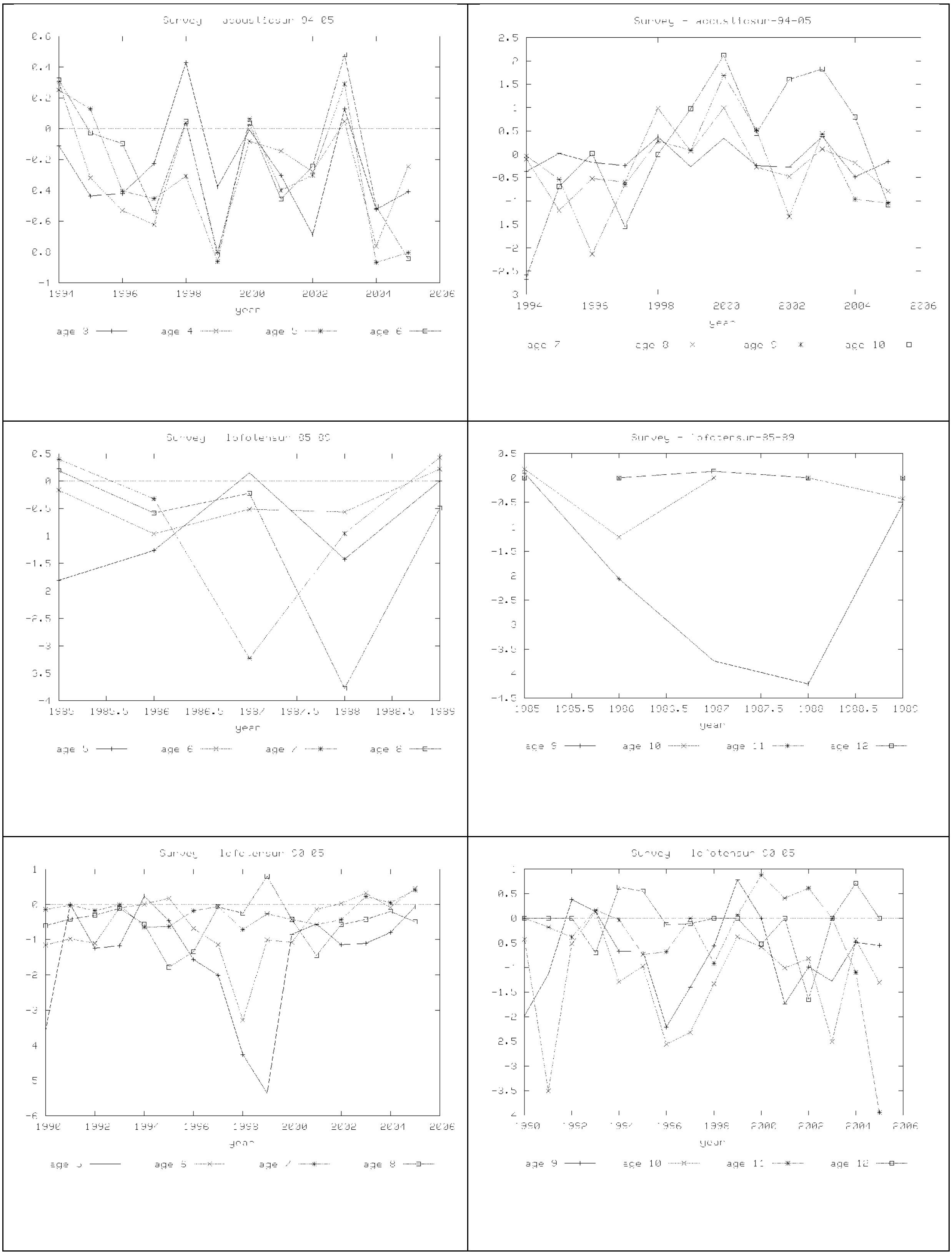


Fig 3.15 (continued). Residual plots for Gadget. Log (observed/modelled) catches and survey indices.

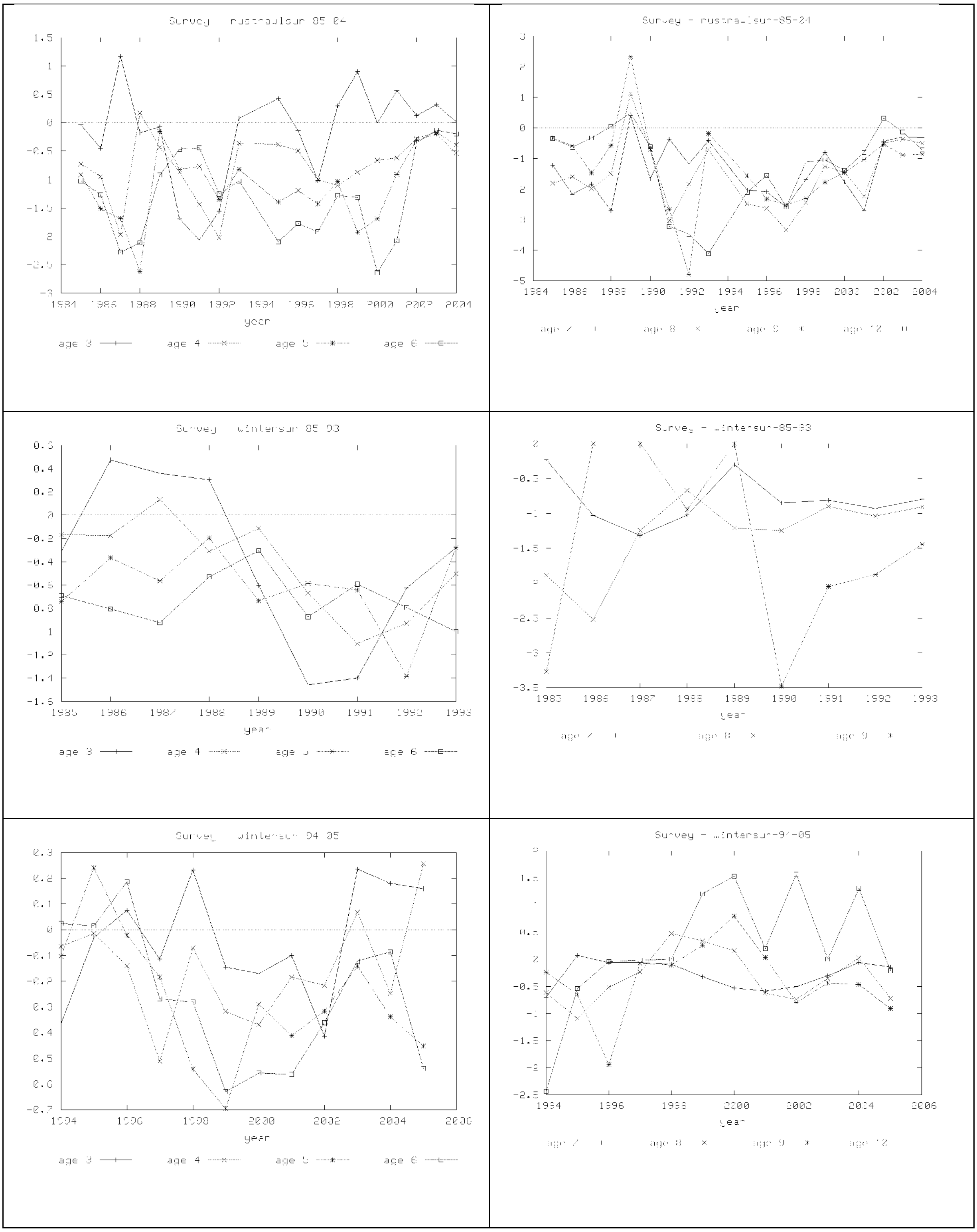


Fig 3.15 (continued). Residual plots for Gadget. Log (observed/modelled) catches and survey indices.

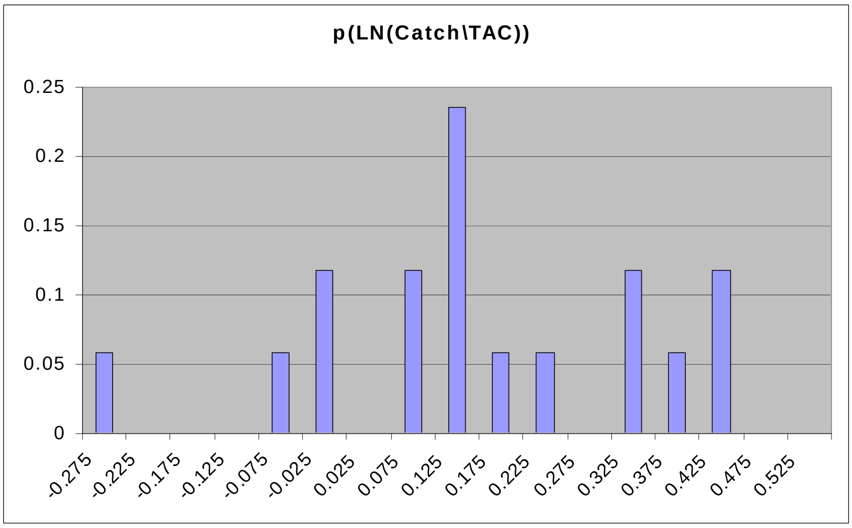


Figure 3.16 Distribution of historic relations between catch and TAC

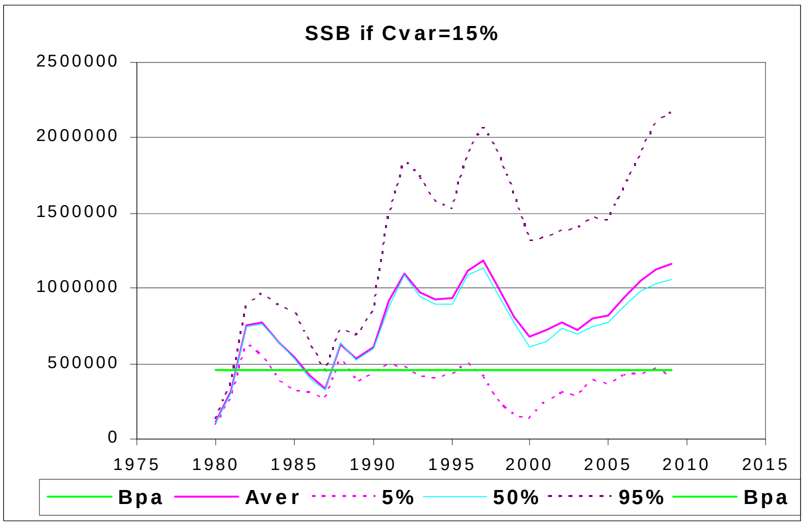


Figure 3. 17 SSB dynamics if the MRNC-5 rule is used – very wide confidence interval.

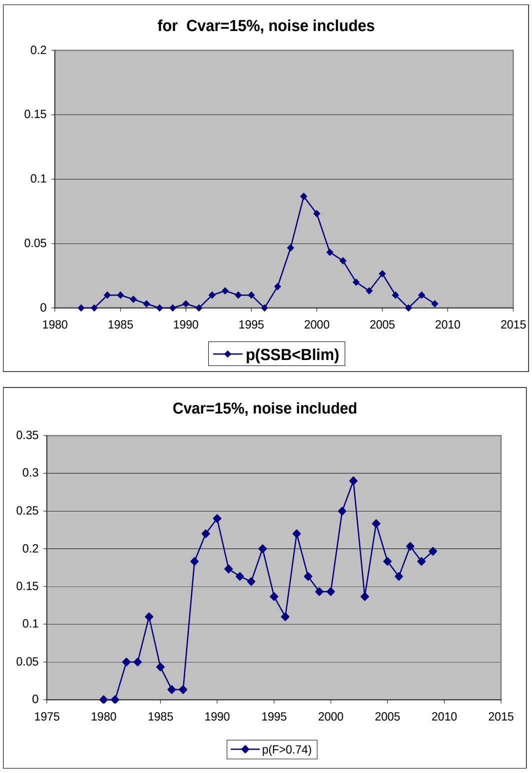


Figure 3.18 Risk in biomass and in fishery mortality for MRNC-5 HCR and for Cvar=15%

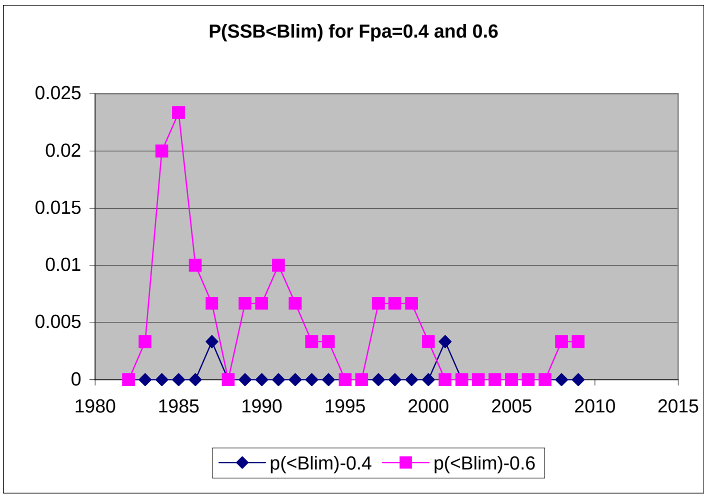


Figure 3.19. The risk probability when the ICES HCR is used with Fpa =0.4 or 0.6 if the uncertainty in catches is included as described above.

Table A1 North-East Arctic COD. Catch per unit effort.

[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.

	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[1]			0.48			0.78		0.84	1.67

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

[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

[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

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

[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

[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

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

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

[1] October-December

[2] September-October

[3] Area IIb not covered

[4] Areas IIa, IIb covered in October-December, part of Area I covered in February-March 1998

[5] Adjusted for incomplete area coverage

[6] Area IIa not covered

Table A11. North-East Arctic COD. Results from the Russian bottom trawl survey in the Barents Sea and adjacent waters in November-December (numbers per hour trawling)

Year	Age										
	0	1	2	3	4	5	6	7	8	9+	Total
			Total (Sub-area I and Division IIa and IIb)								
1982	2.1	2.5	14.1	7.6	9.4	5.8	3.2	1.1	0.4	0.3	46.3
1983	11.7	5.1	6.0	7.3	4.8	2.0	0.7	1.1	0.2	0.2	39.2
1984	11.1	11.3	15.6	9.3	4.9	3.0	1.2	0.5	0.3	0.2	57.2
1985	6.2	39.6	28.3	39.7	18.1	4.5	1.7	0.6	0.1	0.2	139.0
1986	1.5	8.0	49.5	28.6	14.0	5.0	1.4	0.2	0.1	0.1	108.4
1987	0.1	2.5	6.1	40.2	7.8	3.4	0.8	0.2	0.1	0.1	61.2
1988	0.2	1.5	6.6	7.3	19.3	3.3	1.0	0.2	0.1	0.1	39.5
1989	0.3	0.6	3.4	9.1	10.9	16.1	13.1	5.5	2.9	0.8	62.7
1990	3.8	2.9	0.9	2.9	6.5	7.8	9.6	4.3	1.1	0.3	40.1
1991	6.9	7.1	10.2	4.8	5.8	6.6	8.3	7.1	0.7	0.1	57.6
1992	10.8	30.6	30.9	9.0	4.5	4.8	2.6	2.3	0.9	0.1	96.4
1993	4.5	10.3	49.1	52.6	37.7	11.7	4.5	3.2	1.9	2.5	178.0
1994	11.4	5.8	23.0	40.4	38.3	36.6	12.0	4.2	1.3	1.4	174.3
1995	26.0	4.5	11.9	23.5	24.7	10.5	2.3	0.7	0.2	0.2	104.5
1996 [1]	17.8	11.6	7.7	10.1	12.6	8.6	3.6	0.9	0.1	0.1	73.1
1997 [1]	7.3	17.3	9.9	8.3	6.2	3.7	1.8	0.5	0.1	0.0	55.1
1998	4.9	15.9	50.8	33.4	9.7	3.7	1.6	0.7	0.1	0.1	120.9
1999	3.6	14.3	28.4	47.5	16.2	3.1	1.2	0.8	0.2	0.1	115.4
2000	3.1	11.7	27.6	21.9	16.9	5.8	0.8	0.3	0.1	0.1	88.3
2001	6.7	11.0	27.7	37.2	20.6	11.5	2.2	0.3	0.1	0.1	117.4
2002 [2]	12.6	0.3	18.0	14.4	24.1	25.2	11.7	5.2	1.2	0.3	113.1
2003	8.1	4.0	2.8	29.3	17.5	20.2	17.5	6.0	2.3	0.4	108.3
2004	14.0	1.4	8.8	4.3	20.1	9.4	10.0	6.3	1.9	0.7	76.8

[1] Adjusted assuming area distribution as 1982-1995 average.
[2] Adjusted assuming area distribution as 1998-2001 average.

Table A12 North-East Arctic COD. Length at age (cm) from Russian surveys in November–December

Year	Age 0	1	2	3	4	5	6	7	8	9
1984	15.7	22.3	30.7	44.3	51.7	63.6	73.4	82.5	88.4	97.0
1985	15.0	21.1	30.6	43.2	53.7	61.2	72.8	83.0	92.8	101.3
1986	15.2	19.7	28.3	39.0	51.8	62.2	70.9	83.0	91.3	104.0
1987	-	19.2	27.9	33.4	41.4	59.1	69.2	80.1	95.7	102.6
1988	11.3	21.3	28.7	36.2	43.9	53.3	65.3	79.5	85.0	-
1989	-	20.8	28.8	34.8	46.0	53.9	61.8	69.8	78.7	88.6
1990	16.0	24.0	30.4	46.5	54.9	62.5	69.7	77.6	87.8	102.0
1991	11.5	22.4	30.6	43.0	55.9	64.6	72.8	78.5	87.9	101.8
1992	11.3	21.3	31.9	50.1	59.8	69.1	78.6	84.0	90.8	97.5
1993	12.1	17.4	29.1	43.4	52.7	64.3	73.9	81.2	89.1	91.8
1994	12.2	20.3	26.3	33.7	47.4	58.7	70.6	80.8	90.1	96.1
1995	11.6	19.8	27.6	33.8	45.2	60.5	71.1	83.5	92.9	99.1
1996	10.2	20.0	28.1	36.7	48.7	58.9	70.5	80.0	93.6	102.7
1997	9.6	18.5	28.8	38.2	50.8	62.0	70.5	80.1	88.9	103.5
1998	11.4	19.0	28.0	36.4	50.5	61.0	70.7	80.3	91.1	102.5
1999	11.7	19.7	27.9	35.3	51.6	60.6	70.6	78.9	86.8	94.3
2000	10.7	20.8	30.1	34.7	49.8	61.1	71.6	82.0	88.3	85.7
2001	10.6	19.4	29.8	37.3	50.4	61.9	71.9	81.4	91.0	98.7
2002	10.7	19.2	29.9	38.2	52.5	60.4	70.6	82.2	91.3	97.2
2003	9.8	18.9	28.3	34.9	49.2	62.2	71.0	81.5	92.3	100.9
2004	9.8	19.6	29.3	38.4	49.1	60.0	70.5	80.0	91.0	98.0

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

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	4.4	1.6	0.2
1993	1074.0	494.7	357.2	191.1	113.1	35.4	25.5	25.2	27.7	44.5	4.7	0.7
1994	858.3	577.2	349.8	404.5	217.5	89.5	22.5	11.9	9.4	4.4	17.5	2.6
1995	2619.2	292.9	166.2	159.8	216.6	104.0	29.0	4.4	4.3	3.6	2.2	8.0
1996	2396.0	339.8	92.9	70.5	87.2	89.1	44.6	6.5	1.1	0.7	0.8	1.3
1997	1623.5	430.5	188.3	51.7	49.7	42.2	49.9	20.5	2.2	0.5	0.0	0.8
1998	3401.3	632.9	427.7	182.6	42.4	33.8	34.0	24.7	4.9	0.8	0.2	0.0
1999	358.3	304.3	150.0	96.4	45.4	12.2	11.2	18.7	9.2	1.1	0.2	0.1
2000	154.1	221.4	245.2	158.9	145.7	49.3	12.9	6.9	5.2	1.6	0.4	0.1
2001	629.9	63.9	138.2	171.6	81.6	57.3	19.8	2.4	0.8	0.6	0.3	0.1
2002	18.2	215.5	69.3	112.2	104.3	66.1	34.5	9.5	1.2	0.5	0.6	0.0
2003	1693.9	61.5	303.4	114.4	131.5	144.5	64.3	21.2	3.8	0.5	0.1	0.1
2004	157.7	105.2	33.6	92.8	32.7	45.1	46.8	22.2	8.8	2.2	0.2	0.7
2005	465.3	119.6	123.9	33.7	67.1	30.2	43.5	17.2	7.5	1.8	0.1	0.2

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 2005 (Tables 4.1–4.3, Figure 4.1A)

Reported landings in 2003 are still provisional. They now amount to 97 603 t, which is close to the figure used in last year's assessment. The provisional landings for 2004 are 116 293 t (Table 4.1, Figure 4.1A), which is less than the agreed TAC of 130 000 t. The Working Group last year expected 132 000 t. Catches increased in all subareas. The catch by area, broken down by trawl and other gears, is given in Table 4.2. The nominal catch by country is given in Table 4.3. Landings from 2003 and 2004 were revised according to official statistics from ICES or reports given directly to the working group. A landing in column "others" in 2001 (Table 4.3) was slightly corrected in case of technical mistake was done in previous report.

4.1.3 Expected landings in 2005

ACFM recommended to set a TAC lower than 106 000 t for 2005. The agreed TAC for 2005 is 117 000 t. The total reported landing in 2005 is expected to be equal to the agreed TAC.

4.2 Status of Research

4.2.1 Fishing effort and CPUE (Table 4.2)

After a period of reduced trawl fishery for haddock, it has increased in recent years (Table 4.2). The CPUE series of Norwegian trawl fisheries has previously been updated for tuning of the older ages in the VPA. The basis was the trawl effort in Norwegian statistical areas 03, 04, and 05, covering the Norwegian coastal banks north of Lofoten. These areas account for approximately 70% of the Norwegian trawl landings. However, because of the large proportion taken as by-catch it is difficult to estimate the actual trawl effort on haddock. The CPUE series was not used for tuning the XSA in the two previous assessments and the series has not been updated with values for the last three years.

4.2.2 Survey results (Tables B1-B4, 1.10 - 1.11.)

The overall picture seen in the surveys is summarized as follows: the year class 1997 seems to be poor, the 1998, 1999 and the 2001 year classes appear above average. The 2000 and 2003 year classes appear closer to the average, while the 2002 and the 2004 year classes seem to be well above average. The numbers of 7+ appear at low levels.

Norwegian bottom trawl and acoustic survey

Norway provided indices from the 2005 Barents Sea bottom trawl and acoustic survey in January-March (Table B1 and B3). There was a reduced coverage of the Barents Sea in 1997-1998, but full coverage since then. Trawl survey indices from 1983 onwards have been recalculated in the same way as for cod (Section 3.2.2). High indices, caused by the good period of recruitment around 1990, can be tracked from year to year in both series and the 1990-year class appears as the strongest for age groups 3–8. The year classes 1998 to 2001 have been observed as stronger than the 1992-1997 year classes, while the 2003 yearclass does not seem to be that strong. The 2002 year class has been observed three times and the last observation is around half of the level observed for the strong 1990 year class at the same age.

Russian bottom trawl and acoustic survey

Russia provided indices from the 2004 Barents Sea trawl and acoustic survey (Tables B2, B4a, and B4b), which was carried out in October-December. The Russian surveys show the same main trends as the Norwegian survey. From 1995 onwards there has been a substantial change in the method for calculating acoustic indices. The acoustic survey is therefore presented in 2 tables (Table B4a and B4b) for old and new method of calculating indices.

International 0-group survey

Estimates of the abundance of 0-group haddock from the International 0-group survey are presented in Tables 1.10 and 1.11. The indices indicate good recruitment for haddock from 1990 to 1994, average from 1995 to 1997, good in 1998, average in 1999 and good again in 2000 and 2001 and very good in 2002 and 2003. Both the 2004 area based index (Table 1.10), and the 2004 logarithmic index (Table 1.11) are the highest ever recorded.

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 slightly reduced to the weights at age in last year.

4.3 Data Used in the Assessment

4.3.1 Catch-at-age (Table 4.7)

Age and length compositions of the landings for 2004 were available from Norway and Russia in Subarea I, from Norway, Russia, and Germany in Division IIa and IIb. The catches of the other countries were distributed among ages using the combined Norwegian/Russian age composition in Subarea I and in Division IIb, and the Russian trawl age composition in Division IIa (Table 4.7). The SOP check gave no deviation from the nominal catch of 2004.

4.3.2 Weight-at-age (Tables 4.8–4.9, Table B.6)

- The means weights-at-age in the catch (Table 4.8) were calculated as weighted averages of the weights in the catch of Norway and Russia. The weights-at-age in the catch in 2004 are showing a declining tendency for most ages.
- Stock weights (Table 4.9) used from 1985 to 2005 are averages of values derived from Russian surveys in autumn (mostly October-December) and Norwegian surveys in January-March the following year (Table B6). These averages are assumed to give representative values for the beginning of the year.

4.3.3 Natural mortality (Table 4.10)

Natural mortality (Table 4.10) was set to 0.2+mortality from predation by cod (see Section 4.4.1). The proportion of F and M before spawning was set to zero.

4.3.4 Maturity-at-age (Table 4.4 and 4.11)

A maturity ogive was available from Russia for the period 1981-2005 (Table 4.4). The ogives for 2001-2003 shows a relatively early maturation compared to the period 1994 to 1998, while the ogive for 2004, continuing in 2005, indicates a reduction in the proportions mature at age (later spawning). The maturity-at-age series for the whole period 1950-2002 is shown in Table 4.11. There were some revisions of the historic maturity ogives last year (see the same section in the 2004 report).

4.3.5 Data for tuning (Table 4.12, Figures 4.6-4.8)

The following surveys series (Table 4.12) are included in the data for tuning:

Name	Place	Season	Age	Year	prior weight
Russian bottom trawl	Total area	Autumn	1–7	1983–2004	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2004	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2004	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 2004 WG the survey data before 1990 were not used in XSA based on the analysis of survey residuals and changes in some surveys methodology (See Figures 4.6-4.8, Section 4.4.1in the 2002 and the 2004 reports).

4.3.6 Recruitment indices (Table 4.5)

The table with recruitment indices (Table 4.5) 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.

4.3.7 Prediction data (Table 4.19, Table 4.6)

Weights at age and proportions mature at age shows strong cyclic patterns related to periods of good recruitment. The working group believes that the estimated recruitment in the latest years is so high that it will affect growth and maturation processes. The working group therefore decided to use similar trends in weight at age, maturity and natural mortality as has been observed in previous periods following good recruitment. The input data for making the prediction are presented in Table 4.19:

- The estimated recruitment given in Table 4.6.
- The average fishing pattern observed in the 3 last years.
- Observed preliminary maturity for 2005, average maturity for the periods 1987-1989 and 1994-1997 (7 years) for 2007 and 2008 and maturity-at-age in 2006 as the average between 2005 and 2007.
- Observed weight at age in the stock from 2005 was used for 2005. The average observed in the period 1994-1997 was used for 2007 and 2008. The average between 2005 and 2007 was used for 2006.
- Observed weight at age in the catch for 2004, the average observed in the period 1994-1997 for 2006 and 2007 and the average between 2004 and 2006 for 2005.
- Natural mortality in 2005 was calculated as the average of the 2004 and 2006 numbers. Natural mortality for 2006 and 2007 was calculated as average for the periods 1987-1989 and 1994-1997 (7 years).
- And stock numbers and fishing mortalities from the standard VPA.

4.4 Methods Used in the Assessment

4.4.1 VPA and tuning (Table 4.10, Table 4.12)

The Extended Survivors Analysis (XSA) was used to tune the VPA to the available index series (Table 4.12). The settings used by the AFWG in 2004 were not changed:

- The tuning window was reduced (1990-2004).
- 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 (1984–2004). The consumption of NEA haddock by NEA cod is given below:

CONSUMPTION OF HADDOCK BY NEA COD (MILLIONS)

	1	2	3	4	5	6
1984	980.0	14.7	0.1	0.0	0.0	0.0
1985	1203.5	5.2	0.0	0.0	0.0	0.0
1986	563.9	244.9	168.0	0.0	0.0	0.0
1987	766.7	0.0	0.0	0.0	0.0	0.0
1988	17.1	0.5	9.1	0.0	0.2	0.0
1989	236.4	0.0	0.0	0.0	0.0	0.0
1990	142.3	36.4	3.5	0.0	0.0	0.0
1991	460.4	14.4	0.0	0.0	0.0	0.0
1992	2115.3	151.2	1.1	0.0	0.0	0.0
1993	1379.8	167.8	37.4	3.4	2.9	0.0
1994	1412.1	80.9	25.1	7.8	0.9	0.0
1995	2906.5	164.3	12.0	30.1	30.2	0.3
1996	1590.7	161.2	40.0	5.4	2.6	3.4
1997	905.3	35.5	25.7	1.7	0.8	0.5
1998	1527.6	27.9	2.0	2.9	0.5	0.0
1999	925.5	23.6	0.3	0.0	0.0	0.0
2000	1312.1	66.5	2.0	1.1	0.2	0.1
2001	611.6	55.1	4.8	0.1	0.0	0.0
2002	2426.5	224.9	39.6	2.5	0.2	0.0
2003	3520.8	232.8	43.1	14.1	1.4	0.0
2004	1361.0	137.5	8.9	4.7	1.2	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 4.10) was used in the final XSA.

4.4.2 Recruitment (Tables 4.5-4.6)

The recruiting year classes 2002-2004 were estimated using RCT3 (input given in Tables 4.5 and output given in 4.6). 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 2004.

4.5 Results of the Assessment

4.5.1 Fishing mortality and VPA (Tables 4.10, 4.13–4.18 and Figures 4.1A-D)

The tuning diagnostics of the final XSA (predation included) are given in Table 4.13.

Last year the convergence of XSA did not occur at ages older than 5 years after 30 iterations. With increased number of iterations the total absolute differences in F between iterations became greater. Nevertheless, the differences between F values in neighboring iterations were negligible.

Natural mortalities, fishing mortalities, and stock numbers of the final VPA are given in Tables 4.10, 4.14, and 4.15, respectively, while the stock biomass at age and the spawning biomass at age are given in Tables 4.16 and 4.17. A summary of landings, fishing mortality, spawning stock biomass, and recruitment since 1950 is given in Table 4.18 and Figures 4.1A, 4.1B, 4.1C and 4.1D.

This assessment showed the fishing mortality for the period from 1999 to 2004 to be lower compared to the last assessment, especially for old age groups. F_{4-7} indicated a reduced fishing mortality in 2002-2004 relative to the period 1993-2001.

The majority of the reported 2004 catches consisted of the 1998, 1999 and 2000 yearclasses. Compared to the 2003 catches the 1998 yearclass contribution decreased and the 1999 and 2000 yearclasses increased.

The largest contribution (more than 40%) to the spawning stock in 2003 and 2004 was made by the 1996 year class. According to this year's assessment, the spawning stock biomass in 2003 - 2004, compared to that in 2004, increased, i.e. from 126 000 t to 140 000 t and from 115 000 to 131 000 t accordingly.

4.5.2 Recruitment (Tables 4.6, 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 4.6). The recruitment time series is shown in Figure 4.1C.

	Year of assessment		
Year Class	2003	2004	2005
1999	330*	280*	287*
2000	250	187*	197*
2001	277	239	176*
2002	422	384	295
2003		159	156
2004			462

4.5.3 Catch options for 2006-2007 (Tables 4.19 - 4.22)

The input to the prediction is given in Table 4.19.The reported catch in 2004 corresponds to F=0.34 and the estimated spawning stock biomass is 137 000 t in the beginning of 2005. An F_{sq} based on the average of the three last years gives F_{sq}=0.35. This corresponds to a catch of 112 000 t while the TAC for 2005 is 117 000 t. We expect landings in 2005 to be equal to the TAC. Thus, F for 2005 corresponding to the catch equal to TAC, i.e. 0.37, was used.

Assuming the landings in 2005 to be equal to the agreed TAC (F_{2005}=0.37) the deterministic projection suggests an increase in SSB to 155 000 t in the beginning of 2006 (which is well above $\mathbf{B}_{pa}$) (table 4.20).

Fishing at $\mathbf{F}_{pa}$ in 2006 corresponds to total landings of 113 000 t, with a further strengthening of the SSB into the beginning of 2007 to 172 000 t. (table 4.21).

Fishing in period 2006-2008 with F which corresponds to agreed experimental harvest rule (F=0.35) is equal to total mean landings of 120 000 t in 2006 with increasing of the SSB in 2007 to 166 000 t. A prediction with management option table is shown in Table 4.22.

4.6 Biological reference points

4.6.1 Biomass and fishing mortality reference points (Table 4.23, Figures 4.2-4.4)

The biomass reference points 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 (Figure 4.4) adopted by ACFM for this stock are $\mathbf{F}_{lim}$=0.49 and $\mathbf{F}_{pa}$ =0.35. In the last year report it was pointed out that we did not think the uncertainty was reflected well enough in the precautionary reference points. No revisions of these values were put forward for consideration at this meeting. In 2006, at the Study Group on the NEA Haddock Reference Points and HCR, a revision of the reference points will be carried out.

A plot of SSB versus recruitment is shown in Figure 4.2. Yield and SSB per recruit (YPR and SPR) are presented in Table 4.23 and Figure 4.3. $F_{0.1}$ and F_{max} were estimated at 0.19 and 0.65 respectively. YPR curve (Figure 4.3) shows that current F_{bar} is well above $F_{0.1}$ but less than F_{max}. However, the estimate of F_{max} is unreliable as YPR curve is very flat in this area.

4.7 Medium-term simulations (Tables 4.21-4.22)

A three-year harvest control rule for haddock has not been evaluated yet but WG believes that it will be done during the Study Group (see Section 4.10) in 2006. A run with prognoses based on the agreed management plan was done. Results are presented in Tables 4.21 – 4.22. An output table presents a prediction (over 3 years) in accordance with the agreed harvesting rule. TAC for 2006 (120 000 t) corresponds to average catch for period 2006-2008 with F= $\mathbf{F}_{pa}$ =0.35.

4.8 Comments to the assessment and forecasts

These comments relates mainly to uncertainties in assessment and forecasts

Source of uncertainty	**Description**	**Comments**
Incomplete survey coverage (1)	Since 1997 has all of the surveys used for tuning been affected by an incomplete coverage for some of the years. (Due to Norwegian vessels not been given access to REZ, Russian vessels not been given access to NEZ).	All indices affected have been corrected using a factor based on geographical distributions observed before and after the incomplete coverage. This procedure is likely to introduce increased uncertainty to the indices.
Incomplete survey coverage (2)	None of the surveys have a complete coverage of the stock. The proportion of a year class being outside the coverage varies between year classes (see also the WG report from 2002). The most recent "extreme" case is the 1996 year class (deleted from tuning).	May appear as year class dependent changes in survey catchability.
Correlated error structures	Year effects in a survey are quite common. The year effect introduces correlated errors between the age groups, but in this case also between survey series.	
Discards	The level of discarding is not known.	Discarding is known to be a (varying) problem in the longline fisheries related to the abundance of haddock close to, but below the minimum landing size.
Unreported catches	See Introduction (description of unreported landings of cod in 2002 - 2004)	Unreported landings of cod: The estimation showed that landings of other species could also be unreported. Which species and how much is not known.

The WG takes into account that the contributions of the sources of error mentioned above may have increased the uncertainty in the assessment and the predictions the last few years.

The short term forecast is very much depending on the estimates of the year class strength of the incoming year classes. The forecast is also quite depending on the maturity-at-age, natural mortality and weight at age numbers used as input. These parameters are known to vary quite a lot for this stock and we have tried to create a trend observed in such parameters after period of good recruitment (1987-1989 and 1994-1997) like at WG2004 because the expected incoming yearclasses are estimated as strong.

Future work can include estimation of relationships between values of biological parameters at neighbouring ages in cohorts and the use of obtained parameters of regressions in the short-term prediction. This method gives better results than the traditional averaging over some range of the most recent years (WD#24) and will be tried in 2006 after revision of historical time series.

4.8.1 Changes from last year (Figure 4.5)

The following changes was made to the assessment compared to last year:

- Total landings in 2003 were corrected slightly.
- For the reason mentioned in section 4.5.3 TAC constraint catch prediction for intermediate year was applied. F corresponding to the catch level equal to 2005 TAC was 0.37.
- The retrospective performance of the XSA is illustrated in Figure 4.5. Estimate of F_{4-7} in 2005 shows a reduction in fishing mortality for the period 1998-2004 and increase of retrospective estimates of SSB compared to those in previous years.

4.9 Technical Minutes from ACFM

The text in italics is quoted from the Technical Minutes.

The arbitrary decision to use a time taper in the XSA assessment was questioned. The usefulness of tapering should have been looked at; certainly in a benchmark procedure. P shrinkage was applied up to age 7. This choice should be justified because it is in general not the recommended option. Also the P-shrinker gets no weight in estimation of survivors.

In the report (see Figure 4.7) Log catchability residuals are given, which still indicate that data from surveys prior to 1990 are noisier compared to the posterior period. The P- *shrinkage* option is used automatically in XSA if power regression has been chosen. Nevertheless, the *P-shrinker* had minimal effect on the assessment due to its low weight.

One reviewer noted that the discussion on the signals given by the individual fleets the data exploration is less relevant given the dynamics of the stocks. All tuning fleets basically give the same information

In 2004 the benchmark assessment was done, thus signals given by the individual fleets were analysed in relation to stock dynamics.

The assessment has not converged indicating estimated level of fishing mortality is not well defined.

See suggestions in section 4.5.1.

More attention should be given to the discussion of the results. For instance there is only line with a reference to a figure with retrospective performance of the assessment. The patterns and possible reasons should be discussed (in a paragraph with a recognisable header).

The remark has been taken into consideration.

Attention should be given to the comparison of the assessment with those in previous years. ACFM comments on a comparison in its report.

Done

An output table of the predictions (over 3 years) was missing to justify the TAC, which would have been set using the agreed harvesting rule.

For this stock a management plan has been agreed. A run with a prognoses based on the agreed management plan is missing.

Done (see Section 4.7)

There may be an error in the SSB on the x-scale in figure 4.7. The SSB value for the final assessment point 'All SE=0.50' in the upper right figure does not correspond with the summary table (Fig 4.4). The F-value is OK.

In the 2004 report, there was an error in figure 4.7.

4.10 Answer to the special request

The working group is requested to give comments upon aspects of the agreed harvest control rule in relation to the recruitment dynamics for the haddock stock.

We start with quoting the Study Group on Management Strategy (ICES 2005): "stocks exhibiting spasmodic recruitment may need different measures to protect large year classes as they recruit to the fishery".

The haddock stock is characterized by a spasmodic recruitment pattern. A harvest control rule based on a three years prediction implies that the fishing mortality rate may be increased two years before an observed strong yearclass is recruited to the fisheries (Korsbrekke and Hauge, WD 27). The retrospective pattern of this stock shows that the stock has a problem with overestimating stock size, so although the agreed harvest control rule restricts the change in the quota, the working group is concerned that the rule might not be in accordance with the precautionary approach.

Such a rule may necessitate recovery plans regularly, which would complicate the Commission's aim of more stable quotas. It may be that the catch rule will be in accordance with the precautionary approach with a reduced target F and with a similar modification as for cod (reduction of F if SSB falls below $\mathbf{B_{pa}}$).

We would like to point out that the overall objective of high long-term yield from the stock is not reflected in the catch rule itself and that this objective could be addressed using a revised catch rule.

The working group is proposing a Study Group of Reference Points and Harvest Control Rules (SGRFHCR) in March 2006, where the reference points will be revised, the agreed harvest control rule and alternatives will be discussed and the evaluation will be performed. Revisions of historical data (allocation of catch data, weights in stock and catch), maturity ogives and initiating the revisions of reference points are planned to be prepared before the Study Group. The results of harvest control rule evaluation will be discussed at the Arctic Fisheries working group in 2006.

Table 4.1 North-East Arctic HADDOCK. Total nominal catch (t) by fishing areas. (Data provided by Working Group members).

Year	Sub-area I	Division IIa	Division IIb	Total
1960	125 026	27 781	1 844	154 651
1961	165 156	25 641	2 427	193 224
1962	160 561	25 125	1 723	187 408
1963	124 332	20 956	936	146 224
1964	79 262	18 784	1 112	99 158
1965	98 921	18 719	943	118 578
1966	125 009	35 143	1 626	161 778
1967	107 996	27 962	440	136 397
1968	140 970	40 031	725	181 726
1969	89 948	40 306	566	130 820
1970	60 631	27 120	507	88 257
1971	56 989	21 453	463	78 905
1972	221 880	42 111	2 162	266 153
1973	285 644	23 506	13 077	322 226
1974	159 051	47 037	15 069	221 157
1975	121 692	44 337	9 729	175 758
1976	94 054	37 562	5 648	137 264
1977	72 159	28 452	9 547	110 158
1978	63 965	30 478	979	95 422
1979	63 841	39 167	615	103 623
1980	54 205	33 616	68	87 889
1981	36 834	39 864	455	77 153
1982	17 948	29 005	2	46 955
1983	7 550	13 872	185	21 607
1984	4 000	13 247	71	17 318
1985	30 385	10 774	111	41 270
1986	69 865	26 006	714	96 585
1987	109 425	38 181	3 048	150 654
1988	43 990	47 087	668	91 745
1989	31 116	23 390	353	54 859
1990	15 093	10 344	303	25 741
1991	18 772	14 417	416	33 605
1992	30 746	22 177	964	53 887
1993	47 574	27 010	3 037	77 621
1994	75 059	46 329	7 315	128 703
1995	70 390	54 169	14 118	138 677
1996	112 781	57 189	3 294	173 264
1997	78 335	67 917	2 504	148 756
1998	45 471	47 774	701	93 946
1999	36 096	42 036	4 214	82 346
2000	25 312	31 857	4 126	61 292
2001	35 071	39 449	7 323	81 842
2002	40 559	30 630	12 537	83 726
2003	53 726	35 386	8 491	97 603
2004[1]	64 790	39 423	12 147	116 293

[1] **Provisional figures**

Table 4.2 North-East Arctic HADDOCK.

Total nominal catch ('000 t) by trawl and other gear for each area.

	Sub-area I		Division IIa		Division IIb
Year	Trawl	Others	Trawl	Others	Trawl
1967	73.7	34.3	20.5	7.5	0.4
1968	98.1	42.9	31.4	8.6	0.7
1969	41.4	47.8	33.2	7.1	1.3
1970	37.4	23.2	20.6	6.5	0.5
1971	27.5	29.2	15.1	6.7	0.4
1972	193.9	27.9	34.5	7.6	2.2
1973	242.9	42.8	14.0	9.5	13.1
1974	133.1	25.9	39.9	7.1	15.1
1975	103.5	18.2	34.6	9.7	9.7
1976	77.7	16.4	28.1	9.5	5.6
1977	57.6	14.6	19.9	8.6	9.5
1978	53.9	10.1	15.7	14.8	1.0
1979	47.8	16.0	20.3	18.9	0.6
1980	30.5	23.7	14.8	18.9	0.1
1981	18.8	17.7	21.6	18.5	0.5
1982	11.6	11.5	23.9	13.5	-
1983	3.7	3.8	7.6	6.3	0.2
1984	1.6	2.4	6.4	6.9	0.1
1985	24.4	6.0	4.5	6.3	0.1
1986	51.7	18.1	12.8	13.2	0.7
1987	77.8	31.6	22.1	16.1	3.0
1988	27.5	16.5	33.6	13.5	0.7
1989	21.4	9.7	11.6	11.7	0.4
1990	5.9	9.2	4.8	5.6	0.3
1991	9.8	9.0	7.8	6.6	0.4
1992	21.2	9.5	9.3	12.9	1.0
1993	37.9	9.7	18.0	9.0	3.0
1994	61.3	13.8	31.3	15.1	7.3
1995	57.0	12.1	32.6	20.5	13.9
1996	96.3	14.2	34.0	22.0	3.2
1997	56.9	20.6	42.1	25.1	2.5
1998	26.4	20.0	25.3	23.5	0.7
1999	28.5	8.5	16.8	23.7	4.9
2000	19.5	5.8	17.1	14.8	4.0
2001	28.4	6.7	21.5	17.9	7.0
2002	30.2	10.2	15.8	15.1	12.5
2003[1]	41.1	12.6	19.1	16.2	8.1
2004[1]	51.3	13.4	23.7	15.8	11.3

[1] **Provisional**

Table 4.3 North-East Arctic HADDOCK. Nominal catch (t) by countries. Sub-area I and Divisions IIa and IIb combined. (Data provided by Working Group members)

Year	Faroe Islands	France	German Dem.Re.	Fed. Re. Germ.	Norway	Poland	United Kingdom	Russia[2]	Others	Total
1960	172	-	-	5 597	46 263	-	45 469	57 025	125	154 651
1961	285	220	-	6 304	60 862	-	39 650	85 345	558	193 224
1962	83	409	-	2 895	54 567	-	37 486	91 910	58	187 408
1963	17	363	-	2 554	59 955	-	19 809	63 526	-	146 224
1964	-	208	-	1 482	38 695	-	14 653	43 870	250	99 158
1965	-	226	-	1 568	60 447	-	14 345	41 750	242	118 578
1966	-	1 072	11	2 098	82 090	-	27 723	48 710	74	161 778
1967	-	1 208	3	1 705	51 954	-	24 158	57 346	23	136 397
1968	-	-	-	1 867	64 076	-	40 129	75 654	-	181 726
1969	2	-	309	1 490	67 549	-	37 234	24 211	25	130 820
1970	541	-	656	2 119	37 716	-	20 423	26 802	-	88 257
1971	81	-	16	896	45 715	43	16 373	15 778	3	78 905
1972	137	-	829	1 433	46 700	1 433	17 166	196 224	2 231	266 153
1973	1 212	3 214	22	9 534	86 767	34	32 408	186 534	2 501	322 226
1974	925	3 601	454	23 409	66 164	3 045	37 663	78 548	7 348	221 157
1975	299	5 191	437	15 930	55 966	1 080	28 677	65 015	3 163	175 758
1976	536	4 459	348	16 660	49 492	986	16 940	42 485	5 358	137 264
1977	213	1 510	144	4 798	40 118	-	10 878	52 210	287	110 158
1978	466	1 411	369	1 521	39 955	1	5 766	45 895	38	95 422
1979	343	1 198	10	1 948	66 849	2	6 454	26 365	454	103 623
1980	497	226	15	1 365	61 886	-	2 948	20 706	246	87 889
1981	381	414	22	2 398	58 856	**Spain**	1 682	13 400	-	77 153
1982	496	53	-	1 258	41 421	-	827	2 900	-	46 955
1983	428	-	1	729	19 371	139	259	680	-	21 607
1984	297	15	4	400	15 186	37	276	1 103	-	17 318
1985	424	21	20	395	17 490	77	153	22 690	-	41 270
1986	893	33	75	1 079	48 314	22	431	45 738	-	96 585
1987	464	26	83	3 106	69 333	99	563	76 980	-	150 654
1988	1 113	116	78	1 324	57 273	72	435	31 293	41	91 745
1989	1 218	125	26	171	31 825	1	590	20 903	-	54 859
1990	875	-	5	128	17 634	-	494	6 605	-	25 741
1991	1 117	60	**Greenld**	219	19 285	-	514	12 388	22	33 605
1992	1 093	151	1 719	387	30 203	38	596	19 699	1	53 887
1993	546	1 215	880	1 165	36 590	76	1 802	34 700	646	77 620
1994	2 761	678	770	2 412	64 688	22	4 673	51 822	877	128 703
1995	2 833	598	1 351	2 675	72 864	14	3 108	54 516	718	138 677
1996	3 743	537	1 524	942	89 500	669	2 275	73 857	217	173 264
1997	3 327	495	1 877	972	97 789	424	2 340	41 228	304	148 756
1998	1 566	241	854	385	68 747	257	1 241	20 559	96	93 946
1999	1 003	64	252	437	48 632	652	694	30 520	92	82 346
2000	631	169	432	931	34 172	582	814	22 738	823	61 292
2001	1 210	324	553	554	41 269	1 497	1 068	34 307	1 060[3]	81 842
2002	1 564	297	858	627	39 910	1 505	1 125	37 157	683	83 726
2003	1 959	382	1363	918	48 390	1 330	1 018	41 140	1 103	97 603
2004[1]	2 484	103	1680	823	53 983	54	1 250	54 347	1 569	116 293

[1] **Provisional figures, Norwegian catches on Russian quotas are included.**

[2] **USSR prior to 1991.**

[3] **Corrected**

Table 4.4 North-East Arctic HADDOCK. Maturity-at-age in percent from Russian data

	Age									
Year	3	4	5	6	7	8	9	10	11	12
1981	1	12	64	73	96	100	100	-	-	-
1982	9	55	73	93	96	100	93	-	-	-
1983	17	70	100	99	99	100	-	-	-	-
1984	7	14	35	47	74	82	89	-	-	-
1985	2	8	80	93	96	91	96	-	-	-
1986	0	22	53	86	86	100	83	100	-	-
1987	0	1	21	53	100	100	-	100	-	-
1988	0	3	33	51	-	-	-	-	-	-
1989	0	4	30	63	82	100	-	-	-	-
1990	0	2	30	54	77	87	80	100	-	-
1991	0	7	30	50	80	92	100	100	-	-
1992	2	13	50	62	77	80	94	100	-	-
1993	2	22	49	76	79	88	88	87	100	100
1994	0	2	13	41	90	88	100	100	97	100
1995	0	2	12	42	81	88	100	87	100	94
1996	0	0	10	36	78	86	90	93	90	100
1997	0	3	10	29	60	82	100	83	100	100
1998	0	5	28	50	66	81	91	100	-	100
1999	1	17	50	71	81	91	92	100	100	-
2000	0	10	32	59	72	94	94	96	100	100
2001	0	6	54	72	87	94	90	100	91	100
2002	1	13	33	73	83	90	100	94	100	100
2003	0	5	40	69	91	100	94	100	100	100
2004	0	3	20	58	84	93	100	100	100	100
2005[1]	1	4	17	54	86	94	100	100	100	100

[1]Preliminary data (not used in assessment)

(Data provided by Working Group members).

Table 4.5 North-East Arctic HADDOCK. Input data for recruitment prediction (RCT3). Yearclass in first column, VPA numbers at age 3 in second.

'YEAR'	'VPA'	RT1'	RT2'	'NT2'	'NT3'	'NT4'	RT0'	'NT1'	'NA1'
1980	4.7	-11.0	-11.0	1.5	3.1	1.5	-11.0	3.1	7.0
1981	8.4	-11.0	9.5	4.8	18.9	14.7	-11.0	3.9	9.0
1982	254.7	59.2	58.4	514.6	475.9	110.8	-11.0	2919.3	0.3
1983	525.8	58.6	134.3	1593.8	384.6	290.2	29.8	3832.6	1685.0
1984	86.2	14.4	10.7	370.3	154.4	68.9	6.4	1901.1	1530.0
1985	43.1	1.4	1.7	79.9	25.3	21.6	3.0	665.0	556.0
1986	16.8	0.9	0.7	15.3	14.1	3.4	0.2	163.8	85.0
1987	24.4	0.3	2.4	9.5	4.5	5.1	0.3	35.4	18.0
1988	81.4	1.8	10.6	54.6	33.4	24.4	1.3	81.2	52.0
1989	194.4	14.3	17.6	300.3	150.5	105.6	2.2	644.1	270.0
1990	632.5	42.9	128.6	1375.5	507.7	436.6	44.8	2006.0	1890.0
1991	276.8	28.2	35.7	599.0	339.5	171.1	16.7	1659.4	1135.0
1992	79.9	4.8	5.8	228.0	53.6	48.1	16.4	727.9	947.0
1993	90.1	4.9	4.2	179.3	52.5	28.0	3.5	603.2	562.0
1994	99.2	7.2	5.7	263.6	86.1	33.2	9.1	1463.6	1379.0
1995	41.0	2.3	1.9	67.9	22.7	12.2	6.4	309.5	249.0
1996	187.7	4.6	11.5	137.9	59.8	35.4	6.0	1268.0	693.0
1997	63.8	2.9	6.1	57.6	27.2	29.3	1.8	212.9	220.0
1998	272.9	28.9	26.2	452.2	296.0	185.3	10.7	1244.9	856.0
1999	280.1	20.7	26.1	460.3	314.7	182.0	11.7	847.2	1024.0
2000	187.2	14.9	18.9	534.7	317.4	102.7	15.1	1220.5	976.0
2001	176.0	19.3	25.1	513.1	188.1	133.3	20.8	1680.3	2062.0
2002	-11.0	32.8	20.6	711.2	346.5	-11.0	33.2	3332.1	2394.0
2003	-11.0	11.0	-11.0	420.4	-11.0	-11.0	19.8	715.9	752.0
2004	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0	50.0	4630.0	3364.0

RT before 1991 was removed from RCT3 tuning
NT and NA before 1990 was removed from RCT3 tuning
1996 yearclass also removed from XSA tuning
RT1 Russian bottom trawl survey age 2
RT2 Russian bottom trawl survey age 3
NT2 Norwegian bottom trawl survey age 2
NT3 Norwegian bottom trawl survey age 3
NT4 Norwegian bottom trawl survey age 4
RT0 Russian bottom trawl survey age 0
NT1 Norwegian bottom trawl survey age 1
NA1 Norwegian acoustic survey age 1
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 0.2
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Table 4.6 North-East Arctic HADDOCK. Analysis of recruitment by RCT3 ver3.1

YEARCLASS		**2001**							
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights	WAP
RT1	0.91	2.77	0.17	0.964	10	3.01	5.49	0.206	0.273
RT2	0.77	2.97	0.2	0.952	10	3.26	5.47	0.242	0.199
NT2	0.91	-0.12	0.34	0.872	10	6.24	5.53	0.412	0.068
NT3	0.74	1.43	0.25	0.925	10	5.24	5.3	0.302	0.127
NT4	0.77	1.69	0.17	0.965	10	4.9	5.45	0.203	0.28
RT0	1.86	0.65	1.03	0.358	9	3.08	6.4	1.38	0.006
NT1	1.41	-4.48	0.68	0.626	10	7.43	5.99	0.855	0.016
NA1	1.52	-5.07	0.74	0.587	10	7.63	6.51	0.979	0.012
VPA	Mean	=	4.99	0.78	0.019				
Yearclass		2002							
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights	WAP
RT1	0.89	2.77	0.19	0.95	11	3.52	5.91	0.237	0.318
RT2	0.76	2.95	0.21	0.938	11	3.07	5.3	0.251	0.284
NT2	0.89	-0.06	0.34	0.857	11	6.57	5.78	0.415	0.104
NT3	0.73	1.46	0.23	0.924	11	5.85	5.72	0.289	0.214
NT4									
RT0	1.69	0.94	0.95	0.37	10	3.53	6.9	1.331	0.01
NT1	1.36	-4.2	0.67	0.597	11	8.11	6.8	0.925	0.021
NA1	1.43	-4.61	0.78	0.523	11	7.78	6.51	1.021	0.017
VPA	Mean	=	5	0.735	0.033				
Yearclass		2003							
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights	WAP
RT1	0.89	2.78	0.19	0.95	11	2.48	4.98	0.222	0.642
RT2									
NT3									
NT4									
RT0	1.67	0.98	0.95	0.375	10	3.03	6.06	1.215	0.022
NT1	1.34	-4.1	0.68	0.592	11	6.57	4.72	0.809	0.049
NA1	1.41	-4.47	0.78	0.52	11	6.62	4.86	0.932	0.037
VPA	Mean	=	4.99	0.726	0.06				
Yearclass		2004							
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights	WAP
RT1									
RT2									
NT2									
NT3									
NT4									
RT0	1.65	1.03	0.94	0.382	10	3.93	7.53	1.501	0.108
NT1	1.33	-3.99	0.68	0.586	11	8.44	7.21	1.044	0.224
NA1	1.38	-4.3	0.78	0.517	11	8.12	6.94	1.126	0.193
VPA	Mean	=	4.99	0.717	0.475				
Year Class	Weighted Average Prediction	Log WAP Error	Int Std Error	Ext Std	Var Ratio	VPA VPA	Log		
2001	237	5.47	0.11	0.06	0.34	177	5.18		
2002	295	5.69	0.13	0.14	1.02				
2003	156	5.05	0.18	0.09	0.28				
2004	462	6.14	0.49	0.64	1.66				

Table 4.7 Catch numbers at age (Numbers, thousands spec.)

Run title : NEA Haddock (SVPA AFWG05)
At 25/04/2005 16:04

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

YEAR	1950	1951	1952	1953	1954
AGE					
3	3189	65643	6012	64528	6563
4	37949	9178	151996	13013	154696
5	35344	18014	13634	70781	5885
6	18849	13551	9850	5431	27590
7	28868	6808	4693	2867	3233
8	9199	6850	3237	1080	1302
9	1979	3322	2434	424	712
10	1093	1182	606	315	319
+gp	2977	1348	880	1005	543
0 TOTALNUM	139447	125896	193342	159444	200843
TONSLAND	132125	120077	127660	123920	156788
SOPCOF %	45	65	51	57	60

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

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	1154	16437	2074	1727	20318	39910	15429	39503	28466	22363
4	10689	5922	24704	5914	7826	70912	56855	30868	72736	49290
5	176678	14713	7942	31438	7243	13647	63351	48903	18969	30672
6	4993	127879	12535	5820	14040	7101	8706	33836	13579	5815
7	28273	3182	46619	12748	3154	6236	3578	3201	9257	3527
8	1445	8003	1087	17565	2237	1579	4407	1341	1239	2716
9	271	450	1971	822	5918	2340	788	1773	559	833
10	100	200	356	1072	285	2005	527	242	409	104
+gp	100	185	176	601	500	606	1434	756	375	633
0 TOTALNUM	223703	176971	97464	77707	61521	144336	155075	160423	145589	115953
TONSLAND	202286	213924	123583	112672	88211	154651	193224	187408	146224	99158
SOPCOF %	47	55	57	61	80	84	80	75	74	62

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	5936	26345	15907	657	1524	23444	1978	230942	70679	9685
4	46356	22631	41346	67632	1968	2454	24358	22315	260520	41706
5	40201	63176	13496	41267	44634	1906	1257	42981	24180	88120
6	12631	29048	25719	7748	19002	22417	918	3206	6919	5829
7	1679	5752	8872	15599	3620	8100	9279	1611	422	4138
8	974	582	1616	5292	4937	2012	3056	6758	426	382
9	897	438	218	655	1628	2016	826	2638	1692	618
10	123	189	175	182	316	740	1043	900	529	2043
+gp	802	242	271	286	109	293	534	1652	584	1870
0 TOTALNUM	109599	148403	107620	139318	77738	63382	43249	313003	365951	154391
TONSLAND	118578	161778	136397	181726	130820	88257	78905	266153	322226	221157
SOPCOF %	70	66	79	79	80	75	101	86	83	87

Table 4.7 Catch numbers at age (Continuous.)

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	10037	13994	55967	47311	17540	627	486	883	704	447
4	14088	13454	22043	18812	35290	22878	2561	900	1930	825
5	33871	6810	7368	4076	10645	21794	22124	3372	884	820
6	49711	20796	2586	1389	1429	2971	10685	12203	1374	301
7	2135	40057	7781	1626	812	250	1034	2625	3282	750
8	1236	1247	11043	2596	546	504	162	344	906	2206
9	92	1350	311	6215	1466	230	162	75	52	489
10	131	193	388	162	2310	842	72	80	37	69
+gp	934	1604	379	400	323	1460	963	649	172	284
0 TOTALNUM	112235	99505	107866	82587	70361	51556	38249	21131	9341	6191
TONSLAND	175758	137264	110158	95422	103623	87889	77153	46955	21607	17318
SOPCOF %	81	63	77	95	113	104	99	95	92	94

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	29548	25596	3928	794	1045	516	3968	12342	13398	3048
4	1153	61470	88294	9031	3932	1171	1967	12652	25902	43740
5	546	1013	52609	50869	12246	1866	1886	2411	13154	32614
6	715	376	586	19465	22922	4126	2876	1740	2784	8330
7	316	346	207	382	3407	6734	4442	2070	973	1627
8	634	144	123	65	246	849	4422	2619	1297	660
9	1312	295	74	35	11	388	398	2737	2131	1142
10	416	484	119	44	36	50	21	241	2011	1756
+gp	113	157	285	310	66	30	17	18	384	1889
0 TOTALNUM	34753	89881	146225	80995	43911	15730	19997	36830	62034	94806
TONSLAND	41270	96585	150654	91745	54859	25741	33605	53887	77621	128703
SOPCOF %	97	90	98	99	96	97	96	101	100	111

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	1282	1622	2193	2411	20329	939	12010	4735	3298	4631
4	12915	5512	6043	13615	7722	30029	5268	35258	19914	12803
5	71007	34791	11506	8214	16295	5458	35236	7224	39403	27589
6	20209	70893	32302	7303	5765	4489	4045	15782	4987	35612
7	3361	10315	47298	12003	3574	1686	2468	1651	6621	3530
8	367	1885	4579	17811	7095	1206	885	1017	634	3339
9	295	417	530	1117	2764	1390	493	261	313	386
10	447	281	183	227	255	1830	855	235	153	372
+gp	963	1230	536	227	139	327	1014	758	454	481
0 TOTALNUM	110846	126946	105170	62928	63938	47354	62274	66921	75777	88743
TONSLAND	138677	173264	148756	93946	82346	61292	81842	83726	97603	116293
SOPCOF %	105	105	105	106	106	100	100	100	100	100

Table 4.8 Catch weights at age (kg)

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

Table 2 Catch weights at age (kg)

YEAR	1950	1951	1952	1953	1954
AGE					
3	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41
+gp	5.4	5.4	5.4	5.4	5.4
0 SOPCOFAC	0.4545	0.6514	0.5127	0.5742	0.6021

Table 2 Catch weights at age (kg)

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
0 SOPCOFAC	0.4731	0.5529	0.5679	0.6146	0.8007	0.8379	0.8026	0.7459	0.7442	0.6183

Table 2 Catch weights at age (kg)

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
0 SOPCOFAC	0.6978	0.6601	0.7919	0.7921	0.8028	0.7547	1.0105	0.8593	0.8281	0.8657

Table 4.8 (continued)

Table 2 Catch weights at age (kg)

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	1.52	1.57
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.86	1.99
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	2.1	2.42
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.443	2.68
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.753	2.93
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.014	3.37
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.32	3.676
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	3.635	3.39
+gp	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	3.914	4.27
0 SOPCOFAC	0.8127	0.6296	0.7708	0.9507	1.1278	1.0352	0.9942	0.951	0.9552	0.9616

Table 2 Catch weights at age (kg)

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	0.92	0.86	0.64	0.58	0.8	0.89	0.77	0.84	0.59	0.54
4	1.66	1.25	0.86	0.84	0.89	1.22	1.31	1.36	1.06	0.88
5	2.39	1.88	1.33	1.05	1.17	1.4	1.61	1.7	1.52	1.33
6	2.71	2.41	2.45	1.43	1.37	1.6	1.86	1.96	1.84	1.74
7	2.89	2.66	2.98	1.97	1.71	1.77	2.11	2.29	2.18	2.06
8	3.22	3.04	2.98	2.52	2.01	2.16	2.34	2.39	2.3	2.2
9	3.526	3.346	3.286	2.826	2.316	2.466	2.93	2.32	2.52	2.5
10	3.84	3.66	3.6	3.14	2.63	2.78	2.34	2.88	2.64	2.58
+gp	4.12	3.94	3.88	3.42	2.91	3.06	3.24	3.14	3.11	2.89
0 SOPCOFAC	0.983	0.9078	0.9872	1.0026	0.9675	0.9884	0.9599	1.0132	1.0021	1.1128

Table 2 Catch weights at age (kg)

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	0.63	0.64	0.66	0.71	0.73	0.6	0.63	0.583	0.61	0.651
4	0.66	0.79	0.99	0.9	1.06	1.09	0.97	0.999	0.862	0.901
5	1.06	1.04	1.09	1.27	1.27	1.39	1.4	1.403	1.305	1.15
6	1.68	1.34	1.22	1.38	1.55	1.59	1.76	1.663	1.715	1.479
7	2.11	1.81	1.48	1.54	1.66	1.82	1.95	2.145	2.093	1.861
8	2.34	2.29	1.99	1.79	1.79	1.91	2.13	2.254	2.379	2.089
9	2.67	2.31	2.26	2.37	2.06	2.07	2.32	2.725	2.624	2.485
10	2.91	3.18	2.26	2.51	2.6	2.22	2.41	2.505	3.291	2.636
+gp	3.02	2.62	2.98	2.68	2.85	2.58	2.56	2.762	3.496	2.698
0 SOPCOFAC	1.0546	1.0524	1.0498	1.0595	1.0552	1.0019	1.0027	1.0016	1.0018	1.0049

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Table 4.9 Stock weights at age (kg)

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

Table 3 Stock weights at age (kg)

YEAR	1950	1951	1952	1953	1954
AGE					
3	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

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Table 3 Stock weights at age (kg)

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
5	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
6	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
7	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
8	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

Table 4.9 (continued)

Table 3 Stock weights at age (kg)

YEAR		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
3		0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.48	0.289
4		1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.043	0.964
5		1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.641	1.81
6		2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.081	2.506
7		2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.592	2.24
8		3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
9		3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
10		4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
	+gp	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875	6.875

Table 3 Stock weights at age (kg)

YEAR		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
3		0.435	0.296	0.241	0.214	0.279	0.264	0.373	0.342	0.298	0.234
4		0.773	0.776	0.481	0.386	0.441	0.73	0.774	0.82	0.808	0.54
5		1.874	1.049	0.927	0.62	0.679	0.945	1.438	1.519	1.43	1.059
6		2.456	1.47	1.47	1.124	1.005	1.291	1.63	1.962	2.002	1.531
7		1.835	1.835	1.835	1.835	1.415	1.557	1.793	2.24	2.265	1.939
8		2.345	2.345	3.1	2.345	2.345	2.004	2.233	2.32	3.045	2.509
9		2.741	2.741	2.741	2.741	2.741	2.716	2.731	2.568	3.391	2.374
10		3.022	3.022	3.022	3.022	3.022	3.022	3.092	3.525	3.4	2.621
	+gp	3.705	3.705	3.705	3.705	3.705	3.705	3.705	3.705	4.2	3.16

Table 3 Stock weights at age (kg)

YEAR		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
3		0.215	0.208	0.205	0.234	0.282	0.23	0.308	0.194	0.241	0.243
4		0.362	0.448	0.388	0.459	0.592	0.684	0.492	0.578	0.475	0.439
5		0.803	0.685	0.684	0.829	1.017	1.059	1.174	0.973	1.074	0.818
6		1.444	1.125	1.108	1.193	1.488	1.296	1.555	1.518	1.44	1.257
7		1.95	1.845	1.468	1.462	1.653	1.487	2.026	2.049	1.953	1.586
8		2.913	2.43	2.442	1.966	1.914	1.608	2.488	2.469	2.484	2.402
9		2.934	2.815	3.218	3.155	2.539	1.814	2.625	2.704	2.784	2.923
10		3.033	3.323	3.333	2.815	2.513	2.21	2.648	2.867	2.962	2.582
	+gp	3.163	3.479	4.648	3.813	3.813	2.978	3.817	3.817	4.655	3.898
1											

Table 4.10 Natural Mortality (M) at age

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

Table 4 Natural Mortality (M) at age

YEAR	1950	1951	1952	1953	1954
AGE					
3	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

1

Table 4 Natural Mortality (M) at age

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4.10 (continued)

Table 4 Natural Mortality (M) at age

YEAR		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
3		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2103
4		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
3		0.2	0.6443	0.2	0.4677	0.2	0.3738	0.2	0.2063	0.2673	0.3041
4		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2288	0.219
5		0.2	0.2	0.2	0.2024	0.2	0.2	0.2	0.2	0.3036	0.2137
6		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2009
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		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
3		0.3799	0.86	0.5245	0.2518	0.202	0.234	0.2199	0.3783	0.4929	0.2617
4		0.3843	0.3243	0.257	0.2637	0.2	0.2099	0.2016	0.2143	0.2963	0.2502
5		0.3163	0.2271	0.2316	0.2293	0.2	0.2122	0.2	0.2052	0.213	0.213
6		0.2107	0.2258	0.2113	0.2	0.2	0.2081	0.2	0.2013	0.2	0.2
7		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

1

Table 4.11 Proportion mature at age

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

Table 5 Proportion mature at age

YEAR	1950	1951	1952	1953	1954
AGE					
3	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1
10	1	1	1	1	1
+gp	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

1

Table 5 Proportion mature at age

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
5	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
6	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
7	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
8	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 4.11(continued)

Table 5 Proportion mature at age

YEAR		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
3		0	0	0	0	0	0	0.01	0.09	0.17	0.07
4		0.05	0.05	0.05	0.05	0.05	0.05	0.12	0.55	0.7	0.14
5		0.23	0.23	0.23	0.23	0.23	0.23	0.64	0.73	1	0.35
6		0.53	0.53	0.53	0.53	0.53	0.53	0.73	0.93	1	0.47
7		0.88	0.88	0.88	0.88	0.88	0.88	0.96	0.96	1	0.74
8		0.98	0.98	0.98	0.98	0.98	0.98	1	1	1	1
9		1	1	1	1	1	1	1	1	1	1
10		1	1	1	1	1	1	1	1	1	1
	+gp	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
3		0.02	0	0	0	0	0	0	0.02	0.015	0
4		0.08	0.22	0.01	0.03	0.04	0.02	0.07	0.13	0.0735	0.017
5		0.8	0.53	0.21	0.33	0.3	0.3	0.3	0.5	0.49	0.305
6		0.93	0.86	0.53	0.51	0.63	0.54	0.5	0.62	0.76	0.59
7		0.96	0.86	1	1	0.82	0.77	0.8	0.77	0.79	0.9
8		1	1	1	1	1	0.87	0.92	0.8	0.88	0.88
9		1	1	1	1	1	0.8	1	0.94	0.88	1
10		1	1	1	1	1	1	1	1	0.87	1
	+gp	1	1	1	1	1	1	1	1	1	0.97

Table 5 Proportion mature at age

YEAR		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
3		0	0	0	0	0.01	0	0.004	0.008	0.003	0
4		0.02	0	0.03	0.05	0.17	0.1	0.06	0.13	0.05	0.03
5		0.12	0.1	0.1	0.28	0.5	0.32	0.54	0.33	0.4	0.2
6		0.42	0.36	0.29	0.5	0.71	0.59	0.72	0.73	0.69	0.58
7		0.81	0.78	0.6	0.66	0.81	0.72	0.87	0.83	0.91	0.84
8		0.88	0.86	0.82	0.81	0.91	0.94	0.94	0.9	1	0.93
9		1	0.9	1	0.91	0.92	0.94	0.9	1	0.94	1
10		0.87	0.93	0.83	1	1	0.96	1	0.94	1	0.88
	+gp	1	0.9	1	1	1	1	0.91	1	1	1
1											

Table 4.12 Survey indices used in tuning XSA

North-East Arctic haddock

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FLT01: Russian BT survey, total area, Nov-Dec, age 1-7

1 983	2004							
1	1	0.9	1					
1	7							
	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

1 980	2004							
1	1	0.99	1					
1	7							
	1	140	50	210	600	180	10	0
	1	20	30	40	40	100	60	0
	1	50	20	30	10	10	40	20
	1	1730	60	20	10	0	0	0
	1	7760	2150	50	0	0	0	0
	1	2660	4520	1890	0	0	0	0
	1	170	490	1710	500	0	0	0
	1	40	80	230	460	70	0	0
	1	50	60	110	200	210	20	0
	1	350	30	30	40	70	110	20
	1	2520	450	80	30	30	30	60
	1	8680	1340	230	20	0	0	10
	1	6260	5630	1300	130	0	0	0
	1	1930	2550	6310	1110	120	0	0
	1	2850	360	1110	3870	420	20	0
	1	2290	440	310	760	1510	80	0
	1	240	510	170	120	430	430	20
	1	0	200	280	120	50	130	160
	1	460	0	130	140	40	10	20
	1	5090	320	0	190	110	20	10
	1	3160	2100	230	0	10	10	0
	1	2820	2160	1490	140	0	10	0
	1	2790	1450	1980	1690	170	0	0
	1	4740	1270	760	760	660	70	0
	1	2090	2190	1020	360	400	90	0

Table 4.12(continued)

FLT04: Norwegian BT survey, age 1-7, shifted

1 982	2004								
1	1	0.99	1						
1	8								
	1	48	31	24	9	19	25	7	0
	1	5146	189	15	8	2	1	4	1
	1	15938	4759	147	5	5	1	1	4
	1	3703	3846	1108	6	2	1	1	1
	1	799	1544	2902	529	0	0	0	0
	1	153	253	689	1164	138	1	0	0
	1	95	141	216	340	327	34	1	0
	1	546	45	34	50	92	118	18	0
	1	3003	334	51	42	27	17	42	0
	1	13755	1505	244	21	6	7	16	23
	1	5990	5077	1056	105	6	4	3	4
	1	2280	3395	4366	497	34	2	1	2
	1	1793	536	1711	3395	345	28	0	1
	1	2636	525	481	1486	2528	116	9	0
	1	679	861	280	194	467	622	35	1
	1	0	227	332	132	34	80	81	7
	1	576	0	122	102	28	10	17	11
	1	4522	272	0	84	40	8	3	7
	1	4603	2960	293	0	17	9	1	1
	1	5347	3147	1853	176	0	8	3	0
	1	5131	3174	1820	736	55	0	2	1
	1	7112	1881	1027	804	462	59	0	2
	1	4204	3465	1333	668	522	123	6	0

Table 4.13 Extended Survivors Analysis

Lowestoft VPA Version 3.1

25/04/2005 13:25

Extended Survivors Analysis

NEA Haddock (Final XSA AFWG05)

CPUE data from file fleet

Catch data for 55 years. 1950 to 2004. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: Russian BT su	1990	2004	1	7	0.9	1
FLT02: Norwegian aco	1990	2004	1	7	0.99	1
FLT04: Norwegian BT	1990	2004	1	8	0.99	1

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 7

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 7

Catchability independent of age for ages >= 9

Terminal population estimation:

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

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

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00054

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 29	0	0.0015	0.0305	0.1312	0.2795	0.6449	0.3154	0.5902	0.3306	0.5176
Iteration 30	0	0.0015	0.0305	0.1312	0.2795	0.6448	0.3153	0.5901	0.3305	0.5174

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Table 4.13 (continued)

Fishing mortalities

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	0	0	0	0	0	0	0
2	0.001	0.002	0.004	0.009	0.005	0.002	0.002	0.001	0.001	0.002
3	0.019	0.027	0.028	0.065	0.123	0.016	0.048	0.02	0.022	0.031
4	0.079	0.126	0.2	0.302	0.312	0.273	0.123	0.196	0.128	0.131
5	0.274	0.359	0.464	0.483	0.76	0.383	0.6	0.248	0.356	0.279
6	0.635	0.533	0.692	0.626	0.778	0.486	0.554	0.598	0.272	0.645
7	0.634	0.812	0.871	0.608	0.735	0.546	0.547	0.461	0.544	0.315
8	0.326	0.932	1.136	1.018	0.928	0.593	0.626	0.457	0.321	0.59
9	0.398	0.766	0.751	0.995	0.408	0.456	0.518	0.376	0.246	0.33
10	0.498	0.841	0.961	0.882	0.645	0.523	0.568	0.502	0.396	0.517

1

XSA population numbers (Thousands)

	AGE									
YEAR	1	2	3	4	5	6	7	8	9	10
1995	3570000	293000	81400	205000	347000	47800	7910	1460	993	1260
1996	1840000	304000	92200	54600	129000	192000	20500	3440	861	546
1997	1330000	92200	103000	37900	34800	71900	89900	7450	1110	327
1998	1730000	269000	43700	59600	24000	17300	29100	30800	1960	428
1999	1580000	104000	194000	31800	33800	11800	7590	13000	9120	593
2000	2040000	428000	64700	140000	19100	12900	4430	2980	4200	4970
2001	1310000	415000	288000	50400	86300	10500	6470	2100	1350	2180
2002	3410000	500000	287000	221000	36400	38800	4940	3060	920	658
2003	5020000	485000	197000	192000	146000	23100	17400	2550	1590	517
2004	1970000	516000	176000	118000	126000	82800	14400	8280	1520	1020

Estimated population abundance at 1st Jan 2005

	0	358000	282000	131000	80600	76900	35600	8620	3760	892

Taper weighted geometric mean of the VPA populations:

	1920000	288000	137000	87900	54000	25700	10600	4580	1880	890

Standard error of the weighted Log(VPA populations) :

	0.6343	0.7625	0.8135	0.9095	0.973	0.9905	0.9748	0.9972	0.957	1.1398

Table 4.13 (continued)

Log catchability residuals.

Fleet : FLT01: Russian BT su

Age	1990	1991	1992	1993	1994
1	99.99	0.29	0.25	-0.23	-0.56
2	99.99	0.12	0.36	0.17	0.02
3	99.99	0.03	0.3	0.26	0.12
4	99.99	-0.21	-0.15	0.53	0.08
5	99.99	-0.46	-0.45	0.36	0.11
6	99.99	-0.69	0.16	0.35	0.1
7	99.99	0.33	0.51	0.61	-0.51
8	No data for this fleet at this age				

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.45	-0.28	99.99	-0.18	0.59	0.29	0.01	-0.01	0.25	-0.08
2	-0.44	-0.31	-0.15	99.99	0.39	-0.01	0	-0.03	0.27	-0.22
3	-0.32	-0.21	-0.44	0.39	99.99	0.25	-0.12	0.09	0.15	-0.31
4	-0.61	-0.01	0.03	-0.06	0.4	99.99	-0.18	0.29	0.12	-0.32
5	-0.4	0.57	-0.69	-0.47	0.49	0.55	99.99	0.24	0.1	-0.37
6	0.02	0.45	-0.69	-0.83	0.1	0.05	0.31	99.99	0.29	0.16
7	0.25	1.22	-1.27	0.02	-0.13	-0.17	0.14	0.33	99.99	-0.66
8	No data for this fleet at this age									

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

Age	7
Mean Log q	-6.8218
S.E(Log q)	0.6382

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.78	0.816	9.5	0.61	13	0.35	-8.03
2	0.73	2.062	8.6	0.88	13	0.27	-7.12
3	0.65	2.767	8.51	0.88	13	0.29	-6.69
4	0.78	1.91	7.54	0.9	13	0.32	-6.43
5	0.74	1.679	7.59	0.83	13	0.49	-6.41
6	0.89	0.77	6.8	0.85	13	0.45	-6.39

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	1.31	-1.123	6.06	0.61	13	0.83	-6.82

Table 4.13 (continued)

Fleet : FLT02: Norwegian aco

Age	1990	1991	1992	1993	1994
1	0.43	0.27	0.46	0.36	0.31
2	0.08	0.11	-0.01	0.15	-0.15
3	0.3	-0.24	0.17	0.15	-0.28
4	0.04	-0.48	-0.35	0.41	0.08
5	-0.15	99.99	99.99	0.3	0.26
6	-0.47	99.99	99.99	99.99	-0.01
7	0.15	-1.11	99.99	99.99	99.99
8	No data for this fleet at this age				

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.03	-0.91	99.99	-0.42	0.52	0.08	-0.16	-0.21	0.19	-0.16
2	-0.2	-0.18	0.05	99.99	0.08	0.04	0.07	0	0	0.04
3	0.09	-0.12	-0.11	0.02	99.99	0	-0.12	0.19	-0.05	0.12
4	-0.18	-0.25	0.12	-0.13	0.68	99.99	-0.15	0.3	-0.15	-0.25
5	-0.23	-0.1	-0.19	0.04	0.56	-0.76	99.99	0.44	0.05	-0.19
6	0.16	0.05	0.19	-0.52	0.55	-0.34	-0.08	99.99	0.48	-0.3
7	99.99	0.03	0.69	-0.53	0.25	99.99	99.99	99.99	99.99	99.99
8	No data for this fleet at this age									

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

Age	7
Mean Log q	-5.953
S.E(Log q)	0.6099

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	0.93	0.263	5.68	0.59	14	0.42	-4.97
2	0.76	4.526	6.87	0.98	14	0.11	-5.07
3	0.73	4.207	6.92	0.97	14	0.16	-5.1
4	0.75	2.189	6.74	0.9	14	0.34	-5.19
5	0.69	2.154	7.11	0.86	12	0.4	-5.33
6	0.81	1.398	6.72	0.88	11	0.39	-5.86

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	0.84	0.444	6.6	0.79	6	0.59	-5.95

Table 4.13 (continued)

Fleet : FLT04: Norwegian BT

Age	1990	1991	1992	1993	1994
1	0.31	0.37	0.09	0.2	-0.42
2	-0.21	0	-0.43	0.05	0.01
3	-0.19	-0.33	-0.09	-0.2	-0.06
4	0.31	-0.43	-0.48	-0.15	0.05
5	0.17	0.01	-0.19	-0.25	0.2
6	-0.63	-0.4	0.07	-0.47	0.4
7	0.61	0.17	-0.63	-0.81	99.99
8	99.99	0.52	-0.69	-0.45	-0.11

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.17	-0.25	99.99	-0.51	0.09	0.11	0.12	0.01	0.21	0.16
2	-0.24	-0.01	0.1	99.99	-0.08	0.02	0.07	0.26	0	0.07
3	0.3	0.13	-0.11	-0.17	99.99	0.05	-0.06	0.03	0.06	0.21
4	0.38	0.15	0.22	-0.34	0.1	99.99	0.06	-0.27	-0.05	0.26
5	0	0.01	-0.13	0.14	0.14	0.01	99.99	-0.04	-0.13	0.05
6	0.37	0.01	-0.24	-0.21	0.13	-0.07	0.1	99.99	0.42	-0.14
7	0.82	1.4	0.82	0.12	-0.14	-0.89	-0.17	-0.39	99.99	-0.51
8	99.99	-0.22	1.16	0.07	0.4	-0.41	99.99	-0.58	0.16	99.99

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

Age	7	8
Mean Log q	-6.7656	-6.798
S.E(Log q)	0.7157	0.5541

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	0.9	0.567	5.63	0.78	14	0.27	-4.63
2	0.66	4.397	7.49	0.95	14	0.16	-4.77
3	0.75	3.685	6.69	0.96	14	0.17	-4.95
4	0.76	2.566	6.71	0.93	14	0.27	-5.24
5	0.58	9.817	7.89	0.98	14	0.14	-5.73
6	0.65	3.61	7.53	0.92	14	0.31	-6.11

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	0.67	2.481	7.62	0.88	13	0.38	-6.77
8	0.83	0.978	7.12	0.83	11	0.46	-6.8

1

Table 4.13 (continued)

Terminal year survivor and F summaries :

Age 1 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
FLT01: Russian BT su	329278	0.367	0	0	1	0.293	0
FLT02: Norwegian aco	305364	0.443	0	0	1	0.201	0
FLT04: Norwegian BT	421751	0.3	0	0	1	0.438	0
P shrinkage mean	288281	0.76				0.068	0
F shrinkage mean	0	0.5				0	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
358225	0.2	0.09	4	0.435	0

Age 2 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
FLT01: Russian BT su	262947	0.246	0.222	0.9	2	0.287	0.002
FLT02: Norwegian aco	305331	0.256	0.066	0.26	2	0.264	0.001
FLT04: Norwegian BT	322085	0.222	0.07	0.31	2	0.353	0.001
P shrinkage mean	137073	0.81				0.026	0.003
F shrinkage mean	182950	0.5				0.07	0.002

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
281676	0.13	0.09	8	0.679	0.002

Table 4.13 (continued)

Age 3 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
FLT01: Russian BT su	128945	0.186	0.178	0.96	3	0.306	0.031
FLT02: Norwegian aco	132015	0.191	0.084	0.44	3	0.287	0.03
FLT04: Norwegian BT	141258	0.173	0.068	0.39	3	0.351	0.028
P shrinkage mean	87881	0.91				0.013	0.045
F shrinkage mean	86224	0.5				0.043	0.046

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
131053	0.1	0.06	11	0.608	0.031

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Age 4 Catchability dependent on age and year class strength

Year class = 2000

Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
FLT01: Russian BT su	77117	0.164	0.1	0.61	4	0.305	0.137
FLT02: Norwegian aco	73240	0.169	0.057	0.34	4	0.285	0.143
FLT04: Norwegian BT	96147	0.15	0.049	0.33	4	0.362	0.111
P shrinkage mean	54007	0.97				0.01	0.19
F shrinkage mean	48959	0.5				0.038	0.208

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
80613	0.09	0.06	14	0.616	0.131

Table 4.13 (continued)

Age 5 Catchability dependent on age and year class strength
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	81505	0.158	0.087	0.55	5	0.279	0.266
FLT02: Norwegian aco	78642	0.158	0.072	0.46	5	0.28	0.274
FLT04: Norwegian BT	80072	0.135	0.027	0.2	5	0.388	0.27
P shrinkage mean	25652	0.99				0.011	0.676
F shrinkage mean	40960	0.5				0.042	0.473

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
76917	0.08	0.05	17	0.647	0.279

Age 6 Catchability dependent on age and year class strength
Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	41079	0.155	0.103	0.66	6	0.251	0.579
FLT02: Norwegian aco	36323	0.154	0.11	0.71	6	0.268	0.635
FLT04: Norwegian BT	32507	0.129	0.05	0.39	6	0.389	0.689
P shrinkage mean	10622	0.97				0.019	1.395
F shrinkage mean	44780	0.5				0.073	0.542

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
35581	0.09	0.06	20	0.727	0.645

Age 7 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
FLT01: Russian BT su	9341	0.151	0.129	0.85	7	0.279	0.294
FLT02: Norwegian aco	9514	0.151	0.124	0.82	6	0.266	0.289
FLT04: Norwegian BT	8480	0.127	0.117	0.93	7	0.397	0.32
F shrinkage mean	4144	0.5				0.058	0.571

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8617	0.08	0.08	21	0.938	0.315

Table 4.13 (continued)

Age 8 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
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	3758	0.5				1	0.59

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3758	0.5	0	1	0	0.59

Age 9 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
FLT01: Russian BT su	1125	0.174	0.109	0.62	7	0.221	0.27
FLT02: Norwegian aco	853	0.166	0.202	1.22	6	0.196	0.343
FLT04: Norwegian BT	895	0.153	0.063	0.41	8	0.4	0.329
F shrinkage mean	703	0.5				0.183	0.403

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
892	0.12	0.07	22	0.547	0.33

1

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	457	0.188	0.115	0.61	7	0.178	0.552
FLT02: Norwegian aco	454	0.176	0.126	0.71	6	0.156	0.554
FLT04: Norwegian BT	410	0.175	0.089	0.51	8	0.331	0.599
F shrinkage mean	655	0.5				0.335	0.415

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
497	0.18	0.07	22	0.387	0.517

Table 4.14 Fishing mortality (F) at age

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1950	1951	1952	1953	1954
AGE					
3	0.0547	0.14	0.1163	0.072	0.0619
4	0.5936	0.2196	0.5485	0.3926	0.246
5	0.8245	0.6341	0.5849	0.5373	0.3091
6	0.8125	0.9135	0.8887	0.4899	0.4146
7	1.157	0.8053	0.9961	0.7145	0.6139
8	1.0055	1.0036	1.2502	0.6589	0.8609
9	0.6504	1.4256	1.3695	0.5162	1.3582
10	0.946	1.0901	1.2251	0.6331	0.9584
+gp	0.946	1.0901	1.2251	0.6331	0.9584
0 FBAR 4- 7	0.8469	0.6431	0.7546	0.5336	0.3959

Table 8 Fishing mortality (F) at age

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	0.0254	0.1141	0.0454	0.0287	0.0719	0.2012	0.1697	0.1995	0.1219	0.0811
4	0.1356	0.1753	0.2502	0.176	0.175	0.3802	0.4876	0.5958	0.6784	0.3193
5	0.4901	0.2792	0.3751	0.5789	0.3383	0.5192	0.6974	1.0616	0.9366	0.6929
6	0.4691	0.8125	0.4072	0.5215	0.5583	0.6531	0.7516	1.0617	1.0265	0.871
7	1.0131	0.6249	0.8167	0.9643	0.6025	0.5207	0.8335	0.7002	1.0012	0.8437
8	0.6211	0.9345	0.4513	0.8693	0.4321	0.7026	0.8825	0.904	0.6536	0.9605
9	0.43	0.3985	0.6298	0.743	0.8446	1.1478	0.9636	1.1812	1.3586	1.3821
10	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374	1.0158	1.0779
+gp	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976	0.9015	0.9374	1.0158	1.0779
0 FBAR 4- 7	0.527	0.473	0.4623	0.5602	0.4185	0.5183	0.6925	0.8548	0.9107	0.6817

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Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0.0671	0.1303	0.0615	0.0421	0.1016	0.1708	0.0234	0.2858	0.3385	0.2252
4	0.2401	0.3875	0.3091	0.3971	0.1707	0.2355	0.2691	0.392	0.6043	0.3429
5	0.4682	0.5962	0.4224	0.5791	0.498	0.2483	0.1818	1.0699	0.9919	0.4214
6	0.6985	0.7436	0.5206	0.4594	0.5818	0.504	0.1815	0.9505	0.4782	0.6968
7	0.6762	0.8235	0.5329	0.7022	0.4051	0.5298	0.4033	0.5516	0.2982	0.5926
8	0.5955	0.5278	0.5806	0.716	0.5023	0.4139	0.3896	0.581	0.2728	0.4829
9	1.0492	0.5925	0.384	0.4946	0.5017	0.3945	0.2979	0.6928	0.2772	0.8009
10	0.7832	0.6549	0.5027	0.6449	0.4735	0.4494	0.365	0.6151	0.2829	0.6318
+gp	0.7832	0.6549	0.5027	0.6449	0.4735	0.4494	0.365	0.6151	0.2829	0.6318
0 FBAR 4- 7	0.5208	0.6377	0.4462	0.5344	0.4139	0.3794	0.2589	0.741	0.5931	0.5134

Table 4.14 (continued)

Table 8 Fishing mortality (F) at age

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	0.2573	0.3213	0.7669	0.3617	0.1543	0.0378	0.0932	0.1269	0.1809	0.0609
4	0.5905	0.6487	1.2664	0.6432	0.5042	0.3079	0.2128	0.2488	0.4452	0.3329
5	0.5185	0.644	0.9364	0.8653	0.969	0.6796	0.5521	0.4776	0.4125	0.3446
6	0.4478	0.7091	0.5448	0.4462	0.8889	0.8182	0.8698	0.6839	0.3642	0.2395
7	0.6002	0.8047	0.6392	0.807	0.5126	0.3691	0.7737	0.5417	0.3915	0.3467
8	0.3512	0.8775	0.5412	0.4554	0.713	0.7053	0.4354	0.6453	0.3623	0.4988
9	0.2027	0.8146	0.5624	0.6782	0.5066	0.7651	0.5166	0.3694	0.1847	0.3396
10	0.3856	0.8431	0.5858	0.6531	0.582	0.6197	0.5811	0.524	0.314	0.397
+gp	0.3856	0.8431	0.5858	0.6531	0.582	0.6197	0.5811	0.524	0.314	0.397
FBAR 4- 7	0.5393	0.7016	0.8467	0.6904	0.7187	0.5437	0.6021	0.488	0.4034	0.3159

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	0.1366	0.0676	0.0511	0.0233	0.0706	0.0256	0.0552	0.0727	0.0243	0.0128
4	0.2213	0.4619	0.4659	0.1589	0.1791	0.1055	0.1418	0.2487	0.2181	0.1081
5	0.3842	0.3085	0.9389	0.5404	0.3347	0.1208	0.2463	0.2583	0.4683	0.4802
6	0.5737	0.4996	0.2949	1.2067	0.5029	0.1792	0.2758	0.3769	0.5342	0.6696
7	0.4245	0.6119	0.5715	0.3188	0.7028	0.2684	0.2978	0.3271	0.375	0.6984
8	0.5558	0.3491	0.4578	0.352	0.3497	0.3739	0.2835	0.2874	0.351	0.4722
9	0.6326	0.5491	0.3044	0.2264	0.0917	1.567	0.3009	0.2847	0.401	0.5986
10	0.5427	0.5082	0.448	0.299	0.3832	0.7491	0.2954	0.3007	0.35	0.6816
+gp	0.5427	0.5082	0.448	0.299	0.3832	0.7491	0.2954	0.3007	0.35	0.6816
FBAR 4- 7	0.4009	0.4705	0.5678	0.5562	0.4299	0.1685	0.2404	0.3028	0.3989	0.4891

Table 8 Fishing mortality (F) at age

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE											
3	0.0193	0.0269	0.0279	0.065	0.1242	0.0165	0.048	0.0202	0.0215	0.0305	0.0241
4	0.0796	0.1269	0.2007	0.3029	0.3129	0.2737	0.1233	0.197	0.1279	0.1312	0.152
5	0.275	0.3606	0.4647	0.4839	0.758	0.3835	0.6	0.2485	0.3573	0.2795	0.2951
6	0.6368	0.5345	0.692	0.6265	0.7759	0.4855	0.553	0.5979	0.2723	0.6448	0.505
7	0.6357	0.814	0.8701	0.6095	0.7334	0.5455	0.5467	0.46	0.5447	0.3153	0.44
8	0.3287	0.9304	1.1334	1.0123	0.9241	0.5924	0.6246	0.4569	0.321	0.5901	0.456
9	0.4002	0.7681	0.7526	0.9913	0.4085	0.4563	0.5176	0.3765	0.2465	0.3305	0.3178
10	0.4983	0.8406	0.9613	0.8818	0.6447	0.5229	0.5684	0.5023	0.3963	0.5174	0.472
+gp	0.4983	0.8406	0.9613	0.8818	0.6447	0.5229	0.5684	0.5023	0.3963	0.5174	
FBAR 4- 7	0.4067	0.459	0.5569	0.5057	0.645	0.422	0.4558	0.3758	0.3256	0.3427	

Table 4.15 Stock number at age (start of year)

Run title : NEA Haddock (SVPA AFWG05)
At 25/04/2005 16:04

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
AGE					
3	66026	553019	60283	1023249	120542
4	92622	51179	393614	43935	779545
5	68513	41886	33641	186200	24292
6	36893	24596	18190	15346	89074
7	45596	13404	8078	6123	7697
8	15745	11738	4905	2442	2454
9	4518	4716	3523	1150	1035
10	1941	1930	928	733	562
+gp	5287	2201	1348	2339	957
0					
TOTAL	337141	704669	524510	1281518	1026158

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

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	50765	167878	51537	67410	322648	240840	108736	240221	273037	316145
4	92769	40521	122627	40323	53631	245830	161251	75127	161110	197881
5	499066	66319	27842	78175	27687	36860	137614	81075	33898	66931
6	14600	250291	41068	15665	35875	16162	17956	56095	22960	10878
7	48176	7478	90933	22377	7613	16806	6886	6934	15885	6735
8	3411	14321	3277	32898	6985	3412	8175	2450	2818	4779
9	849	1501	4605	1709	11292	3712	1384	2769	812	1200
10	218	452	825	2009	665	3973	964	432	696	171
+gp	218	418	408	1126	1168	1201	2624	1350	638	1040
0										
TOTAL	710071	549179	343123	261691	467564	568796	445591	466453	511853	605760
1										

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	100872	237489	293825	17580	17380	164303	94306	1020039	270060	52804
4	238663	77231	170693	226209	13800	12855	113402	75425	627508	157618
5	117722	153693	42919	102594	124511	9526	8317	70941	41726	280759
6	27406	60348	69323	23033	47073	61952	6084	5677	19925	12670
7	3728	11159	23488	33723	11912	21540	30640	4155	1797	10112
8	2372	1552	4010	11286	13681	6504	10382	16760	1959	1092
9	1497	1070	750	1837	4516	6778	3520	5757	7676	1221
10	247	429	485	418	917	2239	3740	2140	2358	4763
+gp	1609	550	750	657	316	886	1915	3927	2603	4359
0										
TOTAL	494115	543521	606242	417336	234107	286584	272307	1204821	975611	525399

Table 4.15 (continued)

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	48610	55885	113854	170975	135034	18632	6019	8158	4679	8374
4	34517	30770	33181	43292	97500	94753	14689	4489	5883	3197
5	91586	15657	13168	7657	18630	48213	57016	9721	2866	3086
6	150819	44649	6732	4227	2639	5788	20005	26877	4937	1553
7	5168	78906	17988	3197	2215	888	2091	6863	11105	2808
8	4578	2322	28893	7772	1168	1086	503	790	3269	6146
9	551	2638	790	13769	4036	469	439	266	339	1863
10	449	369	956	369	5721	1991	179	215	151	231
+gp	3200	3064	934	910	800	3452	2388	1741	701	950
0										
TOTAL	339477	234260	216497	252167	267743	175272	103328	59119	33930	28209

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	254767	529020	86930	43109	16888	24416	81493	194645	635064	278552
4	6384	181955	259582	67627	26382	12884	16376	63139	147262	474430
5	1876	4189	93867	133381	47232	18059	9492	11635	40312	94189
6	1790	1046	2520	30052	63461	27669	13103	6075	7357	18630
7	1001	826	520	1536	7361	31423	18937	8142	3412	3531
8	1625	536	367	240	914	2984	19671	11512	4806	1920
9	3056	763	310	190	138	528	1681	12129	7071	2770
10	1086	1329	361	187	124	103	90	1019	7470	3877
+gp	295	431	864	1317	227	62	73	76	1426	4170
0										
TOTAL	271881	720096	445319	277639	162728	118127	160916	308372	854181	882069

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 50-**	AMST 50-**
AGE													
3	80447	91079	102304	43305	191753	64293	285358	284568	196319	175100	0	97940	184702
4	202897	53966	37522	58885	31547	138376	50047	218311	191047	117372	130730	67095	125947
5	342068	127598	34370	23742	33415	18889	85313	36166	144702	125004	80156	38311	71436
6	47062	189376	70894	17131	11636	12820	10411	38332	22976	81805	76387	18404	34655
7	7801	20165	88532	28727	7497	4385	6408	4903	17237	14327	35147	8304	15836
8	1438	3382	7315	30363	12785	2948	2081	3037	2534	8185	8558	3753	6677
9	980	847	1092	1928	9033	4155	1335	912	1574	1505	3714	1692	2896
10	1246	538	322	421	586	4916	2155	651	513	1007	885	742	1346
+gp	2685	2354	943	421	319	878	2556	2100	1521	1303	1127		
0													
TOTAL	686624	489305	343295	204924	298572	251660	445663	588980	578424	525607	336705		

Table 4.16 Stock biomass at age with SOP (start of year) Tonnes

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

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
AGE					
3	19804	237753	20398	387813	47898
4	43355	34338	207854	25986	483407
5	55734	48839	30873	191395	26179
6	39904	38131	22195	20973	127633
7	59263	24971	11844	10057	13254
8	23827	25461	8374	4671	4920
9	7596	11367	6682	2444	2305
10	3890	5545	2098	1857	1492
+gp	16519	9858	4751	9236	3960
0					
TOTALBIO	269894	436263	315070	654431	711048

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

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	15852	61258	19316	27344	170497	133185	57597	118254	134114	129020
4	45207	23075	71725	25527	44228	212155	133299	57716	123500	126029
5	422644	65632	28301	86005	39680	55284	197698	108244	45158	74082
6	16440	329341	55505	22915	68363	32229	34299	99578	40668	16009
7	65187	11824	147685	39334	17433	40273	15807	14791	33811	11910
8	5374	26366	6198	67331	18622	9521	21848	6085	6985	9840
9	1487	3070	9677	3886	33452	11508	4109	7642	2237	2746
10	454	1103	2066	5444	2350	14680	3414	1422	2284	466
+gp	708	1591	1592	4758	6427	6917	14481	6924	3264	4422
0										
TOTALBIO	573353	523259	342063	282543	401051	515752	482552	420654	392020	374524

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	46459	103472	153559	9191	9209	81845	62897	578499	147604	30171
4	171543	52513	139218	184567	11411	9994	118034	66757	535242	140548
5	147049	181611	60834	145472	178927	12869	15044	109116	61851	435079
6	45517	94815	130647	43424	89943	111285	14633	11611	39270	26106
7	7440	21067	53192	76402	27350	46495	88554	10210	4255	25038
8	5511	3412	10573	29771	36575	16347	34936	47958	5403	3147
9	3866	2615	2196	5384	13414	18929	13162	18304	23518	3912
10	759	1250	1692	1460	3247	7452	16669	8108	8610	18184
+gp	7717	2495	4086	3577	1746	4600	13304	23202	14818	25947
0										
TOTALBIO	435861	463249	555997	499249	371822	309815	377233	873765	840573	708132

Table 4.16 (continued)

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	26074	23224	57918	107282	100517	12730	3949	5120	2146	2327
4	28894	19956	26342	42393	113265	101029	15041	4397	5861	2964
5	133236	17647	18168	13030	37612	89337	101464	16547	4492	5371
6	291723	66909	12350	9564	7083	14261	47336	60829	9814	3743
7	12012	142094	39651	8692	7145	2630	5945	18667	27496	6048
8	12388	4868	74158	24605	4386	3744	1664	2501	10399	19681
9	1658	6145	2254	48434	16841	1795	1616	937	1199	6628
10	1609	1024	3251	1546	28456	9088	783	900	635	979
+gp	17881	13264	4950	5951	6203	24568	16321	11379	4601	6280
0										
TOTALBIO	525476	295130	239041	261497	321507	259182	194120	121277	66642	54021

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	108938	142151	20681	9249	4559	6371	29178	67450	189654	72534
4	4851	128177	123256	26172	11257	9296	12167	52459	119243	285092
5	3457	3989	85898	82911	31030	16868	13103	17907	57770	110998
6	4321	1396	3656	33866	61708	35307	20501	12077	14760	31740
7	1805	1376	941	2826	10078	48359	32594	18478	7744	7618
8	3747	1141	1122	565	2075	5912	42164	27061	14666	5360
9	8234	1899	838	522	367	1417	4408	31560	24028	7318
10	3226	3646	1077	566	363	309	268	3639	25452	11307
+gp	1074	1450	3161	4892	815	227	260	286	6004	14665
0										
TOTALBIO	139654	285225	240630	161569	122250	124065	154642	230917	459320	546632

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	18240	19937	22016	10737	57057	14816	88125	55295	47397	42756
4	77459	25443	15283	28638	19706	94830	24689	126387	90909	51777
5	289678	91984	24680	20854	35857	20042	100426	35246	155687	102751
6	71668	224211	82461	21654	18269	16647	16232	58282	33145	103329
7	16042	39153	136435	44499	13075	6533	13016	10062	33724	22833
8	4417	8650	18753	63248	25821	4749	5190	7510	6306	19756
9	3033	2510	3690	6446	24200	7551	3513	2471	4391	4420
10	3987	1881	1126	1257	1553	10885	5723	1870	1521	2614
+gp	8957	8620	4599	1702	1285	2621	9783	8030	7092	5102
0										
TOTALBIO	493482	422389	309044	199033	196824	178674	266698	305153	380172	355339

Table 4.17 Spawning stock biomass with SOP (spawning time) Tonnes

Run title : NEA Haddock (SVPA AFWG05)

At 25/04/2005 16:04

Traditional vpa using file input for terminal F

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

YEAR	1950	1951	1952	1953	1954
AGE					
3	0	0	0	0	0
4	2168	1717	10393	1299	24170
5	12819	11233	7101	44021	6021
6	21149	20209	11764	11116	67646
7	52152	21975	10423	8850	11664
8	23351	24952	8207	4577	4821
9	7596	11367	6682	2444	2305
10	3890	5545	2098	1857	1492
+gp	16519	9858	4751	9236	3960
0					
TOTSPBIO	139644	106855	61418	83400	122079

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

YEAR	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	2260	1154	3586	1276	2211	10608	6665	2886	6175	6301
5	97208	15095	6509	19781	9126	12715	45471	24896	10386	17039
6	8713	174551	29417	12145	36232	17082	18179	52776	21554	8485
7	57364	10405	129963	34613	15341	35440	13910	13016	29754	10481
8	5267	25839	6074	65985	18250	9330	21411	5963	6845	9643
9	1487	3070	9677	3886	33452	11508	4109	7642	2237	2746
10	454	1103	2066	5444	2350	14680	3414	1422	2284	466
+gp	708	1591	1592	4758	6427	6917	14481	6924	3264	4422
0										
TOTSPBIO	173462	232807	188884	147888	123389	118280	127639	115524	82499	59583

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	8577	2626	6961	9228	571	500	5902	3338	26762	7027
5	33821	41771	13992	33459	41153	2960	3460	25097	14226	100068
6	24124	50252	69243	23015	47670	58981	7756	6154	20813	13836
7	6547	18539	46809	67233	24068	40915	77928	8985	3745	22033
8	5401	3344	10362	29176	35843	16020	34237	46999	5295	3084
9	3866	2615	2196	5384	13414	18929	13162	18304	23518	3912
10	759	1250	1692	1460	3247	7452	16669	8108	8610	18184
+gp	7717	2495	4086	3577	1746	4600	13304	23202	14818	25947
0										
TOTSPBIO	90813	122890	155341	172533	167712	150357	172417	140186	117788	194092

Table 4.17 (continued)

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

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
3		0	0	0	0	0	0	39	461	365	163
4		1445	998	1317	2120	5663	5051	1805	2418	4103	415
5		30644	4059	4179	2997	8651	20548	64937	12079	4492	1880
6		154613	35462	6545	5069	3754	7558	34555	56571	9814	1759
7		10571	125042	34893	7649	6287	2314	5708	17920	27496	4476
8		12141	4770	72675	24113	4298	3669	1664	2501	10399	19681
9		1658	6145	2254	48434	16841	1795	1616	937	1199	6628
10		1609	1024	3251	1546	28456	9088	783	900	635	979
	+gp	17881	13264	4950	5951	6203	24568	16321	11379	4601	6280
0	TOTSPBIO	230562	190764	130063	97878	80154	74592	127428	105167	63103	42261

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

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
3		2179	0	0	0	0	0	0	1349	2845	0
4		388	28199	1233	785	450	186	852	6820	8764	4847
5		2765	2114	18039	27361	9309	5060	3931	8953	28307	33854
6		4019	1201	1938	17272	38876	19066	10251	7488	11218	18727
7		1733	1183	941	2826	8264	37236	26075	14228	6118	6856
8		3747	1141	1122	565	2075	5143	38791	21649	12906	4717
9		8234	1899	838	522	367	1133	4408	29667	21144	7318
10		3226	3646	1077	566	363	309	268	3639	22143	11307
	+gp	1074	1450	3161	4892	815	227	260	286	6004	14225
0	TOTSPBIO	27366	40834	28348	54788	60518	68361	84834	94078	119449	101850

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

	YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
3		0	0	0	0	571	0	353	442	142	0
4		1549	0	458	1432	3350	9483	1481	16430	4545	1553
5		34761	9198	2468	5839	17929	6413	54230	11631	62275	20550
6		30101	80716	23914	10827	12971	9822	11687	42546	22870	59931
7		12994	30539	81861	29369	10591	4704	11324	8351	30689	19180
8		3887	7439	15378	51231	23497	4464	4879	6759	6306	18373
9		3033	2259	3690	5866	22264	7098	3162	2471	4128	4420
10		3469	1749	935	1257	1553	10449	5723	1758	1521	2300
	+gp	8957	7758	4599	1702	1285	2621	8903	8030	7092	5102
0	TOTSPBIO	98751	139659	133303	107522	94011	55054	101741	98419	139568	131411

Table 4.18 Summary (with SOP correction)

Run title : NEA Haddock (SVPA AFWG05) At 25/04/2005 16:04

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 4- 7
1950	66026	269894	139644	132125	0.9462	0.4545	0.8469
1951	553019	436263	106855	120077	1.1237	0.6514	0.6431
1952	60283	315070	61418	127660	2.0785	0.5127	0.7546
1953	1023249	654431	83400	123920	1.4859	0.5742	0.5336
1954	120542	711048	122079	156788	1.2843	0.6021	0.3959
1955	50765	573353	173462	202286	1.1662	0.4731	0.527
1956	167878	523259	232807	213924	0.9189	0.5529	0.473
1957	51537	342063	188884	123583	0.6543	0.5679	0.4623
1958	67410	282543	147888	112672	0.7619	0.6146	0.5602
1959	322648	401051	123389	88211	0.7149	0.8007	0.4185
1960	240840	515752	118280	154651	1.3075	0.8379	0.5183
1961	108736	482552	127639	193224	1.5138	0.8026	0.6925
1962	240221	420654	115524	187408	1.6222	0.7459	0.8548
1963	273037	392020	82499	146224	1.7724	0.7442	0.9107
1964	316145	374524	59583	99158	1.6642	0.6183	0.6817
1965	100872	435861	90813	118578	1.3057	0.6978	0.5208
1966	237489	463249	122890	161778	1.3164	0.6601	0.6377
1967	293825	555997	155341	136397	0.8781	0.7919	0.4462
1968	17580	499249	172533	181726	1.0533	0.7921	0.5344
1969	17380	371822	167712	130820	0.78	0.8028	0.4139
1970	164303	309815	150357	88257	0.587	0.7547	0.3794
1971	94306	377233	172417	78905	0.4576	1.0105	0.2589
1972	1020039	873765	140186	266153	1.8986	0.8593	0.741
1973	270060	840573	117788	322226	2.7356	0.8281	0.5931
1974	52804	708132	194092	221157	1.1394	0.8657	0.5134
1975	48610	525476	230562	175758	0.7623	0.8127	0.5393
1976	55885	295130	190764	137264	0.7195	0.6296	0.7016
1977	113854	239041	130063	110158	0.847	0.7708	0.8467
1978	170975	261497	97878	95422	0.9749	0.9507	0.6904
1979	135034	321507	80154	103623	1.2928	1.1278	0.7187
1980	18632	259182	74592	87889	1.1783	1.0352	0.5437
1981	6019	194120	127428	77153	0.6055	0.9942	0.6021
1982	8158	121277	105167	46955	0.4465	0.951	0.488
1983	4679	66642	63103	21607	0.3424	0.9552	0.4034
1984	8374	54021	42261	17318	0.4098	0.9616	0.3159
1985	254767	139654	27366	41270	1.5081	0.983	0.4009
1986	529020	285225	40834	96585	2.3653	0.9078	0.4705
1987	86930	240630	28348	150654	5.3145	0.9872	0.5678
1988	43109	161569	54788	91745	1.6745	1.0026	0.5562
1989	16888	122250	60518	54859	0.9065	0.9675	0.4299
1990	24416	124065	68361	25741	0.3765	0.9884	0.1685
1991	81493	154642	84834	33605	0.3961	0.9599	0.2404
1992	194645	230917	94078	53887	0.5728	1.0132	0.3028
1993	635064	459320	119449	77621	0.6498	1.0021	0.3989
1994	278552	546632	101850	128703	1.2636	1.1128	0.4891
1995	80447	493482	98751	138677	1.4043	1.0546	0.4067
1996	91079	422389	139659	173264	1.2406	1.0524	0.459
1997	102304	309044	133303	148756	1.1159	1.0498	0.5569
1998	43305	199033	107522	93946	0.8737	1.0595	0.5057
1999	191753	196824	94011	82346	0.8759	1.0552	0.645
2000	64293	178674	55054	61292	1.1133	1.0019	0.422
2001	285358	266698	101741	81842	0.8044	1.0027	0.4558
2002	284568	305153	98419	83726	0.8507	1.0016	0.3758
2003	196319	380172	139568	97603	0.6993	1.0018	0.3256
2004	175100	355339	131411	116293	0.885	1.0049	0.3427
Arith mean	184739	364360	114351	119881	1.157		0.5215
Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)			

Table 4.19 Predictions with management option table: input data

MFDP version 1a
Run: final
Time and date: 18:34 4/25/2005
Fbar age range: 4-7

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	295000	0.3406	0.0051	0	0	0.253	0.024067	0.634
4	130730	0.2526	0.0372	0	0	0.494	0.152033	0.866
5	80156	0.2202	0.1738	0	0	0.773	0.2951	1.14
6	76387	0.2035	0.54	0	0	1.092	0.505	1.487
7	35147	0.2	0.8647	0	0	1.475	0.44	1.863
8	8558	0.2	0.94	0	0	1.959	0.456	2.147
9	3714	0.2	1	0	0	2.633	0.317833	2.46
10	885	0.2	1	0	0	3.366	0.472	2.684
11	1127	0.2	1	0	0	4.277	0.472	2.788

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	156000	0.4195	0.0026	0	0	0.234	0.024067	0.618
4	.	0.2549	0.0291	0	0	0.464	0.152033	0.83
5	.	0.2273	0.1791	0	0	0.79	0.2951	1.13
6	.	0.207	0.495	0	0	1.197	0.505	1.495
7	.	0.2	0.8545	0	0	1.638	0.44	1.865
8	.	0.2	0.9301	0	0	2.266	0.456	2.205
9	.	0.2	1	0	0	2.734	0.317833	2.435
10	.	0.2	1	0	0	3.222	0.472	2.733
11	.	0.2	1	0	0	3.945	0.472	2.878

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	462000	0.4195	0	0	0	0.216	0.024067	0.618
4	.	0.2549	0.021	0	0	0.435	0.152033	0.83
5	.	0.2273	0.1843	0	0	0.808	0.2951	1.13
6	.	0.207	0.45	0	0	1.302	0.505	1.495
7	.	0.2	0.8443	0	0	1.801	0.44	1.865
8	.	0.2	0.92	0	0	2.574	0.456	2.205
9	.	0.2	1	0	0	2.835	0.317833	2.435
10	.	0.2	1	0	0	3.078	0.472	2.733
11	.	0.2	1	0	0	3.613	0.472	2.878

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	100240	0.4195	0	0	0	0.216	0.024067	0.618
4	.	0.2549	0.021	0	0	0.435	0.152033	0.83
5	.	0.2273	0.1843	0	0	0.808	0.2951	1.13
6	.	0.207	0.45	0	0	1.302	0.505	1.495
7	.	0.2	0.8443	0	0	1.801	0.44	1.865
8	.	0.2	0.92	0	0	2.574	0.456	2.205
9	.	0.2	1	0	0	2.835	0.317833	2.435
10	.	0.2	1	0	0	3.078	0.472	2.733
11	.	0.2	1	0	0	3.613	0.472	2.878

Input units are thousands and kg - output in tonnes

Table 4.20 Predictions with management option table for period 2005-2007

MFDP	version	1a				
Run:	short					
Final2MFDP	Index	file	11/05/2005			
Time	and	date:	18:48	11/05/2005		
Fbar	age	range:	4-7			
2005						
Biomass	SSB	FMult	FBar	Landings		
367570	137209	1.0581	0.3682	117000		
2006					2007	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
379594	154940	0	0	0	570284	256115
.	154940	0.1	0.0348	13064	556287	246027
.	154940	0.2	0.0696	25670	542818	236364
.	154940	0.3	0.1044	37835	529856	227109
.	154940	0.4	0.1392	49578	517380	218242
.	154940	0.5	0.174	60914	505370	209749
.	154940	0.6	0.2088	71862	493807	201611
.	154940	0.7	0.2436	82435	482671	193814
.	154940	0.8	0.2784	92650	471947	186342
.	154940	0.9	0.3132	102519	461616	179182
.	154940	1	0.348	112057	451663	172320
.	154940	1.1	0.3828	121277	442071	165743
.	154940	1.2	0.4176	130190	432828	159439
.	154940	1.3	0.4524	138810	423918	153396
.	154940	1.4	0.4872	147148	415327	147602
.	154940	1.5	0.5221	155214	407044	142047
.	154940	1.6	0.5569	163019	399055	136721
.	154940	1.7	0.5917	170573	391349	131613
.	154940	1.8	0.6265	177885	383915	126715
.	154940	1.9	0.6613	184966	376740	122016
.	154940	2	0.6961	191823	369817	117510

Input units are thousands and kg
- output in tonnes

Table 4.21 Prediction single option table for period 2005-2008

MFDP version 1a
Run: final2
Time and date: 18:41 11/05/2005
Fbar age range: 4-7

Year:	2005	F multiplier:	1.0581	Fbar:	0.3682				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0255	6291	3988	295000	74635	1505	381	1505	381
4	0.1609	17224	14916	130730	64581	4863	2402	4863	2402
5	0.3122	19406	22122	80156	58754	13931	10212	13931	10212
6	0.5343	28868	42927	76387	83415	41249	45044	41249	45044
7	0.4656	11949	22261	35147	51842	30392	44828	30392	44828
8	0.4825	2993	6425	8558	16765	8558	16765	8558	16765
9	0.3363	967	2378	3714	9779	3714	9779	3714	9779
10	0.4994	318	853	885	2979	885	2979	885	2979
11	0.4994	405	1129	1127	4820	1127	4820	1127	4820
Total		88420	117000	631704	367570	106223	137209	106223	137209

Year:	2006	F multiplier:	1.0056	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0242	3049	1884	156000	36504	406	95	406	95
4	0.1529	25684	21318	204570	94921	5953	2762	5953	2762
5	0.2968	19969	22565	86459	68303	15485	12233	15485	12233
6	0.5078	17077	25529	47065	56337	23297	27887	23297	27887
7	0.4425	11923	22237	36524	59827	31210	51122	31210	51122
8	0.4586	6068	13380	18065	40935	16802	38074	16802	38074
9	0.3196	1078	2625	4325	11824	4325	11824	4325	11824
10	0.4746	750	2049	2172	6999	2172	6999	2172	6999
11	0.4746	345	993	1000	3944	1000	3944	1000	3944
Total		85943	112582	556181	379594	100650	154940	100650	154940

Year:	2007	F multiplier:	1.0056	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0242	9030	5581	462000	99792	0	0	0	0
4	0.1529	12567	10431	100098	43543	2102	914	2102	914
5	0.2968	31427	35512	136064	109940	25077	20262	25077	20262
6	0.5078	18575	27769	51194	66654	23037	29994	23037	29994
7	0.4425	7517	14020	23028	41473	19442	35016	19442	35016
8	0.4586	6453	14229	19212	49451	17675	45495	17675	45495
9	0.3196	2331	5675	9350	26509	9350	26509	9350	26509
10	0.4746	888	2427	2572	7917	2572	7917	2572	7917
11	0.4746	558	1605	1616	5837	1616	5837	1616	5837
Total		89346	117249	805134	451116	100871	171944	100871	171944

Year:	2008	F multiplier:	1.0056	Fbar:	0.35				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0242	1959	1211	100240	21652	0	0	0	0
4	0.1529	37219	30892	296446	128954	6225	2708	6225	2708
5	0.2968	15377	17377	66578	53795	12270	9914	12270	9914
6	0.5078	29232	43701	80566	104897	36255	47203	36255	47203
7	0.4425	8177	15250	25048	45111	21148	38087	21148	38087
8	0.4586	4069	8971	12113	31178	11144	28683	11144	28683
9	0.3196	2479	6036	9944	28191	9944	28191	9944	28191
10	0.4746	1920	5247	5561	17117	5561	17117	5561	17117
11	0.4746	736	2119	2133	7707	2133	7707	2133	7707
Total		101167	130803	598628	438601	104680	179612	104680	179612

Table 4.22 Predictions with management option table for period 2005-2008 in accordance with HCR

MFDP	version	1a		
Run:	final3			
Final2MFDP	Index	file	11/05/2005	
Time	and	date:	19:01	11/05/2005
Fbar	age	range:	4-7	

2005

Biomass	SSB	FMult	FBar	Landings
367570	137209	1.0581	0.3682	117000

2006

Biomass	SSB	FMult	FBar	Landings
379594	154940	1.0948	0.381	120806

2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
442560	166078	0	0	0	552429	258760
.	166078	0.1	0.0348	13274	538355	248714
.	166078	0.2	0.0696	26085	524810	239084
.	166078	0.3	0.1044	38451	511771	229853
.	166078	0.4	0.1392	50390	499219	221004
.	166078	0.5	0.174	61920	487132	212521
.	166078	0.6	0.2088	73056	475493	204387
.	166078	0.7	0.2436	83815	464283	196587
.	166078	0.8	0.2784	94210	453484	189108
.	166078	0.9	0.3132	104256	443080	181935
.	166078	1	0.348	113967	433055	175056
.	166078	1.1	0.3828	123356	423393	168457
.	166078	1.2	0.4176	132435	414080	162128
.	166078	1.3	0.4524	141217	405102	156055
.	166078	1.4	0.4872	149713	396446	150230
.	166078	1.5	0.5221	157934	388097	144640
.	166078	1.6	0.5569	165890	380045	139276
.	166078	1.7	0.5917	173593	372278	134129
.	166078	1.8	0.6265	181050	364783	129188
.	166078	1.9	0.6613	188273	357551	124447
.	166078	2	0.6961	195269	350571	119895

Input units are thousands and kg - output in tonnes

Table 4.23. Yield per recruit. Input data and results.

MFYPR	version	2a		
Run:	d			
NEA	Haddock			
Time	and	date:	19:09	11/05/2005
Fbar	age	range:	4-7	

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.262	0.000	0.000	0.000	0.226	0.024	0.615
4	0.250	0.030	0.000	0.000	0.497	0.152	0.921
5	0.213	0.200	0.000	0.000	0.955	0.295	1.286
6	0.200	0.580	0.000	0.000	1.405	0.505	1.619
7	0.200	0.840	0.000	0.000	1.863	0.440	2.033
8	0.200	0.930	0.000	0.000	2.452	0.456	2.241
9	0.200	1.000	0.000	0.000	2.804	0.318	2.611
10	0.200	0.880	0.000	0.000	2.804	0.472	2.811
11	0.200	1.000	0.000	0.000	4.123	0.472	2.985

Weights in kilograms

Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNos Jan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.0412	8.8051	2.4993	7.2169	2.4993	7.2169
0.1	0.0348	0.1135	0.2328	4.479	6.8592	1.9708	5.3258	1.9708	5.3258
0.2	0.0696	0.1924	0.3752	4.0898	5.5842	1.6125	4.1	1.6125	4.1
0.3	0.1044	0.2508	0.4673	3.8029	4.6952	1.3545	3.2555	1.3545	3.2555
0.4	0.1392	0.2961	0.5292	3.5818	4.0468	1.1602	2.6475	1.1602	2.6475
0.5	0.174	0.3323	0.5721	3.4057	3.5573	1.0093	2.1947	1.0093	2.1947
0.6	0.2088	0.362	0.6024	3.2617	3.1773	0.889	1.8486	0.889	1.8486
0.7	0.2436	0.387	0.6242	3.1415	2.8757	0.7911	1.5781	0.7911	1.5781
0.8	0.2784	0.4083	0.6401	3.0396	2.6317	0.7102	1.3629	0.7102	1.3629
0.9	0.3132	0.4268	0.6517	2.9517	2.431	0.6424	1.189	0.6424	1.189
1	0.348	0.443	0.6602	2.8752	2.2636	0.5849	1.0465	0.5849	1.0465
1.1	0.3828	0.4573	0.6665	2.8078	2.1222	0.5357	0.9284	0.5357	0.9284
1.2	0.4176	0.4702	0.6712	2.7479	2.0015	0.4931	0.8295	0.4931	0.8295
1.3	0.4524	0.4817	0.6745	2.6942	1.8972	0.456	0.7459	0.456	0.7459
1.4	0.4872	0.4922	0.6769	2.6458	1.8065	0.4234	0.6746	0.4234	0.6746
1.5	0.5221	0.5018	0.6786	2.6018	1.7268	0.3947	0.6134	0.3947	0.6134
1.6	0.5569	0.5106	0.6797	2.5615	1.6564	0.3692	0.5604	0.3692	0.5604
1.7	0.5917	0.5187	0.6804	2.5246	1.5936	0.3464	0.5142	0.3464	0.5142
1.8	0.6265	0.5263	0.6807	2.4905	1.5374	0.3259	0.4737	0.3259	0.4737
1.9	0.6613	0.5333	0.6808	2.4589	1.4867	0.3075	0.4381	0.3075	0.4381
2	0.6961	0.5399	0.6806	2.4294	1.4407	0.2908	0.4065	0.2908	0.4065

Reference point	F multiplier	Absolute F
Fbar(4-7)	1	0.348
FMax	1.8796	0.6542
F0.1	0.5505	0.1916
F35%SPR	0.4242	0.1476

Weights in kilograms

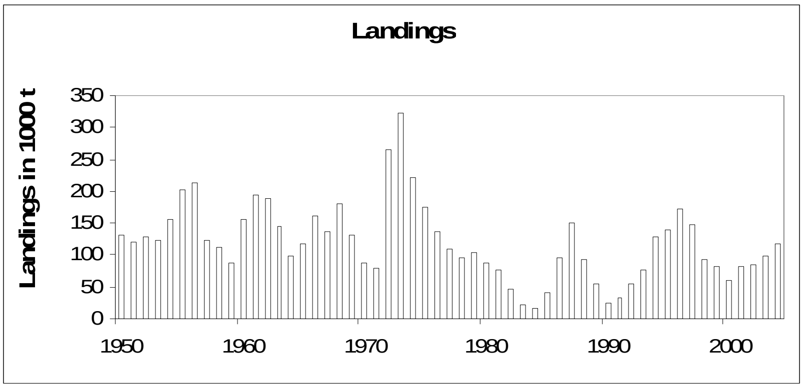


Figure 4.1A Landings of Northeast Arctic Haddock

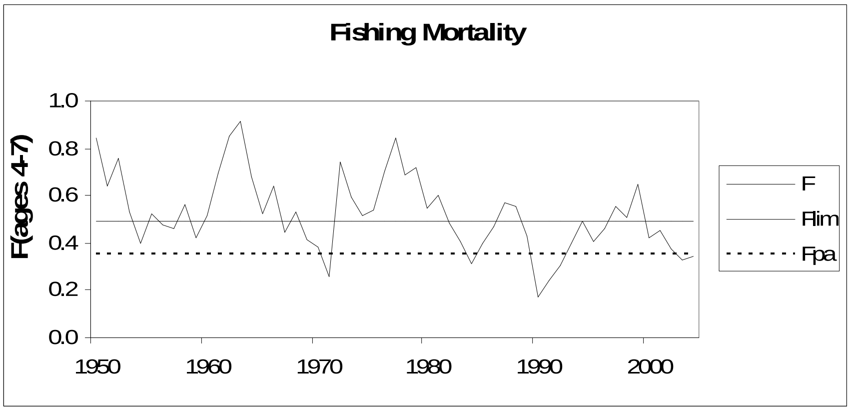


Figure 4.1B Fishing mortality of Northeast Arctic Haddock

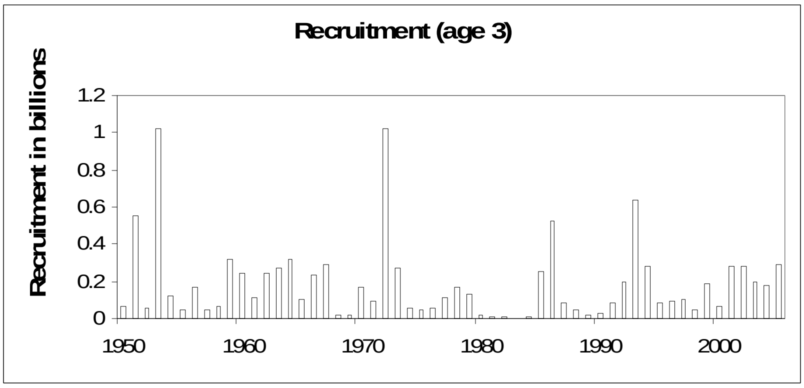


Figure 4.1C Recruitment of Northeast Arctic Haddock

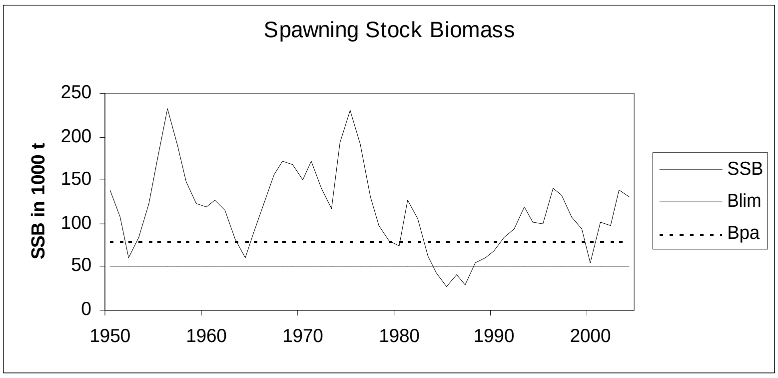


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock

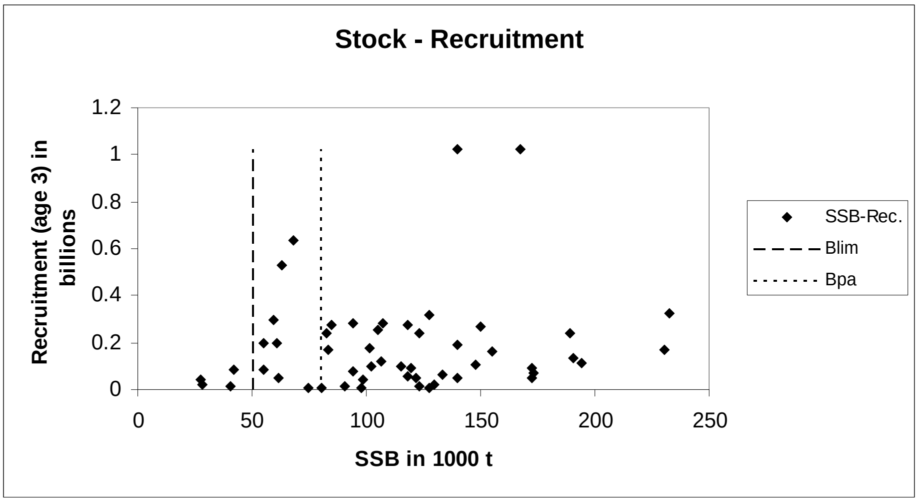


Figure 4.2 Stock-Recruitment relationships of Northeast Arctic haddock

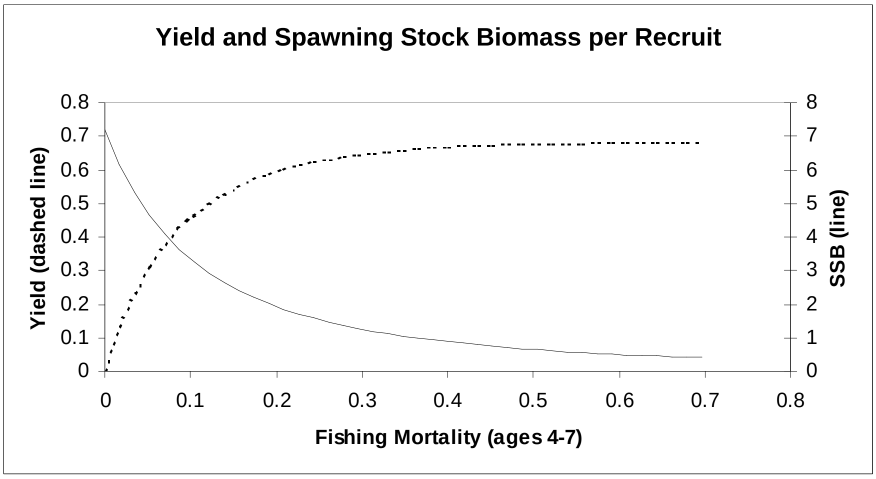


Figure 4.3 Yield and spawning biomass per Recruit of Northeast Arctic haddock

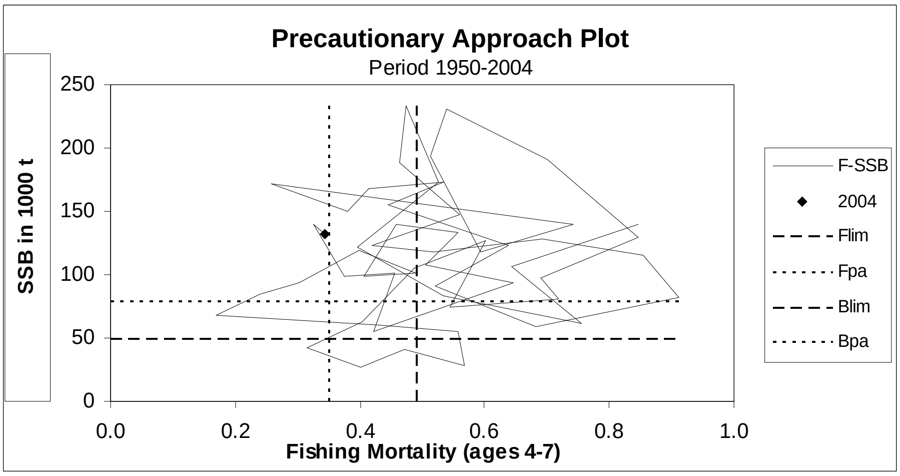


Figure 4.4 Precautionary approach plot of Northeast Arctic haddock

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-7
1950	66026	139644	132125	0.8469
1951	553019	106855	120077	0.6431
1952	60283	61418	127660	0.7546
1953	1023249	83400	123920	0.5336
1954	120542	122079	156788	0.3959
1955	50765	173462	202286	0.5270
1956	167878	232807	213924	0.4730
1957	51537	188884	123583	0.4623
1958	67410	147888	112672	0.5602
1959	322648	123389	88211	0.4185
1960	240840	118280	154651	0.5183
1961	108736	127639	193224	0.6925
1962	240221	115524	187408	0.8548
1963	273037	82499	146224	0.9107
1964	316145	59583	99158	0.6817
1965	100872	90813	118578	0.5208
1966	237489	122890	161778	0.6377
1967	293825	155341	136397	0.4462
1968	17580	172533	181726	0.5344
1969	17380	167712	130820	0.4139
1970	164303	150357	88257	0.3794
1971	94306	172417	78905	0.2589
1972	1020039	140186	266153	0.7410
1973	270060	117788	322226	0.5931
1974	52804	194092	221157	0.5134
1975	48610	230562	175758	0.5393
1976	55885	190764	137264	0.7016
1977	113854	130063	110158	0.8467
1978	170975	97878	95422	0.6904
1979	135034	80154	103623	0.7187
1980	18632	74592	87889	0.5437
1981	6019	127428	77153	0.6021
1982	8158	105167	46955	0.4880
1983	4679	63103	21607	0.4034
1984	8374	42261	17318	0.3159
1985	254767	27366	41270	0.4009
1986	529020	40834	96585	0.4705
1987	86930	28348	150654	0.5678
1988	43109	54788	91745	0.5562
1989	16888	60518	54859	0.4299
1990	24416	68361	25741	0.1685
1991	81493	84834	33605	0.2404
1992	194645	94078	53887	0.3028
1993	635064	119449	77621	0.3989
1994	278552	101850	128703	0.4891
1995	80447	98751	138677	0.4067
1996	91079	139659	173264	0.4590
1997	102304	133303	148756	0.5569
1998	43305	107522	93946	0.5057
1999	191753	94011	82346	0.6450
2000	64293	55054	61292	0.4220
2001	285358	101741	81842	0.4558
2002	284568	98419	83726	0.3758
2003	196319	139568	97603	0.3256
2004	175100	131411	116293	0.3427
2005	295000			
Average	186708	112910	119881	0.5215

F-reference points:

	Fish Mort	Yield/R	SSB/R
	Ages 4-7		
Average last 3 years	0.348	0.660	1.046
FMax	0.654	0.681	0.445
F0.1	0.192	0.589	2.009
Fmed	0.370	0.664	0.971

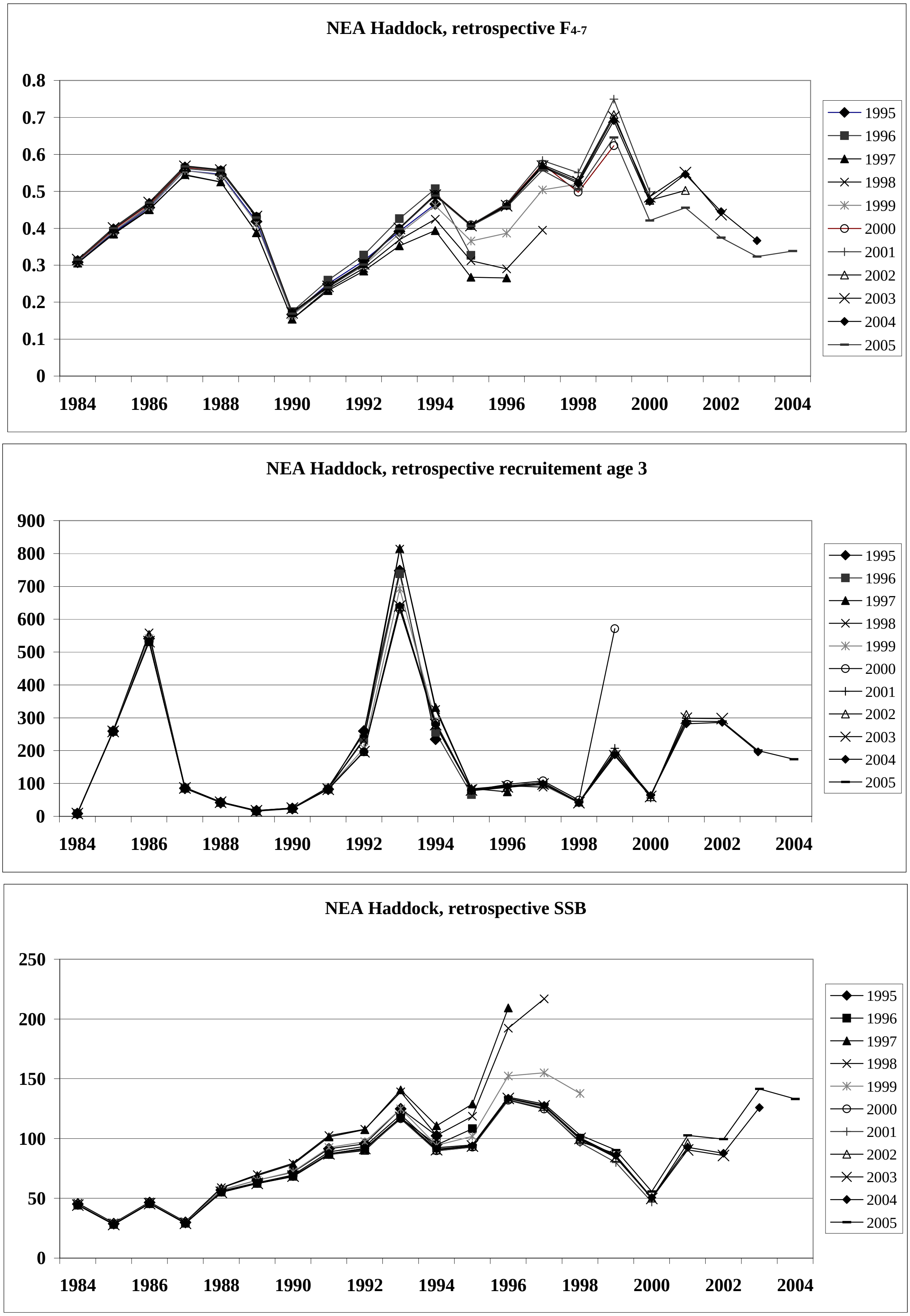


Figure 4.5 NEA haddock. Retrospective plots with shrinkage 0.5

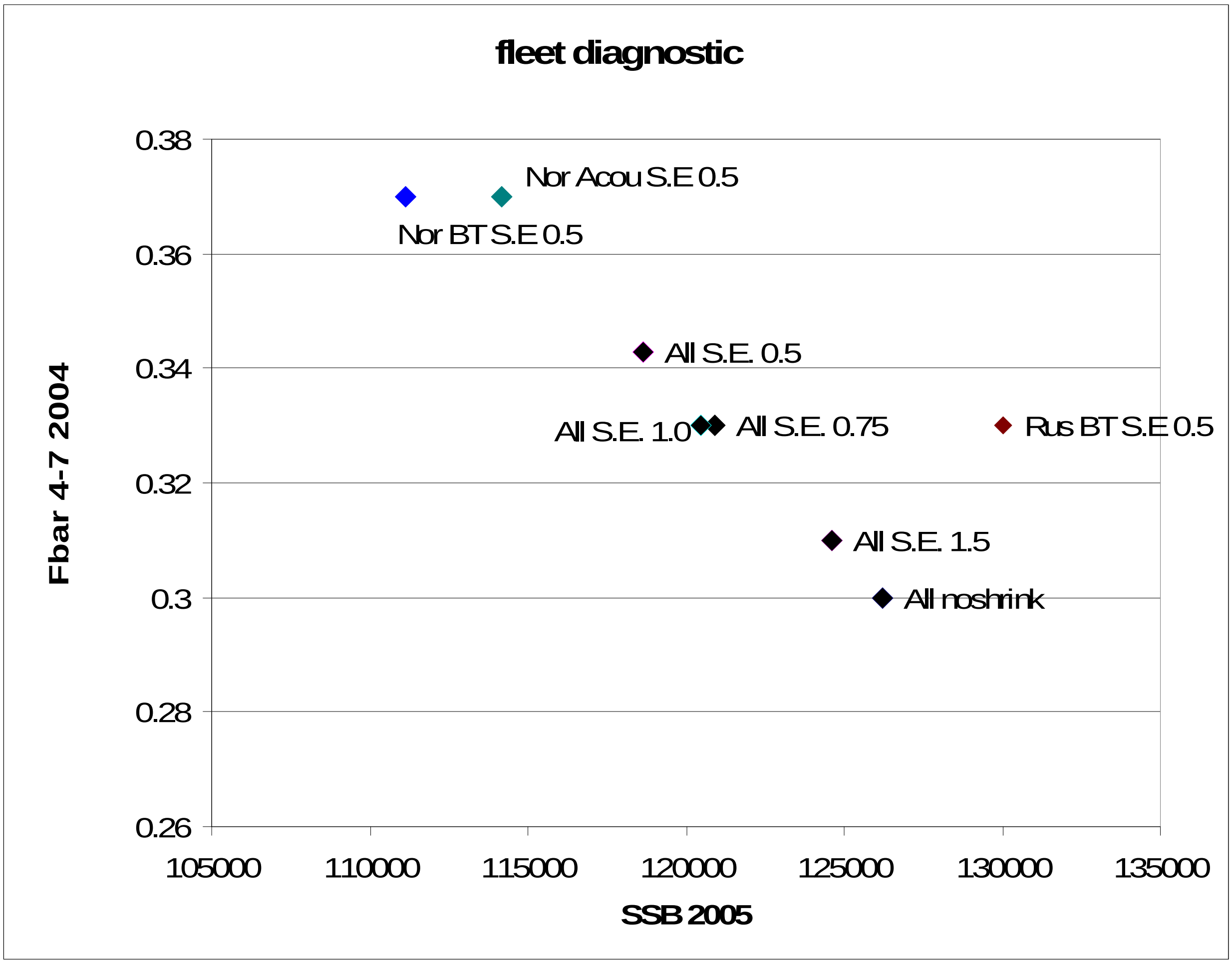


Figure 4.6 Tuning results by fleets with different S.E. of shrinkage.

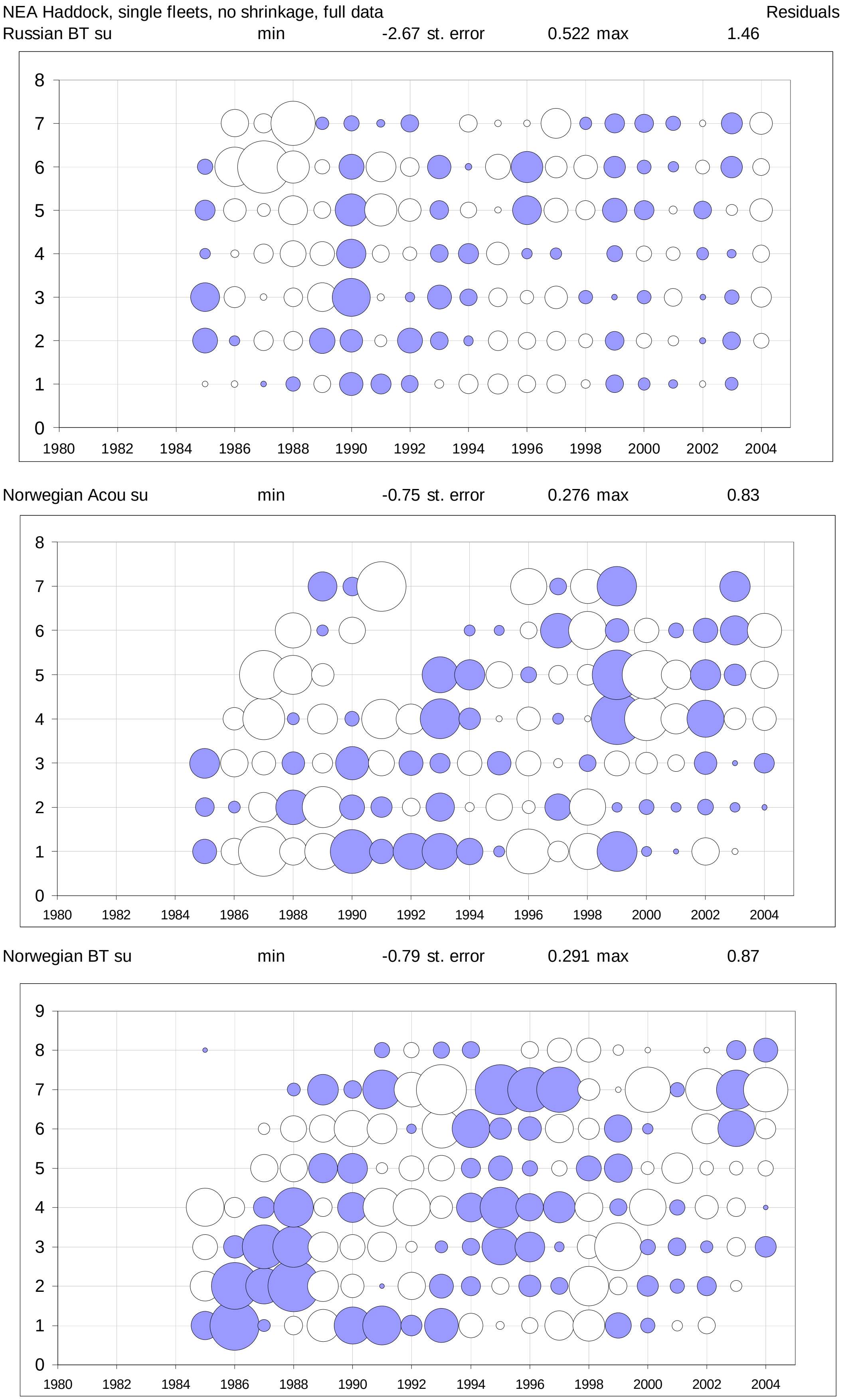
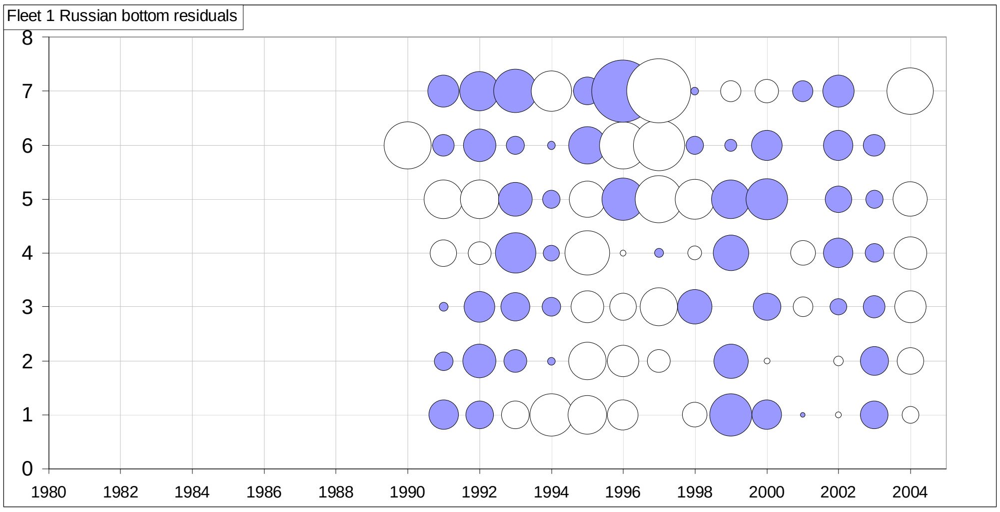


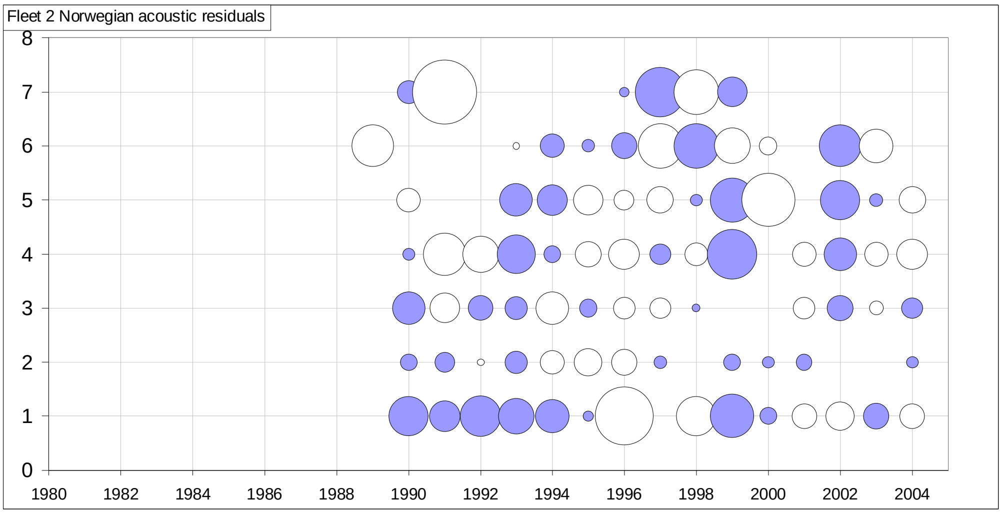
Figure 4.7. NEA Haddock, Log catchability residuals, single fleets, without shrinkage

NEA Haddock, combined fleets, shrinkage 0.5, reduce data Residuals

Russian BT su min -1.27 st. error 0.374 max 1.22



Norwegian Acou su min -1.11 st. error 0.290 max 0.69



Norwegian BT su min -0.89 st. error 0.336 max 1.40

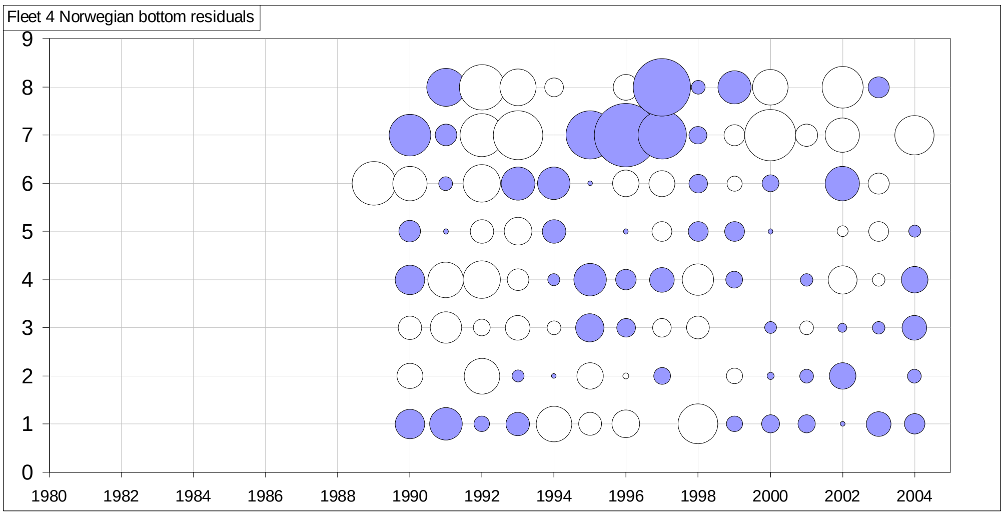


Figure 4.8. NEA Haddock, Log catchability residual plot, fleets combined, with shrinkage 0.5

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

[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
						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

Table B2 (continued)

Year	0	1	2	3	4	5	6	7	8	9	Older	Total
	Age											
						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
					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

[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

[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 1985-2004 (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

[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 1995-2004 (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

[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			
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

[1] Lengths adjusted to account for limited area coverage.

[2] Limited area coverage.

Table B6 North-East Arctic HADDOCK. Weight data (g) from Norwegian surveys in January-March and Russian surveys in November-December.

	Year	Age										
Norway		1	2	3	4	5	6	7				
	1983	52	133	480	1 043	1 641	2 081	2 592				
	1984	36	196	289	964	1 810	2 506	2 240				
	1985	35	138	432	731	1 970	2 517	-				
	1986	47	100	310	734	-	-	-				
	1987	24	91	273	542	934	-	-				
	1988	23	139	232	442	743	1 193	1 569				
	1989	43	125	309	484	731	1 012	1 399				
	1990	34	148	346	854	986	1 295	1 526				
	1991	41	138	457	880	1 539	1 726	1 808				
	1992	32	136	392	949	1 467	2 060	2 274				
	1993	26	93	317	766	1 318	1 805	2 166				
	1994	25	86	250	545	1 041	1 569	1 784				
	1995	30	71	224	386	765	1 286	1 644				
	1996	30	93	220	551	741	1 016	1 782				
	1997	35	88	200	429	625	1 063	1 286				
	1998	25	112	241	470	746	1 169	1 341				
	1999	27	85	333	614	947	1 494	1 616				
	2000	32	108	269	720	1 068	1 341	1 430				
	2001	28	106	337	556	1 100	1 429	2 085				
	2002	30	84	144	623	848	1 341	2 032				
	2003	38	127	202	493	981	1189	1613				
	2004	23	98	266	459	780	1 167	1 328				
	2005	29	84	253	469	699	1 054	1 378				
Russia		0	1	2	3	4	5	6	7	8	9	10
	1984	36	127	438	815	1 777	2 395	2 688	-	-	-	-
	1985	37	105	282	817	1 530	2 262	2 263	-	-	-	-
	1986	38	88	209	419	919	2 240	-	3 100	-	-	-
	1987	-	95	196	330	497	1 055	-	-	-	-	-
	1988	35	106	248	398	627	997	1 431	-	-	-	-
	1989	52	105	181	606	903	1 287	1 587	2 004	2 716	-	-
	1990	62	143	288	667	1 337	1 533	1 778	2 233	2 731	3 092	-
	1991	57	133	292	690	1 570	1 863	2 206	2 320	2 568	3 525	-
	1992	40	108	279	850	1 542	2 199	2 363	3 045	3 391	3 400	4 200
	1993	31	96	217	535	1 077	1 493	2 094	2 509	2 374	2 621	3 160
	1994	27	106	205	337	841	1 602	2 256	2 913	2 934	3 033	3 163
	1995	28	95	196	345	628	1 234	1 908	2 430	2 815	3 323	3 479
	1996[2]	30	103	209	347	743	1 152	1 650	2 442	3 218	3 333	4 648
	1997[2]	22	115	227	447	911	1 216	1 583	1 966	3 155	2 815	3 423
	1998	27	94	230	569	1 087	1 482	1 690	1 914	2 539	3 893	3 900
	1999	-	104	191	648	1 049	1 251	1 544	1 608	1 814	2 210	2 978
	2000	29	110	278	427	1 249	1 681	1 966	2 488	2 625	2 648	-
	2001	26	102	244	533	1 097	1 695	2 065	2 469	2 704	2 867	3 141
	2002	25	127	280	457	1166	1690	2293	2484	2784	2962	4655
	2003	21	104	220	419	855	1 347	1 844	2 402	2 923	2 582	-
	2004	23.9	87	253	518	846	1 130	1 571	1 959	2 633	3 366	

[1] **Lengths adjusted to account for limited area coverage.**

[2] **Limited area coverage.**

5 Northeast Arctic Saithe (Sub-areas I and II)

A benchmark assessment is presented for this stock, comprising an evaluation of catch and survey data available to the WG for evaluating the historical trends and current status of the 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 162,000 t.

There is known to be a discarding problem on trawlers from countries not interested in the saithe fishery or having no or only a small saithe quota and are fishing for cod in areas where also saithe is abundant in the catches (up to 40%). 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%. There are also records of discard from the purse seine fishery. At the moment it is not possible to evaluate the total level of discarding and use the information in the assessment.

5.1.1 ICES advice applicable to 2004 and 2005

The advice from ICES for 2004 was as follows:

ICES advise that fishing mortality should be below Fpa, corresponding to a catch in 2004 of less than 186 000 t.

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.*

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*.

5.1.2 Management applicable in 2004 and 2005

Management of saithe is by TAC and technical measures. Norwegian authorities set the TACs for 2004 and 2005 to 169,000 t and 215,000 t, respectively. The Institute of Marine Research, Bergen, Norway, advised a 2005 TAC at 2004 level in order to stabilise catches and spawning stock development.

5.1.3 The fishery in 2004 and expected landings in 2005

Provisional figures show that the landings in 2004 were approximately 162,000 t, which is slightly lower than the level expected by the WG last year (169,000 t).

Official landings in 2005 are expected to be around the TAC of 215,000 t, though it is uncertain if the about 30 % increase in TAC from 2004 to 2005 will be taken, given the relative low saithe prises. On the other hand one may experience increased problems with discard of small and less paid saithe, as well as 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)

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 due to better availability of schooling saithe (1999-year class) and transfer of quota, allowing for a longer fishing season. In 2004 the effort was reduced again to about the same level as in 2002.

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. The total CPUE index was finally divided on age groups applying yearly catch in numbers and weight at age data from the trawl fishery (Table 5.2.2). There was an increase in the 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.

In 2005 CPUE data from a German freezer trawler was made available to the WG (Table 5.2.3), and the indices was included in exploratory runs (Section 5.4).

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 results from the 2004 survey (Berg *et al*., WD 13) show a higher total index, with more of all age groups except age 4 compared to 2003.

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).

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 1989 – 2002 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. Just prior to the WG the age composition of Norwegian landings in 2003 was updated, also resulting in only minor changes in the catch numbers-at-age and weight-at-age. Age composition data for 2004 was available from

Norway, Russia (Division IIA) 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. At the 2005 WG these estimates were evaluated but not changed (section 5.4.3). Weight at age in the stock was assumed to be the same as weight at age in the catch, and the stock weights for 2- and 3-year olds may be slightly over-estimated in some years. A decrease in individual weight at age from 2002 to 2003 was found for all age groups except age 2, most pronounced for age groups 8 to 11+. From 2003 to 2004 there was a large decrease for age group 2, while the other age groups had more or less the same weight at age as in 2003.

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 5.4.3)

A constant maturity ogive has since the 1995 WG been used for the whole time series. At the 2005 WG these estimates were evaluated (section 5.4.4).

5.3.5 Tuning data (Table 5.4.5)

The tuning has in later years been based on three data series:

Fleet 08. Catch per vessel with annual catch > 100 tonnes in the purse seine fishery (start 1989, age groups 3 to 7)

Fleet 12: CPUE data from the trawl fisheries (start 1994, age groups 5 to 9)

Fleet 13: Indices from the Norwegian acoustic survey on saithe (start 1992, age groups 3 to 6+)

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. Further analyses and evaluation of the survey data and the other tuning series, including a new German freeze trawler CPUE series, are presented in sections 5.4.1-2.

5.4 Data screening and exploratory runs

5.4.1 Survey data (Figures 5.4.1-5.4.4)

The acoustic survey tuning data were screened using SURBA (version 2.20) to examine for year, age and cohort effects. Also age group 2 was included in the analyses. Survey catchability and weighting factors by age were all set to 1.0 with a smoother parameter rho = 2.0. Mean-standardised survey indices by year class and by year show quite good internal consistency in tracking weak and strong year classes (Figure 5.4.1), but with some strong year-effects (Figure 5.4.2). The empirical catch curves show that the survey has low catchability at younger ages causing domed catch curves (Figure 5.4.3). In 1996-1998 and in recent years there seems to have been an increase in catchability of older age groups. Except for ages 2 and 9, the log index residuals showed no strong year-effects (Figure 5.4.4f), while there are strong age effects on selectivity also for age 3 (Figure 5.4.4b). There is no clear temporal trend in F over the time series (Figure 5.4.4a) and mean $F_{3\text{-}6}$ varies between about 0.2 and 0.8 (Figure 5.4.4d). SSB shows a top in 1998 and a subsequent decreases and than an increase (Figure 5.4.4e).

5.4.2 Catch-per-unit-effort (Figures 5.4.5-5.4.16)

Also the commercial tuning fleet data were screened using SURBA. It was only possible to run SURBA version 2.10 on the German freezer trawl CPUE data. The settings were the same as for the acoustic survey data analysis. In the purse seine and German freezer trawl data sets all catch at age data were divided by the effort and scaled to give data sets with effort = 1 and a CPUE with lowest value = 1 for each age group and year (like in the acoustic survey and Norwegian trawl data sets, see Table 5.4.5).

The German freezer trawl CPUE data (1996-2004, 2002 missing, age groups 4-11) do no track weak and strong year classes very well (Figure 5.4.5) and show some very strong year effects both in mean standard index and log index residuals (Figs. 5.4.6. and 5.4.8f). The empirical catch curves do not present any clear picture of the log cohort abundance (Fig 5.4.7). There are strong age effects on selectivity for most age groups (Fig 5.4.8.b). It was not possible to get out any temporal trend in F over the time series or mean F_{3-6} (Fig 5.4.8.a, d). Relative SSB had a top in 1998-1999, and a new increase 2003-2004, but not as pronounced as for the acoustic survey data (Fig 5.4.8.e).

The Norwegian trawl CPUE series is already to some extent analysed for seasonal and vessel effects (Mehl *et al*., WD 20 2000). Only vessels larger than the median length are now included, and a yearly index is calculated by first averaging all CPUE observations for each quarter and then averaging over the year. This series was analysed for year, age and cohort effects using SURBA. Also year 1993 and age group 2 was included in the analyses. The Norwegian trawl CPUE data do tracks weak and strong year classes somewhat better than the German series, but not as well as the acoustic survey (Figure 5.4.9). Except for 1993 there are not any strong year-effects (Figure 5.4.10). For the full cohorts in the middle of the series the empirical catch curves show that younger age groups have lower catchability causing domed catch curves (Figure 5.4.11), and in the last part of the time series there has been a clear increase in catchability also for older age groups. Except for age 3, the log index residuals showed no strong year-effects (Figure 5.4.12f), while there are strong age effects on selectivity for ages 3-6 (Figure 5.4.12b). There is a clear decreasing temporal trend in F over the time series (Figure 5.4.12a) as well as in mean F_{3-6} (Figure 5.4.12d). Modelled SSB (Figure 5.4.12e) shows an increasing trend.

The purse seine data are able to track some of the strong and weak year classes somewhat better than the trawl series (Figure 5.4.13), but there are more strong year-effects (Figure 5.4.14). The empirical catch curves show the cohorts surprisingly well, normally with an increase in catchability the first year and than a steep decrease in cathability with age (Figure 5.4.15). These results reflect that the purse seine fleet target young, schooling saithe just entering the fishery (age 4-5). The steep decrease in log abundance does not necessarily reflect the true stock abundance, but just that older age groups become less available for the purse seine. The log index residuals showed strong year-effects especially for age 3 and to some extent for age 4 (Figure 5.4.16f), while there are strong age effects on selectivity for age 3 only (Figure 5.4.16b). There is a decreasing temporal trend in F over the time series (Figure 5.4.16a) as well as in mean F_{3-6} (Figure 5.4.16d). SSB shows a top in 1997 and a subsequent decrease and than a new increase (Figure 5.4.16e).

5.4.3 Weight at age (Figure 5.4.17)

Constant weights at age values are used for the period 1960 – 1979. For subsequent years, Norwegian weights at age in the catches 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.

Variable weight at age could be set for the period 1989 – 2003 where samples includes specimens weights and lengths. A power function is used to represent weight in the formula:

$weight=a*length^b$

Using an average weight/length relation for each year for specimen samples, the parameters a and b are estimated to:

YEAR	A	B
1989	0.000004726	3.1639
1990	0.000009325	2.9883
1991	0.000009873	2.9716
1992	0.000011104	2.9639
1993	0.000007018	3.0470
1994	0.000007352	3.0500
1995	0.000009644	2.9738
1996	0.000008000	3.0361
1997	0.000005685	3.1129
1998	0.000008039	3.0278
1999	0.000008123	3.0298
2000	0.000009496	2.9900
2001	0.000006903	3.0678
2002	0.000007124	3.0646
2003	0.000008201	3.0256

Variable weights for each year give small differences compared to the general formula used to estimate weights at age in Norwegian landings for the period 1997-2003 (Figure 5.4.17). The WG therefore decided to use this formula to estimate weight at age for Norwegian landings in also 2004.

5.4.4 Maturity at age (Figure 5.4.18, Table 5.4.2)

The currently used maturity ogive is based on analyses of spawning rings in otholiths for the period 1973-1994. 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. The records used are age and age at first spawning. 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 currently applied ogive.

AGE GROUP	2	3	4	5	6	7	8	9	10	11+
Current	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

In the last period the maturity at age has decreased somewhat. Table 5.4.1 presents the annual maturity ogives for the period 1985-2004. In the period 1997-2001 there was a lower maturation for all age groups 4-8, and especially in 1998 the maturation was low. The effect of applying the different maturity ogives (current, 85-04 average, annual 85-04 or 3-year running average 85-04) in the XSA-estimation of SSB is presented in Figure 5.4.18. The reduction in maturity starting in 1997 is quite significant, and the difference in estimated SSB in 1998 is almost 200,000 t between estimates based on current and annual-85-04 ogive, respectively.

The maturity at age based on spawning rings for the period 1996-2000 was compared to maturity at age based on gonad development and measured during the acoustic survey in October. Maturity at age based on gonad development for a given age group in a given year should in theory correspond to maturity at age based on spawning rings for the following age group the next year, i.e. age 6 in 1997 corresponds to age 7 in 1998. However, the survey mainly covers 3 - 5(6) year old fish, while older and mature saithe only is cover to some extent because the fish has already started the migration towards spawning grounds outside the survey area.

Table 5.4.2 presents the comparisons. For the youngest maturing age groups (4 and 5) a lower maturation is estimated based on gonad development at the survey time in October than based on spawning rings the following year (age 5 and 6). But a similar reduction in maturation in the period 1996 to 1999 is observed in both series. For age 6-7 the differences in estimated maturation are less, while for age 7-8 the reduction in maturation is smaller in the gonad based data (age 7) compared to the spawning ring based (age 8).

The question is than whether to use a new fixed average maturity ogive for the whole period after 1985-2004, an annual ogive or a running average. If we completely trusted the otolith-based method, an annual ogive would probably be the best. But the determination of spawning rings is still uncertain and variable between otolith readers, and the effect of errors on SSB-estimates and advice may be large. Since both the spawning ring based maturation and the gonad development based one show similar trends to some degree, the WG decided to use a 3-year running average for the period 1985-2004 (2-year average for the first and last year). Table 5.4.3 presents the 3-year running average maturity ogives.

5.4.5 Exploratory runs

XSA runs based on data until 2003 (Table 5.4.4a)

The settings of the different runs are shown in Table 5.4.4a.

Based on the update of Norwegian catch statistics and allocations of biological samples, first for 1989-2002 (run 1) and later also for 2003 (run 2), SPALY (Same Procedure As Last Year) XSA runs were performed prior to the 2005 WG, giving similar results as in the 2004 assessment. F_{3-6} in 2003 was the same as in last assessment (0.18), and SSB 1 Jan. 2003 only increased a little from 448,000 t to 451,000 t.

XSA runs based on data with 2004 included (Table 5.4.4a-b, 5.4.5, Figures 5.4.19-5.4.24).

The settings of the different runs are shown in Table 5.4.4a-b.

SPALY 2004-data run
A SPALY (Same Procedure As Last Year) XSA run with 2004 data included was performed for comparison (run 7). The results showed that F_{3-6} in 2003 was reduced from 0.18 to 0.15 compared with the SPALY run with data until 2003 (run 3). F_{3-6} in 2004 was also estimated to 0.15. A better fishing pattern was observed in 2004, with lower catches of age group 4. SSB 1 Jan. 2003 increased from 451,000 t to about 516,000 t, and SSB 1 Jan. 2004 was estimated to

610,000 t. The strong 1999-year class now entering the spawning stock, as well as an increased contribution from the 1997-1998 year classes caused this increase.

Single fleet tuning runs

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. Figs. 5.4.19a-c presents S.E. log q by age group and log q residuals by age group and year (line and bubble plot) for purse seine single fleet tuning (run 3). 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 (Figure 5.4.19c), and in the combined tuning the purse seine series get low scaled weights (Figure 5.4.23). Mainly based on this and not so much on the SURBA analysis the WG decided to not include the purse seine tuning fleet in the further and final analysis.

Figs. 5.4.20a-c presents S.E. log q by age group and log q residuals by age group and year (line and bubble plot) for the new German freezer trawl CPUE data (run 6). Age groups 6-8 had the lowest residuals, but the S.E. log qs were above 0.6, and in most cases above 0.8, which is at the same level as for purse seine and higher than for the two other tuning series. As for purse seine there are strong year effects (5.4.20c), and in the combined tuning this fleet gets the lowest scaled weights (Figure5.4.23). Based on this and the results from the SURBA screening the WG decided not to apply the series in the further analysis. The results are perhaps not surprising since the data comes from only one trawler fishing in the first quarter of the year. However, the WG appreciated the work done by German colleagues to provide the input data.

Figure 5.4.21a-c presents corresponding results for Norwegian trawl CPUE single fleet tuning (runs 4a). The Norwegian trawl CPUE time series goes back to 1976, but due to rather large negative log q residuals in the first part of the trawl CPUE time series, the 2001 WG decided to apply only the period after 1993 for tuning. In the present analyses, however, 1993 is included, as well as age groups 3 and 4. The results show acceptable low S.E. log q and log q residuals for age groups 4-8, except in 1993 when the residuals were somewhat higher (Figure 5.4.21b). Also the SURBA analysis also shows that this year stands out (Figure5.4.10). There are some year effects, but not as large as for purse seine and German freezer trawl. In the combined tuning this fleet gets the highest scaled weights for the oldest age groups (Figure5.4.23). The WG decided to apply Norwegian trawl CPUE data for age groups 4-8 in 1994-2004 in the further analyses.

Results from acoustic survey indices single fleet tuning (run 5a) are presented in Figure 5.4.22a-c. Age groups 2-9 in 1994-2004 are included in the analyses. The results show acceptable low S.E. log q and log q residuals for age groups 4-7. Age 6 has somewhat larger S.E. log q and log q residual in 1997-98, mainly caused by a large increase in availability and/or catchability these years. As for Norwegian trawl there are some year effects, but not as large as for purse seine and German freezer trawl. In the combined tuning this fleet gets the highest scaled weights for the youngest age groups (Figure5.4.23). It was also decided to include age 3 in the further analyses since this age group had slightly lower S.E. log q and log q residual than in the Norwegian trawl fleet, where it was left out.

Figure5.24 compares estimates of SSB and F_{3-6} in 2004 from the four single fleet XSA-runs as well as from a combined tuning. The results of the runs based on purse seine, Norwegian trawl and Norwegian acoustic survey tuning data are quite similar, while those based on the German freezer trawl CPUE tuning series are clear outliers. The results of the combined tuning including all four fleets are also close to the three former ones since the German fleet get low scaled weights.

In the further analyses (except the SPALY 2004-data run*)* these two tuning fleets will be included:

- CPUE data from the Norwegian trawl fisheries (start 1994, age groups 4 to 8)
- Indices from the Norwegian acoustic survey on saithe (start 1994, age groups 3 to 7)

Table 5.4.5 presents the combined tuning file based on these fleets.

Recruitment age (Figs. 5.4.25-5.4.26a-c)

In prior assessments age 2 has been 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 (Figure 5.4.25), 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. To compare age 2 and age 3 recruitment indices, retrospective XSA analyses were performed both with age 2 (run 8a) and age 3 (run 8b) as the youngest age group, and one additional analysis with age 2 included in the acoustic tuning fleet (run 8c). The main results are presented in Figure 5.4.26a-c. In the last six years the estimates of 2-year-olds are very uncertain (A), and including age 2 in the tuning gives almost similar results (B). For the age 3 recruitment indices it is only the three last years that are similarly uncertain (C). Applying age 3 as recruitment age therefore implies that one may include three more years (or two year-classes) in the last part of the recruitment time series. When estimating recruitment at age 3 for the projection, it is also possible to use survey indices both at age 2 and 3 as input in recruitment models. However, since age 2 survey indices did not improve the tuning, the contribution in other models such as RCT3 may not be better. The 2005 WG therefore decided to apply age 3 as recruitment age. This will effect the projections, and may be also the PA-reference points, which have been re-calculated (Section 5.6).

Fbar age span (Figure 5.4.27)

In prior assessments age group 3-6 has been 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 % (Figure 5.4.27). 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. $F_{3\text{-}6}$ in 2003 and 2004 was estimated to 0.15 (see paragraph above), and this low value is to a large extent caused by the low fishing mortality on 3-year olds (0.02-0.04 in the four last years).

The 2005 WG therefore decided to apply age group 4-7 as reference age group for Fbar. The fishing mortality PA-reference points therefore have been re-calculated (Section 5.6).

Exploratory runs with recruitment age 3, Fbar 4-7, 2 fleets and new maturity ogive (Table 5.4.4b, Figures 5.4.28-5.4.34)

First some runs were done to investigate the catchability plateau (at what age the catchability is set to be independent of age). The current value is >= 8. The acoustic survey, however, is directed towards age groups that are about to recruit to the fishery (3-5) and covers older saithe to a variable degree due to the spawning migration. Single and multi fleet tuning runs were therefore performed with catchability plateau 6 and 8 (runs 9a-f). Figure 5.4.28 shows comparisons of SSB and F_{4-7} in 2004 from the six different runs. The effect of changing catchability plateau from 8 to 6 is largest for the Norwegian trawl (flt 12) single fleet run, the SSB increases and F_{4-7} is reduced. For the acoustic survey (flt-13) single fleet run the effect is the opposite, and of somewhat less magnitude. The reason for this is the difference in “fishing pattern” and catchability at age between the two fleets. The effect is less on the combined fleet tuning runs. Both fleets got higher S.E. log Qs for older age groups in the combined tuning with a catchability plateau at 6. Figure 5.4.29 presents the terminal Fs at age for the six runs. The figure indicates that for the Norwegian trawl (flt 12) single fleet run and the combined tuning the currently used value of >= 8 are appropriate. Also the retrospective pattern was best with a catchability plateau at 8 (Figure 5.4.30). The WG decided to continue to apply this value.

The catchability is currently set to be independent of stock size for all ages. A few runs with catchability dependent of stock size for ages 3 and 4 were done (runs 10a-e). The runs with acoustic survey single fleet tuning did not converge after 100 iterations when catchability was set dependent of stock size for ages 3 and 4. Figure 5.4.31 shows comparisons of SSB and F_{4-7} in 2004 from the different runs together with the results of runs with catchability independent of stock size for all ages. The results are quite similar within fleets and especially for the combined tuning. The S.E. log Qs in the combined tuning were almost the same for the two settings, while the retrospective pattern was slightly better with catchability independent of stock size (Figure 5.4.32). The WG decided to continue to apply a catchability independent of stock size for all ages.

Finally a few runs were done where the S.E. of the mean to which the estimates are shrunk was increased from 0.5 to 1.0 (11a-c). The runs with acoustic survey single fleet tuning did not converge after 100 iterations. The estimates of SSB and F_{4-7} in 2004 from the different single and multi fleet runs presented in Figure 5.4.33 together with results of runs with the current setting (S.E. = 0.5). Again the result is the opposite for the two tuning fleets, reduced SSB and increased F_{4-7} for Norwegian trawl and increased SSB and reduced F_{4-7} for acoustic indices tuning. The over all effect of increasing the S.E. from 0.5 to 1.0 in the combined tuning is a reduced SSB and increased F_{4-7} since the Norwegian trawl get higher scaled weights than the acoustic survey in the estimates for age group 5 and older. The acoustic fleet got higher S.E. log Qs for most age groups in the combined tuning with a S.E. of 1.0, while the Norwegian trawl fleet got slightly lower S.E. log Qs for most age groups. The retrospective patterns were quite similar with the two settings (Figure 5.4.34) and the WG found no strong reasons for changing the setting.

ICA (Tables 5.4.6-5.4.7)

Two ICA runs were performed with the same input files as to the XSA final run. The parameter settings were as close to the XSA settings as possible, and settings are presented in Table 5.4.6. One run was done with weighting of abundance indices relative to catch-at-age data set to manual with a value of 1, and the other with iterative weighting. The results of the run with manual weighting came closest to the XSA, and the summary output is presented in Table 5.4.7.

ADAPT (Table 5.4.8)

Also an ADAPT run was performed with the same input files as to the XSA final run and settings as close to the XSA settings as possible. The summary output is presented in Table 5.4.8.

Comparison of model result (Figure 5.4.35, Table 5.4.9)

As seen in the text table below and in Figures 5.4.35, the F_{4-7} and SSB in 2004 and long term GM from the three models are quite similar. The XSA estimates a somewhat higher number of survivors in the youngest age groups compared to ICA, while it is the opposite for the oldest age groups (Table 5.4.9). The ADAPT survivor estimates for age groups 5-11+ are also comparable to the result of the two other models, while the age 4 estimate seems to be an outlier. ADAPT, however, shows high CVs for the survivor estimates, especially the youngest and oldest age groups.

	$F_{(4-7)}$ 2004	SSB, 2004	N3, 2005 GM	N4, 2005 FROM GM	N4, 2005 ESTIMATED	N5, 2005	N6, 2005	N7, 2005
XSA final	0.21	595195	163907	118724	56733	45157	113146	48568
ICA	0.22	606513	159722	111468	46000	38510	112600	37400
ADAPT	0.21	644316	163273	121235	253871	57132	94125	57697

5.5 Final assessment run (Tables 5.5.1-5.5.7, Figure 5.5.1-5.5.2a-b)

Extended Survivors Analysis (XSA) was used for the final assessment with settings shown in Table 5.4.4b (run 12). The settings are the same as in the 2004 assessment and previous years. Full tuning fleet diagnostics are given in Table 5.5.1, and Figure 5.5.1 presents S.E. log q and log q residuals (bubble plots) for the two fleets, and Figure 5.5.2a-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 5.5.3)

The fishing mortality (F_{4-7}) in 2003 was 0.19, which is lower than the value of 0.23 from last year's assessment. The fishing mortality (F_{4-7}) in 2004 was 0.21, i.e. a little above the corresponding figure for 2003 but well below the revised F_{pa} (4-7) 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 5.5.3. Previous retrospective analysis carried out fleet by fleet all showed the same trend (Mehl and Fotland,WD 15 2003).

The XSA-estimates of the 2001-2002 year classes are not considered to be valid and these estimates are therefore put in brackets (Tables 5.5.4-5.5.5). The summary table (Table 5.5.7) presents the recalculated recruitment figures and total biomass. The 1996-year class were 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 the 1999-year class is dominating the catches, especially in the purse seine fishery, and in the present assessment appear to be almost as strong as the 1992-year class. The 2000-year class seems to be of average strength or below. 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 (1960-2004) mean since 1993. Likewise, the SSB has been above the long-term mean since 1996 (Tables 5.5.5-5.5.7).

5.5.2 Recruitment (Tables 5.3.1, 5.5.8, Figure 5.1.1)

Estimates of the recruiting year classes up to the 2000-year class (4 year olds) from the XSA were accepted. Catches of age group 2 and to a large extent also age group 3 have declined to very low levels in recent years (Table 5.3.1). RCT3-runs have therefore been 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 are, however, strongly weighted towards the mean value of the input XSA-numbers, which due to the short survey time series also contain year classes that are still not converged. 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.

Updated RCT3 estimates for the 2001-year class, with 3 year olds as input, are presented in Table 5.5.8. The VPA mean got over 80 % of the WAP weights. The WG therefore decided to follow the advise from the ACFM Technical Minutes and use the long-term GM recruitment for the 2001-year class.

The GM recruitment 1960-2003 is 164 million 3 year olds, and this value is used for the 2001-year class. The value is almost similar to the GM recruitment 1994-2003, a period where the SSB has been well above $\mathbf{B}_{pa}$. The corresponding RCT3 value is 222 millions. Preliminary data from the Norwegian 0-group observer program (Borge and Mehl, WD 21 2002) 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. 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.

5.6.1 Biomass reference points (Figures 5.6.1-5.6.3)

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 ($\mathbf{S^*} = \mathbf{B}_{lim}$), 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, and Figure 5.6.1 shows the SSB-recruitment plot with the change point model estimated. The segmented regression fit is statistically significant at the 5% level of significance (p-value 0.03, Figure 5.6.2), and the maximum likelihood estimate of the spawning stock biomass at which recruitment is impaired is 136,055 t. An approximate 80% profile likelihood confidence interval is given by (109755, 190547) tonnes. The sensitivity analysis presented in Figure 5.6.3 shows that dropping one by one of the last ten years in the estimation has relatively little effect on the result. Applying the "magic formula" $\mathbf{B}_{pa} = \mathbf{B}_{lim}\,\exp(1.645*\sigma)$, gives a $\mathbf{B}_{pa}$ of 222,863 t, rounded to 220,000 t. The WG propose this as the new $\mathbf{B}_{pa}$ for Northeast Arctic saithe.

FROM ALGORITHM IN JULIOUS (2001			**FROM SEARCH ON 500X500 GRID**		
S*	$\hat{\alpha}$	R*	S*(10)	S*	S*(90
136378	1.27	173200	109755	136055	190547

5.6.2 Fishing mortality reference points (Tables 5.6.1-5.6.2, 5.7.1, Figure 5.1.1, 5.6.4)

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 0.15 and 0.33, respectively, which is somewhat higher than the values 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. ACFM 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 1998).

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. 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 (Figure 5.6.4). This value is close to the F-values estimated for the period with low SSB and recruitment in the 1980s. Applying the "magic formula" $\mathbf{F_{pa}} = \mathbf{F_{lim}}$ exp(-1.645*σ), gives a $\mathbf{F}_{pa}$ of 0.35. The WG propose this as the new $\mathbf{F_{pa}}$ for Northeast Arctic saithe.

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 2005 was taken from the XSA for age 5 (2000 year class) and older. The recruitment at ages 3 in the last assessment year (2004) was calculated as the long-term GM (geometric mean) recruitment 1960-2003 (Section 5.5.2), and the corresponding numbers at age 4 in the intermediate year (2005) was calculated applying a natural mortality of 0.2 and the F value estimated by XSA (as recommended by the ACFM reviewers). The GM age 3 recruitment of 164 million was also used for the 2002 and subsequent year classes. The natural mortality is the same as were used in the assessment. For the exploitation pattern the average of 2002-2004 has been used. For weight at age in stock and catch the average of the last three years in the XSA is normally used. The estimates of weight-at-age in the catches showed a decreasing trend towards 2003, and at the 2004 WG the 2003 weights at age were applied in the predictions. The effect was approximately a 10 % decrease in estimated SSB and catch in the short-term predictions. The weights-at-age in 2004 was quite similar to the 2003-weights, and the 2005 WG therefore decided to use the average of 2003-2004 in the predictions. For maturity at age the average of the 2003-2004 annual determinations was applied, which is the same as applied for 2004 in the assessment.

5.7.2 Catch options for 2005 (short term predictions) (Table 5.7.2)

The management option table (Table 5.7.2) shows that the expected catch of 215,000 t in 2005 will increase the fishing mortality compared to 2004 from 0.21 to 0.32, which is close to the new F_{pa} of 0.35. A catch in 2006 corresponding to $F_{status\ quo}$ level of 0.21 will give 128,000 t, while the catch corresponding to the new F_{pa} in 2006 is 200,000 t. The SSB is expected to decrease to 487,000 t in the beginning of 2006, which is just below the prediction made by last year's working group for a catch in 2005 corresponding to F_{pa}. At $F_{sstatus\ quo}$ in 2006 SSB is estimated to remain at this level, while at F_{pa} it will decrease to about 400,000 t in the beginning of 2007. The predicted reduction in SSB may be explained by a higher fishing mortality close to or at F_{pa} level and weaker incoming year classes.

5.7.3 Medium-term forecasts

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 for the 2001 and subsequent year classes. The problem with bias in the assessment was not resolved, and the WG therefore made no medium-term forecast.

5.8 Comparison of the present and last year's assessment

The current assessment estimated the total stock to be about 5 % lower in 2004 and SSB 16 % higher, than in the previous assessment. The current assessment estimates a reduction for younger age groups and an increase for older compared to 2003. The F in 2003 was estimated to be somewhat lower than in the previous assessment.

	Total stock (3+) by 1 January 2004	SSB by 1 January 2004	$F_{4\text{-}7}$ in 2004	$F_{4\text{-}7}$ in 2003
WG 2004	913040	510582	0.26 (prediction)	0.23
WG 2005	867721	595195	0.21	0.19

5.9 Comments on the assessment and the forecast

The retrospective pattern of the recruitment estimates improved somewhat changing the age at recruitment from 2 to 3. Shifting the Fbar from 3-6 to 4-7 gives probably a better picture of the average fishing mortality for the most exploited part of the stock. Difficulties in estimating initial stock size due to the widely divergent indices of abundance used in the tuning of the XSA is, in addition to recruitment, at present the major problem in the forecast. This may also be the cause for underestimating the stock size in the assessment year. Prediction of catches beyond the TAC year will, to a large extent, be dependent on assumptions of average recruitment.

5.10 Response to ACFM technical minutes

As last year the reviewers considered the estimated recruitment by RCT is basically the mean and the acoustic survey does not provide additional information. It would be more transparent to use the GM mean. The 2005 WG followed this advise after having done some additional RCT3 analysis.

The review group meant that the way the corrections was made to calculate the survivors in intermediate year for those year classes recruitment estimates were changed manually was questioned. Normally the F values, estimated by XSA, would have been applied to the revised recruitment to calculate the survivors instead of recalculating F at age from the actual catches. Also this advice was followed by the present WG.

The reviewers further wrote, "the retrospective analyses show large trends of overestimating F and underestimating SSB and inability to predict recruitment. This demonstrates considerable uncertainty on the estimated values of the assessment in the most recent years. It was suggested to try other assessment methods such as ADAPT which will also provide CV's of the estimates of fishing mortality and stock numbers. This should be explored next year, when this stock is assessed as a benchmark". The WG tried both ADAPT and ICA. The results were comparable, but ADAPT showed large CV's for the estimates of survivors. The limited time during the WG did not allow for a closer look at the different diagnostics, but the main results of the additional models did not change the perception of the stock situation based on the XSA analyses.

As mentioned by the reviewers similar retrospective patterns (underestimating SSB and overestimating F) have been observed in other saithe stocks may be explained by several factors (choice of wrong M, immigration). As also seen in previous retrospective analysis carried out fleet by fleet for NEA saithe (Mehl and Fotland,WD 15 2003) all runs in the present assessment showed the same trend. The reviewers 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 2005 WG were not able to improve these shortcomings and therefore did not present any medium term analyses, but have plans for including measures of bias in future medium-term risk analysis.

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	136,402
2002	520 [2]	1048	1138 [2]	2,642 [6]	143,840	-	118	5,402	37 [2]	345	75	81	155,246
2003	561 [2]	848	929 [2]	2,763 [6]	150,244	-	143	3,893	13 [2]	265		98	159,757
2004 [1]	708 [2]	188 [2]	891 [2]	2,161 [6]	147,718	-	105	9,192	87	543		323.5 [2]	161,916

[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 [1]	41.8	72.2	26.8	21.1	161.9

[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)	total catch
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	294	63%	37%	3,098.0	40,250.0	43,323.0	7%	93%	16.7	372.7	116.2
2004 [1]	194	70	264	73%	27%	2,898.0	38,801.0	41,699.0	7%	93%	14.9	554.3	75.2
Mean	137.8	84.9	222.8	59%	41%	3,059.4	32,363.5	35,421.4	9%	91%	23.6	390.7	93.9

[1] Provisional figures.

Table 5.2.2 Northeast Arctic saithe. Norwegian trawl CPUE by agegroup (Catch in numbers per trawlhour)

Year	Agegroup									Total CPUE (kg/h)
	effort	3	4	5	6	7	8	9	10	
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]	1	9.7	13.8	264.0	208.5	178.2	233.4	78.8	96.8	1083

[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

[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

Table 5.3.1 Catch numbers at age

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

YEAR	1960	1961	1962	1963	1964
AGE					
3	10509	17824	37266	42050	9001
4	13083	9131	11131	28925	59601
5	13545	12506	4421	5888	13154
6	5064	3799	8290	4650	2718
7	4883	1332	2427	3861	3472
8	2401	968	1024	1099	2655
9	1315	520	938	1075	1251
10	743	405	451	697	1221
+gp	1525	1229	1728	1777	3559
0 TOTAL	53068	47714	67676	90022	96632
TONSL	133515	105951	120707	148627	197426
SOPCO	129	142	123	122	121

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	37115	22392	29664	25196	77333	43540	77019	65178	76296	36782
4	5001	54537	24836	18384	11949	62846	59280	52389	25206	44027
5	26300	13124	35956	5101	16939	13987	26961	29146	26911	15671
6	10142	12899	4125	8282	4747	16189	9556	10186	16031	20419
7	2861	4652	5616	787	4798	5122	9592	5616	7114	12148
8	2110	1374	2916	1913	1126	7950	2901	3547	3935	4802
9	2733	933	1413	900	1711	2504	4352	1865	2871	3258
10	699	965	1397	577	675	3697	2195	2140	2610	2505
+gp	3593	2900	3493	1166	511	2799	5490	3149	3924	3821
0 TOTAL	90554	113776	109416	62306	119789	158634	197346	173216	164898	143433
TONSL	185600	203788	181326	110247	140060	264924	241272	214334	213859	274121
SOPCO	115	112	96	119	98	101	80	85	82	104

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	60832	125030	99049	48969	61963	40796	83954	34733	17244	41466
4	11691	30576	34317	27685	23328	36644	21822	65052	23768	33233
5	16366	7947	10140	12476	14122	9211	21528	13060	32700	12064
6	4436	8712	2062	4534	4400	6379	3619	8212	3226	11204
7	7808	3435	4332	1468	2901	3200	2550	1054	3008	1135
8	6789	3212	1456	1848	963	1338	2008	1251	1177	1772
9	2914	2679	1606	938	1356	147	369	461	760	560
10	2350	1724	963	976	438	730	279	263	247	557
+gp	4140	2880	1134	2150	1192	1629	629	448	760	897
0 TOTAL	117326	186195	155059	101044	110663	100074	136758	124534	82890	102888
TONSL	233453	242486	182817	154464	164180	144554	175516	168034	156936	158786
SOPCO	115	108	107	115	122	99	102	103	106	105

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	48917	22115	17869	8126	12550	23792	68681	44608	22614	7058
4	11974	12895	49829	35847	19285	16930	13630	33266	61398	35593
5	7189	6062	4339	32827	33233	9054	5752	5982	30848	49248
6	5279	4525	3118	4560	18479	10238	4883	5408	3716	18999
7	3740	2805	3490	2328	1751	7341	3877	4748	1744	2053
8	775	1399	755	1219	350	1076	2381	3173	1366	723
9	878	351	620	966	176	160	383	1461	1018	421
10	134	454	257	320	187	112	61	286	790	278
+gp	701	285	797	102	204	269	179	442	146	655
0 TOTAL	79587	50891	81074	86295	86215	68972	99827	99374	123640	115028
TONSL	107183	70458	92391	114242	122310	95848	107326	127516	153584	146544
SOPCO	100	101	104	100	105	102	101	105	101	98

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	17178	10510	11789	3091	9655	9175	3833	6614	2335	1486
4	52109	54886	11698	16215	12236	22767	7979	17554	50447	6501
5	40145	18499	35011	11946	22872	7747	27071	11592	13374	35237
6	30451	18357	13567	31818	10347	10676	8802	25702	7008	11571
7	4177	17834	13452	8376	18930	6123	7147	5323	9467	6863
8	483	2849	7058	5539	3374	8303	3158	4284	5411	7528
9	125	485	812	2873	3343	2530	4706	2390	3497	2631
10	259	214	55	727	2290	2652	1943	3443	2492	2818
+gp	293	474	146	394	597	1219	1942	2392	4102	4844
0 TOTAL	145220	124108	93588	80979	83644	71192	66581	79294	98133	79479
TONSL	168378	171348	143629	153327	150373	135945	136402	155246	159757	161916
SOPCO	100	100	100	100	100	101	100	100	100	100

Table 5.3.2 Catch weight at age
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At 21/04/2005 9:04

Table 2 Catch weights at age (kg)

	YEAR	1960	1961	1962	1963	1964
	AGE					
	3	0.71	0.71	0.71	0.71	0.71
	4	1.11	1.11	1.11	1.11	1.11
	5	1.63	1.63	1.63	1.63	1.63
	6	2.33	2.33	2.33	2.33	2.33
	7	3.16	3.16	3.16	3.16	3.16
	8	4.03	4.03	4.03	4.03	4.03
	9	4.87	4.87	4.87	4.87	4.87
	10	5.63	5.63	5.63	5.63	5.63
	+gp	8.03	8.039	7.924	7.851	7.781
0	SOPC(	1.2863	1.4159	1.2326	1.2169	1.2138

Table 2 Catch weights at age (kg)

	YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	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	7.959	8.106	7.994	7.716	7.479	7.404	7.052	7.477	7.385	7.217
0	SOPC(	1.1472	1.1222	0.9593	1.1889	0.9829	1.0067	0.8017	0.8492	0.8246	1.0407

Table 2 Catch weights at age (kg)

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
	3	0.71	0.71	0.71	0.71	0.71	0.79	0.73	0.77	1.05	0.71
	4	1.11	1.11	1.11	1.11	1.11	1.27	1.4	1.12	1.33	1.26
	5	1.63	1.63	1.63	1.63	1.63	2.03	2.05	2.02	1.86	2.02
	6	2.33	2.33	2.33	2.33	2.33	2.55	2.76	2.61	2.8	2.7
	7	3.16	3.16	3.16	3.16	3.16	3.29	3.3	3.27	4	3.88
	8	4.03	4.03	4.03	4.03	4.03	4.34	4.38	3.91	4.18	4.47
	9	4.87	4.87	4.87	4.87	4.87	5.15	5.95	4.69	5.33	5.36
	10	5.63	5.63	5.63	5.63	5.63	5.75	6.39	5.63	5.68	6.06
	+gp	7.127	7.32	7.394	7.527	7.809	6.937	6.841	7.558	8.665	7.19
0	SOPC(	1.1549	1.0845	1.0695	1.1465	1.2199	0.9879	1.0237	1.0323	1.0564	1.051

Table 2 Catch weights at age (kg)

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
	3	0.75	0.59	0.53	0.62	0.74	0.71	0.68	0.67	0.61	0.52
	4	1.33	1.22	0.84	0.87	0.95	1	1.05	1.01	0.99	0.76
	5	2.07	1.97	1.66	1.31	1.4	1.45	1.85	1.92	1.65	1.24
	6	2.63	2.3	2.32	2.43	1.78	2.09	2.39	2.28	2.46	2.12
	7	3.28	2.87	2.97	3.87	2.96	2.49	3.08	2.77	2.85	3.22
	8	3.96	3.72	4	5.38	3.73	3.75	3.35	3.2	3.03	3.83
	9	4.54	4.3	4.72	5.83	4.62	3.9	4.48	3.73	3.71	4.69
	10	5.55	4.69	5.44	5.36	4.67	6.74	4.66	6.35	4.49	5.31
	+gp	8.012	6.597	6.904	7.448	7.19	6.27	6.58	7.63	6.29	5.97
0	SOPC(	1.0011	1.0079	1.0384	1.0023	1.0484	1.0226	1.0085	1.0517	1.0106	0.9848

Table 2 Catch weights at age (kg)

	YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
	3	0.56	0.59	0.62	0.68	0.67	0.6	0.75	0.69	0.66	0.66
	4	0.79	0.82	0.95	1	1.05	1.03	1.12	1.01	0.91	1.02
	5	1.19	1.33	1.24	1.48	1.45	1.63	1.54	1.5	1.42	1.34
	6	1.71	1.84	1.72	1.87	1.93	2.1	2.04	1.97	1.9	1.9
	7	2.87	2.48	2.35	2.58	2.27	2.67	2.6	2.54	2.54	2.43
	8	3.78	3.73	3.1	3.07	2.97	3.14	3.14	3.25	2.59	3.07
	9	4.06	4.32	4.19	4.13	3.61	3.81	3.63	3.77	3.49	3.48
	10	5.3	5.34	5.79	5.44	4.1	4.41	4.54	4.31	3.75	3.87
	+gp	7.56	7.07	7.44	8.07	5.58	6.13	5.36	5.62	4.9	5.06
0	SOPC(	0.999	1.0018	1.0011	1.0014	1.0009	1.0053	1.001	1.0013	1.0018	1.0046

Table 5.4.1. Northeast Arctic saithe. Annual maturity ogive 1985-2004

					Age group					
Year	2	3	4	5	6	7	8	9	10	11+
1985	0.00	0.00	0.05	0.76	0.79	0.84	1.00	1.00	1.00	1.00
1986	0.00	0.00	0.03	0.75	0.94	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.00	0.01	0.77	0.95	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.00	0.05	0.39	0.76	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.00	0.19	0.53	0.52	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.00	0.23	0.77	0.65	1.00	1.00	1.00	1.00	1.00
1991	0.00	0.00	0.09	0.68	0.69	0.72	1.00	1.00	1.00	1.00
1992	0.00	0.00	0.04	0.71	0.91	0.98	1.00	1.00	1.00	1.00
1993	0.00	0.00	0.03	0.54	0.91	0.96	1.00	1.00	1.00	1.00
1994	0.00	0.00	0.09	0.37	0.89	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.00	0.14	0.58	0.75	0.96	1.00	1.00	1.00	1.00
1996	0.00	0.00	0.15	0.63	0.79	0.72	0.94	1.00	1.00	1.00
1997	0.00	0.00	0.13	0.29	0.66	0.83	0.96	1.00	1.00	1.00
1998	0.00	0.00	0.04	0.32	0.32	0.66	0.54	1.00	1.00	1.00
1999	0.00	0.00	0.06	0.18	0.63	0.57	0.79	1.00	1.00	1.00
2000	0.00	0.00	0.01	0.32	0.66	0.94	0.93	1.00	1.00	1.00
2001	0.00	0.00	0.07	0.32	0.82	0.93	0.91	1.00	1.00	1.00
2002	0.00	0.00	0.08	0.51	0.85	0.94	0.96	1.00	1.00	1.00
2003	0.00	0.00	0.05	0.51	0.91	0.96	1.00	1.00	1.00	1.00
2004	0.00	0.00	0.14	0.35	0.84	0.95	0.83	1.00	1.00	1.00

Table 5.4.2. Northeast Arctic saithe. Maturation based on gonad development and spawning zones in otholiths 1995-2000.

	4	**5**	**6**	**7**	**8**
Gonad					
1995	0.11	0.56	0.95	1.00	1.00
1996	0.02	0.32	0.70	0.97	1.00
1997	0.04	0.17	0.74	0.96	1.00
1998	0.02	0.16	0.42	0.87	0.97
1999	0.19	0.47	0.72	0.90	0.93
Otolith	5	6	7	8	9
1996	0.63	0.79	0.72	0.94	1.00
1997	0.29	0.66	0.83	0.96	1.00
1998	0.32	0.32	0.66	0.54	1.00
1999	0.18	0.63	0.57	0.79	1.00
2000	0.32	0.66	0.94	0.93	0.97

Table 5.4.3. Northeast Arctic saithe. 3-year running average maturity ogive 1985-2004

	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	0.10	0.43	0.87	0.95	0.91	1.00	1.00	1.00

Table 5.4.4a. Data and parameter settings of exploratory XSA-runs

Run No.	**1**	**2**	**3**	**4a-b**	**5a-b**	**6**	**7**
Ass. type	SPALY	SPALY	SFT	SFT	SFT	SFT	SPALY, RETRO
Catch data	1960-03 89-02 up-dated	1960-03 89-03 up-dated	1960-04	1960-04	1960-04	1960-04	1960-04
Age range	2-11+	2-11+	2-11+	2-11+	2-11+	2-11+	2-11+
F bar	3-6	3-6	3-6	3-6	3-6	3-6	3-6
Fleet 08 Purse seine	1989-03 age 3-7	1989-03 age 3-7	1989-04 age 3-7				1989-04 age 3-7
Fleet 12 Norwegian trawl	1994-03 age 5-9	1994-03 age 5-9		1994-04 age 3-10, 4-8			1994-04 age 5-9
Fleet 13 Norwegian ac. survey	1992-03 age 3-6	1992-03 age 3-6			1994-04 age 2-9, 3-7		1992-04 age 3-6
Fleet Ger. freeze trawl						1996-04 age 4-10	
Time series weights	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y
Power model for ages	0	0	0	0	0	0	0
Catchability (q) plateau	8	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	5 years 5 oldest ages
SE of mean	0.5	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	0.3
Prior weight.	None	None	None	None	None	None	None

Table 5.4.4b. Data and parameter settings of exploratory and final XSA-runs

Run No.	**8a-c**	**9a-f**	**10a-e**	**11a-c**	**12=9e**
Ass. type	RETRO	SFT, MFT	SFT, MFT	SFT, MFT	FINAL
Catch data	1960-04	1960-04	1960-04	1960-04	1960-04
Age range	2-11+, 3-11+	3-11+	3-11+	3-11+	3-11+
F bar	3-6	4-7	4-7	4-7	4-7
Fleet 12 Norw. trawl	1994-04 age 4-8	1994-04 age 4-8	1994-04 age 4-8	1994-04 age 4-8	1994-04 age 4-8
Fleet 13 ac. survey	1994-04 age 3-7, 2-7	1994-04 age 3-7	1994-04 age 3-7	1994-04 age 3-7	1994-04 age 3-7
Time series weights	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y
Power model for ages	0	0	3,4	0	0
Catchability (q) plateau	8	8,6	6	6	6
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
SE of mean	0.5	0.5	0.5	1	0.5
Min. fleet SE for pop. Est.	0.3	0.3	0.3	0.3	0.3
Prior weight.	None	None	None	None	None

Table 5.4.5 Tuning data sets applied in final XSA run

```
North-East Arctic saithe (Sub-areas I and II)
102
FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown)
1994 2004
1 1 0.00 1.00
4  8
   1   123.8   417.1   259.1    35.8     8.0
   1   223.0   309.5   336.3    53.4     8.8
   1   114.4   152.9   222.3   293.2    33.6
   1    42.4   220.6   224.7   289.0   181.9
   1    33.0    55.3   244.1    93.0    56.5
   1    37.7   106.2    80.5   186.4    42.7
   1    72.4    77.4   145.2   112.4   151.0
   1    47.0   257.5   185.4   175.1    77.2
   1    76.1   123.7   385.2    86.8    89.2
   1   149.8   228.6   151.7   218.8   141.1
   1    13.8   264.0   208.5   178.2   233.4
FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)
1994 2004
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
```

Table 5.4.6. ICA parameter settings.

PARAMETER	SETTING
No years for separable constraint	6
Reference age for separable constraint	5
Selection pattern model	Constant
Default weighting	Yes
Model for catchability relationship	Linear both fleets
A.Weighting of abundance indices relative to catch-at-age data	Manual = 1
B. Weighting of abundance indices relative to catch-at-age data	Iterative
Maximum value for any weight	2
Shrink the final population	Yes
Numbers of years to shrink	5
S.E. of mean	0.5

Table 5.4.7. STOCK SUMMARY ICA run with manual weighting

Year	Recruits Age 3 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 7	SoP (%)
1960	80750	400076	218767	133515	0.6103	0.3709	128
1961	84860	406490	237162	105951	0.4467	0.2166	141
1962	164850	495010	278981	120707	0.4327	0.2459	123
1963	270580	630299	291166	148627	0.5105	0.26	121
1964	90080	679078	362448	197426	0.5447	0.2777	121
1965	272820	776265	426127	185600	0.4356	0.2614	114
1966	136960	779259	416479	203788	0.4893	0.3302	112
1967	186230	804721	481156	181326	0.3769	0.2965	95
1968	147110	746082	444093	110247	0.2483	0.1284	118
1969	291130	865423	471974	140060	0.2968	0.1708	98
1970	276160	1014098	560468	264924	0.4727	0.347	100
1971	283570	1053639	569393	241272	0.4237	0.3901	80
1972	159420	902577	520270	214334	0.412	0.3437	84
1973	214590	843569	527349	213859	0.4055	0.4087	82
1974	82310	656783	435314	274121	0.6297	0.608	104
1975	147600	527083	341940	233453	0.6827	0.462	115
1976	228440	487167	229590	242486	1.0562	0.5955	108
1977	197900	401825	154791	182817	1.1811	0.5093	106
1978	116180	351312	159971	154464	0.9656	0.5122	114
1979	188500	356932	135106	164180	1.2152	0.5757	121
1980	110260	378787	141311	144554	1.0229	0.5739	98
1981	271880	459333	137761	175516	1.2741	0.5678	102
1982	114310	401517	119792	168034	1.4027	0.6093	103
1983	97640	402161	160905	156936	0.9753	0.5936	105
1984	85200	323545	146357	158786	1.0849	0.6474	105
1985	98150	262220	128515	107183	0.834	0.5469	100
1986	219280	279851	95300	70458	0.7393	0.5417	100
1987	167610	324372	91960	92391	1.0047	0.5622	103
1988	79950	332955	130819	114242	0.8733	0.6868	100
1989	65930	297032	134312	122310	0.9106	0.593	104
1990	70650	249063	124681	95848	0.7687	0.5466	102
1991	244620	350837	126987	107326	0.8452	0.4391	100
1992	394430	534342	117983	127516	1.0808	0.5861	105
1993	290730	658124	143566	153584	1.0698	0.4947	101
1994	213950	624089	239650	146544	0.6115	0.5121	98
1995	384260	762561	313593	168378	0.5369	0.3759	99
1996	144740	794667	373229	171348	0.4591	0.2988	100
1997	185370	801501	364958	143629	0.3935	0.2437	100
1998	118740	870899	411479	153327	0.3726	0.2337	100
1999	260920	897617	409867	150373	0.3669	0.2276	100
2000	128140	927102	494586	135945	0.2749	0.2112	100
2001	161110	947000	549775	136402	0.2481	0.1807	100
2002	316720	1043834	610259	155246	0.2544	0.1934	100
2003	69910	914642	567336	159757	0.2816	0.2248	100
2004	58380	858827	606513	161916	0.267	0.2217	100
Average	177176	619435	311201	159793	0.6620	0.4050	
GM	159722.2						

Table 5.4.8. STOCK SUMMARY Adapt run

Year	Recruitmer	TSB	SSB	F4-7
1960	83655	428048	240986	0.3437
1961	89241	440167	263712	0.2028
1962	166749	535326	312233	0.2294
1963	276677	671178	323271	0.2483
1964	94590	736578	409420	0.2642
1965	275240	838573	479194	0.246
1966	140967	820828	449599	0.3148
1967	187731	853840	523389	0.283
1968	149692	797585	489867	0.1243
1969	293329	900234	501336	0.166
1970	277290	1054190	596123	0.3379
1971	284977	1098626	610764	0.3819
1972	159808	929633	544749	0.3367
1973	214609	872401	554863	0.4016
1974	82459	673731	451663	0.6
1975	147874	546157	360582	0.4545
1976	228579	501351	243358	0.5902
1977	198703	409433	161555	0.5067
1978	116327	360866	168593	0.5064
1979	188749	361340	138794	0.568
1980	110569	381466	143240	0.5666
1981	272178	462997	140661	0.5586
1982	114421	405291	122983	0.6035
1983	97776	406158	164408	0.5873
1984	85297	328814	151283	0.6406
1985	98297	265482	131477	0.5413
1986	220696	282535	96963	0.538
1987	167819	328412	94879	0.5558
1988	80202	335792	132782	0.6768
1989	67157	300484	136119	0.5858
1990	70772	253152	127546	0.5331
1991	246912	357012	130986	0.4321
1992	398937	543610	122109	0.5652
1993	309694	679960	149094	0.4673
1994	227198	652285	247957	0.4957
1995	381209	794076	331256	0.3515
1996	152478	842457	406287	0.2797
1997	201618	856067	394362	0.2197
1998	109409	929934	450652	0.2166
1999	263255	952983	453524	0.2411
2000	123294	976259	547609	0.1644
2001	201403	1010019	586149	0.19
2002	304213	1072947	619486	0.2306
2003	96553	957358	581515	0.1953
2004	311718	1072859	644316	0.2076
Average	186007	650633	331815	0.394458

Table 5.4.9. Comparison of survivors from XSA, ICA and Adapt esimates

	XSA	ICA	Adapt	C.V. NLLS
3		130670	2000	
4	56733	46000	253871	0.6335
5	45157	38510	57132	0.3475
6	113146	112600	94125	0.325
7	48568	37400	57697	0.2878
8	20838	19810	19356	0.3023
9	25527	27030	24267	0.3678
10	6453	8180	5058	0.5958
11+	18513	24000	28701	0.2057

Table 5.5.1. Tuning diagnostics

Lowestoft VPA Version 3.1

21/04/2005 9:01

Extended Survivors Analysis

North-East Arctic saithe

CPUE data from file new fleet 12 13 2004.dat

Catch data for 45 years. 1960 to 2004. Ages 3 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT12: Nc	1994	2004	4	8	0	1
FLT13: Nc	1994	2004	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 53 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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	0.052	0.083	0.073	0.03	0.041	0.083	0.024	0.022	0.033	0.023
4	0.411	0.233	0.125	0.137	0.159	0.127	0.096	0.144	0.229	0.122
5	0.353	0.249	0.229	0.182	0.292	0.143	0.219	0.197	0.155	0.248
6	0.39	0.269	0.292	0.336	0.238	0.215	0.241	0.334	0.176	0.195
7	0.321	0.418	0.324	0.295	0.343	0.216	0.218	0.224	0.196	0.261
8	0.392	0.379	0.289	0.214	0.185	0.247	0.164	0.196	0.374	0.237
9	0.155	0.886	0.175	0.182	0.193	0.206	0.216	0.18	0.244	0.314
10	0.324	0.431	0.22	0.234	0.216	0.231	0.241	0.242	0.29	0.317

1

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10
1995	3.75E+05	1.71E+05	1.49E+05	1.04E+05	1.68E+04	1.65E+03	9.64E+02	1.03E+03
1996	1.46E+05	2.92E+05	9.28E+04	8.59E+04	5.77E+04	9.99E+03	9.12E+02	6.76E+02
1997	1.84E+05	1.10E+05	1.89E+05	5.92E+04	5.38E+04	3.11E+04	5.60E+03	3.08E+02
1998	1.16E+05	1.40E+05	7.92E+04	1.23E+05	3.62E+04	3.18E+04	1.91E+04	3.85E+03
1999	2.68E+05	9.18E+04	9.99E+04	5.41E+04	7.21E+04	2.21E+04	2.11E+04	1.30E+04
2000	1.28E+05	2.11E+05	6.41E+04	6.11E+04	3.49E+04	4.19E+04	1.50E+04	1.42E+04
2001	1.81E+05	9.62E+04	1.52E+05	4.55E+04	4.03E+04	2.30E+04	2.68E+04	1.00E+04
2002	3.40E+05	1.45E+05	7.16E+04	1.00E+05	2.93E+04	2.66E+04	1.60E+04	1.77E+04
2003	7.87E+04	2.72E+05	1.03E+05	4.81E+04	5.87E+04	1.92E+04	1.79E+04	1.09E+04
2004	7.09E+04	6.23E+04	1.77E+05	7.21E+04	3.30E+04	3.95E+04	1.08E+04	1.15E+04

Estimated population abundance at 1st Jan 2005

0.00E+00	5.67E+04	4.52E+04	1.13E+05	4.86E+04	2.08E+04	2.55E+04	6.45E+03

Taper weighted geometric mean of the VPA populations:

1.70E+05	1.37E+05	9.31E+04	5.17E+04	2.67E+04	1.34E+04	6.28E+03	3.11E+03

Standard error of the weighted Log(VPA populations) :

0.588	0.585	0.6432	0.7276	0.9082	1.1599	1.3426	1.5858

1

Log catchability residuals.

Fleet : FLT12: Nor new trawl

Age	1994
3	No data for this fleet at this age
4	0.28
5	0.5
6	0.92
7	0.96
8	0.17

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	No data for this fleet at this age									
4	1.23	-0.06	-0.12	-0.61	-0.05	-0.24	0.1	0.19	0.28	-0.68
5	0.4	0.12	-0.23	-0.77	-0.29	-0.24	0.14	0.15	0.38	0.02
6	0.13	-0.15	0.24	-0.39	-0.72	-0.26	0.29	0.28	0	-0.07
7	-0.2	0.31	0.33	-0.42	-0.4	-0.23	0.07	-0.31	-0.1	0.3
8	0.39	-0.08	0.43	-0.8	-0.72	-0.07	-0.18	-0.17	0.7	0.42

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	-7.578	-6.3156	-5.5812	-5.3035	-5.3393
S.E(Log q)	0.4941	0.3681	0.411	0.3944	0.4858

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	0.71	1.246	8.81	0.7	11	0.34	-7.58
5	0.75	1.115	7.66	0.71	11	0.27	-6.32
6	1.45	-0.802	3.1	0.29	11	0.61	-5.58
7	1.39	-1.66	3.29	0.69	11	0.5	-5.3
8	1.12	-0.665	4.82	0.8	11	0.56	-5.34
1							

Fleet : FLT13: Norway Ac Sur

Age	1994
3	-0.75
4	-0.49
5	-0.3
6	0.16
7	0.48
8	No data for this fleet at this age

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-0.64	0.03	-1.38	-0.02	0.03	0.31	0.57	-0.24	0.27	1.25
4	-0.29	-0.09	0.68	0.54	-0.04	-0.02	-0.6	-0.27	-0.34	0.8
5	0.01	0.02	0.21	0.91	0.65	-0.7	0.03	-0.28	-0.35	-0.19
6	-0.3	-0.29	1.31	1.12	0.48	-0.27	-0.67	-0.75	-0.68	0.06
7	0	-0.65	0.22	0.22	0.64	0.39	-0.03	-0.72	-0.37	-0.05
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	-6.8833	-6.808	-7.6429	-7.9798	-8.435
S.E(Log q)	0.7065	0.4852	0.4707	0.7134	0.4461

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	4.07	-2.084	-8.84	0.05	11	2.45	-6.88
4	1.9	-1.565	2.26	0.28	11	0.85	-6.81
5	0.94	0.165	7.9	0.45	11	0.47	-7.64
6	0.75	0.483	8.76	0.32	11	0.56	-7.98
7	1.12	-0.477	8.2	0.68	11	0.52	-8.44

Terminal year survivor and F summaries :

Age 3 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: Nc	1	0	0	0	0	0	0
FLT13: Nc	198202	0.741	0	0	1	0.308	0.007
F shrinka	32531	0.5				0.692	0.041

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
56733	0.41	1.5	2	3.627	0.023

1

Age 4 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: Nc	22858	0.518	0	0	1	0.268	0.229
FLT13: Nc	85198	0.42	0.248	0.59	2	0.405	0.067
F shrinka	35926	0.5				0.326	0.152

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
45157	0.27	0.34	4	1.234	0.122

Age 5 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: Nc	125235	0.311	0.119	0.38	2	0.413	0.227
FLT13: Nc	88013	0.322	0.049	0.15	3	0.367	0.309
F shrinka	142275	0.5				0.219	0.202

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
113146	0.21	0.1	6	0.488	0.248

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

Year class = 1998

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	57356	0.253	0.143	0.57	3	0.492	0.168
FLT13: Nc	42997	0.296	0.183	0.62	4	0.335	0.218
F shrinka	38300	0.5				0.172	0.242

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
48568	0.18	0.11	8	0.607	0.195

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

Year class = 1997

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	24353	0.219	0.068	0.31	4	0.497	0.227
FLT13: Nc	16106	0.255	0.147	0.58	5	0.354	0.326
F shrinka	22838	0.5				0.149	0.241

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
20838	0.16	0.09	10	0.57	0.261

1

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

Year class = 1996

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	28964	0.208	0.113	0.54	5	0.539	0.211
FLT13: Nc	20144	0.262	0.129	0.49	5	0.294	0.291
F shrinka	25772	0.5				0.166	0.235

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
25527	0.16	0.09	11	0.533	0.237

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

Year class = 1995

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	6962	0.206	0.2	0.97	5	0.496	0.294
FLT13: Nc	3795	0.259	0.148	0.57	5	0.273	0.487
F shrinka	10258	0.5				0.231	0.209

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
6453	0.17	0.16	11	0.936	0.314

1

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

Year class = 1994

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	5693	0.21	0.096	0.46	5	0.487	0.37
FLT13: Nc	7478	0.266	0.265	1	5	0.26	0.293
F shrinka	8886	0.5				0.253	0.252

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
6839	0.18	0.12	11	0.657	0.317

1

Table 5.5.2

Run title : North-East Arctic saithe

At 21/04/2005 9:04

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1960	1961	1962	1963	1964
AGE					
3	0.1412	0.2383	0.2772	0.1747	0.108
4	0.1843	0.1755	0.2297	0.3606	0.4012
5	0.5007	0.2695	0.1204	0.1825	0.276
6	0.2407	0.2519	0.2882	0.1797	0.1198
7	0.3847	0.0915	0.253	0.2108	0.1978
8	0.4184	0.1206	0.0942	0.1734	0.2195
9	0.3585	0.1479	0.1645	0.1355	0.3055
10	0.3832	0.177	0.1849	0.1771	0.2248
+gp	0.3832	0.177	0.1849	0.1771	0.2248
0 FBAR 4	0.3276	0.1971	0.2228	0.2334	0.2487

Table 8 Fishing mortality (F) at age

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0.1562	0.1876	0.1886	0.2041	0.3402	0.188	0.3511	0.5893	0.4905	0.6669
4	0.0805	0.3616	0.3278	0.1709	0.1406	0.5146	0.4216	0.4299	0.4766	0.5911
5	0.3093	0.3131	0.4319	0.1024	0.2354	0.2432	0.4348	0.3782	0.411	0.6231
6	0.3557	0.2447	0.1522	0.1649	0.1307	0.3709	0.261	0.2894	0.3693	0.637
7	0.1786	0.2736	0.1595	0.0391	0.1356	0.2034	0.3929	0.2409	0.3373	0.5334
8	0.1772	0.1219	0.2757	0.0747	0.0721	0.348	0.1697	0.2451	0.2654	0.4017
9	0.369	0.1106	0.1777	0.1274	0.0885	0.2271	0.3262	0.1569	0.321	0.3673
10	0.2795	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635	0.3429	0.5166
+gp	0.2795	0.2138	0.2406	0.102	0.133	0.28	0.3188	0.2635	0.3429	0.5166
0 FBAR 4	0.231	0.2983	0.2679	0.1193	0.1606	0.333	0.3776	0.3346	0.3986	0.5962

Table 8 Fishing mortality (F) at age

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	0.5962	0.9054	0.786	0.6157	0.4447	0.5173	0.4113	0.4036	0.2139	0.7556
4	0.459	0.6942	0.6807	0.524	0.6834	0.5184	0.5846	0.6568	0.5372	0.8244
5	0.4556	0.661	0.5207	0.5675	0.5606	0.6405	0.6683	0.8689	0.8444	0.5815
6	0.3552	0.4704	0.3522	0.467	0.3991	0.5357	0.5632	0.5853	0.5406	0.8101
7	0.5379	0.5163	0.4538	0.4574	0.6258	0.5721	0.4246	0.3134	0.44	0.3684
8	0.656	0.4431	0.4306	0.3556	0.6249	0.6732	0.8957	0.3813	0.6972	0.5069
9	0.4563	0.592	0.4163	0.5508	0.4825	0.1766	0.3908	0.5214	0.4222	0.8815
10	0.496	0.541	0.4379	0.4833	0.543	0.5238	0.5936	0.5384	0.594	0.6353
+gp	0.496	0.541	0.4379	0.4833	0.543	0.5238	0.5936	0.5384	0.594	0.6353
0 FBAR 4	0.4519	0.5855	0.5019	0.504	0.5672	0.5667	0.5602	0.6061	0.5905	0.6461

Table 8 Fishing mortality (F) at age

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	0.7858	0.117	0.124	0.1171	0.2329	0.4579	0.3665	0.1304	0.0883	0.0367
4	0.5077	0.4854	0.4179	0.3907	0.4463	0.5658	0.5216	0.3037	0.2669	0.1953
5	0.413	0.526	0.2967	0.5403	0.7793	0.3894	0.3794	0.4573	0.514	0.3562
6	0.5473	0.4994	0.5706	0.586	0.6786	0.587	0.3763	0.7549	0.5796	0.7043
7	0.711	0.6403	0.9421	1.2094	0.4679	0.6372	0.4611	0.7823	0.587	0.755
8	0.4644	0.6412	0.3494	1.102	0.5652	0.5939	0.4355	0.8807	0.5394	0.5182
9	0.51	0.3959	0.6665	1.0601	0.4377	0.5521	0.4348	0.5259	0.8065	0.3136
10	0.5334	0.545	0.5698	0.9093	0.5908	0.5565	0.4203	0.6866	0.6106	0.5337
+gp	0.5334	0.545	0.5698	0.9093	0.5908	0.5565	0.4203	0.6866	0.6106	0.5337
0 FBAR 4	0.5448	0.5378	0.5568	0.6816	0.593	0.5449	0.4346	0.5745	0.4869	0.5027

Table 8 Fishing mortality (F) at age

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE											
3	0.0519	0.0831	0.0735	0.03	0.0406	0.0828	0.0236	0.0218	0.0333	0.0234	0.0262
4	0.4109	0.233	0.1254	0.1371	0.1593	0.127	0.0961	0.1436	0.2293	0.1225	0.1651
5	0.3525	0.2489	0.2287	0.1823	0.2918	0.1433	0.2189	0.1973	0.1551	0.2483	0.2002
6	0.3903	0.2693	0.2918	0.3358	0.2377	0.2147	0.2406	0.3337	0.1756	0.1952	0.2348
7	0.3209	0.4178	0.3238	0.2951	0.3425	0.2156	0.2179	0.2243	0.1963	0.2608	0.2271
8	0.3916	0.3787	0.2886	0.2135	0.185	0.247	0.1643	0.1963	0.3742	0.2365	0.269
9	0.1548	0.8865	0.1747	0.1819	0.193	0.2059	0.2156	0.1805	0.2437	0.314	0.2461
10	0.324	0.4307	0.2201	0.2341	0.216	0.231	0.2414	0.2421	0.2902	0.3169	0.283
+gp	0.324	0.4307	0.2201	0.2341	0.216	0.231	0.2414	0.2421	0.2902	0.3169	
0 FBAR 4	0.3687	0.2922	0.2424	0.2376	0.2578	0.1751	0.1934	0.2247	0.1891	0.2067	

Table 5.5.3

Run title : North-East Arctic saithe

At 21/04/2005 9:04

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
	AGE					
	3	88173	92920	170143	289935	97186
	4	85921	62681	59948	105582	199330
	5	38001	58508	43057	39010	60271
	6	26165	18857	36586	31252	26611
	7	16897	16840	12001	22453	21379
	8	7761	9416	12582	7630	14890
	9	4823	4181	6833	9375	5252
	10	2580	2759	2953	4746	6703
	+gp	5253	8334	11260	12044	19432
0	TOTA	275574	274496	355364	522026	451054

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

	YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE										
	3	283653	144689	190738	150801	296371	280751	287484	161777	217484	83523
	4	71425	198653	98200	129322	100667	172674	190463	165682	73476	109025
	5	109269	53953	113296	57927	89245	71607	84508	102299	88245	37350
	6	37443	65664	32298	60225	42811	57741	45971	44794	57383	47899
	7	19328	21479	42090	22711	41814	30755	32626	28991	27458	32476
	8	14362	13236	13376	29379	17882	29893	20546	18033	18655	16044
	9	9788	9850	9593	8313	22322	13622	17281	14197	11554	11713
	10	3168	5541	7220	6576	5992	16728	8887	10210	9936	6862
	+gp	16183	16565	17951	13243	4518	12585	22073	14934	14828	10361
0	TOTA	564620	529629	524762	478496	621623	686356	709838	560918	519019	355252

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

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
	3	149691	231999	201093	117719	190761	111631	275148	115581	98950	86425
	4	35101	67514	76813	75018	52071	100115	54482	149307	63202	65411
	5	49425	18160	27609	31838	36369	21524	48811	24861	63381	30239
	6	16400	25657	7677	13430	14778	16999	9288	20483	8537	22304
	7	20741	9413	13123	4420	6893	8118	8145	4330	9340	4071
	8	15597	9916	4599	6825	2290	3018	3751	4361	2591	4925
	9	8790	6627	5212	2448	3915	1004	1261	1254	2439	1056
	10	6641	4560	3001	2814	1155	1979	689	698	610	1309
	+gp	11585	7538	3503	6140	3111	4370	1535	1177	1854	2083
0	TOTA	313972	381384	342632	260650	311343	268758	403109	322052	250904	217822

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

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
	3	99330	221355	169361	81295	66757	71566	247349	403143	295819	216577
	4	33239	37062	161220	122493	59206	43301	37066	140367	289703	221734
	5	23483	16379	18676	86908	67853	31024	20133	18014	84823	181633
	6	13842	12722	7925	11365	41451	25483	17208	11279	9336	41535
	7	8123	6556	6321	3667	5179	17217	11600	9670	4341	4281
	8	2306	3266	2829	2017	896	2655	7454	5989	3621	1976
	9	2429	1187	1409	1633	549	417	1201	3948	2032	1729
	10	358	1194	654	592	463	290	196	636	1910	743
	+gp	1854	742	2005	186	500	689	571	971	349	1732
0	TOTA	184964	300463	370400	310156	242853	192642	342777	594018	691934	671939

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

	YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 60-**	AMST 60-**
	AGE													
	3	375410	145597	183907	115598	268441	127656	181370	339662	78720	70934	0	166727	186624
	4	170932	291816	109695	139903	91847	211045	96214	145025	272107	62338	56733	98644	115441
	5	149334	92797	189256	79226	99871	64126	152188	71554	102853	177136	45157	53687	66187
	6	104147	85940	59237	123270	54055	61072	45492	100106	48094	72107	113146	28704	37505
	7	16815	57716	53752	36223	72135	34894	40341	29282	58704	33035	48568	15256	20837
	8	1647	9987	31117	31836	22078	41931	23029	26562	19157	39497	20838	8067	12157
	9	964	912	5599	19090	21053	15023	26817	15997	17871	10789	25527	4315	7318
	10	1034	676	308	3849	13030	14212	10011	17698	10935	11467	6453	2345	4469
	+gp	1162	1484	812	2075	3379	6497	9949	12226	17883	19575	18513		
0	TOTA	821445	686924	633682	551071	645890	576456	585411	758110	626324	496878	334935		

Table 5.5.4

Run title : North-East Arctic saithe

At 21/04/2005 9:04

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
AGE					
3	0	0	0	0	0
4	859	627	599	1056	1993
5	20901	32179	23681	21455	33149
6	22240	16028	31098	26564	22619
7	16559	16503	11761	22004	20952
8	7761	9416	12582	7630	14890
9	4823	4181	6833	9375	5252
10	2580	2759	2953	4746	6703
+gp	5253	8334	11260	12044	19432

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	714	1987	982	1293	1007	1727	1905	1657	735	1090
5	60098	29674	62313	31860	49085	39384	46480	56264	48535	20543
6	31827	55815	27453	51191	36389	49080	39076	38075	48776	40714
7	18941	21049	41248	22256	40978	30140	31973	28412	26909	31826
8	14362	13236	13376	29379	17882	29893	20546	18033	18655	16044
9	9788	9850	9593	8313	22322	13622	17281	14197	11554	11713
10	3168	5541	7220	6576	5992	16728	8887	10210	9936	6862
+gp	16183	16565	17951	13243	4518	12585	22073	14934	14828	10361

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	351	675	768	750	521	1001	545	1493	632	654
5	27184	9988	15185	17511	20003	11838	26846	13673	34860	16631
6	13940	21809	6526	11415	12561	14449	7895	17411	7257	18958
7	20326	9225	12861	4331	6755	7955	7982	4243	9153	3989
8	15597	9916	4599	6825	2290	3018	3751	4361	2591	4925
9	8790	6627	5212	2448	3915	1004	1261	1254	2439	1056
10	6641	4560	3001	2814	1155	1979	689	698	610	1309
+gp	11585	7538	3503	6140	3111	4370	1535	1177	1854	2083

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	1330	1112	4837	11024	9473	7361	4448	7018	8691	19956
5	17847	12448	11766	48669	37998	20476	14496	11529	45804	90817
6	12042	11322	6974	8410	26529	15799	12906	9474	8496	35304
7	7473	6228	6321	3667	5179	15667	10440	8606	4254	4153
8	2306	3266	2829	2017	896	2655	7454	5989	3621	1976
9	2429	1187	1409	1633	549	417	1201	3948	2032	1729
10	358	1194	654	592	463	290	196	636	1910	743
+gp	1854	742	2005	186	500	689	571	971	349	1732

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	23930	40854	12066	11192	3674	10552	4811	10152	24490	6234
5	79147	46398	79488	21391	27964	17314	57832	32199	47312	76168
6	84359	62736	34950	65333	29190	42750	35484	86092	41842	62733
7	15133	48481	39776	24994	51937	28265	37921	27525	55769	31383
8	1614	9688	25516	24195	16559	36899	21417	25499	17816	35942
9	964	912	5599	19090	21053	15023	26817	15997	17871	10789
10	1034	676	308	3849	13030	14212	10011	17698	10935	11467
+gp	1162	1484	812	2075	3379	6497	9949	12226	17883	19575

Table 5.5.5

Run title : North-East Arctic saithe

At 21/04/2005 9:04

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1960	1961	1962	1963	1964
AGE					
3	62603	65973	120802	205854	69002
4	95372	69576	66543	117196	221257
5	61942	95368	70183	63586	98241
6	60964	43936	85246	72817	62003
7	53395	53214	37924	70952	67559
8	31275	37946	50706	30748	60005
9	23490	20363	33278	45655	25578
10	14524	15534	16625	26719	37736
+gp	42179	66999	89226	94556	151201
0 TOTAL	445745	468910	570532	728082	792583

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

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	201394	102729	135424	107069	210424	199333	204113	114862	154413	59301
4	79282	220505	109002	143548	111741	191669	211414	183907	81559	121018
5	178108	87943	184672	94421	145470	116720	137749	166747	143840	60881
6	87243	152998	75254	140323	99749	134536	107113	104371	133702	111605
7	61076	67874	133004	71766	132132	97187	103098	91613	86767	102623
8	57880	53339	53906	118396	72064	120468	82799	72671	75178	64656
9	47668	47968	46718	40484	108710	66337	84157	69137	56270	57040
10	17837	31196	40649	37021	33734	94177	50032	57485	55938	38634
+gp	128799	134275	143497	102186	33793	93178	155656	111662	109506	74774
0 TOTAL	859287	898826	922127	855213	947816	1113606	1136132	972455	897173	690532

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	106281	164719	142776	83580	135440	88189	200858	88997	103898	61362
4	38962	74940	85262	83270	57799	127146	76275	167224	84058	82417
5	80563	29600	45003	51895	59282	43694	100062	50219	117889	61083
6	38212	59781	17888	31291	34432	43346	25635	53462	23904	60220
7	65540	29746	41470	13966	21781	26707	26879	14158	37359	15794
8	62856	39962	18533	27504	9230	13100	16428	17053	10831	22015
9	42809	32272	25384	11921	19068	5169	7500	5881	12999	5663
10	37392	25674	16898	15844	6504	11378	4401	3931	3462	7933
+gp	82569	55175	25902	46214	24293	30317	10502	8894	16065	14975
0 TOTAL	555183	511870	419116	365486	367829	389046	468540	409819	410466	331462

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	74497	130599	89761	50403	49401	50812	168198	270106	180449	112620
4	44207	45216	135424	106569	56245	43301	38919	141771	286806	168518
5	48610	32267	31003	113850	94994	44984	37245	34587	139958	225226
6	36403	29260	18386	27616	73783	53259	41126	25715	22966	88053
7	26644	18815	18774	14191	15329	42870	35727	26786	12371	13785
8	9131	12151	11318	10854	3342	9958	24970	19165	10972	7568
9	11027	5102	6648	9523	2535	1625	5378	14727	7540	8107
10	1988	5601	3557	3174	2163	1955	915	4041	8578	3945
+gp	14858	4893	13846	1383	3592	4320	3760	7407	2195	10340
0 TOTAL	267366	283904	328717	337562	301384	253085	356240	544305	671835	638161

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

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	210230	85902	114022	78607	179855	76594	136027	234367	51956	46816
4	135036	239289	104210	139903	96439	217376	107760	146475	247617	63585
5	177708	123420	234677	117254	144813	104526	234370	107331	146051	237362
6	178092	158129	101888	230516	104327	128251	92805	197210	91379	137004
7	48258	143135	126316	93456	163747	93168	104888	74376	149108	80276
8	6227	37252	96462	97737	65572	131663	72311	86326	49618	121255
9	3912	3939	23459	78841	76003	57238	97346	60309	62369	37545
10	5482	3609	1781	20940	53422	62676	45448	76278	41005	44378
+gp	8784	10490	6043	16742	18855	39825	53326	68708	87626	99051
0 TOTAL	773729	805165	808859	873995	903033	911317	944280	1051378	926728	867271

Table 5.5.6

Run title : North-East Arctic saithe

At 21/04/2005 9:04

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1960	1961	1962	1963	1964
	AGE					
	3	0	0	0	0	0
	4	954	696	665	1172	2213
	5	34068	52452	38601	34972	54033
	6	51820	37346	72459	61894	52703
	7	52327	52150	37165	69533	66207
	8	31275	37946	50706	30748	60005
	9	23490	20363	33278	45655	25578
	10	14524	15534	16625	26719	37736
	+gp	42179	66999	89226	94556	151201
0	TOTSF	250637	283486	338725	365249	449676

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

	YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	793	2205	1090	1435	1117	1917	2114	1839	816	1210
	5	97959	48369	101570	51931	80009	64196	75762	91711	79112	33484
	6	74156	130048	63966	119275	84787	114356	91046	88715	113647	94864
	7	59854	66516	130344	70330	129489	95243	101036	89781	85031	100571
	8	57880	53339	53906	118396	72064	120468	82799	72671	75178	64656
	9	47668	47968	46718	40484	108710	66337	84157	69137	56270	57040
	10	17837	31196	40649	37021	33734	94177	50032	57485	55938	38634
	+gp	128799	134275	143497	102186	33793	93178	155656	111662	109506	74774
0	TOTSF	484948	513916	581740	541059	543703	649873	642603	583001	575498	465234

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

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	390	749	853	833	578	1271	763	1672	841	824
	5	44309	16280	24752	28543	32605	24031	55034	27620	64839	33596
	6	32480	50814	15204	26597	29267	36844	21789	45442	20319	51187
	7	64230	29151	40640	13687	21345	26173	26342	13875	36612	15478
	8	62856	39962	18533	27504	9230	13100	16428	17053	10831	22015
	9	42809	32272	25384	11921	19068	5169	7500	5881	12999	5663
	10	37392	25674	16898	15844	6504	11378	4401	3931	3462	7933
	+gp	82569	55175	25902	46214	24293	30317	10502	8894	16065	14975
0	TOTSF	367034	250078	168166	171142	142891	148284	142759	124369	165968	151671

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

	YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	1768	1356	4063	9591	8999	7361	4670	7089	8604	15167
	5	36944	24523	19532	63756	53197	29690	26817	22135	75577	112613
	6	31671	26041	16179	20436	47221	33021	30845	21601	20899	74845
	7	24512	17875	18774	14191	15329	39012	32155	23840	12124	13371
	8	9131	12151	11318	10854	3342	9958	24970	19165	10972	7568
	9	11027	5102	6648	9523	2535	1625	5378	14727	7540	8107
	10	1988	5601	3557	3174	2163	1955	915	4041	8578	3945
	+gp	14858	4893	13846	1383	3592	4320	3760	7407	2195	10340
0	TOTSF	131900	97542	93916	132908	136378	126942	129510	120004	146489	245956

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

	YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	18905	33501	11463	11192	3858	10869	5388	10253	22286	6358
	5	94185	61710	98565	31659	40548	28222	89061	48299	67183	102066
	6	144255	115435	60114	122173	56337	89776	72388	169600	79500	119193
	7	43432	120233	93474	64485	117898	75466	98595	69913	141653	76262
	8	6103	36135	79098	74280	49179	115863	67249	82873	46144	110342
	9	3912	3939	23459	78841	76003	57238	97346	60309	62369	37545
	10	5482	3609	1781	20940	53422	62676	45448	76278	41005	44378
	+gp	8784	10490	6043	16742	18855	39825	53326	68708	87626	99051
0	TOTSF	325058	385050	373998	420312	416098	479935	528800	586233	547766	595195

Table 5.5.7

Run title : North-East Arctic saithe

At 21/04/2005 9:04

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RE(Age 3	TOTALE	TOTSPE	LANDIN	YIELD/S!	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	972455	583001	214334	0.3676	0.3346
1973	217484	897173	575498	213859	0.3716	0.3986
1974	83523	690532	465234	274121	0.5892	0.5962
1975	149691	555183	367034	233453	0.6361	0.4519
1976	231999	511870	250078	242486	0.9696	0.5855
1977	201093	419116	168166	182817	1.0871	0.5019
1978	117719	365486	171142	154464	0.9025	0.504
1979	190761	367829	142891	164180	1.149	0.5672
1980	111631	389046	148284	144554	0.9748	0.5667
1981	275148	468540	142759	175516	1.2295	0.5602
1982	115581	409819	124369	168034	1.3511	0.6061
1983	98950	410466	165968	156936	0.9456	0.5905
1984	86425	331462	151671	158786	1.0469	0.6461
1985	99330	267366	131900	107183	0.8126	0.5448
1986	221355	283904	97542	70458	0.7223	0.5378
1987	169361	328717	93916	92391	0.9838	0.5568
1988	81295	337562	132908	114242	0.8596	0.6816
1989	66757	301384	136378	122310	0.8968	0.593
1990	71566	253085	126942	95848	0.7551	0.5449
1991	247349	356240	129510	107326	0.8287	0.4346
1992	403143	544305	120004	127516	1.0626	0.5745
1993	295819	671835	146489	153584	1.0484	0.4869
1994	216577	638161	245956	146544	0.5958	0.5027
1995	375410	773729	325058	168378	0.518	0.3687
1996	145597	805165	385050	171348	0.445	0.2922
1997	183907	808859	373998	143629	0.384	0.2424
1998	115598	873995	420312	153327	0.3648	0.2376
1999	268441	903033	416098	150373	0.3614	0.2578
2000	127656	911317	479935	135945	0.2833	0.1751
2001	181370	944280	528800	136402	0.2579	0.1934
2002	339662	1051378	586233	155246	0.2648	0.2247
2003	78720	926728	547766	159757	0.2917	0.1891
2004	163907	928633	595195	161916	0.272	0.2067
Arith. Mean	181655	652803	336038	159793	0.6239	0.3949
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 5.5.8. RCT3 analysis

Input(c:\rec3.txt):

NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds
1 13 2 (No. of surveys, No. of years, VPA Column No.)
'Yearcl' 'VPA' 'Ac-surv 3'

1989	403	273.6
1990	296	227.7
1991	217	87.1
1992	375	166.1
1993	146	122.6
1994	184	38.0
1995	116	96.7
1996	268	233.8
1997	127	142.5
1998	181	275.9
1999	340	230.2
2000	79	87.5
2001	-11	212.4

Analysis by RCT3 ver3.1 of data from file :

c:\rec3.txt

NORTHEAST ARCTIC SAITHE : recruits as 3 year-olds

Data for 1 surveys over 13 years : 1989 - 2001

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

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

Forecast/Hindcast variance correction used.

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------		I	
Ac-sur	1.48	-2.05	.84	.231	11	4.48	4.60	1.024	.153
				VPA Mean =			5.38	.435	.847

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	-----------Prediction---------		I	
Ac-sur	1.62	-2.75	.88	.276	12	5.36	5.94	1.040	.195
				VPA Mean =			5.28	.512	.805

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	192	5.26	.40	.28	.48	80	4.38
2001	222	5.41	.46	.26	.33		

Table 5.6.1

MFYPR version 1
Run: ypr1
Time and date: 13:33 22.04.2005
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	13.1114	3.2708	10.9280	3.2708	10.9280
0.1000	0.0207	0.0867	0.2421	5.0846	11.2964	2.8547	9.1411	2.8547	9.1411
0.2000	0.0414	0.1554	0.4111	4.7430	9.9092	2.5285	7.7807	2.5285	7.7807
0.3000	0.0620	0.2112	0.5315	4.4652	8.8194	2.2656	6.7167	2.2656	6.7167
0.4000	0.0827	0.2577	0.6186	4.2343	7.9441	2.0492	5.8660	2.0492	5.8660
0.5000	0.1034	0.2971	0.6823	4.0389	7.2282	1.8677	5.1737	1.8677	5.1737
0.6000	0.1241	0.3309	0.7292	3.8710	6.6335	1.7133	4.6017	1.7133	4.6017
0.7000	0.1448	0.3604	0.7639	3.7250	6.1330	1.5804	4.1230	1.5804	4.1230
0.8000	0.1655	0.3864	0.7895	3.5967	5.7069	1.4647	3.7179	1.4647	3.7179
0.9000	0.1861	0.4094	0.8084	3.4828	5.3406	1.3631	3.3717	1.3631	3.3717
1.0000	0.2068	0.4300	0.8222	3.3809	5.0228	1.2732	3.0732	1.2732	3.0732
1.1000	0.2275	0.4486	0.8322	3.2892	4.7449	1.1931	2.8140	1.1931	2.8140
1.2000	0.2482	0.4655	0.8392	3.2061	4.5002	1.1212	2.5873	1.1212	2.5873
1.3000	0.2689	0.4809	0.8439	3.1304	4.2833	1.0564	2.3877	1.0564	2.3877
1.4000	0.2896	0.4950	0.8469	3.0611	4.0899	0.9978	2.2111	0.9978	2.2111
1.5000	0.3102	0.5080	0.8485	2.9973	3.9166	0.9444	2.0539	0.9444	2.0539
1.6000	0.3309	0.5200	0.8491	2.9385	3.7604	0.8957	1.9134	0.8957	1.9134
1.7000	0.3516	0.5311	0.8489	2.8840	3.6191	0.8510	1.7872	0.8510	1.7872
1.8000	0.3723	0.5415	0.8480	2.8333	3.4907	0.8099	1.6734	0.8099	1.6734
1.9000	0.3930	0.5512	0.8466	2.7861	3.3736	0.7720	1.5705	0.7720	1.5705
2.0000	0.4137	0.5603	0.8449	2.7419	3.2663	0.7370	1.4770	0.7370	1.4770

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.2068
FMax	1.6171	0.3345
F0.1	0.7074	0.1463
F35%SPR	0.772	0.1597

Weights in kilograms

Table 5.7.1 Short term projections

MFDP version 1

Run: st1

Time and date: 12:32 22.04.2005

Fbar age range: 4-7

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	163907	0.2	0	0	0	0.66	0.02617	0.66
4	118723.7	0.2	0.1	0	0	0.965	0.165113	0.965
5	45156.99	0.2	0.43	0	0	1.38	0.20023	1.38
6	113146	0.2	0.87	0	0	1.9	0.234843	1.9
7	48568.35	0.2	0.95	0	0	2.485	0.227133	2.485
8	20837.9	0.2	0.91	0	0	2.83	0.269013	2.83
9	25527.01	0.2	1	0	0	3.485	0.246063	3.485
10	6452.84	0.2	1	0	0	3.81	0.28305	3.81
11	18513.29	0.2	1	0	0	4.98	0.28305	4.98

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	163907	0.2	0	0	0	0.66	0.02617	0.66
4	.	0.2	0.1	0	0	0.965	0.165113	0.965
5	.	0.2	0.43	0	0	1.38	0.20023	1.38
6	.	0.2	0.87	0	0	1.9	0.234843	1.9
7	.	0.2	0.95	0	0	2.485	0.227133	2.485
8	.	0.2	0.91	0	0	2.83	0.269013	2.83
9	.	0.2	1	0	0	3.485	0.246063	3.485
10	.	0.2	1	0	0	3.81	0.28305	3.81
11	.	0.2	1	0	0	4.98	0.28305	4.98

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	163907	0.2	0	0	0	0.66	0.02617	0.66
4	.	0.2	0.1	0	0	0.965	0.165113	0.965
5	.	0.2	0.43	0	0	1.38	0.20023	1.38
6	.	0.2	0.87	0	0	1.9	0.234843	1.9
7	.	0.2	0.95	0	0	2.485	0.227133	2.485
8	.	0.2	0.91	0	0	2.83	0.269013	2.83
9	.	0.2	1	0	0	3.485	0.246063	3.485
10	.	0.2	1	0	0	3.81	0.28305	3.81
11	.	0.2	1	0	0	4.98	0.28305	4.98

Input units are thousands and kg - output in tonnes

Table 5.7.2

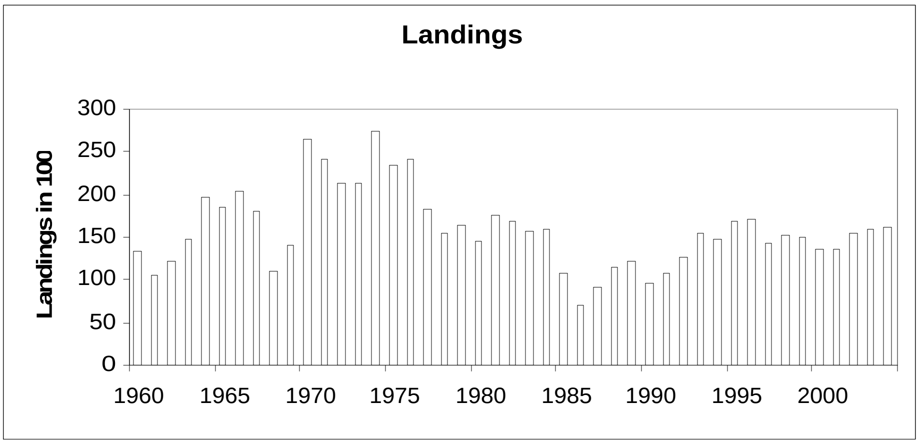
MFDP version 1
Run: st1
st1MFDP Index file 22.04.2005
Time and date: 12:32 22.04.2005
Fbar age range: 4-7

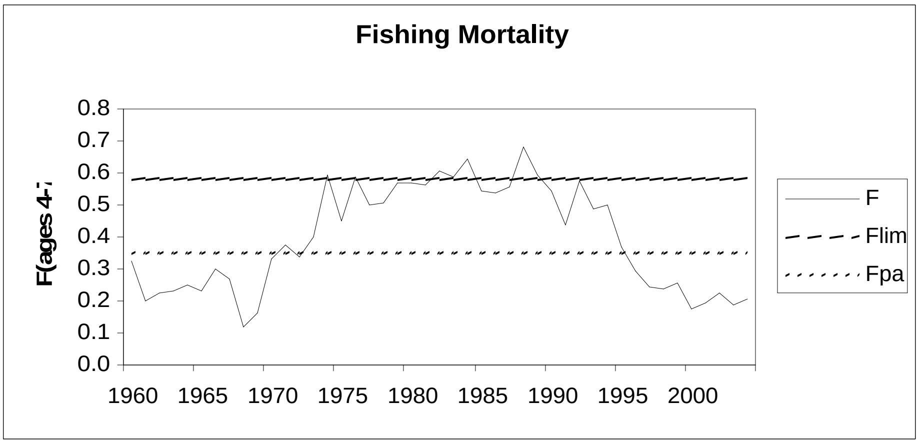
2005				
Biomass	SSB	FMult	FBar	Landings
885448	599348	1.5330	0.3171	215000

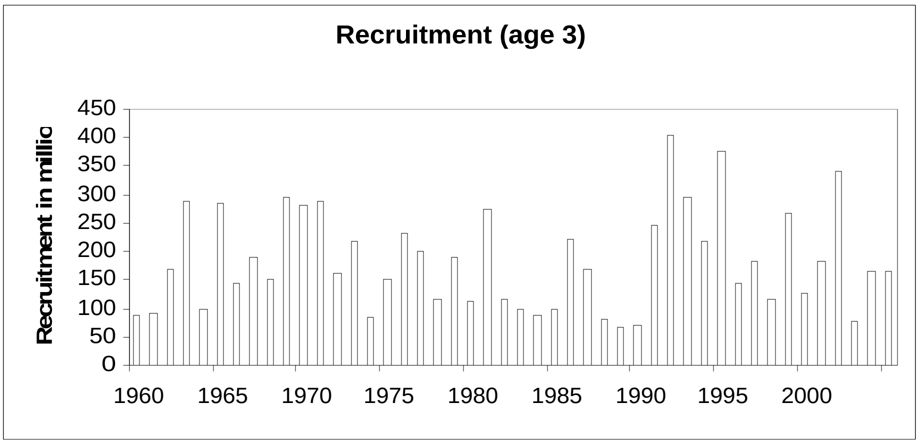
2006					2007	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
788389	486984	0.0000	0.0000	0	933591	594332
.	486984	0.1000	0.0207	14164	917772	580847
.	486984	0.2000	0.0414	28014	902309	567681
.	486984	0.3000	0.0620	41559	887195	554826
.	486984	0.4000	0.0827	54806	872420	542274
.	486984	0.5000	0.1034	67761	857976	530019
.	486984	0.6000	0.1241	80431	843857	518053
.	486984	0.7000	0.1448	92824	830053	506369
.	486984	0.8000	0.1655	104945	816559	494961
.	486984	0.9000	0.1861	116800	803366	483821
.	486984	1.0000	0.2068	128397	790468	472943
.	486984	1.1000	0.2275	139740	777857	462322
.	486984	1.2000	0.2482	150837	765527	451950
.	486984	1.3000	0.2689	161692	753472	441821
.	486984	1.4000	0.2896	172311	741684	431931
.	486984	1.5000	0.3102	182700	730158	422273
.	486984	1.6000	0.3309	192863	718888	412841
.	486984	1.7000	0.3516	202807	707867	403630
.	486984	1.8000	0.3723	212537	697089	394635
.	486984	1.9000	0.3930	222056	686550	385851
.	486984	2.0000	0.4137	231371	676243	377272

Input units are thousands and kg - output in tonnes

Figure 5.1.1 North-East Arctic saithe (Sub-areas I and II)







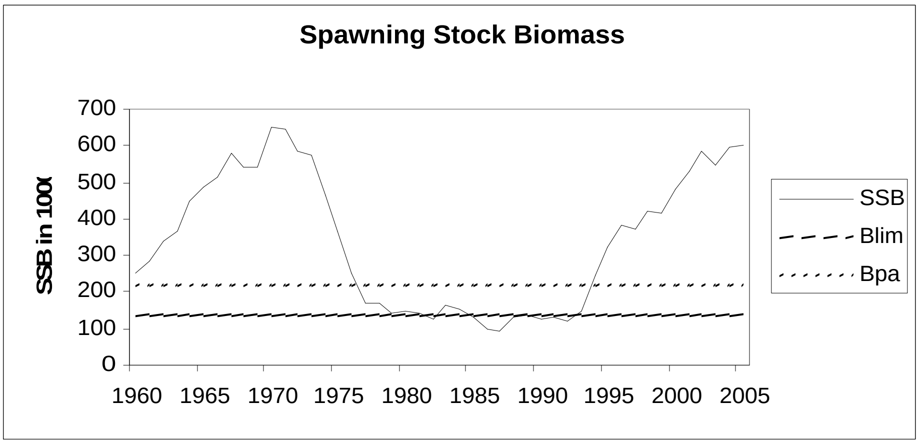
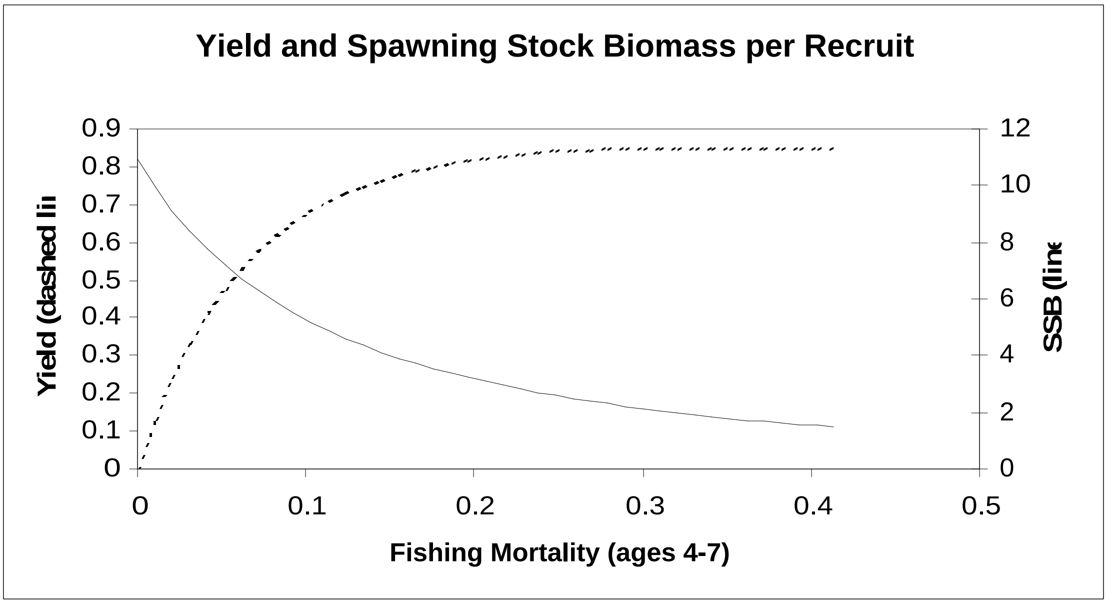


Figure 5.1.1 (continued)



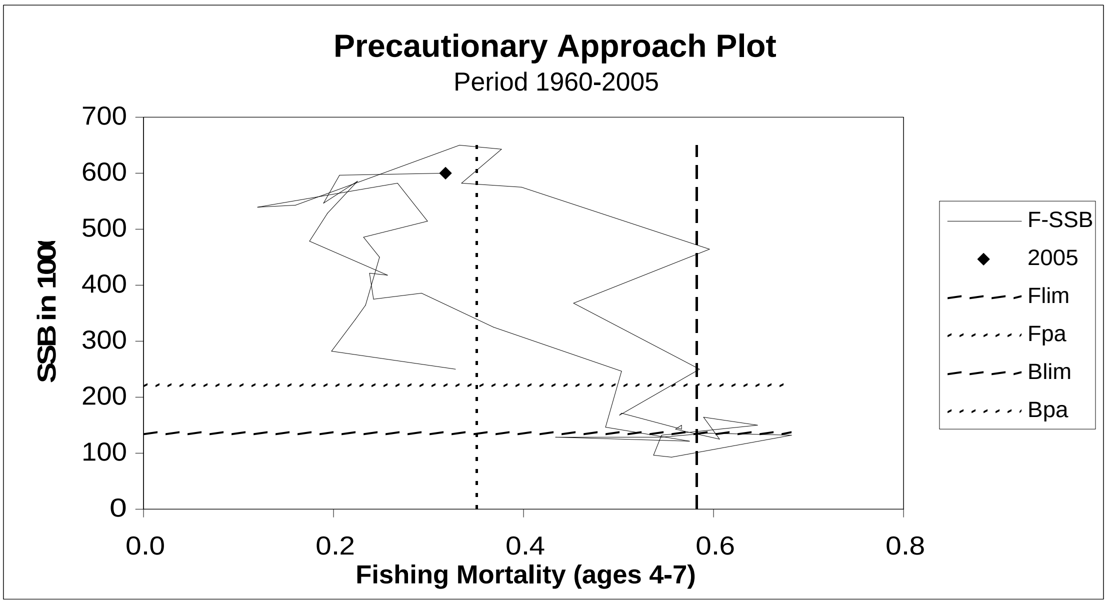


Figure 5.1.1 (continued)

North-East Arctic saithe (Sub-areas I and II)

YEAR	RECRUITMENT	SSB	LANDINGS	MEAN F
	Age 3			Ages 4-7
	thousands	tonnes	tonnes	
1960	88173	250637	133515	0.3276
1961	92920	283486	105951	0.1971
1962	170143	338725	120707	0.2228
1963	289935	365249	148627	0.2334
1964	97186	449676	197426	0.2487
1965	283653	484948	185600	0.2310
1966	144689	513916	203788	0.2983
1967	190738	581740	181326	0.2679
1968	150801	541059	110247	0.1193
1969	296371	543703	140060	0.1606
1970	280751	649873	264924	0.3330
1971	287484	642603	241272	0.3776
1972	161777	583001	214334	0.3346
1973	217484	575498	213859	0.3986
1974	83523	465234	274121	0.5962
1975	149691	367034	233453	0.4519
1976	231999	250078	242486	0.5855
1977	201093	168166	182817	0.5019
1978	117719	171142	154464	0.5040
1979	190761	142891	164180	0.5672
1980	111631	148284	144554	0.5667
1981	275148	142759	175516	0.5602
1982	115581	124369	168034	0.6061
1983	98950	165968	156936	0.5905
1984	86425	151671	158786	0.6461
1985	99330	131900	107183	0.5448
1986	221355	97542	70458	0.5378
1987	169361	93916	92391	0.5568
1988	81295	132908	114242	0.6816
1989	66757	136378	122310	0.5930
1990	71566	126942	95848	0.5449
1991	247349	129510	107326	0.4346
1992	403143	120004	127516	0.5745
1993	295819	146489	153584	0.4869
1994	216577	245956	146544	0.5027
1995	375410	325058	168378	0.3687
1996	145597	385050	171348	0.2922
1997	183907	373998	143629	0.2424
1998	115598	420312	153327	0.2376
1999	268441	416098	150373	0.2578
2000	127656	479935	135945	0.1751
2001	181370	528800	136402	0.1934
2002	339662	586233	155246	0.2247
2003	78720	547766	159757	0.1891
2004	163907	595195	161916	0.2067
2005	163907	599348		0.3171
Average	183290	341762	159793	0.3932

Figure 5.1.1 (continued)

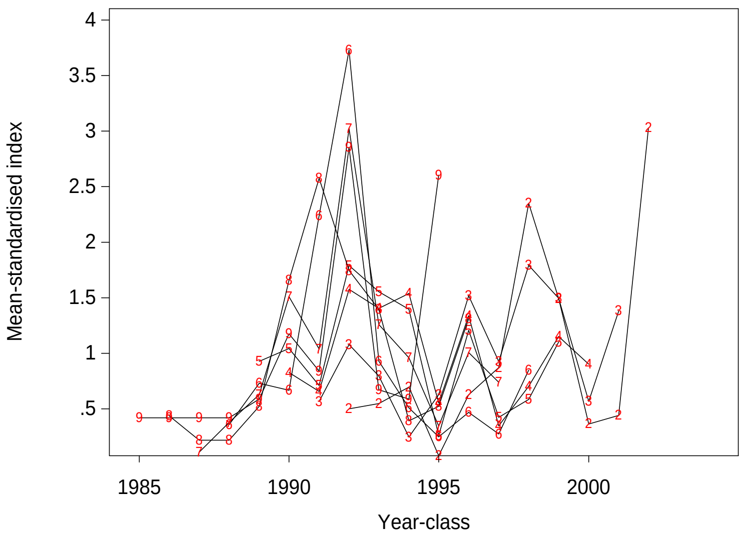
Yield and spawning biomass per Recruit

F-reference points:

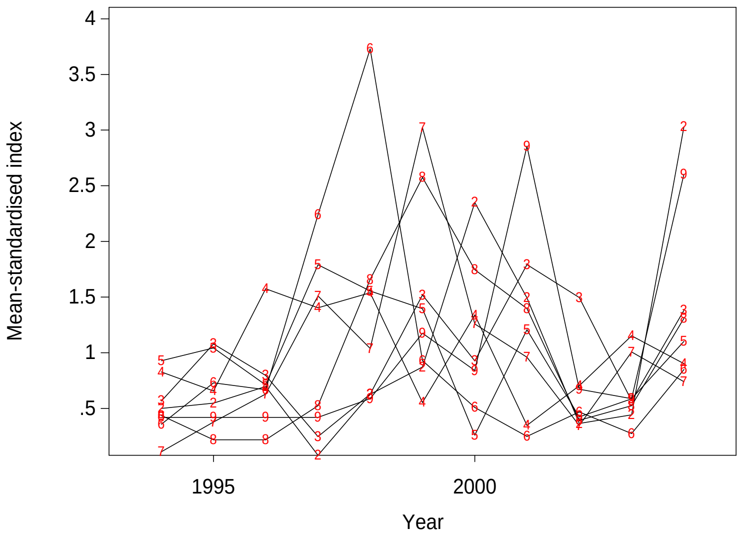
	FISH MORT	YIELD/R	SSB/R
	Ages 4-7		
Average Current	0.207	0.822	3.073
Fmax	0.334	0.849	1.891
F0.1	0.146	0.766	4.091
Fmed	0.394	0.847	1.564

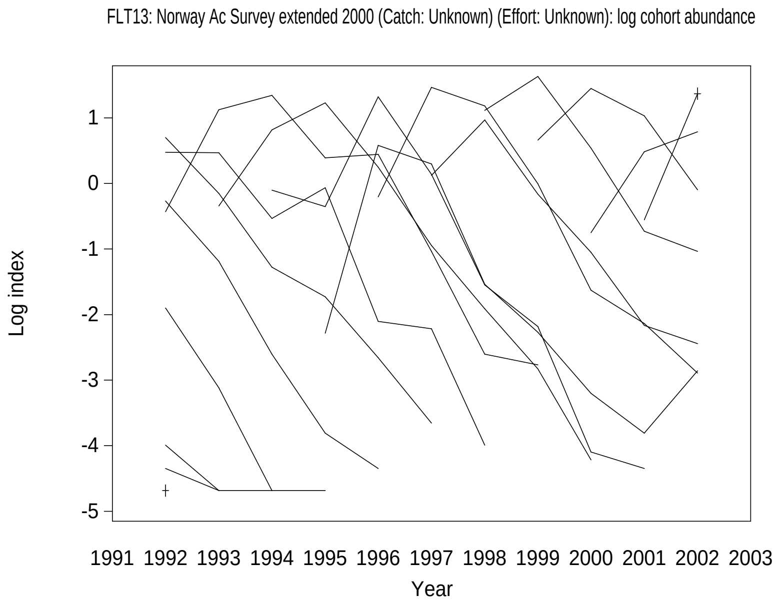
Figures 5.4.1-16. Plots from SURBA analyses

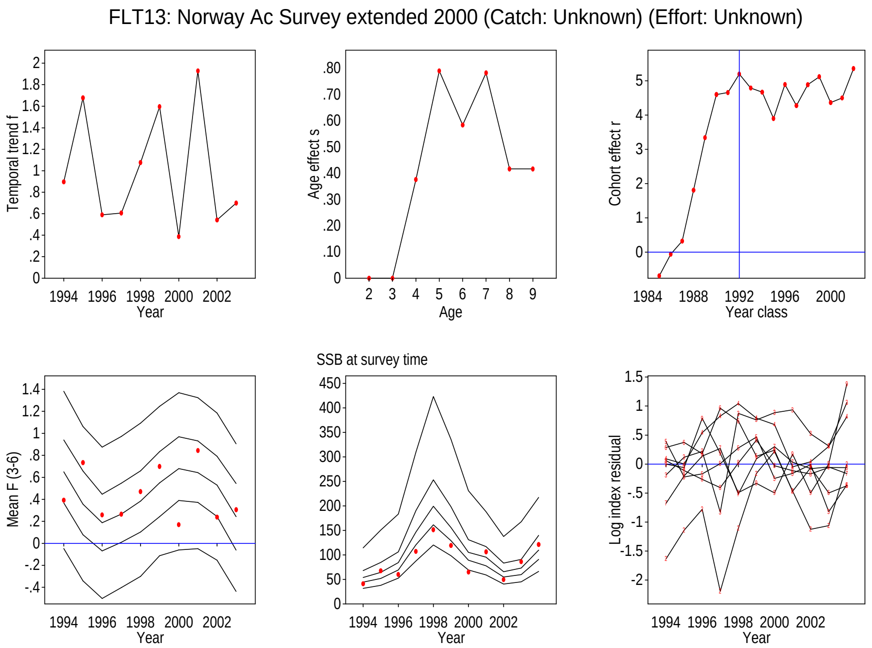
FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)

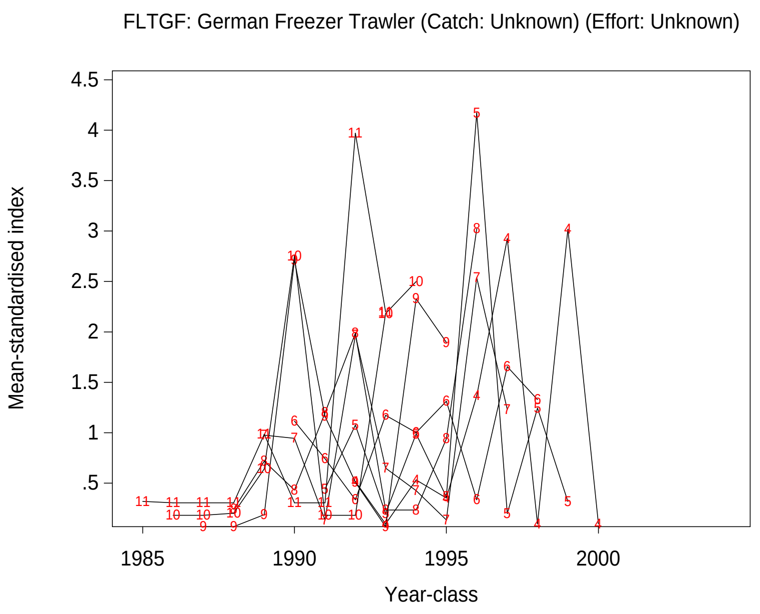


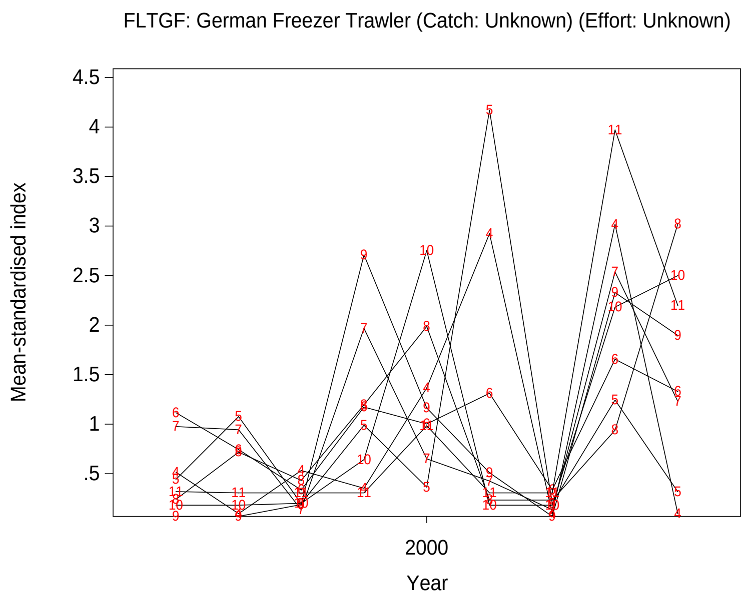
FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)



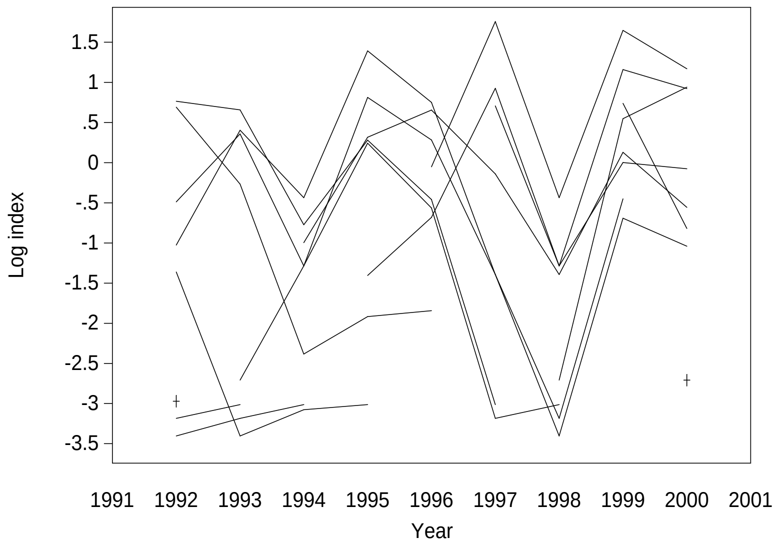

FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown): log cohort abundance
Log index
Year


FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: Unknown)
Temporal trend f
Age effect s
Cohort effect r
Year class
Age
Year
Mean F (3-6)
SSB at survey time
Log index residual

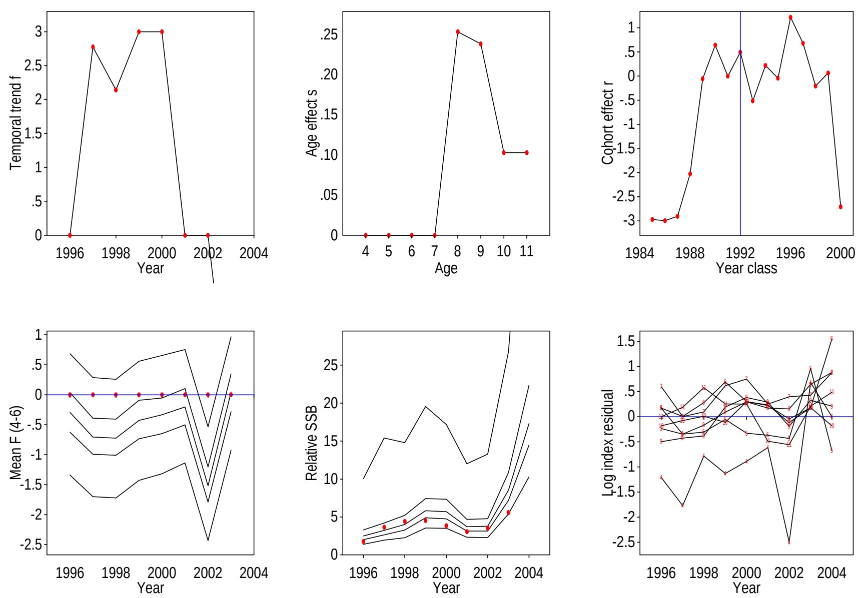

FLTGF: German Freezer Trawler (Catch: Unknown) (Effort: Unknown)
Mean-standardised index
Year-class
4.5
4
3.5
3
2.5
2
1.5
1
.5
1985
1990
1995
2000


FLTGF: German Freezer Trawler (Catch: Unknown) (Effort: Unknown)
Mean-standardised index
Year
4.5
4
3.5
3
2.5
2
1.5
1
.5
2000

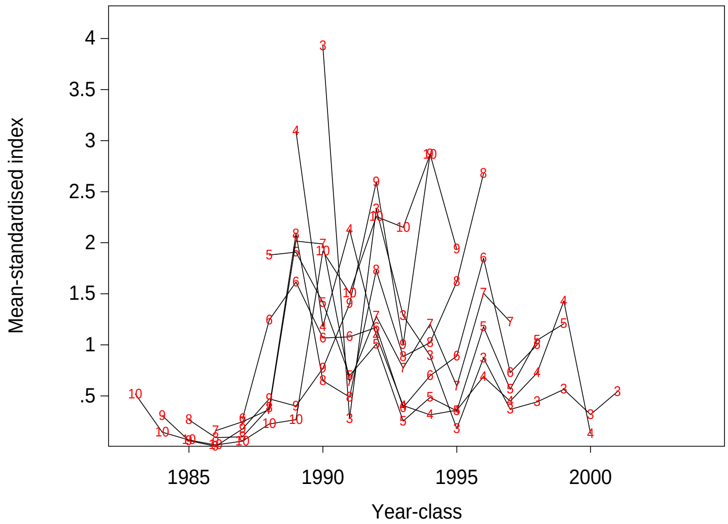
FLTGF: German Freezer Trawler (Catch: Unknown) (Effort: Unknown): log cohort abundance



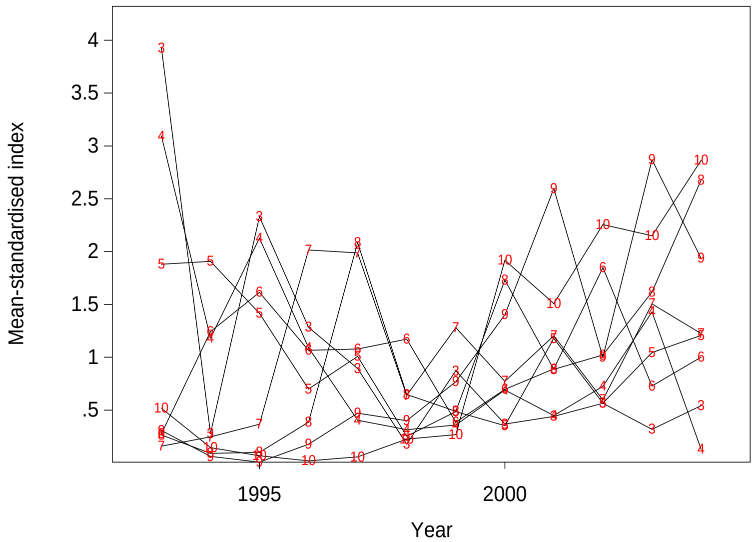
FLTGF: German Freezer Trawler (Catch: Unknown) (Effort: Unknown)



FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown)

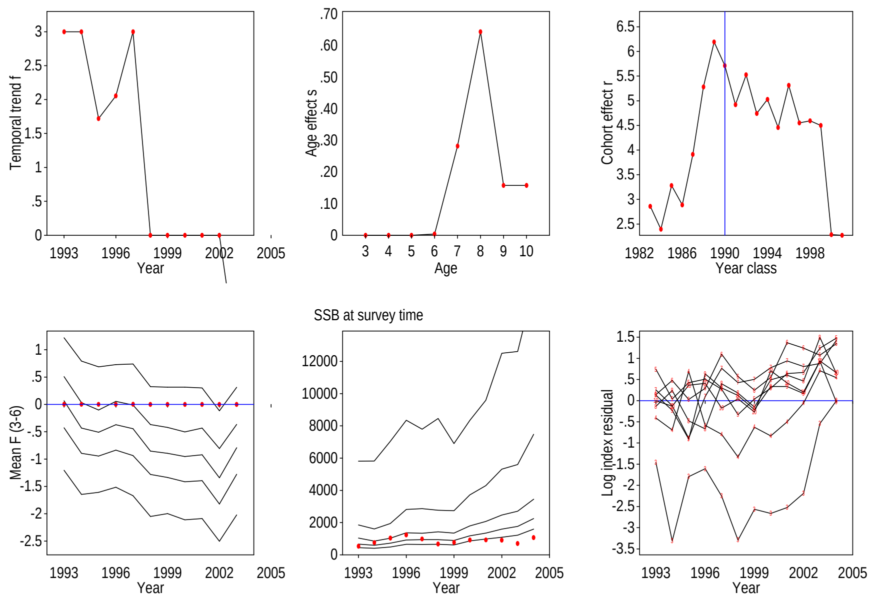


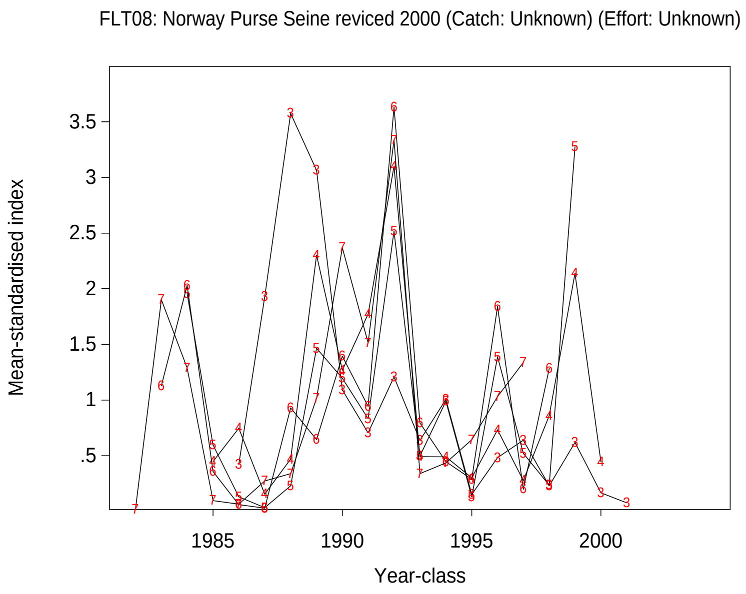
FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown)

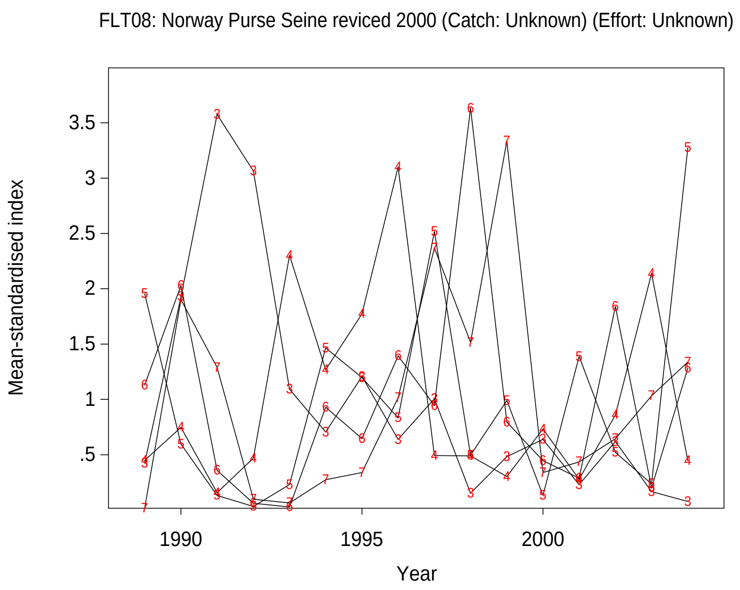


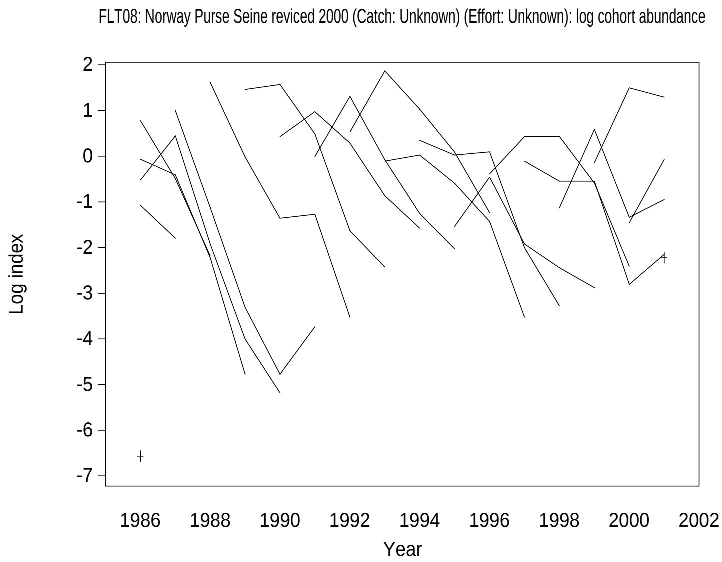
FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown): log cohort abundance

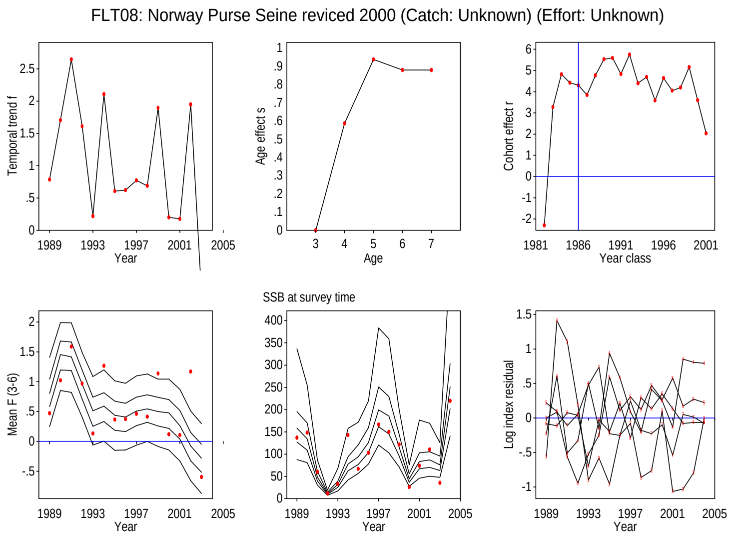
FLT12: Nor new trawl revised 2000 (Catch: Unknown) (Effort: Unknown)




FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
Mean-standardised index
Year-class
1985
1990
1995
2000


FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
Mean-standardised index
Year
1990
1995
2000


FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown): log cohort abundance
Log index
Year
2
1
0
-1
-2
-3
-4
-5
-6
-7
1986
1988
1990
1992
1994
1996
1998
2000
2002


FLT08: Norway Purse Seine reviced 2000 (Catch: Unknown) (Effort: Unknown)
Temporal trend f
Year
Age effect s
Age
Cohort effect r
Year class
Mean F (3-6)
SSB at survey time
Log index residual
1989
1993
1997
2001
2005
1981
1986
1991
1996

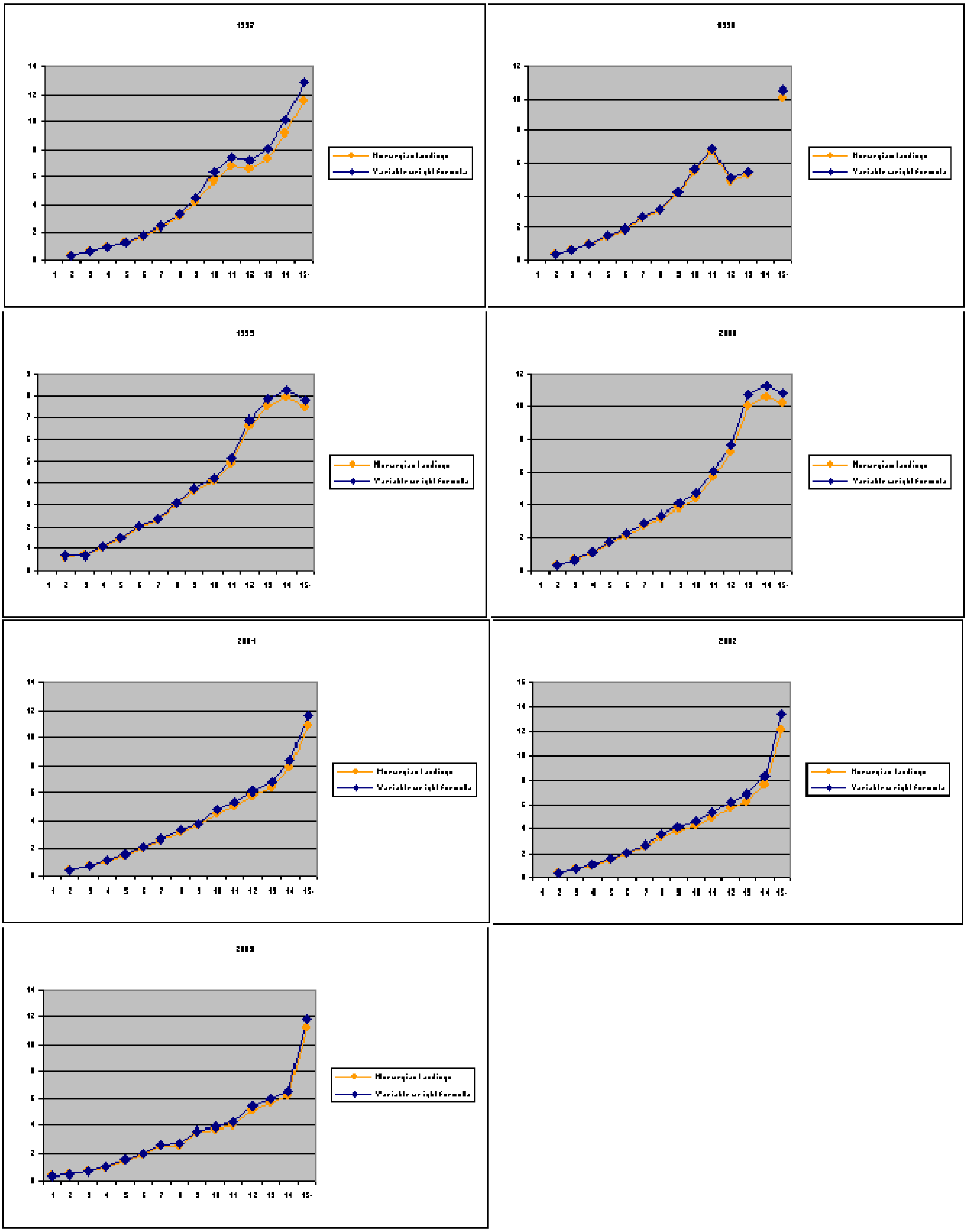


Figure 5.4.17 Comparison of annual weight at age versus the estimation by the general formula used.

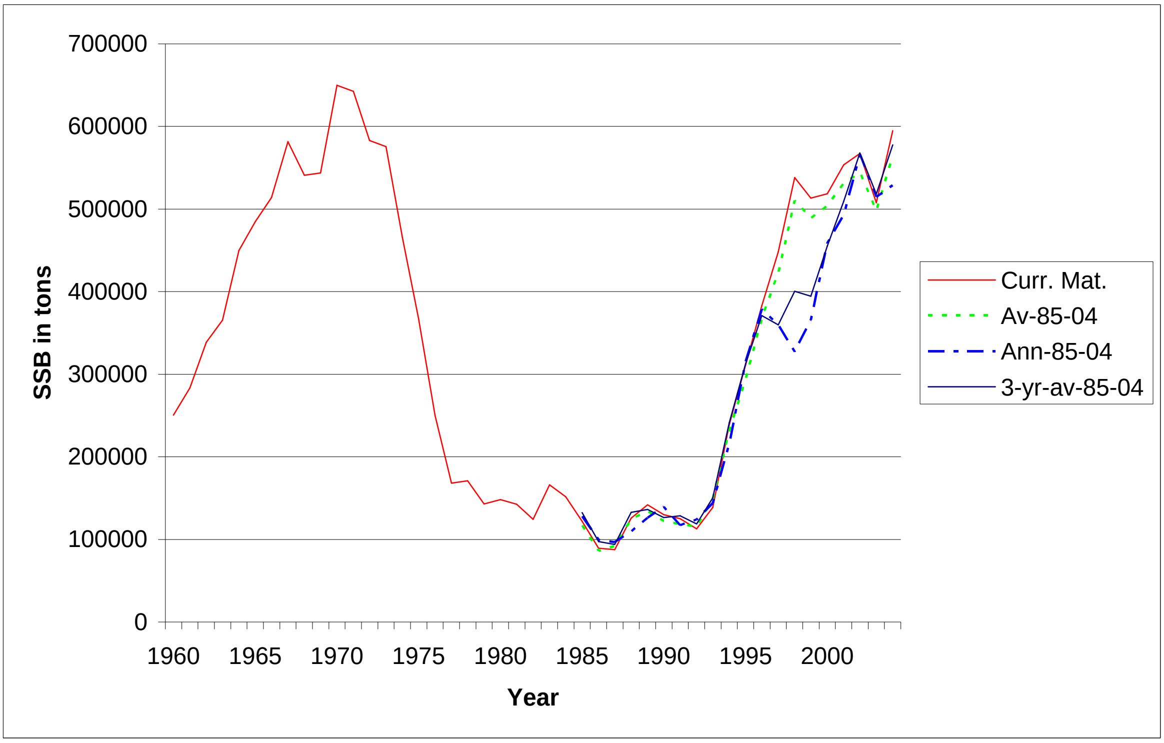
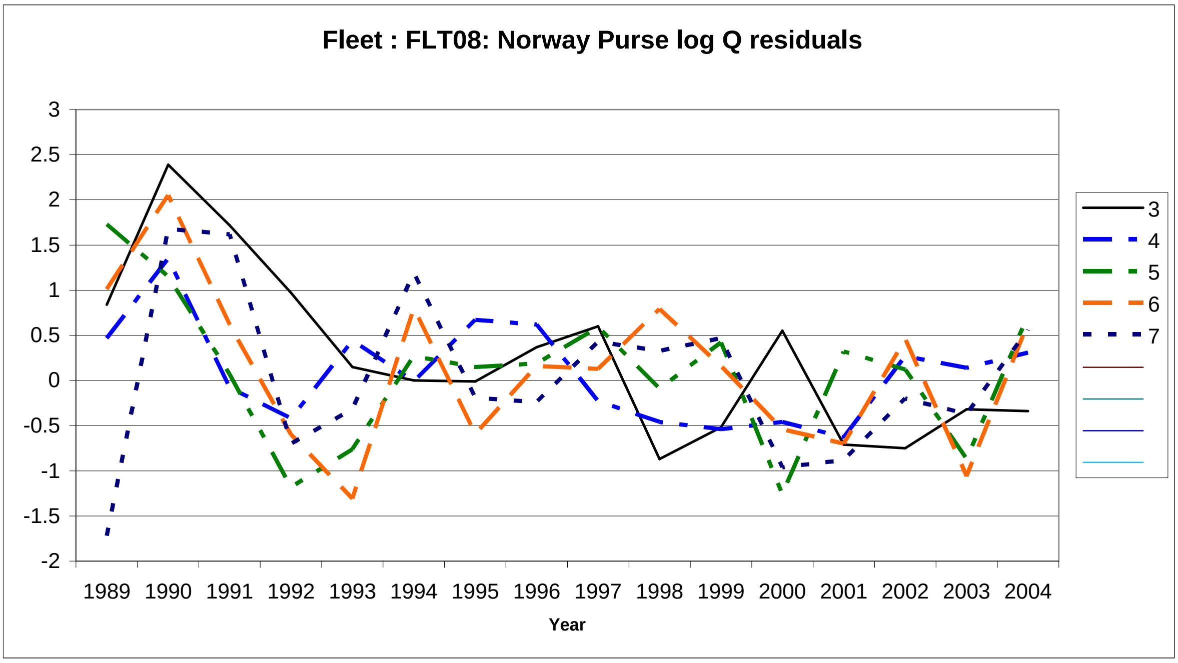
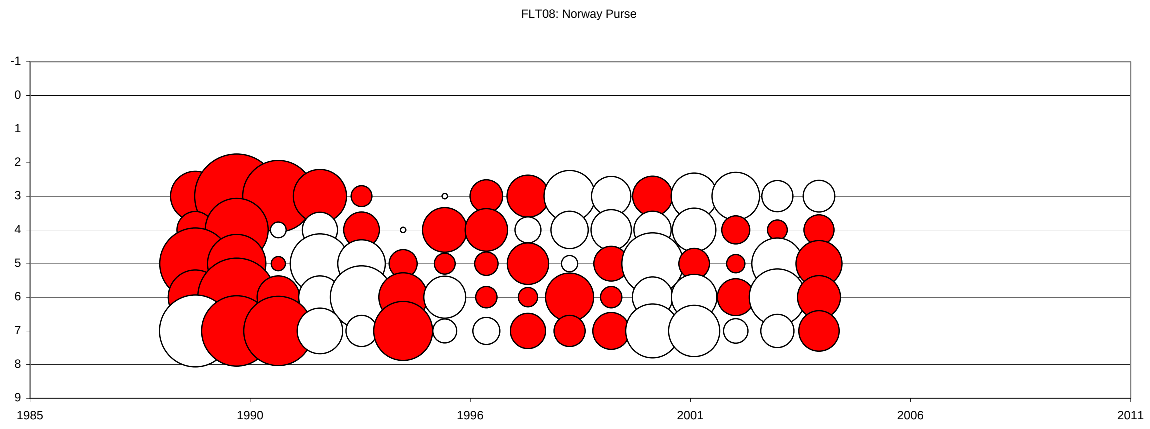


Figure. 5.4.18. XSA-estimates of SSB 1960-2004 based on current maturity ogive for the whole period and new average 1985-2004 and anual ogive 1985-2004.





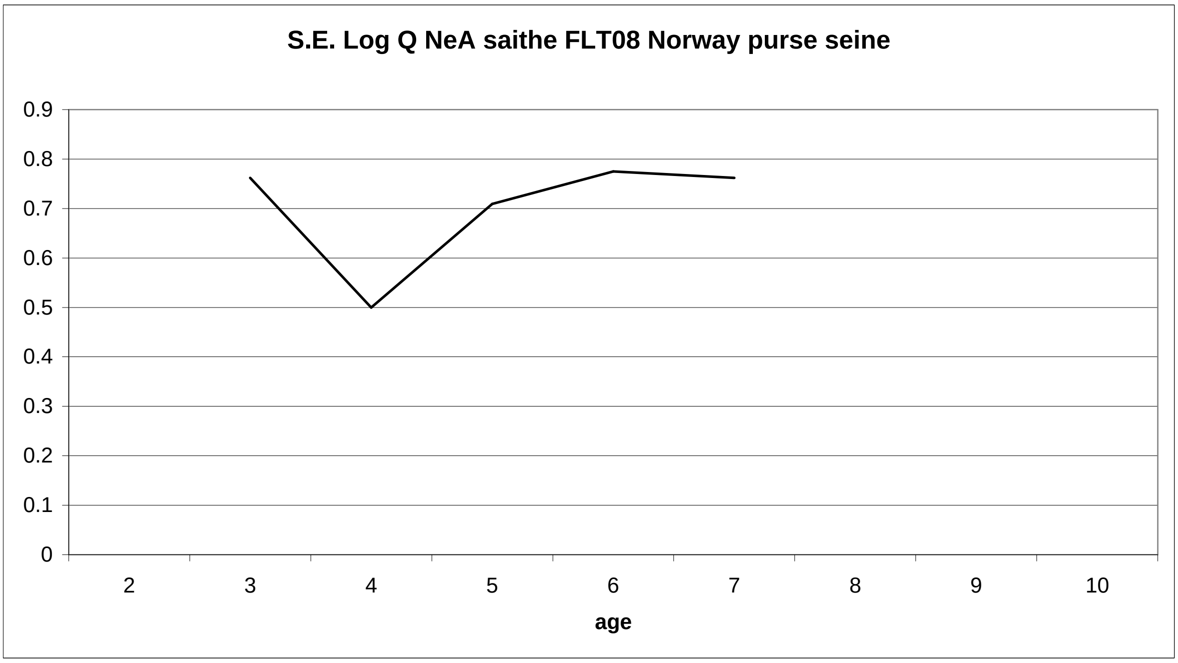
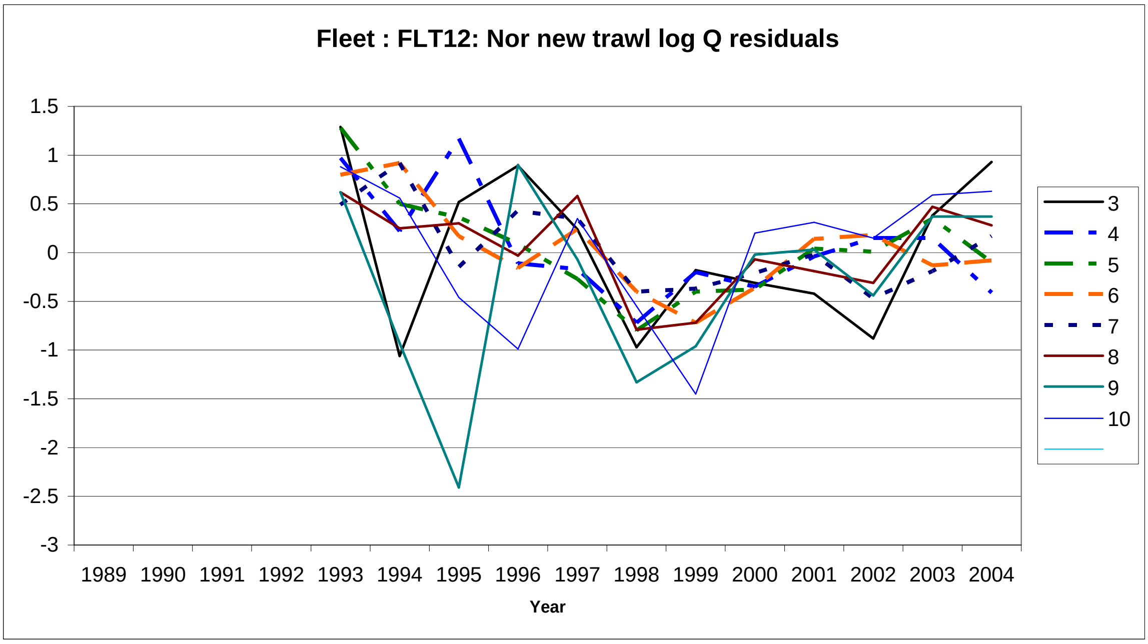
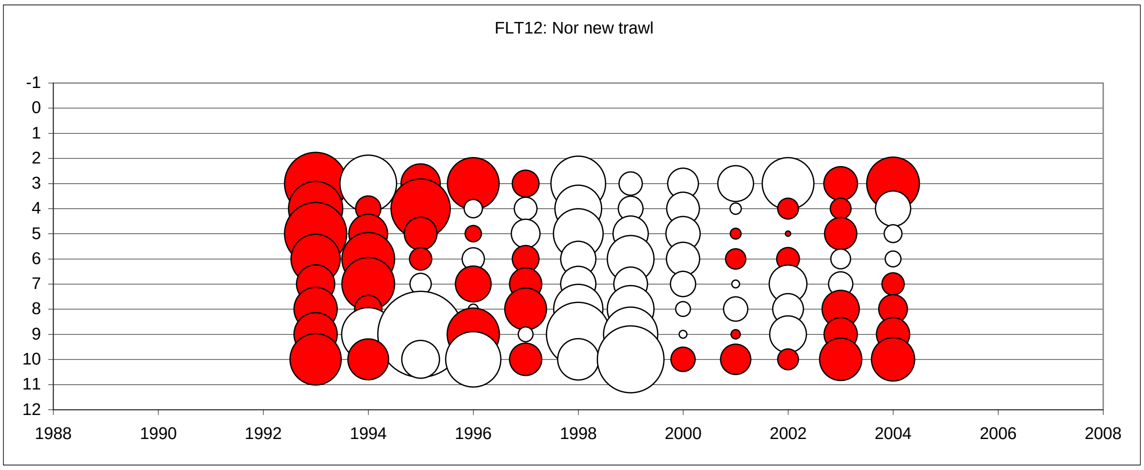


Figure 5.4.19 Single fleet tuning diagnostics Purse seine fleet





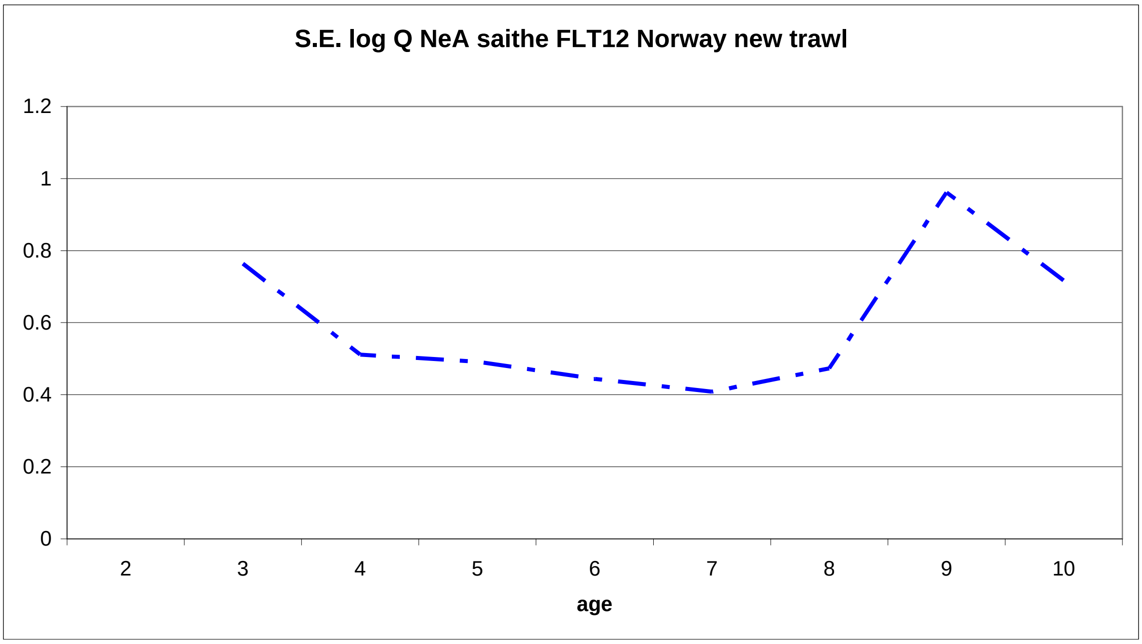
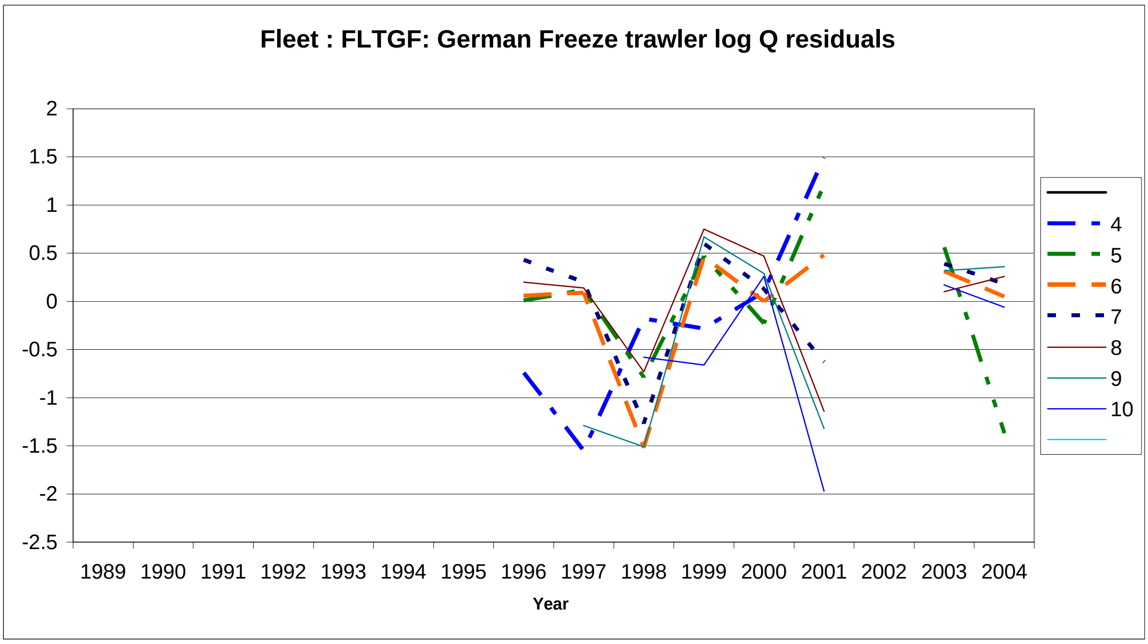
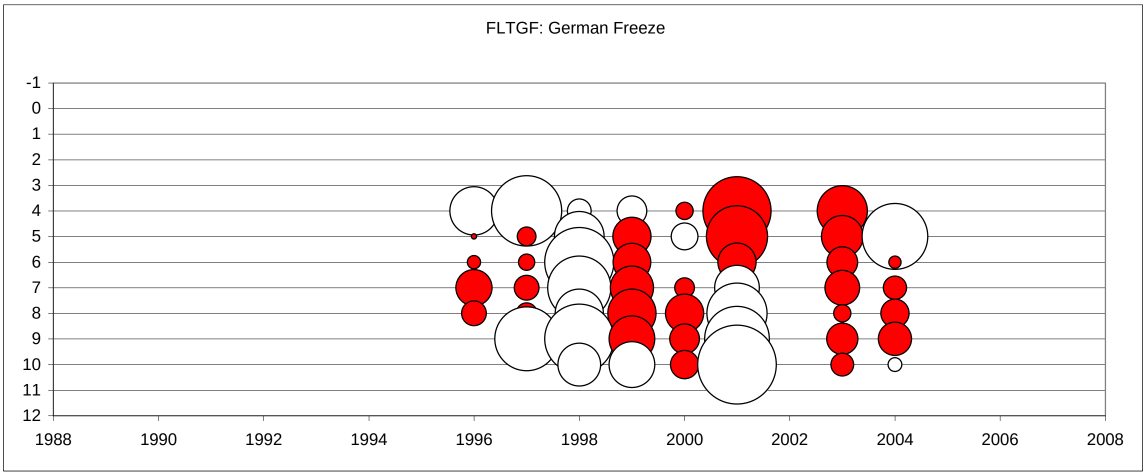


Figure 5.4.20 Single fleet tuning diagnostics Norway new trawl fleet





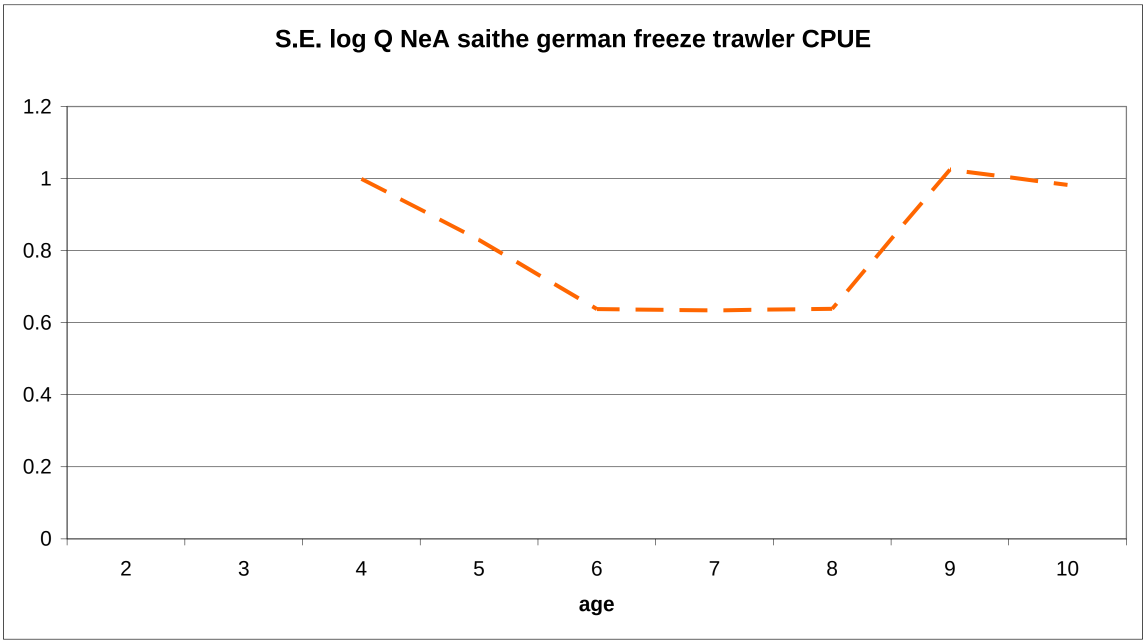
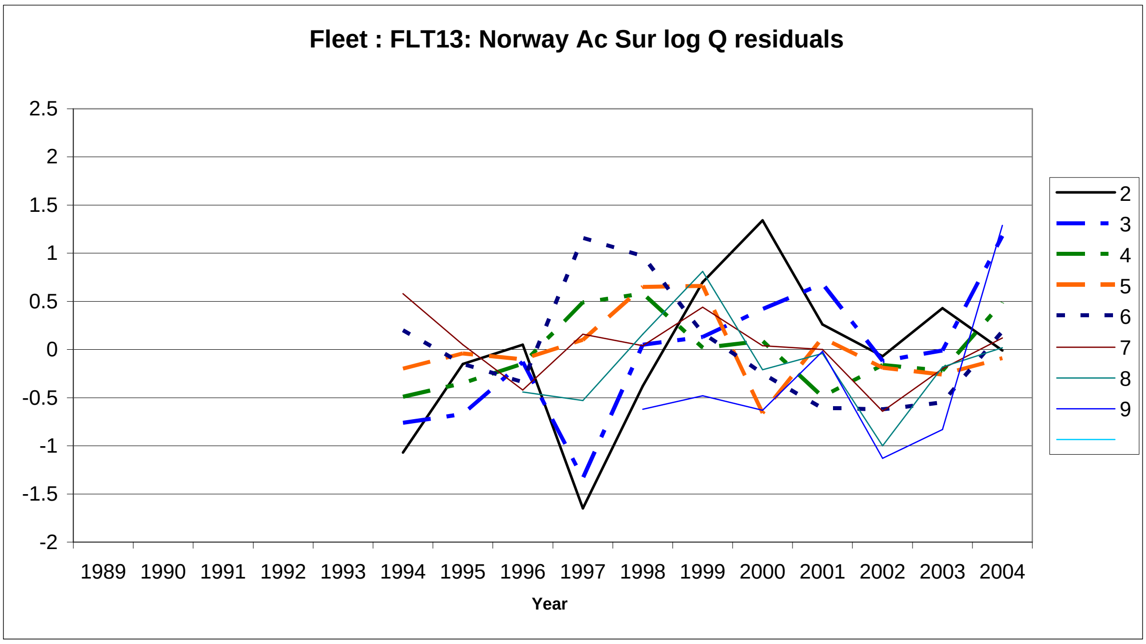
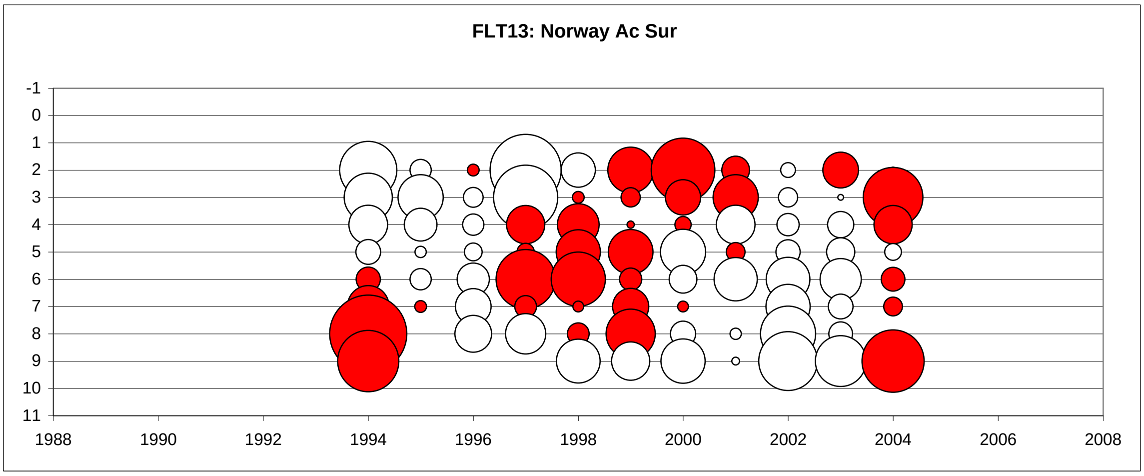


Figure 5.4.21 Single fleet tuning diagnostics German freeze trawl fleet





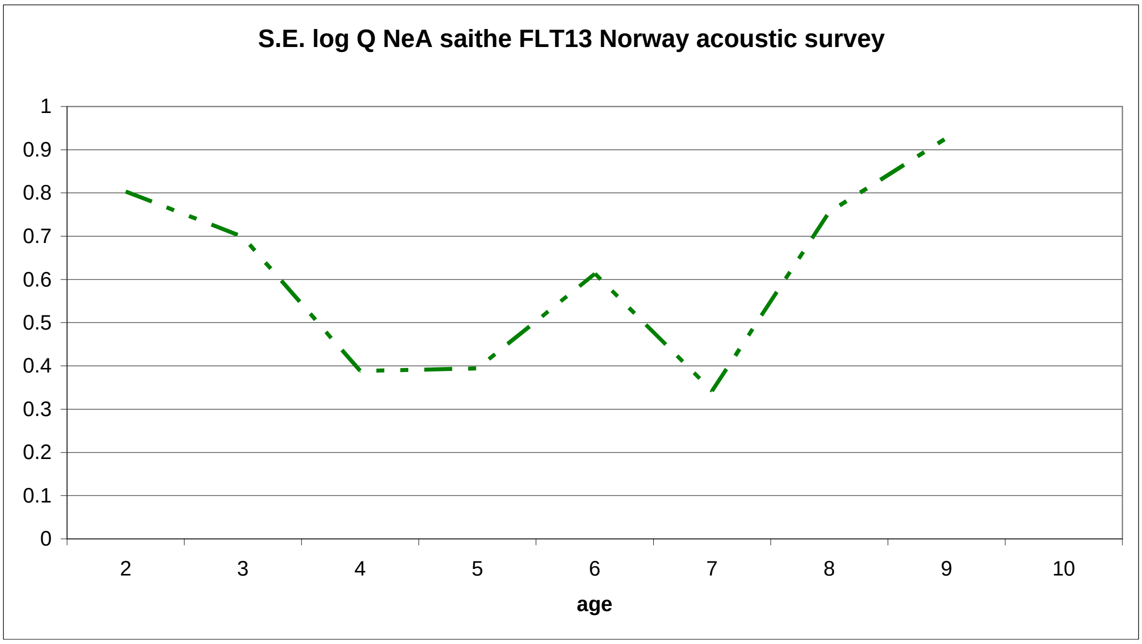


Figure 5.4.22 Single fleet tuning diagnostics Norway acoustic cruise fleet

Scaled weights

Age	2002	2001	2000	1999	1998	1997	1996	1995	1994
FLT08: Norway Purse		0.129	0.224	0.179	0.177	0.154	0.12	0.103	0.092
FLT12: Nor new trawl		0.178	0.225	0.257	0.317	0.338	0.362	0.333	0.37
FLT13: Norway Ac Sur	0.263	0.31	0.341	0.335	0.3	0.319	0.292	0.29	0.255
FLTGF: German Freeze				0.054	0.066	0.069	0.094	0.091	0.095

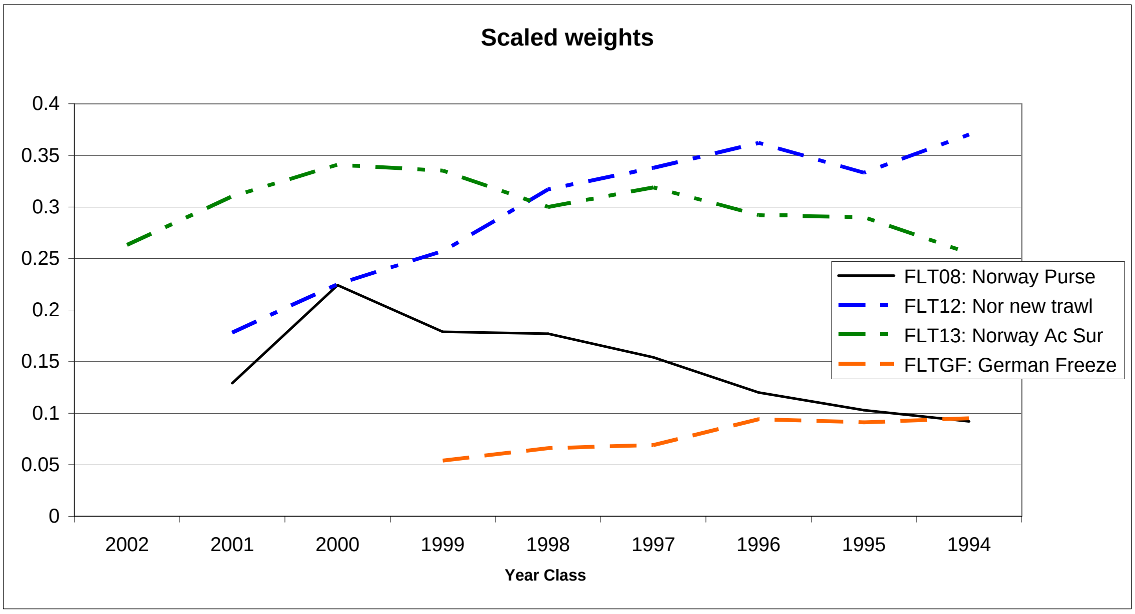


Figure 5.4.23 Scaled weights at age from combined XSA with 4 fleets.

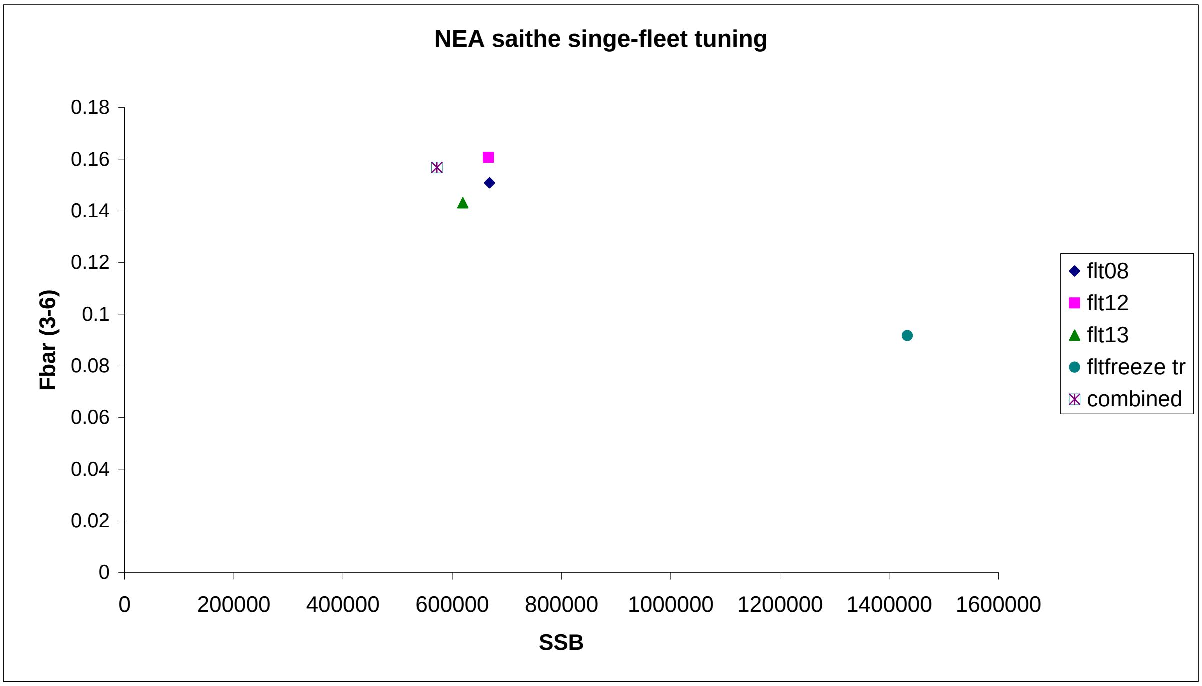


Figure 5.4.24 Comparison of SSB and F3-6 in 2004 from four single fleet and combined XSA runs

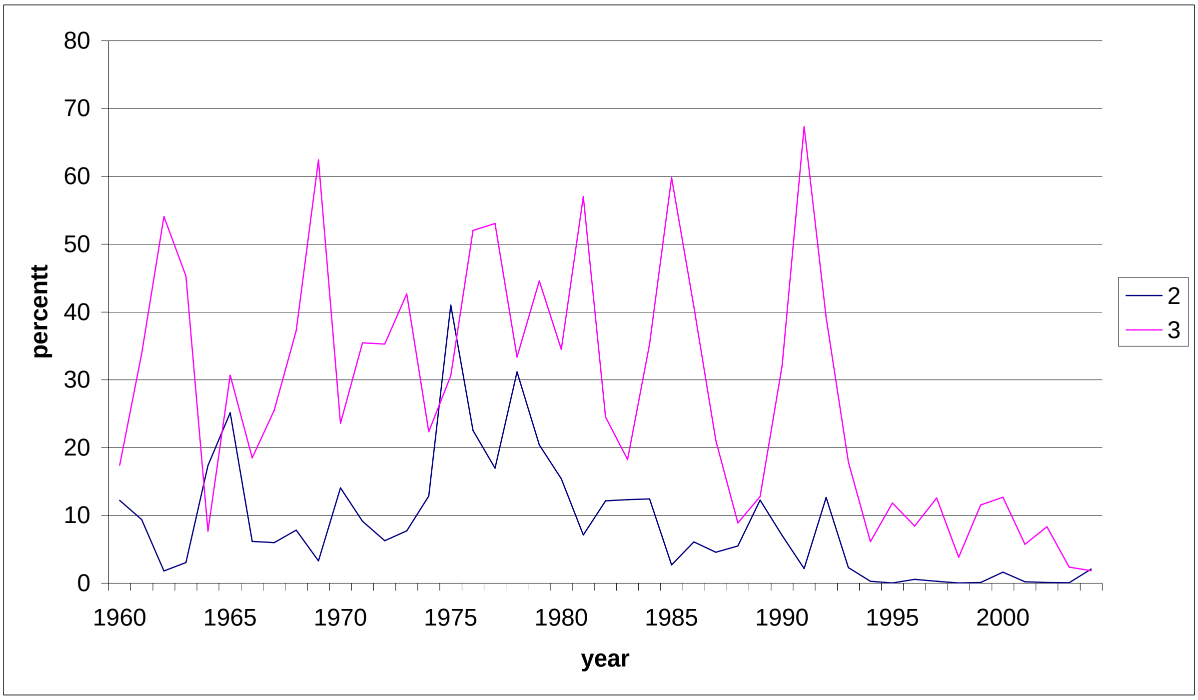


Figure 5.4.25 Catch in percent by numbers of 2 and 3-Year olds 1960-2004

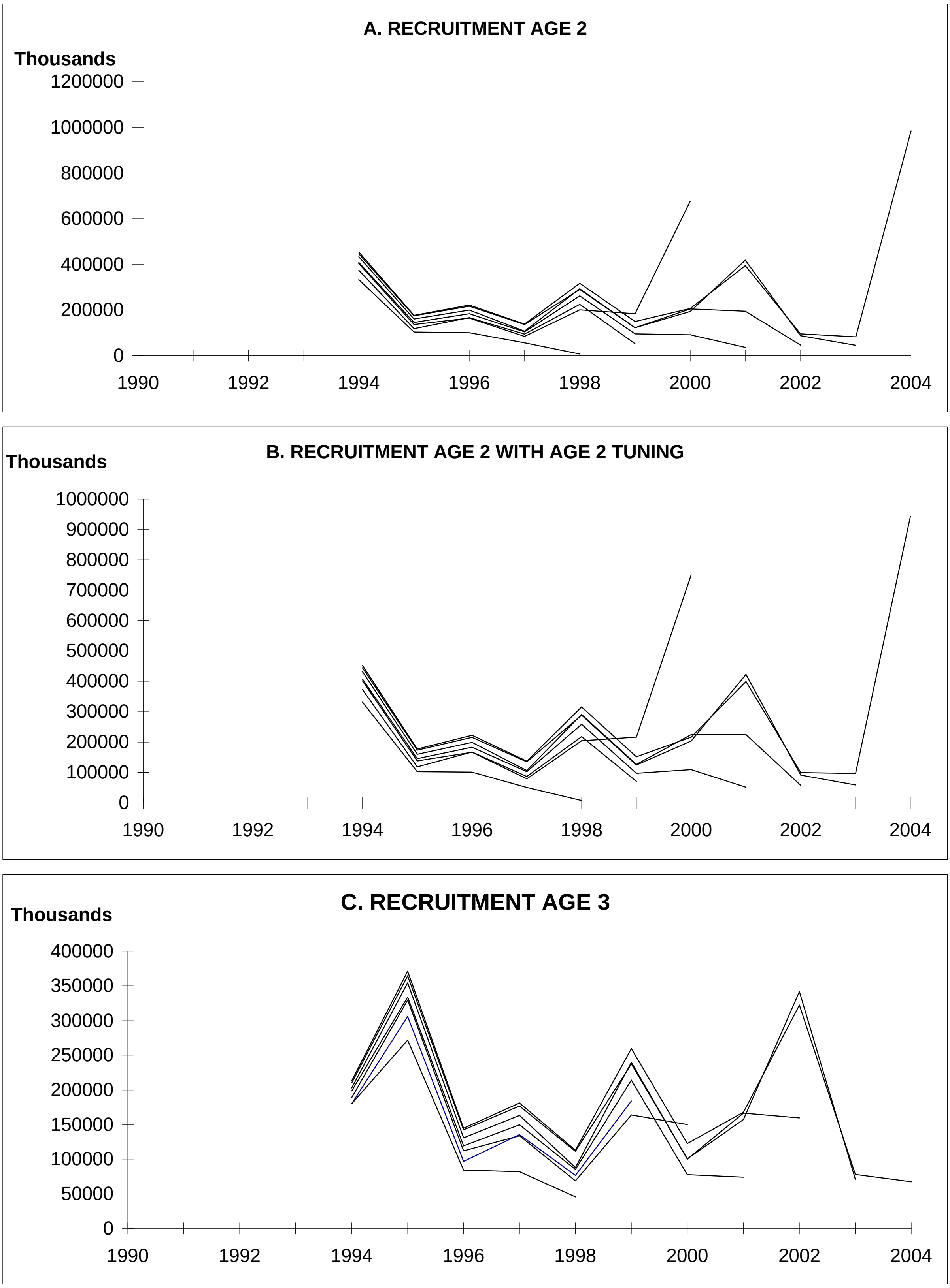


Figure 5.4.26a-c **NeA Saithe retro XSA recruitment age 2 - 3**

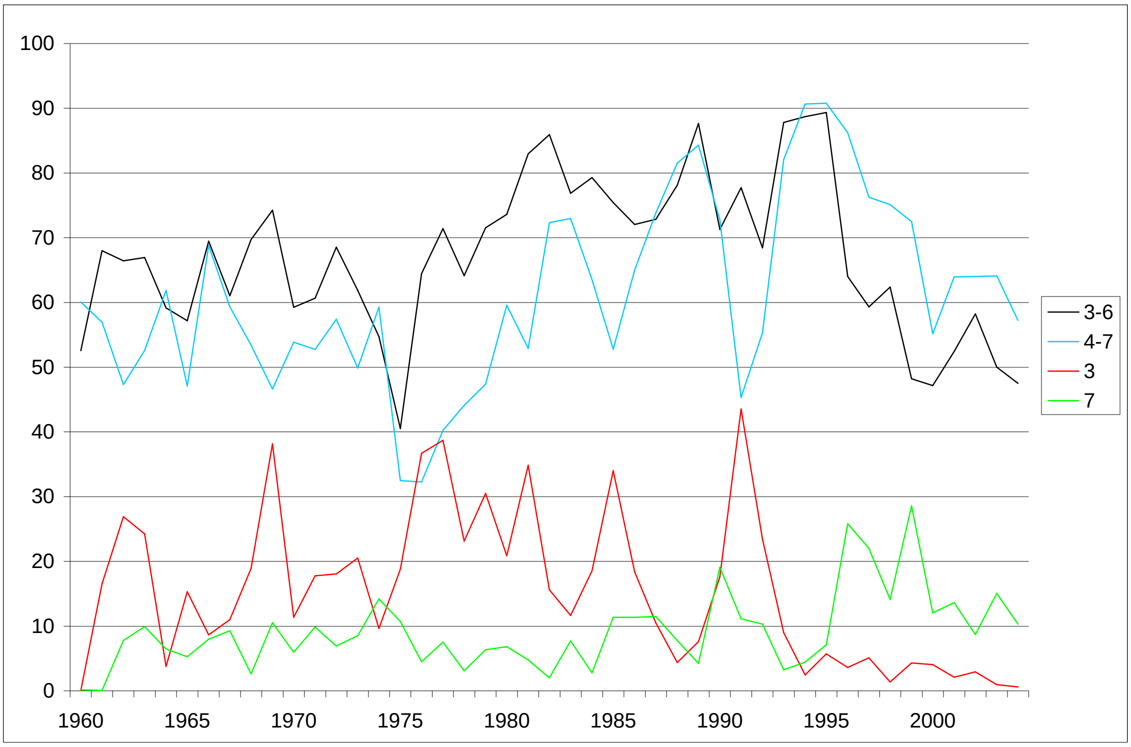


Figure 5.4.27. Northeast Arctic saithe. Percentage contribution to the total stock biomass estimate of ages 3-6, 4-7, 3 and 7

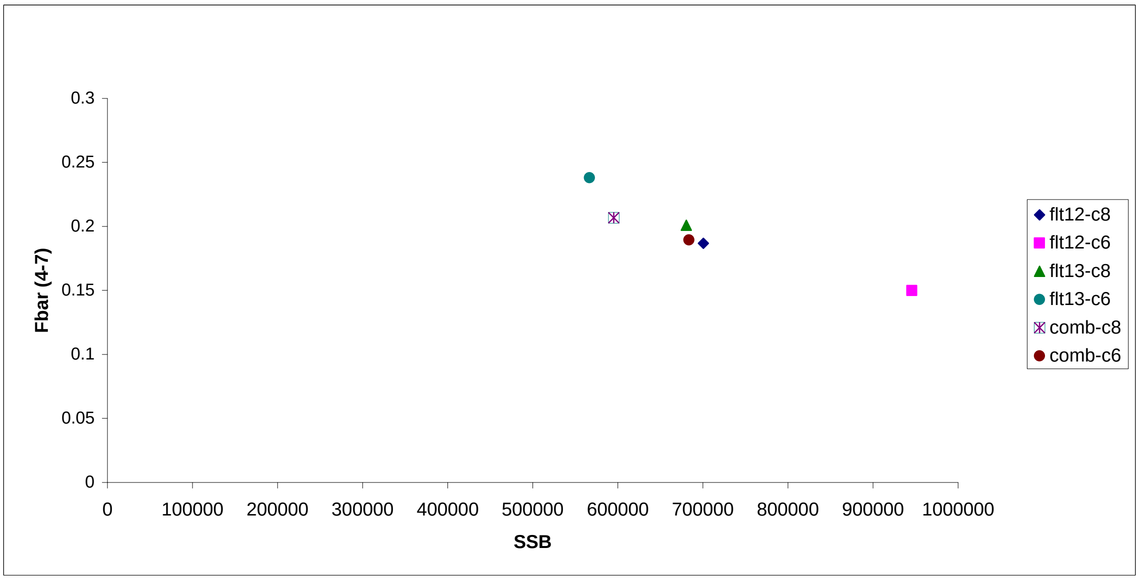


Figure 5.4.28 Comparison of SSB and F3-6 in 2004 from two single fleet and combined XSA runs analysing catchability plateau

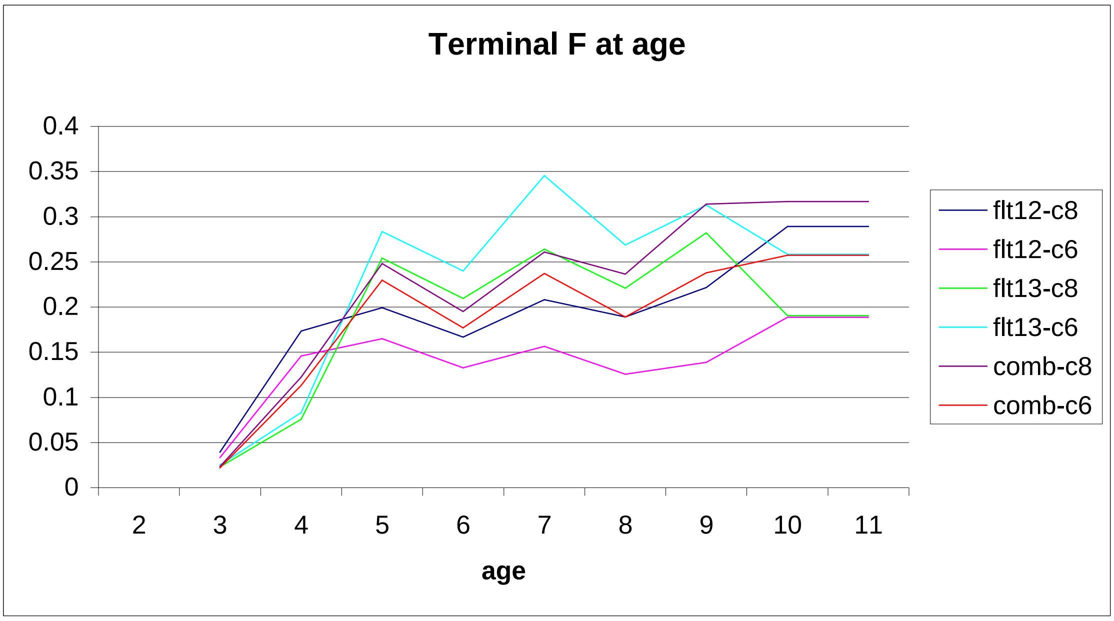
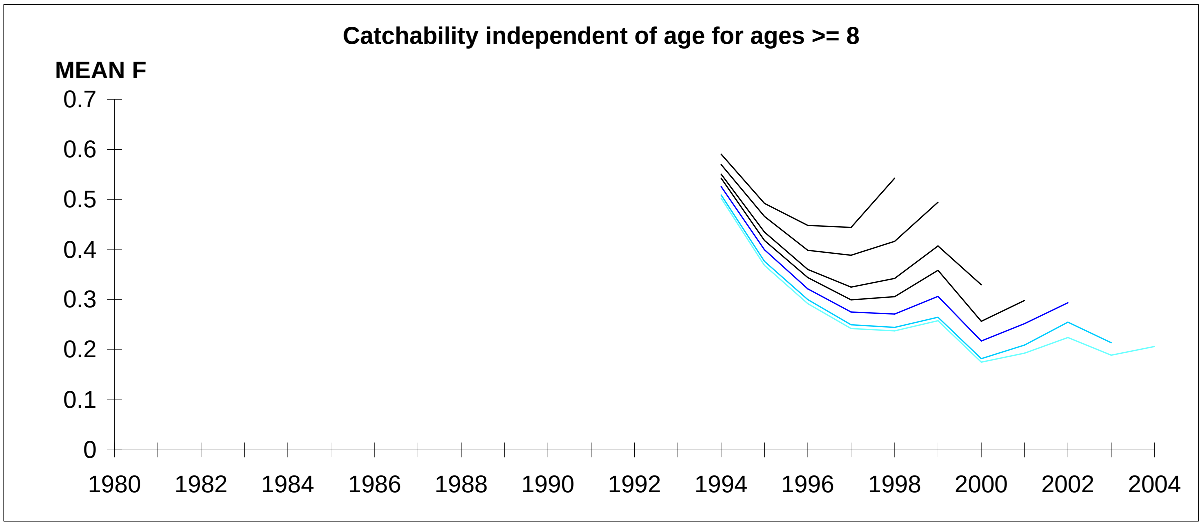


Figure 5.4.29 Terminal F at age in 2004 from two single fleet and combined XSA runs analysing catchability plateau

(Shrinkage SE=0.5) **P-shrinkage ON**



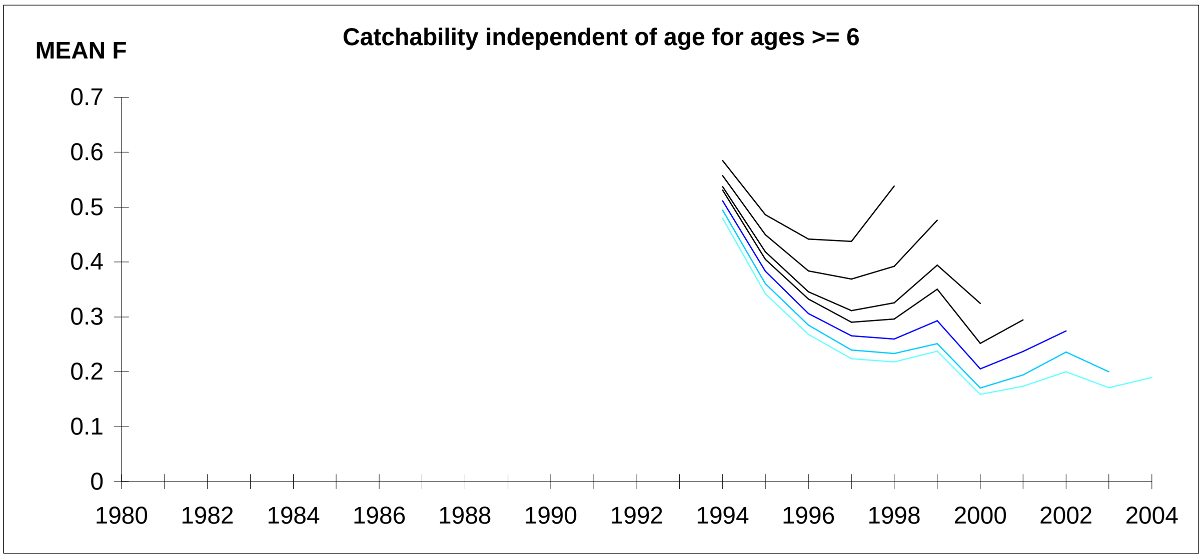


Figure 5.4.30 NeA Saithe RETROSPECTIVE XSA Fbar all fleets analysing catchability plateau

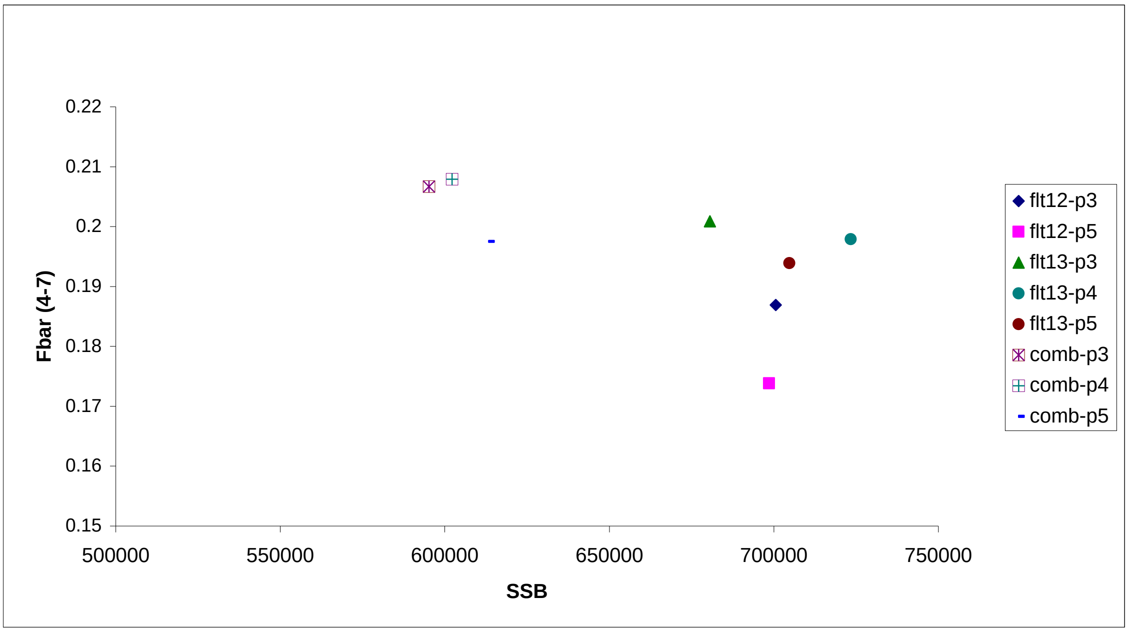
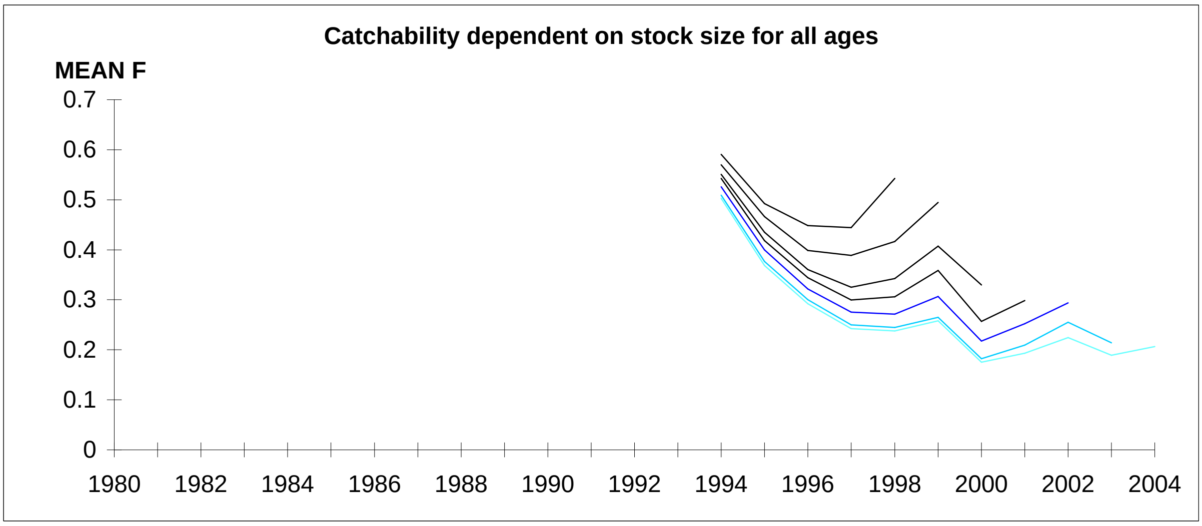


Figure 5.4.31 Comparison of SSB and F3-6 in 2004 from two single fleet and combined XSA runs analysing stock size dependent catchbility



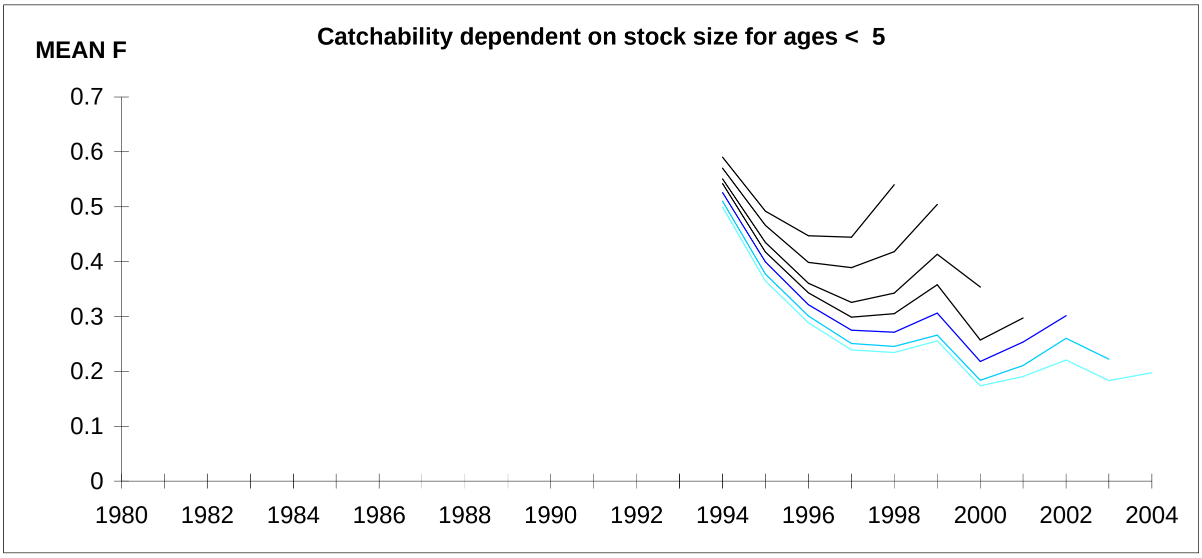


Figure 5.4.32 NeA Saithe RETROSPECTIVE XSA Fbar all fleets analysing stock size dependent catchability

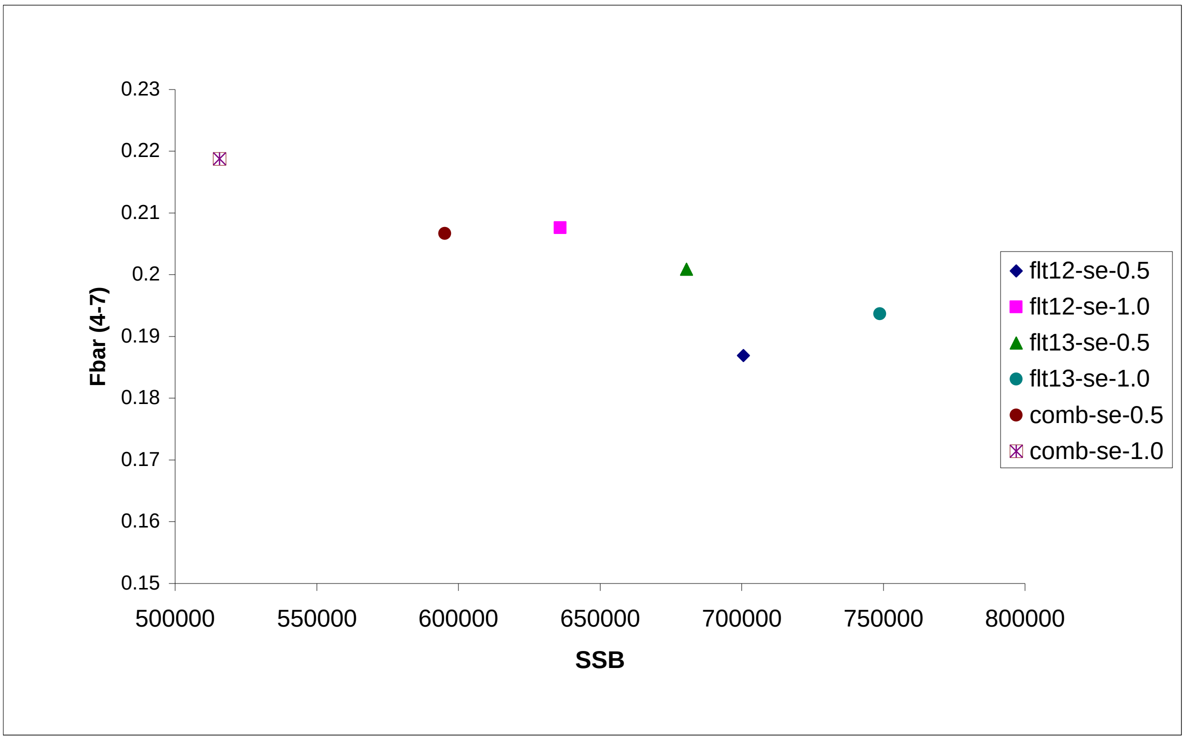


Figure 5.4.33 Comparison of SSB and F3-6 in 2004 from two single fleet and combined XSA runs analysing S.E. of mean to which the estimates are shrunk

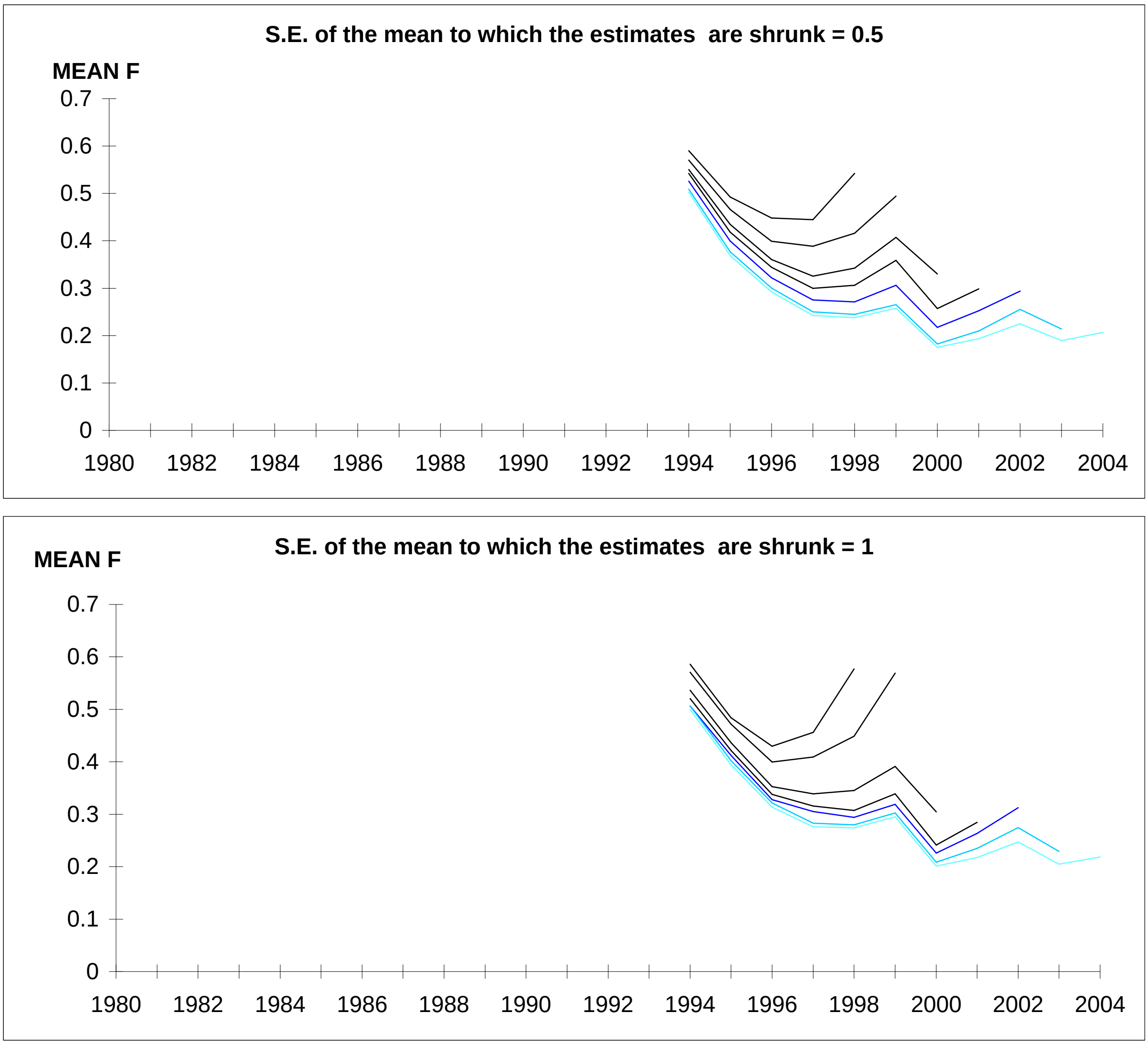


Figure 5.4.34 NeA Saithe RETROSPECTIVE XSA Fbar all fleets analysing
S.E. of the mean to which the estimates are shrunk

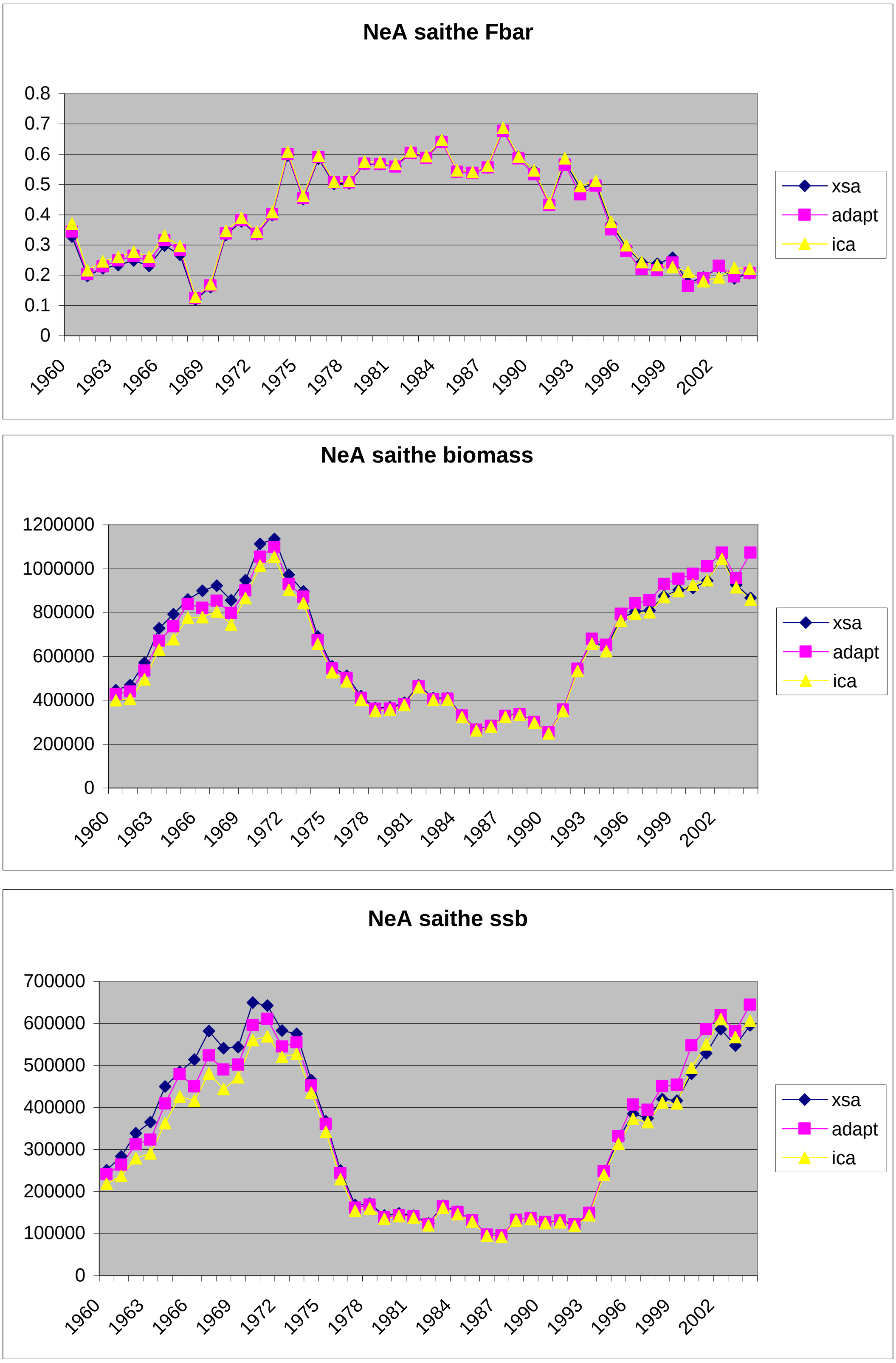


Figure 5.4.35 Comparison of Fbar, TSB and SSB from three models, XSA, ICA and ADAPT

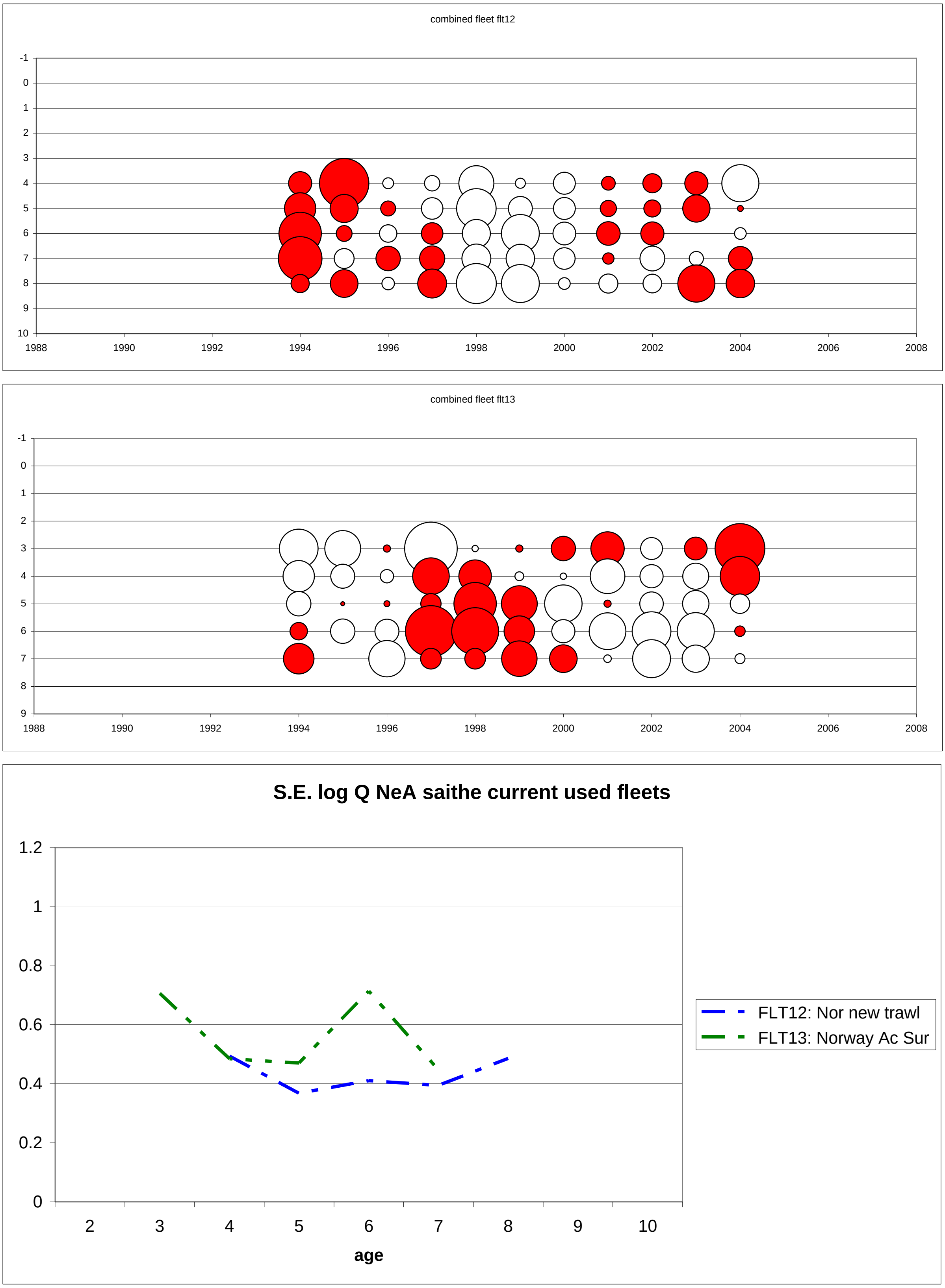


Figure 5.5.1. Final XSA run log Q residuals and S.E. Log Qs

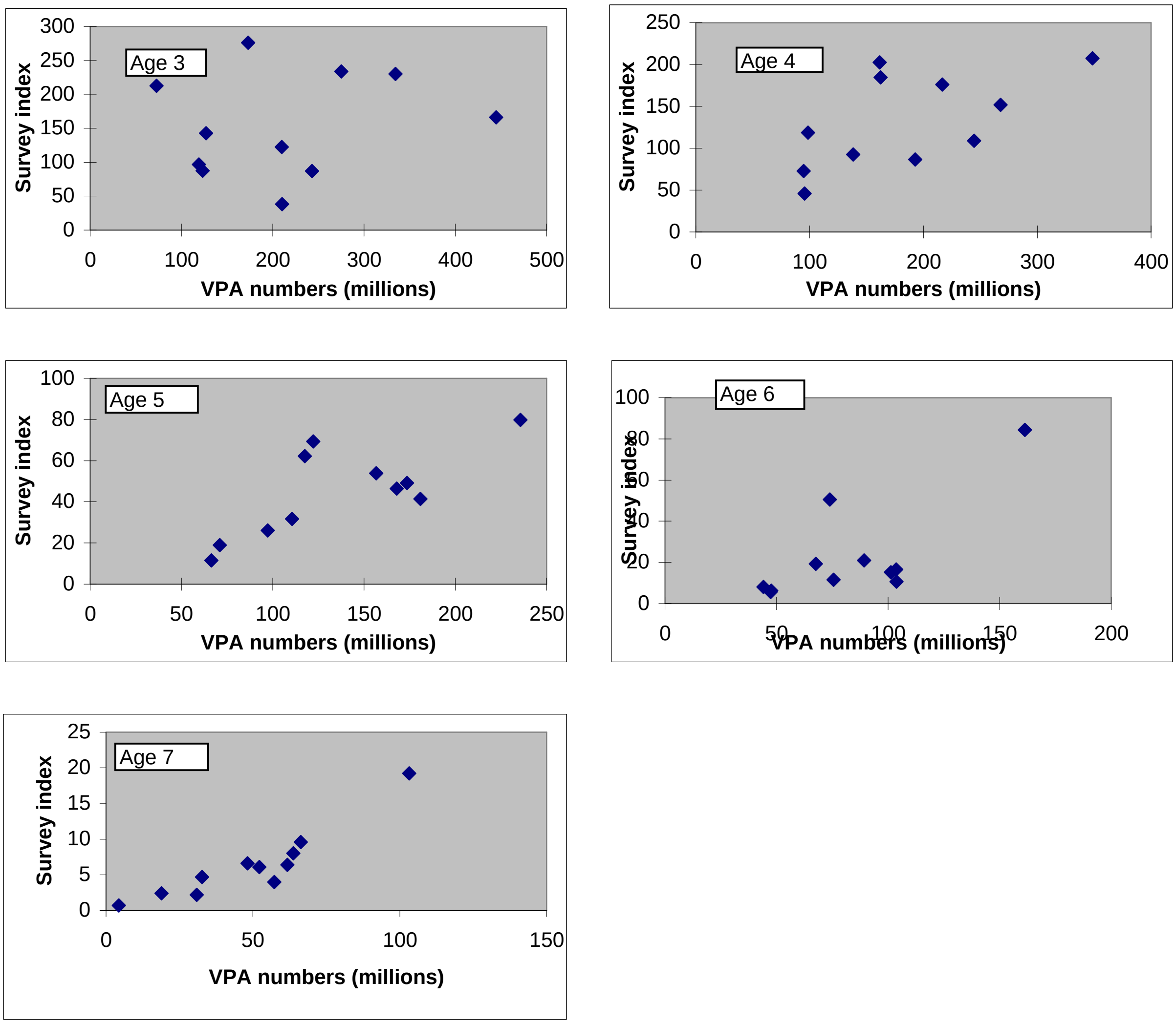


Figure 5.5.2A. North-East Arctic Saithe - Acoustic survey vs VPA

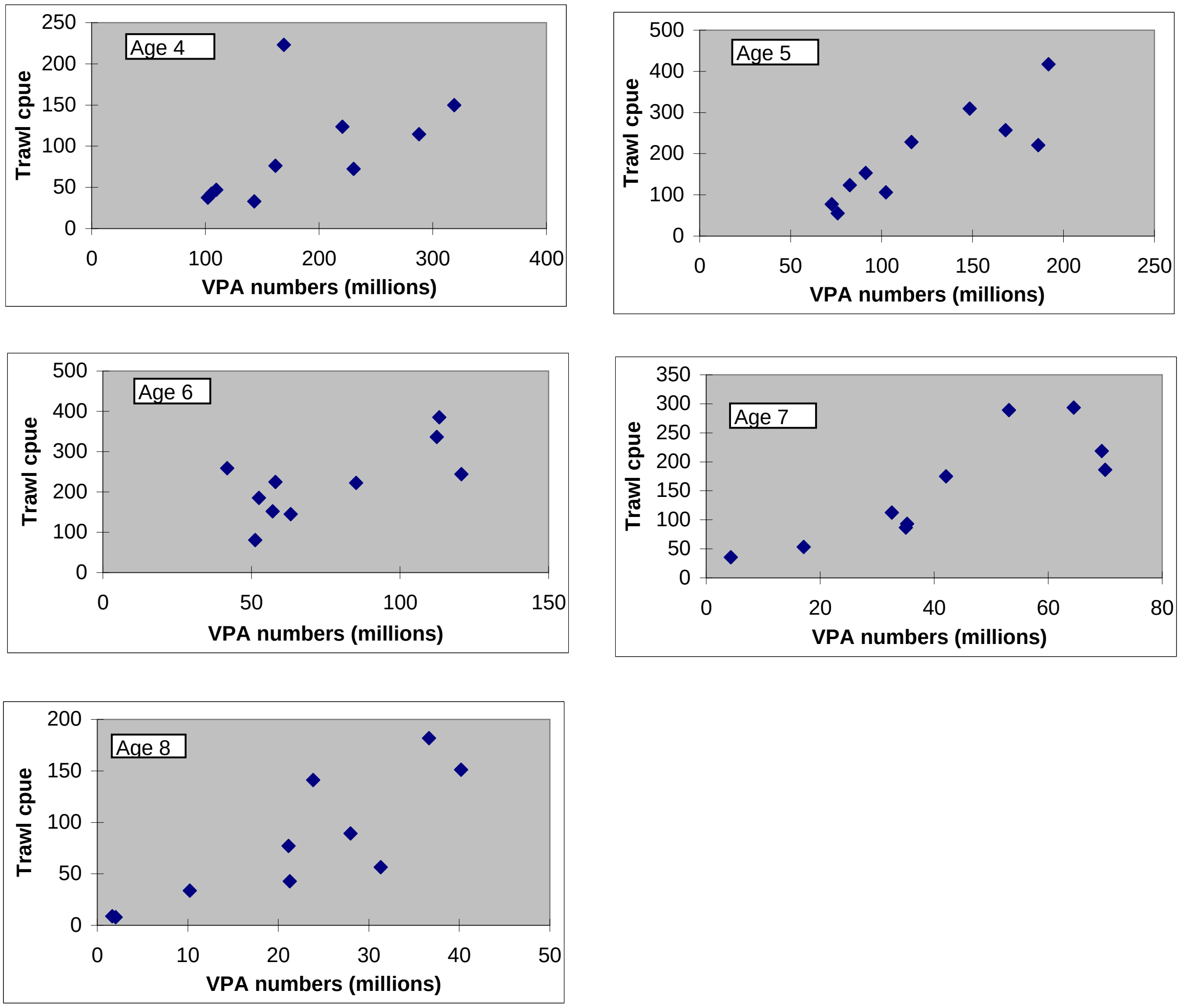
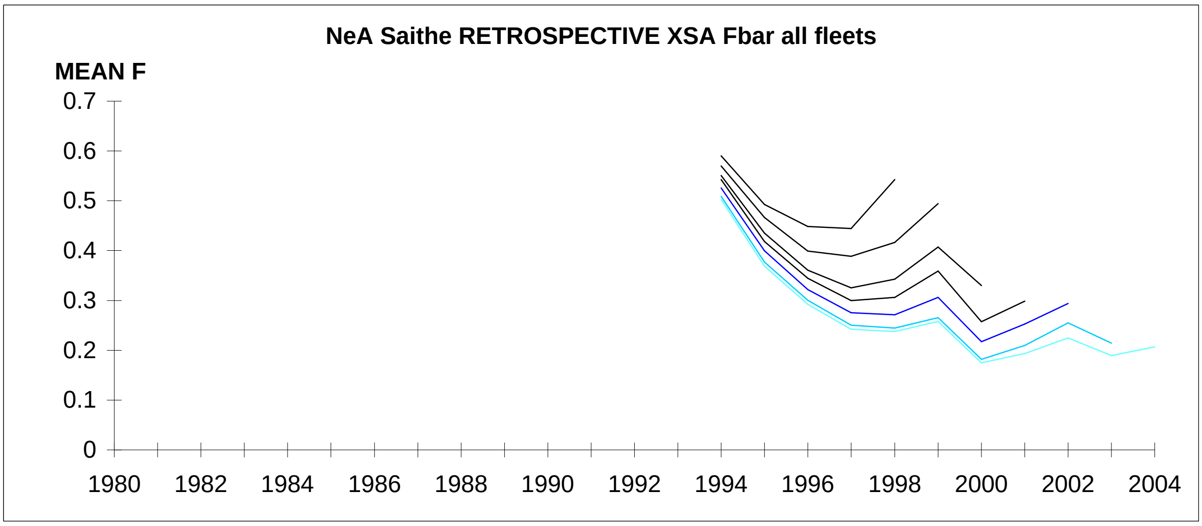
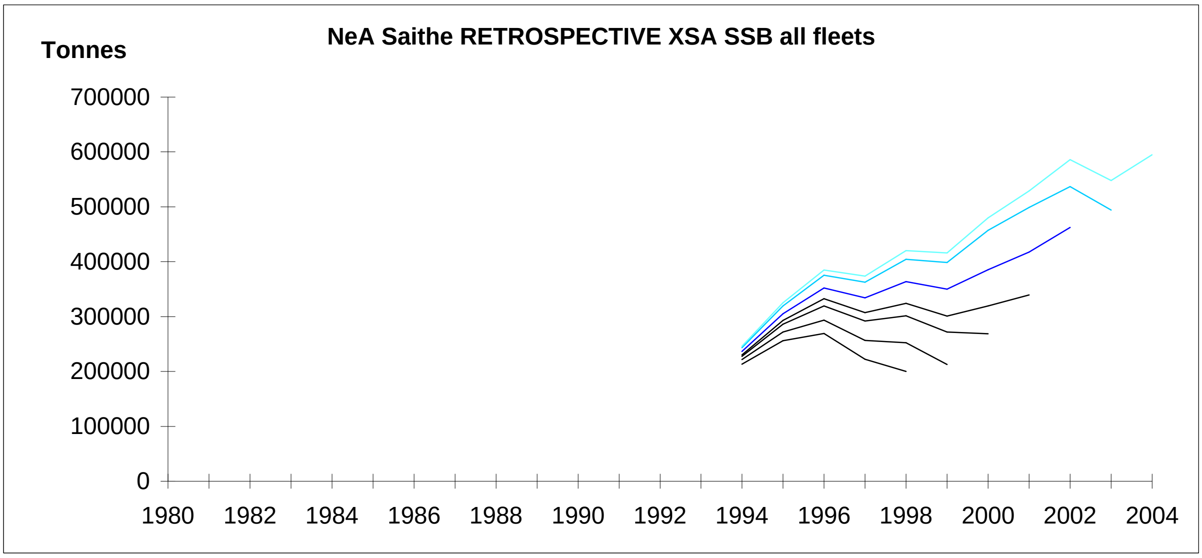


Figure 5.5.2B. North-East Arctic Saithe - Norwegian trawl vs VPA





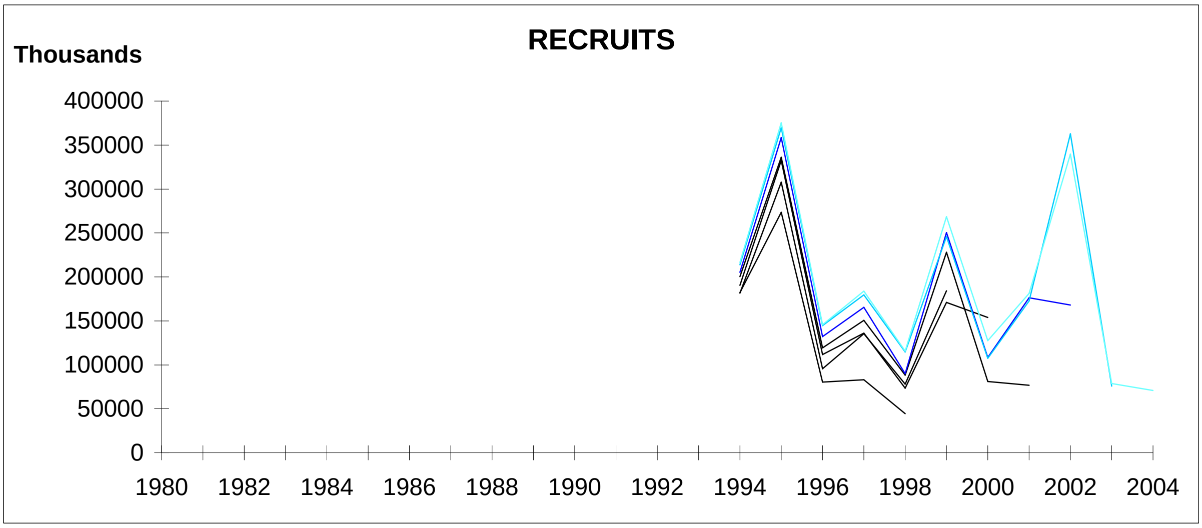


Figure 5.5.3 Retrospective final XSA analyses Fbar, Recruits at age 3 and SSB

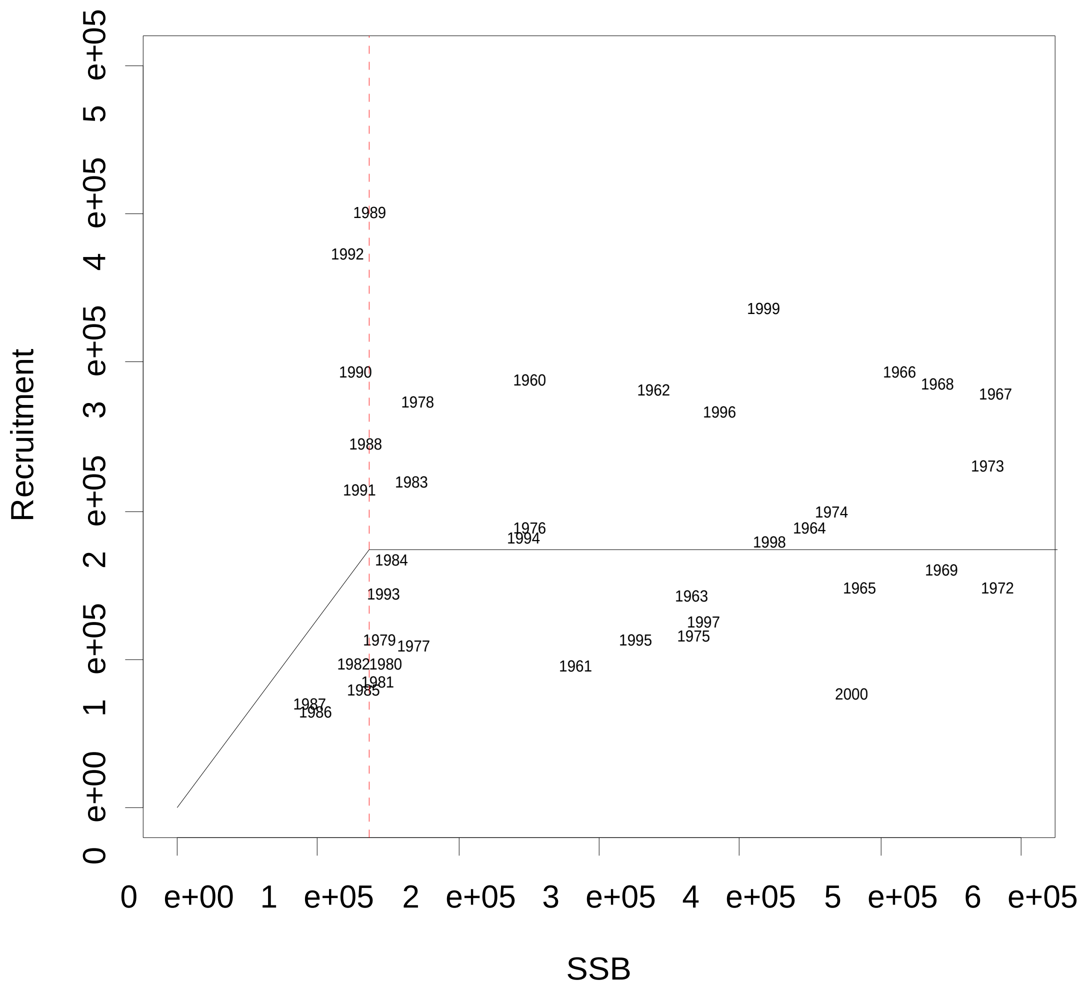


Figure 5.6.1. Segmented regression analysis for Northeast Arctic saithe SSB-recruitment

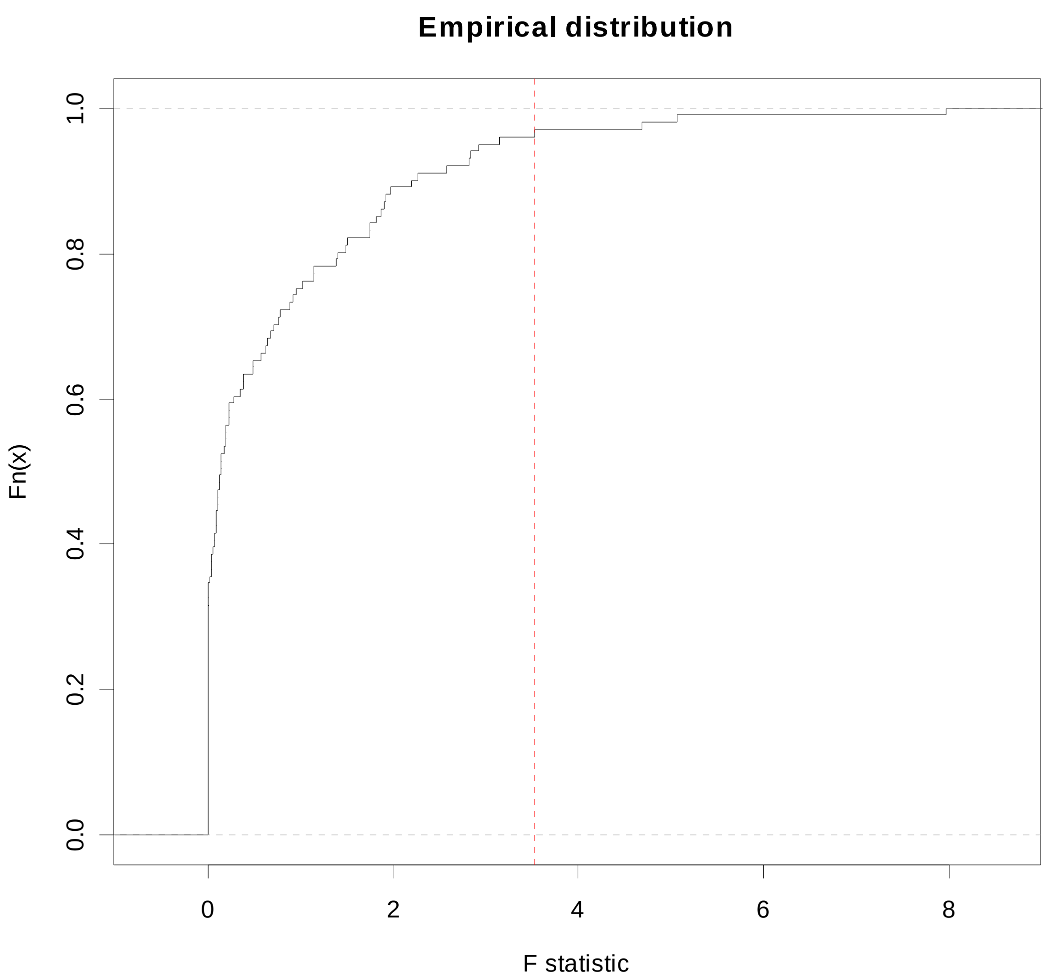


Figure 5.6.2. Significant level of change point from segmented regression on SSB-R pairs.

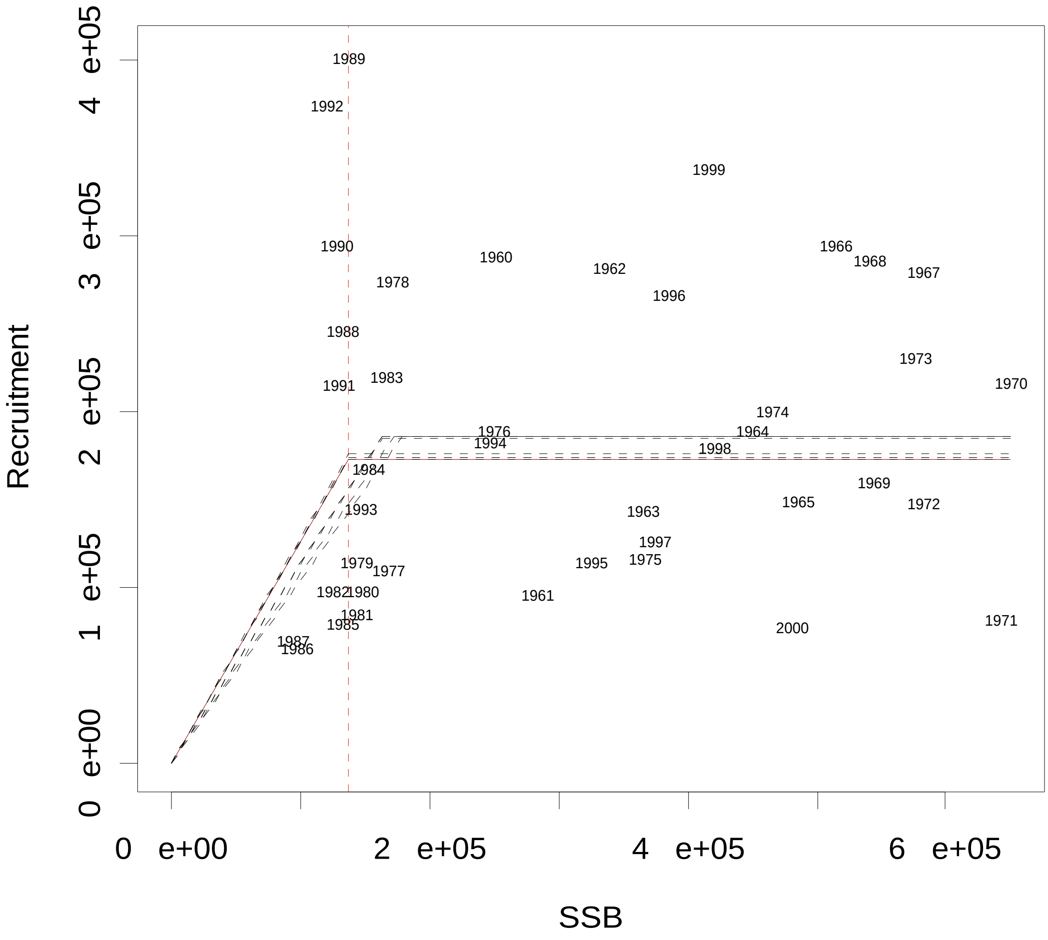


Figure 5.6.3. Result of dropping one by one of the last ten years in Segmented regression analysis of Northeast Arctic saithe SSB-recruitment.

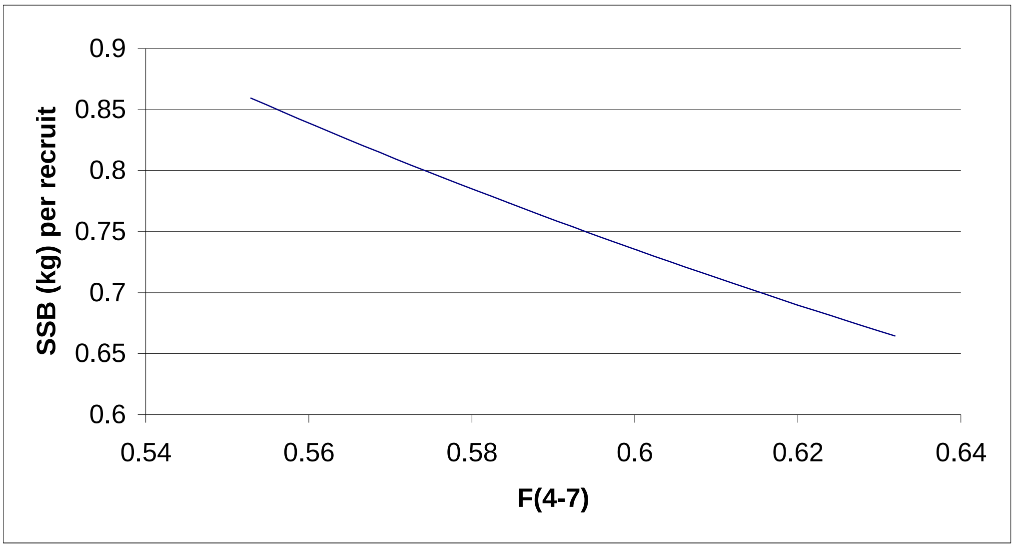


Figure 5.6.4 SSB per recruit versus Fbar used for Flim estimation

6 *Sebastes Mentella* (Deep-sea Redfish) in sub-areas I and II

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 first time, reported landings of *S. mentella* taken in the pelagic Russian fishery for herring and blue whiting in the Norwegian Sea were reported to the working group. Of a total Russian catch of 2,879 tonnes in 2004, 1,510 tonnes (52%) were reported taken as bycatch in these pelagic fisheries. Information about geographic positions, depth and length distribution were provided by Russian observers on board (Table D9 and Figure 6.2.). 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 other species into meal production.

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 the AFWG (WD 18). 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.

6.1.3 Landings prior to 2005 (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* and *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 1965-2004 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 to provisionally 4,914 tonnes in 2004 is mainly caused by Russia, and explained by the pelagic bycatches in their herring and blue whiting fisheries, and an increase of *S. mentella* taken as bycatch in the international cod fisheries in Division IIb.

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 360 t in 2004 (Table D2).

6.1.4 Expected landings in 2005

There will be no directed fishery for *S. mentella* in 2005, and all the current regulations will be continued in 2005. Based on the present regulations, and reports from the first months in 2005, the total landings of *S. mentella* for 2005 are expected to be maximum **4,000 t,** also taking possible bycatches in the pelagic blue whiting and herring fisheries into account.

6.2 Data used in the Assessment

All input data sets were updated up to and including 2004.

6.2.1 Catch at age (Table 6.5)

Catch at age for 2003 was revised according to new catch data. Age data for 2004 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 catch-at-length of these pelagic bycatches was hence converted to catch-at-age by using the Norwegian age-length key from Division IIa (southern part), whereas the Russian catch-at-length of the demersal catches in Division IIa was converted to catch-at-age by using the Norwegian age-length key from Division IIa (northern part). Other countries were assumed to have the same relative age distribution and mean weight as Norway. The available length distribution from Portuguese catches in Division IIb was not included as the mean weight and some of the lengths resembled *S. marinus*.

6.2.2 Weight at age (Table 6.6)

Catch weight-at-age data for 2004 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 1.10, 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 (Table 1.10 and Figure 6.5).

2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December from 1978–2004 in fishing depths of 100–900 m (Table D3, Figure 6.6).

3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1986–2004 in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2004 (Table D4a,b).

4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2005 (joint with Russia since 2000) in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2004 (Tables D5a,b).

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area. This has been done in Figures 6.7a,b.

5) A new Norwegian survey designed for redfish and Greenland halibut covers the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen in August 1996-2004 from less than 100 m to 500 m depth (Table D6, Figures 6.8-6.9). This survey includes survey no. 3 above.

6) Russian acoustic survey in April-May from 1992–2001 (except 1994 and 1996) on *S. mentella* spawning grounds in the western Barents Sea (Table D7).

A considerable reduction in the abundance of 0-group redfish has been observed since 1991: abundance decreased to only 20% of the 1979–1990 average. With the exception of an abundance index of twice the 1991-level in 1994, the indices have remained very low. Record low levels of less than 20% of the 1991–1995 average have been observed for the 1996-1999 year classes. The 2000 year class was stronger than the preceding four year classes, whereas the estimate of the 2001-2004 year classes are among the lowest on record.

Results from the Norwegian ecosystem survey (Table D6 and Figure 6.8) 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 decrease of *S. mentella* for ages 8 and older (i.e., larger than about 27 cm) was especially noticeable in the Svalbard part of the survey. It cannot be excluded that this decrease may be related to the increase of *S. mentella* observed in the pelagic fisheries in the Norwegian Sea.

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, however, very similar in the Russian and Norwegian surveys. However, both the Russian survey back to 1977 and results from combining the Norwegian Barents Sea February and the Svalbard August surveys back to 1986 (Figure 6.7) 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 1.3, 1.4).

Russian acoustic surveys estimating the commercial sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. Table D7 shows a 43% decrease in the estimated spawning stock biomass in 1997 to a low level that was observed up to 2000 inclusive. The strong 1982-year class migrating west-southwest and out of the surveyed area could explain this. The next year classes expected to contribute significantly to the spawning stock (i.e., the 1987–1990 year classes) are now more than 50% mature (males before females), and these year classes contributed in the 2001 survey to a three fold increase in the survey abundance of mature fish (Table D7). This is the only survey targeting commercial sized *S. mentella*, but only a limited area of its distribution. 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 continues to decline.

Any improvement of the stock condition is not expected until a significant increase in spawning stock biomass has been detected in surveys with a following increase in the number of juveniles. As long as the recruitment of new year classes is very poor and no signs of improved recruitment have appeared, it is of crucial importance that the 1987–1990 year classes (approx. 34–39 cm) which currently have recruited more than 75% to the spawning stock are protected.

It is also of vital importance that the younger recruiting year classes be given the strongest possible protection from being taken as by-catch in any fishery, e.g., the shrimp fisheries in the Barents Sea and Svalbard area. This will ensure that they can contribute as much as possible to the stock rebuilding.

6.4 Comments to the assessment

The survey series may still be improved further, and it is imperative for good results that valuable research survey time series are continued, and that Norwegian and Russian research vessels get full access to each other's exclusive economic zones. With great restrictions on the *S. mentella* fishery, it is even more important that surveys are conducted to cover the entire area of this stock's distribution.

6.5 Biological reference points

Last year, the AFWG suggested that 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 would be expressed in biomass units (SSB or fishable stock). The present time series are considered to be too short to do this, but work has now been initiated to present the survey time series also in biomass units (also as SSB and 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 in the SSB at old age (e.g. 10 years old) and surveys indicate failure of recruitment over a long 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 the shrimp trawling may therefore still be delaying the necessary re-building of the *S. mentella* stock. It may therefore be considered to decrease the number of redfish allowed to catch per 10 kg shrimp since the current criterion seldom results in extra protection of redfish as long as the redfish year classes are weak.

As long as the recruitment of new year classes is very poor and no signs of improved recruitment have appeared, it is of crucial importance and urgent that the 1987–1990 year classes (approx. 34–39 cm) which currently have recruited more than 75% to the spawning stock are protected. The Working Group is therefore satisfied with the stronger regulations enforced in the trawl fisheries from 1 January 2003 onwards 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.

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.

ACFM requests the working group to get estimates of bycatch of redfish in the shrimp fisheries. The working group has answered this request in WD-18 and in chapter 6.1.2 for the Norwegian shrimp fishery during 1983-2002. The working group plan to update this information annually, and to include the other national shrimp fishing fleets to get a total annual estimate by length (and age).

Concerning ACFM's request and recommendations regarding biological reference points, the working group refers to chapter 6.5.

Table 6.1 Sebastes mentella. Nominal catch (t) by countries in Sub-area I, Divisions IIa and IIb combined.

Year	Canada	Denmark	Faroe Islands	France	Germany[3]	Greenland	Ireland
1986	-	-	-	-	1,252	-	-
1987	-	-	200	63	1,321	-	-
1988	No species specific data available by country.						
1989	-	-	335	1,111	3,833	-	-
1990	-	-	108	142	6,354	36	-
1991	-	-	487	85	-	23	-
1992	-	-	23	12	-	-	-
1993	8	4	13	50	35	1	-
1994	-	28	4	74	18	1	3
1995	-	-	3	16	176	2	4
1996	-	-	4	75	119	3	2
1997	-	-	4	37	81	16	6
1998	-	-	20	73	100	14	9
1999	Iceland	-	73	26	202	50	3
2000	48	Estonia	50	12	62	29	1
2001	3	-	52	16	198	17	4
2002	41	15	53	58	99	18	4
2003	5	-	8	18	32	8	5
2004[1]	10	-	52	13	10	4	3

Year	Norway	Poland	Portugal	Russia[4]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1986	1,274	-	1,273	17,815	-	84	-	23,112[2]
1987	1,488	-	1,175	6,196	25	49	1	10,455
1988	No species specific data available by country.							15,586
1989	4,633	-	340	13,080	5	174	1	23,512
1990	10,173	-	830	17,355	-	72	-	35,070
1991	33,592	-	166	14,302	1	68	3	48,727
1992	10,751	-	972	3,577	14	238	3	15,590
1993	5,182	-	963	6,260	5	293	-	12,814
1994	6,511	-	895	5,021	30	124	12	12,721
1995	2,646	-	927	6,346	67	93	4	10,284
1996	6,053	-	467	925	328	76	23	8,075
1997	4,657	1	474	2,972	272	71	7	8,598
1998	9,733	13	125	3,646	177	93	41	14,045
1999	7,884	6	65	2,731	29	112	28	11,209
2000	6,020	2	115	3,519	87		130[5]	10,075
2001	13,975[1]	5	179	3,775	90		120[5]	18,434
2002	2,129[1]	8	242	3,904	190	Sweden	188[5]	6,949
2003	1,222[1]	7	44	952	47	-	124[5]	2,471
2004[1]	1,331	42	235	2,879	257	1	76[5]	4,914

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.

5UK(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[1]	292	-	-	298
2004[1]	-	-	-	3	355	-	-	358

1 Provisional figures.

2 Split on species according to reports to Norwegian authorities.

3 Based on preliminary estimates of species breakdown by area.

4 Includes former GDR prior to 1991.

5 USSR prior to 1991.

Table 6.3 Sebastes mentella. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Norway
1986[3]	-	-	1,252	-	-	-
1987[3]	200	63	970	-	-	149
1988	No species specific data presently available					
1989	312[2]	1,065[2]	3,200	-	-	4,573
1990	98[2]	137[2]	1,673	-	-	8,842
1991	487[2]	72[2]	-	-	-	32,810
1992	23[2]	7[2]	-	-	-	9,816
1993	11[2]	15[2]	35	1[2]	-	5,029
1994	2[2]	33[2]	16[2]	1[2]	2[2]	6,119
1995	1[2]	16[2]	176[2]	2[2]	2[2]	2,251
1996	-	75[2]	119[2]	3[2]	-	5,895
1997	-	37[2]	77	12[2]	2[2]	4,422
1998	-	73[2]	58[2]	14[2]	6[2]	9,186
1999	-	16[2]	160[2]	50[2]	3[2]	7,358
2000	50[2]	11[2]	35[2]	29[2]	-	5,892
2001	33[2]	12[2]	161[2]	17[2]	4[2]	13,673[1]
2002	14[2]	54[2]	59[2]	18[2]	4[2]	1,917[1]
2003	5[2]	17[2]	17[2]	8[2]	5[2]	1,023[1]
2004[1]	17[2]	8[2]	4[2]	4[2]	3[2]	1,026

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]	16,834
2002		124[2]	2,615	8[2]	41[2]	157[2, 6]	5,011
2003		17[2]	448	8[2]	5[2]	102[2, 6]	1,655
2004[1]	1[2]	86[2]	2,081	7[2]	10[2]	18[2, 6]	3,266

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 6.4 Sebastes mentella. Nominal catch (t) by countries in Division IIb.

Year	Canada	Denmark	Faroe Islands	France	Germany[5]	Greenland	Ireland
1986[4]	Data not available on countries						
1987[4]	-	-	-	-	349	-	-
1988	No species specific data presently available						
1989	-	-	10	28	633	-	-
1990	-	-	8[2]	5[2]	4,681	36[2]	-
1991	-	-	-	13[2]	-	23	-
1992	-	-	-	5[2]	-	-	-
1993	8[2]	4[2]	-	35[2]	-	-	-
1994	-	28[2]	-	41[2]	-	-	1[2]
1995	-	-	-	-	-	-	2[2]
1996	-	-	4[2]	-	-	-	2[2]
1997	-	-	4[2]	-	3	1[2]	4[2]
1998	-	-	-	-	42[2]	-	3[2]
1999	-	-	4[2]	10[2]	42[2]	-	-
2000	-	-	-	1[2]	27[2]	-	1[2]
2001	-	-	19[2]	4[2]	37[2]	-	-
2002	-	-	39[2]	4[2]	40[2]	-	-
2003	-	-	3[2]	1[2]	15[2]	-	-
2004[1]	-	-	35[2]	5[2]	6[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	294[1]	5[2]	74[2]	763	72[2]	Estonia	25[2, 7]	1,293
2002	208[1]	8[2]	118[2]	702	182[2]	15[8]	31[2, 7]	1,347
2003	192[1]	7	27[2]	212	39[2]	-	22[2, 7]	518
2004[1]	302	42[2]	149[2]	443	250[2]	-	58[2, 7]	1,290

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.)

8Split 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
AGE														
6	1653	1873	159	738	662	223	125	37	9	1	117	2	6	11
7	5453	2498	159	730	941	634	533	882	83	24	372	40	36	24
8	7994	1898	174	722	1279	1699	1287	2904	441	390	542	252	101	102
9	6781	1622	512	992	719	1554	1247	4236	1511	1235	977	572	91	137
10	8226	1780	2094	2561	740	1236	1297	3995	2250	2460	926	710	130	394
11	5344	1531	3139	2734	1230	1078	1244	2741	3262	2149	1713	532	216	581
12	6227	2108	2631	3060	2013	1146	876	1877	1867	1816	2652	1380	377	837
13	9880	2288	2308	1535	4297	1413	1416	1373	1454	1205	2660	1889	382	499
14	10824	2258	2987	2253	3300	1865	1784	1277	1447	1001	1911	1609	425	1247
15	4049	2506	1875	2182	2162	880	1217	1595	1557	993	1772	850	454	937
16	2105	2137	1514	3336	1454	621	537	1117	1418	932	1219	625	501	853
17	9603	1512	1053	1284	757	498	1177	784	1317	505	714	162	194	805
18	6522	677	527	734	794	700	342	786	658	596	813	236	226	480
+gp	19299	9258	6022	3257	2404	2247	3568	6241	3919	5705	16201	4046	1163	1801
TOTALNUM	**103960**	**33946**	**25154**	**26118**	**22752**	**15794**	**16650**	**29845**	**21193**	**19012**	**32589**	**12905**	**4302**	**8708**
TONSLAND	48727	15590	12866	12721	10284	8075	8597	14045	11209	10075	18434	6949	2471	4913

Table 6.6 Sebastes mentella. Catch weights at age

Catch weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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
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
8	0.21	0.26	0.25	0.24	0.19	0.25	0.25	0.23	0.22	0.22	0.2	0.22	0.22	0.22
9	0.27	0.28	0.28	0.3	0.21	0.31	0.29	0.29	0.28	0.26	0.25	0.29	0.28	0.28
10	0.34	0.31	0.33	0.34	0.28	0.42	0.33	0.33	0.33	0.31	0.3	0.34	0.33	0.33
11	0.35	0.33	0.38	0.37	0.32	0.44	0.38	0.38	0.37	0.36	0.34	0.39	0.39	0.39
12	0.42	0.38	0.44	0.4	0.37	0.47	0.46	0.43	0.44	0.42	0.39	0.44	0.43	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	0.44
14	0.51	0.43	0.5	0.45	0.47	0.67	0.51	0.54	0.53	0.51	0.48	0.53	0.51	0.51
15	0.58	0.43	0.57	0.49	0.53	0.69	0.55	0.59	0.56	0.56	0.53	0.57	0.54	0.55
16	0.59	0.45	0.58	0.55	0.58	0.71	0.6	0.61	0.62	0.62	0.59	0.58	0.59	0.59
17	0.58	0.52	0.62	0.58	0.66	0.74	0.66	0.64	0.66	0.63	0.62	0.62	0.57	0.62
18	0.59	0.57	0.65	0.67	0.71	0.74	0.65	0.66	0.67	0.67	0.65	0.61	0.62	0.64
+gp	0.7	0.67	0.662	0.79	0.806	0.847	0.787	0.753	0.805	0.774	0.695	0.738	0.75	0.72

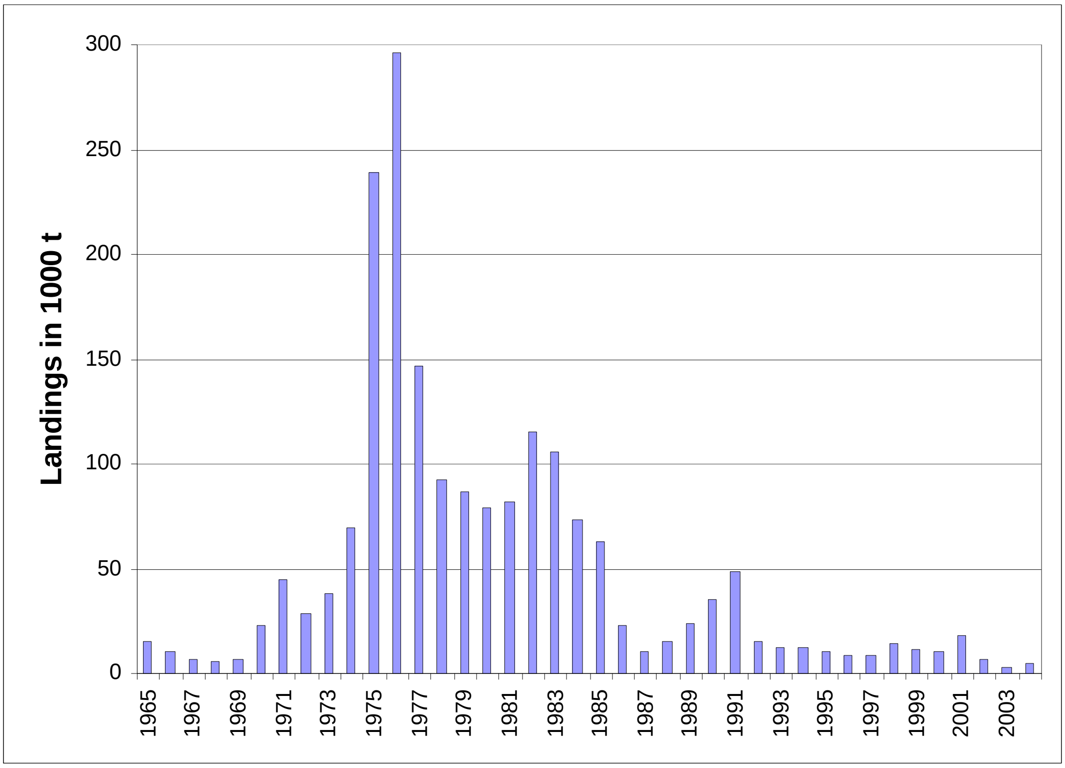


Figure. 6.1. Sebastes mentella in Sub-areas I and II. Total international landings 1965-2004 (thousand tonnes).

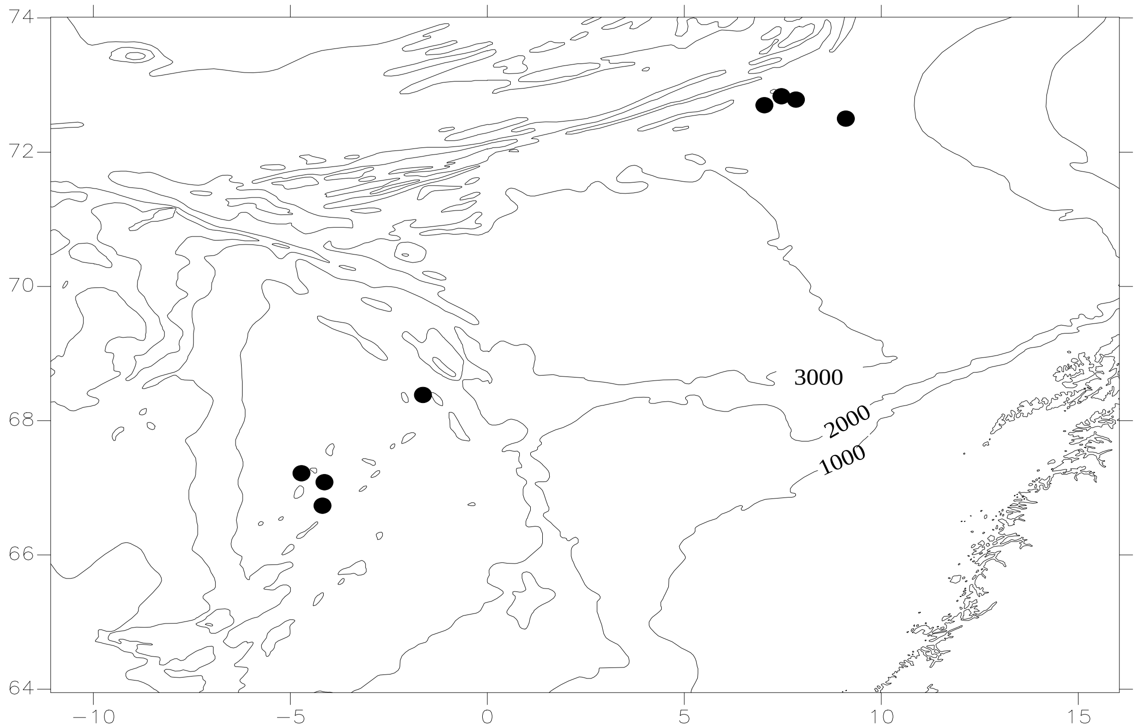


Figure. 6.2. Map showing the geographical positions of the pelagic trawl hauls from which the length samples of S. mentella in Table D9 were collected.

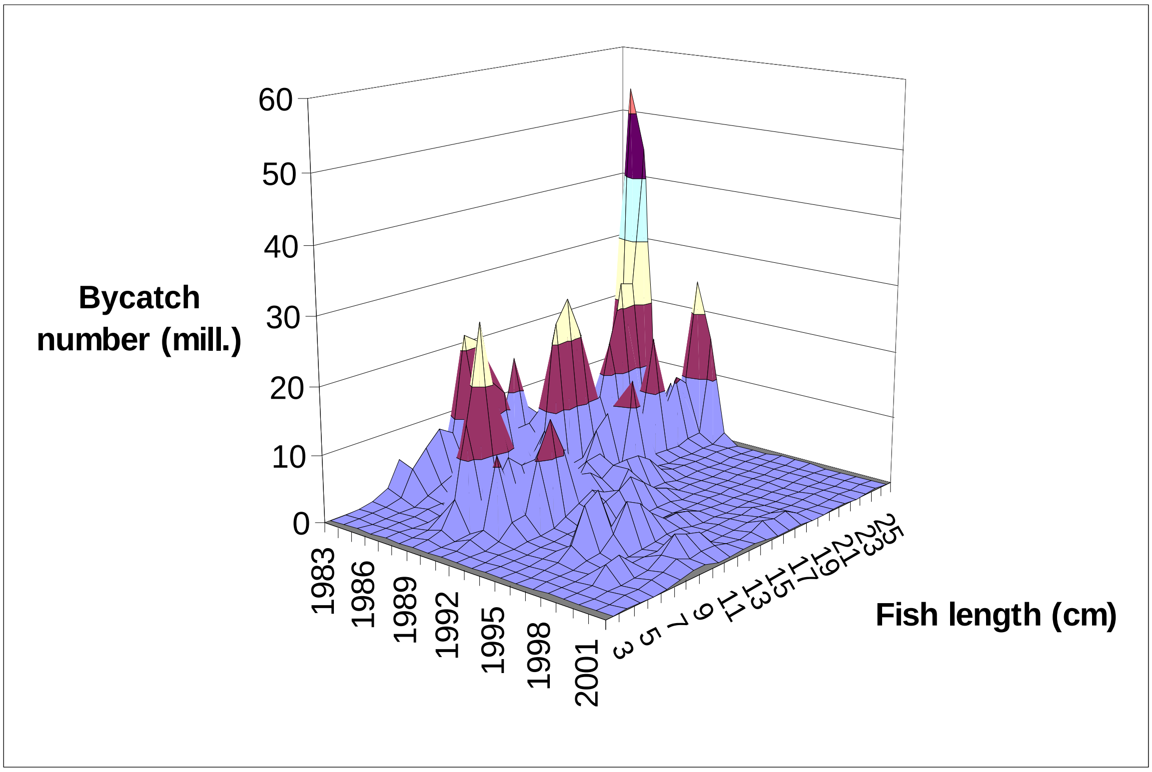


Figure 6.3. Redfish by-catch by year and length group (same data as in Table D10).

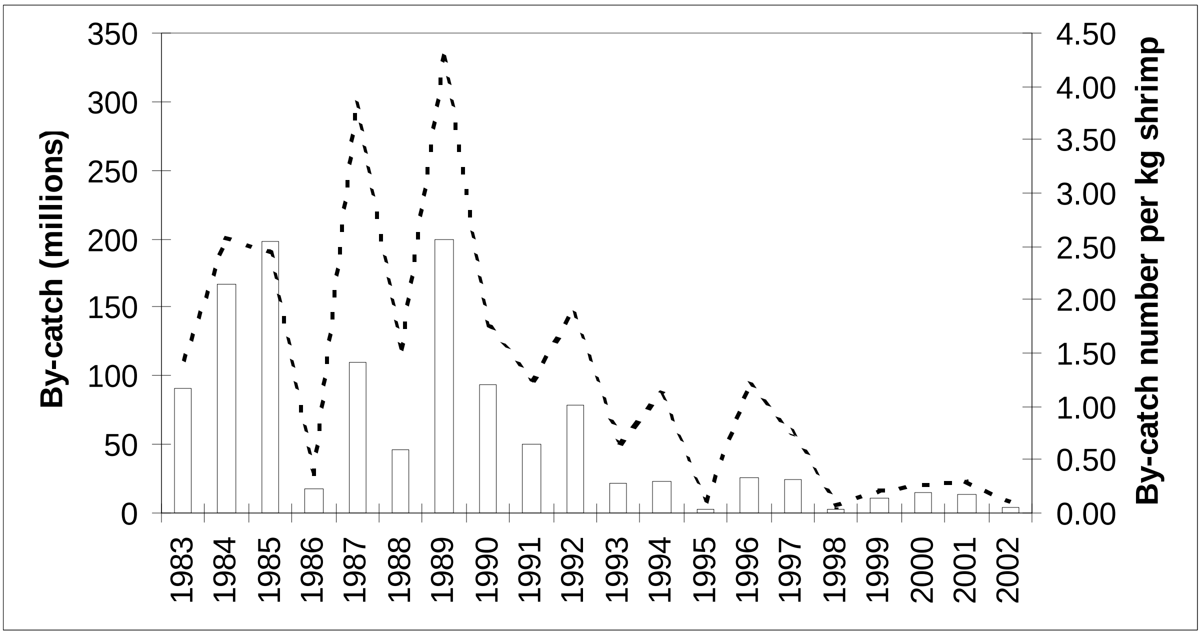


Figure 6.4. Total number of redfish caught by year in the Norwegian shrimp fishery (columns) and bycatch number per kg shrimp (line).

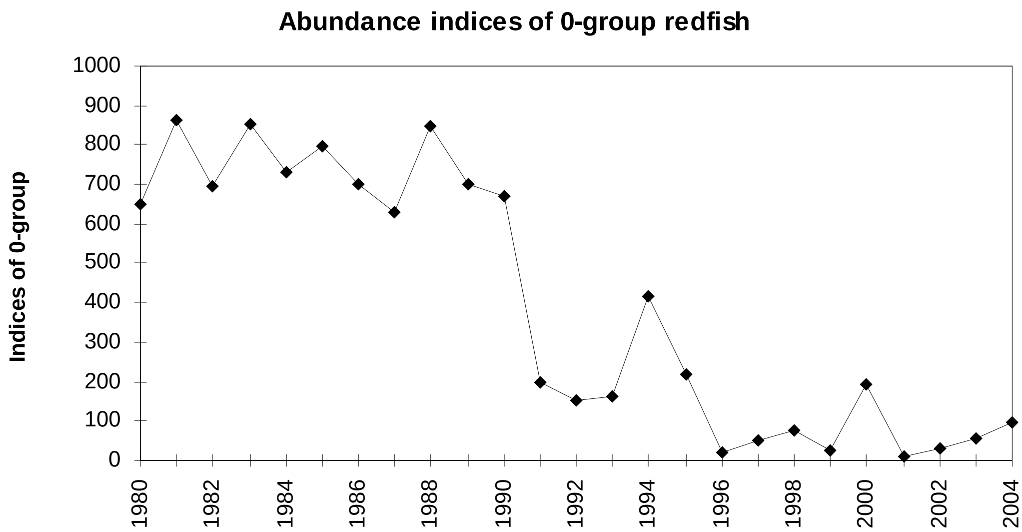


Figure 6.5. Abundance indices of 0-group redfish (believed to be mostly S.mentella) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2004.

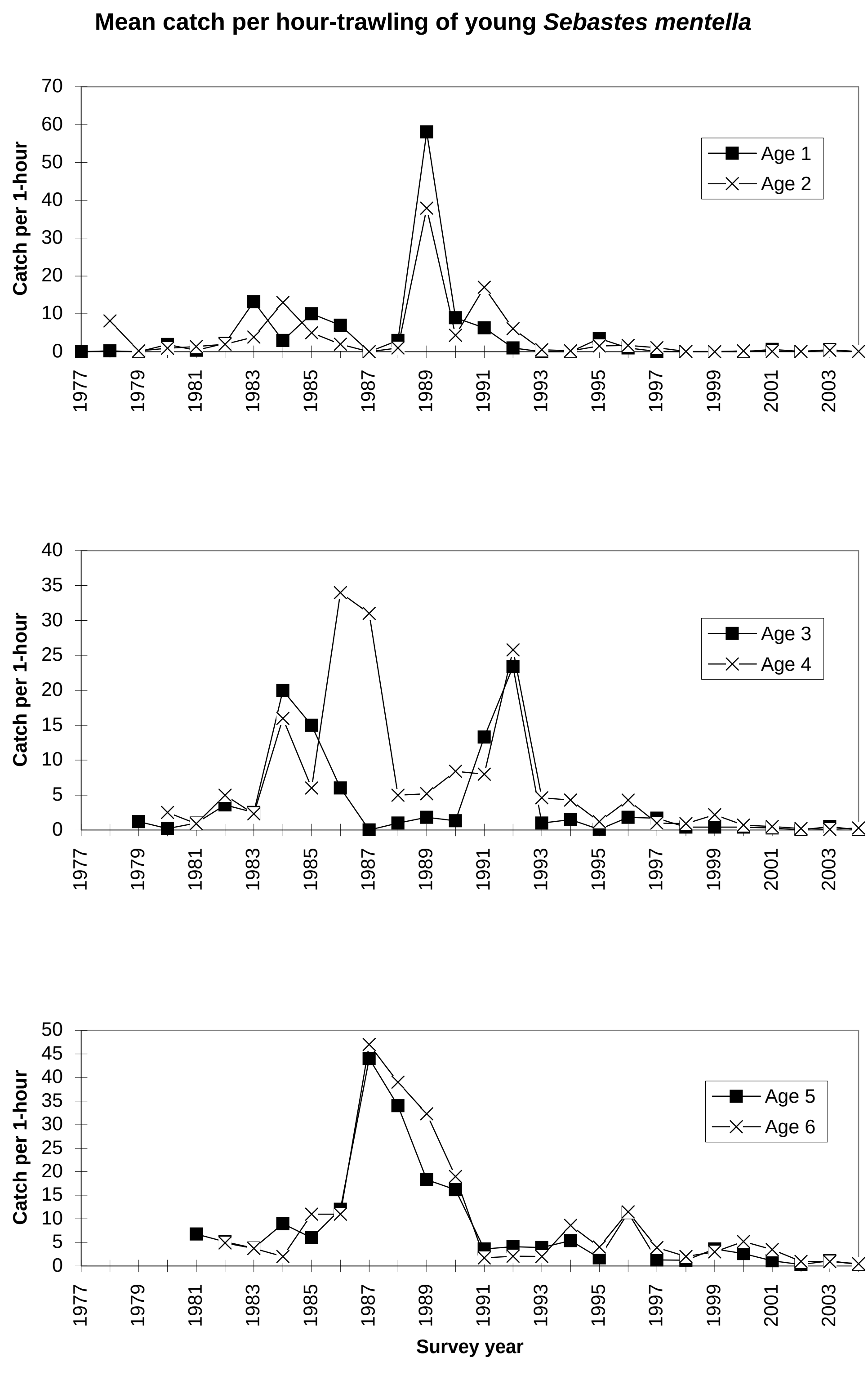
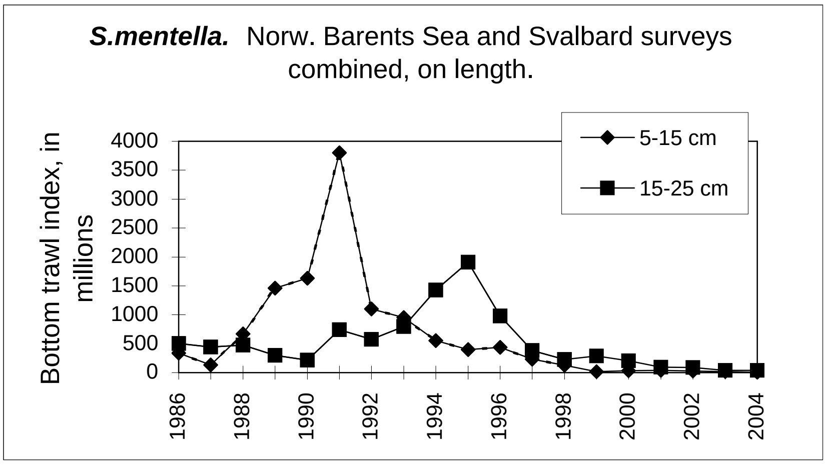


Figure 6.6. Catch (numbers of specimens) per hour trawling of different ages of Sebastes mentella in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D3).



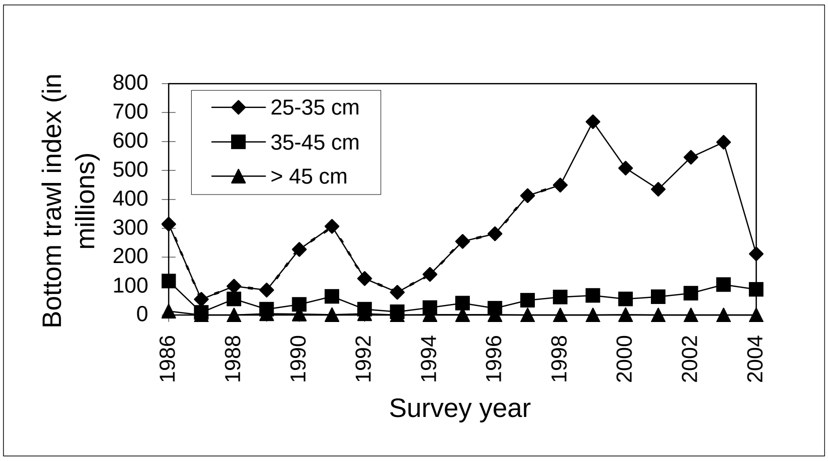
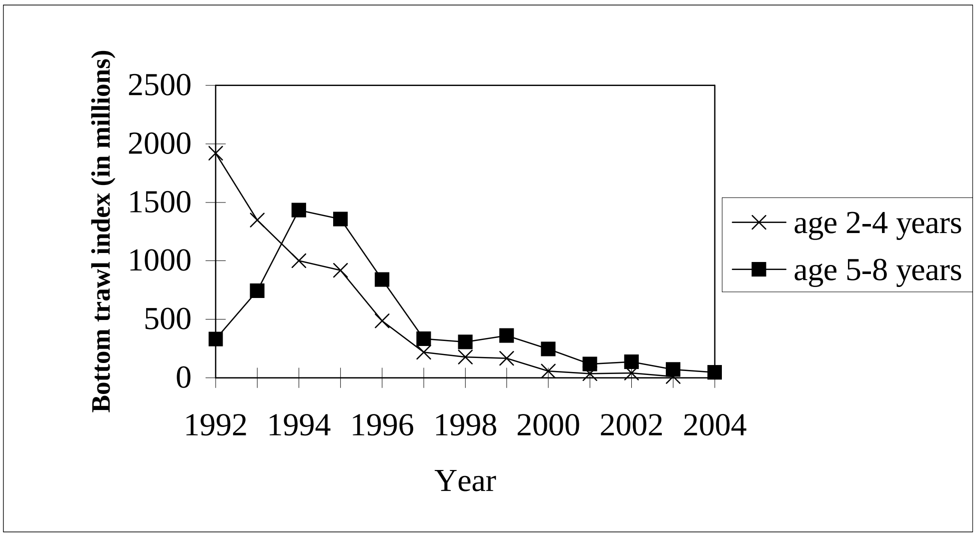


Figure 6.7a. Sebastes mentella. Abundance indices (on length) when combining the Norwegian bottom trawl surveys 1986-2004 at Svalbard (summer/fall) and in the Barents Sea (winter).



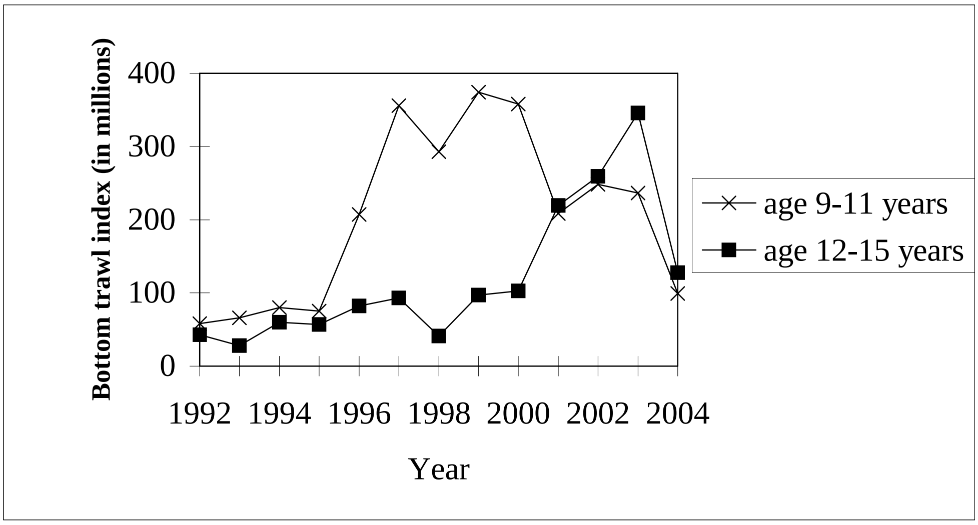


Figure 6.7b. Sebastes mentella. Abundance indices (on age) when combining the Norwegian bottom trawl surveys 1992-2004 at Svalbard (summer/fall) and in the Barents Sea (winter).

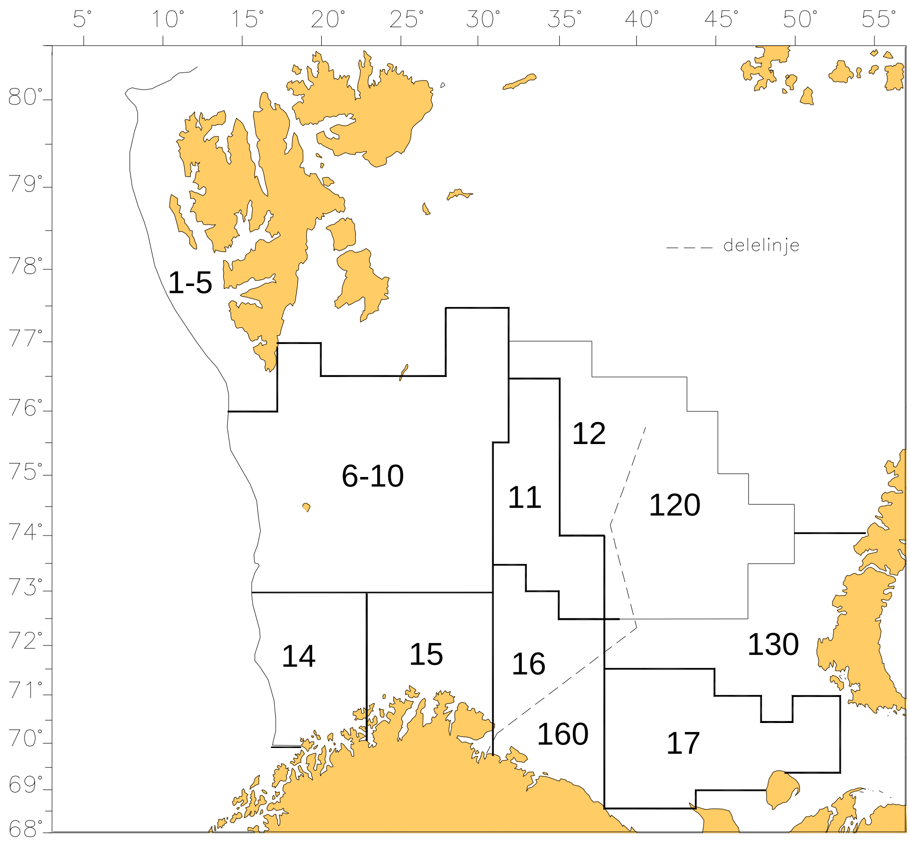
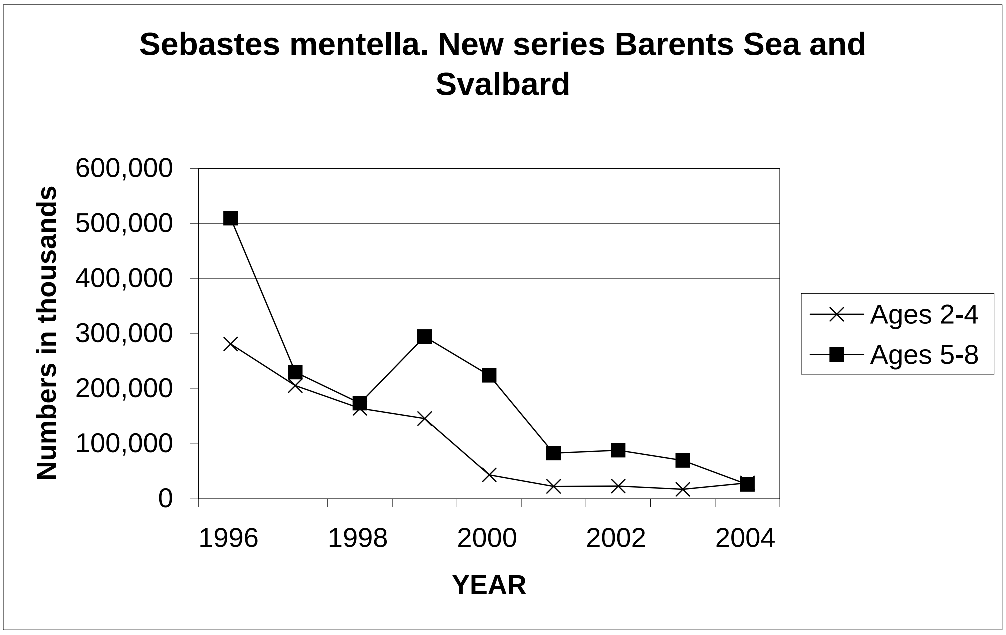


Figure 6.8. Survey regions and subareas in the ecosystem survey in the Barents Sea and adjacent areas in August-September 1996-2004 covered by the standard 1800 Campelen research trawl shallower than ca. 500 m. Subareas 1-10 are further depth stratified. The Svalbard region comprises these ten subareas, 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).



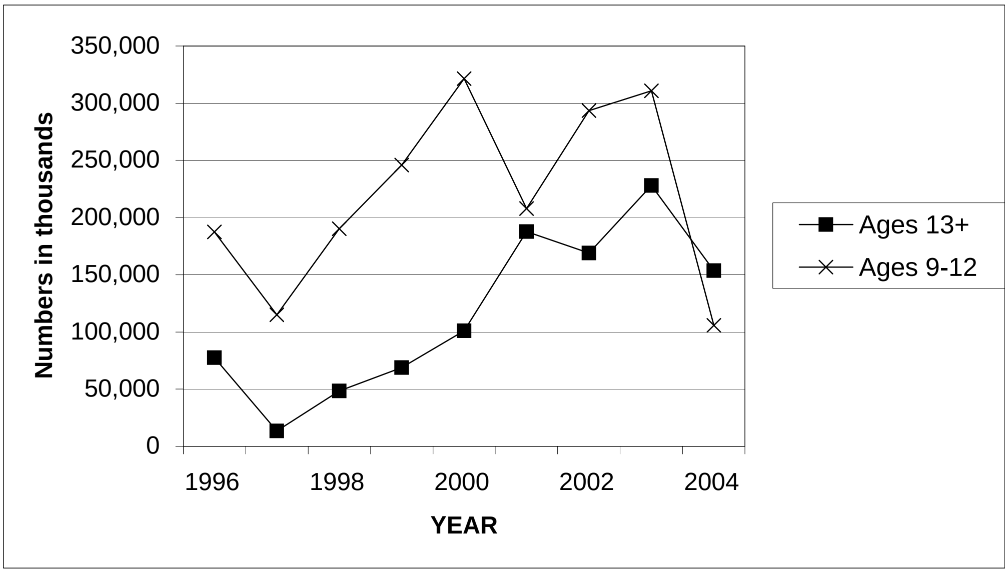


Figure 6.9. Sebastes mentella. Abundance indices (on age) from the Ecosystem survey in August-September 1996-2004 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (ref. Table D6).

Table D1 REDFISH in Sub-areas I and II. Nominal catch (t) by countries in Sub-area I, Divisions IIa and IIb combined as officially reported to ICES.

Year	Canada	Denmark	Faroe Islands	France	Germany[4]	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia[5]	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	2,970	7,457	-	-	-	-	18,650	-	1,806	69,689	25	716	-	101,313
1985	-	-	-	3,326	6,566	-	-	-	-	20,456	-	2,056	59,943	38	167	-	92,552
1986	-	-	29	2,719	4,884	-	-	-	-	23,255	-	1,591	20,694	-	129	14	53,315
1987	-	+	450[3]	1,611	5,829	-	-	-	-	18,051	-	1,175	7,215	25	230	9	34,595
1988	-	-	973	3,349	2,355	-	-	-	-	24,662	-	500	9,139	26	468	2	41,494
1989	-	-	338	1,849	4,245	-	-	-	-	25,295	-	340	14,344	5[2]	271	1	46,688
1990	-	37[3]	386	1,821	6,741	-	-	-	-	34,090	-	830	18,918	-	333	-	63,156
1991	-	23	639	791	981	-	-	-	-	49,463	-	166	15,354	1	336	13	67,768
1992	-	9	58	1,301	530	614	-	-	-	23,451	-	977	4,335	16	479	3	31,773
1993	8[3]	4	152	921	685	15	-	-	-	18,319	-	1,040	7,573	65	734	1	29,517
1994	-	28	26	771	1026	6	4	3	-	21,466	-	985	6,220	34	259	13	30,841
1995	-	-	30	748	692	7	1	5	1	16,162	-	936	6,985	67	252	13	25,899
1996	-	-	42[3]	746	618	37	-	2	-	21,675	-	523	1,641	408	305	121	26,118
1997	-	-	7	1,011	538	39[2]	-	11	-	18,839	1	535	4,556	308	235	29	26,109
1998	-	-	98	567	231	47[3]	-	28	-	26,273	13	131	5,278	228	211	94	33,199
1999	-	-	108	61[3]	430	97	14	10	-	24,634	6	68	4,422	36	247	62	30,195
2000	-	-	67[3]	25	222	51	65	1	-	19,052	2	131	4,631	87		203[6]	24,537
2001	-	-	69[3]	397	436	39	38	5	-	23,133[1]	5	186	4,738	91	Estonia	239[6]	29,376
2002	-	-	70[3]	89	141	49[1]	44	4	-	10,601[1]	8[3]	276	4,736	193[2]	15	234[6]	16,460
2003	-	-	16[3]	25	153	44[3]	9	5[3]	89	8,140[1]	7	50	1,431	47	Sweden	258[6]	10,275
2004[1]	-	-	64[3]	17[3]	78	24[3]	40	3	33	7,658	42	240	3,601	260	1	146[6]	12,206

1 Provisional figures.

2Working Group figure.

3As reported to Norwegian authorities.

4Includes former GDR prior to 1991.

5USSR prior to 1991.

6UK(E&W)+UK(Scot.)

Table D2 REDFISH in Sub-area IV (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Nether-lands	Norway	Sweden	UK (England & Wales)	UK (Scotl)	Total
1986	-	24	-	578	183	-	-	1,048	-	35	1	1,869
1987	-	16	3	833	70	-	-	411	-	16	55	1,404
1988	-	32	90	915	188	-	-	696	-	125	9	2,055
1989	1	23	13	554	111	-	-	500[2]	-	134	6	1,342
1990	+	41	25	554	47	-	-	483[2]	-	369	6	1,525
1991	5	29	144	914	213	-	2	415[2]	-	43	38	1,803
1992	4	22	23	1,960	170	-	1	416	-	65	122	2,783
1993	28	14	4	1,211	33	-	1	373	-	138	71	1,873
1994	4	13	1	863	324	-	8	371	-	38	66	1,688
1995	16	12	65	1,120	80	-	16	297	-	46	241	1,893
1996	20	20	1	932	74	-	41	363	-	37	146	1,634
1997	16	23	-	1,049	45	-	53	595	-	21	528	2,330
1998	2	27	12	570[1]	370	4	21	1,113	-	68	681	2,868
1999	3	52	1	n.a.	58	39	16	862	-	67	465	1,563
2000	5	41	n.a.	224.	19	28	19	443	-	132	486	1,397
2001	4	96	n.a.	272[1]	13	19	+	422[1]	-	80	458	1,364
2002	2	40	n.a.	97	11	7	+	235[1]	-		524[3]	916
2003	1	72	n.a.	21	2	n.a.	-	496	-		463[3]	1,027
2004[1]	+	43	n.a.	n.a.	2	n.a.	n.a.	102	+		213[3]	360

1 Provisional figures.

2 Working Group figure.

3 UK(E/W/)+UK(Scotl)

n.a. = not available.

Table D3. Sebastes mentella. Average catch (numbers of specimens) per hour trawling of different ages of Sebastes mentella in the Russian groundfish survey in the Barents Sea and Svalbard areas (1976–1983 published in "Annales Biologiques").

Year class	0	1	2	3	4	5	6	7	8	9	10	11
1965	-	-	-	-	-	-	-	-	-	-	-	0.4
1966	-	-	-	-	-	-	-	-	-	-	3.0	-
1967	-	-	-	-	-	-	-	-	-	11.7	-	0.3
1968	-	-	-	-	-	-	-	-	16.2	-	1.5	0.3
1969	-	-	-	-	-	-	-	43.4	-	8.7	12.2	3.1
1970	-	-	-	-	-	-	85.8	-	19.8	34.9	11.9	-
1971	-	-	-	-	-	22.7	-	19.5	51.9	18.0	5.7	-
1972	-	-	-	-	9.4	-	6.7	57.6	12.3	6.7	-	-
1973	-	-	-	0.6	-	4.3	37.3	8.6	5.6	-	-	-
1974	-	-	4.8	-	4.9	22.8	4.8	4.8	-	-	-	3.0
1975	-	7.4	-	1.7	6.4	2.4	3.5	5.0	-	-	4.0	-
1976	7.0	-	8.1	1.2	2.5	6.8	4.9	5.0	1.0	13.0	-	-
1977	-	0.2	0.2	0.2	0.9	5.1	3.7	1.0	19.0	2.0	-	-
1978	0.8	0.02	0.9	1.0	5.0	3.8	2.0	20.0	6.0	-	-	-
1979	-	1.9	1.4	3.6	2.3	9.0	11.0	16.0	1.0	-	-	0.1
1980	0.3	0.4	2.0	2.5	16.0	6.0	11.0	25.0	2.0	-	1.5	2.0
1981	-	2.2	3.9	20.0	6.0	12.0	47.0	18.0	6.3	1.6	0.5	1.0
1982	19.8	13.2	13.0	15.0	34.0	44.0	39.0	32.6	4.3	3.1	4.9	+
1983	12.5	3.0	5.0	6.0	31.0	34.0	32.3	13.3	4.0	4.2	0.6	1.1
1984	-	10.0	2.0	-	5.0	18.3	19.0	2.2	2.4	0.2	1.7	2.4
1985	107.0	7.0	-	1.0	5.2	16.2	1.7	1.7	0.6	2.8	3.8	0.3
1986	2.0	-	1.0	1.8	8.4	3.6	2.1	1.2	5.6	8.2	0.9	0.7
1987	-	3.0	37.9	1.3	8.0	4.1	2.0	10.6	9.6	1.4	2.0	1.3
1988	4.0	58.1	4.3	13.3	25.8	3.9	8.6	11.2	2.8	4.2	3.0	4.7
1989	8.7	9.0	17.0	23.4	4.6	5.4	4.0	6.6	6.6	4.1	7.7	5.3
1990	2.5	6.3	6.1	1.0	4.3	1.7	11.5	6.5	5.5	6.7	7.4	3.6
1991	0.3	1.0	0.5	1.5	1.2	11.3	3.9	3.3	4.6	5.8	2.7	1.9
1992	0.6	+	0.2	0.1	4.3	1.3	2.0	2.3	4.9	2.3	1.0	4.1
1993[1]	-	+	1.5	1.8	1.0	1.2	3.0	4.2	2.6	2.0	3.2	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	
1995	2.8	1.0	1.1	0.4	2.2	2.6	3.5	3.4	2.9	1.2		
1996[2]	+	0.1	0.1	0.4	0.7	1.1	1.0	1.4	1.0			
1997	-	-	+	0.4	0.5	0.3	0.9	0.6				
1998	-	0.1	0.2	0.3	0.2	1.1	0.5					
1999	0.1	-	0.1	+	0.1	0.3						
2000	-	0.6	0.1	0.5	0.3							
2001	-	0.1	0.4	-								
2002[3]	0.1	0.5	0.1									
2003	-	-										
2004	-											

[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 1986-2004 (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

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 1992-2004 (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

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 1986-2005 (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

1 - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.

2 - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D5b. Sebastes mentella[1] in Sub-areas I and II. Preliminary Norwegian bottom trawl indices (on age) from the annual Barents Sea survey in February 1992-2004 (numbers in millions). The area coverage was extended from 1993 onwards.

	Age													
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	351	252	132	56	14	11	3	9	18	16	12	11	2	5	892
1993	38	473	192	242	62	45	19	22	13	11	10	4	2	3	1,136
1994	7	85	332	189	370	228	73	42	3	30	8	14	25	7	1,413
1995	308	45	146	264	364	211	69	23	7	17	23	9	11	10	1,507
1996	173	119	109	114	128	122	106	64	24	19	12	7	8	4	1,009
1997[2]	43	101	19	54	96	43	44	171	76	74	39	29	10	9	808
1998[2]	1	73	49	27	13	52	107	104	41	18	7	4	3	3	502
1999	1	+	32	43	30	24	30	81	79	28	2	1	6	+	357
2000	9	12	21	17	9	39	77	73	50	41	14	10	7	6	385
2001	1	17	8	1	7	22	39	30	34	23	24	17	9	3	236
2002	18	4	12	7	4	14	49	55	27	19	34	24	28	11	306
2003	0	2	2	4	6	6	14	39	24	34	39	65	46	20	301
2004	0	2	3	1	9	12	15	20	36	8	28	3	25	12	172

1 - Includes some unidentified *Sebastes* specimens, mostly less than 15 cm.

2 - Adjusted indices to account for not covering the Russian EEZ in Subarea I.

Table D6. Sebastes mentella in Sub-areas I and II. Abundance indices (on age) from the ecosystem survey in August-September 1996-2004 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

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											

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 2004 (see also Figure 6.2).

Date	Position	Depth of sea, m	Depth of trawling, m	Sex	Length, cm														Sum	Mean length, cm
					29	30	31	32	33	34	35	36	37	38	39	40	41	42		
25.07.2004	68^{0}23N 01^{0}38W	3000	300	M									1	1					2	37.5
				F																
26.07.2004	66^{0}44N 04^{0}11W	3000	300	M						1		1	3		1				6	36.7
				F												1			1	40.0
27.07.2004	67^{0}05N 04^{0}08W	3000	100	M											1				1	39.0
				F																
28.07.2004	67^{0}13N 04^{0}43W	3000	80	M									1						1	37.0
				F																
08.10.2004	72^{0}47N 07^{0}50E	2500	250	M		1	1	5	9	8	12	12	11	5	1				65	35.0
				F				2	5	3	14	9	8	8	4	6			59	36.3
09.10.2004	72^{0}42N 07^{0}02E	2500	180	M			7	44	34	38	43	22	21	4	4	1			218	34.2
				F				9	5	4	11	10	19	7	9	11	2		87	36.5
10.10.2004	72^{0}50N 07^{0}28E	2500	320	M		6	34	41	34	39	17	17	8	2		1			199	34.2
				F	1		3	7	10	14	19	16	8	9	10	6	2		105	35.6
11.10.2004	72^{0}30N 09^{0}06E	2500	250	M			2	13	24	27	32	18	24	13	6	1		1	161	35.1
				F			4	5	7	13	25	14	17	9	12	6	2		114	35.9

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.

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 SUB-AREAS I AND II

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 during 20 April-19 June (in 2004: 1-31 May) has been enforced in all fisheries except trawl. When fishing for other species (also during the moratorium) it is allowed to have up to 15% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday.

7.1.2 Landings prior to 2005 (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 figure for *S. marinus* in 2004 of 7,292 t is the lowest since the mid-1940ies (!). The time series of *S. marinus* landings are given in Figure 7.1 and shows a long-term (1908-2004) mean of 17,240 t.

The Norwegian landings are presented by gear and month in Figure 7.2. This shows that the limited moratorium during May 2004 may have lead to a 500 t decrease in the landings, to a level corresponding to about 20% of the previous level for May.

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. For other pelagic fishing fleets, it is likely that bycatches of *S. marinus* 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) 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.

Information describing the splitting of the redfish landings by species and area is given in the Quality handbook.

7.1.3 Expected landings in 2005

On the basis of reports from the first months of the year, a legal by-catch of 15% in any trawl fishery, and an assumed effect of the regulations for the other gears, the Norwegian landings in 2005 are not expected to decrease by more than about 1,000 t compared to 2004, leading to a total

Norwegian catch of about 5,000 t. The Russian catch is expected to be 500 t. On this basis landings of **6,000 t** are expected in 2005.

7.2 Data Used in the Assessment

7.2.1 Catch-per-unit-effort (Tables D11, Figure 7.3)

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.

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 *S. marinus* since 2003, due to regulations, should not compose more than maximum 20% of the catch in each trawl haul. With some variation, the average annual catch-rates have decreased from an average level of 350 kg/trawl hour during mid 1990ies to about 150 kg/h in 2003 and 2004, i.e., about 40% of the former recent level.

7.2.2 Catch at age (Table 7.5)

Catch at age data for 2003 were revised. Age composition data for 2004 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 raised according to the Norwegian age distribution for trawl in 1st quarter in Subarea IIa. 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 2003.

7.2.4 Maturity at age

A maturity ogive was not available for *S. marinus*, and knife-edge maturity at age 15 (age 15 as 100% mature) is assumed.

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 1986–2004 (joint with Russia since 2000) in fishing depths of 100–500 m. Length compositions for the years 1986–2004 are shown in Table D12a and Fig 7.4a. Age compositions for the years 1992–2004 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 1985–2003 in fishing depths of 100–500 m. Length compositions for the years 1985–2003 and age compositions for the years 1992–2003 are shown in Table 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 1995-2003 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.

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

ACFM has 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. (2004). The model has been run from 1986 to 2003, with quarterly time steps (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 together in a single population group. 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. 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 1990–2003 (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 1990-2003 was used, and the age-length key for 1992 was also used as age-length key for 1990-1991.

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". Anything where the line drops down to zero indicates that a parameter has gone past it's bounds. All of the parameters are optimised except redfish.init.age27-30 (these caused problems when optimising them, probably due to the lack of data in the years before they enter the plus group). It may be summarized that none of the optimised parameters are on the bounds, except recruitment in 2004 for which there is no data. All of the parameters are at a definite optimum - though some are very flat. Some parameters are _much_ more important than others (growth parameters, fleet selectivity especially). Figure 7.8 shows the comparison of observed and modelled survey indices.

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 7.9).
- According to the model the total stock biomass (3+) of *S. marinus* has decreased from about 230.000 tonnes around 1990 to about 94.000 tonnes in 2004 (Figure 7.10, Table 7.7).
- The spawning stock biomass (15+) of *S. marinus* has decreased from about 90.000 tonnes in 1990 to 66.000 tonnes in 2004 (Figure 7.10, Table 7.7).
- 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 3.300 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 (e.g. 15 years old) 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.

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.

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 is available, and it is therefore possible to replace the knife-edge ogive with a fully modeled maturation process. This would not only improve the current model, but also provide a comparison to the current ogive.

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.

7.6 Biological reference points

Last year, the AFWG suggested that 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 would be expressed in biomass units (SSB or fishable stock). The present time series are considered to be too short to do this, but work has now 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 has previously recommended the Working Group to investigate possible alternative methods to conventional catch-at-age analyses. For this year's AFWG, the Gadget (Fleksibest) model was prepared with *S. marinus* data, run and results presented at the meeting. In their last Technical Minutes, however, 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, but considers it at present important to quantify the stock development due to the current serious stock situation. A more comprehensive assessment is also believed to have a greater impact on management, and may provide the managers with useful information on current exploitation rate, effort, and stock levels of different size- and age groups compared with recent history.

Concerning ACFM's request and recommendations regarding biological reference points, the working group refers to chapter 7.6 in the present report.

Table 7.1 Sebastes marinus. Nominal catch (t) by countries in Sub-area I and Divisions IIa and IIb combined.

Year	Faroe Islands	France	Germany[2]	Greenland	Iceland	Ireland	Netherlands
1986	29	2,719	3,369	-	-	-	-
1987	250	1,553	4,508	-	-	-	-
1988	No species specific data presently available on countries						
1989	3	796	412	-	-	-	-
1990	278	1,679	387	1	-	-	-
1991	152	706	981	-	-	-	-
1992	35	1,289	530	623	-	-	-
1993	139	871	650	14	-	-	-
1994	22	697	1,008	5	4	-	-
1995	27	732	517	5	1	1	1
1996	38	671	499	34	-	-	-
1997	3	974	457	23	-	5	-
1998	78	494	131	33	-	19	-
1999	35	35	228	47	14	7	-
2000	17	13	160	22	16	-	-
2001	17	30	238	17	-	1	-
2002	17	31	42	31	3	-	-
2003	8	8	121	36	4	-	89
2004[1]	12	4	68	20	30		33

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	9,158[1]	7	963	1		119[4]	10,551
2002	8,472[1]	34	832	3		46[4]	9,511
2003	6,918[1]	6	479	-		134[4]	7,803
2004[1]	6,327[1]	5	722	3		69[4]	7,292

[1] Provisional figures.

[2] Includes former GDR prior to 1991.

[3] USSR prior to 1991.

[4]UK(E&W)+UK(Scot.)

Table 7.2 Sebastes marinus. Nominal catch (t) by countries in Sub-area I.

Year	Faroe Islands	Germany[4]	Greenland	Iceland	Norway	Russia[5]	UK(Eng& Wales)	UK (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	-	11[2]	-	-	1,056[1]	128	France	16[6]	1,211
2002	-	5[2]	-	-	686[1]	220	1[2]	9[2,6]	921
2003	-	-	1	-	823[1]	140		4	968
2004[1]	-	-	-	-	1,157	213	-	12	1,382

[1] Provisional figures.

[2] Split on species according to reports to Norwegian authorities.

[3] Based on preliminary estimates of species breakdown by area.

[4] Includes former GDR prior to 1991.

[5] USSR prior to 1991.

[6] UK(E&W)+UK(Scot.)

Table 7.3 Sebastes marinus. Nominal catch (t) by countries in Division IIa.

Year	Faroe Islands	France	Germany[4]	Greenland	Ireland	Netherlands	Norway	Portugal	Russia[5]	Spain	UK (Eng. & Wales)	UK (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	17[2]	30[2]	227[2]	17[2]	1[2]	-	8,023[1]	6[2]	612	1[2]	Iceland	103[2, 6]	9,037
2002	17[2]	30[2]	37[2]	31[2]	-	-	7,680[1]	18[2]	192	2[2]	3[2]	32[2, 6]	8,042
2003	8[2]	8[2]	121[2]	35[2]	-	89[2]	6,027[1]	6[2]	264		4[2]	130[2, 6]	6,692
2004[1]	12[2]	4[2]	68[2]	20[2]	-	33[2]	5,071	5[2]	396	3[2]	30[2]	58[2, 6]	5,699

[1] Provisional figures.
[2] Split on species according to reports to Norwegian authorities.
[3] Based on preliminary estimates of species breakdown by area.
[4] Includes former GDR prior to 1991.
[5] USSR prior to 1991.
[6] UK(E&W)+UK(Scot.)

Table 7.4 Sebastes marinus. Nominal catch (t) by countries in Division IIb.

Year	Faroe Islands	Germany[5]	Greenland	Norway	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (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]	1[2]	223	-	-	-	303
2002	-	-	-	106[1]	16[2]	420	1[2]	-	5[2, 7]	548
2003	-	-	-	69[1]	-	75	-		-	144
2004[1]	-	-	-	98	-	113	-	-	-	211

[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.)

Numbers*10**-3 YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE													
7	5	0	46	60	9	9	28	78	4	23	13	22	18
8	22	24	7	85	119	98	51	593	13	23	36	25	48
9	78	193	292	230	313	156	206	855	70	44	70	30	47
10	114	359	640	672	361	321	470	572	245	199	141	43	66
11	394	406	816	908	879	686	721	1006	902	346	409	203	200
12	549	1036	1930	1610	1234	1065	968	1230	958	481	678	357	276
13	783	1022	2096	2038	1638	1781	1512	1618	1782	1117	1184	702	507
14	1718	1523	2030	2295	2134	2276	1736	1480	1409	1339	1916	1679	587
15	3102	2353	1601	1783	1675	2172	1582	1612	2121	1670	1359	1331	676
16	2495	1410	2725	1406	1614	1848	1045	1239	2203	1650	1258	1066	956
17	2104	1655	2668	785	1390	1421	1277	1407	1715	1241	1181	932	1053
18	1837	1678	1409	563	952	851	970	1558	753	567	384	479	784
19	998	745	617	670	679	804	1018	1019	483	118	309	365	436
20	858	716	733	593	439	608	846	394	458	183	98	145	166
21	688	534	514	419	560	511	443	197	132	154	103	83	182
22	547	528	256	368	334	205	764	459	230	112	116	51	108
23	268	576	177	250	490	334	486	174	224	135	111	18	80
+gp	3110	3482	1508	3232	3135	2131	3389	2131	895	254	250	69	188
TOTALNUM	19670	18240	20065	17967	17955	17277	17512	17622	14597	9656	9616	7600	6378
TONSLAND	16185	16651	18120	15616	18043	17511	19155	18986	14460	10551	9511	7802	7294

Table 7.5. Sebastes marinus. Catch numbers at age

Table 7.6. *Sebastes marinus.* Catch weights at age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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
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
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	0.35
10	0.42	0.43	0.49	0.61	0.65	0.74	0.62	0.57	0.44	0.56	0.42	0.39	0.45
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
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
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
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	0.81
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	0.97
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	1.09
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	1.24
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	1.36
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	1.60
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	1.70
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	1.79
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	2.14
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	1.94
+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	2.10

Table 7.7. Sebastes marinus.Stock numbers, biomass and mean weight as estimated by GADGET. Note that the years 1986-1989 should be treated as a 'lead-in' period for the model, and the estimates for these years should therefore not be taken as reliable estimates for these years.

	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
1986	648,441	0.42	272,741	114,669	1.14	130,895	533,773	0.27	141,846
1987	637,862	0.41	260,869	105,798	1.11	117,454	532,063	0.27	143,415
1988	618,548	0.41	251,787	97,593	1.09	106,197	520,954	0.28	145,590
1989	592,427	0.41	242,798	90,903	1.06	96,484	501,525	0.29	146,314
1990	568,466	0.41	232,628	86,881	1.03	89,322	481,585	0.30	143,306
1991	544,009	0.42	227,966	85,043	1.01	85,742	458,967	0.31	142,223
1992	521,064	0.43	225,023	87,084	0.99	86,233	433,980	0.32	138,790
1993	485,320	0.45	220,808	88,667	0.98	87,114	396,653	0.34	133,694
1994	438,699	0.49	213,766	85,123	0.99	84,223	353,576	0.37	129,543
1995	391,925	0.52	205,027	83,425	1.00	83,030	308,500	0.40	121,997
1996	350,565	0.56	194,704	82,234	1.00	82,543	268,332	0.42	112,161
1997	316,501	0.57	181,650	78,343	1.02	79,568	238,158	0.43	102,082
1998	282,263	0.59	166,543	78,254	1.01	78,781	204,010	0.43	87,762
1999	249,795	0.60	149,351	75,601	1.00	75,662	174,193	0.42	73,689
2000	219,909	0.61	134,375	71,972	1.00	72,020	147,937	0.42	62,356
2001	191,305	0.63	120,014	67,370	1.00	67,547	123,935	0.42	52,467
2002	165,303	0.67	110,812	66,962	1.01	67,353	98,341	0.44	43,458
2003	147,152	0.69	101,686	65,267	1.01	66,121	81,885	0.43	35,565
2004	127,461	0.74	93,804	64,270	1.02	65,617	63,191	0.45	28,187

	Stock, ages 7+			Stock, ages 3-6		
year	number	mean weight	biomass	number	mean weight	biomass
1986	390,844	0.63	247,866	257,597	0.10	24,875
1987	378,368	0.62	235,760	259,493	0.10	25,109
1988	370,625	0.62	229,408	247,922	0.09	22,379
1989	356,644	0.62	222,525	235,784	0.09	20,273
1990	352,245	0.61	214,373	216,221	0.08	18,255
1991	350,350	0.60	211,852	193,659	0.08	16,113
1992	344,064	0.61	210,286	177,000	0.08	14,737
1993	332,897	0.62	207,024	152,423	0.09	13,784
1994	322,383	0.63	202,238	116,316	0.10	11,528
1995	307,317	0.64	195,868	84,608	0.11	9,159
1996	291,736	0.65	188,784	58,830	0.10	5,920
1997	266,760	0.67	177,752	49,741	0.08	3,898
1998	234,835	0.69	163,084	47,428	0.07	3,459
1999	201,769	0.72	145,607	48,026	0.08	3,744
2000	175,248	0.74	130,410	44,661	0.09	3,965
2001	155,354	0.75	116,663	35,951	0.09	3,351
2002	140,964	0.77	108,037	24,338	0.11	2,775
2003	128,315	0.78	99,800	18,837	0.10	1,886
2004	116,263	0.80	92,625	11,198	0.11	1,179

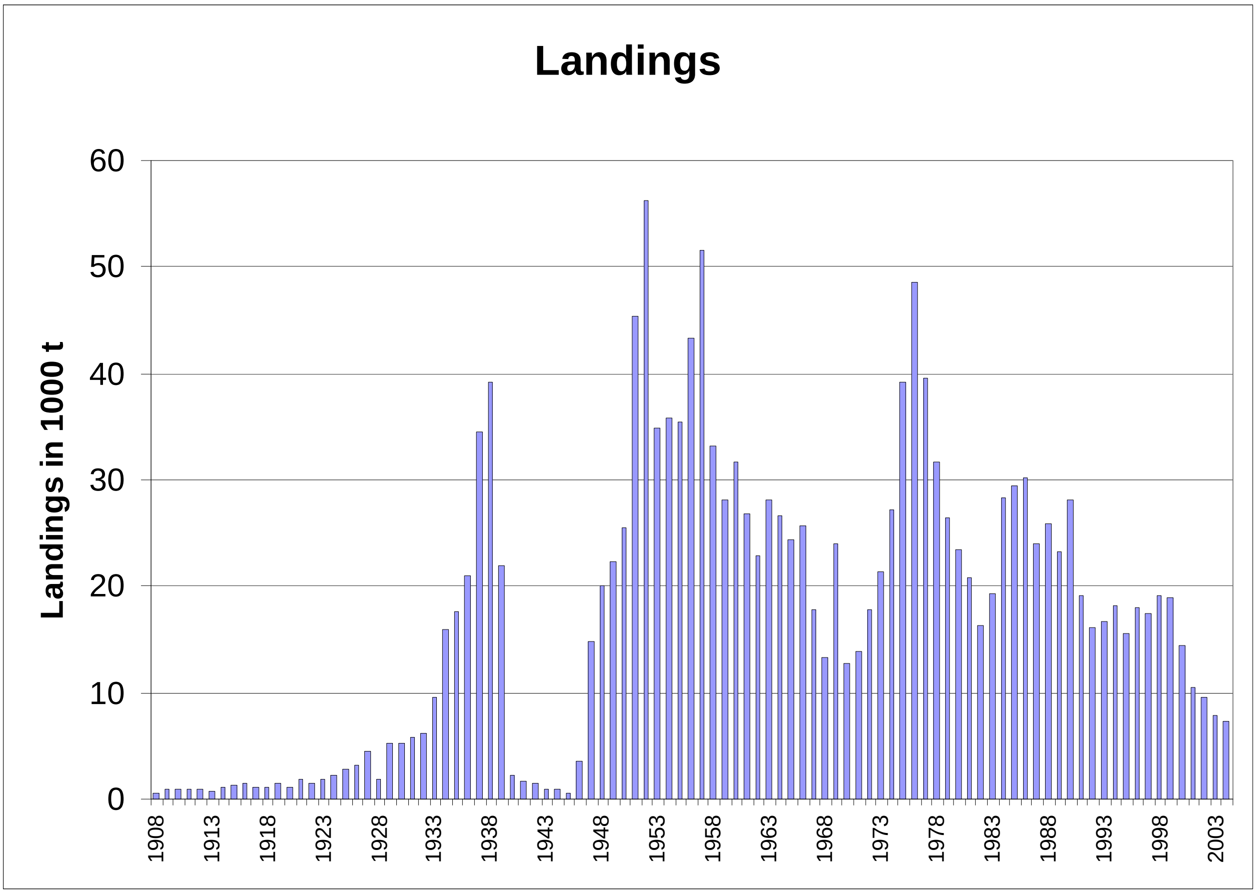


Figure 7.1. Sebastes marinus in Sub-areas I and II. Total international landings 1965-2004 (in thousand tonnes).

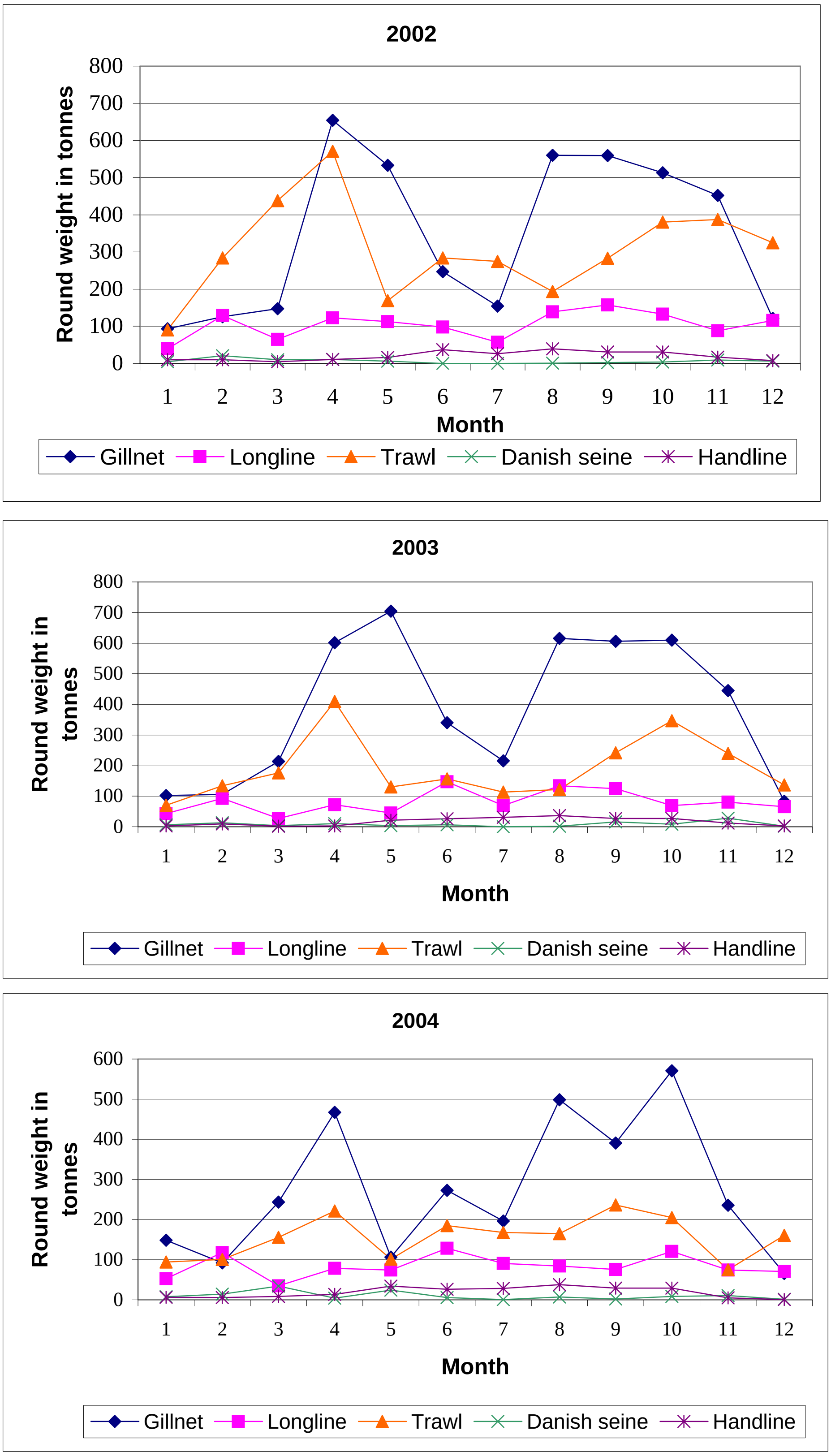


Figure 7.2. Illustration of the seasonality in the different Norwegian S. marinus fisheries, also illustrating the limited effects of current regulations.

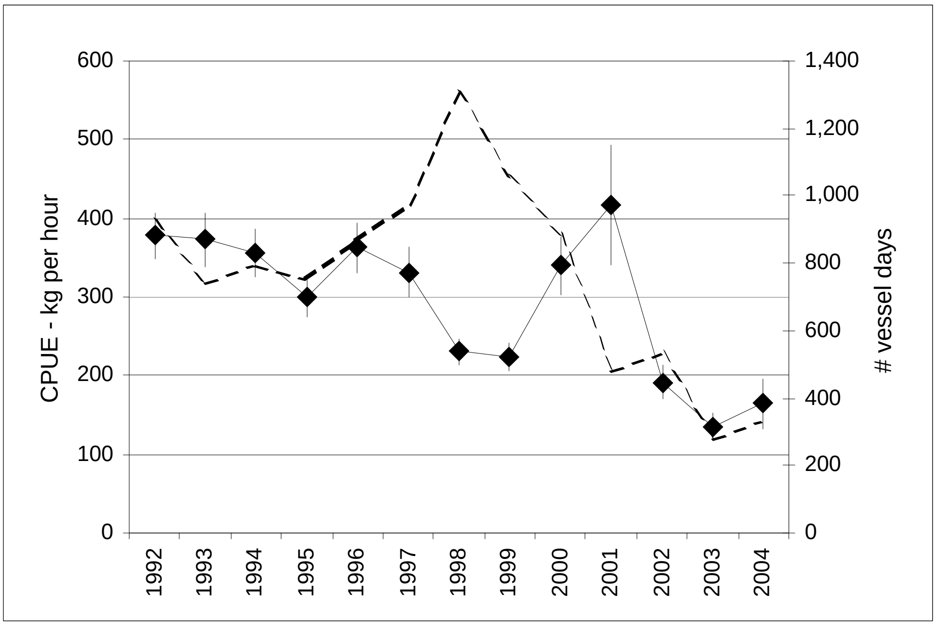
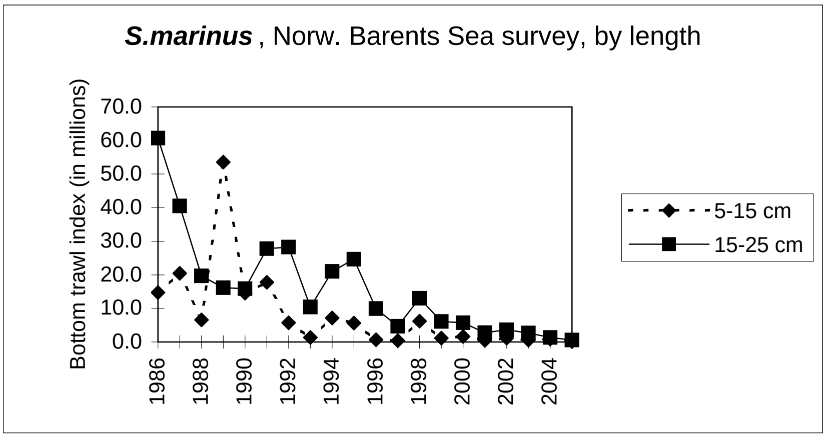


Figure 7.3. Sebastes marinus. Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery, and numbers of vessel days (stippled curve) meeting the criterium of minimum 10% S. marinus in the catch per day. The figure is an illustration of the data given in Table D9.



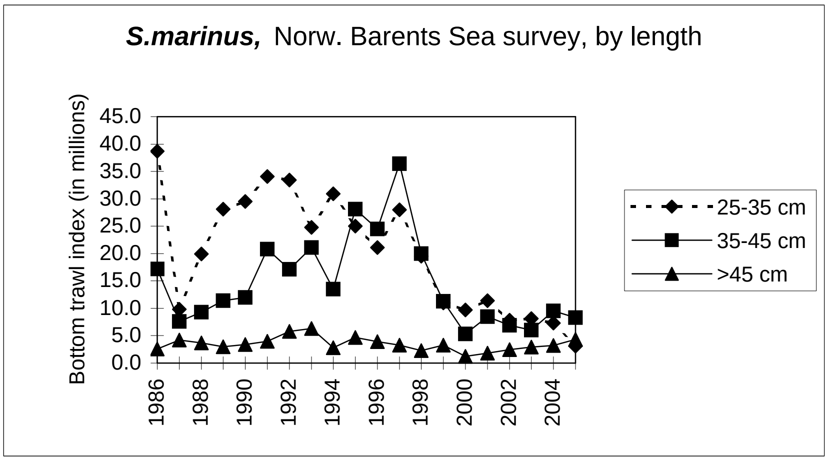
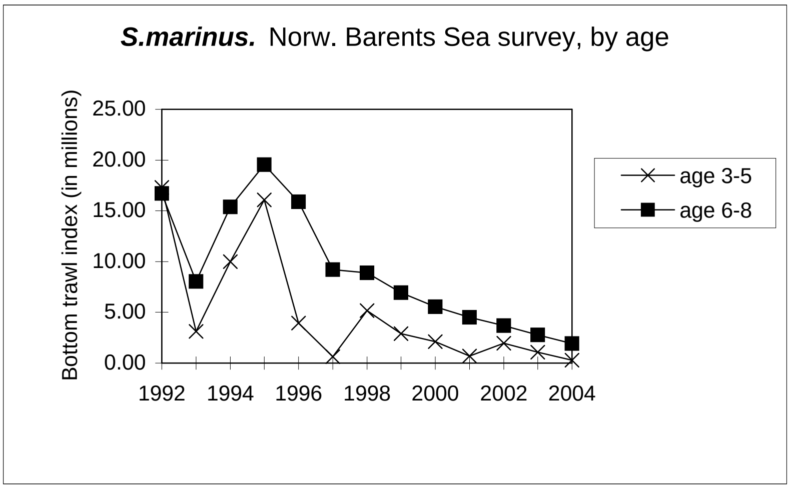


Figure 7.4a. Sebastes marinus. Abundance indices (by length) from the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2005 (ref. Table D10a).



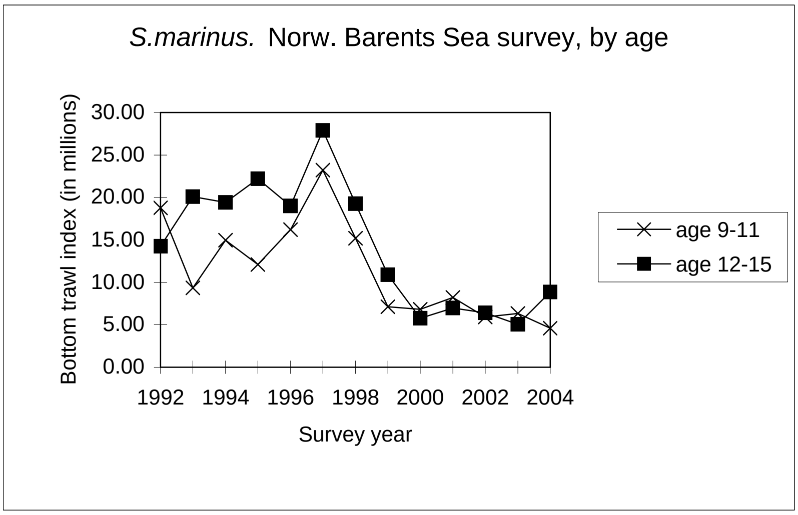
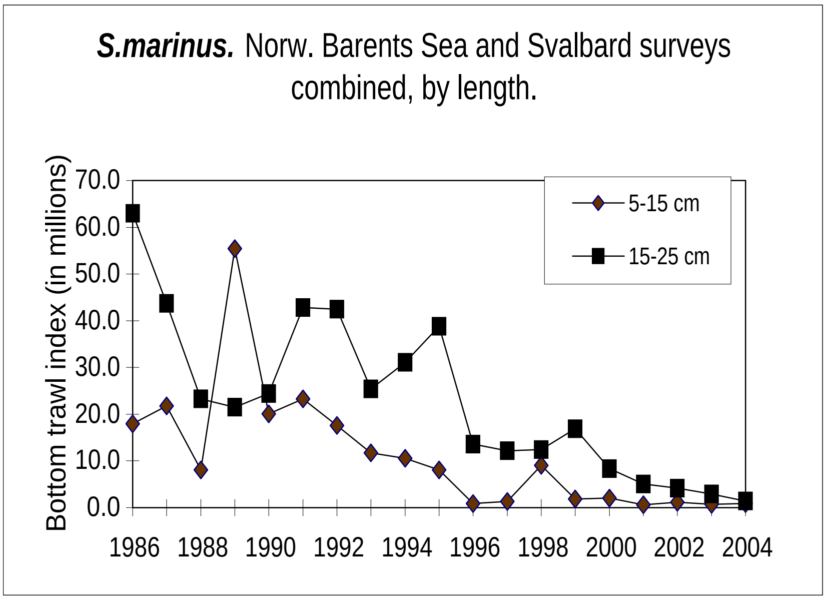


Figure 7.4b. Sebastes marinus. Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2004 in the Barents Sea (ref. Table D10b).



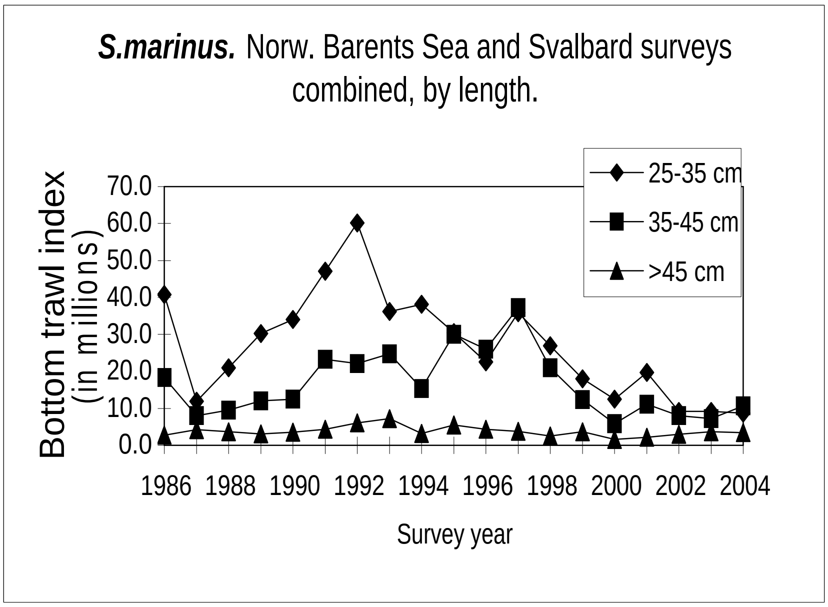
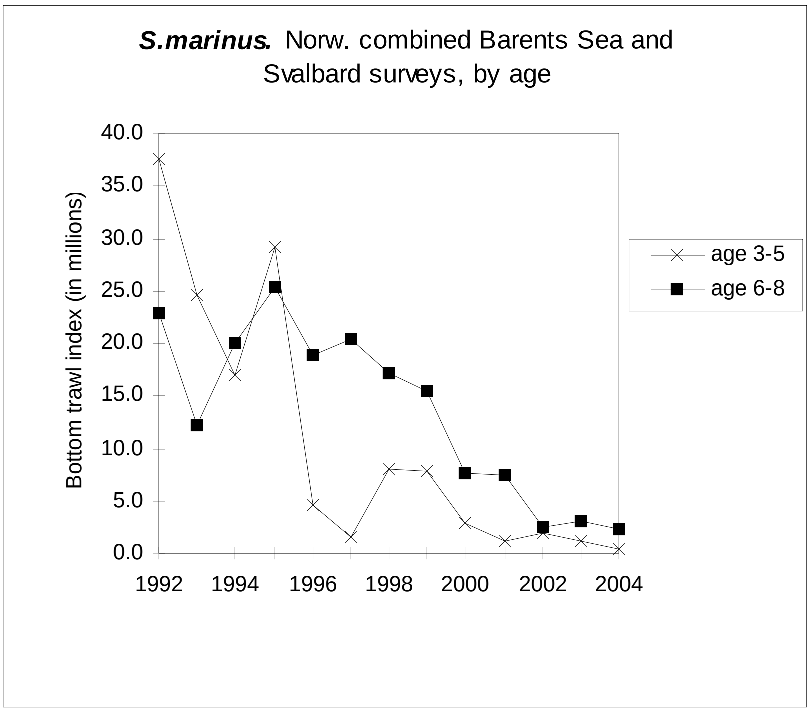


Figure 7.5a. Sebastes marinus. Abundance indices (by length) when combining the Norwegian bottom trawl surveys 1986-2004 in the Barents Sea (winter) and at Svalbard (summer/fall).



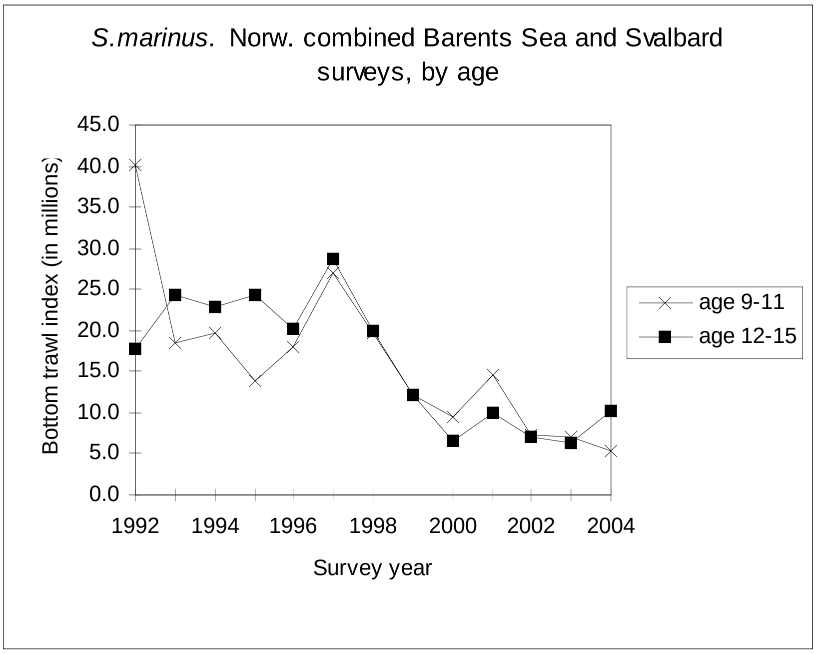


Figure 7.5b. Sebastes marinus. Abundance indices (by age) when combining the Norwegian bottom trawl surveys 1992-2004 in the Barents Sea (winter) and at Svalbard (summer/fall).

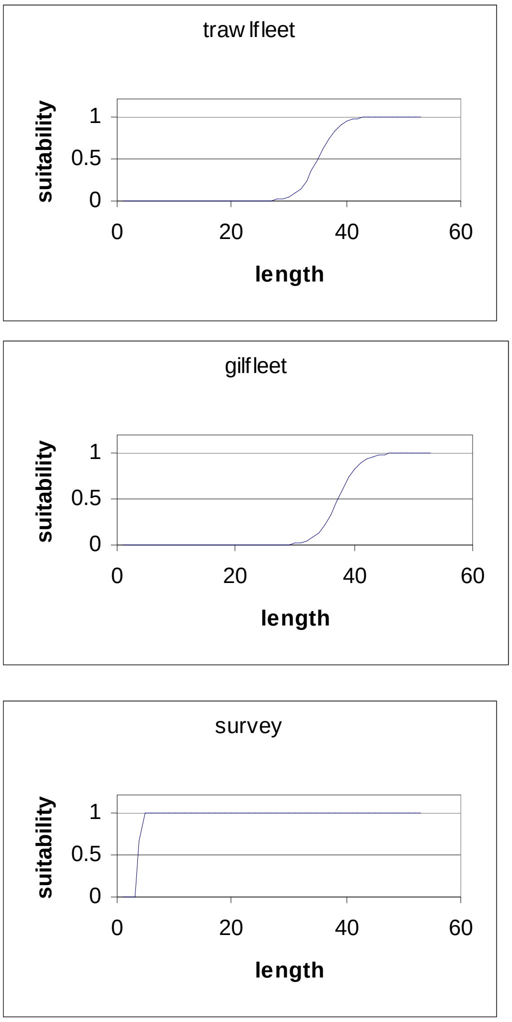


Figure 7.6. Selection curves for the trawl- and gillnet fleets as well as the bottom trawl survey as modelled by Gadget.

Figure 7.7. Sensitivity plots for the redfish 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 (zooming in on the more flat ones).

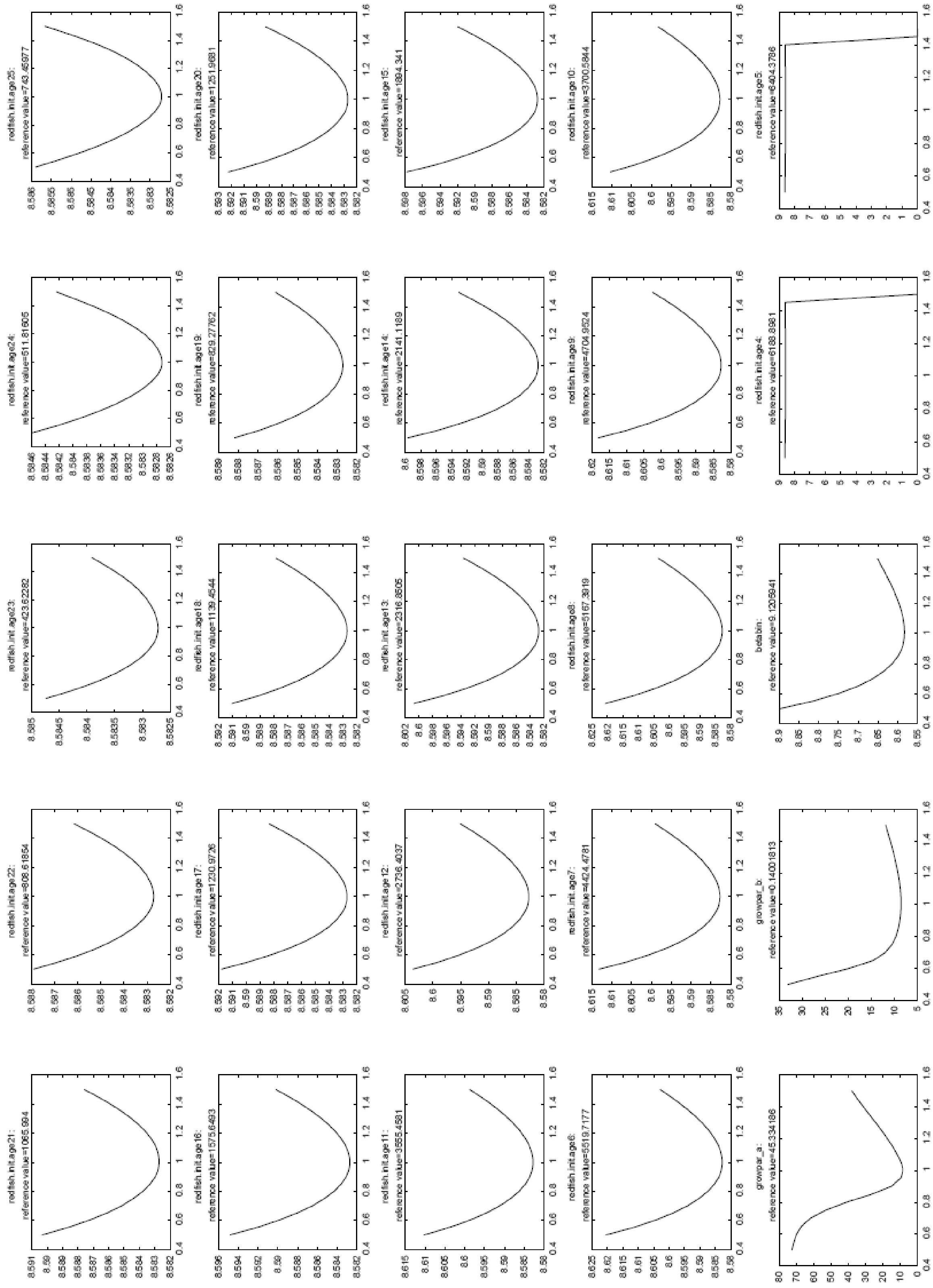
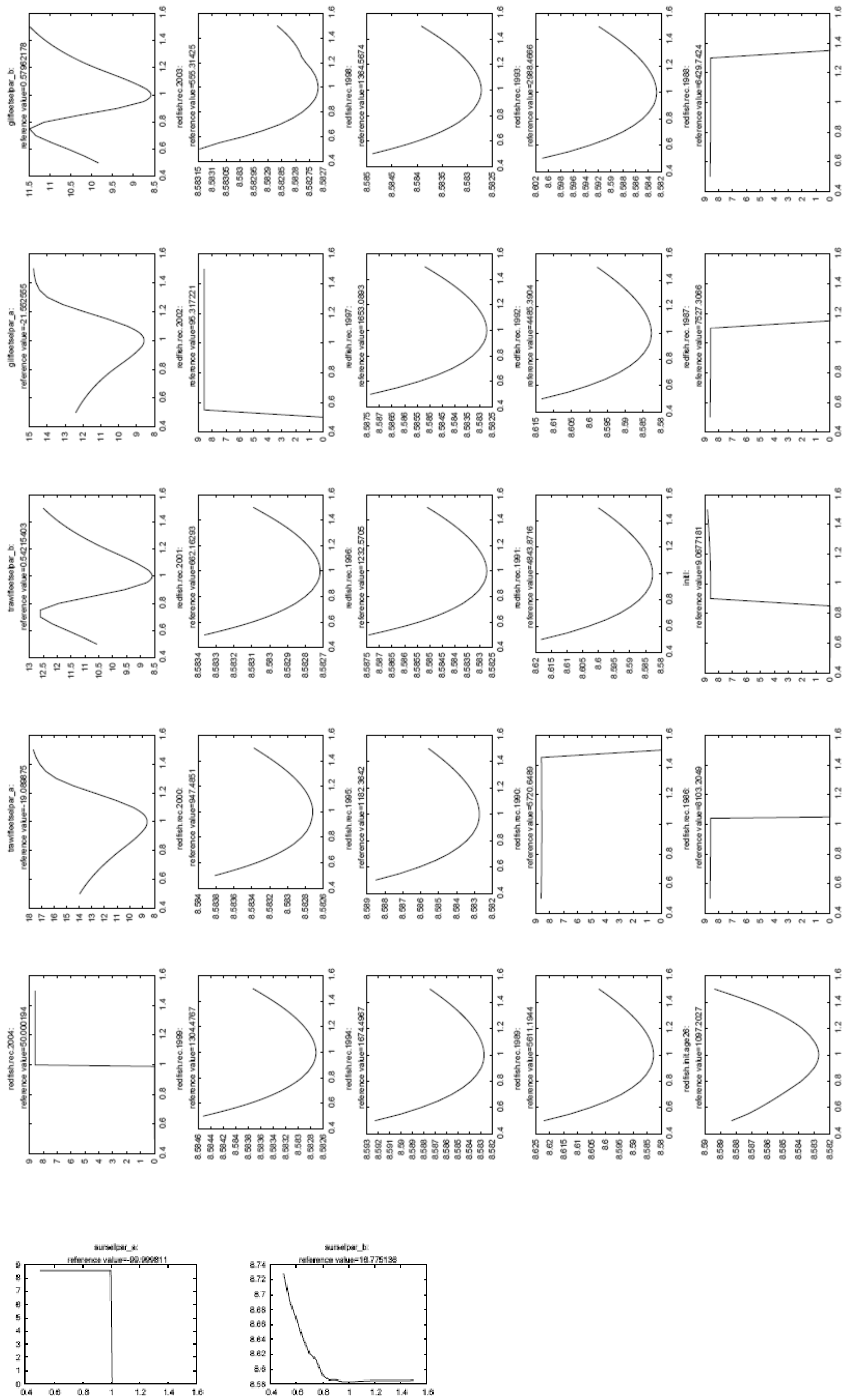


Figure 7.7, continued



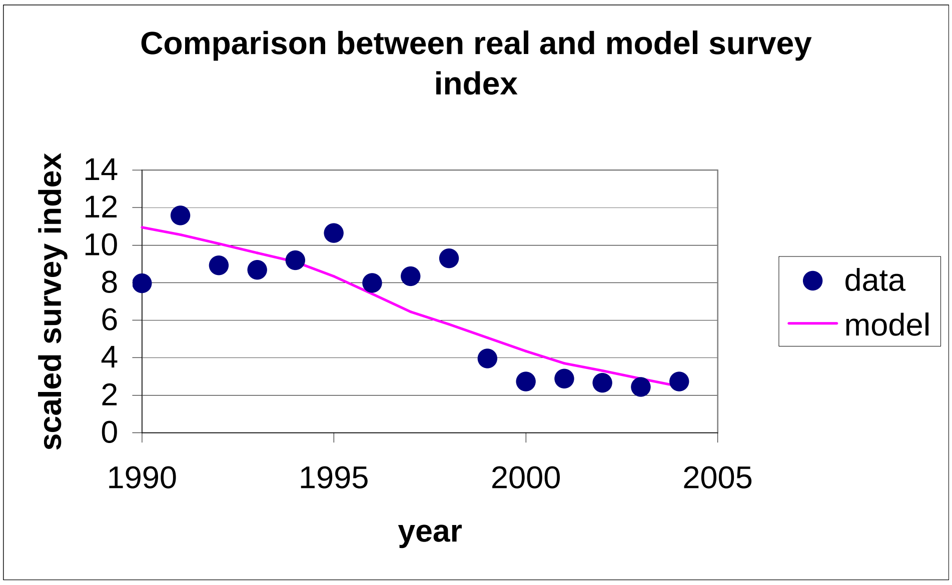


Figure 7.8. Results from the Gadget assessment. The Figure shows comparison of observed and modelled survey indices (total number scaled to sum=100 during the time period).

Figure 7.9. Sebastes marinus. Estimates of recruitment at age 3 (in numbers) by Gadget.

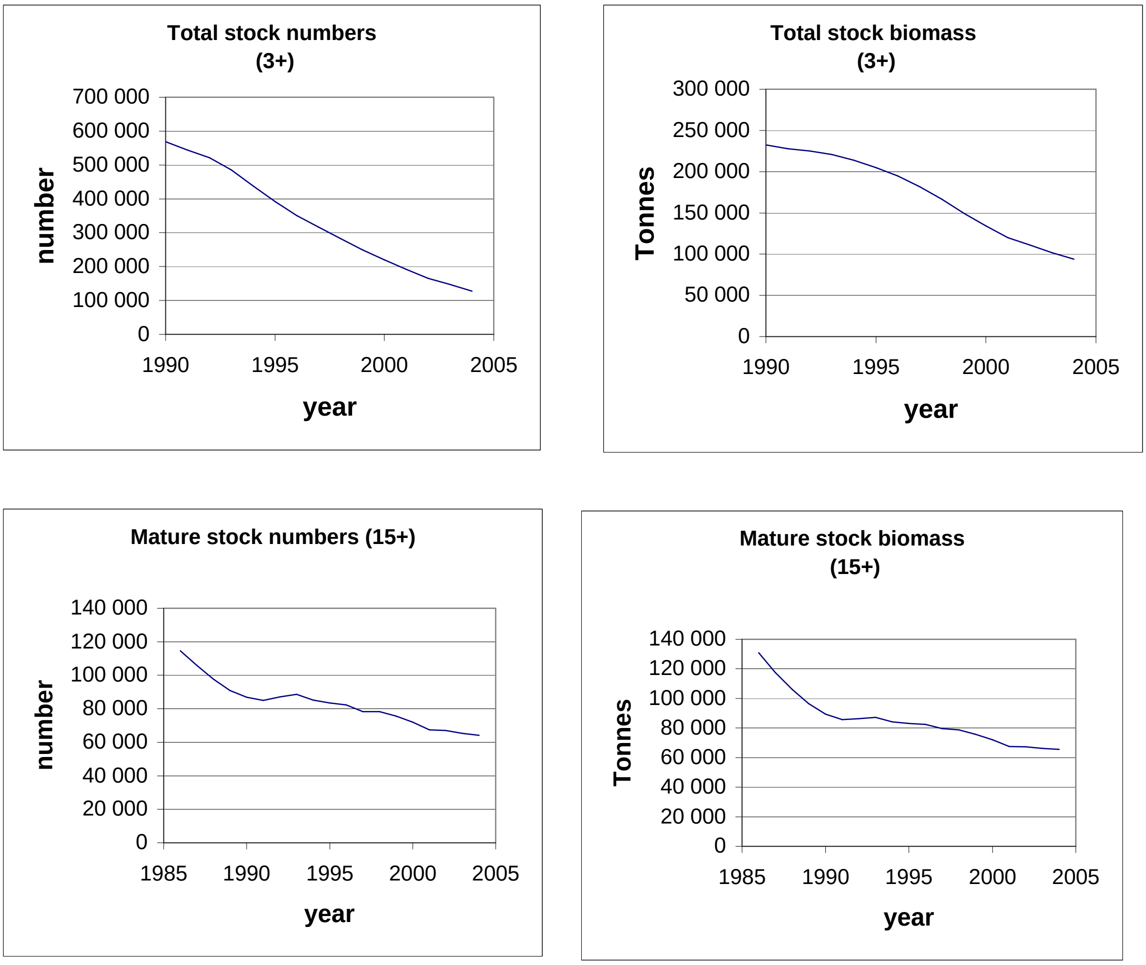


Figure 7.10. Sebastes marinus. Stock numbers (in thousands) and biomass (in tonnes) for the total stock (3+) (upper panel), and the fishable and mature stock (15+) (lower panel), as estimated by Gadget.

Table D11. Sebastes marinus. Effort (vessel days) and catch per unit effort (kg per trawl hour) with 2 x st.error for Norwegian stern 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	340	36.8
2001	478	417	75.6
2002	536	192	22.6
2003	276	136	17.2
2004[2]	334	165	31.8

[1] **Only including days with more than 10% *S. marinus* in the catches.**

[2] **Provisional figures.**

Table D12a. Sebastes marinus. Abundance indices (on length) from the bottom trawl surveys in the Barents Sea in the winter 1986-2005 (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

[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 1992-2004 (numbers in thousands). The area coverage was extended from 1993 onwards.

	Age												
Year	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	2,295	4,261	10,760	2,043	1,474	13,178	4,230	6,302	8,251	3,751	3,865	3,064	3,568	67,042
1993	468	1,218	1,424	2,020	979	5,048	2,968	4,230	2,142	4,634	3,338	2,951	9,148	40,568
1994	2,951	4,485	2,573	3,801	8,338	3,254	1,297	7,231	6,443	248	10,192	6,341	2,612	59,766
1995	2,540	7,450	6,090	7,150	5,820	6,590	5,670	2,000	4,440	6,500	4,320	5,330	6,030	69,930
1996	310	1,300	2,340	3,520	3,660	8,720	5,650	3,960	6,590	5,730	6,230	4,070	2,950	55,030
1997	190	80	360	1,320	2,530	5,370	10,570	6,840	5,810	7,390	8,790	9,740	1,980	60,980
1998	2,380	1,930	850	660	1,140	7,090	6,124	4,962	4,091	5,190	8,790	2,730	2,560	48,487
1999	737	916	1,246	3,469	1,650	1,826	1,679	3,084	2,371	2,953	3,837	2,132	1,979	27,879
2000	490	720	900	1,310	1,800	2,440	2,020	2,710	2,090	940	1,440	2,940	430	20,230
2001	320	170	190	940	1,360	2,220	3,110	2,400	2,690	2,230	2,180	1,200	1,370	20,380
2002	130	910	902	1,590	544	1,546	2,153	1,822	1,900	2,220	1,073	1,294	1,730	17,814
2003	220	250	590	1,080	680	1,020	2,910	1,180	2,250	1,370	1,530	840	1,310	15,230
2004	780	100	100	90	240	540	1,130	1,260	1,590	1,740	1,490	2,570	1,890	16,410

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 1985-2004 (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

[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 1992-2004 (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

Table D14. Sebastes marinus. Mean catch rates (N/nm2) of Sebastes marinus from Norwegian Coastal Surveys in 1995-2004 within 100-350 m depth. Catch rates for the total area.

Length range (cm)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0-4	0	0	0	0	0	0	0	0	0	0
5-9	41	34	4	0	0	0	0	0	0	2
10-14	118	87	9	0	19	2	2	0	1	3
15-19	59	124	12	4	242	13	11	0	3	10
20-24	54	151	64	12	160	7	14	2	22	36
25-29	38	67	112	16	34	10	22	6	50	76
30-34	69	210	96	17	43	30	15	29	51	45
35-39	214	415	178	110	151	160	83	259	213	340
40-44	157	209	190	96	117	155	160	213	185	258
45-49	21	64	45	18	15	30	30	26	37	19
50-54	2	0	2	3	4	4	2	4	4	3
55-59	1	0	1	0	2	0	0	1	0	1
60-64	0	0	0	0	0	0	0	0	0	0
Total	775	1361	715	277	786	411	340	538	568	793
Measured	1026	1233	599	287	459	503	326	326	812	866
# trawls	94	84	95	87	102	99	80	96	95	83
# trawl with species	61	60	57	40	42	50	41	38	59	52

8 Greenland halibut in subareas I and II

8.1 Status of the fisheries

8.1.1 Landings prior to 2005 (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 2003 is 13,578 t, which is 576 t more than used in the previous assessment. The preliminary estimate of the total catch for 2004 is 18,762 t. This is exceeding the projected catch for 2004 estimated by the Working Group during its 2004 meeting for more than 4,700 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 increase in the Norwegian trawl catch from 2,200 t in 2003 to nearly 5,800 t in 2004, i.e. 160 %.

In recent years, some fishing for Greenland halibut has taken place in the northern part of Division IVa. In the period 1973–1990, the annual catch in Division IVa was usually well below 100 t, occasionally reaching 200 t. Since then, catches increased sharply from 558 t in 1991 to 2,010 t in 1996 (Table E10). Catches remained comparatively high until they dropped to below 900 t in 2000. The increase from 1973 to 1991 was due mainly to a gillnet fishery. In recent years most of the catch has been taken by trawl. This fishery is in another management area and is not restricted by any TAC regulations. Although there is a continuous distribution of this species from the southern part of Division IIa along the continental slope towards the Shetland area, little is known about the stock structure and the catch taken from this area has therefore not been added to the catch from Subareas I and II.

Around Jan Mayen, small catches of Greenland halibut have been taken in some years. In the period 2000 - 2003 catches in this area were around 60 t or lower and in 2004 the landings increased slightly to 95 t. 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 2004 and 2005

The advice from ICES for 2004 was as follows:

ICES recommends that catches not exceed 13 000 t for 2004 to allow continued increase in the stock. Furthermore, additional measures to control catch should be implemented.

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.

8.1.3 Management applicable in 2004 and 2005

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).

8.1.4 Expected landings in 2005

The total Norwegian catch in 2005 is expected to be at the same level as in 2004, 14,000 t. In addition 4,500 t is expected to be caught by Russian vessels and 500 t by other countries. Consequently the official landings in 2005 are expected to be 19,000 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 the same level as last year (about 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 2005 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 1.10. With exception of 2003 the last 5 years have shown values well above the average before 2000.

8.2.2 Commercial catch-per-unit-effort (Table 8.6 and E9)

The CPUE from the experimental fishery was found to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1650 kg/h with the highest value in 2003 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series also shows the highest value in 2003. In 2004 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 of the Greenland halibut stock, the problem of low abundance at age 9 in the Norwegian data from surveys remains unresolved. However, the problem seems lesser 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 and a working document was presented for AFWG (Albert, et al., WD 8#2005). This document concludes that the current age data are not suitable for making age structured assessments of the stock. A refined ageing method is presented, but more validation should be done before age-structured assessments are again warranted. It is a very time demanding task to reanalyse archived otolith samples from such a large length-range, large distribution area, several fleets and each quarter of the year. In the meantime alternative approaches should be applied, e.g. traffic light evaluation scheme or simpler length based models. The group decided to use the common age readings to update this years assessment, but before the next WG meeting work must be done to investigate implications to the assessment using inaccurate age readings and also to evaluate alternative models.

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 2003 were updated using revised catch figures and revised Norwegian age composition. Catch-at-age data for 2004 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 2004 (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 1984–2002, except for the year 1991. An average ogive computed for 1984–1987 was applied to 1964–1983. The average of 1990 and 1992 was used to represent the maturity ogive for 1991. For 1984-2002 and 2004 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 1992–2004 for ages 5–14.

Fleet 7: Russian trawl survey from 1992-2004 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 1996-2004 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 2005 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 42,000 by 2004, the highest estimated since 1983.

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 0.18 by 2002 and 2003, the lowest value estimated for the last 20 years. Due to the increase in catch in 2004 the fishing mortality again raised (0.23).

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.

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 fishing mortality and stock size for 2004 have increased.

	TOTAL STOCK (5+) BY 1 JANUARY 2004	SSB BY 1 JANUARY 2004	F6-10 IN 2004	F6-10 IN 2003
WG 2004	83543	29987	0.21*	0.21
WG 2005	96570	42083	0.23	0.18

*prediction

8.8 Comments to the assessment (Figures 8.3 – 8.4)

The current assessment was using the same catch matrix, surveys series and settings as in the previous year with updated data for 2003 and new data for 2004. However, the 2002 and 2003 results from the Russian survey was not used for reasons stated above (section 8.2.1). 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 highly uncertain due to the age-reading problems illustrated in Albert et al., WD8#2005 and section 8.2.3. 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 and expected catch of 2005 will most likely lead to reduction in the spawning stock size, as in the period 1983 to 1989.

8.9 Response to ACFM technical minutes

The three tuning fleets used in the assessment is shown in biomass units (Figure 8.4) as requested. The other problems mentioned in the technical minutes are strongly related to the ageing problem of this stock. Work is continuously done to try to solve this and a working document was presented to the WG (Albert, et al., WD8#2005). Unfortunately more time is needed before any firm conclusions can be drawn.

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	Den-mark	Esto-nia	Faroe Isl.	France	Fed. Rep. Germa-ny	Gre-enl.	Ice-land	Ire-land	Lithu-ania	Norway	Po-land	Portu-gal	Russia[3]	Spain	UK (Engl. & Wales)	UK (Scot land)	Total
1984	0	0	0	138	2,165	0	0	0	0	4,376	0	0	15,181	0	23	0	21,883
1985	0	0	0	239	4,000	0	0	0	0	5,464	0	0	10,237	0	5	0	19,945
1986	0	0	42	13	2,718	0	0	0	0	7,890	0	0	12,200	0	10	2	22,875
1987	0	0	0	13	2,024	0	0	0	0	7,261	0	0	9,733	0	61	20	19,112
1988	0	0	186	67	744	0	0	0	0	9,076	0	0	9,430	0	82	2	19,587
1989	0	0	67	31	600	0	0	0	0	10,622	0	0	8,812	0	6	0	20,138
1990	0	0	163	49	954	0	0	0	0	17,243	0	0	4,764[2]	0	10	0	23,183
1991	11	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[1]	0	0	0	122	58	0	9	1	0	10,896[2]	2	35	4,694	418[2]	100	30	16,365
2002[1]	0	219	0	7	42	22	4	6	0	7,011[2]	5	14	5,584	178[2]	41	28	13,161
2003[1]	0	0	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	13,796[2]	1	51	4,662	186[2]	49	0	18,762

[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[1]	-	-	-	-	-	9	-	925[2]	+	951	-[2]	2	-	1,887
2002[1]	-	-	3	-	-	+	-	791[2]	-	1,167	-[2]	+	-	1,961
2003[1]	-	48	+	+	2	+	1	949[2]	1	735	+[2]	+	+	1,674
2004[1]	-	-	-	-	-	+	-	760[2]	-	633	-[2]	3	-	1,397

[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[1]	-	-	49	122	-[4]	9	1	8,740[2]	-	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	-	11,656[2]	-	24	810	4[2]	7	-	12,514

[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[1]	-	-	-	+	9	-	-	1,231[2]	2	22	3,017	413[2]	42	-	4,736
2002[1]	-	219	-	+	30	6	-	440[2]	5	11	3,568	178[2]	29	-	4,486
2003[1]	+	+	21	-	13	-	-	620[2]	4	9	1,887	216	35	+	2,805
2004[1]	-	-	-	-	5	-	-	1,380[2]	1	26	3,219	182[2]	39	-	4,851

[1]Provisional figures.

[2]Working Group figure.

[3]As reported to Norwegian authorities.

[4] USSR prior to 1991.

Table 8.5. GREENLAND HALIBUT in the Sub-areas I and II. Landings by gear (tonnes). Approximate figures, the total may differ slightly from Table 8.1

Year	Gillnet	Longline	Trawl	Total
1980	1 189	336	11 759	13 284
1981	730	459	13 829	15 018
1982	748	679	15 362	16 789
1983	1 648	1 388	19 111	22 147
1984	1 200	1 453	19 230	21 883
1985	1 668	750	17 527	19 945
1986	1 677	497	20 701	22 875
1987	2 239	588	16 285	19 112
1988	2 815	838	15 934	19 587
1989	1 342	197	18 599	20 138
1990	1 372	1 491	20 325	23 188
1991	1 904	4 552	26 864	33 320
1992	1 679	1 787	5 787	9 253
1993	1 497	2 493	7 889	11 879
1994	1 403	2 392	5 353	9 148
1995	1 500	4 034	5 494	11 028
1996	1 480	4 616	7 977	14 073
1997	998	3 378	5 198	9 574
1998	1 327	3 891	6 664	11 882
1999	2 565	6 804	10 177	19 546
2000	1 707	5 029	7 700	14 437
2001	2 041	6 303	7 968	16 312
2002	1 737	5 309	6 115	13 161
2003	2 046	5 483	6 049	13 578
2004	2 286	7 136	9 340	18 761

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	-	-	-	-	-

[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: 2005/1)

At 21/04/2005 9:57

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
5	372	253	170	156	114	1064	526	80	1109	212
6	1480	853	563	332	283	2420	2792	4486	3521	1117
7	2808	1735	1106	623	452	3208	10464	12712	9605	3923
8	5674	3868	2715	2006	1976	6288	18562	12283	6438	3515
9	4951	4203	4054	3237	3923	4921	10034	6130	2775	2551
10	3981	3799	2499	2409	2950	4431	6671	4339	1734	1919
11	1853	1799	1284	1718	2234	2381	2517	2703	1368	1536
12	1018	1002	783	871	792	812	1250	1660	1234	1127
13	364	372	246	315	146	229	616	1044	675	716
14	251	282	261	155	43	100	1104	300	200	251
+gp	76	50	28	19	7	30	281	143	80	126
0 TOTALNUM	22828	18216	13709	11841	12920	25884	54817	45880	28739	16993
TONSLAND	40391	34751	26321	24267	26168	43789	89484	79034	43055	29938
SOPCOF %	100	100	101	100	100	103	94	104	98	92

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

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
5	917	840	830	2037	1897	2218	731	1896	1304	1543
6	2519	2337	2982	3255	3589	3155	1138	1917	1494	1864
7	6204	6520	5824	4200	4118	2727	1665	1919	1276	1851
8	3838	4118	5002	2524	2365	1234	1341	933	1208	2287
9	1834	2265	3000	1610	1509	495	944	484	1493	1491
10	1942	1654	1350	1104	946	319	473	448	1258	1228
11	1622	1857	915	1062	934	296	511	482	838	713
12	1338	1536	1212	858	438	243	275	380	502	488
13	734	1122	698	595	349	103	242	384	324	247
14	531	600	526	384	147	45	145	150	108	201
+gp	216	368	358	180	112	51	78	62	46	64
0 TOTALNUM	21695	23217	22697	17809	16404	10886	7543	9055	9851	11977
TONSLAND	37763	38172	36074	28827	24617	17312	13284	15018	16789	22147
SOPCOF %	98	88	93	101	105	104	109	107	100	98

Table 8.7 (Continued)

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

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
5	915	1219	1672	1212	907	2080	2139	3312	1098	1140
6	3698	2874	3335	2972	2540	4453	5163	3889	1195	1088
7	3350	2561	2712	3572	3141	3655	4642	4716	1069	1608
8	1938	1548	1531	1746	2096	1657	1932	2355	778	1118
9	1064	972	1128	752	1182	801	1221	1031	360	140
10	1191	1037	997	828	860	318	499	1284	600	976
11	602	614	530	362	481	228	264	774	188	444
12	340	363	434	202	313	126	314	673	150	144
13	171	161	314	186	133	120	42	177	79	36
14	132	120	305	63	140	140	96	266	89	20
+gp	71	63	239	7	47	28	44	517	56	4
0 TOTALNUM	13472	11532	13197	11902	11840	13606	16356	18994	5662	6718
TONSLAND	21883	19945	22875	19112	19587	20138	23183	33320	8602	11933
SOPCOF %	100	99	98	101	100	103	102	105	95	102

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

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE											
5	631	846	1034	330	359	433	380	441	277	397	326
6	708	992	2083	921	1116	1905	735	1347	921	1025	1038
7	1252	1719	3795	1822	2466	3955	1926	2338	1475	1827	2382
8	817	990	1426	953	1464	1810	1464	1325	983	928	1496
9	310	405	262	342	527	914	743	788	631	632	1155
10	642	726	655	822	924	1905	1318	1140	1097	1045	876
11	416	461	270	231	237	380	457	519	563	520	725
12	330	371	132	150	122	237	330	372	301	311	658
13	88	154	29	18	15	67	49	115	132	77	238
14	39	56	22	41	29	42	37	54	59	107	174
+gp	3	8	1	1	15	7	14	12	42	26	127
0 TOTALNUM	5236	6728	9709	5631	7274	11655	7453	8451	6481	6895	9195
TONSLAND	9226	11734	14347	9410	11893	19517	14437	16307	13161	13578	18761
SOPCOF %	99	101	101	99	100	102	101	100	100	100	99

Table 8.8

Run title : Arctic Green.halibut (run: 2005/1)

At 21/04/2005 9:57

Table 2 Catch weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
5	0.42	0.42	0.42	0.42	0.42	0.42	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
7	0.9	0.9	0.91	0.93	0.96	0.91	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
9	1.63	1.66	1.7	1.71	1.74	1.64	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
11	3.11	3	2.94	2.84	2.79	2.99	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
13	4.57	4.4	4.38	4.27	4.27	4.68	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
+gp	5.94	5.89	5.88	5.8	5.99	5.99	5.794	5.841	6.037	6.006
0 SOPCOFAC	0.9986	1.0046	1.0054	1.0024	0.9994	1.0262	0.9436	1.0434	0.9752	0.9231

Table 2 Catch weights at age (kg)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
5	0.567	0.567	0.567	0.567	0.567	0.900	0.702	0.660	0.69	0.75
6	0.737	0.737	0.737	0.737	0.737	1.200	0.872	0.840	0.84	1.04
7	1.079	1.079	1.079	1.079	1.079	1.500	1.141	1.150	1.03	1.34
8	1.421	1.421	1.421	1.421	1.421	1.800	1.468	1.560	1.31	1.57
9	1.848	1.848	1.848	1.848	1.848	2.200	1.778	2.040	1.74	1.97
10	2.281	2.281	2.281	2.281	2.281	2.600	2.302	2.570	2.24	2.73
11	2.887	2.887	2.887	2.887	2.887	3.000	2.664	2.980	2.77	3.29
12	3.247	3.247	3.247	3.247	3.247	3.500	3.046	3.430	3.37	4.22
13	4.303	4.303	4.303	4.303	4.303	4.100	3.368	4.130	4.32	4.71
14	4.931	4.931	4.931	4.931	4.931	4.800	4.285	4.680	5.35	6.08
+gp	5.964	5.91	5.923	6.027	5.906	6.176	5.346	5.999	5.833	6.122
0 SOPCOFAC	0.9825	0.8805	0.9255	1.0095	1.0485	1.0364	1.0894	1.068	1.0038	0.9783

Table 8.8 (Continued)

Table 2 Catch weights at age (kg)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
5	0.63	0.6	0.62	0.709	0.74	0.76	0.71	0.77	0.68	0.79
6	0.96	0.89	0.92	1.003	0.962	1.03	1.06	1.05	0.97	1.02
7	1.18	1.2	1.28	1.266	1.249	1.32	1.29	1.38	1.27	1.35
8	1.53	1.85	1.9	1.683	1.626	1.8	1.7	1.75	1.76	1.88
9	2.31	2.59	2.48	2.482	2.164	2.42	2.1	2.2	2.21	2.46
10	2.87	3.18	3.11	2.982	2.897	3.13	2.61	2.6	2.56	2.67
11	3.46	3.62	3.35	3.547	3.406	3.37	2.87	2.79	3.11	3.43
12	3.77	3.95	3.72	3.8	3.661	4.05	3.45	3.28	3.59	4.29
13	3.99	4.48	4	4.56	4.247	4.29	3.72	3.89	3.83	5.08
14	4.35	4.25	4.18	5.002	4.187	4.5	4.09	4.38	4.25	6.33
+gp	4.525	4.825	4.526	5.953	4.463	4.72	4.52	5.29	4.8	8.91
0 SOPCOFAC	1.0009	0.9858	0.9782	1.0116	0.9973	1.0346	1.0204	1.047	0.9519	1.0183

Table 2 Catch weights at age (kg)

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE											
5	0.72	0.73	0.77	0.77	0.73	0.7	0.76	0.74	0.69	0.715	0.657
6	0.94	0.94	0.97	0.94	0.93	0.95	0.97	1.03	0.94	1.05	0.934
7	1.27	1.25	1.31	1.28	1.3	1.27	1.33	1.39	1.36	1.428	1.324
8	1.72	1.74	1.74	1.64	1.61	1.55	1.63	1.75	1.68	1.748	1.697
9	2.19	2.09	2.24	2.07	2.12	2.00	2.11	2.29	2.18	2.318	2.277
10	2.52	2.51	2.59	2.59	2.57	2.46	2.61	2.68	2.68	2.615	2.638
11	2.97	2.95	3.29	3.3	3.25	3.22	3.35	3.33	3.19	3.043	3.031
12	3.29	3.34	4.02	4.01	3.91	3.85	3.97	3.92	3.89	3.694	3.586
13	3.84	3.83	4.75	4.83	4.9	4.61	4.97	4.81	4.46	4.566	3.983
14	4.95	4.98	6.24	5.95	5.66	5.84	5.82	5.81	5.25	5.568	4.674
+gp	6.68	8.15	6.09	6.26	4.91	5.98	7.22	7.41	6.32	6.365	6.240
0 SOPCOFAC	0.9937	1.0095	1.0066	0.9851	0.9983	1.0172	1.0055	1.0014	1.000	0.996	0.9912

Table 8.9

Run title : Arctic Green.halibut (run: 2005/1)

At 21/04/2005 9:57

Table 5 Proportion mature at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
5	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
7	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
9	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
11	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
13	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
+gp	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	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
5	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
7	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	0.18
9	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.6
10	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.82
11	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.96
12	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
14	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

Table 8.9 (Continued)

Table 5 Proportion mature at age

YEAR		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE											
	5	0	0	0	0	0	0	0	0	0	0.01
	6	0.04	0.04	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	7	0.03	0.04	0.03	0.02	0.01	0.02	0.02	0.04	0.06	0.08
	8	0.18	0.19	0.24	0.22	0.21	0.18	0.17	0.15	0.28	0.32
	9	0.61	0.65	0.74	0.66	0.53	0.49	0.51	0.54	0.66	0.68
	10	0.83	0.85	0.91	0.9	0.87	0.8	0.77	0.77	0.86	0.83
	11	0.97	0.97	0.99	0.95	0.89	0.89	0.91	0.89	0.87	0.88
	12	0.98	0.99	0.98	0.98	0.98	1.000	1.000	1.000	1.000	0.94
	13	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
+gp		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		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE												
	5	0.01	0.01	0	0	0	0	0	0.01	0.02	0.02	0
	6	0.01	0.01	0	0	0	0	0.01	0.03	0.04	0.04	0.01
	7	0.07	0.08	0.07	0.07	0.04	0.02	0.03	0.06	0.09	0.09	0.05
	8	0.34	0.29	0.25	0.21	0.1	0.07	0.1	0.19	0.26	0.26	0.23
	9	0.69	0.58	0.58	0.53	0.45	0.33	0.37	0.49	0.63	0.63	0.68
	10	0.81	0.79	0.88	0.85	0.82	0.66	0.63	0.65	0.72	0.72	0.88
	11	0.95	0.96	0.97	0.94	0.92	0.86	0.87	0.84	0.91	0.91	0.97
	12	0.94	0.89	0.94	0.94	1	0.99	0.96	0.96	0.96	0.96	0.97
	13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.99
	14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.97
+gp		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 8.10.

Lowestoft VPA Version 3.1

24/04/2005 14:25

Extended Survivors Analysis

Arctic Green.halibut (run: 2005/1)

CPUE data from file fleet

Catch data for 41 years. 1964 to 2004. Ages 5 to 15.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT04: Norw. Exp. CP	1992	2004	5	14	0.38	0.44
FLT07: Russ.Surv. ne	1992	2004	5	14	0.75	0.92
FLT08: Norw.Comb.Sur	1996	2004	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 2004
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 41 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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5	0.052	0.062	0.018	0.022	0.032	0.024	0.031	0.017	0.025	0.021
6	0.073	0.167	0.069	0.074	0.148	0.066	0.107	0.081	0.078	0.081
7	0.262	0.41	0.204	0.25	0.378	0.207	0.293	0.156	0.215	0.246
8	0.315	0.341	0.16	0.237	0.278	0.22	0.203	0.182	0.131	0.259
9	0.229	0.121	0.12	0.118	0.216	0.166	0.167	0.133	0.161	0.227
10	0.695	0.661	0.632	0.511	0.749	0.518	0.387	0.349	0.32	0.331
11	0.854	0.568	0.485	0.35	0.384	0.372	0.372	0.317	0.261	0.363
12	1.161	0.596	0.681	0.482	0.668	0.64	0.556	0.362	0.273	0.579
13	1.224	0.222	0.138	0.12	0.503	0.259	0.45	0.366	0.139	0.327
14	0.894	0.509	0.525	0.325	0.538	0.544	0.477	0.414	0.538	0.495

Table 8.10 (Continued)

XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12	13	14
1995	1.79E+04	1.52E+04	8.04E+03	3.95E+03	2.13E+03	1.56E+03	8.65E+02	5.82E+02	2.35E+02	1.02E+02
1996	1.85E+04	1.46E+04	1.22E+04	5.32E+03	2.48E+03	1.46E+03	6.71E+02	3.17E+02	1.57E+02	5.95E+01
1997	2.00E+04	1.49E+04	1.06E+04	6.95E+03	3.26E+03	1.89E+03	6.48E+02	3.27E+02	1.50E+02	1.08E+02
1998	1.78E+04	1.69E+04	1.20E+04	7.47E+03	5.09E+03	2.49E+03	8.64E+02	3.44E+02	1.43E+02	1.13E+02
1999	1.48E+04	1.49E+04	1.35E+04	8.05E+03	5.07E+03	3.90E+03	1.28E+03	5.24E+02	1.83E+02	1.09E+02
2000	1.70E+04	1.23E+04	1.11E+04	7.98E+03	5.25E+03	3.51E+03	1.59E+03	7.53E+02	2.31E+02	9.50E+01
2001	1.54E+04	1.43E+04	9.93E+03	7.76E+03	5.51E+03	3.83E+03	1.80E+03	9.40E+02	3.42E+02	1.54E+02
2002	1.74E+04	1.28E+04	1.10E+04	6.37E+03	5.45E+03	4.01E+03	2.24E+03	1.07E+03	4.64E+02	1.87E+02
2003	1.70E+04	1.48E+04	1.02E+04	8.13E+03	4.57E+03	4.11E+03	2.44E+03	1.40E+03	6.41E+02	2.77E+02
2004	1.70E+04	1.43E+04	1.18E+04	7.07E+03	6.14E+03	3.35E+03	2.57E+03	1.61E+03	9.19E+02	4.80E+02
Estimated population abundance at 1st Jan 2005										
	0.00E+00	1.44E+04	1.13E+04	7.91E+03	4.69E+03	4.21E+03	2.07E+03	1.54E+03	7.79E+02	5.70E+02
Taper weighted geometric mean of the VPA populations:										
	1.66E+04	1.34E+04	9.96E+03	6.16E+03	3.94E+03	2.68E+03	1.31E+03	6.68E+02	2.85E+02	1.51E+02
Standard error of the weighted Log(VPA populations) :										
	0.1559	0.216	0.2695	0.3124	0.3848	0.3819	0.4841	0.5675	0.6514	0.6845

1

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992	1993	1994
5	0.11	0.68	0.43
6	-0.22	0.03	0.16
7	-0.53	0.05	0.07
8	-0.17	0.2	0.29
9	-1.34	-1.31	-0.81
10	-0.47	0.06	0.26
11	-0.24	-0.17	-0.24
12	0.07	-0.22	-0.86
13	-0.39	-0.09	-0.8
14	-1.33	-0.27	-0.59

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5	0.55	0.8	0.74	-0.76	-0.37	0.09	-0.54	-0.43	-0.29	-0.23
6	-0.12	0.72	0.13	-0.17	-0.09	0.04	-0.12	-0.16	-0.04	-0.12
7	0.08	0.3	0	-0.02	-0.16	0.32	-0.15	0.14	-0.08	-0.17
8	0.3	0.19	-0.2	-0.1	-0.19	-0.1	0.41	-0.03	-0.55	0.1
9	0.4	-0.11	0.1	-0.09	-1.02	0.22	0.52	0.48	0.8	0.71
10	0.72	-0.01	0.44	-1.09	0.17	0.33	-0.17	0	0.2	-0.42
11	0.16	-0.7	0.49	-1.04	-1.17	-1.18	-0.82	-0.81	-0.3	-0.31
12	0.14	-0.78	0.42	-0.91	0.48	-0.16	-0.15	-0.71	-0.04	0.12
13	-0.23	99.99	0.06	99.99	-0.67	0.24	-0.92	-1.66	-0.29	-0.28
14	0.07	-0.24	-0.14	99.99	-0.14	99.99	-0.51	-0.04	-0.16	-0.04

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	-4.8784	-4.0367	-3.2218	-3.7256	-4.6481	-3.5717	-3.5717	-3.5717	-3.5717	-3.5717
S.E(Log q)	0.539	0.2404	0.2048	0.2743	0.7159	0.4662	0.7672	0.5236	0.7611	0.4301

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	0.61	0.516	6.74	0.17	13	0.34	-4.88
6	0.99	0.033	4.1	0.45	13	0.25	-4.04
7	0.87	0.632	4	0.72	13	0.18	-3.22
8	1.6	-1.506	0.73	0.41	13	0.41	-3.73
9	0.55	1.585	6.3	0.57	13	0.36	-4.65
10	1.23	-0.483	2.56	0.32	13	0.6	-3.57
11	1.42	-0.883	2.83	0.33	13	0.76	-4.1
12	0.91	0.361	4.01	0.64	13	0.46	-3.77
13	1.31	-0.74	3.55	0.45	11	0.76	-4.05
14	0.95	0.288	3.89	0.81	11	0.33	-3.83

Fleet : FLT07: Russ.Surv. ne

Age	1992	1993	1994
5	1.82	0.68	-0.01
6	0.91	0.61	0.2
7	0.51	0.54	0.04
8	0.29	0.28	0.01
9	-0.65	-0.1	-0.02
10	-0.45	-0.02	0.26
11	0.36	-0.15	-0.47
12	0.27	0.38	-0.05
13	-0.45	-0.33	-0.42
14	-4.94	0.72	0.51

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5	-0.52	-0.39	-1.02	-0.23	-0.31	0.13	0.72	99.99	99.99	0
6	-0.18	-0.03	-0.57	-0.44	-0.49	-0.12	0.65	99.99	99.99	0.07
7	0.02	0.08	-0.27	-0.3	-0.48	-0.15	0.43	99.99	99.99	0.03
8	0.26	0.13	-0.08	-0.01	-0.15	0.09	-0.31	99.99	99.99	-0.16
9	0.29	0.71	-0.18	0.12	0.01	0.07	-0.31	99.99	99.99	-0.13
10	0.2	-0.85	-0.03	0.17	0.09	0.18	0.09	99.99	99.99	0.12
11	-0.06	-0.66	0.31	0.72	-0.24	0.52	0.07	99.99	99.99	0.02
12	0.07	-0.88	-0.41	0.57	0.22	0.55	0.79	99.99	99.99	0.28
13	-0.29	-0.4	0.43	0.4	0.66	-0.82	1.1	99.99	99.99	0.11
14	-1.76	-0.36	-0.33	-0.29	-0.22	0.51	0.47	99.99	99.99	0.66

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	-0.4484	0.5435	0.9684	1.2014	0.7494	0.4028	0.4028	0.4028	0.4028	0.4028
S.E(Log q)	0.6864	0.4716	0.3282	0.1946	0.3248	0.325	0.4293	0.5275	0.6178	1.4027

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	-0.38	-4.361	13.22	0.59	11	0.14	-0.45
6	-2.61	-2.532	35.68	0.07	11	0.95	0.54
7	3.45	-2.395	-25.8	0.12	11	0.9	0.97
8	1.67	-2.775	-7.8	0.71	11	0.24	1.2
9	1.33	-0.916	-3.7	0.53	11	0.44	0.75
10	0.72	1.358	1.91	0.77	11	0.22	0.4
11	0.97	0.087	-0.24	0.56	11	0.44	0.46
12	0.7	1.447	1.49	0.77	11	0.32	0.58
13	0.87	0.387	0.3	0.56	11	0.57	0.46
14	1.02	-0.028	-0.26	0.16	11	1.51	0.14
1							

Fleet : FLT08: Norw.Comb.Sur

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
5	99.99	0.22	-0.11	-0.25	-0.23	0.07	-0.09	0.08	0.23	0.07
6	99.99	0.28	0.12	-0.35	0	-0.07	0.02	-0.04	0.13	-0.06
7	99.99	0.21	-0.06	0.04	-0.14	-0.21	0.13	0.04	0.06	-0.05
8	99.99	0.43	-0.42	-0.24	0.21	-0.1	0.04	0.14	-0.09	0.05
9	99.99	0.01	-0.43	-0.67	-0.38	0.41	-0.14	0.51	0.5	0.07
10	99.99	0.65	0.2	0.17	0.24	-0.42	-0.02	-0.3	-0.03	-0.33
11	99.99	-0.05	-0.09	-0.09	-0.51	-1.09	-0.85	-0.3	-0.8	-0.8
12	99.99	0.12	0.28	0.64	0.63	-0.44	-0.21	0.04	-0.26	0.24
13	99.99	-0.51	-1.22	-3.08	-0.04	-0.72	-0.72	-0.24	-0.38	-0.09
14	99.99	0.08	-0.01	0.2	0.1	-0.65	-0.3	-0.18	-0.51	0.14

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	-0.2197	0.3454	1.0534	0.5305	-0.1296	0.8573	0.8573	0.8573	0.8573	0.8573
S.E(Log q)	0.178	0.168	0.1282	0.2427	0.4338	0.3351	0.6824	0.3978	1.2358	0.3408

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	0.66	0.687	3.47	0.38	9	0.12	-0.22
6	1.67	-0.577	-6.95	0.1	9	0.29	0.35
7	1.66	-0.81	-7.86	0.19	9	0.22	1.05
8	6.89	-1.364	-55.96	0.01	9	1.58	0.53
9	0.79	0.452	1.89	0.41	9	0.36	-0.13
10	2.88	-2.532	-17.53	0.22	9	0.74	0.86
11	2.12	-2.689	-8.88	0.47	9	0.61	0.33
12	1.44	-1.492	-4.24	0.64	9	0.51	0.96
13	0.58	1.665	2.36	0.7	9	0.48	0.1
14	1.02	-0.097	-0.83	0.8	9	0.34	0.72
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 = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	11407	0.563	0	0	1	0.156	0.026
FLT07: Russ.Surv. ne	14401	0.723	0	0	1	0.094	0.021
FLT08: Norw.Comb.Sur	15487	0.3	0	0	1	0.548	0.019
F shrinkage mean	14003	0.5				0.202	0.021

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14371	0.22	0.06	4	0.279	0.021

1

Age 6 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	9667	0.265	0.07	0.26	2	0.319	0.095
FLT07: Russ.Surv. ne	12203	0.497	0	0	1	0.091	0.076
FLT08: Norw.Comb.Sur	12352	0.212	0.145	0.68	2	0.493	0.075
F shrinkage mean	11662	0.5				0.097	0.079

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11347	0.15	0.07	6	0.464	0.081

Age 7 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	6859	0.199	0.085	0.43	3	0.35	0.279
FLT07: Russ.Surv. ne	8135	0.346	0	0	1	0.121	0.24
FLT08: Norw.Comb.Sur	8322	0.173	0.054	0.31	3	0.455	0.236
F shrinkage mean	10821	0.5				0.074	0.186

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7908	0.12	0.06	8	0.492	0.246

1

Table 8.10 (Continued)

Age 8 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	4375	0.167	0.098	0.59	4	0.362	0.276
FLT07: Russ.Surv. ne	4393	0.279	0.276	0.99	2	0.148	0.275
FLT08: Norw.Comb.Sur	4710	0.152	0.036	0.23	4	0.429	0.258
F shrinkage mean	8167	0.5				0.061	0.157

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4695	0.1	0.07	11	0.661	0.259

Age 9 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	3722	0.163	0.177	1.08	5	0.348	0.253
FLT07: Russ.Surv. ne	4492	0.268	0.223	0.83	3	0.148	0.214
FLT08: Norw.Comb.Sur	4258	0.145	0.033	0.22	5	0.444	0.224
F shrinkage mean	6737	0.5				0.06	0.148

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4209	0.1	0.08	14	0.792	0.227

Age 10 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	1923	0.16	0.121	0.76	6	0.313	0.353
FLT07: Russ.Surv. ne	2408	0.222	0.119	0.54	4	0.188	0.291
FLT08: Norw.Comb.Sur	2055	0.139	0.116	0.84	6	0.432	0.333
F shrinkage mean	2033	0.5				0.067	0.336

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2072	0.09	0.06	17	0.68	0.331

Table 8.10 (Continued)

Age 11 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	1802	0.16	0.127	0.8	7	0.294	0.317
FLT07: Russ.Surv. ne	1275	0.197	0.08	0.41	5	0.225	0.424
FLT08: Norw.Comb.Sur	1441	0.139	0.117	0.84	7	0.4	0.383
F shrinkage mean	1998	0.5				0.081	0.29

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1537	0.09	0.07	20	0.732	0.363

Age 12 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	766	0.17	0.086	0.51	8	0.272	0.586
FLT07: Russ.Surv. ne	693	0.188	0.144	0.77	6	0.225	0.632
FLT08: Norw.Comb.Sur	683	0.147	0.098	0.67	8	0.391	0.639
F shrinkage mean	1626	0.5				0.112	0.319

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
779	0.1	0.08	23	0.792	0.579

Age 13 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	518	0.18	0.097	0.54	9	0.272	0.355
FLT07: Russ.Surv. ne	547	0.178	0.077	0.43	7	0.259	0.339
FLT08: Norw.Comb.Sur	577	0.152	0.077	0.5	9	0.359	0.324
F shrinkage mean	766	0.5				0.11	0.253

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
570	0.1	0.05	26	0.48	0.327

Table 8.10 (Continued)

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	221	0.202	0.136	0.67	10	0.291	0.548
FLT07: Russ.Surv. ne	265	0.173	0.075	0.43	8	0.188	0.476
FLT08: Norw.Comb.Sur	239	0.179	0.096	0.54	9	0.388	0.516
F shrinkage mean	364	0.5				0.133	0.367

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
252	0.12	0.06	28	0.549	0.495

Table 8.11

Run title : Arctic Green.halibut (run: 2005/1)

At 24/04/2005 14:38

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	0.3111	0.2406
7	0.4197	0.4666	0.4176	0.4305	0.2659	0.1815	0.1933	0.1284	0.2143	0.3869	0.3476
8	0.3818	0.6251	0.3558	0.4142	0.2074	0.1912	0.1388	0.1696	0.3358	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	0.3981	0.1094	0.1723	0.1533	0.3462	0.4552	0.4075	0.3731
11	0.5023	0.3824	0.4848	0.4738	0.1957	0.2424	0.2519	0.4462	0.318	0.398	0.3585
12	0.5617	0.6829	0.7082	0.3551	0.2024	0.2657	0.2705	0.4256	0.4788	0.2324	0.4192
13	0.5355	0.5074	0.818	0.6673	0.1238	0.3005	0.6807	0.3677	0.3613	0.2877	0.1554
14	0.474	0.4874	0.549	0.4516	0.1533	0.2429	0.2909	0.3837	0.3861	0.315	0.3172
+gp	0.474	0.4874	0.549	0.4516	0.1533	0.2429	0.2909	0.3837	0.3861	0.315	0.3172
0 FBAR 6-10	0.336	0.4264	0.3409	0.3659	0.1911	0.172	0.1445	0.2188	0.2912	0.3384	0.3054

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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	0.0951	0.0696	0.0435	0.1143	0.1727	0.3309	0.1189	0.0996	0.0378	0.0523	0.0622
6	0.2541	0.2306	0.1929	0.2921	0.4297	0.5077	0.1796	0.1571	0.0785	0.073	0.1669
7	0.3542	0.4463	0.3834	0.4395	0.5292	0.8433	0.2373	0.3676	0.258	0.262	0.4101
8	0.3406	0.3826	0.4836	0.3375	0.414	0.5296	0.2927	0.3937	0.3042	0.3152	0.3407
9	0.3393	0.2634	0.4566	0.3232	0.421	0.3827	0.1324	0.0737	0.1689	0.2291	0.121
10	0.4686	0.4223	0.5116	0.1995	0.3231	1.0206	0.3787	0.5905	0.5238	0.6947	0.6613
11	0.3127	0.2906	0.438	0.2303	0.2395	1.1628	0.3594	0.5038	0.5085	0.8542	0.5682
12	0.4371	0.1774	0.4136	0.183	0.5352	1.6176	0.6834	0.486	0.8338	1.161	0.596
13	0.741	0.3188	0.1607	0.259	0.081	0.6227	0.801	0.3194	0.5875	1.2242	0.2221
14	0.4622	0.2957	0.398	0.2398	0.3213	0.9692	0.7026	0.4481	0.6418	0.8943	0.5085
+gp	0.4622	0.2957	0.398	0.2398	0.3213	0.9692	0.7026	0.4481	0.6418	0.8943	0.5085
0 FBAR 6-10	0.3513	0.349	0.4056	0.3184	0.4234	0.6568	0.2441	0.3165	0.2667	0.3148	0.34

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE									
5	0.0179	0.022	0.0321	0.0244	0.0314	0.0173	0.0254	0.0208	0.0212
6	0.0687	0.0737	0.1478	0.0664	0.1073	0.0806	0.0778	0.0815	0.0799
7	0.2041	0.2502	0.3783	0.2071	0.2929	0.1556	0.215	0.2464	0.2057
8	0.1601	0.2375	0.2776	0.2203	0.2033	0.1818	0.1313	0.259	0.1907
9	0.12	0.1182	0.2162	0.1656	0.1674	0.1332	0.1612	0.2268	0.1737
10	0.6325	0.5113	0.749	0.518	0.3872	0.3491	0.3204	0.3309	0.3335
11	0.4847	0.3503	0.3841	0.3721	0.3718	0.3165	0.2615	0.3631	0.3137
12	0.6808	0.4823	0.6683	0.6396	0.5557	0.3616	0.2731	0.5787	0.4045
13	0.1382	0.1203	0.5034	0.2593	0.4505	0.3659	0.1387	0.3274	0.2773
14	0.5252	0.325	0.5376	0.5444	0.4766	0.4143	0.5379	0.4951	0.4825
+gp	0.5252	0.325	0.5376	0.5444	0.4766	0.4143	0.5379	0.4951	
0 FBAR 6-10	0.2371	0.2382	0.3538	0.2355	0.2316	0.1801	0.1812	0.2289	

Table 8.12

Run title : Arctic Green.halibut (run: 2005/1)

At 24/04/2005 14:38

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	22936
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	22539	22097	23686	20591	19699	18600	17874	18932	18986	17816	19928
6	22080	18621	18249	18497	15963	14898	15331	13625	15085	14910	14485
7	20504	16836	13260	12688	12591	10813	11767	11417	10341	11254	9402
8	13986	11599	9088	7517	7100	8307	7762	8347	8643	7183	6579
9	8154	8217	5343	5480	4276	4966	5906	5815	6064	5317	4385
10	5389	4917	4289	3105	3317	3221	3399	4634	3620	3836	3590
11	5069	3104	2980	2668	1795	2559	2333	2510	2822	1976	2197
12	3852	2640	1822	1579	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	676	527	476
+gp	1044	993	456	330	386	388	264	155	214	282	249
0 TOTAL	107248	92386	81302	73664	67851	66752	67842	68496	68712	65606	63638

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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	19874	19439	22990	20752	14538	12672	10557	12966	18336	17880	18477
6	16021	15555	15607	18946	15932	10529	7834	8068	10102	15197	14605
7	9801	10696	10631	11077	12176	8923	5454	5634	5935	8038	12160
8	5717	5920	5892	6236	6143	6173	3305	3703	3357	3947	5324
9	4226	3500	3476	3127	3830	3495	3129	2123	2150	2132	2479
10	2872	2591	2315	1895	1948	2164	2052	2359	1697	1563	1459
11	2128	1547	1462	1195	1336	1214	671	1209	1125	865	671
12	1321	1339	996	812	817	905	327	403	629	582	317
13	647	734	966	567	582	412	155	142	213	235	157
14	888	265	460	708	377	462	190	60	89	102	59
+gp	691	29	153	141	172	887	118	12	7	14	3
0 TOTAL	64187	61617	64947	65455	57850	47834	33791	36678	43641	50556	55711

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	GMST 64-**	AMST 64-**
AGE											
5	20025	17752	14787	16991	15370	17449	17045	17048	0	23132	26116
6	14944	16929	14946	12325	14272	12820	14762	14302	14371	19145	22046
7	10638	12008	13536	11097	9927	11034	10180	11755	11347	14565	17432
8	6945	7466	8048	7981	7764	6375	8129	7067	7908	9600	12292
9	3259	5094	5068	5248	5511	5453	4575	6136	4695	6225	8074
10	1890	2488	3895	3514	3827	4013	4108	3351	4209	4159	5267
11	648	864	1284	1585	1802	2237	2436	2567	2072	2349	3074
12	327	344	524	753	940	1069	1403	1614	1537	1337	1804
13	150	143	183	231	342	464	641	919	779	686	1014
14	108	113	109	95	154	187	277	480	570	391	605
+gp	3	58	18	36	34	133	67	348	435		
0 TOTAL	58939	63258	62397	59856	59943	61235	63622	65587	47922		

Table 8.13

Run title : Arctic Green.halibut (run: 2005/1)

At 24/04/2005 14:38

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	19558
	7	25165	24941	27890	34936	40701	47136	48861	40997	27919	21626	24748
	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	196237	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	17729	13057	11797	13063	14240	11224	11957
	6	16273	13723	13450	13632	19156	12991	12878	11445	15688	14314	12892
	7	22124	18166	14308	13690	18887	12337	13532	11760	13857	13280	11283
	8	19874	16483	12914	10681	12780	12195	12108	10935	13570	10991	12171
	9	15069	15186	9874	10128	9406	8830	12048	10118	11946	12283	11357
	10	12292	11216	9784	7083	8624	7414	8734	10381	9882	11009	11415
	11	14634	8960	8603	7702	5385	6817	6953	6951	9283	6838	7952
	12	12508	8572	5918	5129	5004	3870	5929	5261	5834	6662	4513
	13	12551	8136	4939	3325	3908	3385	3462	4904	4135	2942	5401
	14	8448	7247	4831	2150	1638	3106	2998	1954	4113	2290	2023
	+gp	6168	5883	2747	1949	2381	2076	1581	902	1311	1275	1200
0	TOTALBIO	152722	126102	100798	87144	104898	86078	92021	87675	103860	93109	92163

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
	5	12322	13783	17013	15772	10322	9757	7179	10243	13202	13053	14228
	6	14740	15601	15014	19515	16888	11055	7599	8230	9496	14285	14167
	7	12546	13541	13278	14621	15707	12314	6927	7606	7537	10048	15929
	8	10862	9964	9580	11225	10443	10804	5816	6961	5775	6867	9263
	9	10481	8687	7521	7566	8043	7689	6914	5222	4708	4456	5552
	10	8933	7726	6706	5931	5084	5626	5252	6298	4277	3922	3779
	11	7127	5488	4979	4026	3834	3386	2087	4148	3341	2552	2209
	12	4915	5090	3646	3289	2818	2968	1172	1730	2069	1945	1274
	13	2587	3349	4101	2432	2165	1601	592	721	820	900	745
	14	3713	1327	1924	3184	1540	2024	808	377	439	509	371
	+gp	3129	175	685	665	776	4690	569	106	45	117	16
0	TOTALBIO	91354	84731	84447	88226	77621	71913	44916	51641	51709	58654	67534

Table 8.13 (Continued)

	Table 12	Stock biomass at age (start of year)			Tonnes				
	YEAR		1997	1998	1999	2000	2001	2002	2003	2004
	AGE									
		5	15419	12959	10351	12913	11374	12040	12187	11201
		6	14048	15744	14199	11956	14700	12051	15500	13358
		7	13617	15611	17191	14759	13798	15006	14537	15563
		8	11390	12020	12474	13009	13587	10710	14209	11993
		9	6747	10799	10135	11072	12621	11888	10605	13971
		10	4896	6394	9582	9171	10257	10754	10743	8841
		11	2139	2809	4135	5311	5999	7135	7412	7779
		12	1313	1344	2018	2989	3687	4159	5182	5788
		13	726	699	842	1149	1644	2071	2927	3660
		14	644	638	636	553	892	984	1544	2245
	+gp		16	285	108	258	251	838	426	2172
0	TOTALBIO		70954	79300	81669	83139	88810	87636	95271	96570

Table 8.14

Run title : Arctic Green.halibut (run: 2005/1)

At 24/04/2005 14:38

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	2312
		9	10096	10174	6616	6786	6302	5916	8072	6779	7168	7493	7382
		10	10571	9646	8415	6091	7417	6376	7512	8928	8103	9138	9703
		11	14341	8781	8431	7548	5277	6681	6814	6812	8912	6633	7714
		12	12258	8401	5799	5026	4904	3792	5810	5156	5718	6529	4468
		13	12551	8136	4939	3325	3908	3385	3462	4904	4135	2942	5401
		14	8448	7247	4831	2150	1638	3106	2998	1954	4113	2290	2023
	+gp		6168	5883	2747	1949	2381	2076	1581	902	1311	1275	1200
0	TOTSPBIO		79760	62686	45322	35937	35652	34653	39585	38428	42789	39249	41169

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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	102	132	131	0
		6	442	156	150	195	169	111	76	82	95	143	0
		7	376	271	133	292	314	493	416	608	528	804	1115
		8	2607	2192	2012	2020	1775	1621	1629	2228	1963	1992	2316
		9	7756	5734	3986	3708	4102	4152	4564	3551	3248	2584	3220
		10	8129	6954	5834	4745	3915	4332	4517	5228	3464	3099	3326
		11	7056	5214	4432	3583	3489	3014	1816	3650	3174	2450	2143
		12	4816	4988	3573	3289	2818	2968	1172	1626	1945	1731	1198
		13	2587	3349	4101	2432	2165	1601	592	721	820	900	745
		14	3713	1327	1924	3184	1540	2024	808	377	439	509	371
	+gp		3129	175	685	665	776	4690	569	106	45	117	16
0	TOTSPBIO		40612	30359	26830	24114	21063	25004	16157	18279	15853	14459	14450

Table 8.14 (Continued)

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

	YEAR		1997	1998	1999	2000	2001	2002	2003	2004
	AGE									
		5	0	0	0	0	114	241	244	0
		6	0	0	0	120	441	482	620	134
		7	953	624	344	443	828	1351	1308	778
		8	2392	1202	873	1301	2582	2785	3694	2758
		9	3576	4859	3345	4097	6184	7490	6681	9500
		10	4161	5243	6324	5778	6667	7743	7735	7780
		11	2011	2584	3556	4620	5040	6493	6745	7546
		12	1234	1344	1998	2869	3539	3993	4974	5615
		13	726	699	842	1149	1644	2071	2927	3623
		14	644	638	636	553	892	984	1544	2177
	+gp		16	285	108	258	251	838	426	2172
0	TOTSPBIO		15713	17478	18025	21187	28181	34469	36898	42083
		1								

Table 8.15

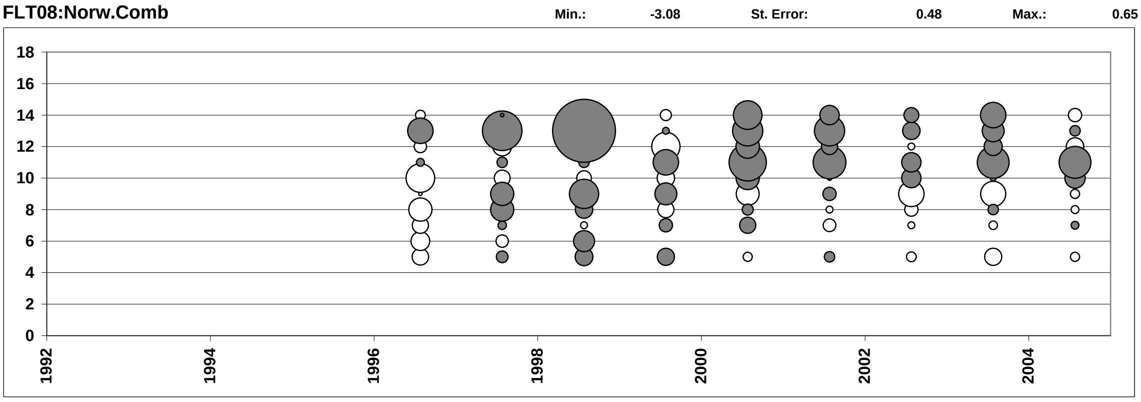
Run title : Arctic Green.halibut (run: 2005/1)

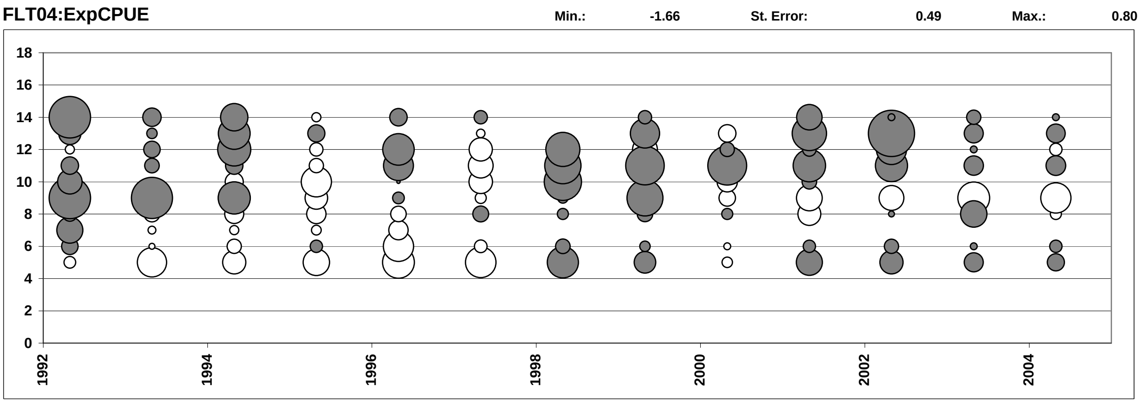
At 24/04/2005 14:38

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	196237	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	22539	152722	79760	38172	0.4786	0.336
1976	22097	126102	62686	36074	0.5755	0.4264
1977	23686	100798	45322	28827	0.636	0.3409
1978	20591	87144	35937	24617	0.685	0.3659
1979	19699	104898	35652	17312	0.4856	0.1911
1980	18600	86078	34653	13284	0.3833	0.172
1981	17874	92021	39585	15018	0.3794	0.1445
1982	18932	87675	38428	16789	0.4369	0.2188
1983	18986	103860	42789	22147	0.5176	0.2912
1984	17816	93109	39249	21883	0.5575	0.3384
1985	19928	92163	41169	19945	0.4845	0.3054
1986	19874	91354	40612	22875	0.5633	0.3513
1987	19439	84731	30359	19112	0.6295	0.349
1988	22990	84447	26830	19587	0.7301	0.4056
1989	20752	88226	24114	20138	0.8351	0.3184
1990	14538	77621	21063	23183	1.1006	0.4234
1991	12672	71913	25004	33320	1.3326	0.6568
1992	10557	44916	16157	8602	0.5324	0.2441
1993	12966	51641	18279	11933	0.6528	0.3165
1994	18336	51709	15853	9226	0.582	0.2667
1995	17880	58654	14459	11734	0.8116	0.3148
1996	18477	67534	14450	14347	0.9929	0.34
1997	20025	70954	15713	9410	0.5989	0.2371
1998	17752	79300	17478	11893	0.6804	0.2382
1999	14787	81669	18025	19517	1.0828	0.3538
2000	16991	83139	21187	14437	0.6814	0.2355
2001	15370	88810	28181	16307	0.5786	0.2316
2002	17449	87636	34469	13161	0.3818	0.1801
2003	17045	95271	36898	13578	0.368	0.1812
2004	17048	96570	42083	18761	0.4458	0.2289
Arith. Mean	25674	120527	48389	25370	0.5891	0.2892
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		





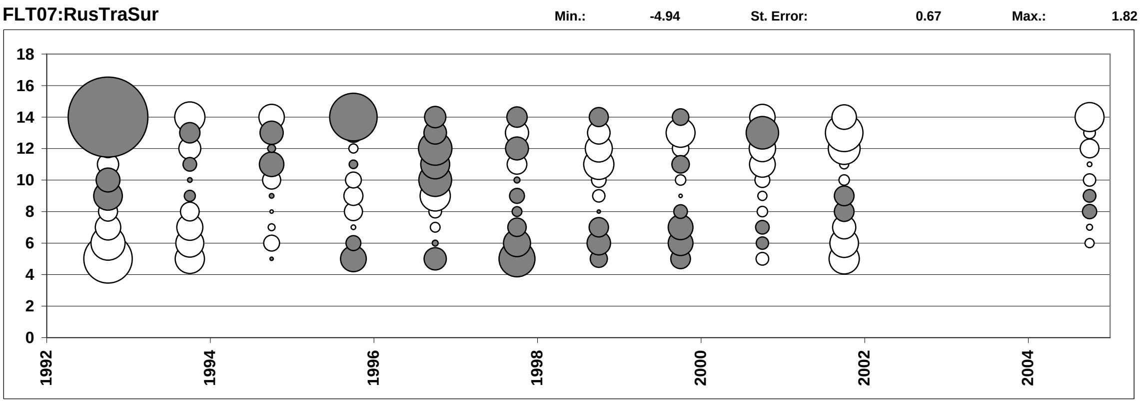


Figure 8.1. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.

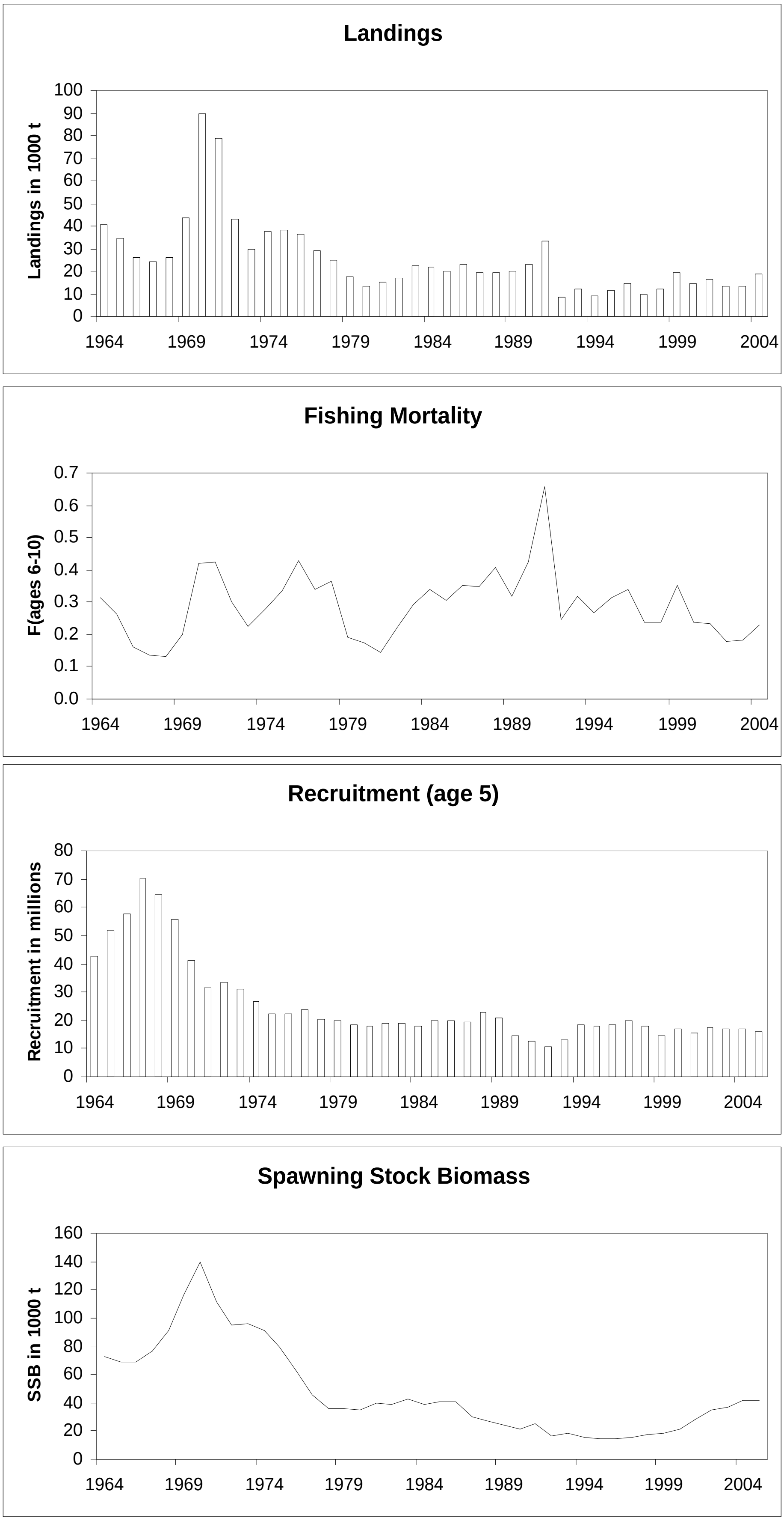


Figure 8.2. Historical landings, recruitment, fishing mortality and spawning stock biomass.

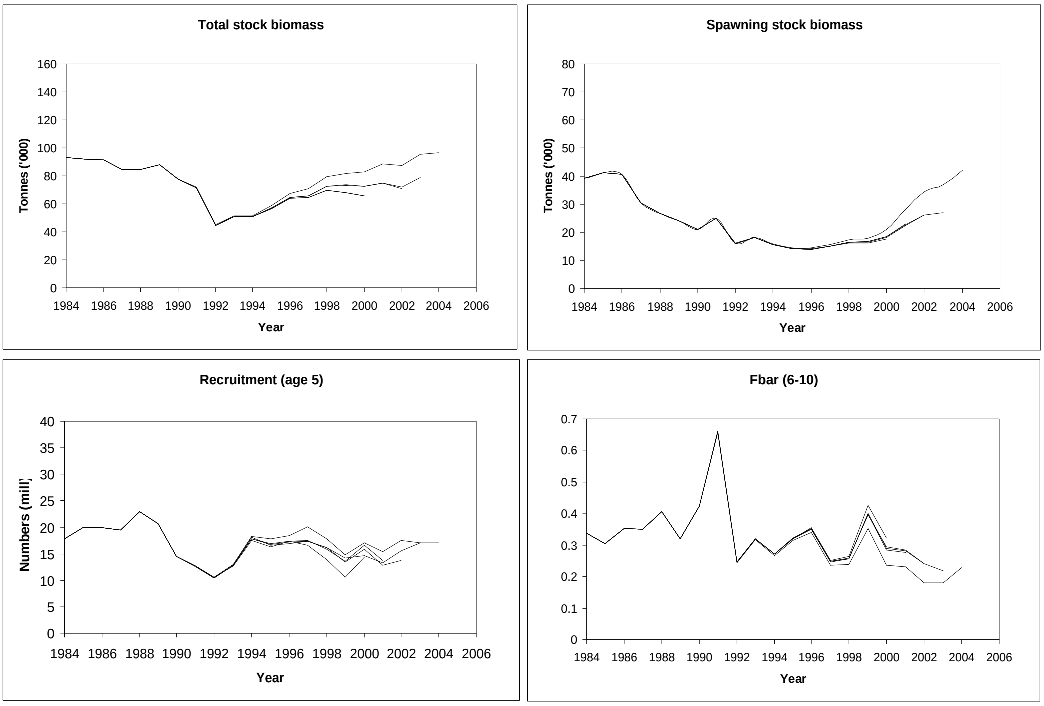


Figure 8.3. Retrospective plots.

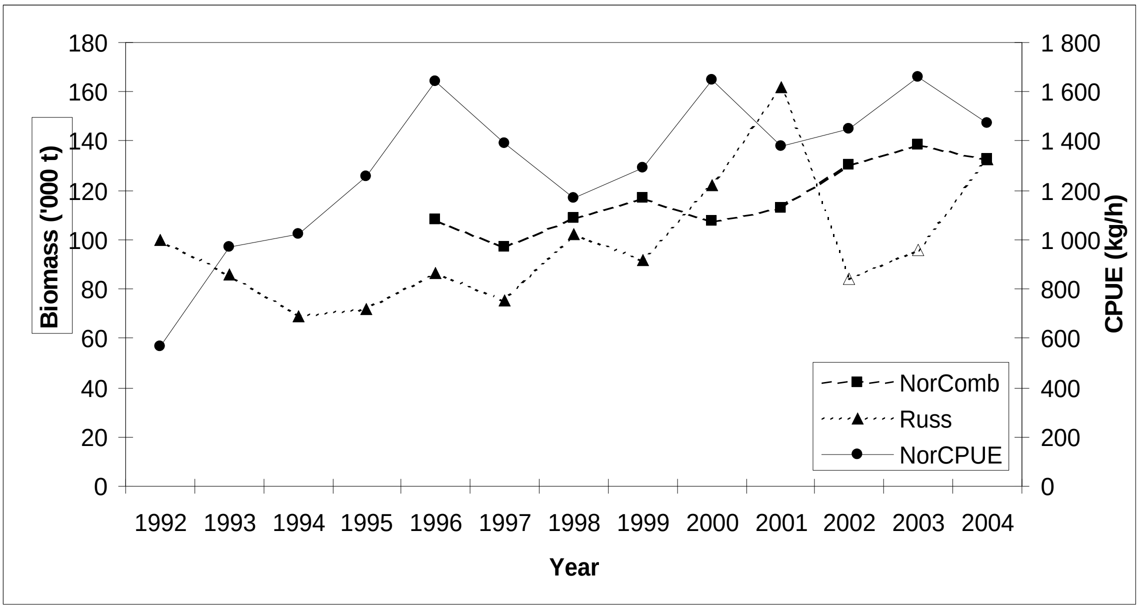


Figure 8.4. Biomass estimates from the tuning series used in the assessment. Years with open symbols in the Russian series excluded from the tuning.

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	Age													
Year	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	Age													
Year	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														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
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

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

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

[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 trata 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

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

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

[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

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

[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 1992-2004. 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
1													
2													
3	0.1			0.1		0.0	0.0	0.0					0.1
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
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
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
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
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
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
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
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
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
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
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
15	0.1					0.0		0.0	0.0	0.2	0.1	0.0	0.4

	Mean individual weight (kg)												
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1													
2													
3	0.26			0.40		0.39							0.27
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
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
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
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
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
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
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
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
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
13	4.44	5.18	5.01	4.62		4.52		5.07	4.47	3.68	5.20	4.28	2.92
14	6.00	6.44	6.29	5.59		5.47		5.60	6.00	5.74	5.59	4.74	3.89
15	5.22								8.79	5.52	7.03	9.17	4.65

'Table E9 (Continued) GREENLAND HALIBUT in Sub-areas I and II. Results from a research program using trawlers in a limited commercial fishery 1992-2004. 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
1													
2													
3	0			1	0	0	0	0	0	0	0	0	1
4	19	30	26	7	7	11	2	7	14	12	7	19	15
5	80	176	198	219	286	298	59	72	132	63	81	90	96
6	97	130	191	220	463	275	229	214	208	201	176	229	203
7	109	191	215	294	521	366	400	369	524	284	447	322	337
8	56	87	90	107	127	121	139	135	150	244	130	101	159
9	7	5	8	26	19	31	40	15	55	78	75	86	102
10	29	52	47	64	29	60	18	90	104	73	92	116	51
11	12	22	19	19	7	23	7	9	11	18	23	43	43
12	7	7	5	11	3	10	3	17	13	17	12	32	38
13	2	3	2	3	0	4	0	2	7	3	2	12	16
14	1	1	1	2	1	2	0	2	0	2	4	5	10
15	0			0	0	0	0	0	0	2	1	0	4

	CPUE (kg) on age												
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1													
2													
3	0			0	0	0	0	0	0	0	0	0	0
4	10	16	13	3	4	5	1	3	7	7	3	9	6
5	57	134	145	153	211	207	45	53	91	41	56	61	63
6	93	127	182	207	435	243	220	197	204	189	164	229	179
7	140	254	276	364	641	423	476	461	645	318	543	411	396
8	99	162	161	183	211	189	249	221	236	361	181	169	228
9	14	11	18	53	38	59	91	32	105	143	127	169	177
10	70	138	121	161	73	141	46	215	250	167	213	275	109
11	38	75	65	64	23	68	25	30	33	54	74	138	101
12	28	30	20	40	11	33	11	64	53	66	48	113	105
13	9	15	8	13	0	16	0	9	32	11	9	52	48
14	5	9	5	11	0	13		10	2	10	24	23	38
15	2			0	0	0		0	3	11	4	4	20

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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
CPUE (kg round weight per trawlhour)**	567	973	1020	1255	1640	1393	1169	1294	1647	1377	1449	1657	1475
CPUE (Number fish per trawlhour)**	420	705	803	973	1464	1201	899	931	1220	998	1050	1055	1077
Catch (in tonnes)	695	862	811	368	436	274	272	269	295	297	288	298	304

***) 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	Greenland	Ireland	Norway	Russia	UK England & Wales	UK Scotland	Total
1973	-	-	-	4	-	-	9	8	28	-	49
1974	-	-	-	2	-	-	2	-	30	-	34
1975	-	-	-	1	-	-	4	-	12	-	17
1976	-	-	-	1	-	-	2	-	18	-	21
1977	-	-	-	2	-	-	2	-	8	-	12
1978	-	-	2	30	-	-	-	-	1	-	33
1979	-	-	2	16	-	-	2	-	1	-	21
1980	-	177	-	34	-	-	5	-	-	-	216
1981	-	-	-	-	-	-	7	-	-	-	7
1982	-	-	2	26	-	-	17	-	-	-	45
1983	-	-	1	64	-	-	89	-	-	-	154
1984	-	-	3	50	-	-	32	-	-	-	85
1985	-	1	2	49	-	-	12	-	-	-	64
1986	-	-	30	2	-	-	34	-	-	-	66
1987	-	28	16	1	-	-	35	-	-	-	80
1988	-	71	62	3	-	-	19	-	1	-	156
1989	-	21	14[1]	1	-	-	197	-	5	-	238
1990	-	10	30[1]	3	-	-	29	-	4	-	76
1991	-	48	291[1]	1	-	-	216	-	2	-	558
1992	1	15	416[1]	3	-	-	626	-	+	1	1 062
1993	1	-	78[1]	1	-	-	858	-	10	+	948
1994	+	103	84[1]	4	-	-	724	-	6	-	921
1995	+	706	165	2	-	-	460	-	52	283	1 668
1996	+	-	249	1	-	-	1 496	-	105	159	2 010
1997	+	-	316	3	-	-	873	-	1	162	1 355
1998	+	-	71[1]	10	-	10	804	-	35	435	1 365
1999	+	-		1	-	18	2 157	-	43	358	2 577
2000	+		41	10	-	19	498[1]	-	67	192	827
2001[1]	+		43	-	-	10	470	-	122	202	847
2002[1]	+		8	+	-	2	200	-	10	246	466
2003[1]	-	-	1	+	+	+	453	-	+	122	576
2004[1]	-	-	-	-	-	-	413	-	90	-	503

[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. During the period 1984 to 1986, 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, no fishery took place.

9.2 Catch Statistics (table 9.1)

The international catch by country and season in the years 1965-2004 is given in Table 9.1. No commercial catches were taken during 2004 and spring 2005.

9.3 Stock Size Estimates

9.3.1 Larval and 0-group estimates in 2004 (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 $2.5 \cdot 10^{12}$ larvae in 2004 is the lowest since 1996 and well below the average for the period 1981-2003. An area-based index, as well as a new swept volume index (Dingsør, 2005) of abundance of 0-group capelin in August-September is also given in Table 9.2 (see also general description, chapter 1). New swept volume indices are calculated 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 2004 (table 9.3-9.4)

Two Russian and two Norwegian vessels jointly carried out the 2004 acoustic survey as part of an ecosystem-survey during autumn (Anon., 2004). The coverage of the total stock was considered complete. 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 0.63 million tonnes. About 50% (0.29 mill t) of the stock biomass consisted of maturing fish (> 14 cm).

9.3.3 Other surveys

During a joint Norwegian-Russian bottom fish survey (01.02-19.03 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.

A Norwegian acoustic survey for capelin along the coast of Northern Norway during the period 20 February-17 March 2005 confirmed the results from the 2004 autumn investigations, in that between 181 000 and 203 000 tonnes of prespawning capelin were detected near the end of the survey period. This is within the 90% confidence interval (75 - 215 000 tonnes) of the abundance of maturing capelin at time of this survey estimated in the 2004 autumn assessment.

9.4 Historical stock development (Tables 9.5-9.11)

An overview of the development of the Barents Sea capelin stock in the period 1995-2004 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 1973-2004.

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 a need for a target biomass reference point for capelin.

Calculations of B_{target} are also in progress.

9.6 Stock assessment autumn 2004

As decided by the Northern Pelagic and Blue Whiting Fisheries Working Group at its 2004 meeting (ICES 2004/ACFM:24), 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, who reported directly to ACFM before its autumn 2004 meeting (Anon., 2004b).

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2005 was presented, using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL). The projection was based on a probabilistic maturation model with parameters estimated by the model Bifrost with uncertainty taken into account and data on size and composition of the cod stock from the 2004 Arctic Fisheries Working Group, but made probabilistic in CapTool in accordance with the risk analysis made by the Arctic Fisheries Working Group.

Probabilistic prognoses for the maturing stock from October 1 2004 until April 1 2005 were made, with a CV of 0.20 on the abundance estimate. With no catch, the estimated mean spawning stock size in 2005 is 122,000 tonnes. The simulations also indicate that with no catch, the probability for the spawning stock in 2005 to be below 200 000 t the $\mathbf{B}_{lim}$ value used by ACFM in recent years is 94 %.

The meeting also concluded that capelin recruitment in 2005 could be seriously negatively affected by the large stock of young herring now found in the Barents Sea.

ACFM at its autumn 2004 meeting (ICES Advice, 1(2) 2004) took all the points in Anon., (2004) into account. ACFM advised that no fishing should take place in spring 2005. This was based on adopting the forecast of the SSB using the limit reference points referred above, and following the harvest control rule that the SSB should fall below B_{lim} with a maximum 5% probability. ACFM also considered that adjustments of the harvest control rule should be further investigated for the purpose of taking better account of the uncertainty in the predicted estimate of spawner abundance, the likely interactions with herring, and the role of capelin as prey.

9.7 Regulation of the fishery for 2005

During its Autumn 2004 meeting, the Mixed Russian Norwegian Fishery Commission decided that no regular fishing should take place on Barents Sea capelin for the winter season 2005. However, they set a research quota of 1,000 t for each of the nations Norway and Russia for 2005.

9.8 Management advice for the fishery in 2006

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 Northern Pelagic and Blue Whiting 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 Murmansk in October 2005 and reported directly to the 2005 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. For technical reasons, this prognosis was not included in the assessment report for capelin in autumn 2004, and we thus include it here. This prognosis may influence the prognosis for cod, as capelin abundance may affect cod growth, maturation and cannibalism.

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 1981-2004. 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 1981-2004.
- 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 1980-2004. 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 1981-2003 year classes, are shown in Figure 9.1. They both gave the same coefficient of determination (0.6), 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 2005 were constructed by bootstrapping. From the 23 pairs of 0-group/1-group data from 1981-2003 23 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 2005 was calculated from the 0-group value in 2004.This procedure was repeated 1000 times.

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 2005, and the SSB in 2006 will also be low. A small increase in stock size is evident compared to 2004, but the uncertainty is considerable.

Because of time constraints, we have not been able to test the performance of this model on historical data. An analysis of the historical performance of the present model on data from 1981-present will be presented to the Joint Norwegian-Russian symposium in Murmansk in August 2005. In that work, we may also try to relate capelin growth to capelin stock size, prey abundance or environmental conditions.

9.10 Sampling

The sampling from scientific surveys and from monitoring of capelin in 2004 and winter 2005 is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Norwegian capelin investigations winter 2004	213	6590	1994
Russian capelin investigations winter 2004	167	9368	883
Acoustic survey autumn 2004 (Norway)	246	7692	1851
Acoustic survey autumn 2004 (Russia)	396	17412	2082
Russian bottom fish survey autumn-winter 2004	8	19351	350
Norwegian capelin investigations winter 2005	236	7001	1893
Joint bottom fish survey winter-spring 2005(Russia)	19	5481	285
2005 winter monitoring (Norway)	6	900	-

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

Table 9.2Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group indices in August.

Year	Larval abundance	0-group index	New 0-group Index (10^6 ind.) without K eff	with K eff
1980	-	502	289233	1078218
1981	9.7	570	146857	571088
1982	9.9	393	241500	815597
1983	9.9	589	134397	443024
1984	8.2	320	97638	224880
1985	8.6	110	32255	97915
1986	0.0	125	18025	75297
1987	0.3	55	799	3070
1988	0.3	187	38435	122766
1989	7.3	1300	344987	1175685
1990	13.0	324	48054	153597
1991	3.0	241	74506	219759
1992	7.3	26	154	465
1993	3.3	43	343	1034
1994	0.1	58	12316	27983
1995	0.0	43	819	2756
1996	2.4	291	62740	191767
1997	6.9	522	76780	261351
1998	14.1	428	47841	117380
1999	36.5	722	118474	393331
2000	19.1	303	52507	186841
2001	10.7	221	6950	26526
2002	22.4	327	27629	29182
2003	11.9	630	174219	611818
2004	2.5	288	22688	74158

Table 9.3. Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September-October 2004. 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 1 2003	2 2002	3 2001	4+ 2000-	Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
6.0 - 6.5	203				203	0.2	0.8
6.5 - 7.0	492				492	0.5	1.0
7.0 - 7.5	892				892	0.9	1.0
7.5 - 8.0	1867				1867	3.3	1.7
8.0 - 8.5	2816				2816	5.5	2.0
8.5 - 9.0	5835				5835	13.6	2.3
9.0 - 9.5	9120	3			9123	24.7	2.7
9.5 - 10.0	6745	48			6794	22.8	3.4
10.0 - 10.5	7308	250			7558	30.2	4.0
10.5 - 11.0	5355	199			5554	26.1	4.7
11.0 - 11.5	4779	595			5374	30.6	5.7
11.5 - 12.0	3458	1138			4597	30.1	6.6
12.0 - 12.5	1497	2125			3622	28.3	7.8
12.5 - 13.0	517	3341			3858	33.6	8.7
13.0 - 13.5	224	4069	3		4296	43.2	10.1
13.5 - 14.0	39	3479	29		3547	40.9	11.5
14.0 - 14.5	12	3519	97		3628	49.3	13.6
14.5 - 15.0	15	2533	414		2962	45.1	15.2
15.0 - 15.5	7	1872	661	49	2589	46.4	17.9
15.5 - 16.0	5	973	1138	80	2197	43.9	20.0
16.0 - 16.5	2	569	1351	142	2063	45.7	22.1
16.5 - 17.0		78	1205	190	1473	36.4	24.7
17.0 - 17.5		9	486	215	711	18.6	26.1
17.5 - 18.0		2	186	24	212	6.2	29.3
18.0 - 18.5		2	23	3	29	0.9	32.8
18.5 - 19.0			3		3	0.1	29.7
19.0 - 19.5			6	6	12	0.5	43.4
19.5 - 20.0				2	2	0.1	40.4
20.0 - 20.5				4	4	0.2	52.3
20.5 - 21.0						0.0	
21.0 - 21.5				2	2	0.1	52.1
TSN (10^6)	51188	24804	5602	717	82315		
TSB (10^3 t)	195.3	293.9	121.4	17.4		628.0	
Mean length (cm)	9.9	13.6	16.1	16.7	11.5		
Mean weight (g)	3.8	11.9	21.5	24.2			7.6
SSN (10^6)	41	9557	5570	717	15885		
SSB (10^3 t)	0.7	154.2	121.1	17.4		293.5	

Based on TS value: 19.1 log L - 74.0, corresponding to σ = 5.0 · 10^{-7} · $L^{1.9}$

Table 9.4Barents 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

Table 9.5 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. August, back-calculated from the survey in September-October.

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	8.3	88.9	111.8	188.4	171.4	474.7	128.0	62.0	111.7	62.5
2	9.4	12.5	44.2	76.5	111.5	116.8	246.6	94.2	13.0	30.3
3	1.6	2.2	2.2	12.1	27.9	35.9	33.0	60.2	14.5	6.9
4	0.4	0.1	0.1	0.7	0.9	0.8	1.2	0.7	1.9	0.8
5	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1
Sum	19.7	103.7	158.3	277.8	311.7	628.4	408.8	217.1	141.1	100.6
Biomass	189	467	866	1860	2580	3840	3480	2145	700	724

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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.0	0.0	0.0	0.00	0.00	0.12	0.09	0.02	0.00	0.00
2	0.0	0.0	0.0	0.00	0.00	0.19	0.51	0.36	0.00	0.00
3	0.0	0.0	0.0	0.00	1.59	5.47	7.56	10.01	2.15	0.00
4	0.0	0.0	0.0	0.00	1.25	8.40	12.13	14.22	10.75	0.00
5	0.0	0.0	0.0	0.00	0.14	0.96	2.18	0.66	1.41	0.00
Sum	0.0	0.0	0.0	0.0	3.0	15.1	22.5	25.3	14.3	0.0
Landings	0	0	0	0	78	386	557	635	282	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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.0	0.0	0.0	0.00	0.00	0.15	0.01	0.02	0.00	0.00
2	0.0	0.0	0.0	0.00	0.00	0.90	0.39	0.29	0.00	0.00
3	0.0	0.0	0.0	0.00	0.00	0.45	0.18	0.55	0.00	0.00
4	0.0	0.0	0.0	0.00	0.00	0.03	0.02	0.01	0.00	0.00
5	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	0.0	0.0	0.0	0.0	0.0	1.5	0.6	0.9	0.0	0.0
Landings	0	0	0	0	0	28	11	16	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.

	1995		1996		1997		1998		1999	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.07	0.22	0.04	0.12	0.06	0.18	0.03	0.08	0.05	0.14
2	0.07	0.22	0.04	0.12	0.06	0.18	0.03	0.08	0.05	0.14
3	0.02	0.06	0.04	0.12	0.06	0.18	0.07	0.21	0.02	0.07
4	0.04	0.13	0.05	0.15	0.01	0.04	0.07	0.21	0.02	0.07
5	0.04	0.13	0.05	0.15	0.01	0.04	0.07	0.21	0.02	0.07
Avr	0.05	0.15	0.04	0.13	0.04	0.13	0.05	0.16	0.03	0.10

Table 9.8(Continued)

	2000		2001		2002		2003		2004	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.03	0.08	0.06	0.18	0.02	0.06	0.15	0.46	0.10	0.30
2	0.03	0.08	0.06	0.18	0.02	0.06	0.15	0.46	0.10	0.30
3	0.03	0.08	0.04	0.12	0.09	0.27	0.14	0.42	0.10	0.30
4	0.03	0.08	0.04	0.12	0.09	0.27	0.14	0.42	0.10	0.30
5	0.03	0.08	0.04	0.12	0.09	0.27	0.14	0.42	0.10	0.30
Avr	0.03	0.08	0.05	0.14	0.06	0.19	0.14	0.43	0.10	0.30

Table 9.9Barents 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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	13.8	118.2	172.0	225.5	238.5	576.1	194.7	70.5	323.8	126.0
2	10.8	5.7	72.5	82.2	165.8	135.3	413.3	94.6	85.4	6.1
3	1.9	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
5	0.1	0.3	0.1	0.1	0.5	0.8	0.7	0.9	0.0	0.0
Sum	28.9	132.2	256.6	341.9	480.6	824.9	740.6	375.7	447.8	140.2
Biomass	156	313	779	1240	2456	3571	4558	3490	2151	430

Table 9.10 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	0	0	0	0	0	0	0
2	1	3	1	1	2	24	5	0	192	27
3	15	71	175	217	650	819	943	733	567	117
4	38	24	49	34	193	472	539	267	0	19
5	1	7	2	2	10	0	0	6	0	0
Sum	55	105	228	254	856	1315	1487	1007	759	163

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. The SSB is obtained by projecting the stock forward assuming a natural mortality that does not take the current predation mortality fully into account.

Year	Stock biomass August 1	Maturing biomass survey Oct. 1	Recruitment Age 1, August 1	Spawning stock biomass, assessment model, April 1	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	67	496	651
2003	680	280	93	427	282
2004	723	294	62	122	0

Table 9.12 Prognosis for capelin biomass, thousand tonnes:

Date	Median	5%	95%
1 October 2005 immature	468	236	795
1 October 2005 maturing	272	29	793
1 January 2006 maturing	253	15	812
1 April 2006 spawning	177	9	583

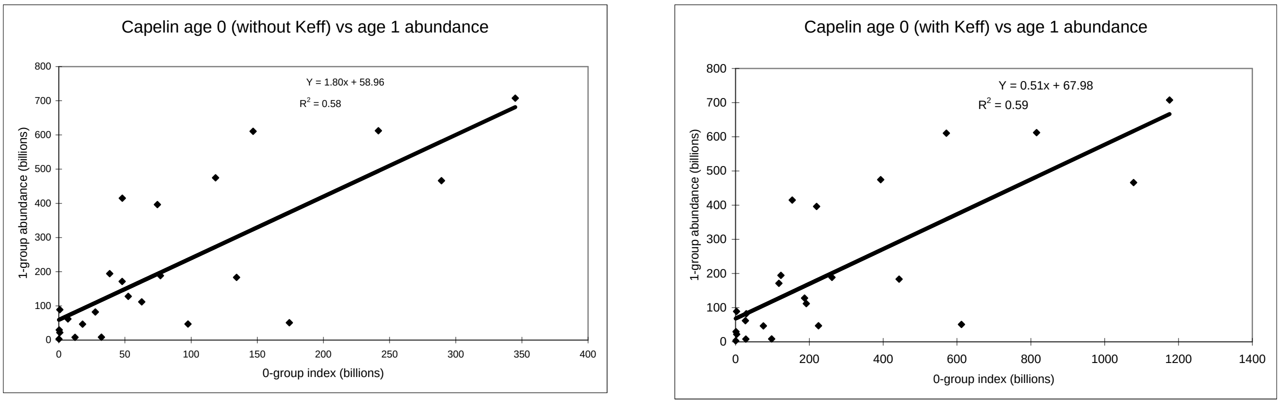


Figure 9.1. Regression of abundance of capelin at age 0 and age 1 of year classes 1981-2003. The 0-group index without K_{eff} is considered to be the official series (Anon., 2005).

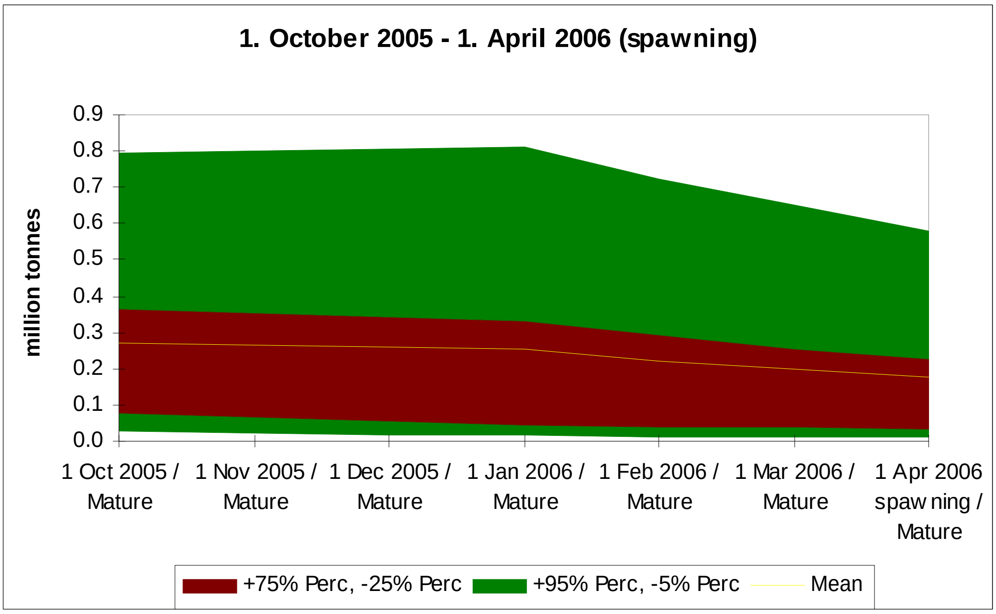


Figure 9.2. Capelin prognosis from 1 Oct 2005 to 1 Apr 2006

10 Working documents

WD#	Title	Authors
1.	IMR status report on the Barents Sea Ecosystem, 2004-2005	Stiansen J. E., Bogstad B, Dalpadado P., Gjøsæter H., Hauge K. H., Ingvaldsen R., Loeng H., Mauritzen M., Mehl S., Ottersen G. and Stenevik E. K.
2.	PROST user guide	Åsnes M.N.
3.	Evaluation of the proposed harvest control rule for Northeast Arctic cod	Bogstad B., Kovalev Y. and Gjøsæter H.
4.	Report of the Portuguese fishery in 2004: ICES Div. I, IIa and IIb	Alpoim R., Vargas J. and Santos E.
5.	The Spanish NE Arctic Cod Fishery in 2004	Casas J. M. and Murua H.
6.	Spanish bottom trawl survey "FLETÁN ÁRTICO 2004" in the slope of Svalbard area, ICES division IIb.	Paz X., González C. and Román E.
7.	Stomach analyses of Northeast arctic saithe sampled during the saithe survey VARANGER-MØRE 1998-2003	Mehl S.
8.	Bias in age reading of Greenland halibut calls for new assessment strategy.	Albert O. T., Salberg A. B., Høines Å. and Harbitz, A.
9.	Food composition and consumption by the most abundant fish species in the Barents Sea	Dolgov A.
10.	Consumption of various prey species by cod in 1984-2004	Dolgov A.
11.	Results of the Russian survey of Greenland halibut in the Barents Sea and adjacent waters in 2004	Smirnov O.V.
12.	Age reading through 50 years of history and quality of long-term stored Northeast Arctic cod otoliths. Might it cause time trends in biological parameters?	Zuykova, N., Aagotnes, P., Koloskova, V., Mjanger, H., Nedreaas, K., Senneset, H., Yaragina, N.

13.	Acoustic abundance of saithe, coastal cod and juvenile herring Finnmark – Møre Environmental investigations in fjords Autumn 2004	Berg E., Korsbrekke K, Mehl S. and Nybakk A.
14.	Development of the simulation model to test the new HCR for the NEA cod	Bulgakova T.
15.	Ecological and genetic characteristics of local groupings of the Northeast arctic cod	Novikov G., Stroganov S. and Shevelev M.
16.	Assessment of Northeast arctic cod and capelin recruitment from data on ecological situation in the Barents Sea in 2004-2005	Titov O., Pedchenko A., Karsakov A.
17.	Assessment of Sebastes marinus using Gadget (Fleksibest) model	Howell D. and Nedreaas K.
18.	Bycatch estimates of redfish (Sebastes spp.) in the Barents Sea shrimp fisheries 1983-2002	Ajiad A., Aglen, A. and Nedreaas K.
19.	Timely Evaluation of Stock Status Based on Scientific Surveys	Michael Pennington and Odd Nakken
20.	To recruitment prognosis of NEA cod	T. Bulgakova
21.	Short status of the results from the Norwegian-Russian cod and haddock comparative age readings	Nedreaas K.H. and Yaragina N.A.
22.	Report from the 2004 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock	Alvarez J., Dingsør G., Fossum P., Gjøsæter H., Kovalev Y., Olsen E., Prozorkevich D., Ratushnyy S., Røttingen B., Ushakov N.
23.	Short note about tourist and recreational fishing in Norway	Nedreaas K.
24.	Prediction of mean weight at age for short-term prediction for North-East Arctic Haddock	Russkikh A.
25.	Estimating stock size of Northeast arctic cod using a stochastic model	Aanes S., Engen S. and Sæther B.
26.	Preliminary results from the Joint Demersal winter survey 2005	Aglen, A.
27.	Comments on The Agreed Harvest Control Rule for NEA Haddock	Korsbrekke K. and Hauge K.N.

11 References

Aanes, S. and Pennigton, M. 2003. On estimating the Age composition of the Commercial Catch of Northeast Arctic cod from a Sample of Clusters. ICES journal of marine science, 60: 297-303.

Aanes, S. 2002. *Precision in age determination of Northeast Arctic cod* in: Working document in: Report of the Arctic Fisheries Working Group. ICES Headquarters 16-25 April 2002. ICES CM 2002/ACFM:18. 451 pp.

Anon. 2001. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2000 to 31 December 2000. Marine Research Institute Technical Report nr. 78, Marine Research Institute, Reykjavik, Iceland.

Anon. 2002. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Anon. 2004a. Survey report from the joint Norwegian/Russian ecosystem survey in the Barents Sea in August-October 2004 (vol.1). IMR/PINRO Joint Report Series, No. 3/2004. ISSN 1502-8828. 67 pp.

Anon. 2004b. Report from the 2004 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock. Kirkenes, 5-8 October 2004. 68 pp.

Anon. 2004c. EU-Norway ad hoc scientific working group on multi-annual management plans for stocks shared by EU and Norway. Brussels 14-18 June 2004.

Anon. 2005. Survey report from joint Norwegian/Russian ecosystem survey in the Barents Sea in August-October 2004 (vol. 2). IMR/PINRO Joint Report Series, No. 1/2005. ISSN 1502-8828. 75 pp.

Berg, E., Sarvas, T. H., Harbitz, A., Fevolden, S.E. and Salberg, A.B. In press. Accuracy and precision in stock separation of Northeast Arctic and Norwegian coastal cod by otoliths - comparing readings, image analyses and a genetic method. Marine and Freshwater Research.

Bjordal, Å., Bogstad, B., Bulgakova, T., Drevetnyak, K., Filin, A., Kovalev, Y., Lepesevich, Y., Mishin, V., Røttingen, I., Sandberg, P., Shevelev, M., Shibanov, V., and Tjelmeland, S. 2004. Report of the Basic Document Working Group (BDWG) to The Mixed Norwegian-Russian Fishery Commission, October 2004.

Bjørge, A. and Kovacs, K.M. (sci. eds.) (in prep.). Report of the working group on seabirds and mammals. The Scientific Basis for Environmental Quality Objectives (EcoQOs) for the Barents Sea Ecosystem. (in prep.) Norway, 2005.

Björnsson, H., and Sigurdsson, T. 2003. Assessment of golden redfish (*Sebastes marinus* L.) in Icelandic waters. Scienta Marina 67 (Suppl. 1):301-314.

Bochkov, Y.A. (1982) Water temperature in the 0-200m layer in the Kola-Meridian in the Barents Sea, 1900-1981. Sb. Nauchn. Trud. PINRO 46: 113-122

Bogstad, B., Hiis Hauge, K., and Ulltang, Ø. 1997. MULTSPEC – A Multi-Species Model for Fish and Marine Mammals in the Barents Sea. J. Northw. Atl. Fish. Sci. 22: 317-341.

Bogstad, B., Aglen, D., Skagen, S., Åsnes, M. N., Kovalev, Y., and Yaragina, N. A. 2004a. Evaluation of the proposed harvest control rule for Northeast Arctic cod. Appendix to Report of the Arctic Fisheries Working Group, Copenhagen 4-13 May 2004. ICES C.M. 2004/ACFM:28, 475 pp.

Bogstad, B., Howell, D., and Åsnes, M. N. 2004b. A closed life-cycle model for Northeast Arctic Cod. ICES C.M.2004/K:26, 26 pp.

Bogstad, B. and Mehl, S. (MS) 1997. Interactions Between Cod (*Gadus morhua*) and Its Prey Species in the Barents Sea. *Forage Fishes in Marine Ecosystems*. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01: 591-615. University of Alaska Fairbanks.

Brander, K. 2002. Predicting weight at age. Internal ICES note to assessment working groups. 2003. Software implementation of process models. Working Document No. 2 to the Arctic Fisheries Working Group, San Sebastian, Spain, 23 April- 2 May 2003.

Bulgakova, T. (2003). NEA cod dynamics simulation to test various management scenarios. ICES CM 2003/X:08, 19 pp.

Bulgakova T. 2004. A simulation testing of various management regimes for the NEA cod stock. ASC ICES CM 2004 / FF:08, 14 p.

Dalpadado, P. B. Bogstad, H. Gjøsæter, S. Mehl and H. R. Skjoldal. 2002. Zooplankton-fish interactions in the Barents Sea. In Large Marine Ecosystems. Blackwell Science Inc.

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

Dingsør, G. E. 2001. Estimation of discards in the commercial trawl fishery for Northeast Arctic cod (*Gadus morhua* L.) and some effects on assessment. Cand. Scient thesis, University of Bergen, 2001

Dingsør, G. E. 2005. Estimating abundance indices from the international 0-group fish survey in the Barents Sea. Fisheries Research 72:205-218

Drobysheva, S.S. 1967. The role of specific composition in the formation of the Barents Sea euphausiid abundance. Trudy PINRO. Vyp.20. p.195-204 (in Russian).

Drobysheva, S.S. 1994. The Barents Sea euphausiids and their role in the formation of fishing biological production. Murmansk: PINRO Press, 1994. 139 p. (in Russian).

Drobysheva, S.S., Nesterova, V.N., Nikiforov, A.G. And N.G.Zhukova. 2003. The role of warm water component in the formation of local concentrations of euphausiids in the southern Barents Sea. Voprosy rybolovstva, 2003, tom 4, No.2 (14) – p.209-216 (in Russian).

Filin A., 2002. Simulation of feeding, growth and maturation rate of cod in the Barents Sea. Working document in: Report of the Arctic Fisheries Working Group. ICES Headquarters 16-25 April 2002. ICES CM 2002/ACFM:18. 451 pp.

Folkow, L.P., Haug, T., Nilssen, K.T. and Nordøy, E.S. 2000. Estimated food consumption of minke whales Balaenoptera acutorostrata in Northeast Atlantic waters in 1992-1995. NAMMCO Scientific Publications 2: 65-80.

Fournier, D. and Archibald, C. P. 1982. A general theory for analysing catch at age data. Can. J. Fish. Aquat. Sci., 39: 1195–1207.

Frøysa, K.G., Bogstad, B., and Skagen, D.W. 2002. Fleksibest – an age-length structured fish stock assessment tool with application to North-east Arctic cod (*Gadus morhua* L.) Fisheries research 55:87-101.

Gjøsæter, H. and Bogstad, B 1998. Effects of the presence of herring (*Clupea harengus*) on the stock-recruitment relationship of Barents Sea capelin (*Mallotus villosus*). Fisheries Research 38, (1): 57-71

Gjøsæter, H., Bogstad, B. and Tjelmeland, S. 2002. Assessment methodology for Barents Sea capelin, *Mallotus villosus* (Müller). ICES Journal of Marine Science, 59:1086-1095.

Gjøsæter, H., Dommasnes, A., and Røttingen, B. 1998. The Barents Sea capelin stock 1972-1997. A synthesis of results from acoustic surveys. Sarsia 83: 497-510.

Gundersen, A.C. and H. Gjøsæter 1998. A comparison between abundance estimates of the Barents Sea capelin (*Mallotus villosus* Müller) at the larval, 0-group and 1-group stage, for the year classes 1981-1994. ICES Journal of Marine Science, 55: 95-101.

Haug, T., Gjøsæter, H., Lindstrøm, U., and Nilssen, K. T. 1995. Diet and food availability for northeast Atlantic minke whales (Balaenoptera acutorostrata), during the summer of 1992. ICES Journal of Marine Science 52, 77-86.

Hirst, D., Aanes, S., Storvik, G. and Tvete, I.F. 2004. Estimating catch at age from market sampling data using a Bayesian hierarchical model. Journal of the royal statistical society. Series c, applied statistics, 53: 1-14.

Hirst, D., Storvik, G., Aldrin, M., Aanes, S and Huseby, R.B. *In press*. Estimating catch-at-age by combining data from different sources. Canadian Journal of Fisheries and Aquatic Sciences.

ICES 1995/Assess:9. Report of the Atlanto-Scandian Herring and Capelin Working Group, Copenhagen 17-21 October 1994. ICES CM 1995/Assess:9 101pp.

ICES 1996. Report of the Arctic Fisheries Working Group. ICES CM 1996/Assess: 4. 311 pp.

ICES 1998. Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10.

ICES. 1998. Technical minutes of ACFM meeting, ICES 20–29 October 1998. Internal document.

ICES. 1999. Report of the Joint ICES/NAFO Working Group on harp and hooded seals. Tromsø, Norway, 29 September – 2 October 1998. ICES CM 1999/ACFM:7, 36 pp.

ICES 2001. Report of the Arctic Fisheries Working Group. Bergen, Norway, 24 April – 3 May 2001. ICES CM 2001/ACFM:19. 380 pp.

ICES 2003. Study Group on Biological Reference Points for Northeast Arctic Cod. Svanhovd, Norway 13-17 January 2003. ICES CM 2003/ACFM:11.

ICES 2003. Study Group on Precautionary Reference Points for Advice on Fisheries Management. ICES Headquarters 24-26 February 2003. ICES CM 2003/ACFM:15.

ICES. 2004. Report of the ICES Advisory Committee on Fishery Management and the ICES Advisory Committee on Ecosystems, 2004. ICES Advice, 1(2): 448 pp + 1072 pp.

ICES 2004. Report of the Arctic Fisheries Working Group, Copenhagen 4-13 May 2004. ICES C.M. 2004/ACFM:28, 475 pp.

ICES 2005. Report of the Study Group on Management Strategies, Copenhagen 31 January – 4 February 2005. ICES C.M. 2005/ACFM:09, 66 pp.

Ingvaldsen, R., Loeng, H and Asplin, L. 2002a. Variability in the Atlantic inflow to the Barents Sea based on a one-year time series from moored current meters. Continental Shelf Research, 22, 505-19.

Ingvaldsen, R., Loeng, H, Ottersen, G, and Ådlandsvik, B. 2002b. The Barents Sea climate during the 1990s. ICES Marine Science Symposia, 219:160-168.

Ingvaldsen, R.B., Asplin, L. and Loeng, H., 2004. Velocity field of the western entrance to the Barents Sea. Journal of geophysical research, 109: 1-12.

Jakobsen, T., Korsbrekke, K., Mehl, S., and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys for demersal fish in the Barents Sea during winter. ICES CM 1997/Y:17.

Julious, S.A. (2001). Inference and estimation in a changepoint regression problem. *The Statistician*, 50: 51-61.

Korsbrekke, K. 1997. Norwegian acoustic survey of Northeast Arctic cod on the spawning grounds off Lofoten. ICES C.M 1997/Y:18.

Kovalev, Y., 2004. *Predicting natural mortality due to cannibalism for Northeast Arctic cod. Working document in:* Report of the Arctic Fisheries Working Group. Copenhagen 4-13 May 2004. ICES CM 2004/ACFM:28, 475 pp.

Kovalev, Y., and Bogstad, B. (in prep). Evaluation of maximum sustainable yield (MSY) for Northeast Arctic cod using a single species model framework. Paper to be presented at the Mixed Russian-Norwegian Symposium in Murmansk, August 2005.

Kutti, T., Høisæter, T., Rapp, H.T., Humborstad, O.B., Løkkeborg, S. and Nøttestad, L. (in press). Immediate effects of experimental otter trawling on a sub-arctic benthic assemblage inside Bear Lehmann, G., Karlsen, Ø., and Holm, J.C. 1991. The impact of feeding on growth and sexual maturation in cod. Final report No 22/1991/HSH/AH. Institute of Marine Research.

Kvamme, C. and Bogstad, B. 2005. The effect of including length structure in yield-per-recruit estimates for northeast Arctic cod (*Gadus morhua* L.). Fisheries Research (submitted).

Lehmann, G., Karlsen, Ø., and Holm, J.C. 1991. The impact of feeding on growth and sexual maturation in cod. Final report No 22/1991/HSH/AH. Institute of Marine Research.

Lindstrom, U., Harbitz A., Haug, T. and Nilssen, K. 1998. Do harp seals Phoca groenlandica exhibit particular prey preferences? ICES Journal of Marine Science 55, 941-953.

Lindstrøm, U., Haug, T. and Røttingen, I. 2002. Predation on herring, *Clupea harengus*, by minke whales, *Balaenoptera acutorostrata*, in the Barents Sea. ICES J. mar. Sci. 59: 58-70.

Loeng, H., Blindheim, J., Ådlandsvik, B., and Ottersen, G. 1992. Climatic variability in the Norwegian and Barents Seas. ICES mar. Sci. Symp. 195: 52-61.

Løkkeborg, S. 2003. Review and evaluation of three mitigation measures - bird-scaring line, underwater setting and line shooter - to reduce seabird bycatch in the North Atlantic longline fishery . Fisheries Research 60 (1): 11-16

Løkkeborg, S. (in press). Impacts of trawling on benthic habitats and communities. Technical report no. T472, Food and Agricultural Organization of the United Nations (FAO), Rome

Marshall, C.T., Kjesbu, O.S., Yaragina, N.A., Solemdal, P., and Ulltang, Ø. 1998. Is spawner biomass a sensitive measure of the reproductive and recruitment potential of Northeast Arctic cod? Can. J. Fish. Aquat. Sci. 55: 1766–1783.

Mankevich, E. M. On methods of sampling and analyzing of age samples of cod. Materials of fisheries research. Northern Basin – 1966. Issue 8, P. 112 – 117. (in Russian).

Marshall C.T., Needle C.,Yaragina N.A., Aijad A., Gusev E.V., 2004. Deriving condition indices from standard fisheries databases and evaluating their sensitivity to variation in stored energy reserves. Can..J..Fish. Aquat. Sci., vol.61: 1900-1917.

Marteinsdottir, G., and Begg, G. 2002. Essential relationships incorporating the influence of age, size and condition on variables required for estimation of reproductive potential in Atlantic cod Gadus morhua. Mar. Ecol. Prog. Ser. 235: 235-256.

Mauchline J. 1998. The biology of calanoid copepods. Advances in MarinBiology 33, Academic Press, London. 710 p.

Mehl, S., and Yaragina, N. A. 1992. Methods and results in the joint PINRO-IMR stomach sampling program. In: Bogstad, B. and Tjelmeland, S. (eds.), *Interrelations between fish populations in the Barents Sea*. Proceedings of the fifth PINRO-IMR Symposium. Murmansk, 12–16 August 1991. Institute of Marine Research, Bergen, Norway, 5–15.

Melle, W. and J.C. Holst, 2001. Klima, planktonproduksjon og vekst hos sild I Norskehavet. Fisken og havet, særnummer 2, 86-90 (in Norwegian).

Nakken, O. and A.Raknes 1996. Corrections of indices of abundance of 0-group fish in the Barents Sea for varying capture efficiency. ICES CM 1996/G:12.

Nedreaas, K. 1990. Age determination of northeast Atlantic *Sebastes* species. J.Cons.int.Explor.Mer, 47: 208-230.

Needle, C.L. 2003. Survey-based assessments with SURBA. Working Document to the ICES Working Group on Methods of Fish Stock Assessment, Copenhagen, 29 January to 5 February 2003.

Needle, C.L. 2004. Absolute abundance estimates and other developments in SURBA. Working Document to the ICES Working Group on Methods of Fish Stock Assessment, Lisbon, 11–18 February 2004.

Nilssen, K.T., Pedersen, O-P., Folkow, L. and Haug, T. 2000. Food consumption estimates of Barents Sea harp seals. NAMMCO Scientific Publications 2: 9-27.

Orlova, E.L., Drobysheva, S.S., Dolgov, A.V. And V.N.Nesterova. 1998. Cod conditions of feeding and fatness with a minimal capelin stock (1995-1996). Reports on the results of research work in 1996-1997 from PINRO Annual Science Conference in Murmansk. 1998. p.50-60 (in Russian)

Ottersen G., Ådlandsvik B., and Loeng, H. 2000. Predictability of Barents Sea temperature. Fisheries Oceanography 9: 121-135.

Pennington, M. On estimating an index of abundance for Greenland halibut. WD 5 to AFWG, San Sebastian 23 April-2 May 2003.

Ponomarenko, I.Ya. 1973. The influence of feeding and temperature conditions on survival of the Barents Sea “bottom” juvenile cod. Voprosy okeanografii severnogo promyslovogo basseina: Selected papers of PINRO. Murmansk, 1973. Vyp.34. p.210-222 (in Russian)

Ponomarenko, I. Ya. and Yaragina, N. A. 1979. Seasonal and year-to-year fluctuations in the feeding of Barents Sea cod on Euphausiacea in 1947-1977. ICES C.M. 1979/G:17, 20 pp.

Ponomarenko, I.Ya. 1984. Survival of “bottom juvenile cod in the Barents Sea and determining factors. Cod reproduction and recruitment: Proceedings of the first Soviet-Norwegian symposium/VNIRO. – M., 1984. – p.301-315 (in Russian)

Ponomarenko, I..Ya. and N.A.Yaragina. 1990. Long-term dynamics of the Barents Sea cod feeding on capelin, euphausiids, shrimp and the annual consumption of these objects. Feeding resources and interrelations of fishes in the North Atlantic: Selected papers of PINRO. Murmansk. 1990. p.109-130 (in Russian).

Rey, F. 1981. The development of the spring phytoplankton outburst at selected sites off the Norwegian coast. In: Sætre, R, Mork, M, editors. The Norwegian Coastal Current. Bergen: University of Bergen. Pp 649-680.

Rey, F. 1993. Planteplanktonet og dets primærproduksjon I det nordlige Barentshavet. Fisken og Havet, 10. 39 p.

Rollefsen, G. The otoliths of the cod. Fiskdir. Skr. ser. HavUnders. – 1933. No. 4 (3). – P. 1-14.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. Int. Whal. Commn* 47: 453-483.

Skagen, D. W., Bogstad, B., Sandberg, P., and Røttingen, I. 2003. Evaluation of candidate management plans, with reference to North-east Arctic cod. ICES C.M. 2003/Y:03, 19 pp.

Skaug, H.J., Øien, N., Bøthun, G. and Schweder, T. 2002. Abundance of northeastern Atlantic minke whales for the survey period 1996-2001. International Whaling Commission, SC/54/RMP5.

Skaug, H.J., Øien, N., Schweder, T., and Bøthun, G. 2004. Abundance of Minke Whales (Balaenoptera Acutorostrata) in the Northeast Atlantic: Variability in Time and Space. Canadian Journal of Fisheries and Aquatic Sciences 61, 870-886.

Stefánsson, G. and Pálsson, Ó.K. 1997. Bormicon. A boreal migration and consumption model. Report no. 58, Marine Research Institute, Reykjavik, Iceland.

Stefánsson, G. and Pálsson, Ó. K.1998. A framework for multispecies modelling of Arcto-boreal systems. Rev. Fish. Biol. Fish. 8,101–104.

Yaragina N.A., C.T. Marshall. 2000. Trophic influences on interannual and seasonal variation in the liver condition index of Northeast Arctic cod (*Gadus morhua*). ICES J. Mar. Sci. – 2000. –Vol.57. –P.42-55.

Øien N. 1996. Lagenorhynchus species in Norwegian waters as revealed from incidental observations and recent sighting surveys. Paper SC/48/SM15 to the IWC Scientific Committee, Aberdeen.

Øien, N. 2003. Distribution and abundance of large whales in the northeast Atlantic, 1995. Working Paper NAMMCO SC/11/MF/10 to the Working Group on Minke and Fin Whales, Copenhagen, Denmark, 20-22.

Ådlandsvik B, Loeng, H. 1991. A study of the climatic system in the Barents Sea. Polar Research 10: 45-49.

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: 28-04-05…

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

Árnason, E. and Pálsson, S. 1996. Mitochondrial cytochrome b DNA sequence variation of Atlantic cod Gadus morhua, from Norway. Molecular Ecology 5: 715-724.

Artemjeva, K.F. and G.G. Novikov. 1990. Peculiarities of population structure of the Northeast Atlantic cod. In: Eco;ogy, reproduction and conservation of biological resources in seas of the Northern Europe. Murmansk, p.162-164 (in Russian)

Berg, E., Eriksen, I. A. and Eliassen, J.-E. 1998. Catch-statistics for Norwegian Coastal cod 1984-1997, -data and methods. Fiskeriforskning,10/1998.

Borisov, V. M., Ponomarenko, V. P. and Yaragina, N. A. (1999). A Critical Review of the Population Status in Coastal cod (Gadus morhua) from Barents Sea Region of Norway. Journal of Ichthyology 39: 18-28.

Fevolden, S. E. and Pogson, G. H. 1995. Difference in nuclear DNA RFLPs between the Norwegian coastal and the Northeast Arctic population of Atlantic cod. pp. 403-415. In: Skjoldal, H. R., Hopkins, C., Erikstad, K. E. and Leinaas, H. P. (ed.) Ecology of Fjords and Coastal Waters, Elsevier Science B. V.

Fevolden, S. E. and Pogson, G. H. 1997. Genetic divergence at the synoptophysin (Syp I) locus among Norwegian coastal and north-east Arctic populations of Atlantic cod. Journal of Fish Biology 51: 895-908.

Jakobsen, T. 1987. Coastal Cod in Northern Norway. Fisheries Research 5: 223-234.

Jørstad, K. E. and Nævdal, G. 1989. Genetic variation and population structure of cod, Gadus morhua L., in some fjords in northern Norway. Journal of Fish Biology 35: 245-252.

Mork, J., Giskeødegård, R. and Sundnes, G. 1984. Population genetics studies in cod (Gadus morhua L.) by means of the haemoglobin polymorphism; observations in a Norwegian coastal population. Fiskeridirektoratets Skrifter Serie Havundersøkelser 17, No. 12: 449-471.

Møller, D. 1969. The relationship between Arctic and coastal cod in their immature stages illustrated by frequencies of genetic charaters. Fiskeridirektoratets Skrifter Serie Havundersøkelser 15: 220-233.

Nøstvik, F. and Pedersen, T. 1999. Movement pattern and growth of wild cod (Gadus morhua L.) and hatchery-reared cod released as 1-group. pp. 315-333. In: Howell, E., Moksness, E. and Svåsand, T. (ed.) Stock Enhancement and Sea Ranching, Fishing News Books, Oxford.

Skreslet, S., Albrigtsen, I., Andersen, A. P., Kolbeinshavn, A., Pedersen, T. and Unstad, K. 1999. Migration, growth and survival in stocked and wild cod (Gadus morhua L.) in the Vestfjord region, North Norway. pp. 306-314. In: Howell, E., Moksness, E. and Svåsand, T. (ed.) Stock Enhancement and Sea Ranching, Fishing News Books, Oxford.

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; Nizovtsev, 1989), with the highest concentrations from 500 to 800 m depth between Norway and Bear Island, which is also regarded as the main spawning area (Nizovtsev, 1968; Godø and Haug 1987; Albert et al. 2001b). Peak spawning occurs in December in the main spawning area, but also in nearby localities during summer (Nizovtsev, 1989; Albert et al. 2001b). Atlantic currents transport eggs and larvae northwards and the juveniles are distributed around Svalbard and in the northeastern Barents Sea, to the waters around Franz Josef Land and Novaja Zemlya area (Borkin, 1983; Nizovtsev, 1983; Godø and Haug 1987; Godø and Haug 1989; Albert et al. 2001a). As they grow older they gradually move southwards and eventually alternate between the spawning area and feeding areas in the central-western Barents Sea (Nizovtsev, 1989).

The Northeast arctic Greenland halibut stock is a pragmatically defined management unit. The degree of exchange with other stocks is not resolved, but is believed to be low. Potential routes of exchange may be drift of larvae towards Greenland and migration of adults between the Barents Sea and the Iceland-Faeroe Islands area.

A.2 Fishery

Before the mid 1960s the fishery for Greenland halibut was mainly a coastal long line fishery off the coasts of eastern Finnmark and Vesterålen in Norway. The annual catch of the coastal fishery was about 3,000 t. In recent years this fishery has landed 3,000–6,000 t although now gillnets are also used in the fishery. In 1964 dense Greenland halibut concentrations were found by Soviet trawlers in the slope area to the west of the Bear Island (Nizovtsev, 1989). Following the introduction of international trawlers in the fishery in the mid 1960s, the total landings increased to about 80,000 t in the early 1970s.The total Greenland halibut landings decreased steadily to about 20,000 t during the early 1980s. This level was maintained until 1991, when the catch increased sharply to 33,000 t. From 1992 total landings varied between 9 000-19 000 t with a peak in 1999.

From 1992 the fishery has been regulated by allowing only the long line and gillnet fisheries by vessels smaller than 28 m to be directed for Greenland halibut. This fishery is also regulated by seasonal closure. Target trawl fishery has been prohibited and trawl catches are limited to bycatch only. From 1992 to autumn 1994 bycatch in each haul was not to exceed 10% by weight. In autumn 1994 this was changed to 5% bycatch of Greenland halibut onboard at any time. In autumn 1996 it was changed to 5% bycatch in each haul, and from January 1999 this percentage was increased to 10%. In August 1999 it was adjusted further to 10% in each haul but only 5% of the landed catch. From 2001 the bycatch regulations again was changed to 12% in each haul and 7% of the landed catch.

The regulations enforced in 1992 reduced the total landings of Greenland halibut by trawlers from 20,000 to about 6,000 t. Since then and until 1998 annual trawler landings have varied between 5,000 and 8,000 t without any clear trend attributable to changes in allowable bycatch. However, the increase of trawler landings in 1999 to 10 000 t may be attributable partly to the less restrictive bycatch regulations. Landings of Greenland halibut from the directed longline and gillnet fisheries have also increased in recent years to well above the level of 2,500 t set by the Norwegian authorities. This is attributed to the increased difficulties of regulating a fishery that only lasts for a few weeks.

A.3 Ecosystem aspects

As investigations show, among the variety of fish, seabirds and marine mammals Greenland halibut were found in the diet of just three species - Greenland shark (*Somniosus microcephalus*), cod (*Gadus morhua morhua*) and Greenland halibut itself. Besides, killer whale (*Orcinus orca*), grey seal (*Halichoerus grypus*) and narwhal (*Monodon monoceros*) could be its potential predators. However, the presence of Greenland halibut in the diet of the above species was minor. Predators fed mainly on juvenile Greenland halibut up to 30-40 cm long.

The mean annual percentage of Greenland halibut in cod diet in 1984-1999 constituted 0,01-0,35% by weight (0,05% in average) (DOLGOV & SMIRNOV 2001). Low levels of consumption are related to the distribution pattern of juvenile Greenland halibut as they spend the first years of the life mainly in the outlying areas of their distribution, in the northern Barents Sea, where both adult Greenland halibut and other abundant predator species are virtually absent.

Cannibalism was the highest in 1960's (up to 1,2% by frequency of occurrence). During the 1980's, in the Greenland halibut stomachs the frequency of occurrence of their own juveniles did not exceed 0,1 %. During the 1990's, the portion of their own juveniles (by weight) was at the level of 0,6-1,3%.

Food composition of the Greenland halibut in the Barents Sea includes more than 40 prey species (NIZOVTSEV 1989; DOLGOV & SMIRNOV 2001). Investigations over a wide area of the continental slope up to the Novaya Zemlya show that the main food source of Greenland halibut consists of fish, mostly capelin (*Mallotus villosus villosus*) and polar cod (*Boreogadus saida*) followed by cephalopods and shrimp (*Pandalus borealis*). During the 1990's an important component of the diet was waste products from fisheries for other species (heads, guts etc.). With growth, a decrease in the importance of small food items (shrimp, capelin) in Greenland halibut diet and the increase of a portion of large fish such as cod and haddock (*Melanogrammus aeglefinus*) were observed.

With the Greenland halibut stock being nearly 100 000 tonnes, the total food consumption of the population is estimated to be about 280 000 tonnes. The biomass of commercial species consumed (shrimp, capelin, herring, polar cod, cod, haddock, redfish (*Sebastes sp*.), long rough dab (*Hippoglossoides platessoides*) does not exceed 5 000-10 000 tonnes per species (DOLGOV & SMIRNOV 2001).

The Greenland halibut as a species thus has a negligible effect on the other commercial species in the Barents Sea both as predator and prey.

Greenland halibut occurs over a wide range of depths (from 20 to 2200 m) and temperatures (from -1.5 to 10º C) (BOJE & HAREIDE, 1993; SHUNTOV, 1965; NIZOVTSEV, 1989). Young Greenland halibut occur mostly in the northeastern Barents Sea (Spitsbergen archipelago and further east to Franz Josef Land) where the presence adult Greenland halibut or other predators appears minimal. Therefore, Greenland halibut mortality after settling in the area is low and stable and driven mainly by envionmental factors.

B Data

B.1 Commercial catch

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of the Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, bottom trawl and shrimp trawl. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for in the catch statistics.

Russian catch based on daily reports from the vessels are combined in the statistics of the All-Russian Research Institute of Fisheries and Oceanography (VNIRO, Moscow). Data are provided separately by ICES areas and gears.

The sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and then from neighbouring areas and similar gears. ALKs from research surveys (shrimp trawl) are also used to fill gaps in age sampling data.

Norway and Russia, on average, have accounted for about 90-95% of the Greenland halibut landings during more recent years. Data on catch in tonnes from other countries are either taken from ICES official statistics (by ICES area) or from reports to Norwegian authorities. A few countries also supply some additional data. The text table below indicates the type of data provided by country:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x		x
Russia	x	x	x	x	x
Germany	x				
United Kingdom	x				
France[1]	x				
Spain[1]	x				
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				
Poland[1]	x				

[1] As reported to Norwegian authorities

The Norwegian input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later input to Excel spreadsheet files before aggregation to international data. The data are archived in the national laboratories and with the Norwegian stock co-ordinator.

The national data have been aggregated with international data on Excel spreadsheet files. The Russian length composition has been applied to Russian landings together with an age-length-key (ALK) and weight at age data from the Norwegian landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian landings. The Excel spreadsheet files used for age distribution, adjustments and aggregations are held by the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, under **w:\acfm\afwg\year\data\grh_arct**.

B.2 Biological

For 1964-1969, separate weight at age data are used for the Norwegian and the Russian catches. Both data sets are mean values for the period and are combined as a weighted average for each year. A constant set of weight-at-age data is used for the total catches in 1970–1978. For subsequent years annual estimates are used. The mean weight at age in the catch is calculated as a weighted average of the weight in the catch from Norway and Russia. The weight at age in the stock is set equal to the weight at age in the catch for all years.

A fixed natural mortality of 0.15 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Annual ogives based on sexes combined using Russian survey data are given for the years 1984–1990 and 1992–last data year. An average ogive derived from 1984–1987 is used for 1964–1983. For 1984 to the last data year a three-year running average is used.

B.3 Surveys

The results from the following research vessel survey series are evaluated by the Working Group:

1. Norwegian bottom trawl survey in August in the Barents Sea and Svalbard from 1984 in fishing depths of less than 100 m and down to 500 m. (Table E1 and E2).

2. Norwegian Greenland halibut surveys in August from 1994. The surveys cover the continental slope from 68 to 80ºN, in depths of 400–1500 m north of 70º30'N, and 400–1000 m south of this latitude. This series has in 2000 been revised to also include depths between 400 – 500 m in all years (Table E3).

3. Norwegian bottom trawl surveys east and north of Svalbard in autumn from 1996 (Table E4).

4. The Norwegian Combined Survey index Table E5, combination of the results from Tables E1-E4.

5. Russian bottom trawl surveys in the Barents Sea from 1984 in fishing depths of 100–900 m. This series has been revised substantially since the 1998 assessment in order to make the years more comparable with respect to area coverage and gear type (Table E6).

6. Spanish bottom trawl survey in the slope of Svalbard area in October, ICES Division IIb: from 1997 (Table E7).

7. Norwegian Barents Sea bottom trawl survey (winter) from 1989 in fishing depths of less than 100 m and down to 500 m. In order to utilise the last year values in the VPA calibration, this series was adjusted back by one year and one age group to reflect sampling as if it occurred in the autumn of the previous year (Table E8).

8. International pelagic 0-group surveys from 1970. (Table A14).

Over the last several years the Working Group has been concerned about trends in catchability within individual surveys used for tuning of the XSA. The trends were seen for younger ages of year classes in the late 80's and early 90's that were initially estimated to be very low in abundance. With increasing age these year classes were estimated to be much closer to the mean abundance. In previous meetings the Working Group therefore increased the lower age used in tuning to five years in order to reduce the problem. This only partly resolved the problem though, and in all subsequent assessments estimated recruitment of the last 2-3 years has increased from one year to the next.

The Norwegian bottom trawl survey in the Barent Sea and Svalbard catch Greenland halibut mainly in the range of ages 1–8, although in most years age 1 is poorly represented and all age group younger than five years are not considered to be well represented in this survey due to the limited depth range covered. The relative strength of the year classes varies considerably with age. In more recent years there has been low but somewhat better representation of young fish in this survey.

The Norwegian juvenile Greenland halibut survey north and east of Svalbard were started in 1996 and from 2000 this survey is conducted as a joint survey between Norway and Russia. As a result it is expected that the area coverage will improve, better representing the distribution of juveniles and will provide a more comparable time series. Only the Norwegian part of these northern surveys is currently included in the Norwegian Combined Survey index (see below) . In future, when the extended coverage in the Russian zone has been repeated for at least five years the Working Group will consider revising the combined index.

The Norwegian Greenland halibut survey along the deep continental slope south and west of Spitsbergen began in 1994. Although Greenland halibut older than 15 years are caught, few fish are represented in the catch over age 12 or less than age 5 (Table E4). Most of the abundance indices are dominated by ages 5–8.

Most of the surveys considered by the Working Group in 2002 cover either the adult population in the slope area or juvenile distribution in northern areas. The problem of underestimation of recruitment in the last few years included in the analyses has been attributed to shortcomings in survey coverage. The Working Group at previous meetings has noted the need for annual surveys that sample most of the population within a short period of time. Prior to the 2002 WG meeting effort was therefore made to combine some of these surveys into a new total index. The new index is termed the Norwegian Combined Survey Index and is established back to 1996, the first year with survey coverage northeast of Svalbard. It includes bottom trawls from the Norwegian bottom trawl survey in August in the Barents Sea and Svalbard (Tables E1 and E2), the Norwegian Greenland halibut survey in August along the continental slope (Table E3), and the Norwegian bottom trawl survey in August-September north and east of Svalbard (Table E4). Prior to the meeting in 2003 work was done to evaluate the combination of these survey series into one index and this was reported in Working Document 5 to the Working Group. Based on these results it was decided to use this combined index in this years assessment.

The Norwegian Combined Survey Index (Table E5) indicates a significant increase in the total stock during the last three years and a stock size in 2002, nearly 40% above last years index. However, there is no clear year class pattern in the data and some ages are consistently underestimated relative to adjacent age groups (e.g. age 9 and partly age 4). The highest indices were observed for age seven, with exception of the two last years when age 1 was most abundant. That indicates that the catchability of younger ages (i.e. those primarily from northern surveys) are not comparable with the older ones (i.e. those primarily from the slope). This is probably a result of pooling different surveys using different gears. These weaknesses reduce the applicability of the combined surveys, and the Working Group advises that further work be done to improve the combined index in the future.

The Russian Barents Sea bottom trawl survey, which extends back to 1984 catch fish mainly in the range of 4–10 years old. The relative abundance of the year classes against age is similar to the surveys above. This survey covers the Barents Sea including the continental slope of the Norwegian Sea. Total abundance indices from this survey show trend to grow since 1996.

The Spanish bottom trawl surveys along the continental slope north of 73°30’ N from 1997 (Table E7) differ from the other survey series indicating reduced abundance in this area since 1999.

The Norwegian bottom trawl survey during winter in the Barents Sea catch Greenland halibut older than 12 years, but are not particularly effective in catching fish older than 7 years. This is likely due to the limited depth distribution of the survey area. Nevertheless, the survey appears very effective at catching Greenland halibut up to age 6. The relative abundance of the year classes against age is comparable with the survey above.

The strengths of the Greenland halibut year classes of 1970–1997 from the International pelagic 0-group surveys in the Barents Sea are shown in Table A14. The results are highly variable over the time period. However, most of the 1970’s and 1980’s year classes are represented in reasonably high numbers. In recent years the 1988–1992 and the 1996 year classes have been well below the long term average. The 1993–1995 and 1997-1999 year classes are closer to the average. Significant increase of 0-group abundance indices with compare to previous years was observed in 2000-2002.

All in all, the surveys seem to indicate that the catchability of the 1990–1995 year classes increased considerably as the fish becomes five years and older. Based on extremely low catch rates in the surveys, these year classes were considered very poor in previous assessments by the Working Group, but improved considerably at older ages. The reason for this change in catchability is not clear. However, it is known that important areas for young Greenland halibut may be found north and east of Svalbard (Table E4). Albert *et al*. (2001a) showed that the south-western end of the distribution area of age 1 fish was gradually displaced northwards along west Spitsbergen in the period 1989–92 and southwards in the period 1994–1996. These displacements corresponded to changes in hydrography and may be explained by increased migration of the 1990–1995 year classes to areas outside the survey area.

B.4 Commercial CPUE

The restrictive regulations imposed on the trawl fishery after 1991 disrupted the traditional time series of commercial CPUE data. However, an attempt to continue the series was made through a research program using two Norwegian trawlers in a limited commercial fishery (Tables 8.6 and E9). This comprises fishing during two weeks in May-June and October, representing an effort somewhat less than 20% of the 1991 level. Since 1994 the fishery has been restricted to May-June. This fishery was conducted, as much as possible, in the same way as the commercial fishery in the previous years. Since 1997 also two Russian trawlers conducted a limited research fishery for Greenland halibut.

The CPUE from the experimental fishery was found, however, to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1650 kg/h with the highest value in 2000 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series also shows the highest value in 2000.

B.5 Other relevant data

None

C Historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
Tapered time weighting applied, power = 3 over 20 years
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 10
Survivor estimates shrunk towards the mean F of the final 2 years or the 5 oldest ages
S.E. of the mean to which the estimate are shrunk = 0.500
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1964 – last data year	- (total)	Yes
Canum	Catch at age in numbers	1964 – last data year	5 – 15+	Yes
Weca	Weight at age in the commercial catch	1964 – last data year	5 – 15+	Yes/No - constant at age from 1964 - 1978
West	Weight at age of the spawning stock at spawning time.	1964 – last data year	5 – 15+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1964 – last data year	5 – 15+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1964 – last data year	5 – 15+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1964 – last data year	5 – 15+	Yes/No – three year running mean, constant at age from 1964 - 1983
Natmor	Natural mortality	1964 – last data year	5 – 15+	No – set to 0.15 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian Combined survey index	1996 – last data year	5 – 15+
Tuning fleet 2	Norwegian experimental CPUE	1992 – last data year	5 - 14
Tuning fleet 3	Russian trawl survey from 1992	1992 – last data year	5 – 15+

D Short-term projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size. Taken from the XSA for age 6 and older. The recruitment at age 5 in the last data year is estimated using the mean from 1990 to two years before the last data year following the argument that recruitment at age 5 shows a sharp reduction in the most recent years in the previous assessments, which is not believed to reflect the true recruitment.

Natural mortality: Set to 0.15 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight at age in the stock: Average weight at age for the last three years used in the assessment

Weight at age in the catch: Average weight at age for the last three years used in the assessment

Exploitation pattern: Average of the three last years

Intermediate year assumptions: Catch constraint

Stock recruitment model used: Constant recruitment as described earlier

Procedures used for splitting projected catches: Not relevant

E Medium-term projections

Not done

F Long-term projections

Not done

G Biological reference points

No limit or precautionary reference points for the fishing mortality or the spawning stock biomass are proposed.

H Other issues

I REFERENCES

Albert, O.T., E.M. Nilssen, K.H. Nedreaas & A.C. Gundersen 2001a. Distribution and abundance of juvenile Northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*) in relation to survey coverage and physical environment. *ICES Journal of Marine Science* 58: 000-000.

Albert, O.T., E.M. Nilssen, A. Stene, A.C. Gundersen & K.H. Nedreaas 2001b. Maturity classes and spawning behaviour of Greenland halibut (*Reinhardtius hippoglossoides*). *Fisheries Research* 51: 217-228.

Boje, J., & N.R. Hareide 1993. Trial deepwater longline fishery in Davis Strait, May-June 1992. NAFO SCR Doc. 93/53, Serial No. N2236, 6 pp.

Borkin, I.V. 1983. Results from research on ichthyophauna in the Frantz-Josef Land area and north of Svalbard. In: Research into biology, morphology and physiology of marine organisms. USSR Academy of Science Publishers, Apatity, pp. 34-42 (in Russian).

Bowering, W.R. & W.B. Brodie 1995. Greenland halibut (*Reinhardtius hippoglossoides*). A review of the dynamics of its distribution and fisheries off eastern Canada and Greenland. -Pp. 113-160 in: Hopper, A.G. (ed.). *Deep-Water Fisheries of the North Atlantic Oceanic Slope*. Kluwer Academic Publishers, Boston, USA.

Bowering, W.R. & K.H. Nedreaas 2000. A comparison of Greenland halibut (*Reinhardtius hippoglossoides*, Walbaum) fisheries and distribution in the Nortwest and Northeast Atlantic. *Sarsia* 85: 61-76.

Fedorov, K.Y. 1971. Zoogeographic characteristics of the Greenland halibut (*Reinhardtius hippoglossoides*, Walbaum).

Journal of Ichthyology 11: 971-976.

Godø, O.R. & T. Haug 1987. Migration and recruitment to the commercial stock of Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum), in the Svalbard area. *FiskeridirektoratetsSkrifterSerieHavundersøkelser* 18: 311-328.

Godø, O.R. & T. Haug 1989. A review of the natural history, fisheries and management of Greenland halibut (*Reinhardtius hippoglossoides*) in the eastern Norwegian and Barents Seas. *Journal du Conseil. Conseil international pour l'Exploration de la Mer* 46: 62-75.

Nizovtsev, G.P. 1968. Distribution and age-length characteristics of Greenland halibut (*Reinhardtius hippoglossoides* Walbaum) catches in the Barents sea in 1996. *Trudy PINRO*,23: 402-413. (in Russian).

Nizovtsev, G.P. 1983. Distribution of young Greenland halibut in the Barents Sea and in the eastern Norwegian Sea. *Rybnoye khozyaistvo,* 12:26-28 (in Russian).

Nizovtsev, G.P. 1989. Recommendations on rational exploitation of Greenland halibut stocks in the Barents and Norwegian seas. *USSR Ministry of Fisheries, PINRO, Murmansk*, 93 pp. (in Russian).

Shuntov, V.P. 1965. Distribution of Greenland halibut and arrowtooth flounder in the northern Pacific.*Trudy VNIRO*, 58: 155-164 (in Russian).

Whitehead, P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese 1986. *Fishes of the North-eastern Atlantic and the Mediterranean.* UNESCO, Paris, France, 1473 pp.

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: 24.04.2005

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 currently applied ogive.

Age group	2	3	4	5	6	7	8	9	10	11+
Current	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

In the last period the maturity at age has decreased somewhat. The next table below presents the annual maturity ogives for the period 1985-2004. In the period 1997-2001 there was a lower maturation for all age groups 4-8, and especially in 1998 the maturation was low. The question is than whether to use a new fixed average maturity ogive for the whole period after 1985-2004, an annual ogive or a running average. If we completely trusted the otolith-based method, an annual ogive would probably be the best. But the determination of spawning rings is still uncertain and variable between otolith readers, and the effect of errors on SSB-estimates and advice may be large. The maturity at age based on spawning rings for the period 1996-2000 was compared to maturity at age based on gonad development and measured during the acoustic survey in October. For the youngest maturing age groups (4 and 5) a lower maturation is estimated based on gonad development at the survey time in October than based on spawning rings the following year (age 5 and 6). But a similar reduction in maturation in the period 1996 to 1999 is observed in both series. For age 6-7 the differences in estimated maturation are less, while for age 7-8 the reduction in maturation is smaller in the gonad based data (age 7) compared to the spawning ring based (age 8). Since both the spawning ring based maturation and the gonad development based one show similar trends to some degree, the WG decided to use a 3-year running average after 1984 (2-year average for the first and last year).

	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	0.10	0.43	0.87	0.95	0.91	1.00	1.00	1.00

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. 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	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: Truncated lognormal distribution, TLOGNORM (mean, standard deviation, minimum, maximum), is used for recruitment age 3, also in the initial year. The long-term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4^{th} last year.

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 (**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*σ), 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				From search on 500x500 grid		
S*	$\hat{\alpha}$	R*		S*(10)	S*	S*(90
136378	1.27	173200		109755	136055	190547

$F_{0.1}$ 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

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

ICES 1965. Report of the Coalfish Working Group. Co-op. Res. Rep. Int. Counc. Explor. Sea ser. A. 6: 1-23.

ICES 1996. Report of the Arctic Fisheries Working Group. ICES CM 1996/Assess: 4. 311 pp.

ICES 1998a. Report of the Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10. 39 pp.

ICES 1998b. Report to the ICES Advisory Committee on Fishery Management, 1998. ICES Cooperative Research Report No. 29.

ICES 1998c. Technical minutes of ACFM meeting, ICES 20-29 October 1998. Internal document.

ICES 2003. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management. ICES Headquarters 24–26 February 2003. ICES CM 2003/ACFM:15.

Jakobseen, T. 1981. Preliminary results of saithe tagging experiments on the Norwegian coast 1975-77. ICES CM 1981/G:35.

Jakobsen, T. 1986. Recruitment and distribution of North-East Arctic saithe in relation to changes in the environment. Pp 213-223 in Loeng, H. (ed.) The effect of oceanographic conditions on distribution and population dynamics of commercial fish stocks in the Barents Sea. Proceedings of the third Soviet-Norwegian Symposium, Murmansk 26-28 May 1986. Institute of Marine Research, Bergen, 1987.

Jakobsen, T. 1987. Variation in rates of migration of saithe from Norwegian waters to Iceland and Faroe Islands. Fisheries Research, 5:217-222.

Julious, S.A. (2001). Inference and estimation in a changepoint regression problem. *The Statistician*, **50**: 51-61.

Mehl, S. 2000. Mengdemåling av sei Finnmark – Møre, hausten 1999 (Abundance of saithe Finnmark – Møre autumn 1999). Fisken og Havet 5 – 2000. 21 pp (in Norwegian with table and figure text also in English).

Korsbrekke, K. og Mehl, S. 2001. Mengdemåling av sei Finnmark – Møre, hausten 2000 (Abundance of saithe Finnmark – Møre autumn 2000). Havforskningsinstituttet, Bergen. Intern. Web rep. http://ressurs.imr.no/bunnfisk/rapporter/seirap00.htm. 21 pp (in Norwegian with table and figure text also in English).

MRAG. 1997. Core program development for the modelling of fishery management strategies. Final Report of EC Study Project 94/110.

Nedreaas, K. 1997. Evaluation of the North-East Arctic saithe (Pollachius virens) acoustic survey. ICES CM 1997/Y:20.

Salthaug, A. and Godø, O.R. 2000. Analysis of CPUE from the Norwegian bottom trawl fleet. ICES CM 2000 /W: 14.

DRAFT

Quality Handbook ANNEX:____

Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock:…North-East Arctic Cod ……………………………………………………

Working Group:…Arctic Fisheries Working Group…………………………………

Date: 20-02-02………………….

1 GENERAL

1.1 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.

1.2 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.

1.3 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).

2 DATA

2.1 COMMERCIAL CATCH

Norway

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES.

No discards are reported or accounted for, but there are several reports of discards. In later years there are also reports of misreporting, saithe is landed as cod in a period with decreasing quotas and availability of cod and good availability of saithe.

The sampling strategy is to have age and length samples from all major gears in each main area and quarter. The main sampling program is sampling the landings. Additional samples from catches are obtained from the coast guard, from observers and from crew members reporting according to an agreed sampling procedure.

There are at present no defined criteria on how to allocate samples to unsampled catches, but the following general procedure has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Russia

Russian commercial catch in tonnes by quarter and area are derived from the All-Russian Institute of fishery and oceanography (Moscow) statistics department. Data from each fishing vessel are aggregated on three ICES sub-Division (1, IIa and IIb).Russian fishery by passive gears was almost stopped by the end of the 1940s. At present bottom trawl fishery constitutes more than 95 % cod catch.

The sampling strategy was to conduct mass measurements and collect age samples directly at sea, onboard of both research and commercial vessels to have age and length distributions from each area and quarter. Data on length distribution of cod in catches were collected in areas of cod fishery all the year round by a "standard" fishery trawl (mesh size is 125 mm in the Russian Economic zone and Svalbard area and 135 mm in the Norwegian Economic zone) and summarized by three ICES sub-areas (1, IIa and IIb). Previously the PINRO area divisions were used, differed from the ICES sub-Divisions.

Age sampling was carried out by two ways: without any selection (otoliths were taken from any fish caught in one trawl, usually from 100-300 sp.) or using a stratified by length sampling method (i.e. approximately 10-15 sp. per each 10-cm length group). The last method has been used since 1988.

All fish taken for age-reading were measured and weighted individually.

Catch at age are reported to ICES AFWG by sub-Division (1, IIa and IIb) and quarter (before 1984 – by sub-Division and year). Data on length distribution of cod in catches, as well as age-length keys, are formed for each quarter and area. In the case when a catch is present in the area/quarter but a length frequency is absent, a length frequency for the corresponding quarter, summarised for the whole sea is used. If there is no data on length composition of cod in catches per a quarter within the whole sea, a frequency summarised for the whole year and whole sea is used. Gaps in age-length distributions in sub-Divisions are filled in with data from the corresponding quarter, summarised for the whole sea. Rest gaps are filled in with information from the age-length key formed for the long-term period (1984-1997) for each quarter and for the whole sea. (Kovalev and Yaragina, 1999). Before 1984 calculation of annually catch cod numbers in sub-Divisions was derived from summarized for both the whole year age-length keys and length distribution in catches.

Germany and Spain
Catch at age reported to the WG by ICES sub-Division (I, IIa and IIb) and quarter, according to national sampling. Missing quarters/sub-Divisions filled in by use of Russian or Norvegian sampling data.

Other nations
Total annual catch in tonnes is reported by ICES sub-Divisions. All caches by other nations are taken by trawl. The age composition from the sampled trawl fleets is therefore applied to the catches by other nations.

The text table below shows which country supplied which kind of data for 2000:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x	x	x
Russia	x	x	x	x	x
Germany	x	x	x		x
United Kingdom	x				
France[1]	x				
Spain	x	x	x		x
Portugal[1]	x				
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				

[1] As reported to Norwegian and Russian authorities

The nations that sample the catches, provide the catch at age data and mean weights at age on Excel spreadsheet files, and the national catches are combined in Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator.

For 1983 and later years mean weight at age in the catch is calculated as the weighted average for the sampled catches. For the earlier period (1946-1982) mean weight at age in catches is set equal to mean weight at age in the stock (ICES 2001).

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\2000\data\cod_arct** or **w:\ifapdata\eximport\afwg\cod_arct**.

2.2 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.

2.3 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).

2.4 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.

3 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	1946 – last data year	3 – 13+	No – set to 0 for all ages in all years

	spawning			
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

4 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

5 MEDIUM-TERM PROJECTIONS

Model used: Age structured

Software used: ????

Initial stock size: Same as in the short-term projections.

Natural mortality: Same as in the short-term projections

Maturity: Same as in the short-term projections

F and M before spawning: Same as in the short-term projections

Weight at age in the stock: Same as last year in the short-term projections

Weight at age in the catch: Same as last year in the short-term projections

Exploitation pattern: Same as in the short-term projections

Intermediate year assumptions: Same as in the short-term projections

Stock recruitment model used: ????

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

1. Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics

2. Natural mortality:

3. Maturity:

4. F and M before spawning:

5. Weight at age in the stock:

6. Weight at age in the catch:

7. Exploitation pattern: Average of the three last years, scaled by the Fbar to the level of the last year

8. Intermediate year assumptions: F-constraint

9. Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4^{th} last year.

6 LONG-TERM PROJECTIONS

SPR and YPR calculations

7 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

8 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.

9 REFERENCES

Aglen, A., Alvsvåg, J., Lepesevich, Y., Korsbrekke, K., Mehl, S., Nedreaas, K.H., Sokolov, K., and Ågotnes, P. 2002. Investigations on demersal fish in the Barents Sea winter 2001. Detailed report. IMR/PINRO Joint report series no 2, 2002. 66pp.

Anon. 2001. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2000 to 31 December 2000. Marine Research Institute Technical Report nr. 78, Marine Research Institute, Reykjavik, Iceland.

Anon. 2002. dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Babayan V.K. and Kizner Z.I.1998. Dynamic models for NFC assessment. Logic, Notentialities, development //CSEAP, Colin. Sci. Pap. ICSEAF, v.15 (1): p.69-83.

Baranenkova, A.S. 1964. Some results of estimation of cod fry in the Barents Sea during 1946-1961. *In:* Materials of PINRO Scientific Council Meeting by the results of investigations conducted in 1962-63. PINRO, Murmansk, 3:72-107 (in Russian).

Beckett, J. S. and Serra, R. 2001. Scientific peer review of Northeast Arcic cod assessment. Internal report to ICES, 9 October 2001, Oslo, Norway.

Berg, E., Eriksen, I.A. and Eliassen, J.E. 1998. Catch-statistics on Norwegian Coastal cod 1984-1997, data and methods. Fiskeriforskning Tromsø, report 10/1998. 13 pp.

Berenboim, B. and Korzhev, V. 1997. On possibility of using Stefansson's production model to assess the northern shrimp (*Pandalus borealis*) stock in the Barents Sea. ICES CM 1997/Y.

Berenboim, B.I., Dolgov, A.V., Korzhev, V.A. and Yaragina N.A. 2001. The impact of cod on the dynamics of Barents Sea shrimp (*Pandalus borealis*) as determined by multispecies models. J. Northw. Atl. Fish. Sci. 27: 1–7.

Bogstad B., Fotland Aa., Mehl S., 1999. A revision of the abundance indices for cod and haddock from the Norwegian winter survey in the Barents Sea, 1983-1999. . Working Document N 16 for the Arctic Fisheries Working Group, August 1999, 14 pp.

Bogstad, B., Haug, T. and Mehl, S. 2000. Who eats whom in the Barents Sea? NAMMCO Scientific Publications 2: 98-119.

Bogstad, B., Lilly, G. R., Mehl, S., Pálsson, Ó. K., and Stefánsson, G. 1994. Cannibalism and year-class strength in Atlantic cod (*Gadus morhua* L.) in Arcto-boreal ecosystems (Barents Sea, Iceland and eastern Newfoundland). ICES mar. Sci, Symp. 198: 576-599.

Bogstad, B. and Mehl, S. (MS) 1997. Interactions Between Cod (*Gadus morhua*) and Its Prey Species in the Barents Sea. *Forage Fishes in Marine Ecosystems*. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01: 591-615. University of Alaska Fairbanks.

Bulgakova , T., D.Vasilyev and A.Dolgov 1995b Some special algorithms for the Barents Sea fish stomach content data base processing// ICES CM 1995/D:13 Ref. G,H,K.

Bulgakova T., D.Vasilyev et al. 1995 c Seasonal and yearly dynamics of the Barents Sea cod rations. ICES CM 1995/G:32 Ref. D,H,K.

Caddy, J.F. 1999. Deciding on precautionary management measures for a stock based on a suite of limit reference points (LRPs) as a basis for a multi-LRP harvest law. NAFO Sci. Coun. Studies, 32: 55–68.

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

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

Dingsør, G. E. 2001. Estimation of discards in the commercial trawl fishery for Northeast Arctic cod (*Gadus morhua* L.) and some effects on assessment. Cand. Scient thesis, University of Bergen, 2001

Folkow, L.P., Haug, T., Nilssen, K.T. and Nordøy, E.S. 2000. Estimated food consumption of minke whales *Balaenoptera acutorostrata* in Northeast Atlantic waters in 1992-1995. NAMMCO Scientific Publications 2: 65-81.

Fournier, D. and Archibald, C. P. 1982. A general theory for analysing catch at age data. Can. J. Fish. Aquat. Sci., 39: 1195–1207.

Frøysa, K. G. 2002. Results and recommendations on test runs of Fleksibest with simulated annealing (SA). Appendix D.6 in dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-

CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Frøysa, K.G., Bogstad, B., and Skagen, D.W. 2002. Fleksibest – an age-length structured fish stock assessment tool with application to North-east Arctic cod (*Gadus morhua* L.) Fisheries research 55:87-101.

Gusev E.V. and Yaragina N.A. 2000. A conversion of cod abundance from the trawl-acoustic survey data to a number of cod in different age-length groups to be used in the Flexibest model. Working Document N 35 for the Arctic Fisheries Working Group, August 2000, 9 pp.

Harbitz, A., Aschan, M. and Sunnanå, K. 1998. Optimum stratified sampling design for biomass estimates in large area trawl surveys - exemplified by shrimp surveys in the Barents Sea. Fisheries research 37:107–113.

Hilborn, R. and Walters, C.J. 1996. Biomass dynamic models. User's manual. FAO computerized information series (fisheries). No. 10. Rome, FAO. 62p.

ICES. 1996. Report of the multispecies assessment working group. Bergen, Norway, 21 – 28 June 1995. ICES CM 1996/Assess:3.

ICES 1996. Report of the Arctic Fisheries Working Group. ICES CM 1996/Assess: 4. 311 pp.

ICES 1997. Report of the Arctic Fisheries Working Group. ICES CM 1997/ACFM: 4. 326 pp.

ICES. 1997. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. ICES CM 1997/ACFM: 14

ICES 1998. Report of the Arctic Fisheries Working Group. ICES CM 1998/ACFM: 2. 366 pp.

ICES 1998a. Report of the Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10. 39 pp.

ICES 1998b. Report to the ICES Advisory Committee on Fishery Management, 1998. ICES Cooperative Research Report No. 29.

ICES 1998. Study Group on the Precautionary Approach to Fisheries Management. ICES CM 1998/ACFM:10.

ICES. 1998. Technical minutes of ACFM meeting, ICES 20–29 October 1998. Internal document.

ICES 1999. Report of the Arctic Fisheries Working Group. ICES CM 1999/ACFM: 3. 276 pp.

ICES. 1999. Report of the Joint ICES/NAFO Working Group on harp and hooded seals. Tromsø, Norway, 29 September – 2 October 1998. ICES CM 1999/ACFM:7, 36 pp.

ICES 2000. Report of the Arctic Fisheries Working Group. ICES CM 2000/ACFM: 3. 312 pp.

ICES 2001. ICES Annual Report for 2000. ISSN 0906-0596. 276 pp.

ICES 2001. Report of the ICES Advisory Committee on Fishery Management, 2001. ICES Cooperative Research Report No. 246.

ICES 2001. Report of the Arctic Fisheries Working Group. ICES Headquarters August 2000. ICES CM 2001/ACFM:02. 340 pp.

ICES 2001. Report of the Workshop on Fleksibest – an age and length based assessment tool. ICES CM 2001/ACFM:09. 61 pp.

ICES 2001. Report of the Arctic Fisheries Working Group. Bergen, Norway, 24 April – 3 May 2001. ICES CM 2001/ACFM:19. 340 pp.

ICES 2002. Report of the Working Group on Methods on Fish Stock Assessments. ICES Headquarters 3-3 December 2001. ICES CM/D:01. 98 pp.

ICES 2002. Report of the Study Group on the Further Development of the Precautionary Approach to Fisheries Management. Lisbon, Portugal, 4-8 March 2002. ICES CM 1998/ACFM: (in prep.).

Ingvaldsen, R., Loeng, H, Ottersen, G, and Ådlandsvik, B. 2002. The Barents Sea climate during the 1990s. ICES Marine Science Symposia (in press)

Jakobsen, T., Korsbrekke, K., Mehl, S., and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys for demersal fish in the Barents Sea during winter. ICES CM 1997/Y:17.

Korsbrekke, K. 1997. Norwegian acoustic survey of Northeast Arctic cod on the spawning grounds off Lofoten. ICES C.M 1997/Y:18.

Korsbrekke, K., Mehl, S., Nakken, O. and Pennington, M. 2001. A survey-based assessment of the Northeast Arctic cod stock. *ICES Journal of Marine Science, 58*: 763-769, 2001.

Kovalev Yu., Yaragina N.A., 1999. Scheme of recalculation of cod commercial catch weight into number of fish of different length-age groups accepted in PINRO (Russia) for the Flexibest model. Working Document N 10 for the Arctic Fisheries Working Group, August 1999, 9 pp.

Kunzlik P.A. 1991. An Introduction to Sullivan, Lai and Gallucci's Catch at Size Analysis (CASA). Working Paper to the 1991 Nephrops Ass.WG. : 21pp.

Lepesevich, Yu. M. and Shevelev, M. S. 1997. Evolution of the Russian survey for demersal fish: From ideal to reality. ICES C. M. 1997/Y:09.

Lepesevich Yu1.M., Smirnov O.V. and K.V. Drevetnyak, 1999. The Russian trawl acoustic survey on demersal adult and young fish stock assessments in the Barents Sea in autumn/winter. Working Document N 7 for the Arctic Fisheries Working Group, August 1999, 11 pp.

Macdonald, P.D.M., and T.J. Pitcher. 1979. Age groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. J. Fish. Res. Board Can., 36: 987–1001.

Marshall, C.T., Kjesbu, O.S., Yaragina, N.A., Solemdal, P., and Ulltang, Ø. 1998. Is spawner biomass a sensitive measure of the reproductive and recruitment potential of Northeast Arctic cod? Can. J. Fish. Aquat. Sci. 55: 1766–1783.

Mehl, S. 1999. Demersal fish investigations in the Barents Sea winter 1999. Fisken og Havet 13-1999. (In Norwegian with table and figure text also in English).

Mehl, S., and Yaragina, N. A. 1992. Methods and results in the joint PINRO-IMR stomach sampling program. In: Bogstad, B. and Tjelmeland, S. (eds.), *Interrelations between fish populations in the Barents Sea*. Proceedings of the fifth PINRO-IMR Symposium. Murmansk, 12–16 August 1991. Institute of Marine Research, Bergen, Norway, 5–16.

MRAG. 1997. Core program development for the modelling management strategies. Final Report of EC Study Project 94/110.

Nilssen, K.T., Pedersen, O-P., Folkow, L. and Haug, T. 2000. Food consumption estimates of Barents Sea harp seals. NAMMCO Scientific Publications 2: 9-27.

Ottersen G., Ådlandsvik B., and Loeng, H. 2000. Predictability of Barents Sea temperature. Fisheries Oceanography 9: 121-135

Pennington, M. (ed). 1999. Report of the workshop on comparison of stock assessment model strategies, with application to Northeast Arctic cod, Bergen 1–4 December 1998. Fisken og havet 4–1999, Institute of Marine Research, Bergen, Norway.

Richards, L.J., Schnute, J.T., Kronlund, A.R., and Beamish, R.J. 1992. Statistical models for the analysis of ageing error," *Canadian Journal of Fisheries and Aquatic Sciences*, 49, 1801-1815.

dos Santos, J and Jobling, M. 1995. Test of a food consumption model for the Atlantic cod. ICES J. mar. Sci., 52:209–219.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. Int. Whal. Commn* 47: 453-483.

Shepherd, J.G. 1991. Simple methods for short-term forecasting of catch and biomass. ICES J. mar. Sci., 48: 67–78.

Shevelev M.S., Mamylov V.S., Ratushny S.V., and E.N. Gavrilov, 1998. Technique of Russian bottom trawl and acoustic surveys of the Barents Sea and how to improve them. NAFO Scientific Council Studies, No. 31, p.13-19.

Skagen, D.W. 2002. Programs for stochastic prediction and management simulation (STPR3 and LTEQ). Program description and instructions for use. (version dated 6-3-2002).

Sokolov, K. M. 2001. On feasibility of assessment of discards of small cod in trawl fishery for *Gadidae* in the Barents Sea and adjacent waters in 1996-2000. 9th joint Russian-Norwegian symposium "Technical regulations and by-catch criteria in the Barents Sea Fisheries" (PINRO, Murmansk, 14-15 August 2001).

Stefánsson, G. and Pálsson, Ó.K. 1997. Bormicon. A boreal migration and consumption model. Report no. 58, Marine Research Institute, Reykjavik, Iceland.

Stefánsson, G. and Pálsson, Ó. K.1998. A framework for multispecies modelling of Arcto-boreal systems. Rev. Fish. Biol. Fish. 8,101–104.

Stefánsson, G., Skúladóttir, U. and Pétursson, G. 1994. The use of a stock production type model in evaluating the offshore *Pandalus borealis* stock of North Icelandic waters, including the predation of Northern shrimp by cod. ICES CM 1994/K:25.

Trenkel, V. O'Brien, C. M. and Bogstad, B. 2002. Length-based population dynamics in state space form. Appendix C.3 in dst2. Development of structurally detailed statistically testable models of marine populations. QLK5-CT1999-01609. Progress report for 1 January 2001 to 31 December 2001. Marine Research Institute Technical Report nr. 87, Marine Research Institute, Reykjavik, Iceland.

Trambachev, M.F. 1981. Young cod in the Barents Sea and Bear Island-Spitsbergen area in the in the autumn and winter 1978-1979. Annls.biol., Copenh., 1981(1979), 36: 107-109.

Zaferman M.L. and L.I., Serebrov. 1984. On the instrumental methods for estimating bottom and demersal fish stocks in the Barents and Norwegian Seas. – In: Reproduction and recruitment of Arctic cod. Reports of the 1st Soviet/Norwegian Symposium, Moscow, P. 359-370 (in Russian).

Quality Handbook
ANNEX:____

Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock: North-East Arctic Haddock

Working Group: Arctic Fisheries Working Group

Date: 13-05-04

A. General

A.1 Stock definition

The North-East Arctic Haddock (*Melanogrammus aeglefinus*) is distributed in the Barents Sea and adjacent waters, mainly in waters above 2° Celsius. Tagging carried out in 1953-1964 showed the contemporary area of the Northeast Arctic haddock to embrace the continental shelf of the Barents Sea, adjacent waters and polar front. The main spawning grounds are located along the Norwegian coast and area between 70°30' and 73° N along the continental slope. Larvae extruded are widely drifted over the Barents Sea by warm currents. The 0-group haddock drifts from the spawning grounds eastwards and northwards and during the international 0-group survey in august it is observed over wide areas in the Barents Sea.Until maturity, haddock are mostly distributed in the southern Barents Sea being their nursery area. Having matured, haddock migrate to the Norwegian Sea.

A.2 Fishery

Haddock are harvested throughout a year; in years when the commercial stock is low they are mostly caught as bycatch in cod trawl fishery; when the commercial stock abundance and biomass are high haddock are harvested during their target fishery. On average approximately 25% of the catch is with conventional gears, mostly longline, which are used almost exclusively by Norway. Part of the longline catches are from a directed fishery.

The fishery is restricted by national quotas. In the Norwegian fishery the quotas are set separately for trawl and other gears. The fishery is also regulated by a minimum landing size, a minimum mesh size in trawls and Danish seine, a maximum by-catch of undersized fish, closure of areas with high density/catches of juveniles and other seasonal and areal restrictions.

In recent years Norway and Russia have accounted for more than 90% of the landings. Before the introduction of national economic zones in 1977, UK (mainly England) landings made up 10–30% of the total. Each country fishing for haddock and engaged in the stock assessment provide catch statistic annually. Summary sheets in AFWG Report indicate total yield of haddock by Subareas I, IIa and IIb as well as catch by each country by years. Catch information by fishing gear used by Norway in the haddock fishery is used internally when making estimations at AFWG meeting. Catch quotas were introduced in the trawl fishery in 1978 and for the fisheries with conventional gears in 1989. Since January 1997 sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area. Discarding is prohibited. The minimum catching size of haddock is 39 cm in the Russian Economic zone, 44 cm in Norwegian Economic zone; both minimum landing sizes are used by respective fleets in the Svalbard area pursuant to the Svalbard Treaty 1920). The fisheries are controlled by inspections at sea, requirement of reporting to catch control points when entering and leaving the EEZs and by inspections when landing the fish for all fishing vessels. Keeping a detailed fishing log-book on board is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis. There is some evidence that the present catch control and reporting systems are not sufficient to prevent discarding and under-reporting of catches.

The historical high catch level of 320,000 t in 1973 divides the time-series into two periods. In the first period, highs were close to 200,000 t around 1956, 1961 and 1968, and lows were between 75,000 and 100,000 t in 1959, 1964 and 1971. The second period showed a steady decline from the peak in 1973 down to the historically low level of 17,300 t in 1984. Afterwards, landings increased to 151,000 t before declining to 26,000 t in 1990. A new increase peaked in 1996 at 174,000 t. The exploitation rate of haddock has been variable.

The highest fishing mortalities for haddock have occurred at intermediate stock levels and show little relationship with the exploitation rate of cod, in spite of haddock being primarily a by-catch in the cod fishery. The exception is the 1990s when more restrictive quota regulations resulted in a similar pattern in the exploitation rate for both species. It might be expected that good year classes of haddock would attract more directed trawl fishing, but this is not reflected in the fishing mortalities.

A.3 Ecosystem aspects

The composition and distribution of species in the Barents Sea depend considerably on the position of the polar front which separates warm and salty Atlantic waters from colder and fresher waters of arctic origin. Variation in the recruitment of haddock has been associated with the changes in the influx of Atlantic waters to the large areas of the Barents Sea shelf.

In dependence on age and season haddock can vary their diet and act as both predator and plankton-eater or benthos-eater. During spawning migration of capelin (*Mallotus villosus*) haddock prey on capelin and their eggs on the spawning grounds. When the capelin abundance is low or when their areas do not overlap, haddock can compensate for lacking capelin with other fish species, i.e. young herring (*Clupea harengus*) or euphausiids and benthos, which are predominant in the haddock diet throughout a year. Haddock growth rate depends on the population abundance, stock status of main preys and water temperature.

Water temperature at the first and second years of the haddock life cycle is a fairly reliable indicator of year-class strength. If mean annual water temperature in the bottom layer during the first two years of haddock life does not exceed 3.75 C (Kola-section), the probability that strong year-classes will appear is very low even under favourable effect of other factors. Besides, a steep rise or fall of the water temperature shows a marked effect on abundance of year-classes.

Nevertheless, water temperature is not always a decisive factor in the formation of year-class abundance. Strength of year-classes is also determined to a great extent by size and structure of the spawning stock. Under favourable environmental conditions strong year-classes are mainly observed in years when the spawning stock is dominated by individuals from older age groups which abundance is at a fairly high level.

Annual consumption of haddock by marine mammals, mostly seals and whales, depends on stock status of capelin as their main prey. In years when the capelin stock is large the importance of haddock in the diet of marine mammals is minimal, while under the capelin stock reduction a considerable increase in consumption by marine mammals of all the rest abundant Gadoid species including haddock is observed (Korzhev and Dolgov, 1999; Bogstad, 2000).

The appearance of haddock strong year classes usually leads to a substantial increase in natural mortality of juveniles as a result of cod predation.

B. Data

B.1 Commercial catch

Norway (for Knut's consideration)

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub-areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES. No discards are reported or accounted for.

The sampling strategy is to have age and length samples from all major gears in each main area and quarter. The main sampling program is sampling the landings. Additional samples from catches are obtained from the coast guard, from observers and from crew members reporting according to an agreed sampling procedure.

There are at present no defined criteria on how to allocate samples to unsampled catches, but the following general procedure has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

Russia

Russian commercial catch in tonnes by seasons and area are derived from the All-Russian Institute of fishery and oceanography (Moscow) statistics department. Data from each fishing vessel are aggregated on three ICES sub-Division (I, IIa and IIb). Russian fishery by passive gears was almost stopped by the end of the 1940s. Until late 1990’s, relative weight (percentage) of haddock taken by bottom trawls in the total Russian yield exceeded 99%. Only in recent years an upward trend in a proportion of Russian long-line fishery for haddock was observed to be up to 5% on the average.

The sampling strategy was to conduct mass measurements and collect age samples directly at sea, onboard of both research and commercial vessels to have age and length distributions from each area and season. Data on length distribution of haddock in catches are collected in areas of cod and haddock fishery all the year round by a "standard" fishery trawl (mesh size is 125 mm in the Russian Economic zone and Svalbard area and 135 mm in the Norwegian Economic zone) and summarized by three ICES sub-areas (I, IIa and IIb). Previously the PINRO area divisions were used, differed from the ICES sub-Divisions.

Age sampling was carried out by two ways: without any selection (otoliths were taken from any fish caught in one trawl, usually from 100-300 sp.) or using a stratified by length sampling method (i.e. approximately 10-15 sp. per each 10-cm length group). The last method has been used since 1988.

All fish taken for age-reading were measured and weighted individually.

Data on length distribution of haddock in catches, as well as age-length keys, are formed for each ICES Subarea, each fishing gear (trawl and longline) and each half year. Catch at age are reported to ICES AFWG by sub-Division (I, IIa and IIb) for the whole year. In case data on size or age composition of catches by half year are lacking or not representative, aggregated data from corresponding areas for year are used. In the lack of data by ICES Subareas, information on size-age composition of catches from other areas is used.

Germany

Catch at age reported to the WG by ICES sub-Division (I, IIa and IIb) according to national sampling. Missing sub-Divisions filled in by use of Russian or Norwegian sampling data.

Other nations

Total annual catch in tonnes is reported by ICES sub-Divisions or by Russian and Norwegian authorities directly to WG. All catches by other nations are taken by trawl. The age composition from the sampled trawl fleets is therefore applied to the catches by other nations.

The text table below shows which country supplied which kind of data:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	x	x	x		x
Russia	x	x	x	x	x
Germany	x	x	x		x
United Kingdom	x				
France	x				
Spain	x				
Portugal	x				
Ireland	x				
Greenland	x				
Faroe Islands	x				
Iceland	x				

The nations that sample the catches, provide the catch at age data and mean weights at age on Excel spreadsheet files, and the national catches are combined in Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator.

For 1983 and later years mean weight at age in the catch is calculated as the weighted average for the sampled catches. For the earlier period (1946-1982) mean weight at age in catches is set equal to mean weight at age in the stock.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\2000\data\had_arct** or **w:\ifapdata\eximport\afwg\had_arct**.

B.2 Biological

For 1983 and later years weight at age in the stock is calculated as weighted averages from Russian (mainly October-December) and Norwegian (February) surveys during the autumn-winter season. Stock weights at age a (W_a) at the start of year y are calculated as follows:

$$W_a = 0.5(W_{rus,a-1} + W_{nbar,a})$$ where

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

$W_{nbar,a}$: Weight at age a in the Norwegian Barents Sea survey in year y

Mean weight at age in the stock reflects weight of haddock in the beginning of a year fairly accurately. In case data on weight of individuals from older age groups are lacking or not representative, the fixed long-term mean estimates are used.

For 1989-2001 Norway presented mean weights from the February and Lofoten surveys and for this period the Norwegian weights were from the Lofoten and the Barents Sea (combined).

Because of the deficiency in the observed data from 1984 to 2002, in 2002 for the mentioned period expert estimates of mean weight of older age groups were given which were reduced to values being more in compliance with the haddock growth rate.

Proportion of mature haddock at age is estimated from data presented by Russia for the period 1981-2003 from late autumn – early spring (both from fisheries and from surveys). Russian data on proportion mature in the stock is to a great extent depends on sampling areas and not always reflects true maturity rate for different age groups (WD# AFWG, 2002). In this relation there is a need to simulate haddock maturity rate by years and age groups or to adjust Russian data to arrive at a more realistic picture. For the earlier period (1946-1980) the maturity at age is set average and based on Russian sampling.

For both estimations and predictions the fixed natural mortality of 0.2 is used, and for age 3-6 mortality from predation is applied in addition.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0. The peak spawning occurs most years in the middle of April.

B.3 Surveys

Russia

Russian surveys of cod and haddock in the southern Barents Sea started in the late 1940s as trawl surveys of young demersal fishes. Since 1957 such surveys have been conducted over the whole feeding area including the Bear Island - Spitbergen area (Baranenkova, 1964; Trambachev, 1981), both young and adult haddock have been surveyed simultaneously. In 1984, acoustic methods started to be implemented during surveys of fish stocks (Zaferman, Serebrov, 1984; Lepesevich, Shevelev, 1997; Lepesevich *et al.*, 1999). In 1995 a new acoustic assessment method was applied for the first time, which allowed the differentiation and registration of echo intensities from fish of different length (Shevelev *et al.*, 1998).

Time of survey conducting has reduced from 5-6 months (September-February) in 1946-1981 to 2-2.5 months (October-December) since 1982. The aim of conducting a survey is to investigate both the commercial size haddock as well as the young haddock. The survey covers the main areas where fries settle down as well as the commercial fishery takes place. A total number of more than 400 trawl hauls are conducted during the survey (mainly bottom trawl, a few pelagic trawl).

There are two survey abundance indices at age: 1). absolute numbers (in thousands) computed from the acoustics and 2). trawl indices, calculated as relative numbers per hour trawling. From 1995 onwards there has been a substantial change in the method for calculating acoustic indices. The acoustic survey is therefore presented in 2 tables (Table B4a and B4b) for old and new method of calculating indices.

Ages 1-7 are used in the XSA-tuning.

Norwegian (from 2000 - Joint Norwegian-Russian) winter (February) survey

The survey started in 1981 and covers the ice-free part of the Barents see. Both swept area estimates from bottom trawl and acoustic estimates are produced. The swept area estimates are used in the tuning for ages 1-8. The survey is described in Jakobsen et al (1997) and Aglen et al. (2002).

Before 2000 this survey was made without participation from Russian vessels, while in the three latest surveys Russian vessels have covered important parts of the Russian zone. The indices for 1997 and 1998, when the Russian EEZ was not covered, have been adjusted as reported previously (Mehl, 1999). The number of fish (age group by age group) in the Russian EEZ in 1997 and 1998 was interpolated assuming a linear development in the proportion found in the Russian EEZ from 1996 to 1999. These estimates were then added to the numbers of fish found in the Norwegian EEZ and the Svalbard area in 1997 and 1998.

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

B.4 Commercial CPUE

Russia

No Russian data are used in the stock estimations.

Norway

Historical time series of observations from onboard Norwegian trawlers were earlier used for tuning of older age groups in VPA. The basis was catch per unit effort (CPUE) in Norwegian statistical areas 03, 04 and 05 embracing coastal banks north of the Lofoten, on which approximately 70% of Norwegian haddock catch fell. However, proportion of haddock taken as by-catch is pretty high and thus it is difficult to estimate their actual catch per unit effort. Since 2002, CPUE indices have not been used in XSA tuning.

Other data

Not used.

C Estimation of historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for ages >6

Catchability independent of age for ages >= 9

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

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

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1950 – last data year	1 – 11+	Yes
Canum	Catch at age in numbers	1950 – last data year	1 – 11+	Yes
Weca	Weight at age in the commercial catch	1983 – last data year	1 – 11+	Yes, set equal to west for 1950-1982
West	Weight at age of the spawning stock at spawning time.	1950 – last data year	1 – 11+	Yes
Mprop	Proportion of natural mortality before spawning	1950 – last data year	1 – 11+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1950 – last data year	1 – 11+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1950 – last data year	1 – 11+	Yes, set equal to average for 1950-1980
Natmor	Natural mortality	1950 – last data year	1 – 11+	Includes annual est. of predation by cod from 1984, otherwise set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Russian bottom trawl survey, October-December	1983 – last data year	1-7
Tuning fleet 2	Joint Barents Sea trawl survey, February	1982– last data year	1 - 8
Tuning fleet 3	Joint Barents Sea Acoustic survey, February	1980 – last data year	1 - 7

D Short-term projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock status: is estimated in XSA as abundance of individuals survived in the terminal year for age 3 and older.

Recruitment at age 3 for the start year and the 2 consecutive years is estimated from survey data in RCT3.

Natural mortality is mainly assumed equal to the level estimated for terminal year or to the average for the recent 3 years in dependence on expected cod predation. Method used to determine this parameter and its substantiation are given in the AFWG Reports.

Proportion mature: for current year preliminary actual data presented by Russia are used; for subsequent years – expert estimates by AFWG members. Method used to determine this parameter and its substantiation are given in the AFWG Reports.

F and M prior to spawning are assumed equal to 0 for all ages in all years.

Weight at age in the stock: Method used to determine this parameter and its substantiation are given in the AFWG Reports.

Weight at age in catch: Method used to determine this parameter and its substantiation are given in the AFWG Reports.

Distribution of fishing mortality at age (fishing pattern): For current year it is taken to be at the level of previous year ($F_{Status\ quo}$) or to be equal to average for the recent 3 years; for subsequent years method used to determine this parameter and its substantiation are given in the AFWG Reports.

F and M before spawning: Set to 0 for all ages in all years

Stock recruitment model used: None

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Time lag: 4 years

Software used: Excel with the build-in @RISK to make statistical estimations.

Initial stock status, natural mortality, proportion mature, proportion of F and M prior to spawning, mean weight at age in stock and in catch, exploitation pattern, predicted F in intermediate year: the same as in the short-term prediction.

Stock recruitment model used: ????

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

1. Initial stock size: Lognormal distribution, LOGNORM (mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern: Average of the three last years, scaled by the Fbar to the level of the last year
8. Intermediate year assumptions: F-constraint
9. Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960 – 4th last year.

F. Long-term projections

Spawning stock biomass per recruit (SPR) and yield per recruit (YPR) are estimated annually.

G. Biological reference points

Introduced 1998: Blim=50000t, Bpa=80000t, Flim=0.49, Fpa=0.35

H REFERENCES

Aglen, A., Alvsvåg, J., Lepesevich, Y., Korsbrekke, K., Mehl, S., Nedreaas, K.H., Sokolov, K., and Ågotnes, P. 2002. Investigations on demersal fish in the Barents Sea winter 2001. Detailed report. IMR/PINRO Joint report series no 2, 2002. 66pp.

Baranenkova, A.S. 1964. Some results of estimation of cod fry in the Barents Sea during 1946-1961. *In:* Materials of PINRO Scientific Council Meeting by the results of investigations conducted in 1962-63. PINRO, Murmansk, 3:72-Bogstad, B., Haug, T. and Mehl, S. 2000. Who eats whom in the Barents Sea? NAMMCO Scientific Publications 2: 98- 119. 107 (in Russian).

Jakobsen, T., Korsbrekke, K., Mehl, S., and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys for demersal fish in the Barents Sea during winter. ICES CM 1997/Y:17.

Korzhev V.A., Dolgov A.V. Multispecies model MSVPA of the commercial species of Barents Sea (in Russian) – Murmansk: PINRO, 1999, - 82 p.

Lepesevich, Yu. M. and Shevelev, M. S. 1997. Evolution of the Russian survey for demersal fish: From ideal to reality. ICES C. M. 1997/Y:09.

Lepesevich Yu1.M., Smirnov O.V. and K.V. Drevetnyak, 1999. The Russian trawl acoustic survey on demersal adult and young fish stock assessments in the Barents Sea in autumn/winter. Working Document N 7 for the Arctic Fisheries Working Group, August 1999, 11 pp.

Mehl, S. 1999. Demersal fish investigations in the Barents Sea winter 1999. Fisken og Havet 13-1999. (In Norwegian with table and figure text also in English).

Shevelev M.S., Mamylov V.S., Ratushny S.V., and E.N. Gavrilov, 1998. Technique of Russian bottom trawl and acoustic surveys of the Barents Sea and how to improve them. NAFO Scientific Council Studies, No. 31, p.13-19.

Trambachev, M.F. 1981. Young cod in the Barents Sea and Bear Island-Spitsbergen area in the in the autumn and winter 1978-1979. Annls.biol., Copenh., 1981(1979), 36: 107-109.

Zaferman M.L. and L.I., Serebrov. 1984. On the instrumental methods for estimating bottom and demersal fish stocks in the Barents and Norwegian Seas. – In: Reproduction and recruitment of Arctic cod. Reports of the 1st Soviet/Norwegian Symposium, Moscow, P. 359-370 (in Russian).

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: 28.04.05

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).

Since 1 January 2000 a maximum legal by-catch criterion of 10 juvenile redfish (both *S.marinus*, *S. mentella* and *S. viviparus*) per 10 kg shrimp has been enforced in the shrimp fishery.

A.3. Ecosystem aspect

As 0-group and juvenile this stock is an important plankton eater in the Barents Sea, and when this stock was sound, 0-group were observed in great abundance in the upper layers utilizing the plankton production. Especially during the first five-six years of life *S. mentella* is also preyed upon by other species, of which its contribution to the cod diet is well documented.

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data are aggregated on 17 areas for bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights at age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length at age

The text table below shows which country supply which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. mentella*	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x	x[2]	x[2]	x	x
Germany	x	x[3]				x[3]
United Kingdom	x	[1]				
France	x	[1]				
Spain	x	[1]				
Portugal	x	[1]				
Ireland	x	[1]				
Greenland	x	[1]				
Faroe Islands[1]						
Iceland	x	[1]				

1) As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)
2) For main fishing area until 2001
3) Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight at age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian trawl landings. In some years the final German and Russian numbers at age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smn_arct** or **w:\ifapdata\eximport\afwg\smn_arct**.

B.2. Biological

Since 1991, the catch in numbers at age of *S. mentella* from Russia is based on otolith readings. The Norwegian catch-at-age is based on otoliths back to 1990. Before 1990, when the Norwegian catches of *S. mentella* were smaller, Russian scale-based age-length keys were used to convert the Norwegian length distribution to age.

As input to trial analytical assessments, weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Age-based maturity ogives for *S. mentella* (sexes combined) are available for 1986–1993, 1995 and 1997–2001 from Russian research vessel observations in spring. Average ogives for 1966-1972 and 1975-1983 have been used for the periods 1965-1975 and 1976-1983, respectively. Average ogives for 1975-1983, 1984-1985 and data for 1986-1993 (Table D8) were used to generate a smoothed maturity ogive for 1984-1992 (3 year running average). The 1992-1993 average was used for 1993 and 1994, the 1995 data for 1995, the average for 1995 and 1997 for 1996, and the collected material for the subsequent years up to 2001 were taken as representative for these years.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the AFWG:

1) The international 0-group survey in the Svalbard and Barents Sea areas in August-September since 1980 (incl.).

2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December since 1978 (incl.) in fishing depths of 100–900 m.

3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since1992.

4) Norwegian Barents Sea bottom trawl survey (February) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since 1992.

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area.

5) A new Norwegian survey designed for redfish and Greenland halibut is covering the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen in August since 1996 from less than 100 m to 500 m depth. The results from this survey includes survey no. 3) above.

6) Russian acoustic survey in April-May since 1992 (except 1994, 1996 and 2002-2004) 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. A considerable reduction in the abundance of 0-group redfish was observed in the 1991 survey: abundance decreased to only 20% of the 1979–1990 average. With the exception of an abundance index of twice the 1991-level in 1994, the indices have remained very low. Record low levels of less than 20% of the 1991–1995 average have been observed for the 1996-1999 year classes. The 2000 year class was stronger than the preceding four year classes, whereas the estimate of the 2001 and 2002 year classes are among the lowest on record.

Russian acoustic surveys estimating the commercially sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. In 1992 the area covered was extended, and data on age are available for 1992–1993, 1995 and 1997–2001. This is the only survey targeting commercially sized *S. mentella,* but only a limited area of its distribution.

B.4. Commercial CPUE

Revised catch-per-hour-trawling data for the *S. mentella* fishery have been available from Russian PST- and BMRT-trawlers fishing in ICES Division IIa in March-May 1975-2002, representative for the directed Russian fishery accounting for 60-80% of the total Russian catch. The Working Group mean that the Russian trawl CPUE series do not represent the trend in stock size but is more a reflection of stock density. This is because the fishery on which these data are based since 1996 was carried out by one or two vessels on localised concentrations in the Kopytov area southwest of Bear Island. This is also reflected by the relative low effort at present. Due to this change in fishing behaviour/effort, CPUEs have been plotted only for the period after 1991.

B.5. Other relevant data

None

C. Historical Stock Development

Model used:
Software used:
Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1965-2004	6-19+	yes
Canum	Catch at age in numbers	1965-2004[1]	6-19+	yes
Weca	Weight at age in the commercial catch	1965-2004	6-19+	yes
West	Weight at age of the spawning stock at spawning time.	1965-2004	6-19+	yes
Mprop	Proportion of natural mortality before spawning	1965-2004	6-19+	Constant=0
Fprop	Proportion of fishing mortality before spawning	1965-2004	6-19+	Constant=0
Matprop	Proportion mature at age	1965-2004	6-19+	1965-1975, const. 1976-1983, const. 1984-variable
Natmor	Natural mortality	1965-2004	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	1991-2004	6-8
Tuning fleet 2	FLT13 Rus acous	1995-2001	6-14
Tuning fleet 3	FLT14 Norw bottom	1996-2004	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

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: 28.04.2005

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 14 April 2004 there were no regulations of the other gears/fleets than trawl fishing for *S. marinus*. After this date, a limited moratorium during 1-31 May 2004 was enforced in all fisheries except trawl. When fishing for other species (also during the moratorium) it was allowed for these fleets to have up to 20% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday. For 2005, this limited moratorium has been enlarged to cover the time period 20 April-19 June, with the corresponding bycatch permission reduced to 15%.

After 1 January 2006 it will be forbidden to use gillnets with meshsize less than 120 mm when fishing for redfish.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated for the gears gill net, long line, hand line, Danish seine and bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters <u>length</u> samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights at age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length at age.

The text table below shows which country supply which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. marinus*	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x				x
Germany	x	x[3]				x
United Kingdom	x	[1]				
France	x	[1]				
Spain	x	[1]				
Portugal	x	[1]				
Ireland	x	[1]				
Greenland	x	[1]				
Faroe Islands[1]						
Iceland	x	[1]				

[1] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)
[2] For main fishing area until 2001
[3] Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight at age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian trawl landings. In some years the final German and Russian numbers at age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smr-arct** or **w:\ifapdata\eximport\afwg\smr-arct**.

B.2. Biological

The total catch-at-age data back to 1991 are based on Norwegian otolith readings. In 1989–1990 it was a combination of the German scale readings on the German catches, and Norwegian otolith readings for the rest. In 1984–1989 only German scale readings were available, while in the years prior to 1984 Russian scale readings exist.

Weight at age in the stock is assumed to be the same as weight at age in the catch.

When an analytical assessment is made, a fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A knife-edge maturity at age 15 (age 15 as 100% mature) has been used for this stock.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the Working Group:

1) Norwegian Barents Sea bottom trawl survey (February) from 1986–2005 in fishing depths of 100–500 m. Data are available on length for the years 1986–2005, and on age for the years 1992–2004. This survey covers important nursery areas for the stock

2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2004 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 1995-2004 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.

Although the trawl fishery until 2003 was almost unregulated, the trawlers experience fewer and fewer fishing days with more than 10% of their catches composed of *S. marinus*.

B.5. Other relevant data

None.

C. Historical Stock Development

The development of the stock has annually been discussed and evaluated based on the research survey series, and information from the fishery.

In some years trial analytical XSA assessments have been made and discussed by the Working Group. In such cases the following settings have been used/recommended, but NOTE that this is subject to further improvement and evaluation before being adopted:

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 24

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

S.E. of the mean to which the estimate are shrunk = 2.00

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1965 – last data year	2 – 24+	Yes
Canum	Catch at age in numbers	1965 – last data year [1)]	2 – 24+	Yes
Weca	Weight at age in the commercial catch	1965 – last data year [1)]	2 – 24+	Yes/No - constant at age in begiining of time series
West	Weight at age of the stock	1965 – last data year [1)]	2 – 24+	Yes/No - assumed to be the same as weight at age in the catch
Mprop	Proportion of natural mortality before spawning	1965 – last data year	2 – 24+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1965 – last data year	2 – 24+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1965 – last data year	2 – 24+	No – knife edged at age 15
Natmor	Natural mortality	1965 – last data year	2 – 24+	No – set to 0.1 for all ages in all years

[1)] Age reading based on only otoliths since 1991 (incl.).

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norway bottom trawl, Svalbard, fall	1992 – last data year	2-15
Tuning fleet 2	Norway bottom trawl, Barents Sea, winter	1992 – last data year	3-15
Tuning fleet 3	Norway trawl CPUE	1992 – last data year	9-23

D. Short-Term Projection

Model used: Visual inspection/analysis of survey results together with information from the fishery.

No analytical short-term projection has been made for this stock.

E. Medium-Term Projections

Model used: Visual inspection/analysis of survey results together with information from the fishery.

No analytical short-term projection has been made for this stock.

Uncertainty models used: None

F. Long-Term Projections

Not done

G. Biological Reference Points

It is proposed to adopt the average 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 1: Technical Minutes

Report of the Review Group

Artic Fisheries Working Group (AFWG)

(ACFM 23-25 May 2005)

The reviewers compliment the Artic Fisheries Working Group for providing a comprehensive report. The terms of references for the assessment of the status and provision of management options for 2006 were addressed, as well as a special request with respect to the testing of the harvest control rule (HCR) for cod and haddock. It was noted that a thorough evaluation of the HCR had been done for cod and comments provided for the haddock HCR (Section 4.10). A comprehensive evaluation of the HCR for haddock will be undertaken next year. Work is underway in that area and the results of that evaluation will be available at the next meeting of the WG.

The detailed response of the WG to the 2004 ACFM Technical Minutes was appreciated. The chair of the WG presented the assessments and other evaluations done by the WG and highlighted the issues which he considered to be of importance to the review group. He was a great help to the reviewers. The review took the best part of three days, on May 23-25, 2005, in ICES Headquarters in Copenhagen.

The reviewers made a number of general comments and some specific comments to the individual assessments which are given in this report. Also included in this report are the comments provided by ACFM during its May 2005 meeting.

Last year, the reviewers felt that the heavy workload and time pressure that resulted from combining the review of the AFWG report and that of the North Western Working Group had negatively affected the quality of the review. It was recommended that the review procedure be evaluated. The problems encountered last year were eliminated by having separate review processes for these two groups. The review went smoothly this year, with more time being allowed for the discussion of various aspects of the assessments and for preparing the Summary Sheets.

A number of general comments were made on the report (order is arbitrary):

1) It was noted that the report does not identify clearly if an assessment is benchmark or an update. This should be put more clearly in the report. The WG Chair clarified the status of each assessment, indicating that the assessment of saithe is a benchmark, the assessments of the two cod stocks are benchmarks as they are on the observation list, the assessments of Greenland Halibut and haddock are updates, and the assessments of *Sebastes mentella* and *marinus* are experimental assessments. Finally, the capelin documentation is provided as an information item. Plus include plan for next year to identify which ones will be.

2) Further to the observation made last year that discard information needs to be included or that discarding issues be discussed in the assessments, it was noted that information on discards had been provided and discards had been the topic of some Working Papers.

3) Last year, the WG was encouraged to use alternative assessment models to explore the data and to illustrate the (un)certainties in the results of the assessment. It was noted that alternative assessment models had been used for some stocks but that the tendency had been to use those as a way to corroborate the results of

XSA without fully exploring the full feature of these models or assessment approaches. Most often, diagnostics were not presented and discussed and it was unclear as to what degree the alternative models had been explored independently of XSA inputs or results.

4) It was noted that the report contains lots of Tables or Figures that are difficult to read (e.g. Figure 7.7). The report would benefit from having clearer headings for figures and tables. Data should be summarized in Figures were possible. The use of summary figures to present the results of alternative runs or assessments was greatly appreciated.

5) The section on Ecosystem Considerations was greatly appreciated. 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.

6) Further to the comments provided last year, it was noted that quantifying uncertainty is still not a common practice and that very few approaches or models provide measures of precision or an evaluation of risks in relation to biological reference points. Also, as alternative approaches are introduced and presented, there is a need to compare the results and the suitability of approaches in an objective way. It was noted that this is a general issue that should be addressed by a Methods WG.

7) The information on the mixed fisheries was a welcome addition to the report. This information is important for ACFM and its advice on mixed fisheries. For instance, it is the first time that a table on mixed fisheries interactions is presented (Table 1.9).

Norwegian coastal cod

This is a benchmark assessment, with the final run based on XSA, with the same settings as per the last assessment. The principal issues were the year effect in the surveys, the high level of unreported landings. The WG notes that estimates of catches from tourist and recreational fishing are not included in the official statistics or the catch data. In 2003, these represented about 30% of the total catch (estimate available for 2003 only). There is only one year of that information and the dynamic is unknown so that estimates of unreported landings have not been incorporated in the assessment *per se*.

The WG used retrospective analyses to select which value of shrinkage SE to use. On the basis of an apparently better retrospective pattern with a SE of 1.0, the WG retained this value instead of using 0.5. However the RG note that the differences in retrospective performance are not that clear cut, and that there are indications that for recent years the estimates of Mean F are more stable with a shrinkage of 0.5. 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. These metrics summarise retrospective performance in a way that is easier to interpret and to compare than a spaghetti plot.

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. In particular the ICA run used showed lower estimate of mean F and higher SSB than the final XSA run. In view of the assessment's tendency to over-estimate F and under-estimate SSB, it would have been interesting to see a retrospective ICA run to see if this helped improve assessment consistency for this stock. Furthermore it would be desirable to evaluate ICA settings more thoroughly and independently instead of selecting settings which are as close as possible to the XSA.

In view of the retrospective over-estimation of F for this stock, there is a need to be careful in selecting fishing mortalities for use in the forecast. In particular the RG questioned the use of the point estimate of mean F in 2004 (0.70) as fishing mortality in 2005. It does appear to be justified in this case as it leads to a catch in line with expectations. However, status quo fishing mortality during 2006 is likely to be closer to a recent mean than to the high point estimate.

No PA reference points are defined for this stock although based on the XSA results recruitment appears to be impaired at SSBs below 100,000t (although no stock-recruitment plot was available in the report – please correct this in future !). While the present state of the stock with respect to any likely candidate for B_{lim} is clear, the WG is asked to revisit the question of estimating reference points for this stock. 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.

The WG are thanked for their clear responses to the points raised in the previous ACFM minutes.

North-East Arctic cod

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

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.

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.

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!

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.

See also the discussion of the use of Gadget in the *S. marinus* Section of these minutes.

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.

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

Again, the WG is thanked for their thorough and detailed response to previous review comments.

References

Jónsson, S and Hjörleifsson, E, (2000) Stock assessment bias and variation analyzed retrospectively and introducing the PA-residual. ICES CM 2000/X:9

Mohn, R (1999) The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES J. Mar. Sci, 56, 473-488.

NEA Haddock

The assessment was classified as an update assessment although the group has performed several exploratory runs (single fleet with low shrinkage and with different shrinkage options). However, the results of the exploratory runs are poorly documented in the report.

For the final run the settings was the same as in last year and, in general, results are in agreement with last years assessment. The assessment was accepted.

The assessment has not converged, raising the concern that the fishing mortality estimates were not well defined. It was noted that the residuals for older age groups are large. Why do we keep them in the assessment? They are also those that prevent XSA to meet the convergence criterion. This should be explored in future assessments.

The Review Group noted that the assumption of the catchability being dependent on stock size is applied for ages < 7. The t-statistics were verified and they support a slope different than 1. Nevertheless, this should be explored in the next benchmark assessment.

No information was provided on discards. The group should consider the possibilities to estimate the discards that can be substantial problem for some fisheries.

Retrospective pattern: The last five years of Fs are now lower than they were in the previous assessment. And last three years of SSB is now higher from current assessment. The reviewers discussed this retrospective pattern and noted that no explanation had been provided by the WG to explain its presence. It was speculated that the P-shrinkage could be responsible for this but it was noted that the weight given to this was small. The possible reasons of such F-change should be explained by the Working Group should it reoccur in future assessments.

Predation mortalities are highly variable especially in the youngest age group before 1998 and not at all estimated before.1984. This will affect the stock recruitment relationship and related reference points. This should be looked at by the NEA haddock reference points and taken into account by the HCR Study Group in 2006.

Regarding the upcoming evaluation of the amended Harvest Control Rule for haddock, the reviewers observed that it will be important to simulate realistic recruitment for haddock, which is sporadic, to properly capture the dynamics of such a stock.

Editorial comments:

- Figure 4.7: Unclear what this Figure is. There is no reference in the text to this Figure.
- Some exploratory runs were made, exploring the shrinkage level and single fleet effects. Relatively tight results. This is not described in the text of the report.

NEA saithe

The assessment was classified as a benchmark assessment. The Working Group has performed a number of exploratory runs (with different shrinkages, single tuning fleets, different assessment software).

It was noted that the total discarding is of the order of 20% in one fleet. This should be investigated with the aim of including this type of information in the assessment data should discarding practices persist.

As the final assessment included several changes in settings, it would be important to include results of the SPALY (Same Procedure As Last Year) assessment in the graphical comparisons (e.g. add the SPALY results to Figures 5.4.28-30, 31, 33).

The final assessment still has significant diagnostic problems:

- Very noisy indices, some with conflicting trends.
- Very strong "reverse" retrospective pattern. This needs to be addressed by exploring the reasons for the retrospective patterns (also, can this be modelled so as to eliminate such effect in the future?).

However, the results are consistent with the previous assessment. Also, despite the uncertainties in assessment data (noisy tuning data), the results are consistent with those obtained with alternative models such as ICA, ADAPT and XSA. The assessment was accepted as a basis for providing advice.

While alternative models have been explored in this benchmark assessment, there is often little information provided on their performance and there seem to be little discussion of their respective diagnostics.

For instance, ADAPT was used with the same settings as XSA. The ADAPT diagnostics have not been presented. Only the results were. This is not too informative for the reader (and the Working Group). Similarly, the ICA results have not been detailed. When alternate methods are explored and in particular in a benchmark, the alternative models should be fully explored through their respective diagnostics. There is no evidence of this in the report. Also, there is a need to explore the data with the model itself to take full advantage of the analytical environment it provides.

Taking into account the diagnostic problems and retrospective pattern, the working group should explore the possibility of using less data-demanding methods in this assessment, e.g. production models, in the next benchmark assessment for this stock.

The Review Group also accepted the rational for reference point change of this stock.

Greenland halibut

The assessment was classified as an update assessment. The precision of the actual estimates of SSB and F by assessment is considered to be low. Nevertheless the assessment was accepted as indicative for stock trends.

Age reading is still the problem for the stock and aging validation should be done. However the assessment does not confirm strong age reading problem. It seems that age reading is consistent between the catch and survey data.

The diagnostics show quite satisfactory R-Square values with exception of Norwegian combined survey fleet. Part of the issue is that there seem to be low contrast in the data. In other words, perhaps the assessment is uncertain not because of the age reading issue but because of the data do not cover a large area of stock dynamics.

Taking into account the age reading, significant differences in growth rates for males and females and certain XSA diagnostic problems, the working group should explore the possibility of using for Greenland halibut assessment length structured assessment tools or production models. These could help gaining confidence in the productivity level of the stock; then, comparing those results with from XSA could help our understanding of stock dynamics.

The effect of the age reading errors of the type observed should be investigated through simulations to gain insight on the impact on the of an XSA assessment results (e.g. are trends reliable)

This assessment is considered to be indicative of trends. The Review Group noted that the current trend in the assessment is consistent with the indices (three) combined (not age-structured).

***Sebastes mentella* in Sub-Areas I and II**

For this stock, no analytical assessment was attempted. Despite the lack of analytical basis for *S. mentella*, the status of this stock is clear and can be deducted from the survey indices.

ACFM confirms again that it is not necessary to consider these stocks every year and updating the tables and figures is sufficient. Presently, this stock is in a very poor situation and this situation is expected to remain for a considerable period irrespective of current management actions. Year-classes recruit in the SSB at old age (e.g. 10 years old) and surveys indicate a failure of recruitment over a long period.

We note that the WG plans to update the bycatch information annually and to include the bycatch information from other national shrimp fishing fleets to get a total annual estimate by length (and age).

Sebastes marinus in Sub-Areas I and II

In the technical minutes of last year, it was recommended that alternative models be explored. It was considered doubtful, however, that the results of such models would give a different perception of the situation of these stocks compared to the information present in the report.

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 that this application as exploratory.

The model was described as a forward simulation model using quarterly time steps, with initial stock size, recruitment (one per year), selectivity and growth as parameters. The model is based on von Bertalanffy growth function, assumes constant catchability by length, no cannibalism or predation in its current formulation. Its parameter estimation is based on the optimization of a likelihood function.

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. 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"). From these observations arises the concern that the model is over-specified (over-parameterized).

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…. .

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 weighthing schemes could influence the outcome or results.

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).

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 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 likelihood function should be described and included when reporting on the results of GADGET so that we can fully evaluate how the model operates.

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.

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.

The reviewers also suggest that simpler approaches, such as production analyses or production models, be explored as an alternative way to assess this stock.

Capelin in Barents Sea

This was essentially presented as an information item. It was noted that the assessment of Barents Sea capelin is now under the AFWG but that it wasn't clear what the AFWG is expected to provide as this assessment is to be done by the parties responsible for the autumn survey. The Joint Russian-Norwegian Working Group will meet at the end of the summer to review the most recent survey and their assessment will be considered at the October meeting of ACFM.