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Executive summary

Cod in subareas I and II (Norwegian coastal waters)

The cod in subareas I and II, Norwegian coastal waters was assessed on the bases of a survey time series 1995-2008. The survey data and catch at age data were analysed by SURBA.

- The stock has varied without a clear trend since 2002. Both the stock biomass and the recruitment are at a low level compared to the first years in the time series.
- The analysis shows a declining trend in mortality.

Cod in Sub-areas I and II (Northeast Arctic) was assessed using XSA with the same settings as in the 2008 assessment.

The fishing mortality ($F_{5\text{-}10}$) has declined since 2005 and is estimated to 0.30 for 2008.. This is the lowest since 1990. Estimated SSB for 2008 is 767,000 t. This assessment represents 18% upward revision of the 2008 SSB and a 13% downward revision of F in 2008,.

- The new"hybrid" recruitment model, introduced last year, was used, resulting in 564 million in 2009, 487million in 2010 and 184 million in 2011.
- A catch in 2009 corresponding to the evaluated and implemented HCR is 577,500 t. This catch corresponds to a fishing mortality of 0.28 in 2010. SSB is estimated to increase from 1079,000 t at the beginning of 2009 to 1353,000 t in 2010. Such high SSBs have only been observed in late 1940-ies. Earlier maturation means that larger proportion of total stock is spawners now compared to these early years.

IUU-catches have decreased from near 30% of the international reported catch in 2005 to 3% of international reported catch in 2008. Uncertainty about the magnitude of IUU-catches in the period 2002-2006 still may cause uncertainty in the assessment of current stock size. The survey results from the latest two years are not consistent with the results from the previous year. This may be related to incomplete coverage in 2006 and 2007.

Haddock in Sub-areas I and II (Northeast Arctic) was assessed using XSA with the same settings as in the 2008 assessment.

- Previously (1950-2000) the fluctuation in the haddock stock have shown strong cyclic pattern caused by spasmodic recruitment, where stock biomass have been dominated by single cohorts. This picture has changed in recent years where three subsequent cohorts (2004-2006) appear very abundant.
- The fishing mortality (F4-7) in the last three years appears stable and has been estimated above 0.3, but the fishing mortalities for the most recent years have been estimated higher this year than last year. The current assessment estimated the total stock to be about 5 % lower and SSB 25 % lower in 2008, compared to the previous assessment.
- In the projection RCT3 was used to estimate recruiting year classes from 2006 and onwards, and resulted in an estimate of slightly more than 1 billon three year olds in 2009, but will decrease in the next two years.

- A catch in 2010 corresponding to the evaluated and agreed HCR is 242,500 t. This catch is likely to lower the fishing mortality in 2010 to approximately 0.25. SSB is expected to increase considerably the next few years.

The assessment of haddock is uncertain, and XSA is sensitive to settings which can give different perception of long time trend in stock dynamics. However, the short time trends seem to be captured and agree well with results from surveys. Difficulties in estimating initial stock size are additional problems in the forecast. One reason is uncertainties in IUU values. The unreported catches are large, but have decreased from 2006 to 2008.

Saithe in Sub-areas I and II (Northeast Arctic) was assessed using XSA with the same settings as in the 2007 assessment.

- Between 1993 and 2006 there have been a couple of years with relatively low CPUE (1998, 1999), but there is no clear trend before the values suddenly increased to an about 25% higher level in 2007-2008. The WG decided to exclude the 2007 CPUE data in the final assessment.
- The current assessment estimated the total stock in 2008 to be 4 % higher and the SSB 4 % lower, compared to the previous assessment. The F in 2007 is estimated to be slightly lower than in the previous assessment and the realized F in 2008 is somewhat lower than the predicted one, which was based on the TAC.
- In the projections the GM age 3 recruitment of 176 million was used for the 2005 and subsequent year classes.
- A catch in 2010 corresponding to the evaluated and implemented HCR is 204,000 t. This catch corresponds to a fishing mortality of 0.30 in 2010. SSB is estimated to decrease from 690,000 t at the beginning of 2009 to 569,000 t in 2010.

Difficulties in estimating initial stock size are the major problem in the forecast. This is due to widely divergent indices of abundance used in the tuning of the XSA, in addition to lack of reliable recruitment estimates. Prediction of catches beyond the TAC year will, to a large extent, be dependent on assumptions of average recruitment.

Beaked redfish (*Sebastes mentella*) in Sub-areas I and II (Northeast Arctic) was assessed on the basis of available trends in the fisheries and surveys, as there are no accepted analytical assessment for this stock.

Golden redfish (*Sebastes marinus*) in Sub-areas I and II (Northeast Arctic) was assessed on the basis of available trends in the fisheries and surveys. There are no accepted analytical assessment for this stock but the Gadget model was used for the fifth time as an experimental analytical assessment model.

- Since 1993, recruitment of *S. marinus* has been extremely low,
- commercial data and surveys show consistent declining trends in the spawning biomass,
- the exploratory assessment conducted using the Gadget simulation model covering the period 1986–2008 showed a reduction of the spawning stock to about 50% of the level in the early 1990ies, and a more severe reduction of the recruitment and the immature stock,
- present available information confirms last year's evaluation of the very poor status of the stock,

Update assessments were presented for the Greenland halibut in Subareas I and II (Northeast Arctic), Beaked redfish (*Sebastes mentella*) in Subareas I and II and Golden redfish (*Sebastes marinus*) in Subareas I and II.

Greenland halibut in Sub-areas I and II (Northeast Arctic), is in category "no advice" this year and last year advice where repeated.

In according to ToR c, the data on Barents Sea capelin where updated.

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0 Introduction

0.1 Participants

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Oleg Titov	Russia
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0.2 Terms of reference

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

b) for Barents Sea capelin oversee the process of providing inter-sessional assessment.

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

AFWG will report by 7 May 2009 (and XX October 2009 for Barents Sea capelin) for the attention of ACOM.

FishStock	Stock Name	Advice
cod-arct	Cod in Subareas I and II (Northeast Arctic)	Advice
cod-coas	Cod in Subareas I and II (Norwegian coastal waters)	Advice
had-arct	Haddock in Subareas I and II (Northeast Arctic)	Advice
sai-arct	Saithe in Subareas I and II (Northeast Arctic)	Advice
cap-bars	Capelin in Subareas I and II (Barents Sea), excluding Division IIa west of 5°W	Advice
ghl-arct	Greenland halibut in Sub-areas I & II	Same advice as last year
smn-arct	Red fish *Sebastes mentella* Subareas I and II	Advice
smr-arct	Red fish *Sebastes marinus* Subareas I and II	Advice

Generic ToRs for Regional and Species Working Groups

The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGHMM and WGANSA.

The working group should focus on:

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

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

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

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

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

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

    ii) Abundance survey results;

    iii) Environmental drivers.

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

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

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

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

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

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

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

iii) Stock status and 2010 catch options;

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

v) Mixed fisheries overview and considerations;

vi) Species interaction effects and ecosystem drivers;

vii) Ecosystem effects of fisheries;

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

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

0.3 Unreported landings

As previous years, AFWG was faced with different estimates of potential unreported landings of cod and haddock in 2008, obtained by Russian and Norwegian specialists. The main reason for the difference appears to be different ways of interpreting the initial data.

The Norwegian method was exactly the same as that used last year, and a description may be found in the 2008 AFWG-report. According to Norwegian estimates for 2008, unreported catches made up 15 000 tonnes of cod and 24 000 tonnes of haddock.

The Russian method was also the same as that used last year, and a description can be found in the 2008 AFWG-report. The Russian estimates indicate that in 2008 the national quotas were underfished by 425 tonnes of cod and 708 tonnes of haddock.

The AFWG notes with satisfaction a noticeable decline in the 2008 IUU estimations for NEA cod as compared with previous years.

AFWG had hoped to get the joint agreed estimates of catches for cod and haddock in 2008 from the ad-hoc Working Group on the technique for complex analysis of cod and haddock catches formed by JRNFC. However, at the AFWG meeting, only the description of a technique which was jointly worked out by experts from the Fisheries Directorate of Norway and from the Murmansk Center of Fishery Monitoring was available. This technique includes the detailed description of the methodological approach to an assessment independent from the official statistical data of catches, and presents the lists of the informative sources obtained from Norway, Russia and third countries on transportation and landings in the ports. Nevertheless, the ad hoc WG on Analysis decided not to carry out the calculations for IUU catches in 2008 by the developed draft technique on the last meeting in Bergen (23-26 March, 2009), because the group found it necessary that JRNFC approved this technique before carrying out the calculation of IUU catches.

The WG highly regrets the current situation, where different estimates of total catches of cod and haddock are provided by Norwegian and Russian authorities. The revision of IUU estimates for recent years based on the new technique developed by JRNFC WG is desirable. Taking into account that in previous years, in the assessments of cod and haddock stocks only Norwegian data of IUU-catches have been used, AFWG decided to base the 2008 assessments for these stocks on the same basis.

0.4 Uncertainties in the data

Catch data

At recent AFWG meetings it has been recognized that there is growing evidence of both substantial mis-/unreporting of catches and discarding throughout the Barents Sea for most groundfish stocks in recent years (ICES CM 2002/ACFM:18, ICES CM 2001/ACFM:02, ICES CM 2001/ACFM:19, Dingsør WD 13 2002 WG, Hareide and Garnes WD 14 2002 WG, Nakken WD 10 2001 WG, Nakken WD8 2000 WG, Schöne WD4 1999 WG, Sokolov, WD 9 2003 WG, Ajiad et al. WD18 2005 WG, WD 24 2004 WG and WD2 2008 WG). In addition to these WDs, Dingsør (2001) estimated discards in the commercial trawl fishery for Northeast Arctic cod (*Gadus morhua* L.) and some effects on assessment, and Sokolov (2004) estimated cod discard in the Russian bottom trawl fishery in the Barents Sea in 1983-2002. This work should be continued, updated and presented annually to the AFWG.

Survey data

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, 2006 and winter 2003, 2007 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 and 2006. 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 Norwegian winter surveys in 2004 and 2005.

From 2004 onwards, a new joint Norwegian-Russian survey has been conducted in August-September. This is a multi-purpose survey termed an "ecosystem survey" because most part of the ecosystem is covered, including a bottom trawl survey and an acoustic survey for demersal fish. Ongoing work is considering the performance of these new index series for inclusion in the assessment of cod and haddock. However, this survey will probably be discontinued for economical reasons, before the time series is long enough for a possible inclusion as a tuning series. This is highly regrettable, since this survey has shown to be valuable for sampling of synoptic ecosystem information in addition to the data on demersal fish, which could prove valuable in future inclusion of more ecosystem information in the fish stock assessments.

Age reading

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 (Yaragina et al. 2009, AFWG 2008, WD 20). Later, a similar exchange program has been established for haddock, Greenland halibut and capelin otoliths. Once a year (for capelin every second 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 observing discrepancies for cod in the magnitude of

15-30%. An observation that is supported by the results of a NEA cod otolith exchange between Norway, Russia and Germany (Høie et al. 2009, AFWG 2009, WD 6). 100 cod otoliths were read by 3 Norwegian, 2 Russian and 1 German reader, reaching nearly 83% agreement (coefficient of variation 8%). The age reading comparisons of these 100 cod otoliths show that there are no reading biases between readers within each country. However, there is a clear trend of bias between the readers from different countries, Russian age readers assign higher ages than the Norwegian and German age readers. This systematic difference is a source of concern and is also discussed in Yaragina et al. (2009). This seems to be a persistent trend and will be revealed in the following annual otolith and age reader exchanges.

A 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. 2-5%. To determine the effects of changes in age reading protocols between contemporary and historical practices, randomly chosen cod otolith material from each decade for the period 1940-1980's has been re-read by experts (Zuykova et al. 2009). Although some year-specific differences in age determination were seen between historical and contemporary readers, there was no significant effect on length at age for the historical time period. A small systematic bias in the number spawning zones detection was observed, demonstrating that the age at first maturation in the historic material as determined by the contemporary readers is younger than that determined by historical readers. The difference was largest in the first sampled years constituting approximately 0.6 years in 1947 and 1957. Then it decreased with time and was found to be within the range of 0.0-0.28 years in the 1970s-1980s. The study also shows that cod otoliths could be used for age and growth studies even after long storage.

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., AFWG 2005, WD 8). Comparative readings among three Norwegian age readers, and also between Russian and Norwegian age readers show good agreement and low CV. However, even with acceptable between reader precisions, there are strong evidences of low accuracy of the age estimates. Since last year, validation work has been continued and the Norwegian age readings have been done using the new approach described in the AFWG 2006 report. This has caused that only the recent Russian age readings have been comparable with the historic data series. The validation work continues and in the future the historic time

series will be converted to the new age understanding. However, this work is very time consuming and it is difficult to estimate when a full assessment can be conducted using the new approach.

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. A Russian Norwegian age reading workshop on capelin will be conducted in May 2009.

From 2009 onwards, an exchange of *Sebastes mentella* otoliths is conducted annually between the Norwegian and Russian laboratories.

Sampling error

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

For the Norwegian estimates of catch at age methods for estimating the precision have been developed, and the work is still in progress (Aanes and Pennington 2003, Hirst et al. 2004, Hirst et al. 2005). The methods are general and can in principle be used for the total catch, including all countries' catches, and provide estimates both at age and at length groups. Typical error coefficients of variation are in the range 5-40% depending on age and year. It is evident that the estimates of the oldest fish are the most imprecise due to the low numbers in the catches and resulting small number of samples on these age groups. From 2006 onwards, the Norwegian catch at age in the assessment has been calculated using the method described by Hirst et al. (2005).

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

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

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

0.5 Climate included in advice of NEA cod

For the second year climate information has been applied in the advice from AFWG. Similar to last year assessment ecosystem information, other than that inherited in the stock itself, was used in the projection of NEA cod. A combination of regression models, which is based on both climate and stock parameters (Ice coverage, air temperature, water temperature, oxygen saturation, survey indices of NEA cod age 0, 1, 2 and 3, capelin maturing biomass) were used for prediction of recruitment at age 3 (details are found in sections 1.4.5 and 3.7.1).

Also, in the AFWG assessment temperature is part of the NEA cod consumption calculations that goes into the historical back-calculations of the amount of cod, haddock and capelin eaten by cod.

However, it should be acknowledged that the WGWIDE for some years has used the climatic NAO index in the historical stock calculations as part of the prediction of herring growth rates.

0.6 Proposals for status of assessments in 2010

The AFWG propose to set the following status for assessments for each stock:

FishStock	Stock Name	Advice in 2010*	Next benchmark
cod-arct	Cod in Subareas I and II (Northeast Arctic)	Advice	-
cod-coas	Cod in Subareas I and II (Norwegian coastal waters)	Advice	-
had-arct	Haddock in Subareas I and II (Northeast Arctic)	Advice	2010
sai-arct	Saithe in Subareas I and II (Northeast Arctic)	Advice	2010
cap-bars	Capelin in Subareas I and II (Barents Sea), excluding Division IIa west of 5°W	Advice	2009
ghl-arct	Greenland halibut in Sub-areas I & II	No advice	-
smn-arct	Redfish Sebastes mentella Subareas I and II	No advice	2011
smr-arct	Redfish Sebastes marinus Subareas I and II	No advice	2012

* "No advice" means: "Same advice as last year"

Benchmark assessment will be planned for Greenland halibut after age reading workshop.

0.7 ICES Quality Handbook

Quality Handbooks for all stocks, except capelin are revised and presented in this report as appendices. For BS capelin, a stock annex for the quality handbook was not produced during the meeting. Since a benchmark workshop (WKSHORT) is planned in the autumn this year, where BS capelin is one of the species dealt with, the stock annex for this stock will be produced/updated before and during that WK.

0.8 InterCatch

The assessment of NEA cod was based on output from InterCatch. WG upload data in InterCatch for Saithe (for 2007 and 2008) and plan to do it before the next meeting for Haddock, Coastal cod, *S. mentella and S. marinus*.

Barents Sea capelin catch statistic is not included into InterCatch, for two reasons: First, this stock is not assessed by catch-at-age analysis and a catch-at-age matrix is therefore not needed in the assessment. Second, the assessment of capelin actually takes place at the end of the annual survey in autumn, and the assessment made in autumn is only presented in the AFWG in spring.

The fishery (only Russia and Norway fish capelin in the BS) for capelin is monitored and catch-at age is calculated, and could in principle be stored in InterCatch. However, for the reasons mentioned above this has not been considered up to now.

0.9 50 year anniversary

The Working Group noted that it this year can celebrate a 50 year anniversary, as the first meeting of the AFWG was held in Bergen in May 1959. AFWG may be the oldest WG of its kind within ICES. A short presentation about the anniversary was made during the WG and can be found on the Sharepoint site.

0.10 Nomination for New Chair

The Working Group was pleased to unanimously endorse the nomination of Bjarte Bogstad, Norway as the new chairman of the Arctic Fisheries Working Group.

0.11 Time and place of Next Meeting

The Working Group proposes to meet next time in Lisbon (Portugal, see WD 15) at April 20 – 29 (22-28 in case of time reduction), 2010.

1 Ecosystem considerations (Figures 1.1–1.23, Tables 1.1–1.17)

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

The ecosystem approach to management is variously defined, but in principal it puts emphasis on a management regime that maintains the health of the ecosystem alongside appropriate use of the marine environment, for the benefit of current and future generations (Jennings, 2004).

Along with fishery, changes in the Barents Sea ecosystem are mainly caused by variations in 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. Climatic conditions govern the formation of primary biological production and feeding conditions for fish, as well as the survival of their offspring. In addition, inter-species trophic relations is an important factor that influences the abundance dynamics of commercial species.

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

- More extensive use of ecosystem information in the population parameters applied in assessment and prognosis,
- Expansion of the use of multi-species models for fishing management.

This chapter is in general based on a preliminary version of the "Joint Norwegian-Russian environmental statutes 2008, report on the Barents Sea Ecosystem" (Arneberg et al., in prep.), which will be published in June 2009, affiliating more than 100 scientist from 24 institutions in Norway and Russia. This report is the successor to the "Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2007, with expected situation and considerations for management" (Stiansen and Filin, 2008). Text, figures and tables taken from this report (i.e. Arneberg et al., in prep) are not further cited in this chapter.

1.1 General description of the Barents Sea ecosystem (Figures 1.1–1.11, Tables 1.1–1.8)

The Barents Sea is a shelf area of approx. 1.4 million km^2, which borders to the Norwegian Sea in the west and the Arctic Ocean in the north, and is part of the continental shelf area surrounding the Arctic Ocean. The extent of the Barents Sea is limited by the continental slope between Norway and Spitsbergen in west, the top of the continental slope against the Arctic Ocean in north, Novaja Zemlya in east and the coast of Norway and Russia in the south (Figure 1.1). The average depth is 230 m, with a maximum depth of about 500 m at the western entrance. There are several bank areas, with depths around 50-200 m.

Climate

Processes of both external and local origin operating on different time scales govern the climate 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 these 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 are 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 climate of the Barents Sea.

The general circulation pattern (Figure 1.1) is strongly influenced by topography. Warm Atlantic water 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. The Norwegian Coastal Current flows along the coastline south of the Norwegian Atlantic Current. The Coastal Water is fresher than the Atlantic water, and has a stronger seasonal temperature signal. In the northern part of the Barents Sea fresh and cold Arctic water flows from northeast to southwest. The Atlantic and Arctic water masses are separated by the Polar Front, which is characterised by strong gradients in both temperature and salinity. In the western Barents Sea the position of the front is relatively stable, but in the eastern part the position of this front has large seasonal, as well as year- to-year, variations. In general, the Barents Sea is characterised by large year-to-year variations in both heat content and ice conditions. The most important cause of this is variation in amount and temperature of the Atlantic water that enters the Barents Sea (Figures 1.2-1.5).

Phytoplankton

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

Zooplankton

Zooplankton biomass has shown large year-to-year variation among years in the Barents Sea (e.g. Figure 1.7-Figure 1.9). 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 (Mauchline 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*. The two latter species make up 80-98% of the total euphausiids abundance (Drobysheva 1994).

The variation in advection of zooplankton species from the Norwegian Sea is connected with the water inflow intensity and is an important factor for the zooplankton abundance in the Barents Sea, especially for copepods and euphausiids.

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

The abundance of euphausiids (Figure 1.9), as well as the distribution and specific composition, is affected by interannual dynamics. This leads to changes in the feeding conditions of fish. Possible reasons for the large year-to-year variations in plankton biomass in the Barents Sea are the differences in advective transport and predation pressure. Figure 1.10 shows the total biomass of zooplankton together with capelin stock size (million tonnes). There seems to be an inverse relationship between capelin stock size and zooplankton biomass, indicating capelin to exercise strong feedback control on the system through its predation pressure on zooplankton. Other plankton feeding fish, which is found in high numbers in the Barents Sea, are polar cod, young herring and young blue whiting.

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

Fish

The Barents Sea is a relatively simple ecosystem with few fish species of potentially high abundance. These are Northeast Arctic cod, haddock, Barents Sea capelin, polar cod and immature Norwegian Spring-Spawning herring. There have been significant variations in abundance of these species (

Figure 1.10-Figure 1.11). These variations are due to a combination of fishing pressure and environmental variability. In the period 2003-2007 there was a relatively high abundance of blue whiting in the Barents Sea, but this stock has since decreased and is now only found in smaller numbers. Until the 1980's the redfish (*Sebastes mentella*) was also an abundant stock in the Barents Sea.

The recruitment of the Barents Sea fish species has also shown a large year-to-year variability (Tables 1.1-1.2). The most important reasons for this variability are variations in the spawning biomass, climate conditions, food availability and predator abundance and distribution. Variation in the recruitment of some species, like cod, haddock and herring, has been associated with changes in the influx of Atlantic waters into the Barents Sea.

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 (Table 1.3-Table 1.6). 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 (Table 1.7, Figure 1.8) have a strong effect on growth, maturation and fecundity of cod, as well as on cod recruitment because of cannibalism. The role of euphausiids for cod feeding increases in the years when capelin stock is at a low level (Ponomarenko and Yaragina 1990). Also, according to Ponomarenko (1973, 1984) interannual changes of euphausiid abundance is important for the survival rate of cod during the first year of life.

Capelin is a key species because it feeds on the zooplankton production near the ice edge and is usually the most important prey species for top predators in the Barents Sea, serving as a major transporter of biomass from the northern Barents Sea to the south (von Quillfeldt and Dommasnes, 2005). The capelin has showed large variations in abundance, with dramatic change over just a 2-4 years period (Figure 1.10).

The herring spawns along the Norwegian western coast and the larvae drifts into the Barents Sea. The juveniles of the Norwegian spring-spawning herring stock are distributed in the southern parts of the Barents Sea. They stay in this area for about three years before they migrate west and southwards along the Norwegian coast and mix with the adult part of the stock. The presence of young herring in the area has a profound effect on the recruitment of capelin, and it has been shown that when rich year classes of herring enters to the Barents Sea, the recruitment to the capelin stock is poor, and in the following years the capelin stock collapses (Gjøsæter and Bogstad, 1998).

Haddock is also a common species, and migrates partly out of the Barents Sea. The stock has large natural variations in stock size. Food composition of haddock consists mainly of benthic organisms (Table 1.8). Totally the mean weight percent of polychaets, mollusks and echinoderms was up to 40 %. Capelin is the dominant prey among fish species. Zooplankton and other fish species are of only marginal importance. There are no clear differences in the food composition of haddock between various length groups.

Saithe is found mainly along the Norwegian coast, but also occurs in the Norwegian Sea and in the southern Barents Sea. The 0-group saithe drifts from the spawning grounds to inshore waters. 2-3 years old the saithe gradually moves to deeper waters, and at age 3-6 it is found at typical saithe grounds. The smaller individuals feed on crustaceans, while larger saithe depends more on fish as prey. Gastropods and cephalopods are also found in saithe stomachs (Dolgov, WD 29, AFWG 2006; Mehl, WD7, AFWG 2005). The main fish prey is young herring, Norway pout, haddock, blue whiting and capelin, while the dominating crustacean prey is krill. 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 due to heavy overfishing these stocks declined strongly during the 1980's, and has since then stayed at a low level. Young redfish are plankton eaters, but larger individuals take larger prey, including fish.

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

The blue whiting has its main distribution area in the Norwegian Sea and Northeast Atlantic, and the marginal northern distribution is at the entrance to the Barents Sea. Usually the blue whiting population in the Barents Sea is small. In years with warm Atlantic water masses the blue whiting may enter the Barents Sea in large numbers, and the blue whiting can be a dominant species in the western areas. This situation occurred from 2001 onwards, and blue whiting were found in great numbers for the period 2003-2007. Since then it has decreased strongly again. This rise and fall is probably due to a combination of variation in stock size and environmental conditions

In general the four pelagic species (herring, capelin, polar cod and blue whiting) 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 and central areas. In southwestern areas blue whiting and herring partly overlap. However, they occupy different parts of the water column.

In the diet of blue whiting zooplankton(copepods, hyperiids and euphausiids) is dominant at the younger age groups, while fish is increasingly important as the blue whiting gets older. It should be noted that fish became the dominant part of blue whiting diet when it reached a length of about 27 cm. (Dolgov, WD 29, AFWG 2006). Cod juveniles only occurred in the stomachs when the blue whiting reaches a length of approximately 25 cm.

When present in the western Barents Sea the blue whiting is not the main prey for any other fish species. In these periods the blue whiting only can account for approximately 2-7% (Dolgov, WD 29, AFWG 2006) of the diet of cod and Greenland halibut. However, cod is the main predator on blue whiting due to the high numbers of cod, but it can also be found in the diet of larger saithe and haddock. There is no information on predation by mammals on blue whiting.

Long rough dab is a typical ichthyobenthophage, which mainly eats benthos (ophiura, polychaetes etc.) and different fish species (Dolgov, WD 29, AFWG 2006). At older stages the proportion of fish in the diet increases (polar cod and cod, capelin and juvenile redfish). The larger long rough dab also feed on their own juveniles and juvenile haddock.

Thorny skate preys primarily on large crustaceans, shrimps and crabs (Dolgov, WD 29, AFWG 2006), but may also in a lesser extent feed on fish. The most common fish species are young cod and capelin. Round skate fed mainly on benthos, especially Polychaeta and *Gammaridae*. Northern shrimp and fisheries waste are also major components of their diets. Fish (mostly capelin and young cod) occure in small quantities. Arctic skate feed mainly on fish and shrimp (herring, capelin, redfish and northern shrimp). Blue skate diet consists largely of fish, mainly young cod and haddock, redfish, and long rough dab). Spinytail skate also prey mostly on fish, which included haddock, redfish and long rough dab. Total yearly food consumption by thorny skate is estimated to be around 160 thousand tonnes, of which around 75 thousand tonnes comprised commercial fishes and invertebrates. Total yearly food consumption by all other skate species was estimated to be around 30 thousand tonnes, of which around 20 thousand tonnes was commercial species (Dolgov, WD 29, AFWG 2006).

Mammals

Marine mammals, as top predators, are significant ecosystem components. Polar bears, seven pinniped (seals and walrus) species and five cetacean (dolphins, and large whales) species reside full-time in the Barents Sea region. Eight additional whale species are regular seasonal migrants. In addition, sei whales (*Balaenoptera borealis*) and three dolphin species are occasionally observed in the Barents Sea. The available abundance estimates of the most abundant cetaceans in the Barents Sea region are: harp seal *Pagophilus groenlandicus* 861,700 (Barents Sea population only); ringed seal *Pusa hispida* 100,000; white-beaked dolphin *Lagenorhynchus albirostris* 60,000-70,000; minke whale *Balaenoptera acutorostrata* 62,600; harbour porpoise *Phocoena phocoena* 11,000; white whale (beluga) *Delphinapterus leucas* 10,000; fin whale *Balaenoptera physalus* 6,400; walrus *Odobenus rosmarus* 5,000; grey seal *Halichoerus grypus* 4,500; polar bear *Ursus maritimus* 2,650; humpback whale *Megaptera novaeangliae* 1,450; narwhal *Monodon monoceros* 1,000 individuals.

Most species of marine mammals feed at relatively high trophic levels, with the polar bear and killer whale being apex predators; although some of the largest baleen whales, such as blue whales and bowhead whales feed low in the food web, at the plankton level, specialising on krill and copepods, respectively. The walrus also feeds primarily on small benthic invertebrates in shallow waters (e.g. Gjertz and Wiig, 1992). Other marine mammals in the region feed on a combination of benthic and pelagic fauna (including both fishes and invertebrates), but schooling fishes including capelin, polar cod and herring are the primary diet of many of the marine mammals in the Barents Sea Region (e.g. Nilssen et al. 1995, Bogstad et al., 2000; Andersen et al., 2004; Labansen et al., 2007). The harp seal summer diet comprising almost exclusively krill and polar cod, while other gadoids and capelin seems to be of very little importance (Lindstrøm et al. 2006). Krill occurred in significantly higher amounts in the seal stomachs than any other prey species except for July when polar cod dominated.

However, in available study periods (1996/1997 and 2004/2005) the capelin stock was at a very low level. This may certainly have influenced the observed seal diets – so far no summer samples are available in periods with high capelin abundance in the Barents Sea.

Consumption estimates for marine mammals in the Barents Sea suggest that as a group they consume 1.5 x the amount of fish biomass harvested by fisheries (e.g. Bogstad et al. 2000, Folkow *et al*., 2000; Nilssen et al., 2000). However, examples of the impacts of extreme lack of prey, such as the effects of the capelin crashes in the Barents Sea in the 1980s and 1990s illustrate that these top predators do not escape "bottom-up" control completely (Haug et al., 1991; Nilssen *et al*., 1998); they can be impacted by overexploitation by fisheries or environmental cycles that causes collapses of their prey.

Minke whales and the harp seal are currently commercially exploited. These harvests are based on annually set quotas.

Seabirds

The Barents Sea Region (here defined as the north-eastern part of the Norwegian and Greenland seas, and the Barents and White seas) supports some of the largest concentrations of seabirds in the world (Norderhaug *et al*., 1977, Anker-Nilssen *et al*., 2000). A total of 33 species breed regularly in the Barents Sea Region. The most typical species belong to the auk and gull families. Atlantic puffin *Fratercula arctica*, black-legged kittiwake *Rissa tridactyla* and common guillemot *Uria aalge* dominate the seabird communities south of the Polar front while more arctic species such as Brünnich's guillemots *Uria lomvia* and little auks *Alle alle* dominate in the north. In total, more than 5 million pairs of seabirds breed in the region. The Norwegian mainland, Novaya Zemlya and Svalbard are the three main breeding areas, supporting more than 80% of the total breeding populations in the region. About 20-25 million seabirds harvest a biomass of approximately 1.2 million tonnes annually from the area (Barrett *et al*. 2002).

Brünnich's guillemot, together with the little auk, is probably the most numerous seabird in the Barents Sea Region. The largest colonies (several over 100 000 pairs) are situated on the Spitsbergen, Hopen, Bjørnøya and the west coast of Novaya Zemlya. Outside the breeding season it appears in coastal waters and at sea, often in ice-filled areas. The diet of adult Brünnich's guillemots consists mainly of fish and crustaceans. In the northern Barents Sea important prey items include polar cod and crustaceans.

A crude estimate of more than 1.0 milion pairs has been made for the Barents Sea little auk population, and. Little auks feed in both inshore and offshore waters. Their main food during the breeding season consists of small crustaceans. Copepods, especially *Calanus* spp. are especially important in the diet.

The black-legged kittiwake is the most common gull in the Barents Sea region and breeds in all sub-regions. The total breeding population in the Barents Sea region is estimated to be 680 000 pairs. The black-legged kittiwake feeds mainly on invertebrates and small fish up to 15-20 cm long, but they also scavenge offal or discarded fish behind fishing boats. In the northern Barents Sea, capelin, polar cod, amphipods and euphausiids are important components of their diet.

The northern fulmar is restricted to the north-western part of the Barents Sea region, with a large breeding population in Svalbard. The population estimates are uncertain, but high (100 000 - 1 000 000 pairs). The northern remains far out at sea except during the breeding season. It feeds on small pelagic animals caught near or on the sea surface. It also scavenges fishery discards.

Benthos

The fauna of the Barents Sea make up more than 3,050 invertebrate species (Sirenko 2001) distribution on, inside or just above the sea bottom. Because benthic communities are dependent on inputs of organic matter, characteristics of the overlying pelagic ecosystem are largely responsible for variation in the distribution and species composition in the benthos. In general, the fauna biomass, including the benthos, increases near the polar front and in the shallow regions and edges of the banks. The main mass of echinoderms is found in western and central parts of the Sea, whereas the mass developments of bivalves are found in the southeastern parts of the Sea. The deeper western part is rich in echinoderms and particularly poor in polychaetes. The bivalves decrease in abundance with increasing depth, whereas the echinoderms increase in numbers and the polychaetes remain essentially unchanged (Zenkevitch 1963).

The northern shrimp (*Pandalus borealis*) is distributed in most deep areas of the Barents Sea and Spitsbergen waters. The densest concentrations are found in depths between 200 and 350 meter. The shrimp mainly feed on detritus, but may also be a scavenger. Shrimp is also important as a food item for many fish species and seals. Biomass and abundance showed peaks in 1984, 1991 and 1999, and their lowest estimates were observed in 1987 and 1995.

Red king crab (*Paralithodes camtschatica*) was introduced to the Barents Sea in the 1960s. The stock is growing and expanding eastwards but more dominantly along the Norwegian coast westwards. Adult red king crabs are opportunistic omnivores..

The Barents Sea snow crab (*Chionoecetes opilio*) is a new invasive species. After the first crab recordings in the Barents Sea in 1996 reports from the bottom trawl fishery on by-catch of snow crab gradually increased. Since 2003 snow crab have been found in the stomachs of cod, haddock, catfishes and thorny skates that indicates that the crab abundance and settlement density substantially increased.

Human activity

The Barents Sea is strongly influenced by human activity; historically involving the fishing and hunting of marine mammals. More recently, human activities also involve transportation of goods, oil and gas, tourism and aquaculture. In the last years interest has increases on the evaluation of the most likely response of the Barents Sea ecosystem to the future climate changes due to anthropogenic effect on climate warming.

Fishing most probably is the largest human impact to the fish stocks in the Barents Sea, and thereby it impacts the functioning of the whole ecosystem. However, the observed variation in both fish species and ecosystem is also impacted by other effects such as climate and predation.

The most widespread gear used in the central Barents Sea is bottom trawl, but also long line and gillnets are used in the demersal fisheries. The pelagic fisheries use purse seine and pelagic trawl.

The Barents Sea remains relatively clean, however, when compared to marine areas in many industrialized parts of the world. Major sources of contaminants in the Barents Sea are natural processes, long-range transport, accidental releases from local activities, and ship fuel emissions.

Results of recent studies indicate low level of contaminants in the Barents Sea marine environment and confirm results of earlier studies on bottom sediments in the same areas. In the near-term, observed levels of contaminants in the marine environment should not have significant impact on commercially important stocks and on the Barents ecosystem as a whole.

Traditionally, fishing having been the most important and far-reaching human activity in the ecosystem has been given most of the attention with analyses of impacts and risks. This need has increased in importance as oil- and gas industries have begun to develop new off-shore fields in the Barents Sea, and ship transport of oil and gas from the region has increased exponentially over the last 5 years.

The Barents Sea is an important region for oil and gas development. Currently off-shore development is limited both in the Russian and Norwegian economic zones (to the Snøhvit field north of Hammerfest in the Norwegian zone) , but this will increase in the future as large oil, and especially gas, fields are being set in production. In Russia there are plans for the development of Stochkman, a large gas-field west of Novaya Zemlya. The environmental risk of oil and gas development in the region has been evaluated several times, and is a key environmental question facing the region.

Transport of oil and other petroleum products from ports and terminals in NW-Russia have been increasing steadily over the last decade. In 2002, about 4 million tons of Russian oil was exported along the Norwegian coast, in 2004, the volume reached almost 12 million and estimates show that in 2010, Russia may export up to 150 million of tons (Bambulyak, Frantsen, 2005). Therefore, this risk of a major accident with such a tanker is one of the largest environmental risks posed to the Barents Sea ecosystem.

1.2 State and expected situation of the ecosystem

1.2.1 Climate (Figures 1.2–1.6)

Athmospherical conditions

During winter and spring, the air temperature was warmer than normal, with maximum positive anomalies (6.0-7.0 °C) in the eastern Barents Sea in February and March. In April-September, the air temperature was generally close to the long-term means, with prevalence of small negative anomalies (<0.5 °C). In October-November, over most of the sea, the air temperature was, on average, 0.5-1.0 °C higher than normal; and in December, positive anomalies increased to 3.0-4.0 °C

Water temperature, salinity and oxygen saturation

In general the temperatures in the entire Barents Sea in2008 was still high (about 0.5-1.0°C above the long-term average), but lower that in 2007, which was among the warmest ever observed. A decreasing trend in the anomalies from the beginning of the year until the autumn, was followed by a slight increase towards the end of 2008. In the beginning of 2009 the temperature was again decreasing towards a medium high level.

The Sea surface temperature (SST) shows much of the same variations as the air temperatures. Sea surface temperature (SST) was slightly above normal most of 2008 year, and close to the long-term mean in the beginning of 2009. . During winter SST was higher-than-normal, with maximum anomalies of 1.2-1.4 °C in the eastern areas. During spring, positive anomalies of SST decreased to 0.3-0.7 °C in the eastern Barents Sea; whereas negative anomalies of SST (0.2-0.3 °C) dominated in the western sea. During summer and autumn, SST anomalies decreased in most of the Barents Sea; on the whole, SST was near normal, with small (0.2-0.4 °C) negative anomalies. During October-December, positive anomalies of SST were observed in most of the sea; maximum anomalies (up to 1.0 °C) were found in the eastern

In the coastal water the temperature was following the pattern of the SST. In the beginning of the year the temperature anomalies were above average. In spring 2008 they decreased towards the long-term mean in the summer, while in fall 2008 and early winter 2009 they were above the long-term mean.

The Fugløya-Bear Island Section, which capture all the Atlantic Water entering the Barents Sea from south-west, showed temperatures of 0.8-1.0 °C above the long-term mean in early 2008 (Figure 1.2). Further east along the 31°13' E longitude, at the Vardø-North Section, the temperature during late winter was 1.5 °C above the long-term mean, which is an all time high since the time series started in 1977. In August 2008 the temperature in south-west was only 0.5 °C above the long-term mean (Figure 1.2). The strong temperature decrease during the year, caused 2008 as a whole to be colder than the previous two years even though it started out with a new record-high temperature. The salinity variations are similar to those in temperature, and the salinity is still high but decreasing since 2006.

At the Kola Section temperature was higher than the long-term mean during most of the year (Figure 1.3). At the beginning of the year, the weaker-than-usual seasonal cooling caused an increase in positive temperature anomalies in the Atlantic Waters compared to December. The temperature anomalies exceeded 1.0 °C through April, and in separate months they reached maximum for the period from 1951-present. During spring and summer temperature anomalies decreased, and in August-September temperatures were near normal with anomalies that did not exceeded 0.2 °C (Figure 1.3). The salinity was typical for warm years. Negative salinity anomalies were observed during winter; in the second half of the year, some increase in salinity anomalies took place

The temperature in the bottom layer in August-September 2008 corresponded to the temperatures of warm years for most of the Barents Sea, and was close to those of 2007. Positive temperature anomalies were, on average, 0.5-1.5 °C; maximum anomalies (above 1.5 °C) were found in the north-eastern Barents Sea (Figure 1.4). Only minor areas of slightly negative anomalies were found in the northwest and southeast.

Since 2002, there has been a gradual increase in oxygen saturation of the bottom layers in the southern Barents Sea, – and this continued in 2008. The oxygen saturation anomaly in the bottom layer was 0.65 % during the first nine months of 2008, while during the same period in 2007 the anomaly was 0.14 %.

Prediction of temperature in the ocean is complicated by the variation being governed by processes of both external and local origin operating on different time scales. Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered. Advection may be considered a natural starting point for predicting Barents Sea temperatures, and temperature variations in the southern Norwegian Sea has often been seen 2-3 years later in the Barents Sea. In the last years this relation has been weaker than normal because the local cooling taking place in the Barents Sea during winter has been less than ususal. However, as the climate of the Barents Sea has a cyclic variation of 5-7 years and most time series now show a decrease since 2006, the temperatures are expected to decrease in 2009 compared to 2008.

According to computation by a prediction model (Boitsov and Karsakov, 2005), based on harmonic analysis of the Kola Section temperature time series, the temperature of Atlantic water in the Murman Current in 2009-2010 is expected to decrease from the anomalous warm year of 2008 (4.7°C) to the warm year of 2009 (4.3 °C), and to the normal year of 2010 (4.1 °C).

Inflow of Atlantic water

The temperature and the volume flux of the inflowing Atlantic Water in the Fugløya-Bear Island Section do not always vary in phase. The temperature is mainly determined by variations upstream in the Norwegian Sea, while the volume flux to a large degree varies with the wind conditions in the western Barents Sea. The volume flux varies with periods of several years, and was significantly lower during 1997-2002 than during 2003-2006 (Figure 1.5). The year of 2006 was a special year as the volume flux both had a maximum (in winter 2006) and minimum (in fall 2006). Since then the inflow has been low, particularly during spring and summer. The inflow in 2008 was much as in 2007; moderate during winter followed by a strong decrease in spring. In early summer 2008 the flux was close to the average. As the observational series still only have data until summer 2008, it cannot give information about the situation in fall 2008 and early winter 2009.

Monthly wind-driven and total volume fluxes and their anomalies were calculated with a numerical model (Trofimov, 2000) for the main currents of the Barents Sea in 2008. In 2008, on the whole, the wind-driven circulation in the Barents Sea increased the general circulation during winter, and decreased it from mid-spring through summer.

Ice conditions

Throughout most of the year of 2008, the sea ice extent was less than normal, but more than in 2007. In comparison with the previous year, the ice coverage (expressed as a percentage of the sea area) was 2-6 % more in January-March and twice as much by June. In May, a polynya started to form south of the Franz Josef Land archipelago and in July the ice massif was finally broken. Come September, the area near Franz Josef Land was ice-free and the main ice massif was in the north-western Barents Sea near the east coast of the Spitsbergen archipelago. Ice formation started in the northernmost sea in October. By the end of the year the ice coverage of the Barents Sea was 5-12 % less than normal and 13-19 % more than in 2007 (Figure 1.6).

Due to the decreasing temperatures and the extreme ice minimum the recent years, the ice cover is expected to increase although it is likely to still be below the long-term mean.

1.2.2 Phytoplankton

There was no new information about phytoplankton in 2008, or for expectations in 2009.

1.2.3 Zooplankton (Figures 1.7 and 1.9)

The zooplankton biomass measured in August–September 2008 decreased compared to 2007. However, unlike last year the plankton samples were not collected in the northeastern areas, where in 2007 were observed high zooplankton concentrations (Figure 1.7).

The macroplankton survey conducted in autumn and winter 2008 showed that the abundance indeceses of euphausiids was close to the identical ones in 2007 and slightly above than the long-term mean (Figure 1.9). Similar to previous years, the main concentrations of euphausiids were formed by Arcto-boreal species *T. inermis* and *T. raschii*; samples included euphausiids of the three age groups (0+, 1+ and 2+).

It is expected that the zooplankton situation in 2009 will be similar to 2008, concerning feeding conditions for planktivorous fish.

1.2.4 Northern shrimp

The 2008 stock assessment (ICES) indicated that the stock has been exploited in a sustainable manner and has remained well above the precautionary reference limit throughout the history of the fishery. The advised TAC (quota) for 2009 is 50 000 tonnes. Indices of stock size have increased from 2004 to 2006, but decreased again from 2006 to 2008. Estimated numbers of small shrimp decreased since 2004, which may result in reduced recruitment to the fishery in 2009.

1.2.5 Fish (Tables 1.3 – 1.6)

The current and expected situation of the commercial stocks in the Barents Sea addressed by the AFWG is given in later chapters. Therefore focus in this subchapter is on other main species that interacts with the AFWG stocks, and on the role of the AFWG species in an ecosystem perspective (e.g. as predators). Special attention is given when there are deviations from the general situation.

NEA cod consumption

Food composition of cod in 1984-2008 is presented in Table 1.3-Table 1.4. According to joint cod stomach base data the main prey items for cod in 2007 were capelin, haddock, polar cod, kril and shrimp. In comparison with 2007 the importance of herring, and hyperiids has decreased, while the role of capelin and polar cod have increased.

The consumption calculations made by IMR show that the total consumption by age 1 and older cod in 2008 was 6 million tonnes (Table 1.3), while similar calculations by PINRO (Table 1.4) gave about 4.5 million tonnes. According to the calculation by IMR and PINRO the consumption per cod in comparison with 2007 decreased for the young age groups (1 – 5 year old) (

Table 1.5 and 1.6) but increased for the old age groups (6 year and older).

Abundance of blue whiting and polar cod

Based on the most recent estimates of fishing mortality and SSB, ICES classifies the blue whiting stock as having full reproductive capacity, but being harvested at increased risk. SSB increased to a historical high in 2003 but has decreased since then and is expected to be just above B_{pa} (2.25 million tonnes) in 2009.

The high abundance of blue whiting in the Barents Sea from 2003 was probably caused by a combination of a large stock and to increased temperatures in the Barents Sea. Blue whiting has been observed in the western and southern Barents Sea for many years, but never in such high quantities and never as far east and north in this area as in 2003-2007. In autumn 2007, the acoustic abundance of blue whiting had decreased to 0.7 million tonnes, and in 2008 to less than 0.1 million tonnes. In recent years, 1-group blue whiting was hardly found in the Barents Sea. Thus, the abundance of blue whiting is expected to decline further in 2009, unless there is recruitment from the 2008 year class into this area. This is rather unlikely since the recruitment of blue whiting has shown a declining trend in recent years.

The polar cod stock is presently at a high level. The stock size has been measured acoustically since 1986 and the stock has fluctuated between 0.1-1.9 million tonnes. In 2008, the stock size was measured to about 1.2 million tonnes, which is equal to the estimate from 2007.

The natural mortality rate in this stock seems to be very high, and this is explained by the importance of polar cod as prey for cod and seals.

Abundance of herring and capelin

Based on the most recent estimates of SSB and recruitment ICES classifies the capelin stock as having full reproductive capacity. The maturing component in autumn 2008 was estimated to be 2.5 mill tonnes. The SSB in April 2009 is predicted to be at 0.82 mill tonnes. The spawning stock in 2009 will consist of fish from the 2005 and 2006 year classes, but the 2006 year class will dominate. The survey estimate at age 1 of the 2007 year class is above the long-term average. Observations during the international 0-group survey in August-September 2008 indicated that the size of the 2008 year class is very strong.

Based on the most recent estimates of SSB and fishing mortality, ICES classifies the herring stock as having full reproductive capacity and being harvested sustainably. The spawning stock is estimated to be well above B_{pa} and near the highest in the recent time-series. The 1998, 1999 and 2002 year classes dominate the current spawning stock which is estimated to 11.9 million t in 2008. The 2004 year class is also estimated to be strong. Parts of this year class were still found in the Barents Sea in autumn 2008, but will probably leave the Barents Sea in the near future. Preliminary indications show that the year classes 2005-2007 are below average. Therefore the abundance of herring in the Barents Sea is believed to be at a relatively low level in 2009.

Non-commercial species

Thorny skate *(Amblyraja radiata)* was quite widely distributed in the Barents Sea excluding south eastern and north eastern regions. The distribution was similar and the abundance was higher than in 2007.

Norway pout (*Trisopterus esmarkii)* was distributed mainly in the south western part of the Barents Sea. Distribution area was near the same as in 2007, but the abundance was much higher.

Snake pipefish were first registered in the Barents Sea ecosystem survey in 2005. In 2006 and 2007 the intrusion into the Barents Sea expanded north to 81°N and east to 35°E. In 2008 the distribution area and abundance of snake pipefish significantly decreased again.

Two rare species were observed during the Barents Sea ecosystem survey for the first time in 2008. One speciement of Deal fish (*Trachipterus arcticus*), which is more typical for southern part of the Norwegian Sea, and three specimens of Polar plaice (*Pleuronectes glacialis*), which is more often found in Arctic areas.

1.2.6 Marine mammals (Figures 1.13–1.14)

Distribution and abundance

In 2008, observations from 12 marine mammal species were recorded by observers during the ecosystem survey. The most abundant cetacean in terms of individuals was the white-beaked dolphin, which was observed over large parts of the Barents Sea (Figure 1.13). Barents Sea sighting surveys conducted during the last 5 years, suggest that the distribution and abundance of white-beaked dolphins seem to be quite stable. Compared to last year, more white-beaks were observed in the central areas, which may be a response to increasing capelin abundance. Being a coastal species, harbor porpoises are not well covered by the cruises in the Barents Sea. In 2008 less the observations of harbour porpoises were recorded (Figure 1.13).

Of the baleen whales, minke, humpback and fin whales were most numerous, and their distributions are shown in (Figure 1.14)**Error! Reference source not found.**. In comparison with last year more distribution of minke whales in the central and north parts of the Barents Sea were observed. Fin whales were distributed mainly in the Svalbard and Bear Island areas. Humpback whales were as in previous years observed in dense aggregations within their core area, along the shelf edge, and on the banks north and east of Bear Island. Humpback whales have the most stable distributions of the baleen whales.

The harp seals are occasionally observed in the Barents Sea, and that is not because they are rare. This numerous seal species is associated with sea ice, and is thus outside the survey areas for most vessels. Recently, its pup production has been in decline, dropping from over 300,000 in 1998-2003 to 123,000 in 2008 (ICES, 2008). The reasons for the decline are not known, but it has been suggested that factors such as climatic conditions altering the ice cover in the White Sea, industrial activity including shipping and pollution effects, competition for fish resources (particularly capelin declines) and hunting levels may have also contributed to the observed reductions (Chernook and Boltnev, 2008; Chernook et al., 2008; Shafikov, 2008; Vorontsova et al., 2008; Zabavnikov et al., 2008).

Predation by mammals

Analyses of consumptions by marine mammals in the Barents Sea for 2008 are not available.

1.2.7 Long-term trends

According to ACIA (ACIA 2005, Arctic Climate Impact Assessment) the air temperature in the world is on expected to increase by 1-2 °C during the next 100 years. An important assumption for this prediction is a continuing increase in the CO_2 outlet to the atmosphere at a rate giving a doubling of the CO_2 level in 100 year compared with today's level. For the Arctic region the effect is assumed to be higher, with air temperatures increasing between 2-7 °C. This is mainly associated with the connected retreat of the ice cover. In the summer the ice cover may disappear, but the effect in the winter is not expected to be so drastic. However, ice habitat species may suffer dramatically under such circumstances. In the Barents Sea the water temperature is expected to increase by 1-2 °C throughout the water column. The recently released IPCC4 (Intergovernmental Panel on Climate Change, 4th assessment report, IPCC 2007) report indicates that the temperature increase will be both higher and more rapid than the ACIA report conclude, and the human-induced warming of the Arctic is expected to be about twice as large as the global average warming. Even if drastic cuts are made in the CO2 emission the temperature is still expected to increase for the next 20-30 years.

The recent warming period in the North Atlantic region (including the Barents Sea) opens for the question about regime shifts in the ecosystem. The question if the ecosystem has reached a different state, which may be irreversible, or is just at a maximum in a natural cycle, is hard to evaluate. The whole ecosystem responds to long-term changes (e.g. temperature). A similar warming period took place in the 1930's, and only though little data are available for this period work is in progress to evaluate affects of this, which would be useful in evaluating the current situation. More knowledge is therefore needed before any conclusions on possible regime shifts can be drawn.

1.3 Impact of the fisheries on the ecosystem

1.3.1 General description of the fisheries and mixed fisheries (Tables 1.10-1.11, Figures 1.14-1.19)

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 2008, catches of nearly 900 thousand tonnes (provisional figures) are reported from the stocks of cod, haddock, saithe, redfish, and Greenland halibut, which is a decrease of 10% as compared to 2006. An additional catch of about 40 000 tonnes was taken from the stocks of wolfish and shrimp. The annual fishing mortalities F (the mortality rate is linked to the proportion of the population being fished by $1\text{-}e^{-F}$) for the assessed demersal fish stocks show large temporal variation within species and large differences across species from 0.1 (≈10% mortality) for some years for *Sebastes marinus* to above 1 (≈63% mortality) for some years for cod (Figure 1.14). The major pelagic stocks are capelin, herring, and polar cod. There was no fishery for capelin in the area in 2004-2008 due to the stock's poor condition, but in 2009 the stock is again sufficient sound to support a quota of 380 000 tonnes. Norwegian spring spawning herring is the largest stock inhabiting the Northeast Arctic with its spawning stock estimated to 12.6 million tonnes in 2009, and 1.5 million tonnes were fished from this stock in 2008. The highly migratory species blue whiting and mackerel extend their feeding migrations into this region, and in 2007 about 65 000 tonnes mackerel and 120 000 tonnes blue whiting were caught in the area, none of this, however, within the Barents Sea. Species with relatively small landings include salmon, Atlantic halibut, hake, pollack, whiting, Norway pout, anglerfish, lumpsucker, argentines, grenadiers, flatfishes, dogfishes, skates, crustaceans, and molluscs.

The most widespread gear used in the central Barents Sea is bottom trawl, but also long line and gillnets are used in the demersal fisheries. The pelagic fisheries use purse seine and pelagic trawl. Other gears more common along the coast include handline and Danish seine. Less frequently used gears are float line (used in a small but directed fishery for haddock along the coast of Finnmark, Norway) and various pots and traps for fish and crabs. The gears used vary with time, area and country, with Norway having the largest variety because of the coastal fishery. For Russia, the most common gear is trawl, but a longline fishery mainly directed at cod and wolffish is also present. 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 regulations differ among gears and species and may be different from country to country, and a non-exhaustive list as well as a description of the major fisheries in the Barents Sea by species can be found in Table 1.10.

Although the degree of mixing may be high, the effect of the fisheries varies among the species. More specifically, the coastal cod stock and the two redfish stocks (especially *S. marinus*) 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, and restrictions in gears). Successful management of an ecosystem includes being able to predict the effect on having a mixed fishery on the individual stocks, and ICES is requested to provide advice which is consistent across stocks for mixed fisheries. Work on incorporating mixed fishery effects in ICES advice is ongoing and various approaches have been evaluated (ICES 2006/ACFM:14). At present such approaches are largely missing due to a need for improving methodology combined with lack of necessary data. However, technical interactions between the fisheries can be explored by the correlation in fishing mortalities among species. The correlation in fishing mortality is positive for Northeast Arctic cod and coastal cod, and for haddock and coastal cod confirming the linkage in these fisheries (Figure 1.15). There is also a significant relationship between saithe and Greenland halibut although the linkage in these fisheries is believed to be low.

The relationships between the other fishing mortalities are scattered and inconclusive. In case of strong dependencies in fishing mortalities this method can in principle be used to produce consistent advice across species concerning fishing mortality and thus fishing effort. It is however too simple since this correlation is influenced by too many confounding factors whose effect cannot be removed without a detailed analysis of data with a higher resolution (e.g. saithe and Greenland halibut, Figure 1.15 and on e.g. changes in distribution of the stocks (ICES 2006/ACFM:14).

A further quantification of the degree of mixing and impact among species requires detailed information about the target species and mix per catch/landing and gear. Such data exist for some fleets (*e.g.* the trawler fleet), but is incomplete for other fleets. The composition of cod, haddock, saithe, Greenland halibut, *Sebastes marinus*, *Sebastes mentella* and other species caught by the Russian and Norwegian trawl fleet shows spatial differences in both catch compositions and catch sizes as well as large differences between the countries (Figure 1.16-1.19) shows the 2008 catches. For the catch distributions in 2005-2007, see previous years' report). In the northeastern part of the Barents Sea the major part of the Russian catches consists of cod, whereas the Norwegian catches include a large proportion of other species (mainly shrimp). In the most western part of the Barents Sea, the Norwegian catches consist of *Sebastes mentella* and Greenland halibut in addition to cod, whereas the Russian catches mainly consist of cod and haddock. The Norwegian trawl fishery along the Norwegian coast includes areas closer to the coast and is also more southerly distributed where saithe is the most dominant species in the catches.

Estimates of unreported catches of cod and haddock in 2002-2008 indicate that this is has been a considerable problem which now seems to be decreasing (section 0.5). A continuous control and surveillance of this problem is necessary. Discarding of cod and haddock (and in some years also 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 discards are scarce, but attempts to obtain better quantification are ongoing

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. In general, the response of benthic organisms to disturbance differs with substrate, depth, gear, and type of organism (Collie et al. 2000). Seabed characteristics from the Barents Sea are only scarcely known (Klages *et al*. 2004) and the lack of high-resolution (±100 m) maps of benthic habitats and biota is currently the most serious impediment to effective protection of vulnerable habitats from fishing activities (Hall 1999). An assessment of fishing intensity on fine spatial scales is critically important in evaluating the overall impact of fishing gear on different habitats and may be achieved, for example, by satellite tracking of fishing vessels (Jennings et al. 2000). The challenge for management is to determine levels of fishing that are sustainable and not degradable for benthic habitats in the long run.

The qualitative effects of trawling 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. Barents Sea hard bottom substrata, with associated attached large epifauna should therefore be identified.

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 2005). The impacts of experimental trawling have been studied on a high seas fishing ground in the Barents Sea (Kutti *et al*. 2005.) Trawling seems to affect the benthic assemblage mainly through resuspension of surface sediment and through relocation of shallow burrowing infaunal species to the surface of the seafloor.

Work is currently going on in the Arctic, also jointly between Norway and Russia, exploring the possibility of using pelagic trawls when targeting demersal fish. The purpose is to avoid impact on bottom fauna and to reduce the mixture of other species. It will be mandatory to use sorting grids to avoid catches of undersized fish.

Lost gears such as gillnets may continue to fish for a long time (ghost fishing). The catch 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 (Suuronen 2005; Broadhurst et al 2006; Ingólfsson et al 2007). 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 2005). 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. In this way there is an economic incentive for the fishermen, and where bird by-catch is a problem, the bird-scaring line is used without any forced regulation.

1.4 Management improvement issues (Tables 1.12–1.17, Figures 1.21–1.22)

1.4.1 Overview

The availability of necessary ecosystem information is only one of the needed items for implementation of an ecosystem approach to management. Another needed element is the development of appropriate methods and instruments for incorporation of ecosystem information into stock assessment and harvest control rules.

This section summarizes ecosystem information that has the potential of being implemented in, and therefore improves, the advice for sustainable fishery management.

Management of fisheries is always based on decision-making under levels of uncertainty. Incorporating data on ocean climate, lower trophic level bio-production, as well as species interactions on higher trophic levels in catch recommendations for target species, should reduce the uncertainty of scientific recommendations for sustainable harvest levels.

1.4.2 Multispecies models

Development of multispecies models designed to improve fisheries management in the Barents Sea based on species interactions started in the mid 1980s. The first models developed were MULTSPEC, AGGMULT and SYSTMOD in IMR and MSVPA in PINRO (Tjelmeland and Bogstad, 1998; Hamre and Hatlebakk, 1998, Korzhev and Dolgov, 1999). In total, these models contained the species cod, capelin, herring, haddock, polar cod, shrimp, harp seal and minke whale. Even though further development of these models has been discontinued, they serve as predecessors to newly developed models, such as EcoCod, Bifrost, Gadget and STOCOBAR. Benefits of multispecies models include: improved estimates of natural mortality and recruitment; better understanding of stock-recruit relationships and variability in growth rates; alternatives views on biological reference points. Brief descriptions of the multispecies models are given below.

A model comparison exercise will be conducted examining the similarities and differences in projected stock dynamics using the STOCOBAR and Gadget cod models. These models have different internal structure and formulation, but are both forward simulation models capable of producing medium or long term simulated populations. Projected populations for the two models will be compared under a range of different fishing and environmental scenarios, providing an insight into the uncertainty related to the choice of model structure. This uncertainty is difficult to assess, but is important in understanding the uncertainties around model results, especially in the context of the precautionary principal. Ignoring such structural factors will lead to any estimate of uncertainty being, at best, a lower bound. It is anticipated that the work will be completed before the next AFWG in 2010.

EcoCod

The development of this model started in 2005 as the main task in the first stage of the joint PINRO-IMR Programme on Estimation of Maximum Long-Term Yield of North-East Arctic cod, taking into account the effect of ecosystem factors. This 10-year research programme was initiated following a request from the Russian-Norwegian Fishery Commission (Filin and Tjelmeland, 2005). EcoCod is a stepwise extension of a single species model for cod (CodSim; Kovalev and Bogstad, 2005), where cod growth, maturation, cannibalism and recruitment is modeled in a multispecies setting. Preliminary sub-models for cod growth, fecundity and malformation of eggs have been implemented in EcoCod.

Bifrost

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

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

STOCOBAR

The STOCOBAR (STOck of COd in the BARents Sea) is a cod-ecosystem coupled model that describes stock dynamics of cod in the Barents Sea, taking into account trophic interactions and environmental influence (Filin, 2007). It is designed as a tool for prediction and exploration of cod stock development as well as for evaluation of harvest strategies and recovery plans under different ecosystem scenarios. The STOCOBAR is an age-structured, a single-area and a single-fleet model with one year time steps. It includes a cod as predator on up to eight prey items: capelin, shrimp, polar cod, herring, krill, haddock, own young and other food. Species structure of the model is not permanent and it can be reduced from seven-species version to a simple version, which includes cod and capelin only. Recruitment function is used for cod only. Stochastic nature of recruitment is realized by including residuals in the simulated data. Impact assessment of ecosystem factors on cod stock dynamics are based on «what if» scenarios. The first version of STOCOBAR was created at PINRO in 2001 and development of this model is continuing. The work on the development of the STOCOBAR model is part of the Barents Sea Case Study within the EU project UNCOVER (2006-2010) and the joint PINRO-IMR project (2004-2013) Optimal long-term harvest in the Barents Sea.

GADGET

A multi-species Gadget age-length structured model (www.hafro.is/gadget ; Begley and Howell, 2004, developed during the EU project dst^2 (2000-2003)), is being used for modeling the interactions between cod, herring, capelin and minke whale in the Barents Sea as part of the EU projects BECAUSE (2004-2007) and UNCOVER (2006-2010). This is a multi-area, multi-species model, focusing on predation interactions within the Barents Sea. The predator species are minke whale and cod, with capelin, immature cod, and juvenile herring as prey species. Krill is included as an exogenous food for minke whales (Lindstrøm et al. in prep.). The cod model employed is based on the model presented at AFWG each year.

The modeling approach taken has many similarities to the MULTSPEC approach (Bogstad et al., 1997). Work is ongoing to enhance the modeling of recruitment processes during the EU project UNCOVER. An FLR routine has been written that can run Gadget models as FLR Operating Models. It is intended to explore this further during the UNCOVER project. This also gives the possibility of using Gadget as an operating model to test the performance of various assessment programs under a range of scenarios. In addition the Gadget multi-species model is being developed to assess the likely impact on medium-term population dynamics of oil-spill induced larval mortalities.

1.4.3 Statistical models

Recruitment of commercial fish

Prediction of recruitment in fish stocks is essential for harvest prognosis stocks, both in a single-species and multi-species context. Traditionally, prediction methods have been based on spawning stock biomass and survey indices of juvenile fish and have not included effects of climate variability. Multiple linear regression models can be used to incorporate both climate and parental fish stock parameters. Especially interesting are the cases where there exists a time lag between the predictor and response variables. Such models for cod, which are available for AFWG are presented in section 1.4.5 (*Prediction of NEA cod recruitment).*

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. The relationship between weight- and length-at age shows that for a given length, weight-at-length is positively correlated with proportion mature-at-length for the period 1985-2001 (Marshall *et al*., 2004).

Estimates of weight-at-length were multiplied by the Russian liver condition index at length (Yaragina and Marshall, 2000) to derive estimates of liver weights in grams for cod at a standard length (see Marshall et al. 2004 for details of the calculation). This analysis indicated that for the period 1985-2001 there is a consistently significant, positive relationship between liver weight and proportion mature.

Condition of fish

Relative body condition (the quantity of stored energy) is an important tool in understanding demographic variation and the ability of a population to respond to environmental stressors, varying food availability and competition. A high-resolution database was used to examine causes of variation in the condition of North-east arctic cod for the period 1967–2004, over annual and monthly timescales. Temperature was shown to have a positive impact on condition at both inter- and intra-annual timescales. Interannually, temperature may affect stock distribution, in particular its overlap with the capelin stock. At shorter timescales it is likely that temperature directly affects the metabolism of the cod. Intra-annually, the quantity of capelin in cod stomachs positively affected cod condition in the current and the preceding month for all lengths of cod. This indicated a time lag between a change in food consumption and a subsequent change in condition, or 'latency'.

Results presented by Sandeman *et al.* (in press; WD18) point to the importance of the impact of varying temperature on condition. The effects of climate are likely to be particularly important where the species is close to its outer distribution area or where the animal is an ectotherm.

Growth of fish

Large interannual variations in growth rate are observed for all commercial fish species in the Barents Sea. The most important causes are temperature change, density dependence and changes in prey availability. Variation in growth rate can contribute substantially to variability in stock biomass and can have a large impact on reproductive output. Regressions of weight at age of cod on temperature, capelin and the cod stock itself are used in EcoCod model.

Growth of the youngest capelin is correlated with abundance of the smallest zooplankton, whereas growth of older capelin is more closely correlated with abundance of the larger zooplankton. The developed regression equations have low determination coefficient, and are therefore not presented here. However, they may prove useful in the future when further developed.

1.4.4 Consumption models

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

A bioenergetic approach (as is usually the case for marine mammals and seabirds as predators)

By combining data on stomach content weight with models for stomach evacuation rate, based on experiments.

As shown in Johannesen *et al*, WD 20, AFWG 2006 different methods of type 2 for calculation of cod consumption give significantly different results, and thus further work is needed.

1.4.5 Expected impact of ecosystem factors on stock dynamics (Tables 1.12–1.14, Figures 1.20–1.22)

STOCOBAR simulations of impact on cod from future climate change

The results of long-term simulations by STOCOBAR show that a rising of temperature in the Barents Sea by 1-4C° will lead to acceleration of cod growth and maturation rates. This will positively affect the general production of the cod stock. On the other side cannibalism of cod will also increase in response to expected warming in the Barents Sea, which will have a negative effect for cod recruitment and total abundance.

The summarized consequences of temperature increase in the Barents Sea for the cod stock and catches are presented in Figure 1.22. The harvest control rule for cod in the simulations correspondents to the management strategy which is based at the precautionary approach. The cod yield for the all temperature scenarios were calculated using existing values of the biological references points for the cod stock.

Prediction of NEA cod recruitment.

Several statistical models, which use multiple linear regressions, have been developed for recruitment of North East Arctic cod. All models try to predict recruitment at age 3 (at 1 January), as calculated from the VPA, with cannibalism included. This quantity is denoted as R3.

Stiansen et al. (2005) developed a model (JES1) with 2 year prediction possibility:

JES1: R3~ Temp(-3) + Age1(-2) + MatBio(-2)

JES2: R3~ Temp(-3) + Age2(-1) + MatBio(-2)

JES3: R3~ Temp(-3) + Age3(0) + MatBio(-2)

Temp is the Kola yearly temperature (0-200m), Age1 is the winter survey bottom trawl index for cod age 1, and MatBio the maturing biomass of capelin. The number in parenthesis is the time lag in years. Two other similar models (JES2, JES3) can be made by substituting the term Age1(-2) with Age2(-1) and Age3(0), respectively (winter survey bottom trawl index for cod age 2 and age 3, respectively), This gives 1 and 0 year predictions, respectively.

Svendsen et al. (2007) used a model (SV) based only data from the ROMS numerical hydro-dynamical model, with 3 year prognosis possibility:

SV: R3~ Phyto(-3) + Inflow(-3)

Where Phyto is the modelled phytoplankton production in the whole Barents Sea and Inflow is the modelled inflow through the western entrance to the Barents Sea in the autumn. The number in parenthesis is the time lag in years.

The recruitment model (TB) suggested by T. Bulgakova (AFWG 2005 WD14, WD9) is a modification of Ricker's model for stock-recruitment defined by:

TB: R3~ m(-3) exp[-SSB(-3) + N(-3)]

Where R3 is the number of age3 recruits for NEA cod, m is an index of population fecundity, SSB is the spawning stock biomass and N is equal to the numbers of months with positive temperature anomalies (TA) on the Kola Section in the birth year for the year class. The number in parenthesis is the time lag in years. For the years before 1998 TA was calculated relatively to monthly average for the period

1951-2000. For intervals after 1998, the TA was calculated with relatively linear trend in the temperature for the period 1998-present. The model was run using two time intervals (using cod year classes 1984-2000 and year classes 1984-2004) for estimationg the model coefficients.

Titov (AFWG 2005 WD16 and WD23) developed models with 1 to 4 year prediction possibility (TITOV1, TITOV2, TITOV3, TITOV4, respectively), based on the oxygen saturation at bottom layers of the Kola section stations 3-7 (OxSat), air temperature at the Murmansk station (Ta), water temperature: 3-7 stations of the Kola section (layer 0-200m) (Tw), ice coverage in the Barents Sea (I), spawning stock biomass (SSB), and the acoustic abundance of cod at age 1 and 2, derived from the joint winter Barents Sea acoustic survey:

TITOV0: $R3^1 \sim DOxSat^2(t-13) + DOxSat(t-13) + ITa(t-39) + CodA3(t+1) + Tw(t-17)$

TITOV1: $R3^1 \sim DOxSat^2(t-13) + DOxSat(t-13) + ITa(t-39) + CodA2(t-11) + Tw(t-17)$

TITOV2: $R3^2 \sim DOxSat^2(t-13) - DOxSat(t-13) + ITa(t-39) + CodA1(t-23) + Tw(t-17)$

TITOV3: $R3^3 \sim OxSat^2(t-44) + ITa(t-39) + lgCodC0(t-28)$

TITOV4: $R3^4 \sim OxSat^2(t-44) + ITa(t-39) + SSB(t-36)$

Where $DOxSat(t-13) \sim Exp(OxSat(t-13)) - OxSat(t-38)$, $ITa(t-39) \sim I(t-39) + Ta(t-44)$. The number in parenthesis is the time lag in months, relative to 1 January at age 3. The ITa index coincides in time with the increase of horizontal gradients of water temperatures in the area of the Polar Front (Titov, 2001). Some changes were brought in 2009 (AFWG 2009 WD 12). New equation (TITOV0) was added, 0-group abundance indices, corrected for capture efficiency (CodC0) was entered instead of former indices in TITOV3.

At AFWG 2008, Subbey et al. presented a comparative study (AFWG 2008 WD27) on the ability of the above proposed models in predicting stock recruitment for NEA cod (Age 3). The study adopted the VPA2007 estimates (number of recruits) as truth. In the first step, model parameters were estimated using data from 1985-1998. Time series of future predictions were generated by repeatedly updating the model parameters for each additional year after 1998, and generating recruitment prognosis for between one to four years after each update.

The resulting prognosis time series were then compared to the VPA2007 values in the period 1999-2006, and evaluated on the basis of fit and how well they follow the trend in the VPA values. The two parameters used in the evaluation were the variance of the prognoses relative to VPA2007 values between 1999 and 2006, and the correlation coefficient between the prognosis and the VPA2007 values in the same time interval. A high variance indicates the risk of a model to give unreasonable values (spikes) for some years. The correlation coefficient, on the other hand, quantifies how well the models follow trends in recruitment. Results of the comparative survey are presented in Table 1.14, where the variance and correlation coefficients are denoted by σ^2 and C, respectively. The designations TB, JES1, SV, TITOV1, TITOV2, TITOV3 and TITOV4 in Table 1.14 refer to models described above (JES2 and JES3 were not available for this comparison study).

It should be recalled that almost all of the models involved in this study have reported $R^2 > 0.6$ between the fitted model and the VPA2007. While a high R^2 value is indicative of the degree to which the model match the historical data (during parameter estimation), it is not a sufficient condition for good predictive ability. AFWG 2008 WD 27 showed that there were few models among the ensemble studied, which gave good indications to the trend and level in future fish recruitment in the retrospective projection runs.

The results in Figures 1.20-1.21 show prognosis for 1 and 2 years, where the hybrid model is an arithmetic mean of models with correlation coefficient greater than 0.5, calculated as described above. The graphs also show the official ICES prognosis (taken from earlier AFWG reports), as well as the VPA2007 values (considered as truth). The results indicate that more accurate prognosis are obtained by averaging over a selected number of such models with correlation coefficients greater than 0.5. The correlation coefficient limit of 0.5 is arbitrary, and a more robust averaging procedure (other than arithmetic) should be studied. Prognosis of all the models, including the hybrid is presented in Table 1.12. New comparison was not conducted for the 2009 assessment.

In the 2009 predictions the cod recruitment (section 3.7.1) the same models and calculation procedure were used for the hybrid model estimates as in last years' assessment. The VPA R3 estimate was taken from the final run of this years' assessment (section 3.5). For the 2009 prognoses the estimates of the hybrid model consist of the average of the estimates from Titov1, Titov3 and JES1. For the 2010 prognoses it was used the average of the estimates from Titov2, Titov 3 and JES1, and for the 2011 hybrid estimate only the Titov3 model was used. The result is shown in Table 1.12.

Cannibalism mortality for cod

Table 1.13 shows the proportion of cod in the cod diet for the period 1984-2008, by predator age and year. This proportion increases by predator age.

An alternative approach for prediction of NEA cod cannibalism based on the linear relationship between the natural mortality of cod at ages 3-5 and the biomass of cod spawning stock with minus 3-year lag was proposed by Kovalev (2004). Using this approach the predicted natural mortality coefficient for cod including cannibalism for resent years seems to be higher compared to "the standard" assessment and prediction (section 3.7.1). Because the mechanisms 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 1.15 shows the proportion of cod in the cod diet, by predator age and year. This proportion increases by predator age. Values for the years 2009 to 2011, predicted by the regression, are given in the Table 1.15.

1.4.6 Fishery induced evolution

There is a vital need for the fisheries science community to maintain sustainable fisheries ensuring the effective conservation, management and development of living aquatic resources. The precautionary approach was proclaimed and applied within the ICES community to meet (promote) these aims. This approach takes into account uncertainties relating to the size and productivity of the stocks. Uncertainties relating to fisheries induced evolution are most likely taken into consideration in case of a proper implementation of precautionary approach into responsible fishery.

The Study Group on Fisheries Induced Adaptive Change (SGFIAC) proposed to create evolutionary impact assessment (EvoIA), quantifying the evolutionary effects of management measures (ICES, 2008). It is a very complicated but promising task given that commercial fishery could act as a selective factor resulting in evolutionary response of exploited populations.

The papers published by the SGFIAC Group members concern basically probabilistic maturation reaction norms (PMRNs) estimations for different commercial stocks/species, and shift in cohort-specific PMRNs interpreted as a genetic change at the population level. It is rather difficult to test that findings directly as the genes associated with maturation have a polygenic nature. The strength and weakness of the PMRNs approach were discussed in detail in Theme Session issue of the Marine ecology progress series, 2007, vol. 335, 249- 310.

North east arctic cod stock demonstrates long-term trends in maturation as well as in demography of the stock and weight at length of fish. The historical trends could be caused both by genetic and plastic effects on maturation. Population density factors and environmental conditions can contribute to feeding success resulting in changing maturation rates in NEA cod for the time period investigated (Marshall, McAdam, 2007; Kovalev, Yaragina, in press). The causes in a discontinuity of the decreasing trend observed in length for 50% maturation probability in the beginning of the 80's are unknown, but they are most likely non-genetic given that they occurred synchronously across age-classes (Marshall and McAdam, 2007).

More research is needed to evaluate underlined mechanisms of population changes including biological, physiological, ecological studies, not to mention genetic ones.

It takes a lot of time and efforts for the ICES community to implement the precautionary approach into a scientific/management practice. It is likely to take some time before the SGFIAC can evaluate and present some results applicable to test on real management measures recommendations. AFWG considers it premature at present to discuss any proposals of management measures (or reference points for fisheries management) in terms of fisheries induced evolution. Dialogues with scientists of the mentioned WG could also be carried out through the ICES Sharepoint.

1.5 Monitoring of the ecosystem

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

1.5.1 Standard sections and fixed stations (Figure 1.23, Table 1.16)

Some of the longest ocean time series in the world are along standard sections (Figure 1.23) in the Barents Sea. The monitoring of basic oceanographic variables for most of the sections goes back 30-50 years, with the longest time series stretching over one century. In the last decades also zooplankton is sampled at some of these sections. An overview of length, observation frequency and present measured variables for the standard sections in the Barents Sea is given in Table 1.16.

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

1.5.2 Area coverage (Table 1.17)

Area surveys are conducted throughout the year. The number of vessels in each survey differs, not only between surveys but may also change from year to year for the same survey. However, most surveys are conducted with only one vessel. It is not possible to measure all ecosystem components during each survey. Effort is always put on measuring as many parameters as possible on each survey, but available time put restrictions on what is possible to accomplish. Also, an investigation should not take too long time in order to give a synoptic picture of the conditions. Therefore the surveys must focus on a specific set of parameters/species. Other measured parameters may therefore not have optimal coverage and thereby increased uncertainty, but will still give important information. An overview of the measured parameters/species on each main survey is given in Table 1.17. Specific considerations for the most important surveys are giving in the following text.

Norwegian/Russian winter survey

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

Lofoten survey

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

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

Norwegian coastal surveys

In 1985-2002 a Norwegian acoustic survey specially designed for saithe was conducted annually in October-November (Nedreaas 1998). The survey covered the near coastal banks from the Varangerfjord close to the Russian border and southwards to 62° N. The whole area has been covered since 1992, and the major parts since 1988. The aim of conducting an acoustic survey targeting Northeast Arctic saithe was to support the stock assessment with fishery-independent data of the abundance of the youngest saithe. The survey mainly covered the grounds where the trawl fishery takes place, normally dominated by 3 - 5(6) year old fish. 2-year-old saithe, mainly inhabiting the fjords and more coastal areas, were also represented in the survey, although highly variable from year to year. In 1995-2002 a Norwegian acoustic survey for coastal cod was conducted along the coast and in the fjords from Varanger to Stad in September, just prior to the saithe survey described above. This survey covered coastal areas not included in the regular saithe survey. Autumn 2003 the saithe- and coastal cod surveys were combined.

Joint ecosystem autumn survey

The survey is carried out from early August to early October, and covers the whole Barents Sea. Five vessels are normally applied, three Norwegian and two Russian. Most aspects of the ecosystem are covered, from physical and chemical oceanography, primary and secondary production, fish (both young and adult stages), sea mammals, benthos and birds. Many kinds of methods and gears are used, from water sampling, plankton nets, pelagic and demersal trawls, grabs and sledges, acoustics, directs observations (birds and sea mammals). The survey has developed from joint surveys on 0-group, capelin and juvenile Greenland halibut, through general acoustic surveys including observations of physical oceanography and plankton, gradually developing into the ecosystem survey carried out in recent years. The predecessor of the survey dates back to 1972 and has been carried out every fall since. In 2009 only parts of this survey is planned be conducted, covering the O-group and capelin parts. Therefore, it cannot be considered a full ecosystem survey this year. Also, the future of this survey in undetermined.

Russian Autumn-winter trawl-acoustic survey

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

Norwegian Greenland halibut survey

The survey is carried out in August, and cover the continental slope from 68 to 80ºN, in depths of 400–1500 m north of 70º30'N, and 400–1000 m south of this latitude. This survey was run the first time in 1994, and is now part of the Norwegian Combined survey index for Greenland halibut.

Russian young herring survey

This survey is conducted in May and takes 2-3 weeks. It is including also observations of physical oceanography and plankton. In 1991-1995 it was joint survey, since1996 the survey is carrying out by PINRO.

1.5.3 Other information sources

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

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

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

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

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

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

1.6 Main conclusions

State and expected situation in the ecosystem (section 1.2)

Climate

- The air temperature was above the long-term mean during 2008..
- The sea temperature in the Barents Sea is still high, but lower than in 2007, and are still expected to decrease towards the long-term mean during 2009.
- Salinity is still high but decreasing since 2006
- Inflow of Atlantic waters at the western entrance was low in 2008
- Oxygen levels were about normal in 2008.
- Ice extent in 2008 was less than normal, but more than in 2007. The ice cover is expected to increase in 2009 but still be below the long-term mean..

Plankton and northern shrimp

- The mesozooplankton biomass measured in August–September 2008 was some less compared to 2007
- The zooplankton biomass measured in August–September 2008 was some less compared to 2007. Abundance indices of euphausiids in the end of 2008 were close to the identical ones in 2007 and slightly above than the long-term mean.
- As in previous years *Calanus finmarchicus* was the dominant species in mesoplankton and *T. inermis* and *T. raschii* formed the main concentrations of krill.
- The shrimp stock in the Barents Sea and Spitsbergen area in 2008 decreased compared to 2007 but is still at a long-term mean level.

Fish

- The Capelin have recovered to a medium level in 2008. The size of 2007 year class is above the long-term average, and the 0-group seems to be strong.

- Young herring was at medium low level in 2007 in the Barents Sea. However, the rest of the strong 2004 year class will probably leave the Barents Sea in 2009. Preliminary indications show that the year classes 2005-2007 are below average. Therefore the abundance of herring in the Barents Sea is believed to be at a relatively low level in 2009.
- Blue whiting had strongly declined in 2008, and are at a very low level. The abundance is expected to remain low in 2009.
- The polar cod stock is presently at a high level

Mammals

- In 2008 the most abundant and widely distributed cetaceans were white-beaked dolphins, minke whales fin whales and humpback whales, while harbour porpoises were abundant along the coast.
- The distributions of prey species, first of all capelin, are likely mainly to have influenced the marine mammal distributions in 2008 in the Barents Sea.
- There are evidences on decrease in harp seal pups production in the White Sea, and in the total abundance of this population during the last years.

Impact of fisheries on the ecosystem (section 1.3)

- The most widespread gear is trawl.
- The demersal fisheries are mixed, and currently have largest effect on coastal cod and redfish due to the poor condition of these stocks.
- The pelagic fisheries are less mixed, and are weakly linked to the demersal fisheries (however, by-catches of young pelagic stages of demersal species have been reported in some pelagic fisheries)
- Trawling has largest effect on hard bottom habitats; whereas the effects on other habitats are not clear and consistent.
- Work is currently going on exploring the possibility of using pelagic trawls when targeting demersal fish. The purpose is to avoid impact on bottom fauna and to reduce the mixture of other species. It will be mandatory to use sorting grids to avoid catches of undersized fish.
- Fishery induced mortality (lost gillnets, contact with active fishing gears, etc.) on fish is a potential problem but not quantified at present.

Management improvement issues (section 1.4)

- Several methods, which take ecosystem information into account, are presently under development. These methods should in the future be valuable for the improvement of the stock assessment and advice.
- Model analysis (STOCOBAR) show that a rising of temperature in the Barents Sea by 1-4 C° will lead to an increase in cod stock production.
- The cod recruitment (age 3) in 2009 and 2010 are expected to be somewhat below the long-term mean, while it is expected to be well below the long-term mean in 2011.

1.7 Response to technical minutes

To review group

The review group (RG) suggested to have a continuum in the use of cod recruitment models, after the change from RCT3 to the hybrid model last assessment. Therefore, the hybrid recruitment model used in the projection of the NEA cod stock remained the same this year (contained the same basic models). However, the WG sees the need for a proper evaluation of the method. It is therefore suggested to form a special study group (SG) on this issues. The SG should evaluate, assess and possible improve the method for projection of age 3 cod in the AFWG assessment. Such a SG should take a broad approach, including all available models and preferably test other models also (including adding a temperature term to the RCT3 and weighting aspects). The SG should meet between AFWG meetings this or next year for a 2-3 days meeting.

Table 1.1. 0-group abundance indices (in millions) with 95% confidence limits, not corrected 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	197278	131674	262883	72	38	105	59	38	81	4	1	8	277873	0	701273
1981	123870	71852	175888	48	33	64	15	7	22	3	0	8	153279	0	363283
1982	168128	35275	300982	651	466	835	649	486	812	202	0	506	106140	63753	148528
1983	100042	56325	143759	3924	1749	6099	1356	904	1809	40557	19526	61589	172392	33352	311432
1984	68051	43308	92794	5284	2889	7679	1295	937	1653	6313	1930	10697	83182	36137	130227
1985	21267	1638	40896	15484	7603	23365	695	397	992	7237	646	13827	412777	40510	785044
1986	11409	98	22721	2054	1509	2599	592	367	817	7	0	15	91621	0	184194
1987	1209	435	1983	167	86	249	126	76	176	2	0	5	23747	12740	34755
1988	19624	3821	35427	507	296	718	387	157	618	8686	3325	14048	107027	23378	190675
1989	251485	201110	301861	717	404	1030	173	117	228	4196	1396	6996	16092	7589	24595
1990	36475	24372	48578	6612	3573	9651	1148	847	1450	9508	0	23943	94790	52658	136922
1991	57390	24772	90007	10874	7860	13888	3857	2907	4807	81175	43230	119121	41499	0	83751
1992	970	105	1835	44583	24730	64437	1617	1150	2083	37183	21675	52690	13782	0	36494
1993	330	125	534	38015	15944	60086	1502	911	2092	61508	2885	120131	5458	0	13543
1994	5386	0	10915	21677	11980	31375	1695	825	2566	14884	0	31270	52258	0	121547
1995	862	0	1812	74930	38459	111401	472	269	675	1308	434	2182	11816	3386	20246
1996	44268	22447	66089	66047	42607	89488	1049	782	1316	57169	28040	86299	28	8	47
1997	54802	22682	86922	67061	49487	84634	600	420	780	45808	21160	70455	132	0	272
1998	33841	21406	46277	7050	4209	9890	5964	3800	8128	79492	44207	114778	755	23	1487
1999	85306	45266	125346	1289	135	2442	1137	368	1906	15931	1632	30229	46	14	79
2000	39813	1069	78556	26177	14287	38068	2907	1851	3962	49614	3246	95982	7530	0	16826
2001	33646	0	85901	908	152	1663	1706	1113	2299	844	177	1511	6	1	10
2002	19426	10648	28205	19157	11015	27300	1843	1276	2410	23354	12144	34564	130	20	241
2003	94902	41128	148676	17304	10225	24383	7910	3757	12063	28579	15504	41653	216	0	495
2004	16701	2541	30862	19157	13987	24328	19144	12649	25638	133350	94873	171826	849	0	1766
2005	41808	12316	71300	21532	14732	28331	33283	24377	42190	26332	1132	51532	12332	631	24034
2006	166400	102749	230050	7860	3658	12061	11421	7553	15289	66819	22759	110880	20864	10057	31671
2007	157913	87370	228456	9707	5887	13527	2826	1787	3866	22481	4556	40405	159159	44882	273436
2008	284259	175817	392700	50265	30637	69893	2562	860	4265	15727	4306	27147	9364	0	19623
Mean	73685			18590			3724			28906			64660		

Table 1.1. (cont.). 0-group abundance indices (in millions) with 95% confidence limits, not corrected for catching efficiency.

Year	Saithe			Gr halibut			Long rough dab			Polar cod (east)			Polar cod (west)		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	3	0	6	111	35	187	1273	883	1664	28958	9784	48132	9650	0	20622
1981	0	0	0	74	46	101	556	300	813	595	226	963	5150	1956	8345
1982	143	0	371	39	11	68	1013	698	1328	1435	144	2725	1187	0	3298
1983	239	83	394	41	22	59	420	264	577	1246	0	2501	9693	0	20851
1984	1339	407	2271	31	18	45	60	43	77	127	0	303	3182	737	5628
1985	12	1	23	48	29	67	265	110	420	19220	4989	33451	809	0	1628
1986	1	0	2	112	60	164	6846	4941	8752	12938	2355	23521	2130	180	4081
1987	1	0	1	35	23	47	804	411	1197	7694	0	17552	74	31	117
1988	17	4	30	8	3	13	205	113	297	383	9	757	4634	0	9889
1989	1	0	3	1	0	3	180	100	260	199	0	423	18056	2182	33931
1990	11	2	20	1	0	2	55	26	84	399	129	669	31939	0	70847
1991	4	2	6	1	0	2	90	49	131	88292	39856	136727	38709	0	110568
1992	159	86	233	9	0	17	121	25	218	7539	0	15873	9978	1591	18365
1993	366	0	913	4	2	7	56	25	87	41207	0	96068	8254	1359	15148
1994	2	0	5	39	0	93	1696	1083	2309	267997	151917	384078	5455	0	12032
1995	148	68	229	15	5	24	229	39	419	1	0	2	25	1	49
1996	131	57	204	6	3	9	41	2	79	70134	43196	97072	4902	0	12235
1997	78	37	120	5	3	7	97	44	150	33580	18788	48371	7593	623	14563
1998	86	39	133	8	3	12	27	13	42	11223	6849	15597	10311	0	23358
1999	136	68	204	14	8	21	105	1	210	129980	82936	177023	2848	407	5288
2000	206	111	301	43	17	69	233	120	346	116121	67589	164652	22740	14924	30556
2001	20	0	46	51	20	83	162	78	246	3697	658	6736	13490	0	28796
2002	553	108	998	51	0	112	731	342	1121	96954	57530	136378	27753	4184	51322
2003	65	0	146	13	0	34	78	45	110	11211	6100	16323	1627	0	3643
2004	1395	860	1930	70	28	113	36	20	52	37156	19040	55271	367	125	610
2005	55	36	73	9	4	14	200	109	292	6540	3196	9884	3216	1269	5162
2006	142	60	224	11	1	20	710	437	983	26016	9996	42036	2078	464	3693
2007	51	6	96	1	1	0	262	45	478	25883	8494	43273	2532	0	5134
2008	43	21	65	6	0	13	941	399	1484	6649	845	12453	91	0	182
Mean	186			30			603			36323			8568		

Table 1.2. 0-group abundance indices (in millions) with 95% confidence limits, corrected for catching efficiency.

Year	Capelin			Cod			Haddock			Herring		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	740289	495187	985391	276	131	421	265	169	361	77	12	142
1981	477260	273493	681026	289	201	377	75	34	117	37	0	86
1982	599596	145299	1053893	3480	2540	4421	2927	2200	3655	2519	0	5992
1983	340200	191122	489278	19299	9538	29061	6217	3978	8456	195446	69415	321477
1984	275233	161408	389057	24326	14489	34164	5512	3981	7043	27354	3425	51284
1985	63771	5893	121648	66630	32914	100346	2457	1520	3393	20081	3933	36228
1986	41814	642	82986	10509	7719	13299	2579	1621	3537	93	27	160
1987	4032	1458	6607	1035	504	1565	708	432	984	49	0	111
1988	65127	12101	118153	2570	1519	3622	1661	630	2693	60782	20877	100687
1989	862394	690983	1033806	2775	1624	3925	650	448	852	17956	8252	27661
1990	115636	77306	153966	23593	13426	33759	3122	2318	3926	15172	0	36389
1991	169455	74078	264832	40631	29843	51419	13713	10530	16897	267644	107990	427299
1992	2337	250	4423	166276	92113	240438	4739	3217	6262	83909	48399	119419
1993	952	289	1616	133046	58312	207779	3785	2335	5236	291468	1429	581506
1994	13898	70	27725	70761	39933	101589	4470	2354	6586	103891	0	212765
1995	2869	0	6032	233885	114258	353512	1203	686	1720	11018	4409	17627
1996	136674	69801	203546	280916	188630	373203	2632	1999	3265	549608	256160	843055
1997	189372	80734	298011	294607	218967	370247	1983	1391	2575	463243	176669	749817
1998	113390	70516	156263	24951	15827	34076	14116	9524	18707	476065	277542	674589
1999	287760	143243	432278	4150	944	7355	2740	1018	4463	35932	13017	58848
2000	140837	6551	275123	108093	58416	157770	10906	6837	14975	469626	22507	916746
2001	90181	0	217345	4150	798	7502	4649	3189	6109	10008	2021	17996
2002	67130	36971	97288	76146	42253	110040	4381	2998	5764	151514	58954	244073
2003	340877	146178	535575	81977	47715	116240	30792	15352	46232	177676	52699	302653
2004	53950	11999	95900	65969	47743	84195	39303	26359	52246	773891	544964	1002819
2005	148466	51669	245263	72137	50662	93611	91606	67869	115343	125927	20407	231447
2006	515770	325776	705764	25061	11469	38653	28505	18754	38256	294649	102788	486511
2007	480069	272313	687825	42628	26652	58605	8401	5587	11214	144002	25099	262905
2008	979 481	616554	1342408	218851	127536	310166	9069	1339	16799	197166	65795	328537
Mean	252373			72380			10454			171269		

Table 1.2 (cont.). 0-group abundance indices (in millions) with 95% confidence limits, corrected for catching efficiency.

Year	Saithe			Polar cod (east)			Polar cod (west)		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	21	0	47	203226	69898	336554	82871	0	176632
1981	0	0	0	4882	1842	7922	46155	17810	74500
1982	296	0	699	1443	154	2731	10565	0	29314
1983	562	211	912	1246	0	2501	87272	0	190005
1984	2577	725	4430	871	0	2118	26316	6097	46534
1985	30	7	53	143257	39633	246881	6670	0	13613
1986	4	0	9	102869	16336	189403	18644	125	37164
1987	4	0	10	64171	0	144389	631	265	996
1988	32	11	52	2588	59	5117	41133	0	89068
1989	10	0	23	1391	0	2934	164058	15439	312678
1990	29	4	55	2862	879	4846	246819	0	545410
1991	9	4	14	823828	366924	1280732	281434	0	799822
1992	326	156	495	49757	0	104634	80747	12984	148509
1993	1033	0	2512	297397	0	690030	70019	12321	127716
1994	7	1	12	2139223	1230225	3048220	49237	0	109432
1995	415	196	634	6	0	14	195	0	390
1996	430	180	679	588020	368361	807678	46671	0	116324
1997	341	162	521	297828	164107	431550	62084	6037	118131
1998	182	91	272	96874	59118	134630	95609	0	220926
1999	275	139	411	1154149	728616	1579682	24015	3768	44262
2000	851	446	1256	916625	530966	1302284	190661	133249	248072
2001	47	0	106	29087	5648	52526	119023	0	252146
2002	2112	134	4090	829216	496352	1162079	215572	36403	394741
2003	286	0	631	82315	42707	121923	12998	0	30565
2004	4779	2810	6749	290686	147492	433879	2892	989	4796
2005	176	115	237	44663	22890	66436	25970	9987	41953
2006	280	116	443	182713	73645	291781	15965	3414	28517
2007	286	3	568	191111	57403	324819	22803	0	46521
2008	136	68	204	42657	5936	79377	616	23	1209
Mean	536			296033			70608		

Table 1.3. The North-east arctic cod stock's consumption of various prey species in 1984-2008 (1000 tonnes), based on Norwegian consumption calculations.

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Blue whiting	Long rough dab	Total
1984	479	27	113	436	722	78	15	22	50	364	0	0	24	2330
1985	1109	169	57	155	1619	183	3	32	47	225	0	1	41	3642
1986	601	1223	108	142	835	133	141	83	110	313	0	0	54	3744
1987	670	1084	67	191	229	32	205	25	4	324	1	0	9	2841
1988	400	1236	317	129	339	8	92	9	3	223	0	4	5	2766
1989	655	799	241	131	571	3	32	8	10	228	0	0	57	2736
1990	1337	137	83	194	1601	7	6	19	15	243	0	87	95	3825
1991	758	65	75	188	2888	8	12	26	20	311	7	10	270	4639
1992	907	102	158	373	2455	331	97	55	106	188	20	2	93	4885
1993	751	253	715	315	3033	163	278	285	71	100	2	2	26	5995
1994	625	563	704	518	1085	147	582	224	49	79	0	1	39	4615
1995	813	981	515	362	629	115	254	393	116	193	1	0	34	4406
1996	598	631	1157	340	538	47	104	536	69	96	0	10	34	4160
1997	443	381	519	315	907	5	112	338	41	36	0	33	14	3144
1998	411	363	456	325	715	87	152	155	33	9	0	13	15	2732
1999	380	146	273	252	1736	129	223	62	26	16	1	31	7	3283
2000	386	167	463	450	1726	53	194	76	51	8	0	38	18	3630
2001	684	171	373	276	1720	71	249	66	49	6	1	151	29	3845
2002	361	95	259	230	1923	85	269	107	123	1	0	224	15	3693
2003	540	278	519	237	2133	211	269	114	167	3	0	74	48	4592
2004	662	668	335	243	1276	195	332	121	191	3	12	74	61	4174
2005	660	390	493	256	1198	181	340	114	333	2	3	109	45	4125
2006	717	156	871	289	1424	192	108	67	341	14	1	116	88	4384
2007	1029	263	853	322	1669	244	154	89	332	34	0	38	58	5084
2008	1250	135	783	308	2349	105	446	202	310	53	11	28	94	6074

Table 1.4. The North-east arctic COD stock's consumption of various prey species in 1984-2008 (1000 tonnes), based on Russian consumption calculations.

Year	Euphausids	Hyperiids	Shrimp	Herring	Capelin	Polar cod	Cod	Haddock	Blue whiting	Norway pout	Redfish	Long rough dab	Greenland halibut	Other fish	Other food	Total consumption
1984	92,9	31,1	351,1	33,3	591,9	17,1	13,2	49,7	4,7	1,2	194,9	51,5	0,0	269,3	285,5	1987,3
1985	30,0	431,8	202,1	24,4	989,5	0,0	97,8	34,3	17,7	14,9	97,2	22,8	0,0	518,8	198,0	2679,3
1986	54,6	832,9	141,4	45,6	785,5	154,3	27,7	102,6	3,5	26,5	155,2	24,0	0,7	362,3	163,2	2880,0
1987	69,5	510,9	202,4	7,5	162,8	105,8	26,9	1,9	10,3	14,7	118,9	5,7	0,4	270,3	189,6	1697,6
1988	211,2	170,2	118,9	18,6	294,7	0,0	19,9	93,6	0,0	0,0	128,2	20,2	0,0	241,0	244,1	1560,6
1989	168,5	293,4	104,9	3,8	686,9	34,1	34,5	2,1	0,0	0,0	159,3	56,7	0,0	203,7	250,7	1998,6
1990	101,9	29,9	273,4	65,1	1268,5	7,6	21,7	16,6	39,6	14,8	234,8	79,5	0,0	102,3	168,4	2423,9
1991	54,9	84,4	289,6	28,4	3324,5	44,1	52,7	22,6	6,7	6,1	145,3	46,1	5,5	134,0	159,3	4404,3
1992	215,5	38,3	266,1	379,2	2043,1	192,3	84,8	38,1	0,0	77,6	122,2	44,0	0,8	297,7	422,8	4222,6
1993	188,1	176,5	223,3	178,6	2802,1	171,9	147,4	154,4	3,9	25,6	41,2	48,0	4,9	160,8	380,9	4707,8
1994	355,2	290,5	450,2	102,8	1281,9	468,0	367,7	70,0	1,2	1,3	56,1	40,2	0,1	95,2	344,1	3924,4
1995	377,8	436,9	523,5	188,3	663,0	183,9	528,3	126,3	0,3	0,6	111,4	52,3	2,5	146,5	343,2	3684,7
1996	942,8	349,8	191,5	75,2	460,0	73,1	440,9	58,0	8,3	35,7	70,4	46,7	0,1	459,2	164,6	3376,5
1997	386,4	84,9	206,5	49,4	497,5	109,6	408,9	33,6	2,9	0,1	36,6	33,2	1,7	96,1	399,4	2346,7
1998	598,6	186,8	244,4	66,0	798,6	121,8	126,8	21,7	23,3	18,2	15,2	18,5	0,0	50,2	213,8	2503,8
1999	454,0	75,2	239,7	73,8	1401,8	162,6	47,9	14,3	25,0	0,8	13,1	8,5	0,5	58,1	107,4	2682,8
2000	394,4	110,4	361,9	48,2	1652,6	156,0	56,4	28,3	26,1	8,1	4,2	20,1	0,1	35,1	179,5	3081,3
2001	366,0	71,0	296,2	87,4	1423,0	140,5	58,8	48,6	137,1	28,1	4,0	30,7	2,2	142,8	181,0	3017,5
2002	303,6	42,6	185,3	49,2	2218,4	278,3	92,0	75,9	102,6	3,5	3,5	16,4	0,0	40,8	165,1	3577,3
2003	228,6	137,1	205,0	140,5	1130,6	200,0	125,2	312,9	25,6	5,0	1,5	37,7	0,0	85,5	263,6	2898,9
2004	309,2	356,6	228,2	116,3	997,3	334,9	80,4	151,0	47,3	19,4	6,7	58,1	14,6	168,9	253,4	3142,4
2005	487,5	122,8	205,9	154,4	872,6	292,2	109,1	255,9	62,5	39,4	6,9	43,1	2,1	145,1	187,0	2986,5
2006	714,5	49,1	168,3	205,2	993,4	89,4	81,9	228,7	85,9	69,3	13,8	79,4	0,4	72,5	265,1	3116,7
2007	543,2	103,4	183,8	195,1	950,6	155,8	50,5	222,7	23,6	13,6	15,1	43,8	0,5	133,1	239,1	2873,9
2008	541.7	31.1	199.1	88.1	2043.6	424.5	111.1	277.5	14.0	13.6	37.0	91.2	10.7	254.9	356.3	4494.5
Mean	327.6	201.9	242.5	97.0	1213.4	156.7	128.5	97.6	26.9	17.5	71.7	40.7	1.9	181.8	245.0	3050.8

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	1,684	2,513	3,948	5,203	7,973	8,486	9,139	9,867	9,941
1985	0,304	0,761	1,829	3,101	4,671	7,357	11,172	11,892	12,416	13,660	13,773
1986	0,160	0,488	1,347	3,158	5,604	6,834	10,989	11,899	12,701	13,461	13,694
1987	0,219	0,601	1,275	2,055	3,537	5,457	7,044	8,111	8,922	9,343	9,295
1988	0,164	0,703	1,149	2,148	3,744	5,875	10,096	11,218	12,570	13,122	13,345
1989	0,223	0,716	1,606	2,705	3,973	5,601	7,648	8,464	9,559	10,156	10,599
1990	0,358	0,905	1,889	3,027	4,156	5,323	6,251	6,668	6,700	7,045	7,680
1991	0,293	0,969	2,168	3,500	5,281	7,026	9,392	10,154	11,200	12,239	11,886
1992	0,215	0,663	2,095	3,133	4,142	5,093	7,832	8,965	9,352	10,071	10,117
1993	0,112	0,528	1,546	3,044	4,809	6,285	9,421	11,239	11,763	12,253	12,876
1994	0,130	0,408	0,922	2,521	3,504	4,511	6,396	8,846	9,672	9,977	10,176
1995	0,103	0,296	0,921	1,820	3,361	5,252	7,697	10,405	12,333	12,734	13,181
1996	0,108	0,356	0,929	1,847	3,068	4,429	7,381	11,143	14,702	14,876	15,265
1997	0,140	0,319	0,940	1,768	2,710	3,536	5,253	8,149	12,582	13,484	13,091
1998	0,117	0,397	0,983	1,942	2,923	4,186	5,746	8,061	11,339	11,850	11,898
1999	0,163	0,505	1,093	2,717	3,717	5,442	6,965	9,179	11,004	12,007	12,107
2000	0,170	0,499	1,243	2,461	4,252	5,651	7,951	9,364	12,485	13,258	13,296
2001	0,171	0,456	1,309	2,439	3,682	5,294	7,523	11,085	13,422	14,117	14,436
2002	0,199	0,551	1,167	2,441	3,380	4,719	6,357	9,039	10,224	11,538	10,910
2003	0,207	0,653	1,312	2,390	3,995	5,946	8,411	10,405	12,786	13,397	14,335
2004	0,194	0,474	1,280	2,529	3,882	5,588	7,323	11,213	16,665	18,557	18,011
2005	0,194	0,653	1,376	2,592	3,918	5,588	7,182	9,771	13,090	14,012	14,797
2006	0,181	0,595	1,589	2,796	4,185	5,870	7,482	11,255	13,695	14,692	15,625
2007	0,213	0,618	1,719	3,213	4,707	6,062	7,860	9,620	12,666	13,251	13,873
2008	0.205	0.660	1.476	2.981	4.301	6.286	8.012	10.793	14.015	14.697	15.385

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	16.511
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	17.643
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	14.97	19.294	17.509	20.109	22.109
1992	0.178	0.969	2.475	2.866	3.995	5.138	6.724	7.414	8.754	12.304	13.518	13.744	14.908
1993	0.133	0.476	1.512	2.865	3.944	5.108	7.372	8.945	10.343	11.600	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	1.801	3.204	4.847	7.332	9.688	13.835	15.247	16.960	18.230	19.202
1996	0.170	0.498	1.028	1.916	3.059	4.189	6.987	10.212	12.185	13.614	14.581	16.214	16.876
1997	0.119	0.341	0.992	1.908	2.668	3.503	4.954	7.980	12.174	21.523	20.666	21.822	24.237
1998	0.232	0.528	1.081	2.016	2.823	4.089	5.469	7.346	9.586	13.012	14.455	15.579	16.201
1999	0.261	0.431	1.128	2.490	3.676	5.222	6.398	8.220	9.194	13.364	15.325	16.918	17.567
2000	0.186	0.545	1.288	2.551	4.387	6.559	8.833	10.483	11.522	15.132	17.155	19.717	20.514
2001	0.150	0.413	1.163	2.110	3.43	5.571	6.835	10.233	12.457	15.130	17.374	19.322	20.559
2002	0.252	0.677	1.303	2.699	3.847	5.591	7.846	10.796	13.238	18.787	17.902	20.202	21.027
2003	0.228	0.618	1.296	2.028	3.547	4.716	6.684	8.905	13.418	14.492	19.540	19.239	20.036
2004	0.250	0.654	1.412	2.567	3.857	5.660	7.730	11.126	15.907	20.770	21.687	24.852	25.892
2005	0.255	0.687	1.514	2.504	3.896	5.264	7.192	9.395	13.163	15.981	22.656	23.387	24.181
2006	0.354	0.921	1.833	2.763	3.986	5.317	7.396	10,202	12.762	16.462	21.563	25.940	26.875
2007	0.234	0.666	1.870	3.018	4.295	5.810	7.444	9.017	11.754	15.961	20.903	25.154	26.064
2008	0.223	0.706	1.641	2.881	4.071	6.006	7.705	10.317	13.471	17.596	22.968	27.431	27.328

Table 1.7. Capelin stock history from 1973-present and prognosis for capelin biomass in 2009. M output biomass is the estimated biomass of 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	3195
2004	82	628	293	812
2005	42	324	174	817
2006	88	787	437	733
2007	280	1885	836	2033
2008	570	4426	2468	3285
2009*		5080	1600	

*** Prognosis, includes the 2008 year class, which size is estimated from a regression on an 0-group index**

Table 1.8. Diet composition of main fish species in 2005, % by weight (Data from Dolgov, WD 28 and WD 29, AFWG 2006)

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

Table 1.9. 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 1.10. 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 2007[A] (tonnes)	As by-catch in fleet(s)	Location	Agreements and regulations
Capelin	PS, TP	seasonal	4[B]	TR, TS	Northern coastal areas to south of 74°N	Bilateral agreement, Norway and Russia
Coastal cod	GN, LL, HL, DS	all year	23 841[C]	TS, PS, DS, TP	Norwegian coast line	Q, MS, MCS, MBU, MBN, C, RS, RA
Cod	TR, GN, LL, HL	all year	486 883[C]	TS, PS, TP, DS	North of 62°N, Barents Sea, Svalbard	Q, MS, SG, MCS, MBU, MBN, C, RS, RA
Wolffish[D]	LL	all year	13 401[E]	TR, (GN), (HL)	North of 62°N, Barents Sea, Svalbard	Q, MB
Haddock	TR, GN, LL, HL	all year	146 830	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	197 334	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[F]	LL, GN	seasonal	14 828	TR, TS	Deep shelf and at the continental slope	Q, MS, RS, RG, MBH, MBL
Sebastes mentella	TP (Norwegian Sea)	all year	19 828	TR, TS	Deep shelf and at the continental slope	C, SG, MB
Sebastes marinus	GN, LL, HL	all year	7 187	TR, TS	Norwegian coast	SG, MB MCS, MBU, C
Shrimp	TS	all year	25 919[E]		Spitsbergen, Barents Sea, Coastal	ED, EF, SG, C, MCS

[A] **Provisional figures**

[B] **On a research quota**

[C] **The total cod catch north of 62 N (499,247 t) is the sum of the NEA cod catch given in the table and the total cod catches between 62ºN and 67ºN for the whole year and between 67ºN and 69ºN for the second half of the year (12,364 t).**

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

[E] **Norwegian and Russian landings**

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

Table 1.11. Flexibility in coupling between the fisheries. Fleets and impact on the other species (H, high, M, medium, L, low and 0, nothing). The table below the diagonal indicates what gears couples the species, and the strength of the coupling is given above the 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 1.12. Overview of available prognoses of NEA cod recruitment (in million induviduls of age 3) from different models (sections 1.5.5) together with the 2008 assessment estimates (ICES AFWG 2008 Table 1.13).

Model	Prognostic years	Updated	2009 Prognoses	2010 Prognoses	2011 Prognoses	2012 prognoses
Titov0	0	At assessment	721			
Titov1	1 (2 [1])	At assessment	645*	530		
Titov2	2	At assessment	584	440 *		
Titov3	3	At assessment	253 *	177 *	184*	
Titov4	4	At assessment	415	430	368	765
TB (1984-2000)	3	At assessment	800	632	553	
TB (1984-2004)	3	At assessment	796	627	551	
JES1	2 (3 [2])	At assessment	794 *	845 *	970	
JES2	1 (2 [2])	At assessment	665	866		
JES3	0 (1 [2])	At assessment	1514			
SV	3	Februar 2007	642			
RCT3 2009	3	At assessment	474	336	588	
Hybrid Model (Assessment 2009)		At assessment	564	487	184	
Hybrid model (Assessment 2008)		Last year assessment	509	152		

[1] Based on calculation of data from 2009.

[2] Based on prognosis estimate of capelin maturing biomass for October 1 2009, thereby allowing for an additional year.

*** Models that are used in the Hybrid model**

Table 1.13. 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	0.0328	0.0359	0.0367	0.0390	0.0374
1985	0.0015	0.0009	0.0014	0.0017	0.0314	0.0076	0.0827	0.0834	0.0842	0.0847	0.0853
1986	0.0000	0.0022	0.0015	0.0004	0.0130	0.1761	0.1767	0.1766	0.1762	0.1757	0.1748
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	0.0035	0.0035	0.0039	0.0038	0.0041
1990	0.0000	0.0000	0.0000	0.0012	0.0017	0.0019	0.0268	0.0268	0.0268	0.0268	0.0268
1991	0.0000	0.0005	0.0000	0.0003	0.0032	0.0020	0.0224	0.0232	0.0235	0.0239	0.0241
1992	0.0000	0.0021	0.0037	0.0129	0.0250	0.0475	0.0120	0.0159	0.0232	0.0232	0.0230
1993	0.0000	0.0413	0.0368	0.0515	0.0536	0.1156	0.0498	0.0801	0.0801	0.0801	0.0805
1994	0.0000	0.0038	0.0917	0.0347	0.0285	0.0784	0.1247	0.1339	0.2616	0.2634	0.2605
1995	0.0069	0.0811	0.0744	0.1102	0.0925	0.1123	0.1389	0.2533	0.2553	0.2561	0.2575
1996	0.0000	0.1493	0.2549	0.2060	0.1322	0.1267	0.1851	0.2082	0.2459	0.2471	0.2465
1997	0.0000	0.0704	0.0767	0.1140	0.1552	0.1554	0.2329	0.2267	0.2882	0.2815	0.2832
1998	0.0000	0.0135	0.0272	0.0418	0.1041	0.0981	0.1081	0.1492	0.2758	0.2767	0.2778
1999	0.0000	0.0000	0.0049	0.0137	0.0148	0.0338	0.0620	0.1117	0.1937	0.1941	0.1841
2000	0.0000	0.0000	0.0286	0.0147	0.0134	0.0266	0.0498	0.0567	0.2760	0.2727	0.2755
2001	0.0000	0.0158	0.0116	0.0082	0.0131	0.0241	0.0496	0.0382	0.3296	0.3262	0.3300
2002	0.0000	0.0386	0.0590	0.0142	0.0187	0.0285	0.0359	0.0626	0.1596	0.1573	0.1584
2003	0.0000	0.0193	0.0198	0.0199	0.0206	0.0188	0.0456	0.1043	0.2259	0.2296	0.2275
2004	0.0217	0.0224	0.0294	0.0214	0.0184	0.0294	0.0391	0.0710	0.1059	0.1058	0.1071
2005	0.0000	0.0265	0.0229	0.0258	0.0155	0.0240	0.0486	0.0836	0.1687	0.1664	0.1676
2006	0.0000	0.0050	0.0007	0.0131	0.0285	0.0124	0.0393	0.0315	0.0827	0.0846	0.0838
2007	0.0000	0.0000	0.0010	0.0110	0.0137	0.0332	0.0339	0.0725	0.1523	0.1532	0.1507
2008	0.0000	0.0939	0.0274	0.0089	0.0112	0.0134	0.0885	0.1032	0.1216	0.1206	0.1209
Average	**0.0012**	**0.0235**	**0.0312**	**0.0293**	**0.0348**	**0.0489**	**0.0692**	**0.0878**	**0.1458**	**0.1455**	**0.1454**

Table 1.14. Comparison of NEA cod recruitment models. Prognoses between 1999—2006, based on VPA2007. C is correlation coefficient and σ² is variance, according to WD 27. Models with bold C are used for the hybrid model. Models marked with '*' is used for the NEA cod projections.

1-year ahead prognosis								
	TB	JES1	SV	TITOV1	TITOV2	TITOV3	TITOV4	Hybrid*
σ^2	469.82	467.41	590.77	253.04	318.22	290.31	317.94	174.22
C	0.10	0.57	-0.06	0.57	0.41	0.86	0.32	0.85
2-year ahead prognosis								
	TB	JES1	SV		TITOV2	TITOV3	TITOV4	Hybrid*
σ^2	476.67	443.72	557.64		293.73	296.45	298.69	214.73
C	0.16	0.59	0.02		0.61	0.85	0.38	0.83
3-year ahead prognosis								
	TB		SV			TITOV3	TITOV4	
σ^2	494.95		547.65			280.07	293.77	
C	-0.29		0.12			0.87	0.30	

Table 1.15. Cannibalism in cod.

Year	M2 age 3	M2 age 4
	by regression	
2008	0.43	0.28
2009	0.43	0.28
2010	0.47	0.30
2011	0.50	0.31
	values used in assessment	
2009-2011	0.3107	0.227

Table 1.16. Overview of the standard sections monitored by IMR and PINRO in the Barents Sea, with observed parameters. Parameters are: T-temperature, S-Salinity, N-nutrients, chla-chlorophyll, zoo-zooplankton, O-oxygen.

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

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

Table 1.17. Overview of conducted monitoring surveys by IMR and PINRO in the Barents Sea, with observed parameters and species. For zooplankton, mammals and benthos abundance and distribution for many species are investigated. Therefore, in the table it is only indicated whether sampling is conducted. Climate and phytoplankton parameters are: T-temperature, S-Salinity, N-nutrients, chla-chlorophyll.

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

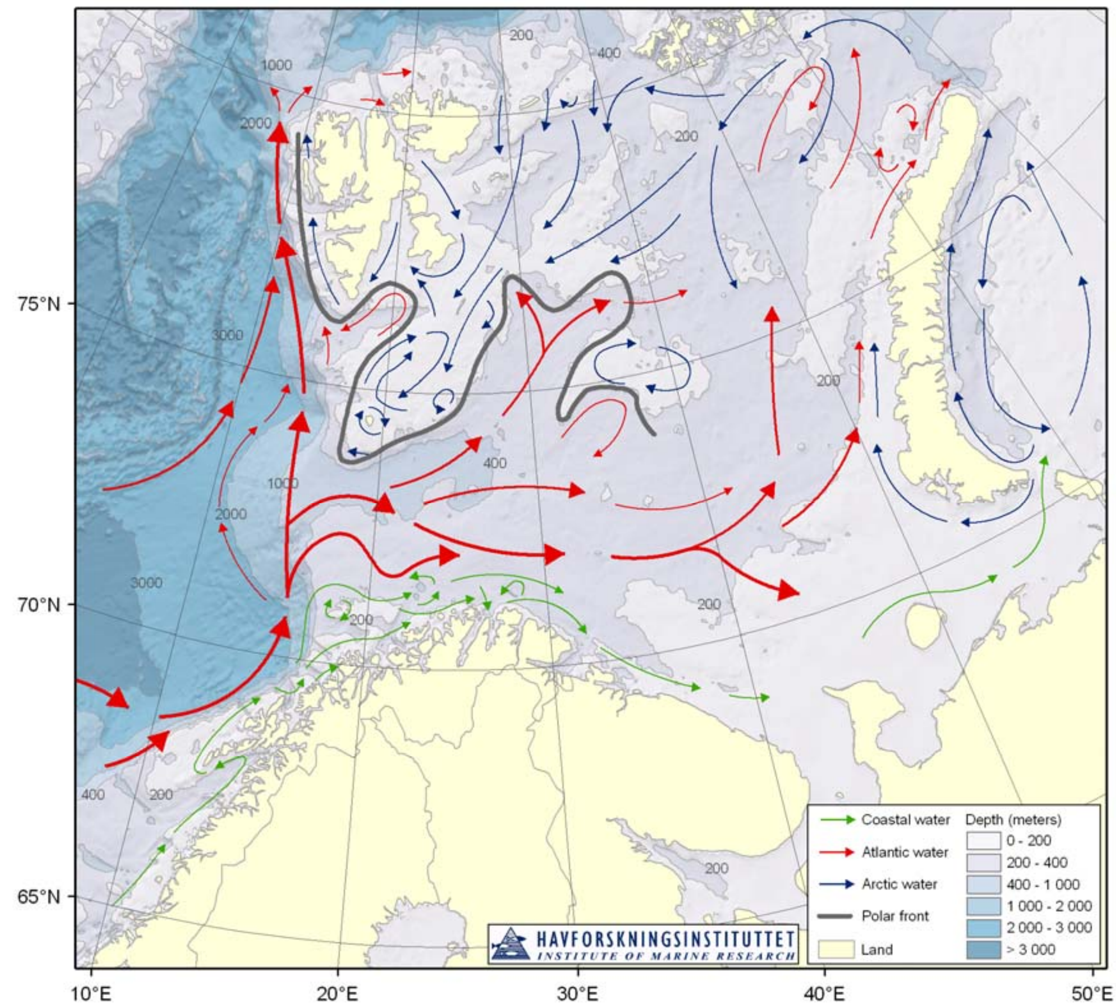

Figure 1.1. The main features of the circulation and bathymetry of the Barents Sea.

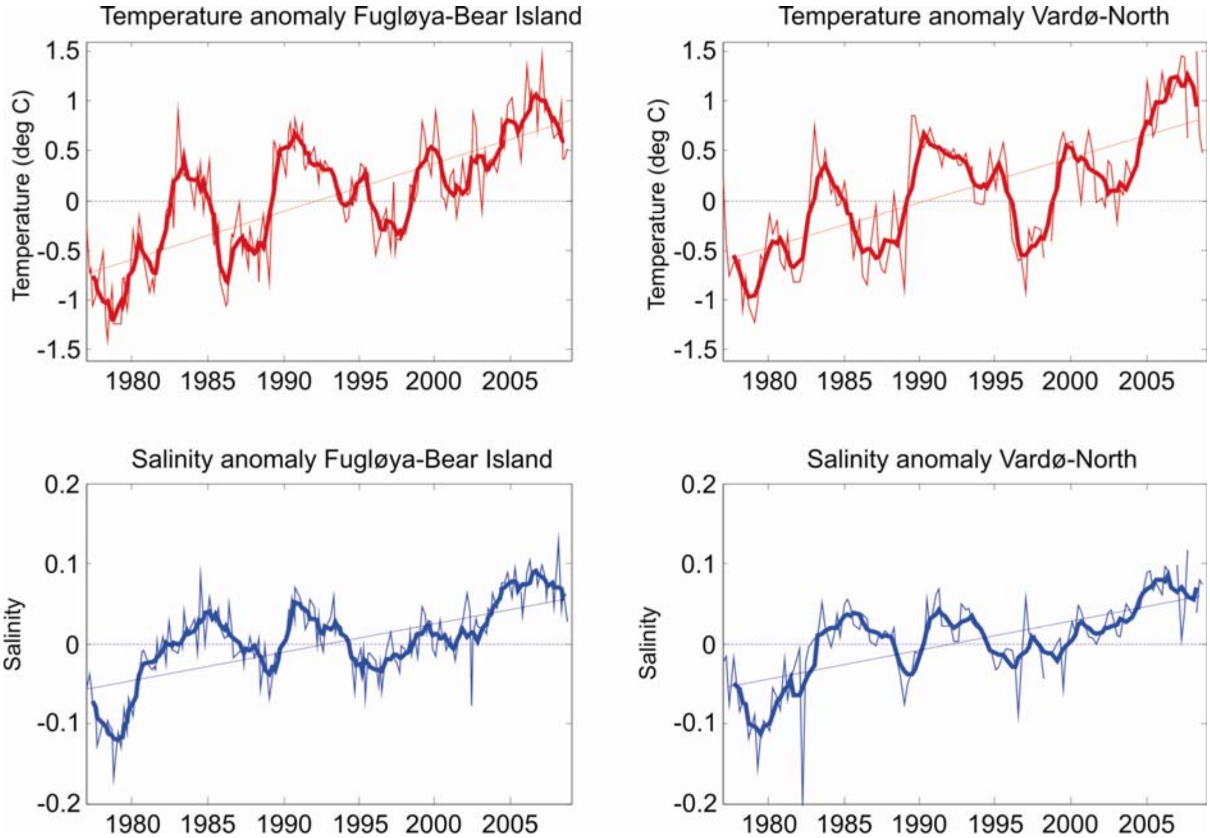

Figure 1.2. Temperature (upper) and salinity (lower) anomalies in the 50-200 m layer of the Fugløya-Bear Island section (left) and the Vardø-North section (right).

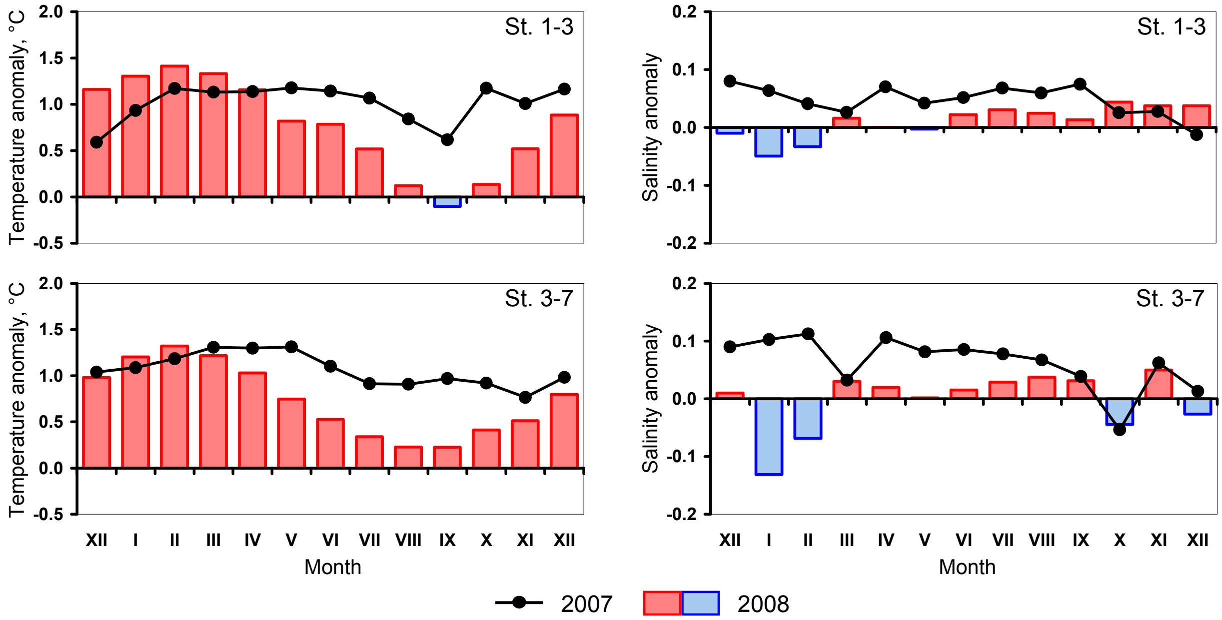

Figure 1.3. Monthly mean temperature (left) and salinity (right) anomalies in the 0-200 m layer of the Kola Section in 2007 and 2008. St. 1-3 – coastal waters, St. 3-7 – Murman Current.

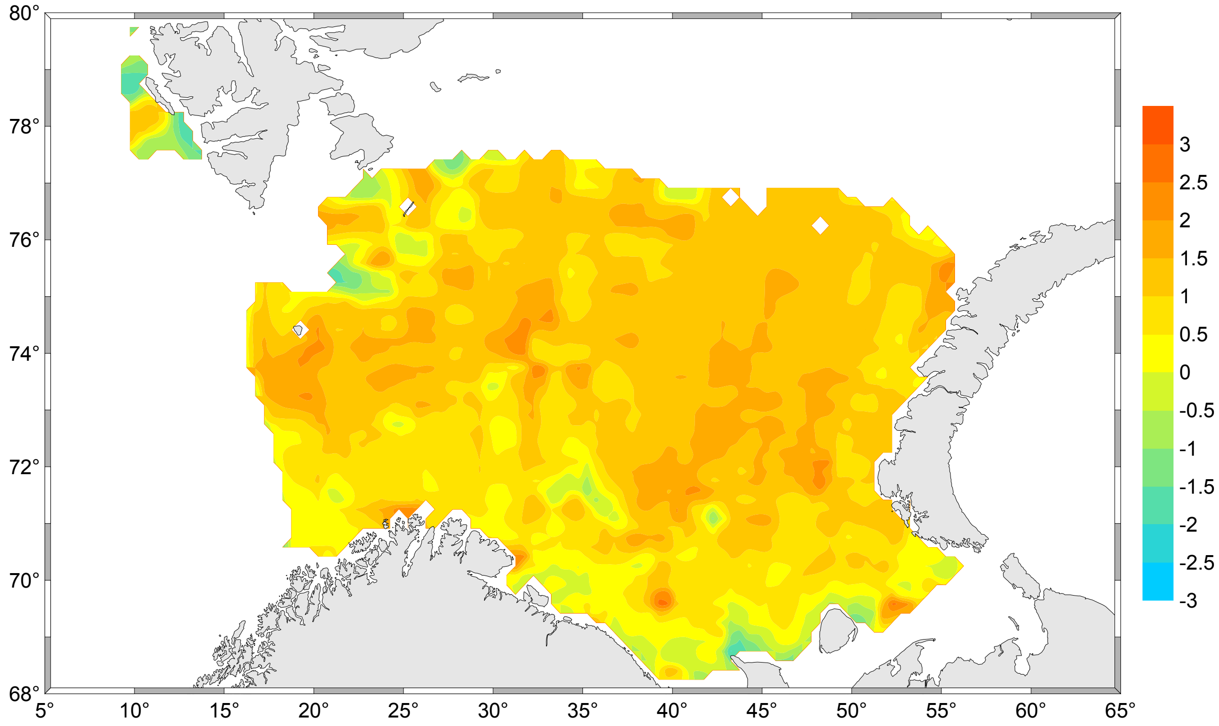

Figure 1.4. Bottom temperature anomalies in the Barents Sea in August-September 2008.

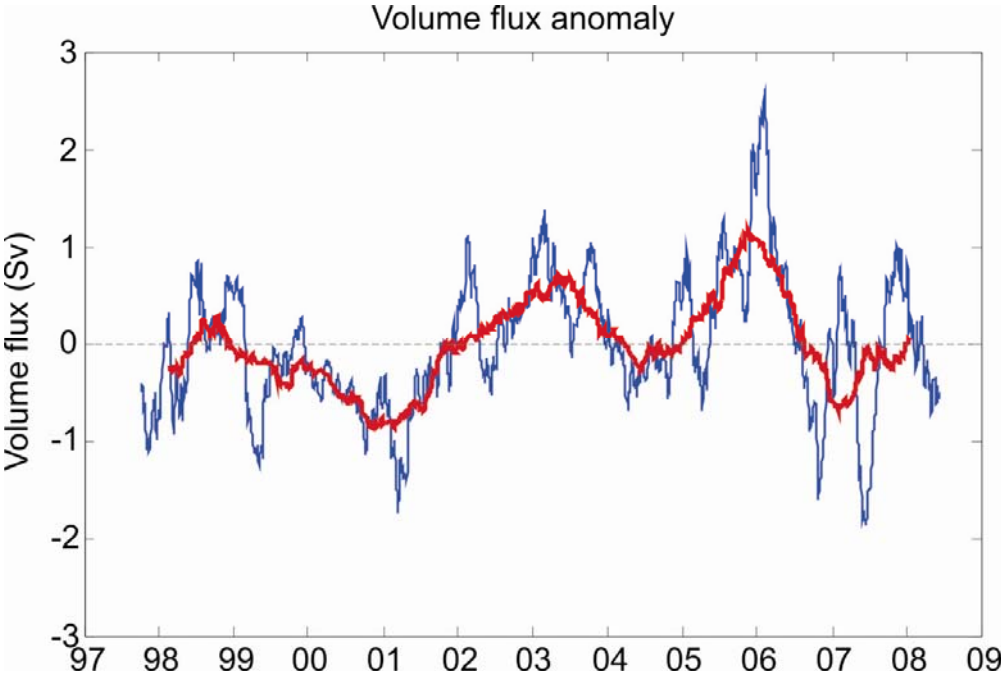

Figure 1.5. Observed Atlantic Water volume flux through the Fugløya-Bear Island section estimated from current meter moorings. Three months (blue line) and 12-months (red line) running means are shown.

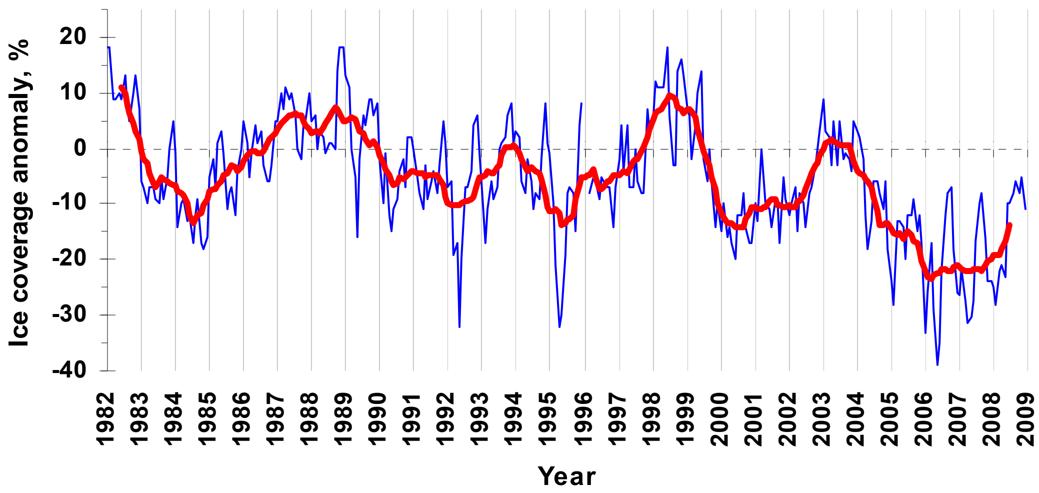

Figure 1.6. Anomalies of mean monthly ice extent in the Barents Sea. The blue line shows monthly values, the red one – 11-month moving average values.

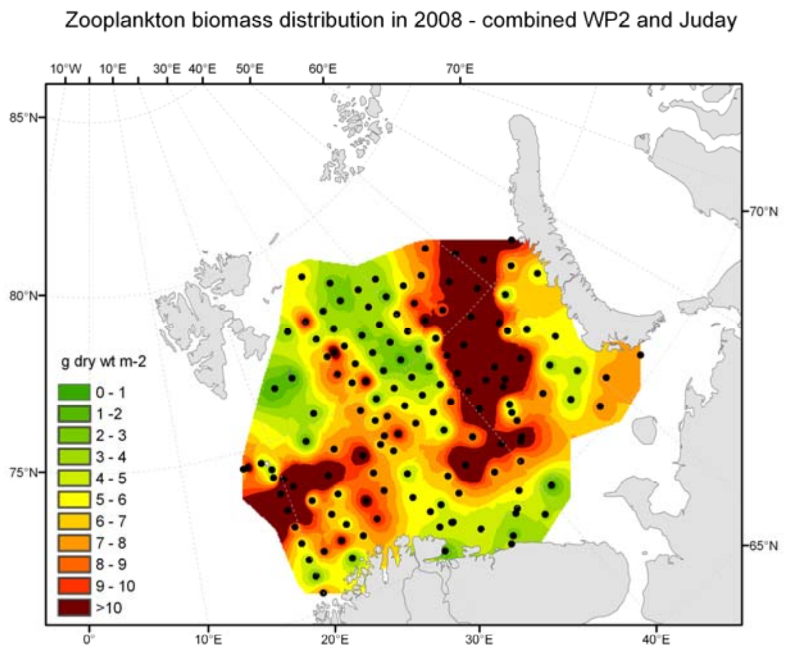

Figure 1.7. Horizontal distribution of zooplankton in 2008 (g m^{-2} of dry weight from bottom-0 m).

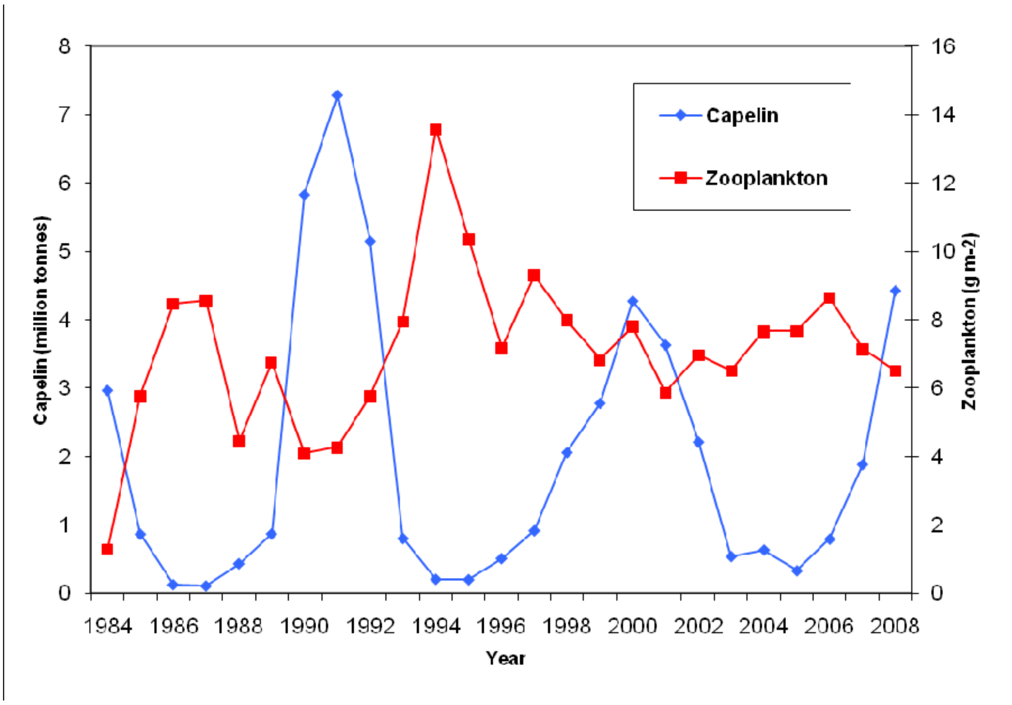

Figure 1.8. Average zooplankton biomass (dry weight, g m^{-2}, red line) together with biomass of one year old and older capelin (million tonnes, blue line) during 1984 – 2008, in the Barents Sea (from Dalpadado et al. 2002, updated with data for 2001-2008).

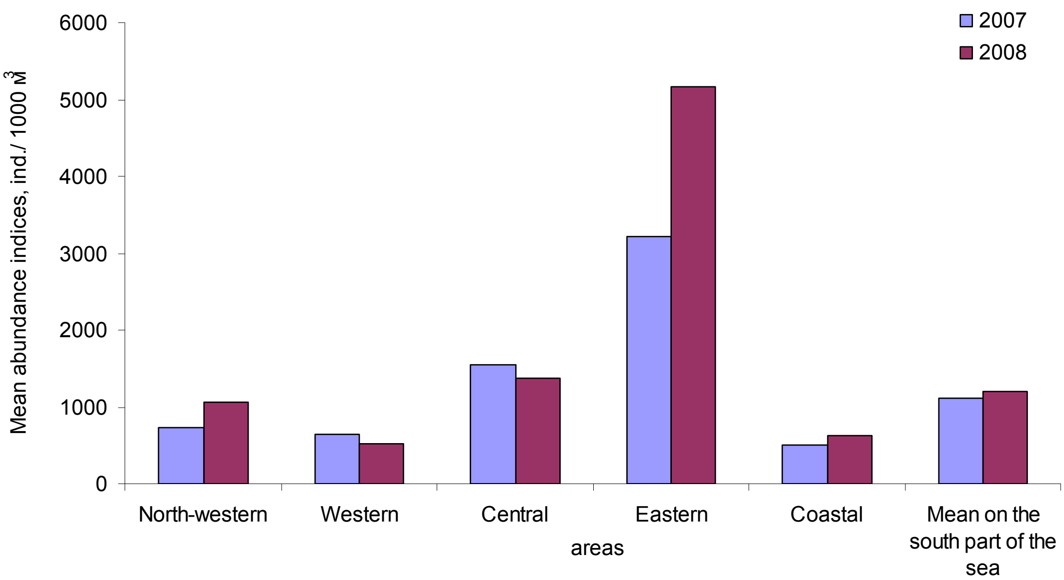

Figure 1.9. Mean abundance indices of euphausiids in the different areas of the Barents Sea in autumn surveys 2007 and 2008.

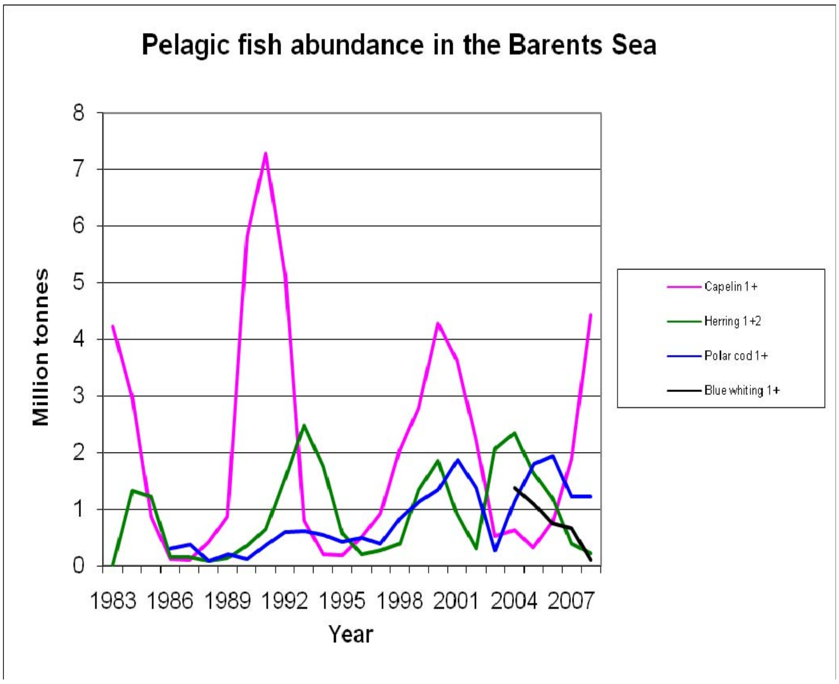

Figure 1.10. Biomass of pelagic fish species in the Barents Sea. Data are taken from; capelin: Acoustic estimates in September-October, age 1+ (ICES AFWG 2008;Anon. 2008, herring: VPA estimates of age 1 and 2 herring (ICES WGWIDE 2008) using standard weights at age (9 g for age 1 and 20g for age 2); polar cod: Acoustic estimates in September-October, age 1+ (Anon., 2008); blue whiting: Acoustic estimates in September-October, age 1+ (Anon., 2008).

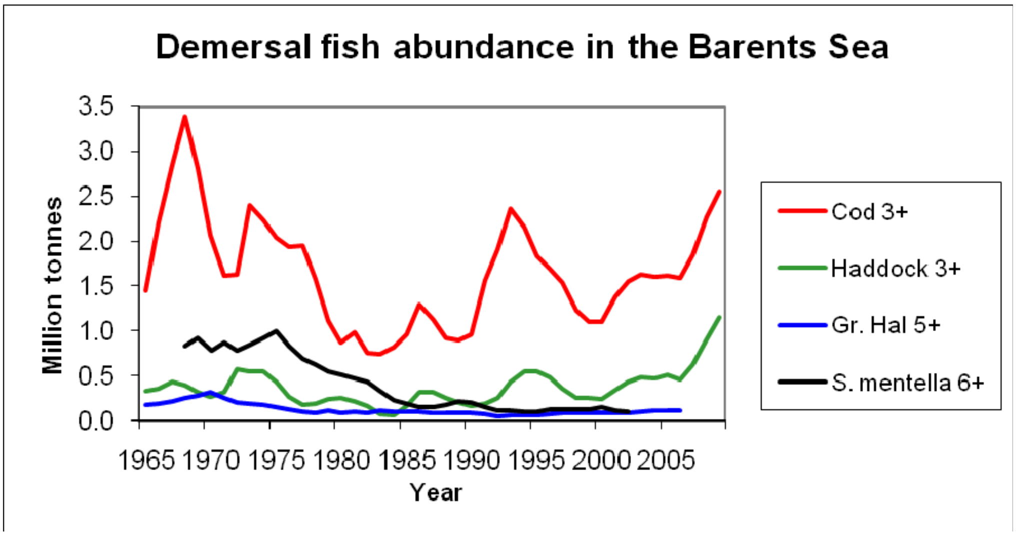

Figure 1.11. Biomass of demersal fish species in the Barents Sea. Data are taken from; cod: VPA estimates, age 3+ (ICES, 2009); haddock: VPA estimates, age 3+ (ICES, 2009); Greenland halibut: VPA estimates, age 5+ (ICES, 2007); Sebastes mentella: VPA estimates, age 6+ (ICES, 1995 for the years 1968-1990; ICES, 2003 for the years 1991-2002).

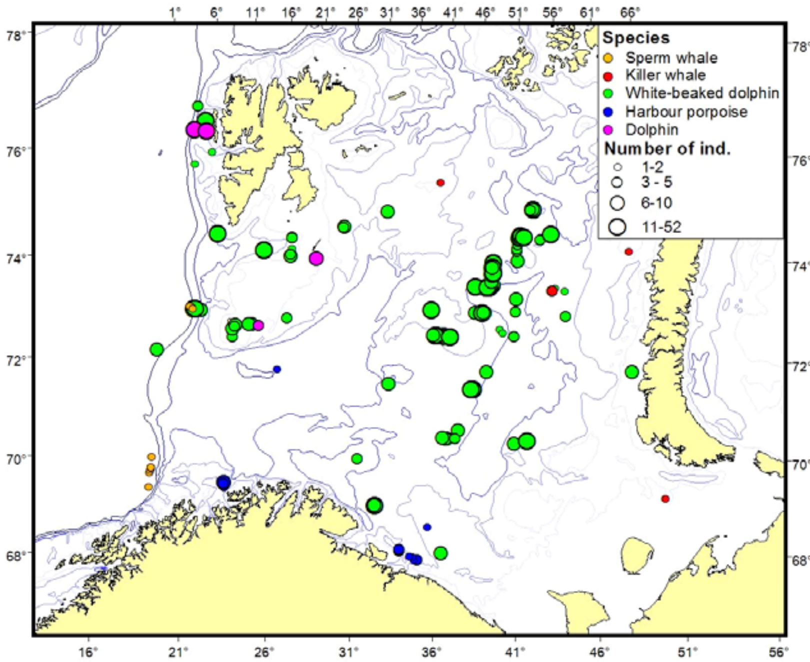

Figure 1.12. Distribution of white-beaked dolphins (green dots) and harbor porpoise (blue dots) as observed in 2008. Dot sizes reflect number of individuals observed.

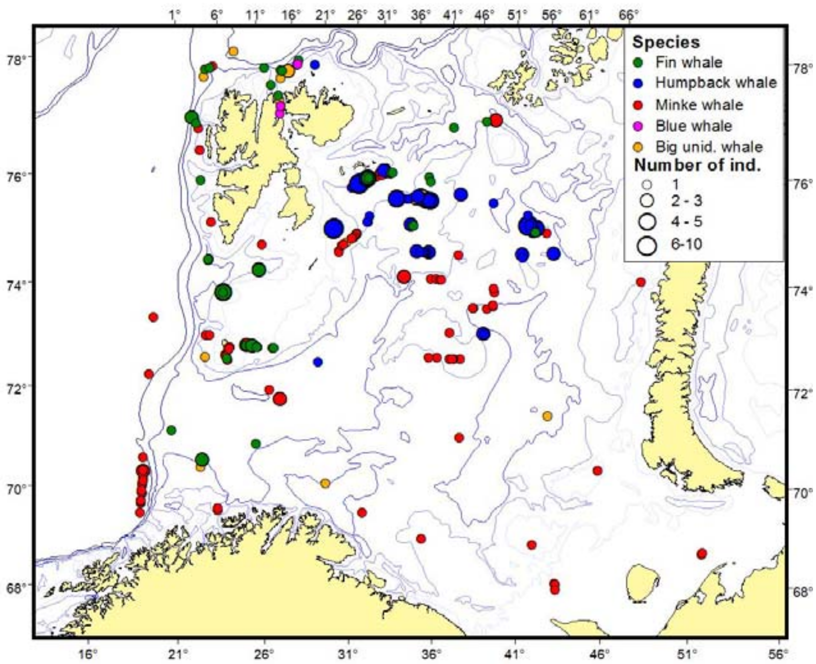

Figure 1.13. Distribution of minke (red dots), humpback (green dots) and fin whales (blue dots) as observed in 2008. Dot sizes reflect number of individuals observed.

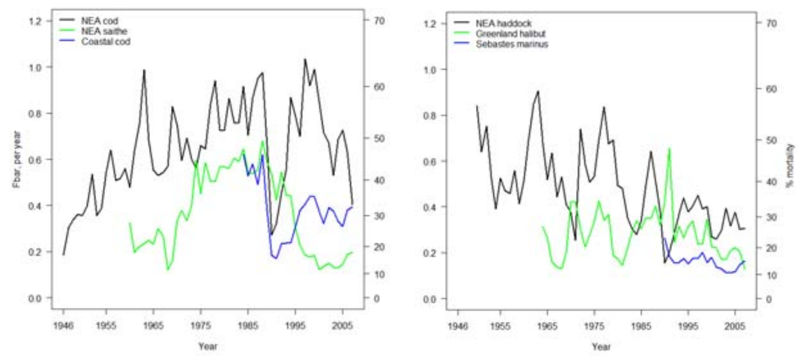

Figure 1.14. Time series of annual average fishing mortalities for Northeast Arctic cod (time period 1946-2007, average for ages 5-10), Northeast Arctic saithe (time period 1960-2007, average for ages 4-7), coastal cod (1984-2007, average for ages 4-7), Northeast Arctic haddock (time period 1950-2007, average for ages 4-7), Greenland halibut (time period 1964-2007, average for ages 6-10) and *Sebastes marinus* (time period 1990-2007, average for ages 12-19).

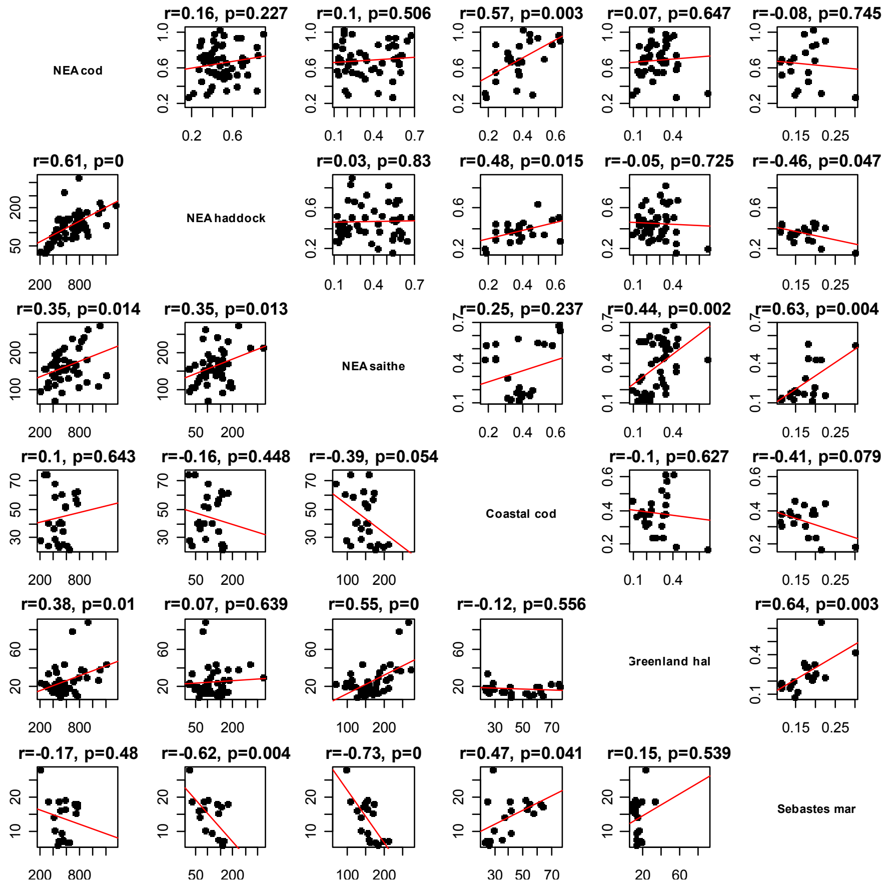

Figure 1.15. Pair-wise plots of annual average fishing mortalities (above diagonal) and landings (below diagonal) for overlapping time periods for Northeast Arctic cod (time period 1946-2008, average for ages 5-10), Northeast Arctic haddock (time period 1950-2008, average for ages 4-7), Northeast Arctic saithe (time period 1960-2008, average for ages 4-7), coastal cod (1984-2008, average for ages 4-7), Greenland halibut (time period 1964-2008, average for ages 6-10) and *Sebastes marinus* (time period 1990-2008, average for ages 12-19). The correlation and the corresponding p-value are given in the legend.

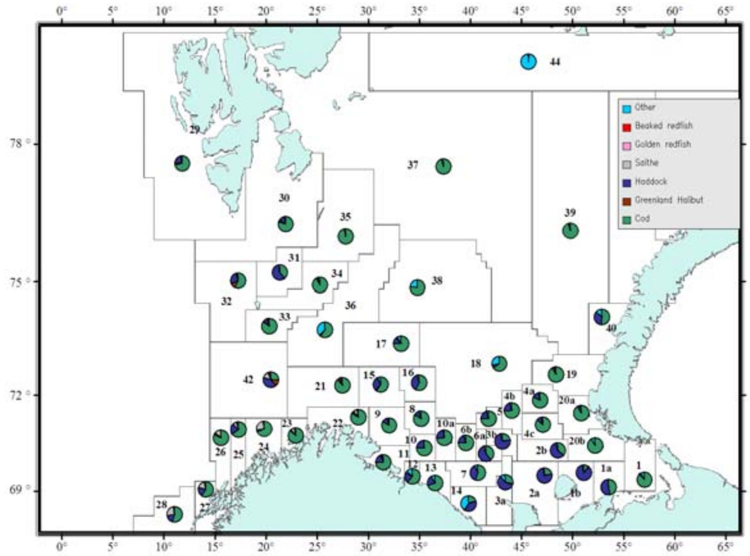

Figure 1.16. Relative distribution by weight of cod, haddock, saithe, Greenland halibut, golden redfish (*Sebastes marinus*), beaked redfish (*Sebastes mentella)* and other species taken by Russian bottom trawl in 2008 per main area for the Russian strata system.

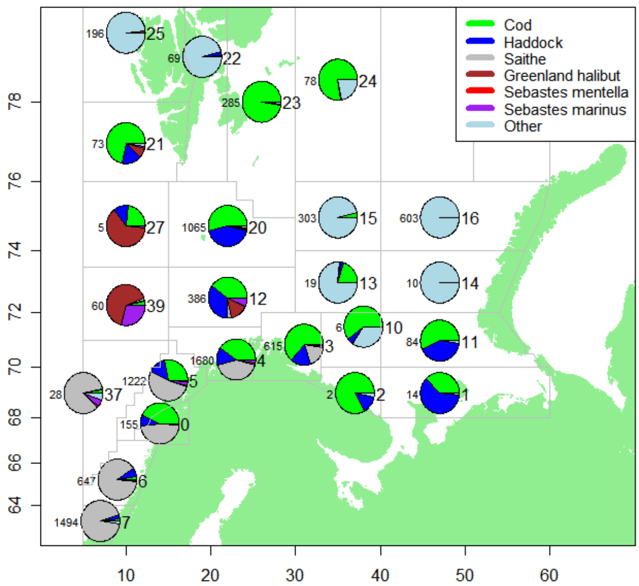

Figure 1.17. Relative distribution by weight of cod, haddock, saithe, Greenland halibut, *Sebastes marinus* (golden redfish), *Sebastes mentella* (beaked redfish) and other species taken by Norwegian bottom trawl in 2008 per main area for the Norwegian strata system. The large number to the right of each pie diagram is the name of the stratum, while the small number to the left is the number of vessel days recorded in this area.

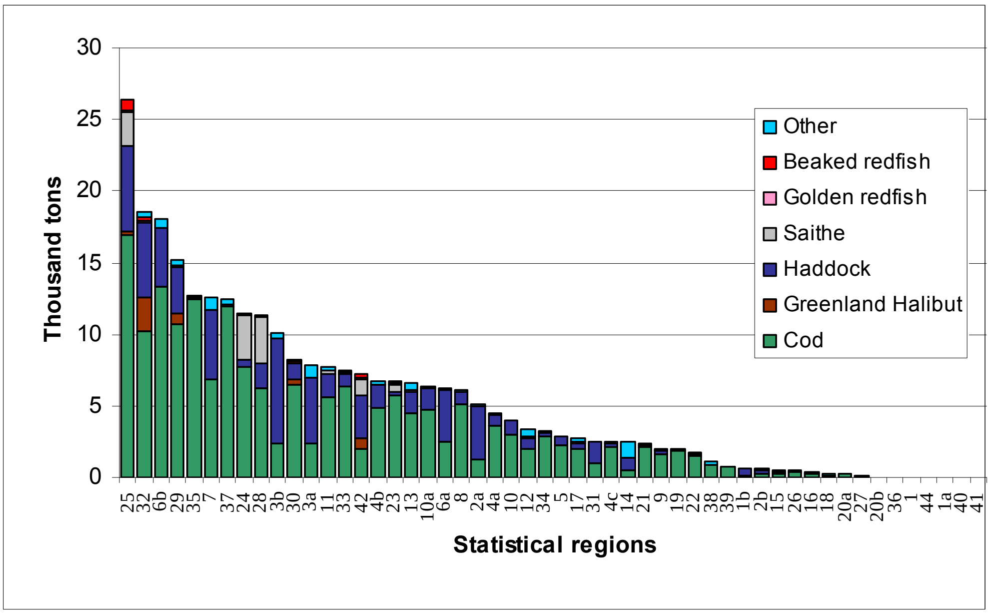

Figure 1.18. The Russian catch of cod, haddock, saithe, Greenland halibut, *Sebastes marinus*, *Sebastes mentella* and other species taken by bottom trawl by main statistical areas in 2008, thousand tonnes. The statistical areas correspond to the areas shown in Figure 1.16.

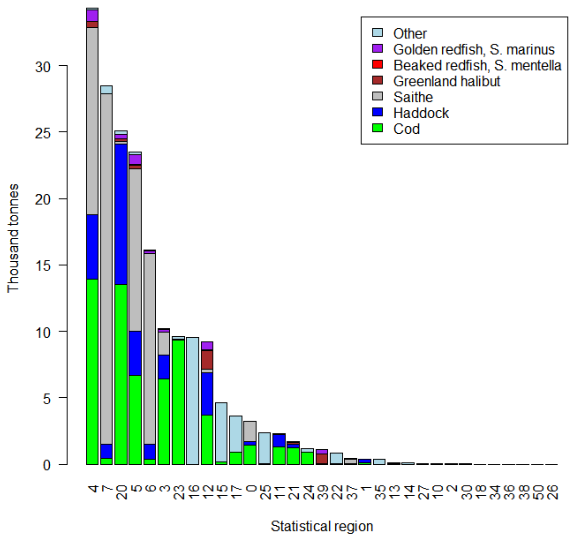

Figure 1.19. The Norwegian catch of cod, haddock, saithe, Greenland halibut, *Sebastes marinus*, *Sebastes mentella* and other species taken by bottom trawl by main statistical areas in 2008, thousand tonnes. The statistical areas correspond to the areas shown in Figure 1.16.

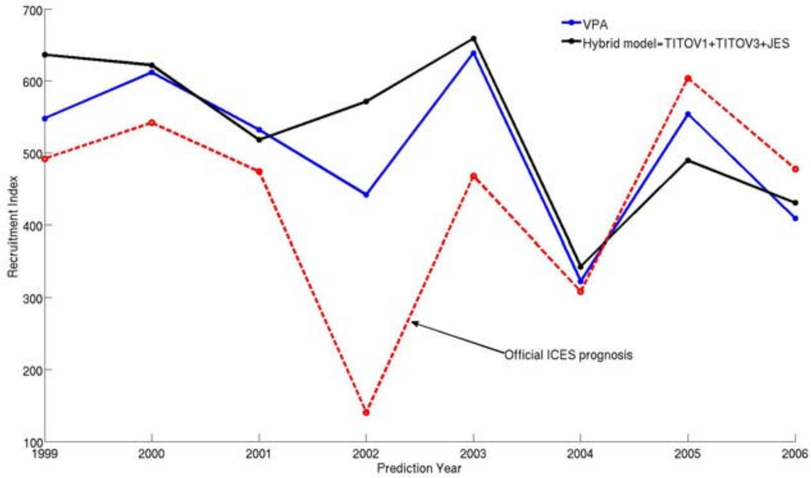

Figure 1.20. Comparison of NEA cod recruitment models. Prognosis for 1-year ahead. Hybrid model is an arithmetic mean of models with correlation coefficient greater than 0.5.

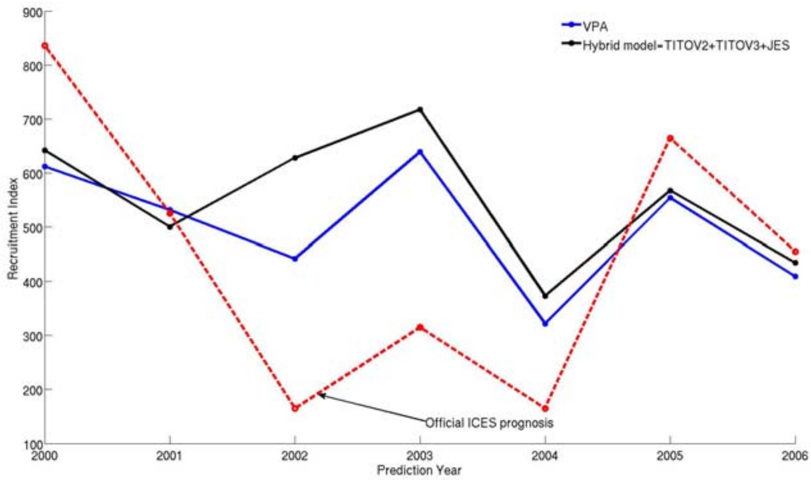

Figure 1.21. Comparison of NEA cod recruitment models. Prognosis for 2- years ahead. Hybrid model is an arithmetic mean of models with correlation coefficient greater than 0.5.

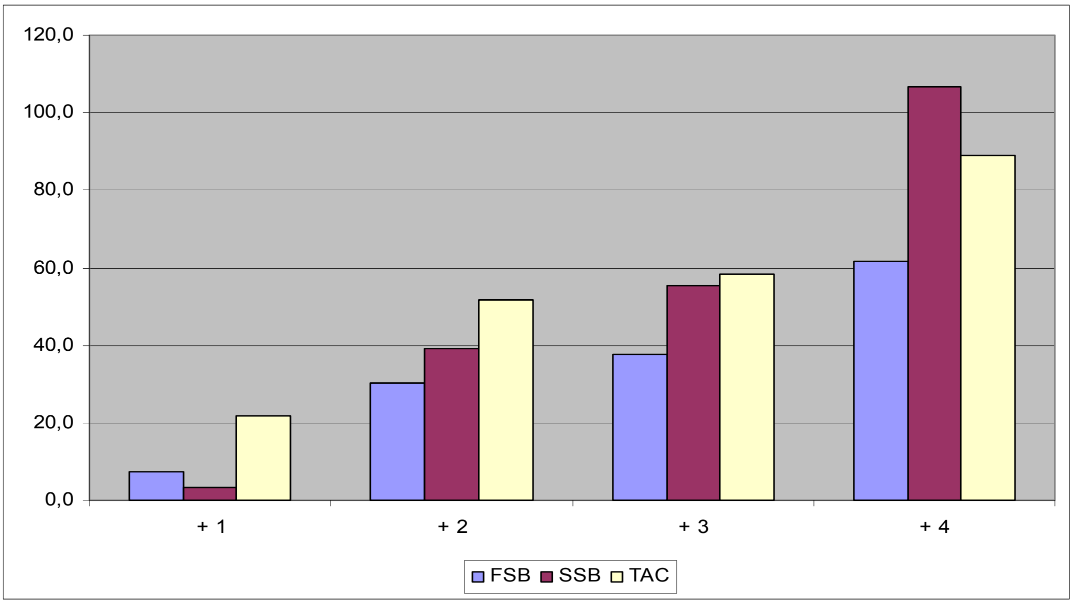

Figure 1.22. Relative changes (% to simulated values under the current temperature regime) of cod stock biomass and catches at temperature increase in the Barents Sea by 1-4 C° according to the STOCOBAR simulations. FSB – fishable stock biomass, SSB – spawning stock biomass, TAC – total allowable catch.

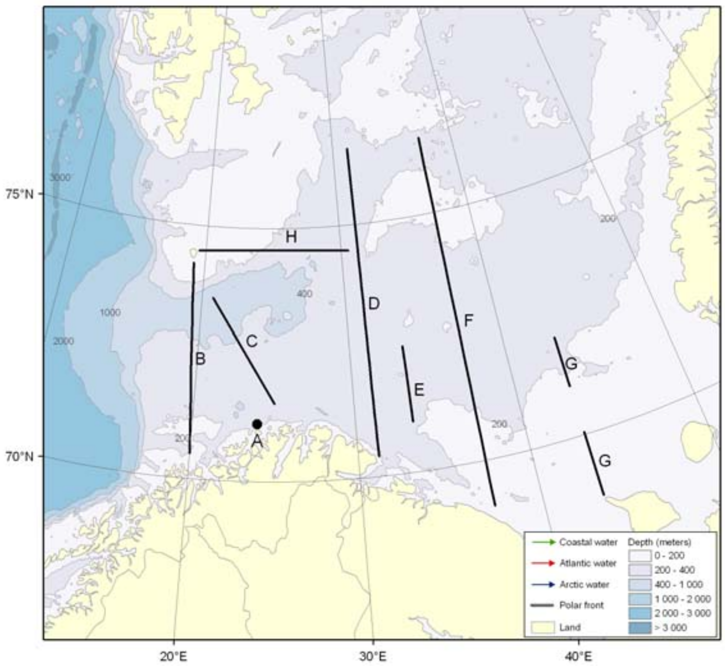

Figure 1.23. Positions of the standard sections monitored in the Barents Sea. A is fixed station Ingøy, B is Fugløya-BearIsland, C is North cape-Bear Island, D is Vardø-North, E is Kola, F is Sem Island-North G is Kanin section and H is Bear Island-East section.

2 Cod in subareas I and II (Norwegian coastal waters)

Type of assessment: Update.

No data revisions, data updated with figures from 2008.

The working group states that the fisheries on this stock have to be much more restricted than the present level, to bring the catches down towards zero, and reiterate the latest advice that has been given for this stock of zero fishing.

The data explorations made in 2007 revealed inconsistencies between survey indices at age and landings at age. There has not been made any attempt to solve these problems yet, and the current updates include both a survey based (SURBA program) and a catch based (XSA VPA) assessment analysis. Estimated landings at age are updated with 2008 data. General information regarding the stock and earlier assessments are given in an updated Quality Handbook Stock Annex.

Further topics raised by last Review Group:

-SURBA stock weights

-Allocation of quotas of Coastal cod

-Variation of survey indices

-Catchability estimates from the SURBA analysis

2.1 Fisheries

Coastal cod is to a variable extent fished throughout the year and within nearly all the distribution area (inside the 12 n.mile zone in the Norwegian statistical areas 03, 04, 05, 00, 06, 07, Figures 2.1- 2.3). The main fishery for coastal cod takes place in the first half of the year. The main fishing areas are along the coast from Varangerfjord to Lofoten (areas 03, 04, 05, 00) . Recreational fisheries take an important fraction of the catches in some local areas, especially near the coastal cities and in some fjords where commercial fishing activity is low. There are no reliable estimates for recreational catches. Except for the open fjords in eastern Finnmark, the quantities fished inside fjords are quite low. The total share between gear types in the estimated coastal cod commercial landings has in recent years been around 50% for gillnet, 20% for Danish seine, 20% for long-line/hand-line and less than 5% for bottom trawl.

2.1.1 Sampling fisheries and estimating catches (Tables 2.1–2.2)

The catches of Norwegian Coastal cod (NCC) have been calculated back to 1984 (Table 2.1a). For this period the estimated landings have been between 22,000 and 75,000 t. The estimated landings of NCC in 2007 is 23,841t and in 2008 it is 25,777t (Table 2.1a, Figure 2.4). Table 2.1b shows the estimated catch by gears, area and quarters.

Catches are separated to type of cod by the structure of the otoliths in commercial samples. Figure 2.5 illustrates the main difference between the two types: The figure and the following text is from (Berg *et al*., 2005): *Coastal cod has a smaller and more circular first translucent zone than north-east Arctic cod, and the distance between the first and the second translucent zone is larger* (Fig. 2.5). *The shape of the first translucent zone in north-east Arctic cod is similar to the outer edge of the broken otolith and to the subsequent established translucent zones. This pattern is established at an age of 2 years, and error in differentiating between the two major types does not increase with age since the established* *growth zones do not change with age*. The precision and accuracy of the separation method has been investigated by comparison of different otolith readers and results from genetic investigation of cod. The results indicate high accuracy using in the otolith method (Berg *et al*., 2005). Nevertheless, in cases with a low percentage misclassification of large catches of pure NEA cod, the catches of coastal cod could be severely overestimated.

The basis for estimating coastal cod catches is the total landings of cod inside the 12 n.mile zone in the Norwegian statistical areas 03, 04, 05, 00, 06, 07 (Figures 2.1-2.3), combined with the sampling of these fisheries. Tables 2.2 and 2.3 show the sampling of the cod fishery by quarters and areas in 2008. The total number of age samples was 356. Since the catches are separated to type of cod by the structure of the otoliths, the numbers of age samples are critical for the estimated catch of coastal cod. A total of about 13,000 fish were aged. Nearly 3900 of these otoliths were classified as coastal cod.

Table 2.4 shows the estimated catches of coastal cod by statistical area and quarter for the years 2004-2008. The corresponding fractions of coastal cod in cod catches are also shown. In the southern areas (06/07) the proportions are close to 1.0 in all quarters, except for some years when some NEA cod spawn far to the south in quarter 1 and 2. In the other areas the proportions are lower in quarter 1 and 2 in all years due to the spawning migration of NEA cod. In area 03 (eastern Finnmark) a considerable proportion of NEA cod is present also during autumn.

The calculation of coastal cod landings for recent years has been problematic for parts of the Lofoten area. This relates to the Norwegian statistical area 00 (outer Vestfjord, the area south of Lofoten archipelago, Figure 2.3) in quarter 1 and 2. This area has historically been an important spawning area for Northeast Arctic cod. In the period 2004-2008 a major part of the Northeast Arctic cod was spawning in the outer, south-western part of the area, and almost nothing in the north-eastern part. Most of the commercial catches in the area were taken in the south-western part (locations 03 and 04, Figure 2.3) where the density of cod was much higher than in the north-eastern part. In the same period the sampling intensity has been highest for the catches in the north-eastern part (locations 46 and 48) where coastal cod dominated. (In most of this north-eastern area the fishery was restricted to vessels below 15m and use of Danish seine was not allowed). The catch sampling has not been sufficiently accurate to split the catches between those locations. Merging all samples in the whole area is therefore considered to overestimate landings of coastal cod. In order to obtain a more realistic catch in the area for the years 2004-2006, the 2007 working group used only the samples taken from the south-western part for separating the total catch in the area between coastal cod and Northeast Arctic cod, and this was also done in 2008. The recorded positions of the samples are considered to be accurate. The same procedure is used for estimating the catch of coastal cod in quarter 1 and 2 in 2008.

2.1.2 Regulations

The Norwegian cod TAC is a combined TAC for both NEAC stock and NCC stock. The coastal cod part of this combined quota was set 40,000t in 2003 and earlier years. In 2004 it was set to 20,000t, and in the following years to 21,000t. There are no separate quotas given for the coastal cod for the different groups of the fishing fleet.

Trawl fishing for cod is not allowed inside the 6-n.mile. Since the mid 90-ies the fjords in Finnmark and northern Troms (areas 03 and 04) has been closed for fishing with

Danish seine. Since 2000 the large longliners have been restricted to fish outside the 4 n.mile.

To achieve a reduction in landings of coastal cod additional technical regulations in coastal areas were introduced in May 2004 (after the main fishing season) and continued with small modifications in 2005 and 2006. In the new regulations "fjord-lines" are drawn along the coast to close the fjords for direct cod fishing with vessels larger than 15 meter. A box closed for all fishing gears except hand-line and fishing rod is defined in the Henningsvær-Svolvær area. This is an area where spawning concentrations of coastal cod is usually observed and where the catches of coastal cod has been high. Since the coastal cod is fished under a merged coastal cod/north-east arctic cod quota, these regulations are supposed to turn parts of 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. Further restrictions were introduced in 2007, and continued in 2008, by not allowing pelagic gill net fishing for cod and by reducing the allowed by-catch of cod when fishing for other species inside fjord lines from 25% to 5%, and outside fjord-lines from 25% to 20%. In 2009 one more spawning area was closed for fishery (except for hand line and fishing rod) in the spawning season (March-April). This is Borgundfjorden near Ålesund, which is the most important spawning area in the southern part of the stock distribution area.

2.2 Survey data

A trawl-acoustic survey along the Norwegian coast from the Russian boarder to 62 N was started in the autumn 1995. In 2003 the survey was somewhat modified by being combined with the former saithe survey at the coastal banks and the survey was moved from September to October-November. This new survey covers a larger area than the coastal surveys in 1995-2002. However, the survey indices for cod to be used in this report are calculated using the same area coverage and the same method as in the years previous to 2003.

2.2.1 Indices of abundance and biomass (Tables 2.5–2.11, Figs 2.7 to 2.13)

The results of the 2008 survey (Aglen *et al*. WD 3 2009) are presented in Tables 2.5-2.11 for the area inside the 12 n.miles boarder in the Norwegian statistical areas 03, 04, 05, 00, 06, and 07 (Figures 2.1 and 2.2). The survey time series of estimated numbers of NCC per age groups is given in Table 2.6. For most age groups the estimates are lower than or close to the lowest ever observed, and the total number is the lowest ever observed. The 2008 estimate of survey biomass is about 30,500 t (Table 2.9) and this is very close to the lowest observed. The estimated spawning biomass is 15,500 t, and this is still slightly above the lowest observed (Tables 2.11). The bulk of the spawning biomass is comprised of ages 5-7. The 4+ biomass (summed from Table 2.9) is plotted together with total biomass and spawning biomass in Figure 2.13.

The pattern seen (Figure 2.6) over the full time series of abundance at age is that ages 2 and 3 have declined more, and over a longer period, compared to the older fish. The series now indicates a rather stable stock at a low level. The period since 2002 shows considerable variation, however, without any trend.

Figures 2.7-2.12 show the time series of stock number within each statistical area. In areas 03, 04 and 05 the decline since the late 90's is rather parallel. In the other three areas the year-to- year variation is larger, but similar trends are indicated. These latter southern areas contribute less to the total estimate.

2.2.2 Age reading and stock separation (Tables 2.2, 2.3, 2.8–2.10)

A total of 1785 cod otoliths were sampled during the 2007.

As in previous years, NCC was found throughout the survey area. The 2008 survey data on the stock separation are similar to the 2007 data and shows the same pattern as the 1995-2007 surveys. The sampling showed a higher proportion of NCC in the fjords and to the south compared with the northern and outer areas. The proportion of the NCC increases going from north to south along the Norwegian coast. Table 2.12 show the proportions of coastal cod in the survey samples by age and statistical areas in 2008. Nearly all otoliths collected south of 67° N (Norwegian statistical areas 06 and 07) were NCC type. Although the proportions are lower, the total abundance of NCC is higher north of 67° N (Table 2.5).

Table 2.12 also show the proportions of coastal cod in the survey samples by age for 5 previous years. The proportion is rather stable between years, but is consistently higher for young fish compared to old.

It must be emphasised that the Norwegian coastal surveys is conducted in October-November, and there is usually more NEA cod in the coastal areas at other times of the year, especially during the spawning season in the late winter. This is reflected in the commercial sampling as shown in Table 2.4.

2.2.3 Weights at age (Table 2.8)

As observed in the earlier surveys, there is a general tendency for costal cod to have higher weight at age when caught in the southernmost area. Table 2.8 show the time series of mean weights at age for the whole survey.

2.2.4 Maturity-at-age (Table 2.10)

The maturity-at-age is estimated from the data collected at the coastal survey. The age at 50% maturity (M_{50}) for the NCC was near 5 in 2006, 2007 and 2008 surveys (Table 2.10). Both the estimated weights at age and the estimate of maturities are influenced by uncertain values in areas where few fish are sampled. In addition, the survey is conducted in the period October/November, a period when maturation stages are difficult to interpret. Therefore, much of the year to year variation observed might not be real, and a fixed long term average could be a reasonable alternative.

2.3 Data available for the Assessment

2.3.1 Catch at age (Table 2.1)

The estimated catch at age (2-10+) for the period 1984-2008 is given in Table 2.1.

The total 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 both from tourist fishing and from recreational fishing activity by Norwegian citizen. Two different investigations have estimated the amount of cod landed from these two activities and the reports were published in 2003 (in Norwegian). A summary of these two reports was presented as a WD to the 2005 WG (WD 23). The unreported catch of coastal cod in 2003 was estimated to approximately 9.300 tonnes from the recreational fishing activity and 500-800 tonnes from the tourist fishing. These figures sum up almost 30% of the official landings of coastal cod in

2003. There have also been conducted two investigations trying to 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.

The Institute of Marine Research in cooperation with the Directorate of Fisheries, Statistics Norway and relevant tourist organizations have started a 3-year project "Coastal fish resources: the foundation for tourist fishing and related commerce", financed by the Norwegian Research Council (NRC), to estimate the catches taken by tourists in Norway.

Although it certainly has been unreported catches for a long period, there are no available data for other years. It is also unknown whether the amount of unreported catch fluctuates with the stock size or with other factors.

2.3.2 Weights at age (Tables 2.8 and 2.13)

Weight at age in catches is derived from the commercial sampling and is shown in Table 2.13.

The weight-at-age in the stock is obtained from the Norwegian coastal survey (Table 2.8). The survey is covering the distribution area of the stock. Weight-at-age from the survey is therefore assumed to be a relevant measure of the weight-at-age in the stock at survey time (October). These weights will, however, overestimate the stock biomass at start of the year. There are also some problems with unreliable values, and in the SURBA analysis weights have been calculated as the un-weighted average values from the survey (Table 2.13).

2.3.3 Natural mortality

A fixed natural mortality of 0.2 has been assumed in earlier assessments. In the Barents Sea cod cannibalism has been documented to be a significant source of mortality that varies in relation to alternative food and in relation to the abundance of large cod. This might also be the case for the coastal cod (Pedersen and Pope, 2003 a and b). In the 2005 coastal cod survey 1125 cod stomachs were analysed (Mortensen 2007). The observed average frequency of occurrence of cod in cod stomachs was around 4%. Other important predators on cod in coastal waters are cormorants and otters (Pedersen *et al.*, 2007). Young saithe (ages 2-4) has been observed to consume postlarvae and 0-group cod during summer/autumn.

2.3.4 Maturity-at-age (Tables 2.10, 2.13)

The maturity data in 2008 is obtained from the Norwegian coastal survey (Table 2.10). The observed maturity at age does not show any strong time trends, and a fixed long term average could be a reasonable alternative (Table 2.13).

2.4 Methods used for assessing stock trends

The main basis for assessing the stock is the survey time series plotted in Figures 2.6-2.13.

SURBA was used for further analysing the survey trends. The 2.1 version (Needle, 2003) was run for ages 2-9 with the time series of surveys and commercial catch. Input data are shown in Table 2.13. Survey catchability at age was estimated (unbounded) by the model. No age weighting was applied.

Catch curves were produced from the catch at age data (Figure 2.15)

For comparison with earlier assessment based on xsa, this model was run with the same model settings as in the three previous years. The inputs are the same as used by SURBA (Table 2.13)

2.5 Results of the Assessment

2.5.1 Indicators of stock biomass and mortality trends (Tables 2.14 – 2.16, Figure 2.13, 2.15–2.23)

Figure 2.13 show the time series of survey biomass. Figures 2.16-2.23 show the output of SURBA analysis of the indices for ages 2-9. The age effects shown in Figure 2.16 have a rather peculiar dip at age 7. Figure 2.17 shows that there are some methodical problems in estimating the catchabilty in the survey, as for most year classes the observed values for ages 2 and 3 and for ages 8 and 9 are below the modelled values. However, the residual plots (Figures 2.19-2.21) and retrospective plots (Figure 2.23) seem reasonable. The estimated average catchabilities by age (Figure 2.22) are dome shaped (similar to the shape observed in the xsa when assuming a plateau at age 8), and this is to be expected for the younger ages. The failure of the survey to reflect the older ages is worrying.

The estimated mean F has wide confidence limits but indicates a declining trend in mortalities, while the absolute F is rather uncertain. The trend since 2003 is also seen in the relative catch/biomass ratio in Figure 2.14. The relative SSB shows a fairly stable stock size since about 2002. The current stock biomass is indicated to be about 1/4 of the biomass in 1995. The trial xsa-run is in general agreement with this biomass trend, but shows no clear trend in F (Tables 2.15-2.16).

2.5.2 Recruitment (Tables 2.7, 2.15, 2.19)

The survey estimates of young age groups (1-3) in 2008 are among the lowest in the series. For ages 1, 2 and 3 the 2008 value is about 1/10 of the peak values in 1995, 1996 and 1997. At present there are therefore poor prospects for any rapid rebuilding of the stock in near future.

2.6 Comments to the Assessment

The acoustic survey probably has a larger relative uncertainty in later years compared to earlier. This is because cod now contributes to a lower fraction of the total observed acoustic values. The cod estimate is thus more vulnerable to allocation error. 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 can be difficult to define exactly and might influence the estimation of maturity-at-age and hence the estimation of SSB.

The catches of Coastal cod are severely underestimated (see 2.3.1). Although unreported catches have certainly existed for a long period, there are no available data for years other than 2003. Also, it is unknown whether the amount of unreported catch fluctuates with the stock size or with other factors.

2.7 Reference points

No reference points have been established for this stock.

2.8 Management considerations

Although the absolute value of the stock size is uncertain, the survey based assessment shows that the stock size for all years after 2001 are consistently much lower than in the late 90-ies. This applies both for the recruits and older age groups.

New regulations for coastal cod became operative in May 2004 and further extended into 2008 (see chapter 2.1.2). These regulations have reduced the fishing effort from vessels larger than 15m in the inner coastal areas and fjords. The estimated catch has been stable, however with some fluctuations, over these resent years with additional regulations. As described, there are uncertainties in catch estimation. However, the working group states that the fisheries have to be much more restricted to bring the catches down towards zero, and reiterate the latest advice that has been given for this stock of zero fishing.

Table 2.1a. Norwegian coastal cod. Estimated landings in numbers ('000) at age, and total tonnes by year.

	Age									Tonnes
	2	3	4	5	6	7	8	9	10+	landed
1984	829	3478	6954	7278	6004	4964	2161	819	624	74824
1985	396	7848	7367	8699	7085	3066	705	433	264	75451
1986	4095	4095	12662	8906	5750	3868	1270	342	407	68905
1987	170	940	8236	12430	4427	2649	1127	313	149	60972
1988	110	1921	3343	6451	6626	4687	1461	497	333	59294
1989	41	1159	1434	2299	5197	2720	949	236	86	40285
1990	7	349	1233	1330	1129	3456	773	141	73	28127
1991	125	607	1452	3114	1873	1297	873	132	94	24822
1992	40	665	3160	4422	2992	1945	898	837	279	41690
1993	4	369	1706	2343	2684	3072	1871	627	690	52557
1994	332	573	1693	4302	2467	3337	1514	777	798	54562
1995	810	896	2345	5188	5546	3270	1455	557	433	57207
1996	1193	2376	2480	4930	4647	4160	2082	898	543	61776
1997	1326	3438	3150	2258	2490	3935	3312	959	684	63319
1998	554	2819	4786	4023	2272	1546	1826	975	343	51572
1999	252	1322	2346	4263	2773	1602	751	774	320	40732
2000	156	971	3664	3807	2671	1104	326	132	152	36715
2001	44	505	1837	2974	1998	1409	542	187	119	29699
2002	192	893	2331	2822	2742	1538	915	325	377	40994
2003	81	1107	2094	2506	2158	1374	598	258	99	34635
2004	12	306	924	1713	1820	1444	609	226	264	24547
2005	15	474	1299	1828	1436	1115	513	188	143	22432
2006	71	315	1656	1695	1695	1246	671	326	224	26134
2007	88	515	1396	1846	1252	824	391	256	196	23841
2008	92	670	1438	1635	1232	862	440	215	170	25777

Table 2.1b. Esimated catch of coastal cod in 2008 by gear and area (tonnes).

Year	2008					
Area	03	04	00	05	06/07	Total
Gillnet	933	2 493	2 977	1 637	5 271	13 310
L.line/Jig	1 104	1 224	1 649	1 205	880	6 061
Danish seine	973	1 519	990	1 342	298	5 121
Trawl	516	572	176	7	14	1 285
Total	3 526	5 807	5 791	4 190	6 463	25 777

Table 2.2. Sampling from cod fisheries in 2008 in the statistical areas 00, 03,04,05, 06+07. Number of age samples of cod by quarter, total number of cod otoliths.

Quarter	3	4	0	5	6+7	Tot
1	20	32	37	53	20	162
2	43	36	6	22	9	116
3	9	3	1	13	9	35
4	16	7	2	18	0	43
Total samples	88	78	46	106	38	356
Total otoliths	3657	2754	1695	3759	818	12683
Coastal cod type otoliths	671	575	909	994	736	3885

Table 2.3 Number of otoliths sampled by quarter from commercial catches in the period 1985-2008. 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	1451	3852	777	1540	1277	1767	1966	730	5471	7889	41
1986	940	1594	1656	2579	0	0	669	966	3265	5139	39
1987	1195	2322	937	3051	638	1108	1122	1137	3892	7618	34
1988	257	546	160	619	87	135	55	44	559	1344	29
1989	556	1387	72	374	65	501	97	663	790	2925	21
1990	731	2974	61	689	252	97	265	674	1309	4434	23
1991	285	1168	92	561	77	96	279	718	733	2543	22
1992	152	619	281	788	79	82	272	672	784	2161	27
1993	314	1098	172	1046	0	0	310	541	796	2685	23
1994	317	1605	179	923	21	31	126	674	643	3233	17
1995	188	1591	232	1682	2095	1057	752	1330	3267	5660	37
1996	861	5486	591	1958	1784	1076	958	2256	4194	10776	28
1997	1106	5429	367	2494	1940	894	1690	1755	5103	10572	33
1998	608	4930	552	1342	489	1094	2999	2217	4648	9583	33
1999	1277	4702	493	2379	202	717	961	1987	2933	9785	23
2000	1283	4918	365	2112	386	1295	472	668	2506	9993	20
2001	1102	5091	352	2295	126	786	432	983	2012	9155	18
2002	823	5818	321	1656	503	831	897	1355	2544	9660	21
2003	821	4197	445	2850	790	936	1112	1286	3168	9269	25
2004	1511	7539	758	2565	532	685	531	1317	3332	12106	22
2005	1583	6219	767	4383	473	258	877	1258	3700	12188	23
2006	2244	5087	1329	2819	590	271	119	71	4282	8248	34
2007	1867	5895	944	2496	503	648	637	1163	3951	10202	28
2008	1450	4162	1116	3122	626	515	693	999	3885	8798	31

Table 2.4. Landings in tonnes of Coastal cod by area and quarter 2004-2007 (upper 4 tables) Proportion (of total) coastal cod in landings by area and quarter 2004-2007 (lower 4 tables).

Year	2005					
Qu./Area	03	04	00	05	06-07	Total
1	587	2972	2449	1245	3131	10384
2	1741	1851	610	872	1579	6652
3	287	826	341	225	484	2164
4	553	785	830	684	378	3230
Total	3169	6434	4230	3027	5572	22432

Year	2006					
Qu./Area	03	04	00	05	06-07	Total
1	291	3483	2677	3150	4169	13769
2	1485	2298	601	507	1388	6279
3	343	893	338	635	564	2774
4	253	1232	444	1071	312	3312
Total	2372	7906	4059	5363	6434	26134

Year	2007					
Qu./Area	03	04	00	05	06-07	Total
1	664	1812	3787	2274	3843	12380
2	2962	1762	679	803	1324	7530
3	416	393	537	279	423	2049
4	557	343	346	354	283	1883
Total	4599	4311	5349	3709	5873	23841

Year	2008					
Qu./Area	03	04	00	05	06-07	Total
1	653	2206	3964	2222	4090	13134
2	2005	2162	1116	979	1640	7902
3	513	647	287	332	434	2212
4	356	793	424	657	299	2529
Total	3526	5807	5791	4190	6463	25777

Year	2005					
Qu./Area	03	04	00	05	06-07	Total
1	0.09	0.22	0.12	0.05	0.89	0.15
2	0.11	0.14	0.12	0.16	1.00	0.16
3	0.26	0.70	0.91	0.50	0.89	0.59
4	0.23	0.52	0.92	0.50	0.97	0.49
Total	0.12	0.22	0.16	0.10	0.93	0.19

Year	2006					
Qu./Area	03	04	00	05	06-07	Total
1	0.05	0.20	0.13	0.13	0.88	0.19
2	0.20	0.16	0.13	0.10	0.96	0.19
3	0.35	0.81	0.91	0.95	0.98	0.75
4	0.10	0.85	0.91	0.95	0.99	0.56
Total	0.15	0.23	0.15	0.17	0.91	0.23

Year	2007					
Qu./Area	03	04	00	05	06-07	Total
1	0.08	0.09	0.24	0.07	0.79	0.16
2	0.28	0.13	0.24	0.23	0.95	0.23
3	0.33	0.49	0.98	0.50	1.00	0.57
4	0.23	0.36	0.98	0.52	0.90	0.40
Total	0.20	0.12	0.28	0.11	0.84	0.20

Year	2008					
Qu./Area	03	04	00	05	06-07	Total
1	0.10	0.10	0.23	0.08	0.86	0.17
2	0.22	0.19	0.29	0.27	0.92	0.26
3	0.30	0.60	0.95	0.60	1.00	0.54
4	0.14	0.65	0.95	0.57	1.00	0.44
Total	0.18	0.16	0.27	0.12	0.89	0.22

Table 2.5. Coastal cod. Acoustic abundance indices by sub areas and in total in 2008 (in thousands).

	Alder (Årsklasse) / *Age (Year class)*										
Område	1	2	3	4	5	6	7	8	9	10+	
Area	(07)	(06)	(05)	(04)	(03)	(02)	(01)	(00)	(99)	(98+)	Total
03	763	513	928	1130	431	630	178	208	57	16	4854
04	897	642	577	430	492	250	190	60	80	54	3672
05	82	126	258	200	65	6	56	32	5	4	834
00	78	420	193	699	755	257	245	41	133	78	2899
06	305	342	390	349	324	65	116	62	38	21	2012
07	3	138	129	55	34	11	30		6	4	410
Total	2128	2181	2475	2863	2101	1219	815	403	319	177	14681

Table 2.6. Coastal cod. Acoustic abundance indices by age 1995 – 2008 (in thousands).

År	Alder / *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	69099
1999	6850	11309	12171	10123	7197	3052	850	242	112	54	51960
2000	9587	11528	11612	8974	7984	5451	1365	488	85	97	57171
2001	8366	6729	7994	7578	4751	2567	1493	487	189	116	40270
2002	1329	2990	4103	4940	3617	2593	1470	408	29	128	21607
2003	2084	2145	3545	3880	2788	2389	1144	589	364	80	19008
2004	3217	3541	3696	4320	2758	1940	783	448	98	110	20914
2005	1443	1843	3525	3198	3217	1700	1120	552	330	78	17006
2006	1929	2525	4049	3783	3472	2509	1811	399	229	13	20719
2007	2202	3300	4080	5518	3259	2447	1444	760	197	34	23241
2008	2128	2181	2475	2863	2101	1219	815	403	319	177	14681

Table 2.7. Coastal cod. Mean length (cm) at age 1995 – 2008.

År	Alder / *Age*									
Year	1	2	3	4	5	6	7	8	9	10+
1995	21.5	33.0	43.0	52.0	59.1	64.1	76.0	87.4	89.0	108.3
1996	19.0	30.2	41.7	52.5	59.2	65.2	79.1	84.8	87.0	114.2
1997	16.8	28.7	40.8	51.6	58.1	65.9	73.6	80.8	102.0	110.7
1998	20.3	33.3	43.8	51.4	59.1	66.3	74.1	81.0	93.2	116.9
1999	21.5	32.6	43.8	54.6	59.6	65.8	77.9	90.8	99.4	118.0
2000	21.6	33.3	43.4	53.5	61.0	66.1	75.5	90.8	99.1	105.5
2001	21.1	33.3	44.5	53.6	62.9	64.7	88.7	84.2	85.7	102.1
2002	22.5	34.4	44.6	56.0	61.6	67.7	72.4	66.6	89.0	108.3
2003	18.9	33.8	42.1	51.6	60.0	67.2	72.7	76.9	84.9	94.8
2004	20.7	32.9	43.5	54.5	59.9	68.0	71.9	75.0	74.6	91.8
2005	22.5	32.8	42.2	57.9	60.6	64.0	71.3	69.9	73.5	108.4
2006	22.2	36.1	47.0	55.5	61.4	68.0	69.5	77.8	87.0	100.5
2007	21.6	36.0	48.0	57.9	62.2	66.8	71.8	86.6	100.2	106.3
2008	21.9	36.9	49.2	59.0	66.1	70.9	71.7	74.1	77.6	98.8

Table 2.8. Coastal cod. Mean weight (grams) at age 1995-2008.

År	Alder / *Age*									
Year	1	2	3	4	5	6	7	8	9	10+
1995	81	390	791	1525	2222	2881	4665	6979	6759	9897
1996	59	252	724	1433	2053	2748	4722	6685	6932	9723
1997	43	240	683	1364	1893	2816	4426	6406	7805	1827
1998	52	372	883	1456	2107	2950	4319	5625	8323	12468
1999	70	323	841	1675	2192	2857	4540	6579	9454	12902
2000	72	365	809	1554	2539	3049	4352	6203	8527	12066
2001	51	396	966	1524	2314	3320	3695	6144	8768	12468
2002	103	428	895	1741	2433	3133	4273	4397	7759	12992
2003	62	385	738	1353	2145	3103	3981	4921	6923	9956
2004	83	352	834	1690	2255	3312	4150	4594	4383	9733
2005	112	359	786	2168	2265	2756	4174	3373	4502	15887
2006	105	474	1080	1746	2430	3336	3684	5125	7028	14650
2007	103	518	1185	2011	2500	3160	4241	6806	11051	14931
2008	96	508	1208	2095	2987	3671	3976	4387	5415	11588

Table 2.9. Coastal cod. Acoustic biomass indices (tonnes) in 1995 – 2008.

År	Alder / Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1995	2337	7868	10786	23846	36039	27515	14445	8761	4933	7779	144309
1996	145	4386	16521	17739	25687	18731	15562	4376	3130	46	106323
1997	1319	4518	19748	23644	23435	29884	15060	8860	249	8643	135360
1998	752	5078	13247	19274	15627	9255	6675	1646	1329	2083	74966
1999	477	3650	10233	16960	15774	8720	4723	2097	1220	567	64421
2000	688	4321	9824	14464	20482	17067	5936	4359	926	1232	79299
2001	425	2662	7724	11548	10993	8521	5517	3010	1705	1917	54022
2002	137	1279	3672	8600	8801	8124	6282	1794	225	1663	40577
2003	125	876	2569	5328	5788	6995	4201	2754	2674	1136	32446
2004	329	1269	3087	7394	6089	6901	3009	1779	454	1058	31405
2005	109	675	2947	6521	7167	4807	3648	1942	1315	1205	30336
2006	202	1197	4374	6605	8435	8367	6672	2045	1602	190	39689
2007	227	1709	4835	11097	8148	7733	6124	5173	2177	508	47731
2008	206	1212	3120	6085	6593	4203	3437	2014	1492	2066	30506

Table 2.10. Coastal cod. Maturity ogives by age in the period 1995 – 2008.

År				Alder	/ Age				
Year	1	2	3	4	5	6	7	8	9	10+
1995	0.00	0.00	0.01	0.21	0.48	0.71	0.87	0.87	1.00	1.00
1996	0.00	0.00	0.03	0.25	0.56	0.81	0.92	0.99	1.00	1.00
1997	0.00	0.00	0.06	0.29	0.45	0.76	0.97	1.00	1.00	1.00
1998	0.00	0.02	0.15	0.25	0.53	0.74	0.87	0.89	1.00	1.00
1999	0.00	0.02	0.03	0.21	0.43	0.66	0.74	1.00	1.00	1.00
2000	0.00	0.00	0.00	0.16	0.31	0.61	0.76	0.64	0.99	1.00
2001	0.00	0.00	0.00	0.04	0.37	0.78	0.98	0.99	0.97	1.00
2002	0.00	0.02	0.02	0.26	0.88	0.93	0.90	0.97	1.00	1.00
2003	0.00	0.00	0.00	0.05	0.29	0.49	0.90	0.98	0.96	1.00
2004	0.00	0.00	0.01	0.09	0.37	0.76	0.95	0.98	1.00	1.00
2005	0.00	0.00	0.00	0.07	0.40	0.56	0.89	0.98	1.00	1.00
2006	0.00	0.00	0.00	0.14	0.52	0.75	0.91	0.87	0.96	1.00
2007	0.00	0.00	0.00	0.14	0.54	0.76	0.96	0.83	1.00	1.00
2008	0.00	0.00	0.03	0.12	0.48	0.72	0.89	0.94	0.96	1.00

Table 2.11. Coastal cod. Acoustic spawning biomass indices (tonnes) in 1995 – 2008.

År	Alder / Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1995	0	0	96	4925	17424	19614	12573	7648	4933	7779	74992
1996	0	0	468	4467	14320	15130	14365	4311	3130	46	56237
1997	0	0	1185	6857	10546	22712	14608	8860	249	8643	73660
1998	0	92	2026	4870	8252	6804	5774	1461	1329	2083	32691
1999	0	56	315	3544	6778	5716	3478	2097	1220	567	23771
2000	0	0	0	2366	6354	10426	4486	2798	916	1232	28579
2001	0	0	15	508	4102	6662	5398	2978	1650	1917	23230
2002	0	20	87	2240	7702	7551	5650	1747	225	1663	26885
2003	0	0	0	269	1670	3428	3778	2686	2554	1136	15521
2004	0	0	28	679	2252	5253	2853	1736	434	722	13959
2005	0	0	0	447	2844	2670	3247	1898	1315	288	12709
2006	0	0	0	925	4386	6275	6072	1779	1538	571	21546
2007	0	0	0	1554	4400	5877	5879	4294	2177	508	24689
2008	0	0	107	734	3189	3012	3049	1902	1434	2066	15493

Table 2.12. Proportion coastal cod among sampled cod during the coastal survey by age and statistical areas in the years 2003-2008.

Year	Area/Age	2	3	4	5	6	7	8	9	10+
2003	3	0,86	0,79	0,77	0,78	0,71	0,76	0,58	0,49	0,06
2003	4	0,97	0,95	0,92	0,87	0,84	0,80	0,79	0,72	0,65
2003	5	1,00	0,95	0,84	0,90	0,97	0,92	1,00	0,55	0,12
2003	0	0,99	0,80	0,92	0,88	0,88	0,70	0,51	0,65	0,89
2003	6	0,74	0,79	0,72	0,71	0,77	0,64	0,69	0,84	0,00
2003	7	0,50	0,54	0,87	0,66	0,76	0,93	0,83	0,80	
2004	3	0,61	0,62	0,35	0,43	0,39	0,34	0,45	0,33	0,69
2004	4	0,84	0,83	0,74	0,76	0,77	0,47	0,77	0,44	0,44
2004	5	0,80	0,89	0,82	0,79	0,62	0,85	0,75	0,50	0,20
2004	0	1,00	0,94	0,94	0,60	0,85	1,00	1,00	1,00	0,07
2004	6	0,85	0,94	0,86	0,85	0,74	0,77	0,64	1,00	
2004	7	0,98	0,96	0,99	0,97	0,90	0,91	0,75	1,00	
2005	3	0,63	0,54	0,54	0,45	0,35	0,30	0,20	0,48	0,03
2005	4	0,96	0,91	0,76	0,74	0,71	0,60	0,76	0,81	0,50
2005	5	0,00	0,54	0,65	0,68	0,52	1,00	1,00	0,67	
2005	0	0,11	0,39	0,70	0,61	0,70	0,85	0,50	1,00	
2005	6	1,00	1,00	0,93	0,87	0,81	0,81	0,59	0,96	
2005	7	1,00	1,00	1,00	1,00	1,00	0,86	0,67	0,00	
2006	3	0,79	0,77	0,63	0,59	0,45	0,37	0,30	0,39	0,00
2006	4	1,00	0,88	0,84	0,79	0,68	0,63	0,82	0,40	0,42
2006	5	1,00	0,98	0,81	0,88	0,77	0,63	0,80	0,00	0,50
2006	0	0,99	0,99	0,95	0,87	0,86	0,89	0,85	0,33	
2006	6	1,00	1,00	0,95	0,99	0,80	0,72	1,00	0,67	
2006	7	1,00	0,97	0,95	0,98	0,89	1,00	0,50		
2007	3	0,83	0,38	0,40	0,59	0,27	0,32	0,00	1,00	
2007	4	0,91	0,92	0,92	0,80	0,80	0,90	0,71	0,67	1,00
2007	5	0,97	1,00	0,97	0,94	0,94	0,95	0,86	0,67	0,00
2007	0	1,00	0,88	1,00	1,00	1,00	0,00	1,00	1,00	
2007	6	1,00	1,00	0,95	0,87	0,91	0,81			
2007	7	1,00	1,00	1,00	0,89	0,86	0,86	1,00	1,00	1,00
2008	3	0.98	0.97	0.80	0.83	0.79	0.72	0.53	1.00	0.40
2008	4	1.00	0.99	0.80	0.88	0.84	0.78	0.88	0.88	0.86
2008	5	1.00	1.00	0.93	0.96	1.00	0.80	0.67	1.00	1.00
2008	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
2008	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2008	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2.13. Inputs for SURBA analysis.

```
SURBA 2.10
----------
Run performed at 15:03:42 on 22/04/2009
Working directory: C:\Documents and Settings\knutsu\Skrivebord\AFWG\2009\SURBA

--------------------------------------------------------------------

Analysis will use data from fleet.txt

Survey: Norw. Coast. survey tot.

Index dimensions
----------------

Number of years              14 (1995-2008)
Number of ages                8 (2-9)
Last age plus group          No
Mean F range                4-7
No. years for forecast F      3
No. years for forecast M      3
No. years for forecast Wt     3
No. years for forecast Mat    3
No. years for GM rec         10
No. years for forecast       10

Default age weightings
```

Age	2	3	4	5	6	7	8	9
w	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Default catchabilities

Age	2	3	4	5	6	7	8	9
q	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Survey index data

Year	Age 2	3	4	5	6	7	8	9
1995	20191.0	13633.0	15636.0	16219.0	9550.0	3174.0	1158.0	781.0
1996	17378.0	22815.0	12382.0	12514.0	6817.0	3180.0	754.0	242.0
1997	18827.0	28913.0	17334.0	12379.0	10612.0	3928.0	1515.0	26.0
1998	13659.0	15003.0	13239.0	7415.0	3136.0	1577.0	316.0	169.0
1999	11309.0	12171.0	10123.0	7197.0	3052.0	850.0	242.0	112.0
2000	11528.0	11612.0	8974.0	7984.0	5451.0	1365.0	488.0	85.0
2001	6729.0	7993.0	7578.0	4751.0	2565.0	1493.0	487.0	190.0
2002	2990.0	4103.0	4940.0	3617.0	2593.0	1470.0	408.0	29.0
2003	2144.0	3545.0	3880.0	2788.0	2389.0	1144.0	589.0	364.0
2004	3541.0	3697.0	4320.0	2759.0	1941.0	782.0	448.0	99.0
2005	1843.0	3525.0	3198.0	3217.0	1700.0	1120.0	552.0	330.0
2006	2525.0	4049.0	3783.0	3472.0	2509.0	1811.0	399.0	229.0
2007	3300.0	4080.0	5518.0	3259.0	2447.0	1444.0	760.0	197.0
2008	2181.0	2475.0	2863.0	2101.0	1219.0	815.0	403.0	319.0

Table 2.13. continued

Natural mortality = 0.2 for all ages

Catch weights by age

Year	Age 2	3	4	5	6	7	8	9
1995	0.302	0.710	1.335	1.842	2.467	4.191	5.778	6.376
1996	0.274	0.921	1.464	1.979	2.516	3.461	4.866	5.391
1997	0.277	0.970	1.554	1.970	2.897	3.716	4.829	6.349
1998	0.376	0.978	1.518	2.281	3.125	3.900	5.520	6.333
1999	0.467	1.155	1.633	2.171	3.249	4.095	5.013	6.018
2000	0.515	1.305	2.272	2.555	3.283	4.504	5.400	6.379
2001	0.164	0.952	1.637	2.881	3.424	4.038	5.397	7.208
2002	0.491	1.179	1.800	2.485	3.860	4.760	5.195	5.507
2003	0.944	1.552	2.146	3.082	3.594	4.953	5.736	6.477
2004	0.824	1.374	1.877	2.679	3.365	4.013	4.847	5.554
2005	0.820	1.317	2.094	2.795	3.493	4.087	4.836	6.264
2006	1.274	1.599	1.894	2.687	3.562	4.029	5.182	5.905
2007	1.241	1.744	2.143	2.718	4.098	4.884	5.939	6.890
2008	0.977	1.882	2.444	3.747	4.165	4.989	5.992	6.143

Proportion mature

Year	Age 2	3	4	5	6	7	8	9
1995	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
1996	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
1997	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
1998	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
1999	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2000	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2001	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2002	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2003	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2004	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2005	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2006	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2007	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000
2008	0.01000	0.06000	0.24000	0.49000	0.72000	0.88000	0.95000	1.00000

Stock weights

Year	Age 2	3	4	5	6	7	8	9
1995	0.2980	0.7000	1.3380	1.9730	2.6490	4.1640	7.0510	6.4130
1996	0.2700	0.7170	1.4350	2.0440	2.6940	4.8170	6.2800	11.3650
1997	0.2320	0.6770	1.3630	1.9030	2.8160	3.8330	5.8490	9.6000
1998	0.3230	0.8340	1.3660	2.0750	3.0130	4.2550	5.3050	8.3500
1999	0.3180	0.8040	1.5590	2.0420	2.7980	4.6780	7.1510	8.9590
2000	0.3460	0.7770	1.4580	2.2960	2.7350	4.0480	7.0110	9.2240
2001	0.3470	0.8780	1.5430	2.2130	2.8620	3.3210	4.8490	7.3390
2002	0.4300	0.8800	1.6980	2.4520	3.5380	4.3970	4.1910	7.0460
2003	0.3080	0.6860	1.2990	2.1490	3.1350	4.0480	5.0080	5.7890
2004	0.3390	0.8340	1.6140	2.2690	3.2900	4.1240	4.7180	4.9760
2005	0.4070	0.8460	1.7480	2.2000	2.6930	3.8170	3.7970	5.3440
2006	0.4900	1.1250	1.8120	2.5590	3.5790	3.9640	4.8220	7.3320
2007	0.5180	1.1850	2.0110	2.5000	3.1600	4.2410	6.8060	11.0510
2008	0.5080	1.2080	2.0950	2.9870	3.6710	3.9760	4.3870	5.4150

Table 2.14. Report file from SURBA analysis (forecast and bootstrap omitted).

Survey index data (mean-standardised)

Year	Age 2	3	4	5	6	7	8	9
1995	4.10398	2.77102	3.17814	3.29664	1.94111	0.64514	0.23537	0.15874
1996	3.53222	4.63733	2.51674	2.54357	1.38561	0.64636	0.15326	0.04919
1997	3.82674	5.87680	3.52327	2.51613	2.15697	0.79840	0.30794	0.00528
1998	2.77630	3.04948	2.69093	1.50716	0.63742	0.32054	0.06423	0.03435
1999	2.29864	2.47385	2.05758	1.46285	0.62034	0.17277	0.04919	0.02276
2000	2.34316	2.36023	1.82404	1.62281	1.10796	0.27745	0.09919	0.01728
2001	1.36772	1.62464	1.54029	0.96568	0.52136	0.30346	0.09899	0.03862
2002	0.60774	0.83397	1.00409	0.73518	0.52705	0.29879	0.08293	0.00589
2003	0.43579	0.72055	0.78864	0.56668	0.48558	0.23253	0.11972	0.07399
2004	0.71974	0.75144	0.87807	0.56079	0.39452	0.15895	0.09106	0.02012
2005	0.37460	0.71648	0.65002	0.65388	0.34554	0.22765	0.11220	0.06708
2006	0.51323	0.82299	0.76892	0.70571	0.50997	0.36810	0.08110	0.04655
2007	0.67075	0.82929	1.12158	0.66242	0.49737	0.29350	0.15448	0.04004
2008	0.44331	0.50306	0.58193	0.42704	0.24777	0.16566	0.08191	0.06484

Scaling factor = 4919.85714

Smoothing indices by cohorts

YC	N	a1	a2	IFAIL	RSS	Smoothed index by age 2	3	4	5	6	7	8	9
1986	1	9	9	9	0.000	NA	NA	NA	NA	NA	NA	NA	0.159
1987	2	8	9	9	0.000	NA	NA	NA	NA	NA	NA	0.235	0.049
1988	3	7	9	9	0.000	NA	NA	NA	NA	NA	0.645	0.153	0.005
1989	4	6	9	0	0.298	NA	NA	NA	NA	2.160	0.690	0.196	0.045
1990	5	5	9	0	0.601	NA	NA	NA	3.925	1.426	0.433	0.100	0.022
1991	6	4	9	0	0.624	NA	NA	4.231	2.553	1.157	0.327	0.072	0.016
1992	7	3	9	0	0.407	NA	3.413	2.538	1.531	0.655	0.241	0.094	0.038
1993	8	2	9	0	0.613	4.965	4.202	2.988	1.648	0.726	0.249	0.058	0.009
1994	8	2	9	0	0.577	4.666	4.067	2.853	1.641	0.791	0.317	0.127	0.059
1995	8	2	9	0	0.235	4.086	3.056	2.140	1.303	0.647	0.273	0.093	0.026
1996	8	2	9	0	0.092	3.100	2.370	1.635	0.962	0.494	0.235	0.113	0.060
1997	8	2	9	0	0.157	2.682	2.063	1.391	0.802	0.416	0.202	0.099	0.048
1998	8	2	9	0	0.053	2.413	1.577	1.005	0.622	0.368	0.195	0.091	0.041
1999	8	2	9	0	0.160	1.291	0.959	0.738	0.561	0.409	0.274	0.152	0.074
2000	7	2	8	0	0.124	0.660	0.754	0.786	0.678	0.463	0.242	0.104	NA
2001	6	2	7	0	0.188	0.518	0.649	0.700	0.610	0.403	0.214	NA	NA
2002	5	2	6	0	0.145	0.776	0.762	0.687	0.511	0.314	NA	NA	NA
2003	4	2	5	0	0.412	0.491	0.677	0.735	0.604	NA	NA	NA	NA
2004	3	2	4	9	0.000	0.513	0.829	0.582	NA	NA	NA	NA	NA
2005	2	2	3	9	0.000	0.671	0.503	NA	NA	NA	NA	NA	NA
2006	1	2	2	9	0.000	0.443	NA	NA	NA	NA	NA	NA	NA

Smoothed index

Year	Age 2	3	4	5	6	7	8	9
1995	4.96451	3.41307	4.23051	3.92510	2.15990	0.64514	0.23537	0.15874
1996	4.66604	4.20161	2.53837	2.55305	1.42574	0.69017	0.15326	0.04919
1997	4.08596	4.06702	2.98832	1.53052	1.15674	0.43290	0.19604	0.00528
1998	3.09952	3.05618	2.85329	1.64766	0.65520	0.32693	0.09979	0.04541
1999	2.68162	2.37037	2.14012	1.64148	0.72622	0.24147	0.07227	0.02206
2000	2.41329	2.06256	1.63532	1.30306	0.79135	0.24892	0.09371	0.01609
2001	1.29070	1.57681	1.39075	0.96205	0.64713	0.31690	0.05830	0.03765
2002	0.66001	0.95945	1.00532	0.80202	0.49445	0.27277	0.12736	0.00938
2003	0.51839	0.75363	0.73832	0.62244	0.41638	0.23471	0.09259	0.05938
2004	0.77581	0.64887	0.78649	0.56067	0.36822	0.20174	0.11341	0.02569
2005	0.49136	0.76191	0.69967	0.67771	0.40888	0.19453	0.09923	0.05953
2006	0.51323	0.67695	0.68711	0.60990	0.46255	0.27398	0.09078	0.04816
2007	0.67075	0.82929	0.73454	0.51101	0.40321	0.24247	0.15155	0.04080
2008	0.44331	0.50306	0.58193	0.60436	0.31357	0.21385	0.10367	0.07384

Table 2.14. continued

```
Catchability estimation
-----------------------
IFAIL from E04JYF =    0
RSS =     2.639

Estimated catchabilities

Age   Catchability
 2    0.427
 3    0.607
 4    0.891
 5    1.000
 6    0.979
 7    0.945
 8    0.465
 9    0.688

Analysis definitions and results
--------------------------------
Indices smoothed before analysis
Estimated catchabilities
User-defined age weighting
Unconstrained parameter estimation

Index smoother            =    2.0000
SSQ smoother              =    0.0000
IFAIL on exit from E04FYF  =    5
Residual sum-of-squares    =    2.6385
Number of observations     =  124
Number of parameters       =   40
IFAIL on exit from E04YCF  =    0

Catchabilities used in analysis

Age        2        3        4        5        6        7        8        9
q      0.427    0.607    0.891    1.000    0.979    0.945    0.465    0.688

Age weightings used in analysis

Age        2        3        4        5        6        7        8        9
w      1.000    1.000    1.000    1.000    1.000    1.000    1.000    1.000

Parameter estimates
                        Estimate   s.e.    Initial
Temporal trends:  1995   1.2057   0.1292   1.0000
                  1996   2.2710   0.1205   1.0000
                  1997   1.1971   0.1151   1.0000
                  1998   1.2285   0.1114   1.0000
                  1999   1.4404   0.1100   1.0000
                  2000   0.7930   0.1098   1.0000
                  2001   1.6214   0.1115   1.0000
                  2002   0.6636   0.1101   1.0000
                  2003   0.9109   0.1086   1.0000
                  2004   0.3636   0.1085   1.0000
                  2005   0.3642   0.1077   1.0000
                  2006   0.5430   0.1066   1.0000
                  2007   0.3976       NA       NA
Table 2.14.  continued…

Age effects:         2   0.2413   0.0557   0.5000
                     3   0.4081   0.0510   0.5000
                     4   0.3041   0.0502   0.5000
                     5   0.4229   0.0509   0.5000
                     6   0.5937   0.0531   0.5000
                     7   0.1460   0.0571   0.5000
                     8   1.5166   0.0634   0.5000
                     9   1.5166       NA       NA
```

Cohort effects:

1986	-1.4666	0.1772	-0.9077
1987	-0.6450	0.1646	-0.5138
1988	-0.6546	0.1248	0.4945
1989	0.6805	0.1208	1.7028
1990	1.2562	0.1112	2.3001
1991	1.5556	0.1039	2.3751
1992	1.9098	0.1035	2.1604
1993	2.5555	0.0988	2.2955
1994	2.5583	0.1181	2.2335
1995	2.1353	0.0876	2.1007
1996	1.8910	0.0893	1.8244
1997	1.5657	0.0950	1.6796
1998	1.2941	0.0856	1.5741
1999	1.0883	0.0993	0.9483
2000	0.7362	0.0804	0.2776
2001	0.4785	0.0869	0.0361
2002	0.4098	0.0853	0.4393
2003	0.3950	0.0933	-0.0174
2004	0.3644	0.1061	0.0261
2005	0.2795	0.1265	0.2938
2006	0.0366	0.1772	-0.1203

Fishing mortality-at-age

	Age							
Year	2	3	4	5	6	7	8	9
1995	0.29093	0.49211	0.36664	0.50991	0.71584	0.17603	1.82868	1.82868
1996	0.54796	0.92687	0.69055	0.96039	1.34825	0.33154	3.44424	3.44424
1997	0.28885	0.48859	0.36401	0.50625	0.71071	0.17477	1.81558	1.81558
1998	0.29642	0.50139	0.37355	0.51952	0.72933	0.17935	1.86315	1.86315
1999	0.34755	0.58789	0.43800	0.60915	0.85516	0.21029	2.18459	2.18459
2000	0.19135	0.32367	0.24115	0.33538	0.47083	0.11578	1.20277	1.20277
2001	0.39122	0.66175	0.49303	0.68568	0.96260	0.23671	2.45905	2.45905
2002	0.16012	0.27084	0.20178	0.28063	0.39397	0.09688	1.00643	1.00643
2003	0.21980	0.37179	0.27700	0.38524	0.54082	0.13299	1.38158	1.38158
2004	0.08774	0.14841	0.11057	0.15377	0.21587	0.05308	0.55147	0.55147
2005	0.08787	0.14863	0.11073	0.15401	0.21620	0.05316	0.55231	0.55231
2006	0.13102	0.22162	0.16511	0.22963	0.32237	0.07927	0.82353	0.82353
2007	0.09593	0.16227	0.12090	0.16814	0.23604	0.05804	0.60299	0.60299
2008	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 2.14. continued…

Log fitted survey index

Year	Age 2	3	4	5	6	7	8	9
1995	2.55553	1.90978	1.55561	1.25623	0.68045	-0.65464	-0.64503	-1.46659
1996	2.55827	2.06460	1.21766	0.98897	0.54632	-0.23539	-1.03067	-2.67372
1997	2.13530	1.81031	0.93773	0.32711	-0.17142	-1.00193	-0.76693	-4.67491
1998	1.89105	1.64645	1.12173	0.37372	-0.37914	-1.08213	-1.37669	-2.78251
1999	1.56566	1.39463	0.94506	0.54817	-0.34581	-1.30848	-1.46148	-3.43985
2000	1.29412	1.01810	0.60674	0.30707	-0.26097	-1.40096	-1.71876	-3.84606
2001	1.08832	0.90277	0.49443	0.16559	-0.22831	-0.93180	-1.71674	-3.12153
2002	0.73623	0.49710	0.04102	-0.19860	-0.72009	-1.39091	-1.36851	-4.37579
2003	0.47849	0.37611	0.02627	-0.36076	-0.67923	-1.31406	-1.68779	-2.57494
2004	0.40982	0.05869	-0.19568	-0.45073	-0.94600	-1.42005	-1.64704	-3.26937
2005	0.39496	0.12208	-0.28971	-0.50625	-0.80451	-1.36188	-1.67314	-2.39852
2006	0.36445	0.10709	-0.22655	-0.60045	-0.86026	-1.22071	-1.61504	-2.42545
2007	0.27953	0.03343	-0.31453	-0.59166	-1.03008	-1.38263	-1.49998	-2.63857
2008	0.03658	-0.01640	-0.32884	-0.63542	-0.95980	-1.46612	-1.64067	-2.30297

Fitted survey index

Year	Age 2	3	4	5	6	7	8	9
1995	12.8782	6.7516	4.7380	3.5122	1.9748	0.5196	0.5246	0.2307
1996	12.9135	7.8822	3.3793	2.6885	1.7269	0.7903	0.3568	0.0690
1997	8.4596	6.1124	2.5542	1.3870	0.8425	0.3672	0.4644	0.0093
1998	6.6263	5.1885	3.0702	1.4531	0.6844	0.3389	0.2524	0.0619
1999	4.7858	4.0335	2.5730	1.7301	0.7077	0.2702	0.2319	0.0321
2000	3.6478	2.7679	1.8344	1.3594	0.7703	0.2464	0.1793	0.0214
2001	2.9693	2.4664	1.6396	1.1801	0.7959	0.3938	0.1797	0.0441
2002	2.0880	1.6440	1.0419	0.8199	0.4867	0.2488	0.2545	0.0126
2003	1.6136	1.4566	1.0266	0.6971	0.5070	0.2687	0.1849	0.0762
2004	1.5065	1.0604	0.8223	0.6372	0.3883	0.2417	0.1926	0.0380
2005	1.4843	1.1298	0.7485	0.6028	0.4473	0.2562	0.1877	0.0909
2006	1.4397	1.1130	0.7973	0.5486	0.4231	0.2950	0.1989	0.0884
2007	1.3225	1.0340	0.7301	0.5534	0.3570	0.2509	0.2231	0.0715
2008	1.0373	0.9837	0.7198	0.5297	0.3830	0.2308	0.1939	0.1000

Fitted catch-at-age

Year	Age 2	3	4	5	6	7	8	9
1995	2.96070	2.39781	1.32613	1.28231	0.92583	0.07624	0.41073	0.18062
1996	4.98252	4.38236	1.54489	1.52783	1.18407	0.20323	0.32837	0.06350
1997	1.93277	2.15860	0.71062	0.50357	0.39300	0.05352	0.36261	0.00728
1998	1.54820	1.86974	0.87278	0.53826	0.32507	0.05058	0.19898	0.04878
1999	1.28082	1.64083	0.83312	0.72256	0.37386	0.04661	0.19287	0.02667
2000	0.57763	0.69743	0.35769	0.35303	0.26422	0.02446	0.11592	0.01381
2001	0.87700	1.09394	0.58313	0.53681	0.45292	0.07554	0.15451	0.03792
2002	0.28075	0.35511	0.17313	0.18268	0.14458	0.02086	0.14877	0.00735
2003	0.28964	0.41246	0.22616	0.20331	0.19368	0.03040	0.12832	0.05285
2004	0.11486	0.13289	0.07815	0.08252	0.06858	0.01134	0.07468	0.01475
2005	0.11333	0.14178	0.07124	0.07818	0.07911	0.01203	0.07284	0.03527
2006	0.16059	0.20127	0.11029	0.10240	0.10623	0.02041	0.10252	0.04559
2007	0.10982	0.14075	0.07551	0.07784	0.06829	0.01284	0.09249	0.02962
2008	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 2.14. continued

Log residuals

Year	Age 2	3	4	5	6	7	8	9
1995	-0.10314	-0.18272	0.00185	0.11141	0.11073	0.27307	-0.03549	0.00000
1996	-0.16788	-0.12969	-0.17100	-0.05143	-0.17051	-0.07871	-0.07891	0.03549
1997	0.12234	0.09204	0.27212	0.09874	0.33814	0.22139	-0.09643	-0.19416
1998	0.09028	-0.02984	0.04188	0.12589	-0.02255	0.02085	-0.16195	0.06442
1999	0.27084	-0.03214	-0.06906	-0.05232	0.04702	-0.05582	-0.39977	-0.00035
2000	0.43695	0.20530	0.00024	-0.04210	0.04808	0.06707	0.11727	0.09036
2001	0.01694	0.05208	-0.04944	-0.20404	-0.18578	-0.16065	-0.35934	0.21608
2002	-0.30165	-0.03905	0.07942	-0.02177	0.03690	0.14850	0.07386	0.08006
2003	-0.28543	-0.15951	-0.21450	-0.11309	-0.17580	-0.07864	0.07427	0.12498
2004	0.18641	0.00824	0.07065	-0.12763	-0.03196	-0.12401	0.23634	-0.01833
2005	-0.25545	0.10544	0.04770	0.11746	-0.06872	-0.21856	0.12891	-0.04894
2006	-0.18141	0.00220	-0.03358	0.10624	0.11036	-0.01729	-0.01822	-0.23402
2007	0.17119	0.27884	0.12116	-0.07946	0.14291	0.02246	0.37922	-0.18662
2008	0.00000	-0.17119	-0.09743	0.13209	-0.17882	-0.01966	0.14023	0.07103

Index by year-class

YCls	Age 2	3	4	5	6	7	8	9
1986	NA	NA	NA	NA	NA	NA	NA	0.1587
1987	NA	NA	NA	NA	NA	NA	0.2354	0.0492
1988	NA	NA	NA	NA	NA	0.6451	0.1533	0.0053
1989	NA	NA	NA	NA	1.9411	0.6464	0.3079	0.0344
1990	NA	NA	NA	3.2966	1.3856	0.7984	0.0642	0.0228
1991	NA	NA	3.1781	2.5436	2.1570	0.3205	0.0492	0.0173
1992	NA	2.7710	2.5167	2.5161	0.6374	0.1728	0.0992	0.0386
1993	4.1040	4.6373	3.5233	1.5072	0.6203	0.2774	0.0990	0.0059
1994	3.5322	5.8768	2.6909	1.4628	1.1080	0.3035	0.0829	0.0740
1995	3.8267	3.0495	2.0576	1.6228	0.5214	0.2988	0.1197	0.0201
1996	2.7763	2.4739	1.8240	0.9657	0.5270	0.2325	0.0911	0.0671
1997	2.2986	2.3602	1.5403	0.7352	0.4856	0.1589	0.1122	0.0465
1998	2.3432	1.6246	1.0041	0.5667	0.3945	0.2276	0.0811	0.0400
1999	1.3677	0.8340	0.7886	0.5608	0.3455	0.3681	0.1545	0.0648
2000	0.6077	0.7205	0.8781	0.6539	0.5100	0.2935	0.0819	NA
2001	0.4358	0.7514	0.6500	0.7057	0.4974	0.1657	NA	NA
2002	0.7197	0.7165	0.7689	0.6624	0.2478	NA	NA	NA
2003	0.3746	0.8230	1.1216	0.4270	NA	NA	NA	NA
2004	0.5132	0.8293	0.5819	NA	NA	NA	NA	NA
2005	0.6708	0.5031	NA	NA	NA	NA	NA	NA
2006	0.4433	NA	NA	NA	NA	NA	NA	NA

Table 2.14. continued

Fitted index by year-class

YCls	Age 2	3	4	5	6	7	8	9
1986	NA	NA	NA	NA	NA	NA	NA	0.2307
1987	NA	NA	NA	NA	NA	NA	0.5246	0.0690
1988	NA	NA	NA	NA	NA	0.5196	0.3568	0.0093
1989	NA	NA	NA	NA	1.9748	0.7903	0.4644	0.0619
1990	NA	NA	NA	3.5122	1.7269	0.3672	0.2524	0.0321
1991	NA	NA	4.7380	2.6885	0.8425	0.3389	0.2319	0.0214
1992	NA	6.7516	3.3793	1.3870	0.6844	0.2702	0.1793	0.0441
1993	12.8782	7.8822	2.5542	1.4531	0.7077	0.2464	0.1797	0.0126
1994	12.9135	6.1124	3.0702	1.7301	0.7703	0.3938	0.2545	0.0762
1995	8.4596	5.1885	2.5730	1.3594	0.7959	0.2488	0.1849	0.0380
1996	6.6263	4.0335	1.8344	1.1801	0.4867	0.2687	0.1926	0.0909
1997	4.7858	2.7679	1.6396	0.8199	0.5070	0.2417	0.1877	0.0884
1998	3.6478	2.4664	1.0419	0.6971	0.3883	0.2562	0.1989	0.0715
1999	2.9693	1.6440	1.0266	0.6372	0.4473	0.2950	0.2231	0.1000
2000	2.0880	1.4566	0.8223	0.6028	0.4231	0.2509	0.1939	NA
2001	1.6136	1.0604	0.7485	0.5486	0.3570	0.2308	NA	NA
2002	1.5065	1.1298	0.7973	0.5534	0.3830	NA	NA	NA
2003	1.4843	1.1130	0.7301	0.5297	NA	NA	NA	NA
2004	1.4397	1.0340	0.7198	NA	NA	NA	NA	NA
2005	1.3225	0.9837	NA	NA	NA	NA	NA	NA
2006	1.0373	NA	NA	NA	NA	NA	NA	NA

Stock summary

Year	Yield	TSB	SSB	Recruits	Mean F (4-7)
1995	9.560	34.406	15.903	12.878	0.442
1996	14.217	30.966	13.843	12.913	0.833
1997	6.122	18.807	8.014	8.460	0.439
1998	5.452	19.037	7.308	6.626	0.450
1999	5.117	17.499	7.304	4.786	0.528
2000	2.404	13.767	6.099	3.648	0.291
2001	3.812	13.118	5.969	2.969	0.595
2002	1.313	10.095	4.810	2.088	0.243
2003	1.537	8.372	4.541	1.614	0.334
2004	0.578	7.540	3.935	1.507	0.133
2005	0.604	7.575	3.917	1.484	0.134
2006	0.849	9.097	4.796	1.440	0.199
2007	0.607	9.263	5.092	1.323	0.146
2008	NA	8.521	4.383	1.037	NA

Table 2.15 Diagnostics from trial xsa

Lowestoft VPA Version 3.1

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 Extended Survivors Analysis

 Norwegian Coastal Cod,COMBSEX,PLUSGROUP

 CPUE data from file coast-9.txt

 Catch data for  25 years. 1984 to 2008. Ages  2 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,     year, year,  age ,  age
 Norw. Coast. survey ,   1995, 2008,   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 had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00455

 Final year F values
 Age         ,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 29,  .0122,  .0964,  .2692,  .4133,  .5665,  .5814,  .4024,  .2364
 Iteration 30,  .0122,  .0963,  .2690,  .4129,  .5658,  .5803,  .4012,  .2355

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

Table 2.15 continued…

Fishing mortalities

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	.011	.008	.002	.012	.006	.001	.001	.007	.010	.012
3	.061	.054	.030	.058	.086	.028	.046	.035	.067	.096
4	.150	.240	.136	.192	.187	.095	.160	.227	.212	.269
5	.395	.387	.313	.321	.325	.231	.277	.323	.425	.413
6	.537	.463	.361	.534	.436	.417	.309	.449	.421	.566
7	.680	.424	.477	.527	.565	.591	.489	.483	.410	.580
8	.777	.277	.381	.664	.399	.529	.431	.622	.272	.401
9	1.033	.291	.253	.415	.392	.257	.305	.541	.515	.235

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9
1999	2.53E+04	2.47E+04	1.86E+04	1.44E+04	7.37E+03	3.59E+03	1.54E+03	1.33E+03
2000	2.29E+04	2.05E+04	1.90E+04	1.31E+04	7.96E+03	3.53E+03	1.49E+03	5.78E+02
2001	2.15E+04	1.86E+04	1.59E+04	1.22E+04	7.28E+03	4.10E+03	1.89E+03	9.23E+02
2002	1.84E+04	1.75E+04	1.48E+04	1.14E+04	7.33E+03	4.15E+03	2.08E+03	1.06E+03
2003	1.50E+04	1.49E+04	1.35E+04	9.98E+03	6.75E+03	3.52E+03	2.01E+03	8.78E+02
2004	1.41E+04	1.22E+04	1.12E+04	9.19E+03	5.90E+03	3.58E+03	1.64E+03	1.10E+03
2005	1.25E+04	1.15E+04	9.73E+03	8.35E+03	5.98E+03	3.19E+03	1.62E+03	7.90E+02
2006	1.08E+04	1.02E+04	9.02E+03	6.79E+03	5.18E+03	3.59E+03	1.60E+03	8.63E+02
2007	9.95E+03	8.80E+03	8.07E+03	5.89E+03	4.03E+03	2.71E+03	1.82E+03	7.03E+02
2008	8.40E+03	8.07E+03	6.74E+03	5.34E+03	3.15E+03	2.16E+03	1.47E+03	1.13E+03

Estimated population abundance at 1st Jan 2009

, 0.00E+00, 6.80E+03, 6.00E+03, 4.22E+03, 2.90E+03, 1.47E+03, 9.94E+02, 8.09E+02,

Taper weighted geometric mean of the VPA populations:

, 1.76E+04, 1.59E+04, 1.36E+04, 1.03E+04, 6.71E+03, 4.03E+03, 2.15E+03, 1.12E+03,

Standard error of the weighted Log(VPA populations) :

, .4976, .4680, .4404, .4324, .4458, .4581, .4668, .4624,

Log catchability residuals.

Fleet : Norw. Coast. survey

Age	1995	1996	1997	1998
2	.75	.44	.72	.45
3	.48	.77	.86	.41
4	.48	.50	.63	.27
5	.28	.77	.84	.23
6	-.08	-.07	1.25	.04
7	-.09	-.41	.34	.30
8	-.03	-.30	.19	-.82

Table 2.15 continued…

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	.45	.57	.09	-.56	-.69	-.13	-.66	-.20	.15	-.09
3	.19	.33	.03	-.55	-.52	-.32	-.30	-.04	.14	-.25
4	.12	.05	-.02	-.33	-.49	-.27	-.37	-.08	.40	-.03
5	.13	.32	-.19	-.38	-.51	-.51	-.23	.09	.25	-.10
6	.01	.46	-.29	-.15	-.22	-.31	-.54	.10	.30	-.03
7	-.30	-.01	-.03	-.02	-.07	-.45	-.06	.30	.30	.09
8	-.24	.09	-.07	-.12	.08	.11	.25	.09	.33	.01

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	-1.0882	-.6923	-.4529	-.3464	-.3057	-.4381	-.8249
S.E(Log q)	.4853	.4205	.3403	.3996	.4068	.2529	.2733

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	.62	2.334	4.37	.80	14	.25	-1.09
3	.64	2.238	3.93	.80	14	.23	-.69
4	.81	.872	2.19	.68	14	.28	-.45
5	.83	.621	1.87	.58	14	.34	-.35
6	1.02	-.070	.11	.50	14	.44	-.31
7	1.14	-.636	-.63	.70	14	.30	-.44
8	1.28	-1.155	-1.08	.64	14	.34	-.82

1

Terminal year survivor and F summaries :

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

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. survey	6206.	.506	.000	.00	1	.794	.013
F shrinkage mean	9677.	1.00				.206	.009

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6801.	.45	.20	2	.446	.012

Table 2.15 continued…

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

 Year class = 2005

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Norw. Coast. survey ,      5539.,   .331,       .200,    .60,   2,  .892,     .104

   F shrinkage mean  ,     11604.,   1.00,,,,                        .108,     .051

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      6001.,       .31,      .22,    3,    .692,   .096

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

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Norw. Coast. survey ,      4143.,   .242,       .085,    .35,   3,  .926,     .273

   F shrinkage mean  ,      5274.,   1.00,,,,                        .074,     .221

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4218.,       .24,      .08,    4,    .326,   .269

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

 Year class = 2003

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Norw. Coast. survey ,      2872.,   .211,       .205,    .97,   4,  .927,     .416

   F shrinkage mean  ,      3236.,   1.00,,,,                        .073,     .376

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2897.,       .21,      .17,    5,    .823,   .413

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

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Norw. Coast. survey ,      1422.,   .197,       .085,    .43,   5,  .910,     .579

   F shrinkage mean  ,      2028.,   1.00,,,,                        .090,     .438

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1468.,       .20,      .09,    6,    .433,   .566
```

Table 2.15 continued…

```
 Age  7   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 ,       970.,   .173,       .121,    .70,   6,  .931,     .590

   F shrinkage mean  ,      1373.,   1.00,,,,                        .069,     .450

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       994.,       .18,      .11,    7,    .646,   .580


1
 Age  8   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 ,       816.,   .160,       .098,    .62,   7,  .948,     .397

   F shrinkage mean  ,       700.,   1.00,,,,                        .052,     .450

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       809.,       .16,      .09,    8,    .560,   .401


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

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 Norw. Coast. survey ,       776.,   .159,       .156,    .98,   7,  .942,     .224

   F shrinkage mean  ,       305.,   1.00,,,,                        .058,     .494

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       736.,       .16,      .16,    8,   1.022,   .235
```

Table 2.16. Summary output of trial xsa.

Summary (without SOP correction)
Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 7,
1984,	87921,	310159,	152149,	74824,	.4918,	.6221,
1985,	74454,	293934,	128242,	75451,	.5883,	.5276,
1986,	35577,	290571,	134020,	68905,	.5141,	.5807,
1987,	36684,	254719,	125192,	60972,	.4870,	.4918,
1988,	39976,	230521,	125539,	59294,	.4723,	.6200,
1989,	43540,	196072,	100545,	40285,	.4007,	.3759,
1990,	42202,	209711,	109577,	28127,	.2567,	.1841,
1991,	60282,	245203,	131706,	24822,	.1885,	.1709,
1992,	49117,	287037,	163888,	41690,	.2544,	.2348,
1993,	30441,	299850,	177476,	52557,	.2961,	.2364,
1994,	25552,	299904,	185955,	54562,	.2934,	.2374,
1995,	33809,	262260,	171026,	57207,	.3345,	.3061,
1996,	40157,	264760,	182873,	61776,	.3378,	.3799,
1997,	33006,	205623,	135013,	63319,	.4690,	.4054,
1998,	30735,	180181,	103463,	51572,	.4985,	.4410,
1999,	25327,	156528,	84512,	40732,	.4820,	.4407,
2000,	22884,	141569,	74032,	36715,	.4959,	.3787,
2001,	21459,	132542,	69426,	29699,	.4278,	.3220,
2002,	18441,	155647,	90141,	40994,	.4548,	.3932,
2003,	15019,	107824,	61172,	34635,	.5662,	.3783,
2004,	14114,	109469,	63157,	24547,	.3887,	.3335,
2005,	12476,	97701,	54925,	22432,	.4084,	.3085,
2006,	10824,	105932,	61317,	26134,	.4262,	.3703,
2007,	9948,	98820,	58522,	23841,	.4074,	.3671,
2008,	8403,	87133,	50291,	25777,	.5126,	.4570,
Arith. Mean ,	32894,	200947,	111766,	44835,	.4181,	.3825,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

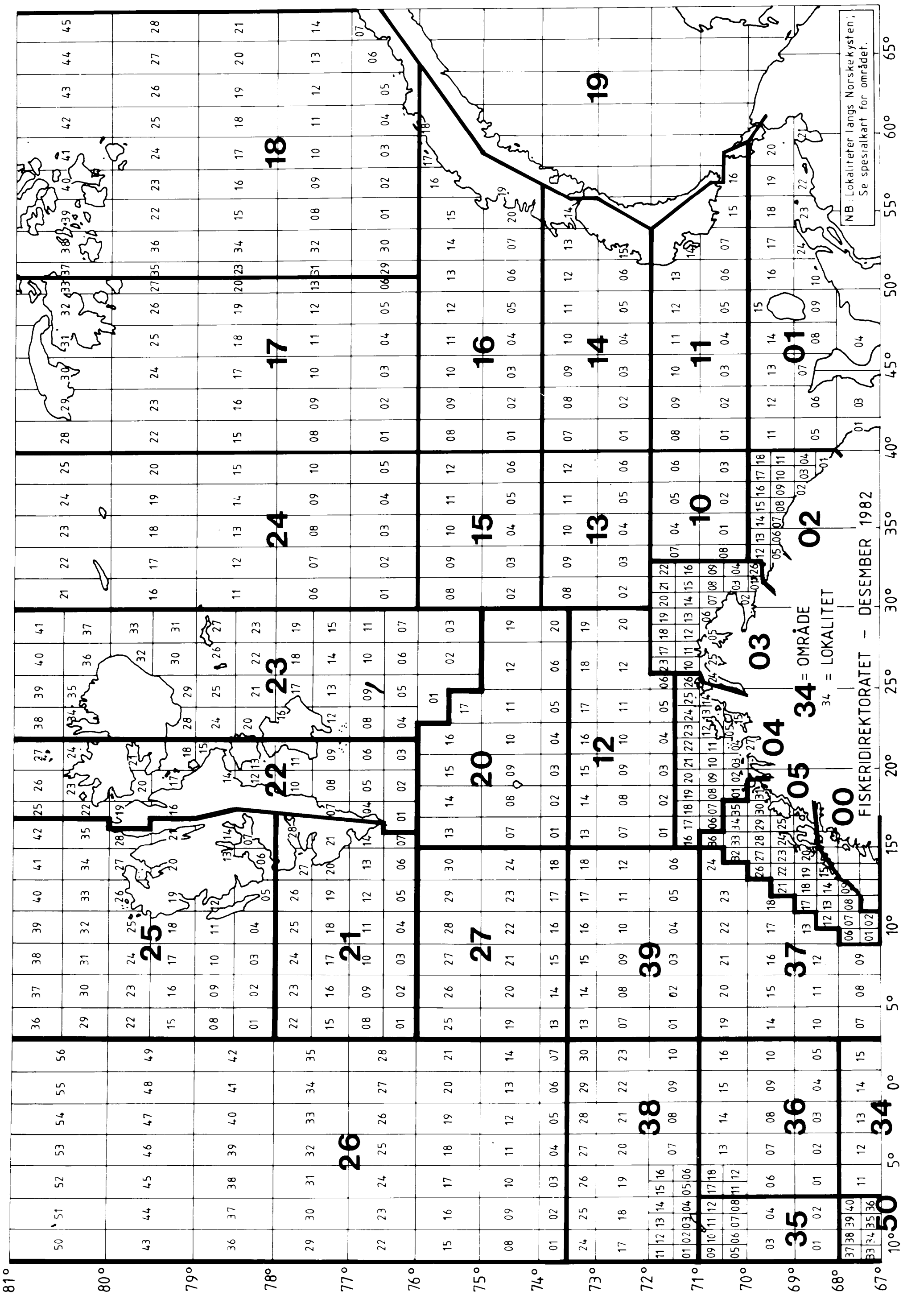


Figure 2.1. Norwegian statistical rectangles in the Barents Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 03 and 04. The same areas are also referred to in the survey results (sec. 2.3).

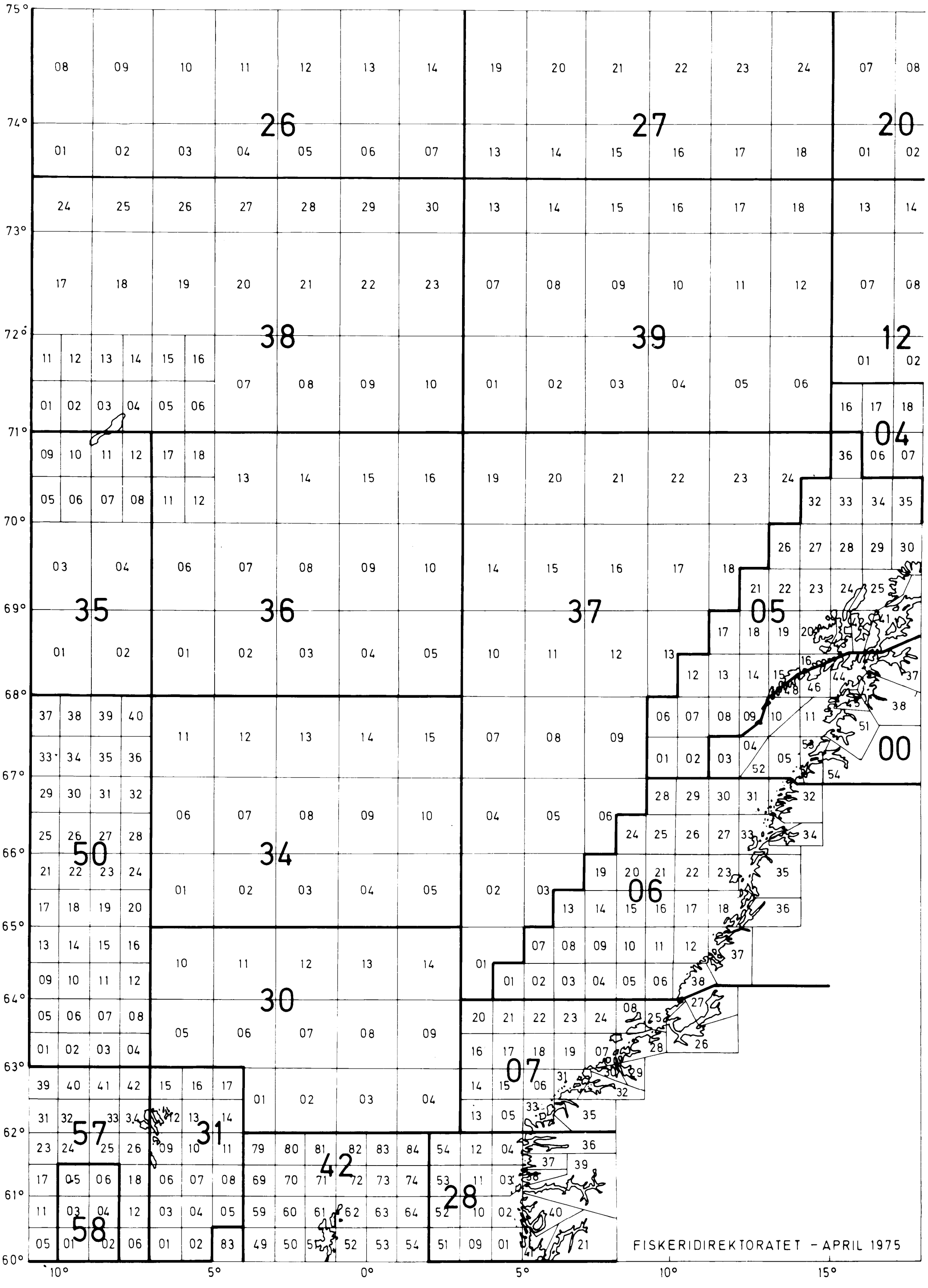


Figure 2.2. Norwegian statistical rectangles in the Norwegian Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 05, 00, 06 and 07. The same areas are also referred to in the survey results (sec. 2.3).

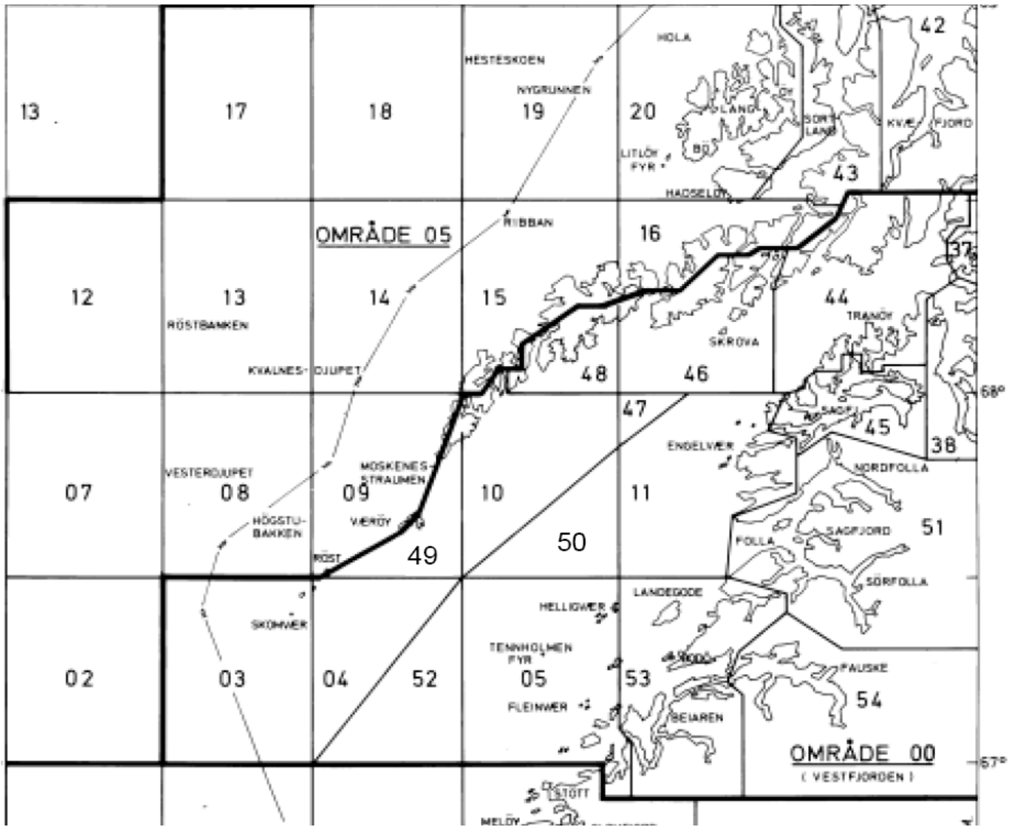


Figure 2.3. Map showing Vestfjorden, the Norwegian statistical area 00 ("OMRÅDE 00") with the south-western location 03 and 04 and the north-eastern locations 46 and 48.

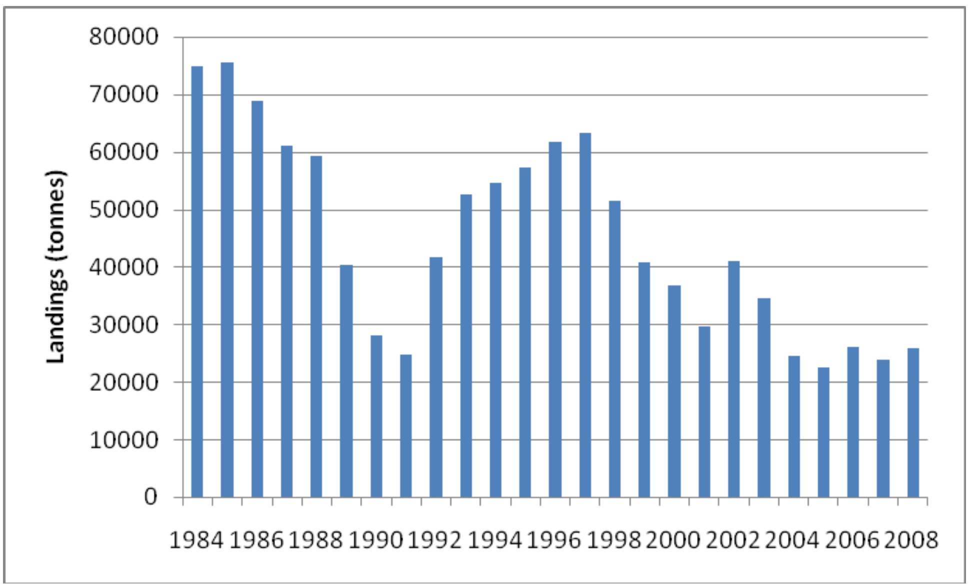


Figure 2.4. Estimated landings of Norwegian coastal cod.

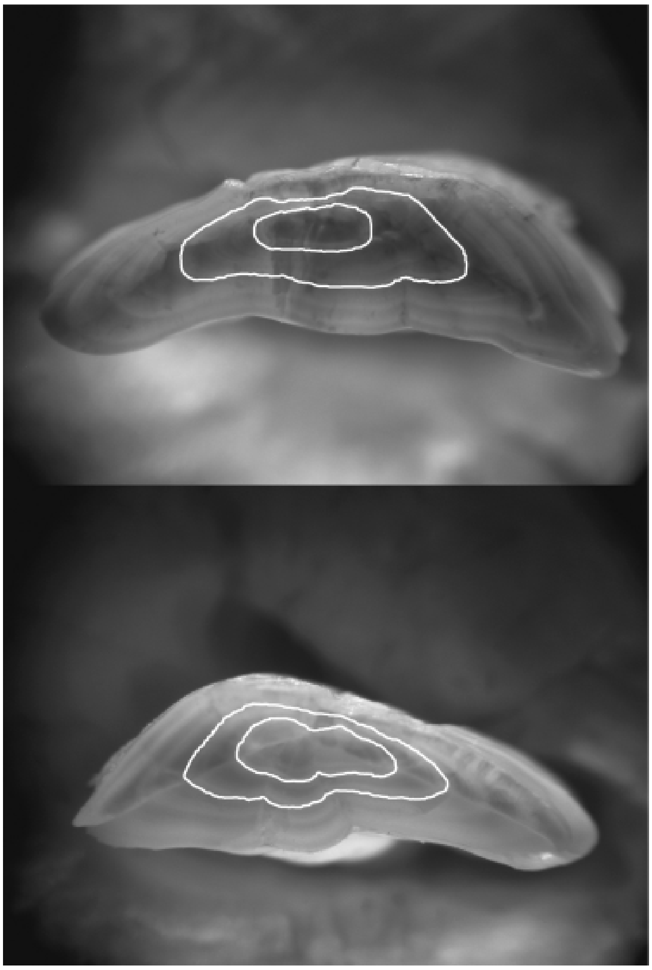
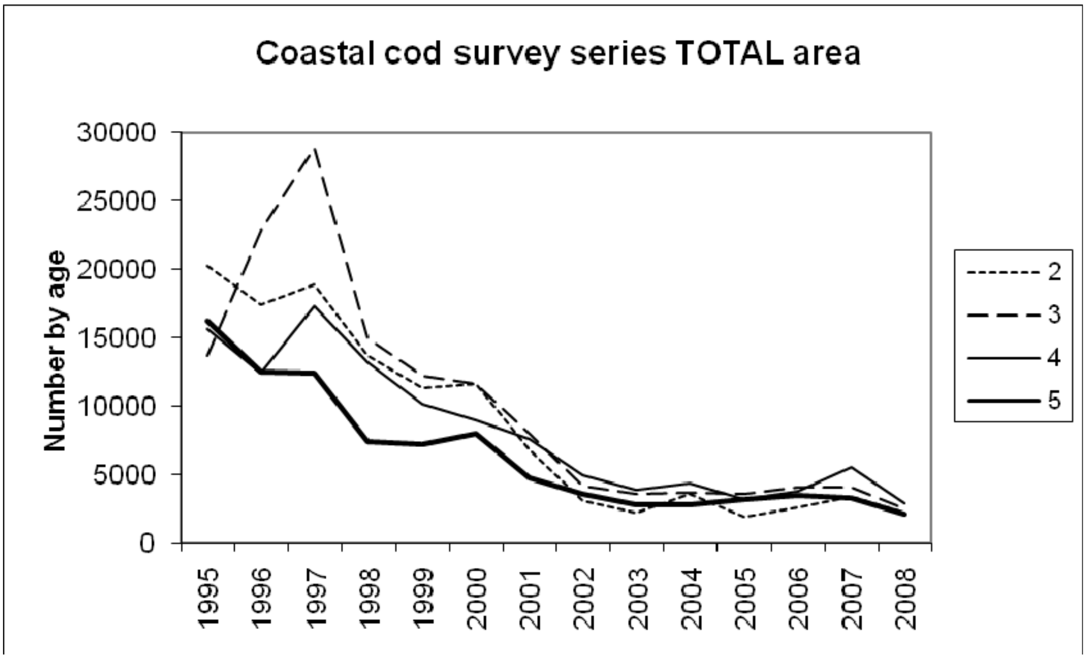


Figure 2.5. An image of a coastal cod otolith (top) and a north-east Arctic cod otolith (bottom). The two first translucent zones are highlighted. (from Berg *et al*. 2005)



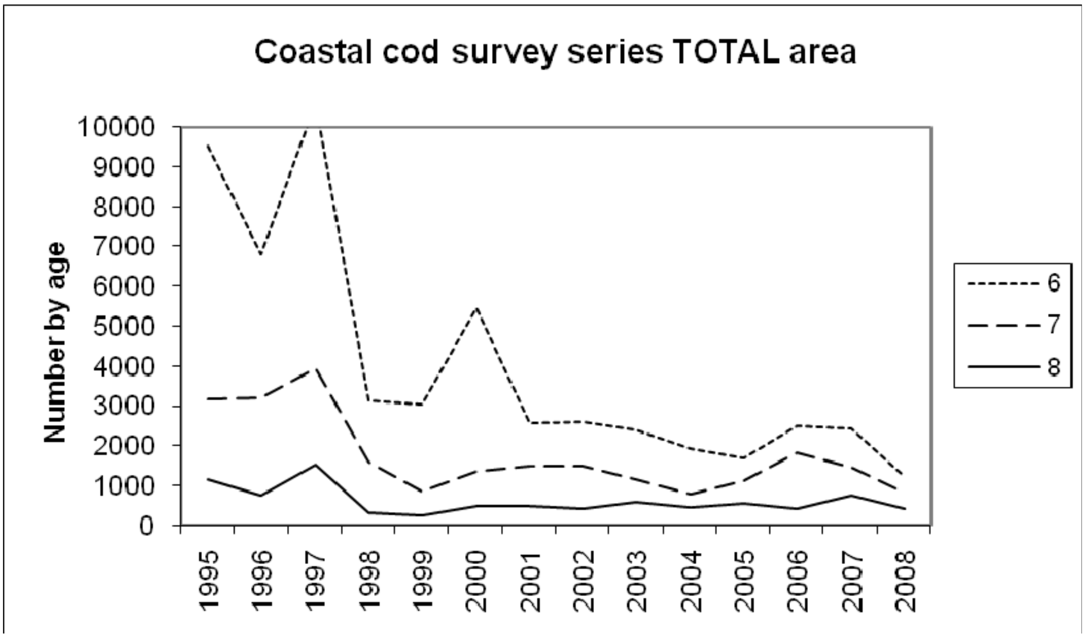


Figure 2.6 Coastal cod. Abundance at age in the total survey. Upper: ages 2-5, Lower: ages 6-8.

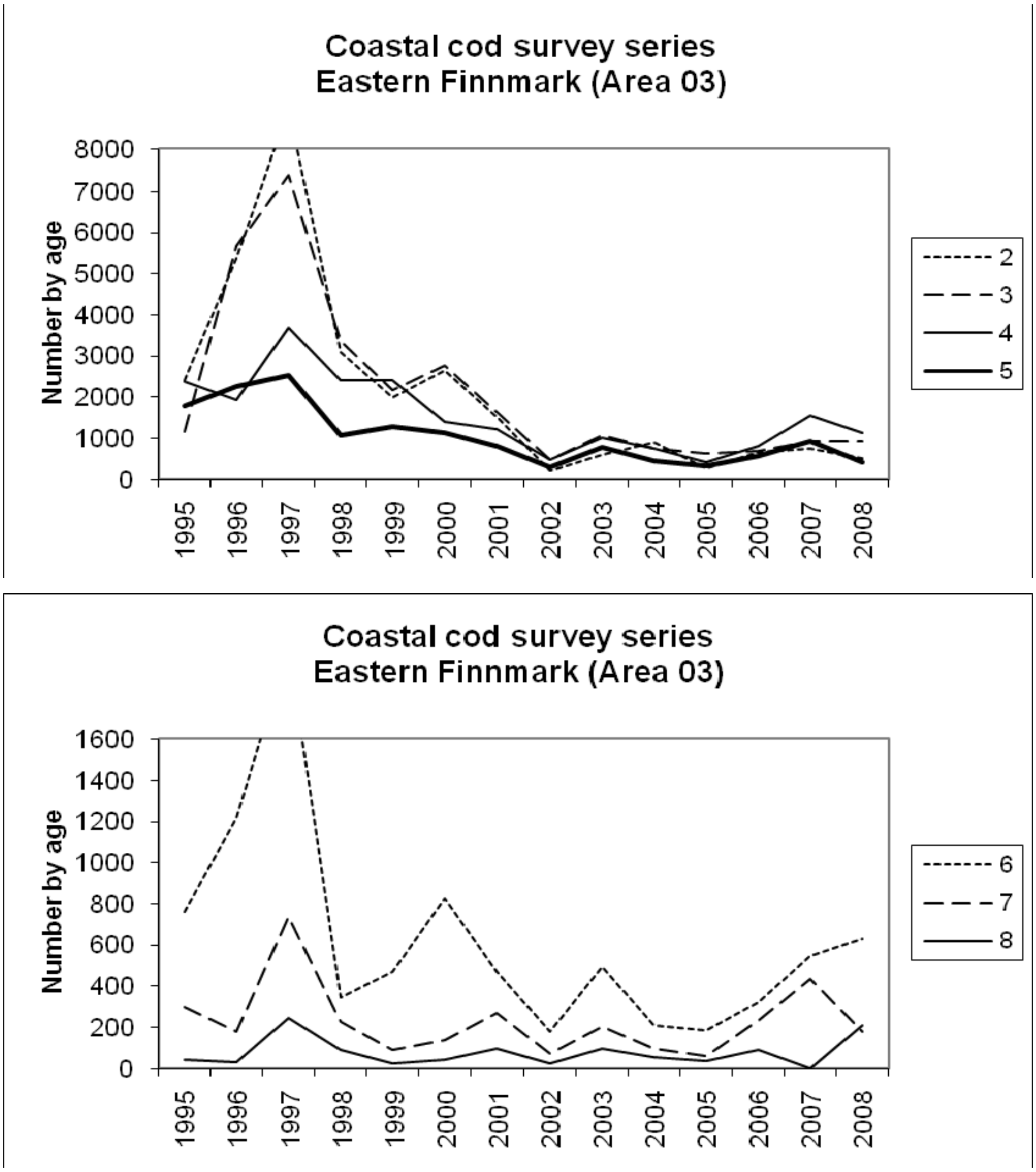
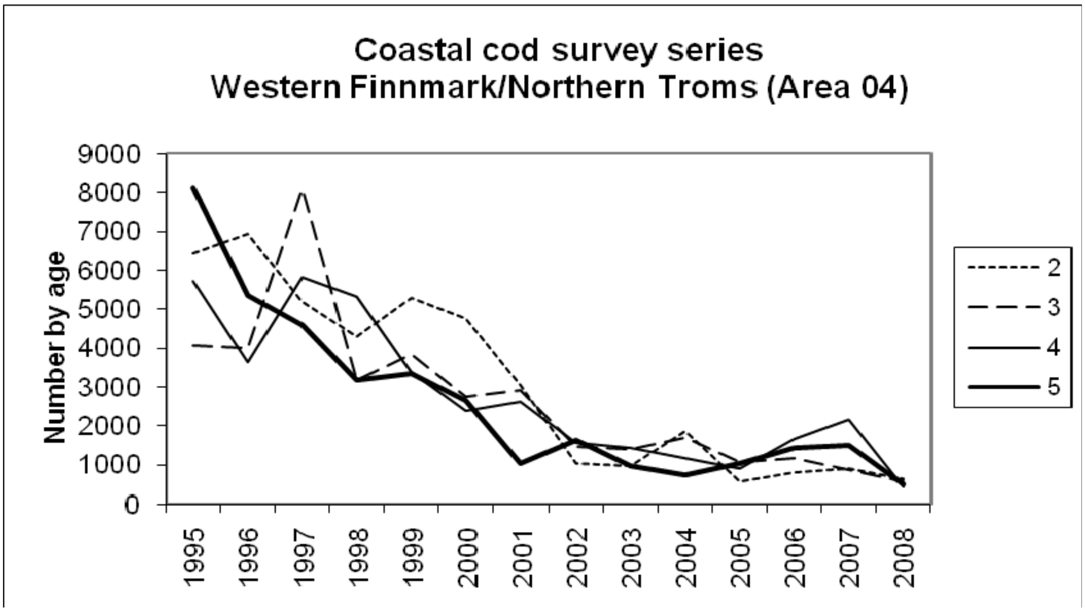


Figure 2.7 Coastal cod. Abundance at age in the survey, statistical area 03. Upper: ages 2-5, Lower: ages 6-8.



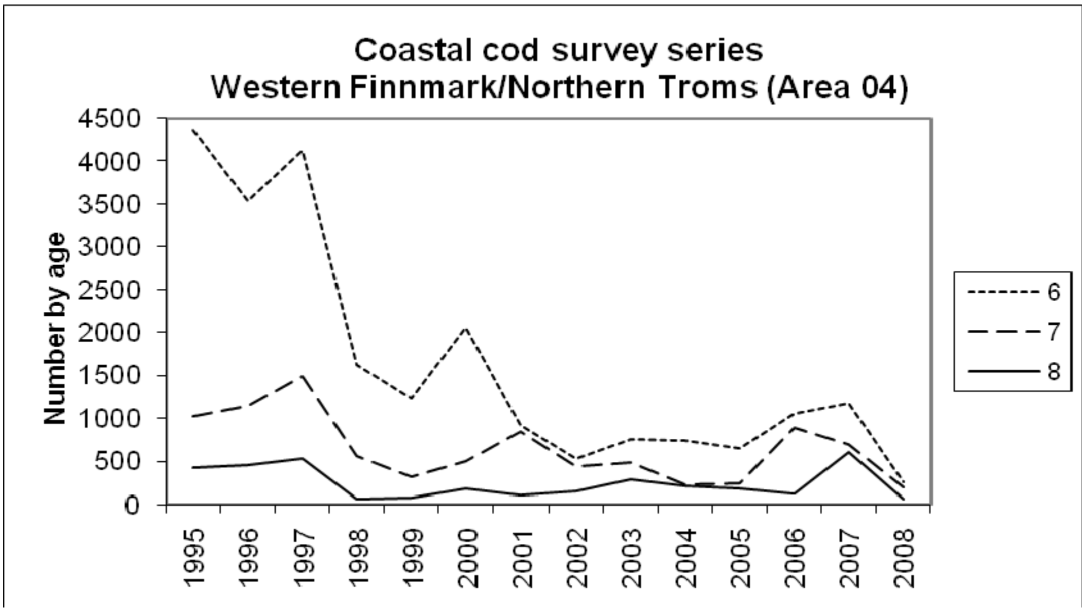
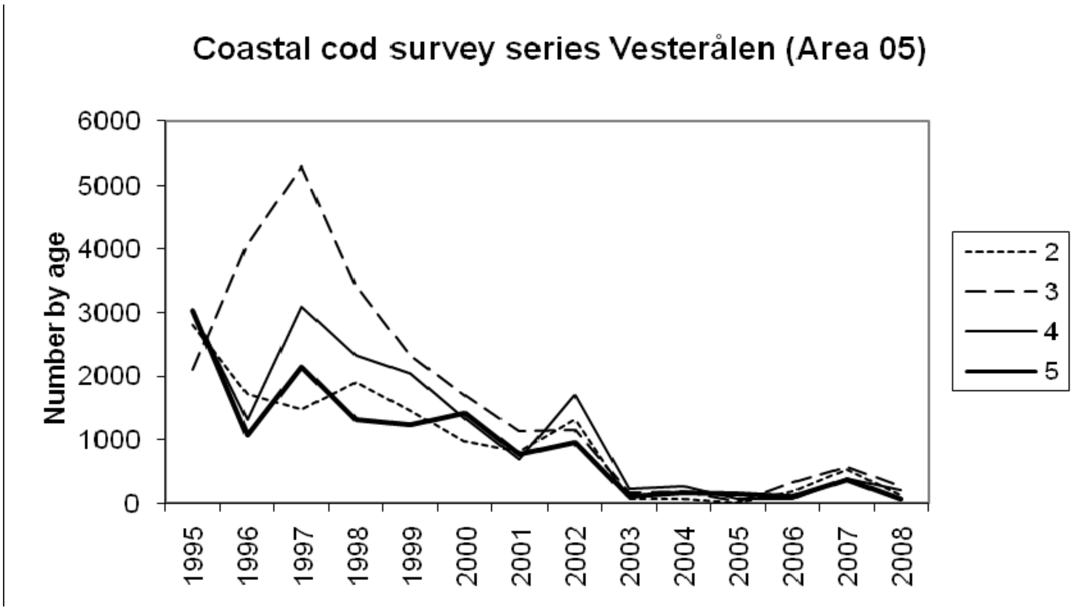


Figure 2.8 Coastal cod. Abundance at age in the survey, statistical area 04. Upper: ages 2-5, Lower: ages 6-8

.



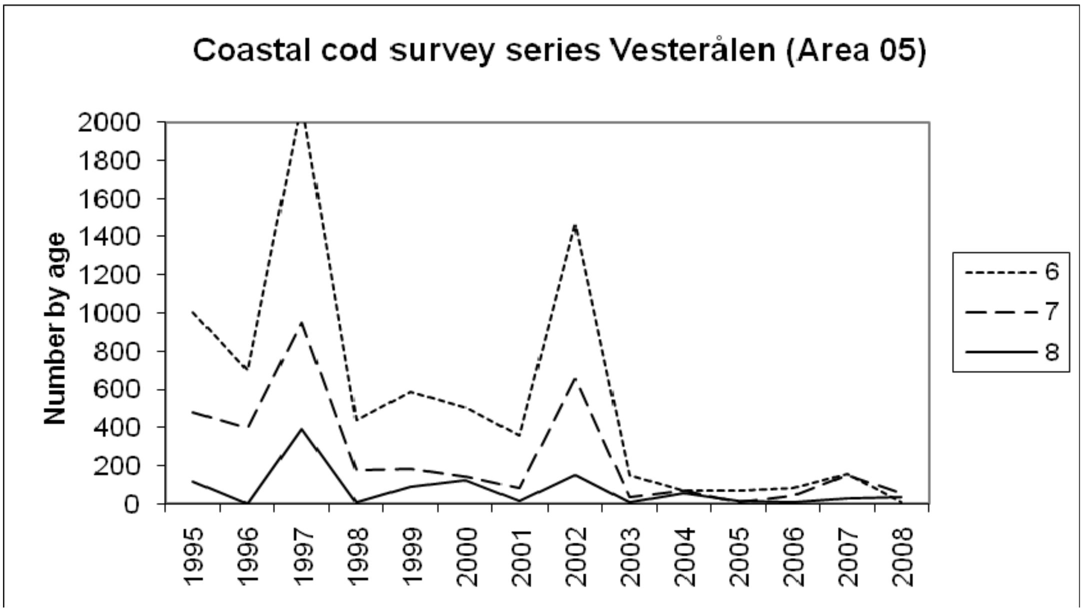


Figure 2.9 Coastal cod. Abundance at age in the survey, statistical area 05. Upper: ages 2-5, Lower: ages 6-8.

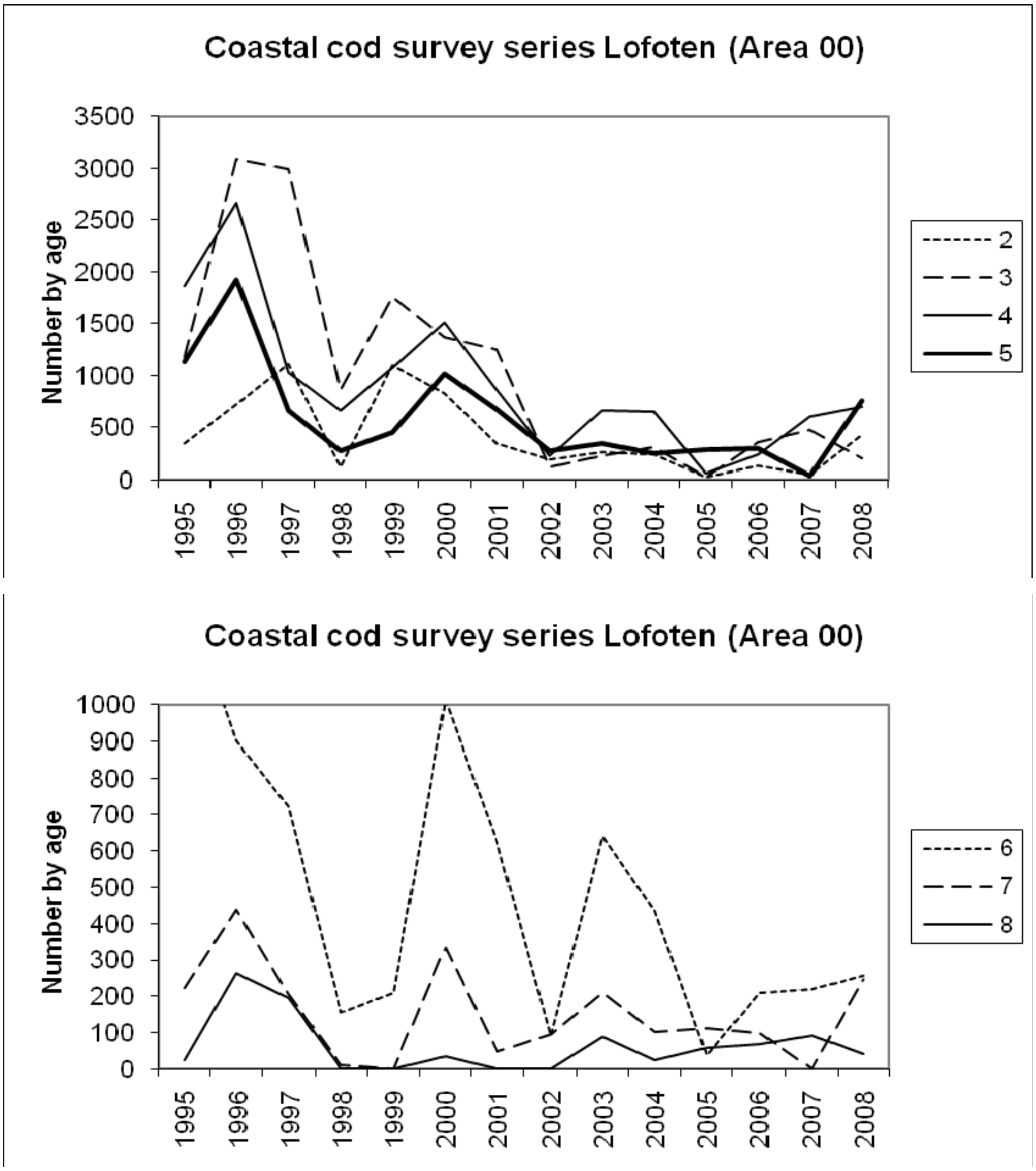
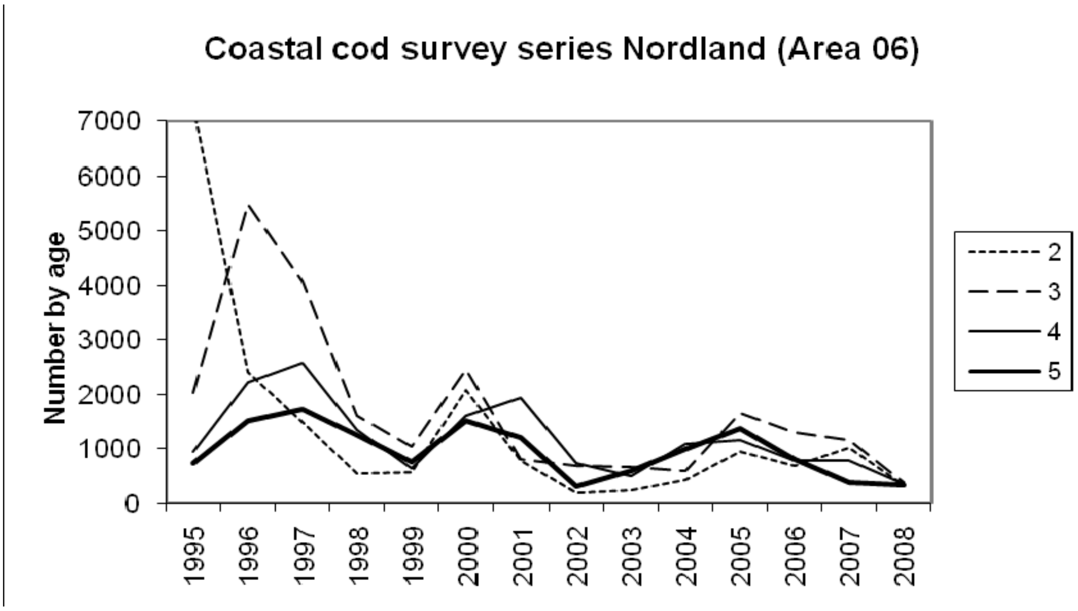


Figure 2.10 Coastal cod. Abundance at age in the survey, statistical rectangle 00. Upper: ages 2-5, Lower: ages 6-8.



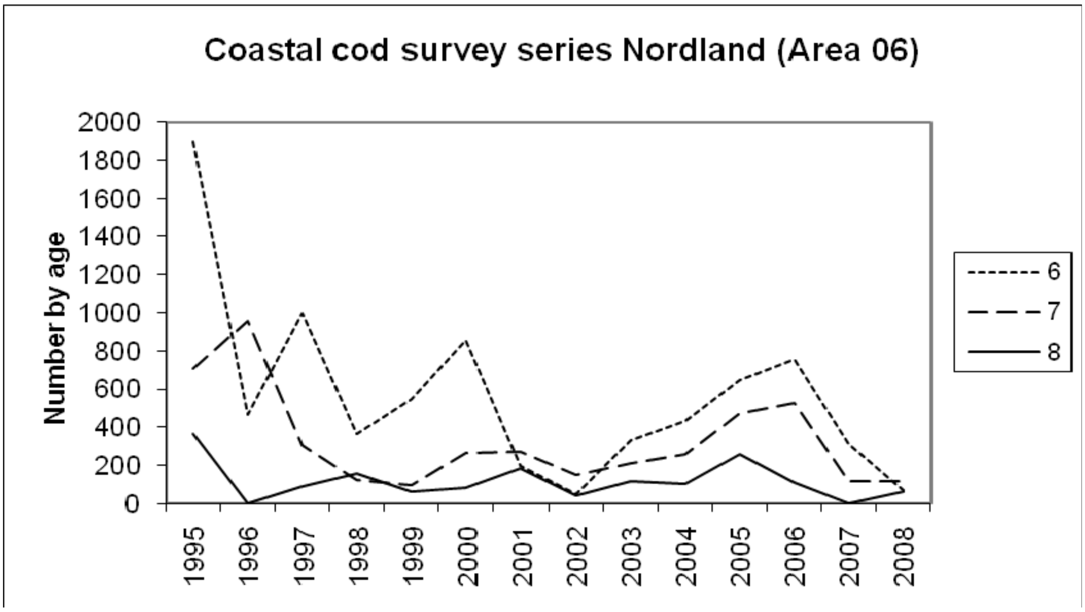
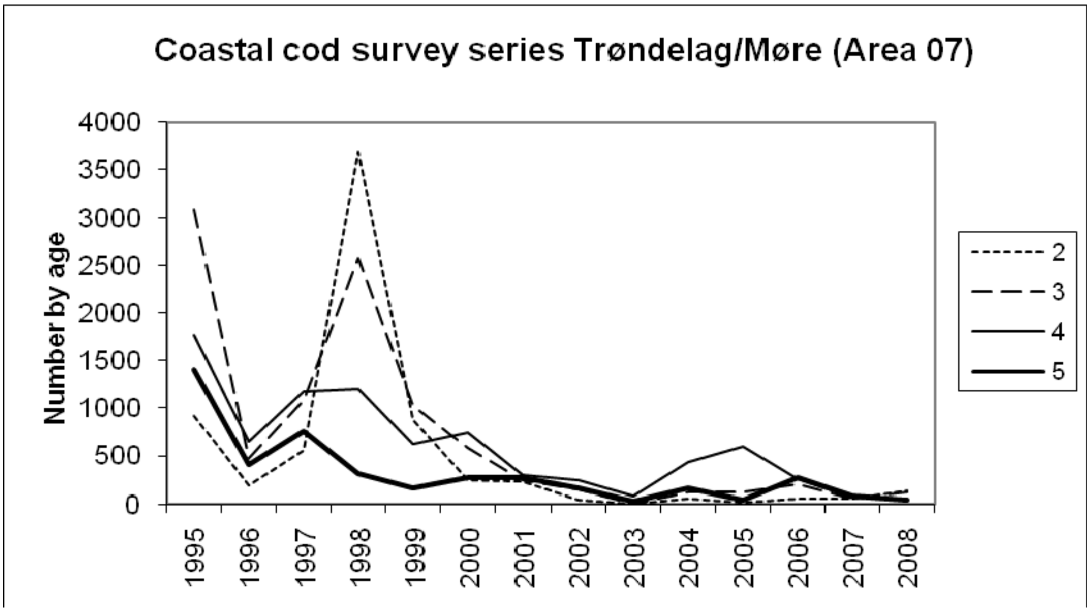


Figure 2.11 Coastal cod. Abundance at age in the survey, statistical area 06. Upper: ages 2-5, Lower: ages 6-8.



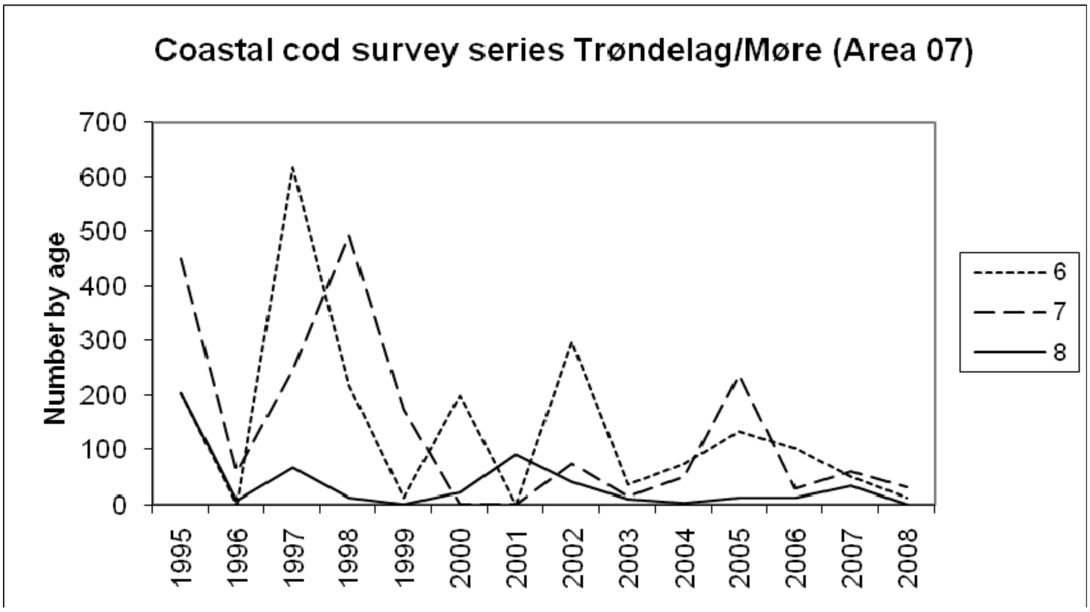


Figure 2.12 Coastal cod. Abundance at age in the survey, statistical area 07. Upper: ages 2-5, Lower: ages 6-8.

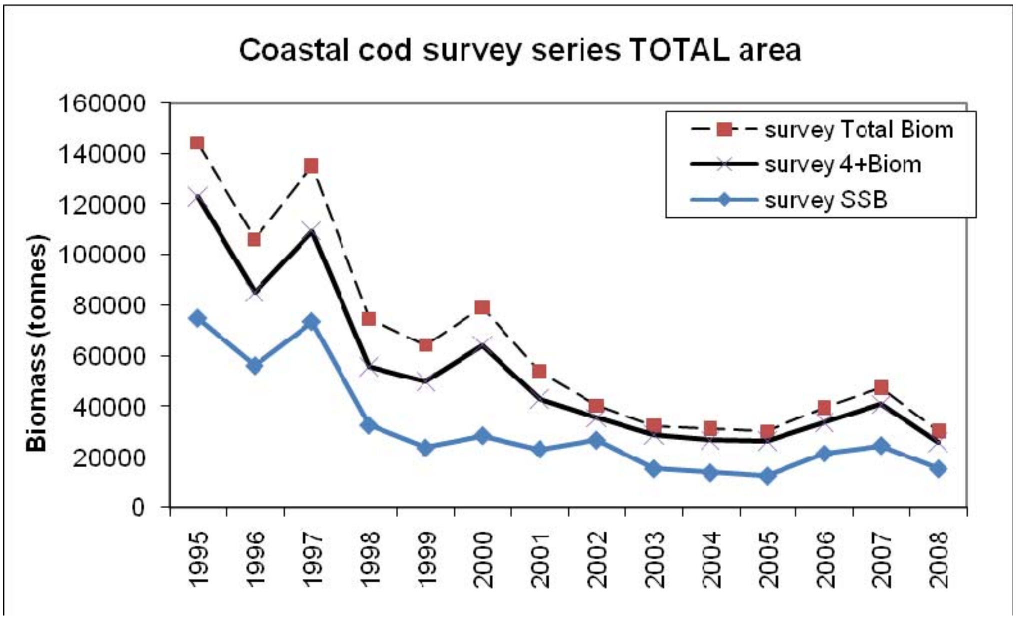


Figure 2.13 Coastal cod. Different biomass estimates from the Norwegian coastal survey: Total biomass, 4+ biomass, and spawning biomass.

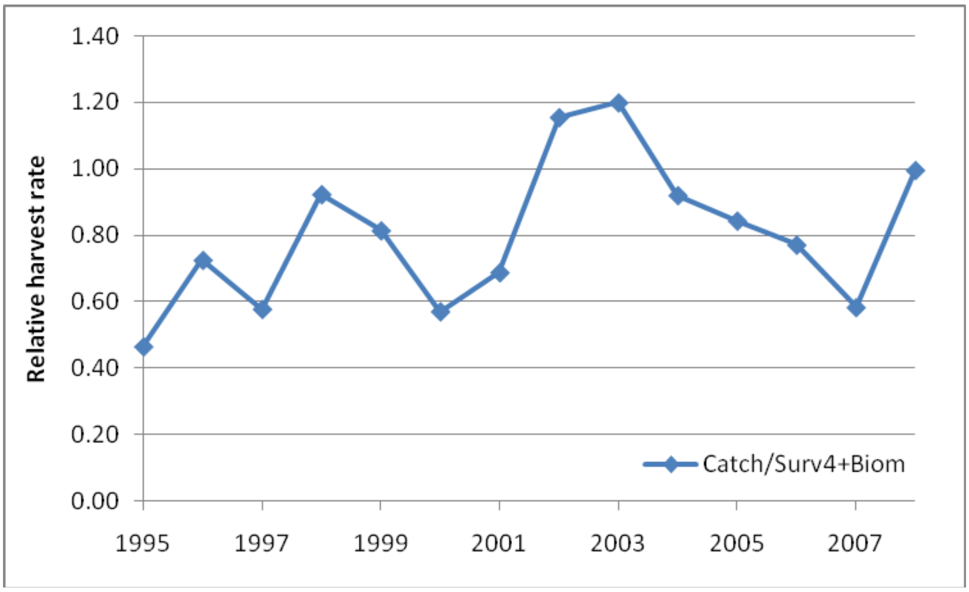


Figure 2.14. Relative harvest rate; Catch relative to the 4+ biomass estimated from the survey.

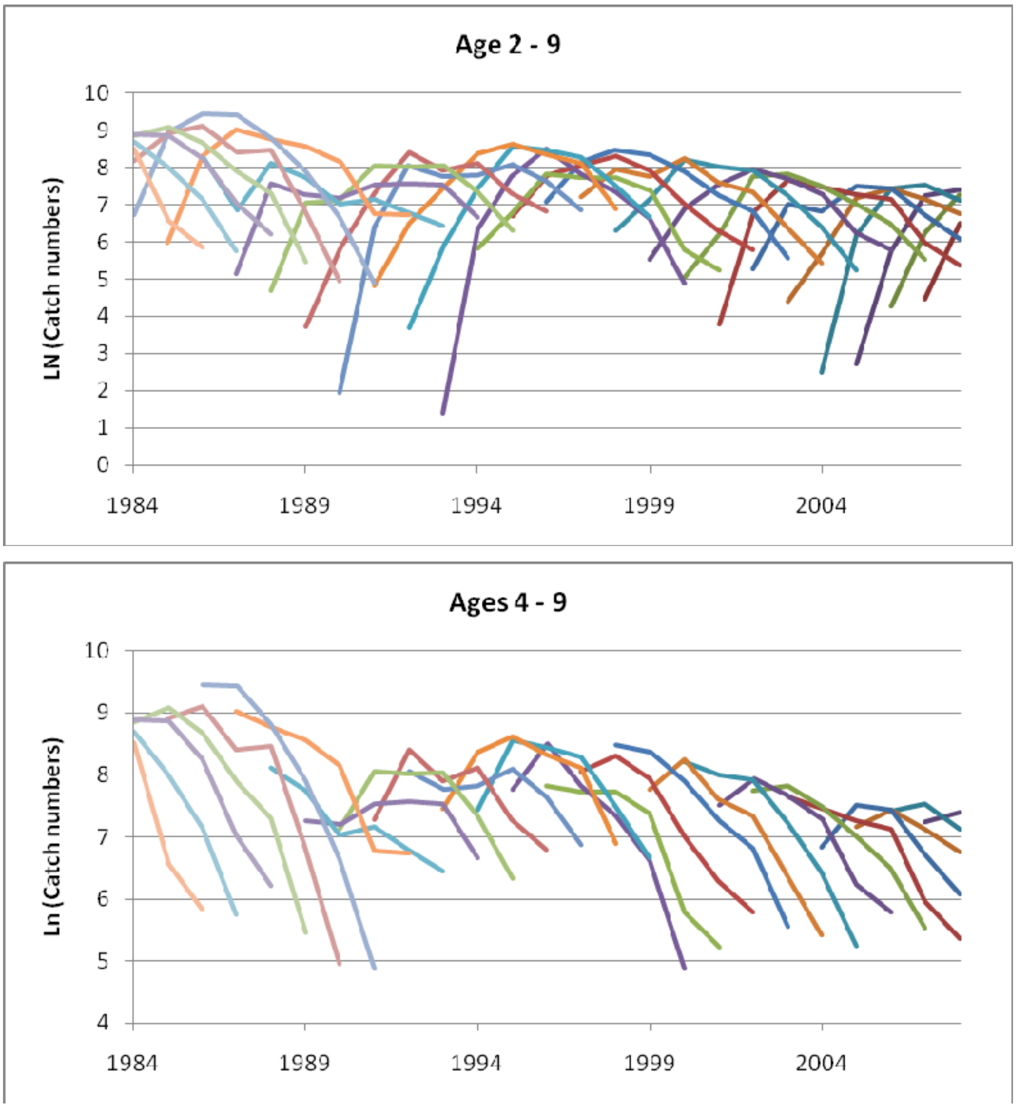


Figure 2.15. Log catch number at age by cohort and catch year. The plot starts with the 1977 year-classes in 1984 and ends with the 2004 yea-rclass in 2008.

Upper: ages 2-9, Lower: ages 4-9.

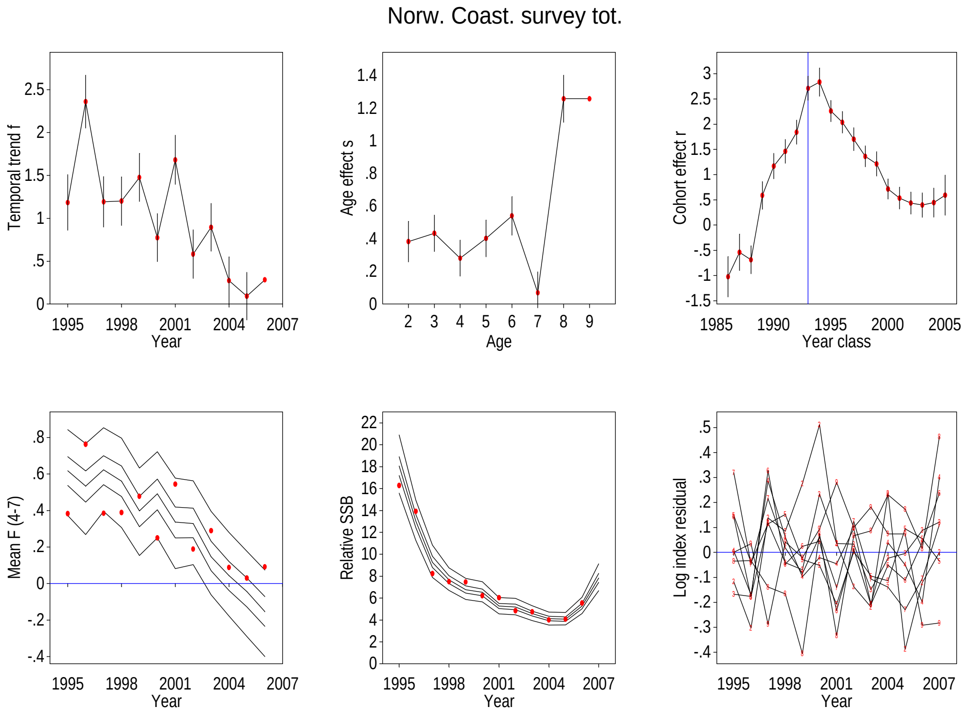


Figure 2.16. Summaries of results from SURBA analysis.

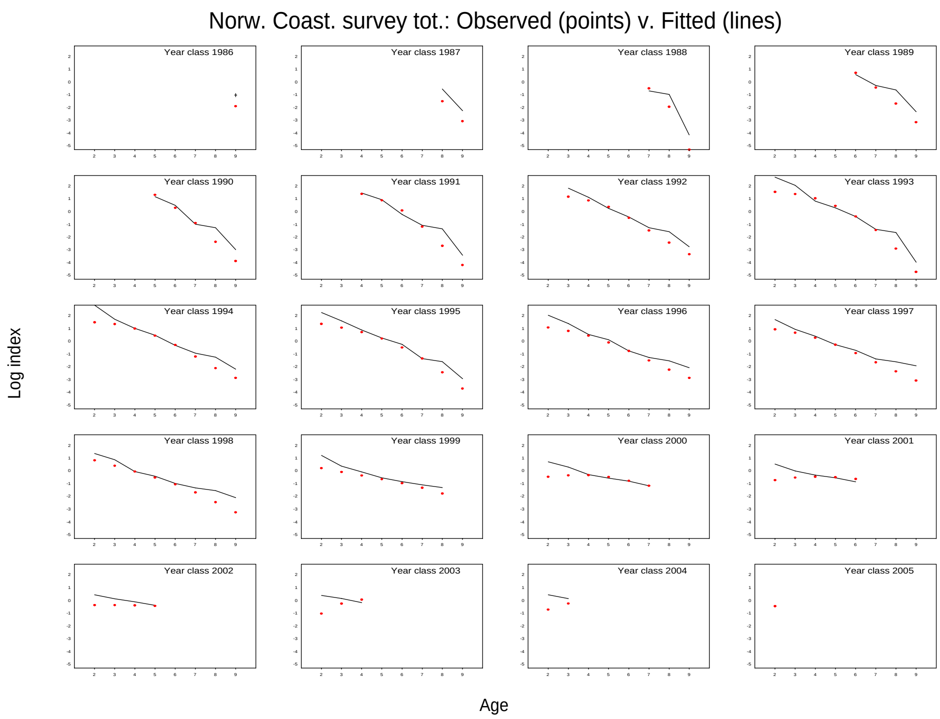


Figure 2.17. SURBA. Modelled values by compared to observations.

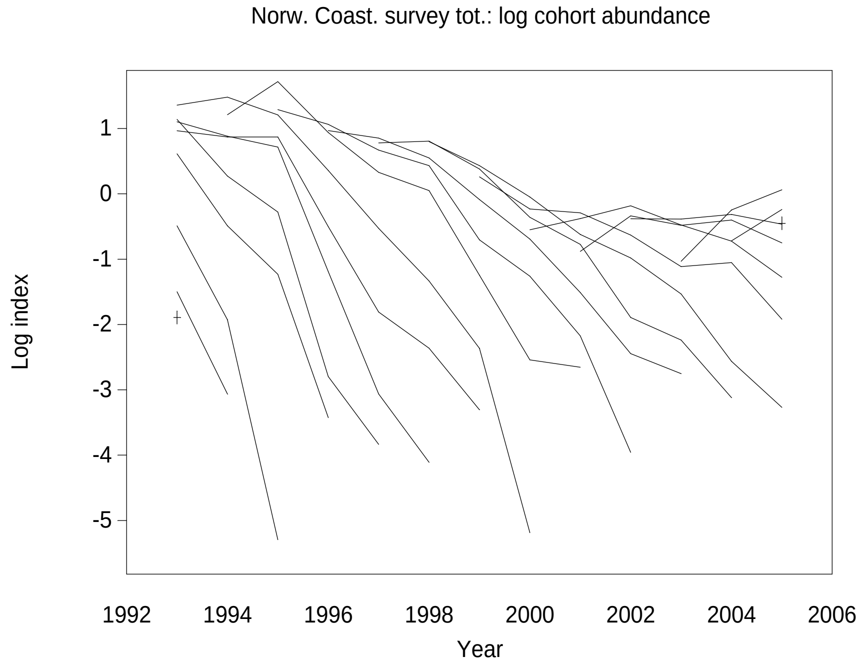


Figure 2.18. SURBA. Survey indicies by cohort.

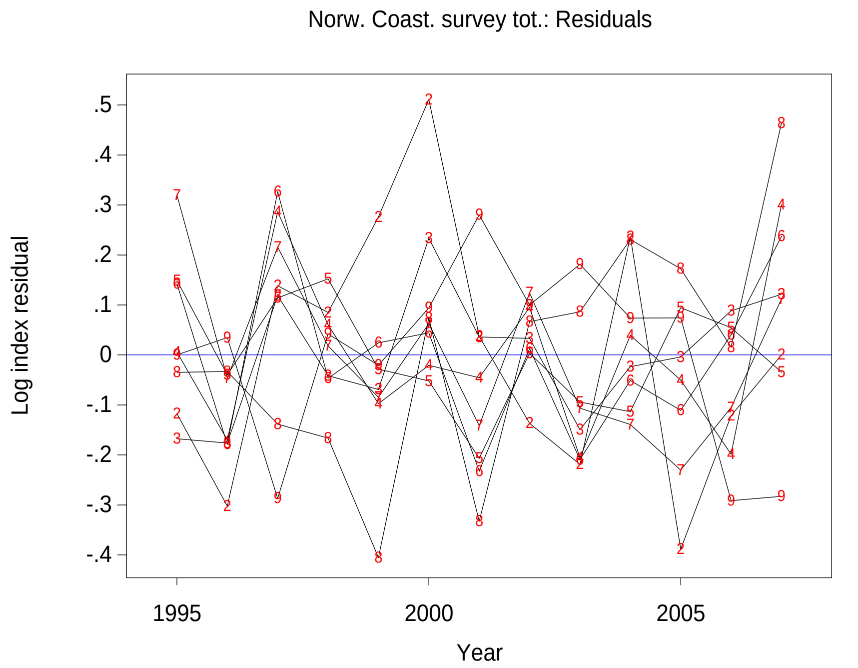


Figure 2.19. SURBA. Residuals by years labelled by age.

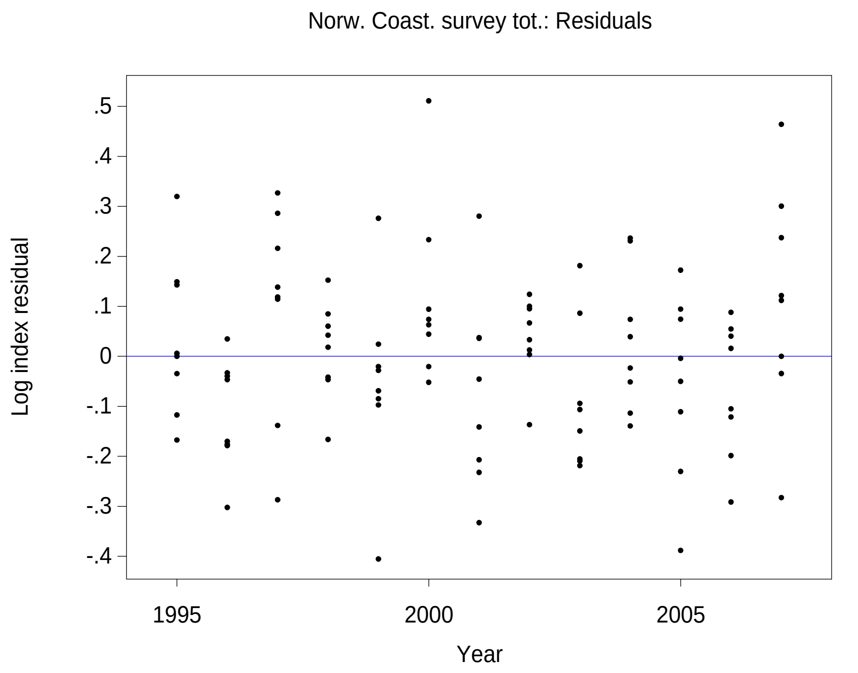


Figure 2.20. SURBA. Residuals by age and years (not labelled)

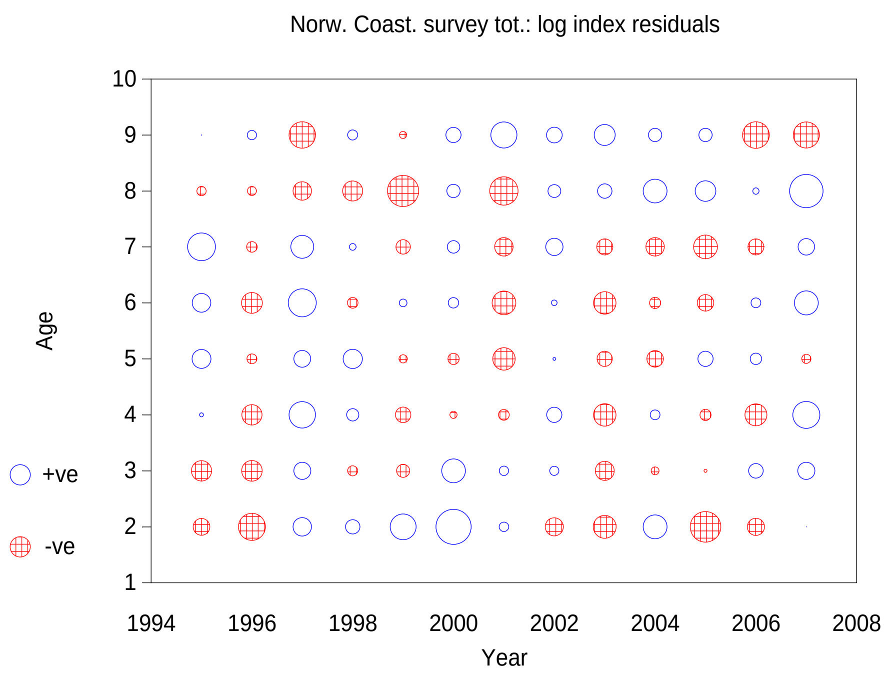


Figure 2.21. SURBA. Bubble plot of residuals.

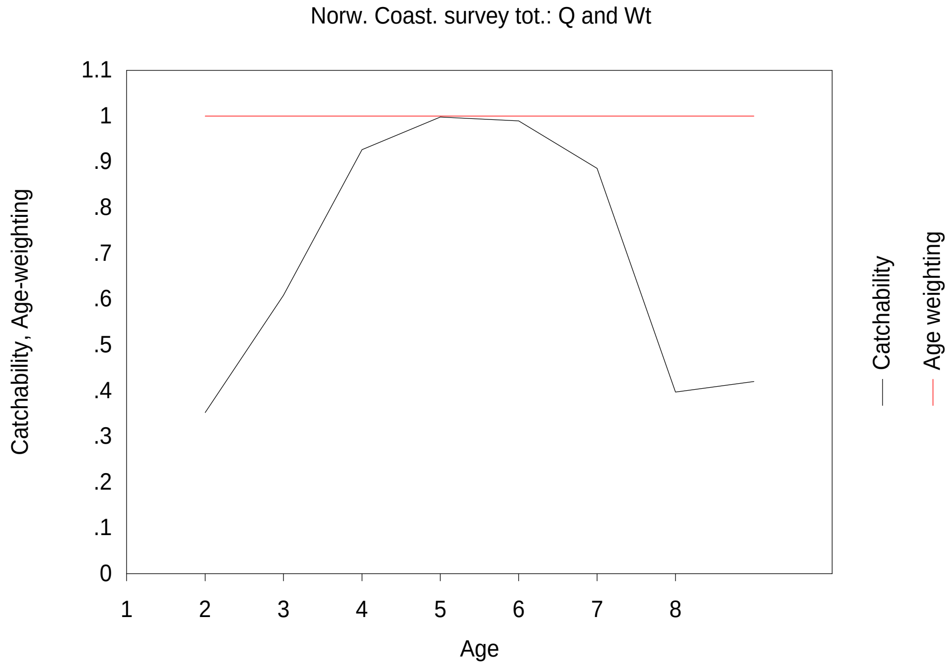


Figure 2.22. SURBA. Fitted survey catchability by age.

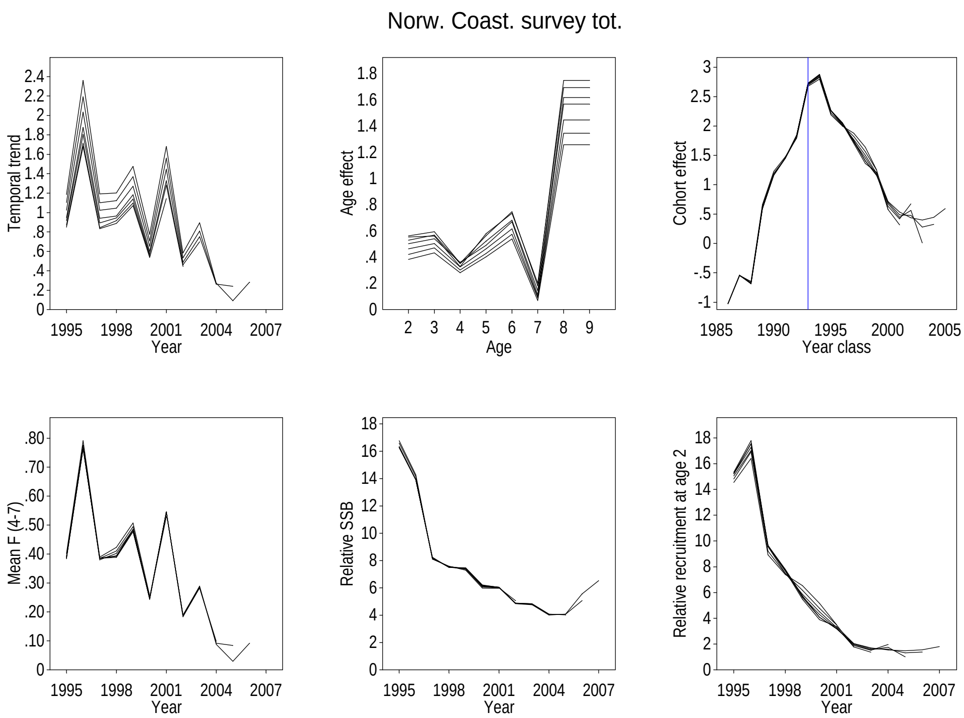


Figure 2.23. SURBA. Summary of retrospective runs.

3 North-East Arctic Cod (Subareas 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. After 2000, the reported catches have been between 400,000 and 500,000 t, in addition there have been unreported catches (see below). 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 Reported landings prior to 2009 (Tables 3.1–3.3, Figure 3.1)

Reported landings of cod in subarea I and Divisions IIa and IIb:

Final official landings for 2007 amount to 458,857 t. The provisional landings for 2008 reported to the working group are 465,814 t.

Reported landings 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) leads to reported landings of North-East Arctic cod of 445,796 t in 2007 and 449,171 t in 2008 (Table 3.3). The coastal cod catches calculated this way in 2007 and 2008 were 13,061 t and 16,643 t, respectively. The catches of coastal cod calculated this way for the period 1960-2008 are given in Table 3.1b together with the coastal cod catches calculated based on otolith types as described in Section 2.

The landings by area, are shown in Table 3.1a, and further split into trawl and other gears in Table 3.2. The distribution of catches by areas and gears in 2008 was similar to 2007. The nominal landings by country are given in Table 3.3.

3.1.3 Unreported catches of Northeast Arctic cod in 2002–2008

In the years 2002-2007 certain quantities of unreported catches (IUU catches) have been added to the reported landings. More details on this issue are given in Section 0.3. The Norwegian and Russian estimates of IUU for this period are given in Table 3.1a. For 2008 there was a Norwegian IUU estimate of 15,000 tonnes which were adopted by the Working Group.

3.1.4 TACs and advised catches for 2008 and 2009

The Joint Norwegian-Russian Fisheries Commission (JNRFC) agreed on a cod TAC of 451,000 t for 2008, including 21,000 t Norwegian coastal cod. The total reported catch of 465,814 t in 2008 was 14,814 t above the agreed TAC.

The advice for 2009 given by ACFM in 2008 was based on the 'Nor-IUU' assessment made by AFWG in 2008. The agreed harvest control rule then implied a NEA cod TAC for 2009 of 473,000 tonnes. However, the JNRFC did not follow the HCR this year because of a good condition of the stock registered, and set the NEA cod TAC for 2009 to 525,000 tonnes. They noted that next year, they would go back to following the rule.

The Working Group has no information on the size of expected unreported landings in 2009.

3.2 Status of research

3.2.1 Fishing effort and CPUE (Table A1)

Updated CPUE series of the Norwegian and Russian 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 – abundance at age (Tables 3.6, A2–A4, A9–A10, A13–A14)

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 2009 are given in Tables A2 and A3. More details on this survey are given in Aglen et al. (WD 11). The coverage was fairly good within the strata system defined for the survey. There has been a pattern in recent years to have concentrations of cod near the boarders of the strata system. This could indicate an increasing amount of fish being distributed outside the strata system.

Before 2000 this survey was made without participation from Russian vessels, while in 2001-2005 and 2008-2009 Russian vessels have covered important parts of the Russian zone. In 2006-2007 the survey was carried out only by Norwegian vessels. In 2007 the vessels were not allowed to cover the Russian EEZ. The method for adjustment for incomplete area coverage in 2007 is described in the 2007 report. Table 3.6 shows areas covered in the time series and the additional areas implied in the method used to adjust for missing coverage in Russian Economic Zone. In 4 of the 5 adjusted years the adjustments were not based on area ratios, but the "index ratio by age" was used. This means that the index by age (for the area outside REZ) was scaled by the observed ratio between total index and the index outside REZ observed in the years prior to the survey.

Regarding the older part of this time series it should be noted that the survey prior to 1993 covered a smaller area (Jakobsen *et al*. 1997), and the number of young cod (particularly 1- and 2-year old fish) was probably underestimated. Other changes in the survey methodology through the 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). The 2009 survey showed a considerable increase in numbers compared to the 2008 survey, and the fraction of repeat spawners was also considerably higher.

Russian autumn survey

Abundance estimates from the Russian autumn survey (November-December) are given in Table A9 (acoustic estimates) and Table A10 (bottom trawl estimates). The entire bottom trawl time series was in 2007 revised backwards to 1982 (Golovanov et al., 2007, WD3), using the same method as in the revision presented in 2006, which went back to 1994. The new swept area indices reflect Northeast Arctic cod stock dynamics more precisely compared to the previous one - catch per hour trawling. The Russian autumn survey in 2006 was carried out with reduced area coverage. Divisions IIa and IIb were adequately investigated in the survey in contrast to Sub-area I, where the survey covered approximately 40% of the long-term average area coverage. The Subarea I survey indices were calculated based on actual covered area (40 541 sq. miles). The 2007 AFWG decided to use the final year class indices without any correction because of satisfactory internal correspondence between year class abundances at age 2-9 years according to the 2006 survey and ones due to the previous surveys.

The Russian autumn 2008 survey was conducted in the standard period and under the standard methods. An area of 230 $*10^3$ sq. miles was covered, which is somewhat larger than the standard area. The 2008 abundance indices were calculated based on the standard area adopted at the two previous AFWG (2007 and 2006) (Golovanov *et al.*, WD 3 in 2007; WD 21 in 2006).

Overall increase of cod numbers was observed in the last survey, especially for cod at age 3 and 4 years. Rather wide distribution of cod was registered, and besides, delaying of return migrations of maturing fish from the eastern feeding grounds was observed.

Joint Ecosystem survey

Swept area bottom trawl estimates from the joint Norwegian-Russian ecosystem survey in August-September for the period 2004-2008 are given in Table A14.

General comments

Both the Russian autumn and the joint winter surveys have during the last two years showed higher abundance of cod than should be expected from previous surveys. The reasons for this are not fully explored, but incomplete coverage at some surveys in 2006 and 2007 may explain some of it. There has also been observed some change in geographical distribution, with higher densities near the borders of the area covered.

3.2.3 Survey results – length and weight at age (Tables A5–A8, A11–A12)

Length at age is shown in Table A5 for the Norwegian survey in the Barents Sea in winter, in Table A7 for the Lofoten survey and in Table A11 for the Russian survey in October-December. Weight 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.

Both the Joint winter survey in 2009 and the Russian autumn survey in 2008 show a slightly reduced size-at-age for young fish (2004 year class and younger) compared to the previous survey, while the size-at-age for older fish seems stable or increasing (Table A6 and A12).

3.2.4 Age reading

The joint Norwegian-Russian work on cod otolith reading has continued, with regular exchanges of otoliths and age readers (see chapter 0.5). The results of fifteen years of annual comparative age readings are described in Yaragina et al. (2009b). Zuykova et al. (2009) re-read old otoliths and found no significant difference in contemporary and historical age determination and subsequent length at age. However, age at first maturation in the historical material as determined by contemporary readers is younger than that determined by historical readers. Taking this difference into account would thus have effect on the spawning stock-recruitment relationship and thus on the biological reference points.

3.3 Data used in the assessment

3.3.1 Catch at age (Tables 3.7 and 3.9)

For 2008, age compositions from all areas were available from Russia, Germany and Norway. Poland provided age compositions from Division IIb. Unsampled catches (including estimated IUU catches) were distributed on age by using data from Russian trawl in Sub-area I and Division IIa, and by using data from Norwegian trawl in Division IIb. Table 3.7 shows available catch at age data for all ages 1-15+. The 2008 catch at age data was calculated using Intercatch, see section 0.4.

3.3.2 Weight at age (Tables 3.4 and 3.10–3.11).

Catch weights

For 2008, the mean weight at age in the catch (Table 3.10) was obtained from Intercatch as a weighted average of the weight at age in the catch for Norway, Russia, Germany and Poland. The weight at age in the catch for these countries is given in Table 3.4.

Stock weights

Since ages 12 and 13+ are scarce in the survey samples, fixed values for ages 12 to 15+ has formerly been used (set equal to typical weights for these ages observed in catches). Since the 2000 working group the assessment has applied 13 as plus group. For the years 1946-1984 the 13+ weights are calculated year by year as a weighted mean of the former fixed values for older ages. For later years they are calculated from the average observed weight for age 11 in the years 1995-2008 increased by 1.58 kg for age 12 and 2x1.58 kg for age 13+.

For ages 1-11 stock weights at age a at the start of year y ($W_{a,y}$) for 1983-2009 (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 A12)

$N_{nbar,a,y}$: 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 A6)

$N_{lof,a,y}$: 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 A8)

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 3.12)

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 1985-2009, Norwegian maturity at age ogives have been obtained by combining the Barents Sea winter survey and the Lofoten survey. Russian maturity ogives from the autumn survey as well as from commercial fishery for November-February 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 ogives for 1989 and later years were revised in 2006, due to a slight change of methodology.

3.3.5 Cannibalism

The method used for calculation of the prey consumption by cod described by Bogstad and Mehl (1997) is used to calculate the consumption of cod by cod for use in XSA. The consumption is calculated based on cod stomach content data taken from the joint PINRO-IMR stomach content database (methods described in Mehl and Yaragina 1992). On average about 9,000 cod stomachs from the Barents Sea have been analysed annually in the period 1984-2008. The consumption calculations this year have been updated by data for 2008. These data are used to calculate the per capita consumption of cod by cod for each half-year (by prey age groups 0-6 and predator age groups 1-11+). It was assumed that the mature part of the cod stock is found outside the Barents Sea for three months during the first half of the year. Thus, consumption by cod in the spawning period was omitted from the calculations.

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). All occurrences of intra-cohort predation were removed from the data set as these could possibly cause problems with convergence.

3.4 Assessment using VPA models

The XSA was also this year used as the main assessment method, as an update assessment was carried out. The TISVPA method was also run on the same data. Additional assessment methods (survey calibration of VPA, Gadget, GIS and synoptic methods) are presented in Section 3.9.

The following surveys and commercial CPUE data series were used for tuning of both models:

XSA name	TISVPA name	Name	Place	Season	Age	Years
Fleet 09	Fleet1	Russian trawl CPUE	Total area	All year	9-11	1985-2008
Fleet 15	Fleet2	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2009
Fleet 16	Fleet3	Joint acoustic survey	Barents Sea+Lofoten	Feb-Mar	3-9	1985-2009
Fleet 18	Fleet4	Russian bottom trawl surv.	Total area	Oct-Dec	3-9	1994-2008

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 2009 could be included in the assessment. The tuning fleet file is shown in Table 3.13. Note that the joint acoustic survey (sum of Barents Sea and Lofoten acoustic survey indices) is given in Table A13.

3.4.1 XSA settings

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 (Section 3.4.3). These age groups are not included in the tuning, however.

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.

XSA was run 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. Since the assessments in August 2000, few changes in model settings and data choices have been made.

3.4.2 Including cannibalism in XSA (Table 3.8)

The catch numbers shown in Table 3.9 together with cannibalism numbers (Tables 3.8) were used in the XSA tuning.

For the cod assessment data from annual sampling of cod stomachs has been used for estimating cannibalism, since the 1995 assessment. The argument has been raised that the uncertainty in such calculations are so large that they introduce too much noise in the assessment. A rather comprehensive analysis of the usefulness of this was presented in Appendix 1 in the 2004 AFWG report. The conclusion was that it improves the assessment.

The following procedure was followed: As a starting point the number of cod consumed by cod was estimated from the stock estimates in the last assessment and the per capita estimates of consumption of cod by cod. Then the number consumed was added to the catches used for tuning. The resulting stock then leads to new estimates of consumption. This procedure was repeated until the consumed numbers for the latest year (2008) differed less than 1% from the previous iteration. This procedure has also been implemented in the FLR version of the XSA, see WD 5, 2008. The final numbers of cod eaten by cod are given in Table 3.8.

It would be promising to include cannibalism to the historical period (1946-1983) data to make the VPA time series consistent. There have been some approaches proposed (Yaragina et al. 2009a).

3.4.3 XSA Tuning diagnostics (Table 3.14–3.15, Figure 3.2–3.3)

The tuning diagnostics from XSA with cannibalism are given in Table 3.15. Figure 3.2 shows the log catchability residuals of the tuning series. Most of the residuals are negative in 2006 and positive in 2007, and for some of the surveys, the difference between the 2006 and 2007 residuals is rather large. The residuals in 2008 also tend to be at the positive side, particularly age 9 and 10 in the trawl cpue (fleet 09). For age 9 in fleet 18 there seem to be an increasing trend in catchability.

Figure 3.3 and Table 3.14 compares the estimated survivors (by end of 2008) and Fs before shrinkage in single fleet tunings. (The single fleet runs applies the same shrinkage settings as the standard run, but the tabulated values of F and survivors are the pure survey predictions in the diagnostics output). For ages 6, 7, 10 and 11 there are some discrepancies between fleets, and the combined result (ALL, including shrinkage) tend to be closest to the fleets giving highest abundance. For the remaining ages there is a fair agreement between fleets. The patterns described above may have caused some overestimation of the older ages, and thereby also the SSB.

ACFM technical minutes have several times commented on the rather unconventional use of “stock size dependant catchability” (ssdq). For NEA cod, this is assumed for age groups 3-5. It is true that this choice involves more parameters to be estimated and a likely less precise parameter fit, in particular when the tuning is restricted to the latest 10 years. It is also observed that the influence of shrinkage is considerably higher for the age groups estimated by this q-assumption (Table 3.14). The 2005 WG argued for keeping this setting on the basis of compared retrospective patterns, and the ACFM reviewers agreed that without ssdq some problems might occur again as soon as some high survey values occur, which is now the case. In spite of rather high survey values for ages 3 and 4, a test run without stock size dependant catchability gave hardly any difference in reference F and SSB for 2008.

Several earlier assessments have shown to be sensitive both to the length of the tuning period, and the choice of stock size dependant catchability. In addition, this year's analysis showed that fleet 15 and fleet 18 for several age groups had internal SE<0.3, which is the minimum value used in the default setting. The following comparative runs were therefore made to explore the sensitivity to these choices:

Model setting different from the standard run	F(5-10)-08	SSB-08
No stock size dependant catchability	0.296	792
Stock size dependant catchability for ages 3-7	0.309	755
15 year tuning period	0.302	770
Minimum SE for fleet weighting reduced from 0.3 to 0.1	0.288	807
Standard run	0.302	767

From this it seems that the assessment is rather robust to the above changes of model setting, but the diagnostics discussed above indicate some sensitivity to the choice of tuning data.

Retrospective plots of F, SSB and recruitment, going back to 1999 as the last year in the assessment, are shown in Figure 3.4. Cannibalism is taken into account, but the number of cod consumed by cod was not recalculated year by year in the retrospective analysis. The retrospective pattern seems satisfactory.

3.4.4 Results (Table 3.16–3.26)

The total fishing mortalities (true fishing mortality plus mortality from cannibalism) and population numbers in Tables 3.16 and 3.17.

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 (real 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 3.18) was used together with the new real Fs (Table 3.20) to run the final VPA on ages 3-13+. M2 and F values for ages 1-6 in 1984-2008 are given in Tables 3.19 and 3.21.

The stock numbers from the final run are given in Tables 3.22, while the corresponding stock biomass at age and the spawning stock biomass at age are given in Tables 3.23-3.24. Summaries of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1946 runs are given in Table 3.25 and Figure 3.1.

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 3.26).

3.4.5 TISVPA (Fig 3.5–3.11)

The TISVPA (Triple Instantaneous Separable VPA) model (Vasilyev, 2006) represents fishing mortality coefficients (more precisely – exploitation rates) as a product of three parameters: f(year)*s(age)*g(cohort). The generation-dependent parameters, which are estimated within the model, are intended to adapt traditional separable representation of fishing mortality to situations when several year classes may have peculiarities in their interaction with fishing fleets caused by different spatial distribution, higher attractiveness of more abundant schools to fishermen, or by some other reasons. The model was first presented and tested at the ICES Working Group on Methods of Fish Stock Assessments (WGMG 2006) and was used for data exploration and stock assessment for several ICES stocks, including North-East Atlantic mackerel, blue whiting, Norwegian spring spawning herring (WGMHSA 2006, 2007; WGNPBW 2006, 2007) and for NEA cod (AFWG 2008). The model is an extension of the ISVPA model (Kizner and Vasilyev, 1997; Vasilyev, 2005).

This year the TISVPA model was applied to NEA cod data including Norwegian estimates of unreported catches. Natural mortality from cannibalism values were taken from the XSA runs. As well as in XSA runs, 4 sets of age-structured tuning data were included into analysis: Russian trawl *cpue* ("fleet 1"); joint bottom trawl surveys ("fleet 2"); joint acoustic surveys (Barents Sea and Lofoten) – "fleet 3", and Russian bottom trawl surveys ("fleet 4").

Settings of the TISVPA model as for previous year, were the following: so called "catch-controlled" version, considering catch-at-age data as true and attributing residuals in logarithmic catch-at-age to violations of assumption about stability of selection pattern. This version was chosen because it is ideologically most close to XSA, which also considers catch-at-age data as true, but unlike XSA, the TISVPA model, being separable, even in this version gives possibility to get signal about the stock size from catch-at-age data taken separately. Additional restriction on the solution was unbiased separable representation of fishing mortality coefficients (more precisely - of exploitation rates).

The generation-dependent factors in triple-separable representation of fishing mortality coefficients were estimated for age groups from 3 to 12.

The experiments with various versions of loss function component for catch-at age matrix showed that MDN (median of absolute residuals) had to be chosen (Figure 3. 5) as in this case minimum was more pronounced.

For the all "fleets" the simplest measure of closeness of fit of the model to the data - sum of squares of residuals in logarithmic abundance-at-age gave the apparent minima of respective components of the model loss function (Figure 3. 6) .

Residuals in logarithmic catch-at-age and in abundance-at-age (for fleets) are shown on Fig.3.7. Results of retrospective runs (Figure 3.8) show a reasonable historical stability of the estimates and the absence of systematic shifting tendency.

The retrospective analyses were carried out with the same options as the final TISVPA run.

The estimates of uncertainty in the results (parametric conditional bootstrap with respect to catch-at-age, "fleet" data were noised by lognormal noise with sigma=0.3) are presented on Figure 3.9.

It is necessary to underline that extremely high estimates of abundance at age 3 in 2007 (in particular) and 2008 in the results are due to high catch of these age groups, as the abundance estimates are directly comes from the catch value and average selection. That is why these estimates always are the least reliable ones. Figure 3.10 compares the historical catches at age 3 to the estimates of abundance at age 3 for previous years (which are more reliable since they are more supported by the information). As it can be seen, the catch-at-age values at age 3 were similarly high in 1985, 1986, 1992 and 1998. But the estimates of abundance at age (3) in these years were not so extremely high. Thus it was decided to substitute the estimates of abundance at age 3 in 2007 and in 2008 by the mean abundance estimate for 1985, 1986, 1992 and 1998. Accordingly, the estimates of biomass B(3+) for two last years were also corrected.

There are a number of properties of the TISVPA model which make the model a valuable tool for data exploration in NEA cod stock assessment. These properties include the possibility to strictly formulate a statistical meaning of the solution; not to consider as absolutely true the catch-at-age data, survey data, fleet cpue, or the assumption about stability of selection pattern; to take into account the generation-dependent peculiarities in selection pattern; to trace the information about the stock size independently from each source of data (including catch-at-age); attention to robustness of the results (by means of possibility to apply robust measures of the goodness of fit and to ensure the unbiasedness of the solution), as well as the experience in its application to other ICES stocks.

The total stock biomass in 2008 from the TISVPA runs totalled 2,736 thousand tons, while the spawning stock biomass was 1,044 thou. t and $F_{5\text{-}10}$ in 2008 was 0.237.

3.4.6 Comparison of TISVPA and XSA results (Fig 3.11)

A comparison of the results from the TISVPA and XSA are given in Figure 3.11. The trends are similar. TISVPA gives a somewhat higher current stock size than XSA after 2004 (the value for the 2004 and 2005 year classes would also have been much higher in TISVPA if the adjustment mentioned in Section 3.4.5 had not been applied). The main reason for this is that stock size dependent catchability for ages 3-5 is used in XSA, and thus high survey indices for these ages groups will affect the current stock size less in XSA than in TISVPA, which uses stock size independent catchability for these age groups.

Also, the TISVPA run gives higher stock size in the last year than the XSA and lower terminal estimates of F(5-10).

3.5 Results of the assessment

3.5.1 Fishing mortalities and VPA (Tables 3.20–3.25, Figure 3.1)

The estimated $F_{5\text{-}10}$ in 2008 from the SVPA is 0.30, which is below F_{pa} and is the lowest since 1990. Fishing mortility has gradually declined since 2005. The spawning stock biomass in 2009 is estimated to be 1079,000 t, which is the highest since 1947. Total stock biomass in 2009 is estimated to about 2500,000 tonnes which is not that outstanding in the time series. One should bear in mind that in the early part of the time series the fraction mature was lower.

3.5.2 Recruitment (Table 1.13)

Since survey data for the youngest ages are not used in the XSA, these ages are estimated by other models. At the 2008 working group several models for cod recruitment (age 3) were presented and evaluated (Section 1.4.5). It was decided to use a hybrid model, which is an arithmetic mean of models with correlation coefficient greater than 0.5. It was agreed to use the same models this year. The input data for those models are the following time series; survey data for ages 0, 1 and 2 (Russian autumn survey) and ages 1, 2 and 3 (Joint winter survey) , 0-group from the ecosystem survey, capelin biomass, ice coverage, temperature and oxygen saturation at the Kola section, air temperature at Murman coast. Prognosis from all the models, including the hybrid is presented in Table 1.13. Here also the results from the earlier used RCT3 model are shown. The numbers at age 3 calculated by the hybrid method were:

564 million for the 2006 year class, 487 million for the 2007 year class and 184 million for the 2008 year class.

3.6 Reference points and harvest control rules

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: $F_{0.1}$ =0.15 and F_{max} =0.28.

3.6.3 Adopted harvest control rule

At the 31st session of The Joint Norwegian-Russian Fishery Commission (JRNFC) in autumn 2002, the Parties agreed on a new harvest control rule. This rule was applied for the first time when setting quotas for 2004. The rule was somewhat amended at the 33rd session of The Joint Norwegian-Russian Fishery Commission in autumn 2004. The amended rule was evaluated by ICES in 2005 and found to be precautionary.

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

conditions for high long-term yield from the stocks

achievement of year-to-year stability in TACs

full utilization of all available information on stock development

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

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

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

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

A review and discussion of this and other harvest control rule was made by the ICES SGMAS (ICES 2007c). They discovered that this HCR may give unexpected and possibly unwanted results if the assessment changes much from year to year in a situation when SSB is close to B_{pa}. This problem has, however, so far not been encountered in the application of the HCR.

3.6.4 Target reference points

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

3.7 Prediction (Table 3.27–3.29)

3.7.1 Prediction input (Tables 3.28, Figure 3.12a–b, 13)

The input data to the short-term prediction with management option table (2009-2011) are given in Table 3.27. For 2009 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2009 onwards and stock weights in 2010 onwards are predicted by the method described by Brander (2002), where the latest observation of weights by cohort are used together with average annual increments to predict the weight of the cohort the following year.

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

This method was introduced in the cod prediction in the 2003 working group. Then it was decided that for Catch Weights average annual increments by age were calculated for the period 1994-2001, and for Stock Weights average annual increments by age were calculated for the period 1995-2002. At the 2004 working group it was decided to follow the same procedure, except that for stock weights the period (2001-2003) was chosen for calculating average annual increment. The reason was that those years indicate a declining trend that could be associated with declining capelin stock. The same argument was considered valid at the 2005 and later working groups and only the 3 most recent values of annual increments were used for predicting stock weights. For catch weights, we use a 10-year period (1998-2007) for averaging the increments. Figures 3.12a and 3.12b show how these predictions perform back in history.

The maturity ogive for the years 2010 and 2011 was predicted by using the 2007-2009 average. The exploitation pattern in 2009 and later years was set equal to the 2006-2008 average.

The stock number at age in 2009 was taken from the final VPA (Table 3.22) for ages 4 and older. The recruitment at age 3 in year 2009-2011 was estimated as described in section 1.4.5. Figure 3.13 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 1984-2008. The recent 3 years average M was used as input for the years 2008-2010 in the prediction.

For 2012, the 2011 values were used for all input data, except for recruitment, where the long-term arithmetic mean (600 million at age 3) was used.

The assessment shows a decrease in F from 2006 to 2008. Effort has also decreased (Figure 3.17), and thus F in 2008 is considered to be a better estimate for F in the intermediate year (2009) than the estimate using three year average F. Table 3.27 shows input data to the predictions.

3.7.2 Prediction results

The catches corresponding to F_{sq} in 2009 is 522 000 tonnes (Table 3.28). This is close to the TAC for 2009 (525 000 tonnes). The resulting SSB in 2010 is 1353,000 tonnes. Table 3.28 also shows the short-term consequences over a range of F-values in 2010. The detailed outputs corresponding to F_{sq} in 2009, the F corresponding to the HCR in 2010 and F_{pa} in 2011-2012 is given in Table 3.29b. Summarised results are shown in text table below

Rationale	Landings [1] (2010)	Basis	F (2010)	SSB (2011)	%SSB change [2]	% TAC change [3]
Zero catch	0	$0*F_{sq}$	0	2184	+62	-100
Agreed management Plan[4]	577.5	$0.95*F_{sq}$	0.28	1655	+22	+10
Status quo	605	$1.00*F_{sq}$	0.30	1631	+21	+15
Precautionary Limits	776	F_{pa}	0.400	1353	+0	+48

Weights in '000 t.

[1] Landings are total landings without IUU landings. If this figure is taken as TAC, no implementation error is assumed.

[2] SSB 2011 relative to SSB 2010.

[3] TAC 2010 relative to TAC 2009.

[4] Forecast based on 10% increased TAC.

This catch forecast covers all catches. It is then implied that all types of catches are to be counted against this TAC. It also means that if any overfishing is expected to take place, the above calculated TAC should be reduced by the expected amount of overfishing. The average Fpa catch over the years 2010-2012 is more than 10% above the quota for 2009 (Table 3.29a). The harvest rule allows the TAC to increase by maximum 10%. This restricts the 2010 catches to a total of 577,500 tonnes. This corresponds to an F=0.28 and allows for further increase in SSB by about 20%.

The quota for 2009 (525,000 t) was set above the catch corresponding to the agreed management plan (473,000 t). Using the latter value as basis for a 10% increase gives a TAC in 2010 of 520,300 t.

The earlier testing of the agreed management plan pre-assumed that the plan should be strictly followed for setting TAC, and the deviation from the management plan in last year is not considered to be a precautionary practice.

3.8 Comparison with last year's assessment

The text table below compares this year's estimates with last year's estimates for the year 2008 numbers at age (millions), total biomass, spawning biomass (thousand tonnes), as well as reference F for the year 2007.

		N(2008)										
Assessment yr (specification)	F(2007)	age3	age4	age5	age6	age7	age8	age9	age10	TSB (2008)	SSB (2008)	F (2008)
2008 WG	0.40	714*	549	282	176	61	54	13.6	6.4	2052	650	0.40**
2009 WG	0.35	802	623	288	181	64	68	17.6	8.0	2272	767	0.30
Ratio 2009 WG/ 2008 WG	0.87	1.12	1.14	1.02	1.03	1.04	1.26	1.29	1.25	1.11	1.18	0.74

*estimated by recruitment models **assuming F_{sq}

The final assessment values for ages 5, 6 and 7 are fairly close to the 2008 assessment, while ages 3, 4 and 8-10 has this year been revised upward. The F in 2007 is 0.05 (13%) below last year's estimate, and the SSB in 2008 is revised up by 18%. The new estimate of SSB in 2009 (1079,000 tonnes) is 28 % above the prediction from last year (844,000 tonnes). This is partly caused by higher maturation at age being observed in 2009, compared to the one predicted.

3.9 Additional assessment methods

3.9.1 Survey calibration method

A "calibrated" prediction method 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, was carried out. The method is described in Pennington and Nakken (WD14, 2008). The regression is done for ages 4-6 and 7+ separately. The results, using a regression method with intercept, are shown in Figures 3.14-3.15 and in the text table in Section 3.12. The figures show a shift both for ages 4-6 and 7+ occurring around 2006 for the relation between the survey calibration method and the VPA.

3.9.2 Gadget (Figure 3.16)

The biological Gadget model used for Northeast Arctic cod is described in Bogstad et al. (2004). The same model as last year was run, updated with an additional year of data. Model runs are now performed using Gadget version 2.1.03. In 2008 the most recent survey results caused an unrealistically large predicted recruitment in the last few years of the model run. The cause of this was unclear and the surveys were excluded from the model in 2008. As a result the modeled results presented last year were considered very uncertain. In the present year all surveys have been used in tuning the model. As a result of adding the two recent years of survey data suggesting higher recruitment the perception of recent recruitment, and hence stock size, has increased dramatically from that presented last year (Figure 3.16). The modeled stock from 1985-2004 is almost the same as that presented last year, although the mature biomass for this period has been revised slightly downwards. In contrast recruitment estimates have been revised upwards from 2004 onwards. This has resulted in increased total and spawning stock biomasses. The Gadget model is in broad agreement with the XSA model in that that current stock is close to the highest values seen over the last 20 years. There is some indication in the model results that recruitment may now be dropping from the recent high levels.

3.10 Comments to the assessment

The magnitude of IUU catches has decreased considerably from around 30% of official landings to 3%. The uncertainty relating to total catch for the years 2002-2006 could still have significant influence on the assessment of the current stock.

The survey results from the two latest years are not consistent with the results from the previous years. Some of this inconsistency may be explained by inadequate spatial coverage of surveys in 2006/2007. The main uncertainty in the current assessment seems to be on the older fish where there are some discrepancies between tuning fleets.

XSA has for several years been used for the assessment of cod, but in recent years additional assessment models have been tried, e.g. the "survey calibration model", "gadget", the "GIS method", the "Synoptic method", and various variants of "ISVPA". These models have given results characterized by differences in level of stock size and exploitation, although the trends have in most cases been similar.

The WG realizes that imprecise input data, in particular the catch-at-age matrix, could be a main obstacle to producing precise stock assessments, irrelevant of which model is used. The WG, therefore, recognizes the need for improvements to the input data, and in particular more reliable catch data (see chapter 0.3).

However, the WG also recognizes the need for a more thorough comparison of assessment methodologies. In particular, the models XSA and ISVPA would be interesting to explore and compare. These two models are related to the same class of cohort analysis models.

XSA model is used in many years by AFWG, that has a big experience to work with this model, but ISVPA has some advantages. In particular, ISVPA allows strictly to formulate a statistical meaning of solution, is more robust and reliable.

Benchmarking of various assessment models is not a trivial task, since criteria for performance are not easy to establish across models. Therefore, some guidance for how to perform such comparisons would be valued. It is also clear that a benchmark workshop should not be planned too early, since most of the work in connection with the benchmarking will have to be done prior to the workshop.

3.11 New data sources

This section describes some data sources, which could be included in the assessment in the future.

3.11.1 Catch data

Discard and bycatch data series (Table 3.30, 3.31) should be updated and then included in the catch at age matrix. Table 3.31 (taken from Ajiad *et al.*, WD2, 2008) presents by-catch in the Norwegian shrimp fishery by cod age (previously this has been given by cod length). The by-catch mainly consists of age 1 and 2 fish, but the bycatch is generally small compared to other reported sources of mortality: catches, discards and the number of cod eaten by cod. From 1992 onwards, by-catches of age 3 and older fish are negligible, because use of sorting grids was made mandatory. However, in 1985, by-catches of age 5 and 6 cod were about one third of the reported catches for those age groups. The year class for which the by-catches were highest, was the 1983 year class (total by-catch of age 2 and older fish of about 60 million, compared to a stock estimate of about 1000 million at age 3).

Also the time series described by Hylen (2002), extending the VPA back to 1932, should be reviewed. Consistency between the catch data used for NEA cod and coastal cod should also be ensured. At present, the catch figures used in the coastal cod assessment are not equal to the difference between the total cod catch and the catch used in the NEA cod assessment (Table 3.1b).

It could also be considered to take the difference in age at maturation determined by contemporary and historic age readers (Section 0.4) into account.

Updating the catch data series as indicated here will affect the reference points, but only to a small extent estimate of present stock size. These updates all should be carried out at the same time.

3.11.2 Consumption data

Work on extending the cannibalism time series back to 1947 is ongoing (Yaragina et al. 2009a).

3.11.3 Survey data

The bottom trawl estimates from the joint ecosystem survey in August-September, starting in 2004 (Table A14), could in the future (when the time series becomes more than 5 years long) be considered for use as a tuning series. This survey covers the entire distribution area of cod.

3.11.4 New CPUE series

The new biomass indices described in WD11(2008) and 21(2008), based on vessels' daily reports, may in the future be included in the tuning of assessment models.

3.12 Answering 2008 comments from Reviewers:

The minutes of the review of the 2008 AFWG report contained a number of comments to the NEA cod assessment. Below is a summary how AFWG has responded to this:

1-3. Attempts are made to make Tables and graphs more clear and more explained by their legends.

4-5. The hybrid recruitment model has been applied as proposed by reviewers, but no attempts have been made to include environmental variables in RCT3.

6. Quality Handbook is updated

8. Table 3.6 shows areas covered in surveys and areas for adjusted surveys

9. There is no obvious explanation for the recent pattern observed in some surveys; that some year classes measured as low or moderate at younger ages pops up at ages 3, 4 or 5. One hypothesis is that young ages have been distributed outside the standard survey areas during the recent warm period.

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

Year	Sub-area I	Division IIa	Division IIb	Unreported catches	Total catch
1961	409 694	153 019	220 508		783 221
1962	548 621	139 848	220 797		909 266
1963	547 469	117 100	111 768		776 337
1964	206 883	104 698	126 114		437 695
1965	241 489	100 011	103 430		444 983
1966	292 253	134 805	56 653		483 711
1967	322 798	128 747	121 060		572 605
1968	642 452	162 472	269 254		1 074 084
1969	679 373	255 599	262 254		1 197 226
1970	603 855	243 835	85 556		933 246
1971	312 505	319 623	56 920		689 048
1972	197 015	335 257	32 982		565 254
1973	492 716	211 762	88 207		792 685
1974	723 489	124 214	254 730		1 102 433
1975	561 701	120 276	147 400		829 377
1976	526 685	237 245	103 533		867 463
1977	538 231	257 073	109 997		905 301
1978	418 265	263 157	17 293		698 715
1979	195 166	235 449	9 923		440 538
1980	168 671	199 313	12 450		380 434
1981	137 033	245 167	16 837		399 037
1982	96 576	236 125	31 029		363 730
1983	64 803	200 279	24 910		289 992
1984	54 317	197 573	25 761		277 651
1985	112 605	173 559	21 756		307 920
1986	157 631	202 688	69 794		430 113
1987	146 106	245 387	131 578		523 071
1988	166 649	209 930	58 360		434 939
1989	164 512	149 360	18 609		332 481
1990	62 272	99 465	25 263	25 000	212 000
1991	70 970	156 966	41 222	50 000	319 158
1992	124 219	172 532	86 483	130 000	513 234
1993	195 771	269 383	66 457	50 000	581 611
1994	353 425	306 417	86 244	25 000	771 086
1995	251 448	317 585	170 966		739 999
1996	278 364	297 237	156 627		732 228
1997	273 376	326 689	162 338		762 403
1998	250 815	257 398	84 411		592 624
1999	159 021	216 898	108 991		484 910
2000	137 197	204 167	73 506		414 870
2001	142 628	185 890	97 953		426 471
2002 [2]	184 789	189 013	71 242	90000/21716	535045/466760
2003 [2]	163 109	222 052	51 829	115000/27748	551990/464738
2004 [2]	177 888	219 261	92 296	117000/30000	606445/519445
2005 [2]	159 573	194 644	121 059	166000/41000	641276/516276
2006 [2]	159 851	204 603	104 743	127000/28000	596197/497197
2007 [2]	152 522	195 383	97 891	41087/8757	486883/454553
2008 [1]	144905	203244	101022	15000/0	464171/449171

[1] Provisional figures.

[2] two alternative estimates (see Chapter 3.1.3 of the 2008 AFWG Report for further details)

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

Year	Landings in '000 t: As calculated from samples and reported to AFWG	By area and time of capture
1960	-	43
1961	-	32
1962	-	30
1963	-	40
1964	-	46
1965	-	24
1966	-	29
1967	-	33
1968	-	47
1969	-	52
1970	-	49
1971	-	*)
1972	-	*)
1973	-	*)
1974	-	*)
1975	-	*)
1976	-	*)
1977	-	*)
1978	-	*)
1979	-	*)
1980	-	40
1981	-	49
1982	-	42
1983	-	38
1984	74	33
1985	75	28
1986	69	26
1987	61	31
1988	59	22
1989	40	17
1990	28	24
1991	25	25
1992	42	35
1993	53	44
1994	55	48
1995	57	39
1996	62	32
1997	63	36
1998	52	29
1999	41	23
2000	37	19
2001	30	14
2002	41	20
2003	35	19
2004	25	14
2005	22	13
2006	26	15
2007	24	13
2008	26	17
Average 1984-2008	45	25

*) 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	154.4	23.5	100.3	118.9	88.8	3.5
2005	132.4	27.2	87.0	107.7	115.4	5.6
2006	141.8	18.1	91.2	113.4	100.1	4.6
2007	129.6	22.9	84.8	110.6	91.6	6.3
2008 [1]	123.8	21.1	94.8	108.4	95.3	5.7

[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 prvided by Working Group members)

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep. Germany	Norway	Poland	United Kingdom	Russia[2]		Others	Total all countries
1961	3 934	13 755	3 921	8 129	268 377	-	158 113	325 780		1 212	783 221
1962	3 109	20 482	1 532	6 503	225 615	-	175 020	476 760		245	909 266
1963	-	18 318	129	4 223	205 056	108	129 779	417 964		-	775 577
1964	-	8 634	297	3 202	149 878	-	94 549	180 550		585	437 695
1965	-	526	91	3 670	197 085	-	89 962	152 780		816	444 930
1966	-	2 967	228	4 284	203 792	-	103 012	169 300		121	483 704
1967	-	664	45	3 632	218 910	-	87 008	262 340		6	572 605
1968	-	-	225	1 073	255 611	-	140 387	676 758		-	1 074 084
1969	29 374	-	5 907	5 543	305 241	7 856	231 066	612 215		133	1 197 226
1970	26 265	44 245	12 413	9 451	377 606	5 153	181 481	276 632		-	933 246
1971	5 877	34 772	4 998	9 726	407 044	1 512	80 102	144 802		215	689 048
1972	1 393	8 915	1 300	3 405	394 181	892	58 382	96 653		166	565 287
1973	1 916	17 028	4 684	16 751	285 184	843	78 808	387 196		276	792 686
1974	5 717	46 028	4 860	78 507	287 276	9 898	90 894	540 801		38 453	1 102 434
1975	11 309	28 734	9 981	30 037	277 099	7 435	101 843	343 580		19 368	829 377
1976	11 511	20 941	8 946	24 369	344 502	6 986	89 061	343 057		18 090	867 463
1977	9 167	15 414	3 463	12 763	388 982	1 084	86 781	369 876		17 771	905 301
1978	9 092	9 394	3 029	5 434	363 088	566	35 449	267 138		5 525	698 715
1979	6 320	3 046	547	2 513	294 821	15	17 991	105 846		9 439	440 538
1980	9 981	1 705	233	1 921	232 242	3	10 366	115 194		8 789	380 434
						Spain					
1981	12 825	3 106	298	2 228	277 818	14 500	5 262	83 000		-	399 037
1982	11 998	761	302	1 717	287 525	14 515	6 601	40 311		-	363 730
1983	11 106	126	473	1 243	234 000	14 229	5 840	22 975		-	289 992
1984	10 674	11	686	1 010	230 743	8 608	3 663	22 256		-	277 651
1985	13 418	23	1 019	4 395	211 065	7 846	3 335	62 489		4 330	307 920
1986	18 667	591	1 543	10 092	232 096	5 497	7 581	150 541		3 505	430 113
1987	15 036	1	986	7 035	268 004	16 223	10 957	202 314		2 515	523 071
1988	15 329	2 551	605	2 803	223 412	10 905	8 107	169 365		1 862	434 939
1989	15 625	3 231	326	3 291	158 684	7 802	7 056	134 593		1 273	332 481
1990	9 584	592	169	1 437	88 737	7 950	3 412	74 609		510	187 000
1991	8 981	975	**Greenland**	2 613	126 226	3 677	3 981	119 427 [3]		3 278	269 158
1992	11 663	2	3 337	3 911	168 460	6 217	6 120	182 315	**Iceland**	1 209	383 234
1993	17 435	3 572	5 389	5 887	221 051	8 800	11 336	244 860	9 374	3 907	531 611
1994	22 826	1 962	6 882	8 283	318 395	14 929	15 579	291 925	36 737	28 568	746 086
1995	22 262	4 912	7 462	7 428	319 987	15 505	16 329	296 158	34 214	15 742	739 999
1996	17 758	5 352	6 529	8 326	319 158	15 871	16 061	305 317	23 005	14 851	732 228
1997	20 076	5 353	6 426	6 680	357 825	17 130	18 066	313 344	4 200	13 303	762 403
1998	14 290	1 197	6 388	3 841	284 647	14 212	14 294	244 115	1 423	8 217	592 624
1999	13 700	2 137	4 093	3 019	223 390	8 994	11 315	210 379	1 985	5 898	484 910
2000	13 350	2 621	5 787	3 513	192 860	8 695	9 165	166 202	7 562	5 115	414 870
2001	12 500	2 681	5 727	4 524	188 431	9 196	8 698	183 572	5 917	5 225	426 471
2002	15 693	2 934	6 419	4 517	202 559	8 414	8 977	184 072	5 975	5 484	445 045
2003	19 427	2 921	7 026	4 732	191 977	7 924	8 711	182 160	5 963	6 149	436 990
2004	19 226	3 621	8 196	6 187	212 117	11 285	14 004	201 525	7 201	6 082	489 445
2005	16 273	3 491	8 135	5 848	207 825	9 349	10 744	200 077	5 874	7 660	475 276
2006	16 327	4 376	8 164	3 837	201 987	9 219	10 594	203 782	5 972	6 271	470 527
2007	14 788	3 190	5951	4619	199 809	9 496	9298	186 229	7316	5 101	445 796
2008 [1]	15812	3149	5617	4955	196 598	9658	8287	190225	7535	7 336	449 171

[1] Provisional figures.

[2] USSR prior to 1991.

[3] Includes Baltic countries.

Table 3.4 North-east Arctic COD. Weights at age (kg) in landings from various countries

Norway

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	0.41	0.82	1.32	2.05	2.82	3.94	5.53	7.70	9.17	11.46	16.59	16.42	16.96	24.46
1984	1.16	1.47	1.97	2.53	3.13	3.82	4.81	5.95	7.19	7.86	8.46	7.99	9.78	10.64
1985	0.34	0.99	1.43	2.14	3.27	4.68	6.05	7.73	9.86	11.87	14.16	14.17	13.52	15.33
1986	0.30	0.67	1.34	2.04	3.14	4.60	5.78	6.70	7.52	9.74	10.68	12.86	9.59	16.31
1987	0.24	0.48	0.88	1.66	2.72	4.35	6.21	8.78	9.78	12.50	13.75	15.12	10.43	19.95
1988	0.36	0.56	0.83	1.31	2.34	3.84	6.50	8.76	9.97	11.06	14.43	19.02	12.89	10.16
1989	0.53	0.75	0.90	1.17	1.95	3.20	4.88	7.82	9.40	11.52	11.47		19.47	14.68
1990	0.40	0.81	1.22	1.59	2.14	3.29	4.99	7.83	10.54	14.21	17.63	7.97	14.64	
1991	0.63	1.37	1.77	2.31	3.01	3.68	4.63	6.06	8.98	12.89	17.00		14.17	16.63
1992	0.41	1.10	1.79	2.45	3.22	4.33	5.27	6.21	8.10	10.51	11.59		15.81	6.52
1993	0.30	0.83	1.70	2.41	3.35	4.27	5.45	6.28	7.10	7.82	10.10	16.03	19.51	17.68
1994	0.30	0.82	1.37	2.23	3.35	4.27	5.56	6.86	7.45	7.98	9.53	12.16	11.45	19.79
1995	0.44	0.78	1.26	1.87	2.80	4.12	5.15	5.96	7.90	8.67	9.20	11.53	17.77	21.11
1996	0.29	0.90	1.15	1.67	2.58	4.08	6.04	6.62	7.96	9.36	10.55	11.41	9.51	24.24
1997	0.35	0.78	1.14	1.56	2.25	3.48	5.35	7.38	7.55	8.30	11.15	8.64	12.80	
1998	0.38	0.68	1.03	1.64	2.23	3.24	4.85	6.88	9.18	9.84	15.78	14.37	13.77	15.58
1999	0.46	0.88	1.16	1.65	2.40	3.12	4.26	6.00	6.52	10.64	14.05	12.67	9.20	17.22
2000	0.31	0.65	1.23	1.80	2.54	3.58	4.49	5.71	7.54	7.86	12.71	14.71	15.40	20.26
2001	0.30	0.77	1.18	1.83	2.75	3.64	4.88	5.93	7.43	8.90	10.22	11.11	13.03	18.85
2002	0.31	0.90	1.40	1.90	2.60	3.55	4.60	5.80	7.40	9.56	8.71	12.92	8.42	17.61
2003	0.55	0.88	1.39	2.01	2.63	3.59	4.83	5.57	7.26	9.36	9.52	9.52	10.68	21.66
2004	0.54	1.08	1.41	1.95	2.69	3.46	4.77	6.72	7.90	8.66	12.21	14.02	16.50	11.37
2005	0.58	0.92	1.38	1.86	2.61	3.54	4.57	6.41	8.24	9.89	11.04	14.08	11.81	20.08
2006	0.51	0.97	1.45	2.06	2.71	3.56	4.57	5.53	6.61	7.53	8.55	8.44	9.82	12.31
2007	0.53	1.07	1.70	2.37	3.26	4.36	5.45	6.71	8.08	8.56	9.75	11.72	12.72	15.58
2008	0.65	1.12	1.70	2.44	3.32	4.41	5.61	6.84	8.25	9.31	10.54	12.45	13.59	21.15

Russia (trawl only)

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	0.65	1.05	1.58	2.31	3.39	4.87	6.86	8.72	10.40	12.07	14.43			
1984	0.53	0.88	1.45	2.22	3.21	4.73	6.05	8.43	10.34	12.61	14.95			
1985	0.33	0.77	1.31	1.84	2.96	4.17	5.94	6.38	8.58	10.28				
1986	0.29	0.61	1.14	1.75	2.45	4.17	6.18	8.04	9.48	11.33	12.35	14.13		
1987	0.24	0.52	0.88	1.42	2.07	2.96	5.07	7.56	8.93	10.80	13.05	18.16		
1988	0.27	0.49	0.88	1.32	2.06	3.02	4.40	6.91	9.15	11.65	12.53	14.68		
1989	0.50	0.73	1.00	1.39	1.88	2.67	4.06	6.09	7.76	9.88				
1990	0.45	0.83	1.21	1.70	2.27	3.16	4.35	6.25	8.73	10.85	13.52			
1991	0.36	0.64	1.05	2.03	2.85	3.77	4.92	6.13	8.36	10.44	15.84	19.33		
1992	0.55	1.20	1.44	2.07	3.04	4.24	5.14	5.97	7.25	9.28	11.36			
1993	0.48	0.78	1.39	2.06	2.62	4.07	5.72	6.79	7.59	11.26	14.79	17.71		
1994	0.41	0.81	1.24	1.80	2.55	2.88	4.96	6.91	8.12	10.28	12.42	16.93		
1995	0.37	0.77	1.21	1.74	2.37	3.40	4.71	6.73	8.47	9.58	12.03	16.99		
1996	0.30	0.64	1.09	1.60	2.37	3.42	5.30	7.86	8.86	10.87	11.80			
1997	0.30	0.57	1.00	1.52	2.18	3.30	4.94	7.15	10.08	11.87	13.54			
1998	0.33	0.68	1.06	1.60	2.34	3.39	5.03	6.89	10.76	12.39	13.61	14.72		
1999	0.24	0.58	0.98	1.41	2.17	3.26	4.42	5.70	7.27	10.24	14.12			
2000	0.18	0.48	0.85	1.44	2.16	3.12	4.44	5.79	7.49	9.66	10.36			
2001	0.12	0.31	0.62	1.00	1.53	2.30	3.31	4.57	6.55	8.11	9.52	11.99		
2002	0.20	0.60	1.05	1.46	2.14	3.27	4.47	6.23	8.37	10.06	12.37			
2003	0.23	0.63	1.06	1.78	2.40	3.41	4.86	6.28	7.55	11.10	13.41	12.12	14.51	
2004	0.30	0.57	1.09	1.55	2.37	3.20	4.73	6.92	8.41	9.77	11.08			
2005	0.33	0.65	0.98	1.50	2.10	3.08	4.31	5.81	8.42	10.37	13.56	14.13		
2006	0.27	0.68	1.05	1.49	2.25	3.16	4.54	5.90	8.59	10.31	12.31			
2007	0.23	0.67	1.12	1.66	2.25	3.31	4.57	6.27	8.20	10.02	12.36	12.4		
2008	0.28	0.64	1.16	1.74	2.65	3.58	4.74	5.73	7.32	8.07	9.52	12.5		

Germany (Division IIa and IIb)

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994		0.68	1.04	2.24	3.49	4.51	5.79	6.93	8.16	8.46	8.74	9.48	15.25	
1995		0.44	0.84	1.50	2.72	3.81	4.46	4.81	7.37	7.69	8.25	9.47		
1996		0.84	1.15	1.64	2.53	3.58	4.13	3.90	4.68	6.98	6.43	11.32		
1997		0.43	0.92	1.42	2.01	3.15	4.04	5.16	4.82	3.96	7.04	8.80		
1998	0.23	0.73	1.17	1.89	2.72	3.25	4.13	5.63	6.50	8.57	8.42	11.45	8.79	
1999 [1]		0.85	1.45	2.00	2.65	3.47	4.16	5.45	6.82	5.90		8.01		
2000 [2]	0.26	0.73	1.36	2.04	2.87	3.67	4.88	5.78	7.05	8.45	8.67	9.33	6.88	
2001	0.38	0.80	1.21	1.90	2.74	3.90	4.99	5.69	7.15	7.32	11.72	9.11	6.60	
2002	0.35	1.00	1.31	1.80	2.53	3.64	4.38	5.07	6.82	9.21	7.59	13.18	19.17	19.20
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
2005 [3]	0.57	0.77	1.13	1.66	2.33	3.36	4.38	5.92	6.65	7.26	10.01	11.14		
2006 [2]	0.71	0.91	1.39	1.88	2.56	3.77	5.33	6.68	9.14	10.89	11.51	16.83	18.77	
2007 [3]	0.59	1.35	1.79	2.51	3.53	4	4.95	6.55	7.54	9.71	11.40	11.57	23.34	15.61
2008 [3]	0.23	0.51	1.14	1.76	2.57	3.15	4.4	5.43	7.18	8.39	10.15	10.03	10.99	14.26

[1] Division IIa only
[2] IIa and IIb combined
[3] I,IIa and IIb combined

Spain (Division IIb)

Year	Age 2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994	0.43	1.08	1.38	2.32	2.47	2.68	3.46	5.20	7.04	6.79	7.20	8.04	10.46	15.35
1995	0.42	0.51	0.98	1.99	3.41	4.95	5.52	8.62	9.21	11.42	9.78	8.08		
1996		0.66	1.12	1.57	2.43	3.17	3.59	4.44	5.48	6.79	8.10			
1997 [1]	0.51	0.65	1.22	1.68	2.60	3.39	4.27	6.67	7.88	11.34	13.33	10.03	8.69	
1998	0.47	0.74	1.15	1.82	2.44	3.32	3.71	5.00	7.26					
1999 [1]	0.21	0.69	1.06	1.69	2.50	3.32	4.72	5.76	6.77	7.24	7.63			
2000 [1]	0.23	0.61	1.24	1.75	2.47	3.12	4.65	6.06	7.66	10.94	11.40	7.20		
2001	0.23	0.64	1.25	1.95	2.86	3.55	4.95	6.46	8.50	11.07	13.09			
2002	0.16	0.55	1.00	1.48	2.17	3.29	4.47	5.35	8.29	12.23	9.01	12.16	15.2	
2003		0.58	1.05	1.70	2.33	3.33	4.92	6.24	9.98	13.07	14.74	14.17		
2004 [1]	0.31	0.56	0.80	1.28	1.96	2.59	3.72	5.36	5.28	7.41		11.43		
2005 [1]		0.63	1.14	1.85	2.48	3.43	4.25	5.38	8.41	11.19	15.04	16.93		
2006	0.30	0.61	0.99	1.46	2.04	2.55	3.39	3.50	4.70	6.36				
2007	0.42	0.60	1.20	1.76	2.40	3.18	3.96	5.19	6.61	9.48	7.65	12.65	15.74	19.66

[1] IIa and IIb combined

Iceland (Sub-area I)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1994	0.42	0.85	1.44	2.77	3.54	4.08	5.84	6.37	7.02	7.48	7.37			
1995		1.17	0.91	1.60	2.28	3.61	4.73	6.27			6.26			
1996		0.36	0.99	1.55	2.83	3.79	4.81	5.34	7.25	7.68	9.08	8.98	10.52	
1997	0.42	0.43	0.76	1.60	2.40	3.45	4.40	5.74	6.15		8.28	10.52	9.89	

UK (England & Wales)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1995 [1]			1.47	2.11	3.47	5.57	6.43	7.17	8.12	8.05	10.2	10.1		
1996 [2]			1.55	1.81	2.42	3.61	6.3	6.47	7.83	7.91	8.93	9.38	10.9	
1997 [2]			1.93	2.17	3.07	4.17	4.89	6.46		12.3	8.44			

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

Poland (Division IIb)

Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
2006	0.18	0.51	0.89	1.55	2.23	3.6	5.28	6.95	8.48	11	10.8	15.6	18.9	
2008		0.49	0.90	1.45	2.24	2.79	3.82	4.68	5.01	6.45	7.02	7.22	5.99	6.91

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

Norway

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

Russia

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1984	-	5	18	31	56	90	99	100
1985	-	1	10	33	59	85	92	100
1986	-	2	9	19	56	76	89	100
1987	-	1	9	23	27	61	81	80
1988	-	1	3	25	53	79	100	100
1989	-	-	2	15	39	59	83	100
1990	-	2	6	20	47	62	81	95
1991	-	3	1	23	66	82	96	100
1992	-	1	8	31	73	92	95	100
1993	-	3	7	21	56	89	95	99
1994	-	1	8	30	55	84	95	98
1995	-	-	4	23	61	75	94	97
1996	-	-	1	22	56	82	95	100
1997	-	-	1	10	48	73	90	100
1998	-	-	2	15	47	87	97	96
1999	-	-	1	10	38	75	94	100
2000	-	-	6	19	51	84	96	100
2001	-	-	4	28	62	89	96	100
2002		2	11	34	68	83	98	100
2003	0	0	11	29	66	90	95	100
2004	0	1	8	34	63	83	96	96
2005	0	1	5	24	62	85	95	98
2006	0	0	6	30	60	89	96	100
2007	0	0	6	21	60	84	96	100
2008	0	1	4	25	48	84	95	99
2009	0	0	6	28	66	85	97	100

Norway

	Percentage mature							
	Age							
Year	3	4	5	6	7	8	9	10
1985	-	1	9	38	51	85	100	79
1986	3	7	8	19	50	67	36	80
1987	-	0	4	12	16	31	19	-
1988	-	2	6	41	54	45	100	100
1989	2	1	4	31	70	82	100	100
1990	2	1	4	22	58	81	100	100
1991	0	3	14	38	76	90	95	100
1992	0	2	21	53	87	97	100	100
1993	0	3	10	53	85	97	99	100
1994	1	0	16	37	63	88	98	100
1995	0	1	8	52	64	81	98	99
1996	0	0	3	30	70	82	100	100
1997	0	0	2	18	73	93	99	100
1998	0	1	3	15	47	76	94	100
1999	0	0	2	28	71	95	99	100
2000	0	0	8	30	77	82	100	100
2001	1	1	9	44	63	74	94	100
2002	0	1	6	43	68	85	93	100
2003	0	0	7	36	69	88	96	100
2004	0	1	10	55	82	91	99	99
2005	0	0	9	55	82	94	98	100
2006	0	0	6	44	70	90	97	100
2007	0	0	9	48	84	92	99	100
2008	0	0	9	34	61	88	91	100
2009	0	0	9	46	85	86	98	99

Table 3.6. Barents Sea winter survey. Area covered ('000 square nautical miles) and areas implied in the method used to adjust for missing coverage in Russian Economic Zone. In 4 of the 5 adjusted years the adjustments were not based on area ratios, but the "index ratio by age" was used. This means that the index by age (for the area outside REZ) was scaled by the observed ratio between total index and the index outside REZ observed in the years prior to the survey.

Year	Area covered	Additional area implied in adjustment	Adjustment method
1981-92	88.1		
1993	137.6		
1994	143.8		
1995	186.6		
1996	165.3		
1997	87.5	78.0	Index ratio
1998	99.2	78.0	Index ratio
1999	118.3		
2000	162.4		
2001	164.1		
2002	156.7		
2003	146.6		
2004	164.6		
2005	178.9		
2006	169.1	18.1	Partly covered strata raised to full area
2007	122.2	56.7	Index ratio
2008	164.4		
2009	170.9		

Table 3.7
NE Arctic cod. International catch (thousands) at age for ages 1-15+

					AGE										
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1946	1	16	4008	10387	18906	16596	13843	15370	59845	22618	10093	9573	5460	1927	750
1947	1	1	710	13192	43890	52017	45501	13075	19718	47678	31392	9348	9330	4622	4103
1948	1	16	140	3872	31054	55983	77375	21482	15237	9815	30041	7945	4491	3899	4205
1949	1	7	991	6808	35214	100497	83283	29727	13207	5606	8617	13154	3657	1895	2167
1950	1	79	1281	10954	29045	45233	62579	30037	19481	9172	6019	4133	6750	1662	1450
1951	1615	1625	24687	77924	64013	46867	37535	33673	23510	10589	4221	1288	1002	3322	611
1952	1	1202	24099	120704	113203	73827	49389	20562	24367	15651	8327	3565	647	467	1044
1953	1	81	47413	107659	112040	55500	22742	16863	10559	10553	5637	1752	468	173	156
1954	1	9	11473	155171	146395	100751	40635	10713	11791	8557	6751	2370	896	268	123
1955	1	322	3902	37652	201834	161336	84031	30451	13713	9481	4140	2406	867	355	128
1956	81	1498	10614	24172	129803	250472	86784	51091	14987	7465	3952	1655	1292	448	166
1957	987	3487	17321	33931	27182	70702	87033	39213	17747	6219	3232	1220	347	299	173
1958	1	2600	31219	133576	71051	40737	38380	35786	13338	10475	3289	1070	252	40	141
1959	590	2601	32308	77942	148285	53480	18498	17735	23118	9483	3748	997	254	161	98
1960	465	7147	37882	97865	64222	67425	23117	8429	7240	11675	4504	1843	354	102	226
1961	1	1699	45478	132655	123458	51167	38740	17376	5791	6778	5560	1682	910	280	108
1962	1	1713	42416	170566	167241	89460	28297	21996	7956	2728	2603	1647	392	280	103
1963	1	4	13196	106984	205549	95498	35518	16221	11894	3884	1021	1025	498	129	157
1964	103	675	5298	45912	97950	58575	19642	9162	6196	3553	783	172	387	264	131
1965	1	2522	15725	25999	78299	68511	25444	8438	3569	1467	1161	131	67	91	179
1966	1	869	55937	55644	34676	42539	37169	18500	5077	1495	380	403	77	9	70
1967	1	151	34467	160048	69235	22061	26295	25139	11323	2329	687	316	225	40	14
1968	1	1	3709	174585	267961	107051	26701	16399	11597	3657	657	122	124	70	46
1969	1	275	2307	24545	238511	181239	79363	26989	13463	5092	1913	414	121	23	46
1970	1	591	7164	10792	25813	137829	96420	31920	8933	3249	1232	260	106	39	35
1971	38	2210	7754	13739	11831	9527	59290	52003	12093	2434	762	418	149	42	25
1972	1	4701	35536	45431	26832	12089	7918	34885	22315	4572	1215	353	315	121	40
1973	1	8277	294262	131493	61000	20569	7248	8328	19130	4499	677	195	81	59	55
1974	115	21347	91855	437377	203772	47006	12630	4370	2523	5607	2127	322	151	83	62
1975	1	1184	45282	59798	226646	118567	29522	9353	2617	1555	1928	575	231	15	37
1976	706	1908	85337	114341	79993	118236	47872	13962	4051	936	558	442	139	26	53
1977	1	11288	39594	168609	136335	52925	61821	23338	5659	1521	610	271	122	92	54
1978	3	802	78822	45400	88495	56823	25407	31821	9408	1227	913	446	748	48	51
1979	0	224	8600	77484	43677	31943	16815	8274	10974	1785	427	103	59	38	45
1980	31	403	3911	17086	81986	40061	17664	7442	3508	3196	678	79	24	26	8
1981	1	212	3407	9466	20803	63433	21788	9933	4267	1311	882	109	37	3	1
1982	2	94	8948	20933	19345	28084	42496	8395	2878	708	271	260	27	5	5
1983	13	86	3108	19594	20473	17656	17004	18329	2545	646	229	74	58	20	5
1984	11	999	6942	14240	18807	20086	15145	8287	5988	783	232	153	49	12	8
1985	92	1805	24634	45769	27806	19418	11369	3747	1557	768	137	36	31	32	8
1986	41	855	28968	70993	78672	25215	11711	4063	976	726	557	136	28	34	14
1987	14	390	13648	137106	98210	61407	13707	3866	910	455	187	227	21	59	20
1988	4	178	9828	22774	135347	54379	21015	3304	1236	519	106	69	43	14	5
1989	3	237	5085	17313	32165	81756	27854	5501	827	290	41	13	1	11	16
1990	6	170	1911	7551	12999	17827	30007	6810	828	179	59	15	6	5	2
1991	24	663	4963	10933	16467	20342	19479	25193	3888	428	48	12	1	1	2
1992	844	1184	21835	36015	27494	23392	18351	13541	18321	2529	264	82	3	9	1
1993	42	634	10094	46182	63578	33623	14866	9449	6571	12593	1749	377	63	22	1
1994	32	312	6531	59444	102548	59766	32504	10019	6163	3671	7528	995	121	19	4
1995	9	212	4879	42587	115329	98485	32036	7334	3014	1725	1174	1920	222	41	1
1996	184	895	7655	28782	80711	100509	54590	10545	2023	930	462	230	809	84	1
1997	79	1228	12827	36491	69633	83017	65768	28392	4651	1151	373	213	144	238	1
1998	97	1596	31887	88874	48972	40493	34513	26354	6583	965	197	69	42	22	53
1999	13	313	7501	77714	92816	31139	15778	15851	8828	1837	195	40	34	8	30
2000	32	215	4701	33094	93044	47210	12671	6677	4787	1647	321	71	11	1	14
2001	23	237	5044	35019	62139	62456	22794	5266	1773	1163	343	84	6	7	22
2002	47	130	2348	31033	76175	67656	42122	11527	1801	529	223	120	21	9	5
2003	6	187	7263	20885	64447	71109	36706	14002	2887	492	142	97	21	43	1
2004	8	183	2090	38226	50826	68350	50838	18118	6239	1746	295	127	39	16	8
2005	11	453	5815	19768	113144	61665	44777	20553	6285	2348	562	100	21	24	7
2006	112	1164	8548	47207	33625	78150	31770	15667	7244	1788	737	210	26	45	155
2007	1438	2625	25473	43817	62877	26304	34392	11240	4080	1381	505	285	44	13	35
2008	42	667	8459	51704	40656	35072	14037	20676	5503	1794	715	229	42	26	12

Table 3.8 Total number of cod (million) consumed by cod, by year and prey age group

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1984	0	417	21	0	0	0	
1985	1510	376	67	0	0	0	
1986	53	966	392	99	0	0	
1987	681	182	281	14	0	0	
1988	29	411	22	2	0	0	
1989	916	144	0	0	0	0	
1990	0	126	28	0	0	0	
1991	123	151	214	2	0	0	
1992	4305	1027	155	4	0	0	
1993	3833	20282	512	52	1	0	
1994	8344	6947	647	131	52	8	
1995	8315	15380	758	251	87	4	
1996	9905	21734	1502	143	56	20	
1997	2936	15988	1857	174	17	1	
1998	79	4853	536	211	25	2	
1999	592	1833	295	52	4	0	
2000	1675	2233	171	37	14	4	
2001	89	2271	113	24	12	2	
2002	7664	459	395	41	6	1	
2003	5636	4397	107	23	0	0	
2004	5768	1540	513	19	10	1	
2005	2223	2766	159	85	3	5	
2006	1817	2195	131	5	2	0	
2007	1750	1265	218	86	5	0	
2008	10765	1962	115	133	31	4	

Table 3.9. North-East Arctic COD. Catch numbers at age

1

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

At 23/04/2009 16:35

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

	YEAR	1946	1947	1948
	AGE			
	3	4008	710	140
	4	10387	13192	3872
	5	18906	43890	31054
	6	16596	52017	55983
	7	13843	45501	77375
	8	15370	13075	21482
	9	59845	19718	15237
	10	22618	47678	9815
	11	10093	31392	30041
	12	9573	9348	7945
	+gp	8137	18055	12595
0	TOTAL	189376	294576	265539
	TONSL	706000	882017	774295
	SOPCO	103	91	89

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

	YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
	AGE										
	3	991	1281	24687	24099	47413	11473	3902	10614	17321	31219
	4	6808	10954	77924	120704	107659	155171	37652	24172	33931	133576
	5	35214	29045	64013	113203	112040	146395	201834	129803	27182	71051
	6	100497	45233	46867	73827	55500	100751	161336	250472	70702	40737
	7	83283	62579	37535	49389	22742	40635	84031	86784	87033	38380
	8	29727	30037	33673	20562	16863	10713	30451	51091	39213	35786
	9	13207	19481	23510	24367	10559	11791	13713	14987	17747	13338
	10	5606	9172	10589	15651	10553	8557	9481	7465	6219	10475
	11	8617	6019	4221	8327	5637	6751	4140	3952	3232	3289
	12	13154	4133	1288	3565	1752	2370	2406	1655	1220	1070
	+gp	7719	9862	4935	2158	797	1287	1350	1906	819	433
0	TOTAL	304823	227796	329242	455852	391515	495894	550296	582901	304619	379354
	TONSL	800122	731982	827180	876795	695546	826021	1147841	1343068	792557	769313
	SOPCO	99	109	115	93	105	93	106	105	100	112

1

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

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

	YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE										
	3	32308	37882	45478	42416	13196	5298	15725	55937	34467	3709
	4	77942	97865	132655	170566	106984	45912	25999	55644	160048	174585
	5	148285	64222	123458	167241	205549	97950	78299	34676	69235	267961
	6	53480	67425	51167	89460	95498	58575	68511	42539	22061	107051
	7	18498	23117	38740	28297	35518	19642	25444	37169	26295	26701
	8	17735	8429	17376	21996	16221	9162	8438	18500	25139	16399
	9	23118	7240	5791	7956	11894	6196	3569	5077	11323	11597
	10	9483	11675	6778	2728	3884	3553	1467	1495	2329	3657
	11	3748	4504	5560	2603	1021	783	1161	380	687	657
	12	997	1843	1682	1647	1025	172	131	403	316	122
	+gp	513	682	1298	775	784	782	337	156	279	240
0	TOTAL	386107	324884	429983	535685	491574	248025	229081	251976	352179	612679
	TONSL	744607	622042	783221	909266	776337	437695	444930	483711	572605	1074084
	SOPCO	93	104	110	124	102	103	129	123	109	108

Table 3.9(continued)

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

	YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	AGE										
	3	2307	7164	7754	35536	294262	91855	45282	85337	39594	78822
	4	24545	10792	13739	45431	131493	437377	59798	114341	168609	45400
	5	238511	25813	11831	26832	61000	203772	226646	79993	136335	88495
	6	181239	137829	9527	12089	20569	47006	118567	118236	52925	56823
	7	79363	96420	59290	7918	7248	12630	29522	47872	61821	25407
	8	26989	31920	52003	34885	8328	4370	9353	13962	23338	31821
	9	13463	8933	12093	22315	19130	2523	2617	4051	5659	9408
	10	5092	3249	2434	4572	4499	5607	1555	936	1521	1227
	11	1913	1232	762	1215	677	2127	1928	558	610	913
	12	414	260	418	353	195	322	575	442	271	446
	+gp	190	180	216	476	195	296	283	218	268	847
0	TOTAL	574026	323792	170067	191622	547596	807885	496126	465946	490951	339609
	TONSL	1197226	933246	689048	565254	792685	1102433	829377	867463	905301	698715
	SOPCC	105	112	124	118	130	137	115	127	107	109

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

	YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	8600	3911	3407	8948	3108	6942	24634	28968	13648	9828
	4	77484	17086	9466	20933	19594	14240	45769	70993	137106	22774
	5	43677	81986	20803	19345	20473	18807	27806	78672	98210	135347
	6	31943	40061	63433	28084	17656	20086	19418	25215	61407	54379
	7	16815	17664	21788	42496	17004	15145	11369	11711	13707	21015
	8	8274	7442	9933	8395	18329	8287	3747	4063	3866	3304
	9	10974	3508	4267	2878	2545	5988	1557	976	910	1236
	10	1785	3196	1311	708	646	783	768	726	455	519
	11	427	678	882	271	229	232	137	557	187	106
	12	103	79	109	260	74	153	36	136	227	69
	+gp	142	58	41	37	83	69	71	76	100	62
0	TOTAL	200224	175669	135440	132355	99741	90732	135312	222093	329823	248639
	TONSL	440538	380434	399038	363730	289992	277651	307920	430113	523071	434939
	SOPCC	121	127	118	125	90	95	102	102	102	100

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

	YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	5085	1911	4963	21835	10094	6531	4879	7655	12827	31887
	4	17313	7551	10933	36015	46182	59444	42587	28782	36491	88874
	5	32165	12999	16467	27494	63578	102548	115329	80711	69633	48972
	6	81756	17827	20342	23392	33623	59766	98485	100509	83017	40493
	7	27854	30007	19479	18351	14866	32504	32036	54590	65768	34513
	8	5501	6810	25193	13541	9449	10019	7334	10545	28392	26354
	9	827	828	3888	18321	6571	6163	3014	2023	4651	6583
	10	290	179	428	2529	12593	3671	1725	930	1151	965
	11	41	59	48	264	1749	7528	1174	462	373	197
	12	13	15	12	82	377	995	1920	230	213	69
	+gp	28	13	4	13	86	144	264	894	383	117
0	TOTAL	170873	78199	101757	161837	199168	289313	308747	287331	302899	279024
	TONSL	332481	212000	319158	513234	581611	771086	739999	732228	762403	592624
	SOPCC	99	101	95	103	101	101	100	101	100	101

Table 3.9(continued)

	Table 1	Catch numbers at age				Numbers*10**-3					
	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE										
	3	7501	4701	5044	2348	7263	2090	5815	8548	25473	8459
	4	77714	33094	35019	31033	20885	38226	19768	47207	43817	51704
	5	92816	93044	62139	76175	64447	50826	113144	33625	62877	40656
	6	31139	47210	62456	67656	71109	68350	61665	78150	26303	35072
	7	15778	12671	22794	42122	36706	50838	44777	31770	34392	14037
	8	15851	6677	5266	11527	14002	18118	20553	15667	11240	20676
	9	8828	4787	1773	1801	2887	6239	6285	7245	4080	5503
	10	1837	1647	1163	529	492	1746	2348	1788	1381	1794
	11	195	321	343	223	142	295	562	737	505	715
	12	40	71	85	120	97	127	100	210	285	229
	+gp	72	26	35	36	65	63	52	226	92	81
0	TOTAL	251771	204249	196117	233570	218095	236918	275069	225173	210445	178926
	TONSL/	484910	414868	426471	535045	551990	606445	641276	537642	486883	464171
	SOPCC	100	100	100	100	100	100	100	100	100	100

Table 3.10. North-East Arctic COD. Catch weights at age

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

At 23/04/2009 16:35

Table 2 Catch weights at age (kg)

	YEAR	1946	1947	1948
	AGE			
	3	0.35	0.32	0.34
	4	0.59	0.56	0.53
	5	1.11	0.95	1.26
	6	1.69	1.5	1.93
	7	2.37	2.14	2.46
	8	3.17	2.92	3.36
	9	3.98	3.65	4.22
	10	5.05	4.56	5.31
	11	5.92	5.84	5.92
	12	7.2	7.42	7.09
	+gp	8.146	8.848	8.43
0	SOPC(	1.03	0.9143	0.8915

Table 2 Catch weights at age (kg)

	YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
	AGE										
	3	0.37	0.39	0.4	0.44	0.4	0.44	0.32	0.33	0.33	0.34
	4	0.67	0.64	0.83	0.8	0.76	0.77	0.57	0.58	0.59	0.52
	5	1.11	1.29	1.39	1.33	1.28	1.26	1.13	1.07	1.02	0.95
	6	1.66	1.7	1.88	1.92	1.93	1.97	1.73	1.83	1.82	1.92
	7	2.5	2.36	2.54	2.64	2.81	3.03	2.75	2.89	2.89	2.94
	8	3.23	3.48	3.46	3.71	3.72	4.33	3.94	4.25	4.28	4.21
	9	4.07	4.52	4.88	5.06	5.06	5.4	4.9	5.55	5.49	5.61
	10	5.27	5.62	5.2	6.05	6.34	6.75	7.04	7.28	7.51	7.35
	11	5.99	6.4	7.14	7.42	7.4	7.79	7.2	8	8.24	8.67
	12	7.08	7.96	8.22	8.43	8.67	10.67	8.78	8.35	9.25	9.58
	+gp	8.218	8.891	9.389	10.185	10.238	9.68	10.077	9.944	10.605	11.631
0	SOPC(	0.992	1.088	1.1483	0.9348	1.0485	0.9294	1.0634	1.0455	1.0004	1.1232
	1										

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

At 23/04/2009 16:35

Table 2 Catch weights at age (kg)

	YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE										
	3	0.35	0.34	0.31	0.32	0.32	0.33	0.38	0.44	0.29	0.33
	4	0.72	0.51	0.55	0.55	0.61	0.55	0.68	0.74	0.81	0.7
	5	1.47	1.09	1.05	0.93	0.96	0.95	1.03	1.18	1.35	1.48
	6	2.68	2.13	2.2	1.7	1.73	1.86	1.49	1.78	2.04	2.12
	7	3.59	3.38	3.23	3.03	3.04	3.25	2.41	2.46	2.81	3.14
	8	4.32	4.87	5.11	5.03	4.96	4.97	3.52	3.82	3.48	4.21
	9	5.45	6.12	6.15	6.55	6.44	6.41	5.73	5.36	4.89	5.27
	10	6.44	8.49	8.15	7.7	7.91	8.07	7.54	7.27	7.11	6.65
	11	7.17	7.79	8.68	9.27	9.62	9.34	8.47	8.63	9.03	9.01
	12	8.63	8.3	9.6	10.56	11.31	10.16	11.17	10.66	10.59	9.66
	+gp	11.621	11.422	11.952	12.717	12.737	12.886	13.722	14.148	13.829	14.848
0	SOPC(	0.9305	1.0416	1.097	1.2356	1.0226	1.0277	1.2903	1.2327	1.0911	1.0785

Table 3.10 (continued).

Table 2 Catch weights at age (kg)

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	0.44	0.37	0.45	0.38	0.38	0.32	0.41	0.35	0.49	0.49
4	0.79	0.91	0.88	0.77	0.91	0.66	0.64	0.73	0.9	0.81
5	1.23	1.34	1.38	1.43	1.54	1.17	1.11	1.19	1.43	1.45
6	2.03	2	2.16	2.12	2.26	2.22	1.9	2.01	2.05	2.15
7	2.9	3	3.07	3.23	3.29	3.21	2.95	2.76	3.3	3.04
8	3.81	4.15	4.22	4.38	4.61	4.39	4.37	4.22	4.56	4.46
9	5.02	5.59	5.81	5.83	6.57	5.52	5.74	5.88	6.46	6.54
10	6.43	7.6	7.13	7.62	8.37	7.86	8.77	9.3	8.63	7.98
11	8.33	8.97	8.62	9.52	10.54	9.82	9.92	10.28	9.93	10.15
12	10.71	10.99	10.83	12.09	11.62	11.41	11.81	11.86	10.9	10.85
+gp	14.211	14.074	12.945	13.673	13.904	13.242	13.107	13.544	13.668	13.177
0 SOPC(	1.052	1.117	1.2405	1.1822	1.3003	1.366	1.152	1.2688	1.0683	1.089

Table 2 Catch weights at age (kg)

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0.35	0.27	0.49	0.37	0.84	1.42	0.94	0.64	0.49	0.54
4	0.7	0.56	0.98	0.66	1.37	1.93	1.37	1.27	0.88	0.85
5	1.24	1.02	1.44	1.35	2.09	2.49	2.02	1.88	1.55	1.32
6	2.14	1.72	2.09	1.99	2.86	3.14	3.22	2.79	2.33	2.24
7	3.15	3.02	2.98	2.93	3.99	3.91	4.63	4.49	3.44	3.52
8	4.29	4.2	4.85	4.24	5.58	4.91	6.04	5.84	5.92	5.35
9	6.58	5.84	6.57	6.46	7.77	6.02	7.66	6.83	8.6	8.06
10	8.61	7.26	9.16	8.51	9.29	7.4	9.81	7.69	9.6	9.51
11	9.22	8.84	10.82	12.24	11.55	8.13	11.8	9.81	12.17	11.36
12	10.89	9.28	10.77	10.78	16.2	8.57	14.16	10.71	13.72	14.09
+gp	14.344	14.448	13.932	14.041	17.034	8.609	14.008	12.051	13.38	16.706
0 SOPC(	1.2139	1.2723	1.1809	1.2521	0.8953	0.9483	1.0182	1.016	1.0224	1.0001

Table 2 Catch weights at age (kg)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0.74	0.81	1.05	1.16	0.81	0.82	0.77	0.79	0.67	0.68
4	0.96	1.22	1.45	1.57	1.52	1.3	1.2	1.11	1.04	1.05
5	1.31	1.64	2.15	2.21	2.16	2.06	1.78	1.61	1.53	1.62
6	1.92	2.22	2.89	3.1	2.79	2.89	2.59	2.46	2.22	2.3
7	2.93	3.24	3.75	4.27	4.07	3.21	3.81	3.82	3.42	3.3
8	4.64	4.68	4.71	5.19	5.53	5.2	4.99	5.72	5.2	4.86
9	7.52	7.3	6.08	6.14	6.47	6.8	6.23	6.74	7.19	6.87
10	9.12	9.84	8.82	7.77	7.19	7.57	8.05	8.04	7.73	9.3
11	11.08	13.25	11.8	10.12	7.98	8.01	8.74	9.28	8.61	10.3
12	11.47	16.88	16.58	11.54	10.11	9.48	9.22	10.4	11.07	15.05
+gp	16.484	11.617	16.69	14.332	14.183	11.978	12.319	10.966	11.117	14.524
0 SOPC(	0.9879	1.0108	0.9521	1.027	1.0127	1.009	1.003	1.0147	1.0004	1.0072

Table 3.10 (continued).

Table 2 Catch weights at age (kg)

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
3	0.63	0.572	0.66	0.723	0.672	0.72	0.693	0.721	0.736	0.769
4	1.01	1.036	1.05	1.133	1.119	1.13	1.081	1.145	1.214	1.273
5	1.54	1.609	1.62	1.56	1.827	1.607	1.566	1.603	1.832	1.866
6	2.34	2.344	2.51	2.306	2.499	2.429	2.205	2.388	2.511	2.818
7	3.21	3.341	3.51	3.52	3.575	3.274	3.263	3.318	3.822	3.786
8	4.29	4.476	4.78	4.784	5.039	4.725	4.443	4.535	5.043	5.122
9	6	5.724	6.04	6.2	6.355	6.712	6.228	5.466	6.584	6.223
10	6.73	7.523	7.54	7.659	8.196	7.984	8.187	6.777	8.077	7.752
11	10.08	8.021	9	9.14	10.711	9.192	9.724	7.699	8.942	8.405
12	13.88	12.478	10.48	8.197	11.958	12.024	11.496	8.578	10.173	10.117
+gp	14.036	17.241	16.18	10.325	10.657	14.245	14.417	10.155	13.364	13.674
0 SOPC(1	0.9967	1.0039	0.9994	1.0025	1.0014	1.0017	0.9993	0.9981	0.9978	1.0011

Table 3.11. North-East Arctic COD. Stock weights at age

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

At 23/04/2009 16:35

Table 3 Stock weights at age (kg)

YEAR	1946	1947	1948
AGE			
3	0.35	0.32	0.34
4	0.59	0.56	0.53
5	1.11	0.95	1.26
6	1.69	1.5	1.93
7	2.37	2.14	2.46
8	3.17	2.92	3.36
9	3.98	3.65	4.22
10	5.05	4.56	5.31
11	5.92	5.84	5.92
12	7.2	7.42	7.09
+gp	8.146	8.848	8.43

Table 3 Stock weights at age (kg)

YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
AGE										
3	0.37	0.39	0.4	0.44	0.4	0.44	0.32	0.33	0.33	0.34
4	0.67	0.64	0.83	0.8	0.76	0.77	0.57	0.58	0.59	0.52
5	1.11	1.29	1.39	1.33	1.28	1.26	1.13	1.07	1.02	0.95
6	1.66	1.7	1.88	1.92	1.93	1.97	1.73	1.83	1.82	1.92
7	2.5	2.36	2.54	2.64	2.81	3.03	2.75	2.89	2.89	2.94
8	3.23	3.48	3.46	3.71	3.72	4.33	3.94	4.25	4.28	4.21
9	4.07	4.52	4.88	5.06	5.06	5.4	4.9	5.55	5.49	5.61
10	5.27	5.62	5.2	6.05	6.34	6.75	7.04	7.28	7.51	7.35
11	5.99	6.4	7.14	7.42	7.4	7.79	7.2	8	8.24	8.67
12	7.08	7.96	8.22	8.43	8.67	10.67	8.78	8.35	9.25	9.58
+gp	8.218	8.891	9.389	10.185	10.238	9.68	10.077	9.944	10.605	11.631
1										

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

At 23/04/2009 16:35

Table 3 Stock weights at age (kg)

YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE										
3	0.35	0.34	0.31	0.32	0.32	0.33	0.38	0.44	0.29	0.33
4	0.72	0.51	0.55	0.55	0.61	0.55	0.68	0.74	0.81	0.7
5	1.47	1.09	1.05	0.93	0.96	0.95	1.03	1.18	1.35	1.48
6	2.68	2.13	2.2	1.7	1.73	1.86	1.49	1.78	2.04	2.12
7	3.59	3.38	3.23	3.03	3.04	3.25	2.41	2.46	2.81	3.14
8	4.32	4.87	5.11	5.03	4.96	4.97	3.52	3.82	3.48	4.21
9	5.45	6.12	6.15	6.55	6.44	6.41	5.73	5.36	4.89	5.27
10	6.44	8.49	8.15	7.7	7.91	8.07	7.54	7.27	7.11	6.65
11	7.17	7.79	8.68	9.27	9.62	9.34	8.47	8.63	9.03	9.01
12	8.63	8.3	9.6	10.56	11.31	10.16	11.17	10.66	10.59	9.66
+gp	11.621	11.422	11.952	12.717	12.737	12.886	13.722	14.148	13.829	14.848

Table 3.11 (continued).

Table 3 Stock weights at age (kg)

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	0.44	0.37	0.45	0.38	0.38	0.32	0.41	0.35	0.49	0.49
4	0.79	0.91	0.88	0.77	0.91	0.66	0.64	0.73	0.9	0.81
5	1.23	1.34	1.38	1.43	1.54	1.17	1.11	1.19	1.43	1.45
6	2.03	2	2.16	2.12	2.26	2.22	1.9	2.01	2.05	2.15
7	2.9	3	3.07	3.23	3.29	3.21	2.95	2.76	3.3	3.04
8	3.81	4.15	4.22	4.38	4.61	4.39	4.37	4.22	4.56	4.46
9	5.02	5.59	5.81	5.83	6.57	5.52	5.74	5.88	6.46	6.54
10	6.43	7.6	7.13	7.62	8.37	7.86	8.77	9.3	8.63	7.98
11	8.33	8.97	8.62	9.52	10.54	9.82	9.92	10.28	9.93	10.15
12	10.71	10.99	10.83	12.09	11.62	11.41	11.81	11.86	10.9	10.85
+gp	14.211	14.074	12.945	13.673	13.904	13.242	13.107	13.544	13.668	13.177

Table 3 Stock weights at age (kg)

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0.35	0.27	0.49	0.37	0.37	0.42	0.413	0.311	0.211	0.212
4	0.7	0.56	0.98	0.66	0.92	1.16	0.875	0.88	0.498	0.404
5	1.24	1.02	1.44	1.35	1.6	1.81	1.603	1.47	1.254	0.79
6	2.14	1.72	2.09	1.99	2.44	2.79	2.81	2.467	2.047	1.903
7	3.15	3.02	2.98	2.93	3.82	3.78	4.059	3.915	3.431	2.977
8	4.29	4.2	4.85	4.24	4.76	4.57	5.833	5.81	5.137	4.392
9	6.58	5.84	6.57	6.46	6.17	6.17	7.685	6.58	6.523	7.812
10	8.61	7.26	9.16	8.51	7.7	7.7	10.117	6.833	9.3	12.112
11	9.22	8.84	10.82	12.24	9.25	9.25	14.29	11.004	13.15	13.107
12	10.89	9.28	10.77	10.78	10.85	10.85	12.731	12.731	12.731	12.731
+gp	14.344	14.448	13.932	14.041	12.988	13.033	14.311	14.311	14.311	14.311

Table 3 Stock weights at age (kg)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0.299	0.398	0.518	0.44	0.344	0.235	0.201	0.195	0.202	0.217
4	0.52	0.705	1.136	0.931	1.172	0.753	0.485	0.487	0.521	0.533
5	0.868	1.182	1.743	1.812	1.82	1.42	1.14	0.971	1.079	1.161
6	1.477	1.719	2.428	2.716	2.823	2.413	2.118	2.054	1.878	1.939
7	2.686	2.458	3.214	3.895	4.031	3.825	3.47	3.527	3.369	2.945
8	4.628	3.565	4.538	5.176	5.497	5.416	4.938	5.503	5.263	4.574
9	7.048	4.71	6.88	6.774	6.765	6.631	7.16	7.767	8.927	7.423
10	9.98	7.801	10.719	9.598	8.571	7.63	9.119	10.159	12.154	10.367
11	9.25	8.956	9.445	12.427	10.847	8.112	10.101	10.669	11.204	11.738
12	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731	12.731
+gp	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311	14.311

Table 3.11 (continued).

Table 3 Stock weights at age (kg)

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
3	0.203	0.194	0.285	0.251	0.23	0.25	0.231	0.256	0.262	0.286
4	0.52	0.465	0.522	0.605	0.537	0.546	0.624	0.602	0.699	0.734
5	1.174	1.208	1.196	1.189	1.31	1.087	1.118	1.201	1.341	1.37
6	2.031	1.972	2.239	2.138	2.009	2.035	1.932	2.009	2.121	2.367
7	3.034	3.048	3.313	3.333	3.241	2.921	3.046	3.114	3.167	3.29
8	4.464	4.096	5.118	4.766	4.971	4.384	3.955	4.427	4.64	4.82
9	6.482	5.724	6.376	6.859	6.739	6.254	5.811	6.03	6.495	6.548
10	10.269	7.457	9.241	9.333	8.706	8.543	8.289	8.037	9.123	8.483
11	10.882	9.582	11.322	10.186	15.026	9.735	13.44	9.928	11.78	8.902
12	12.731	12.731	12.731	12.731	12.731	12.731	12.731	15.784	17.255	9.44
+gp	14.311	14.311	14.311	14.311	14.311	14.311	14.311	17.533	14.311	14.311
1										

Table 3.12. Northeast Arctic cod. Proportion mature at age.

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

At 23/04/2009 16:35

Table 5 Proportion mature at age

YEAR	1946	1947	1948
AGE			
3	0	0	0
4	0	0	0
5	0.01	0.01	0.01
6	0.03	0.03	0.03
7	0.06	0.06	0.07
8	0.11	0.13	0.13
9	0.18	0.16	0.25
10	0.44	0.42	0.47
11	0.65	0.75	0.73
12	0.86	0.91	0.91
+gp	0.96	0.95	0.97

Table 5 Proportion mature at age

YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
7	0.09	0.09	0.1	0.08	0.07	0.08	0.07	0.06	0.06	0.06
8	0.17	0.23	0.24	0.22	0.19	0.16	0.13	0.12	0.09	0.1
9	0.29	0.35	0.4	0.41	0.4	0.37	0.26	0.14	0.12	0.1
10	0.54	0.52	0.58	0.63	0.64	0.68	0.53	0.41	0.22	0.3
11	0.79	0.79	0.72	0.82	0.84	0.87	0.83	0.67	0.6	0.5
12	0.88	0.95	0.85	0.92	0.94	0.93	0.92	0.91	0.82	0.82
+gp	0.97	0.97	0.96	0.97	0.97	0.96	0.97	0.96	0.97	0.97
1										

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

At 23/04/2009 16:35

Table 5 Proportion mature at age

YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	0	0.01	0	0	0.01	0	0	0	0	0
5	0.01	0.03	0.01	0.01	0.01	0	0	0.01	0	0.03
6	0.04	0.06	0.06	0.05	0.03	0.03	0.01	0.02	0.03	0.05
7	0.12	0.1	0.12	0.15	0.07	0.13	0.06	0.06	0.07	0.09
8	0.34	0.19	0.31	0.34	0.28	0.37	0.2	0.22	0.14	0.19
9	0.49	0.45	0.65	0.61	0.42	0.66	0.55	0.35	0.38	0.39
10	0.67	0.69	0.91	0.81	0.81	0.89	0.73	0.74	0.64	0.58
11	0.84	0.77	0.98	0.92	0.98	0.95	0.99	0.94	0.89	0.82
12	0.87	0.85	0.98	0.97	0.98	0.99	0.98	0.94	0.9	1
+gp	1	0.99	1	1	1	1	1	1	1	1

Table 3.12 (continued)

Table 5 Proportion mature at age

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	0	0	0	0.01	0	0	0	0	0	0
4	0	0.01	0	0.02	0	0	0	0	0	0
5	0	0	0.01	0.02	0	0	0.01	0	0.02	0
6	0.02	0.01	0.05	0.01	0.02	0.01	0.02	0.05	0.08	0.02
7	0.04	0.07	0.11	0.1	0.16	0.03	0.09	0.12	0.26	0.13
8	0.12	0.23	0.3	0.34	0.53	0.21	0.21	0.29	0.54	0.44
9	0.34	0.58	0.59	0.64	0.81	0.5	0.56	0.45	0.76	0.71
10	0.55	0.81	0.79	0.81	0.92	0.96	0.78	0.84	0.87	0.77
11	0.74	0.89	0.86	0.94	0.95	1	0.79	0.83	0.93	0.81
12	0.95	0.91	0.88	1	0.98	0.96	0.95	1	0.94	0.89
+gp	1	1	1	1	1	1	1	0.9	0.9	0.8

Table 5 Proportion mature at age

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0	0	0	0	0.01	0	0	0	0	0
4	0	0	0	0.05	0.08	0.05	0.01	0.05	0.01	0.02
5	0	0	0.02	0.1	0.1	0.18	0.09	0.08	0.07	0.05
6	0.03	0.02	0.07	0.34	0.3	0.31	0.36	0.19	0.18	0.33
7	0.13	0.13	0.2	0.65	0.73	0.56	0.55	0.53	0.22	0.53
8	0.39	0.35	0.54	0.82	0.88	0.9	0.85	0.71	0.46	0.62
9	0.77	0.65	0.8	0.92	0.97	0.99	0.96	0.62	0.5	1
10	0.89	0.82	0.97	1	1	1	0.9	0.9	0.75	1
11	0.83	1	1	1	1	1	1	1	1	1
12	0.78	0.9	1	1	1	1	1	1	1	1
+gp	0.9	0.9	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0.008	0.008	0.001	0.001	0	0.003	0	0	0	0.001
4	0.003	0.013	0.032	0.014	0.028	0.007	0.003	0	0	0.003
5	0.029	0.051	0.075	0.145	0.087	0.119	0.061	0.019	0.012	0.026
6	0.228	0.21	0.305	0.419	0.368	0.335	0.372	0.258	0.14	0.152
7	0.547	0.522	0.708	0.8	0.704	0.589	0.624	0.631	0.607	0.472
8	0.705	0.715	0.861	0.943	0.931	0.862	0.781	0.82	0.83	0.814
9	0.915	0.905	0.957	0.974	0.972	0.963	0.96	0.975	0.946	0.957
10	1	0.975	1	1	0.994	0.99	0.979	1	1	0.98
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 3.12 (continued)

Table 5 Proportion mature at age

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
3	0.002	0	0.003	0.002	0.001	0.001	0	0	0	0
4	0.002	0.001	0.003	0.013	0.001	0.01	0.004	0.001	0.004	0.004
5	0.014	0.071	0.065	0.084	0.088	0.091	0.068	0.06	0.072	0.066
6	0.187	0.247	0.359	0.388	0.326	0.442	0.397	0.369	0.343	0.294
7	0.544	0.643	0.624	0.683	0.672	0.726	0.716	0.647	0.723	0.548
8	0.847	0.83	0.819	0.841	0.888	0.872	0.892	0.897	0.876	0.862
9	0.965	0.978	0.952	0.951	0.957	0.976	0.967	0.965	0.976	0.929
10	1	1	1	1	1	0.977	0.991	1	1	0.994
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 3.13. North-East Arctic COD. Tuning data

North-East Arctic		cod	(Sub-areas I		and	II)	(run	name:	XSAASA01)				
104													
FLT09:	Russian	trawl	catch	and	effort	ages		9 -		11 (Catch:	Thousa	(Catch:	Unknown) (Effo
1985	2008												
1	1	0	1										
9	11												
	0.7	291	77	30									
	1.52	87	59	22									
	2.1	127	95	37									
	2.75	442	215	53									
	2.12	140	47	11									
	1.11	204	49	14									
	1.56	791	71	16									
	2.5	3852	689	62									
	2.64	2019	1778	68									
	2.96	1237	595	167									
	3.88	684	345	146									
	3.73	364	164	34									
	4.92	488	99	34									
	6.77	559	88	34									
	6.39	882	171	0									
	4.25	742	185	25									
	3.5	235	95	35									
	3.15	336	61	18									
	2.34	319	83	19									
	3.47	710	262	56									
	3.54	588	203	57									
	3.64	1182	183	102									
	2.69	554	244	83									
	2	1741	556	175									
FLT15:	NorBarTrS rev99		(Catch:	Unknown)	(Effort:	Unknown)							
1980	2008												
1	1	0.99	1										
3	8												
1	233	400	384	48	10	3							
1	277	236	155	160	14	2							
1	523	433	170	58	32	10							
1	283	214	117	41	4	1							
1	1260	199	77	33	2	1							
1	1439	641	83	19	3	0							
1	3911	543	157	20	5	0							
1	805	1733	205	36	5	0							
1	759	378	902	98	9	1							
1	349	346	206	272	16	4							
1	337	257	215	122	127	6							
1	577	178	128	77	43	27							
1	1401	725	158	62	39	22							
1	3102	1474	506	93	24	16							
1	2414	2559	767	185	24	8							
1	1154	1372	1061	240	29	4							
1	640	704	527	283	57	9							
1	1813	365	259	178	86	10							
1	1732	581	134	65	51	12							
1	1321	1083	269	43	20	12							
1	1828	834	382	89	11	4							
1	1350	1096	425	151	24	3							
1	1297	911	673	183	49	10							
1	1725	569	447	273	76	17							
1	621	981	247	155	45	11							
1	1115	287	437	102	49	14							
1	850	629	148	179	48	18							
1	3336	910	472	130	88	20							
1	2195	1939	587	196	68	49							

Table 3.13 (continued)

FLT16:	NorBarLof/ rev99		(Catch:	Unknown) (Effort:		Unknown)				
1984	2008									
1	1	0.99	1							
3	9									
1	1416	204	154	157	33	13	10			
1	1343	684	116	77	31	3	0			
1	2049	502	174	14	30	7	0			
1	355	578	109	40	3	0	1			
1	344	214	670	166	32	5	2			
1	206	262	269	668	73	6	3			
1	346	293	339	367	500	37	2			
1	658	215	184	284	254	824	43			
1	1911	1131	354	255	252	277	442			
1	4045	2175	895	225	119	94	39			
1	1598	2166	1040	290	44	43	30			
1	705	872	891	446	65	11	4			
1	517	497	422	499	205	22	5			
1	1826	424	338	340	247	49	7			
1	964	454	122	112	187	92	10			
1	1589	1457	493	129	69	52	12			
1	1716	816	573	198	24	8	6			
1	1122	1043	661	345	95	12	5			
1	1144	1315	1445	643	212	38	5			
1	928	327	451	468	222	88	22			
1	337	661	299	432	172	75	18			
1	591	157	381	169	155	88	24			
1	371	318	130	426	137	75	35			
1	3061	1410	754	246	329	58	28			
1	1783	1405	495	401	133	260	37			
FLT18:	RusSwept/ rev05		(ages	3-9)	(Catch:	Unknown) (		(Catch:	Unknown) (Effort:	Unknown)
1982	2008									
1	1	0.9	1							
3	9									
1	1413	1525	721	198	551	174	37			
1	520	642	506	358	179	252	94			
1	1189	700	489	357	154	69	61			
1	1188	1592	1068	365	165	37	8			
1	1622	1532	1493	481	189	42	2			
1	557	3076	900	701	184	60	25			
1	993	938	2879	583	260	47	24			
1	490	978	1062	1454	1167	299	112			
1	167	487	627	972	1538	673	153			
1	1077	484	532	583	685	747	98			
1	675	308	239	273	218	175	25			
1	1604	1135	681	416	354	87	3			
1	1363	1309	1019	354	128	49	21			
1	589	1065	1395	849	251	83	19			
1	733	784	1035	773	348	132	19			
1	1342	835	613	602	348	116	32			
1	2028	1363	788	470	259	130	48			
1	1587	2072	980	301	123	94	42			
1	1839	1286	1786	773	114	52	23			
1	1224	1557	1290	1061	304	50	14			
1	980	1473	1473	896	600	182	29			
1	1246	1057	1166	1203	535	241	40			
1	329	1576	880	1111	776	279	93			
1	1408	631	1832	744	605	244	88			
1	927	1613	777	1801	662	342	161			
1	2579	1617	1903	846	1525	553	226			
1	2203	3088	1635	1472	830	863	291			

Table 3.14. Final xsa compared with single fleet tunings run with standard shrinkage settings. Upper part of table shows the weight given to shrinkage at the various runs. Pshrink is population shrinkage and Fshrink is F-shrinkage. Values above 0.3 are shown in bold. Lower part of the table shows population and F at age as estimated before shrinkage (prediction values listed in xsa diagnostics) compared to final run (ALL) with shrinkage. Fs for the youngest ages (3-5) includes cannibalism mortality

		FLT 09 Rus trawl CPUE	FLT 15 Joint BT survey	FLT 16 Joint+Lof Ac survey	FLT 18 Rus BT survey	Final run ALL Fleets
Ages with fleet data		9 to 11	3 to 8	3 to 9	3 to 9	3 to 11
age3	PshrinkW	**0.89**	**0.54**	**0.51**	**0.53**	0.25
	FshrinkW	0.11	0.05	0.06	0.05	0.03
age4	PshrinkW	**0.86**	**0.42**	**0.44**	**0.41**	0.20
	FshrinkW	0.14	0.03	0.05	0.03	0.02
age5	PshrinkW	**0.83**	**0.38**	**0.38**	**0.36**	0.16
	FshrinkW	0.17	0.03	0.04	0.03	0.01
age6	FshrinkW	**1.00**	0.04	0.07	0.04	0.01
age7	FshrinkW	**1.00**	0.04	0.06	0.04	0.01
age8	FshrinkW	**1.00**	0.06	0.06	0.05	0.02
age9	FshrinkW	0.10	0.13	0.10	0.06	0.02
age10	FshrinkW	0.09	0.28	0.16	0.13	0.03
age11	FshrinkW	0.06	**0.61**	**0.30**	**0.39**	0.04
age12	FshrinkW	0.13	**0.79**	**0.53**	**0.57**	0.09
2008	F(5-10)	0.442	0.429	0.465	0.299	0.302
TSB2008	incl Age1-2	1738	2036	1738	2344	2405
SSB2008	('000 T)	629	611	629	775	772
N2009	yc2006	441717	514072	487286	782207	550920
N*10^-3	yc2005	375400	439739	444400	398389	530880
with	yc2004	260960	349687	340909	311634	437510
shrinkage	yc2003	134480	174523	157896	110424	196410
	yc2002	46985	96641	80633	122253	117670
	yc2001	14044	38001	24987	36029	39860
	yc2000	18943	26683	31299	12997	37150
	yc1999	20736	5179	4638	3824	9530
		No	**shrinkage**			**Shrinkage**
Survivors	yc2005		471537	492565	512623	530880
end of 08	yc2004		419589	419673	430359	437510
direct	yc2003		186319	165056	203077	196410
predic.	yc2002		99449	83757	135056	117670
by the	yc2001		39697	26161	43599	39860
survey	yc2000		27615	32724	39245	37150
N*10^-3	yc1999	24386	5399	4683	11530	9530
	yc1998	4680	2330	2258	4679	5000
F2008	yc2005		0.241	0.232	0.224	0.217
	yc2004		0.165	0.165	0.161	0.159
direct	yc2003		0.198	0.221	0.183	0.189
predic.	yc2002		0.277	0.321	0.211	0.239
by the	yc2001		0.278	0.396	0.256	0.277
survey	yc2000		0.517	0.452	0.390	0.408
	yc1999	0.186	0.654	0.724	0.359	0.421
	yc1998	0.298	0.529	0.542	0.298	0.282
2008	F(5-10)		0.409	0.443	0.283	0.302

Table 3.15 . Northeast Arctic Cod. Diagnostics for final XSA.

Lowestoft VPA Version 3.1

23/04/2009 13:30

Extended Survivors Analysis

Arctic Cod (run: XSAASA01/X01)

CPUE data from file fleet

Catch data for 25 years. 1984 to 2008. Ages 1 to 13.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
FLT09: Ru	1999	2008	9	11	0	1
FLT15: Nc	1999	2008	3	8	0.99	1
FLT16: Nc	1999	2008	3	9	0.99	1
FLT18: Ru	1999	2008	3	9	0.9	1

Time series weights :

Tapered time weighting applied
Power = 3 over 10 years

Catchability analysis :

Catchability dependent on stock size for ages < 6

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

Catchability independent of age for ages >= 10

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00166

Final year F values

Age	1	2	3	4	5	6	7	8	9	10
Iteration 2!	1.0527	0.1733	0.2167	0.1585	0.1887	0.2388	0.2768	0.4081	0.4209	0.2819
Iteration 3(	1.0526	0.1733	0.2167	0.1585	0.1887	0.2388	0.2767	0.4079	0.4206	0.2816

Age	11	12
Iteration 2!	0.264	0.3659
Iteration 3(	0.2638	0.3654

Regression weights

0.02	0.116	0.284	0.482	0.67	0.82	0.921	0.976	0.997	1

Fishing mortalities

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	1.093	1.375	0.94	0.613	1.399	1.006	1.11	0.963	0.889	1.053
2	0.36	0.257	0.202	0.402	0.276	0.572	0.247	0.126	0.221	0.173
3	0.126	0.078	0.062	0.111	0.047	0.078	0.181	0.031	0.149	0.217
4	0.21	0.14	0.117	0.105	0.071	0.1	0.116	0.142	0.142	0.158
5	0.548	0.411	0.285	0.289	0.27	0.254	0.377	0.25	0.271	0.189
6	0.722	0.604	0.519	0.555	0.474	0.514	0.55	0.459	0.315	0.239
7	0.81	0.748	0.671	0.805	0.677	0.753	0.771	0.612	0.376	0.277
8	1.06	1.034	0.831	0.893	0.698	0.876	0.808	0.686	0.454	0.408
9	1.389	1.191	0.887	0.78	0.582	0.797	0.901	0.767	0.376	0.421
10	1.417	1.159	1.138	0.734	0.501	0.877	0.822	0.709	0.312	0.282
11	0.929	1.098	0.813	0.687	0.439	0.646	0.802	0.671	0.44	0.264
12	1.187	1.142	1.019	0.768	0.744	0.922	0.472	0.825	0.598	0.365

Table 3.15 (continued)

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1999	3.05E+06	1.08E+06	5.55E+05	4.79E+05	2.43E+05	6.69E+04	3.14E+04	2.68E+04	1.30E+04	2.68E+03
2000	3.30E+06	8.37E+05	6.15E+05	4.00E+05	3.18E+05	1.15E+05	2.66E+04	1.14E+04	7.60E+03	2.65E+03
2001	4.12E+06	6.84E+05	5.30E+05	4.66E+05	2.85E+05	1.73E+05	5.15E+04	1.03E+04	3.33E+03	1.89E+03
2002	1.11E+06	1.32E+06	4.58E+05	4.08E+05	3.40E+05	1.76E+05	8.42E+04	2.16E+04	3.68E+03	1.12E+03
2003	6.45E+06	4.91E+05	7.22E+05	3.36E+05	3.01E+05	2.08E+05	8.25E+04	3.08E+04	7.23E+03	1.38E+03
2004	2.68E+06	1.30E+06	3.05E+05	5.64E+05	2.56E+05	1.88E+05	1.06E+05	3.43E+04	1.26E+04	3.30E+03
2005	4.56E+06	8.03E+05	6.03E+05	2.31E+05	4.18E+05	1.62E+05	9.21E+04	4.10E+04	1.17E+04	4.63E+03
2006	3.92E+06	1.23E+06	5.14E+05	4.12E+05	1.69E+05	2.35E+05	7.67E+04	3.49E+04	1.50E+04	3.89E+03
2007	2.38E+06	1.23E+06	8.88E+05	4.08E+05	2.92E+05	1.07E+05	1.21E+05	3.41E+04	1.44E+04	5.69E+03
2008	3.33E+06	8.00E+05	8.05E+05	6.26E+05	2.90E+05	1.82E+05	6.42E+04	6.82E+04	1.77E+04	8.08E+03

Estimated population abundance at 1st Jan 2009

0.00E+00	9.52E+05	5.51E+05	5.31E+05	4.38E+05	1.96E+05	1.18E+05	3.99E+04	3.72E+04	9.53E+03

Taper weighted geometric mean of the VPA populations:

3.28E+06	9.58E+05	5.95E+05	4.14E+05	2.82E+05	1.72E+05	8.38E+04	3.48E+04	1.10E+04	3.64E+03

Standard error of the weighted Log(VPA populations) :

0.4679	0.3489	0.3639	0.3359	0.2859	0.2712	0.3103	0.4691	0.5373	0.6639

YEAR	AGE 11	12
1999	3.56E+02	6.36E+01
2000	5.32E+02	1.15E+02
2001	6.81E+02	1.45E+02
2002	4.96E+02	2.47E+02
2003	4.42E+02	2.04E+02
2004	6.85E+02	2.33E+02
2005	1.13E+03	2.94E+02
2006	1.67E+03	4.13E+02
2007	1.57E+03	6.98E+02
2008	3.41E+03	8.27E+02

Estimated population abundance at 1st Jan 2009

5.00E+03	2.15E+03

Taper weighted geometric mean of the VPA populations:

1.15E+03	3.66E+02

Standard error of the weighted Log(VPA populations) :

0.7226	0.625

1

Log catchability residuals.

Fleet : FLT09: Russian trawl

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	-0.39	0.3	0.05	0.37	-0.14	-0.2	-0.29	0.08	-0.51	0.74
10	-0.3	0.1	-0.04	-0.02	0.27	0.32	-0.32	-0.32	-0.29	0.47
11	99.99	-0.32	-0.15	-0.45	-0.09	0.25	-0.18	-0.08	-0.02	0.17

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

Age	9	10	11
Mean Log	-3.4611	-3.6059	-3.6059
S.E(Log q)	0.4398	0.346	0.2115

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	0.99	0.025	3.52	0.6	10	0.48	-3.46
10	1.01	-0.052	3.55	0.78	10	0.39	-3.61
11	0.89	0.968	4.02	0.95	9	0.19	-3.64

1

Table 3.15 (continued)

Fleet : FLT15: NorBarTrSur r

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.03	0.1	0.05	0.2	-0.11	0.12	-0.13	-0.23	0.16	0.04
4	0.08	0.07	0.06	0.08	-0.01	-0.2	0	-0.12	0.1	0.12
5	0.11	-0.03	0.07	0.19	0.04	-0.18	-0.23	-0.08	0.11	0.2
6	-0.08	-0.02	0.02	0.23	0.38	-0.04	-0.28	-0.17	0.14	-0.05
7	0.19	-0.3	-0.26	0.09	0.43	-0.28	-0.03	-0.03	-0.11	0.17
8	0.32	0.05	-0.34	0.19	0.17	-0.2	-0.2	0.09	-0.01	0.15
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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

Age	6	7	8
Mean Log	-6.348	-6.5428	-6.7787
S.E(Log q)	0.2172	0.2224	0.1788

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.63	1.726	8.5	0.84	10	0.18	-5.72
4	0.57	2.496	8.94	0.89	10	0.13	-5.94
5	0.63	1.289	8.53	0.74	10	0.19	-6.15

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
6	1.18	-0.392	5.35	0.54	10	0.28	-6.35
7	1.16	-0.414	5.76	0.6	10	0.28	-6.54
8	0.91	0.587	7.13	0.9	10	0.17	-6.78
1							

Fleet : FLT16: NorBarLofAcSu

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.35	0.26	0.19	0.37	-0.22	0.14	-0.2	-0.35	0.22	0.08
4	0.32	0.18	0.14	0.38	-0.13	-0.28	-0.09	-0.31	0.44	0.01
5	0.38	0.12	0.24	0.5	-0.03	-0.11	-0.4	-0.16	0.28	0.01
6	0.25	0.02	0.08	0.72	0.15	0.22	-0.54	-0.07	0.01	-0.1
7	0.3	-0.65	-0.02	0.43	0.37	-0.06	-0.01	-0.11	0.08	-0.29
8	0.25	-0.79	-0.48	-0.01	0.28	0.19	0.1	-0.01	-0.48	0.28
9	-0.03	-0.38	-0.04	-0.25	0.36	-0.18	0.29	0.28	-0.29	-0.17
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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

Age	6	7	8	9
Mean Log	-5.5813	-5.4134	-5.2454	-5.379
S.E(Log q)	0.3352	0.2524	0.3201	0.2843

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.5	1.459	9.71	0.67	10	0.29	-6.16
4	0.49	1.205	9.6	0.57	10	0.32	-6.2
5	0.56	0.952	8.92	0.52	10	0.31	-6.03

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
6	0.93	0.132	6.05	0.43	10	0.34	-5.58
7	0.74	1.016	6.98	0.78	10	0.19	-5.41
8	0.72	1.471	6.72	0.86	10	0.21	-5.25
9	1.01	-0.051	5.33	0.78	10	0.32	-5.38

Table 3.15 (continued)

Fleet : FLT18: RusSweptArea

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.2	0.15	0.08	0.14	-0.23	-0.05	0.09	-0.05	0	0.05
4	0.15	-0.05	-0.08	0	-0.06	-0.28	-0.02	0.08	0.09	0.13
5	0.11	0.25	-0.03	-0.08	-0.18	-0.28	-0.02	0.03	0.28	0.09
6	-0.09	0.2	0.03	-0.12	-0.08	-0.01	-0.24	0.2	0.08	0.04
7	-0.57	-0.54	-0.29	0.03	-0.19	0	-0.09	0.04	0.19	0.12
8	-0.6	-0.37	-0.5	0.12	-0.15	0.06	-0.31	0.07	0.35	0.06
9	-0.38	-0.64	-0.6	-0.07	-0.61	-0.11	0	0.23	0.24	0.32
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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

Age	6	7	8	9
Mean Log	-4.4384	-4.0174	-3.8519	-3.8438
S.E(Log q)	0.1459	0.1658	0.2537	0.3443

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.52	3.318	9.4	0.92	10	0.12	-5.87
4	0.71	1.48	7.57	0.86	10	0.15	-5.33
5	0.87	0.399	5.86	0.7	10	0.21	-4.91

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
6	0.96	0.146	4.72	0.79	10	0.16	-4.44
7	0.77	1.38	5.69	0.89	10	0.12	-4.02
8	0.86	0.665	4.79	0.84	10	0.23	-3.85
9	0.68	2.19	5.58	0.92	10	0.18	-3.84
1							

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2007

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	1	0	0	0	0	0	0
FLT15: No	1	0	0	0	0	0	0
FLT16: No	1	0	0	0	0	0	0
FLT18: Ru	1	0	0	0	0	0	0
P shrinka	957756	0.35				0.891	1.049
F shrinka	904599	1				0.109	1.086

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
951840	0.33	13.77	2	41.789	1.053

1

Age 2 Catchability dependent on age and year class strength

Year class = 2006

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	1	0	0	0	0	0	0
FLT15: No	1	0	0	0	0	0	0
FLT16: No	1	0	0	0	0	0	0
FLT18: Ru	1	0	0	0	0	0	0
P shrinka	594560	0.36				0.883	0.161
F shrinka	309771	1				0.117	0.29

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
550924	0.34	13.22	2	38.667	0.173

Table 3.15 (continued)

Age 3 Catchability dependent on age and year class strength

Year class = 2005

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	1	0	0	0	0	0	0
FLT15: Nc	550308	0.3	0	0	1	0.253	0.21
FLT16: Nc	574401	0.325	0	0	1	0.215	0.202
FLT18: Ru	557146	0.3	0	0	1	0.253	0.207
P shrinka	413642	0.34				0.251	0.27
F shrinka	1253375	1				0.028	0.098

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
530883	0.16	0.1	5	0.654	0.217

1

Age 4 Catchability dependent on age and year class strength

Year class = 2004

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	1	0	0	0	0	0	0
FLT15: Nc	501574	0.213	0.022	0.11	2	0.292	0.14
FLT16: Nc	490857	0.258	0.102	0.4	2	0.198	0.142
FLT18: Ru	469943	0.213	0.066	0.31	2	0.292	0.148
P shrinka	281505	0.29				0.202	0.237
F shrinka	617586	1				0.017	0.115

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
437511	0.12	0.1	8	0.821	0.158

Age 5 Catchability dependent on age and year class strength

Year class = 2003

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	1	0	0	0	0	0	0
FLT15: Nc	203785	0.174	0.129	0.74	3	0.299	0.182
FLT16: Nc	198772	0.201	0.214	1.07	3	0.226	0.187
FLT18: Ru	205887	0.174	0.045	0.26	3	0.299	0.181
P shrinka	171657	0.27				0.164	0.213
F shrinka	123157	1				0.012	0.286

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
196414	0.1	0.06	11	0.643	0.189

1

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

Year class = 2002

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	1	0	0	0	0	0	0
FLT15: Nc	113292	0.156	0.052	0.33	4	0.359	0.247
FLT16: Nc	110210	0.179	0.127	0.71	4	0.268	0.253
FLT18: Ru	132372	0.156	0.056	0.36	4	0.359	0.215
F shrinka	53469	1				0.014	0.466

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
117673	0.09	0.05	13	0.576	0.239

Table 3.15 (continued)

Age 7 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
FLT09: Ru	1	0	0	0	0	0	0
FLT15: Nc	43425	0.144	0.048	0.34	5	0.358	0.257
FLT16: Nc	34892	0.171	0.079	0.46	5	0.27	0.31
FLT18: Ru	42071	0.144	0.031	0.22	5	0.358	0.264
F shrinka	14066	1				0.014	0.643

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
39855	0.09	0.05	16	0.552	0.277

1

Age 8 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
FLT09: Ru	1	0	0	0	0	0	0
FLT15: Nc	35388	0.147	0.067	0.46	6	0.348	0.424
FLT16: Nc	38304	0.161	0.102	0.64	6	0.287	0.398
FLT18: Ru	39403	0.147	0.066	0.45	6	0.348	0.389
F shrinka	18055	1				0.017	0.711

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
37155	0.09	0.05	19	0.55	0.408

Age 9 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
FLT09: Ru	20007	0.473	0	0	1	0.065	0.222
FLT15: Nc	9023	0.161	0.048	0.3	6	0.232	0.439
FLT16: Nc	7530	0.169	0.076	0.45	7	0.343	0.508
FLT18: Ru	11379	0.16	0.091	0.57	7	0.338	0.363
F shrinka	5000	1				0.022	0.691

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
9531	0.1	0.07	22	0.745	0.421

1

Age 10 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
FLT09: Ru	5956	0.297	0.447	1.5	2	0.231	0.241
FLT15: Nc	5211	0.178	0.026	0.14	6	0.165	0.271
FLT16: Nc	4316	0.191	0.071	0.37	7	0.298	0.319
FLT18: Ru	5505	0.184	0.054	0.29	7	0.277	0.258
F shrinka	1773	1				0.03	0.65

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
4996	0.11	0.07	23	0.638	0.282

Table 3.15 (continued)

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

Year class = 1997

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	2198	0.22	0.144	0.65	3	0.54	0.258
FLT15: Nc	1914	0.195	0.096	0.49	6	0.086	0.291
FLT16: Nc	2631	0.208	0.051	0.25	7	0.175	0.22
FLT18: Ru	2155	0.202	0.095	0.47	7	0.159	0.263
F shrinka	778	1				0.039	0.605

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
2145	0.14	0.06	24	0.458	0.264

1

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

Year class = 1996

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Ru	424	0.234	0.095	0.4	3	0.627	0.398
FLT15: Nc	478	0.222	0.121	0.54	6	0.052	0.36
FLT16: Nc	626	0.225	0.037	0.16	7	0.123	0.286
FLT18: Ru	464	0.225	0.032	0.14	7	0.107	0.369
F shrinka	657	1				0.091	0.274

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
470	0.18	0.04	24	0.249	0.365

Table 3.16. Northeast Arctic cod. Fishing mortality for XSA run down to age 1. Number of cod eaten by cod included in catch matrix

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

At 23/04/2009 13:37

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988
AGE					
1	0.2457	0.3591	0.9368	0.5267	0.8044
2	0.0373	0.0577	0.8027	0.8028	0.1102
3	0.0199	0.0533	0.1451	0.1137	0.0629
4	0.1235	0.1701	0.2122	0.2285	0.127
5	0.3075	0.3763	0.4933	0.5097	0.3704
6	0.6274	0.6051	0.7052	0.9363	0.5971
7	1.1361	0.9248	0.948	1.1398	1.0446
8	1.2111	1.0189	1.0909	1.0143	0.9834
9	1.2623	0.7786	0.8281	0.7784	1.1591
10	0.9579	0.5057	1.112	1.3241	1.718
11	1.0876	0.4205	0.8745	1.027	1.5371
12	1.0345	0.4665	1.0045	1.1899	1.6497
+gp	1.0345	0.4665	1.0045	1.1899	1.6497
0 FBAR 5	0.9171	0.7016	0.8629	0.9504	0.9788

Table 8 Fishing mortality (F) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	0.2157	0.0962	0.1019	0.4665	2.565	1.7147	1.8671	1.9948	2.5157	1.624
2	0.002	0.0594	0.2364	0.1451	0.4493	0.6303	0.9353	1.058	1.0883	0.6297
3	0.0327	0.0086	0.0182	0.0405	0.079	0.2053	0.5531	0.471	0.337	0.377
4	0.1284	0.0622	0.0624	0.1265	0.0961	0.1986	0.3042	0.3529	0.2992	0.3526
5	0.266	0.1342	0.1875	0.2205	0.3465	0.3391	0.3381	0.4118	0.5692	0.5211
6	0.4016	0.231	0.321	0.4428	0.4597	0.6456	0.5772	0.5426	0.724	0.7796
7	0.7156	0.2504	0.4259	0.5396	0.5663	1.1681	0.8908	0.7495	0.8426	0.7725
8	0.8891	0.3742	0.3451	0.5993	0.5976	0.9863	0.9434	0.8621	1.2341	1.042
9	0.7166	0.3058	0.3805	0.4558	0.6665	1.0542	0.9617	0.7519	1.3357	1.1701
10	0.9855	0.3242	0.256	0.4586	0.6631	1.0399	1.0193	0.9392	1.5097	1.2387
11	0.5821	0.54	0.134	0.2482	0.6763	1.1611	1.2531	0.866	1.4407	1.3355
12	0.7917	0.4352	0.1959	0.3556	0.6759	1.1136	1.1498	0.9124	1.4947	1.3034
+gp	0.7917	0.4352	0.1959	0.3556	0.6759	1.1136	1.1498	0.9124	1.4947	1.3034
0 FBAR 5	0.6624	0.27	0.3193	0.4528	0.55	0.8722	0.7884	0.7095	1.0359	0.9207

1

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

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Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	FBAR **-**
AGE											
1	1.0927	1.3746	0.9396	0.613	1.3991	1.0061	1.11	0.9627	0.8889	1.0526	0.9681
2	0.3604	0.2565	0.2018	0.4019	0.2758	0.5716	0.2471	0.1263	0.2211	0.1733	0.1736
3	0.1263	0.0775	0.0615	0.1106	0.0474	0.0779	0.1813	0.0306	0.1491	0.2167	0.1322
4	0.2098	0.1395	0.1169	0.1046	0.0713	0.1002	0.1165	0.1421	0.142	0.1585	0.1475
5	0.5477	0.4107	0.2848	0.2887	0.2701	0.2542	0.3766	0.2498	0.2715	0.1887	0.2367
6	0.7224	0.6042	0.5193	0.5553	0.4735	0.514	0.5502	0.4592	0.3154	0.2388	0.3378
7	0.8096	0.7476	0.6711	0.8053	0.677	0.7526	0.7709	0.612	0.3758	0.2767	0.4215
8	1.0603	1.0343	0.8312	0.8933	0.6979	0.876	0.808	0.6862	0.4537	0.4079	0.5159
9	1.3892	1.191	0.8868	0.7796	0.5825	0.7971	0.9008	0.7666	0.3764	0.4206	0.5212
10	1.4166	1.1591	1.1384	0.7344	0.5007	0.8769	0.8219	0.7089	0.3124	0.2816	0.4343
11	0.9287	1.0984	0.8127	0.687	0.4392	0.6462	0.8023	0.6709	0.4399	0.2638	0.4582
12	1.187	1.1424	1.019	0.7676	0.7439	0.9224	0.4718	0.8248	0.5977	0.3654	0.596
+gp	1.187	1.1424	1.019	0.7676	0.7439	0.9224	0.4718	0.8248	0.5977	0.3654	
0 FBAR 5	0.991	0.8578	0.7219	0.6761	0.5336	0.6785	0.7048	0.5804	0.3509	0.3024	

Table 3.17. Northeast Arctic cod. Stock number at age

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

At 23/04/2009 13:37

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1984	1985	1986	1987	1988
AGE					
1	211680	137713	175527	49253	82174
2	67035	135548	78736	56317	23815
3	40282	52874	104751	28886	20660
4	13543	32331	41043	74178	21109
5	7852	9800	22329	27180	48326
6	4763	4727	5507	11163	13366
7	2465	2082	2113	2227	3583
8	1304	648	676	670	583
9	923	318	192	186	199
10	140	214	120	69	70
11	39	44	106	32	15
12	26	11	24	36	9
+gp	12	21	13	16	8
0 TOTA	350065	376330	431137	250213	213918

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

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	81811	151782	172783	304765	2428260	936278	2010530	2780254	1922336	667958
2	30098	53986	112872	127757	156490	152921	137993	254437	309655	127174
3	17463	24593	41651	72958	90468	81753	66662	44339	72314	85380
4	15883	13838	19962	33488	57363	68440	54510	31391	22665	42268
5	15222	11438	10646	15355	24159	42661	45940	32922	18059	13759
6	27319	9552	8188	7226	10083	13987	24884	26823	17857	8368
7	6023	14969	6207	4863	3800	5213	6004	11439	12765	7088
8	1032	2411	9541	3320	2321	1766	1327	2017	4426	4500
9	179	347	1358	5532	1493	1045	539	423	697	1055
10	51	71	209	760	2871	628	298	169	163	150
11	10	16	42	133	393	1211	182	88	54	30
12	3	5	7	30	85	164	311	42	30	10
+gp	6	4	2	5	19	23	42	162	53	17
0 TOTA	195100	283012	383470	576191	2777805	1306090	2349222	3184508	2381075	957758

1

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

At 23/04/2009 13:37

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	GMST 84-**	AMST 84-**
AGE													
1	304780	330302	411959	110768	645141	268275	455979	392429	237722	333072	0	349437	653597
2	107790	83668	68403	131801	49130	130372	80308	123027	122691	80013	95184	95911	113014
3	55469	61546	53003	45770	72193	30530	60270	51357	88771	80526	55092	50231	55442
4	47947	40024	46630	40806	33552	56373	23123	41164	40779	62610	53088	34064	37897
5	24325	31826	28502	33964	30091	25580	41753	16850	29237	28968	43751	22285	25154
6	6690	11517	17281	17553	20835	18805	16243	23456	10746	18246	19641	12398	14182
7	3142	2660	5153	8418	8248	10624	9208	7671	12133	6418	11767	5383	6346
8	2680	1145	1031	2157	3080	3431	4098	3487	3406	6822	3986	1936	2507
9	1300	760	333	368	723	1255	1170	1496	1438	1771	3715	649	952
10	268	265	189	112	138	330	463	389	569	808	953	211	354
11	36	53	68	50	44	68	113	167	157	341	500	64	130
12	6	12	15	25	20	23	29	41	70	83	215	22	42
+gp	11	4	6	7	14	11	15	44	22	29	64		
0 TOTA	554444	563782	632573	391799	863209	545678	692772	661578	547739	619707	287956		

1

Table 3.18. Northeast Arctic cod. Natural mortality used in final VPA.

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

At 23/04/2009 16:35

Table 4 Natural Mortality (M) at age

YEAR	1946	1947	1948
AGE			
3	0.2	0.2	0.2
4	0.2	0.2	0.2
5	0.2	0.2	0.2
6	0.2	0.2	0.2
7	0.2	0.2	0.2
8	0.2	0.2	0.2
9	0.2	0.2	0.2
10	0.2	0.2	0.2
11	0.2	0.2	0.2
12	0.2	0.2	0.2
+gp	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
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
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

1

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

At 23/04/2009 16:35

Table 4 Natural Mortality (M) at age

YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
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
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
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
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 3.18 (continued).

Table 4 Natural Mortality (M) at age

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0.2	0.2	0.2	0.2	0.2	0.2006	0.2004	0.3123	0.2584	0.2087
4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0.2	0.2	0.205	0.2067	0.266	0.3997	0.7412	0.645	0.5145	0.5273
4	0.2	0.2	0.2	0.2	0.2028	0.2939	0.4038	0.4321	0.2932	0.2768
5	0.2	0.2	0.2	0.2	0.2024	0.2258	0.2111	0.2812	0.2103	0.2163
6	0.2	0.2	0.2	0.2	0.2	0.2046	0.2014	0.206	0.202	0.2095
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 4 Natural Mortality (M) at age

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
3	0.3104	0.2688	0.2506	0.3044	0.2361	0.2696	0.3702	0.212	0.3155	0.4047
4	0.2112	0.2416	0.229	0.2161	0.2	0.2216	0.2163	0.2062	0.2146	0.2601
5	0.2	0.2167	0.2079	0.2033	0.2	0.2055	0.2173	0.2006	0.2001	0.2185
6	0.2	0.2006	0.2072	0.2002	0.2	0.2003	0.2047	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
+gp	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1										

Table 3.19 Northeast arctic cod. Natural mortality of cod (M2) due to cannibalism

Year	M2 age 1	M2 age 2	M2 age 3	M2 age 4	M2 age 5	M2 age 6
1984	0.2457	0.0356	0.0006	0.0000	0.0000	0.0000
1985	0.3590	0.0562	0.0004	0.0000	0.0000	0.0000
1986	0.9368	0.8010	0.1123	0.0000	0.0000	0.0000
1987	0.5267	0.8017	0.0585	0.0000	0.0000	0.0000
1988	0.8044	0.1093	0.0087	0.0000	0.0000	0.0000
1989	0.2157	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0962	0.0590	0.0000	0.0000	0.0000	0.0000
1991	0.1019	0.2357	0.0049	0.0000	0.0000	0.0000
1992	0.4661	0.1440	0.0067	0.0000	0.0000	0.0000
1993	2.5650	0.4487	0.0662	0.0028	0.0024	0.0000
1994	1.7147	0.6300	0.1955	0.0928	0.0258	0.0046
1995	1.8671	0.9350	0.5426	0.2041	0.0111	0.0014
1996	1.9948	1.0574	0.4471	0.2326	0.0812	0.0060
1997	2.5157	1.0876	0.3139	0.0933	0.0103	0.0020
1998	1.6240	0.6278	0.3275	0.0768	0.0163	0.0095
1999	1.0927	0.3600	0.1104	0.0112	0.0000	0.0000
2000	1.3746	0.2562	0.0687	0.0416	0.0167	0.0006
2001	0.9396	0.2014	0.0507	0.0290	0.0079	0.0072
2002	0.6129	0.4018	0.1046	0.0161	0.0033	0.0002
2003	1.3991	0.2753	0.0360	0.0000	0.0000	0.0000
2004	1.0061	0.5714	0.0700	0.0215	0.0055	0.0003
2005	1.1100	0.2464	0.1696	0.0164	0.0172	0.0047
2006	0.9627	0.1252	0.0119	0.0062	0.0006	0.0000
2007	0.8879	0.2185	0.1150	0.0146	0.0001	0.0000
2008	1.0526	0.1723	0.2038	0.0598	0.0185	0.0000

Table 3.20. Northeast Arctic cod. Fishing mortality, final VPA

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1946	1947	1948
AGE			
3	0.0061	0.0018	0.0003
4	0.02	0.0249	0.0124
5	0.0532	0.1101	0.0751
6	0.0973	0.2024	0.1997
7	0.1781	0.416	0.5201
8	0.1932	0.2545	0.3536
9	0.3125	0.4047	0.5286
10	0.2798	0.4405	0.3617
11	0.3432	0.7827	0.5536
12	0.312	0.6182	0.4604
+gp	0.312	0.6182	0.4604
0 FBAR 5	0.1857	0.3047	0.3398

Table 8 Fishing mortality (F) at age

YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
AGE										
3	0.0023	0.002	0.0254	0.0225	0.0334	0.0199	0.0159	0.027	0.024	0.0718
4	0.0209	0.0321	0.1612	0.1667	0.1325	0.1457	0.084	0.1291	0.1128	0.2589
5	0.1484	0.1167	0.2637	0.37	0.2299	0.2676	0.2859	0.4568	0.2094	0.3626
6	0.3662	0.2882	0.2787	0.5501	0.3125	0.3333	0.5297	0.69	0.4862	0.5517
7	0.5101	0.4096	0.4122	0.5311	0.3243	0.3969	0.5139	0.6129	0.5494	0.5357
8	0.3869	0.348	0.4046	0.4175	0.3469	0.2494	0.588	0.688	0.6287	0.4593
9	0.3832	0.4741	0.5057	0.579	0.3932	0.4364	0.5805	0.6551	0.5463	0.4535
10	0.3766	0.5031	0.5149	0.7613	0.5364	0.6441	0.7645	0.738	0.6333	0.7388
11	0.6259	0.9031	0.4585	1.026	0.698	0.8035	0.7621	0.8756	0.8584	0.8415
12	0.5039	0.7111	0.4879	0.9056	0.6217	0.7304	0.7704	0.8152	0.7529	0.799
+gp	0.5039	0.7111	0.4879	0.9056	0.6217	0.7304	0.7704	0.8152	0.7529	0.799
0 FBAR 5	0.3619	0.3566	0.3966	0.5348	0.3572	0.3879	0.5437	0.6401	0.5089	0.5169
1										

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE										
3	0.0535	0.0543	0.0562	0.0663	0.0313	0.0174	0.0226	0.0398	0.0298	0.0251
4	0.2564	0.2266	0.2717	0.3063	0.2366	0.1449	0.111	0.1037	0.1525	0.2064
5	0.5093	0.3477	0.4944	0.6498	0.742	0.3537	0.3909	0.2119	0.1814	0.4087
6	0.5121	0.4607	0.5168	0.8279	1.0069	0.4854	0.4494	0.3818	0.2026	0.4683
7	0.5251	0.4363	0.5279	0.6094	0.9764	0.5787	0.4033	0.4713	0.432	0.4019
8	0.5111	0.4855	0.6931	0.6564	0.8798	0.7409	0.5303	0.5797	0.6844	0.5291
9	0.6141	0.4053	0.7389	0.8167	0.9416	1.0674	0.7389	0.7183	0.8781	0.8041
10	0.686	0.7381	0.8379	0.9855	1.3731	0.8476	0.8074	0.8182	0.885	0.8105
11	0.6511	0.8449	1.0011	0.9522	1.4366	1.2968	0.7617	0.5024	1.2253	0.6772
12	0.6734	0.7981	0.9284	0.9756	1.4264	1.0883	0.7927	0.6634	1.0696	0.7458
+gp	0.6734	0.7981	0.9284	0.9756	1.4264	1.0883	0.7927	0.6634	1.0696	0.7458
0 FBAR 5	0.5596	0.4789	0.6348	0.7576	0.9866	0.6789	0.5533	0.5302	0.5439	0.5704

Table 8 Fishing mortality (F) at age

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	0.023	0.0409	0.0214	0.0394	0.1959	0.2141	0.0837	0.166	0.1338	0.146
4	0.2292	0.1422	0.1028	0.1673	0.1996	0.4959	0.2106	0.3121	0.5671	0.2234
5	0.4792	0.4004	0.2285	0.2976	0.3536	0.5375	0.5211	0.48	0.7544	0.6703
6	0.5382	0.568	0.2517	0.3849	0.3917	0.5078	0.7021	0.5715	0.6857	0.8497
7	0.7725	0.6211	0.5144	0.3427	0.421	0.4451	0.705	0.6973	0.6763	0.8581
8	0.9302	0.8479	0.833	0.6583	0.7375	0.4863	0.7032	0.8908	0.9121	0.9296
9	1.1783	0.9682	0.9584	1.1338	0.9698	0.5192	0.6109	0.7746	1.2298	1.3057
10	1.0769	1.09	0.7876	1.3393	0.7386	0.8842	0.7149	0.46	0.7689	1.0301
11	1.5554	0.8533	0.8388	1.2904	0.7222	0.9905	0.9079	0.6132	0.6231	1.8042
12	1.3377	0.9829	0.8179	1.3377	0.7358	0.9492	0.8218	0.5389	0.6958	1.4375
+gp	1.3377	0.9829	0.8179	1.3377	0.7358	0.9492	0.8218	0.5389	0.6958	1.4375
0 FBAR 5	0.8292	0.7493	0.5956	0.6928	0.602	0.5633	0.6595	0.6457	0.8379	0.9406

Table 3.20 (continued).

Table 8 Fishing mortality (F) at age

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0.0489	0.0318	0.0252	0.0672	0.0208	0.0194	0.0533	0.033	0.0555	0.0546
4	0.209	0.1296	0.1003	0.2121	0.205	0.1247	0.1716	0.2133	0.2293	0.1277
5	0.3475	0.3562	0.23	0.3045	0.3308	0.3096	0.3788	0.496	0.5104	0.371
6	0.5478	0.6225	0.5163	0.5518	0.5033	0.6301	0.6078	0.7078	0.9362	0.5974
7	0.6643	0.6766	0.8475	0.7996	0.7821	1.135	0.9264	0.9487	1.1362	1.0411
8	0.7789	0.7123	1.0788	0.9846	1.0295	1.2083	1.0191	1.091	1.0143	0.9788
9	1.0352	0.939	1.2764	1.1588	0.9701	1.2572	0.7818	0.8325	0.7841	1.1546
10	0.9848	1.038	1.2299	0.7507	0.9203	0.9564	0.5088	1.1134	1.3245	1.7027
11	1.4314	1.4798	0.9557	0.9516	0.5853	1.081	0.4237	0.8774	1.0329	1.5282
12	1.2219	1.2775	1.1082	0.8607	0.759	1.0345	0.4665	1.0045	1.1899	1.6497
+gp	1.2219	1.2775	1.1082	0.8607	0.759	1.0345	0.4665	1.0045	1.1899	1.6497
0 FBAR 5	0.7264	0.7241	0.8632	0.7583	0.756	0.9161	0.7038	0.8649	0.951	0.9743

Table 8 Fishing mortality (F) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0.033	0.0087	0.0134	0.0341	0.0129	0.0098	0.0106	0.024	0.0232	0.0497
4	0.1292	0.0627	0.0631	0.1276	0.0942	0.1065	0.1008	0.121	0.2069	0.2768
5	0.2671	0.1352	0.1888	0.2226	0.3463	0.3153	0.329	0.3324	0.5606	0.506
6	0.4024	0.2324	0.3228	0.4449	0.4635	0.6433	0.5785	0.5394	0.7236	0.7709
7	0.7142	0.2518	0.4277	0.5417	0.5693	1.1663	0.8922	0.7534	0.8452	0.7752
8	0.8851	0.3755	0.347	0.6013	0.6009	0.9867	0.9447	0.8659	1.2337	1.0445
9	0.7134	0.3067	0.3823	0.4585	0.6697	1.0542	0.9632	0.7577	1.3339	1.1711
10	0.9791	0.3242	0.2572	0.4612	0.6668	1.041	1.0203	0.9436	1.5072	1.2363
11	0.581	0.5377	0.1345	0.2497	0.6797	1.161	1.2493	0.8716	1.4392	1.3339
12	0.7917	0.4352	0.1959	0.3556	0.6759	1.1136	1.1498	0.9125	1.4947	1.3034
+gp	0.7917	0.4352	0.1959	0.3556	0.6759	1.1136	1.1498	0.9125	1.4947	1.3034
0 FBAR 5	0.6602	0.271	0.321	0.455	0.5528	0.8678	0.788	0.6987	1.034	0.9173

Table 8 Fishing mortality (F) at age

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	FBAR **-**
AGE											
3	0.016	0.0088	0.0109	0.006	0.0115	0.0078	0.0117	0.0188	0.0343	0.013	0.022
4	0.1997	0.0986	0.0887	0.089	0.0717	0.0795	0.0997	0.1367	0.1277	0.0992	0.1212
5	0.5486	0.3954	0.2784	0.2872	0.2709	0.2494	0.3619	0.2474	0.2726	0.1706	0.2302
6	0.7225	0.6047	0.5137	0.5565	0.4762	0.5134	0.5443	0.4632	0.312	0.2403	0.3385
7	0.8109	0.7474	0.6723	0.8046	0.6783	0.7554	0.7652	0.6087	0.3814	0.2729	0.421
8	1.061	1.0322	0.8288	0.8918	0.6985	0.8753	0.8136	0.6771	0.4511	0.4167	0.515
9	1.3853	1.189	0.8855	0.7756	0.5844	0.7966	0.8983	0.7789	0.3704	0.4171	0.5221
10	1.4098	1.1554	1.134	0.7345	0.4989	0.8764	0.8203	0.7078	0.3238	0.2759	0.4358
11	0.9308	1.09	0.8127	0.6876	0.442	0.6399	0.8029	0.6704	0.4411	0.277	0.4629
12	1.1871	1.1427	1.0196	0.7684	0.7442	0.9226	0.4655	0.8256	0.6008	0.3674	0.5979
+gp	1.1871	1.1427	1.0196	0.7684	0.7442	0.9226	0.4655	0.8256	0.6008	0.3674	
0 FBAR 5	0.9897	0.854	0.7188	0.6751	0.5345	0.6778	0.7006	0.5805	0.3519	0.2989	
1											

Table 3.21 Northeast arctic cod. Fishing mortality of age 1-6 cod

Year	F age 1	F age 2	F age 3	F age 4	F age 5	F age 6
1984	0.0000	0.0017	0.0193	0.1235	0.3075	0.6274
1985	0.0001	0.0015	0.0529	0.1701	0.3763	0.6051
1986	0.0000	0.0017	0.0328	0.2122	0.4933	0.7052
1987	0.0000	0.0011	0.0552	0.2285	0.5097	0.9363
1988	0.0000	0.0009	0.0542	0.1270	0.3704	0.5971
1989	0.0000	0.0009	0.0327	0.1284	0.2660	0.4016
1990	0.0000	0.0004	0.0086	0.0622	0.1342	0.2310
1991	0.0000	0.0007	0.0133	0.0624	0.1875	0.3210
1992	0.0004	0.0011	0.0338	0.1265	0.2205	0.4428
1993	0.0000	0.0006	0.0128	0.0933	0.3441	0.4597
1994	0.0000	0.0003	0.0098	0.1058	0.3133	0.6410
1995	0.0000	0.0003	0.0105	0.1001	0.3270	0.5758
1996	0.0000	0.0006	0.0239	0.1203	0.3306	0.5366
1997	0.0000	0.0007	0.0231	0.2059	0.5589	0.7220
1998	0.0000	0.0019	0.0495	0.2758	0.5048	0.7701
1999	0.0000	0.0004	0.0159	0.1986	0.5477	0.7224
2000	0.0000	0.0003	0.0088	0.0979	0.3940	0.6036
2001	0.0000	0.0004	0.0108	0.0879	0.2769	0.5121
2002	0.0001	0.0001	0.0060	0.0885	0.2854	0.5551
2003	0.0000	0.0005	0.0114	0.0713	0.2701	0.4735
2004	0.0000	0.0002	0.0079	0.0787	0.2487	0.5137
2005	0.0000	0.0007	0.0117	0.1001	0.3594	0.5455
2006	0.0000	0.0011	0.0187	0.1359	0.2492	0.4592
2007	0.0010	0.0026	0.0341	0.1274	0.2714	0.3154
2008	0.0000	0.0010	0.0129	0.0987	0.1702	0.2388

Table 3.22. Northeast Arctic cod. Stock number at age. Final VPA

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

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

	YEAR	1946	1947	1948
	AGE			
	3	728139	425311	442592
	4	577860	592530	347574
	5	402060	463732	473210
	6	197212	312115	340097
	7	93323	146496	208708
	8	96213	63939	79121
	9	244722	64933	40588
	10	101777	146581	35470
	11	38117	62991	77255
	12	39205	22142	23578
	+gp	33324	42765	37377
0	TOT/	2551952	2343535	2105569

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

	YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
	AGE										
	3	468348	704908	1083753	1193111	1590377	641584	272778	439602	804781	496824
	4	362238	382556	575973	865011	955076	1259285	514924	219807	350332	643259
	5	281072	290427	303320	401364	599477	684912	891184	387619	158175	256234
	6	359415	198391	211595	190765	226975	389987	429102	548181	200984	105033
	7	228044	204032	121764	131099	90099	135956	228785	206850	225110	101196
	8	101579	112107	110900	66016	63110	53333	74845	112048	91748	106395
	9	45487	56484	64808	60583	35603	36525	34028	34036	46105	40060
	10	19586	25387	28785	32000	27799	19673	19329	15591	14474	21860
	11	20227	11003	12568	14083	12237	13311	8459	7368	6103	6291
	12	36361	8856	3651	6506	4133	4985	4880	3232	2513	2118
	+gp	21337	21133	13989	3938	1880	2707	2738	3722	1687	857
0	TOT/	1943694	2015284	2531108	2964476	3606766	3242259	2481052	1978057	1902013	1780129
	1										

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

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

	YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE										
	3	683690	789653	916842	728338	472064	338678	776941	1582560	1295416	164955
	4	378598	530599	612324	709603	558039	374580	272501	621906	1245195	1029477
	5	406511	239862	346346	382037	427678	360621	265306	199663	458995	875269
	6	145989	199996	138702	172949	163321	166726	207288	146941	132256	313440
	7	49529	71623	103298	67732	61876	48854	84015	108284	82121	88421
	8	48488	23986	37908	49883	30149	19083	22424	45954	55340	43651
	9	55027	23813	12084	15518	21185	10240	7448	10803	21072	22854
	10	20840	24380	13000	4726	5614	6764	2883	2913	4313	7170
	11	8550	8592	9541	4605	1444	1164	2373	1053	1052	1457
	12	2220	3650	3022	2871	1455	281	261	907	522	253
	+gp	1142	1351	2332	1351	1113	1278	670	351	461	498
0	TOT/	1800584	1917505	2195401	2139612	1743938	1328269	1642109	2721334	3296742	2547445

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

	YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	AGE										
	3	112039	197105	404774	1015319	1818949	523916	621616	613942	348054	638490
	4	131705	89647	154909	324399	799193	1224278	346265	468089	425778	249276
	5	685697	85743	63671	114439	224670	535936	610486	229669	280485	197708
	6	476187	347649	47037	41482	69576	129164	256342	296843	116349	108004
	7	160667	227600	161288	29940	23112	38504	63643	104000	137232	47987
	8	48433	60756	100131	78947	17401	12421	20199	25746	42398	57130
	9	21054	15642	21306	35642	33463	6815	6253	8186	8650	13943
	10	8373	5306	4863	6690	9391	10388	3320	2779	3089	2070
	11	2610	2335	1461	1811	1435	3673	3513	1330	1436	1172
	12	606	451	815	517	408	571	1117	1160	590	631
	+gp	278	312	421	697	408	525	550	572	583	1198
0	TOT/	1647648	1032545	960676	1649883	2998007	2486189	1933304	1752317	1364643	1317608

Table 3.22 (continued).

	Table 10	Stock number at age (start of year)				Numbers*10**-3					
	YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	198490	137735	150868	151830	166831	397831	523674	1038825	286344	204644
	4	451722	154747	109237	120444	116234	133783	319254	406348	735514	209193
	5	163230	300088	111295	80899	79769	77525	96695	220157	268787	478807
	6	82807	94414	172067	72401	48848	46916	46570	54207	109763	132093
	7	37806	39202	41481	84063	34138	24176	20455	20763	21867	35238
	8	16658	15929	16316	14551	30937	12785	6362	6632	6583	5747
	9	18463	6259	6397	4542	4451	9048	3127	1880	1824	1954
	10	3093	5368	2004	1461	1167	1381	2107	1171	669	682
	11	605	946	1557	480	565	381	435	1037	315	146
	12	158	118	176	490	152	258	106	233	353	92
	+gp	218	87	66	70	170	116	209	130	156	82
0	TOT/	973250	754893	611465	531231	483261	704200	1018993	1751382	1432174	1068679

	Table 10	Stock number at age (start of year)				Numbers*10**-3					
	YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	172782	242749	411784	721110	894891	810451	656938	437487	715761	845028
	4	157267	136871	197020	330988	566808	677071	538114	309768	224090	418082
	5	150744	113154	105246	151440	238526	421175	453653	324891	178174	135898
	6	270501	94492	80926	71340	99244	137792	245178	264331	175898	82420
	7	59509	148105	61322	47980	37433	51114	59018	112405	125437	69706
	8	10186	23854	94265	32734	22853	17344	13036	19800	43324	44106
	9	1768	3442	13417	54551	14689	10259	5294	4150	6819	10329
	10	504	709	2074	7495	28238	6156	2927	1654	1593	1471
	11	102	155	420	1313	3869	11868	1780	864	527	289
	12	26	47	74	301	837	1605	3043	418	296	102
	+gp	56	40	25	48	191	232	418	1624	532	174
0	TOT/	823444	763618	966573	1419299	1907580	2145067	1979399	1477391	1472450	1607605

	Table 10	Stock number at age (start of year)				Numbers*10**-3								
	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	GMST 46-**	AMST 46-**
	AGE													
	3	548930	608558	525622	454021	712993	305204	597565	510258	880265	796022	0	498243	602699
	4	474569	396056	461022	404672	332862	556614	231259	407873	405110	620440	524229	377142	455250
	5	240341	314665	281851	335554	298270	253681	411882	168602	289467	287675	433170	260554	312108
	6	65994	113687	170622	173309	205462	186247	160969	230800	107717	180432	194947	151110	181564
	7	30922	26235	50815	82975	81316	104487	91230	76113	118907	64554	116170	73619	91090
	8	26289	11253	10173	21240	30383	33786	40190	34750	33904	66481	40229	32318	43178
	9	12706	7450	3282	3636	7128	12372	11528	14585	14455	17680	35881	13430	23448
	10	2622	2603	1857	1108	1371	3253	4567	3844	5480	8172	9539	5173	12301
	11	350	524	671	489	435	681	1109	1646	1551	3246	5077	1926	6298
	12	62	113	144	244	201	229	294	407	689	817	2014	698	3197
	+gp	112	41	59	73	135	114	153	438	223	289	627		
0	TOT/	1402896	1481185	1506119	1477322	1670556	1456669	1550746	1449316	1857766	2045807	1361883		
	1													

Table 3.23. Northeast Arctic cod. Stock biomass at age. Final VPA

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

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

YEAR	1946	1947	1948
AGE			
3	254849	136099	150481
4	340937	331817	184214
5	446286	440545	596245
6	333289	468173	656387
7	221176	313502	513421
8	304996	186702	265846
9	973994	237005	171279
10	513974	668411	188345
11	225651	367868	457348
12	282275	164292	167165
+gp	271456	378386	315087
0 TOTAL	4168882	3692801	3665819

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

YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
AGE										
3	173289	274914	433501	524969	636151	282297	87289	145069	265578	168920
4	242699	244836	478058	692009	725857	969649	293507	127488	206696	334495
5	311990	374651	421615	533814	767331	862989	1007038	414753	161338	243423
6	596629	337265	397799	366270	438062	768275	742347	1003170	365792	201664
7	570111	481515	309280	346101	253178	411947	629160	597796	650567	297518
8	328099	390132	383714	244919	234769	230934	294890	476204	392683	447924
9	185131	255308	316264	306548	180151	197233	166739	188902	253117	224738
10	103218	142673	149682	193600	176245	132792	136079	113501	108698	160673
11	121160	70420	89737	104495	90555	103693	60902	58944	50286	54540
12	257435	70497	30013	54844	35831	53190	42844	26988	23247	20287
+gp	175349	187892	131347	40110	19247	26204	27591	37015	17892	9967
0 TOTAL	3065111	2830103	3141009	3407679	3557376	4039204	3488383	3189831	2495895	2164149

1

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

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

YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE										
3	239291	268482	284221	233068	151061	111764	295238	696327	375671	54435
4	272591	270606	336778	390282	340404	206019	185301	460210	1008608	720634
5	597571	261449	363663	355294	410571	342590	273265	235602	619644	1295399
6	391251	425991	305145	294013	282545	310111	308859	261555	269803	664492
7	177809	242086	333654	205229	188104	158775	202475	266378	230760	277642
8	209470	116810	193710	250910	149537	94841	78931	175545	192584	183771
9	299899	145737	74320	101645	136428	65640	42675	57905	103040	120443
10	134210	206985	105953	36390	44408	54588	21740	21174	30662	47678
11	61300	66934	82819	42684	13894	10875	20098	9087	9500	13129
12	19159	30297	29013	30314	16454	2856	2911	9669	5524	2444
+gp	13275	15429	27875	17178	14173	16470	9201	4967	6369	7389
0 TOTAL	2415826	2050805	2137149	1957006	1747579	1374529	1440693	2198418	2852164	3387455

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

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	49297	72929	182148	385821	691201	167653	254863	214880	170547	312860
4	104047	81578	136320	249787	727266	808024	221610	341705	383200	201913
5	843407	114895	87866	163647	345992	627045	677639	273307	401093	286676
6	966659	695298	101599	87943	157241	286743	487049	596655	238515	232208
7	465934	682799	495154	96707	76038	123596	187748	287041	452865	145879
8	184531	252138	422555	345787	80219	54527	88269	108649	193334	254800
9	105690	87437	123791	207793	219854	37616	35894	48132	55876	91184
10	53839	40323	34676	50977	78601	81651	29113	25849	26656	16521
11	21742	20948	12590	17245	15127	36074	34848	13669	14264	11898
12	6492	4958	8822	6248	4742	6512	13192	13760	6427	6843
+gp	3953	4396	5449	9529	5674	6947	7206	7750	7970	15783
0 TOTAL	2805591	2057698	1610969	1621485	2401955	2236387	2037430	1931396	1950748	1576565

Table 3.23 (continued).

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

	YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	69471	37188	73926	56177	61727	167089	216277	323075	60419	43385
	4	316206	86659	107052	79493	106936	155188	279347	357586	366286	84514
	5	202406	306090	160265	109213	127630	140320	155003	323630	337058	378258
	6	177208	162392	359620	144077	119188	130896	130862	133728	224685	251374
	7	119088	118389	123613	246304	130406	91385	83027	81286	75026	104902
	8	71461	66900	79133	61698	147262	58429	37111	38530	33816	25242
	9	121484	36552	42028	29340	27463	55823	24029	12370	11896	15268
	10	26635	38975	18354	12436	8986	10636	21316	8004	6226	8256
	11	5579	8362	16843	5870	5224	3521	6210	11412	4142	1910
	12	1720	1099	1899	5283	1645	2794	1346	2965	4496	1169
	+gp	3124	1256	924	979	2209	1514	2984	1863	2226	1181
0	TOTAL	1114381	863862	983658	750871	738675	817596	957513	1294449	1126275	915459

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

	YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	51662	96614	213304	317289	307843	190456	132045	85310	144584	183371
	4	81779	96494	223814	308150	664299	509835	260985	150857	116751	222838
	5	130846	133748	183445	274410	434117	598068	517164	315469	192249	157777
	6	399530	162432	196490	193760	280167	332492	519288	542935	330337	159813
	7	159840	364043	197088	186881	150891	195511	204791	396453	422596	205285
	8	47139	85040	427776	169433	125624	93935	64373	108959	228012	201740
	9	12462	16210	92306	369528	99373	68029	37906	32230	60876	76672
	10	5034	5534	22227	71933	242026	46970	26691	16806	19356	15249
	11	941	1389	3966	16313	41966	96272	17976	9216	5907	3390
	12	330	593	944	3826	10659	20437	38740	5318	3766	1303
	+gp	798	578	354	682	2733	3325	5988	23237	7613	2484
0	TOTAL	890360	962674	1561715	1912204	2359699	2155329	1825947	1686790	1532046	1229923

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

	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE										
	3	111433	118060	149802	113959	163988	76301	138037	130626	230629	227662
	4	246776	184166	240654	244826	178747	303911	144306	245539	283172	455403
	5	282160	380116	337094	398974	390733	275751	460484	202491	388175	394114
	6	134033	224192	382023	370535	412773	379012	310993	463676	228468	427083
	7	93818	79963	168350	276556	263544	305207	277886	237016	376577	212381
	8	117352	46090	52064	101230	151036	148119	158952	153837	157315	320438
	9	82359	42642	20925	24939	48037	77375	66991	87947	93886	115771
	10	26923	19413	17164	10344	11933	27792	37854	30894	49992	69322
	11	3807	5023	7599	4984	6541	6633	14901	16344	18268	28892
	12	793	1437	1837	3104	2564	2916	3745	6420	11895	7710
	+gp	1605	592	850	1047	1932	1626	2189	7674	3185	4134
0	TOTAL	1101059	1101693	1378363	1550500	1631827	1604645	1616338	1582465	1841561	2262913
	1										

Table 3.24. Northeast Arctic cod. Spawning stock biomass at age

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

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

	YEAR	1946	1947	1948
	AGE			
	3	0	0	0
	4	0	0	0
	5	4463	4405	5962
	6	9999	14045	19692
	7	13271	18810	35939
	8	33550	24271	34560
	9	175319	37921	42820
	10	226148	280733	88522
	11	146673	275901	333864
	12	242756	149506	152120
	+gp	260598	359467	305634
0	TOTSF	1112776	1165059	1019114

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

	YEAR	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	3120	3747	4216	5338	7673	8630	10070	4148	1613	2434
	6	17899	10118	11934	10988	13142	23048	22270	30095	10974	6050
	7	51310	43336	30928	27688	17722	32956	44041	35868	39034	17851
	8	55777	89730	92091	53882	44606	36949	38336	57144	35341	44792
	9	53688	89358	126506	125685	72060	72976	43352	26446	30374	22474
	10	55738	74190	86815	121968	112796	90299	72122	46535	23914	48202
	11	95716	55632	64611	85686	76066	90213	50549	39492	30172	27270
	12	226543	66972	25511	50457	33681	49467	39416	24559	19063	16635
	+gp	170088	182256	126093	38907	18670	25156	26763	35534	17356	9668
0	TOTSF	729879	615339	568705	520599	396417	429694	346919	299823	207840	195377
	1										

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

At 23/04/2009 16:35

Traditional vpa using file input for terminal F

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

	YEAR	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	0	2706	0	0	3404	0	0	0	0	0
	5	5976	7843	3637	3553	4106	0	0	2356	0	38862
	6	15650	25559	18309	14701	8476	9303	3089	5231	8094	33225
	7	21337	24209	40038	30784	13167	20641	12149	15983	16153	24988
	8	71220	22194	60050	85309	41870	35091	15786	38620	26962	34917
	9	146950	65582	48308	62004	57300	43323	23471	20267	39155	46973
	10	89921	142819	96417	29476	35970	48583	15870	15669	19624	27653
	11	51492	51539	81163	39269	13616	10332	19897	8542	8455	10766
	12	16668	25753	28433	29404	16125	2828	2853	9089	4972	2444
	+gp	13275	15274	27875	17178	14173	16470	9201	4967	6369	7389
0	TOTSF	432489	383479	404228	311678	208207	186570	102315	120722	129784	227215

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

	YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	AGE										
	3	0	0	0	3858	0	0	0	0	0	0
	4	0	816	0	4996	0	0	0	0	0	0
	5	0	0	879	3273	0	0	6776	0	8022	0
	6	19333	6953	5080	879	3145	2867	9741	29833	19081	4644
	7	18637	47796	54467	9671	12166	3708	16897	34445	117745	18964
	8	22144	57992	126766	117567	42516	11451	18536	31508	104400	112112
	9	35935	50714	73036	132988	178082	18808	20100	21659	42466	64741
	10	29611	32662	27394	41292	72313	78385	22708	21713	23191	12721
	11	16089	18644	10827	16210	14370	36074	27530	11345	13266	9637
	12	6167	4512	7763	6248	4647	6251	12532	13760	6041	6090
	+gp	3953	4396	5449	9529	5674	6947	7206	6975	7173	12626
0	TOTSF	151870	224482	311662	346511	332913	164491	142028	171238	341385	241536

Table 3.24 (continued).

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

	YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	0	0	0	0	617	0	0	0	0	0
	4	0	0	0	3975	8555	7759	2793	17879	3663	1690
	5	0	0	3205	10921	12763	25258	13950	25890	23594	18913
	6	5316	3248	25173	48986	35756	40578	47110	25408	40443	82953
	7	15481	15391	24723	160097	95196	51176	45665	43081	16506	55598
	8	27870	23415	42732	50592	129590	52586	31544	27356	15555	15650
	9	93543	23759	33622	26992	26639	55265	23068	7669	5948	15268
	10	23705	31960	17804	12436	8986	10636	19184	7204	4670	8256
	11	4630	8362	16843	5870	5224	3521	6210	11412	4142	1910
	12	1342	989	1899	5283	1645	2794	1346	2965	4496	1169
	+gp	2812	1130	924	979	2209	1514	2984	1863	2226	1181
0	TOTSF	174699	108253	166926	326133	327181	251087	193856	170729	121243	202589

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

	YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	413	773	213	317	0	571	0	0	0	183
	4	245	1254	7162	4314	18600	3569	783	0	0	669
	5	3795	6821	13758	39789	37768	71170	31547	5994	2307	4102
	6	91093	34111	59929	81185	103101	111385	193175	140077	46247	24292
	7	87433	190031	139538	149505	106227	115156	127790	250162	256516	96895
	8	33233	60804	368315	159775	116955	80972	50275	89346	189250	164217
	9	11403	14670	88337	359921	96591	65512	36390	31424	57589	73376
	10	5034	5395	22227	71933	240574	46500	26131	16806	19356	14944
	11	941	1389	3966	16313	41966	96272	17976	9216	5907	3390
	12	330	593	944	3826	10659	20437	38740	5318	3766	1303
	+gp	798	578	354	682	2733	3325	5988	23237	7613	2484
0	TOTSF	234716	316418	704745	887561	775177	614868	528795	571581	588550	385854

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

	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE										
	3	223	0	449	228	164	76	0	0	0	0
	4	494	184	722	3183	179	3039	577	246	1133	1822
	5	3950	26988	21911	33514	34385	25093	31313	12149	27949	26012
	6	25064	55375	137146	143768	134564	167523	123464	171097	78364	125562
	7	51037	51416	105051	188888	177101	221580	198966	153349	272265	116385
	8	99398	38255	42640	85135	134120	129160	141785	137992	137808	276218
	9	79477	41704	19920	23717	45971	75518	64780	84869	91633	107551
	10	26923	19413	17164	10344	11933	27152	37513	30894	49992	68906
	11	3807	5023	7599	4984	6541	6633	14901	16344	18268	28892
	12	793	1437	1837	3104	2564	2916	3745	6420	11895	7710
	+gp	1605	592	850	1047	1932	1626	2189	7674	3185	4134
0	TOTSF	292770	240387	355291	497911	549453	660319	619234	621033	692491	763193
	1										

Table 3.25. Northeast Arctic cod. Summary Table. Final VPA.

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

At 23/04/2009 16:35

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/S:	FBAR 5-10
1946	728139	4168882	1112776	706000	0.6344	0.1857
1947	425311	3692801	1165059	882017	0.7571	0.3047
1948	442592	3665819	1019114	774295	0.7598	0.3398
1949	468348	3065111	729879	800122	1.0962	0.3619
1950	704908	2830103	615339	731982	1.1896	0.3566
1951	1083753	3141009	568705	827180	1.4545	0.3966
1952	1193111	3407679	520599	876795	1.6842	0.5348
1953	1590377	3557376	396417	695546	1.7546	0.3572
1954	641584	4039204	429694	826021	1.9223	0.3879
1955	272778	3488383	346919	1147841	3.3087	0.5437
1956	439602	3189831	299823	1343068	4.4795	0.6401
1957	804781	2495895	207840	792557	3.8133	0.5089
1958	496824	2164149	195377	769313	3.9376	0.5169
1959	683690	2415826	432489	744607	1.7217	0.5596
1960	789653	2050805	383479	622042	1.6221	0.4789
1961	916842	2137149	404228	783221	1.9376	0.6348
1962	728338	1957006	311678	909266	2.9173	0.7576
1963	472064	1747579	208207	776337	3.7287	0.9866
1964	338678	1374529	186570	437695	2.346	0.6789
1965	776941	1440693	102315	444930	4.3486	0.5533
1966	1582560	2198418	120722	483711	4.0068	0.5302
1967	1295416	2852164	129784	572605	4.412	0.5439
1968	164955	3387455	227215	1074084	4.7272	0.5704
1969	112039	2805591	151870	1197226	7.8832	0.8292
1970	197105	2057698	224482	933246	4.1573	0.7493
1971	404774	1610969	311662	689048	2.2109	0.5956
1972	1015319	1621485	346511	565254	1.6313	0.6928
1973	1818949	2401955	332913	792685	2.3811	0.602
1974	523916	2236387	164491	1102433	6.7021	0.5633
1975	621616	2037430	142028	829377	5.8395	0.6595
1976	613942	1931396	171238	867463	5.0658	0.6457
1977	348054	1950748	341385	905301	2.6518	0.8379
1978	638490	1576565	241536	698715	2.8928	0.9406
1979	198490	1114381	174699	440538	2.5217	0.7264
1980	137735	863862	108253	380434	3.5143	0.7241
1981	150868	983658	166926	399038	2.3905	0.8632
1982	151830	750871	326133	363730	1.1153	0.7583
1983	166831	738675	327181	289992	0.8863	0.756
1984	397831	817596	251087	277651	1.1058	0.9161
1985	523674	957513	193856	307920	1.5884	0.7038
1986	1038825	1294449	170729	430113	2.5193	0.8649
1987	286344	1126275	121243	523071	4.3142	0.951
1988	204644	915459	202589	434939	2.1469	0.9743
1989	172782	890360	234716	332481	1.4165	0.6602
1990	242749	962674	316418	212000	0.67	0.271
1991	411784	1561715	704745	319158	0.4529	0.321
1992	721110	1912204	887561	513234	0.5783	0.455
1993	894891	2359699	775177	581611	0.7503	0.5528
1994	810451	2155329	614868	771086	1.2541	0.8678
1995	656938	1825947	528795	739999	1.3994	0.788
1996	437487	1686790	571581	732228	1.2811	0.6987
1997	715761	1532046	588550	762403	1.2954	1.034
1998	845028	1229923	385854	592624	1.5359	0.9173
1999	548930	1101059	292770	484910	1.6563	0.9897
2000	608558	1101693	240387	414868	1.7258	0.854
2001	525622	1378363	355291	426471	1.2003	0.7188
2002	454021	1550500	497911	535045	1.0746	0.6751
2003	712993	1631827	549453	551990	1.0046	0.5345
2004	305204	1604645	660319	606445	0.9184	0.6778
2005	597565	1616338	619234	641276	1.0356	0.7006
2006	510258	1582465	621033	537642	0.8657	0.5805
2007	880265	1841561	692491	486883	0.7031	0.3519
2008	796022	2262913	763193	464171	0.6082	0.2989
Arith. Mean	610174	2000775	404530	653269	2.2779	0.6354
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

1

Table 3.26. Northeast Arctic cod. Summary table, run without cannibalism.

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

At 25/04/2009 12:27

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECR Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-10
1946	728139	4168882	1112776	706000	0.6344	0.1857
1947	425311	3692801	1165059	882017	0.7571	0.3047
1948	442592	3665819	1019114	774295	0.7598	0.3398
1949	468348	3065111	729879	800122	1.0962	0.3619
1950	704908	2830103	615339	731982	1.1896	0.3566
1951	1083753	3141009	568705	827180	1.4545	0.3966
1952	1193111	3407679	520599	876795	1.6842	0.5348
1953	1590377	3557376	396417	695546	1.7546	0.3572
1954	641584	4039204	429694	826021	1.9223	0.3879
1955	272778	3488383	346919	1147841	3.3087	0.5437
1956	439602	3189831	299823	1343068	4.4795	0.6401
1957	804781	2495895	207840	792557	3.8133	0.5089
1958	496824	2164149	195377	769313	3.9376	0.5169
1959	683690	2415826	432489	744607	1.7217	0.5596
1960	789653	2050805	383479	622042	1.6221	0.4789
1961	916842	2137149	404228	783221	1.9376	0.6348
1962	728338	1957006	311678	909266	2.9173	0.7576
1963	472064	1747579	208207	776337	3.7287	0.9866
1964	338678	1374529	186570	437695	2.346	0.6789
1965	776941	1440693	102315	444930	4.3486	0.5533
1966	1582560	2198418	120722	483711	4.0068	0.5302
1967	1295416	2852164	129784	572605	4.412	0.5439
1968	164955	3387455	227215	1074084	4.7272	0.5704
1969	112039	2805591	151870	1197226	7.8832	0.8292
1970	197105	2057698	224482	933246	4.1573	0.7493
1971	404774	1610969	311662	689048	2.2109	0.5956
1972	1015319	1621485	346511	565254	1.6313	0.6928
1973	1818949	2401955	332913	792685	2.3811	0.602
1974	523916	2236387	164491	1102433	6.7021	0.5633
1975	621616	2037430	142028	829377	5.8395	0.6595
1976	613942	1931396	171238	867463	5.0658	0.6457
1977	348054	1950748	341385	905301	2.6518	0.8379
1978	638490	1576565	241536	698715	2.8928	0.9406
1979	198490	1114381	174699	440538	2.5217	0.7264
1980	137735	863862	108253	380434	3.5143	0.7241
1981	150868	983658	166926	399038	2.3905	0.8632
1982	151830	750871	326133	363730	1.1153	0.7583
1983	166831	738675	327181	289992	0.8863	0.756
1984	397595	817497	251087	277651	1.1058	0.9161
1985	523470	957429	193856	307920	1.5884	0.7038
1986	930301	1260698	170729	430113	2.5193	0.8649
1987	270553	1122943	121243	523071	4.3142	0.951
1988	202920	915093	202589	434939	2.1469	0.9743
1989	172782	890360	234716	332481	1.4165	0.6602
1990	242749	962674	316418	212000	0.67	0.271
1991	408181	1559848	704743	319158	0.4529	0.321
1992	700385	1901894	887535	513234	0.5783	0.455
1993	759308	2295805	774581	581611	0.7509	0.553
1994	516626	2023115	612345	771086	1.2592	0.8687
1995	306825	1689789	528016	739999	1.4015	0.7885
1996	257597	1597378	570536	732228	1.2834	0.7011
1997	491798	1473659	588460	762403	1.2956	1.035
1998	600834	1159488	385549	592624	1.5371	0.9184
1999	470368	1079081	292725	484910	1.6565	0.9897
2000	552196	1075827	239875	414868	1.7295	0.8548
2001	491608	1357331	354309	426471	1.2037	0.7194
2002	405860	1533745	497762	535045	1.0749	0.6753
2003	668305	1620337	549665	551990	1.0042	0.5347
2004	278563	1587074	660392	606445	0.9183	0.6775
2005	503520	1585941	618683	641276	1.0365	0.6999
2006	494726	1579830	622345	537642	0.8639	0.5785
2007	768229	1810763	695143	486883	0.7004	0.3507
2008	728015	2235054	766502	464171	0.6056	0.2993
Arith. Mean	575945	1987971	404529	653269	2.2781	0.6355
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

1

Table 3.27. Northeast Arctic cod. Input for the short-term prediction

MFDP version 1a
Run: out3
Time and date: 19:56 24.04.2009
Fbar age range: 5-10

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	564000	0.3107	0	0	0	0.286	0.016	0.655
4	524229	0.227	0	0	0	0.682	0.0883	1.076
5	433170	0.2064	0.075	0	0	1.363	0.1676	1.741
6	194947	0.2	0.37	0	0	2.255	0.2465	2.575
7	116170	0.2	0.755	0	0	3.484	0.3066	3.704
8	40229	0.2	0.855	0	0	4.604	0.375	4.9
9	35881	0.2	0.975	0	0	6.677	0.3802	6.602
10	9539	0.2	0.995	0	0	8.999	0.3174	7.978
11	5077	0.2	1	0	0	11.91	0.3371	9.519
12	2014	0.2	1	0	0	10.805	0.4354	11.012
13	627	0.2	1	0	0	11.343	0.4354	11.877

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	487000	0.3107	0	0	0	0.261	0.016	0.655
4	.	0.227	0.003	0	0	0.683	0.0883	1.076
5	.	0.2064	0.071	0	0	1.314	0.1676	1.741
6	.	0.2	0.336	0	0	2.322	0.2465	2.575
7	.	0.2	0.676	0	0	3.6	0.3066	3.704
8	.	0.2	0.864	0	0	5.43	0.375	4.9
9	.	0.2	0.96	0	0	7.014	0.3802	6.602
10	.	0.2	0.996	0	0	9.097	0.3174	7.978
11	.	0.2	1	0	0	10.588	0.3371	9.519
12	.	0.2	1	0	0	11.411	0.4354	11.012
13	.	0.2	1	0	0	16.883	0.4354	11.877

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	184000	0.3107	0	0	0	0.267	0.016	0.655
4	.	0.227	0.003	0	0	0.685	0.0883	1.076
5	.	0.2064	0.071	0	0	1.356	0.1676	1.741
6	.	0.2	0.336	0	0	2.293	0.2465	2.575
7	.	0.2	0.676	0	0	3.562	0.3066	3.704
8	.	0.2	0.864	0	0	5.267	0.375	4.9
9	.	0.2	0.96	0	0	7.333	0.3802	6.602
10	.	0.2	0.996	0	0	9.557	0.3174	7.978
11	.	0.2	1	0	0	10.588	0.3371	9.519
12	.	0.2	1	0	0	12.567	0.4354	11.012
13	.	0.2	1	0	0	13.39	0.4354	11.877

Input units are thousands and kg - output in tonnes

Table 3.28. Northeast Arctic cod. Management option table

MFDP version 1a
Run: out3
preMFDP Index file 25.04.2005
Time and date: 19:56 24.04.2009
Fbar age range: 5-10

2009				
Biomass	SSB	FMult	FBar	Landings
2553554	1079210	1	0.2989	522084

2010					2011	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
2887820	1353074	0	0	0	3731538	2184260
.	1353074	0.1	0.0299	68053	3646528	2120813
.	1353074	0.2	0.0598	134291	3563892	2059321
.	1353074	0.3	0.0897	198767	3483558	1999719
.	1353074	0.4	0.1196	261533	3405457	1941948
.	1353074	0.5	0.1494	322641	3329520	1885949
.	1353074	0.6	0.1793	382138	3255682	1831664
.	1353074	0.7	0.2092	440074	3183879	1779039
.	1353074	0.8	0.2391	496493	3114051	1728021
.	1353074	0.9	0.269	551440	3046137	1678559
.	1353074	1	0.2989	604959	2980081	1630602
.	1353074	1.1	0.3288	657091	2915826	1584104
.	1353074	1.2	0.3587	707877	2853319	1539017
.	1353074	1.3	0.3885	757355	2792508	1495297
.	1353074	1.4	0.4184	805564	2733341	1452900
.	1353074	1.5	0.4483	852541	2675770	1411784
.	1353074	1.6	0.4782	898322	2619748	1371910
.	1353074	1.7	0.5081	942940	2565228	1333236
.	1353074	1.8	0.538	986430	2512166	1295727
.	1353074	1.9	0.5679	1028823	2460519	1259344
.	1353074	2	0.5978	1070152	2410246	1224053

Input units are thousands and kg - output in tonnes

Table 3.29a. Northeast Arctic cod. Detailed prediction output assumed F_{pa} in 2010-2012.

MFDP version 1a
Run: out4
Time and date: 20:02 24.04.2009
Fbar age range: 5-10

Year:	2009	F multiplier	1	Fbar:	0.2989				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.016	7698	5042	564000	161304	0	0	0	0
4	0.0883	39702	42719	524229	357524	0	0	0	0
5	0.1676	60569	105450	433170	590411	32488	44281	32488	44281
6	0.2465	38760	99806	194947	439605	72130	162654	72130	162654
7	0.3066	27944	103506	116170	404736	87708	305576	87708	305576
8	0.375	11473	56218	40229	185214	34396	158358	34396	158358
9	0.3802	10351	68334	35881	239577	34984	233588	34984	233588
10	0.3174	2364	18858	9539	85841	9491	85412	9491	85412
11	0.3371	1324	12605	5077	60467	5077	60467	5077	60467
12	0.4354	649	7147	2014	21761	2014	21761	2014	21761
13	0.4354	202	2400	627	7112	627	7112	627	7112
Total		201035	522084	1925883	2553554	278916	1079210	278916	1079210

Year:	2010	F multiplier	1.3382	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0214	8873	5812	487000	127107	0	0	0	0
4	0.1182	40652	43741	406813	277853	1220	834	1220	834
5	0.2243	69697	121342	382462	502555	27155	35681	27155	35681
6	0.3299	76310	196498	298011	691981	100132	232506	100132	232506
7	0.4103	38308	141894	124740	449062	84324	303566	84324	303566
8	0.5018	25241	123682	69997	380085	60478	328393	60478	328393
9	0.5088	8251	54472	22637	158776	21732	152425	21732	152425
10	0.4247	6344	50616	20086	182720	20005	181989	20005	181989
11	0.4511	1885	17944	5686	60202	5686	60202	5686	60202
12	0.5827	1199	13204	2967	33859	2967	33859	2967	33859
13	0.5827	565	6714	1399	23619	1399	23619	1399	23619
Total		277325	775919	1821797	2887820	325097	1353074	325097	1353074

Year:	2011	F multiplier	1.3382	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0214	3352	2196	184000	49128	0	0	0	0
4	0.1182	34912	37566	349377	239324	1048	718	1048	718
5	0.2243	52495	91394	288066	390618	20453	27734	20453	27734
6	0.3299	63664	163934	248625	570097	83538	191553	83538	191553
7	0.4103	53877	199560	175434	624897	118594	422430	118594	422430
8	0.5018	24434	119725	67758	356879	58543	308343	58543	308343
9	0.5088	12646	83490	34696	254427	33308	244250	33308	244250
10	0.4247	3520	28080	11143	106493	11098	106067	11098	106067
11	0.4511	3565	33939	10754	113862	10754	113862	10754	113862
12	0.5827	1198	13194	2965	37261	2965	37261	2965	37261
13	0.5827	807	9581	1996	26729	1996	26729	1996	26729
Total		254470	782658	1374815	2769715	342297	1478947	342297	1478947

Year:	2012	F multiplier	1.3382	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0214	10931	7160	600000	160200	0	0	0	0
4	0.1182	13191	14193	132003	90422	396	271	396	271
5	0.2243	45083	78490	247396	335469	17565	23818	17565	23818
6	0.3299	47951	123474	187262	429392	62920	144276	62920	144276
7	0.4103	44949	166490	146362	521340	98940	352426	98940	352426
8	0.5018	34364	168381	95294	501916	82334	433655	82334	433655
9	0.5088	12241	80818	33586	246286	32243	236435	32243	236435
10	0.4247	5395	43039	17079	163223	17011	162571	17011	162571
11	0.4511	1978	18828	5966	63167	5966	63167	5966	63167
12	0.5827	2266	24954	5608	70473	5608	70473	5608	70473
13	0.5827	917	10886	2268	30372	2268	30372	2268	30372
Total		219265	736714	1472824	2612260	325251	1517463	325251	1517463

Table 3.29b. Northeast Arctic cod. Detailed prediction output assumed HCR in 2010 and F_{pa} in 2011-2012.

MFDP version 1a
Run: out7
Time and date: 20:19 24.04.2009
Fbar age range: 5-10

Year:	2009	F multiplier	1	Fbar:	0.2989				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.016	7698	5042	564000	161304	0	0	0	0
4	0.0883	39702	42719	524229	357524	0	0	0	0
5	0.1676	60569	105450	433170	590411	32488	44281	32488	44281
6	0.2465	38760	99806	194947	439605	72130	162654	72130	162654
7	0.3066	27944	103506	116170	404736	87708	305576	87708	305576
8	0.375	11473	56218	40229	185214	34396	158358	34396	158358
9	0.3802	10351	68334	35881	239577	34984	233588	34984	233588
10	0.3174	2364	18858	9539	85841	9491	85412	9491	85412
11	0.3371	1324	12605	5077	60467	5077	60467	5077	60467
12	0.4354	649	7147	2014	21761	2014	21761	2014	21761
13	0.4354	202	2400	627	7112	627	7112	627	7112
Total		201035	522084	1925883	2553554	278916	1079210	278916	1079210

Year:	2010	F multiplier	0.9485	Fbar:	0.2835				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0152	6307	4131	487000	127107	0	0	0	0
4	0.0838	29286	31512	406813	277853	1220	834	1220	834
5	0.159	50930	88669	382462	502555	27155	35681	27155	35681
6	0.2338	56531	145567	298011	691981	100132	232506	100132	232506
7	0.2908	28667	106183	124740	449062	84324	303566	84324	303566
8	0.3557	19101	93595	69997	380085	60478	328393	60478	328393
9	0.3606	6249	41255	22637	158776	21732	152425	21732	152425
10	0.3011	4756	37945	20086	182720	20005	181989	20005	181989
11	0.3197	1418	13496	5686	60202	5686	60202	5686	60202
12	0.413	916	10088	2967	33859	2967	33859	2967	33859
13	0.413	432	5130	1399	23619	1399	23619	1399	23619
Total		204594	577573	1821797	2887820	325097	1353074	325097	1353074

Year:	2011	F multiplier	1.3382	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0214	3352	2196	184000	49128	0	0	0	0
4	0.1182	35131	37801	351563	240820	1055	722	1055	722
5	0.2243	54333	94593	298151	404293	21169	28705	21169	28705
6	0.3299	67961	174999	265406	608576	89176	204481	89176	204481
7	0.4103	59309	219681	193123	687903	130551	465022	130551	465022
8	0.5018	27535	134919	76357	402171	65972	347476	65972	347476
9	0.5088	14636	96627	40156	294463	38550	282684	38550	282684
10	0.4247	4082	32565	12922	123500	12871	123006	12871	123006
11	0.4511	4035	38407	12170	128853	12170	128853	12170	128853
12	0.5827	1366	15046	3381	42492	3381	42492	3381	42492
13	0.5827	956	11352	2365	31672	2365	31672	2365	31672
Total		272695	858187	1439594	3013872	377260	1655115	377260	1655115

Year:	2012	F multiplier	1.3382	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
3	0.0214	10931	7160	600000	160200	0	0	0	0
4	0.1182	13191	14193	132003	90422	396	271	396	271
5	0.2243	45365	78981	248943	337567	17675	23967	17675	23967
6	0.3299	49630	127796	193818	444425	65123	149327	65123	149327
7	0.4103	47982	177727	156240	556527	105618	376212	105618	376212
8	0.5018	37828	185358	104903	552522	90636	477379	90636	477379
9	0.5088	13795	91075	37849	277543	36335	266442	36335	266442
10	0.4247	6244	49811	19766	188907	19687	188152	19687	188152
11	0.4511	2294	21835	6919	73255	6919	73255	6919	73255
12	0.5827	2564	28240	6346	79752	6346	79752	6346	79752
13	0.5827	1062	12610	2627	35179	2627	35179	2627	35179
Total		230886	794787	1509414	2796300	351362	1669937	351362	1669937

Table 3.30. 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 3.31. Northeast Arctic cod. Number (thousands) of cod by age groups taken as by-catch in the Norwegian shrimp fishery (1984-2006)

Age\Year	1984	1985	1986	1987	1988	1989	1990	1991
0	322	4537	28	1408	259	717	2971	11651
1	4913	19437	2339	3259	1719	668	13731	34450
2	1624	49334	6952	1961	1534	418	1518	2759
3	1073	2720	5245	499	1380	694	1019	87
4	2200	1891	716	2210	1882	2096	403	64
5	161	9306	737	1715	1124	2281	909	33
6	89	6374	520	411	269	1135	2913	293
7	144	266	92	79	186	184	1434	1138
8	38	1	93	28	178	13	185	316
9	1	2	165	6	1	0	3	29
10	0	3	88	1	0	0	9	0
11	0	0	0	0	0	0	0	0
Total('000)	10564	93872	16976	11576	8532	8206	25095	50819

Age\Year	1992	1993	1994	1995	1996	1997	1998	1999
0	6486	604	1042	1138	519	896	506	651
1	5236	6702	1628	1896	9084	17157	40314	7155
2	2922	4032	410	99	359	1805	5248	245
3	242	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
Total('000)	14886	11339	3080	3133	9962	19858	46068	8052

Age\Year	2000	2001	2002	2003	2004	2005	2006
0	66	1188	478	4253	713	945	1355
1	1572	7187	293	8805	1014	3411	2597
2	3152	1348	893	96	323	1628	218
3	218	0	190	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
Total('000)	5007	9723	1854	13154	2051	5984	4170

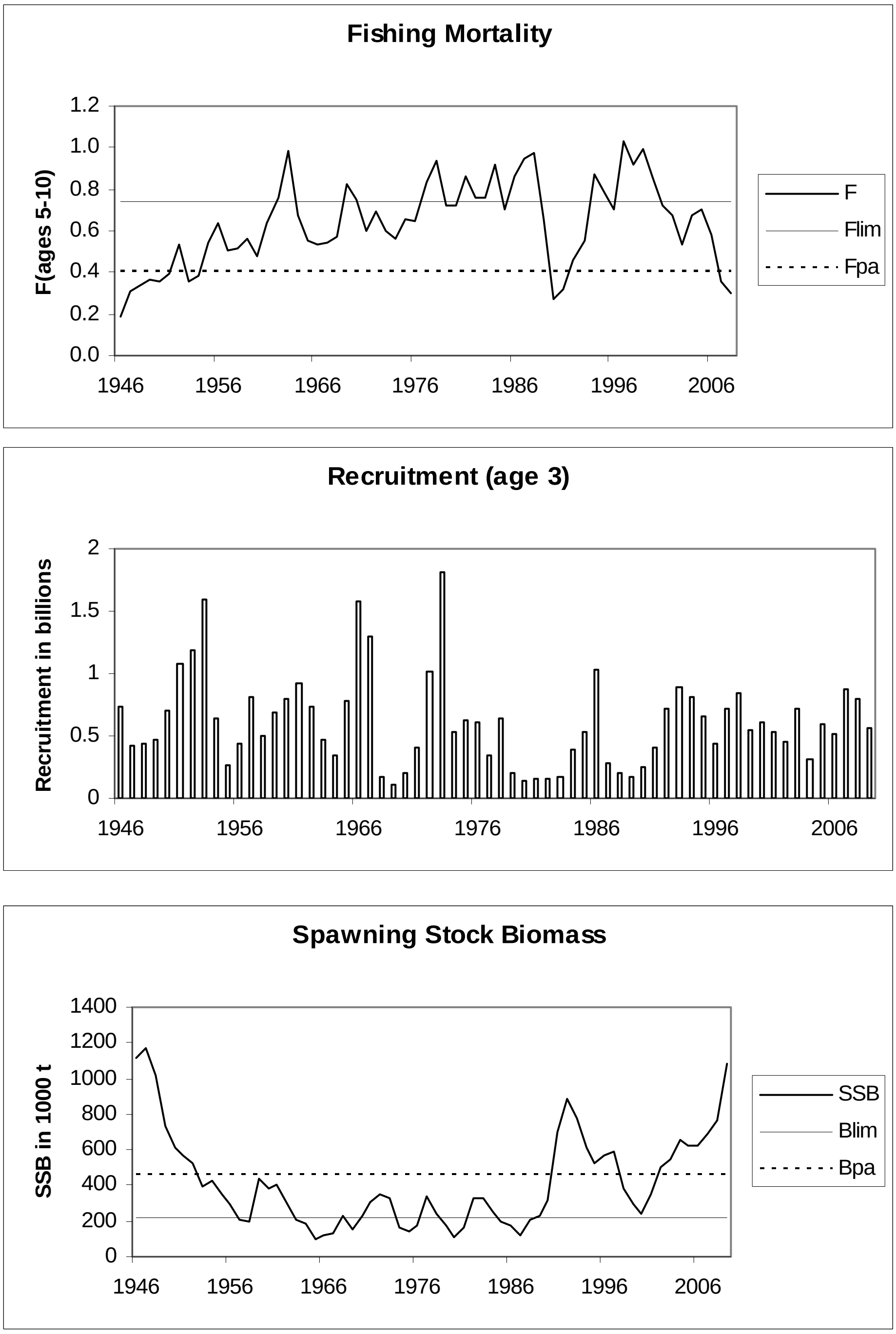
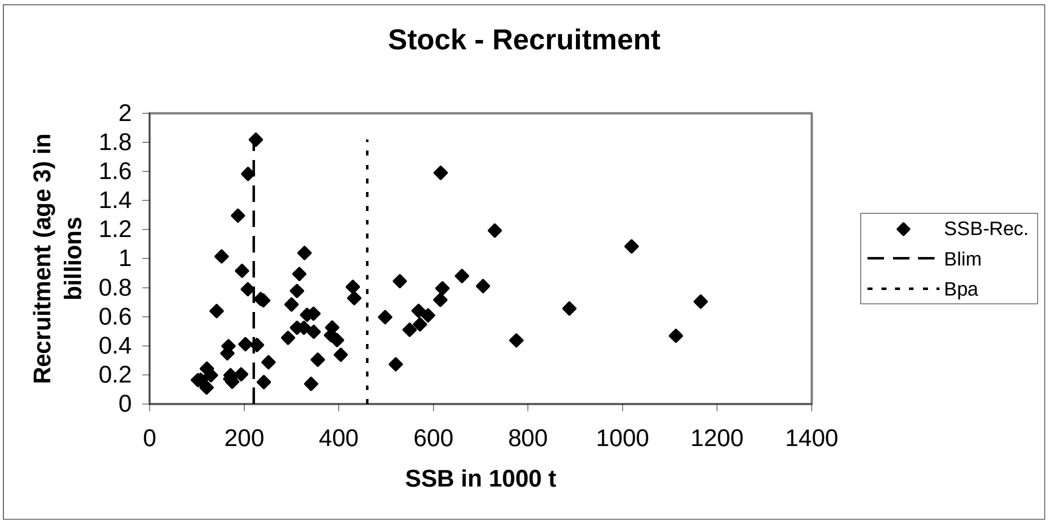
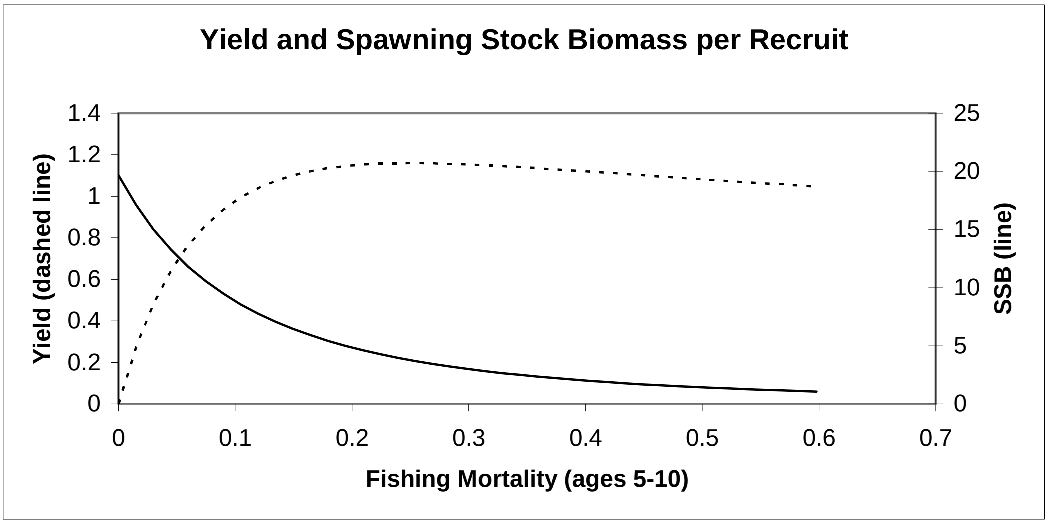


Figure 3.1. ICES Standard plots for Northeast Arctic cod (sub-area I and II)





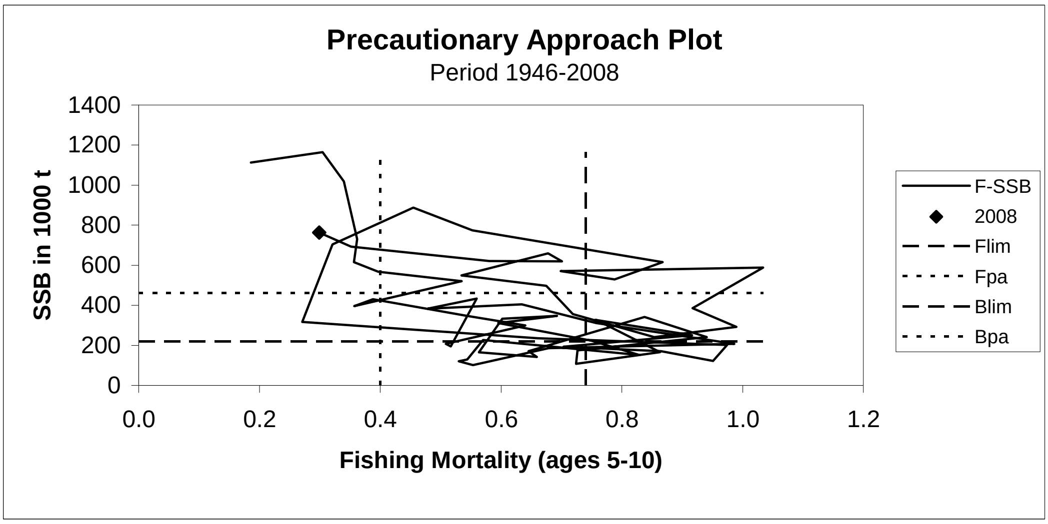


Figure 3.1. Continued. ICES Standard plots for Northeast Arctic cod (sub-area I and II)

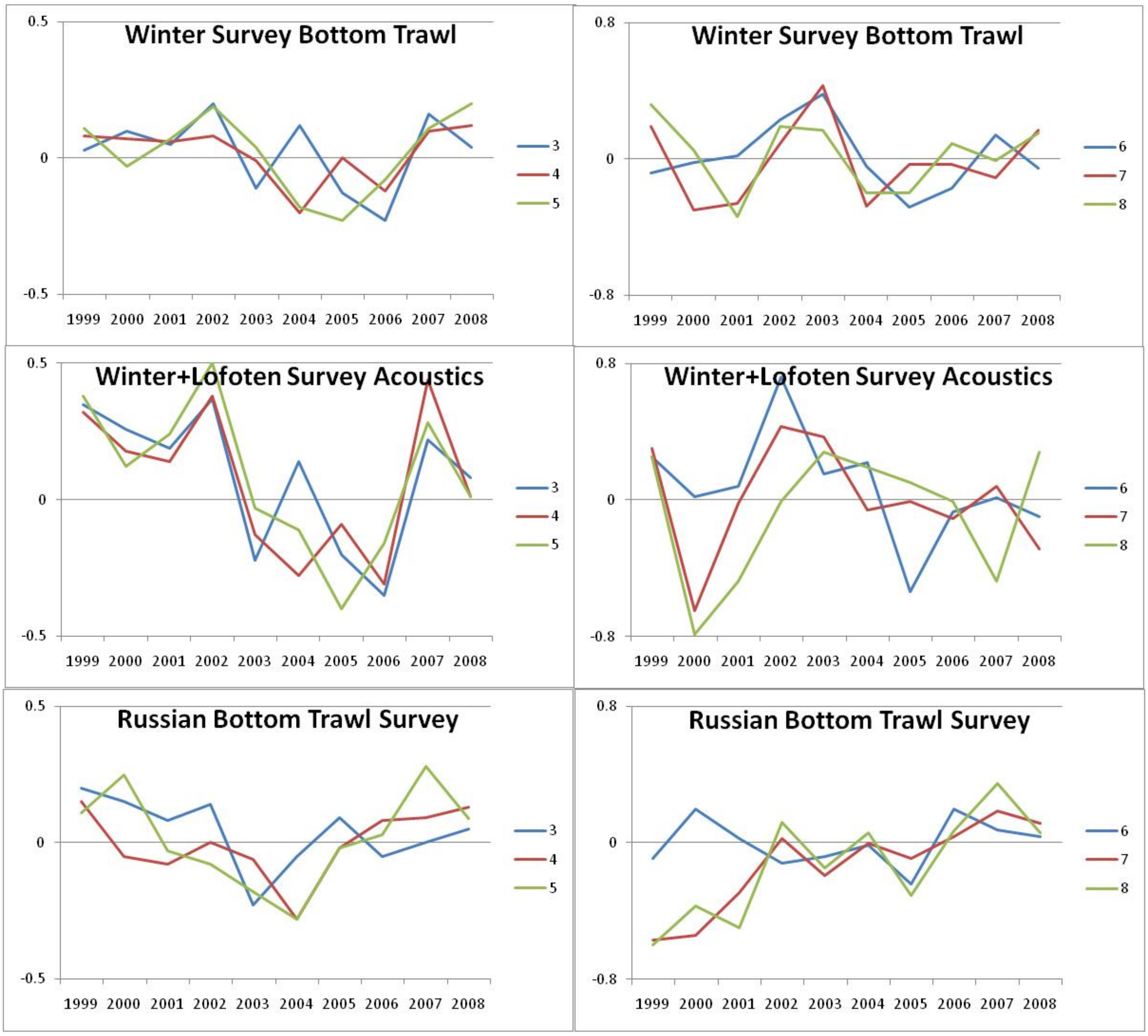


Figure 3.2. Northeast Arctic cod. Log catchability residual (y-axis) by fleets for the tuning data used in xsa. Ages 3-5 in left hand panel and 6-8 in right hand panel.

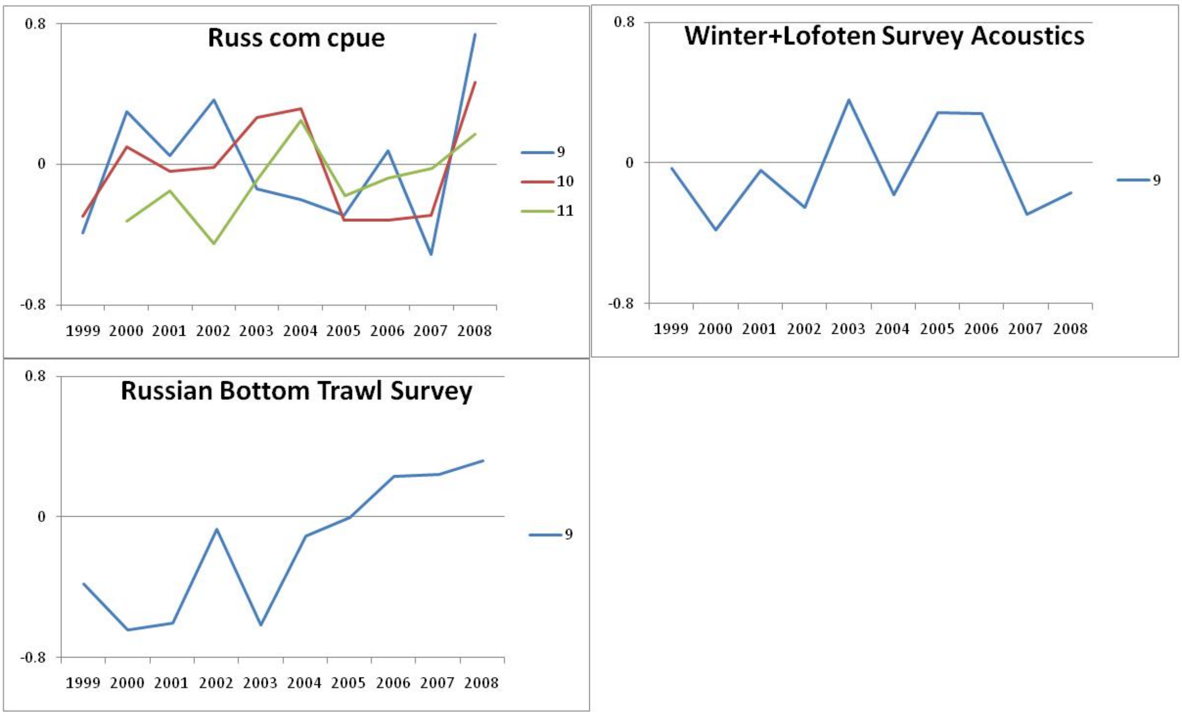


Figure 3.2 continued…. Northeast Arctic cod. Log catchability residual (y-axis) by fleets for the tuning data used in xsa. Ages 9-11.

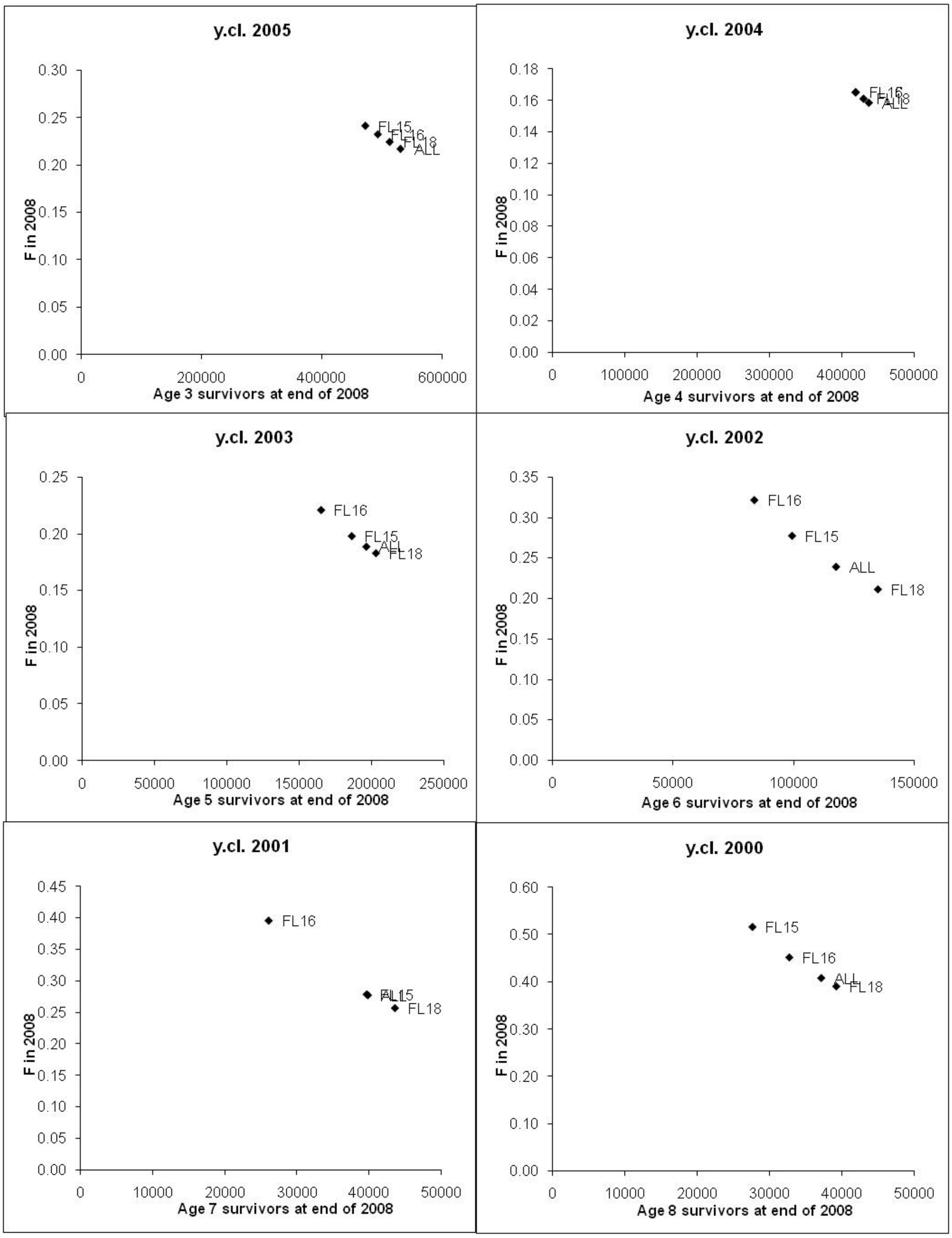


Figure 3.3. Northeast Arctic cod. Single fleet estimates (before shrinkage) of F2008 and survivors at the end of 2008 taken from xsa-diagnostics of single fleet runs. "ALL" is the estimates from the final xsa (with shrinkage, including all fleets). The Fs for ages 3-5 includes cannibalism mortality.

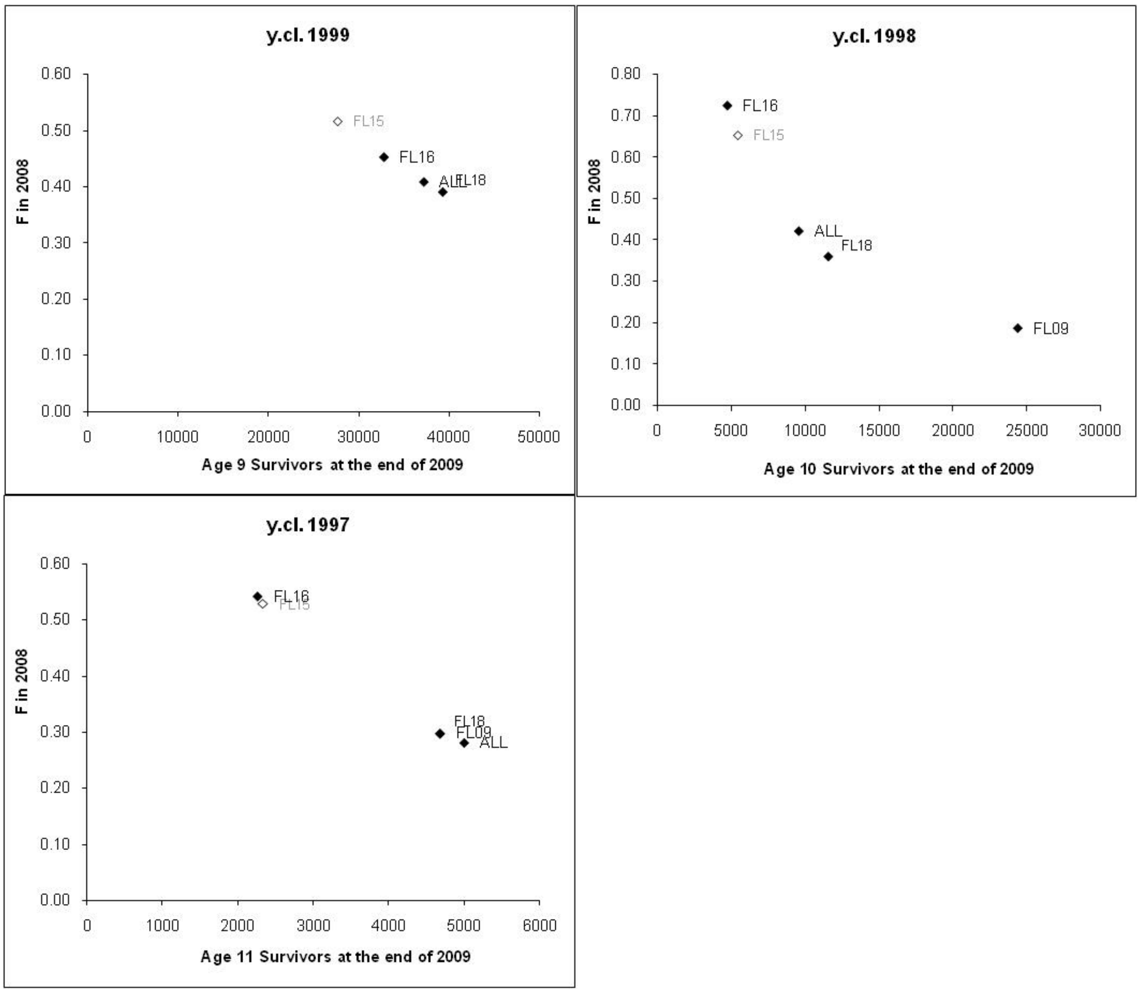


Figure 3.3. continued…. Northeast Arctic cod. Single fleet estimates (before shrinkage) of F2008 and survivors at the end of 2008 taken from xsa-diagnostics of single fleet runs. "ALL" is the estimate from the final xsa (with shrinkage, including all fleets).

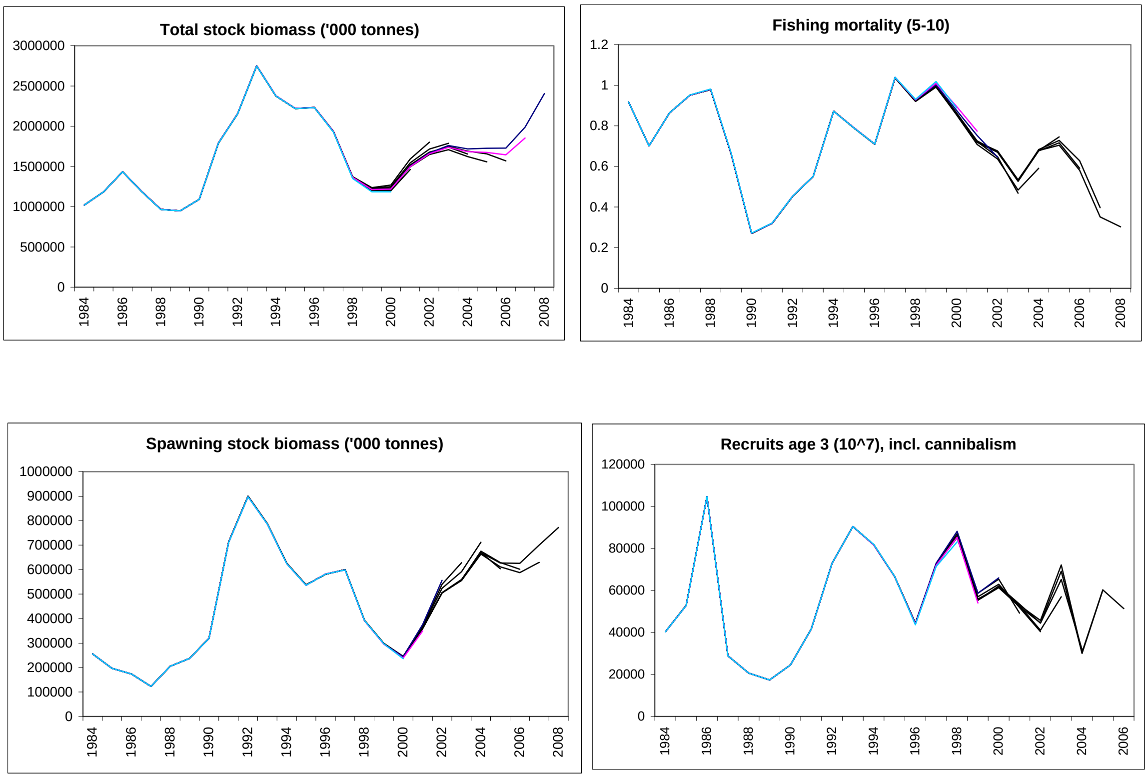


Figure 3.4. Northeast Arctic cod. Retrospective plots with catchability dependent on stock size for ages < 6.

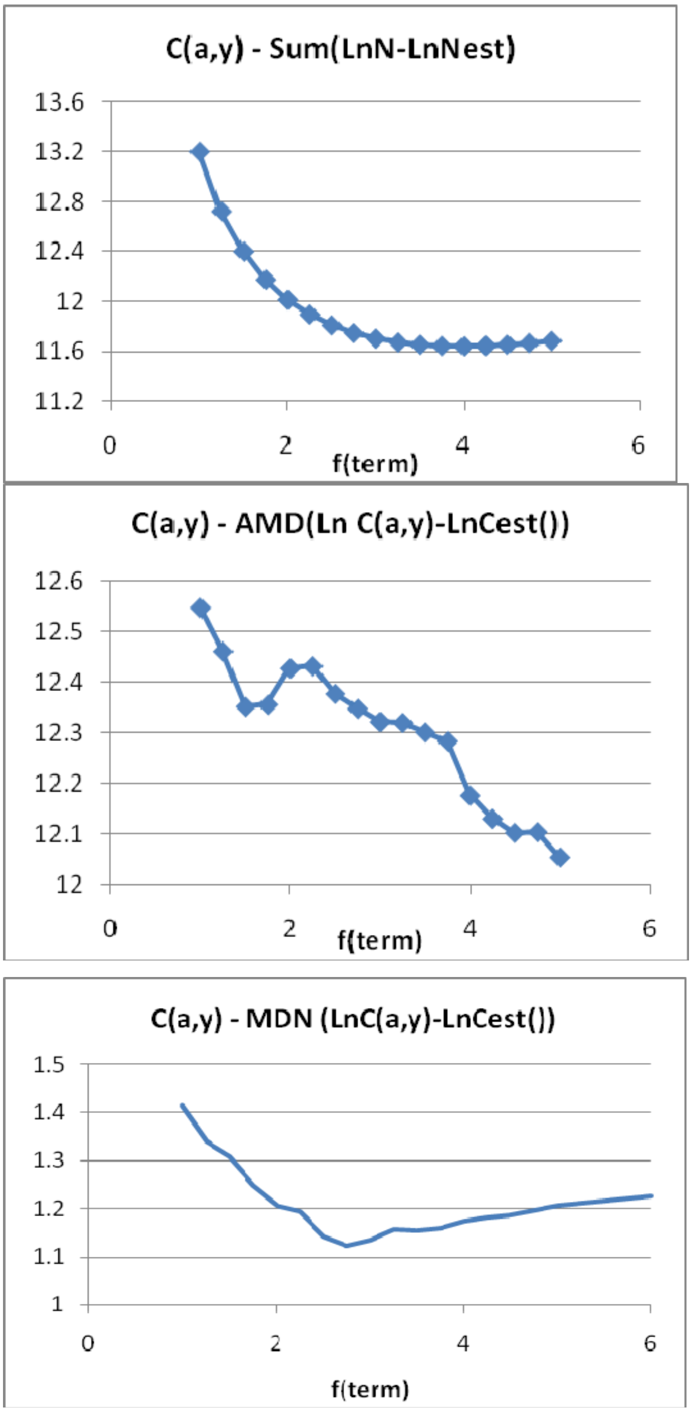
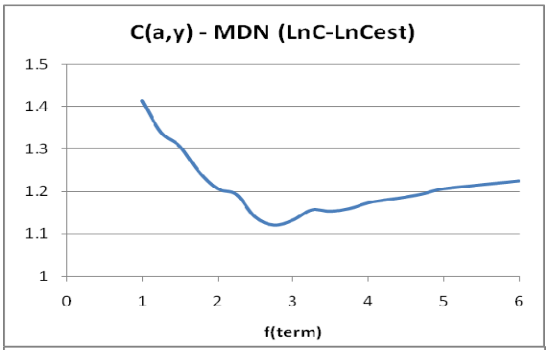
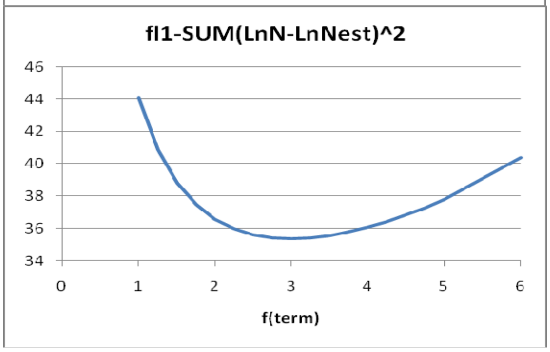
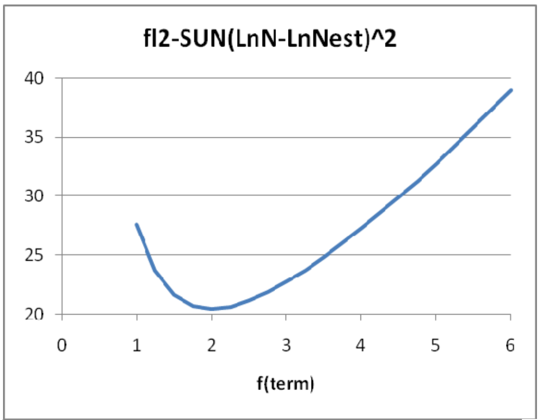
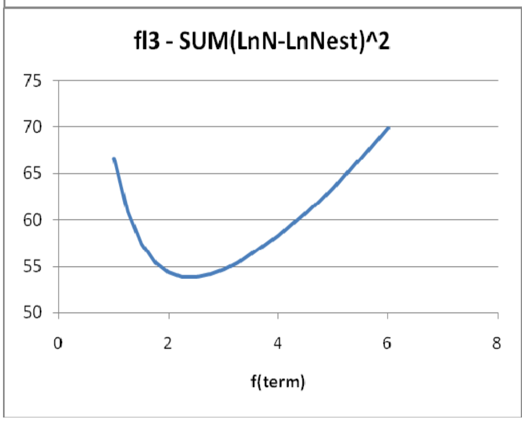


Figure 3.5. Northeast Arctic cod. The profiles of various versions loss function for C(a,y) (from file profils.xls, list C fl1-variants)


C(a,y) - MDN (LnC-LnCest)
1.5
1.4
1.3
1.2
1.1
1
0
1
2
3
4
5
6
f(term)


fl1-SUM(LnN-LnNest)^2
46
44
42
40
38
36
34
0
1
2
3
4
5
6
f(term)


fl2-SUN(LnN-LnNest)^2
40
35
30
25
20
0
1
2
3
4
5
6
f(term)


fl3 - SUM(LnN-LnNest)^2
75
70
65
60
55
50
0
2
4
6
8
f(term)

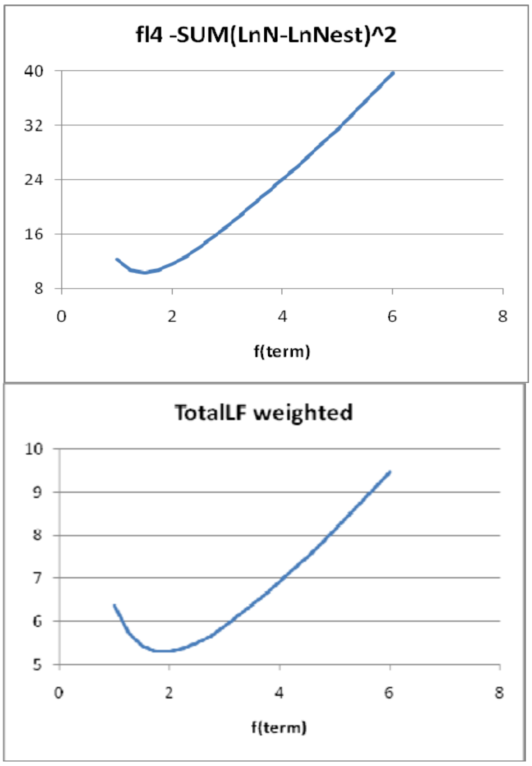
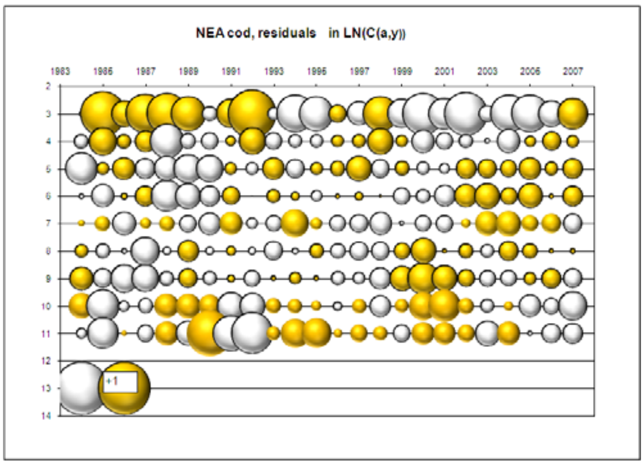
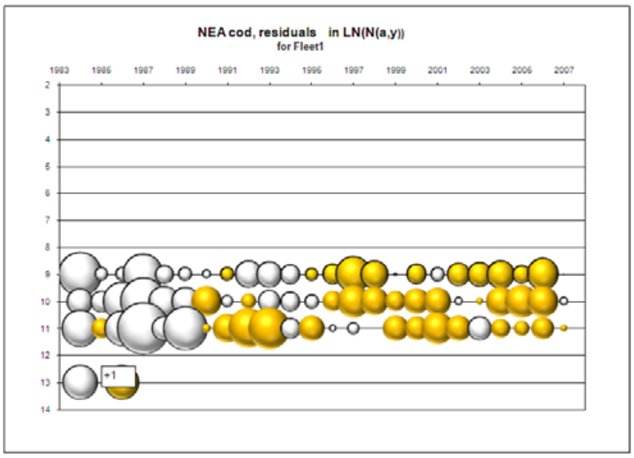
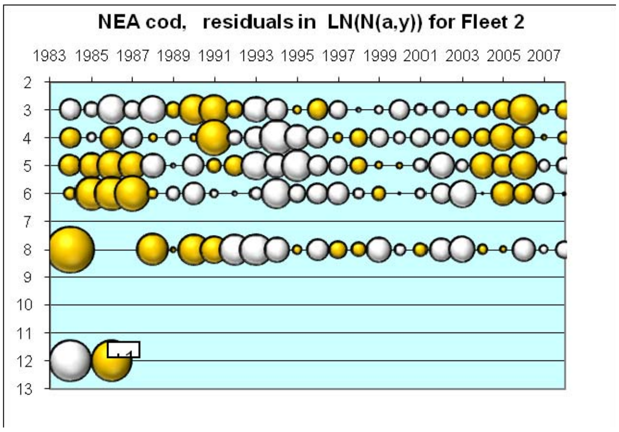
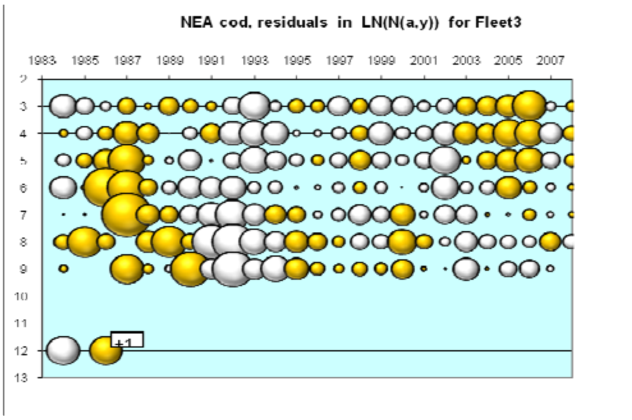


Figure 3.6. Northeast Arctic cod. Profiles of the components of the TISVPA loss function taken for final run (from file profils.xls, list minim)


NEA cod, residuals in LN(C(a,y))
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
+1


NEA cod, residuals in LN(N(a,y))
for Fleet1
+1


NEA cod, residuals in LN(N(a,y)) for Fleet 2
1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007


NEA cod, residuals in LN(N(a,y)) for Fleet3
1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007

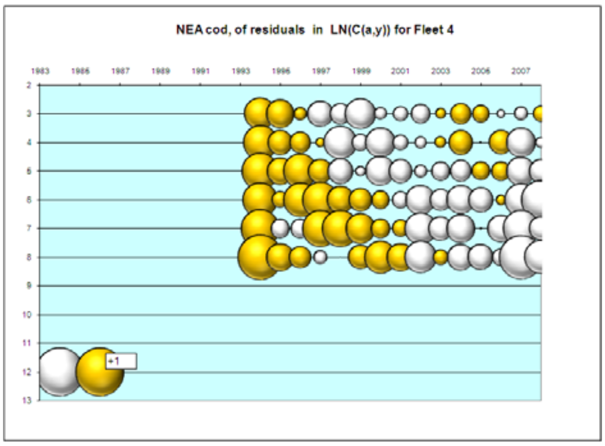


Figure 3.7. Northeast Arctic cod. TISVPA residuals in logarithmic catch-at- age and abundance-at age . (from diagnoatic.xls, 5 lists – 5 figures as 3.11)

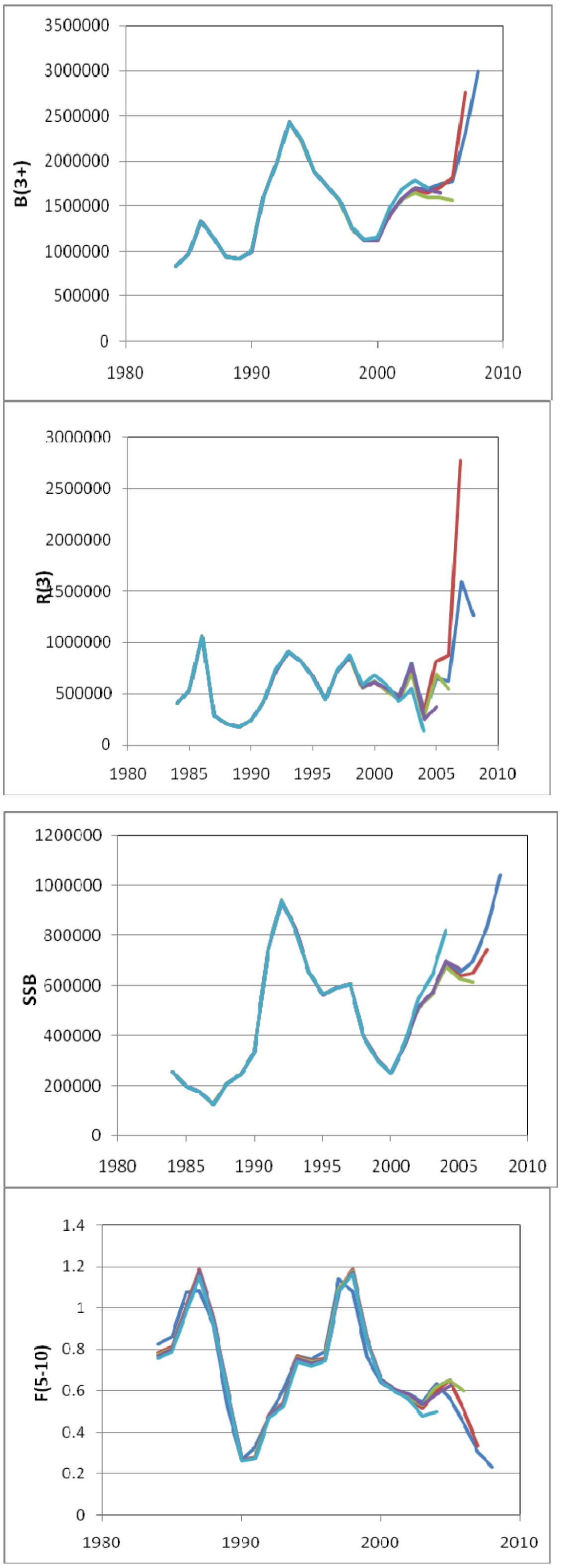


Figure 3.8. Northeast Arctic cod. TISVPA retrospective runs. (from retro-tisvpa.xls list "out") – 4 figures in this fig.

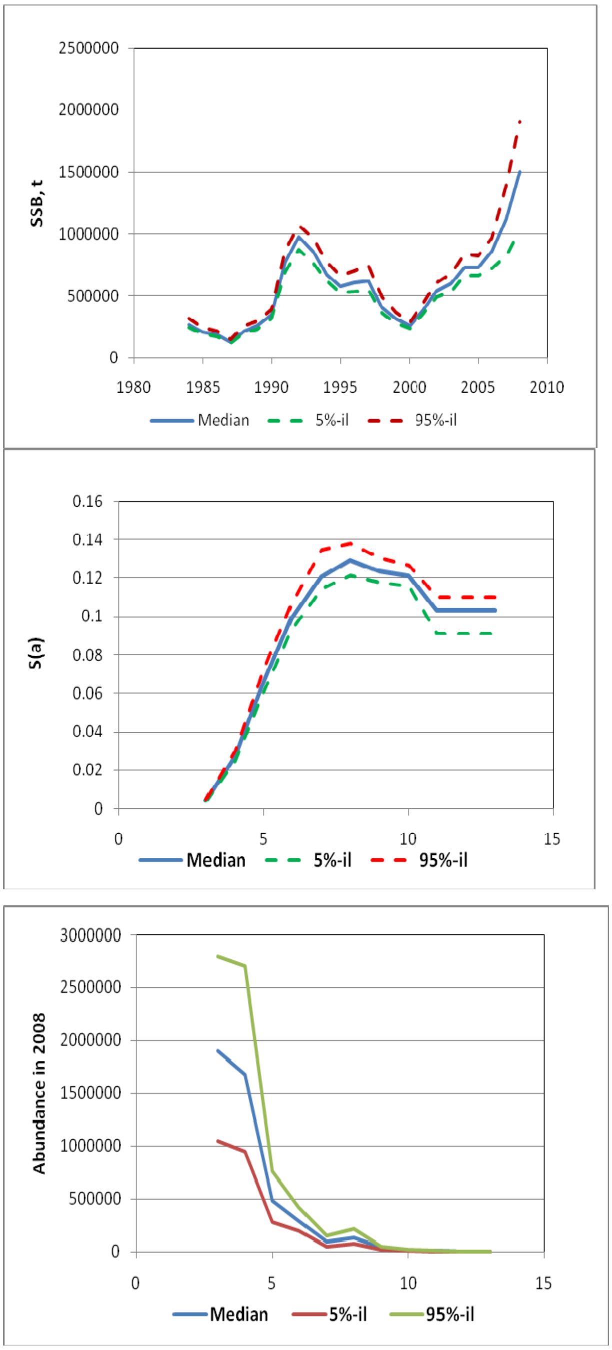


Figure 3.9. Northeast Arctic cod. Bootstrep-estimates of uncertainty in the TISVPA results. (from 3 lists of file boot-all.xls)

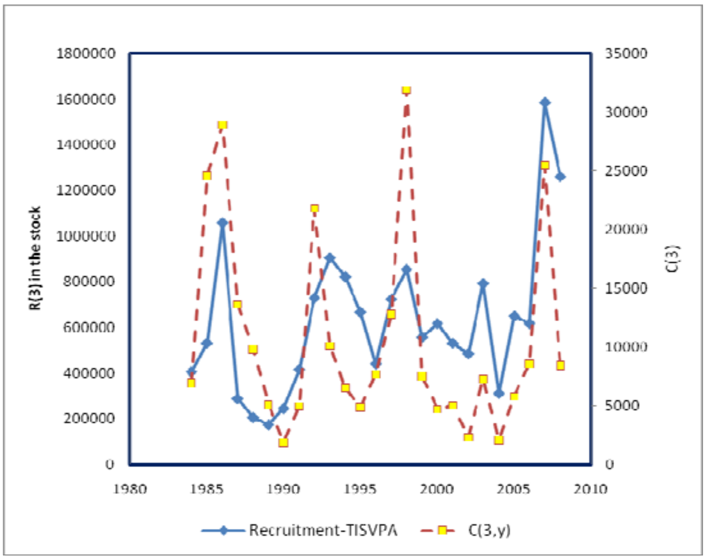
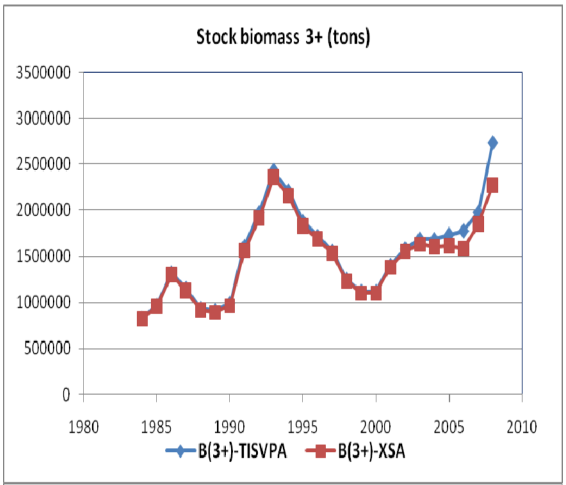
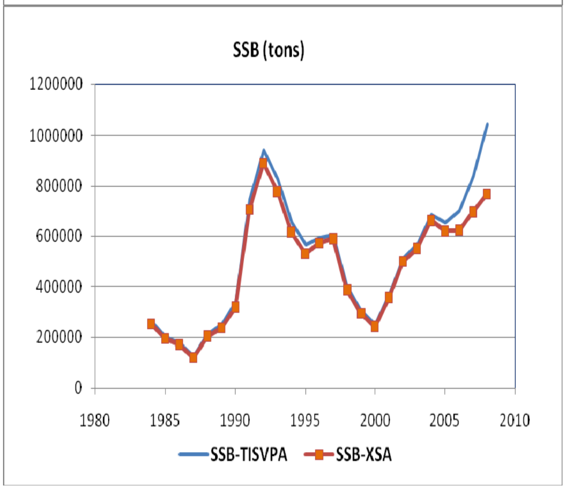


Figure 3.10. Northeast Arctic cod. Comparison of catches at age 3 to the TISVPA-derived estimates of abundance (from output-final.xls, list Figs)


Stock biomass 3+ (tons)
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1980
1985
1990
1995
2000
2005
2010
B(3+)-TISVPA
B(3+)-XSA


SSB (tons)
1200000
1000000
800000
600000
400000
200000
0
1980
1985
1990
1995
2000
2005
2010
SSB-TISVPA
SSB-XSA

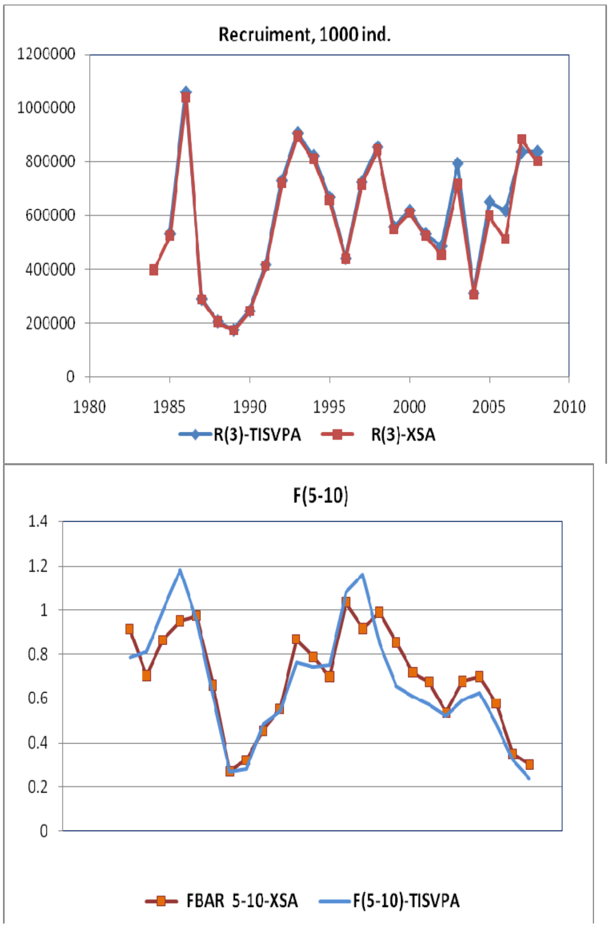


Figure 3.11. Northeast Arctic cod. Comparison of XSA and TISVPA runs. (from file output-final.xls)

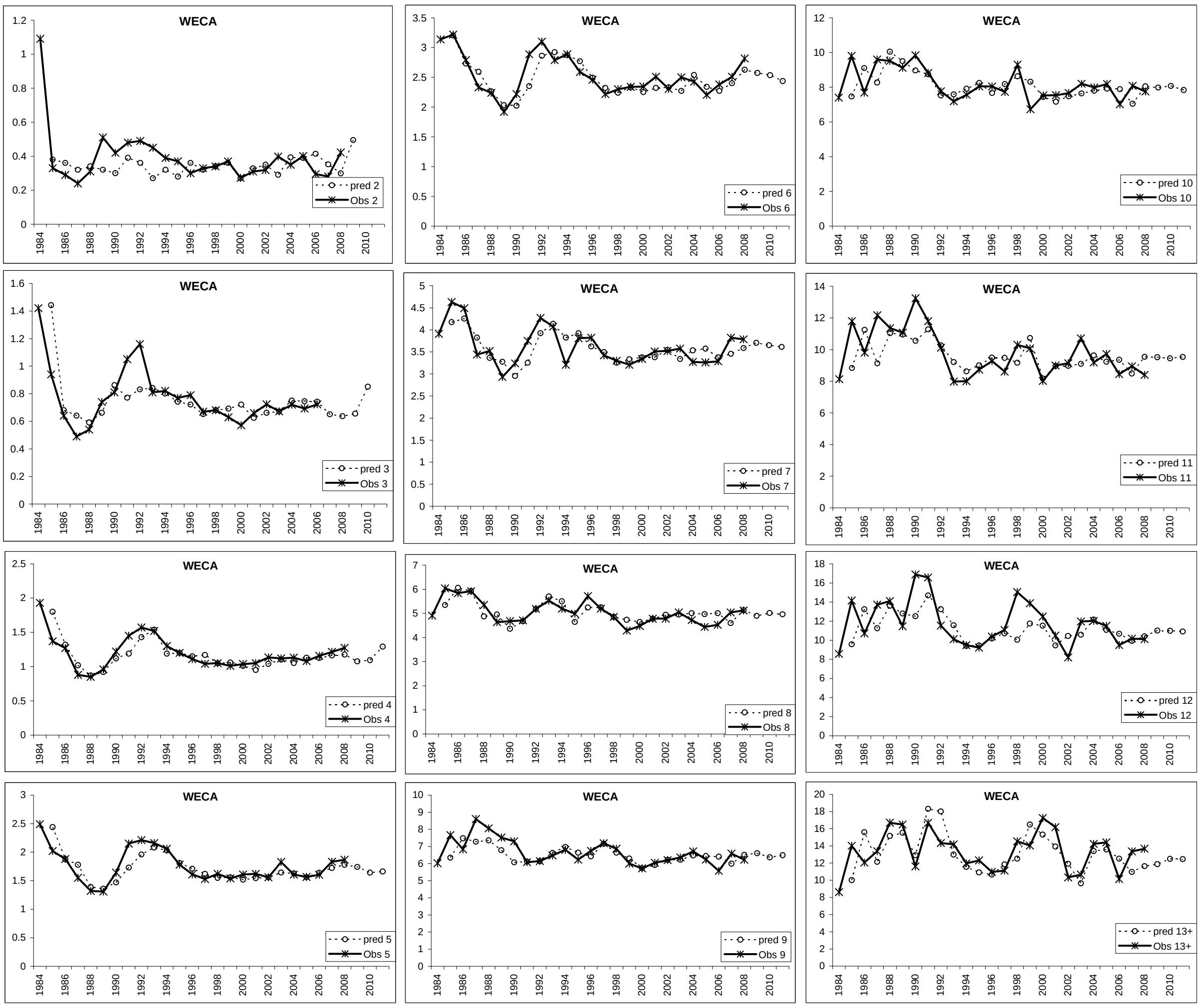


Figure 3.12a. Northeast Arctic cod. Weight in catch predictions.

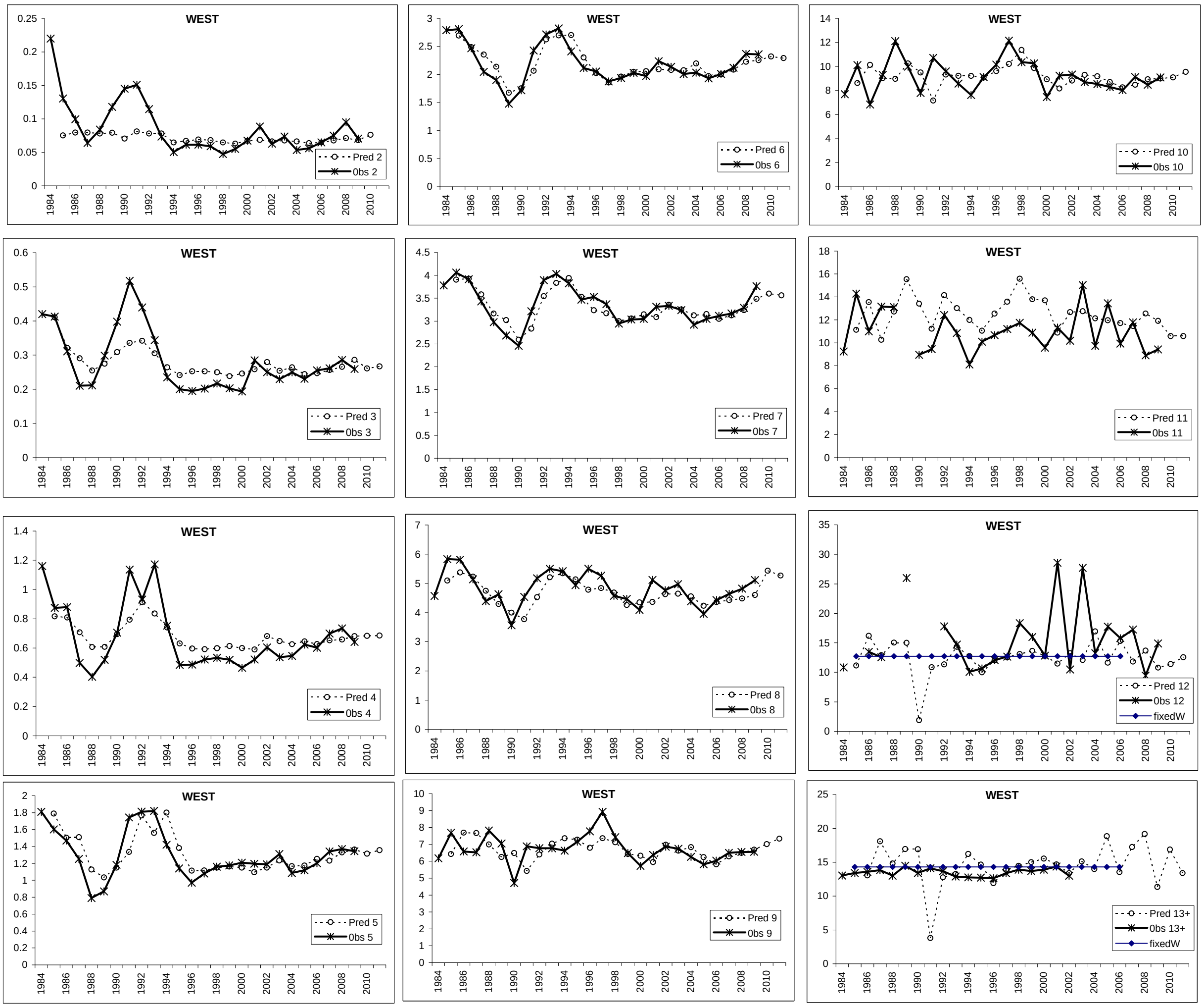


Figure 3.12b. Northeast Arctic cod. Weight in stock projections

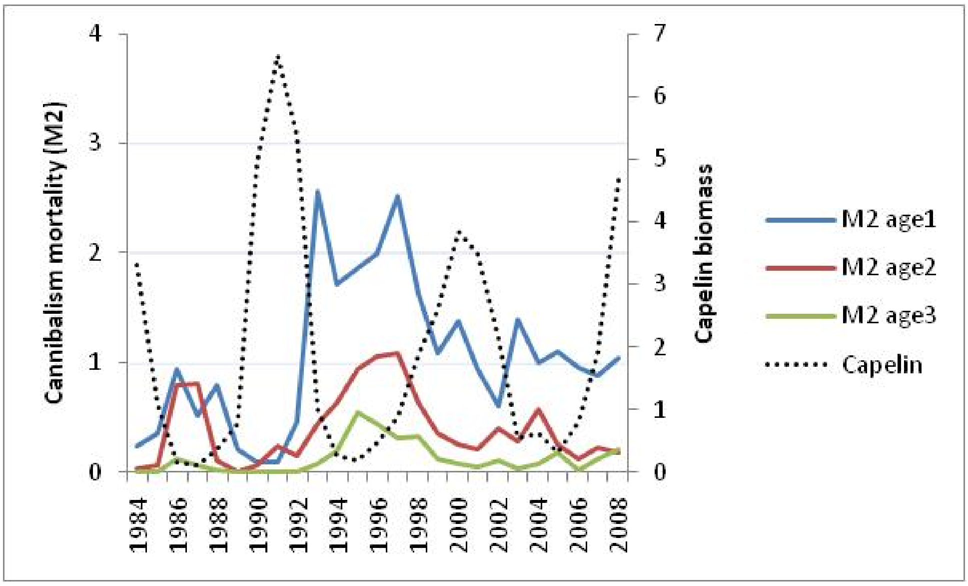


Figure 3.13. Capelin biomass and cannibalism mortality on cod age 1, 2 and 3.

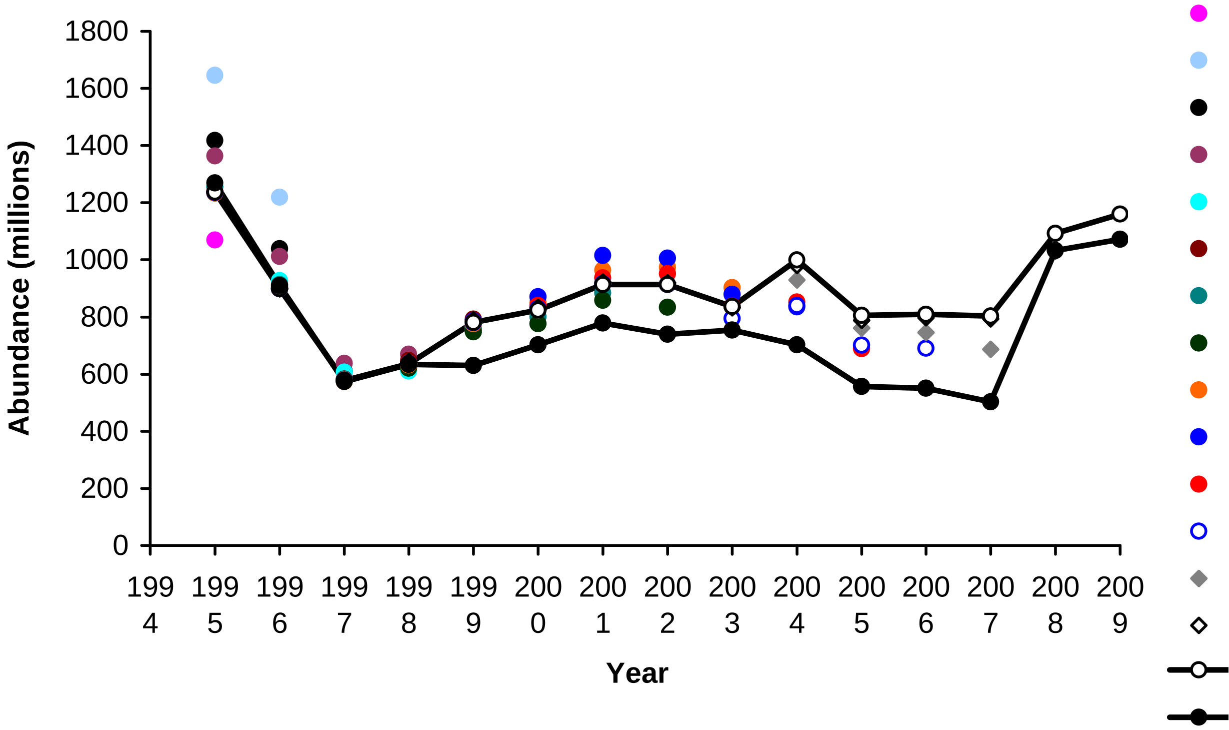


Figure 3.14. Calibrated (with intercept) bottom trawl survey estimates (connected solid circles), ICES 2009 estimates (connected open diamonds) and the 1995- 2008 ICES annual assessments (unconnected symbols) of the total number of Northeast Arctic cod ages 4 through 6.

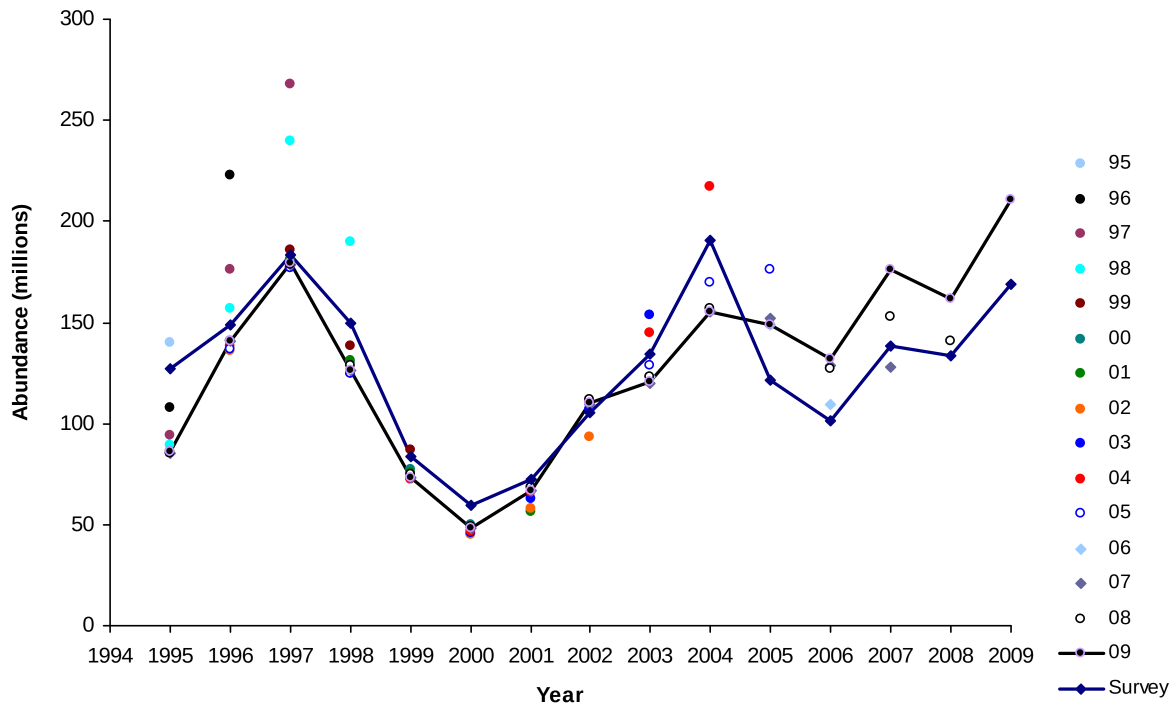


Figure 3.15. Calibrated (with intercept) bottom trawl survey estimates (connected solid diamonds), ICES 2009 estimates (connected open circles) and the 1995- 2008 ICES annual assessments (unconnected symbols) of the total number of Northeast Arctic cod ages 7 and older.

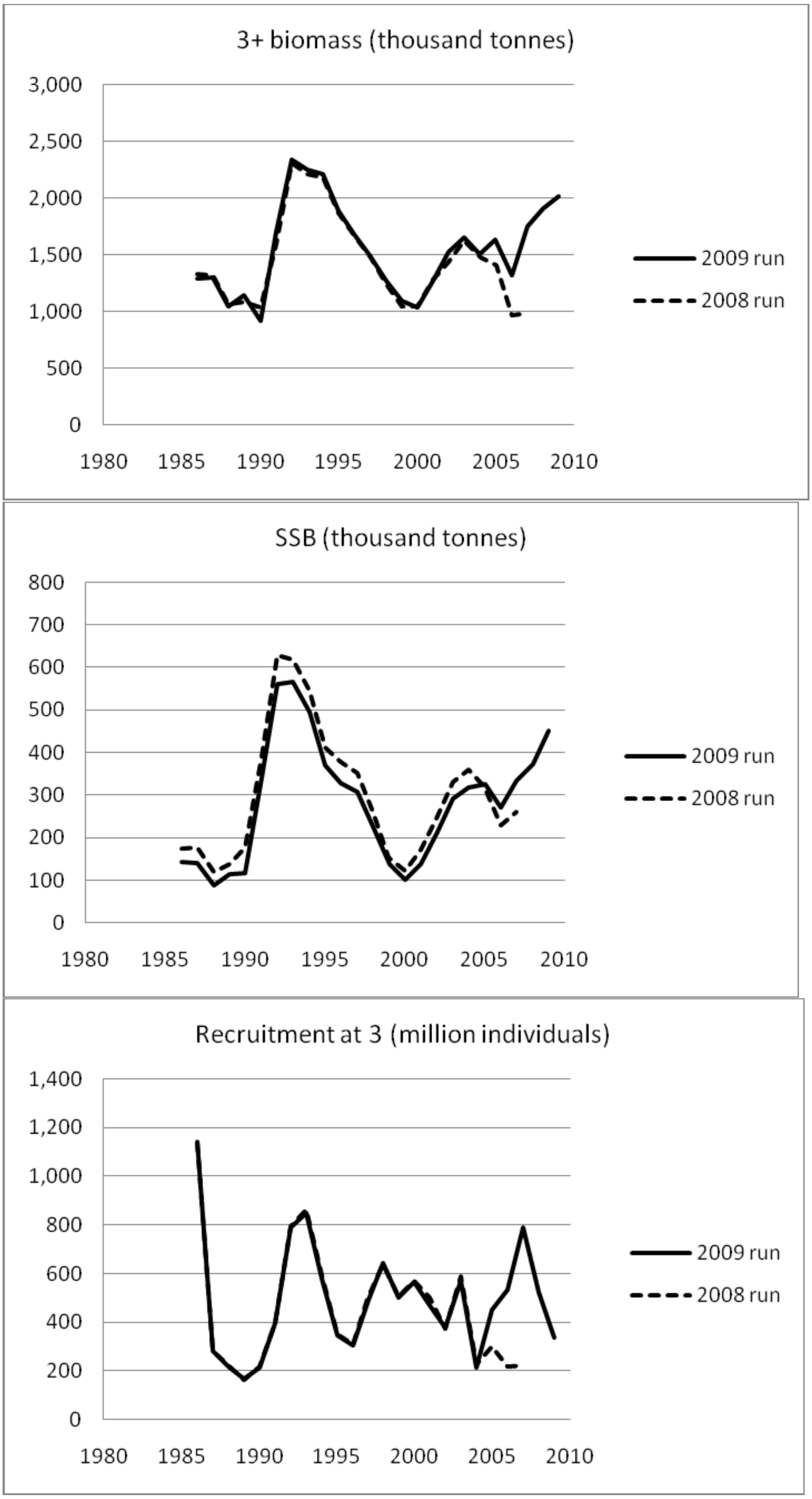
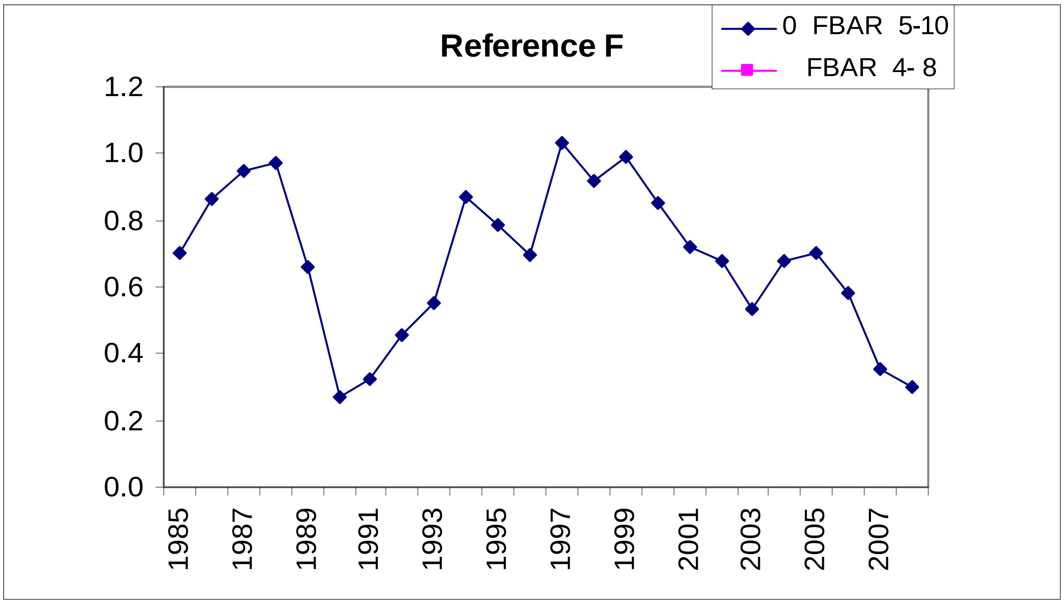


Figure 3.16. Northeast Arctic cod. Gadget results



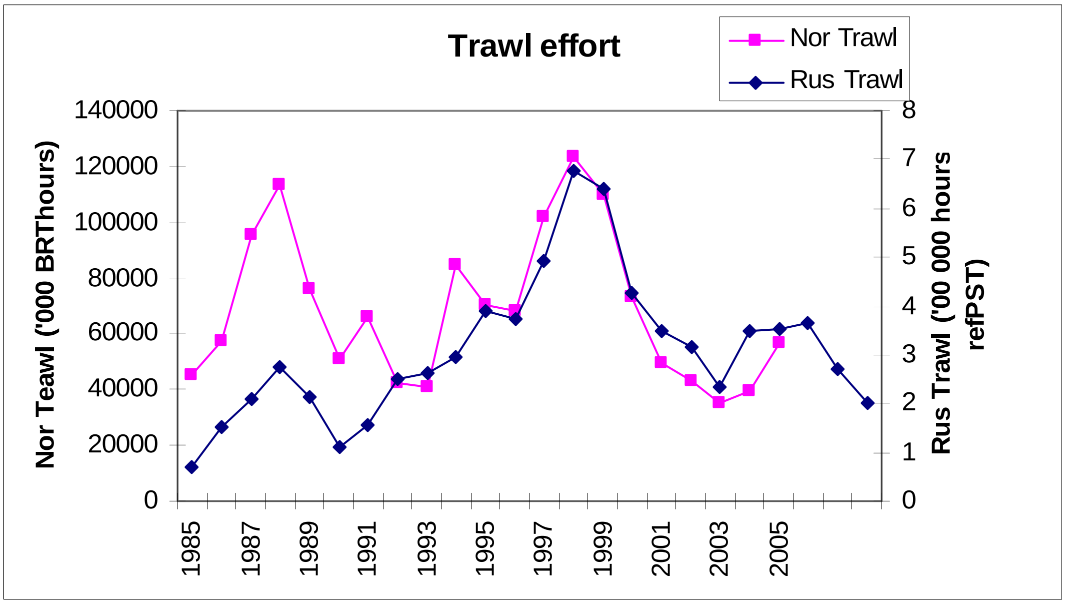


Figure 3.17. Northeast Arctic cod. Fishing mortality ($F_{5\text{-}10}$) (top panel) and trawl efforts in 1985-2008 (bottom panel).

Table A1. North-East Arctic COD. Catch per unit effort.

	Sub-area I			Division IIb			Division IIa		Total
Year	Norway[2]	UK[3]	Russia[4]	Norway[2]	UK[3]	Russia[4]	Norway[2]	UK[3]	Norway
1960	-	0.075	0.42	-	0.105	0.31	-	0.067	
1961	-	0.079	0.38	-	0.129	0.44	-	0.058	
1962	-	0.092	0.59	-	0.133	0.74	-	0.066	
1963	-	0.085	0.60	-	0.098	0.55	-	0.066	
1964	-	0.056	0.37	-	0.092	0.39	-	0.070	
1965	-	0.066	0.39	-	0.109	0.49	-	0.066	
1966	-	0.074	0.42	-	0.078	0.19	-	0.067	
1967	-	0.081	0.53	-	0.106	0.87	-	0.052	
1968	-	0.110	1.09	-	0.173	1.21	-	0.056	
1969	-	0.113	1.00	-	0.135	1.17	-	0.094	
1970	-	0.100	0.80	-	0.100	0.80	-	0.066	
1971	-	0.056	0.43	-	0.071	0.16	-	0.062	
1972	0.90	0.047	0.34	0.59	0.051	0.18	1.08	0.055	
1973	1.05	0.057	0.56	0.43	0.054	0.57	0.71	0.043	
1974	1.75	0.079	0.86	1.94	0.106	0.77	0.19	0.028	
1975	1.82	0.077	0.94	1.67	0.100	0.43	1.36	0.033	
1976	1.69	0.060	0.84	1.20	0.081	0.30	1.69	0.035	
1977	1.54	0.052	0.63	0.91	0.056	0.25	1.16	0.044	1.17
1978	1.37	0.062	0.52	0.56	0.044	0.08	1.12	0.037	0.94
1979	0.85	0.046	0.43	0.62	-	0.06	1.06	0.042	0.85
1980	1.47	-	0.49	0.41	-	0.16	1.27	-	1.23
					Spain[5]			Russia[4]	
1981	1.42	-	0.41	(0.96)	-	0.07	1.02	0.35	1.21
1982	1.30	-	0.35	-	0.86	0.26	1.01	0.34	1.09
1983	1.58	-	0.31	(1.31)	0.92	0.36	1.05	0.38	1.11
1984	1.40	-	0.45	1.20	0.78	0.35	0.73	0.27	0.96
1985	1.86	-	1.04	1.51	1.37	0.50	0.90	0.39	1.29
1986	1.97	-	1.00	2.39	1.73	0.84	1.36	1.14	1.70
1987	1.77	-	0.97	2.00	1.82	1.05	1.73	0.67	1.77
1988	1.58	-	0.66	1.61	(1.36)	0.54	0.97	0.55	1.03
1989	1.49	-	0.71	0.41	2.70	0.45	0.78	0.43	0.76
1990	1.35	-	0.70	0.39	2.69	0.80	0.38	0.60	0.49
1991	1.38	-	0.67	0.29	4.96	0.76	0.50	0.90	0.44
1992	2.19	-	0.79	3.06	2.47	0.23	0.98	0.65	1.29
1993	2.33	-	0.85	2.98	3.38	1.00	1.74	1.03	1.87
1994	2.50	-	1.01	2.82	1.44	1.14	1.27	0.86	1.59
1995	1.57	-	0.59	2.73	1.65	1.10	1.00	1.01	1.92
1996			0.74		1.11	0.85		0.99	1.81
1997			0.61			0.57		0.74	1.36
1998			0.37			0.29		0.40	0.83
1999			0.29			0.34		0.39	0.74
2000			0.34			0.37		0.53	0.92
2001			0.46			0.46		0.69	1.21
2002			0.58			0.66		0.57	1.35
2003			0.70			1.22		0.73	1.67
2004			0.48			0.78		0.84	1.67
2005			0.45			0.62		0.81	1.23
2006			0.49			0.54		0.84	1.32
2007			0.71			0.51		0.88	1.18
2008[1]			0.93			0.79		1.21	1.44

[1]Preliminary figures.

[2]Norwegian data - t per 1,000 tonnage*hrs fishing.

[3]United Kingdom data - t per 100 tonnage*hrs fishing.

[4]Russian data - t per hr fishing.

[5]Spanish data - t per hr fishing.

Period	Sub-area I	Divisions IIa and IIb
1960–1973	RT	RT
1974–1980	PST	RT
1981–	PST	PST

Vessel type:

RT = side trawlers, 800–1000 HP, PST = stern trawlers, up to 2000 HP.

Table A2. North-east Arctic COD. Abundance indices (millions) from the Norwegian acoustic survey in the Barents Sea in January-March. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length-dependent effective spread of trawl.

Year	Age										
	1	2	3	4	5	6	7	8	9	10+	Total
1981	8.0	82.0	40.0	63.0	106.0	103.0	16.0	3.0	1.0	1.0	423.0
1982	4.0	5.0	49.0	43.0	40.0	26.0	28.0	2.0	+	0.0	197.0
1983	60.5	2.8	5.3	14.3	17.4	11.1	5.6	3.0	0.5	0.1	120.5
1984	745.4	146.1	39.1	13.6	11.3	7.4	2.8	0.2	0.0	0.0	966.0
1985	69.1	446.3	153.0	141.6	19.7	7.6	3.3	0.2	0.1	0.0	840.9
1986	353.6	243.9	499.6	134.3	65.9	8.3	2.2	0.4	0.1	0.0	1308.2
1987	1.6	34.1	62.8	204.9	41.4	10.4	1.2	0.2	0.7	0.0	357.3
1988	2.0	26.3	50.4	35.5	56.2	6.5	1.4	0.2	0.0	0.0	178.4
1989	7.5	8.0	17.0	34.4	21.4	53.8	6.9	1.0	0.1	0.1	150.1
1990	81.1	24.9	14.8	20.6	26.1	24.3	39.8	2.4	0.1	0.0	234.1
1991	181.0	219.5	50.2	34.6	29.3	28.9	16.9	17.3	0.9	0.0	578.7
1992	241.4	562.1	176.5	65.8	18.8	13.2	7.6	4.5	2.8	0.2	1092.9
1993 [1]	1074.0	494.7	357.2	191.1	108.2	20.8	8.1	5.0	2.3	2.5	2264.0
1994 [1]	858.3	577.2	349.8	404.5	193.7	63.6	12.1	3.7	1.7	0.9	2465.4
1995 [1]	2619.2	292.9	166.2	159.8	210.1	68.8	16.7	2.1	0.7	1.0	3537.4
1996 [1]	2396.0	339.8	92.9	70.5	85.8	74.7	20.6	2.8	0.3	0.4	3083.8
1997 [1,2]	1623.5	430.5	188.3	51.7	49.3	37.2	22.3	4.0	0.7	0.1	2407.5
1998 [1,2]	3401.3	632.9	427.7	182.6	42.3	33.5	26.9	13.6	1.7	0.3	4762.8
1999 [1]	358.3	304.3	150.0	96.4	45.1	10.3	6.4	4.1	0.8	0.3	976.1
2000 [1]	154.1	221.4	245.2	158.9	142.1	45.4	9.6	4.7	3.0	1.1	985.5
2001 [1]	629.9	63.9	138.2	171.6	77.3	39.7	11.8	1.4	0.5	0.2	1134.5
2002 [1]	18.2	215.5	69.3	112.2	102.0	47.0	18.0	3.0	0.4	0.3	585.9
2003 [1]	1693.9	61.5	303.4	114.4	129.0	114.9	34.3	7.7	1.9	0.5	2461.5
2004 [1]	157.6	105.2	33.6	92.8	30.7	27.6	17.0	5.9	1.2	0.2	471.8
2005 [1]	465.3	119.6	123.9	33.7	62.8	16.9	14.5	4.2	1.0	0.4	842.4
2006 [1]	544.6	216.6	79.8	59.1	15.5	25.6	8.8	4.5	1.4	0.5	956.5
2007 [1,2]	125.0	61.7	80.3	37.1	30.4	9.1	14.1	5.0	2.1	0.7	365.6
2008 [1]	68.8	97.6	210.2	306.1	140.6	69.4	21.6	12.2	3.1	0.8	930.4
2009 [1]	321.5	30.6	182.6	178.3	137.1	35.0	12.5	5.2	3.7	0.9	907.3

[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.

	Age										
Year	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 [1]	128.8	248.3	235.2	132.1	108.3	26.9	4.3	2.0	1.2	0.4	887.5
2001 [1]	657.9	76.6	191.1	182.8	83.4	38.2	8.9	1.1	0.4	0.2	1240.6
2002 [1]	35.3	443.9	88.3	135.0	109.6	42.5	15.1	2.4	0.3	0.2	872.6
2003 [1]	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	3760.3
2004 [1]	328.5	235.4	76.6	172.5	56.9	44.7	27.3	7.6	1.7	0.4	951.6
2005 [1]	824.3	224.6	246.9	62.1	98.1	24.7	15.5	4.5	1.1	0.4	1502.3
2006 [1]	862.7	288.4	118.1	111.5	28.7	43.7	10.2	4.9	1.4	0.6	1470.4
2007 [1,2]	485.9	393.9	367.7	85.0	62.9	14.8	17.9	4.8	1.8	0.7	1435.4
2008 [1]	70.4	95.1	190.2	333.6	91.0	47.2	13.0	8.8	2.0	0.4	851.7
2009 [1]	382.7	39.1	118.3	219.5	193.9	58.7	19.6	6.8	4.8	0.9	1044.3

[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	3.33	12.93	28.75	13.06	6.51	1.55	0.06	0.16	66.35
2006	0.20	12.50	8.11	10.98	7.42	2.12	0.16	0.66	42.14
2007	1.46	3.88	28.52	8.69	5.35	2.80	0.68	0.36	51.72
2008	0.45	5.96	2.95	20.72	2.70	2.02	1.66	0.71	37.17
2009	3.417	14.483	27.644	8.095	22.308	3.069	1.56	0.373	80.95

Table A5. North-east Arctic COD. Mean length at age(cm) from Norwegian surveys in January-March 1983-1999 values re-calculated from raw data.

Year	1	2	3	4	5	6	7	8
1978	14.2	23.1	32.1	45.9	54.2	64.6	67.6	76.9
1979	12.8	22.9	33.1	40.0	52.3	64.4	74.7	83.0
1980	17.6	24.8	34.2	40.5	52.5	63.5	73.6	83.6
1981	17.0	26.1	35.5	44.7	52.0	61.3	69.6	77.9
1982	14.8	25.8	37.6	46.3	54.7	63.1	70.8	82.9
1983	12.8	27.6	34.8	45.9	54.5	62.7	73.1	78.6
1984	14.2	28.4	35.8	48.6	56.6	66.2	74.1	79.7
1985	16.5	23.7	40.3	48.7	61.3	71.1	81.2	85.7
1986	11.9	21.6	34.4	49.9	59.8	69.4	80.3	93.8
1987	13.9	21.0	31.8	41.3	56.3	66.3	77.6	87.9
1988	15.3	23.3	29.7	38.7	47.6	56.8	71.7	79.4
1989	12.5	25.4	34.7	39.9	46.8	56.2	67.0	83.3
1990	14.4	27.9	39.4	47.1	53.8	60.6	68.2	79.2
1991	13.6	27.2	41.6	51.7	59.5	67.1	72.3	77.6
1992	13.2	23.9	41.3	49.9	60.2	68.4	76.1	82.8
1993	11.3	20.3	35.9	50.8	59.0	68.2	76.8	85.8
1994	12.0	18.3	30.5	44.7	55.4	64.3	73.5	82.4
1995	12.7	18.7	29.9	42.0	54.1	64.1	74.8	80.6
1996	12.6	19.6	28.1	41.0	49.3	61.4	72.2	85.3
1997 [1]	11.4	18.8	28.0	40.4	49.9	59.3	69.1	80.6
1998 [1]	10.9	17.4	28.7	40.0	50.5	58.9	67.5	76.3
1999	12.1	18.8	29.0	40.6	50.6	59.9	70.3	78.0
2000	13.0	21.0	28.7	39.7	51.5	61.6	70.5	75.7
2001	12.0	22.5	33.1	41.6	52.2	63.1	71.2	79.2
2002	12.2	19.9	30.1	43.6	52.2	61.7	71.6	79.1
2003	12.0	21.2	29.1	39.2	53.3	61.6	70.3	80.7
2004	11.0	18.9	32.0	40.9	52.0	61.8	69.0	79.0
2005	11.5	18.6	29.3	43.0	51.1	60.3	71.1	78.4
2006	12.2	19.9	31.3	42.1	53.5	60.8	68.9	77.7
2007	13.4	21.3	30.7	42.2	52.8	62.3	70.5	77.9
2008	12.5	22.3	32.5	43.7	52.4	63.6	71.6	80.8
2009 [1]	11.7	21.4	32.2	43.2	53.6	63.3	76.0	84.4

Table A6. North-east Arctic COD. Weight (g) at age from Norwegian surveys in January-March

Year	Age							
	1	2	3	4	5	6	7	8
1983		190	372	923	1597	2442	3821	4758
1984	23	219	421	1155	1806	2793	3777	4566
1985		171	576	1003	2019	3353	5015	6154
1986		119	377	997	1623	2926	3838	7385
1987 [2]	21	65	230	490	1380	2300	3970	
1988	24	114	241	492	892	1635	3040	4373
1989	16	158	374	604	947	1535	2582	4906
1990	26	217	580	1009	1435	1977	2829	4435
1991	18	196	805	1364	2067	2806	3557	4502
1992	20	136	619	1118	1912	2792	3933	5127
1993	9	71	415	1179	1743	2742	3977	5758
1994	13	55	259	788	1468	2233	3355	4908
1995	16	54	248	654	1335	2221	3483	4713
1996	15	62	210	636	1063	1999	3344	5514
1997 [1]	12	54	213	606	1112	1790	2851	4761
1998 [1]	10	47	231	579	1145	1732	2589	3930
1999	13	55	219	604	1161	1865	2981	3991
2000	17	77	210	559	1189	1978	2989	3797
2001	14	103	338	664	1257	2188	3145	4463
2002	15	68	256	747	1234	2024	3190	4511
2003	14	82	228	569	1302	1980	2975	4666
2004	11	58	294	600	1167	1934	2657	4025
2005	13	57	230	705	1135	1817	2948	4081
2006	15	71	288	682	1366	1991	2959	4354
2007	19	78	253	691	1302	2128	3032	4327
2008	16	94	319	798	1393	2412	3413	5067
2009	13	83	291	724	1337	2180	3775	5267

[1] Adjusted weights
[2] Estimated weights

Table A7. 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	56.3	65.4	72.3	76.0	85.3	95.5	110.5	117.8
2006	56.2	63.7	72.6	77.5	82.9	88.3	89.2	116.3
2007	63.0	66.4	72.4	82.5	88.2	99.8	103.7	115.0
2008	63.8	69.1	73.6	80.9	90.0	94.9	94.9	96.5
2009	60.5	69.3	76.5	82.7	88.7	98.8	92.9	111.6

Table A8. 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	1.56	2.40	3.20	3.71	5.79	8.52	16.27	18.63
2006	1.54	2.35	3.44	4.19	5.43	6.57	6.19	18.15
2007	2.34	2.67	3.53	5.30	6.70	9.95	11.24	16.62
2008	2.21	2.97	3.63	4.88	6.74	8.18	7.70	9.07
2009	2.04	2.98	4.1	5.19	6.56	9.38	8.58	15.67

Table A9 North-east Arctic COD. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent wates in the autumn. Stock number in millions.

Year	Age										
	1	2	3	4	5	6	7	8	9	10+	Total
1985 [1]	77	569	400	568	244	51	20	8	1	3	1941
1986 [1]	25	129	899	612	238	69	20	3	2	1	1998
1987 [2]	2	58	103	855	198	82	19	4	1	1	1323
1988 [2]	3	23	96	100	305	54	16	3	1	1	602
1989 [1]	1	3	17	45	57	91	75	25	13	5	332
1990 [1]	36	27	8	27	62	74	91	39	10	3	377
1991 [1]	63	65	96	45	50	54	66	49	5	1	494
1992 [1]	133	399	380	121	56	58	33	29	11	2	1222
1993 [1]	20	44	220	234	164	51	19	13	8	10	783
1994 [1]	105	38	147	275	303	314	100	35	10	8	1335
1995 [1]	242	42	111	219	229	97	21	6	2	2	971
1996 [1,3,5]	424	275	189	316	449	314	126	27	3	4	2127
1997 [4,5]	72	160	263	198	112	57	27	9	1	1	900
1998 [1]	26	86	279	186	57	23	10	4	1	0	672
1999 [1]	19	79	166	260	98	20	8	5	2	1	658
2000 [1, rev]	24	82	191	159	127	48	6	3	1	1	642
2001 [1]	38	59	148	204	120	70	14	2	1		656
2002 [1,5,6]	83	2	106	85	140	151	67	30	7	1	672
2003	69	36	25	218	142	167	163	60	23	4	908
2004	375	35	170	85	345	194	229	167	49	19	1669
2005	112	48	65	154	70	214	68	47	17	8	803
2006 [7]	12	20	39	49	78	32	64	23	13	8	341
2007	13	35	165	372	208	189	74	113	32	20	1221

[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
[7] Area I not fully covered

Table A10. North-East Arctic COD. Abundance indices (millions) from the Russian bottom trawl survey in the Barents Sea

Year	Age											
	0	1	2	3	4	5	6	7	8	9	10+	Total
			Total (Sub-area I and Division IIa and IIb)									
1982	849.3	1905.3	33.2	141.3	152.5	72.1	19.8	55.1	17.4	3.7	1.9	3251.6
1983	1872.2	2003.4	73.2	52.0	64.2	50.6	35.8	17.9	25.2	9.4	0.0	4203.9
1984	363.3	180.5	104.4	118.9	70.0	48.9	35.7	15.4	6.9	6.1	1.7	951.8
1985	284.6	15.6	129.0	118.8	159.2	106.8	36.5	16.5	3.7	0.8	1.6	873.1
1986	329.9	7.6	31.7	162.2	153.2	149.3	48.1	18.9	4.2	0.2	0.6	905.9
1987	7.7	1.3	46.9	55.7	307.6	90.0	70.1	18.4	6.0	2.5	0.4	606.6
1988	92.5	2.9	31.3	99.3	93.8	287.9	58.3	26.0	4.7	2.4	0.1	699.2
1989	355.8	3.0	14.7	49.0	97.8	106.2	145.4	116.7	29.9	11.2	4.7	934.4
1990	1248.4	31.1	51.0	16.7	48.7	62.7	97.2	153.8	67.3	15.3	4.9	1797.1
1991	974.0	64.0	91.1	107.7	48.4	53.2	58.3	68.5	74.7	9.8	1.4	1551.1
1992	1204.8	157.7	151.1	67.5	30.8	23.9	27.3	21.8	17.5	2.5	0.4	1705.3
1993	484.8	38.0	158.6	160.4	113.5	68.1	41.6	35.4	8.7	0.3	0.7	1110.1
1994	1606.6	833.2	69.9	136.3	130.9	101.9	35.4	12.8	4.9	2.1	1.1	2935.1
1995	5703.5	471.9	36.9	58.9	106.5	139.5	84.9	25.1	8.3	1.9	1.8	6639.2
1996	2660.3	396.5	128.5	73.3	78.4	103.5	77.3	34.8	13.2	1.9	0.5	3568.2
1997	1371.4	353.9	135.3	134.2	83.5	61.3	60.2	34.8	11.6	3.2	1.5	2250.9
1998	304.8	276.8	89.6	202.8	136.3	78.8	47.0	25.9	13.0	4.8	0.5	1180.3
1999	266.9	40.1	118.4	158.7	207.2	98.0	30.1	12.3	9.4	4.2	0.4	945.7
2000	1436.5	37.7	103.6	183.9	128.6	178.6	77.3	11.4	5.2	2.3	0.9	2166.0
2001	321.6	233.8	77.3	122.4	155.7	129.0	106.1	30.4	5.0	1.4	0.5	1183.2
2002	1797.9	26.7	135.6	98.0	147.3	147.3	89.6	60.0	18.2	2.9	0.8	2524.3
2003	489.5	517.5	26.8	124.6	105.7	116.6	120.3	53.5	24.1	4.0	0.9	1583.5
2004	1770.4	158.4	87.5	32.9	157.6	88.0	111.1	77.6	27.9	9.3	2.3	2523.0
2005	2298.0	323.9	61.7	140.8	63.1	183.2	74.4	60.5	24.4	8.8	2.8	3241.6
2006 corr	427.4	52.4	63.2	92.7	161.3	77.7	180.1	66.2	34.2	16.1	6.8	1178.1
2007	177.5	37.0	148.6	257.9	161.7	190.3	84.6	152.5	55.3	22.6	15.3	1303.3
2008	1468.6	45.2	86.3	220.3	308.8	163.5	147.2	83.0	86.3	29.1	0.0	2638.2

Table A11 North-East Arctic COD. Length at age (cm) from Russian surveys in November–December

Year	Age 0	1	2	3	4	5	6	7	8	9
1984	15.7	22.3	30.7	44.3	51.7	63.6	73.4	82.5	88.4	97.0
1985	15.0	21.1	30.6	43.2	53.7	61.2	72.8	83.0	92.8	101.3
1986	15.2	19.7	28.3	39.0	51.8	62.2	70.9	83.0	91.3	104.0
1987	-	19.2	27.9	33.4	41.4	59.1	69.2	80.1	95.7	102.6
1988	11.3	21.3	28.7	36.2	43.9	53.3	65.3	79.5	85.0	-
1989	-	20.8	28.8	34.8	46.0	53.9	61.8	69.8	78.7	88.6
1990	16.0	24.0	30.4	46.5	54.9	62.5	69.7	77.6	87.8	102.0
1991	11.5	22.4	30.6	43.0	55.9	64.6	72.8	78.5	87.9	101.8
1992	11.3	21.3	31.9	50.1	59.8	69.1	78.6	84.0	90.8	97.5
1993	12.1	17.4	29.1	43.4	52.7	64.3	73.9	81.2	89.1	91.8
1994	12.2	20.3	26.3	33.7	47.4	58.7	70.6	80.8	90.1	96.1
1995	11.6	19.8	27.6	33.8	45.2	60.5	71.1	83.5	92.9	99.1
1996	10.2	20.0	28.1	36.7	48.7	58.9	70.5	80.0	93.6	102.7
1997	9.6	18.5	28.8	38.2	50.8	62.0	70.5	80.1	88.9	103.5
1998	11.4	19.0	28.0	36.4	50.5	61.0	70.7	80.3	91.1	102.5
1999	11.7	19.7	27.9	35.3	51.6	60.6	70.6	78.9	86.8	94.3
2000	10.7	20.8	30.1	34.7	49.8	61.1	71.6	82.0	88.3	85.7
2001	10.6	19.4	29.8	37.3	50.4	61.9	71.9	81.4	91.0	98.7
2002	10.7	19.2	29.9	38.2	52.5	60.4	70.6	82.2	91.3	97.2
2003	9.8	18.9	28.3	34.9	49.2	62.2	71.0	81.5	92.3	100.9
2004	9.8	19.6	29.3	38.4	49.1	60.0	70.5	80.0	91.0	98.0
2005	11.2	19.4	29.7	38.5	48.7	59.3	69.3	79.2	87.7	96.1
2006	13.0	21.9	31.6	42.7	53.2	60.1	70.2	79.1	88.3	95.2
2007	10.7	21.5	30.8	42.2	53.6	63.7	71.0	79.6	87.3	95.9
2008	10.2	20.0	30.3	40.2	53.7	64.5	74.6	82.7	89.5	98.2

Table A12 North-East Arctic COD. Weight (g) at age from Russian surveys in November–December.

Year	Age										
	0	1	2	3	4	5	6	7	8	9	10
1984	26	90	250	746	1,187	2,234	3,422	5,027	6,479	9,503	-
1985	26	80	245	762	1,296	1,924	3,346	5,094	7,360	6,833	11,167
1986	25	63	191	506	1,117	1,940	2,949	4,942	7,406	9,300	-
1987	-	54	182	316	672	1,691	2,688	3,959	8,353	10,583	13,107
1988	15	78	223	435	789	1,373	2,609	4,465	5,816	-	-
1989	-	73	216	401	928	1,427	2,200	3,133	4,649	6,801	8,956
1990	28	106	230	908	1,418	2,092	2,897	4,131	6,359	10,078	13,540
1991	26	93	260	743	1,629	2,623	3,816	4,975	7,198	11,165	15,353
1992	10	76	273	1,165	1,895	2,971	4,377	5,596	7,319	9,452	12,414
1993	11	46	211	717	1,280	2,293	3,509	4,902	6,621	7,339	8,494
1994	12	69	153	316	919	1,670	2,884	4,505	6,520	8,207	9,812
1995	11	61	180	337	861	1,987	3,298	5,427	7,614	9,787	10,757
1996	7	64	191	436	1,035	1,834	3,329	5,001	8,203	10,898	11,358
1997	6	48	203	487	1,176	2,142	3,220	4,805	6,925	10,823	12,426
1998	11	55	187	435	1,186	2,050	3,096	4,759	7,044	11,207	12,593
1999	10	58	177	371	1,214	1,925	3,064	4,378	6,128	7,843	11,543
2000	8	74	232	379	1,101	2,128	3,341	5,054	6,560	8,497	12,353
2001	9	58	221	459	1,125	2,078	3,329	4,950	7,270	9,541	11,672
2002	8	65	232	505	1,299	1,964	3,271	5,325	7,249	9,195	11,389
2003	6	49	205	492	972	1,993	2,953	4,393	6,638	9,319	11,085
2004	6	55	231	543	1,079	1,798	2,977	4,110	5,822	8,061	12,442
2005	10	59	223	521	1,034	1,910	3,036	4,619	6,580	9,106	12,006
2006	13	72	270	707	1,332	1,953	2,969	4,340	6,410	8,622	12,436
2007	10	96	252	669	1,344	2,277	3,140	4,691	6,178	8,567	10,014
2008	7	58	228	558	1,332	2,305	3,527	5,001	6,519	8,848	10,339

Table A13. North-East Arctic COD. Sum of acoustic abundance estimates (millions) in the Joint winter Barents Sea survey (Table A2) and the Norwegian Lofoten acoustic survey (Table A4)

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1985	69.1	446.3	153.0	141.6	20.4	15.1	15.7	3.3	1.3	1.0	0.5	0.0
1986	353.6	243.9	499.6	134.3	68.4	11.6	7.7	3.1	0.3	0.0	0.4	0.1
1987	1.6	34.1	62.8	204.9	50.2	17.4	1.4	3.0	0.7	0.0	0.0	0.0
1988	2.0	26.3	50.4	35.5	57.8	10.9	4.0	0.3	0.0	0.1	0.0	0.0
1989	7.5	8.0	17.0	34.4	21.4	67.0	16.6	3.2	0.5	0.2	0.0	0.1
1990	81.1	24.9	14.8	20.6	26.2	26.9	66.8	7.3	0.6	0.3	0.0	0.0
1991	181.0	219.5	50.2	34.6	29.3	33.9	36.7	50.0	3.7	0.2	0.2	0.0
1992	241.4	562.1	176.5	65.8	21.5	18.4	28.4	25.4	82.4	4.3	1.7	0.2
1993	1074.0	494.7	357.2	191.1	113.1	35.4	25.5	25.2	27.7	44.2	4.9	0.8
1994	858.3	577.2	349.8	404.5	217.5	89.5	22.5	11.9	9.4	3.9	18.0	2.7
1995	2619.2	292.9	166.2	159.8	216.6	104.0	29.0	4.4	4.3	3.0	2.6	8.1
1996	2396.0	339.8	92.9	70.5	87.2	89.1	44.6	6.5	1.1	0.4	0.9	1.4
1997	1623.5	430.5	188.3	51.7	49.7	42.2	49.9	20.5	2.2	0.5	0.0	0.8
1998	3401.3	632.9	427.7	182.6	42.4	33.8	34.0	24.7	4.9	0.7	0.2	0.1
1999	358.3	304.3	150.0	96.4	45.4	12.2	11.2	18.7	9.2	1.0	0.2	0.2
2000	154.1	221.4	245.2	158.9	145.7	49.3	12.9	6.9	5.2	1.2	0.6	0.2
2001	629.9	63.9	138.2	171.6	81.6	57.3	19.8	2.4	0.8	0.6	0.3	0.1
2002	18.2	215.5	69.3	112.2	104.3	66.1	34.5	9.5	1.2	0.5	0.6	0.0
2003	1693.9	61.5	303.4	114.4	131.5	144.5	64.3	21.2	3.8	0.5	0.1	0.1
2004	157.7	105.2	33.6	92.8	32.7	45.1	46.8	22.2	8.8	2.2	0.2	0.7
2005	465.3	119.6	123.9	33.7	66.1	29.9	43.2	17.2	7.5	1.8	0.1	0.2
2006	544.6	216.6	79.8	59.1	15.7	38.1	16.9	15.5	8.8	2.4	0.3	0.8
2007	125.0	61.7	80.3	37.1	31.8	13.0	42.7	13.8	7.5	3.3	0.8	0.4
2008	68.8	97.6	210.2	306.1	141.0	75.4	24.6	32.9	5.8	2.8	1.7	0.8
2009	321.5	30.6	182.6	178.3	140.5	49.5	40.1	13.3	26.0	3.7	1.7	0.4

Table A14. Swept area estimates (millions) by age of Northeast Arctic Cod from the Joint Norwegian-Russian ecosystem survey in August-September. Stratified average density (numbers per square km)

	1	2	3	4	5	6	7	8	9	10+
2004	291.09	258.85	111.36	264.03	64.51	63.99	27.88	7.50	2.21	0.60
2005	320.34	126.41	154.53	40.90	53.87	14.91	12.54	3.57	1.04	1.06
2006	404.17	302.78	87.09	97.32	24.21	41.86	11.23	5.21	1.93	0.68
2007	298.72	370.89	336.52	91.40	45.85	12.55	17.28	4.19	1.05	0.90
2008	97.17	218.18	318.51	278.64	61.82	38.91	9.79	12.98	2.35	0.52

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 by-catch in the fishery for cod. Also a directed trawl fishery for haddock is conducted and the proportion of total catches taken by this 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. Some of the longline catch are from a directed fishery, which is restricted by national quotas. In the Norwegian management 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 area restrictions.

The exploitation rate of haddock has been variable. The highest fishing mortalities for haddock have occurred at low to intermediate stock levels and historically show little relationship with the exploitation rate of cod, in spite of haddock being primarily caught as by-catch in the cod fishery. However, the more restrictive quota regulations introduced around 1990 have resulted in a more similar pattern in the exploitation rate.

4.1.2 Landings prior to 2009 (Tables 4.1–4.3, Figure 4.1A)

The official landings for 2007 amount to 146,972 t, and the provisional official landings for 2008 are 149,776 t.

In the last three years, estimates of unreported catches (IUU catches) of haddock have been added to reported landings for the years 2002 and onwards. In 2007 and 2008 two estimates of IUU catches were available, based on Norwegian and Russian estimates of IUU catches, respectively. In 2008 the Working Group decided to focus the presentation of the assessments on the Norwegian IUU estimates. This year, the Working Group decided to follow the same procedure as last year and only use the Norwegian IUU estimates. More details on this issue are given in Sections 0.3 and 3.1.3. Before 2002 the Working Group has no information about IUU catches on haddock, but the WG consider the IUU fisheries prior to 2002 to be low.

The basis for the IUU estimates is the annual ratio between cod and haddock in the international reported landings from Subarea I and Division IIb in 2002-2008. These ratios are assumed to be representative of the ratios in the IUU catches. The ratio is applied to the estimated IUU catches of cod in order to get the estimate for haddock. In 2005-2007 the estimates are similar to those made by the Norwegian Directorate of Fisheries, both in absolute values and trend. In 2008, the estimate is 4 times smaller than estimate made by the Norwegian Directorate of Fisheries resulting from the low cod estimate compared to last year. Compared to the total reported catch in 2008, these estimates amounts to 4%, and 16%, respectively. Nevertheless, the Working Group has previously regarded the estimates provided by the Norwegian Directorate of Fisheries as too imprecise for haddock (AFWG 2007, 2008) and we therefore base the estimates of IUU catches of haddock on the same procedure as last year.

The table below shows the ratio haddock/cod from international reported landings of haddock in ICES area I and IIb (ratio 1), ratio haddock/cod from estimates of total catch of haddock based from Norwegian Directorate of Fisheries (ratio 2), estimated unreported landings of haddock applying ratio 1 to estimates of IUU for cod, estimates of unreported landings of haddock provided by the Norwegian Directorate of Fisheries (IUU2), and the percentage of IUU of official landings of haddock (% of reported landings). No data from Directorate of Fisheries is available for 2002 through 2004, and is denoted NA (not available).

Year	Ratio 1	Ratio 2	IUU	IUU 2	% of reported landings
2002	0,21	NA	19	NA	20
2003	0,29	NA	33	NA	31
2004	0,29	NA	34	NA	27
2005	0,24	0,23	40	38	34
2006	0,32	0,43	21	29	16
2007	0,35	0,45	15	19	10
2008	0,36	0,46	6	25	4

It should be noted that although the exploitation rate for haddock in general is not well correlated with that of cod, there are large parts of the cod fishery, e.g. the Lofoten spawning fishery, where haddock is not a significant by-catch. Furthermore, not all haddock catches, especially those taken by conventional gears, are by-catch in trawl fisheries. A good correlation between the overall exploitation rates is therefore not necessarily expected.

In 2006 it was decided to include reported Norwegian landings of haddock from the Norwegian statistical areas 06 and 07 (i.e., between 62°N and Lofoten) not previously included in the total landings of NEA haddock used as input for this stock assessment (Tables 4.1 – 4.3). This practice is continued.

4.1.3 Catch advice and landings for 2008 and 2009

ACFM recommended to set a TAC lower than 130 000 t for 2008, while the agreed TAC for 2008 was 155,000 t by applying the agreed harvest control rule. The provisional reported catch in 2008 is 149,776 t. In 2006 and 2007 the assessment of haddock was rejected by ACFM and the advices was in both years to set a TAC lower than 130,000 t based on the increase in SSB 2001-2004 being associated with this catch level. In 2008 the assessment of haddock was accepted on the basis of improvement in diagnostics and a clearer explanation of the IUU calculation, and the advice was given according to the agreed 1-year harvest control rule (see Section 4.7.2). The mixed Norwegian-Russian Fisheries Commission agreed on a TAC of 194,000 t which corresponds to the agreed 1-year harvest control rule (see Section 4.7.2) according to the assessment. The F-status quo for 2009 (average F over last 3 years) is chosen on a technical basis for the purpose of reducing errors in the predictions for 2010. The F-status quo predicts the catch for 2009 to 255 000 t which is higher than the TAC (194 000 t). The high 2009 catch corresponding to Fsq should not be interpreted as an estimate of a TAC overshoot in 2009.

4.2 Status of Research

4.2.1 Survey results (Tables B1-B4, 4.9-4.11, Figure 4.5)

The overall picture seen in the surveys is summarized as follows: the last poor year class is 1997 and the following six year classes all appear to be at or above average abundance. These are followed by three year classes 2004-2006, which all seem to rank among the 6-7 most abundant year classes in the VPA time series.

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 2009 are given in Aglen (WD 11).

Before 2000 this survey was made without participation from Russian vessels, while in 2001-2005 Russian vessels covered important parts of the Russian zone. In 2006-2007 only Norwegian vessels carried out the survey again and permit to cover the Russian EEZ was not given in 2007, which meant that the 2007 indices had to be adjusted to take into account the incomplete coverage. These adjustments is described in detail in the 2007 report. However, in 2008 and 2009 permit to enter the Russian zone was again given and the survey was conducted according to the standard area coverage. The survey indices and areas covered are given in Tables B1 and B3 and shown in Figure 4.5.

High indices, caused by the period of good 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 until the 2004-2006 year classes arrive. In the 2008 bottom trawl survey, all these three year classes show an abundance well above that of the 1990 year class at the same age, In the acoustic survey, the index of the 2004 year class at age 4 is, however, lower than for the 1990 year class and the acoustic survey on the whole indicates a lower abundance of this year class than the bottom trawl survey.

Russian bottom trawl and acoustic survey

Russia provided indices from the 2008 Barents Sea trawl and acoustic survey (Tables B2, B4a, B4b, 4.11 and Figure 4.5), which was carried out in October-December. The Russian survey shows the same main trends as the Norwegian survey, and also shows the somewhat lower abundance of the 2004 year class found in the Norwegian acoustic estimates.

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 the old and the new method of calculating indices, respectively.

Also in the Russian bottom trawl and acoustic survey the coverage of REZ in 2006 was reduced compared to previous years, and the survey indices for 2006 were adjusted similar to that of the indices from the joint Barents Sea winter survey. See report from 2007 for details. In the 2007 and 2008 surveys the area covered was again the standard coverage.

International 0-group survey

Estimates of the abundance of 0-group haddock from the International 0-group survey are presented in Tables 1.1 -1.2. The four tables show slightly different pictures, but all indicate that the 2002-2006 year classes are very strong, whereas 2007-2008 year classes are below average.

4.2.2 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 in the Norwegian survey has decreased compared to last year, whereas the Russian survey shows an decrease for ages 0-3, and stable for ages 4 and older.

4.3 Data Used in the Assessment

4.3.1 Estimates of unreported catches (Tables 4.1–4.3)

We include the estimates of IUU catches in 2002-2008 (see Section 0.3 and Section 4.1.2). Differences in assessment with and without IUU catches is only shown in a figure.

4.3.2 Catch-at-age (Table 4.4)

The Norwegian catch at age data for 2007 was revised due to inclusion of samples from the Norwegian coast guard. Age and length compositions of the landings in 2008 were available from Norway and Russia in Subarea I and Division IIb, and from Norway, Russia, and Germany in Division IIa. The unreported landings were distributed on ages using the catch-at-age matrix for the international trawl fleet from Subarea I and Division IIb for both estimates of unreported catches. The combined catch data were estimated by the SALLOC program (Patterson, 1998). The SOP check gave no deviation from the nominal catch of 2008. Estimated catch at age (including IUU catches) is listed in Table 4.4.

The age distribution and weight at age for the Norwegian catches were estimated using the software based on the method of Hirst *et al*. (2005). In this method, the three different types of available samples (age and weight samples, age and weight stratified by length groups, and length samples) are modelled simultaneously using a previously developed Bayesian hierarchical model (Hirst *et al*., 2004).

4.3.3 Weight-at-age (Tables 4.5-4.6, Table B.6)

The mean weight-at-age in the catches were calculated by the SALLOC program (Patterson, 1998) and based on weights in the catches of Russia, Norway and Germany (Table 4.5). The weights-at-age in the catch in 2008 have increased slightly for all age groups compared to 2007.

Stock weights (Table 4.6) used from 1985 to 2008 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. In 2006 the Working group decided to model the stock weight-at-age data in order to remove some of the sampling variability in the estimates. The weight at age is modelled as follows: Mean length at age is modelled using a von Bertalanffy model with L_∞ and T_0 parameters estimated over the whole time series and a separate K parameter for each year class. Weight at age is estimated from a length-weight relationship using the smoothed (modelled) length at age. Estimates were produced separately for the Russian autumn survey and the joint winter survey and were later combined as plain average.

4.3.4 Natural mortality (Table 4.7)

Natural mortality used in the assessment was 0.2+mortality from predation by cod (see Section 4.4.2). The proportion of F and M before spawning was set to zero. For the period from 1984 to 2008 actual data from predation for cod have been used (see table below) while for the previous years (1950-1983) the average natural mortality for 1984-2008 was used (age groups 1-6).

4.3.5 Maturity-at-age (Table 4.8)

In 2006 the Working Group revised the estimates of maturity at age. For the years 1980 onwards the series consists of predicted values using a logistic link function with age and length as explanatory variables from the joint winter survey combined with predicted proportions from the Russian autumn survey:

$$Mat = \frac{1}{1+e^{(-a*(age-age50\%)}}$$

The new series is based on the data from the Russian autumn survey and the joint winter survey. For the period 1950-1979 an average of both data series is used.

The estimates of maturity-at-age are shown in Table 4.8. The proportions mature at age are presently lower than historic averages.

4.3.6 Changes in data from last year (Tables 4.1–4.3)

As stock weights are modelled (See Chapter 4.3.3) the values of this parameter have been changed slightly both in 1950-1984 for which average values are used and in 1985-2008. The same approach has been used in consumption of NEA haddock by NEA cod estimates and in maturity at age.

4.4 Assessment Using VPA

The assessment method was also this year XSA.

4.4.1 Data for tuning (Table 4.9, Figure 4.5)

The following surveys series are included in the data for tuning:

Name	Place	Season	Age	Year	prior weight
Russian bottom trawl	Barents Sea	Autumn	1–7	1983–2008	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2009	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2009	1

The indices for the Russian BT survey in the 1990 were not used for tuning the XSA. Since the 2004 WG meeting the survey data before 1990 have not been used in the XSA run. This decision was based on the analysis of survey residuals and changes in survey methodology (See Figures 4.6-4.8, Section 0 in the 2002 and the 2004 reports).

4.4.2 VPA and tuning (Table 4.9)

The Extended Survivors Analysis (XSA) was used to tune the VPA to the available index series (Table 4.9). As last year, FLR was used for the assessment of haddock (see 2008 report), and thus all results concerning XSA is obtained using FLR. The settings used by the AFWG in 2008 were not changed:

The tuning window is set to 20 years

The F shrinkage was given 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 (1984–2008). 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	980.7	14.7	0.1	0.0	0.0	0.0
1985	1206.2	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	230.2	0.0	0.0	0.0	0.0	0.0
1990	143.8	37.8	3.7	0.0	0.0	0.0
1991	457.6	14.2	0.0	0.0	0.0	0.0
1992	2111.1	150.6	1.1	0.0	0.0	0.0
1993	1376.5	165.7	36.8	3.4	2.9	0.0
1994	1412.6	80.6	24.9	7.7	0.9	0.0
1995	2899.8	163.6	12.0	29.7	29.9	0.3
1996	1592.2	161.3	40.2	5.5	2.6	3.4
1997	906.1	35.5	25.5	1.7	0.8	0.5
1998	1534.8	28.2	2.0	2.9	0.5	0.0
1999	908.9	23.6	0.3	0.0	0.0	0.0
2000	1215.9	65.1	2.1	1.1	0.2	0.1
2001	553.5	52.7	5.0	0.1	0.0	0.0
2002	2394.5	229.8	38.2	2.5	0.4	0.2
2003	3661.4	221.8	38.9	12.4	1.2	0.0
2004	2333.4	303.7	44.2	9.0	2.5	0.0
2005	5980.2	272.6	70.0	12.3	3.6	1.2
2006	8171.2	347.1	3.5	4.8	1.3	0.5
2007	8797.3	615.2	24.7	2.7	2.9	0.4
2008	1064.5	827.4	265.9	36.0	18.9	3.1

The fishing mortality estimated by the 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 were then prepared by adding 0.2 (M1) to the predation mortality. This new M matrix (Table 4.7) was used in the final XSA.

The proportion of M and F before spawning was set to 0.

4.4.3 Recruitment indices (Table 4.10, Table 4.11, Figure 4.1C)

The RCT3 program has been used to estimate the recruiting year-classes 2006-2008 with survey data for ages 0-3 as input data (Russian autumn survey and joint winter survey). Input data and results are shown in Table 4.10 and 4.11, respectively. Similar to XSA tuning, data points from the 1990 Russian BT were removed from recruitment estimation.

The numbers marked with * are XSA estimates, and the rest are RCT results (Table 4.11). The recruitment time series is shown in Figure 4.1C.

N	Year of assessment				
Year Class	2005	2006	2007	2008	2009
2000	197*	237*	236*	249*	236*
2001	176*	219*	224*	257*	245*
2002	295	313*	339*	367*	365*
2003	156	183	135*	161*	171*
2004	462	755	672	665*	668*
2005		521	731	943	975*
2006			463	832	1036
2007				202	208
2008					149

4.4.4 Prediction data (Table 4.11, Table 4.19)

Weights at age and proportions mature at age show strong cyclic patterns related to periods of good recruitment. The Working Group believes that the estimated recruitment in the most recent 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 from RCT for 2009-2011 is given in Table 4.19.
- The average fishing pattern observed in the 3 last years.
- Smoothed observed maturity for 2009, smoothed average maturity for the 1982-1985, 1990-1993 and 2000-2006 year classes for 2010-2011.
- Smoothed observed weights at age in the stock for 2009, smoothed average weights for the 1982-1985, 1990-1993 and 2000-2006 year classes for 2010-2011.
- The average weights in the catch for the 1982-1985, 1990-1993 and 2000-2006 year classes for 2009-2011.
- Natural mortality – average for the 3 last years (2006-2008).
- Stock numbers and fishing mortalities from the standard VPA.

4.5 Results of the Assessments

4.5.1 Comparison of assessments (Figures 4.6 and 4.7)

In view of the very large increase in biomass in the assessment, the differences between assessment with and without IUU estimates seem insignificant and are unlikely to give cause for different management actions (Figure 4.6). Both runs show the same trends, but the assessment without IUU estimates gives a slightly lower F in the most recent years and a slightly higher SSB. The recent trends are however, very similar.

There is a notable systematic difference between the time series of abundance at age from the XSA and those observed by the surveys, namely that the XSA time series is smoother and generally does not follow the relatively sharp peaks and through seen in the surveys. Neither the reason for this nor its significance for the assessment are fully understood (Figure 4.7).

4.5.2 Fishing mortality and VPA (Tables 4.12-4.18 and Figures 4.1A-D, 4.8-9)

The tuning diagnostics of the final XSA (predation included) is given in Table 4.12, the retrospective plot in Figure 4.8 and the log catchability residuals plot is presented in Figure 4.9.

The proportion of M and F before spawning was set to 0. Fishing morality are given in Table 4.13, while the stock numbers and spawning stock numbers, stock biomass at age and the spawning biomass at age of the final VPA are given in Tables 4.14-4.17. A summary of landings, fishing mortality, spawning stock biomass, and recruitment since 1950 are given in Table 4.18 and Figures 4.1A, 4.1B, 4.1C and 4.1D.

The assessments show a stable fishing mortality over the last three years, but the Fishing mortalities for the most recent years have been estimated higher this year than last year (Figure 4.8). Fishing mortality is currently estimated well below the long term mean but only slightly below Fpa.

The dominating feature of the updated assessments is the rapid increase in biomass in 2008 and further in 2009, which is mainly the effect of a vastly improved recruitment. The increase in spawning stock biomass is still present but the rate of increase appears smaller compared to last year

4.5.3 Catch options for 2010-2011 (Tables 4.19 - 4.22)

Input to the predictions is given in Table 4.19. The estimated catch in 2008 gives F=0.34 and the corresponding spawning stock biomasses is 241 000 t at the beginning of 2009, which is among the highest recorded.

The average F for the last three years (F status quo, F_{sq}=0.36) was used for 2009. The deterministic projection shows a further increase in SSB in the beginning of 2010 (Table 4.20).

Fishing at $\mathbf{F_{pa}}$ in 2010 corresponds to total landings more than 320 000 t, raising the SSB at the beginning of 2011 further to more than 460 000 t (Table 4.21). But the 25 % limitation restricting the TAC (see Section 4.7.2) results in a TAC on 242 500 t for 2010 (+25% compared to TAC for 2009 equal to 194 000 t) predicting F=0.25 in 2010 (Table 4.22).

4.6 Comments to the assessment and forecasts

The problems using XSA on the Northeast Arctic haddock stock was discussed in 2008 (WD 24, AFWG 2008). The main conclusion was, and still is, that the XSA output is rather sensitive to the XSA settings (Figure 4.10), but the reasons for this are not fully understood.

See also section 4.1.3 concerning F-pattern used in predictions.

The table below mainly reflects uncertainties in assessment and forecasts.

SOURCE OF UNCERTAINTY	DESCRIPTION	COMMENTS
Incomplete survey coverage (1)	Since 1997 all of the surveys used for tuning have 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 (see AFWG 2007 and 4.2).
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).	May appear as year class dependent changes in survey catchability. Catches of haddock in Norwegian statistical areas 06 and 07 (coastal areas) are added to the NEA haddock. These include haddock of older ages compared to the landings of NEA haddock. Since the surveys do not cover the coastal regions the coverage of older ages may be poorer.
Correlated error structures	Year effects in a survey are quite common. The year effect introduces correlated errors between the age groups, but in this case also between survey series.	
Discards	The level of discarding is not known.	Discarding is known to be a (varying) problem in the longline fisheries related to the abundance of haddock close to, but below the minimum landing size.
Unreported catches	This year, estimates for unreported catches were provided for 2002-2008.	The estimates are considered quite uncertain.
Predation on young age groups	The survival due to predation (to a large extent by cod) varies substantially from year to year.	The predictions of young age groups are very uncertain, escpecially for the 3-years HCR.
Sampling error	Estimation of catch at age is based on sampling of catches. The error in the estimates caused by sampling can be considerable even if the total catch is known. The estimation of the abundance indices from surveys will also be affected by sampling error.	The effect of not taking sampling error into account when fitting models to data may introduce bias in the resulting estimates. This bias is likely to increase with sampling error.

4.7 Reference points and harvest control rules (Tables 4.23 and Figures 4.2-4.3)

4.7.1 Biomass and fishing mortality reference points

In 2006 the data used in the assessment were revised for the entire time series, and some additional catches previously not included into statistic (Norwegian statistical regions 06 and 07) have been added (see AFWG 2006 for a detailed description). The reference points have not been updated accordingly. The biomass reference points previously adopted and currently used by ACFM for this stock are $\mathbf{B}_{lim}$=50,000 t and $\mathbf{B}_{pa}$ =80,000 t. The fishing mortality reference points are $\mathbf{F}_{lim}$=0.49 and $\mathbf{F}_{pa}$ =0.35 (Figure 4.4). Due to time constraints there was no work done during the AFWG meeting on revising the reference points of NEA haddock. The WG leave this work to the next benchmark assessment. 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.

4.7.2 Harvest control rule

The harvest control rule (HCR) was evaluated by ICES in 2007 (AFWG 2007) and found to be in agreement with the precautionary approach. The agreed HCR for haddock is as follows (Protocol of the 36th Session of The Joint Norwegian Russian Fishery Commission, 10 October 2007):

- *TAC for the next year will be set at level corresponding to F_{pa}.*
- *The TAC should not be changed by more than +/- 25% compared with the previous year 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 and a year ahead) there should be no limitations on the year-to-year variations in TAC.*

4.8 Comments to Technical Minutes from ACFM

Our comments to Technical Minutes from ACFM are in *italics* below each comment from ACFM.

General comments

The use of FLR gives nice results but it seems difficult to get an overview of diagnostics and data, and to fully evaluate results.

See below.

IUU handling: for cod there is a 6 year time series for IUU fisheries, for haddock only the last 3 years of less precise datasets. The WG decided last year to use the IUU cod time series to make haddock IUU estimates based on proportion of cod/haddock in catches. This was attempted last year but not accepted by the RG. The IUU catches are around 10-15% of the catches and they do not influence the assessment very much.

RG asks for explanation on the history of IUU influence before 2002 (1st year of IUU data). The WG can include a sentence on the assumption that before 2002 IUU fisheries was low or negligible. RG accepts the WG way of calculating IUU catches.

We have added a sentence on this in Section 4.1.2.

Last years the XSA and survey indices results did not match, causing the RG not to accept the assessment. This year the survey indices do support the increase that XSA showed previously as well (figure 4.7).

Predictions depend on cyclic periods of high recruitment, followed by a period of slow growth and maturation processes. The WG used previously encountered trends as feed in to the predictions. This amounts to the same settings as last year which is a positive outcome.

Technical comments

1. RG notes that there may be density dependent mortality, judging the differences between XSA and survey runs. Work for next benchmark.

   This is noted and see last comment.

2. Table 4.12: Diagnostics are lacking. RG needs to see survivor estimates, t-statistics, slopes, standard errors, weights of estimates to evaluate the results of the assessment. The results as they are look very stable between surveys. The WG Chair kindly provided a standard XSA run with all diagnostics for comparison, (see attached Table). The diagnostics indicate consistent estimates of survivors by three surveys. Generally, RG did not find serious indications in diagnostics to reject assessment.

   To avoid any confusion we have included diagnostics from a standard XSA run in sharepoint (file "Table4.12lowestoft" on AFWG 2009 > Data > NEA haddock>LowestoftXSA). It should however be noticed that FLR and standard XSA do not produce equivalent results, although very similar and the same from a practical point of view, probably due to rounding errors and perhaps a different implementation of convergence criteria (see also WD24, in last year report).

3. In paragraph 4.4.4. the WG states that the WG 'believes' that the estimated recruitment in the most recent years is so high that it will affect growth and maturation processes. This 'belief' is explained through graphs, the RG would like to see this explanation next year in text and statistical terms.

   A valid comment, but the working group has decided to postpone this work to the benchmark assessment due to time limitations on this WG. Furthermore, in the present situation, it is highly unlikely that this will affect the advice for 2010.

4. Tables B1-B4: please improve table headings: it is unclear what +/- signs mean.

   This is noted.

5. A table with meta data on survey coverage is needed especially since there are problems with survey coverage, both Russian and Norwegian. It would be useful to have a table that gives the annual area covered by the surveys, the total unadjusted abundance/biomass, and the total adjusted abundance/biomass. This would help us understand the adjustments.

   We agree. The areas covered are now included in the tables B1 and B3.

6. The level of IUU catch seems uncertain, but important. Some estimates for 2002-2007 are available. One wonders about IUU prior to 2002. This makes the XSA results uncertain. Total mortalities should be corroborated by a survey-only analysis.

   This is likely to shed some light on the situation. However, due to time constraints we consider this too as work for the next benchmark.

7. Figure 4.7. The surveys themselves are curious. The NBT tends to peak 1-2 years later than NAC or RBT. One wonders if the average-age's in these Q-corrected surveys are the same. They should be if the catchability model is correct.

   This may be true for some ages and some years (ages 4-6, 2000-), but is not the general picture (see figure 4.7). We would claim that the surveys are remarkably similar.

8. Figure 4.7. The XSA would not follow the peaks and valleys in the surveys if there is density-dependent mortality (M) that is not in the XSA. This could also explain some of the cohort trends in residuals in Fig. 4.9. Another possible cause if incorrect catchability assumptions for the surveys.

   This is noted, but will be part of the next benchmark where other models than XSA will be explored.

9. The retrospective diagnostics in Figure 4.8 are not good, although they are not severe either. It is not surprising to have retro's when there are some cohort-trends in residuals. This indicates that there are stock processes that are changing but this change is not accounted for in the XSA.

   See below.

10. Overall there is a sense that the XSA has not given a very good description of the stock dynamics. It may be reasonable enough for short-term management considerations, but this depends on the processes that are apparently not accounted for by the XSA. For example, if there is density-dependent mortality that increases for large year classes (prey-switching) then the M in the projections may be too low. This is speculation, but the patterns in the XSA diagnostics makes one want to speculate about what is really going on. I am not confident that fishing at Fpa will lead to 2010 SSB described in Table 4.21. Nonetheless, the bottom panel of Fig. 4.4 suggests that substantial model misspecification would be required for this stock to pose a conservation concern.

    In general there are a number of points suggesting that either XSA does not give a good and/or perhaps in combination with the quality of the input data and assumptions made about them. For example we suspect that discarding might present a serious problem, but we do not currently have any good data on it. All this calls for a benchmark assessment for haddock. However we do believe that the current situation of the stock is well described, although there is a question of the absolute level of the stock, and the actual size of the stock now compared to the long term dynamics. For a benchmark we will look into other models such as Surba, the model presented in last year report (WD25, 2008) and others. We are not aware of any existing models taking density dependent mortality into account, although it can be included in the model presented in last year report (WD25, 2008). Other hints on this subject will be appreciated!

Conclusions

The RG concludes that the use of FLR needs further development within WG: a well prepared script in R is needed to produce in FLR not only stock dynamics results but full diagnostic output and preliminary analysis of the data as well. Such scripts were developed and used by other WG's (e.g. HAWG, WGBFAS) and could be used for Arctic stocks after some modifications.

The RG decides to accept the assessment on the basis of the improvement diagnostics and a clearer explanation of the IUU calculation. Moreover, the stock is on the safe side, with an underestimation of SSB and overstimation of F within the assessment.

RG accepts the prediction, while remarking that overall there is a sense that the XSA has not given a very good description of the stock dynamics. It may be reasonable enough for short-term management considerations, but this depends on the processes that are apparently not accounted for by the XSA.

Table 4.1 North-East Arctic HADDOCK. Total nominal catch (t) by fishing areas. (Data provided by Working Group members).

Year	Subarea I	Division IIa	Division IIb	2 unreported	3 unreported	2 Total	3 Total	4 Norwegian statistical areas 06 and 07
1960	12502	27781	1844	-	-	15465	15465	6000
1961	16515	25641	2427	-	-	19322	19322	4000
1962	16056	25125	1723	-	-	18740	18740	3000
1963	12433	20956	936	-	-	14622	14622	4000
1964	79262	18784	1112	-	-	99158	99158	6000
1965	98921	18719	943	-	-	11858	11858	6000
1966	12500	35143	1626	-	-	16177	16177	5000
1967	10799	27962	440	-	-	13639	13639	3000
1968	14097	40031	725	-	-	18172	18172	3000
1969	89948	40306	566	-	-	13082	13082	2000
1970	60631	27120	507	-	-	88258	88258	-
1971	56989	21453	463	-	-	78905	78905	-
1972	22188	42111	2162	-	-	26615	26615	-
1973	28564	23506	13077	-	-	32222	32222	-
1974	15905	47037	15069	-	-	22115	22115	10000
1975	12169	44337	9729	-	-	17575	17575	6000
1976	94054	37562	5648	-	-	13726	13726	2000
1977	72159	28452	9547	-	-	11015	11015	2000
1978	63965	30478	979	-	-	95422	95422	2000
1979	63841	39167	615	-	-	10362	10362	6000
1980	54205	33616	68	-	-	87889	87889	5098
1981	36834	39864	455	-	-	77153	77153	4767
1982	17948	29005	2	-	-	46955	46955	3335
1983	5837	16859	1904	-	-	24600	24600	3112
1984	2934	16683	1328	-	-	20945	20945	3803
1985	27982	14340	2730	-	-	45052	45052	3583
1986	61729	29771	9063	-	-	10056	10056	4021
1987	97091	41084	16741	-	-	15491	15491	3194
1988	45060	49564	631	-	-	95255	95255	3756
1989	29723	28478	317	-	-	58518	58518	4701
1990	13306	13275	601	-	-	27182	27182	2912
1991	17985	17801	430	-	-	36216	36216	3045
1992	30884	28064	974	-	-	59922	59922	5634
1993	46918	32433	3028	-	-	82379	82379	5559
1994	76748	50388	8050	-	-	13518	13518	6311
1995	75860	53460	13128	-	-	14244	14244	5444
1996	11274	61722	3657	-	-	17812	17812	5126
1997	78128	73475	2756	-	-	15435	15435	5987
1998	45640	53936	1054	-	-	10063	10063	6338
1999	38291	40819	4085	-	-	83195	83195	5743
2000	25931	39169	3844	-	-	68944	68944	4536
2001	35072	47245	7323	-	-	89640	89640	4542
2002	40721	42774	12567	18736	5310	11479	10137	6898
2003	53653	43564	8483	33226	9417	13892	11511	4279
2004	64873	47483	12146	33777	8661	15827	13316	3743
2005	53518	48081	16416	40283	9949	15829	12796	5538
2006	51124	47291	33291	21451	8949	15315	14065	5410
2007	62904	58141	25927	14553	3102	16152	15007	7110
2008[1]	58379	60178	31219	5828	-	15560	14977	6629

1 Provisional figures, Norwegian catches on Russian quotas are included

2 Figures based on Norwegian IUU estimates

3 Figures based on Russian IUU estimates

4 Included in total landings and in landings in region IIa

Table 4.2 North-East Arctic HADDOCK. **Total nominal catch ('000 t) by trawl and other gear for each area.**

		Sub-area I		Division IIa		Division IIb		[2] unreported	[3] unreported
Year		Trawl	Others	Trawl	Others	Trawl	Others		
1967		73.7	34.3	20.5	7.5	0.4	-	-	-
1968		98.1	42.9	31.4	8.6	0.7	-	-	-
1969		41.4	47.8	33.2	7.1	1.3	-	-	-
1970		37.4	23.2	20.6	6.5	0.5	-	-	-
1971		27.5	29.2	15.1	6.7	0.4	-	-	-
1972		193.9	27.9	34.5	7.6	2.2	-	-	-
1973		242.9	42.8	14.0	9.5	13.1	-	-	-
1974		133.1	25.9	39.9	7.1	15.1	-	-	-
1975		103.5	18.2	34.6	9.7	9.7	-	-	-
1976		77.7	16.4	28.1	9.5	5.6	-	-	-
1977		57.6	14.6	19.9	8.6	9.5	-	-	-
1978		53.9	10.1	15.7	14.8	1.0	-	-	-
1979		47.8	16.0	20.3	18.9	0.6	-	-	-
1980		30.5	23.7	14.8	18.9	0.1	-	-	-
1981		18.8	17.7	21.6	18.5	0.5	-	-	-
1982		11.6	11.5	23.9	13.5	-	-	-	-
1983		3.6	2.2	8.7	8.2	0.2	1.7	-	-
1984		1.6	1.3	7.6	9.1	0.1	1.2	-	-
1985		24.4	3.5	6.2	8.1	0.1	2.6	-	-
1986		51.7	10.1	14.0	15.8	0.8	8.3	-	-
1987		79.0	18.1	23.0	18.1	3.0	13.8	-	-
1988		28.7	16.4	34.3	15.3	0.6	0.0	-	-
1989		20.0	9.7	13.5	15.0	0.3	0.0	-	-
1990		4.4	8.9	5.1	8.2	0.6	0.0	-	-
1991		9.0	8.9	8.9	8.9	0.2	0.2	-	-
1992		21.3	9.6	11.9	16.1	1.0	0.0	-	-
1993		35.3	11.6	14.5	17.9	3.0	0.0	-	-
1994		58.6	18.2	26.1	24.3	7.9	0.2	-	-
1995		63.9	12.0	29.6	23.8	12.1	1.0	-	-
1996		98.3	14.4	36.5	25.2	3.4	0.3	-	-
1997		57.4	20.7	44.9	28.6	2.5	0.3	-	-
1998		26.0	19.6	27.1	26.9	0.7	0.3	-	-
1999		29.4	8.9	19.1	21.8	4.0	0.1	-	-
2000		20.1	5.9	18.8	20.4	3.7	0.1	-	-
2001		28.4	6.7	23.4	23.8	7.0	0.3	-	-
2002		30.5	10.2	19.5	23.3	12.5	0.1	18.7	5.3
2003		42.7	10.9	21.9	21.7	8.1	0.4	33.2	9.4
2004		52.4	12.5	27.0	20.5	11.5	0.6	33.8	8.7
2005		38.5	15.0	24.9	20.9	13.0	1.6	40.3	9.9
2006		40.1	11	22	25.3	30.1	3.2	21.5	8.9
2007		51.8	11.1	30.5	27.7	20.4	5.5	14.6	3.1
2008	[1]	46.8	11.6	30.9	29.3	24.9	6.3	5.8	-

1 Provisional estimates **2 Figures based on Norwegian IUU estimates** **3 Figures based on Russian IUU**

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[5]	Poland	United Kingdom	Russia[2]	Others	unreported catches[3]	unreported catches[4]	Total[3]	Total[4]
1960	172	-	-	5597	46263	-	45469	57025	125	-	-	154651	154479
1961	285	220	-	6304	60862	-	39650	85345	558	-	-	193224	192939
1962	83	409	-	2895	54567	-	37486	91910	58	-	-	187408	187325
1963	17	363	-	2554	59955	-	19809	63526	-	-		146224	146224
1964	-	208	-	1482	38695	-	14653	43870	250	-		99158	99158
1965	-	226	-	1568	60447	-	14345	41750	242	-		118578	118578
1966	-	1072	11	2098	82090	-	27723	48710	74	-		161778	161778
1967	-	1208	3	1705	51954	-	24158	57346	23	-		136397	136397
1968	-	-	-	1867	64076	-	40129	75654	-	-		181726	181726
1969	2	-	309	1490	67549	-	37234	24211	25	-		130820	130820
1970	541	-	656	2119	37716	-	20423	26802	-	-		88257	88257
1971	81	-	16	896	45715	43	16373	15778	3	-		78905	78905
1972	137	-	829	1433	46700	1433	17166	196224	2231	-		266153	266153
1973	1212	3214	22	9534	86767	34	32408	186534	2501	-		322226	322226
1974	925	3601	454	23409	66164	3045	37663	78548	7348	-		221157	221157
1975	299	5191	437	15930	55966	1080	28677	65015	3163	-		175758	175758
1976	536	4459	348	16660	49492	986	16940	42485	5358	-		137264	137264
1977	213	1510	144	4798	40118	-	10878	52210	287	-		110158	110158
1978	466	1411	369	1521	39955	1	5766	45895	38	-		95422	95422
1979	343	1198	10	1948	66849	2	6454	26365	454	-		103623	103623
1980	497	226	15	1365	66501	-	2948	20706	246	-		92504	92504
1981	381	414	22	2402	63435	Spain	1682	13400	-	-		81736	81736
1982	496	53	-	1258	43702	-	827	2900	-	-		49236	49236
1983	428	-	1	729	22364	139	259	680	-	-		24600	24600
1984	297	15	4	400	18813	37	276	1103	-	-		20945	20945
1985	424	21	20	395	21272	77	153	22690	-	-		45052	45052
1986	893	12	75	1079	52313	22	431	45738	-	-		100563	100563

1987	464	7	83	3105	72419	59	563	78211	5	-		154916	154916
1988	1113	116	78	1323	60823	72	435	31293	2	-		95255	95255
1989	1217	-	26	171	36451	1	590	20062	-	-		58518	58518
1990	705	-	5	167	20621	-	494	5190	-	-		27182	27182
1991	1117	-	Greenld	213	22178	-	514	12177	17	-		36216	36216
1992	1093	151	1719	387	36238	38	596	19699	1	-		59922	59922
1993	546	1215	880	1165	40978	76	1802	35071	646	-		82379	82379
1994	2761	678	770	2412	71171	22	4673	51822	877	-		135186	135186
1995	2833	598	1097	2675	76886	14	3111	54516	718	-		142448	142448
1996	3743	6	1510	942	94527	669	2275	74239	217	-		178128	178128
1997	3327	540	1877	972	103407	364	2340	41228	304	-		154359	154359
1998	1903	241	854	385	75108	257	1229	20559	94	-		100630	100630
1999	1913	64	437	641	48182	652	694	30520	92	-		83195	83195
2000	631	178	432	880	42009	502	747	22738	827	-		68944	68944
2001	1210	324	553	554	49067	1497	1068	34307	1060	-		89640	89640
2002	1564	297	858	627	52247	1505	1125	37157	682	18736	5310	114798	101372
2003	1959	382	1363	918	56485	1330	1018	41142	1103	33226	9417	138926	115117
2004	2484	103	1680	823	62192	54	1250	54347	1569	33777	8661	158279	133163
2005	2138	333	15	996	60850	963	1899	50012	1262	40283	9949	158751	128417
2006	2390	883	1830	989	69272	703	1164	53313	1162	21451	8949	153157	140655
2007	2307	277	1464	1123	71244	125	1351	66569	2511	14553	3102	161525	150074
2008[1]	2687	311	1659	535	72779	283	971	68792	1759	5828	-	155604	149776

1 Provisional figures. 2 USSR prior to 1991. 3 Figures based on Norwegian IUU estimates

4 Figures based on Russian IUU estimates 5 included landings in Norwegian statistical areas 06 and 07 (from 1983)

Table 4.4. Northeast Arctic haddock. Catch numbers at age (numbers, thousands spec.)

year										
age	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	3189	65643	6012	64528	6563	1154	16437	2074	1727	20318
4	37949	9178	151996	13013	154696	10689	5922	24704	5914	7826
5	35344	18014	13634	70781	5885	176678	14713	7942	31438	7243
6	18849	13551	9850	5431	27590	4993	127879	12535	5820	14040
7	28868	6808	4693	2867	3233	28273	3182	46619	12748	3154
8	9199	6850	3237	1080	1302	1445	8003	1087	17565	2237
9	1979	3322	2434	424	712	271	450	1971	822	5918
10	1093	1182	606	315	319	100	200	356	1072	285
11+	2977	1348	880	1005	543	100	185	176	601	500
TOTNU	139447	125896	193342	159444	200843	223703	176971	97464	77707	61521
TONS	132125	120077	127660	123920	156788	202286	213924	123583	112672	88211
SOPCOF%	61	79	54	67	66	63	77	78	86	102

year										
age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	39910	15429	39503	28466	22363	5936	26345	15907	657	1524
4	70912	56855	30868	72736	49290	46356	22631	41346	67632	1968
5	13647	63351	48903	18969	30672	40201	63176	13496	41267	44634
6	7101	8706	33836	13579	5815	12631	29048	25719	7748	19002
7	6236	3578	3201	9257	3527	1679	5752	8872	15599	3620
8	1579	4407	1341	1239	2716	974	582	1616	5292	4937
9	2340	788	1773	559	833	897	438	218	655	1628
10	2005	527	242	409	104	123	189	175	182	316
11+	606	1434	756	375	633	802	242	271	286	109
TOTNU	144336	155075	160423	145589	115953	109599	148403	107620	139318	77738
TONS	154651	193224	187408	146224	99158	118578	161778	136397	181726	130820
SOPCOF%	92	97	92	85	72	84	83	98	98	110

year										
age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	23444	1978	230942	70679	9685	10037	13994	55967	47311	17540
4	2454	24358	22315	260520	41706	14088	13454	22043	18812	35290
5	1906	1257	42981	24180	88120	33871	6810	7368	4076	10645
6	22417	918	3206	6919	5829	49711	20796	2586	1389	1429
7	8100	9279	1611	422	4138	2135	40057	7781	1626	812
8	2012	3056	6758	426	382	1236	1247	11043	2596	546
9	2016	826	2638	1692	618	92	1350	311	6215	1466
10	740	1043	900	529	2043	131	193	388	162	2310
11+	293	534	1652	584	1870	934	1604	379	400	323
TOTNU	63382	43249	313003	365951	154391	112235	99505	107866	82587	70361
TONS	88257	78905	266153	322226	221157	175758	137264	110158	95422	103623
SOPCOF%	100	124	88	83	108	107	84	83	105	127

Table 4.4 (continued).

year										
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	627	486	883	1173	1271	29624	23113	5031	1439	2157
4	22878	2561	900	2636	1019	1695	68429	87170	12478	4986
5	21794	22124	3372	1360	1899	564	1565	64556	47890	16071
6	2971	10685	12203	2394	657	1009	783	960	20429	25313
7	250	1034	2625	2506	950	943	896	597	397	3198
8	504	162	344	1799	2619	886	393	376	178	147
9	230	162	75	267	352	1763	702	212	74	1
10	842	72	80	37	87	588	1144	230	88	28
11+	1460	963	649	292	77	281	987	738	446	177
TOTNU	51556	38249	21131	12464	8931	37353	98012	159870	83419	52078
TONS	87889	77153	46955	24600	20945	45052	100563	154916	95255	58518
SOPCOF%	129	136	135	94	92	100	95	101	100	102

year										
age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	1015	4421	11571	13487	3374	2003	1662	2280	1701	16839
4	2580	3564	11567	19457	47821	16109	6818	5633	11304	8039
5	2142	2416	4099	13704	36333	72644	36473	12603	9258	15365
6	4046	3299	2642	4103	13264	19145	73579	32832	8633	6073
7	6221	4633	2894	1747	2057	6417	13426	49478	13801	4466
8	840	3953	3327	1886	903	746	2944	5636	19469	6355
9	134	461	3498	2105	1453	361	573	778	2113	6204
10	42	83	486	1965	2769	770	365	245	330	647
11+	71	54	84	323	2110	1576	1897	748	490	446
TOTNU	17091	22884	40168	58777	110084	119771	137737	110233	67099	64434
TONS	27182	36216	59922	82379	135186	142448	178128	154359	100630	83195
SOPCOF%	97	96	100	99	99	98	98	95	98	97

year									
age	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	1520	12971	7132	6803	7993	11452	4539	30707	14536
4	29986	5230	46335	31448	21116	19369	35040	15213	44192
5	6496	32049	11084	56480	41310	22887	27571	45992	15926
6	5149	5279	21985	11736	41226	37067	15033	18516	31173
7	2406	2941	2602	14541	4939	24461	16023	10642	9145
8	1657	1137	1602	1637	4914	2393	8567	7889	4520
9	1570	1161	482	2178	598	2997	1259	2570	2846
10	1744	1169	448	858	1252	990	1298	678	1181
11+	437	1204	1029	1219	901	1524	718	988	654
TOTNU	50965	63141	92699	126900	124249	123140	110048	133195	124173
TONS	68944	89640	114798	138926	158279	158298	153157	161525	155604
SOPCOF%	97	100	99	98	98	99	100	100	100

Table 4.5. Northeast Arctic haddock. Catch weights at age (kg)

year										
	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768
4	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065
5	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353
6	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663
7	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921
8	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183
9	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463
10	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752
11+	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177
SOPCOF%	61	79	54	67	66	63	77	78	86	102

year										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768
4	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065
5	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353
6	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663
7	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921
8	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183
9	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463
10	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752
11+	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177
SOPCOF%	92	97	92	85	72	84	83	98	98	110

year										
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768
4	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065	1.065
5	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353
6	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663	1.663
7	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921	1.921
8	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183	2.183
9	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463	2.463
10	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752	2.752
11+	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177	3.177
SOPCOF%	100	124	88	83	108	107	84	83	105	127

Table 4.5 (continued).

year										
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	0.768	0.768	0.768	1.033	1.218	0.835	0.612	0.497	0.55	0.684
4	1.065	1.065	1.065	1.408	1.632	1.29	1.064	0.765	0.908	0.84
5	1.353	1.353	1.353	1.71	2.038	1.816	1.539	1.179	1.097	0.998
6	1.663	1.663	1.663	2.149	2.852	2.174	1.944	1.724	1.357	1.176
7	1.921	1.921	1.921	2.469	2.845	2.301	2.362	2.135	1.537	1.546
8	2.183	2.183	2.183	2.748	3.218	2.835	2.794	2.551	1.704	1.713
9	2.463	2.463	2.463	3.069	3.605	3.253	3.25	3.009	2.403	1.949
10	2.752	2.752	2.752	3.687	4.065	3.721	3.643	3.414	2.403	2.14
11+	3.177	3.177	3.177	4.516	4.667	4.416	5.283	4.213	2.571	2.685
SOPCOF%	129	136	135	94	92	100	95	101	100	102

year										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.793	0.941	0.906	0.94	0.614	0.739	0.683	0.682	0.748	0.826
4	1.172	1.281	1.263	1.204	0.906	0.808	0.868	1.028	0.974	1.079
5	1.397	1.556	1.535	1.487	1.287	1.107	1.045	1.151	1.262	1.261
6	1.624	1.797	1.747	1.748	1.602	1.556	1.363	1.369	1.433	1.485
7	1.885	2.044	2.043	1.994	1.968	1.838	1.71	1.637	1.641	1.634
8	2.112	2.079	2.2	2.237	2.059	2.234	1.886	1.856	1.863	1.798
9	2.653	2.311	2.298	2.417	2.39	2.416	2.214	2.073	2.069	2.032
10	3.102	2.788	2.494	2.654	2.545	2.602	2.37	2.5	2.335	2.237
11+	3.338	3.219	2.652	3.026	2.893	3.13	2.675	2.554	2.81	2.712
SOPCOF%	97	96	100	99	99	98	98	95	98	97

year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.853	0.751	0.687	0.594	0.636	0.722	0.745	0.652	0.658
4	1.186	1.104	1.001	0.875	0.886	0.906	1.041	0.899	0.901
5	1.395	1.459	1.363	1.113	1.183	1.121	1.287	1.197	1.242
6	1.588	1.709	1.643	1.364	1.508	1.343	1.504	1.435	1.515
7	1.808	1.921	1.975	1.361	1.821	1.619	1.72	1.722	1.781
8	1.989	2.182	2.086	1.972	2.075	2.036	2.082	1.99	2.18
9	2.264	2.331	2.294	1.636	2.339	2.177	2.377	2.309	2.33
10	2.415	2.609	2.487	1.877	2.58	2.382	2.738	2.715	2.664
11+	2.892	2.981	2.778	2.409	2.991	2.768	3.212	3.028	3.328
SOPCOF%	97	100	99	98	98	99	100	100	100

Table 4.6. Northeast Arctic haddock. Stock weights at age (kg)

year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356
4	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656
5	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018
6	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425
7	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861
8	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
9	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767
10	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195
11+	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602

year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356
4	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656
5	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018
6	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425
7	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861
8	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
9	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767
10	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195
11+	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602

year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356	0.356
4	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656	0.656
5	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018	1.018
6	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425	1.425
7	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861
8	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
9	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767	2.767
10	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195	3.195
11+	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602	3.602

Table 4.6 (continued).

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	0.448	0.598	0.624	0.518	0.387	0.375	0.307	0.327	0.38	0.441
4	0.869	0.797	1.043	1.089	0.918	0.695	0.678	0.565	0.599	0.684
5	1.163	1.305	1.209	1.553	1.623	1.386	1.062	1.042	0.882	0.931
6	1.682	1.589	1.772	1.656	2.09	2.188	1.891	1.467	1.447	1.243
7	2.303	2.129	2.028	2.246	2.115	2.628	2.756	2.406	1.889	1.873
8	3.151	2.745	2.57	2.465	2.711	2.569	3.145	3.306	2.913	2.312
9	3.333	3.534	3.164	2.993	2.888	3.154	3.005	3.63	3.826	3.397
10	3.582	3.708	3.883	3.554	3.392	3.29	3.569	3.416	4.075	4.307
11+	3.865	3.94	4.052	4.201	3.914	3.765	3.668	3.952	3.797	4.477

year										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.409	0.398	0.336	0.276	0.26	0.279	0.297	0.327	0.344	0.334
4	0.783	0.731	0.715	0.611	0.508	0.481	0.516	0.545	0.595	0.626
5	1.048	1.186	1.113	1.094	0.946	0.796	0.756	0.812	0.853	0.923
6	1.307	1.452	1.624	1.53	1.512	1.321	1.123	1.072	1.151	1.202
7	1.631	1.709	1.876	2.075	1.964	1.947	1.719	1.477	1.415	1.519
8	2.306	2.033	2.124	2.305	2.524	2.397	2.385	2.124	1.844	1.773
9	2.726	2.733	2.437	2.539	2.728	2.959	2.819	2.814	2.525	2.214
10	3.85	3.123	3.145	2.834	2.947	3.137	3.372	3.222	3.224	2.914
11+	4.746	4.268	3.496	3.538	3.219	3.341	3.526	3.758	3.601	3.611

year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.289	0.297	0.279	0.286	0.299	0.32	0.332	0.33	0.302
4	0.608	0.531	0.545	0.513	0.526	0.549	0.586	0.605	0.604
5	0.969	0.942	0.831	0.85	0.804	0.825	0.859	0.913	0.94
6	1.291	1.353	1.317	1.173	1.195	1.136	1.165	1.21	1.281
7	1.579	1.684	1.762	1.716	1.541	1.564	1.494	1.533	1.589
8	1.903	1.969	2.087	2.18	2.123	1.923	1.946	1.865	1.915
9	2.136	2.292	2.362	2.488	2.596	2.528	2.307	2.329	2.24
10	2.58	2.497	2.678	2.749	2.881	3.002	2.922	2.686	2.704
11+	3.284	2.934	2.85	3.055	3.124	3.258	3.39	3.298	3.053

Table 4.7. Northeast Arctic haddock. Natural mortality (M) at age

year										
	1950-1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	0.325	0.2074	0.2	0.6477	0.2	0.4049	0.2	0.3193	0.2	0.2058
4	0.2314	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2252	0.2	0.2	0.2	0.2	0.2024	0.2	0.2	0.2	0.2
6	0.2058	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11+	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

year										
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.2617	0.2956	0.3446	0.758	0.4731	0.2377	0.2017	0.2268	0.215	0.3272
4	0.2255	0.2174	0.3668	0.2978	0.2436	0.25	0.2	0.2081	0.2013	0.2103
5	0.2681	0.2115	0.3052	0.2246	0.2232	0.2208	0.2	0.2079	0.2	0.21
6	0.2	0.2005	0.2082	0.2228	0.2097	0.2	0.2	0.2042	0.2	0.204
7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11+	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

year						
	2003	2004	2005	2006	2007	2008
3	0.4078	0.424	0.432	0.2204	0.2409	0.4741
4	0.2602	0.2755	0.299	0.2244	0.2206	0.2835
5	0.2079	0.2195	0.2502	0.2174	0.2251	0.4374
6	0.2	0.2	0.2188	0.2131	0.2097	0.2531
7	0.2	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2	0.2
11+	0.2	0.2	0.2	0.2	0.2	0.2

Table 4.8. Northeast Arctic haddock. Proportion mature at age

year										
	1950-1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	0.029	0.026	0.056	0.054	0.056	0.044	0.027	0.021	0.021	0.025
4	0.105	0.077	0.104	0.162	0.184	0.196	0.149	0.103	0.076	0.074
5	0.32	0.244	0.304	0.333	0.473	0.51	0.521	0.453	0.294	0.24
6	0.627	0.649	0.552	0.579	0.666	0.802	0.797	0.757	0.713	0.576
7	0.845	0.86	0.857	0.772	0.802	0.863	0.928	0.929	0.917	0.898
8	0.944	0.95	0.948	0.947	0.908	0.922	0.953	0.978	0.976	0.975
9	0.982	0.984	0.984	0.983	0.983	0.967	0.973	0.984	0.993	0.993
10	0.994	0.995	0.995	0.995	0.995	0.995	0.989	0.991	0.994	0.998
11+	1	1	1	1	1	1	1	1	1	1

year										
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.032	0.046	0.041	0.03	0.018	0.016	0.016	0.02	0.025	0.032
4	0.09	0.127	0.164	0.147	0.113	0.073	0.059	0.069	0.074	0.093
5	0.25	0.305	0.358	0.449	0.396	0.329	0.227	0.213	0.204	0.257
6	0.534	0.578	0.623	0.704	0.741	0.702	0.633	0.497	0.495	0.502
7	0.822	0.798	0.82	0.855	0.878	0.903	0.885	0.855	0.76	0.75
8	0.966	0.937	0.925	0.936	0.95	0.96	0.969	0.964	0.948	0.907
9	0.992	0.99	0.98	0.976	0.979	0.984	0.987	0.991	0.989	0.984
10	0.998	0.997	0.997	0.994	0.992	0.993	0.995	0.996	0.997	0.997
11+	1	1	1	1	1	1	1	1	1	1

year										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.043	0.029	0.03	0.022	0.022	0.026	0.028	0.019	0.013	0.011
4	0.117	0.147	0.101	0.109	0.091	0.079	0.09	0.098	0.068	0.061
5	0.306	0.348	0.394	0.314	0.323	0.256	0.252	0.278	0.314	0.248
6	0.583	0.62	0.664	0.708	0.636	0.627	0.563	0.57	0.596	0.624
7	0.76	0.796	0.855	0.88	0.895	0.841	0.848	0.808	0.821	0.834
8	0.898	0.9	0.927	0.949	0.958	0.967	0.952	0.951	0.933	0.934
9	0.969	0.966	0.967	0.978	0.984	0.987	0.99	0.985	0.983	0.978
10	0.995	0.99	0.989	0.989	0.992	0.995	0.996	0.997	0.995	0.995
11+	1	1	1	1	1	1	1	1	1	1

Table 4.9. Northeast Arctic haddock. 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

1983 2008

1 1 0.9 1.00

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	-11	-11	-11	-11	-11	-11	-11
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	46	19	32	32	10	27	10
1	29	115	38	46	8	5	15
1	289	61	196	39	37	8	3
1	207	262	60	109	26	11	2
1	149	261	334	40	65	11	4
1	193	189	399	450	47	24	4
1	328	251	221	299	231	34	16
1	110	206	113	94	107	87	5
1	792	136	240	86	48	57	24
1	792	1227	113	119	57	26	24
1	839	2142	838	73	137	38	14
1	127	2327	2557	1051	124	111	17

Table 4.9 (continued).

FLT02: Norwegian acoustic, age 1-7, shifted

1980 2008

1 1 0.99 1.00

1 7

1	140	50	210	600	180	10	0
1	20	30	40	40	100	60	0
1	50	20	30	10	10	40	20
1	1730	60	20	10	0	0	0
1	7760	2150	50	0	0	0	0
1	2660	4520	1890	0	0	0	0
1	170	490	1710	500	0	0	0
1	40	80	230	460	70	0	0
1	50	60	110	200	210	20	0
1	350	30	30	40	70	110	20
1	2520	450	80	30	30	30	60
1	8680	1340	230	20	0	0	10
1	6260	5630	1300	130	0	0	0
1	1930	2550	6310	1110	120	0	0
1	2850	360	1110	3870	420	20	0
1	2290	440	310	760	1510	80	0
1	240	510	170	120	430	430	20
1	1220	200	280	120	50	130	160
1	460	570	130	140	40	10	20
1	5090	320	650	190	110	20	10
1	3160	2100	230	220	10	10	0
1	2820	2160	1490	140	120	10	0
1	2790	1450	1980	1690	170	50	0
1	4740	1270	760	760	660	70	20
1	2090	2190	1020	360	400	90	0
1	8040	540	860	300	120	90	20
1	8680	3790	540	880	220	60	50
1	18352	7234	2517	573	742	102	58
1	2463	10217	7730	4021	313	149	16

Table 4.9 (continued).

FLT04: Norwegian BT survey, age 1-8, shifted
1982 2008
1 1 0.99 1.00
1 8

1	48	31	24	9	19	25	7	0
1	5146	189	15	8	2	1	4	1
1	15938	4759	147	5	5	1	1	4
1	3703	3846	1108	6	2	1	1	1
1	799	1544	2902	529	0	0	0	0
1	153	253	689	1164	138	1	0	0
1	95	141	216	340	327	34	1	0
1	546	45	34	50	92	118	18	0
1	3003	334	51	42	27	17	42	0
1	13755	1505	244	21	6	7	16	23
1	5990	5077	1056	105	6	4	3	4
1	2280	3395	4366	497	34	2	1	2
1	1793	536	1711	3395	345	28	0	1
1	2636	525	481	1486	2528	116	9	0
1	679	861	280	194	467	622	35	1
1	1379	227	332	132	34	80	81	7
1	576	598	122	102	28	10	17	11
1	4522	272	354	84	40	8	3	7
1	4603	2960	293	251	17	9	1	1
1	5347	3147	1853	176	82	8	3	0
1	5131	3174	1820	736	55	23	2	1
1	7112	1881	1027	804	462	59	11	2
1	4204	3465	1333	668	522	123	6	2
1	13131	774	1405	482	196	152	31	1
1	15938	5077	660	860	233	75	37	14
1	21294	15224	6009	868	489	62.7	25.1	8.2
1	3280	12704	7732	3654	385	106	14	1

Table 4.10. Northeast Arctic haddock. Input data for recruitment prediction (RCT3)

NORTHEAST ARCTIC HADDOCK: RECRUITS AS 3 YEAR-OLDS

9 19 2

'Year-class'	'VPA'	'NT1'	'NT2'	'NT3'	'NAK1'	'NAK2'	'NAK3'	'RT1'	'RT2'	'RT3'
1990	681	2006	1375.5	507.7	1890	868	563	-11	42.9	128.6
1991	302	1659.4	599	339.5	1135	626	255	16.7	28.2	35.7
1992	99	727.9	228	53.6	947	193	36	16.4	4.8	5.8
1993	104	603.2	179.3	52.5	562	285	44	3.5	4.9	4.2
1994	118	1463.6	263.6	86.1	1379	229	51	9.1	7.2	5.7
1995	59	309.5	67.9	22.7	249	24	20	6.4	2.3	1.9
1996	230	1268	137.9	59.8	693	122	57	6	4.6	11.5
1997	87	212.9	57.6	27.2	220	46	32	1.8	2.9	6.1
1998	373	1244.9	452.2	296	856	509	210	10.7	28.9	26.2
1999	357	847.2	460.3	314.7	1024	316	216	11.7	20.7	26.1
2000	236	1220.5	534.7	317.4	976	282	145	15.1	14.9	18.9
2001	245	1680.3	513.1	188.1	2062	279	127	20.8	19.3	25.1
2002	365	3332.1	711.2	346.5	2394	474	219	33.2	32.8	20.6
2003	171	715.9	420.4	77.4	752	209	54	19.8	11	13.6
2004	668	4630.2	1313.1	507.7	3364	804	379	50	79.2	122.7
2005	897	5141.3	1593.8	1522.4	2767	868	723.4	62	79.2	214.2
2006	-11	3874.4	2129.4	1270	3197	1835.2	1021.7	53.4	83.9	232.7
2007	-11	860.2	328	-11	1266.6	246.3	-11	6.5	12.7	-11
2008	-11	564.7	-11	-11	849	-11	-11	5.7	-11	-11

1990 RT was removed from XSA tuning

RT1 Russian bottom trawl survey age 1

RT2 Russian bottom trawl survey age 2

RT3 Russian bottom trawl survey age 3

NT1 Norwegian bottom trawl survey age 1

NT2 Norwegian bottom trawl survey age 2

NT3 Norwegian bottom trawl survey age 3

NA1 Norwegian acoustic survey age 1

NA2 Norwegian acoustic survey age 2

NA3 Norwegian acoustic survey age 3

Table 4.11. Northeast Arctic haddock. Analysis by RCT3 ver.1

Data for 9 surveys over 19 years : 1990 – 2008 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	=	2003	Regression				Prediction		
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
NT1	1.15	-2.66	0.61	0.589	13	6.57	4.9	0.706	0.033
NT2	0.87	0.33	0.42	0.746	13	6.04	5.61	0.493	0.067
NT3	0.7	1.87	0.3	0.851	13	4.36	4.94	0.355	0.129
NAK1	1.27	-3.32	0.7	0.522	13	6.62	5.09	0.805	0.025
NAK2	0.84	0.77	0.49	0.687	13	5.35	5.26	0.567	0.051
NAK3	0.76	1.84	0.2	0.931	13	4.01	4.87	0.233	0.302
RT1	1.42	1.81	0.83	0.406	12	3.03	6.11	0.997	0.016
RT2	0.84	3.18	0.31	0.847	13	2.48	5.27	0.357	0.128
RT3	0.78	3.2	0.24	0.903	13	2.68	5.3	0.275	0.215
VPA	Mean	=					5.29	0.69	0.034
Yearclass	=	2004	Regression				Prediction		
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
NT1	1.12	-2.44	0.57	0.589	14	8.44	7.03	0.77	0.034
NT2	0.88	0.24	0.43	0.714	14	7.18	6.58	0.557	0.065
NT3	0.69	1.93	0.29	0.845	14	6.23	6.26	0.365	0.151
NAK1	1.24	-3.13	0.65	0.525	14	8.12	6.96	0.855	0.027
NAK2	0.83	0.8	0.46	0.69	14	6.69	6.38	0.571	0.062
NAK3	0.75	1.89	0.21	0.918	14	5.94	6.35	0.26	0.298
RT1	1.42	1.71	0.85	0.369	13	3.93	7.31	1.151	0.015
RT2	0.84	3.17	0.3	0.841	14	4.38	6.86	0.409	0.12
RT3	0.8	3.15	0.23	0.896	14	4.82	7	0.334	0.181
VPA	Mean	=					5.28	0.651	0.047
Yearclass	=	2005	Regression				Prediction		
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
NT1	1	-1.6	0.5	0.687	15	8.55	6.91	0.647	0.047
NT2	0.87	0.34	0.41	0.769	15	7.37	6.72	0.518	0.074
NT3	0.73	1.8	0.3	0.858	15	7.33	7.12	0.414	0.115
NAK1	1.12	-2.3	0.57	0.631	15	7.93	6.55	0.695	0.041
NAK2	0.85	0.74	0.44	0.743	15	6.77	6.48	0.536	0.069
NAK3	0.78	1.78	0.2	0.929	15	6.59	6.9	0.274	0.262
RT1	1.19	2.25	0.7	0.522	14	4.14	7.18	0.918	0.023
RT2	0.78	3.3	0.28	0.879	15	4.38	6.73	0.356	0.156
RT3	0.73	3.29	0.24	0.907	15	5.37	7.24	0.336	0.175
VPA	Mean	=					5.39	0.707	0.039

Table 4.11 (continued).

Yearclass	=	2006	Regression				Prediction		
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
NT1	0.96	-1.33	0.46	0.761	16	8.26	6.58	0.554	0.055
NT2	0.88	0.29	0.39	0.813	16	7.66	7	0.5	0.068
NT3	0.68	2	0.28	0.894	16	7.15	6.87	0.356	0.135
NAK1	1.15	-2.51	0.56	0.681	16	8.07	6.77	0.685	0.036
NAK2	0.89	0.52	0.43	0.78	16	7.52	7.24	0.57	0.052
NAK3	0.76	1.85	0.19	0.948	16	6.93	7.14	0.254	0.264
RT1	1.09	2.48	0.61	0.639	15	4	6.85	0.756	0.03
RT2	0.79	3.29	0.26	0.906	16	4.44	6.78	0.33	0.156
RT3	0.68	3.43	0.24	0.923	16	5.45	7.13	0.312	0.175
VPA	Mean	=					5.53	0.78	0.028

Yearclass	=	2007	Regression				Prediction		
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
NT1	0.94	-1.18	0.45	0.769	16	6.76	5.15	0.523	0.122
NT2	0.87	0.31	0.39	0.814	16	5.8	5.36	0.453	0.163
NT3									
NAK1	1.13	-2.37	0.55	0.69	16	7.14	5.7	0.635	0.083
NAK2	0.89	0.56	0.42	0.795	16	5.51	5.46	0.481	0.145
NAK3									
RT1	1.08	2.52	0.6	0.65	15	2.01	4.69	0.719	0.065
RT2	0.78	3.3	0.26	0.908	16	2.62	5.35	0.302	0.367
RT3									
VPA	Mean	=					5.56	0.777	0.055

Yearclass	=	2008	Regression				Prediction		
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
NT1	0.92	-1.03	0.44	0.779	16	6.34	4.78	0.534	0.367
NT2									
NT3									
NAK1	1.11	-2.23	0.54	0.699	16	6.75	5.25	0.634	0.26
NAK2									
NAK3									
RT1	1.06	2.56	0.59	0.66	15	1.9	4.58	0.727	0.198
RT2 RT3									
VPA	Mean	=					5.59	0.773	0.175

Year Class Prediction	Weighted Average	Log WAP	Int Std Error	Ext Std Error	Var	VPA Ratio	Log VPA
2003	169	5.13	0.13	0.09	0.47	171	5.15
2004	689	6.54	0.14	0.14	0.95	668	6.51
2005	943	6.85	0.14	0.12	0.78	897	6.8
2006	1036	6.94	0.13	0.1	0.59		
2007	208	5.34	0.18	0.09	0.24		
2008	149	5	0.32	0.21	0.42		

Table 4.12. Northeast Arctic haddock. Extended Survivors Analysis

FLR XSA Diagnostics 2009-04-25 18:00:06

CPUE data from indices

Catch data for 59 years. 1950 to 2008. Ages 1 to 11.

fleet	first age	last age	first year	last year	alpha	beta
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	1	7	1983	2008	0.9	1
2 FLT02: Norwegian acoustic, age 1-7, shifted	1	7	1980	2008	0.99	1
3 FLT04: Norwegian BT survey, age 1-8, shifted	1	8	1982	2008	0.99	1

Time series weights :

Tapered time weighting applied

Power = 3 over 20 years

Catchability analysis :

Catchability independent of size for ages > 6

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 = 0.5

Minimum standard error for population

estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0	0	0	0	0	0	0	0	0	0
2	0.005	0.002	0.004	0.002	0.002	0.002	0.003	0.003	0.003	0.002
3	0.084	0.02	0.039	0.024	0.036	0.041	0.039	0.03	0.053	0.019
4	0.218	0.212	0.088	0.194	0.152	0.173	0.156	0.186	0.134	0.107
5	0.458	0.276	0.371	0.274	0.387	0.321	0.31	0.373	0.41	0.234
6	0.475	0.272	0.38	0.473	0.527	0.55	0.551	0.357	0.472	0.573
7	0.499	0.348	0.246	0.326	0.672	0.441	0.758	0.497	0.468	0.455
8	0.541	0.347	0.275	0.206	0.352	0.503	0.397	0.664	0.489	0.371
9	0.558	0.244	0.438	0.179	0.476	0.208	0.668	0.376	0.423	0.326
10	0.485	0.297	0.29	0.3	0.554	0.56	0.632	0.699	0.356	0.351
11	0.485	0.297	0.29	0.3	0.554	0.56	0.632	0.699	0.356	0.351

XSA population number (Thousand)

year	1	2	3	4	5	6	7	8	9	10	11
1999	1658982	133835	231599	45426	46249	17764	12566	16801	16028	1862	1271
2000	1963255	533383	87813	174080	29917	23962	9049	6247	8005	7509	1869
2001	1294661	500094	377011	68639	114350	18448	14887	5231	3615	5134	5253
2002	3312079	549631	359828	292435	51394	64623	10327	9528	3254	1909	4357
2003	4884330	547926	237698	253366	195259	31681	32844	6101	6351	2228	3132
2004	2885889	778999	247603	152548	167702	107698	15319	13733	3514	3229	2299
2005	7807896	481733	369531	155568	97417	97635	50873	8073	6798	2336	3552
2006	9343827	1191950	173937	230680	98681	55659	45224	19518	4444	2854	1558
2007	10964191	1749243	671772	135464	152987	54669	31463	22528	8228	2500	3615
2008	2487266	1963762	984514	500739	95024	81059	27655	16131	11306	4411	2425

Estimated population abundance at 1st Jan 2009

year	1	2	3	4	5	6	7	8	9	10	11
2009	14499	570498	946437	601348	338784	48569	35479	14374	9125	6690	2546

Table 4.12 (continued).

Fleet: 1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7

Log catchability residuals.

year											
age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	NA	NA	NA	NA	NA	NA	NA	NA	0.298	0.256	-0.09
2	NA	NA	NA	NA	NA	NA	NA	NA	0.155	0.148	0.109
3	NA	NA	NA	NA	NA	NA	NA	NA	0.041	0.286	0.235
4	NA	NA	NA	NA	NA	NA	NA	NA	-0.081	-0.032	0.494
5	NA	NA	NA	NA	NA	NA	NA	NA	-0.322	-0.314	0.174
6	NA	NA	NA	NA	NA	NA	NA	NA	-0.301	0.303	0.421
7	NA	NA	NA	NA	NA	NA	NA	NA	0.292	0.492	0.69

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.291	-0.245	-0.175	-0.265	-0.137	0.423	0.238	0.103	0.037	0.058	-0.172
2	0.072	-0.164	-0.107	-0.002	-0.075	0.253	-0.073	-0.042	-0.039	0.054	-0.254
3	0.167	-0.15	-0.067	-0.2	0.214	0.012	0.141	-0.096	0.038	0.101	-0.179
4	0.172	-0.245	0.109	0.135	0.055	0.288	-0.145	-0.057	0.203	0.1	-0.113
5	0.178	-0.145	0.539	-0.463	-0.337	0.219	0.266	-0.182	0.182	0.095	-0.216
6	0.025	0.039	0.264	-0.36	-0.493	0.018	-0.134	0.117	-0.333	0.421	0.044
7	-0.608	0.17	1.146	-1.164	0.145	-0.472	-0.692	-0.593	-0.152	0.406	-0.214

age	2005	2006	2007	2008
1	0.213	-0.024	-0.088	-0.148
2	-0.018	0.096	0.072	0.087
3	-0.132	-0.038	-0.083	0.188
4	-0.169	-0.307	-0.203	0.247
5	-0.228	-0.134	0.022	0.329
6	-0.109	-0.233	0.052	0.433
7	0.455	0.325	0.122	0.432

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

Mean_Logq	S.E_Logq
-7.2047	0.5769

Regression statistics

Ages with q dependent on year class strength

		slope	intercept
Age	1	0.73713	9.92503
Age	2	0.61433	9.44419
Age	3	0.62513	8.90255
Age	4	0.71663	8.21657
Age	5	0.71489	8.0203
Age	6	0.74758	7.77497

Table 4.12 (continued).

2 FLT02: Norwegian acoustic, age 1-7, shifted

Log catchability residuals.

	year										
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.399	0.523	0.437	0.436	0.161	-0.627	-0.156	-0.281	0.48	0.158	0.061
2	0.251	0.127	0.257	0.002	0.007	0.008	0.088	-0.282	0.096	0.049	0.102
3	-0.117	0.279	0.246	-0.044	0.136	0.005	0.023	0.011	-0.132	0.011	-0.074
4	-0.321	-0.216	0.363	0.136	-0.01	-0.107	0.131	-0.053	0.408	-0.46	-0.094
5	NA	NA	0.128	0.197	-0.107	0.026	-0.046	0.074	0.242	-0.413	-0.298
6	NA	NA	NA	-0.07	0.108	0.028	0.175	-0.315	0.253	-0.388	-0.156
7	-1.11	NA	NA	NA	NA	-0.018	0.818	-0.366	-0.069	NA	NA

age	2002	2003	2004	2005	2006	2007	2008
1	-0.066	0.014	-0.165	0.03	-0.215	0.225	-0.149
2	0.09	-0.001	0.007	-0.243	-0.103	-0.038	0.143
3	0.153	0.009	0.14	-0.229	-0.04	-0.199	0.2
4	0.168	-0.119	-0.112	-0.212	0.018	0.153	0.21
5	0.273	-0.002	-0.108	-0.206	0.013	0.2	0.19
6	-0.201	0.484	-0.236	-0.158	-0.06	0.265	0.244
7	NA	-0.165	NA	-0.517	0.257	0.74	-0.432

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

Mean_Logq	S.E_Logq
-6.3714	0.5832

Regression statistics

Ages with q dependent on year class strength

		slope	intercept
Age	1	0.85254	6.64557
Age	2	0.72951	7.42226
Age	3	0.71304	7.34642
Age	4	0.69993	7.34273
Age	5	0.59662	7.95292
Age	6	0.69712	7.59166

Table 4.12 (continued).

Table 4.12 (continued).

	Fleet: Log	FLT04: catchability	Norwegian residuals.	BT	survey,	age	1-8,	shifted			
age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.441	0.199
2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.149	-0.131
3	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.153	0.069
4	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.331	-0.349
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.039	-0.07
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.14	0.128
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.092	-0.685
8	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.38	-0.251

age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.276	-0.152	-0.018	-0.124	-0.297	-0.353	0.126	0.156	0.256	0.09	0.016
2	0.182	0.084	-0.032	0.116	0.077	-0.325	-0.053	0.04	0.101	0.263	0.019
3	-0.068	0.062	0.261	0.166	0.026	-0.078	-0.502	0.056	-0.072	-0.003	0.055
4	-0.05	0.06	0.306	0.107	0.155	-0.235	-0.018	-0.42	-0.005	-0.259	-0.109
5	-0.174	0.132	0.017	0.061	-0.053	0.069	-0.003	-0.058	-0.304	-0.018	-0.102
6	-0.153	0.156	0.235	0.054	-0.042	-0.108	0.01	-0.192	-0.044	-0.384	0.37
7	-0.767	NA	0.698	1.273	0.869	0.203	-0.542	-1.462	-0.962	-0.922	-0.031
8	0.061	0.526	NA	0.228	1.22	0.425	0.669	-0.481	NA	-1.044	0.24

age	2004	2005	2006	2007	2008
1	0.062	0.074	-0.08	0.014	-0.197
2	0.031	-0.185	-0.158	0.067	-0.021
3	0.16	-0.087	-0.029	0.104	0.053
4	0.174	0.001	-0.01	0.342	0.153
5	-0.003	0.017	0.067	0.053	0.247
6	-0.086	0.05	0.07	0.057	0.055
7	-0.105	0.653	0.688	0.634	0.166
8	-0.42	-0.688	1.334	0.482	-1.406

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

	7	8
Mean_Logq	-7.1032	-7.7142
S.E_Logq	0.7714	0.8211

Regression statistics

Ages with q dependent on year class strength

		slope	intercept
Age	1	0.82209	6.6275
Age	2	0.65892	7.75341
Age	3	0.68569	7.40202
Age	4	0.70542	7.27932
Age	5	0.52523	8.45483
Age	6	0.58361	8.19626

Table 4.12 (continued).

Terminal year survivor and F summaries:

Age 1 Year class =2007	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.304	466871	2007
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.241	479138	2007
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.304	449001	2007
fshk	0.11	2864433	2007
nshk	0.04	558875	2007
Age 2 Year class =2006	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.298	1091012	2006
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.298	1151786	2006
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.298	916786	2006
fshk	0.107	552380	2006
Age 3 Year class =2005	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.297	812086	2005
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.297	795670	2005
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.297	649827	2005
fshk	0.109	280567	2005
Age 4 Year class =2004	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.298	478157	2004
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.254	457247	2004
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.278	420735	2004
fshk	0.17	218918	2004
Age 5 Year class =2003	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.208	76936	2003
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.229	66733	2003
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.387	77745	2003
fshk	0.176	28893	2003
Age 6 Year class =2002	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.2	63320	2002
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.204	50352	2002
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.32	38999	2002
fshk	0.276	42736	2002
Age 7 Year class =2001	scaledWts	survivors	yrcls
1 FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	0.216	22136	2001
2 FLT02: Norwegian acoustic, age 1-7, shifted	0.241	9327	2001
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.106	16966	2001
fshk	0.437	10724	2001
Age 8 Year class =2000	scaledWts	survivors	yrcls
3 FLT04: Norwegian BT survey, age 1-8, shifted	0.173	2234	2000
fshk	0.827	6557	2000
Age 9 Year class =1999	scaledWts	survivors	yrcls
fshk	1	4746	1999
Age 10 Year class =1998	scaledWts	survivors	yrcls
fshk	1	2266	1998

Table 4.13. Northeast Arctic haddock. Fishing mortality at age

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
3	0.0491	0.1271	0.1049	0.0647	0.0552	0.0227	0.1027	0.0406	0.0256	0.065	0.1833
4	0.5767	0.2122	0.532	0.3791	0.2376	0.1304	0.1689	0.2419	0.1695	0.1689	0.3687
5	0.8142	0.6257	0.5767	0.5296	0.3043	0.4832	0.2748	0.3694	0.5708	0.3332	0.5119
6	0.8106	0.9114	0.8868	0.4887	0.4135	0.4679	0.8106	0.4062	0.5202	0.5569	0.6515
7	1.157	0.8053	0.9961	0.7145	0.6139	1.0131	0.6249	0.8167	0.9643	0.6025	0.5207
8	1.0055	1.0036	1.2502	0.6589	0.8609	0.6211	0.9345	0.4513	0.8693	0.4321	0.7026
9	0.6504	1.4256	1.3695	0.5162	1.3582	0.43	0.3985	0.6298	0.743	0.8446	1.1478
10	0.946	1.0901	1.2251	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976
11+	0.946	1.0901	1.2251	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976
FBAR4-7	0.8396	0.6386	0.7479	0.528	0.3923	0.5237	0.4698	0.4585	0.5562	0.4154	0.5132
	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
3	0.1548	0.1821	0.11	0.0729	0.0604	0.1175	0.0555	0.0375	0.091	0.1547	0.0211
4	0.4746	0.5802	0.66	0.3087	0.2321	0.3746	0.299	0.3842	0.164	0.2265	0.2611
5	0.6885	1.0495	0.9253	0.6837	0.4615	0.5878	0.416	0.5709	0.4907	0.2441	0.1789
6	0.7498	1.0594	1.0243	0.869	0.6969	0.7419	0.5193	0.4582	0.5803	0.5026	0.1809
7	0.8335	0.7002	1.0012	0.8437	0.6762	0.8235	0.5329	0.7021	0.4049	0.5297	0.4031
8	0.8825	0.904	0.6536	0.9605	0.5954	0.5278	0.5805	0.7159	0.5022	0.4138	0.3894
9	0.9636	1.1811	1.3586	1.3821	1.0492	0.5924	0.3839	0.4945	0.5015	0.3944	0.2977
10	0.9015	0.9374	1.0158	1.0779	0.7832	0.6549	0.5027	0.6448	0.4733	0.4492	0.3649
11+	0.9015	0.9374	1.0158	1.0779	0.7832	0.6549	0.5027	0.6448	0.4733	0.4492	0.3649
FBAR4-7	0.6866	0.8473	0.9027	0.6763	0.5167	0.632	0.4418	0.5289	0.41	0.3757	0.256
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.2607	0.3075	0.2049	0.2341	0.298	0.6982	0.3203	0.1327	0.0261	0.0456	0.0668
4	0.3808	0.585	0.3309	0.5716	0.6263	1.2475	0.6026	0.4662	0.2804	0.1536	0.1213
5	1.0564	0.9793	0.4141	0.5093	0.6312	0.9072	0.8694	0.8799	0.6158	0.4974	0.3201
6	0.9474	0.4764	0.694	0.445	0.7027	0.5372	0.4291	0.9239	0.6751	0.7286	0.5812
7	0.5512	0.2977	0.5912	0.5984	0.7989	0.6309	0.7892	0.4836	0.3982	0.5313	0.3924
8	0.5804	0.2726	0.4815	0.3499	0.872	0.5337	0.4453	0.6806	0.6355	0.4887	0.3366
9	0.6922	0.2768	0.7994	0.2019	0.8092	0.5553	0.6613	0.4889	0.6963	0.4305	0.4411
10	0.6145	0.2825	0.6304	0.3844	0.8375	0.5781	0.6382	0.5556	0.5827	0.4879	0.3926
11+	0.6145	0.2825	0.6304	0.3844	0.8375	0.5781	0.6382	0.5556	0.5827	0.4879	0.3926
FBAR4-7	0.734	0.5846	0.5076	0.5311	0.6898	0.8307	0.6726	0.6884	0.4924	0.4777	0.3537
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.1648	0.1239	0.1196	0.0615	0.0491	0.0323	0.0945	0.0333	0.048	0.0632	0.0227
4	0.3171	0.2269	0.2424	0.4409	0.4618	0.165	0.1679	0.1562	0.1674	0.1705	0.146
5	0.2798	0.4058	0.1891	0.3692	1.0019	0.5009	0.3304	0.101	0.2147	0.295	0.324
6	0.4037	0.2149	0.3928	0.4333	0.4071	1.0941	0.5448	0.1288	0.2225	0.3841	0.541
7	0.2225	0.2775	0.5412	0.7319	0.699	0.2934	0.4838	0.2465	0.2131	0.31	0.4742
8	0.5132	0.3817	0.4514	0.4557	0.804	0.4618	0.1678	0.2237	0.2446	0.2335	0.3413
9	0.4757	0.1757	0.4805	0.7962	0.4784	0.3551	0.0041	0.2272	0.1841	0.3552	0.2272
10	0.4068	0.2787	0.4941	0.6683	0.6695	0.3734	0.22	0.2335	0.2145	0.3009	0.3463
11+	0.4068	0.2787	0.4941	0.6683	0.6695	0.3734	0.22	0.2335	0.2145	0.3009	0.3463
FBAR4-7	0.3058	0.2813	0.3414	0.4939	0.6424	0.5133	0.3817	0.1581	0.2044	0.2899	0.3713

Table 4.13 (continued).

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	0.013	0.0243	0.0231	0.0246	0.0329	0.0843	0.0197	0.0393	0.0237	0.0357	0.0407
4	0.1094	0.0906	0.1224	0.1433	0.1956	0.2182	0.213	0.0885	0.1945	0.1529	0.1732
5	0.4518	0.2568	0.3403	0.3735	0.383	0.4571	0.2762	0.3718	0.2744	0.3881	0.3221
6	0.6297	0.4639	0.4877	0.601	0.483	0.4742	0.2723	0.3805	0.4737	0.5258	0.5506
7	0.5784	0.729	0.705	0.7356	0.5546	0.4979	0.3484	0.2471	0.3271	0.6715	0.4402
8	0.4829	0.4274	0.9149	0.7437	0.7387	0.5395	0.3469	0.2756	0.2066	0.3527	0.5044
9	0.4812	0.362	0.6893	0.6636	0.7046	0.5564	0.2445	0.4376	0.1798	0.4769	0.2097
10	0.5241	0.5105	0.7661	0.7296	0.6693	0.4845	0.2966	0.2899	0.3001	0.5544	0.5595
11+	0.5241	0.5105	0.7661	0.7296	0.6693	0.4845	0.2966	0.2899	0.3001	0.5544	0.5595
FBAR4-7	0.4423	0.3851	0.4139	0.4633	0.404	0.4119	0.2775	0.272	0.3175	0.4346	0.3715

	2005	2006	2007	2008	FBAR2006-2008
3	0.0393	0.0299	0.0531	0.0189	0.034
4	0.1564	0.1875	0.1355	0.1072	0.1434
5	0.3094	0.3735	0.4118	0.2339	0.3397
6	0.5495	0.3574	0.4715	0.5735	0.4675
7	0.7559	0.4962	0.4675	0.4549	0.4728
8	0.3967	0.6615	0.4884	0.3706	0.5068
9	0.6682	0.3754	0.423	0.326	0.3748
10	0.632	0.6986	0.3564	0.3508	0.4686
11+	0.632	0.6986	0.3564	0.3508	
FBAR4-7	0.4428	0.3536	0.3716	0.3424	

Table 4.14. Northeast Arctic haddock. Stock numbers at age (start of year). Numbers *10-3**

year										
age	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	77862	641975	70498	1204344	142881	60250	196656	61052	79843	377777
4	95931	53561	408469	45862	815633	97687	42555	128213	42357	56227
5	69809	42758	34374	190377	24907	510301	68033	28519	79876	28369
6	37038	24688	18259	15415	89493	14667	251272	41262	15735	36033
7	45596	13404	8078	6123	7697	48176	7478	90934	22377	7613
8	15745	11738	4905	2442	2454	3411	14321	3277	32898	6985
9	4518	4716	3523	1150	1035	849	1501	4605	1709	11292
10	1941	1930	928	733	562	218	452	825	2008	665
11+	5287	2201	1348	2339	957	218	418	408	1126	1168
TOTAL	353727	796971	550381	1468787	1085620	735776	582687	359095	277930	526129

Table 4.14 (continued).

year										
age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	277670	125517	276534	319256	371589	118432	277359	344869	20877	20468
4	255782	167010	77684	166531	206646	249587	80553	178169	235729	14528
5	37680	140369	82440	34506	68296	120414	157018	43945	104831	127371
6	16230	18029	56293	23042	10920	27520	60593	69636	23142	47284
7	16806	6886	6934	15885	6735	3728	11159	23489	33726	11914
8	3412	8175	2450	2818	4779	2372	1552	4010	11287	13683
9	3712	1384	2769	812	1200	1497	1071	750	1837	4517
10	3973	964	432	696	171	247	429	485	418	917
11+	1201	2624	1350	638	1040	1609	550	751	657	316
TOTAL	616465	470959	506885	564184	671375	525405	590284	666103	432504	240999
year										
age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	190834	110758	1170464	310141	60903	55965	63104	128047	200455	164727
4	13502	118121	78350	651596	164758	35852	31994	33845	46025	105136
5	9784	8542	72183	42478	288037	93895	16061	13570	7713	19990
6	62250	6119	5702	20037	12737	151984	45044	6821	4373	2581
7	21545	30655	4157	1800	10130	5179	79285	18159	3245	2318
8	6506	10386	16772	1961	1094	4592	2331	29200	7911	1207
9	6780	3522	5761	7685	1223	553	2649	798	14019	4149
10	2239	3742	2141	2360	4771	450	370	966	375	5924
11+	887	1916	3930	2606	4367	3209	3078	943	926	828
TOTAL	314326	293760	1359460	1040665	548018	351678	243917	232349	285042	306861
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	28529	12759	15978	9003	12050	289359	524470	115808	54955	26355
4	104226	20082	8808	10799	5516	8652	210200	258045	90274	35490
5	52334	62474	13665	6191	6240	3599	5559	110733	133126	62669
6	6620	22569	30331	7920	3736	3405	2439	3146	33290	65891
7	834	2744	8866	13807	4306	2467	1882	1295	1714	9126
8	1170	459	1320	4903	9049	2671	1176	741	527	1047
9	500	507	230	772	2403	5058	1393	610	272	272
10	2084	204	270	121	393	1650	2561	514	310	156
11+	3613	2730	2191	957	348	789	2210	1650	1570	985
TOTAL	199910	124528	81660	54474	44041	317651	751889	492542	316037	201991
age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	36191	104029	208772	681248	301745	98631	103543	117787	59087	229567
4	19632	25438	81181	159522	512610	221624	68205	47409	71605	45081
5	24565	13749	17616	56046	110021	369719	140275	44803	32201	45857
6	36871	18181	9082	10738	31003	56681	210755	79733	24669	17606
7	31286	26541	11916	5064	5118	13516	28943	103565	35444	12461
8	4606	20018	17559	7155	2580	2350	5338	11709	40634	16666
9	725	3015	12833	11383	4164	1303	1255	1751	4557	15894
10	222	473	2054	7365	7425	2107	743	516	738	1844
11+	375	308	355	1211	5658	4313	3862	1574	1096	1271
TOTAL	154472	211750	361368	939732	980324	770245	562920	408846	270030	386246

Table 4.14 (continued).

age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	87117	373485	356627	235733	245382	365254	171422	667919	974628	0
4	172466	68088	289622	251090	151287	154172	227987	133457	497805	595286
5	29673	113187	50958	193198	166116	96590	97772	151011	93476	336776
6	23770	18288	63897	31393	106453	96651	55197	54152	79881	47770
7	8972	14760	10234	32445	15193	50253	44828	31200	27401	34952
8	6201	5185	9438	6041	13573	8010	19320	22346	16005	14235
9	7955	3589	3222	6285	3476	6710	4410	8163	11227	9046
10	7460	5101	1897	2204	3194	2308	2816	2481	4378	6635
11+	1869	5253	4357	3132	2299	3552	1558	3615	2425	3922
TOTAL	345483	606934	790252	761521	706972	783500	625311	1074343	1707225	1048621

age	GMST 50-08	AMST 50-08
3	135436	237772
4	85977	146581
5	49401	82540
6	24181	40992
7	11205	19108
8	5091	8347
9	2342	3822

Table 4.15. Northeast Arctic haddock. Spawning stock numbers at age (spawning time). Numbers *10-3**

year										
age	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	2258	18617	2044	34926	4144	1747	5703	1770	2315	10956
4	10073	5624	42889	4815	85641	10257	4468	13462	4447	5904
5	22339	13683	11000	60921	7970	163296	21771	9126	25560	9078
6	23223	15479	11448	9665	56112	9196	157547	25871	9866	22593
7	38529	11326	6826	5174	6504	40708	6319	76839	18908	6433
8	14863	11080	4630	2306	2316	3220	13519	3094	31056	6594
9	4436	4631	3459	1130	1016	834	1474	4522	1678	11089
10	1930	1918	923	729	559	216	450	820	1996	661
11+	5287	2201	1348	2339	957	218	418	408	1126	1168

year										
age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	8052	3640	8019	9258	10776	3435	8043	10001	605	594
4	26857	17536	8157	17486	21698	26207	8458	18708	24752	1525
5	12058	44918	26381	11042	21855	38533	50246	14062	33546	40759
6	10176	11304	35296	14447	6847	17255	37992	43662	14510	29647
7	14201	5819	5859	13423	5691	3150	9429	19848	28498	10068
8	3221	7717	2313	2661	4511	2239	1465	3785	10655	12917
9	3645	1359	2719	798	1179	1470	1051	736	1804	4435
10	3949	959	430	692	170	245	427	482	416	912
11+	1201	2624	1350	638	1040	1609	550	751	657	316

year										
age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	5534	3212	33943	8994	1766	1623	1830	3713	5813	4777
4	1418	12403	8227	68418	17300	3764	3359	3554	4833	11039
5	3131	2733	23098	13593	92172	30046	5140	4342	2468	6397
6	39030	3837	3575	12563	7986	95294	28243	4277	2742	1619
7	18205	25903	3513	1521	8560	4377	66996	15344	2742	1959
8	6142	9804	15833	1851	1033	4335	2200	27565	7468	1139
9	6658	3459	5657	7547	1201	543	2602	784	13767	4075
10	2226	3719	2128	2346	4742	447	368	960	373	5889
11+	887	1916	3930	2606	4367	3209	3078	943	926	828

Table 4.14 (continued).

year										
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	742	715	863	504	530	7813	11014	2432	1374	843
4	8025	2089	1427	1987	1081	1289	21651	19611	6680	3194
5	12769	18992	4550	2928	3182	1875	2518	32555	31950	15667
6	4297	12458	17561	5275	2996	2713	1846	2243	19175	35186
7	717	2351	6845	11073	3716	2290	1748	1187	1540	7502
8	1111	435	1250	4452	8343	2546	1150	723	514	1011
9	492	499	226	759	2324	4921	1370	606	270	270
10	2073	203	269	121	391	1632	2538	511	309	156
11+	3613	2730	2191	957	348	789	2210	1650	1570	985

year										
age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	1665	4265	6263	12262	4828	1578	2071	2945	1891	9871
4	2493	4172	11934	18026	37421	13076	4706	3508	6659	5274
5	7492	4922	7910	22194	36197	83926	29879	9140	8276	14032
6	21312	11326	6394	7957	21764	35879	104745	39468	12384	10265
7	24966	21763	10188	4446	4622	11961	24746	78709	26583	9470
8	4316	18516	16436	6797	2477	2277	5146	11100	36855	14966
9	717	2955	12525	11144	4097	1287	1244	1731	4484	15401
10	221	471	2041	7306	7373	2097	740	514	736	1835
11+	375	308	355	1211	5658	4313	3862	1574	1096	1271

year									
age	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	2526	11205	7846	5186	6380	10227	3257	8683	10721
4	25353	6877	31569	22849	11952	13875	22343	9075	30366
5	10326	44596	16001	62403	42526	24341	27181	47417	23182
6	14737	12143	45239	19966	66746	54415	31462	32274	49846
7	7142	12620	9006	29038	12777	42615	36221	25615	22853
8	5581	4806	8957	5787	13125	7625	18374	20849	14949
9	7685	3470	3152	6185	3431	6643	4344	8025	10980
10	7385	5044	1876	2187	3178	2298	2808	2468	4356
11+	1869	5253	4357	3132	2299	3552	1558	3615	2425

Table 4.16. Northeast Arctic haddock. Stock biomass at age with SOP (start of year). Tonnes

Age\year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	16858	180380	13630	286371	33537	13607	53691	16980	24481	137458
4	38273	27731	145521	20095	352770	40653	21409	65711	23932	37699
5	43220	34355	19004	129446	16717	329557	53114	22682	70034	29517
6	32098	27766	14130	14672	84081	13259	274599	45937	19312	52481
7	51605	19688	8164	7612	9445	56876	10673	132212	35866	14481
8	22215	21493	6180	3785	3753	5020	25480	5941	65737	16562
9	7602	10300	5294	2126	1888	1491	3185	9956	4072	31936
10	3772	4867	1610	1565	1184	441	1108	2059	5527	2173
11+	11582	6258	2637	5628	2272	498	1156	1148	3493	4298
TOTBIO	227225	332837	216170	471299	505647	461402	444415	302626	252455	326607
Age\year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	91184	43159	90199	96128	94795	35303	82270	119820	7269	8026
4	154780	105819	46692	92398	97141	137094	44028	114067	151239	10497
5	35384	138019	76893	29710	49821	102640	133183	43659	104373	142815
6	21334	24814	73497	27771	11151	32836	71943	96844	32253	74215
7	28851	12378	11823	25003	8981	5809	17303	42661	61384	24421
8	7303	18318	5208	5530	7945	4607	3000	9079	25611	34965
9	9475	3698	7020	1901	2380	3469	2468	2024	4972	13765
10	11709	2976	1265	1880	391	660	1143	1511	1306	3228
11+	3990	9130	4456	1944	2685	4851	1650	2638	2314	1255
TOTBIO	364010	358312	317052	282266	275291	327269	356988	432306	390721	313188
Age\year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	67637	48878	367620	91619	23427	21321	18982	37870	74753	74466
4	8818	96055	45346	354698	116781	25168	17734	18445	31627	87578
5	9916	10779	64829	35883	316824	102288	13815	11476	8225	25841
6	88314	10809	7168	23694	19611	231766	54235	8075	6527	4671
7	39917	70719	6825	2779	20369	10315	124671	28074	6325	5477
8	15028	29869	34329	3776	2743	11400	4569	56279	19226	3555
9	18677	12080	14063	17646	3655	1639	6194	1834	40634	14579
10	7123	14819	6035	6258	16469	1539	1000	2563	1255	24036
11+	3180	8554	12489	7789	16995	12368	9366	2823	3493	3789
TOTBIO	258610	302563	558705	544141	536874	417804	250566	167440	192066	243991
Age\year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	16428	10358	13465	4405	4307	108351	152633	38159	20959	11832
4	116418	21727	12407	11109	4677	6004	135099	146913	54273	24712
5	78232	110672	22311	9082	9353	4982	5596	116268	117847	59396
6	14313	48681	72583	12390	7211	7438	4372	4651	48347	83377
7	2469	7929	24283	29295	8411	6475	4917	3139	3250	17402
8	4739	1709	4583	11417	22658	6852	3505	2469	1541	2464
9	2143	2434	984	2183	6410	15929	3967	2232	1043	940
10	9593	1027	1416	407	1231	5422	8665	1770	1267	683
11+	17948	14601	11990	3800	1257	2965	7683	6571	5982	4490
TOTBIO	262283	219138	164023	84088	65516	164419	326438	322172	254508	205296
Age\year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	14430	39558	70072	186617	77948	26847	30199	36593	19883	74692
4	14985	17766	57981	96738	258729	104000	34561	24548	41676	27491
5	25096	15579	19586	60855	103409	287115	104142	34563	26868	41231
6	46978	25222	14733	16307	46575	73049	232424	81205	27774	20616
7	49742	43337	22330	10430	9988	25673	48859	145326	49059	18438
8	10355	38883	37256	16369	6471	5496	12502	23627	73295	28784
9	1926	7874	31240	28684	11286	3763	3474	4680	11255	34279
10	832	1410	6451	20717	21740	6449	2461	1579	2328	5235
11+	1734	1254	1240	4251	18095	14057	13372	5621	3860	4472
TOTBIO	166077	190883	260888	440967	554242	546448	481994	357741	255998	255237
age	2000	2001	2002	2003	2004	2005	2006	2007	2008	
3	24382	110412	98194	66046	71720	116158	56711	219784	294226	
4	101550	35988	155773	126184	77788	84116	133129	80511	300560	
5	27846	106130	41790	160872	130554	79193	83689	137479	87834	
6	29718	24629	83048	36074	124352	109116	64077	65336	102288	
7	13719	24741	17796	54541	22886	78110	66737	47693	43524	
8	11428	10161	19440	12901	28167	15307	37465	41557	30638	
9	16456	8187	7512	15319	8821	16859	10139	18958	25138	
10	18639	12677	5013	5936	8995	6884	8200	6644	11834	
11+	5945	15342	12254	9372	7019	11501	5262	11888	7399	
TOTBIO	249682	348266	440820	487245	480300	517244	465408	629850	903441	

Table 4.17. Northeast Arctic haddock. Spawning stock biomass at age with SOP (spawning time). Tonnes

Age\year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	489	5231	395	8305	973	395	1557	492	710	3986
4	4019	2912	15280	2110	37041	4269	2248	6900	2513	3958
5	13830	10993	6081	41423	5350	105458	16997	7258	22411	9446
6	20126	17409	8860	9199	52719	8313	172174	28803	12109	32906
7	43607	16636	6899	6432	7981	48060	9018	111719	30307	12237
8	20971	20289	5834	3573	3543	4739	24054	5608	62055	15635
9	7465	10114	5198	2088	1854	1464	3127	9777	3999	31361
10	3749	4838	1601	1555	1177	439	1102	2047	5494	2160
11+	11582	6258	2637	5628	2272	498	1156	1148	3493	4298
TOTSP	125838	94681	52784	80313	112908	173635	231432	173751	143091	115986
Age\year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	2644	1252	2616	2788	2749	1024	2386	3475	211	233
4	16252	11111	4903	9702	10200	14395	4623	11977	15880	1102
5	11323	44166	24606	9507	15943	32845	42618	13971	33399	45701
6	13376	15558	46083	17412	6991	20588	45108	60721	20222	46533
7	24379	10460	9990	21128	7589	4909	14621	36049	51869	20636
8	6894	17292	4916	5221	7500	4349	2832	8571	24176	33007
9	9305	3632	6894	1867	2337	3407	2424	1988	4883	13517
10	11639	2958	1258	1869	389	656	1136	1502	1299	3209
11+	3990	9130	4456	1944	2685	4851	1650	2638	2314	1255
TOTSP	99801	115559	105720	71437	56383	87023	117399	140893	154254	165193
Age\year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	1961	1417	10661	2657	679	618	550	1098	2168	2160
4	926	10086	4761	37243	12262	2643	1862	1937	3321	9196
5	3173	3449	20745	11483	101384	32732	4421	3672	2632	8269
6	55373	6777	4495	14856	12296	145317	34005	5063	4093	2929
7	33730	59758	5767	2348	17212	8716	105347	23723	5345	4628
8	14187	28197	32407	3564	2589	10762	4313	53127	18149	3356
9	18341	11863	13809	17328	3590	1609	6083	1801	39902	14317
10	7081	14730	5999	6220	16371	1530	994	2548	1247	23892
11+	3180	8554	12489	7789	16995	12368	9366	2823	3493	3789
TOTSP	137951	144831	111134	103489	183377	216295	166942	95793	80350	72534
Age\year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	427	580	727	247	190	2925	3205	801	524	379
4	8964	2260	2010	2044	917	895	13915	11165	4016	2224
5	19089	33644	7430	4296	4770	2595	2535	34183	28283	14849
6	9289	26872	42026	8252	5784	5928	3310	3316	27848	44523
7	2124	6795	18746	23494	7259	6008	4568	2878	2919	14304
8	4502	1620	4340	10367	20891	6530	3428	2409	1502	2380
9	2109	2395	967	2146	6198	15499	3904	2217	1035	933
10	9545	1022	1409	405	1224	5362	8587	1760	1264	682
11+	17948	14601	11990	3800	1257	2965	7683	6571	5982	4490
TOTSP	73996	89790	89646	55050	48489	48709	51135	65301	73373	84764
Age\year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	664	1622	2102	3359	1247	430	604	915	636	3212
4	1903	2914	8523	10931	18887	6136	2385	1817	3876	3216
5	7654	5577	8794	24099	34022	65175	22182	7051	6905	12617
6	27153	15713	10372	12083	32696	46240	115515	40196	13943	12019
7	39694	35536	19092	9157	9019	22720	41774	110448	36794	14013
8	9702	35966	34871	15550	6212	5325	12052	22398	66479	25848
9	1906	7716	30490	28082	11106	3714	3443	4628	11075	33216
10	829	1406	6413	20551	21588	6416	2451	1574	2321	5209
11+	1734	1254	1240	4251	18095	14057	13372	5621	3860	4472
TOTSP	91240	107705	121897	128064	152872	170214	213778	194649	145889	113821
Age\year	2000	2001	2002	2003	2004	2005	2006	2007	2008	
3	707	3312	2160	1453	1865	3252	1078	2857	3236	
4	14928	3635	16979	11483	6145	7570	13047	5475	18334	
5	9690	41815	13122	51962	33422	19957	23266	43168	21783	
6	18425	16353	58798	22943	77968	61432	36524	38940	63828	
7	10921	21153	15660	48814	19247	66237	53923	39156	36299	
8	10285	9420	18448	12359	27237	14573	35629	38773	28616	
9	15896	7917	7346	15074	8706	16690	9987	18636	24585	
10	18453	12538	4958	5888	8950	6857	8175	6611	11775	
11+	5945	15342	12254	9372	7019	11501	5262	11888	7399	
TOTSP	105249	131485	149726	179348	190560	208069	186890	205504	215856	

Table 4.18. Northeast Arctic haddock. Summary.

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR4_7
1950	77862	227225	125838	132125	1.05	0.6082	0.8396
1951	641975	332837	94681	120077	1.2682	0.7893	0.6386
1952	70498	216170	52784	127660	2.4185	0.5431	0.7479
1953	1204344	471299	80313	123920	1.543	0.6679	0.528
1954	142881	505647	112908	156788	1.3886	0.6593	0.3923
1955	60250	461402	173635	202286	1.165	0.6344	0.5237
1956	196656	444415	231432	213924	0.9243	0.7669	0.4698
1957	61052	302626	173751	123583	0.7113	0.7813	0.4585
1958	79843	252455	143091	112672	0.7874	0.8613	0.5562
1959	377777	326607	115986	88211	0.7605	1.0221	0.4154
1960	277670	364010	99801	154651	1.5496	0.9224	0.5132
1961	125517	358312	115559	193224	1.6721	0.9659	0.6866
1962	276534	317052	105720	187408	1.7727	0.9162	0.8473
1963	319256	282266	71437	146224	2.0469	0.8458	0.9027
1964	371589	275291	56383	99158	1.7586	0.7166	0.6763
1965	118432	327269	87023	118578	1.3626	0.8373	0.5167
1966	277359	356988	117399	161778	1.378	0.8332	0.632
1967	344869	432306	140893	136397	0.9681	0.9759	0.4418
1968	20877	390721	154254	181726	1.1781	0.978	0.5289
1969	20468	313188	165193	130820	0.7919	1.1014	0.41
1970	190834	258610	137951	88257	0.6398	0.9956	0.3757
1971	110758	302563	144831	78905	0.5448	1.2396	0.256
1972	1170464	558705	111134	266153	2.3949	0.8822	0.734
1973	310141	544141	103489	322226	3.1136	0.8298	0.5846
1974	60903	536874	183377	221157	1.206	1.0805	0.5076
1975	55965	417804	216295	175758	0.8126	1.0701	0.5311
1976	63104	250566	166942	137264	0.8222	0.8449	0.6898
1977	128047	167440	95793	110158	1.15	0.8308	0.8307
1978	200455	192066	80350	95422	1.1876	1.0475	0.6726
1979	164727	243991	72534	103623	1.4286	1.2698	0.6884
1980	28529	262283	73996	87889	1.1878	1.2854	0.4924
1981	12759	219138	89790	77153	0.8593	1.3575	0.4777
1982	15978	164023	89646	46955	0.5238	1.3505	0.3537
1983	9003	84088	55050	24600	0.4469	0.9447	0.3058
1984	12050	65516	48489	20945	0.432	0.9236	0.2813
1985	289359	164419	48709	45052	0.9249	0.9985	0.3414
1986	524470	326438	51135	100563	1.9666	0.948	0.4939
1987	115808	322172	65301	154916	2.3723	1.0077	0.6424
1988	54955	254508	73373	95255	1.2982	1.0037	0.5133
1989	26355	205296	84764	58518	0.6904	1.018	0.3817
1990	36191	166077	91240	27182	0.2979	0.9748	0.1581
1991	104029	190883	107705	36216	0.3363	0.9554	0.2044
1992	208772	260888	121897	59922	0.4916	0.9989	0.2899
1993	681248	440967	128064	82379	0.6433	0.9925	0.3713
1994	301745	554242	152872	135186	0.8843	0.9936	0.4423
1995	98631	546448	170214	142448	0.8369	0.9756	0.3851
1996	103543	481994	213778	178128	0.8332	0.982	0.4139
1997	117787	357741	194649	154359	0.793	0.9501	0.4633
1998	59087	255998	145889	100630	0.6898	0.9782	0.404
1999	229567	255237	113821	83195	0.7309	0.9741	0.4119
2000	87117	249682	105249	68944	0.6551	0.9684	0.2775
2001	373485	348266	131485	89640	0.6818	0.9954	0.272
2002	356627	440820	149726	114798	0.7667	0.9869	0.3175
2003	235733	487245	179348	138926	0.7746	0.9796	0.4346
2004	245382	480300	190560	158279	0.8306	0.9775	0.3715
2005	365254	517244	208069	158298	0.7608	0.9938	0.4428
2006	171422	465408	186890	153157	0.8195	0.9965	0.3536
2007	667919	629850	205504	161525	0.786	0.9971	0.3716
2008	974628	903441	215856	155604	0.7209	0.9996	0.3424
Mean	237772	347991	125828	125776	1.0819	0.9496	0.4849

Table 4.19. Northeast Arctic haddock. Prediction with management option table: Input data

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	1036000	0.312	0.008	0	0	0.294	0.034	0.677
4	595286	0.243	0.047	0	0	0.555	0.143	0.909
5	336776	0.293	0.206	0	0	0.939	0.34	1.174
6	47770	0.225	0.516	0	0	1.317	0.467	1.46
7	34952	0.2	0.85	0	0	1.675	0.473	1.774
8	14235	0.2	0.944	0	0	1.98	0.507	2.071
9	9046	0.2	0.98	0	0	2.3	0.375	2.292
10	6635	0.2	0.993	0	0	2.61	0.469	2.46
11	3922	0.2	1	0	0	3.066	0.469	2.86

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	208000	0.312	0.02	0	0	0.312	0.034	0.677
4	NA	0.243	0.078	0	0	0.573	0.143	0.909
5	NA	0.293	0.257	0	0	0.888	0.34	1.174
6	NA	0.225	0.562	0	0	1.241	0.467	1.46
7	NA	0.2	0.802	0	0	1.62	0.473	1.774
8	NA	0.2	0.924	0	0	2.019	0.507	2.071
9	NA	0.2	0.975	0	0	2.43	0.375	2.292
10	NA	0.2	0.992	0	0	2.821	0.469	2.46
11	NA	0.2	1	0	0	3.198	0.469	2.86

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	149000	0.312	0.02	0	0	0.312	0.034	0.677
4	NA	0.243	0.078	0	0	0.573	0.143	0.909
5	NA	0.293	0.257	0	0	0.888	0.34	1.174
6	NA	0.225	0.562	0	0	1.241	0.467	1.46
7	NA	0.2	0.802	0	0	1.62	0.473	1.774
8	NA	0.2	0.924	0	0	2.019	0.507	2.071
9	NA	0.2	0.975	0	0	2.43	0.375	2.292
10	NA	0.2	0.992	0	0	2.821	0.469	2.46
11	NA	0.2	1	0	0	3.198	0.469	2.86

Table 4.20. Northeast Arctic haddock. Prediction with management option table for 2009-2011

Biomass2009		SSB2009	FMult	FBar2009		Landings2009
1151180		241483	1	0.3559		254903

Biomass2010	SSB2010	FMULT	FBar2010	Landings2010	Biomass2011	SSB2011
1189528	363473	0	0	0	1368906	649291
1189528	363473	0.1	0.0356	38411	1332834	626663
1189528	363473	0.2	0.0712	75569	1298018	604925
1189528	363473	0.3	0.1068	111523	1264407	584039
1189528	363473	0.4	0.1423	146318	1231956	563971
1189528	363473	0.5	0.1779	179996	1200619	544685
1189528	363473	0.6	0.2135	212601	1170352	526151
1189528	363473	0.7	0.2491	244172	1141115	508336
1189528	363473	0.8	0.2847	274747	1112867	491210
1189528	363473	0.9	0.3203	304364	1085570	474746
1189528	363473	1	0.3559	333058	1059189	458916
1189528	363473	1.1	0.3914	360863	1033687	443694
1189528	363473	1.2	0.427	387811	1009032	429055
1189528	363473	1.3	0.4626	413935	985191	414975
1189528	363473	1.4	0.4982	439264	962133	401431
1189528	363473	1.5	0.5338	463827	939828	388401
1189528	363473	1.6	0.5694	487652	918249	375864
1189528	363473	1.7	0.605	510765	897367	363800
1189528	363473	1.8	0.6405	533193	877156	352190
1189528	363473	1.9	0.6761	554959	857592	341015
1189528	363473	2	0.7117	576088	838651	330258

Table 4.21. Northeast Arctic haddock. Prediction single option table for 2009-2011

Year: 2009 Fbar= 0.3559

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.034	29746	20136	1036000	304617	8666	2548
4	0.1434	70818	64390	595286	330664	27723	15399
5	0.3397	84766	99480	336776	316098	69365	65106
6	0.4675	16111	23519	47770	62923	24638	32454
7	0.4728	12030	21342	34952	58545	29717	49776
8	0.5068	5173	10714	14235	28184	13441	26611
9	0.3748	2579	5911	9046	20808	8862	20385
10	0.4686	2267	5578	6635	17318	6589	17198
11	0.4686	1340	3833	3922	12023	3916	12004
Total		224830	254903	2084622	1151180	192917	241481

Year: 2010 Fbar= 0.35

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.0334	5875	3977	208000	64926	4205	1312
4	0.1411	85878	78083	733148	419925	57186	32754
5	0.3341	100400	117827	404549	359273	103902	92273
6	0.4598	59522	86891	178828	221958	100436	124660
7	0.4651	8116	14399	23894	38711	19154	31031
8	0.4985	6398	13251	17835	36010	16475	33265
9	0.3686	1974	4525	7021	17062	6845	16633
10	0.4609	1717	4224	5091	14361	5049	14243
11	0.4609	1824	5218	5409	17301	5409	17301
Total		271704	328395	1583775	1189527	318661	363472

Year: 2011 Fbar= 0.35

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.0334	4209	2849	149000	46509	3012	940
4	0.1411	17252	15686	147278	84356	11488	6580
5	0.3341	123943	145458	499416	443523	128267	113912
6	0.4598	71901	104962	216021	268121	121325	150586
7	0.4651	30619	54321	90141	146038	72257	117064
8	0.4985	4408	9129	12288	24810	11351	22919
9	0.3686	2494	5716	8870	21555	8647	21013
10	0.4609	1341	3299	3976	11216	3943	11123
11	0.4609	1829	5231	5423	17343	5423	17343
Total		257996	346651	1132413	1063471	365713	461480

Table 4.22. Northeast Arctic haddock. Prediction using catch constraint for 2010-2011

Year: 2009 Fbar= 0.3559

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.034	29746	20136	1036000	304617	8666	2548
4	0.1434	70818	64390	595286	330664	27723	15399
5	0.3397	84766	99480	336776	316098	69365	65106
6	0.4675	16111	23519	47770	62923	24638	32454
7	0.4728	12030	21342	34952	58545	29717	49776
8	0.5068	5173	10714	14235	28184	13441	26611
9	0.3748	2579	5911	9046	20808	8862	20385
10	0.4686	2267	5578	6635	17318	6589	17198
11	0.4686	1340	3833	3922	12023	3916	12004
Total		224830	254903	2084622	1151180	192917	241481

Year: 2010 Fbar= 0.2472: Catch constraint 194000*1.25=242500

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.0236	4169	2822	208000	64926	4205	1312
4	0.0996	61844	56230	733148	419925	57186	32754
5	0.236	74124	86991	404549	359273	103902	92273
6	0.3247	44665	65202	178828	221958	100436	124660
7	0.3284	6096	10815	23894	38711	19154	31031
8	0.3521	4825	9993	17835	36010	16475	33265
9	0.2604	1465	3358	7021	17062	6845	16633
10	0.3255	1289	3171	5091	14361	5049	14243
11	0.3255	1369	3917	5409	17301	5409	17301
Total		199846	242499	1583775	1189527	318661	363472

Year: 2011 Fbar= 0.272: Catch constraint 194000*1.25*1.25=303126

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0.026	3282	2222	149000	46509	3012	940
4	0.1096	13739	12492	148730	85188	11601	6645
5	0.2596	103819	121841	520544	462287	133693	118731
6	0.3573	64528	94199	238298	295771	133837	166116
7	0.3614	28532	50619	103176	167155	82706	133991
8	0.3874	4127	8547	14086	28442	13013	26274
9	0.2865	2329	5339	10269	24954	10011	24327
10	0.3581	1216	2992	4431	12498	4394	12395
11	0.3581	1704	4874	6209	19857	6209	19857
Total		223276	303125	1194743	1142661	398476	509276

Table 4.23. Northeast Arctic haddock.Yield per recruit. Input data and results.

MFYPR version 2a

TestProjection index file.

Time and date: 15:32 26.04.2009

Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.474	0.011	0	0	0.321	0.033	0.685
4	0.284	0.061	0	0	0.598	0.138	0.947
5	0.437	0.248	0	0	0.904	0.327	1.242
6	0.253	0.624	0	0	1.219	0.450	1.485
7	0.2	0.834	0	0	1.539	0.455	1.741
8	0.2	0.934	0	0	1.909	0.488	2.084
9	0.2	0.978	0	0	2.292	0.361	2.339
10	0.2	0.995	0	0	2.771	0.451	2.706
11	0.2	1	0	0	3.247	0.451	3.189

Yield per results

FMult	Fbar	Catch Nos	Yield	Stock Nos	Biomass	SpwnNos Jan	SSBJan	SpwnNos Spwn	SSBSpwn
0	0	0	0	3.6904	4.8255	1.5949	3.6067	1.5949	3.6067
0.1	0.0342	0.0722	0.1386	3.3545	3.8967	1.2782	2.7015	1.2782	2.7015
0.2	0.0685	0.124	0.2239	3.1197	3.28	1.0617	2.1067	1.0617	2.1067
0.3	0.1027	0.1635	0.2798	2.9456	2.8459	0.9049	1.6931	0.9049	1.6931
0.4	0.137	0.1949	0.3182	2.8107	2.5269	0.7864	1.3933	0.7864	1.3933
0.5	0.1712	0.2208	0.3457	2.7026	2.2846	0.6941	1.169	0.6941	1.169
0.6	0.2054	0.2427	0.3662	2.6139	2.0954	0.6203	0.9967	0.6203	0.9967
0.7	0.2397	0.2617	0.382	2.5394	1.9443	0.5601	0.8616	0.5601	0.8616
0.8	0.2739	0.2783	0.3945	2.4758	1.8214	0.5102	0.7537	0.5102	0.7537
0.9	0.3081	0.293	0.4047	2.4207	1.7197	0.4682	0.6663	0.4682	0.6663
1	0.3424	0.3063	0.4132	2.3724	1.6343	0.4325	0.5944	0.4325	0.5944
1.1	0.3766	0.3184	0.4205	2.3295	1.5616	0.4017	0.5346	0.4017	0.5346
1.2	0.4109	0.3295	0.4268	2.2911	1.4991	0.375	0.4843	0.375	0.4843
1.3	0.4451	0.3397	0.4323	2.2564	1.4447	0.3516	0.4416	0.3516	0.4416
1.4	0.4793	0.3491	0.4373	2.2249	1.3969	0.3309	0.4051	0.3309	0.4051
1.5	0.5136	0.358	0.4419	2.1961	1.3547	0.3126	0.3735	0.3126	0.3735
1.6	0.5478	0.3663	0.446	2.1696	1.3169	0.2962	0.346	0.2962	0.346
1.7	0.582	0.3741	0.4498	2.145	1.283	0.2814	0.3219	0.2814	0.3219
1.8	0.6163	0.3814	0.4533	2.1222	1.2524	0.2681	0.3007	0.2681	0.3007
1.9	0.6505	0.3884	0.4566	2.1009	1.2244	0.256	0.2819	0.256	0.2819
2	0.6848	0.395	0.4597	2.0809	1.1989	0.245	0.2651	0.245	0.2651

Reference point	F multiplier	Absolute F
Fbar(4-7)	1	0.3424
FMax	>=1000000	
F0.1	0.5986	0.2049
F35%SPR	0.455	0.1558

Weights in kilograms

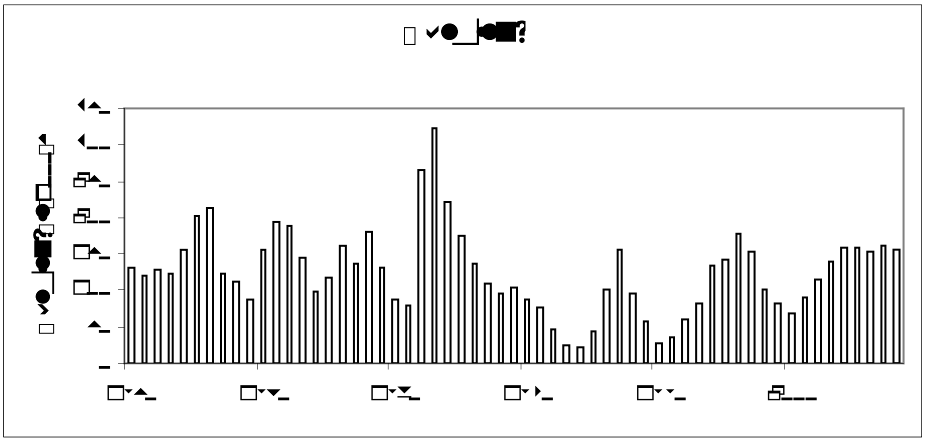


Figure 4.1A Landings of Northeast Arctic Haddock 1950-2008

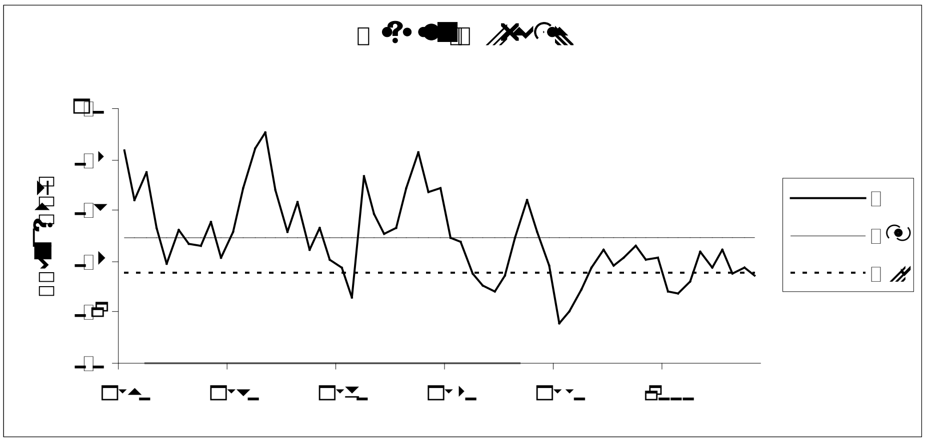


Figure 4.1B Fishing mortality of Northeast Arctic Haddock 1950-2008

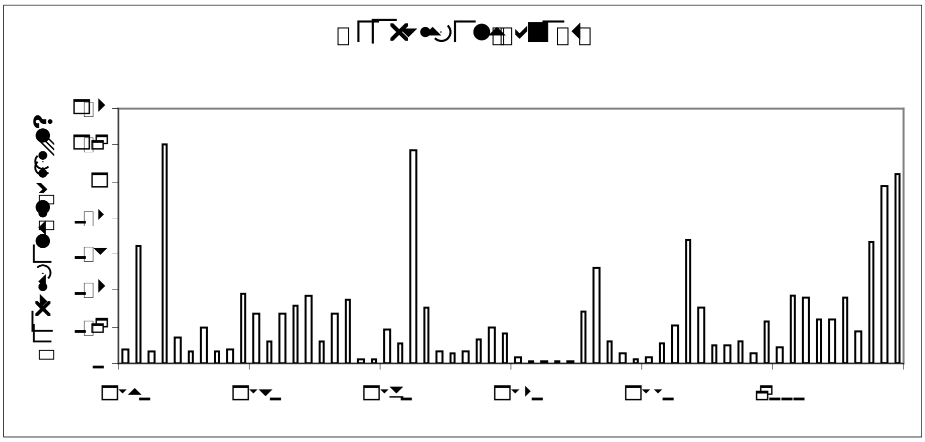


Figure 4.1C Recruitment of Northeast Arctic Haddock 1950-2009

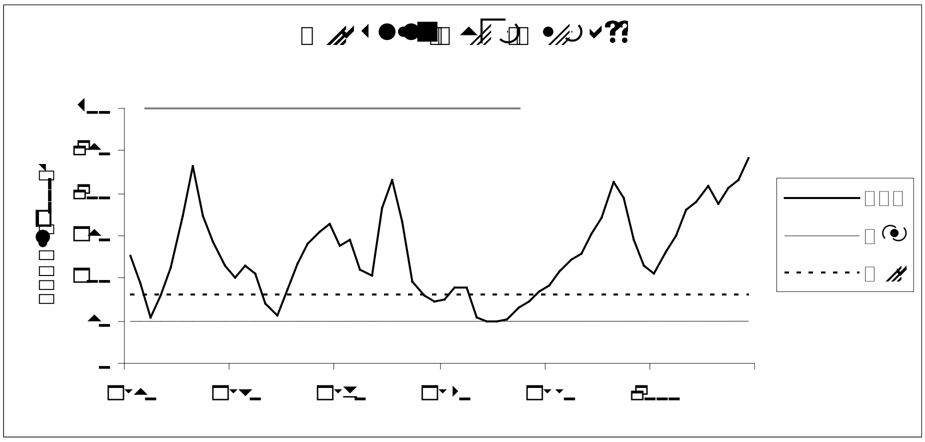


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock 1950-2008

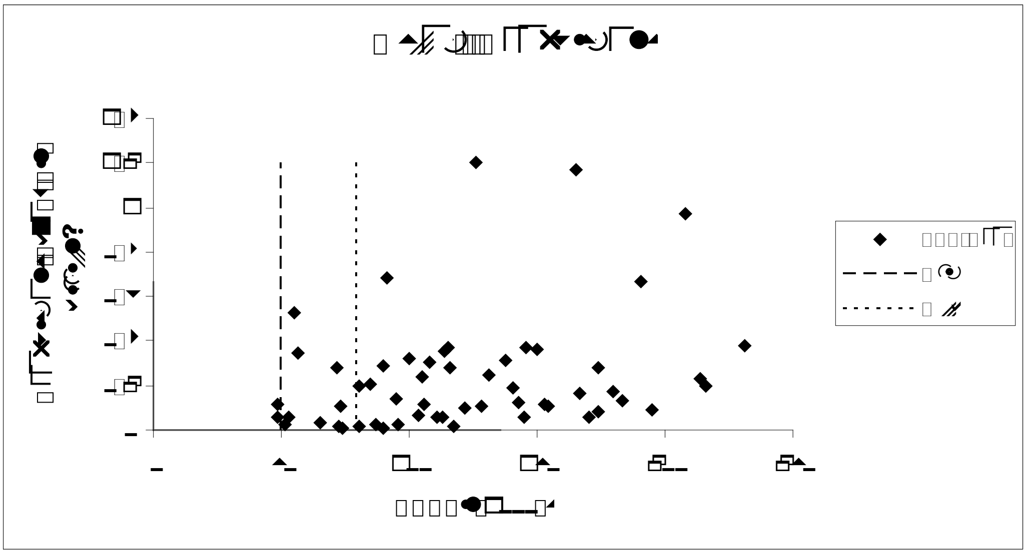


Figure 4.2 Stock-Recruitment relationship of Northeast Arctic haddock 1950-2008

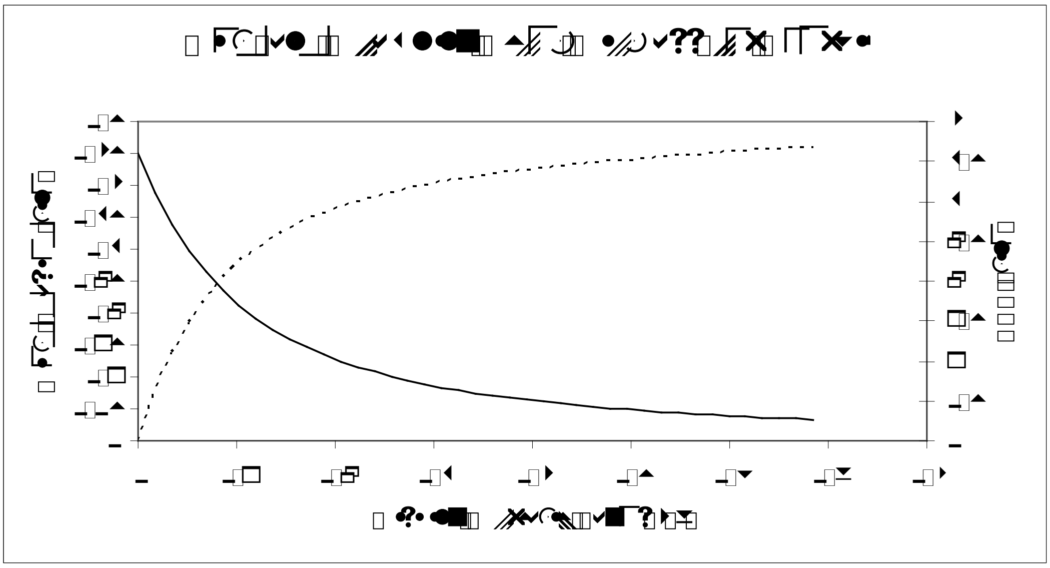


Figure 4.3 Yield and Spawning Stock Biomass per Recruit of Northeast Arctic haddock

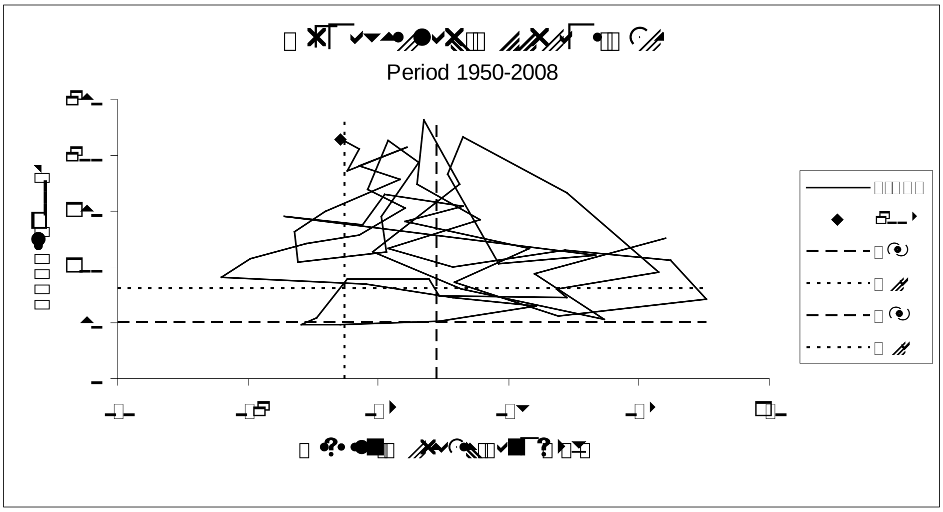


Figure 4.4 Spawning stock biomass – fishing mortality relationship of Northeast Arctic haddock 1950- 2008

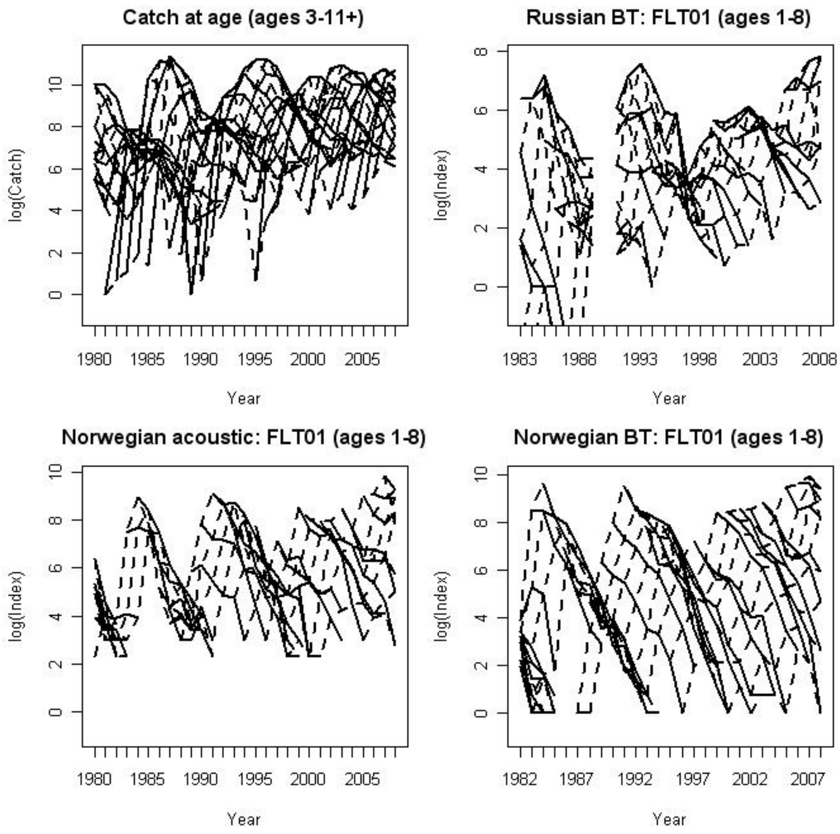


Figure 4.5. Northeast Arctic haddock. Surface of log catch (ages 3-11+) and survey indices (ages 1-8) used for tuning of the XSA and fitting the stochastic time series model. Solid lines trace cohorts, while dotted follow age. The year 1990 is removed from the Russian bottom trawl series.

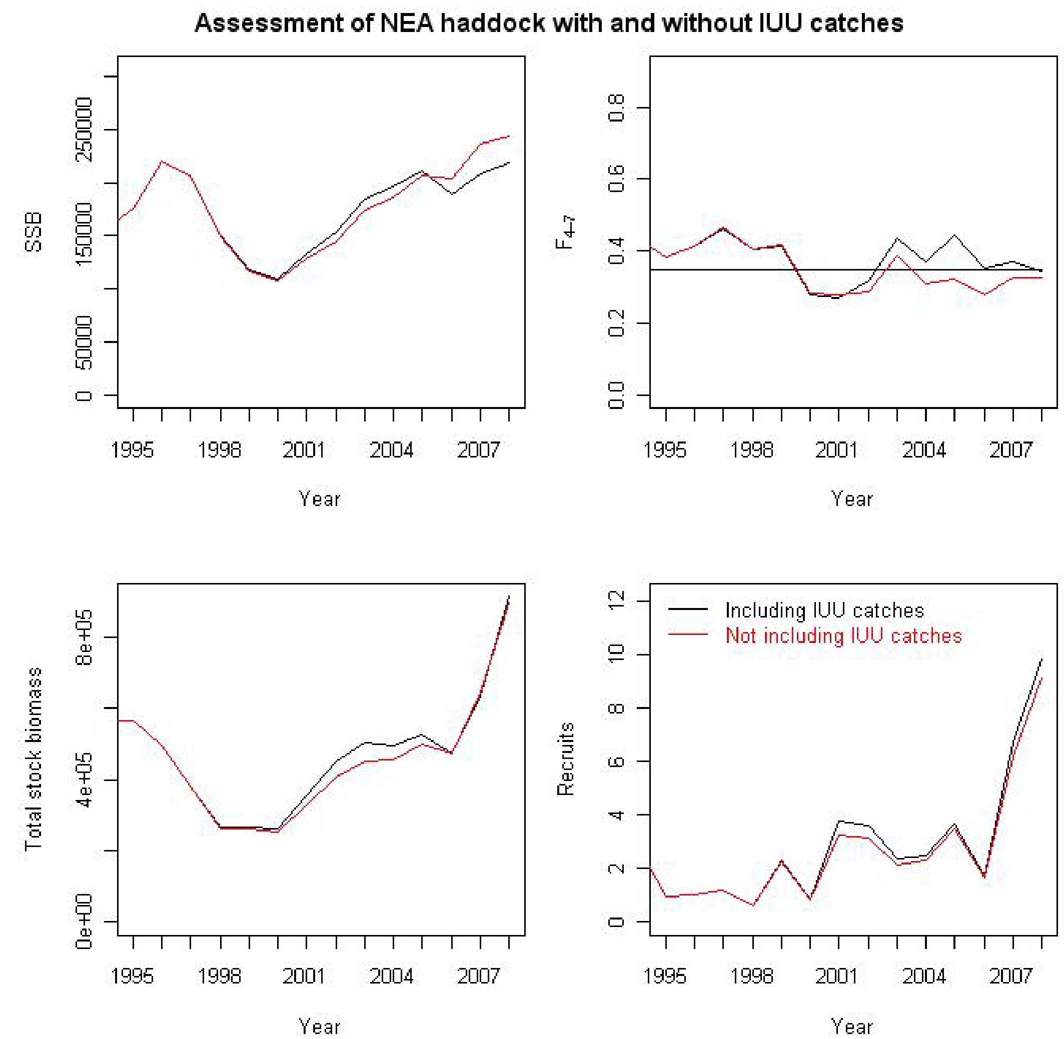


Figure 4.6. Northeast Arctic haddock. Dynamics of spawning stock biomass fishing mortality, total stock biomass and recruitment in two runs corresponding to catches with estimates of IUU catches of haddock and without estimates of IUU catches.

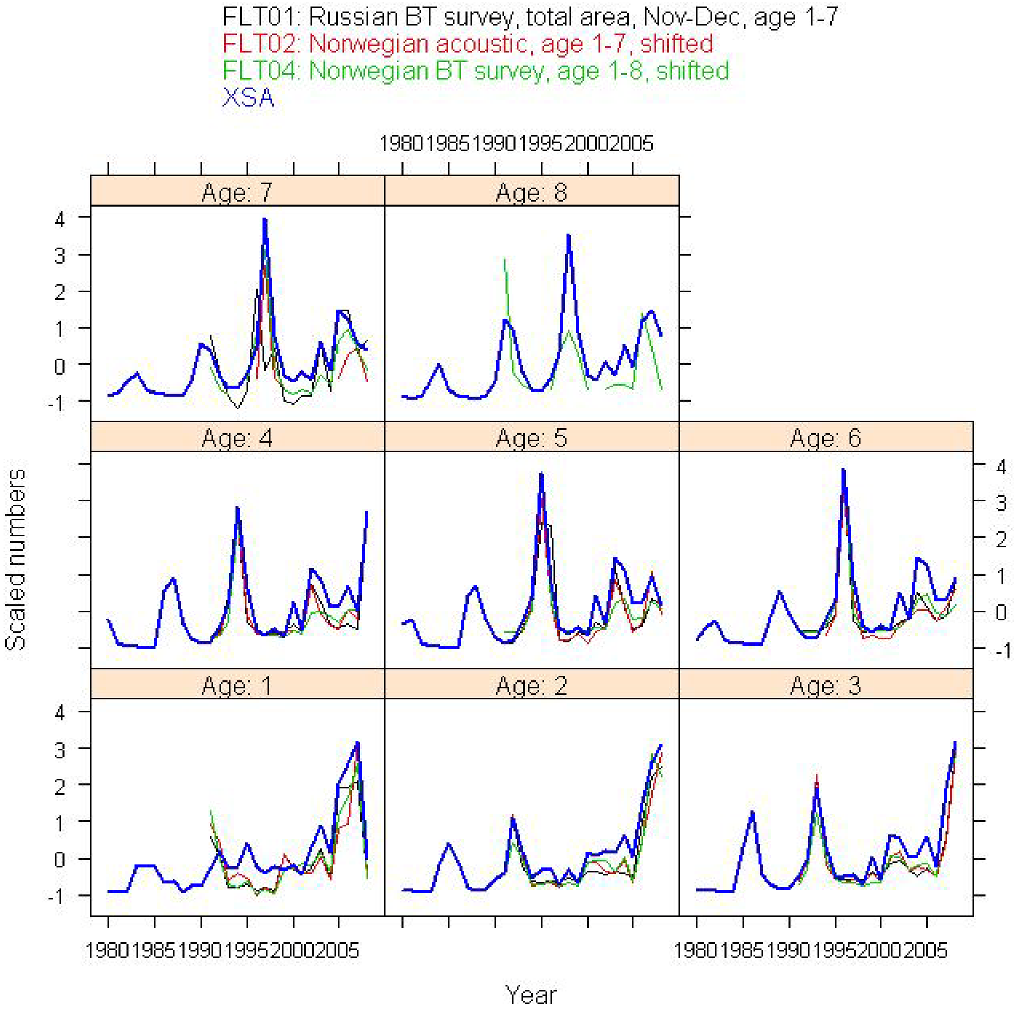


Figure 4.7. Northeast Arctic haddock. Comparing survey trends in abundance 1-8 years with XSA. All time series are scaled.

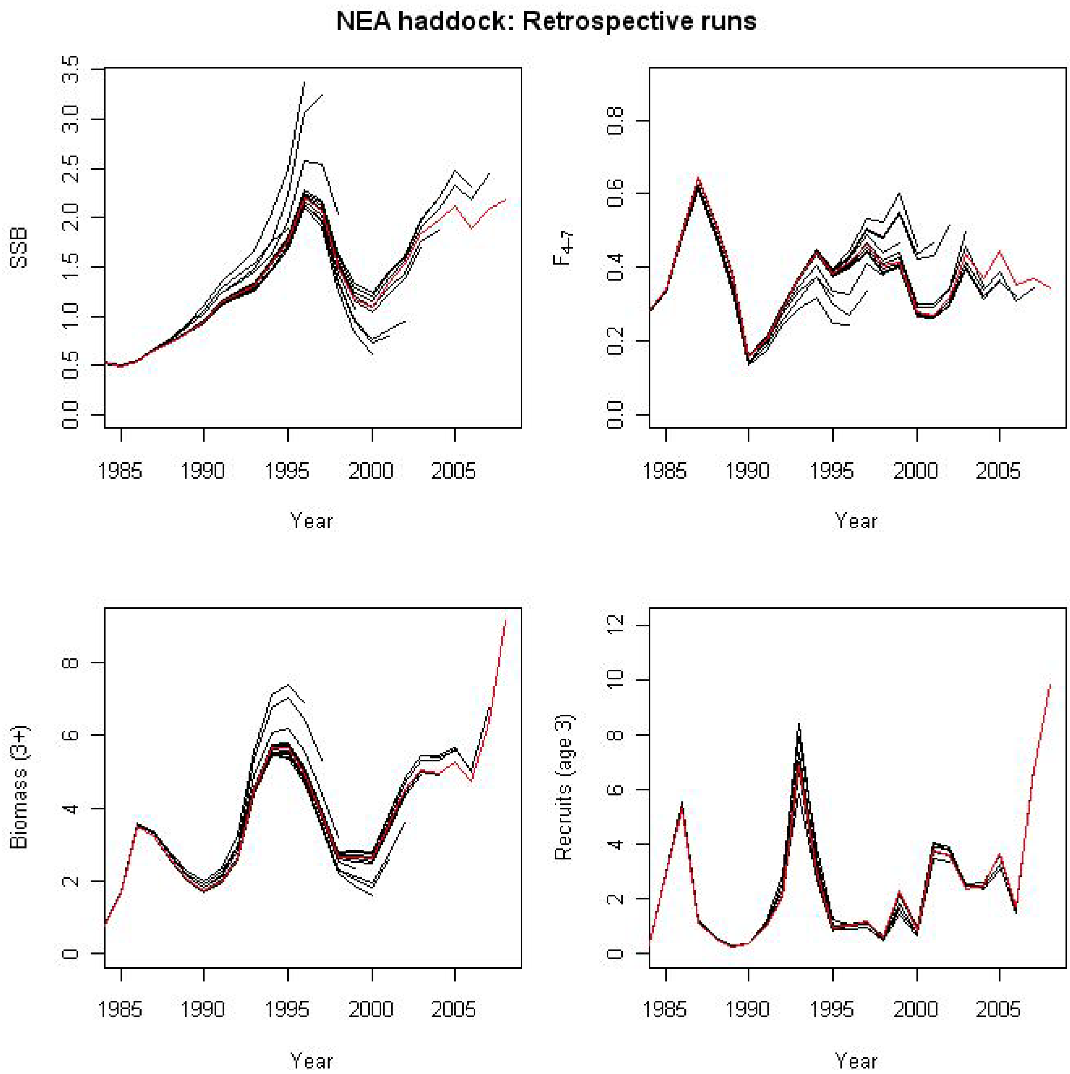
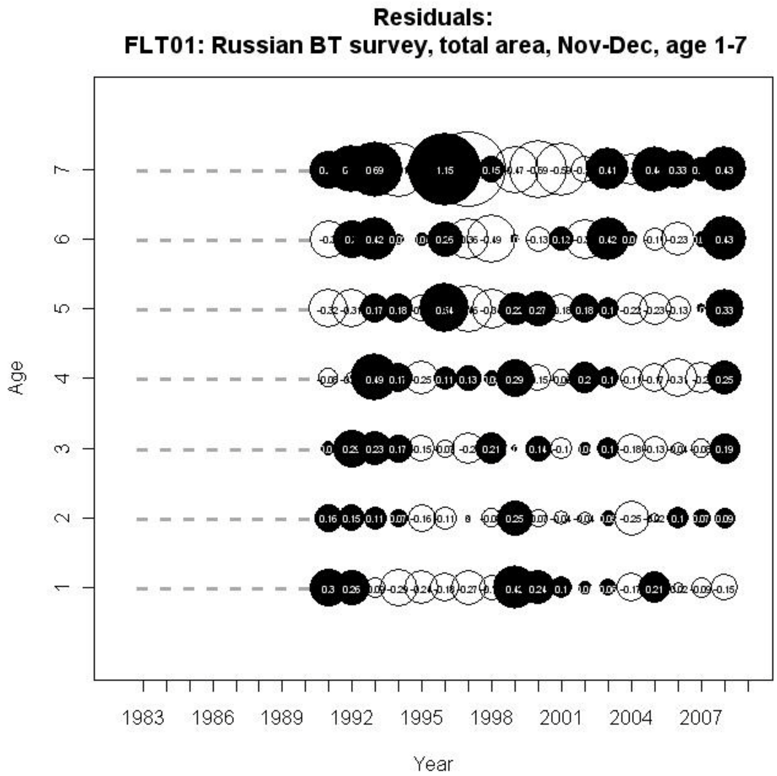


Figure 4.8. Retrospective plots for assessment years 1994-2009 using standard settings in the XSA runs and keeping weight, maturity and natural mortality as estimated in 2009 for all runs.



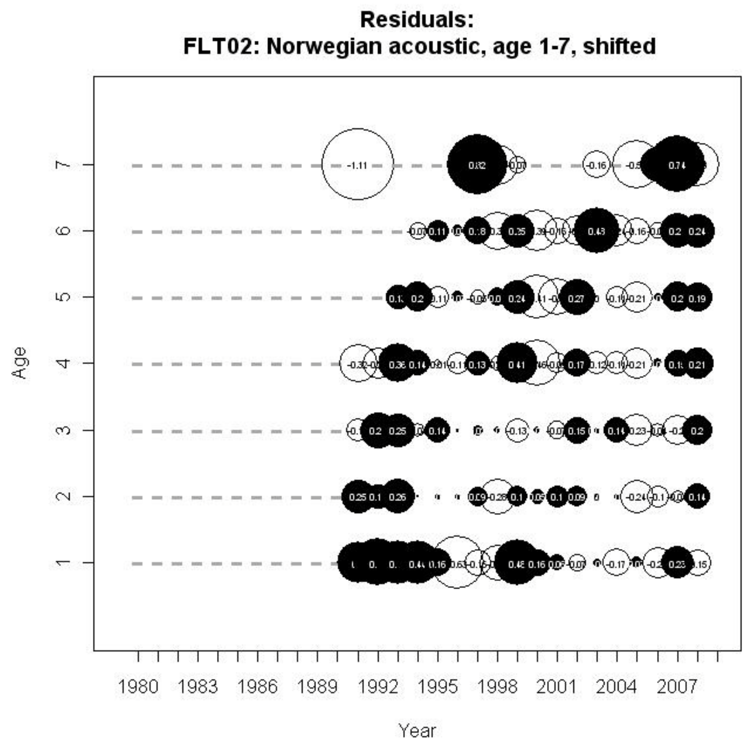


Figure 4.9. Northeast Arctic haddock; log catchability residuals plot, fleets combined, with shrinkage 0.5

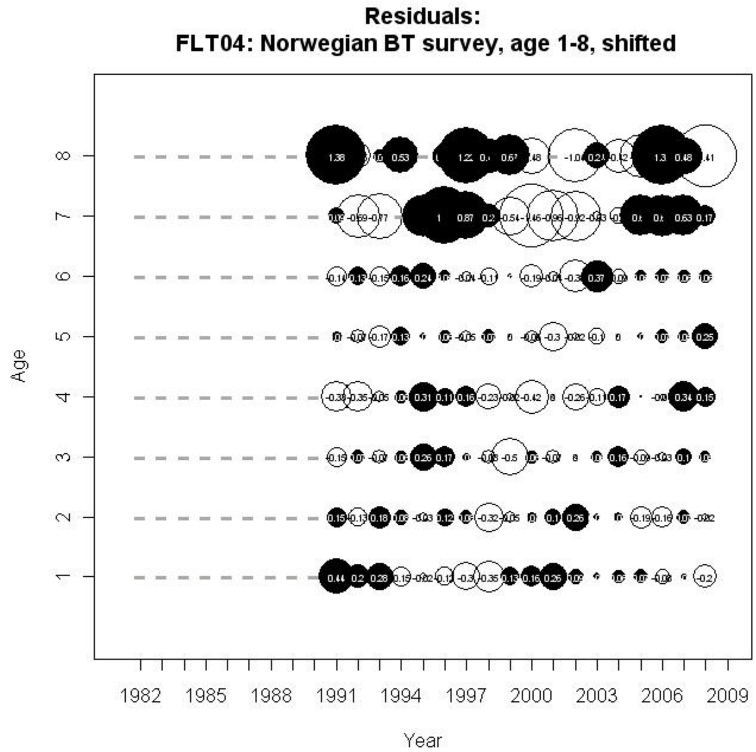


Figure 4.9 (continued).

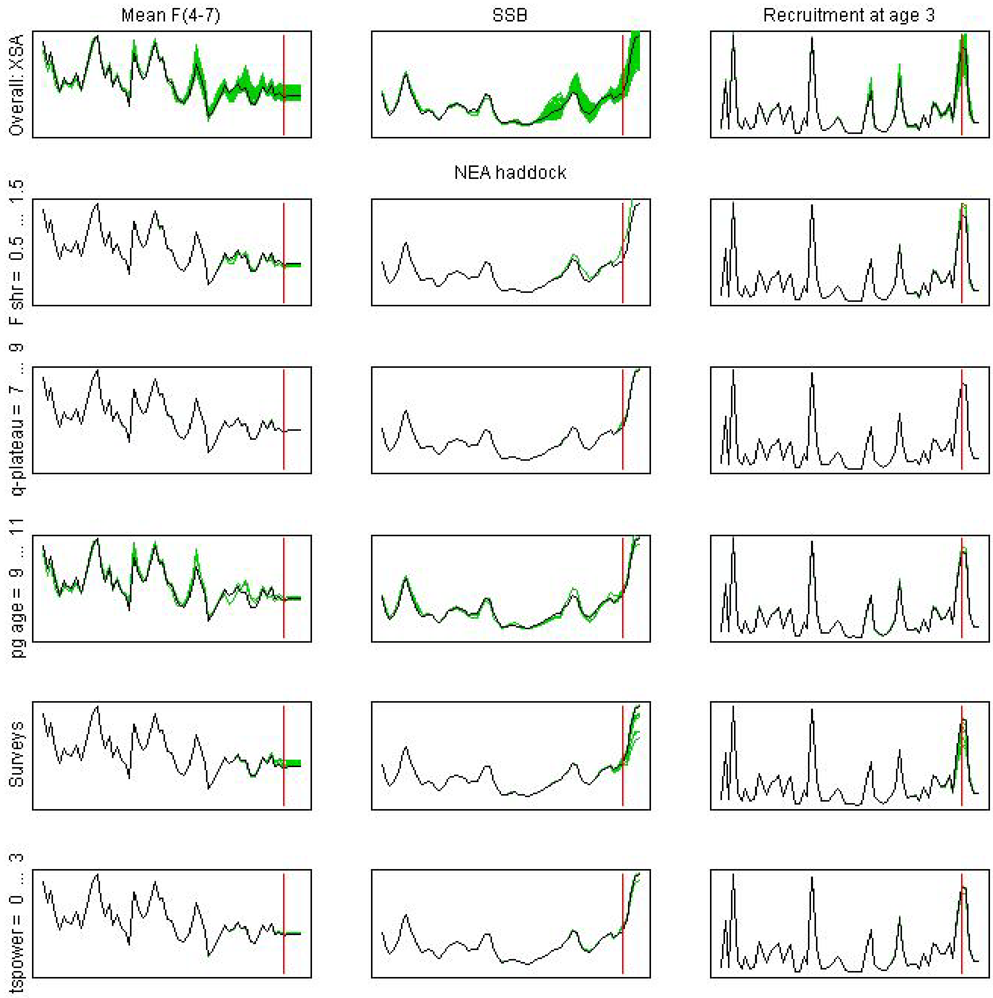


Figure 4.10. Northeast Arctic haddock. Sensitivity analysis of XSA to settings for Northeast Arctic Haddock for Fishing mortality, Spawning stock biomass, and Recruitment at age 3 for the time period 1950 to 2008 indicated by the red line. A Status quo (three year) forecast for 2009 through 2011 is to the right of the red line. The XSA settings considered are F shr=(0.5,1.0,1.5), q-plateau=(7,8,9), plusgroup=(9,10,11), surveys=all (see text), and tspower=(0,2,3). The upper panels shows the differences to all combinations of settings, while the lower 5 panels shows the differences relative to the chosen baseline settings: F shr=0.5, q-plateau=9, plusgroup=11, surveys=all, and tspower=3.

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											Area covered
Year	1	2	3	4	5	6	7	8	9	10+	Total	(1000 nm^2)
1981	3.1	7.3	2.3	7.8	1.8	5.3	0.5	0.2	0	0	28.3	88.1
1982	3.9	1.5	1.7	1.8	1.9	4.8	2.4	0.2	0	0	18.2	88.1
1983	2919.3	4.8	3.1	2.4	0.9	1.9	2.5	0.7	0	0	2935.6	88.1
1984	3832.6	514.6	18.9	1.5	0.8	0.2	0.1	0.4	0.1	0	4369.2	88.1
1985	1901.1	1593.8	475.9	14.7	0.5	0.5	0.1	0.1	0.4	0.3	3987.4	88.1
1986	665.0	370.3	384.6	110.8	0.6	0.2	0.1	0.1	0.1	0.1	1531.9	88.1
1987	163.8	79.9	154.4	290.2	52.9	0.0	0	0	0	0.3	741.5	88.1
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	0	0	0	275.2	88.1
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	0	0	196.6	88.1
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	0	0	734.4	88.1
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	0	0	2357.6	88.1
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3	0	3217.1	88.1
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1953.5	137.6
1994	603.2	228.0	339.5	436.6	49.7	3.4	0.2	0.1	0.2	0.6	1661.5	143.8
1995	1463.6	179.3	53.6	171.1	339.5	34.5	2.8	0	0.1	0	2244.5	186.6
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	0	0.1	1087.7	165.3
1997[1]	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	0	1581.9	87.5
1998[1]	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440.2	99.2
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1	0	1391.3	118.3
2000	847.2	452.2	27.2	35.4	8.4	4.0	0.8	0.3	0.7	0.2	1376.4	162.4
2001	1220.5	460.3	296.0	29.3	25.1	1.7	0.9	0.1	0.1	0.3	2034.3	164.1
2002	1680.3	534.7	314.7	185.3	17.6	8.2	0.8	0.3	0	0.3	2742.2	156.7
2003	3332.1	513.1	317.4	182	73.6	5.5	2.3	0.2	0.1	0.2	4426.5	146.6
2004	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.1	1852	164.6
2005	4630.2	420.4	346.5	133.3	66.8	52.2	12.3	0.6	0.2	0	5662.4	178.9
2006	5141.3	1313.1	77.4	140.5	48.2	19.6	15.2	3.1	0.1	0.3	6758.8	1691
2007[1]	3874.4	1593.8	507.7	66	86	23.3	7.5	3.7	1.4	0.2	6164	122.2
2008	860.2	2129.4	1522.4	600.9	86.8	48.9	6.27	2.51	0.82	0.13	7257	164.4
2009	564.7	328	1270.4	773.2	365.4	38.5	10.6	1.4	0.1	0.3	998	170.9

[1]**Indices adjusted to account for limited area coverage.**

Survey areas 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	10+	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
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	3.6	0.7	2.5	7.1	13.9	1.8	0.1	+	-	36
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	3.3	2.6	0.3	-	125.1
1992	19.6	44.2	180.6	52.1	8.4	0.7	1	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	65.9	146	15.9	1.7	0.1	0.2	0.7	-	258.8
1995	9.9	12.7	6.5	4	26.8	77.6	7.3	1	0.1	0.5	-	146.3
1996	5	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	5.3	5.6	1.2	0.3	0.9	0.3	-	98.2
2000	18	25.4	37.5	9.3	13	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
2004	47.9	12	27.9	18.6	12.8	16.1	12.4	0.8	0.3	0.1	-	148.9
2005	62.7	109.6	20.7	34.4	12.4	6.5	7.1	2.5	0.1	0.1	-	256.1
2006 [3]	48	168.7	157.9	15.2	25.5	7.3	3.1	2.7	0.8	0.2	-	429.4
2007	4.3	90.2	153.6	98.7	9.1	9	2.3	0.7	0.4	0.1	-	368.5
2008	5.9	14.6	284.4	283.4	153	17.2	11.8	1.5	0.3	0.3	-	772.5
					Division IIa							
1983	5.4	5.5	0.1	0.2	0.3	0.1	-	-	-	-	1	12.6
1984	4.9	14.4	5.6	0.1	0.1	0.1	-	-	-	-	0.2	25.4
1985	3.8	7	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	0.1	-	+	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	0.3	0.3	0.4	0.4	-	-	15.8
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	0.6	0.5	3.1	15.9	4.4	1.5	+	0.1	0.1	-	27.2
1995	5	8.5	6.3	5.3	6.2	23.9	4.1	0.6	+	0.2	-	60.1
1996	29.2	4.1	25	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	0.9	0.2	0.2	0.4	-	80.1
2001	39	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	3.3	0.3	0.1	0.2	-	133.7
2003	20.6	30.8	9.8	8.3	10.4	16.1	2.4	2.1	0.2	+	-	100.7
2004	100.2	32.8	18.1	4.5	5.5	7.2	8.1	0.7	1.1	0.3	-	178.4
2005	61.6	23.9	4.6	10.9	2.1	2.7	5.3	2.9	0.5	0.2	-	114.6
2006	33.3	36.9	15.2	1.9	8.2	3.4	2.5	1.8	1.8	0.3	-	105.5
2007	28.2	96	33.9	14.1	2.1	5.1	2.2	0.6	0.9	0.4	-	183.4
2008	13.6	23.8	64.3	26.8	9.6	1.8	2.6	0.4	0.3	0.3	-	143.6

Table B2 (continued)

	Age											
Year	0	1	2	3	4	5	6	7	8	9	10+	Total
Division IIb												
1983	22.1	9.9	0.2	0.1	+	+	-	-	-	-	0.1	32.4
1984	2.2	14.3	1.8	-	-	-	-	-	-	-	+	18.3
1985	1.4	10.2	61.4	5.1	+	+	+	-	-	-	+	78.1
1986	+	0.2	3.1	7.2	1.4	-	+	-	-	-	-	12
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	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[1]	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	-	32.9
2000	7.9	10	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
2002[2]	9	4.2	7.7	5.1	2.6	0.7	0.8	0.1	0.1	0.1	-	30.4
2003	3.6	21.5	10.4	15.5	11.3	15.9	3.6	3	0.4	0.3	-	85.7
2004	34.9	5.6	6.4	1.3	2.6	1.8	2.9	0.1	0.2	0.1	-	56
2005	60.9	43.5	4.1	10.3	4.1	2.7	3.6	2.2	0.1	0.3	-	131.7
2006[3]	75.4	110.6	71.6	4.6	6.1	2.4	1.4	2	1.8	0.3	-	276.2
2007	3.3	67.3	396.4	78.7	5.5	26	7.3	2.9	2.6	0.8	-	590.9
2008	1.5	3.8	204.1	304.3	50.7	7.4	13.6	2.9	2	0.7	-	591.9
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	14.4	134.3	90	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	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
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	0.4	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	4	0.5	0.1	0.3	-	75.1
1996[1]	6	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	2.7	1	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	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
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	11	20.6	11.3	9.4	10.7	8.7	0.5	0.4	0.2	-	122.8
2005	62	79.2	13.6	24	8.6	4.8	5.7	2.4	0.1	0.2	-	200.7
2006[3]	53.4	79.2	122.7	11.3	11.9	5.7	2.6	2.4	1.1	0.2	-	290.5
2007	6.5	83.9	214.2	83.8	7.3	13.7	3.8	1.4	1.1	0.4	-	416
2008	5.7	12.7	232.7	255.7	105.1	12.4	11.1	1.7	0.7	0.4	-	638.7

1**Adjuusted data based on average 1985-1995 distribution.**

2**Adjusted based on 2001 distribution.**

3**Adjusted based on 2004-2006 distribution.**

+ means value <0.1; - means 0 value

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 backcalculated from bobbins gear). Corrected for length dependent effective spread of the trawl.

	Age											Area covered
Year	1	2	3	4	5	6	7	8	9	10	Total	(1000 nm^2)
1981	7	14	5	21	60	18	1	0	0	0	126	88.1
1982	9	2	3	4	4	10	6	0	0	0	38	88.1
1983	0	5	2	3	1	1	4	2	0	0	18	88.1
1984	1685	173	6	2	1	0	0	0	0	0	1867	88.1
1985	1530	776	215	5	0	0	0	0	0	0	2526	88.1
1986	556	266	452	189	0	0	0	0	0	0	1463	88.1
1987	85	17	49	171	50	0	0	0	0	0	372	88.1
1988	18	4	8	23	46	7	0	0	0	0	106	88.1
1989	52	5	6	11	20	21	2	0	0	0	117	88.1
1990	270	35	3	3	4	7	11	2	0	0	335	88.1
1991	1890	252	45	8	3	3	3	6	0	0	2210	88.1
1992	1135	868	134	23	2	0	0	1	2	0	2165	88.1
1993	947	626	563	130	13	0	0	0	0	3	2282	137.6
1994	562	193	255	631	111	12	0	0	0	0	1764	143.8
1995	1379	285	36	111	387	42	2	0	0	0	2242	186.6
1996	249	229	44	31	76	151	8	0	0	0	788	165.3
1997[1]	693	24	51	17	12	43	43	2	0	0	885	87.5
1998[1]	220	122	20	28	12	5	13	16	1	0	437	99.2
1999	856	46	57	13	14	4	1	2	2	0	994	118.3
2000	1024	509	32	65	19	11	2	1	2	0	1664	162.4
2001	976	316	210	23	22	1	1	0	0	1	1549	164.1
2002	2062	282	216	149	14	12	1	0	0	1	2737	156.7
2003	2394	279	145	198	169	17	5	0	0	1	3208	146.6
2004	752	474	127	76	76	66	7	2	0	0	1580	164.6
2005	3364	209	219	102	36	40	9	0	0	0	3979	178.9
2006	2767	804	54	86	30	12	9	2	0	0	3764	1691
2007[1]	3197	868	379	54	88	22	6	5	2	0	4621	122.2
2008	1266.6	1835	723	252	57	74	10	6	0	1	4226	164.4
2009	849	246.3	1021.7	773	402.1	31.3	14.9	1.6	0.13	0.53	3341	170.9

[1]Indices adjusted to account for limited area coverage.

Survey areas extended from 1993 onwards.

Table B4a. North - East HADDOCK. Results from the Russian trawl - acoustic survey in the Barents Sea and adjacent waters in late autumn 1985 - 2005 and 2008 (old method). Index of number of fish at age (+ means value <1; - means 0 value).

	Age										
Year	0	1	2	3	4	5	6	7	8	9+	Total
1985[1]	194	434	1468	636	3	1	+	-	-	1	2737
1986[1]	34	37	208	917	910	2	+	+	+	+	2109
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	1004
1991[1]	240	368	143	65	11	4	7	21	17	2	878
1992[1]	199	245	758	218	35	3	4	7	6	+	1475
1993[1]	20	26	199	1076	228	31	5	2	3	5	1595
1994[1]	118	51	39	252	591	76	9	+	1	4	1141
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	1181
1997[1,4]	70	138	41	207	82	48	41	25	20	-	671
1998[3]	107	27	82	22	25	7	3	9	3	+	284
1999[1]	222	330	43	129	25	29	7	3	7	2	798
2000[1]	246	292	238	49	86	23	9	2	1	4	949
2001[1]	256	122	200	229	24	45	7	3	1	2	888
2002[1,5,6]	868	811	581	447	237	329	49	20	12	10	3364
2003[6]	352	310	189	124	161	124	19	9	1	1	1290
2004	3164	472	421	176	143	154	151	10	21	5	4722
2005	7156	2521	271	476	172	114	154	79	5	7	10956
2006	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-	-
2008	106	172	1960	1911	783	99	96	15	7	5	5153

Table B4b. North - East HADDOCK. Results from the Russian trawl - acoustic survey in the Barents Sea and adjacent waters in late autumn 1996 - 2008 (new method). Index of number of fish at age (+ means value <1; - means 0 value).

	Age											
Year	0	1	2	3	4	5	6	7	8	9	10+	Total
1995[5]	163	170	79	71	230	404	41	5	1	1	2	1168
1996[1,3]	992	245	291	91	63	206	187	17	1	+	+	2092
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	+	1355
2000[1]	524	395	287	54	57	14	6	1	1	1	1	1340
2001[1]	491	160	227	221	19	35	5	2	1	1	1	1163
2002[1,4,5]	1045	209	139	268	239	27	17	2	1	+	1	1947
2003	1168	473	217	116	134	94	14	6	1	+	+	2223
2004	8529	1141	342	116	54	55	44	3	4	1	1	10289
2005	17782	2903	123	205	62	33	38	16	1	1	+	21165
2006[6]	9396	1286	308	30	31	10	-	5	5	4	1	11075
2007	812	1473	2226	745	53	75	22	8	7	2	1	5423
2008	245	203	2134	1947	728	88	83	13	6	4	2	5455

1October-December 2September-October 3November-January

4Adjusted based on average 1985-1995 distribution

5Adjusted based on 2001 distribution

6Adjusted data in 2004 7Not adjusted data to the whole area

Table B5 North‑East Arctic HADDOCK. Length data (cm) from Norwegian surveys in January‑March and Russian surveys in November‑December.

		Age									
Norway	Year	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	28.0	37.2	46.5	49.6	54.7			
	2004	14.2	22.3	30.6	36.3	43.4	49.8	51.4			
	2005	15.1	20.8	30.0	36.6	41.5	47.9	51.9			
	2006	14.7	22.6	31.3	37.8	43.2	48.0	50.8			
	2007[1]	15.7	23.2	28.7	37.4	45.5	48.5	53.5			
	2008	15.9	23.8	30.1	38.1	39.7	48.6	53.4			
	2009	14.5	22.5	29.6	36	41.9	46.9	51.7			
Russia	Year	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[1]	15.8	22.8	28.4	33.7	42.0	48.7	54.8	63.4	69.3	72.0
	1997[1]	13.8	23.5	29.3	36.1	45.3	50.0	54.6	58.9	69.4	66.0
	1998	15.0	22.0	29.0	38.3	47.7	52.1	54.5	57.8	63.4	-
	1999	-	22.8	27.4	40.1	47.4	50.9	54.6	55.9	58.0	61.6
	2000	15.0	22.7	30.4	35.2	49.3	55.1	57.8	62.4	63.3	63.6
	2001	15.1	22.4	29.8	37.8	48	55.3	58.8	62.1	63.6	65.4
	2002	14.6	23.8	30.1	35.6	48.2	55.1	60.2	60.5	63.3	66.8
	2003	14.0	22.9	28.9	35.3	44.8	52.2	57.5	63.1	66.3	69.6
	2004	14.4	23.1	30.4	37.7	44.2	49.4	56.4	61.6	66.4	69.1
	2005	14.9	23.5	30.0	36.9	44.8	49.9	54.7	59.2	65.9	66.6
	2006[1]	15.3	24.1	32.6	39.8	46.7	51.8	54.9	59.0	62.4	65.3
	2007	15.4	23.7	30.6	39.2	46.6	52.0	54.4	58.4	61.3	65.8
	2008	14.5	22.3	30.8	38.1	47.3	52.8	55.8	59.1	62.8	65.0

1Limited area coverage, lengths are not adjusted to account for limited area coverage.

Table B6 North-East Arctic HADDOCK. Weight data (g) from Norwegian surveys in January-March and Russian surveys in November-December.

Norway

Year /Age	1	2	3	4	5	6	7
1983	52	133	480	1043	1641	2081	2592
1984	36	196	289	964	1810	2506	2240
1985	35	138	432	731	1970	2517	-
1986	47	100	310	734	-	-	-
1987	24	91	273	542	934	-	-
1988	23	139	232	442	743	1193	1569
1989	43	125	309	484	731	1012	1399
1990	34	148	346	854	986	1295	1526
1991	41	138	457	880	1539	1726	1808
1992	32	136	392	949	1467	2060	2274
1993	26	93	317	766	1318	1805	2166
1994	25	86	250	545	1041	1569	1784
1995	30	71	224	386	765	1286	1644
1996	30	93	220	551	741	1016	1782
1997	35	88	200	429	625	1063	1286
1998	25	112	241	470	746	1169	1341
1999	27	85	333	614	947	1494	1616
2000	32	108	269	720	1068	1341	1430
2001	28	106	337	556	1100	1429	2085
2002	30	84	144	623	848	1341	2032
2003	38	127	202	493	981	1189	1613
2004	23	98	266	459	780	1167	1328
2005	29	84	253	469	699	1054	1378
2006	26	107	303	540	821	1111	1332
2007[1]	32	112	237	539	970	1195	1608
2008	33	115	250	538	692	1259	1609
2009	25	98	230	440	718	1029	1402

Russia

Year /Age	0	1	2	3	4	5	6	7	8	9	10
1984	36	127	438	815	1777	2395	2688	-	-	-	-
1985	37	105	282	817	1530	2262	2263	-	-	-	-
1986	38	88	209	419	919	2240	-	3100	-	-	-
1987	-	95	196	330	497	1055	-	-	-	-	-
1988	35	106	248	398	627	997	1431	-	-	-	-
1989	52	105	181	606	903	1287	1587	2004	2716	-	-
1990	62	143	288	667	1337	1533	1778	2233	2731	3092	-
1991	57	133	292	690	1570	1863	2206	2320	2568	3525	-
1992	40	108	279	850	1542	2199	2363	3045	3391	3400	4200
1993	31	96	217	535	1077	1493	2094	2509	2374	2621	3160
1994	27	106	205	337	841	1602	2256	2913	2934	3033	3163
1995	28	95	196	345	628	1234	1908	2430	2815	3323	3479
1996	30	103	209	347	743	1152	1650	2442	3218	3333	4648
1997	22	115	227	447	911	1216	1583	1966	3155	2815	3423
1998	27	94	230	569	1087	1482	1690	1914	2539	3893	3900
1999	-	104	191	648	1049	1251	1544	1608	1814	2210	2978
2000	29	110	278	427	1249	1681	1966	2488	2625	2648	-
2001	26	102	244	533	1097	1695	2065	2469	2704	2867	3141
2002	25	127	280	457	1166	1690	2293	2484	2784	2962	4655
2003	21	104	220	419	855	1347	1844	2402	2923	2582	-
2004	24	87	253	518	846	1130	1571	1959	2633	3366	-
2005	27	115	259	511	933	1289	1670	2079	2833	2965	-
2006[1]	26	105	269	444	867	1307	1604	1922	2274	2520	-
2007	30	117	274	600	1012	1436	1647	2018	3214	2885	-
2008	25	94	267	545	1046	1445	1755	2126	2458	2735	3289

[1]Limited area coverage, weights are not adjusted to account for limited area coverage.

5 Saithe in Subareas I and II (Northeast Arctic)

An update assessment is presented for this stock. General information is located in the Quality Handbook.

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. After 1990 landings increased again and reached 171,000 t in 1996, followed by a new decline to 136,000 t in 2000 and 2001. Since then the annual landings have increased gradually to 212,000 t in 2006, followed by a decline to 199 000 t in 2007 and 183,000 t in 2008.

Discarding, although illegal, occurs in the saithe fishery, but is not considered a major problem in the assessment. Due to its near-shore distribution saithe is virtually inaccessible for commercial gears during the first couple of years of life and there are no reports indicating overall high discard rates in the Norwegian fisheries. There are reported incidents of slipping in the purse seine fishery, mainly related to minimum landing size. On trawlers, discarding may occur when vessels targeting other species catch saithe, for which they may not have a quota or have filled it, and there are undocumented observations and comparisons of scientific samples from non-Norwegian commercial trawlers indicating that discarding may be substantial in certain areas and seasons. However, there are no quantitative estimates of the level of discarding available.

5.1.1 ICES advice applicable to 2008 and 2009

The advice from ICES for 2008 was as follows:

Exploitation boundaries in relation to proposed and evaluated management plan: ICES recommend that the proposed and evaluated management plan be implemented. This implies a TAC of 247 000 t in 2008, or less if a lower target fishing mortality is chosen.

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 (0.20) is at a level that sustains high long-term yield. This corresponds to a catch of 180 000 t.

Exploitation boundaries in relation to precautionary limits: Fishing mortality should be at or below F_{pa}. This corresponds to landings of no more than 290 000 t in 2008.

Conclusion: The implemented management plan is in accordance with the precautionary approach and ICES therefore advises according to this plan. This implies a TAC of 247 000 t in 2008, or less if a lower target fishing mortality is chosen.

The advice from ICES for 2009 was as follows:

Exploitation boundaries in relation to proposed and evaluated management plan: The implemented management plan implies a TAC based on the average catches for the coming 3 years based on F_{pa}. This results in a TAC of 225 000 t in 2009, and a fishing mortality of 0.29.

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential, and considering ecosystem effects: The current fishing mortality is lower than the F associated with high long-term yield when applied within the agreed HCR.

Exploitation boundaries in relation to precautionary limits: The implemented management plan has been found to be consistent with the precautionary approach and ICES therefore advises according to this plan. This results in a TAC of 225 000 t in 2009.

5.1.2 Management applicable in 2008 and 2009

Management of Saithe in Sub-areas I and II is by TAC and technical measures. Norwegian authorities set the TACs for 2008 and 2009 to 247,000 t and 225,000 t, respectively. The Institute of Marine Research, Bergen, Norway (IMR), advised a TAC for 2008 of 235,000 t, estimated by applying a fishing mortality of 0.32 to the HCR, i.e. a little below the target F of 0.35 (F_{pa}) specified in the HCR. Following the same principle, IMR advised a TAC of 214 000 t for 2009. ICES, in the evaluation of the management plan, also recommended using 0.32, corresponding to the highest long-term yield, in the HCR (ICES Advice 2007).

5.1.3 The fishery in 2008 and expected landings in 2009

Provisional figures show that the landings in 2008 were approximately 183,000 t, which is about 64,000 t less than the TAC of 247,000 t, which also were expected landings in the forecast last year.

Official landings in 2009 will probably also be less than the TAC of 225,000 t, which is 9 % less than the 2008 TAC, but 23 % higher than the 2008 landings. However, since the WG does not have any prognosis of total landings in 2009 available, the TAC of 225,000 t is used in the projections.

5.2 Commercial catch-effort data and research vessel surveys

5.2.1 Fishing Effort and Catch-per-unit-effort (Tables 5.2.1–5.2.3, Figure 5.2.1)

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 than the total number of vessels. The numbers have been raised to the total purse seine catch (Table 5.2.1). The highest effort was in 1998-2000. In subsequent years the effort has on the average been about 30% lower, but quite variable. These variations may be explained both by better availability of schooling saithe in years with strong recruiting year classes and by transfer of quotas, allowing for a longer fishing season. The 2005 WG decided not to use the series in the analyses. Data for 2008 were not available to the WG.

In the Norwegian trawl CPUE indices, all days with 20% or more saithe in the catches from vessels larger than the median length were included. In the 2007 WG double trawl catches were excluded from the data because this trawl has a much higher efficiency and the use of it has increased over the last few years. The CPUE observations were averaged over each quarter, and then a yearly index was 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. Due to a large increase in first quarter CPUE since 2003 (Figure 5.2.1), this quarter has been left out in the averaging used for tuning since the 2006 WG (ICES 2006/ACFM:25). Between 1993 and 2006 there have been a couple of years with relatively low CPUE (1998, 1999), but there is no clear trend before the values suddenly increased to an about 25% higher level in 2007-2008 (Table 5.2.2, Figure 5.2.1).

In 2005 German freezer trawler CPUE data were made available for the WG (Table 5.2.3), but only data up to 2006 are presented in this report. The data come from one trawler only fishing in the first quarter of the year. Analyses performed by the 2005 WG showed that the CPUE data did not track weak and strong year classes very well and showed some very strong year effects. There were strong age effects on selectivity for most age groups. In the combined tuning this fleet got the lowest scaled weights and the WG decided not to apply the series in the analysis.

5.2.2 Survey results (Table 5.2.4, Figure 5.2.2)

In autumn 2003 the saithe and coastal cod surveys were combined (Berg *et al.*, WD 11 2004). However, until a new time series can be established, in order to maintain the currently used time series, the estimation of abundance indices is as far as possible done as before. The total index for 2008 (Aglen *et al.*, WD 3) decreased by 20% compared to 2007, the same rate of decline as the year before, and is the lowest since 1991. The age groups 3-7 are all below average level. In recent years the proportion of saithe in the southern part of the survey area (sub areas C+D) has increased, from about 30% in 1997-2002 to over 60% in 2008.

5.2.3 Recruitment indices

Owing to the near-shore distribution of juvenile saithe, obtaining early estimates of recruitment is a common problem in saithe stocks. Attempts at establishing year class strength at ages 0-2 for the Northeast Arctic stock have so far failed. The survey recruitment indices are strongly dependent on the extent to which 2-4 year old saithe have migrated from the coastal areas and become available to the acoustic saithe survey on the banks, and this varies between years. An observer programme for establishing an 0-group index series started in 2000 (Borge and Mehl, WD 21 2002). However, these observations do not seem to pick up the year class strength very well, and the programme will be evaluated in connection with the next saithe benchmark assessment (Mehl, WD 6 2007).

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 2007 was updated applying the same method as used until the 2007 WG. The reason for this was that the new method (ECA, Hirst *et al.* 2004, 2005), produced unrealistic high weights at age compared to previous years (ICES 2007/ACFM:16). The total landings by numbers were adjusted to the official total catch reported to ICES. This revision resulted in only minor changes in catch numbers-at-age and weight-at-age. Age composition data for 2008 were available from Norway, Russia (Sub-areas I and II) and Germany (Subarea II). These countries accounted for 98% of the landings. Other areas and countries were assumed to have the same age composition as Norwegian trawlers. Also these data were treated according to the traditional method.

The 2007 and 2008 catch and sample data were uploaded to the InterCatch database, and there were only minor discrepancies between data allocated and aggregated in InterCatch and data from the spreadsheets used until now (see Section 0).

5.3.2 Weight at age (Table 5.3.2)

Constant weights at age values are used for the period 1960-1979. For subsequent years, annual estimates of weight at age in the catches are used. Weight at age in the stock is assumed to be the same as weight at age in the catch. Compared to the previous years, there were only small differences in weight at age for the most important age groups in 2008.

5.3.3 Natural mortality

A fixed natural mortality of 0.2 for all age groups was used both in the assessment and the forecast.

5.3.4 Maturity at age (Table 5.3.3)

A constant maturity ogive was used until the 2005 WG, when these estimates were evaluated. In later years the maturity at age had decreased somewhat, and the WG decided to use a 3-year running average for the period from 1985 and onwards (2-year average for the first and last year). New analyses were only available back to 1985. Table 5.3.3 presents the 3-year running average maturity ogives.

In later years there has been a southward shift in the distribution of saithe (Figure 5.2.2) and the biological sampling from the southern part of the distribution area shows a higher maturation for ages 4 and 5 compared to samples from the northern part of the distribution area. The 3-year running average ogive used in the assessment is not weighted by abundance, and due to an increase in the number of samples in the south, the data from this area has contributed more in later years. The increasing proportion of the stock in the southern part may justify this, but the approach is not satisfactory and alternative methods for estimating maturity ogives should be investigated.

5.3.5 Tuning data (Table 5.3.4, Figures 5.3.1–5.3.2)

Until the 2005 WG, the tuning was based on three data series: CPUE from Norwegian purse seine and Norwegian trawl and indices from a Norwegian acoustic survey. The 2005 WG found rather large and variable log q residuals and large S.E. log q for the purse seine fleet, as well as strong year effects, and in the combined tuning the fleet got low-scaled weights. The WG decided not to include the purse seine tuning fleet in the final analysis and the following two fleets have been used since 2005:

> Fleet 12: CPUE data from the Norwegian trawl fisheries (start 1994, age groups 4 to 8, quarter 2-4)
>
> Fleet 13: Indices from the Norwegian acoustic survey (start 1994, age groups 3 to 7).

Figure 5.3.1 presents the tuning data by fleet, year and age. In the CPUE data, which show an overall increase in the last two years, most of the values are above the long-term average, but the 2002-year class is the one that contributes most to the higher overall level. Figure 5.3.2 shows comparative scatter plots at age in the CPUE series and in both 2007 and 2008 three out of four of the age groups are above the trend line. Compared to previous years the total CPUE in 2007 and 2008 increased by about 25%, while the total survey index declined by about 20% in both of these years. For consistency, the WG chose to base the assessment on not including 2007 and 2008 CPUE data in the assessment (see Section 5.9). However, the difference from including these years is not large (approximately 10% higher F in the run used).

5.4 Exploratory runs (Table 5.4.1, Figures 5.4.1–5.4.3)

The settings of the different runs are shown in Table 5.4.1 and the results are given in Figures 5.4.1-3.

Based on the update of Norwegian catch statistics and the "old" method for allocation of biological samples, a SPALY (Same Procedure As Last Year) XSA (run 1) was performed, giving slightly different results compared to the 2007 assessment. $F_{4\text{-}7}$ in 2007 is now estimated to 0.19 compared to 0.20, while SSB in 2008 decreased from 834,000 t to 813,000 t (Figure 5.4.1).

Three single fleet tuning runs were performed; two with the Norwegian trawl CPUE (run 2 and 3), the latter without 2007 and 2008 data, and one with the Norwegian acoustic survey (run 4). The last two runs (5 and 6) were with combined fleets, the latter without 2007 and 2008 in the CPUE series.

Figure 5.4.1, in addition to the update, also compares estimates of SSB and $F_{4\text{-}7}$ in 2007 from the three single fleet XSA-runs and the two combined tuning runs. The single fleet tuning runs based on the CPUE give the lowest $F_{4\text{-}7}$ and highest SSB in the last assessment year (2008), and the $F_{4\text{-}7}$ are especially low in the one with 2007 and 2008 data included (run 3). The highest $F_{4\text{-}7}$ and the lowest SSB is given by the combined run excluding CPUE in 2007 and 2008 (run 6), which was used as the final run.

Figure 5.4.2 presents S.E. log q for the different age groups in the fleets used in the single fleet tuning runs. The single fleet tuning run based on the survey has a much lower S.E. log q for age 4, similar for age 5, much higher for age 6, and the same for age 7, compared to the runs based on the CPUE. The high S.E. log q for age group 6 may be due to a large increase in availability and/or catchability of this age group in 1997-98. Figure 5.4.3 presents log q residuals for the CPUE fleet with 2007 and 2008 data, and most of the residuals change from negative to positive between 2006 and 2007 and remain positive in 2008.

5.5 Final assessment run (Tables 5.5.1–5.5.7, Figures 5.5.1–5.5.3)

Last year, the 2007 CPUE data were considered an outlier in the time series and the overall 2008 value is at the same level, indicating a more permanent change. The survey (Aglen *et al*., WD 3) shows a higher proportion of saithe in the southern half of the distribution area in the last years (Figure 5.2.2), and logbook data show that the trawl catches included in the CPUE calculations also have become gradually more southerly distributed, i.e. the trawlers follow saithe aggregations that may have become extra available in 2007 and 2008. The biological samples used for dividing total CPUE on age groups are, however, from the whole saithe fishery and therefore include age groups that are not numerous in these aggregations. Due to this, and the 20% decline in total survey index showing a conflicting trend, the WG decided to exclude the 2007 and 2008 CPUE data in the final assessment.

Extended Survivors Analysis (XSA) was used for the final assessment with settings shown in Table 5.4.1. The settings for this update assessment are the same as in the 2007 assessment. Full tuning fleet diagnostics are given in Table 5.5.1. Figure 5.5.1 presents log q residuals for the two fleets, and there are some year and age effects in both fleets. Figure 5.5.2 shows the scaled weights. The survey gets the highest weights for all ages up to 7. Figure 5.5.3a-b shows plots of the tuning indices versus stock numbers from the XSA.

5.5.1 Fishing mortalities and VPA (Tables 5.5.2–5.5.7, 5.7.1 Figure 5.5.4)

The fishing mortality ($F_{4\text{-}7}$) in 2007 was 0.18, which is marginally lower than the value of 0.19 from last year's assessment. The fishing mortality ($F_{4\text{-}7}$) in 2008 was 0.20, i.e. slightly above the corresponding figure for 2007 and well below the F_{pa} of 0.35. Fishing mortality and stock size have in the last decade been over- and underestimated, respectively, in the last assessment year as is illustrated by the retrospective plots in Figure 5.5.4.

The XSA-estimates of the 2005-2006 year classes are not considered to be reliable and are therefore shaded (Tables 5.5.3 and 5.5.5). In the projections, both were set to the long-term geometrical mean, the value of the 2005-year class at age 4 being obtained by applying Pope's approximation. The figures are given in input data for prediction (Table 5.7.1). The 2002 year class has been the most numerous in the landings the four last years and is estimated to be of the same strength as the very strong 1989 and 1992-year classes. The 2003-year class is confirmed to be one of the weakest in the time series, and the 2004-year class also seems to be poor. Little information is available on the strength of recent year classes, but the 2005-year class is clearly more prominent in the catch at age 3 than its two predecessors.

The total biomass (ages 3+) has been above the long-term (1960-2008) mean since 1995, reached a maximum in 2002, and is presently declining. The SSB has been above the long-term mean since 1996 and above B_{pa} since 1994 (Tables 5.5.5-5.5.7). It is declining, but is still more than three times the B_{pa}.

5.5.2 Recruitment (Table 5.3.1, Figure 5.1.1)

Estimates of the recruiting year classes up to the 2004-year class (4 year olds) from the XSA were accepted. Catches of age group 3 were low in 2006 and 2007, but increased somewhat in 2008 (Table 5.3.1). Until the 2005 WG, RCT3-runs were conducted to estimate the corresponding year classes, with 2 and 3 year olds from the acoustic survey as input together with VPA numbers. These estimates were, however, strongly weighted towards the mean value of the input XSA-numbers, which due to the short survey time series also contained year classes that were still not converged. It has therefore been stated several times in the ACFM Technical Minutes that it would be more transparent to use the long-term GM (geometric mean) recruitment.

The GM recruitment 1960-2007 is 176 million 3 year olds, and this value is used for the 2005-year class. The value is lower than the GM recruitment 1994-2007 (219 million), a period where the SSB has been well above B_{pa}. Preliminary data from the Norwegian 0-group observer programme indicate slightly above average recruitment since 2000, but this series is not yet evaluated for use in the assessment.

5.6 Reference points

Due to the change of Fbar from 3-6 to 4-7 and age at recruitment from 2 to 3, the LIM and PA reference points were re-estimated at the 2005 WG. The LIM reference points were estimated according to the new methodology outlined in ICES CM 2003/ACFM:15, while the PA reference point estimation was based on the old procedure (ICES CM 1998/ACFM:10).

5.6.1 Biomass reference points

In 1995 MBAL for Saithe in sub areas I and II was set at 170,000 t. (ICES 1996/Assess: 4). This was also proposed as a suitable level for B_{pa} by The Study Group on the Precautionary Approach to Fisheries Management (SGPAFM, ICES 1998/ACFM:10). Based on an examination of the stock-recruitment plot ACFM reduced the B_{pa} to 150,000 t (ICES 1998).

At the 2005 WG parameter values, including the change-point, were computed using segmented regression on the 1960-2000 time series of SSB-recruitment pairs. The maximum likelihood estimate of the spawning stock biomass at which recruitment is impaired was 136,055 t, and B_{lim} was set at 136,000 t. Applying the "magic formula" $B_{pa} = B_{lim} \exp(1.645*\sigma)$, with a value of 0.3 for σ, gave a B_{pa} of 222,863 t, rounded to 220,000 t. This new B_{pa} for Saithe in Sub-areas I and II was accepted by ACFM.

5.6.2 Fishing mortality reference points (Tables 5.6.1, 5.7.1, Figure 5.1.1)

Yield and SSB per recruit were based on the parameters in Table 5.7.1 and are presented in Table 5.6.1. $F_{0.1}$ and F_{max} were estimated to be 0.16 and 0.39. These are increases from 0.14 and 0.32, respectively, revealing that especially the estimate of F_{max} is unstable for this stock. The plot of SSB versus recruitment is shown in Figure 5.1.1. The values of F_{low}, F_{med} and F_{high} obtained by the 2002 WG were 0.11, 0.34 and 0.69, respectively. In 1998 ACFM estimated F_{pa} using the formula $F_{pa}=F_{lim} \cdot e^{-1.645\sigma}$ with $\sigma = 0.3$ giving a $F_{pa} = 0.26$ based on an estimated $F_{lim} = 0.45$ (ICES 1998).

At the 2005 WG F_{lim} was set on the basis of B_{lim} (ICES CM 2003/ACFM:15). The functional relationship between spawner-per-recruit and F gave the F associated with the R/SSB slope derived from the B_{lim} estimate obtained from the segmented regression. R/SSB = 1.27 from the B_{lim} estimation gave SSB/R = 0.7874 and a $F_{lim} = 0.58$. Applying the "magic formula" $F_{pa} = F_{lim} \exp(-1.645*\sigma)$, gave a F_{pa} of 0.35. This new F_{pa} for Saithe in Sub-areas I and II was accepted by ACFM.

5.6.3 Harvest control rule

In 2007 Norway asked ICES to evaluate whether a proposal for a harvest control rule for setting the annual fishing quota (TAC) for Northeast Arctic saithe was consistent with the precautionary approach. The harvest control rule contains the following elements:

- Estimate the average TAC level for the coming 3 years based on $\mathbf{F}_{pa}$. 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 15% compared with the previous year's TAC.
- If the spawning stock biomass (SSB) in the beginning of the year for which the quota is set (first year of prediction), is below $\mathbf{B}_{pa}$, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from $\mathbf{F}_{pa}$ at SSB=$\mathbf{B}_{pa}$ to 0 at SSB equal to zero. At SSB levels below $\mathbf{B}_{pa}$ in any of the operational years (current year and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.

ICES concluded that the HCR is consistent with the precautionary approach for all simulated data and settings, including a rebuilding situation under the condition that the assessment uncertainty and error are not greater than those calculated from historic data. This also holds true when an implementation error (difference between TAC and catch) equal to the historic level of 3% is included.

The highest long-term yield was obtained for an exploitation level of 0.32, i.e. a little below the target F used in the HCR (F_{pa}), and ICES recommended using a lower value in the HCR.

The HCR is expected to rebuild a depleted stock to a level above B_{lim} within three years.

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 are given in Table 5.7.1. The stock number at age in 2009 was taken from the XSA for age 5 (2004 year class) and older. The recruitment at age 3 in the last assessment year (2008) was calculated as the long-term GM (geometric mean) recruitment 1960-2007 (Section 5.5.2), and the corresponding numbers at age 4 in the intermediate year (2009) was calculated applying a natural mortality of 0.2 and using Pope's approximation (as recommended by the ACFM reviewers in 2008). The GM age 3 recruitment of 176 million was also used for the 2006 and subsequent year classes. The natural mortality of 0.2 is the same as used in the assessment. For exploitation pattern the average of 2006-2008, scaled to the 2008 level, has been used. For weight at age in stock and catch the average of the last three years in the XSA was used. For maturity at age the average of the 2007-2008 annual determinations was applied.

5.7.2 Catch options for 2010 (short-term predictions) (Tables 5.7.2-5.7.5)

The management option table (Table 5.7.2) shows that the expected catch of 225,000 t in 2009 will increase the fishing mortality compared to 2008 from 0.20 to 0.28, which is still well below the F_{pa} of 0.35. A catch in 2010 corresponding to $F_{status\ quo}$ level of 0.20 will be 144,000 t, while a catch at F_{pa} in 2010 is 233,000 t. A catch in 2010 corresponding to the evaluated and implemented HCR (average TAC level for the coming 3 years based on F_{pa}, see Table 5.7.3) is 204,000 t. This catch corresponds to a fishing mortality of 0.30 in 2010.

In the management plan evaluations in 2007 the highest long-term yield was obtained for an exploitation level of 0.32, i.e. a little below the target F used in the HCR (Fpa), and ICES recommended using a lower value in the HCR. The catch in 2010 corresponding to an exploitation level of 0.32 in the HCR is 216,000 t.

For a catch in 2009 corresponding to the HCR, i.e. 225,000 t, the SSB is expected to decrease from about 690,000 t at the beginning of 2009 to 569,000 t at the beginning of 2010, which is close to the prediction made by last year's working group. At $F_{status\ quo}$ in 2010 SSB is estimated to decrease to 539,000 t at the beginning of 2011, for a catch corresponding to the HCR it will decrease to about 486,000 t, for an exploitation level of 0.32 in the HCR SSB will decline to 475,000 t, while at F_{pa} in 2010 SSB will decrease to about 460,000 t in 2011. Higher fishing mortalities and incoming year classes of below average strength mainly explain this predicted reduction in SSB. Table 5.7.4 presents detailed output for fishing according to the HCR in 2010.

5.7.3 Medium term simulations (Figure 5.7.1a-b)

The ACFM review groups have not consider the medium term analyses reliable as the results are mainly driven by the assumption of mean recruitment and ignoring the bias in the assessment. Although the recent assessment indicates a reduction of the bias problem, no improved recruitment estimates are available. However, the WG made medium-term simulations just to illustrate a scenario following the HCR.

The input data were the same as used for the short-term predictions (Table 5.7.1). Following the HCR, the catch will decrease to 164,000 t in 2013, while the SSB will be reduced to 409,000 t.

5.7.4 Comparison of the present and last year's assessment

The current assessment estimated the total stock in 2008 to be 4 % higher and the SSB 4 % lower, compared to the previous assessment. The F in 2007 is estimated to be slightly lower than in the previous assessment and the realized F in 2008 is somewhat lower than the predicted one, which was based on the TAC.

	Total stock (3+) by 1 January 2008 (tonnes)	SSB by 1 January 2008 (tonnes)	F_{4-7} in 2008	F_{4-7} in 2007
WG 2008	1093382	810538	0.27 (TAC constraint)	0.19
WG 2009	1134969	775883	0.20	0.18

5.8 Comments on the assessment and the forecast (Figures 5.8.1a-b, 5.8.2).

In view of the findings during the meeting, which indicated substantial changes to the assessment if applied, and the important issues still unsolved, it was decided to wait for the benchmark assessment before decisions on changes are made. Hence, the update assessment was made as closely as possible to the previous one, creating little change from last year. The forecast still give a TAC according to the management plan that is higher than the recent catches.

The retrospective pattern has been a major concern in the assessment, but the last two years, the assessment has become more stable. An examination of the tuning data revealed a large shift in catchability for ages 4-6 in the survey around 2000 (Figure 5.8.1a,b) and it was suspected that this could be the major cause of the retrospective pattern. Due to the time tapering the data from the earlier years now have less influence on the assessment, which may explain the recent stabilization of the assessment.

A trial run was made using tuning data only from 2000 onwards and in this run the retrospective pattern disappeared (Figure 5.9.2). However, the time slot for retrospective analysis becomes quite short. The fishing mortality in this trial run was reduced to a level not much above 0.1 and the SSB was nearly doubled, but showed a similar declining trend as the update assessment. Extending the trawl series backwards reduced the changes to some extent, but they are still substantial, and there would be a marked increase in the TAC if the HCR is applied.

Even if it is concluded that the change in catchability in the survey has been the cause of the retrospective problem, there are other problems that need to be addressed in a benchmark assessment. One is explaining the different trend in the CPUE and the survey, which again may be linked to the southward change in the stock distribution, a probably temporal shift back to a situation similar to that in the 1960s. Examining the effect of this change in distribution on the tuning indices should be a major task during the benchmark assessment.

5.9 Response to ACFM technical minutes

The review group were mainly concerned with the validity of the assessment and if it suitable as basis for advice. They point to the severe retrospective pattern and question the effects of discarding and the unclear stock border in the south. Concerning the retrospective pattern, this appears to be linked to a change in the catchability in the survey (see Section 5.9). The text on discarding in last year's report gave the impression that this could be a large problem, whereas in fact discarding has never been considered to be extensive, with the possible exception of sectors of the international fleet, which account for a small part (<10 %) of the directed saithe effort. Migration across the stock border at 62°N is known to take place, both for mature and for immature fish, and goes both ways. The stock area definition was the subject of the ICES Saithe Study Group in 1995, which recommended to keep the border at 62°N. Considering the extension of the distribution area, a leak in the south is hardly crucial for the assessment, but it may create some noise, especially in years when the stock tends to have a more southern distribution. Since the border is with the North Sea stock, irregularities in the assessment should be mirrored in that stock.

The review group also point to differences in the recent trends between the CPUE data and the survey and points to poor convergence in the VPA due to the low fishing mortality, which could mean that the current rate of exploitation is poorly estimated. These problems are not resolved and should be addressed in a benchmark assessment. However, the catch-numbers-at-age data point to low levels of total mortality in recent years.

The suggestion that changed growth may be the cause of the retrospective pattern appears to be unfounded, mainly because growth changes in general have been small, but also because the survey and the cpue series do not show the same trends in catchability over time. However, the observed weights-at-age are part of the problem of migration from the coast to the banks and should be examined in a benchmark assessment.

The "mirroring" of the survey indices for ages 3 and 4 may be linked to the mechanisms of migration from the coastal grounds to the banks, but to verify this requires further investigations.

The review group point out that the approach (recommended by a previous review group) to calculating abundance of a recruiting year class at age 4 corresponding to the GM at age 3 is illogical, and they suggest that Pope's approximation is used. The WG has adopted this approach. However, this year the difference between the two methods was marginal.

Table 5.1.1 Saithe in Sub-areas I and II (Northeast Arctic).

Nominal catch (t) by countries as officially reported to ICES.

Year	Faroe Islands	France	Germany Dem.Rep	Fed.Rep. Germany	Iceland	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	146 [2]	141,941	-	17 [2]	3,929	24 [2]	336	3	32 [2]	150,375
2000	224 [2]	1438 [2]	651 [2]	2,573 [6]	32 [2]	125,950	-	46	4,452	117 [2]	445	9	8 [2]	135,945
2001	519	1279	701	2,690	57 [2]	125,495	-	75	4,951	119	352	162	2 [2]	136,402
2002	520 [2]	1048	1138 [2]	2,642 [6]	78 [2]	143,840	-	118	5,402	37 [2]	345	75	3 [2]	155,246
2003	561 [2]	848	929 [2]	2,763 [6]	80 [2]	150,244	-	143	3,893	13 [2]	265		18 [2]	159,757
2004	708 [2]	188 [2]	891 [2]	2,161 [6]	319 [2]	147,933	-	105	9,192	87	522	21	14 [2]	162,140
2005	1,192 [2]	348 [2]	817 [2]	2,048 [6]	366 [2]	162,537	-	354	8,362	25	629			176,678
2006	1,674	899	786 [2]	2,797 [6]	255 [2]	195,448	88	339	9,823	21 [2]	532		8 [2]	212,670
2007	2,048	951	810 [2]	3,019 [6]	220 [2]	178,984	99	400	12,168	53 [2]	453		1	199,206
2008 [1]	1,543 [2]	302	503 [2]	2,263	131	166,263	65.9	335	11,577	33 [2]	418		9.7	183,443

[1] Provisional figures.

[2] As reported to Norwegian authorities.

[3] USSR prior to 1991.

[4] Includes Estonia.

[5] Includes Denmark,Netherlands, Ireland and Sweden

[6] As reported by Working Group members

Table 5.1.2 Saithe in Sub-areas I and II (Northeast Arctic).
Landings ('000 tonnes) by gear category.

Year	Purse Seine	Trawl	Gill Net	Others	Total
1977	75.2	69.5	19.3	12.7	176.7 [2]
1978	62.9	57.7	21.1	13.9	155.6 [2]
1979	74.7	52.0	21.6	15.9	164.2
1980	61.3	46.8	21.1	15.4	144.6
1981	64.3	72.4	24.0	14.8	175.5
1982	76.4	59.4	16.7	15.5	168.0
1983	54.1	68.2	19.6	15.0	156.9
1984	36.4	85.6	23.7	13.1	158.8
1985	31.1	49.9	14.6	11.6	107.2
1986	7.9	36.2	12.3	8.2	64.6 [2]
1987	34.9	28.0	19.0	10.8	92.7 [2]
1988	43.5	45.4	15.3	10.0	114.2
1989	48.6	44.8	16.8	12.1	122.3
1990	24.6	44.0	19.3	7.9	95.8
1991	38.9	40.1	18.9	9.4	107.3
1992	27.1	66.9	21.2	12.3	127.5
1993	33.1	83.5	21.2	15.8	153.6
1994	30.2	81.7	21.1	13.5	146.5 [3]
1995	21.8	103.5	26.9	16.1	168.4 [4]
1996	46.9	72.8	31.6	20.1	171.3
1997	44.4	56.1	24.4	18.8	143.6
1998	44.4	58.1	27.6	23.2	153.3
1999	39.2	57.9	29.7	23.6	150.4
2000	28.3	54.6	29.6	23.5	135.9
2001	28.1	58.3	28.2	21.7	136.4
2002	27.4	75.9	30.4	21.5	155.2
2003	43.3	72.2	25.2	19.0	159.8
2004	41.8	72.0	26.9	21.3	162.1
2005	42.1	90.7	25.6	18.3	176.7
2006	73.5	86.6	29.8	22.8	212.7
2007	41.8	100.9	33.3	23.2	199.2
2008 [1]	39.4	90.0	36.9	17.1	183.4

[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. Purse seine catches splitted on vessels with annual catch < 100 t and > 100 t, and number of vessels with catch > 100 t scaled by total purse seine catch

	No. of vessels with catch			% vessels with catch		Annual catch (t) from vessel with catch			Catch in % by vessel		Catch per vessel by vessel		Effort (No.) vessel>100(t) scaled to total catch
Year	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	total	< 100 (t)	> 100 (t)	< 100 (t)	> 100 (t)	
1989	160	109	269	59%	41%	4,164.8	44,308.7	48,473.5	9%	91%	26.0	406.5	119.2
1990	110	51	161	68%	32%	2,340.7	22,277.5	24,618.2	10%	90%	21.3	435.8	56.4
1991	105	92	197	53%	47%	2,568.5	36,329.4	38,897.9	7%	93%	24.5	394.9	98.5
1992	89	80	169	53%	47%	2,670.7	24,206.3	26,877.0	10%	90%	30.0	302.6	88.8
1993	41	69	110	37%	63%	1,319.4	31,831.5	33,150.9	4%	96%	32.2	461.3	71.9
1994	56	75	131	43%	57%	1,601.3	27,746.3	29,347.6	5%	95%	28.6	370.0	79.3
1995	72	48	120	60%	40%	1,762.7	20,137.6	21,900.3	8%	92%	24.5	419.5	52.2
1996	83	79	162	51%	49%	1,653.7	45,194.5	46,848.2	4%	96%	19.9	572.1	81.9
1997	69	88	157	44%	56%	1,942.7	42,357.8	44,300.5	4%	96%	28.2	481.3	92.0
1998	193	118	311	62%	38%	4,141.5	40,234.0	44,375.5	9%	91%	21.5	341.0	130.1
1999	213	115	328	65%	35%	5,314.0	33,885.0	39,199.0	14%	86%	24.8	293.8	133.0
2000	200	102	302	66%	34%	5,308.0	22,922.0	28,230.0	19%	81%	26.5	224.7	125.6
2001	215	87	302	71%	29%	4,732.0	23,396.0	28,128.0	17%	83%	22.0	268.9	104.6
2002	219	68	287	76%	24%	3,435.0	23,938.0	27,373.0	13%	87%	15.7	352.0	77.8
2003	185	108	294	63%	37%	3,098.0	40,250.0	43,348.0	7%	93%	16.7	372.7	116.3
2004	194	71	264	73%	27%	2,905.0	38,892.0	41,797.0	7%	93%	15.0	547.8	76.3
2005	220	78	299	74%	26%	2,637.0	39,411.0	42,048.0	6%	94%	12.0	505.3	83.2
2006	187	109	296	63%	37%	1,694.0	71,798.0	73,492.0	2%	98%	9.1	658.7	111.6
2007	152	70	222	68%	32%	1,943.2	39,844.1	41,787.3	5%	95%	12.8	569.2	73.4
2008 [2]													
Mean	145.4	85.1	230.6	61%	39%	2,907.0	35,208.4	38,115.4	8%	92%	21.6	419.9	93.3

[1] Provisional figures.

[2] No data available.

Table 5.2.2 Saithe in Sub-areas I and II (Northeast Arctic).
Norwegian trawl CPUE by agegroup (Catch in numbers per trawlhour).
Only quarter 2-4 included in the calculatons, Year 1994-2006 included.

Year	Agegroup									Total CPUE (kg/h)
	effort	3	4	5	6	7	8	9	10	Quarter 2-4
1993	1	73.3	337.8	428.2	60.0	24.1	24.2	13.0	18.1	979
1994	1	5.1	126.0	424.3	263.6	36.4	8.1	2.6	5.0	871
1995	1	39.5	211.0	292.9	318.3	50.5	8.3	0.3	2.1	923
1996	1	21.3	105.9	141.5	205.7	271.3	31.1	6.7	0.6	784
1997	1	15.2	40.4	210.1	214.0	275.3	173.3	18.3	1.8	948
1998	1	3.2	32.4	54.3	239.5	91.2	55.5	16.0	7.5	499
1999	1	16.1	39.0	109.8	83.2	192.8	44.2	32.4	9.3	527
2000	1	7.3	80.3	85.8	160.9	124.6	167.3	63.3	71.5	761
2001	1	8.3	49.6	271.9	195.7	184.9	78.3	111.6	53.5	954
2002	1	9.9	74.8	121.7	378.9	85.4	87.7	40.1	74.6	873
2003	1	5.0	130.8	199.7	132.5	191.1	123.3	102.0	63.1	947
2004	1	3.1	7.7	189.0	140.4	180.3	226.0	72.6	99.7	919
2005	1	12.8	36.9	98.7	291.9	139.4	78.4	139.2	46.8	844
2006	1	17.5	70.5	101.7	316.5	166.1	95.9	141.8	63.4	973
2007	1	4.9	17.1	309.8	238.0	152.2	212.1	141.4	71.9	1147
2008 [1]	1	24.3	96.9	60.3	375.2	186.2	124.3	173.7	109.1	1150

[1] Provisional figures.

Table 5.2.3 Saithe in Sub-areas I and II (Northeast Arctic).
German freezer trawl CPUE (kg/h) and catch in numbers by age group.

Year	Agegroup													
	CPUE	3	4	5	6	7	8	9	10	11	12	13	14	15
1995 [1]	314	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	746	0	7	12	42	39	5	0	0	1	0	1	0	0
1997	1148	0	2	45	43	58	23	1	0	0	0	0	0	0
1998	828	0	8	6	14	6	10	2	1	0	0	0	0	0
1999	779	0	5	28	46	82	26	27	3	1	0	0	0	0
2000	1208	0	30	16	61	42	67	18	20	5	2	1	0	1
2001	922	1	49	140	61	21	6	6	1	0	0	0	0	0
2002 [1]	876	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	839	0	46	38	70	114	22	25	11	14	11	9	3	1
2004	866	0	0	10	58	57	73	21	13	8	8	7	7	4
2005	907	1	5	64	41	29	36	15	6	6	10	4	3	0
2006	758	0	3	8	17	51	39	18	18	6	3	2	1	3
2007 [2]														
2008 [2]														

[1] No age based data available
[2] No data available

Table 5.2.4 Saithe in Sub-areas I and II (Northeast Arctic).
Acoustic abundance indices from Norwegian surveys in October-November.
In 1985 - 1991 the area coverage was incomplete. Numbers in millions.

Year	Age									Total
	2	3	4	5	6/6+	7	8	9	10+	
1985	3.1	4.9	2.4	0.5	0.0					10.9
1986	19.5	40.8	3.6	1.8	1.8					67.5
1987	1.8	22.0	48.4	1.8	1.7					75.7
1988	15.7	22.5	19.0	7.1	0.6					64.9
1989	24.8	28.4	17.0	10.1	12.4					92.7
1990	99.6	31.9	14.7	5.1	7.4					158.7
1991	87.8	104.0	4.6	4.0	7.1					207.5
1992	163.5	273.6	57.5	6.2	8.8					509.6
1993	106.9	227.7	103.9	12.7	3.2					454.4
1994	35.1	87.1	108.9	41.4	8.1	0.7	1.0	0.5	1.0	283.8
1995	38.4	166.1	86.5	46.5	16.5	2.4	0.0	0.0	1.0	357.5
1996	48.8	122.6	207.4	31.7	15.1	4.0	0.5	0.0	0.0	430.0
1997	5.5	38.0	184.8	79.8	50.6	9.6	1.2	0.0	0.3	369.8
1998	44.0	96.7	202.6	69.3	84.3	6.6	3.8	0.7	0.1	508.1
1999	61.1	233.8	72.9	62.2	21.0	19.2	5.9	1.4	0.4	477.8
2000	164.8	142.5	176.3	11.6	11.5	8.0	4.0	1.0	2.0	521.7
2001	104.7	275.9	45.9	53.8	5.6	6.1	3.2	3.4	1.9	500.5
2002	25.5	230.2	92.6	18.9	10.6	2.2	0.9	0.8	1.2	382.9
2003	31.0	87.5	151.7	26.1	6.2	6.4	1.2	0.7	1.3	312.1
2004	152.2	212.4	118.7	49.1	19.2	4.7	3.0	3.1	3.1	565.5
2005	22.2	228.1	67.2	20.3	16.5	7.7	2.2	1.7	0.9	366.7
2006	98.2	42.6	142.9	19.4	4.6	8.5	5.6	2.1	3.5	327.3
2007	45.4	111.0	27.1	61.1	7.9	5.8	4.1	4.3	1.1	267.9
2008	55.6	97.2	29.2	13.8	11.9	4.0	1.0	1.0	1.6	215.3

Table 5.3.1 Catch numbers at age
Run title : North-East Arctic saithe

At 23/04/2009 10:28

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

	YEAF	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE									
	3	10509	17824	37266	42050	9001	37115	22392	29664	25196
	4	13083	9131	11131	28925	59601	5001	54537	24836	18384
	5	13545	12506	4421	5888	13154	26300	13124	35956	5101
	6	5064	3799	8290	4650	2718	10142	12899	4125	8282
	7	4883	1332	2427	3861	3472	2861	4652	5616	787
	8	2401	968	1024	1099	2655	2110	1374	2916	1913
	9	1315	520	938	1075	1251	2733	933	1413	900
	10	743	405	451	697	1221	699	965	1397	577
	+gp	1525	1229	1728	1777	3559	3593	2900	3493	1166
0	TOTAL	53068	47714	67676	90022	96632	90554	113776	109416	62306
	TONSL	133515	105951	120707	148627	197426	185600	203788	181326	110247
	SOPC(	129	142	123	122	121	115	112	96	119

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

	YEAF	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	AGE										
	3	77333	43540	77019	65178	76296	36782	60832	125030	99049	48969
	4	11949	62846	59280	52389	25206	44027	11691	30576	34317	27685
	5	16939	13987	26961	29146	26911	15671	16366	7947	10140	12476
	6	4747	16189	9556	10186	16031	20419	4436	8712	2062	4534
	7	4798	5122	9592	5616	7114	12148	7808	3435	4332	1468
	8	1126	7950	2901	3547	3935	4802	6789	3212	1456	1848
	9	1711	2504	4352	1865	2871	3258	2914	2679	1606	938
	10	675	3697	2195	2140	2610	2505	2350	1724	963	976
	+gp	511	2799	5490	3149	3924	3821	4140	2880	1134	2150
0	TOTAL	119789	158634	197346	173216	164898	143433	117326	186195	155059	101044
	TONSL	140060	264924	241272	214334	213859	274121	233453	242486	182817	154464
	SOPC(	98	101	80	85	82	104	115	108	107	115

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

	YEAF	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	61963	40796	83954	34733	17244	41466	48917	22115	17869	8126
	4	23328	36644	21822	65052	23768	33233	11974	12895	49829	35847
	5	14122	9211	21528	13060	32700	12064	7189	6062	4339	32827
	6	4400	6379	3619	8212	3226	11204	5279	4525	3118	4560
	7	2901	3200	2550	1054	3008	1135	3740	2805	3490	2328
	8	963	1338	2008	1251	1177	1772	775	1399	755	1219
	9	1356	147	369	461	760	560	878	351	620	966
	10	438	730	279	263	247	557	134	454	257	320
	+gp	1192	1629	629	448	760	897	701	285	797	102
0	TOTAL	110663	100074	136758	124534	82890	102888	79587	50891	81074	86295
	TONSL	164180	144554	175516	168034	156936	158786	107183	70458	92391	114242
	SOPC(	122	99	102	103	106	105	100	101	104	100

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

	YEAF	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	12550	23792	68681	44608	22614	7058	17178	10510	11789	3091
	4	19285	16930	13630	33266	61398	35593	52109	54886	11698	16215
	5	33233	9054	5752	5982	30848	49248	40145	18499	35011	11946
	6	18479	10238	4883	5408	3716	18999	30451	18357	13567	31818
	7	1751	7341	3877	4748	1744	2053	4177	17834	13452	8376
	8	350	1076	2381	3173	1366	723	483	2849	7058	5539
	9	176	160	383	1461	1018	421	125	485	812	2873
	10	187	112	61	286	790	278	259	214	55	727
	+gp	204	269	179	442	146	655	293	474	146	394
0	TOTAL	86215	68972	99827	99374	123640	115028	145220	124108	93588	80979
	TONSL	122310	95848	107326	127516	153584	146544	168378	171348	143629	153327
	SOPC(	105	102	101	105	101	98	100	100	100	100

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

	YEAF	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE										
	3	9655	9175	3833	6614	2335	991	26083	1975	2159	8932
	4	12236	22767	7979	17554	50447	6111	12478	68651	4038	11507
	5	22872	7747	27071	11592	13374	33548	9696	11805	41139	4990
	6	10347	10676	8802	25702	7008	10441	22822	10087	16346	28102
	7	18930	6123	7147	5323	9467	7321	10640	16806	8155	12005
	8	3374	8303	3158	4284	5411	8133	5595	8059	11088	6347
	9	3343	2530	4706	2390	3497	2742	7745	5602	7569	8340
	10	2290	2652	1943	3443	2492	3026	2644	5097	4023	5102
	+gp	597	1219	1942	2392	4102	5336	2276	4275	2891	3256
0	TOTAL	83644	71192	66581	79294	98133	77649	99979	132357	97408	88581
	TONSL	150373	135945	136402	155246	159757	162140	176678	212670	199206	183444
	SOPC(	100	101	100	100	100	100	100	100	100	100

Table 5.3.2 Catch weight at age
Run title : North-East Arctic saithe

At 23/04/2009 10:28

Table 2 Catch weights at age (kg)

	YEAF	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE									
	3	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
	5	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
	7	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
	9	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
	+gp	8.03	8.039	7.924	7.851	7.781	7.959	8.106	7.994	7.716
0	SOPC	1.2863	1.4159	1.2326	1.2169	1.2138	1.1472	1.1222	0.9593	1.1889

Table 2 Catch weights at age (kg)

	YEAF	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	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	7.479	7.404	7.052	7.477	7.385	7.217	7.127	7.32	7.394	7.527
0	SOPC	0.9829	1.0067	0.8017	0.8492	0.8246	1.0407	1.1549	1.0845	1.0695	1.1465

Table 2 Catch weights at age (kg)

	YEAF	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	0.71	0.79	0.73	0.77	1.05	0.71	0.75	0.59	0.53	0.62
	4	1.11	1.27	1.4	1.12	1.33	1.26	1.33	1.22	0.84	0.87
	5	1.63	2.03	2.05	2.02	1.86	2.02	2.07	1.97	1.66	1.31
	6	2.33	2.55	2.76	2.61	2.8	2.7	2.63	2.3	2.32	2.43
	7	3.16	3.29	3.3	3.27	4	3.88	3.28	2.87	2.97	3.87
	8	4.03	4.34	4.38	3.91	4.18	4.47	3.96	3.72	4	5.38
	9	4.87	5.15	5.95	4.69	5.33	5.36	4.54	4.3	4.72	5.83
	10	5.63	5.75	6.39	5.63	5.68	6.06	5.55	4.69	5.44	5.36
	+gp	7.809	6.937	6.841	7.558	8.665	7.19	8.012	6.597	6.904	7.448
0	SOPC	1.2199	0.9879	1.0237	1.0323	1.0564	1.051	1.0011	1.0079	1.0384	1.0023

Table 2 Catch weights at age (kg)

	YEAF	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	0.74	0.71	0.68	0.67	0.61	0.52	0.56	0.59	0.62	0.68
	4	0.95	1	1.05	1.01	0.99	0.76	0.79	0.82	0.95	1
	5	1.4	1.45	1.85	1.92	1.65	1.24	1.19	1.33	1.24	1.48
	6	1.78	2.09	2.39	2.28	2.46	2.12	1.71	1.84	1.72	1.87
	7	2.96	2.49	3.08	2.77	2.85	3.22	2.87	2.48	2.35	2.58
	8	3.73	3.75	3.35	3.2	3.03	3.83	3.78	3.73	3.1	3.07
	9	4.62	3.9	4.48	3.73	3.71	4.69	4.06	4.32	4.19	4.13
	10	4.67	6.74	4.66	6.35	4.49	5.31	5.3	5.34	5.79	5.44
	+gp	7.19	6.27	6.58	7.63	6.29	5.97	7.56	7.07	7.44	8.07
0	SOPC	1.0484	1.0226	1.0085	1.0517	1.0106	0.9848	0.999	1.0018	1.0011	1.0014

Table 2 Catch weights at age (kg)

	YEAF	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE										
	3	0.67	0.6	0.75	0.69	0.66	0.71	0.59	0.59	0.756	0.717
	4	1.05	1.03	1.12	1.01	0.91	1.03	0.89	0.83	1.075	1.091
	5	1.45	1.63	1.54	1.5	1.42	1.37	1.49	1.46	1.412	1.51
	6	1.93	2.1	2.04	1.97	1.9	1.9	2.09	1.78	1.853	1.973
	7	2.27	2.67	2.6	2.54	2.54	2.42	2.16	2.26	2.401	2.262
	8	2.97	3.14	3.14	3.25	2.59	2.99	3	2.73	2.908	2.772
	9	3.61	3.81	3.63	3.77	3.49	3.45	3.24	3.02	3.331	3.081
	10	4.1	4.41	4.54	4.31	3.75	3.73	3.82	3.89	3.639	3.354
	+gp	5.58	6.13	5.36	5.62	4.9	4.9	5.49	5.08	4.527	4.21
0	SOPC	1.0009	1.0053	1.001	1.0013	1.0018	1.0026	1.0033	1.0042	1.0005	1.0013

Table 5.3.3. Saithe in Sub-areas I and II (Northeast Arctic).3-year running average maturity ogive 1985-2008

Year	1	2	3	4	5	6	7	8	9	10	11+
1985				0.04	0.73	0.88	0.88	1	1	1	1
1986				0.03	0.74	0.90	0.92	1	1	1	1
1987				0.04	0.63	0.88	1	1	1	1	1
1988				0.09	0.56	0.74	1	1	1	1	1
1989				0.16	0.56	0.64	1	1	1	1	1
1990				0.17	0.66	0.62	0.91	1	1	1	1
1991				0.12	0.72	0.75	0.90	1	1	1	1
1992				0.05	0.64	0.84	0.89	1	1	1	1
1993				0.04	0.56	0.90	0.98	1	1	1	1
1994				0.09	0.52	0.86	0.97	1	1	1	1
1995				0.14	0.55	0.81	0.90	0.98	1	1	1
1996				0.14	0.50	0.74	0.84	0.97	1	1	1
1997				0.11	0.42	0.59	0.74	0.82	1	1	1
1998				0.08	0.26	0.53	0.69	0.76	1	1	1
1999				0.04	0.28	0.54	0.72	0.75	0.99	1	1
2000				0.05	0.27	0.70	0.81	0.87	0.87	1	1
2001				0.06	0.38	0.78	0.94	0.93	0.87	1	1
2002				0.07	0.45	0.86	0.94	0.96	0.85918	1	1
2003				0.10	0.46	0.87	0.95	0.93	0.980392	1	1
2004				0.13	0.55	0.84	0.92	0.90	1	1	1
2005				0.17	0.61	0.85	0.92	0.87	1	1	1
2006				0.13	0.62	0.88	0.93	0.92	1	1	1
2007				0.09	0.50	0.88	0.96	0.95	1	0.97	1
2008				0.06	0.41	0.85	0.97	0.98	1	0.95	1

Table 5.3.4 Tuning data sets applied in final XSA run (flt12 CPUE from Quarter 2,3,4)

```
North-East Arctic saithe (Subareas I and II)
102
FLT12: Nor new trawl revised 2006 (Catch: Unknown) (Effort: Un-
known)
1994 2006
1 1 0.00 1.00
4  8
   1   126.0   424.3   263.6    36.4     8.1
   1   211.0   292.9   318.3    50.5     8.3
   1   105.9   141.5   205.7   271.3    31.1
   1    40.4   210.1   214.0   275.3   173.3
   1    32.4    54.3   239.5    91.2    55.5
   1    39.0   109.8    83.2   192.8    44.2
   1    80.3    85.8   160.9   124.6   167.3
   1    49.6   271.9   195.7   184.9    78.3
   1    74.8   121.7   378.9    85.4    87.7
   1   130.8   199.7   132.5   191.1   123.3
   1     7.7   189.0   140.4   180.3   226.0
   1    36.9    98.7   291.9   139.4    78.4
   1    70.5   101.7   316.5   166.1    95.9
FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort:
Unknown)
1994 2008
1 1 0.75 0.85
3  7
   1    87.1   108.9    41.4     8.1     0.7
   1   166.1    86.5    46.5    16.5     2.4
   1   122.6   207.4    31.7    15.1     4.0
   1    38.0   184.8    79.8    50.6     9.6
   1    96.7   202.6    69.3    84.3     6.6
   1   233.8    72.9    62.2    21.0    19.2
   1   142.5   176.3    11.6    11.5     8.0
   1   275.9    45.9    53.8     5.6     6.1
   1   230.2    92.6    18.9    10.6     2.2
   1    87.5   151.7    26.1     6.2     6.4
   1   212.4   118.7    49.1    19.2     4.7
   1   228.1    67.2    20.3    16.5     7.7
   1    42.6   142.9    19.4     4.6     8.5
   1   111.0    27.1    61.1     7.9     5.8
   1    97.2    29.2    13.8    11.9     4.0
```

Table 5.4.1. Data and parameter settings of exploratory and final XSA-runs

Run No.	1	2	3	4	5	6
Ass. type	SPALY	SFT	SFT	SFT	CFT	FINAL
Catch data	1960-07	1960-08	1960-08	1960-08	1960-08	1960-08
Age range	3-11+	3-11+	3-11+	3-11+	3-11+	3-11+
F bar	4-7	4-7	4-7	4-7	4-7	4-7
Fleet 12 Norw. trawl	1994-06 age 4-8 Q2-4	1994-06 age 4-8 Q2-4	1994-08 age 4-8 Q2-4		1994-08 age 4-8 Q2-4	1994-06 age 4-8 Q2-4
Fleet 13 ac. survey	1994-07 age 3-7			1994-08 age 3-7	1994-08 age 3-7	1994-08 age 3-7
Time series weights	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y	Tricubic over 20y
Power model	No	No	No	No	No	No
Catchability (q) plateau	8	8	8	8	8	8
Survivor est. shrunk tow. Mean of	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages	5 years 5 oldest ages
SE of mean	0.5	0.5	0.5	0.5	0.5	0.5
Min. fleet SE for pop. Est.	0.3	0.3	0.3	0.3	0.3	0.3
Prior weight.	None	None	None	None	None	None

Table 5.5.1. Tuning diagnostics

Lowestoft VPA Version 3.1
23/04/2009 10:27
Extended Survivors Analysis

North-East Arctic saithe

CPUE data from file flt-1206-13re51.dat
Catch data for 49 years. 1960 to 2008. Ages 3 to 11.

Fleet	Fi year	Last year	First age	Last age	Alpha	Beta
FLT12: Nc	1994	2008	4	8	0	1
FLT13: Nc	1994	2008	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 88 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	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.031	0.058	0.017	0.019	0.015	0.006	0.064	0.031	0.022	0.041
4	0.121	0.094	0.066	0.103	0.196	0.051	0.094	0.237	0.081	0.157
5	0.206	0.105	0.154	0.128	0.107	0.194	0.106	0.121	0.218	0.136
6	0.149	0.14	0.167	0.215	0.106	0.114	0.195	0.153	0.244	0.228
7	0.205	0.123	0.131	0.144	0.114	0.155	0.162	0.216	0.179	0.285
8	0.11	0.13	0.086	0.108	0.213	0.136	0.17	0.178	0.216	0.206
9	0.103	0.112	0.101	0.087	0.121	0.159	0.186	0.256	0.253	0.25
10	0.112	0.111	0.118	0.1	0.123	0.146	0.227	0.179	0.296	0.27

Table 5.5.1 Continued

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10
1999	3.53E+05	1.19E+05	1.36E+05	8.27E+04	1.13E+05	3.59E+04	3.78E+04	2.40E+04
2000	1.80E+05	2.81E+05	8.60E+04	9.05E+04	5.83E+04	7.51E+04	2.63E+04	2.79E+04
2001	2.46E+05	1.39E+05	2.09E+05	6.34E+04	6.44E+04	4.22E+04	5.40E+04	1.93E+04
2002	3.90E+05	1.98E+05	1.07E+05	1.47E+05	4.40E+04	4.63E+04	3.17E+04	4.00E+04
2003	1.70E+05	3.13E+05	1.46E+05	7.68E+04	9.68E+04	3.12E+04	3.40E+04	2.38E+04
2004	1.89E+05	1.37E+05	2.11E+05	1.07E+05	5.65E+04	7.07E+04	2.06E+04	2.47E+04
2005	4.67E+05	1.54E+05	1.06E+05	1.42E+05	7.85E+04	3.96E+04	5.05E+04	1.44E+04
2006	7.22E+04	3.59E+05	1.15E+05	7.84E+04	9.57E+04	5.47E+04	2.74E+04	3.44E+04
2007	1.10E+05	5.73E+04	2.32E+05	8.34E+04	5.50E+04	6.31E+04	3.75E+04	1.74E+04
2008	2.45E+05	8.77E+04	4.33E+04	1.53E+05	5.35E+04	3.77E+04	4.16E+04	2.38E+04

Estimated population abundance at 1st Jan 2009

0.00E+00	1.93E+05	6.14E+04	3.09E+04	9.95E+04	3.29E+04	2.51E+04	2.65E+04

Taper weighted geometric mean of the VPA populations:

2.14E+05	1.69E+05	1.27E+05	9.41E+04	5.72E+04	3.57E+04	2.18E+04	1.23E+04

Standard error of the weighted Log(VPA populations) :

	0.5504	0.5673	0.545	0.5188	0.6746	0.9043	1.1406	1.3859
1								

Log catchability residuals.

Fleet : FLT12: Nor new trawl

Age	1994	1995	1996	1997	1998
3	No data for this fleet at this age				
4	0.61	1.49	0.13	0	-0.4
5	0.76	0.5	0.19	-0.17	-0.76
6	1.15	0.23	-0.16	0.26	-0.39
7	1.46	0.03	0.47	0.43	-0.29
8	0.56	0.75	0.03	0.51	-0.75

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	No data for this fleet at this age									
4	0.23	0.08	0.29	0.36	0.51	-1.57	-0.1	-0.23	99.99	99.99
5	-0.19	-0.03	0.26	0.12	0.29	-0.09	-0.1	-0.14	99.99	99.99
6	-0.75	-0.18	0.38	0.23	-0.23	-0.5	-0.01	0.65	99.99	99.99
7	-0.29	-0.1	0.2	-0.19	-0.19	0.31	-0.27	-0.27	99.99	99.99
8	-0.61	-0.01	-0.22	-0.18	0.6	0.35	-0.11	-0.23	99.99	99.99

Table 5.5.1 Continued

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	-8.0963	-6.7323	-5.9872	-5.8889	-5.9354
S.E(Log q	0.6796	0.3221	0.4653	0.3837	0.4448

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	0.69	0.779	9.39	0.44	13	0.48	-8.1
5	0.78	0.866	7.86	0.67	13	0.25	-6.73
6	1.95	-1.066	0.77	0.14	13	0.9	-5.99
7	1.66	-2.27	2.46	0.6	13	0.53	-5.89
8	1.25	-1.235	4.8	0.76	13	0.54	-5.94
1							

Fleet : FLT13: Norway Ac Sur

Age	1994	1995	1996	1997	1998
3	-0.57	-0.53	0.04	-1.32	0.06
4	-0.23	-0.04	0.12	0.8	0.72
5	-0.1	0.12	0.13	0.29	0.89
6	0.61	0.11	0.03	1.63	1.38
7	0.88	0.2	-0.51	0.29	0.29
8	No data for this fleet at this age				

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.08	0.29	0.6	-0.04	-0.18	0.59	-0.19	-0.03	0.5	-0.42
4	0.15	0.15	-0.52	-0.14	-0.03	0.44	-0.22	-0.19	-0.14	-0.44
5	0.68	-0.62	0.06	-0.33	-0.34	-0.01	-0.28	-0.39	0.14	0.26
6	0.67	-0.03	-0.37	-0.53	-0.51	0.29	-0.08	-0.79	-0.24	-0.45
7	0.62	0.33	-0.03	-0.66	-0.4	-0.14	0.03	-0.03	0.12	-0.14
8	No data for this fleet at this age									

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

Age	3	4	5	6	7
Mean Log	-7.2203	-7.2875	-8.0428	-8.6683	-8.9702
S.E(Log q	0.4774	0.3759	0.4099	0.6758	0.3685

Table 5.5.1 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
3	1.32	-0.904	5.6	0.45	15	0.64	-7.22
4	0.92	0.429	7.69	0.73	15	0.36	-7.29
5	0.93	0.293	8.31	0.63	15	0.4	-8.04
6	0.85	0.277	9.1	0.26	15	0.6	-8.67
7	1.17	-0.678	8.63	0.63	15	0.44	-8.97
1							

Terminal year survivor and F summaries :

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

Year class = 2005

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	1	0	0	0	0	0	0
FLT13: Nc	126610	0.497	0	0	1	0.492	0.062
F shrink:	289173	0.5				0.508	0.028

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
192565	0.35	0.59	2	1.668	0.041

1

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

Year class = 2004

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	1	0	0	0	0	0	0
FLT13: Nc	56644	0.308	0.455	1.48	2	0.691	0.169
F shrink:	73613	0.5				0.309	0.132

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
61419	0.26	0.29	3	1.09	0.157

Table 5.5.1 Continued

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

Year class = 2003

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	1	0	0	0	0	0	0
FLT13: Nc	31858	0.25	0.127	0.51	3	0.767	0.133
F shrink	27971	0.5				0.233	0.15

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
30907	0.22	0.1	4	0.437	0.136

1

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

Year class = 2002

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	79162	0.715	0	0	1	0.065	0.279
FLT13: Nc	88199	0.24	0.118	0.49	4	0.674	0.253
F shrink	143391	0.5				0.262	0.163

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
99469	0.21	0.14	6	0.641	0.228

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

Year class = 2001

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	28798	0.307	0.016	0.05	2	0.232	0.32
FLT13: Nc	29233	0.205	0.146	0.71	5	0.598	0.316
F shrink	60223	0.5				0.17	0.166

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
32937	0.17	0.14	8	0.857	0.285

Table 5.5.1 Continued

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

Year class = 2000

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	23926	0.261	0.462	1.77	3	0.309	0.215
FLT13: Nc	24873	0.204	0.175	0.86	5	0.535	0.208
F shrink:	28559	0.5				0.156	0.183

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
25112	0.16	0.16	9	1.015	0.206

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

Year class = 1999

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	23961	0.224	0.109	0.49	4	0.391	0.274
FLT13: Nc	25806	0.21	0.009	0.04	5	0.419	0.257
F shrink:	34922	0.5				0.189	0.196

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
26544	0.16	0.06	10	0.409	0.25

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

Year class = 1998

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	13482	0.203	0.152	0.75	5	0.443	0.294
FLT13: Nc	15042	0.209	0.145	0.69	5	0.375	0.268
F shrink:	18562	0.5				0.182	0.222

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
14888	0.15	0.09	11	0.625	0.27

Table 5.5.2 Fishing mortality
Run title : North-East Arctic saithe

At 23/04/2009 10:28
Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAF	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE									
3	0.1412	0.2383	0.2772	0.1747	0.108	0.1562	0.1876	0.1886	0.2041
4	0.1843	0.1755	0.2297	0.3606	0.4012	0.0805	0.3616	0.3278	0.1709
5	0.5007	0.2695	0.1204	0.1825	0.276	0.3093	0.3131	0.4319	0.1024
6	0.2407	0.2519	0.2882	0.1797	0.1198	0.3557	0.2447	0.1522	0.1649
7	0.3847	0.0915	0.253	0.2108	0.1978	0.1786	0.2736	0.1595	0.0391
8	0.4184	0.1206	0.0942	0.1734	0.2195	0.1772	0.1219	0.2757	0.0747
9	0.3585	0.1479	0.1645	0.1355	0.3055	0.369	0.1106	0.1777	0.1274
10	0.3832	0.177	0.1849	0.1771	0.2248	0.2795	0.2138	0.2406	0.102
+gp	0.3832	0.177	0.1849	0.1771	0.2248	0.2795	0.2138	0.2406	0.102
0 FBAR 4	0.3276	0.1971	0.2228	0.2334	0.2487	0.231	0.2983	0.2679	0.1193

Table 8 Fishing mortality (F) at age

YEAF	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	0.3402	0.188	0.3511	0.5893	0.4905	0.6669	0.5962	0.9054	0.786	0.6157
4	0.1406	0.5146	0.4216	0.4299	0.4766	0.5911	0.459	0.6942	0.6807	0.524
5	0.2354	0.2432	0.4348	0.3782	0.411	0.6231	0.4556	0.661	0.5207	0.5675
6	0.1307	0.3709	0.261	0.2894	0.3693	0.637	0.3552	0.4704	0.3522	0.467
7	0.1356	0.2034	0.3929	0.2409	0.3373	0.5334	0.5379	0.5163	0.4538	0.4574
8	0.0721	0.348	0.1697	0.2451	0.2654	0.4017	0.656	0.4431	0.4306	0.3556
9	0.0885	0.2271	0.3262	0.1569	0.321	0.3673	0.4563	0.592	0.4163	0.5508
10	0.133	0.28	0.3188	0.2635	0.3429	0.5166	0.496	0.541	0.4379	0.4833
+gp	0.133	0.28	0.3188	0.2635	0.3429	0.5166	0.496	0.541	0.4379	0.4833
0 FBAR 4	0.1606	0.333	0.3776	0.3346	0.3986	0.5961	0.4519	0.5855	0.5019	0.504

Table 8 Fishing mortality (F) at age

YEAF	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0.4447	0.5173	0.4113	0.4036	0.2139	0.7553	0.7846	0.1167	0.1236	0.1155
4	0.6834	0.5183	0.5845	0.6568	0.5371	0.8241	0.5074	0.4839	0.4163	0.3893
5	0.5606	0.6404	0.6683	0.8687	0.8443	0.5812	0.4127	0.5254	0.2955	0.537
6	0.3991	0.5357	0.5632	0.5852	0.5404	0.8098	0.5469	0.4989	0.5695	0.582
7	0.6257	0.5721	0.4246	0.3134	0.4398	0.3681	0.7105	0.6394	0.9401	1.2031
8	0.6249	0.6731	0.8956	0.3812	0.6971	0.5067	0.4639	0.6403	0.3486	1.0955
9	0.4824	0.1766	0.3908	0.5213	0.4221	0.8812	0.5096	0.3953	0.6648	1.0552
10	0.543	0.5237	0.5936	0.5383	0.5938	0.635	0.533	0.5443	0.5684	0.9042
+gp	0.543	0.5237	0.5936	0.5383	0.5938	0.635	0.533	0.5443	0.5684	0.9042
0 FBAR 4	0.5672	0.5666	0.5601	0.606	0.5904	0.6458	0.5444	0.5369	0.5553	0.6779

Table 8 Fishing mortality (F) at age

YEAF	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0.229	0.4522	0.3472	0.1167	0.0738	0.0312	0.0416	0.0605	0.0564	0.0233
4	0.4385	0.5516	0.5109	0.2818	0.2333	0.1592	0.3362	0.1814	0.0886	0.1026
5	0.7744	0.3792	0.3645	0.4423	0.46	0.2977	0.2715	0.1903	0.1683	0.1229
6	0.6709	0.5797	0.3621	0.7032	0.5483	0.5787	0.3036	0.1914	0.2079	0.2275
7	0.4626	0.6233	0.4515	0.7303	0.514	0.679	0.2363	0.2927	0.2093	0.1915
8	0.5585	0.5824	0.4196	0.8451	0.4748	0.4158	0.3275	0.2511	0.1796	0.1245
9	0.4324	0.5408	0.421	0.4955	0.735	0.2597	0.1153	0.6448	0.1047	0.1029
10	0.5847	0.5456	0.4065	0.6491	0.5509	0.4495	0.2521	0.2951	0.134	0.1286
+gp	0.5847	0.5456	0.4065	0.6491	0.5509	0.4495	0.2521	0.2951	0.134	0.1286
0 FBAR 4	0.5866	0.5335	0.4223	0.5394	0.4389	0.4286	0.2869	0.2139	0.1685	0.1611

Table 8 Fishing mortality (F) at age

YEAF	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	FBAR **-**
AGE											
3	0.0307	0.058	0.0174	0.0189	0.0153	0.0058	0.0637	0.0307	0.022	0.0411	0.0313
4	0.1211	0.094	0.0655	0.1033	0.1962	0.0506	0.0937	0.2374	0.0811	0.1566	0.1584
5	0.2059	0.1048	0.1544	0.1281	0.1067	0.1937	0.1061	0.1205	0.2184	0.1364	0.1584
6	0.1488	0.1397	0.1665	0.2152	0.1063	0.1136	0.1955	0.1534	0.2441	0.2277	0.2084
7	0.2054	0.1233	0.1308	0.1437	0.1143	0.1545	0.1622	0.2159	0.1788	0.285	0.2266
8	0.1096	0.1303	0.0863	0.1079	0.213	0.1359	0.1696	0.1779	0.2159	0.206	0.1999
9	0.1029	0.1122	0.1013	0.087	0.1206	0.1589	0.1855	0.2562	0.2527	0.2502	0.253
10	0.1115	0.1109	0.1181	0.1001	0.123	0.1455	0.2267	0.179	0.2958	0.2701	0.2483
+gp	0.1115	0.1109	0.1181	0.1001	0.123	0.1455	0.2267	0.179	0.2958	0.2701	
0 FBAR 4	0.1703	0.1154	0.1293	0.1476	0.1309	0.1281	0.1394	0.1818	0.1806	0.2014	

Table 5.5.3

Run title : North-East Arctic saithe

At 23/04/2009 10:28

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAF	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE									
	3	88173	92920	170143	289935	97186	283653	144689	190738	150801
	4	85921	62681	59948	105582	199330	71425	198653	98200	129322
	5	38001	58508	43057	39010	60271	109269	53953	113296	57927
	6	26165	18857	36586	31252	26611	37443	65664	32298	60225
	7	16897	16840	12001	22453	21379	19328	21479	42090	22711
	8	7761	9416	12582	7630	14890	14362	13236	13376	29379
	9	4823	4181	6833	9375	5252	9788	9850	9593	8313
	10	2580	2759	2953	4746	6703	3168	5541	7220	6576
	+gp	5253	8334	11260	12044	19432	16183	16565	17951	13243
0	TOT/	275574	274496	355364	522026	451054	564620	529629	524762	478496

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

	YEAF	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	AGE										
	3	296371	280751	287484	161777	217484	83523	149692	231999	201095	117719
	4	100667	172675	190463	165682	73477	109025	35101	67514	76813	75019
	5	89245	71607	84509	102299	88246	37350	49425	18160	27610	31838
	6	42811	57741	45971	44794	57383	47899	16400	25657	7677	13430
	7	41814	30755	32626	28991	27458	32476	20741	9413	13124	4420
	8	17882	29893	20546	18033	18655	16044	15597	9916	4599	6825
	9	22322	13622	17281	14197	11554	11713	8790	6627	5212	2448
	10	5992	16728	8887	10210	9936	6862	6642	4560	3001	2814
	+gp	4518	12585	22073	14934	14828	10361	11585	7538	3503	6140
0	TOT/	621623	686357	709838	560918	519020	355253	313973	381385	342634	260653

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

	YEAF	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	190765	111636	275156	115595	98968	86447	99433	221966	169790	82308
	4	52072	100119	54486	149314	63213	65425	33256	37147	161720	122844
	5	36370	21525	48814	24864	63387	30249	23495	16394	18746	87318
	6	14778	16999	9288	20486	8540	22308	13849	12731	7937	11422
	7	6893	8118	8146	4330	9342	4073	8127	6562	6329	3677
	8	2290	3018	3751	4362	2591	4927	2308	3270	2835	2024
	9	3916	1004	1261	1254	2439	1057	2430	1188	1411	1638
	10	1155	1979	689	698	610	1310	358	1195	655	594
	+gp	3111	4370	1535	1177	1854	2083	1856	742	2009	186
0	TOT/	311350	268769	403126	322080	250944	217878	185113	301196	371432	312011

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

	YEAF	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	67771	72284	258747	447567	351388	254182	465669	197773	237543	148263
	4	60036	44130	37653	149699	326073	267230	201720	365714	152413	183817
	5	68140	31703	20812	18495	92463	211411	186584	118004	249759	114200
	6	41787	25718	17764	11835	9730	47790	128527	116437	79875	172806
	7	5225	17492	11793	10126	4796	4604	21936	77676	78721	53120
	8	904	2694	7678	6147	3994	2349	1911	14180	47459	52279
	9	554	423	1232	4132	2162	2034	1269	1128	9032	32470
	10	467	294	202	662	2061	849	1284	926	485	6660
	+gp	503	700	587	1010	377	1981	1444	2037	1281	3596
0	TOT/	245387	195438	356468	649672	793043	792429	1010345	893875	856567	767210

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

	YEAF	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	GMST 60-**	AMST 60-**
	AGE													
	3	353321	179913	245760	389556	169623	189373	467274	72174	109542	245064	0	177525	203327
	4	118591	280539	138998	197743	312957	136763	154149	358970	57304	87732	192565	111738	136261
	5	135824	86022	209085	106582	146015	210581	106442	114916	231782	43263	61419	61742	80251
	6	82690	90508	63419	146690	76773	107445	142054	78374	83404	152543	30907	33942	48371
	7	112691	58339	64442	43959	96843	56516	78521	95654	55040	53495	99469	18897	29682
	8	35912	75135	42223	46294	31174	70722	39647	54660	63108	37684	32937	10202	18029
	9	37791	26350	54003	31712	34026	20627	50543	27397	37460	41635	25112	5605	11410
	10	23984	27915	19284	39955	23801	24694	14407	34374	17362	23821	26544	3144	7435
	+gp	6231	12786	19204	27666	39033	43367	12335	28697	12395	15109	24330		
0	TOT/	907035	837507	856418	1030157	930245	860088	1065372	865216	667397	700346	493283		

Table 5.5.4

Run title : North-East Arctic saithe
At 23/04/2009 10:28

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE									
3	0	0	0	0	0	0	0	0	0
4	859	627	599	1056	1993	714	1987	982	1293
5	20901	32179	23681	21455	33149	60098	29674	62313	31860
6	22240	16028	31098	26564	22619	31827	55815	27453	51191
7	16559	16503	11761	22004	20952	18941	21049	41248	22256
8	7761	9416	12582	7630	14890	14362	13236	13376	29379
9	4823	4181	6833	9375	5252	9788	9850	9593	8313
10	2580	2759	2953	4746	6703	3168	5541	7220	6576
+gp	5253	8334	11260	12044	19432	16183	16565	17951	13243

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

YEAR	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	1007	1727	1905	1657	735	1090	351	675	768	750
5	49085	39384	46480	56265	48535	20543	27184	9988	15185	17511
6	36389	49080	39076	38075	48776	40714	13940	21809	6526	11415
7	40978	30140	31973	28412	26909	31826	20326	9225	12861	4331
8	17882	29893	20546	18033	18655	16044	15597	9916	4599	6825
9	22322	13622	17281	14197	11554	11713	8790	6627	5212	2448
10	5992	16728	8887	10210	9936	6862	6642	4560	3001	2814
+gp	4518	12585	22073	14934	14828	10361	11585	7538	3503	6140

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

YEAR	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	521	1001	545	1493	632	654	1330	1114	4852	11056
5	20004	11838	26848	13675	34863	16637	17856	12459	11810	48898
6	12561	14449	7895	17413	7259	18962	12049	11331	6984	8452
7	6755	7956	7983	4243	9155	3991	7477	6234	6329	3677
8	2290	3018	3751	4362	2591	4927	2308	3270	2835	2024
9	3916	1004	1261	1254	2439	1057	2430	1188	1411	1638
10	1155	1979	689	698	610	1310	358	1195	655	594
+gp	3111	4370	1535	1177	1854	2083	1856	742	2009	186

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

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	9606	7502	4518	7485	9782	24051	28241	51200	16765	14705
5	38159	20924	14985	11837	49930	105706	98889	59002	104899	30834
6	26743	15945	13323	9941	8854	40621	104107	84999	47126	91587
7	5225	15917	10613	9012	4700	4465	19742	65248	58253	36653
8	904	2694	7678	6147	3994	2349	1873	13755	38916	39732
9	554	423	1232	4132	2162	2034	1269	1128	9032	32470
10	467	294	202	662	2061	849	1284	926	485	6660
+gp	503	700	587	1010	377	1981	1444	2037	1281	3596

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

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	4744	14027	6950	13842	31296	17779	26205	46666	5157	5264
5	38031	23226	79452	47962	67167	115820	64930	71248	115891	17738
6	44653	63356	49467	126153	66793	90254	120746	68969	73395	129662
7	81138	47254	60575	41321	92001	51994	72240	88958	52839	51890
8	26934	66119	39268	44442	28992	63650	34493	50288	59952	36931
9	37791	26350	54003	31712	34026	20627	50543	27397	37460	41635
10	23984	27915	19284	39955	23801	24694	14407	34374	16841	22630
+gp	6231	12786	19204	27666	39033	43367	12335	28697	12395	15109

Table 5.5.5

Run title : North-East Arctic saithe
At 23/04/2009 10:28

Terminal Fs derived using XSA (With F shrinkage)

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

YEAF	1960	1961	1962	1963	1964	1965	1966	1967	1968
AGE									
3	62603	65973	120802	205854	69002	201394	102729	135424	107069
4	95372	69576	66543	117196	221257	79282	220505	109002	143548
5	61942	95368	70183	63586	98241	178108	87943	184672	94421
6	60964	43936	85246	72817	62003	87243	152998	75254	140323
7	53395	53214	37924	70952	67559	61076	67874	133004	71766
8	31275	37946	50706	30748	60005	57880	53339	53906	118396
9	23490	20363	33278	45655	25578	47668	47968	46718	40485
10	14524	15534	16625	26719	37736	17837	31196	40649	37021
+gp	42179	66999	89226	94556	151201	128799	134275	143497	102186
0 TOTAL	445745	468910	570532	728082	792583	859287	898826	922127	855213

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

YEAF	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE										
3	210424	199333	204114	114862	154414	59301	106281	164720	142778	83581
4	111741	191669	211414	183907	81559	121018	38962	74941	85263	83272
5	145470	116720	137749	166748	143840	60881	80563	29600	45004	51896
6	99750	134537	107113	104371	133702	111605	38212	59782	17888	31292
7	132132	97187	103098	91613	86767	102624	65541	29746	41470	13966
8	72064	120468	82800	72672	75178	64656	62856	39962	18533	27504
9	108710	66337	84157	69137	56270	57040	42809	32272	25384	11921
10	33734	94177	50032	57485	55938	38634	37392	25674	16898	15844
+gp	33793	93178	155657	111662	109506	74774	82569	55176	25902	46215
0 TOTAL	947816	1113607	1136133	972456	897174	690533	555185	511873	419120	365491

Terminal Fs derived using XSA (With F shrinkage)

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

YEAF	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
AGE										
3	135443	88192	200864	89008	103916	61377	74575	130960	89989	51031
4	57799	127151	76281	167232	84074	82436	44231	45320	135845	106874
5	59284	43695	100068	50225	117899	61102	48635	32295	31118	114386
6	34433	43348	25636	53468	23912	60233	36424	29282	18413	27755
7	21782	26708	26882	14159	37368	15803	26656	18834	18797	14229
8	9230	13100	16429	17056	10832	22023	9138	12163	11339	10889
9	19069	5169	7501	5882	13002	5664	11034	5108	6660	9548
10	6505	11378	4401	3931	3463	7936	1989	5606	3564	3185
+gp	24294	30318	10502	8895	16068	14980	14867	4898	13871	1388
0 TOTAL	367838	389061	468564	409856	410533	331552	267548	284466	329596	339285

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

YEAF	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
3	50150	51322	175948	299870	214347	132174	260775	116686	147277	100819
4	57034	44130	39536	151196	322813	203095	159359	299886	144792	183817
5	95397	45970	38502	35510	152563	262150	222035	156946	309701	169017
6	74380	53751	42456	26983	23935	101314	219782	214244	137385	323147
7	15467	43554	36321	28048	13669	14824	62956	192637	184993	137050
8	3371	10101	25723	19670	12102	8995	7225	52891	147123	160497
9	2560	1651	5518	15413	8020	9539	5151	4873	37843	134100
10	2180	1984	940	4203	9255	4506	6807	4943	2806	36229
+gp	3620	4386	3864	7709	2370	11829	10920	14400	9534	29017
0 TOTAL	304159	256849	368808	588603	759073	748427	955009	1057505	1121454	1273692

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

YEAF	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
3	236725	107948	184320	268794	111951	134455	275691	42583	82814	175711
4	124520	288955	155678	199720	284791	140866	137193	297945	61602	95715
5	196945	140216	321991	159873	207341	288496	158599	167777	327276	65327
6	159592	190067	129375	288978	145869	204146	296892	139506	154547	300967
7	255809	155764	167549	111655	245981	136768	169606	216177	132152	121005
8	106659	235925	132581	150454	80741	211460	118940	149223	183517	104461
9	136424	100392	196030	119555	118750	71163	163761	82740	124779	128279
10	98336	123107	87549	172208	89254	92107	55034	133713	63181	79896
+gp	34767	78381	102934	155485	191262	212497	67717	145778	56112	63608
0 TOTAL	1349779	1420754	1478007	1626723	1475940	1491958	1443434	1375443	1185981	1134969

Table 5.5.6

Run title : North-East Arctic saithe
At 23/04/2009 10:28

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAF	1960	1961	1962	1963	1964	1965	1966	1967	1968
	AGE									
	3	0	0	0	0	0	0	0	0	0
	4	954	696	665	1172	2213	793	2205	1090	1435
	5	34068	52452	38601	34972	54033	97959	48369	101570	51931
	6	51820	37346	72459	61894	52703	74156	130048	63966	119275
	7	52327	52150	37165	69533	66207	59854	66516	130344	70330
	8	31275	37946	50706	30748	60005	57880	53339	53906	118396
	9	23490	20363	33278	45655	25578	47668	47968	46718	40485
	10	14524	15534	16625	26719	37736	17837	31196	40649	37021
	+gp	42179	66999	89226	94556	151201	128799	134275	143497	102186
0	TOTSF	250637	283486	338725	365249	449676	484948	513916	581740	541059

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

	YEAF	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	1117	1917	2114	1839	816	1210	390	749	853	833
	5	80009	64196	75762	91711	79112	33484	44310	16280	24752	28543
	6	84787	114356	91046	88715	113647	94865	32480	50814	15205	26598
	7	129489	95243	101036	89781	85032	100571	64230	29151	40641	13687
	8	72064	120468	82800	72672	75178	64656	62856	39962	18533	27504
	9	108710	66337	84157	69137	56270	57040	42809	32272	25384	11921
	10	33734	94177	50032	57485	55938	38634	37392	25674	16898	15844
	+gp	33793	93178	155657	111662	109506	74774	82569	55176	25902	46215
0	TOTSF	543703	649873	642603	583002	575499	465235	367035	250079	168168	171145

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

	YEAF	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	578	1272	763	1672	841	824	1769	1360	4075	9619
	5	32606	24032	55037	27624	64844	33606	36962	24544	19604	64056
	6	29268	36846	21790	45448	20325	51198	31689	26061	16204	20538
	7	21346	26174	26344	13876	36620	15486	24523	17892	18797	14229
	8	9230	13100	16429	17056	10832	22023	9138	12163	11339	10889
	9	19069	5169	7501	5882	13002	5664	11034	5108	6660	9548
	10	6505	11378	4401	3931	3463	7936	1989	5606	3564	3185
	+gp	24294	30318	10502	8895	16068	14980	14867	4898	13871	1388
0	TOTSF	142895	148289	142768	124384	165995	151717	131972	97632	94114	133452

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

	YEAF	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	9125	7502	4744	7560	9684	18279	22310	41984	15927	14705
	5	53422	30340	27721	22727	82384	131075	117678	78473	130074	45635
	6	47603	33326	31842	22666	21781	86117	178023	156398	81057	171268
	7	15467	39634	32689	24963	13395	14379	56660	161815	136895	94565
	8	3371	10101	25723	19670	12102	8995	7081	51305	120641	121977
	9	2560	1651	5518	15413	8020	9539	5151	4873	37843	134100
	10	2180	1984	940	4203	9255	4506	6807	4943	2806	36229
	+gp	3620	4386	3864	7709	2370	11829	10920	14400	9534	29017
0	TOTSF	137349	128924	133042	124911	158991	284719	404631	514190	534778	647496

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

	YEAF	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	4981	14448	7784	13980	28479	18313	23323	38733	5544	5743
	5	55145	37858	122357	71943	95377	158673	96746	104022	163638	26784
	6	86180	133047	100913	248521	126906	171483	252358	122766	136001	255822
	7	184183	126169	157496	104956	233682	125826	156038	201045	126866	117375
	8	79995	207614	123301	144436	75089	190314	103478	137285	174342	102372
	9	136424	100392	196030	119555	118750	71163	163761	82740	124779	128279
	10	98336	123107	87549	172208	89254	92107	55034	133713	61286	75901
	+gp	34767	78381	102934	155485	191262	212497	67717	145778	56112	63608
0	TOTSF	680010	821016	898363	1031085	958799	1040376	918454	966082	848568	775883

Table 5.5.7

Run title : North-East Arctic saithe
At 23/04/2009 10:28

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	1113607	649873	264924	0.4077	0.333
1971	287484	1136133	642603	241272	0.3755	0.3776
1972	161777	972456	583002	214334	0.3676	0.3346
1973	217484	897174	575499	213859	0.3716	0.3986
1974	83523	690533	465235	274121	0.5892	0.5961
1975	149692	555185	367035	233453	0.6361	0.4519
1976	231999	511873	250079	242486	0.9696	0.5855
1977	201095	419120	168168	182817	1.0871	0.5019
1978	117719	365491	171145	154464	0.9025	0.504
1979	190765	367838	142895	164180	1.149	0.5672
1980	111636	389061	148289	144554	0.9748	0.5666
1981	275156	468564	142768	175516	1.2294	0.5601
1982	115595	409856	124384	168034	1.3509	0.606
1983	98968	410533	165995	156936	0.9454	0.5904
1984	86447	331552	151717	158786	1.0466	0.6458
1985	99433	267548	131972	107183	0.8122	0.5444
1986	221966	284466	97632	70458	0.7217	0.5369
1987	169790	329596	94114	92391	0.9817	0.5553
1988	82308	339285	133452	114242	0.8561	0.6779
1989	67771	304159	137349	122310	0.8905	0.5866
1990	72284	256849	128924	95848	0.7434	0.5335
1991	258747	368808	133042	107326	0.8067	0.4223
1992	447567	588603	124911	127516	1.0209	0.5394
1993	351388	759073	158991	153584	0.966	0.4389
1994	254182	748427	284719	146544	0.5147	0.4286
1995	465669	955009	404631	168378	0.4161	0.2869
1996	197773	1057505	514190	171348	0.3332	0.2139
1997	237543	1121454	534778	143629	0.2686	0.1685
1998	148263	1273692	647496	153327	0.2368	0.1611
1999	353321	1349779	680010	150373	0.2211	0.1703
2000	179913	1420754	821016	135945	0.1656	0.1154
2001	245760	1478007	898363	136402	0.1518	0.1293
2002	389556	1626723	1031085	155246	0.1506	0.1476
2003	169623	1475940	958799	159757	0.1666	0.1309
2004	189373	1491958	1040376	162140	0.1558	0.1281
2005	467274	1443434	918454	176678	0.1924	0.1394
2006	72174	1375443	966082	212670	0.2201	0.1818
2007	109542	1185981	848568	199206	0.2348	0.1806
2008	245064	1134969	775883	183444	0.2364	0.2014
Arith. Mean	202265	799297	440136	162509	0.5618	0.3581
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 5.6.1 Yield per recruit

MFYPR version 2a
Run: ypr
Time and date: 17:51 23.04.2009
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpw	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	12.5494	3.2361	10.2652	3.2361	10.2652
0.1000	0.0201	0.0837	0.2209	5.0995	10.9224	2.8353	8.6670	2.8353	8.6670
0.2000	0.0403	0.1508	0.3789	4.7658	9.6614	2.5176	7.4335	2.5176	7.4335
0.3000	0.0604	0.2058	0.4941	4.4922	8.6594	2.2593	6.4577	2.2593	6.4577
0.4000	0.0806	0.2519	0.5795	4.2631	7.8470	2.0451	5.6703	2.0451	5.6703
0.5000	0.1007	0.2912	0.6435	4.0681	7.1770	1.8645	5.0243	1.8645	5.0243
0.6000	0.1209	0.3251	0.6919	3.8998	6.6164	1.7102	4.4867	1.7102	4.4867
0.7000	0.1410	0.3548	0.7288	3.7528	6.1415	1.5768	4.0339	1.5768	4.0339
0.8000	0.1611	0.3810	0.7570	3.6231	5.7349	1.4603	3.6485	1.4603	3.6485
0.9000	0.1813	0.4043	0.7786	3.5077	5.3834	1.3577	3.3175	1.3577	3.3175
1.0000	0.2014	0.4253	0.7952	3.4042	5.0770	1.2666	3.0307	1.2666	3.0307
1.1000	0.2216	0.4442	0.8078	3.3107	4.8078	1.1853	2.7806	1.1853	2.7806
1.2000	0.2417	0.4614	0.8175	3.2258	4.5696	1.1122	2.5608	1.1122	2.5608
1.3000	0.2619	0.4772	0.8247	3.1483	4.3577	1.0462	2.3667	1.0462	2.3667
1.4000	0.2820	0.4917	0.8301	3.0771	4.1680	0.9864	2.1942	0.9864	2.1942
1.5000	0.3021	0.5050	0.8341	3.0116	3.9973	0.9318	2.0402	0.9318	2.0402
1.6000	0.3223	0.5174	0.8368	2.9510	3.8429	0.8819	1.9021	0.8819	1.9021
1.7000	0.3424	0.5288	0.8386	2.8947	3.7028	0.8361	1.7776	0.8361	1.7776
1.8000	0.3626	0.5395	0.8396	2.8423	3.5750	0.7940	1.6651	0.7940	1.6651
1.9000	0.3827	0.5495	0.8401	2.7934	3.4580	0.7551	1.5630	0.7551	1.5630
2.0000	0.4029	0.5589	0.8400	2.7475	3.3506	0.7191	1.4700	0.7191	1.4700

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.2014
FMax	1.9381	0.3904
F0.1	0.7766	0.1564
F35%SPR	0.8158	0.1643

Weights in kilograms

Table 5.7.1 Prediction input data

MFDP version 1a
Run: sht
Time and date: 17:24 23.04.2009
Fbar age range: 4-7

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	175748	0.2	0	0	0	0.688	0.03351	0.688
4	134865	0.2	0.06	0	0	0.999	0.16973	0.999
5	61419	0.2	0.41	0	0	1.461	0.16980	1.461
6	30907	0.2	0.85	0	0	1.869	0.22335	1.869
7	99469	0.2	0.97	0	0	2.308	0.24282	2.308
8	32937	0.2	0.98	0	0	2.803	0.21428	2.803
9	25112	0.2	1	0	0	3.144	0.27119	3.144
10	26544	0.2	0.95	0	0	3.628	0.26611	3.628
11	24330	0.2	1	0	0	4.606	0.26611	4.606

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	175748	0.2	0	0	0	0.688	0.03351	0.688
4	.	0.2	0.06	0	0	0.999	0.16973	0.999
5	.	0.2	0.41	0	0	1.461	0.16980	1.461
6	.	0.2	0.85	0	0	1.869	0.22335	1.869
7	.	0.2	0.97	0	0	2.308	0.24282	2.308
8	.	0.2	0.98	0	0	2.803	0.21428	2.803
9	.	0.2	1	0	0	3.144	0.27119	3.144
10	.	0.2	0.95	0	0	3.628	0.26611	3.628
11	.	0.2	1	0	0	4.606	0.26611	4.606

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	175748	0.2	0	0	0	0.688	0.03351	0.688
4	.	0.2	0.06	0	0	0.999	0.16973	0.999
5	.	0.2	0.41	0	0	1.461	0.16980	1.461
6	.	0.2	0.85	0	0	1.869	0.22335	1.869
7	.	0.2	0.97	0	0	2.308	0.24282	2.308
8	.	0.2	0.98	0	0	2.803	0.21428	2.803
9	.	0.2	1	0	0	3.144	0.27119	3.144
10	.	0.2	0.95	0	0	3.628	0.26611	3.628
11	.	0.2	1	0	0	4.606	0.26611	4.606

Input units are thousands and kg - output in tonnes

Table 5.7.2 Short term prediction

MFDP version 1a
Run: sht
shtMFDP Index file 23.04.2009
Time and date: 17:40 23.04.2009
Fbar age range: 4-7

2009				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
1012184	689583	1.3907	0.2801	225000

2010					2011	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
911846	568684	0.0000	0.0000	0	1050462	671540
.	568684	0.1000	0.0201	15851	1033287	656933
.	568684	0.2000	0.0403	31367	1016479	642657
.	568684	0.3000	0.0604	46555	1000032	628703
.	568684	0.4000	0.0806	61424	983937	615064
.	568684	0.5000	0.1007	75980	968185	601732
.	568684	0.6000	0.1209	90230	952770	588701
.	568684	0.7000	0.1410	104181	937683	575963
.	568684	0.8000	0.1611	117840	922918	563512
.	568684	0.9000	0.1813	131213	908466	551341
.	568684	1.0000	0.2014	144307	894322	539443
.	568684	1.1000	0.2216	157128	880477	527813
.	568684	1.2000	0.2417	169682	866926	516443
.	568684	1.3000	0.2619	181975	853662	505329
.	568684	1.4000	0.2820	194013	840678	494464
.	568684	1.5000	0.3021	205801	827968	483842
.	568684	1.6000	0.3223	217346	815526	473458
.	568684	1.7000	0.3424	228651	803346	463306
.	568684	1.8000	0.3626	239724	791422	453381
.	568684	1.9000	0.3827	250569	779749	443678
.	568684	2.0000	0.4029	261190	768320	434192

Input units are thousands and kg - output in tonnes

Table 5.7.3. Short term projection output HCR landings

MFDP version 1a
Run: hcs
hcrMFDP Index file 24.04.2009
Time and date: 09:33 24.04.2009
Fbar age range: 4-7

2009

Biomass	SSB	FMult	FBar	Landings
1012184	689583	1.3907	0.2801	225000

2010

Biomass	SSB	FMult	FBar	Landings
911846	568684	1.4837	0.2988	203892

	average
2010	232844
2011	201592
2012	177241

2011					2012	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
830026	485561	0	0	0	981016	599064
.	485561	0.1	0.0201	14401	965171	585868
.	485561	0.2	0.0403	28494	949670	572975
.	485561	0.3	0.0604	42285	934505	560378
.	485561	0.4	0.0806	55783	919669	548070
.	485561	0.5	0.1007	68993	905152	536045
.	485561	0.6	0.1209	81921	890949	524295
.	485561	0.7	0.141	94576	877053	512814
.	485561	0.8	0.1611	106962	863455	501596
.	485561	0.9	0.1813	119085	850149	490635
.	485561	1	0.2014	130953	837130	479924
.	485561	1.1	0.2216	142570	824389	469458
.	485561	1.2	0.2417	153942	811921	459230
.	485561	1.3	0.2619	165076	799719	449236
.	485561	1.4	0.282	175975	787779	439470
.	485561	1.5	0.3021	186646	776092	429926
.	485561	1.6	0.3223	197094	764654	420600
.	485561	1.7	0.3424	207323	753460	411485
.	485561	1.8	0.3626	217339	742503	402578
.	485561	1.9	0.3827	227147	731778	393873
.	485561	2	0.4029	236750	721281	385365

Input units are thousands and kg - output in tonnes

Table 5.7.4. Detailed short term projection output

MFDP version 1a

Run: hcs

Time and date: 09:33 24.04.2009

Fbar age range: 4-7

Year:		2009	F multiplie	1.3907	Fbar:	0.2801				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0466	7258	4991	175748	120856	0	0	0	0
	4	0.236	25801	25767	134865	134685	8092	8081	8092	8081
	5	0.2361	11754	17169	61419	89713	25182	36782	25182	36782
	6	0.3106	7518	14049	30907	57755	26271	49092	26271	49092
	7	0.3377	25982	59957	99469	229541	96485	222655	96485	222655
	8	0.298	7731	21672	32937	92333	32278	90487	32278	90487
	9	0.3771	7196	22623	25112	78952	25112	78952	25112	78952
	10	0.3701	7488	27162	26544	96293	25217	91478	25217	91478
	11	0.3701	6863	31609	24330	112056	24330	112056	24330	112056
Total			107591	225000	611331	1012184	262967	689583	262967	689583

Year:		2010	F multiplie	1.4837	Fbar:	0.2988				
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	3	0.0497	7732	5317	175748	120856	0	0	0	0
	4	0.2518	27826	27789	137339	137155	8240	8229	8240	8229
	5	0.2519	17675	25817	87203	127374	35753	52223	35753	52223
	6	0.3314	10208	19075	39709	74203	33753	63073	33753	63073
	7	0.3603	5116	11806	18548	42803	17992	41519	17992	41519
	8	0.3179	14417	40414	58099	162872	56937	159615	56937	159615
	9	0.4023	6050	19021	20017	62935	20017	62935	20017	62935
	10	0.3948	4196	15222	14100	51152	13395	48594	13395	48594
	11	0.3948	8561	39430	28768	132496	28768	132496	28768	132496
Total			101781	203892	579532	911846	214856	568684	214856	568684

Input units are thousands and kg - output in tonnes

Table 5.7.5. Short term projection output HCR $F_{0.32}$ landings

MFDP version 1a
Run: maz
maxMFDP Index file 24.04.2009
Time and date: 09:53 24.04.2009
Fbar age range: 4-7

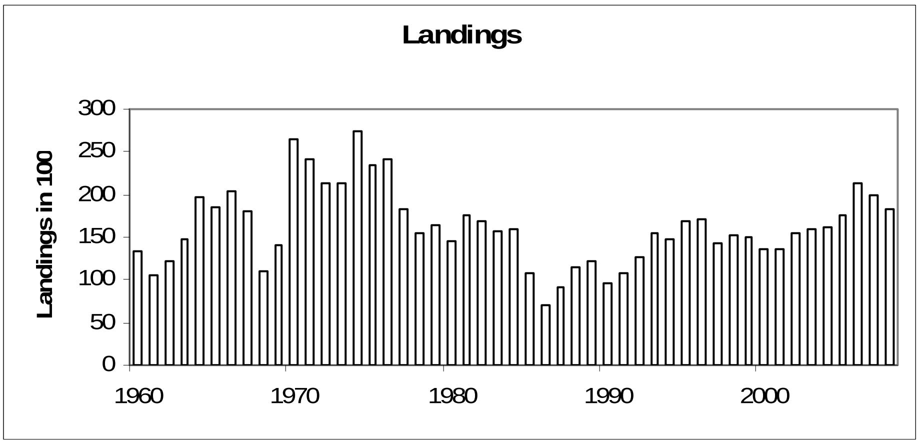
2009				
Biomass	SSB	FMult	FBar	Landings
1012184	689583	1.3907	0.2801	225000

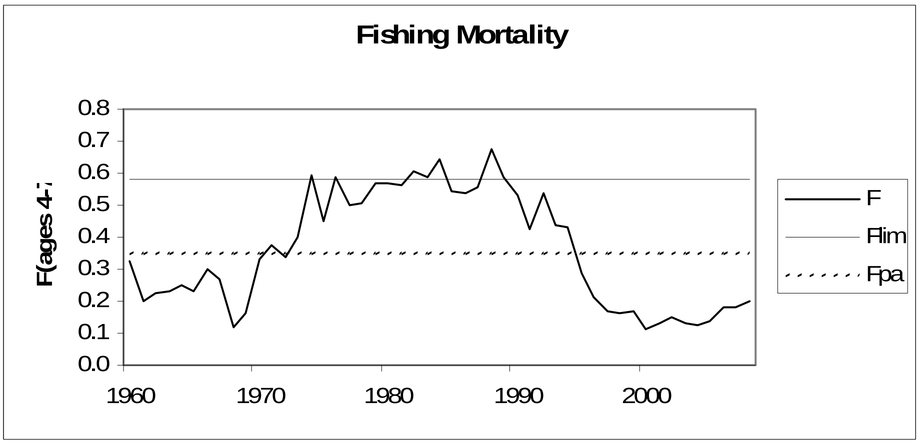
2010				
Biomass	SSB	FMult	FBar	HCR $F_{0.32}$ landings
911846	568684	1.396	0.2812	193534

	average
2010	216051
2011	192203
2012	172347

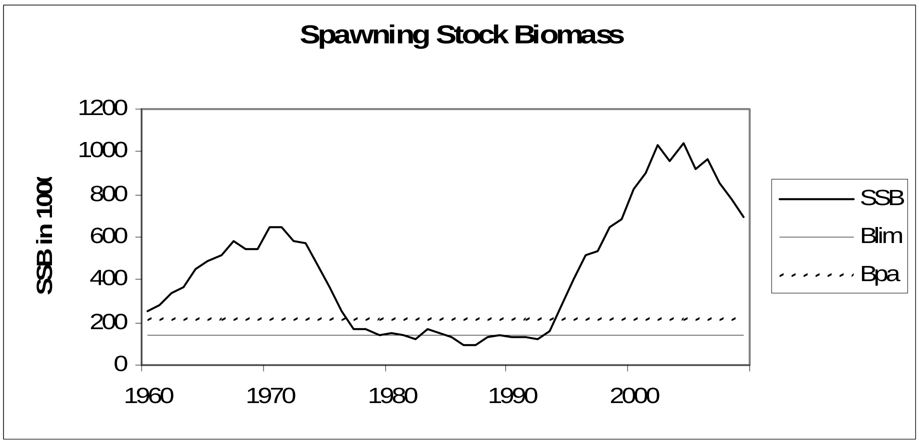
2011					2012	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
841195	494896	0	0	0	991771	609069
.	494896	0.1	0.0201	14637	975679	595639
.	494896	0.2	0.0403	28960	959936	582517
.	494896	0.3	0.0604	42977	944534	569697
.	494896	0.4	0.0806	56695	929467	557172
.	494896	0.5	0.1007	70120	914725	544934
.	494896	0.6	0.1209	83258	900302	532977
.	494896	0.7	0.141	96118	886191	521294
.	494896	0.8	0.1611	108704	872383	509878
.	494896	0.9	0.1813	121024	858873	498724
.	494896	1	0.2014	133083	845653	487825
.	494896	1.1	0.2216	144887	832717	477175
.	494896	1.2	0.2417	156442	820058	466769
.	494896	1.3	0.2619	167754	807671	456599
.	494896	1.4	0.282	178828	795548	446662
.	494896	1.5	0.3021	189669	783684	436952
.	494896	1.6	0.3223	200283	772073	427462
.	494896	1.7	0.3424	210675	760710	418189
.	494896	1.8	0.3626	220851	749587	409126
.	494896	1.9	0.3827	230814	738701	400269
.	494896	2	0.4029	240569	728046	391614

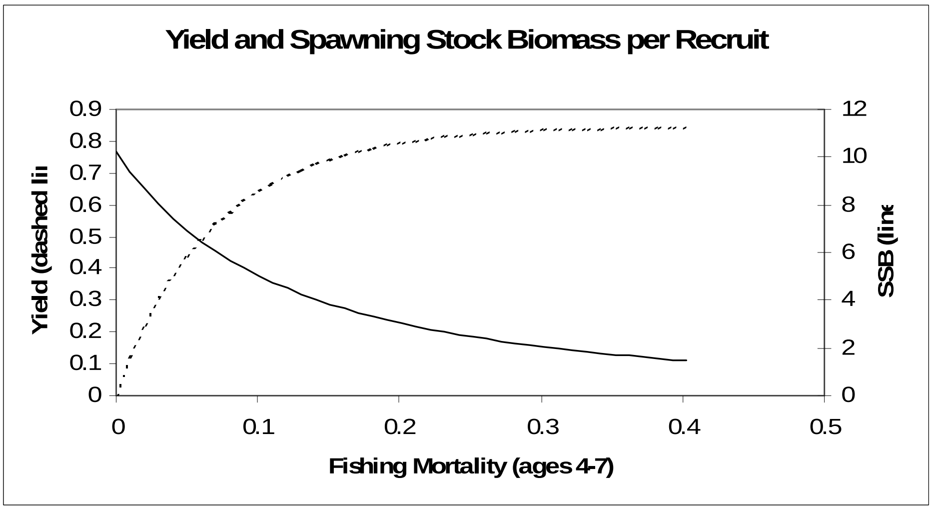
Input units are thousands and kg - output in tonnes


Landings
Landings in 100
300
250
200
150
100
50
0
1960
1970
1980
1990
2000


Fishing Mortality
F(ages 4-7
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1960
1970
1980
1990
2000
F
Flim
Fpa


Recruitment (age 3)
Recruitment in millio
500
400
300
200
100
0
1960
1970
1980
1990
2000


Spawning Stock Biomass
SSB in 100(
1200
1000
800
600
400
200
0
1960
1970
1980
1990
2000
SSB
Blim
Bpa



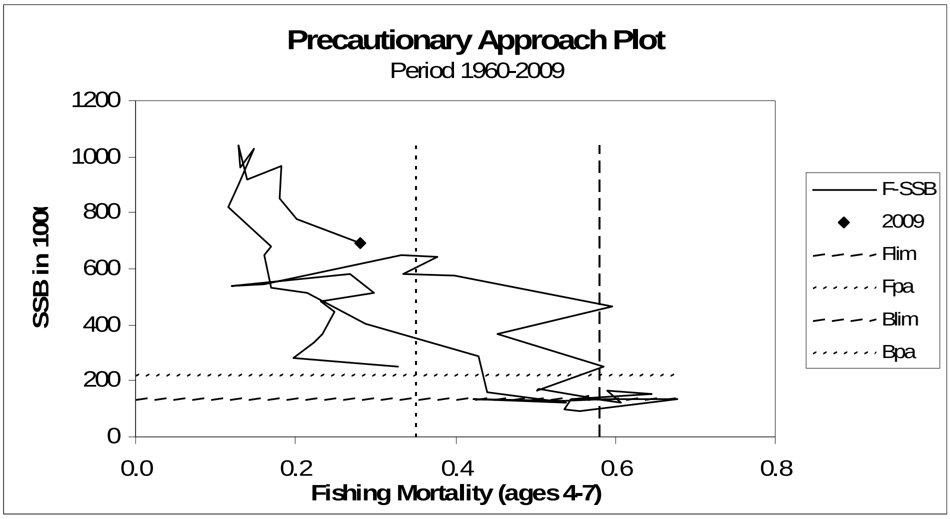


Figure 5.1.1 North-East Arctic saithe (Subareas I and II)

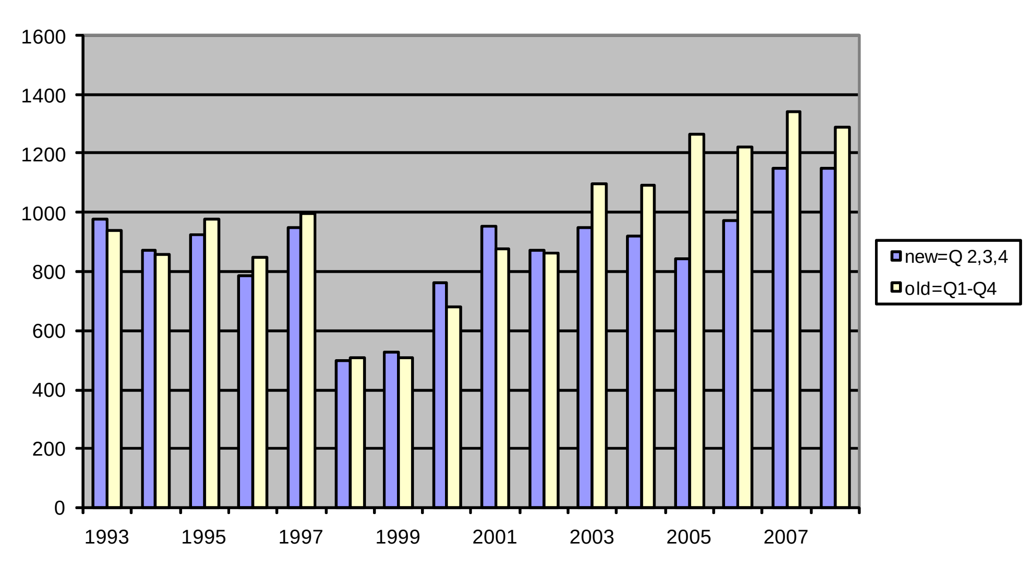


Figure 5.2.1. Norwegian trawl CPUE by year, averaged over quarter 1-4 (old) and over quarter 2-4 (new,from afwg2006)

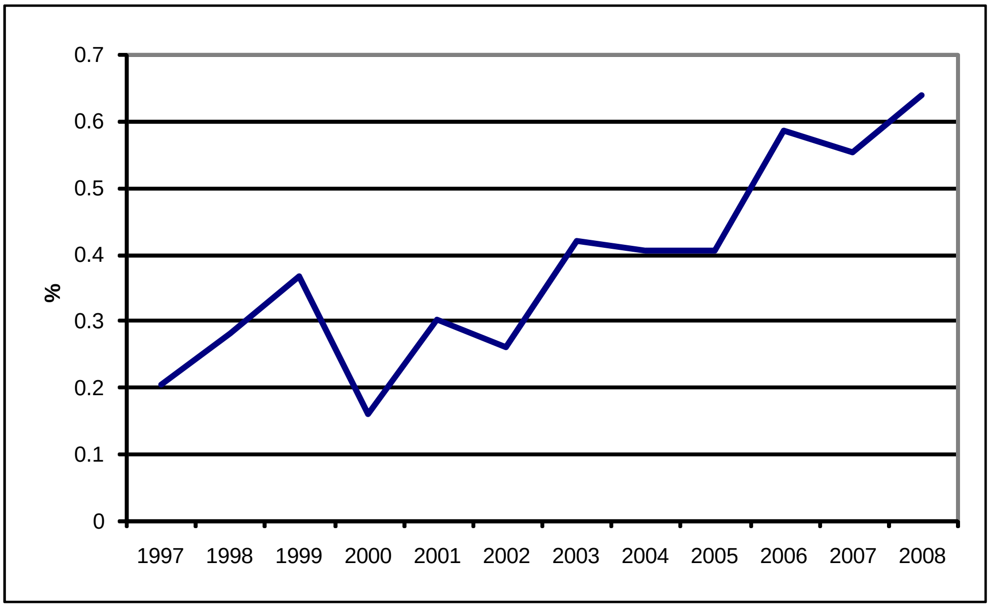
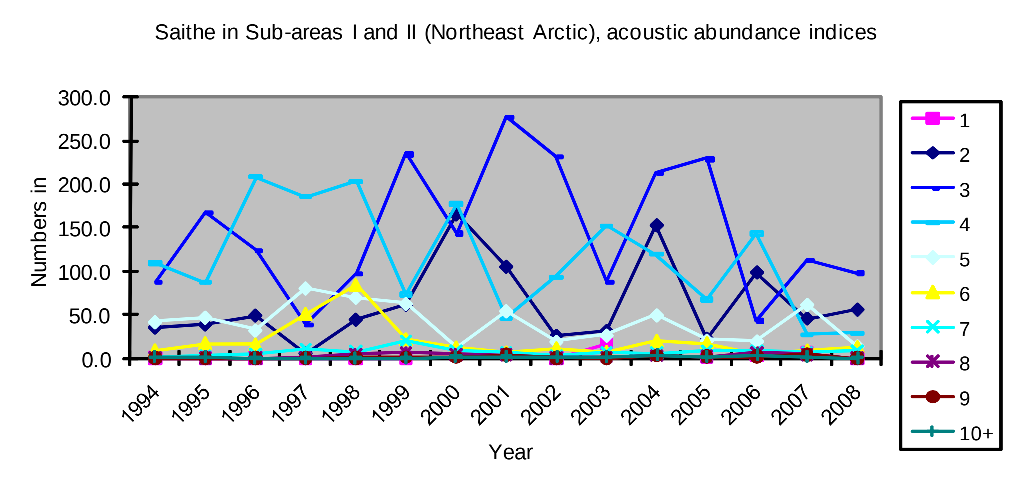


Figure 5.2.2. Proportion of saithe in the southern half of the survey area (sub area C+D).



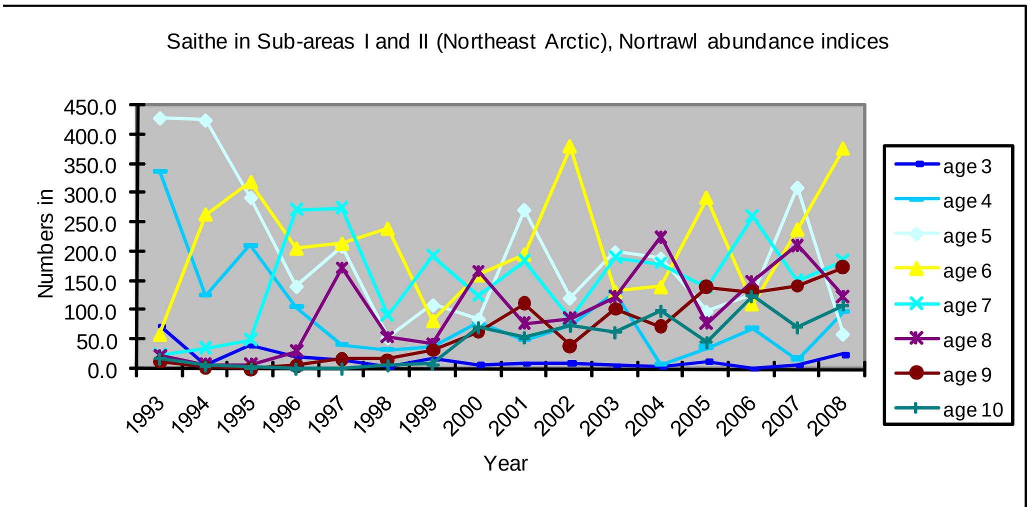


Figure 5.3.1 Saithe in sub-areas I and II (Northeast Arctic), tuning abundance indices.

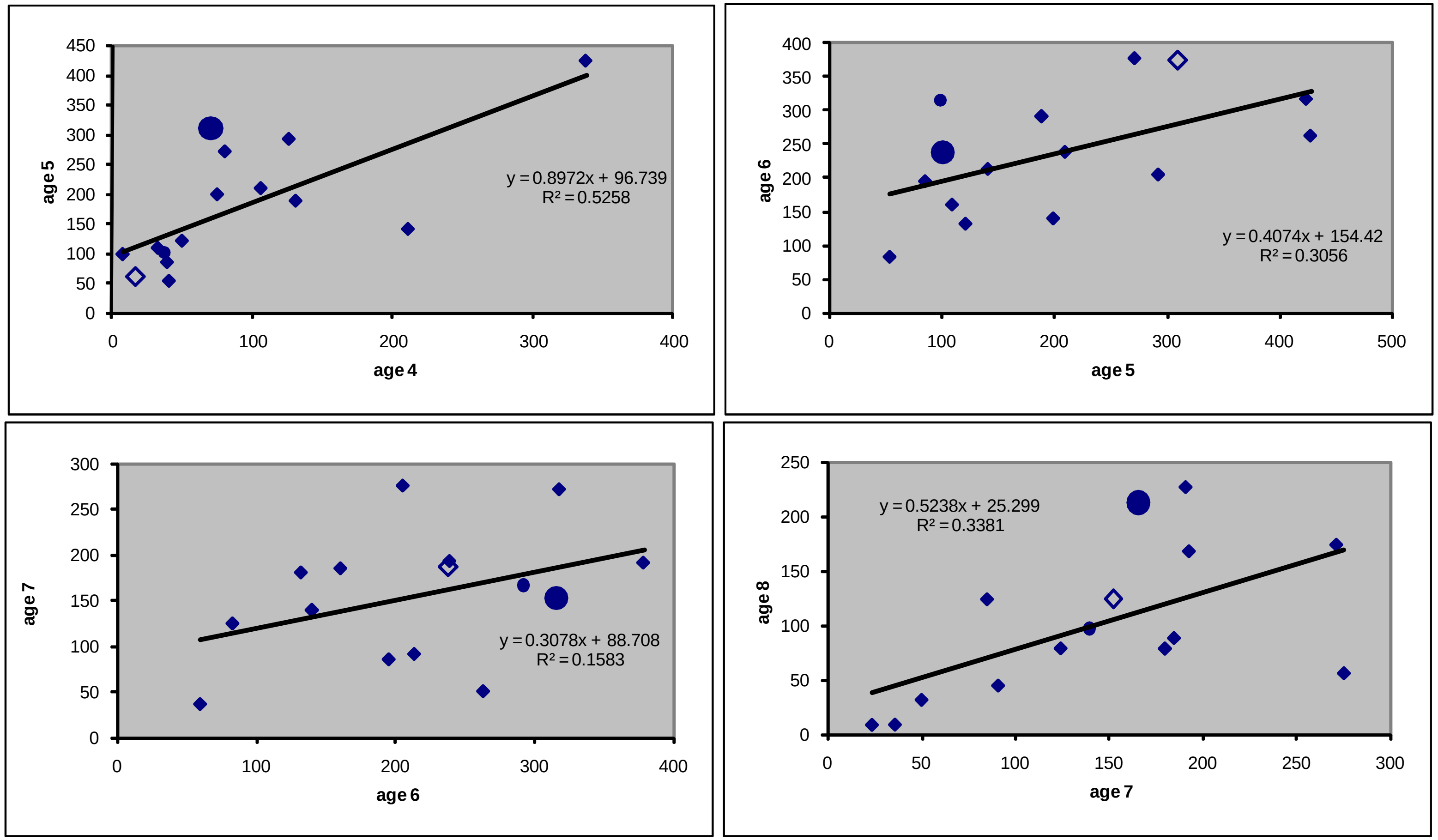


Figure 5.3.2 Comparative scatter plots at age of in the CPUE series. 2007-2008 indicated.

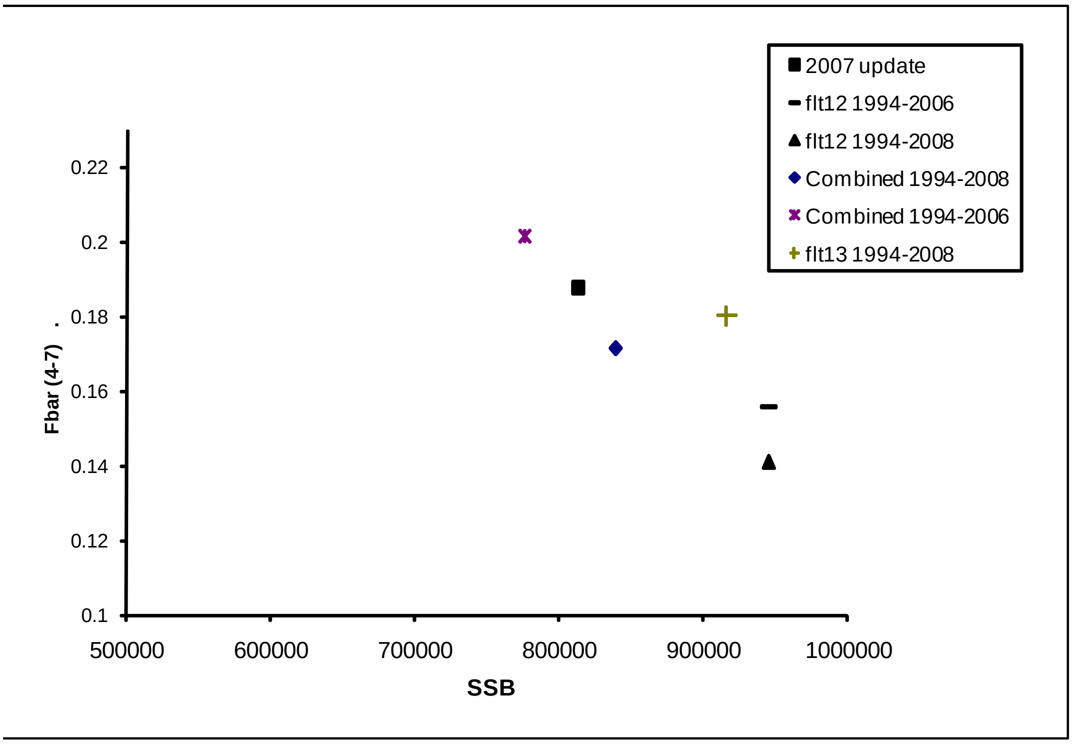


Figure 5.4.1 Comparison of SSB and F4-7 in 2008 from single fleet and combined XSA runs. SSB and F4-7 in 2007 from an updated 2007-data run is also presented.

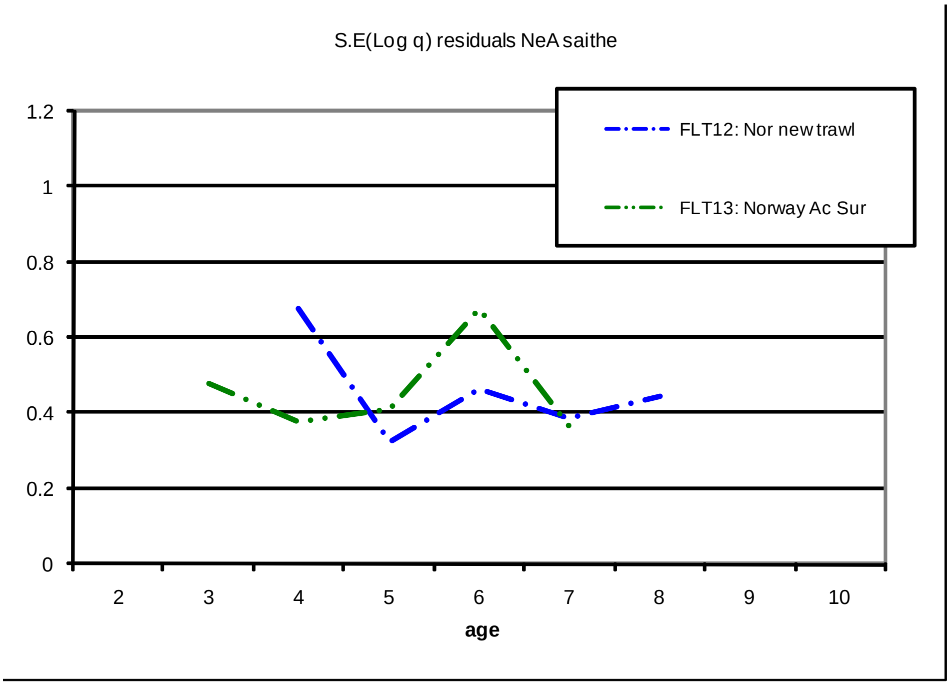


Figure 5.4.2. S.E. log catchability from two XSA fleet tuning run.

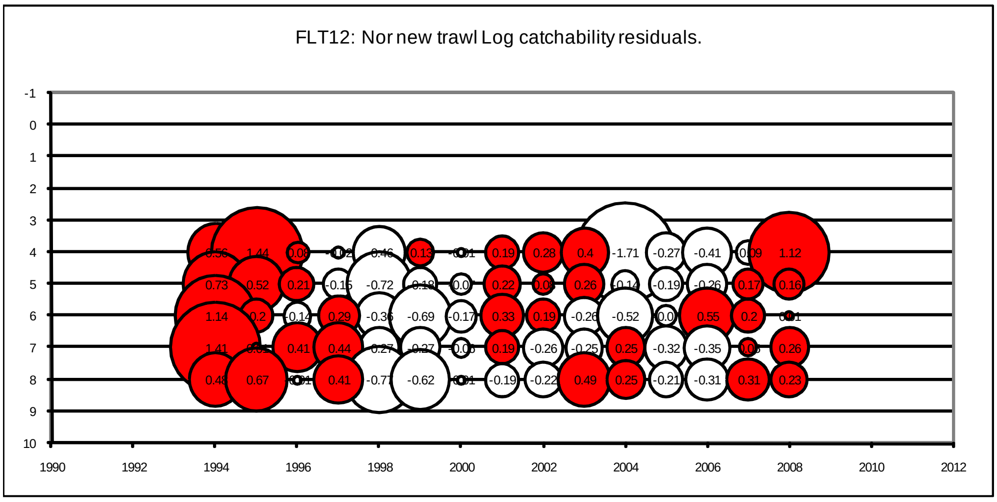


Figure 5.4.3 log Q residuals exploratory run: flt 12 1994-2008

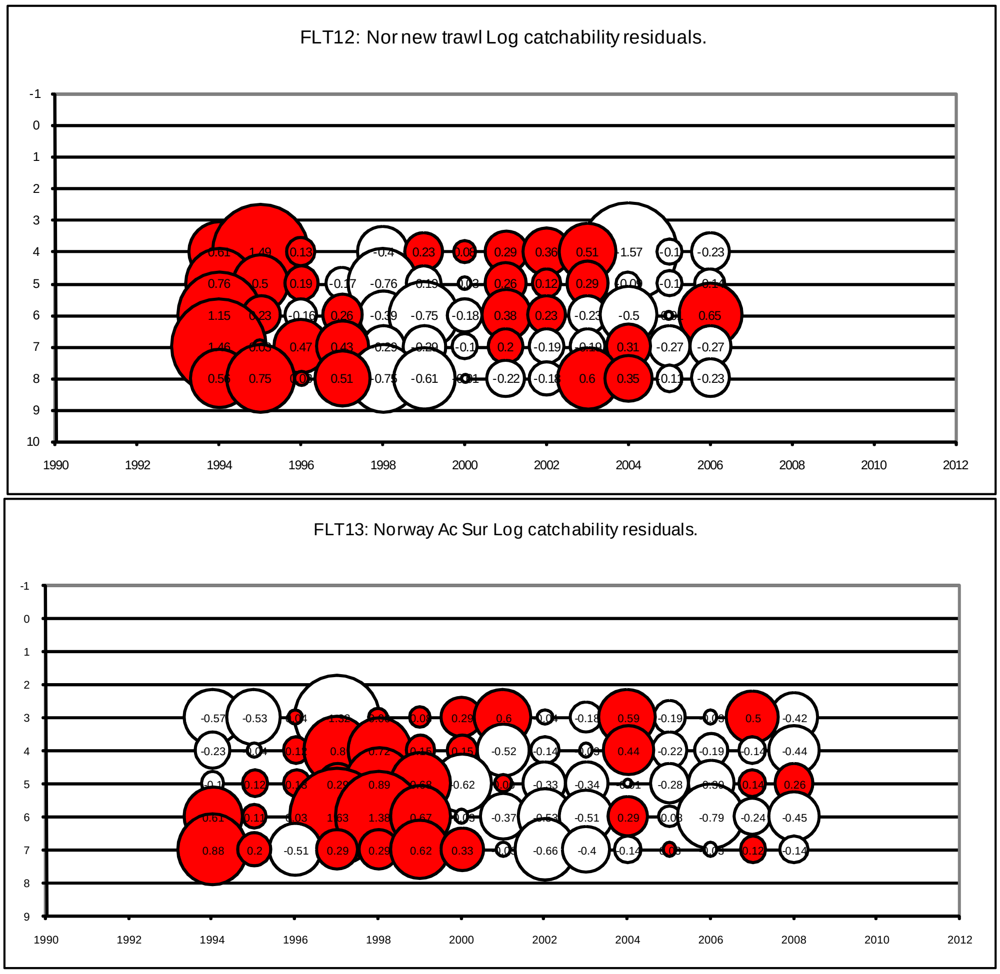


Figure 5.5.1 Final run log Q residuals

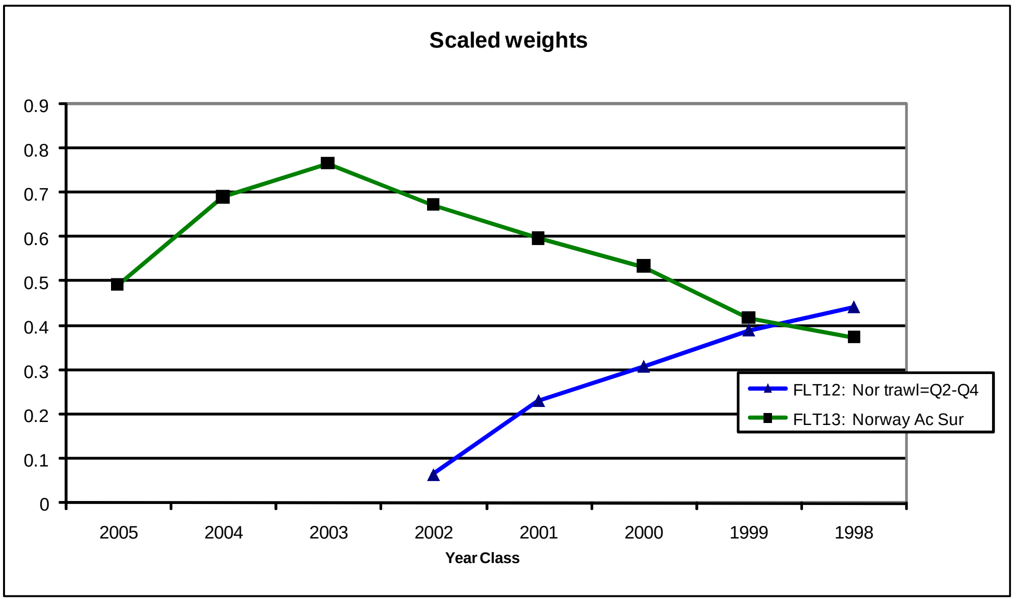


Figure 5.5.2 Scaled weights at age from final XSA run with 2 fleets.

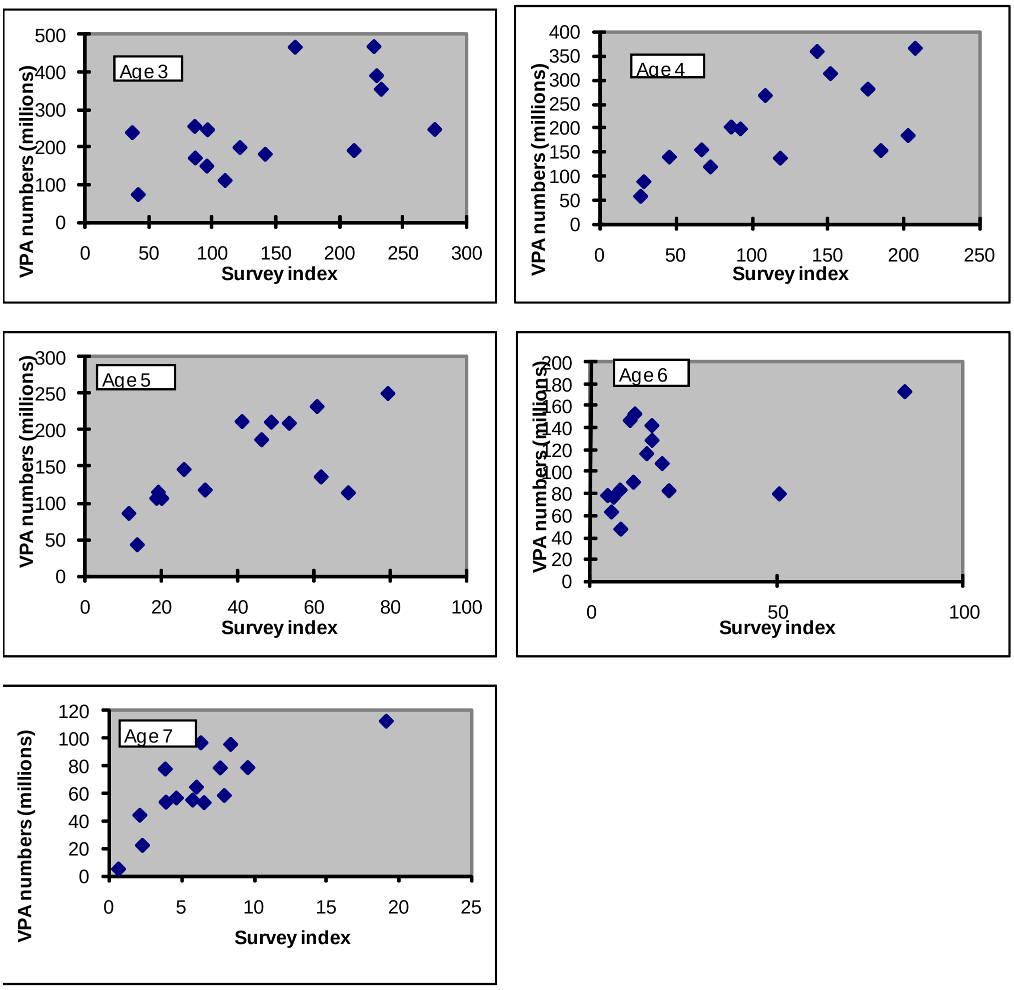


Figure 5.5.3A. North-East Arctic Saithe - Acoustic survey vs VPA

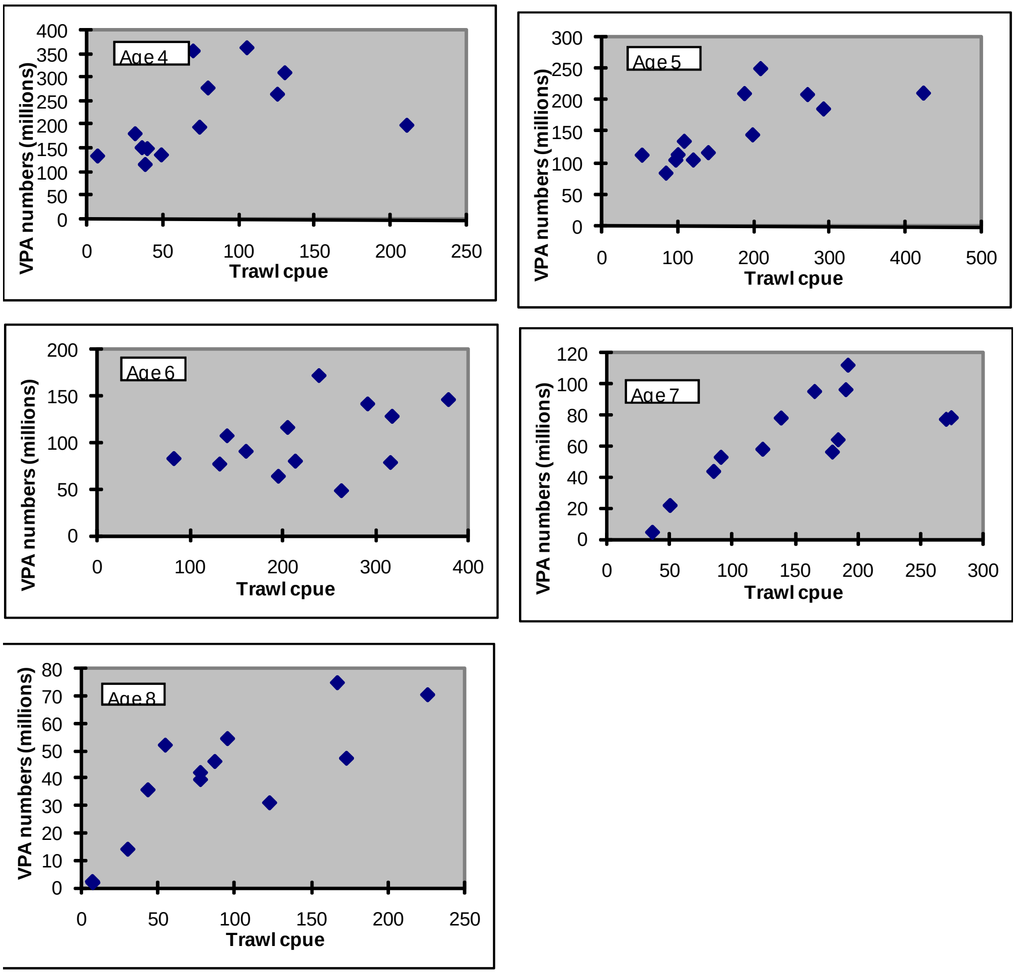


Figure 5.5.3B. North-East Arctic Saithe - Norwegian trawl vs VPA

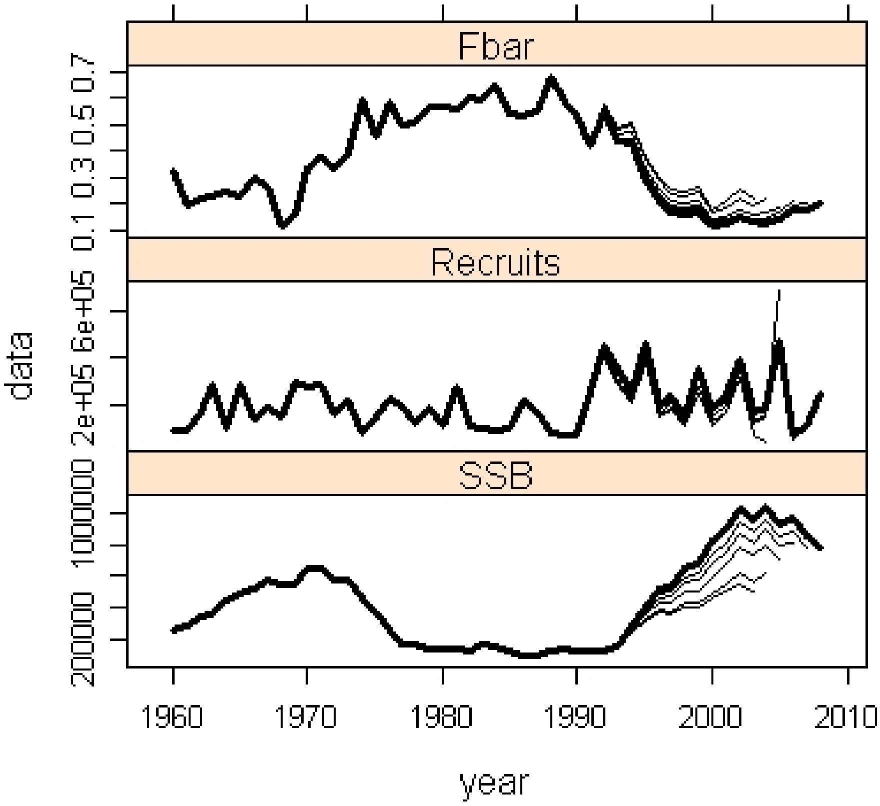


Figure 5.5.4 Saithe in Sub-areas I and II (North-East Arctic) RETROSPECTIVE XSA F_{4-7}, recruits and SSB for all fleets

Figure 5.7.1 A Quantiles of the SSB distribution, HCR (running average of Fpa for 3 Years)

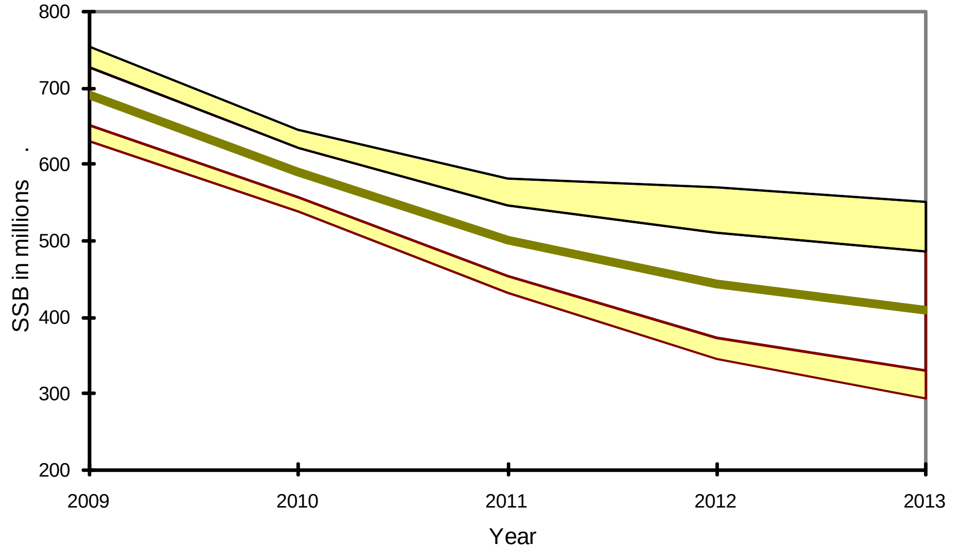


Figure 5.7.1 B Quantiles of the Catch distribution, HCR (running average of Fpa for 3 Years)

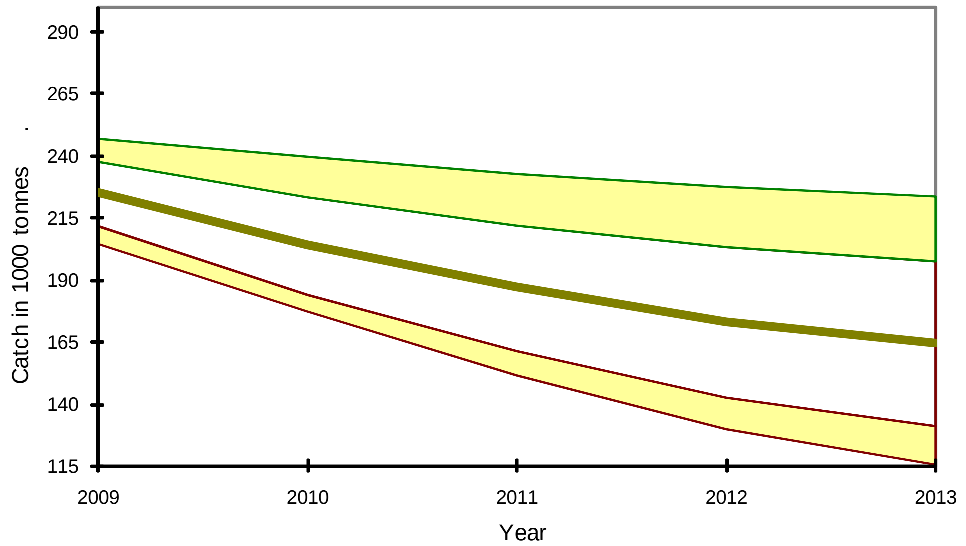


Figure 5.7.1A-B. Quantiles of SSB and catch distribution from mediumterm risk analyses, HCR

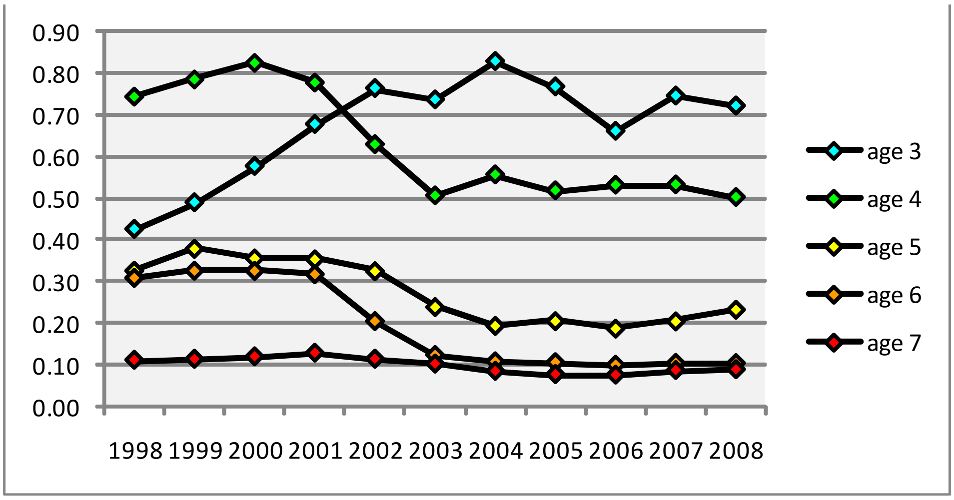


Figure 5.8.1 a Catchability (indeks/N) at age in the Norwegian acoustic survey
5 year running average, reference year beeing the last in the 5 year period.

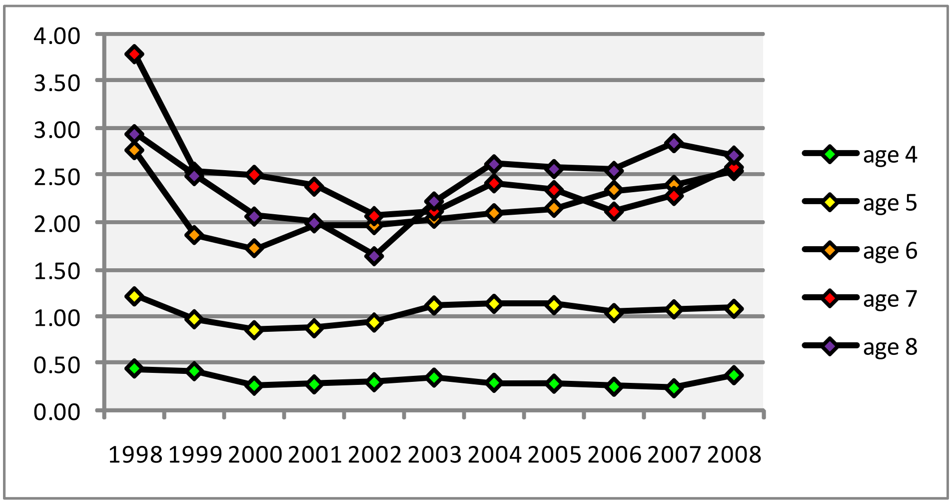


Figure 5.8.1 b Catchability (indeks/N) at age in the Norwegian trawl cpue serie
5 year running average, reference year beeing the last in the 5 year period.

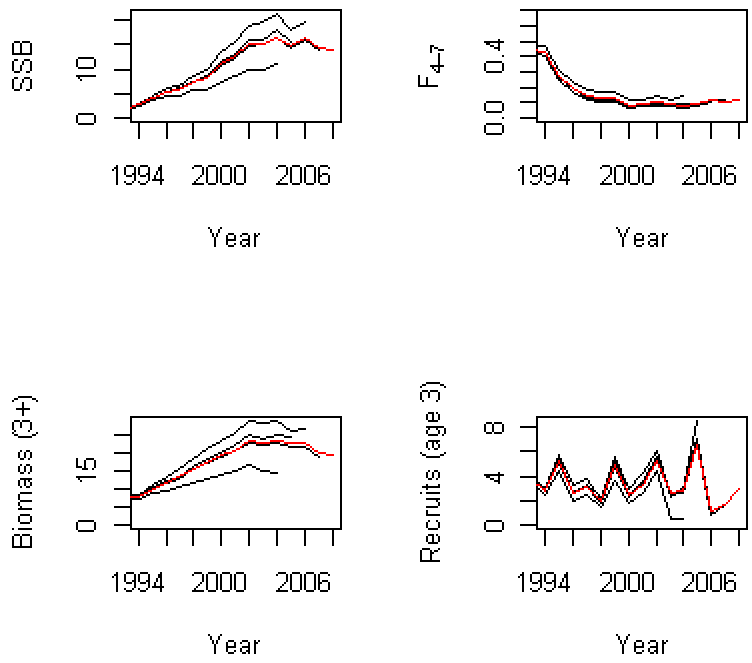


Figure 5.8.2 Retrospective plot SSB, Fbar, Biomass and Recruits.

6 Beaked redfish *(Sebastes mentella)* in Subareas I and II

ACFM considers any analytical assessments for this stock to be experimental. Since ACFM considers it not necessary to assess this stock every year since the status of the stock can clearly be deducted from the surveys, no analytical assessment has been made.

6.1 Status of the Fisheries

6.1.1 Development of the fishery

A description of the historical development of the fishery in Subareas I and II except the pelagic fishery is found in the Quality handbook for this stock. The Handbook was updated at this year's AFWG.

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. From 1 January 2006, the maximum bycatch of redfish juveniles in the international shrimp fisheries in the northeast Arctic has been reduced from ten to three redfish per 10 kg shrimp.

A pelagic fishery has developed in the Norwegian Sea outside EEZs since 2004. This fishery, which is further described in Chapter 6.3, is managed by the North-East Atlantic Fisheries Commission, and during its 27th annual meeting in November 2008 the Commission adopted by consensus a TAC for 2009 of 10,500 t.

6.1.2 Bycatch in other fisheries

All catches of *S. mentella*, exept the pelagic fishery in the Norwegian Sea outside EEZ, are currently taken as by-catches in other fisheries. Some of the pelagic catches reported on in chapter 6.1.3 are taken as by-catches in the blue-whiting and herring fisheries.

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 have previously been presented to the AFWG. The results show that shrimp trawlers removed significant numbers of juvenile redfish during the beginning of the 1980's with a peak during 1985 amounting to about 200 millions individuals. As sorting grids became mandatory in 1993, by-catches of redfish reduced drastically during the 1990's. The results also show that closure of areas is necessary to protect the smallest redfish juveniles since these smallest redfish sizegroups are not sufficiently protected by the sorting grid.

6.1.3 Landings prior to 2009 (Tables 6.1–6.5, 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 6.2–6.5. Total international landings in 1965-2008 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. The increase in 2004-2008 is explained by the pelagic bycatches in the blue whiting and herring fisheries and the direct fishery of pelagic redfish in international waters, mainly from 2005 onwards. This fishery peaked in 2006 with 28,429 t, but has since declined due to the NEAFC regulations. Nevertheless, contrary to the ICES advice of no directed trawl fishery, NEAFC set a TAC of 14,500 t (incl. all by-catches) to be taken in the pelagic trawl fisheries in international waters of the Norwegian Sea in 2008. According to reports to NEAFC and ICES, 9,183 t were caught. Not all the countries reported the catches to ICES. It caused some problems that EU does not report the catches to NEAFC splitted by country. For this reason catches taken by Latvia and Spain were recalculated according to the preliminary proportions reported to NEAFC during the fishery.

The redfish population in Sub-area IV (North Sea) is believed to belong to the Northeast 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 up to 2003 been 1,000–3,000 t per year. Since 2004 the annual landings from this area have been about 150-300 t (Table D2).

6.1.4 Expected landings in 2009

In 2009 there will be no directed demersal fishery for *S. mentella* , and all the current regulations will be continued in 2009, including the protection of juveniles from being caught in the shrimp fisheries. Based on the present regulations, and reports from the first months in 2009, the total landings of *S. mentella* for 2009 are expected to be maximum 5,000 t.

In addition to this comes, however, the pelagic catches in the Norwegian Sea outside the EEZs. The Northeast Atlantic Fisheries Commission (NEAFC) has set a TAC of 10,500 t for an olympic fishery in these international waters starting 15 August 2009. During an international trawl-acoustic survey in the Norwegian Sea in July-August 2009, another 2,000 t may be taken. In total this may lead to expected landings in 2009 of more than 18,000 t.

6.2 Data used in the Assessment

No analytical assessment was attempted for this stock this year. All input data sets were, however, updated up to and including 2008.

6.2.1 Catch at age (Tables 6.6 and 6.8)

Catch at age for 2004-2007 was revised according to new catch data. Age data for 2008 for demersal *S. mentella* were available from Norway for all areas, and from Russia in Division IIb. Age data based on recommended otolith readings were available from Norway and Russia for pelagic *S.mentella* in 2008. Russian total catch-at-length in Sub-area I and Division IIa (demersal fishery) were converted to catch-at-age by using the Norwegian age-length keys from Sub-area I and Division IIa (northern part), respectively. The available length distribution from Portugees catches in Divisions IIa and IIb were converted to catch-at-age by using the Norwegian age-length keys from Division IIa (northern part) and Division IIb. Other countries were assumed to have the same relative age distribution and mean weight as Norway.

6.2.2 Weight at age (Tables 6.7 and 6.9)

Catch weight-at-age data for 2008 were available from Norway for all areas, and from Russia from the demersal fishery in Division IIb and the pelagic fishery. 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. No new data were available to the present working group.

6.2.4 Survey results in the Barents Sea and Svalbard area (Tables 1.1, 1.4, D3–D7, Figures 6.2–6.6)

The results from the following research vessel survey series were evaluated by the Working Group:

1) The international 0-group survey in the Svalbard and Barents Sea areas in August-September, now part of the Ecosystem survey (Table 1.1 and Figures 6.2).
2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December from 1978–2008 in fishing depths of 100–900 m (Table D3, Figure 6.3).
3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1986–2008 in fishing depths of 100–500 m (swept area down to 800 m). Data disaggregated by age only for the years 1992–2008 (Table D4a,b).
4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2009 (joint with Russia since 2000, except 2006 and 2007) in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2008 (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 by length back to 1986 and by age back to 1992. This has been done in Figures 6.4 a,b.

5) The Norwegian survey initially designed for redfish and Greenland halibut is now part of the ecosystem survey and covers the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen during August 1996-2008 from less than 100 m to 800 m depth (Table D6, Figures 6.5-6.6). This survey includes survey no. 3 above, and has been a joint survey with Russia since 2003, and since then called the Ecosystem survey.
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. A promising increase was observed since 2005 with the 2007 year class being the strongest observed since 1990, but recent data indicate low abundance of 0-group fish in 2008 (Figures 6.2).

Results from the Ecosystem survey (Table D6 and Figures 6.5-6.6) confirm the stock development as interpreted from the 0-group survey (Figures 6.2), i.e., relative strong 1988-1990 year classes, followed by weaker 1991-1995 year classes, very weak year classes during 1996-2003, and confirming an improved recruitment since then. It also shows how the year-classes born before 1991 have grown in biomass. A sudden decrease of *S. mentella* for ages 9 and older (i.e., larger than about 28 cm) after 2003 was observed. The WG has earlier reported this decrease as likely related to the increase of *S. mentella* observed in the pelagic fisheries in the Norwegian Sea happening at the same time. This decrease was also seen in Figure 6.4a and b. Some later improvement in the abundance indices of these year classes may have been caused by fish returning from the pelagic and back to the continental slope. The latest adult biomass (age 10 and older) estimates by the Ecosystem survey show a strong decrease from 200,000 t in 2007 to about 88,000 t in 2008.

In the Russian bottom trawl survey the estimates for the 2003- and later year classes indicated an improved recruitment (Table D3, Figure 6.3) but the 0-group index for 2008 has returned to low values. The overall picture of the relative strength of the year classes is very similar in the Russian and Norwegian surveys. However, both the Russian survey back to 1977 and results from combining the Norwegian Barents Sea February and the Svalbard August surveys back to 1986 (Figure 6.4) show lower and more variable abundance of *S. mentella* in the 1980-ies than could be expected from the 0-group indices and when compared with the abundance observed at present. Figure 6.4a shows that the cod's predation on juvenile redfish during these years (Figure 6.4a) confirms the presence of many redfish juveniles. A more pelagic behaviour of the juvenile redfish and/or the cod's predation itself may have contributed to this variable bottom trawl survey abundance during the late 1980-ies.

The decrease in the abundance of young redfish in the surveys during the 1990-ies is consistent with the decline in the consumption of redfish by cod (Tables 1.5, 1.6; Figure 6.4a). It is important that the estimation of the consumption of redfish by cod is being continued.

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 1992. Until the pelagic surveys in 2007, and with the exception of a trial Norwegian survey between 62-70°N i spring 1992, this Russian survey has been the only survey targeting commercial sized *S. mentella*, though on a limited area of its distribution. The survey has unfortunately not been run since 2001. Table D7 shows a 43% decrease in the estimated spawning stock biomass from 1992 to 1997 to a low level that was observed up to 2000 inclusive before a three fold increase in the survey abundance of mature fish was seen in 2001 (Table D7). The strong 1982-year class migrating west-southwest and out of the surveyed area could explain this intermediate low level. The next, and to date last year classes contributing significantly to the spawning stock are the 1987–1990 year classes. These are now almost

100% mature and is causing the improved recruitment currently seen in the Barents Sea.

6.3 Description of the pelagic redfish, fishery and surveys in the Norwegian Sea outside the EEZs

6.3.1 Description of the pelagic fishery (Figure 6.7)

Landings of *S. mentella* taken in the pelagic fishery for blue whiting and herring in the Norwegian Sea have for some countries for some years been reported to the working group (Table 6.5). In 2004-2006 this fishery developed further to become a directed and free fishery in 2006. Since 2007 NEAFC has decided on a TAC to be fished in an olympic fishery. In 2008, seven countries and 31 trawlers were involved in this fishery. Although sporadic registrations and scattered catches of *S. marinus* may be observed, biological samples of the catches collected by observers and fishers show that the commercial catches are completely dominated by the deep-water redfish *S. mentella*.

Vinnichenko (WD 9, AFWG 2007) gives a good and comprehensive description of the previous abundance of pelagic *S. mentella* in the international waters of the Norwegian Sea, and how by-catches and exploratory fishing have developed during 1979-2006. According to Vinnichenko, in 1998-2000 small by-catches of redfish (no more than 8 t per year) were reported from the blue whiting and herring fisheries in the international waters of the Norwegian Sea and in the Norwegian Economic Zone. In 2001-2003 occurrence of redfish was reported from a larger area and catches increased to 60-118 t.

In 2004 the amount of redfish in catches increased significantly, and in June-August this species was more frequently occurring in the south of the sea. In September catches of redfish (0.5 t per hour haul) were reported from international waters and the NEZ. In October, in the northern part of the international waters, trawlers had a catch of redfish of 0.5-10 t per day, sometimes to 15-40 t. By-catches of redfish were also reported from the Bear Island-Spitsbergen area and the NEZ. The total reported catch of pelagic *S. mentella* in 2004 was 1,512 t.

In summer of 2005 small quantities of redfish were steadily present in catches on the blue whiting and herring fisheries in the international waters of the Norwegian Sea and the Bear Island-Spitsbergen area. In the first half of September some vessels operating in the Bear Island-Spitsbergen reported by-catches of *S. mentella* as large as 6-25 t per day. In the end of September in the north of the international waters of the Norwegian Sea large Russian trawlers for the first time began fishing for redfish in a directed fishery. They fished with a gigantic "Gloria" trawl. The fishery finished in the beginning of November after the redfish dispersed. In 2005 the Russian fleet reported a catch of *S. mentella* of 3 299 t, including the by-catch in the blue whiting and herring fisheries. Fishing for redfish was also conducted by a Faroese trawler. Besides, small quantities of redfish were fished by German vessels in the blue whiting fishery.

In 2006 first small catches of redfish (to 50 kg per haul) were reported from the herring fishery in the NEZ in February. In June-August catches of redfish of 70-120 kg per hour haul were reported in the blue whiting and mackerel fisheries in the international waters south of 70° N. Targeted redfish fishery by the Faroese and Russian trawlers began at the Mona Ridge (i.e., the ridge separating the Norwegian Sea into two main basins) in August . By mid-September the number of fishing vessels operating in that area was as high as 40 vessels, including 8-12 vessels from Russia and up to 30 vessels from Iceland, Faroe Islands, Norway and EU. In October 15-25 vessels continued the fishery. It finished in mid-November as the fish then had disappeared from the area. The Russian catch in the directed *S. mentella* fishery was 9 157 t. Redfish also occurred in catches by trawlers, that fished for blue whiting and herring. The total reported catch of pelagic *S. mentella* by Russian vessels in 2006 was, according to provisional data, 9 390 t, and a total of 28 429 t by all nations during this non-regulated fishery in 2006 (Table 6.5).

For 2007, the North East Atlantic Fisheries Commission (NEAFC) agreed to set a TAC of 15 500 t that could be fished in international waters in an olympic fishery (i.e., free competition among vessels until the TAC is taken) starting on 1 September. Information about the fishery in 2007 was presented to the working group in 2008 by several countries. Working Documents were available from Germany (WD 1, AFWG 2008), Spain (WD 3, AFWG 2008), Portugal (WD 7, AFWG 2008), Poland (WD 8, AFWG 2008) and Russia (WD 17, AFWG 2008). Figure 6.7 shows where *S. mentella* occurred in the Russian pelagic catches in the Norwegian Sea in 2008, either as by-catch or during the directed olympic fishery. A total catch of 15 808 t *S. mentella* has been reported to ICES and the AFWG as caught in the pelagic fisheries in the Norwegian Sea, incl. minor by-catches in the blue whiting and herring fisheries (Table 6.5).

For 2008, the North East Atlantic Fisheries Commission (NEAFC) agreed to set a TAC of 14 500 t that could be fished in international waters in an olympic fishery starting on 1 September. Only Portugal provided a Working Document about this fishery (WD 2), but in addition, Russia and Spain, provided length distribution of their pelagic catches. Norway distributed their pelagic catches by length and age using data collected during the scientific survey in the fishing area one week before the fishing started. A total catch of 9 183 t *S. mentella* has been reported to ICES and the AFWG as caught in the pelagic fisheries in the Norwegian Sea (Table 6.5).

Some countries have only reported catches taken in Sub-area IIa, without information whether the fish were caught pelagic or demersal. For these countries, the WG has considered all catches not reported to Norwegian authorities as being caught in international waters outside the EEZ.

Bycatch of herring could be a problem during day-time trawling in these waters at this time of the year. In some catches with the research survey trawl (40 mm mesh size in codend) up to 30% (in weight) herring was caught as bycatch when targetting the redfish. Even with a commercial trawl (100 mm mesh size in codend) reports from the fishery show that mixed catches of herring may happen. Even if some of the herring is selected out through the meshes, mortality through mesh selection may be high. During the 2007 olympic fishery bycatches of blue whiting were small. Best catch-rates of *S. mentella* were usually done during day-time. According to the skippers they observed and got the best catch-rates of redfish about 50 meters deeper than last year, i.e. at about 400 m. Two tons redfish per trawl hour was considered as a very good catch rate. With a common haul duration of 18 hours, catch rates of 30-40 tons/day were not uncommon. Even catch rates up to 70 tons/day were reported.

6.3.2 Length- and age composition from the pelagic fishery (Figures 6.8-6.12)

According to Vinnichenko (WD 9, AFWG 2007), the length of redfish collected from pelagic waters of the Norwegian Sea from 1979-2006 (collected with trawls with 20-135 mm mesh size in codend) show lengths from 20 cm to nearly 50 cm, mostly mature fish (95%) of 32-38 cm and 0.5-0.7 kg. Recently, however, few fish less than 30cm have been observed. In summer the catches have, as a rule, been dominated by females in number, in autumn the sex ratio has usually been 1:1. Germany, Norway, Poland, Russia and Spain report of 59-65% males in their 2007 catches.

Length distributions of the commercial pelagic catches of *S. mentella* in the Norwegian Sea outside EEZ in ICES Sub-areas IIa and IIb in 2007 are shown in Figure 6.8. Similar, length-distributions of the commercial demersal by-catches (no directed fishery allowed, maximum 15% by-catch) inside EEZ in ICES Sub-areas IIa and IIb are shown in Figure 6.9. All length-distributions seem to be rather similar.

Due to the slow growth of adult redfish a rather narrow length distribution may contain several age- and year-classes, and this is clearly seen from the age distributions based on otolith readings by Poland and Norway in 2007 (Figure 6.10). Similar results were presented from the 2006 fishery in AFWG 2007 report. The independent age readings by the two countries show the same age composition, i.e., that the bulk of the pelagic *S. mentella* catches in 2007 (as in 2006) were composed of the 1990-1992 and older year-classes, even more than 40 years old specimens. Figure 6.11 compares the age composition outside (pelagic) and inside (demersal) the EEZ showing a rather similar age and year-class composition. Norwegian age samples of *S. mentella* from pelagic catches during the research survey inside the EEZ show similar age composition.

6.3.3 Pelagic surveys in the Norwegian Sea in 2008 (Figures 6.12-6.16).

During 2008, two attempts were made to investigate the distribution and abundance of pelagic *Sebastes mentella* in the Norwegian Sea:

i. Norwegian part (RV G.O.Sars, May 2008) of the international ecosystem survey in the Nordic Seas in spring 2008 (PGNAPES, Fig. 6.12).
ii. ICES coordinated international trawl and acoustic survey conducted by Norway, Russia and the Faroes (Fig.6.13).

This was the second year that the Norwegian ecosystem survey in the Norwegian Sea in May 2008, as part of the international PGNAPES survey also focused on identifying and acoustically measuring the abundance of pelagic *S. mentella* in the surveyed region. Figure 6.12 shows the acoustic registrations (sA-values, m^2/NM^2) of pelagic *S. mentella* along the survey tracks. A preliminary acoustic estimate of the pelagic component gives about 380 000 tonnes of adult *S. mentella* within the area shown on the distribution map.

During 11-28 August 2008 the horizontal and vertical distribution of pelagic *S. mentella* was investigated by three vessels carrying pelagic trawling and hydroacoustics: Atlantic Star (Norway), Osveyskoe (Russia) and Skálaberg (Faroes) (Figure 6.13). Despite the large area covered by the survey, the distribution area of *S. mentella* could not be fully covered. In the northern part of the survey, the Atlantic Star used of a trawl fitted with multiple cod-ends. This allowed for a detailed investigation of the vertical distribution of *S. mentella*. In this area, the catch-rates of pelagic *S. mentella* were highest at 350-550 meters depth, but *S. mentella* specimens were caught down to 800 m. This depth corresponds to the Deep Scattering Layer (DSL), where high concentration of small preys occur (myctophids, shrimps, cephalopods,…). *S. mentella* was observed in more than 90% of the trawls, over most of the area covered by the survey. Generally larger and older individuals were found in deeper waters (Fig. 6.15) and towards the southern area of the study (Fig. 6.16). Methodological difficulties and discrepancies did not allow for joint robust estimates of distribution and abundance of *S mentella* in the Norwegian Sea on the basis of hydroacoustics registrations. An abundance estimated was made using the trawl method. The method assumed 1) that the trawl samples are representative of the population in the area (i.e. sufficient trawl hauls in different subareas and depth strata and sufficient sampling volume) and 2) that catchability of redfish in the trawl is known. Calculations were performed with an assumed catchability of 100%. If a catchability of 25% was applied (as is commonly accepted by Russian scientists), the biomass estimates should be raised by a factor of 4. Furthermore, 3 different types of trawls were used during the survey and the degree to which data from different trawls can be compared is unknown. The trawl based calculations were therefore done in an indicative manner but cannot provide a robust abundance estimate at the present time. The total abundance estimate derived from the trawl method is 203,000 (north) + 270,000 (middle) + 65,000 (south) = 538,000 t. The results from the international survey are presented in ICES (2008 – AGRED report).

Planned surveys in 2009

The Norwegian part of the international ecosystem survey in the Nordic Seas in spring 2009 (PGNAPES) will continue to focus on *Sebastes mentella* in addition to the other target species, herring and blue whiting.

The international conducted in August 2008 will be repeated in 2009. The planning of this survey is coordinated by the ICES planning group on redfish surveys (PGRS, ICES, 2009 – PGRS report).

6.4 Results of the Assessment

The signals of the various surveys are in agreement. The improved recruitment of 0-group and juveniles which were confirmed by a couple of surveys in 2007 appears to have returned to lower values in 2008. It is of vital importance that these 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.

It is likely that the strong protection of the last previous good year-classes (i.e., those born before 1991) as these were growing has caused the increased abundance of fish larger than 30 cm seen in both demersal and pelagic surveys (e.g., Figure 6.4).

The WG has previously concluded that 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. Positive signs in that direction are now seen. The only year classes that can contribute to the spawning stock in near future are, however, those prior to 1991 as the following fifteen year classes are very poor. These adult year classes need to be protected as the SSB will continue to be composed mainly from these year classes in the next decade.

6.5 Comments to the assessment

Since ACFM until now has considered it not necessary to assess this stock every year as long as the status of the stock can clearly be deducted from the demersal surveys, no experimental analytical assessment has been attempted. However, the recent expansion of the pelagic fishery in the Norwegian Sea and the results from the international surveys in this area (section 6.3) indicate that this will not hold true anymore as the stock is not properly covered by demersal surveys. In the current context of rapid change in the fisheries dynamics and possible changes in the contribution of the pelagic and demersal components of the stock, management plans and harvesting strategies will suffer from lacking an analytical 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. In addition, it is necessary to pursue pelagic surveys in the Norwegian (section 6.8) to cover the whole distribution area, incl. the areas where the bulk of the catches have been taken in recent years.

6.6 Biological reference points

Until an analytical assessment will be available and used as basis for reference points calculations for this stock, candidate reference points for the biomass could be set at the average biomass level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. ACFM supported these suggestions and stated that U-type reference points could be developed provided that a sufficient long time series demonstrating a dynamic range is available. Also the reference point should be expressed in biomass units (SSB or fishable stock).

6.7 Management advice

In the Barents Sea and Svalbard area, the stock is still historically low taking all age groups into consideration, and this situation is expected to remain for a considerable period irrespective current management actions. Year-classes recruit to the SSB at old age (>10-15 years old) and surveys indicate failure of recruitment over a long time period. Positive signs in the recruitment were seen in recent years but these seem to have halted in 2008. In addition the estimated fishable biomass has decreased from 200,000 t in 2007 to 88,000 t in 2008. The protective measures introduced in 2003 should be continued, i.e. 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.

In the Norwegian Sea, no data is available to describe the historical development of the stock. Results from the pelagic survey conducted in 2008 indicate a possible spawning biomass of about 500,000 t but such estimate is highly imprecise. This, however, suggests that this stock could support a limited fishery. It is, however, necessary to maintain this stock close to the current level since very few new mature individuals will enter the stock for at least the next 12-15 years.

Anticipated increases in TACs for cod and haddock in the Barents Sea will likely result in higher bycatches of redfish. This should be taken into consideration in the management of the stock of *S. mentella*. High and unreported bycatches in the pelagic trawl fisheries for blue whiting, herring, and mackerel in the Norwegian Sea should be avoided.

The AFWG has earlier estimated the minimum acceptable spawning stock level (MBAL) for *S. mentella* in ICES Sub-areas I and II to be at least 300 000 tons without impairing the recruitment. If this still holds, and how the current SSB is in relation to this is uncertain. It should therefore be the observed recruitment in the Barents Sea that should be decisive when evaluating the spawning and recruitment success. The current size of the mature stock, as estimated from surveys, may at present sustain a small fishery, but will inevitably be reduced in the future due to natural mortality and expected poor new recruitment, and may within some years reach the MBAL level. The poor recruitment in 2008 (after a few years of some promising recruitment) and clear reduction of the biomass in the Barents Sea indicate a need for great caution when monitoring this stock.

Experience from other *Sebastes* stocks, e.g, in the Pacific and in the Irminger Sea, suggests that annual harvest rates of such slow growing and longlived species should not exceed 5% if the stock is recruiting normal. It may be difficult to transfer this knowledge to the *S. mentella* in Sub-areas I and II, as part of the long-term rebuilding plan. It may, however, be considered appropriate to allow for a small harvest of e.g. maximum 2% per year if this is monitored closely.

Based on the above considerations, the AFWG may recommend that a precautionary adaptive management approach be adopted to determine how resilient the stock is to such a small exploitation, and that this be monitored closely.

The WG considers therefore a total catch not larger than in 2008, i.e., 14 000 tons, all bycatches (which are expected to become larger in 2010) and scientific catches included, to be the maximum acceptable catch for 2010.

In order to assess the state of the stock, it is necessary that the whole distribution area of *S. mentella* in Areas I and II is surveyed, both the pelagic and the demersal components. Coordinated pelagic and demersal surveys should be continued.

The WG is concerned about the actual levels allowed as by-catch, including international waters. Concerning the shrimp fishery, the sorting grid is not capable of sorting out all of the smallest redfish, and closure of areas is therefore necessary.

The connection between the pelagic component outside the EEZ and the pelagic and demersal occurrence inside the EEZ is still poorly understood. This will need to be further investigated, in particular to quantify the contribution of the adult component in the Norwegian Sea to recruitment in the Barents Sea and Svalbard area.

Complete and detailed catch and landings data from all nations fishing on the resource, as well as accompanying biological data, are to be provided to ICES and the AFWG.

6.8 Response to RGAFNW Technical minutes

In 2008, RGAFNW did not comment on the assessment report for *S. mentella* because the advice was a re-conduction of the previous year's advice.

Table 6.1 ***Sebastes mentella*** **in Sub-areas I and II. Nominal catch (t) by countries in Sub-area I, Divisions IIa and IIb combined.**

Year	Canada	Denmark	Faroe Islands	France	Germany[3]	Greenland	Ireland
1989	-	-	335	1,111	3,833	-	-
1990	-	-	108	142	6,354	36	-
1991	-	-	487	85	-	23	-
1992	-	-	23	12	-	-	-
1993	8	4	13	50	35	1	-
1994	-	28	4	74	18	1	3
1995	-	-	3	16	176	2	4
1996	-	-	4	75	119	3	2
1997	-	-	4	37	81	16	6
1998	-	-	20	73	100	14	9
1999	Iceland	-	73	26	202	50	3
2000	48	Estonia	50	12	62	29	1
2001	3	-	74	16	198	17	4
2002	41	15	75	58	99	18	4
2003	5	-	64	22	32	8	5
2004	10	-	588	13	10	4	3
2005	4	5	1,147	46	33	39	4
2006	2,513	396	3,808	215	2,483	63	9
2007	1,579	684	2,197	234	520	29	6
2008[1]	10		1,833	129	17	25	2

Table 6.1 Cont'd

Year	Norway	Poland	Portugal	Russia[4]	Spain	UK (Eng. & Wales)	UK (Scotland)	Total
1989	4,633	-	340	13,080	5	174	1	23,512
1990	10,173	-	830	17,355	-	72	-	35,070
1991	33,592	-	166	14,302	1	68	3	48,727
1992	10,751	-	972	3,577	14	238	3	15,590
1993	5,182	-	963	6,260	5	293	-	12,814
1994	6,511	-	895	5,021	30	124	12	12,721
1995	2,646	-	927	6,346	67	93	4	10,284
1996	6,053	-	467	925	328	76	23	8,075
1997	4,657	1	474	2,972	272	71	7	8,598
1998	9,733	13	125	3,646	177	93	41	14,045
1999	7,884	6	65	2,731	29	112	28	11,209
2000	6,020	2	115	3,519	87		130[5]	10,075
2001	13,937	5	179	3,775	90		120[5]	18,418
2002	2,152	8	242	3,904	190	Sweden	188[5]	6,993
2003	1,210	7	44	952	47	-	124[5]	2,520
2004	1,375	42	235	2,879	257	1	76[5]	5,493
2005	1,760[1]	-	140	5,023	163	Netherl -7	95[5]	8,465
2006	4,680[1]	2,496	1,804	11,413	710	Lithu -845 Can - 433	1,027[5]	32,895
2007	3,195[1]	1,081	1,483	5,660	2,181	Lithu -785	202	19,837
2008[1]	2,231	8	713	7,117	1,179	Lithu -373 Latvia-130 Netherl -13	81	13,860

[1] Provisional figures.

[2] Including 1,414 tonnes in Division IIb not split on countries.

[3] Includes former GDR prior to 1991.

[4] USSR prior to 1991.

[5] UK(E&W)+UK(Scot.)

Table 6.2 ***Sebastes mentella*** **in Sub-areas I and II. 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	296	-	3[2]	307
2002	-	-	-	4	587	-	-	591
2003	-	-	-	6	292	-	-	298
2004	-	-	-	2	355	-	-	357
2005	-	-	-	3[1]	327	-	-	330
2006	2	-	-	12[1]	460	2	-	476
2007	-	Lithuania	-	11[1]	210	20	-	241
2008[1]	-	25	-	5	155	-	-	185

[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*** **in Sub-areas I and II. Nominal catch (t) by countries in Division IIa (including landings from the pelagic trawl fishery in the international water).**

Year	Estonia	Faroe Islands	France	Germany[3]	Greenland	Ireland	Norway
1989		312[2]	1,065[2]	3,200	-	-	4,573
1990		98[2]	137[2]	1,673	-	-	8,842
1991		487[2]	72[2]	-	-	-	32,810
1992		23[2]	7[2]	-	-	-	9,816
1993		11[2]	15[2]	35	1[2]	-	5,029
1994		2[2]	33[2]	16[2]	1[2]	2[2]	6,119
1995		1[2]	16[2]	176[2]	2[2]	2[2]	2,251
1996		-	75[2]	119[2]	3[2]	-	5,895
1997		-	37[2]	77	12[2]	2[2]	4,422
1998		-	73[2]	58[2]	14[2]	6[2]	9,186
1999		-	16[2]	160[2]	50[2]	3[2]	7,358
2000		50[2]	11[2]	35[2]	29[2]	-	5,892
2001		63[2]	12[2]	161[2]	17[2]	4[2]	13,636
2002		37[2]	54[2]	59[2]	18[2]	4[2]	1,937
2003		58[2]	18[2]	17[2]	8[2]	5[2]	1,014
2004		555[2]	8[2]	4[2]	4[2]	3[2]	987
2005		1,101[2]	36[2]	17[2]	38[2]	4[2]	1,083[1]
2006	396	3,793	199	2,475	52[2]	8[2]	3,985
2007	684	2,157	226	519	29[2]	5[2]	3,030
2008[1]	-	1,810[6]	128[2]	10[2]	24[2]	2[2]	1,758

Table 6.3 (Cont'd)

Year	Sweden	Portugal	Poland	Russia[4]	Spain	UK (Eng.& Wales)	UK (Scotland)	Total
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[2,5]	8,403
2001		105[2]		2,716	18[2]	-	95[2,5]	16,827
2002		124[2]		2,615	8[2]	41[2]	157[2,5]	5,055
2003		17[2]		448	8[2]	5[2]	102[2,5]	1,700
2004	1[2]	86[2]		2,081	7[2]	10[2]	18[2,5]	3,765
2005	-	71[2]		3,307	20[2]	2[2]	15[2,5]	5,693
2006	Lithu -845 **Can** - 433	1,731	2,467	10,110	589	2,513[2,6]	958[2,5]	32,895
2007	Lithu -785	1,395	1,079	5,061	2,159	1,579[6]	120[2,5]	18,827
2008[1]	Lithu -348 Latvia - 130 Nether - 13[2]	666	1	6,442	1,146	10[2]	62[2,5]	12,550

[1] Provisional figures.

[2] Split on species according to reports to Norwegian authorities.

[3] Includes former GDR prior to 1991.

[4] USSR prior to 1991.

[5] UK(E&W)+UK(Scot.)

[6] As reported to NEAFC

Table 6.4 ***Sebastes mentella*** **in Sub-areas I and II. Nominal catch (t) by countries in Division IIb.**

Year	Canada	Denmark	Faroe Islands	France	Germany[4]	Greenland	Ireland
1989	-	-	10	28	633	-	-
1990	-	-	8[2]	5[2]	4,681	36[2]	-
1991	-	-	-	13[2]	-	23	-
1992	-	-	-	5[2]	-	-	-
1993	8[2]	4[2]	-	35[2]	-	-	-
1994	-	28[2]	-	41[2]	-	-	1[2]
1995	-	-	-	-	-	-	2[2]
1996	-	-	4[2]	-	-	-	2[2]
1997	-	-	4[2]	-	3	1[2]	4[2]
1998	-	-	-	-	42[2]	-	3[2]
1999	-	-	4[2]	10[2]	42[2]	-	-
2000	-	-	-	1[2]	27[2]	-	1[2]
2001	-	-	11[2]	4[2]	37[2]	-	-
2002	-	-	38[2]	4[2]	40[2]	-	-
2003	-	-	6[2]	4[2]	15[2]	-	-
2004	-	-	33[2]	5[2]	6[2]	-	-
2005	Netherl - 7[2]	Iceland - 2[2]	46[2]	10[2]	17[2]	1[2]	-
2006	-	-	13[2]	16[2]	8[2]	11[2]	1[2]
2007	-	-	40	8[2]	1	-	1[2]
2008[1]	-		23[2]	1[2]	7[2]	1[2]	-

Table 6.4 (Cont'd)

Year	Norway	Poland	Portugal	Russia[5]	Spain	UK(Eng. & Wales)	UK (Scotland)	Total
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[2,6]	1,172
2001	293	5[2]	74[2]	763	72[2]	Estonia	25[2,6]	1,284
2002	210	8[2]	118[2]	702	182[2]	15	31[2,6]	1,348
2003	190	7	27[2]	212	39[2]	-	22[2,6]	522
2004	386	42[2]	149[2]	443	250[2]	-	58[2,6]	1,372
2005	673[1]	-	69[2]	1,389	143[2]	5	80[2,6]	2,442
2006	684[1]	29	73[2]	843	121[2]	-	67[2,6]	1,866
2007	155[1]	2	88	389	22[2]	-	62[2,6]	768
2008[1]	468	6	47[2]	520	33[2]	-	19[2,6]	1,125

[1] Provisional figures.

[2] Split on species according to reports to Norwegian authorities.

[3] Split on species according to the 1992 catches.

[4]. Includes former GDR prior to 1991

[5]. USSR prior to 1991.

[6] UK(E&W)+UK(Scot.)

Table 6.5 ***Sebastes mentella*** **in Sub-areas I and II. Nominal catch (t) by countries of the pelagic fishery in international waters of the Norwegian Sea (see text for further details)**

Year	Can	Estonia	Faroe Islands	France	Germany	Iceland	Lithuania
2002					9		
2003					40		
2004			500		2		
2005			1,083		20		
2006	433	396	3,766	192	2,475	2,510[2]	845
2007	Latvia	684	1,968[2]	226	497	1,579[2]	785
2008[1]	130	-	1,797[2]	-	-	-	348

Year	Norway	Poland	Portugal	Russia	Spain	UK	Total
2002							9
2003							40
2004				1,510			1,512
2005				3,299			3,319
2006	2,862	2,447	1,697	9,390	575	841	28,429
2007	1,813[2]	1,079	1,377	3,645	2,155	-	15,808
2008[1]	291[2]	-	624	4,901	1,092	-	9,183

[1] **Provisional figures.**

[2] **As reported to NEAFC**

Table 6.6. *S.mentella* in Sub-areas I and II. Catch numbers at age.

Catch numbers at age (thous.)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE																	
6	1873	159	738	662	223	125	37	9	1	117	2	6	11	5	0	0	0
7	2498	159	730	941	634	533	882	83	24	372	40	37	24	44	10	1	0
8	1898	174	722	1279	1699	1287	2904	441	390	542	252	103	108	128	8	5	1
9	1622	512	992	719	1554	1247	4236	1511	1235	976	572	93	148	347	89	32	10
10	1780	2094	2561	740	1236	1297	3995	2250	2460	925	709	132	427	540	153	52	44
11	1531	3139	2734	1230	1078	1244	2741	3262	2149	1712	532	220	624	567	256	151	128
12	2108	2631	3060	2013	1146	876	1877	1867	1816	2651	1382	384	931	432	877	314	186
13	2288	2308	1535	4297	1413	1416	1373	1454	1205	2660	1893	391	580	1607	1980	1025	492
14	2258	2987	2253	3300	1865	1784	1277	1447	1001	1911	1617	434	1385	1332	2774	2466	541
15	2506	1875	2182	2162	880	1217	1595	1557	993	1773	855	466	1047	3174	4580	2836	1444
16	2137	1514	3336	1454	621	537	1117	1418	932	1220	629	513	937	1041	5154	3570	1423
17	1512	1053	1284	757	498	1177	784	1317	505	714	163	199	927	1216	4823	4002	923
18	677	527	734	794	700	342	786	658	596	814	237	231	549	1024	4261	2866	1730
+gp	9258	6022	3257	2404	2247	3568	6241	3919	5705	16234	4082	1193	2055	4266	35350	17148	16389
TOTALNUM	33946	25154	26118	22752	15794	16650	29845	21193	19012	32621	12965	4400	9754	15725	60313	34469	23311
TONSLAND	15590	12866	12721	10284	8075	8597	14045	11209	10075	18418	6993	2520	5493	8466	32895	19837	13860

Table 6.7. *S.mentella* in Sub-areas I and II. Catch weights at age (kg).

Catch weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE																		
6	0,13	0,19	0,17	0,16	0,14	0,2	0,18	0,14	0,15	0,1	0,11	0,13	0,09	0,13	0,13			
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	0,17	0,14	0,14	0,29
8	0,21	0,26	0,25	0,24	0,19	0,25	0,25	0,23	0,22	0,22	0,20	0,22	0,22	0,22	0,21	0,23	0,25	0,30
9	0,27	0,28	0,28	0,3	0,21	0,31	0,29	0,29	0,28	0,26	0,25	0,29	0,28	0,27	0,28	0,29	0,33	0,30
10	0,34	0,31	0,33	0,34	0,28	0,42	0,33	0,33	0,33	0,31	0,30	0,34	0,33	0,33	0,34	0,34	0,19	0,32
11	0,35	0,33	0,38	0,37	0,32	0,44	0,38	0,38	0,37	0,36	0,34	0,38	0,39	0,38	0,38	0,42	0,33	0,36
12	0,42	0,38	0,44	0,4	0,37	0,47	0,46	0,43	0,44	0,42	0,39	0,43	0,43	0,43	0,43	0,45	0,30	0,49
13	0,46	0,46	0,47	0,44	0,41	0,59	0,48	0,48	0,49	0,44	0,44	0,44	0,45	0,43	0,45	0,46	0,29	0,43
14	0,51	0,43	0,5	0,45	0,47	0,67	0,51	0,54	0,53	0,51	0,48	0,52	0,50	0,50	0,50	0,49	0,48	0,63
15	0,58	0,43	0,57	0,49	0,53	0,69	0,55	0,59	0,56	0,56	0,53	0,56	0,54	0,54	0,55	0,53	0,48	0,56
16	0,59	0,45	0,58	0,55	0,58	0,71	0,6	0,61	0,62	0,62	0,59	0,57	0,59	0,58	0,56	0,54	0,51	0,55
17	0,58	0,52	0,62	0,58	0,66	0,74	0,66	0,64	0,66	0,63	0,62	0,60	0,57	0,61	0,59	0,55	0,61	0,64
18	0,59	0,57	0,65	0,67	0,71	0,74	0,65	0,66	0,67	0,67	0,65	0,59	0,62	0,64	0,61	0,56	0,59	0,32
+gp	0,7	0,67	0,66	0,79	0,81	0,85	0,79	0,75	0,81	0,77	0,70	0,73	0,75	0,72	0,70	0,66	0,68	0,64

Table 6.8 Pelagic *Sebastes mentella* in the Norwegian Sea (outside the EEZ). Catch numbers at age.

Numbers*10**-3					Age				
YEAR	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19+**
2006	23	93	1083	323	1563	3628	2514	3756	29704
2007	75	440	1331	2909	3347	4138	3692	3437	9114
2008	28	146	115	143	214	594	752	753	13258

Table 6.9 Pelagic *Sebastes mentella* in the Norwegian Sea (outside the EEZ). Catch weights at age (kg).

					Age				
YEAR	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19+**
2006	0,44	0,44	0,52	0,44	0,49	0,55	0,53	0,56	0,61
2007	0,39	0,43	0,41	0,48	0,50	0,52	0,55	0,57	0,64
2008	0,36	0,47	0,56	0,50	0,56	0,54	0,56	0,55	0,64

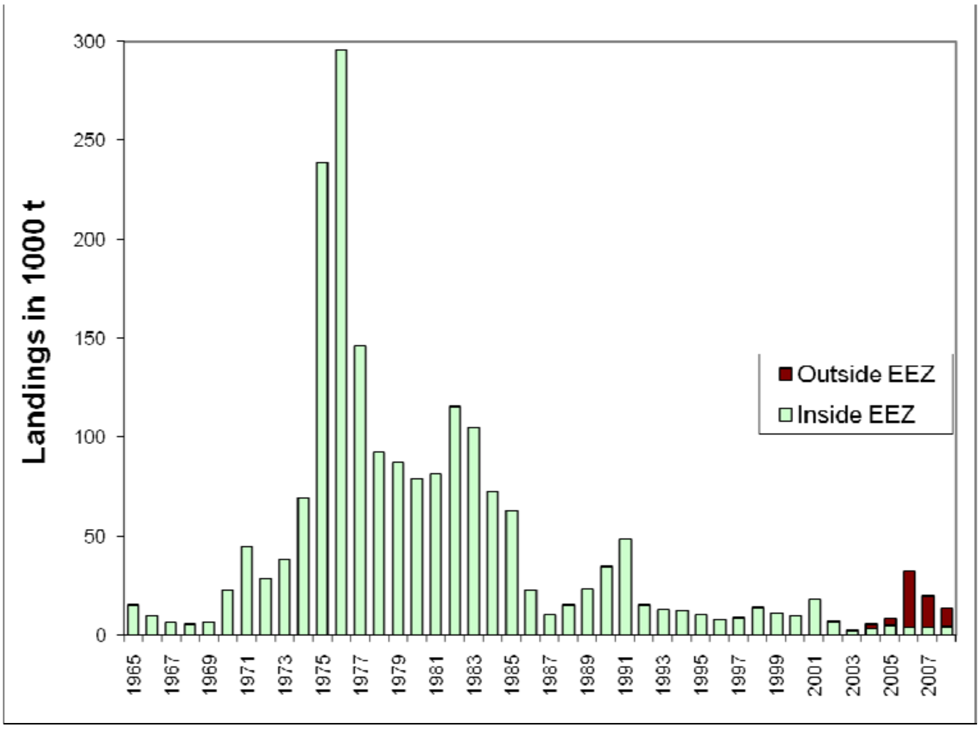


Figure. 6.1. *Sebastes mentella* in Sub-areas I and II. Total international landings 1965-2008 (thousand tonnes).

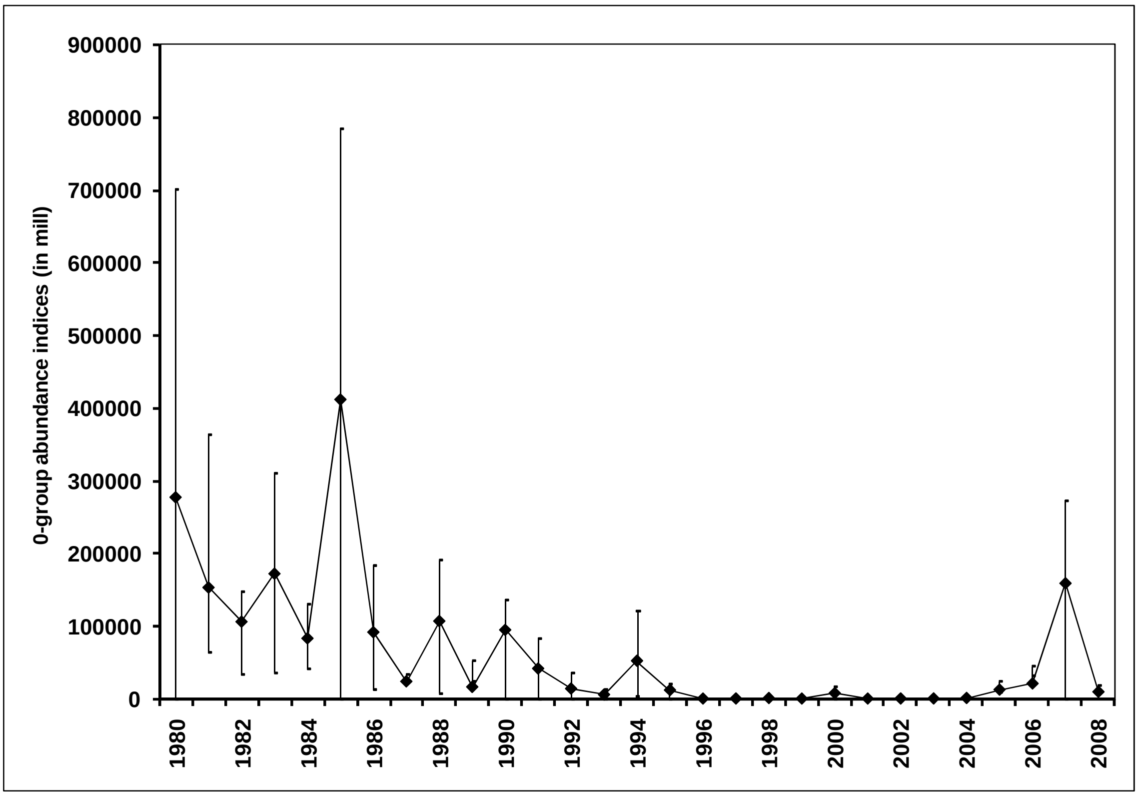


Figure 6.2. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (in millions) with 95% confidence limits of 0-group redfish (believed to be mostly *S.mentella*) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2008, as calculated by the new method, and not corrected for catching efficiency.**

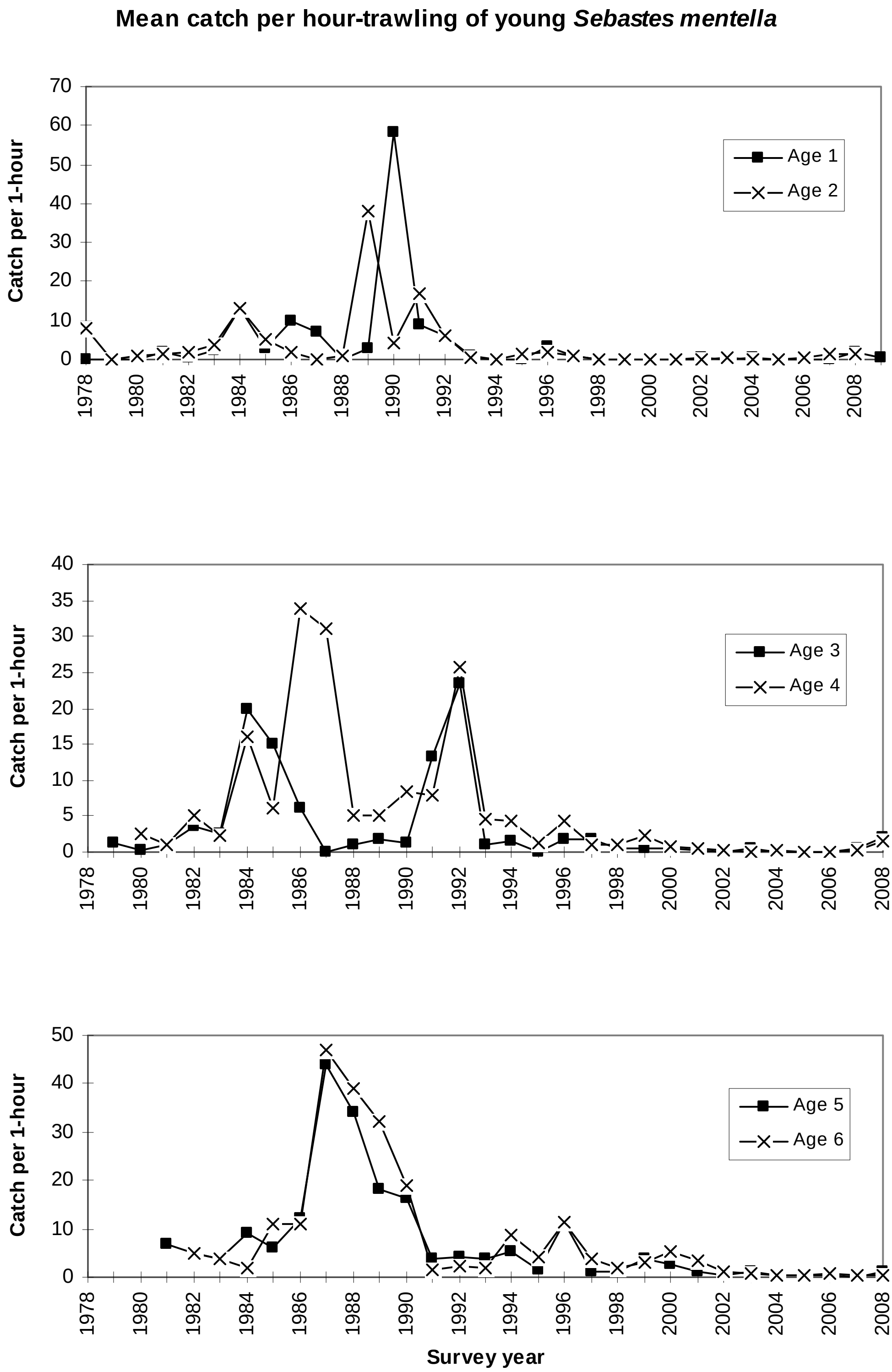


Figure 6.3. ***Sebastes mentella*** **in Sub-areas I and II. Catch (numbers of specimens) per hour trawling of different ages of** ***S. mentella*** **in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D3).**

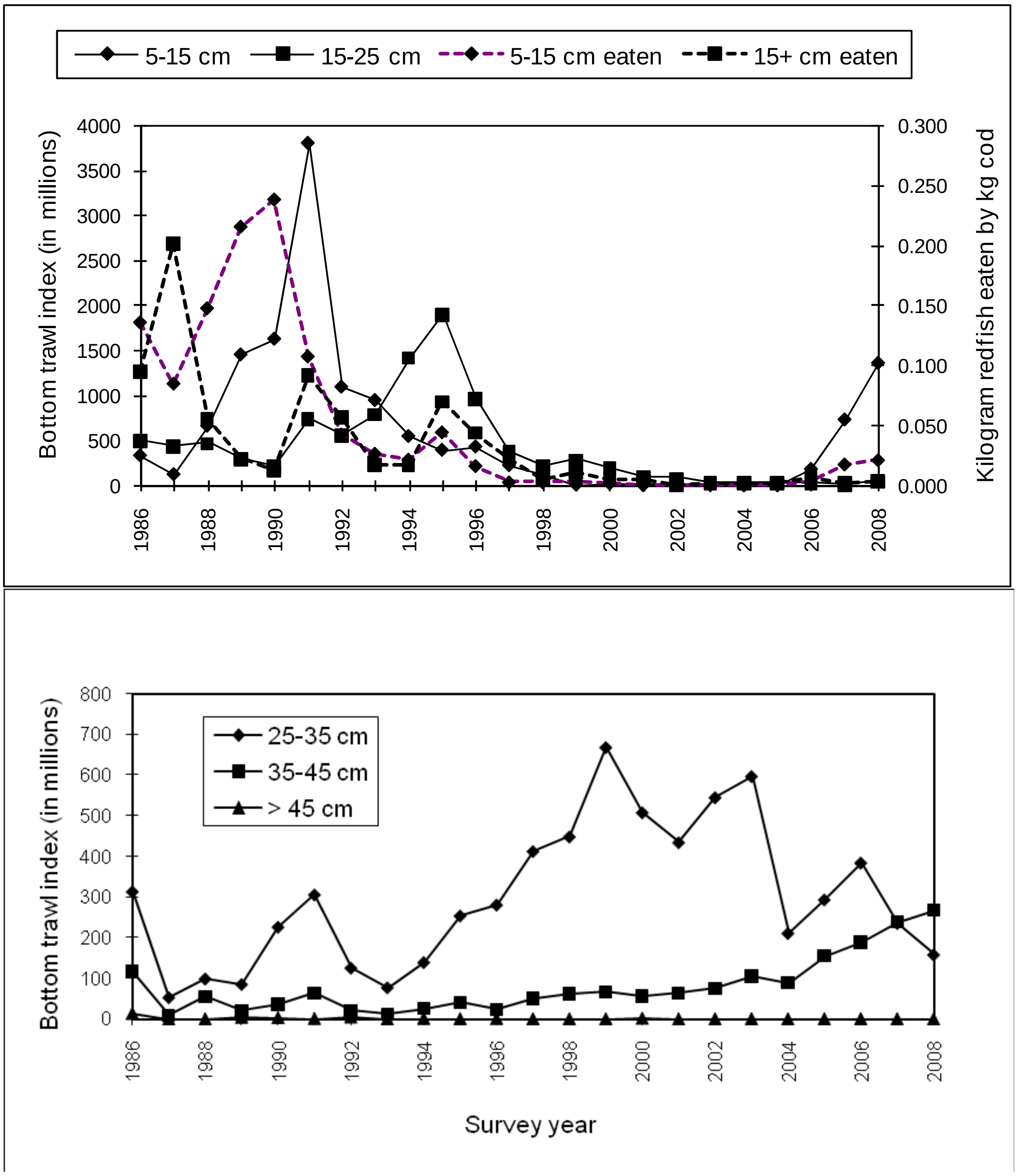
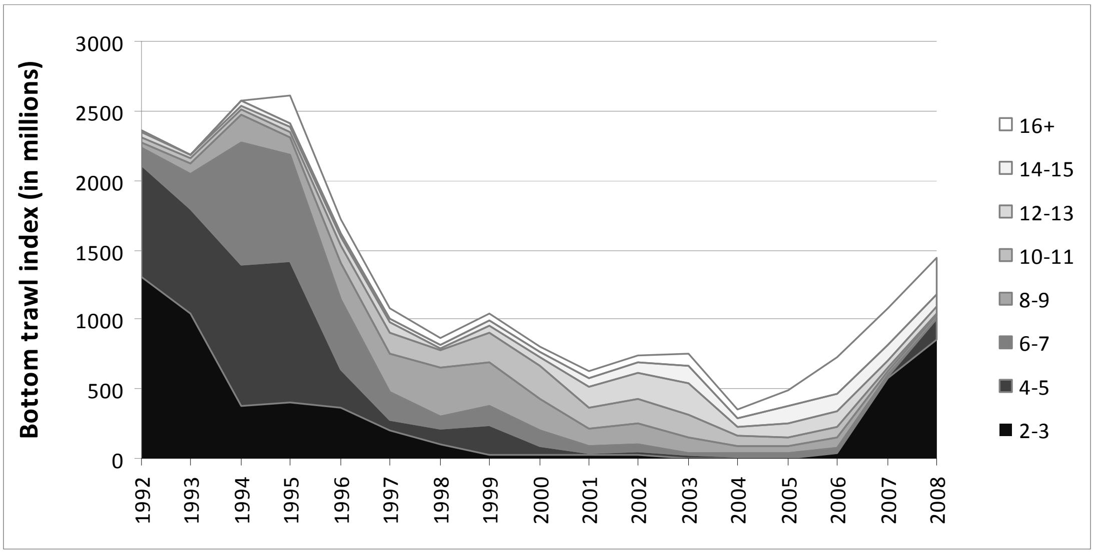


Figure 6.4a. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (on length) when combining the Norwegian bottom trawl surveys 1986-2008 at Svalbard (summer/fall) and in the Barents Sea (winter). Kilogram redfish eaten by kilogram cod is shown in the upper panel for two size groups of redfish.**



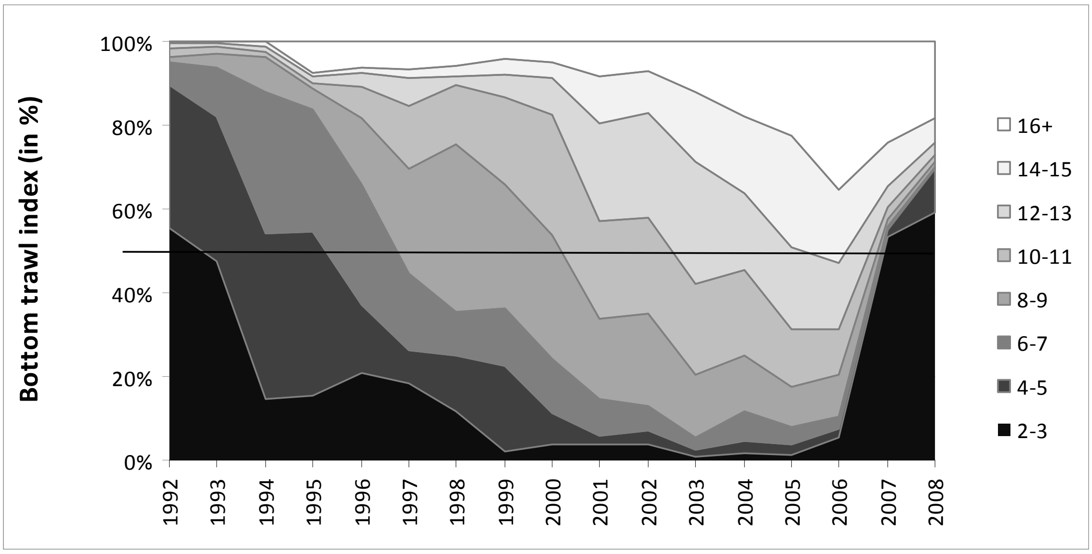


Figure 6.4b. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (on age) when combining the Norwegian bottom trawl surveys 1992-2008 at Svalbard (Division IIb, summer/fall) and in the Barents Sea (Division IIa, winter).**

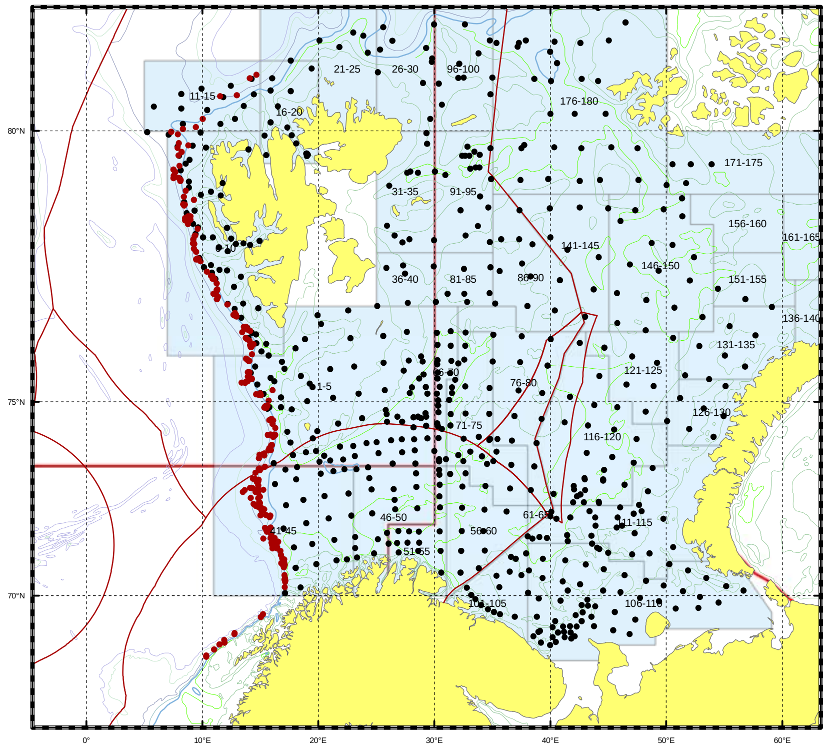
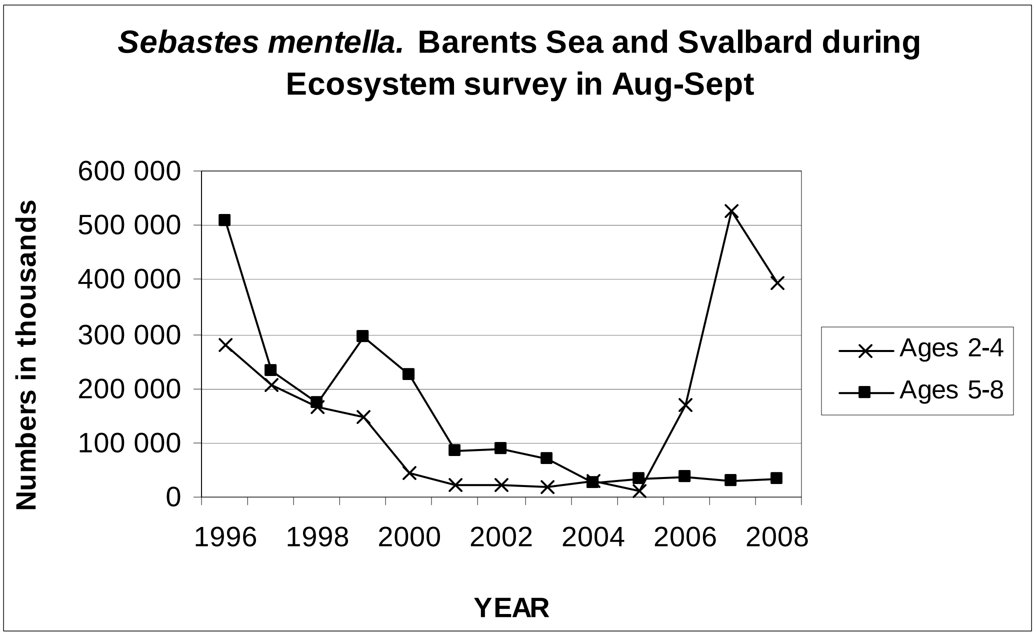


Figure 6.5. Survey regions and subareas in the ecosystem survey in the Barents Sea and adjacent areas as covered in August-September 2007 by the standard 1800 Campelen research trawl (22 mm codend) shallower than about 500 m, and the Alfredo 5 trawl (60 mm codend) from 500-1500 m along the continental slope from 68-80°N. The sub-areas are further depth stratified (ref. Table D6).



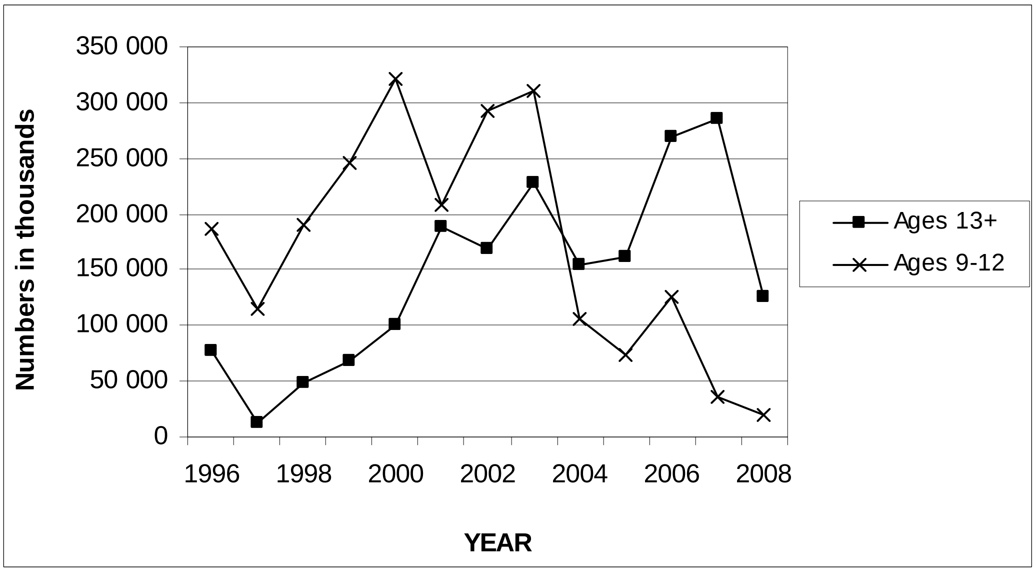


Figure 6.6. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (on age) from the Ecosystem survey in August-September 1996-2008 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (ref. Table D6).**

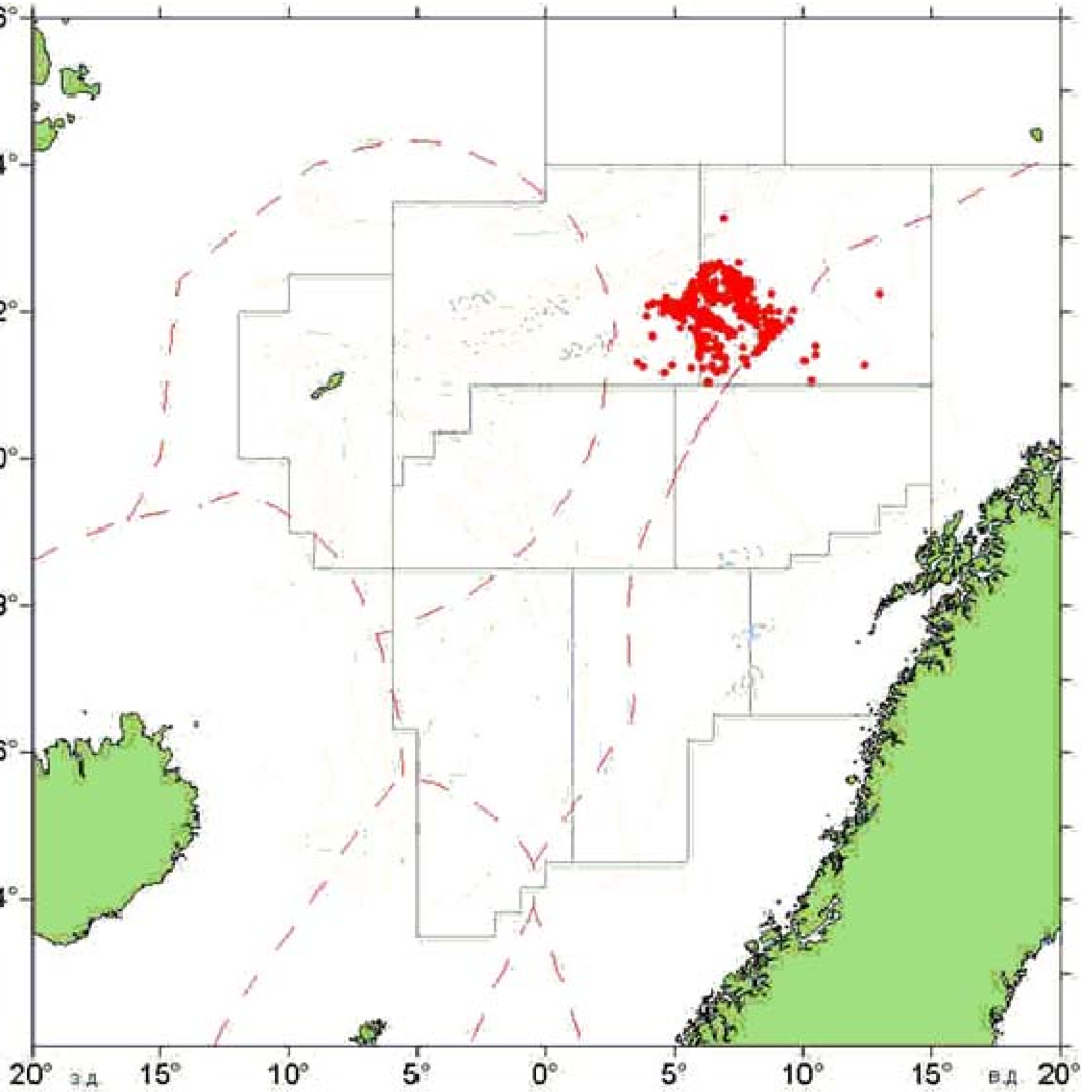


Figure 6.7. Location of S. mentella catches by Russian fishing vessels in 2008.

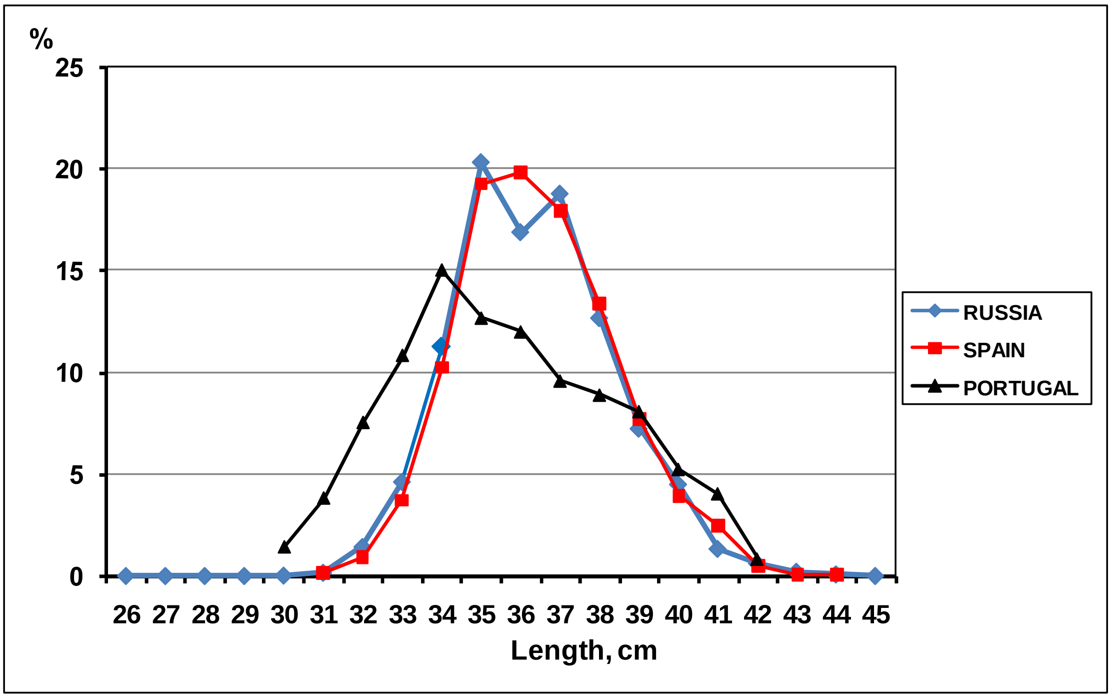


Figure 6.8. Length-distributions of the commercial pelagic catches in the Norwegian Sea outside EEZ in ICES Sub-area IIa by those countries providing length data from their pelagic fisheries in 2008.

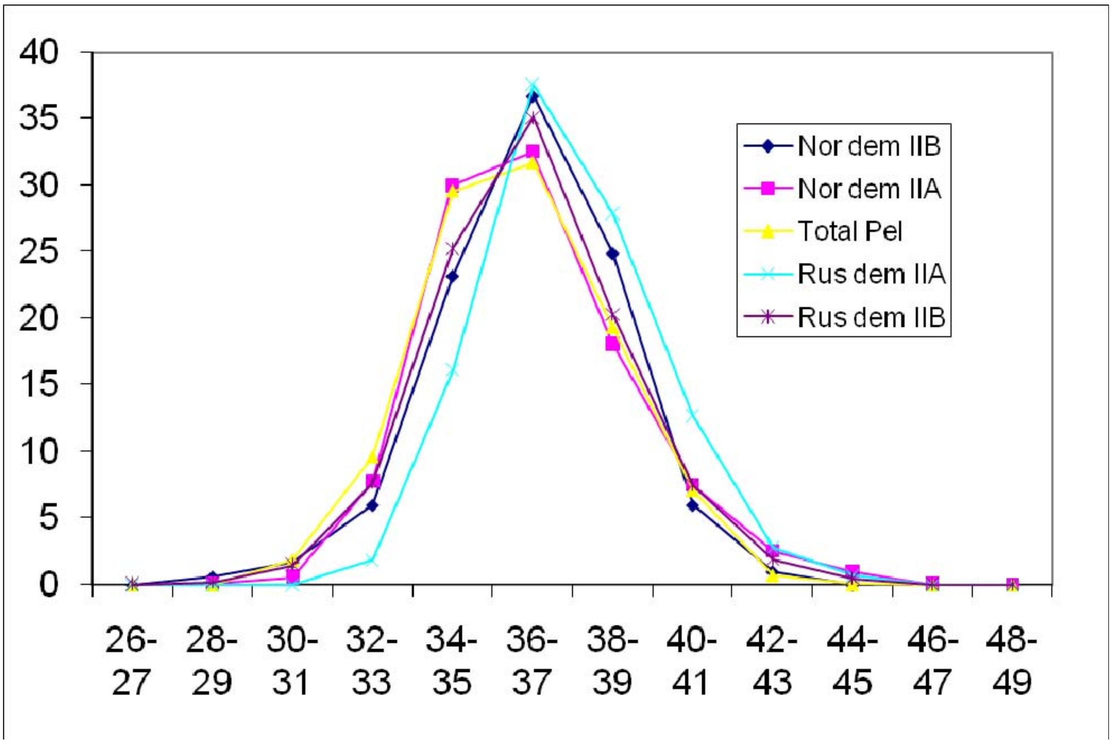


Figure 6.9. Length-distributions of the commercial demersal catches inside EEZ in ICES Sub-areas IIa and IIb by those countries providing length data from their demersal by-catches of *S. mentella* in 2007. The combined international length distribution from the pelagic fishery in international waters is shown for comparison.

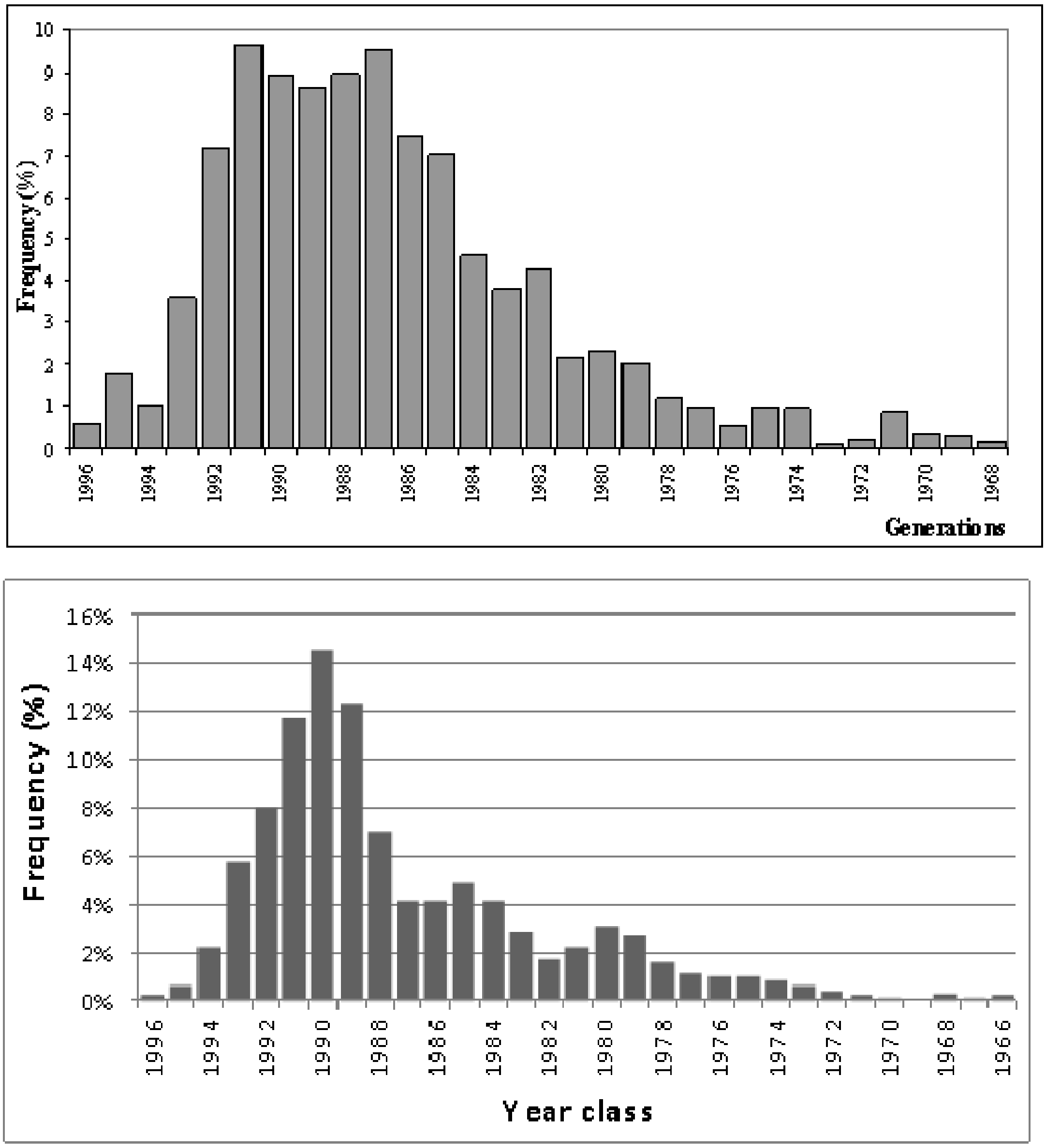


Figure 6.10. ***Sebastes mentella*** **in Sub-areas I and II. Age distributions of the (top) Polish and (bottom) Norwegian catches of pelagic *S. mentella* in the Norwegian Sea (Sub-area II) outside EEZ in 2007.**

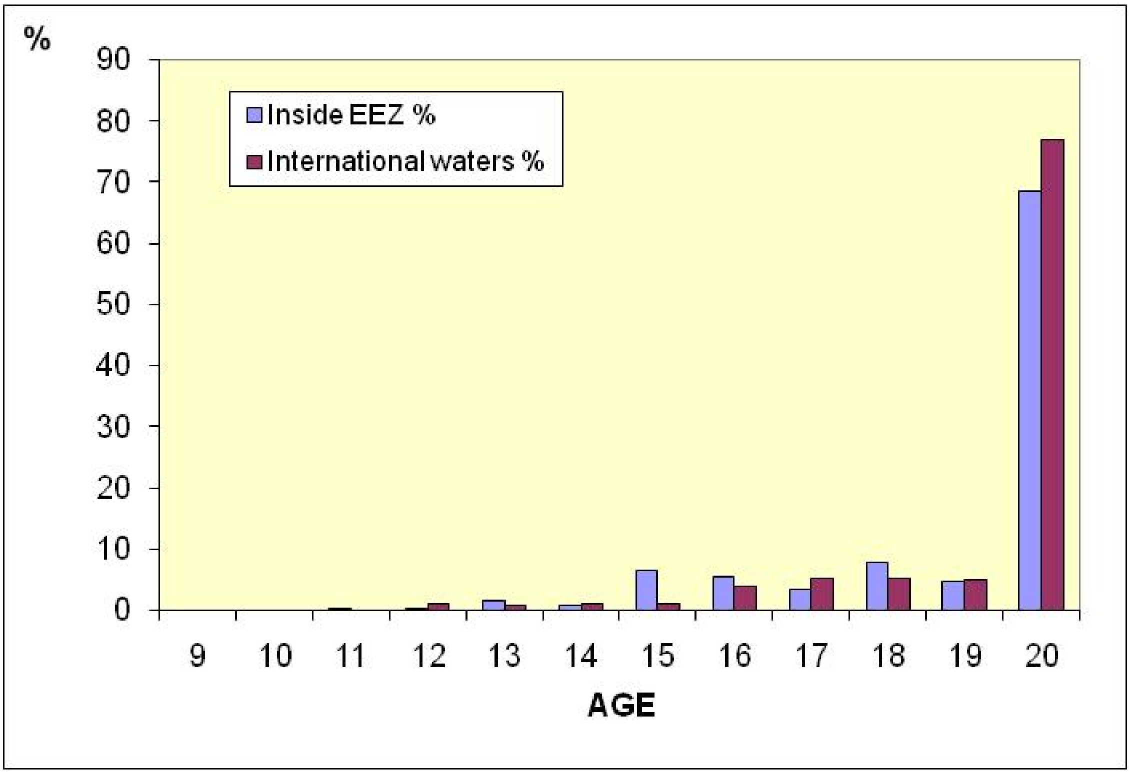


Figure 6.11. Age distributions of the Sebastes mentella caught as bycatch inside the economic zone (EEZ) (demersal) and outside in international waters (pelagic olympic fishery) as shown by the age distribution of the Norwegian catches in 2008.

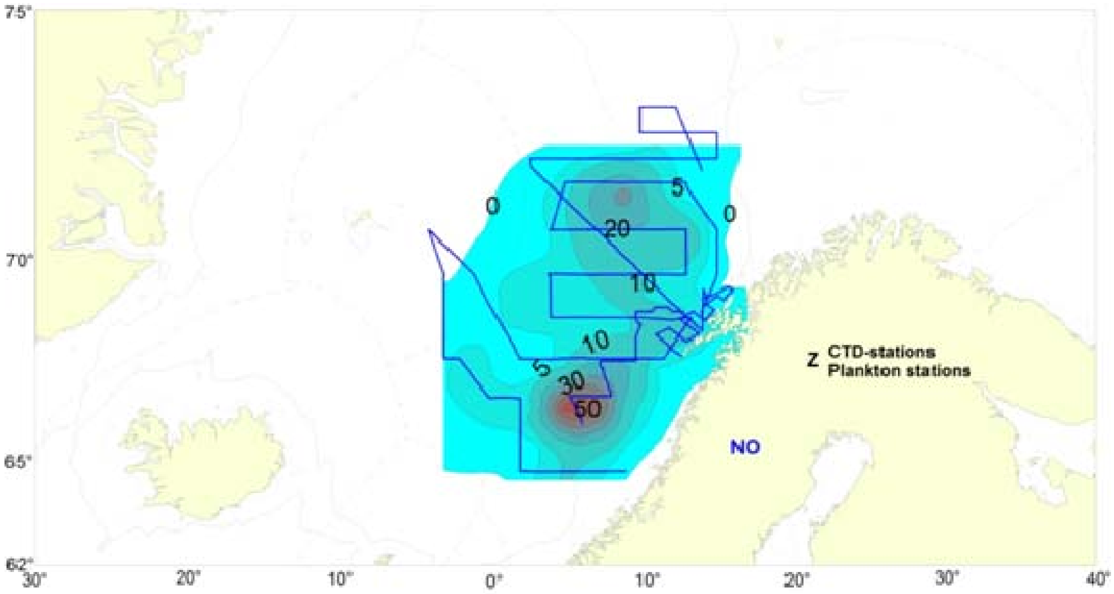


Figure 6.12. Acoustic registration (expressed in s_A-values, m^2/NM^2) of *Sebastes* species during the Norwegian PGNAPES survey with RV "G.O.Sars" in May 2008.

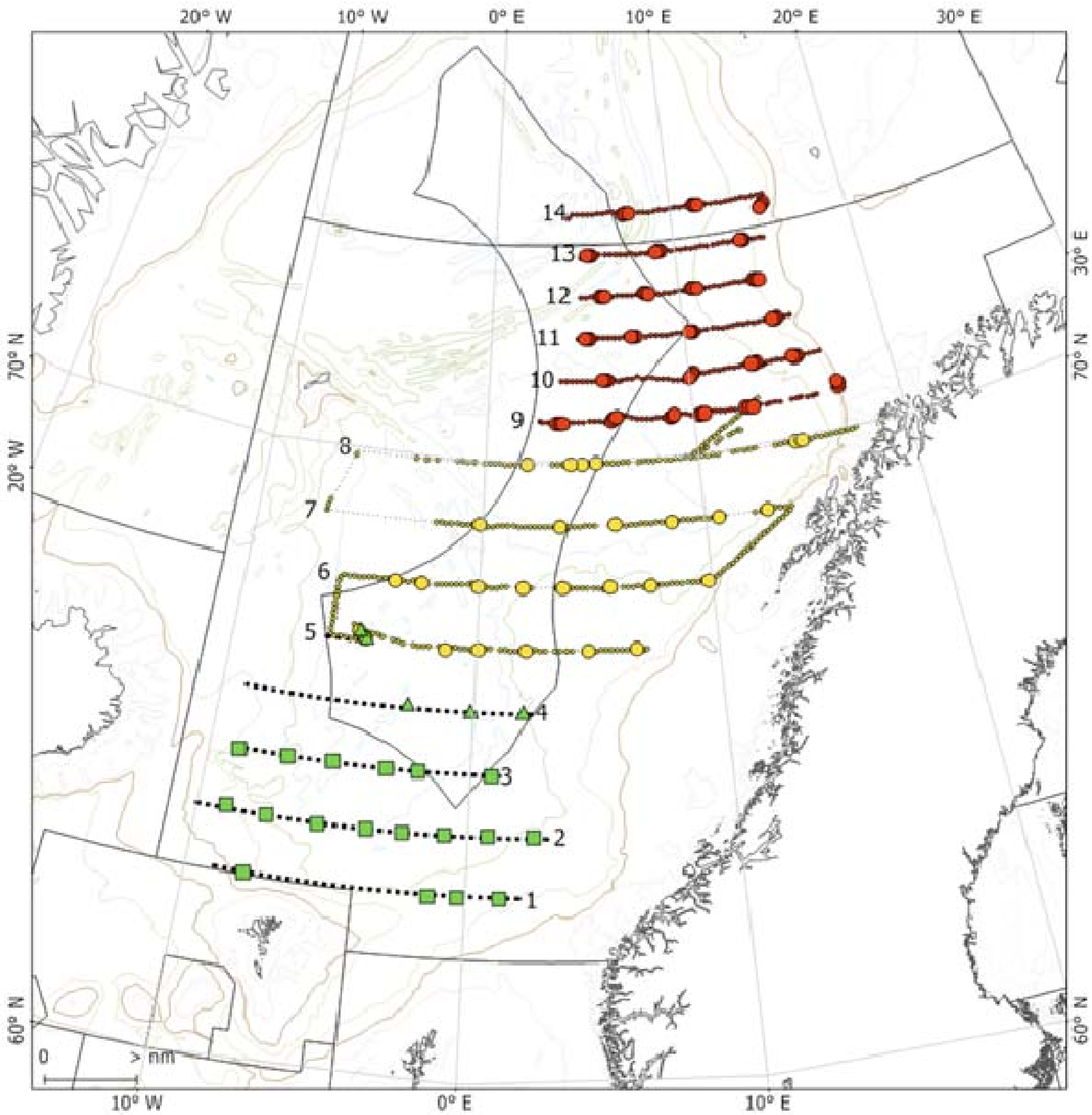


Figure. 6.13. Geographical extent and sampling activity during the *S. mentella* survey in August 2008. Small dots show the location of 5 nm sections retained for acoustic scrutinizing. Lager dots indicate the location of biological sampling (trawling) for Norway (red), Russia (yellow) and the Faroe Islands (green). Circles: Trawl Gloria 2048, triangle: Trawl Gloria 4096, squares: Trawl Red Lion. The acoustic data for the Faroese part is not available at the time of the report; acoustics tracks are thus shown as dotted lines.

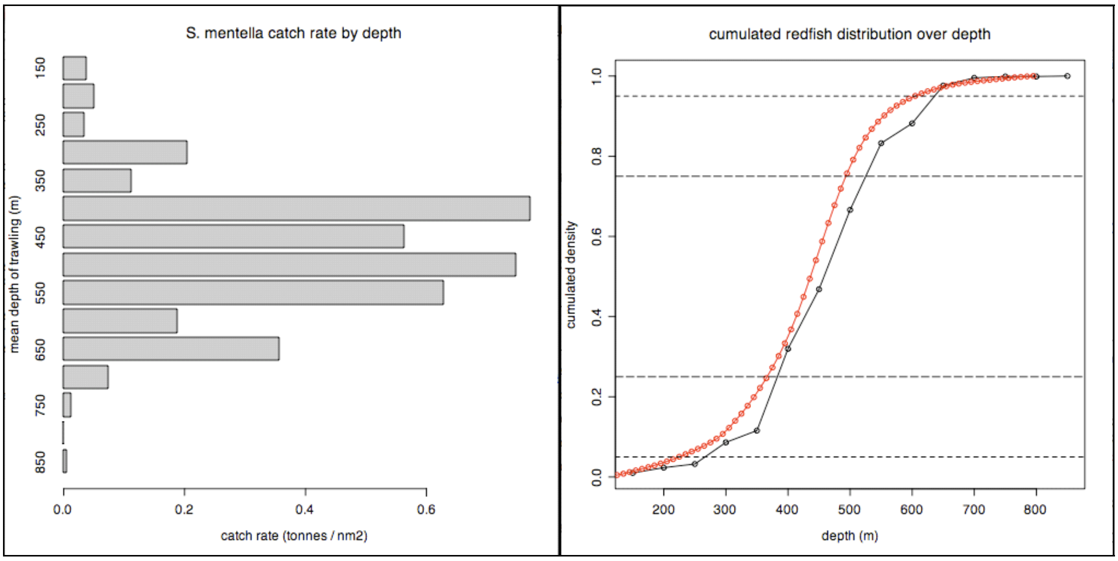


Figure 6.14 Left: Vertical distribution of catch rates. Right: cumulated density distribution of catch rates (black) and area backscattering coefficient (s_A, red) as a function of depth. Dotted lines in-di-cate the 5 and 95% probability levels. Dashed lines indicate the 25% and 75% probability levels. Data are from the northern part of the survey only (F/T Atlantic Star).

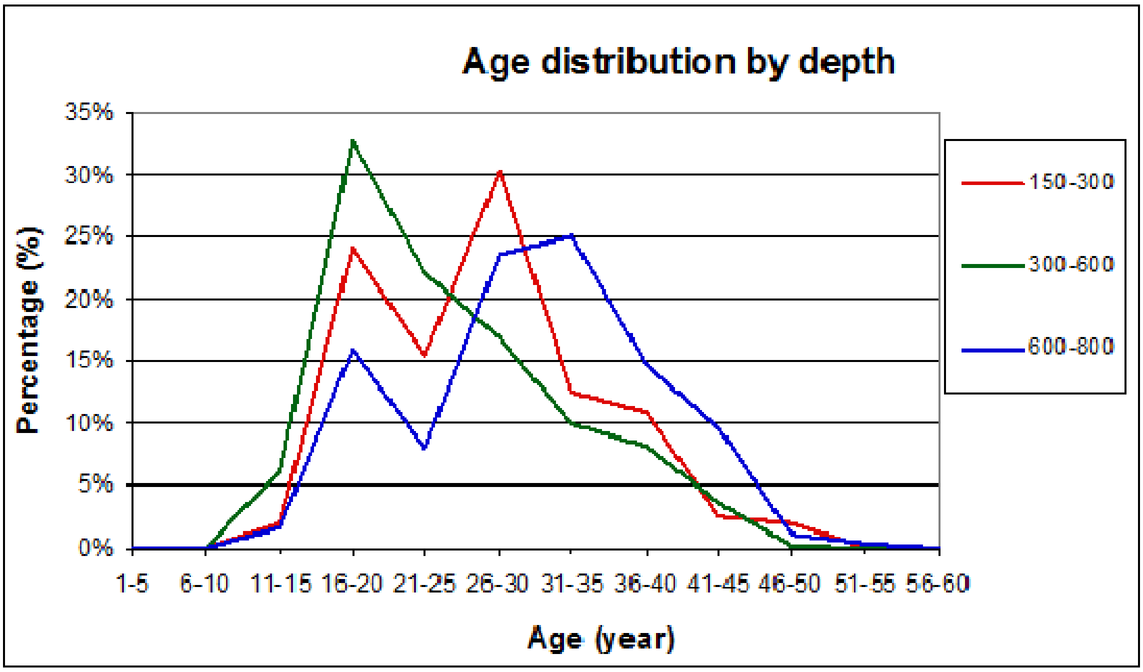


Figure 6.15 Body length distributions of *S. mentella* for three depth layers: layer 150–300 m (red), 300–600 m (green) and 600–800 m (blue).

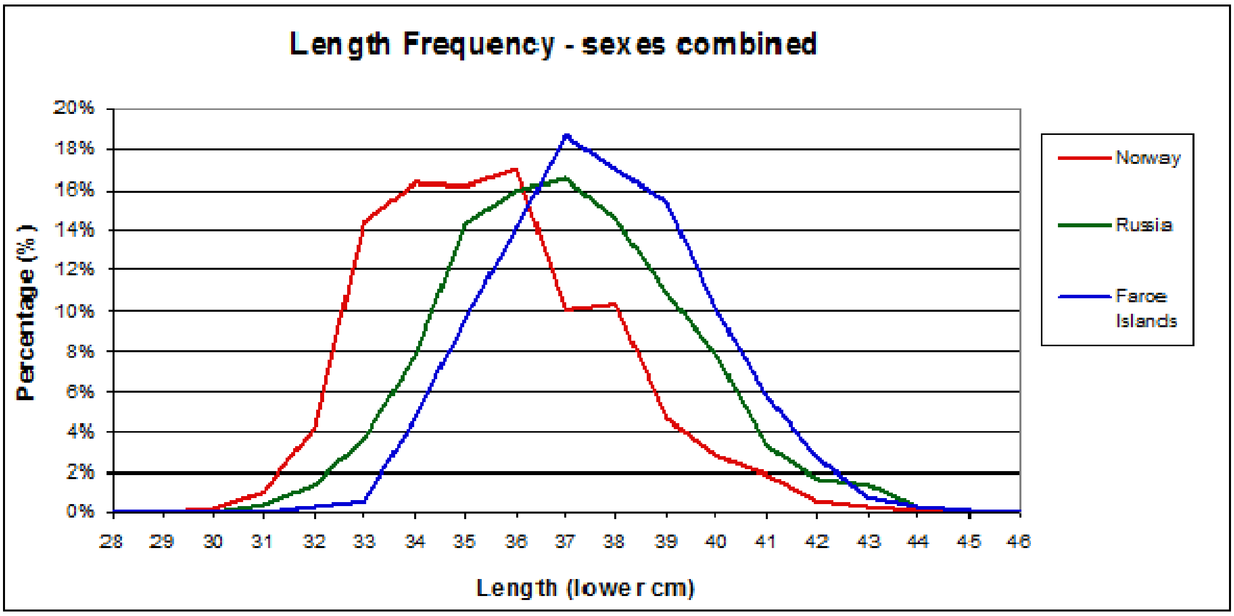


Figure 6.16 Body length distribution of *S. mentella* for the Norwegian (red), Russian (green) and Faroese (blue) parts of the survey.

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	-	-	111[3]	46	436	34	3	5	-	23,071	5	186	4,738	91	**Estonia**	239[6]	28,965
2002	-	-	135[3]	89	141	49	44	4	-	10,713	8[3]	276	4,736	193[2]	15	234[6]	16,637
2003	**Swed**	-	173[3]	31	154	44[3]	9	5[3]	89	8,063	7	50	1,431	47[2]	-	258[6]	10,361
2004	1	-	607	17[3]	78	24[3]	40	3	33	7,608[1,2]	42	240	3,601[2]	260[2]	-	146[6]	12,699
2005	**Can**	**Lith**	1,194	56	106	75[3]	12[2]	4[3]	55[2]	7,844[1,2]	-	196	5,637	171[3]	5	147[6]	15,501
2006	433	845	3,919	223	2,518	107[3]	2,544[3]	12[3]	21	10,945[2]	2,476[2]	1,873	12,126	719[2]	396	1,064[6]	40,243
2007	**Latv**	785	2,343	249	587	84[3]	1,647[2]	7[3]	20	8,954[2]	1,081[2]	1,708	6,550	2,186[2]	684	257[6]	27,142
2008[1]	130	398	1,956[3]	179	46	74[3]	26[3]	2[3]	15	7,341	8	785	7,866	1,183[2]	-	151[6]	20,160

[1] Provisional figures.

[2] Working Group figure.

[3] As reported to Norwegian authorities or NEAFC.

[4] Includes former GDR prior to 1991.

[5] USSR prior to 1991.

6 UK(E&W)+UK(Scot.)

Table D2. REDFISH in Sub-area IV (North Sea). Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment.

Year	Belgium	Denmark	Faroe Islands	France	Germany	Ireland	Netherlands	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	370	4	21	1,113	-	68	681	2,868
1999	3	52	1	-	58	39	16	862	-	67	465	1,563
2000	5	41	-	224	19	28	19	443	-	132	486	1,397
2001	4	96	-	272	13	19	+	421	-	80	458	1,363
2002	2	40	2	98	11	7	+	241	-		524[3]	925
2003	1	71	2	26	2	-	-	474	-	Portugal	463[3]	1,071
2004	+	42	3	26	1	-	-	287	-	-	214[3]	578
2005	2	34	-	10	1	-	-	84	-	-	28[3]	159
2006	1	49	1	12	3	-	-	155	-	33	79[3]	333
2007[1]	+	27	-	8	1	-	-	107	+	-	78[3]	221
2008[1]	+	3	-	35	1	-	-	77	+	-	54[3]	170

[1] Provisional figures.

[2] Working Group figure.

[3] UK(E/W/)+UK(Scotl)

+ less than 0.5 ton.

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	-
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	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
1975	-	7.4	-	1.7	6.4	2.4	3.5	5	-	-	4	-
1976	7	-	8.1	1.2	2.5	6.8	4.9	5	1	13	-	-
1977	-	0.2	0.2	0.2	0.9	5.1	3.7	1	19	2	-	-
1978	0.8	0.02	0.9	1	5	3.8	2	20	6	-	-	-
1979	-	1.9	1.4	3.6	2.3	9	11	16	1	-	-	0.1
1980	0.3	0.4	2	2.5	16	6	11	25	2	-	1.5	2
1981	-	2.2	3.9	20	6	12	47	18	6.3	1.6	0.5	1
1982	19.8	13.2	13	15	34	44	39	32.6	4.3	3.1	4.9	+
1983	12.5	3	5	6	31	34	32.3	13.3	4	4.2	0.6	1.1
1984	-	10	2	-	5	18.3	19	2.2	2.4	0.2	1.7	2.4
1985	107	7	-	1	5.2	16.2	1.7	1.7	0.6	2.8	3.8	0.3
1986	2	-	1	1.8	8.4	3.6	2.1	1.2	5.6	8.2	0.9	0.7
1987	-	3	37.9	1.3	8	4.1	2	10.6	9.6	1.4	2	1.3
1988	4	58.1	4.3	13.3	25.8	3.9	8.6	11.2	2.8	4.2	3	4.7
1989	8.7	9	17	23.4	4.6	5.4	4	6.6	6.6	4.1	7.7	5.3
1990	2.5	6.3	6.1	1	4.3	1.7	11.5	6.5	5.5	6.7	7.4	3.6
1991	0.3	1	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	2.3	4.9	2.3	1	4.1
1993[1]	-	+	1.5	1.8	1	1.2	3	4.2	2.6	2	3.2	2.1
1994	0.3	3.5	1.7	1.7	0.9	3.6	5.2	4.3	3.1	3.3	1.8	1.2
1995	2.8	1	1.1	0.4	2.2	2.6	3.5	3.4	2.9	1.2	1	8.5
1996[2]	+	0.1	0.1	0.4	0.7	1.1	1	1.4	1	0.8	3.7	0.6
1997	-	-	+	0.4	0.5	0.3	0.9	0.6	1	1.1	0.5	0.4
1998	-	0.1	0.2	0.3	0.2	1.1	0.5	0.7	1	0.4	0.4	
1999	0.1	-	0.1	+	0.1	0.3	0.5	0.8	0.5	0.2		
2000	-	0.6	0.1	0.5	0.3	0.3	0.6	0.4	0.1			
2001	-	0.1	0.4	-	0.1	0.2	0.2	0.3				
2002[3]	0.1	0.5	0.1	-	-	0.1	0.5					
2003	-	-	0.1	-	0.3	1.0						
2004	-	0.2	0.3	0.5	1.5							
2005	-	-	1.4	1.9								
2006[4]	0.1	1.8	1.2									
2007	2.5	0.4										
2008	0.1											

[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 onl
[4] - Area surveyed restricted to Division IIa and 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 1986-20068 (numbers in millions).

	Length group (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1986[2]	6	101	192	17	10	5	2	4	+	338
1987[2]	20	14	140	19	6	2	1	2	+	208
1988[2]	33	23	82	77	7	3	2	2	+	228
1989	566	225	24	72	17	2	2	8	4	921
1990	184	820	59	65	111	23	15	7	3	1,287
1991	1,533	1,426	563	55	138	38	30	7	1	3,791
1992	149	446	268	43	22	15	4	7	4	958
1993	9	320	272	89	16	13	3	1	+	722
1994	4	284	613	242	10	9	2	2	1	1,165
1995	33	33	417	349	77	18	5	1	+	933
1996	56	69	139	310	97	8	4	1	1	685
1997	3	44	13	65	57	9	5	+	+	195
1998	+	37	35	28	132	73	45	2	+	353
1999	4	3	121	62	259	169	42	1	0	661
2000	+	10	31	59	126	143	21	1	0	391
2001	1	5	3	32	57	228	50	3	0	378
2002	1	4	6	21	62	266	47	4	+	410
2003	1	5	7	11	56	271	50	1	0	403
2004	0	2	7	6	14	78	53	2	0	163
2005	1	1	6	11	19	93	63	1	0	196
2006	82	6	5	7	49	211	101	3	0	463
2007	98	68	1	5	11	95	109	3	0	387
2008	119	45	20	3	9	25	79	4	0	303

[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 1992-2006 (numbers in millions).

	Age														
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	283	419	484	131	58	45	14	8	5	2	7	2	1	3	1,462
1993	2	527	117	202	142	8	23	6	13	1	7	1	1	+	1,050
1994	7	280	290	202	235	42	94	1	1	3	4	1	1	+	1,161
1995	4	50	365	237	132	61	19	17	11	+	1	3	0	0	900
1996	23	47	15	37	105	144	84	17	51	32	34	9	6	2	605
1997	8	43	6	6	40	20	30	25	7	3	1	2	2	1	194
1998	+	26	28	14	10	13	69	66	49	15	1	6	15	5	317
1999	3	16	114	27	36	53	117	78	67	41	45	11	19	13	640
2000	4	6	6	14	35	22	31	54	81	60	24	24	10	8	379
2001	2	4	3	1	9	16	22	30	34	57	57	50	54	6	344
2002	3	2	4	2	5	22	34	23	88	36	62	64	15	21	379
2003	0.3	3	4	3	5	4	29	31	50	59	45	70	38	23	365
2004	1	1	3	3	1	4	2	9	9	18	15	17	19	9	113
2005	1	1	2	3	3	6	9	15	14	16	14	21	22	25	152
2006	33	1	3	3	2	9	17	27	24	35	29	45	25	34	287
2007	23	45	0	0	3	2	5	5	8	5	5	9	29	19	158
2008	6	22	22	12	1	2	2	5	4	4	3	5	10	6	102

[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 1986-2007 (numbers in millions). The area coverage was extended from 1993 onwards.**

	Length group (cm)									
Year	5.0-9.9	10.0-	15.0-	20.0-	25.0-	30.0-	35.0-	40.0-	>45.0	Total
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	950.2
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	432.9
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1068.2
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	961.0
1990	323.6	304.5	36.4	55.9	80.2	12.9	12.5	1.5	0.2	827.7
1991	395.2	448.8	86.2	38.9	95.6	34.8	24.3	2.5	0.2	1126.5
1992	139.0	366.5	227.1	34.6	55.2	34.4	7.5	1.8	0.5	866.6
1993	30.8	592.7	320.2	116.3	24.2	25.0	6.3	1.0	+	1116.5
1994	6.9	258.6	289.4	284.3	51.4	69.8	19.9	1.4	0.1	981.8
1995	263.7	71.4	637.8	505.8	90.8	68.8	31.3	3.9	0.5	1674.0
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1036.6
1997[2]	62.8	121.1	24.7	277.9	274.4	72.3	40.7	5.1	0.2	879.0
1998[2]	1.3	90.6	62.8	100.8	203.1	40.7	13.0	1.7	0.2	514.0
1999	2.2	6.8	67.6	36.8	167.4	71.9	21.0	3.1	0.1	376.8
2000	9.0	12.9	39.3	76.8	141.9	97.2	26.6	6.9	1.5	412.1
2001	9.3	22.5	7.0	54.9	77.4	73.2	9.4	0.6	0.1	254.2
2002	16.1	7.2	19.1	41.7	103.9	113.7	22.9	1.4	+	326.0
2003	3.9	3.9	10.0	12.4	70.8	199.8	46.9	6.0	0.3	354.0
2004	2.2	3.0	6.9	18.5	32.9	86.7	31.8	2.0	0.1	184.1
2005	+	6.3	7.3	10.7	28.4	153.4	86.6	3.9	0.2	296.8
2006	98.8	1.9	9.8	14.6	22.7	102.8	81.9	2.7	0.7	336.0
2007	445.8	125.1	2.5	6.5	12.0	118.9	119.6	7.4	0.2	837.9
2008	846.0	353.6	26.2	5.3	11.9	114.0	179.9	4.9	0.1	1541.9

[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 1992-2007 (numbers in millions). The area coverage was extended from 1993 onwards.**

														Age
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	351	252	132	56	14	11	3	9	18	16	12	11	2	5	892
1993	38	473	192	242	62	45	19	22	13	11	10	4	2	3	1,136
1994	7	85	332	189	370	228	73	42	3	30	8	14	25	7	1,413
1995	308	45	146	264	364	211	69	23	7	17	23	9	11	10	1,507
1996	173	119	109	114	128	122	106	64	24	19	12	7	8	4	1,009
1997[2]	43	101	19	54	96	43	44	171	76	74	39	29	10	9	808
1998[2]	1	73	49	27	13	52	107	104	41	18	7	4	3	3	502
1999	1	+	32	43	30	24	30	81	79	28	2	1	6	+	357
2000	9	12	21	17	9	39	77	73	50	41	14	10	7	6	385
2001	1	17	8	1	7	22	39	30	34	23	24	17	9	3	236
2002	18	4	12	7	4	14	49	55	27	19	34	24	28	11	306
2003	0	2	2	4	6	6	14	39	24	34	39	65	46	20	301
2004	0	2	3	1	9	12	15	20	36	8	28	3	25	12	172
2005	0	4	3	3	6	6	11	15	23	14	21	40	35	49	229
2006	4	1	5	5	5	8	15	12	6	15	21	17	32	36	180
2007	428	82	13	1	2	2	5	7	8	8	21	20	31	35	144
2008	648	173	107	11	0	2	5	7	5	10	10	28	27	40	1073

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 1996-2007 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (numbers in thousands) and the continental slope down to 1500 m.**

Year	Age														
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+	Total
1996	146198	112742	22353	53507	165531	181980	108738	43328	65310	40546	38254	19843	29446	10931	17414	1366761
1997	62682	130816	12492	23452	74342	55880	76607	82503	17640	14274	675	2238	1723	633	8765	587223
1998	313	78767	85715	39849	25805	23413	84825	100332	54287	24329	11334	7457	15250	576	25212	577670
1999	5359	23240	117170	47851	41608	76797	128677	73306	58018	64781	49890	13565	18458	12171	24672	755562
2000	5964	23169	14336	19960	52666	68081	83857	77513	100442	72294	71148	36599	17183	20590	26501	690837
2001	5026	6541	10957	1093	19766	25591	36594	51644	44407	61704	50083	86122	53952	15699	31877	507131
2002	9112	6646	7379	3821	8635	28215	47456	63903	103368	49964	76133	71970	25241	36765	34957	573565
2003	3954	7394	6142	3540	8030	9388	48564	59051	98554	69901	83192	73521	69970	37162	47323	625687
2004	9068	10837	9008	7292	2510	7896	8193	15268	25544	29654	35249	21142	39581	25976	66792	314030
2005	1310	4406	5241	5031	5722	8740	13452	20672	16207	19353	17430	32028	37564	34815	57103	279072
2006	156578	5162	6695	5217	3768	10754	18771	29174	25278	38958	31869	46885	30895	44299	147951	602255
2007	302988	224153	290	7686	11346	2031	7903	10770	12182	6578	6367	9998	41425	22090	211178	876986
2008	86880	183796	121430	21430	4178	3009	3334	6991	5120	4441	3581	6008	10352	10172	99808	1024894

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 10⁶	Biomass t 10³	SSN 10⁶	SSB t 10³	in n.m.²
1992	April	29	27	27	37	36	50	78	39	34	40	44	43	28	17	13	4	7	3	566	218	191	114	25300
1993	April	31	15	13	6	6	20	56	56	38	28	29	27	19	12	7	3	1	2	396	150	151	90	23500
1994													No Data											
1995	May	+	32	51	83	90	41	31	31	41	94	73	48	30	10	9	4	1	+	669	202	211	102	23300
1996													No Data											
1997	Apr-May	86	6	24	102	150	53	48	24	20	26	36	28	11	9	4	2	1	+	630	170	111	58	22400
1998	April	1	+	8	47	77	63	71	46	27	19	23	23	25	6	3	2	1	+	442	153	106	57	22931
1999	Apr-May	11	1	9	14	57	75	63	73	31	25	17	15	11	8	3	1	1	1	415	134	120	55	19333
2000	Apr-May	2	2	14	15	62	100	143	122	54	34	24	29	12	11	7	2	1	1	635	208	114	53	22000
2001	Apr-May	11	1	11	22	24	84	123	134	144	115	78	40	27	19	10	4	+	3	850	316	339	152	23000
2002													No Data											
2003													No Data											
2004													No Data											
2005													No Data											
2006													No Data											
2007													No Data											
2008													No Data											

Table D8. Sebastes mentella in Sub-areas I and II. Maturity ogives from Russian research vessels. Sexes combined. Data collected during April-June in the Kopytov area (western Barents Sea) and adjacent waters.

Age	1988	1989	1990	1991	1992	1993	1995	1997	1998	1999	2000	2001
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.021	0.000	0.000	0.000
8	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.000	0.014	0.016	0.000	0.000
9	0.000	0.000	0.012	0.139	0.013	0.033	0.000	0.027	0.000	0.059	0.048	0.082
10	0.028	0.074	0.131	0.174	0.092	0.133	0.055	0.130	0.074	0.110	0.087	0.196
11	0.125	0.178	0.300	0.138	0.169	0.364	0.111	0.312	0.171	0.333	0.202	0.405
12	0.297	0.473	0.688	0.358	0.396	0.480	0.368	0.281	0.276	0.579	0.375	0.442
13	0.562	0.684	0.714	0.470	0.452	0.696	0.587	0.566	0.622	0.689	0.489	0.442
14	0.760	0.716	0.824	0.637	0.761	0.925	0.696	0.736	0.714	0.788	0.742	0.648
15	0.855	0.794	0.848	0.762	0.939	0.962	0.729	0.831	0.871	0.813	0.833	0.775
16	1.000	1.000	1.000	1.000	0.886	0.953	0.789	0.958	0.919	0.903	0.904	0.865
17	1.000	1.000	1.000	1.000	1.000	0.977	1.000	0.950	1.000	0.923	1.000	0.909
18	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

7 Golden redfish *(Sebastes marinus)* in Subareas 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. The Handbook has been updated in 2009 (see Annex in this report).

Until 1 January 2003 there were no regulations particularly for the *S. marinus* fishery, and the regulations aimed at *S. mentella* (see chapter 6.1.1) had only marginal effects on the *S. marinus* stock. After this date, all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) outside the permanently closed areas have been forbidden in the Norwegian Economic Zone north of 62°N and in the Svalbard area. When fishing for other species it is currently legal to have up to 15% redfish (both species together) in round weight as bycatch per haul and on board at any time. Until 14 April 2004 there were no regulations of the other gears/fleets fishing for *S. marinus*. After this date, a minimum legal catch size of 32 cm has been set for all fisheries, with the allowance to have up to 10% undersized (i.e., less than 32 cm) specimens of *S.marinus* (in numbers) per haul. In addition, a limited moratorium has been enforced in the conventional fisheries (gillnet, longline, handline, Danish seine). Since 2007 this moratorium has been during 5 months, i.e., March-June and September, a change from April-May and September in 2006, 20 April-19 June in 2005 and 1-31 May in 2004. When fishing for other species (also during the moratorium) it is allowed to have up to 15% bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday.

7.1.2 Landings prior to 2009 (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 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 total landings figures for *S. marinus* in 2003-2007 have been remarkable stable between 7,000-7,800 t, the lowest since the mid-1940ies. Provisional figures for 2008 indicate a further decline in landings down to 6,300 t. No significant changes in landings can be observed in area IIa. The time series of *S. marinus* landings is given in Figure 7.1 and shows a long-term (1908-2008) mean of 16,835 t.

The Norwegian landings are presented by gear and month in Figure 7.2. Reported landings have diminished in 2008 for all gears except gillnet. Since 2003 the limited moratorium for conventional gears seems to have reduced the catches taken by these gears from about 5,900 t to about 3,200 t in 2007, but this trend has halted due to the increase in gillnet bycatches in 2008. For all other fishing gear, bycatches in 2008 are the lowest observed for the period 2003-2008.

For 2004 and 2005, the AFWG received catch data from Russia on *S. marinus* caught as bycatch in the pelagic trawl fishery for herring and blue whiting in the Norwegian Sea. Of a total reported Russian catch of 722 tonnes in 2004, 117 tonnes were caught as bycatch in these fisheries. In 2005 this pelagic catch decreased to 15 tonnes of a total of 614 tonnes. In 2007 and 2008 Russia reported a catch of *S. marinus* of 890 t and 749 t respectively (Table 7.1)

The bycatch estimates of redfish (*Sebastes* spp.) in the Norwegian Barents Sea shrimp fisheries during 1983-2002 are completely dominated by *S. mentella*, and hence will influence the *S. marinus* to a much lesser extent. However, it probably inflicted an extra mortality on *S. marinus* in the coastal areas before the sorting grid was enforced in 1990. From 1 January 2006, the maximum authorised bycatch of redfish juveniles in the international shrimp fisheries in the northeast Arctic has been reduced from ten to three redfish per 10 kg shrimp.

Information describing the splitting of the redfish landings by species and area is given in the Quality handbook.

7.1.3 Expected landings in 2009

In 2008, total Norwegian catch (5,111 t, provisional figure) and total Russian catch (749 t) are close to the values expected in the previous year. Under similar assumptions (reports from the first months of the year, a legal by-catch of 15% in all trawl fisheries, and an assumed effect of the regulations for the other gears) the Norwegian and Russian landings in 2009 are expected to be similar to those reported in 2008.

7.2 Data Used in the Assessment (Figure D1)

The sampling levels are presented in Figure D1.

7.2.1 Catch-per-unit-effort (Table D11, Figure 7.3)

The CPUE-series for *S. marinus* from Norwegian 32-50 meter freezer trawlers and Factory trawlers (>53m) is presented from 1992 onwards (Table D11, Figure 7.3). 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. Provisional figures for 2006-2008 indicate an important reduction in the effort of freezer trawlers since 2006 in comparison with the previous decade. The effort of factory trawlers has remained stable around 150 days since 2003.

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* (Figure 7.3). During 2001-2005 both the catch-rates and the number of vessel-days were rapidly decreasing, and this is worrying since the criterion for defining it to be a *S. marinus* vessel-day have not been more than 20% (since 2003) or 15% (since 2004) *S. marinus* in each trawl haul. Since 2005 a slight improvements of the catch-rates are seen for both trawler fleets, but it is worrying that the number of vessel days containing a minimum of 10% redfish still are decreasing in one of the fleets. With some variation, the average annual catch-rates for the freezer trawlers have decreased from an average level of 350 kg/trawl hour during mid 1990ies to about 150 kg/h since 2003, i.e., less than 40% of the former recent level. Corresponding values for the factory trawlers are 600 kg/trawl until 2001 and about 200-300 kg/h since 2002. The decrease seems though to have halted for both fleets.

7.2.2 Catch at age (Table 7.5b)

Catch at age data for 2004-2006 were revised. Age composition data for 2007 were only provided by Norway, accounting for 80% of the total landings. Russian catch-at-length from each Sub-area were converted to catch-at-age by using the Norwegian age-length keys in Subarea I, Divisions IIa (northern part) and IIb, respectively. Other countries were assumed to have the same relative age distribution and mean weight as Norway. The updated catch-in-numbers at age matrix is shown in Table 7.5.

7.2.3 Weight at Age (Table 7.6)

Weight-at-age data for ages 7–24+ were available from the Norwegian landings in 2007. Variations in the weight-at-age of young individuals (<10y) must be considered with caution as these numbers are derived from only a small number of aged individuals.

7.2.4 Maturity at age (Figure 7.7)

A maturity ogive has previously not been available for *S. marinus,* and knife-edge maturity at age 15 (age 15 as 100% mature) has hence been assumed. An improved maturity ogive modelled by the Gadget model, and based on maturation data (by length and age) collected from Norwegian surveys and landings, is presented (Figure 7.7). This analysis shows that 50% of the fish are mature at age 12.

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 (Division IIa) bottom trawl survey (February) from 1986–2009 (joint with Russia 2000-2006) in fishing depths of 100–500 m. Length compositions for the years 1986–2009 are shown in Table D12a and Fig 7.4a. Age compositions for the years 1992–2008 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 1985–2007 in fishing depths of 100–500 m (depths down to 800 m incl. in the swept area). Length compositions for the years 1985–2008 and age compositions for the years 1992–2008 are shown in Table D13a and D13b, respectively. This survey covers the northernmost part of the species' distribution.

3) Data on length and age from both these surveys have been combined and are shown in Figures 7.5a,b.

4) Age disaggregated catch rates (numbers/nm^2 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 1995-2007 from Finnmark to Møre (Table D14). The series was updated from last year's assessment for 2008. Observations in 2008 indicate maximum catch rates for the 40-44 cm length group, as in 2006 and 2007.

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 but declined to lower levels afterwards. Abundance of pre-recruits

(<25cm) has steadily decreased since 1986 and has remained at very low levels since 2000. Observation from the Barents Sea survey in winter 2008 suggested an increase in abundance of the smallest group (5-14 cm). However, there remain some uncertainty in the species identification for individuals of small size and the group suggested in 2008 that these results should be interpreted with great caution. The return to low survey indices for small size individuals in 2009 (Fig 7.4a) did not confirm this increase.

Results from the Norwegian Coastal and Fjord survey confirm poor recruitment up to 2008 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 with the GADGET model

Description of the model

Since AFWG2005, experimental analytical assessments have been conducted on this stock using GADGET, and results presented for the years 1990 – last year.

The GADGET model used for the assessment of *S. marinus* in areas I and II is closely related to the GADGET 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 and data used for tuning, is described in Bogstad et al. (2004b) and in the latest Quailty Handbook for *S. marinus* (2009).

Data used for tuning

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 Barents Sea (Division IIa) bottom trawl survey (February) from 1990–2009 (Table D12a).

Age-length keys and age disaggregated survey indices from the same survey up to 2008 (Table D12b).

Length disaggregated catch rates (numbers/nautical mile) of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2008 from Finnmark to Møre (Division IIa) (Table D14).

Changes made to the model and in input data compared with last year's Working Group

Model configuration and settings are identical to that of 2008. Commercial catch data have been revised for years 2007 and updated with year 2008. The proportion at mature data for 2008 showed unrealistically high proportions mature at ages 7-12, with the highest values for those ages over the entire time series. These data points were based on small numbers of fish, and have been treated as outliers and removed. While this analysis was being conducted ages 23 and 24 were also removed from 1998 (which showed unrealistically low maturity percentages from a very small sample). It was also decided to remove the years 1990-1992 from the tuning data, as maturity ogive implied by the data in these years could not be reconciled with that from later years of data.

Assessment results using the Gadget model

The text table below compares the results from this year's Gadget model with the three previous year's.

	Total stock (3+) by 1 January 1990 (tons)	Mean weight in stock 1990 (kg)	SSB (15+) by 1 January 1990[1] (tons)	Total stock (3+) by 1 January 2003 (tons)	Mean weight in stock 2003 (kg)	SSB (15+) by 1 January 2003[1] (tons)
WG 2006	179 313	0.39	64 019	71 013	0.71	38 927
WG 2007	163 536	0.35	66 712	64 240	0.64	43 096
WG 2008	158 851	0.35	64 838	74 717	0.78	47 693
WG 2009	149 763	0.34	66 153	73 673	0.77	51 683

1) Since WG2007 based on modeled maturation and not 15+.

The general patterns in the stock dynamics of *S. marinus* are very similar to those modelled in 2008. The addition of the most recent data has however resulted in a slight decrease (few percents) in the abundance and biomass estimates in the early part of the time. The most important conclusions to be drawn from the current assessment using the Gadget model are:

- The recruitment to the stock is very poor (Figure 7.9) but increasing, although estimated abundance for new year classes are highly uncertain.
- The estimated fishing mortality has declined since 1990 and increased again since 2005. The current mortality is estimated around 0.15 (Figure 7.8).
- According to the model the total stock biomass (3+) of *S. marinus* has decreased from about 150.000 tonnes in 1992-1993 to less than 44.000 tonnes in 2008 (Figure 7.10, Table 7.8).
- The spawning stock biomass of *S. marinus* has decreased from a maximum of about 70 thousand tonnes in 1996 to approximately 32 thousand tonnes in 2008 (-54%, Figure 7.10, Table 7.8). The spawning stock in numbers (SSN) is declining faster than spawning stock biomass (SSB) with a reduction of approximately 68% in the same period of time. This is primarily the result of low recruitment in the last 10-15 years.

7.4 State of the stock

Survey observations and Gadget assessment update confirm previous diagnostics that this stock is currently in a very poor situation. This situation is expected to remain for several years irrespective of current management actions. Year-classes recruit in the SSB at old age (~12 years) and surveys indicate failure of recruitment over a long period. There were some indications that new recruits (<15cm) may have entered the population in 2008 (Fig 7.4a) but this has not been confirmed by recent survey results, and may results from species misidentification rather than true increase in the number of pre-recruits.

The analytical assessment using the Gadget model confirms the poor stock situation, and quantifies the 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 and the model suggests that the declining trend in number and biomass is still going on. In order to turn this negative development, no directed fishery should be conducted on this stock until a clear increase in the number of juveniles has been detected in surveys, and an improved situation of the mature stock is confirmed by the assessment.

7.5 Comments on the Assessment

The current model assumes constant selectivity through time. It may be possible to extend this to allow for varying selectivity. The model may also be used for comparing modeled mean length at age with the actual data as a contribution to the age reading validation.

S. marinus is considered to be an easier species to age than *S. mentella*, and it is possible to follow year classes through the input survey data series. An annual updated database on catch-in-numbers at age and length, weight-at-age, and trawl survey indices both by length and age should be continued to be used in future assessment methods.

7.6 Biological reference points

Until an analytical assessment can be accepted and used as basis for reference points calculations for this stock, candidate reference points for the biomass could be set at the average biomass level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. ACFM is supporting this suggestions and states that U-type reference points could be developed provided that a sufficient long time series demonstrating a dynamic range is available. Also the reference point should be expressed in biomass units (SSB or fishable stock), and work has hence been initiated to present the survey time series also in biomass units (also as SSB and fishable stock).

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 mature biomass. A corresponding 5% harvest of this would yield not more than 1,600 t, which is well below the current landings and those expected for 2009 of around 6,000 t.

7.7 Management advice

AFWG 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 low recruitment. Despite the extended ban on the directed fishery by conventional gears from 3 months in 2006 to 5 months in 2007, the current measures are considered 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 thus 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 RGAFNW Technical Minutes

In 2008, RGAFNW did not comment on the assessment report for *S. marinus* because the advice was a re-conduction of the previous year advice. In earlier years, it was recommended that the group should consider use of more simple models e.g. SURBA. As for previous years, the working group is very positive about the proposal by the review group to investigate alternative assessment models but did not have the necessary resource to conduct such work inter-sessionaly. The group anticipate that such investigation can be carried out for the next benchmark assessment for *S. marinus*, possibly in 2012.

Table 7.1 ***Sebastes marinus*** **in Sub-areas I and II. 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
1989	3	796	412	-	-	-	-
1990	278	1,679	387	1	-	-	-
1991	152	706	981	-	-	-	-
1992	35	1,289	530	623	-	-	-
1993	139	871	650	14	-	-	-
1994	22	697	1,008	5	4	-	-
1995	27	732	517	5	1	1	1
1996	38	671	499	34	-	-	-
1997	3	974	457	23	-	5	-
1998	78	494	131	33	-	19	-
1999	35	35	228	47	14	7	-
2000	17	13	160	22	16	-	-
2001	37	30	238	17	-	1	-
2002	60	31	42	31	3	-	-
2003	109	8	122	36	4	-	89
2004	19	4	68	20	30	-	33
2005	47	10	72	36	8	-	48
2006	111	8	35	44	31	3	21
2007	146	15	67	55	68	1	20
2008[1]	123	49	30	49	16	-	2

Year	Norway	Portugal	Russia[3]	Spain	UK (Eng. & Wales)	UK (Scotl)	Total
1989	20,662	-	1,264	-	97	-	23,234
1990	23,917	-	1,549	-	261	-	28,072
1991	15,872	-	1.052	-	268	10	19,041
1992	12,700	5	758	2	241	2	16,185
1993	13,137	77	1,313	8	441	1	16,651
1994	14,955	90	1,199	4	135	1	18,120
1995	13,516	9	639	-	159	9	15,616
1996	15,622	55	716	81	229	98	18,043
1997	14,182	61	1,584	36	164	22	17,511
1998	16,540	6	1,632	51	118	53	19,155
1999	16,750	3	1,691	7	135	34	18,986
2000	13,032	16	1,112	-		73[4]	14,461
2001	9,134	7	963	1		119[4]	10,547
2002	8,561	34	832	3		46[4]	9,643
2003	6,853	6	479	-		134[4]	7,840
2004	6,233	5	722	3		69[4]	7,206
2005	6,085[1]	56	614	8		52[4]	7,037
2006	6,265[1]	69	713	9		39[4]	7,348
2007	5,759[1]	225	890	5		55[4]	7,306
2008[1]	5,111	72	749	4		70	6,300

[1] Provisional figures.

[2] Includes former GDR prior to 1991.

[3] USSR prior to 1991.

4UK(E&W)+UK(Scot.)

Table 7.2 *Sebastes marinus*. Nominal catch (t) by countries in Sub-area I.

Year	Faroe Islands	Germany[4]	Greenland	Iceland	Norway	Russia[5]	UK(Eng&Wales)	UK(Scotl)	Total
1989	-	-	-	-	1,763	110	4[2]	-	1,877
1990	5	-	-	-	1,263	14	-	-	1,282
1991	-	-	-	-	1,993	92	-	-	2,085
1992	-	-	-	-	2,162	174	-	-	2,336
1993	24[2]	-	-	-	1,178	330	-	-	1,532
1994	12[2]	72	-	4	1,607	109		-	1,804
1995	19[2]	1[2]	-	1[2]	1,947	201	1[2]	-	2,170
1996	7[2]	-	-	-	2,245	131	3[2]	-	2,386
1997	3[2]	-	5[2]	-	2,431	160	2[2]	-	2,601
1998	78[2]	5[2]	-	-	2,109	308	30[2]	-	2,530
1999	35[2]	18[2]	9[2]	14[2]	2,114	360	11[2]	-	2,561
2000	-	1[2]	-	16[2]	1,983	146		12[6]	2,159
2001	4	11[2]	-	-	1,053	128	France	16[6]	1,212
2002	15	5[2]	-	-	693	220	1[2]	9[2,6]	943
2003	15[2]	-	1	-	815	140	-	4[6]	975
2004	7	-	-	-	1,237	213	-	12[6]	1,469
2005	10	-	-	-	1,002[1]	61	1	4[6]	1,078
2006	46	-	-	-	685	136	-	-	867
2007	15	12	Spain- 2	-	1,029	49	-	20[6]	1,127
2008[1]	-	1	Portug- 3	Ltu-25	695	49	9	-	783

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.)

7 Split on species according to reports to Russian authorities.

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
1989	3[2]	784[2]	412	-	-	-	18,833	-	912	-	93[2]	-	21,037
1990	273	1,684[2]	387	-	-	-	22,444	-	392	-	261	-	25,441
1991	152[2]	706[2]	678	-	-	-	13,835	-	534	-	268[2]	10[2]	16,183
1992	35[2]	1,294[2]	211	614	-	-	10,536	-	404	-	206[2]	2[2]	13,302
1993	115[2]	871[2]	473	14[2]	-	-	11,959	77[2]	940	-	431[2]	1[2]	14,881
1994	10[2]	697[2]	654[2]	5[2]	-	-	13,330	90[2]	1,030	-	129[2]	-	15,945
1995	8[2]	732[2]	328[2]	5[2]	1[2]	1	11,466	2[2]	405	-	158[2]	9[2]	13,115
1996	27[2]	671[2]	448[2]	34[2]	-	-	13,329	51[2]	449	5[2]	223[2]	98[2]	15,335
1997	-	974[2]	438	18[2]	5[2]	-	11,708	61[2]	1,199	36[2]	162[2]	22[2]	14,623
1998	-	494[2]	116[2]	33[2]	19[2]	-	14,326	6[2]	1,078	51[2]	85[2]	52[2]	16,260
1999	-	35[2]	210[2]	38[2]	7[2]	-	14,598	3[2]	976	7[2]	122[2]	34[2]	16,030
2000	17[2]	13[2]	159[2]	22[2]	-	-	11,038	16[2]	658	-		61[6]	11,984
2001	33[2]	30[2]	227[2]	17[2]	1[2]	-	8,002	6[2]	612	1[2]	**Iceland**	103[2, 6]	9,031
2002	45[2]	30[2]	37[2]	31[2]	-	-	7,761	18[2]	192	2[2]	3[2]	32[2, 6]	8,151
2003	94[2]	9[2]	122[2]	35[2]	-	89[2]	5,970	6[2]	264		4[2]	130[2, 6]	6,722
2004	12[2]	4[2]	68[2]	20[2]	-	33[2]	4,872	5[2]	396	3[2]	30[2]	58[2, 6]	5,500
2005	37[2]	9[2]	60[2]	36[2]	-	48	4,855[1]	56[2]	265	8[2]	8[2]	48[2, 6]	5,430
2006	60[2]	8[2]	35[2]	44[2]	3[2]	21[2]	4,376[1]	59[2]	293	9[2]	31[2]	39[2, 6]	4,978
2007	119[2]	15[2]	55[2]	55[2]	1[2]	20[2]	4,084[1]	70	599	3[2]	68	35[2, 6]	5,124
2008[1]	123[2]	40[2]	28[2]	49[2]	-	2[2]	4,303	68[2]	450	4[2]	16[2]	70[2, 6]	5,153

1 Provisional figures.

2 Split on species according to reports to Norwegian authorities.

3 Based on preliminary estimates of species breakdown by area.

4 Includes former GDR prior to 1991.

5 USSR prior to 1991.

6UK(E&W)+UK(Scot.)

Table 7.4 ***Sebastes marinus*****. Nominal catch (t) by countries in Division IIb.**

Year	Faroe Islands	Germany[5]	Greenland	Norway	Portugal	Russia[6]	Spain	UK(Eng. & Wales)	UK (Scotl.)	Total
1989	-	-	-	66	-	242	-	-	-	308
1990	-	-	1[2]	210	-	1157	-	-	-	1,368
1991	-	303	-	44	-	426	-	-	-	773
1992	-	319	9[2]	2	5[2]	180	2	35[2]	-	552
1993	-	177	-	-	-	43	8[3]	10[2]	-	238
1994	-	282	-	18	-	60	4[3]	6[2]	1[2]	371
1995	-	187	-	103	7	33	-	-	-	330
1996	4	51[2]	-	27	5	136	76[2]	3[2]	-	302
1997	-	20	-	43	-	225	-	-	-	288
1998	-	10[2]	-	105	-	246	-	3[2]	-	364
1999	-	-	-	38	-	355	-	2[2]	-	395
2000	-	-	-	10	-	308	-	-	-	318
2001	-	-	-	79	1[2]	223	-	-	-	303
2002	-	-	-	107	16[2]	420	1[2]		5[2,7]	549
2003	-	-	-	68	-	75	-		-	143
2004	-	-	-	124	-	113	-		-	237
2005	-	13[2]	-	228[1]	-	288	-		-	529
2006	5[2]	-	-	1,204[1]	10[2]	284	-		-	1,503
2007	122	-	-	646[1]	155	242	-		-	1,054
2008[1]	-	-	-	113	1[2]	250	-		-	364

1 Provisional figures.
2 Split on species according to reports to Norwegian authorities.
3 Split on species according to the 1992 catches.
4 Based on preliminary estimates of species breakdown by area.
5 Includes former GDR prior to 1991.
6 USSR prior to 1991.
7UK(E&W)+UK(Scot.)

Table 7.5. ***Sebastes marinus*** **in Sub-areas I and II. Catch numbers at age (in thousands).**

Year/Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
7	0	46	60	9	9	28	78	4	23	14	22	19	40	47	15	1
8	24	7	85	119	98	51	593	13	23	36	25	47	55	34	21	4
9	193	292	230	313	156	206	855	70	44	71	30	46	94	59	30	13
10	359	640	672	361	321	470	572	245	199	143	44	65	80	73	67	12
11	406	816	908	879	686	721	1006	902	347	414	204	198	165	256	136	47
12	1036	1930	1610	1234	1065	968	1230	958	482	686	359	277	173	213	301	134
13	1022	2096	2038	1638	1781	1512	1618	1782	1120	1199	705	504	393	210	441	255
14	1523	2030	2295	2134	2276	1736	1480	1409	1342	1943	1687	590	779	847	487	352
15	2353	1601	1783	1675	2172	1582	1612	2121	1674	1377	1338	677	741	575	514	347
16	1410	2725	1406	1614	1848	1045	1239	2203	1653	1274	1071	963	916	815	626	426
17	1655	2668	785	1390	1421	1277	1407	1715	1243	1196	937	1059	926	831	877	425
18	1678	1409	563	952	851	970	1558	753	568	388	481	787	743	782	606	517
19	745	617	670	679	804	1018	1019	483	119	313	367	436	376	519	501	526
20	716	733	593	439	608	846	394	458	183	99	146	169	210	347	389	460
21	534	514	419	560	511	443	197	132	154	104	84	183	189	324	221	270
22	528	256	368	334	205	764	459	230	112	117	51	108	129	197	317	214
23	576	177	250	490	334	486	174	224	135	113	18	79	111	173	167	138
+gp	3482	1508	3232	3135	2131	3389	2131	895	254	253	69	186	220	416	619	992
TOTALNUM	**18240**	**20065**	**17967**	**17955**	**17277**	**17512**	**17622**	**14597**	**9675**	**9740**	**7637**	**6390**	**6338**	**6718**	**6335**	**5132**
TONSLAND	16651	18120	15616	18043	17511	19155	18986	14460	10547	9643	7841	7320	7037	7690	7184	6301

Table 7.6. *Sebastes marinus* in Sub-areas I and II. Catch weights at age (kg)

Year/Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
7	0.20	0.25	0.33	0.22	0.23	0.37	0.14	0.19	0.15	0.17	0.19	0.21	0.16	0.13	0.15	0.41
8	0.33	0.37	0.43	0.49	0.51	0.21	0.26	0.24	0.26	0.25	0.22	0.26	0.21	0.15	0.21	0.55
9	0.36	0.38	0.64	0.56	0.53	0.47	0.44	0.32	0.45	0.33	0.31	0.36	0.36	0.28	0.33	0.55
10	0.43	0.49	0.61	0.65	0.74	0.62	0.57	0.44	0.55	0.42	0.39	0.45	0.45	0.41	0.39	0.57
11	0.51	0.51	0.59	0.71	0.72	0.67	0.69	0.53	0.58	0.54	0.49	0.51	0.52	0.51	0.50	0.52
12	0.51	0.64	0.65	0.81	0.78	0.77	0.78	0.64	0.67	0.67	0.58	0.59	0.58	0.58	0.59	0.58
13	0.64	0.74	0.74	0.84	0.80	0.77	0.86	0.73	0.80	0.72	0.69	0.68	0.68	0.66	0.65	0.65
14	0.64	0.76	0.79	0.88	0.86	0.85	1.04	0.84	0.89	0.84	0.84	0.80	0.82	0.74	0.77	0.81
15	0.76	0.86	0.84	0.96	0.91	1.05	1.07	0.96	1.01	0.98	0.96	0.96	0.94	0.83	0.90	0.90
16	0.86	0.95	0.92	1.00	0.99	0.96	1.12	1.11	1.14	1.09	1.05	1.07	1.03	1.00	1.00	1.07
17	0.89	1.03	1.12	1.02	1.16	1.25	1.18	1.25	1.33	1.20	1.29	1.22	1.16	1.14	1.09	1.14
18	0.98	1.07	1.01	1.01	1.18	1.28	1.71	1.32	1.43	1.30	1.36	1.34	1.36	1.27	1.27	1.36
19	1.00	1.11	1.01	1.00	1.21	1.30	1.09	1.53	1.62	1.44	1.65	1.57	1.46	1.39	1.42	1.51
20	1.03	1.16	1.21	1.03	1.34	1.23	1.18	1.06	1.60	1.78	1.74	1.67	1.51	1.46	1.32	1.81
21	1.21	1.15	1.14	1.04	1.28	1.87	1.04	1.29	1.47	1.68	2.09	1.75	1.67	1.37	1.53	1.99
22	1.03	1.13	1.09	1.14	1.54	1.46	1.34	1.32	2.00	1.88	1.85	2.09	1.91	1.47	1.47	2.01
23	1.20	1.02	1.30	1.09	1.19	1.73	1.18	1.12	2.70	2.12	2.30	1.90	2.23	1.64	1.69	2.26
+gp	1.14	1.36	1.01	1.16	1.29	1.29	1.34	1.20	2.31	1.84	2.38	2.04	2.27	2.03	1.81	1.93

Table 7.7. *Sebastes marinus* in Sub-areas I and II. Fishing mortalities as estimated by Gadget.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
7	0.004	0.003	0.002	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.002
8	0.039	0.010	0.008	0.008	0.008	0.010	0.008	0.007	0.009	0.006	0.007	0.005	0.005	0.004	0.004	0.005	0.006	0.006	0.006
9	0.071	0.052	0.021	0.020	0.021	0.022	0.020	0.019	0.022	0.016	0.018	0.013	0.013	0.011	0.011	0.012	0.015	0.016	0.015
10	0.095	0.079	0.070	0.041	0.042	0.042	0.041	0.040	0.045	0.033	0.037	0.028	0.027	0.022	0.022	0.024	0.031	0.033	0.030
11	0.124	0.100	0.095	0.100	0.072	0.068	0.069	0.068	0.077	0.058	0.064	0.048	0.046	0.038	0.039	0.041	0.051	0.055	0.051
12	0.158	0.122	0.112	0.123	0.139	0.104	0.102	0.100	0.114	0.086	0.096	0.072	0.069	0.058	0.058	0.061	0.075	0.082	0.077
13	0.196	0.147	0.131	0.140	0.162	0.148	0.136	0.134	0.152	0.116	0.129	0.097	0.092	0.078	0.077	0.081	0.100	0.108	0.103
14	0.238	0.174	0.150	0.157	0.178	0.163	0.192	0.165	0.188	0.144	0.161	0.121	0.113	0.096	0.095	0.099	0.122	0.133	0.128
15	0.281	0.201	0.170	0.174	0.194	0.175	0.206	0.212	0.219	0.169	0.189	0.143	0.132	0.112	0.110	0.114	0.140	0.153	0.149
16	0.327	0.229	0.190	0.191	0.210	0.186	0.217	0.222	0.261	0.190	0.212	0.160	0.147	0.126	0.122	0.126	0.154	0.170	0.166
17	0.372	0.257	0.209	0.207	0.224	0.196	0.228	0.231	0.270	0.216	0.230	0.174	0.159	0.136	0.132	0.135	0.165	0.182	0.179
18	0.394	0.284	0.227	0.222	0.238	0.206	0.237	0.239	0.278	0.221	0.253	0.185	0.169	0.144	0.139	0.142	0.172	0.190	0.188
19	0.415	0.296	0.244	0.236	0.250	0.214	0.245	0.246	0.284	0.226	0.257	0.197	0.175	0.149	0.144	0.147	0.178	0.196	0.194
20	0.435	0.309	0.252	0.248	0.261	0.222	0.252	0.252	0.290	0.230	0.261	0.200	0.183	0.153	0.147	0.150	0.181	0.200	0.199
21	0.454	0.320	0.260	0.254	0.271	0.229	0.259	0.257	0.295	0.233	0.264	0.202	0.184	0.158	0.150	0.153	0.184	0.203	0.202
22	0.472	0.331	0.267	0.259	0.275	0.234	0.264	0.262	0.299	0.236	0.266	0.203	0.185	0.158	0.153	0.154	0.186	0.205	0.203
23	0.487	0.341	0.273	0.264	0.280	0.236	0.269	0.265	0.303	0.238	0.269	0.205	0.186	0.159	0.153	0.156	0.187	0.206	0.205
24	0.500	0.349	0.279	0.269	0.283	0.239	0.271	0.269	0.306	0.240	0.271	0.206	0.187	0.160	0.153	0.156	0.188	0.207	0.206
25	0.511	0.357	0.284	0.273	0.287	0.241	0.273	0.270	0.308	0.242	0.272	0.207	0.188	0.160	0.154	0.157	0.189	0.208	0.206
26	0.520	0.363	0.288	0.276	0.290	0.243	0.275	0.271	0.309	0.243	0.273	0.208	0.188	0.161	0.154	0.157	0.189	0.209	0.207
27	0.527	0.367	0.292	0.279	0.292	0.244	0.276	0.272	0.310	0.244	0.274	0.208	0.189	0.161	0.154	0.157	0.189	0.209	0.207
28	0.532	0.371	0.294	0.281	0.294	0.246	0.277	0.273	0.311	0.244	0.275	0.209	0.189	0.161	0.155	0.157	0.189	0.209	0.207
29	0.536	0.374	0.296	0.283	0.296	0.247	0.278	0.274	0.312	0.245	0.275	0.209	0.189	0.161	0.155	0.157	0.189	0.209	0.207
30	0.541	0.378	0.300	0.286	0.299	0.181	0.281	0.277	0.313	0.245	0.276	0.209	0.190	0.162	0.155	0.158	0.190	0.209	0.208

Table 7.8. *Sebastes marinus* in Sub-areas I and II. Stock numbers, biomass, mean weight and maturity ogives as estimated by GADGET using two survey series as input.

	redfish			mature			immature			recruit
year	number	mean weight	biomass	number	mean weight	biomass	number	mean weight	biomass	number
1986	524,322,436	0.33	172,034	75,605,786	0.39	29,172	448,716,650	0.32	142,863	88,874,896
1987	515,847,580	0.32	164,896	108,461,570	0.58	63,161	407,386,010	0.25	101,735	66,403,172
1988	492,820,410	0.33	160,355	113,777,740	0.63	72,178	379,042,670	0.23	88,177	49,220,266
1989	465,979,180	0.33	155,729	108,800,210	0.65	70,691	357,178,970	0.24	85,038	43,640,067
1990	444,980,830	0.34	149,763	101,056,060	0.65	66,153	343,924,770	0.24	83,610	48,578,157
1991	432,019,861	0.35	149,084	97,288,001	0.67	65,569	334,731,860	0.25	83,516	48,762,253
1992	413,227,047	0.36	150,175	95,605,537	0.70	67,000	317,621,510	0.26	83,175	38,855,220
1993	389,392,870	0.39	150,267	94,104,420	0.73	68,654	295,288,450	0.28	81,614	31,878,760
1994	358,326,502	0.41	147,920	91,790,312	0.76	69,393	266,536,190	0.29	78,526	23,303,378
1995	322,908,711	0.45	144,284	89,345,171	0.78	69,870	233,563,540	0.32	74,413	15,434,668
1996	286,053,050	0.49	139,453	86,740,130	0.81	70,197	199,312,920	0.35	69,256	9,917,886
1997	251,450,996	0.52	131,924	82,778,146	0.83	69,095	168,672,850	0.37	62,828	9,273,795
1998	215,995,995	0.56	122,013	77,484,085	0.86	66,491	138,511,910	0.40	55,522	5,462,885
1999	180,939,812	0.60	109,402	70,469,722	0.88	61,858	110,470,090	0.43	47,544	3,218,955
2000	151,196,051	0.65	98,232	64,337,956	0.90	58,039	86,858,095	0.46	40,193	2,229,401
2001	125,430,361	0.69	86,984	58,023,734	0.93	53,915	67,406,627	0.49	33,070	2,085,554
2002	108,524,385	0.74	80,432	54,604,409	0.97	53,088	53,919,976	0.51	27,345	3,186,918
2003	96,263,931	0.77	73,673	50,742,601	1.02	51,683	45,521,330	0.48	21,989	5,401,037
2004	110,210,332	0.61	67,041	46,412,187	1.07	49,470	63,798,145	0.28	17,571	29,761,788
2005	94,507,480	0.65	61,101	42,271,507	1.11	46,827	52,235,973	0.27	14,274	500,000
2006	103,365,934	0.53	55,143	37,500,936	1.15	42,940	65,864,998	0.19	12,203	23,472,977
2007	92,815,858	0.53	48,867	32,325,911	1.16	37,637	60,489,947	0.19	11,230	5,111,749
2008	94,152,634	0.46	43,730	27,720,729	1.17	32,365	66,431,905	0.17	11,365	15,209,787

	Proportion mature					
age	1991-1993	1994-1996	1997-1999	2000-2002	2003-2005	2006-2008
4	0.03	0.03	0.03	0.03	0.03	0.03
5	0.05	0.05	0.05	0.05	0.05	0.05
6	0.08	0.08	0.08	0.08	0.08	0.08
7	0.12	0.12	0.12	0.12	0.12	0.12
8	0.24	0.17	0.17	0.17	0.17	0.17
9	0.32	0.24	0.24	0.24	0.24	0.24
10	0.43	0.32	0.32	0.32	0.32	0.32
11	0.51	0.46	0.42	0.42	0.42	0.42
12	0.60	0.58	0.53	0.53	0.53	0.53
13	0.65	0.70	0.64	0.64	0.64	0.64
14	0.72	0.79	0.77	0.75	0.75	0.75
15	0.80	0.87	0.86	0.84	0.84	0.84
16	0.92	0.92	0.93	0.92	0.92	0.92
17	0.98	0.96	0.97	0.96	0.96	0.96
18	1.00	0.98	0.99	0.99	0.99	0.99
19	0.99	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00
21	1.00	1.00	1.00	1.00	1.00	1.00
22	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	1.00	1.00	1.00	1.00	1.00
24	1.00	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00	1.00
26	1.00	1.00	1.00	1.00	1.00	1.00
27	1.00	1.00	1.00	1.00	1.00	1.00
28	1.00	1.00	1.00	1.00	1.00	1.00
29	1.00	1.00	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00	1.00	1.00

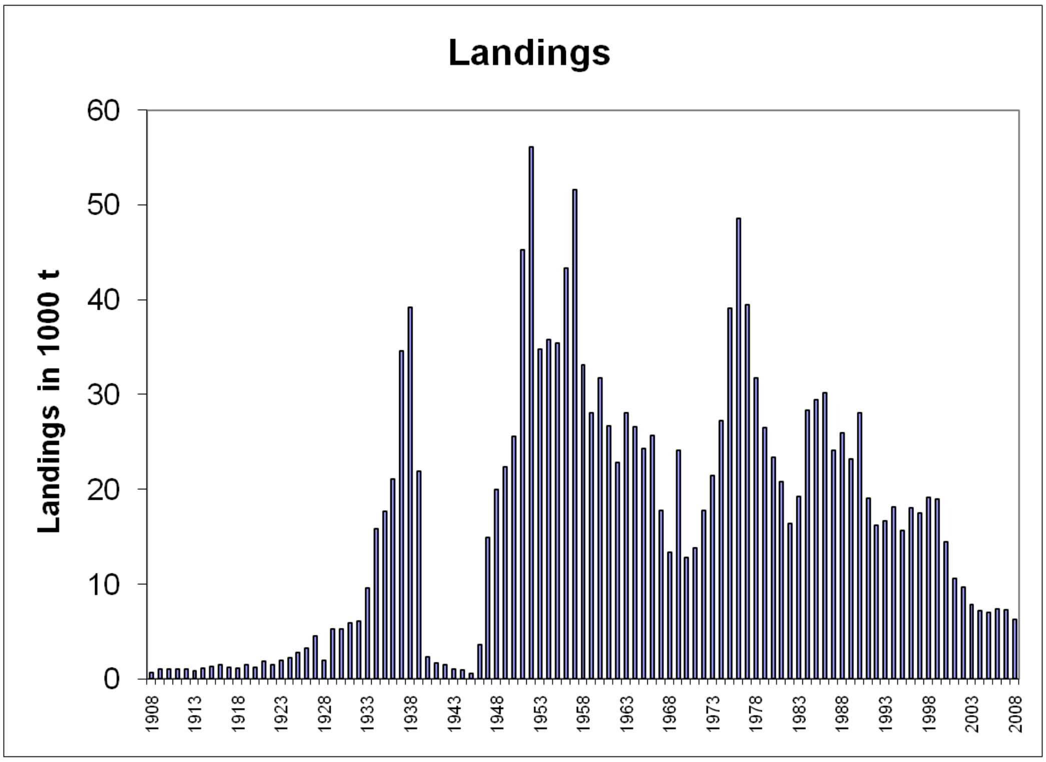


Figure 7.1. ***Sebastes marinus*** **in Sub-areas I and II. Total international landings 1965-2008 (in thousand tonnes)**

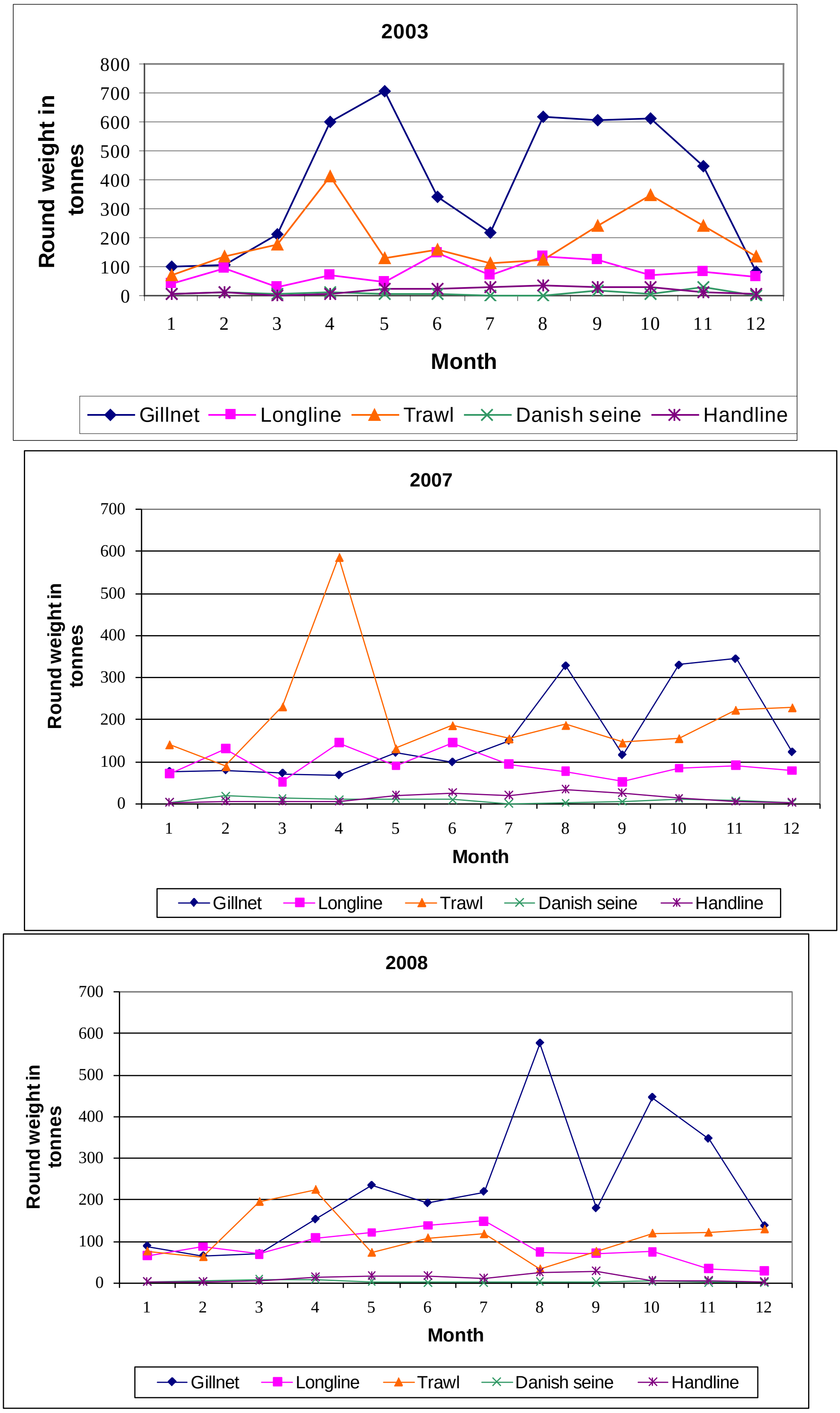


Figure 7.2. Illustration of the seasonality in the different Norwegian *S. marinus* fisheries in 2003, 2007 and 2008, also illustrating how the current regulations are working.

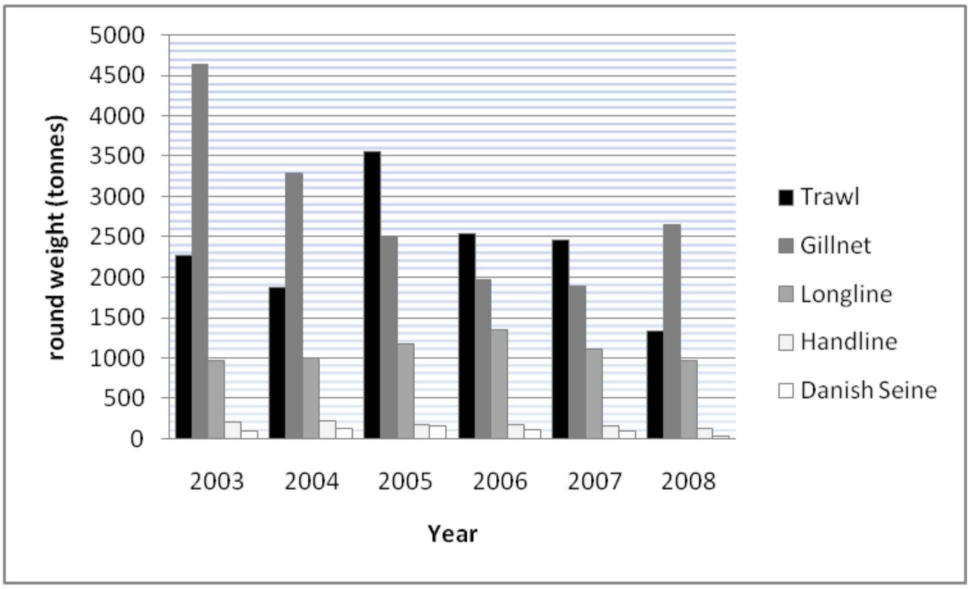


Figure 7.2b. Inter annual changes in the catches reported by different Norwegian *S. marinus* fisheries (2003-2008).

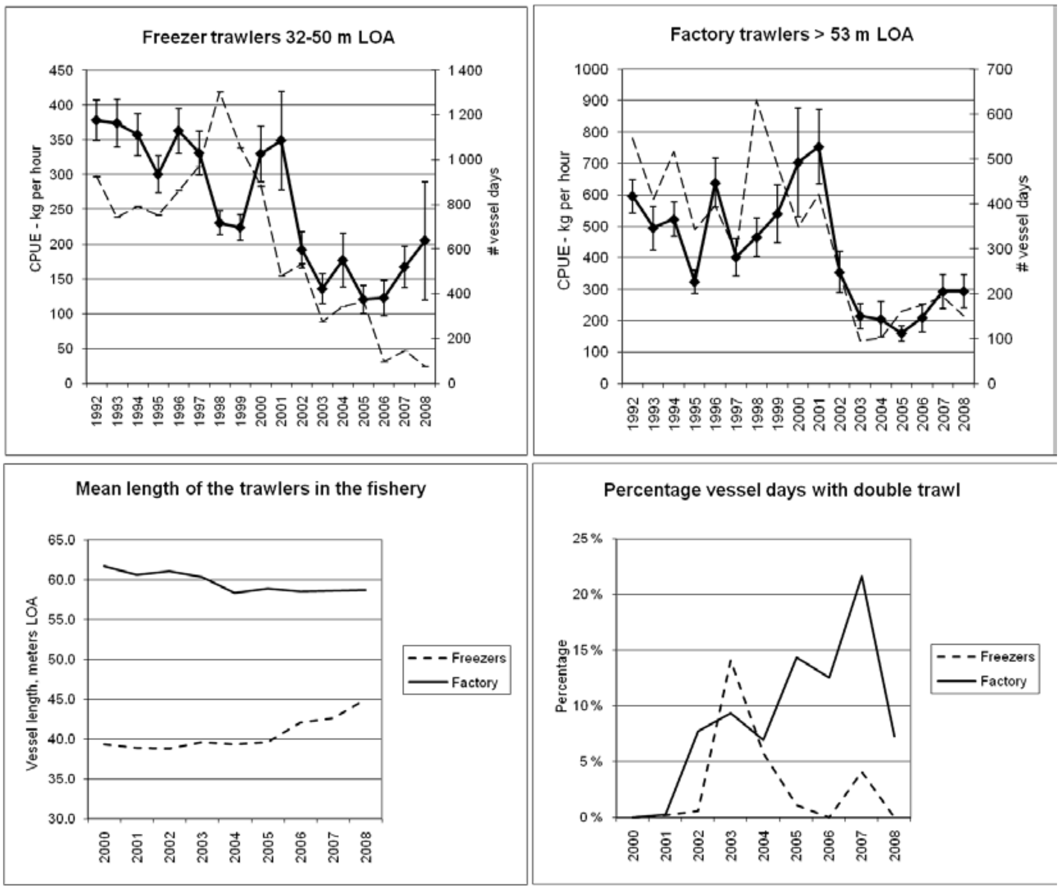


Figure 7.3. Sebastes marinus. Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery, and numbers of vessel days (stippled curve) meeting the criterium of minimum 10% S. marinus in the catch per day. Upper panel shows data from the logbooks of freezer trawlers (left) and factory trawlers (right). The lower panel shows how the vessel length and use of double trawl have developed through the time series. The figure is an illustration of the data given in Table D11.

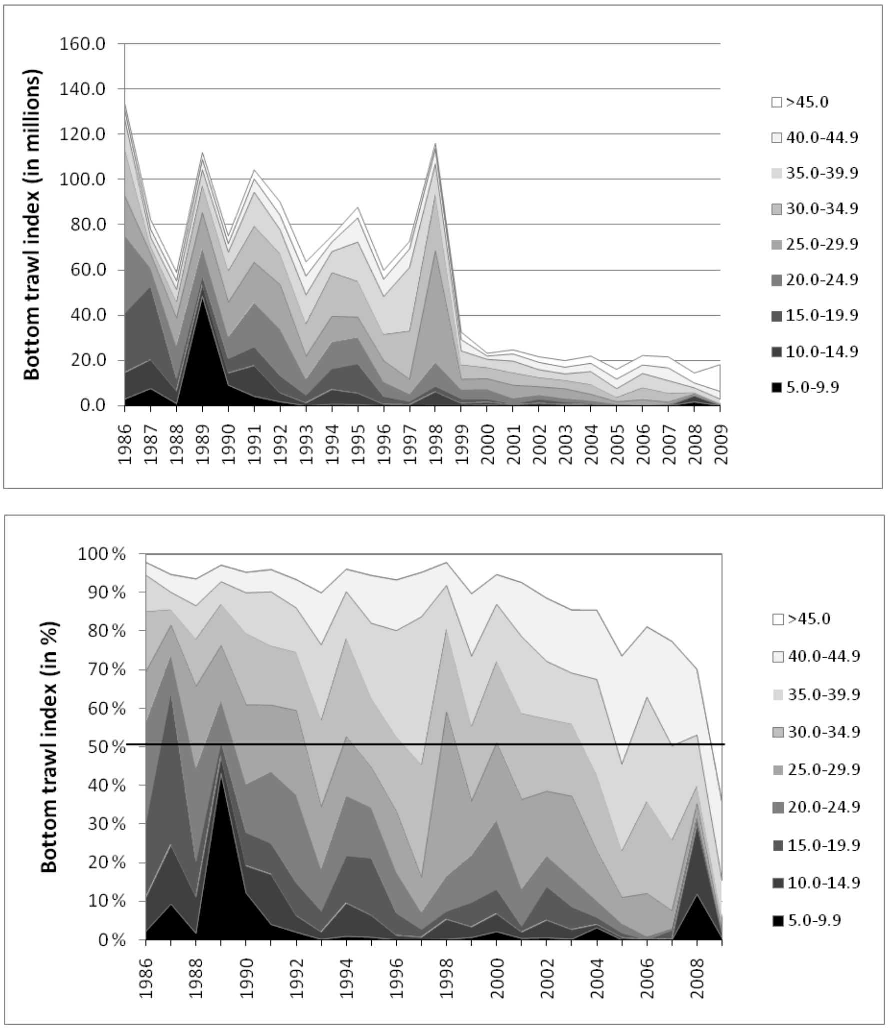


Figure 7.4a. Sebastes marinus. Abundance indices disaggregated by length for the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2009 (ref. Table D12a). Top: absolute index values, bottom: relative frequencies. Horizontal lines indicates the median length in the surveyed population.

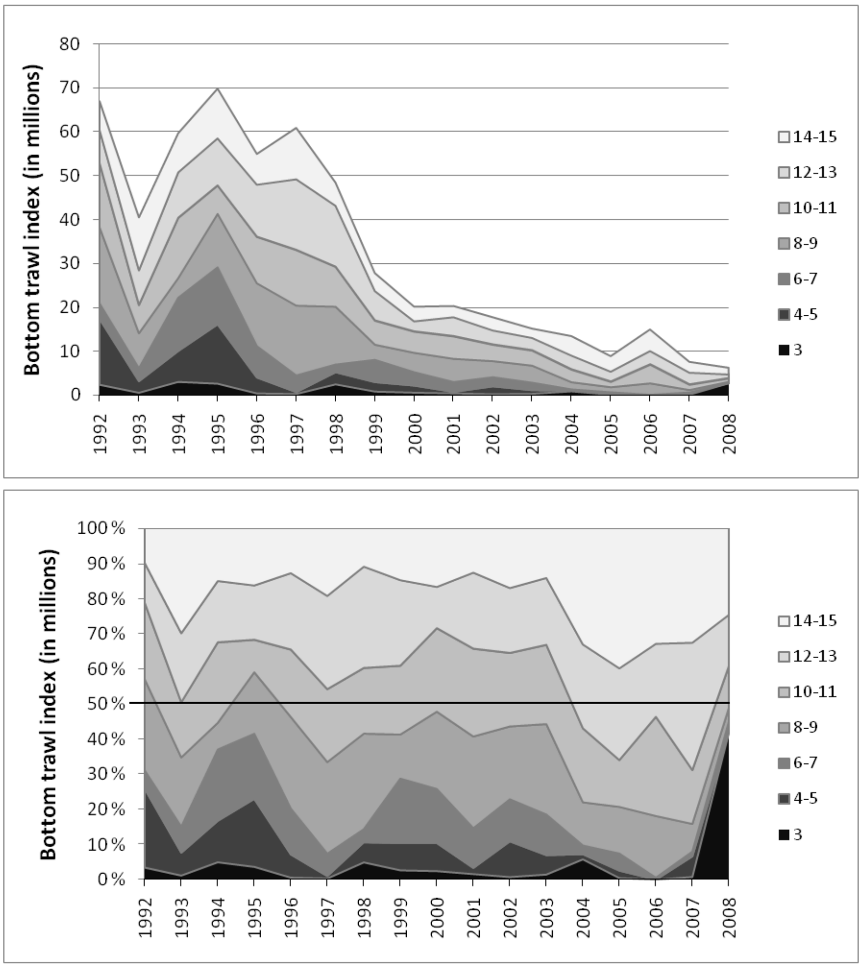


Figure 7.4b. ***Sebastes marinus.*** **Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2008 in the Barents Sea (ref. Table D12b). Top: absolute index, bottom: relative frequencies. Horizonla line indicate the median age of the surveyed population.**

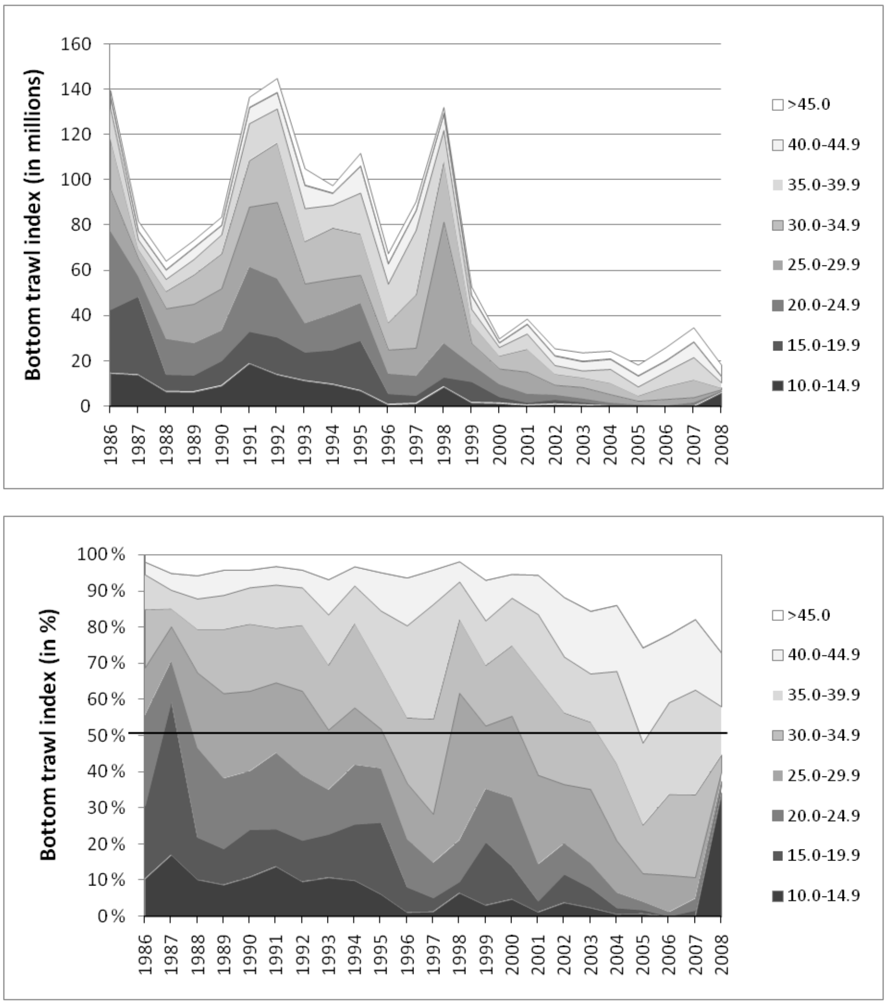
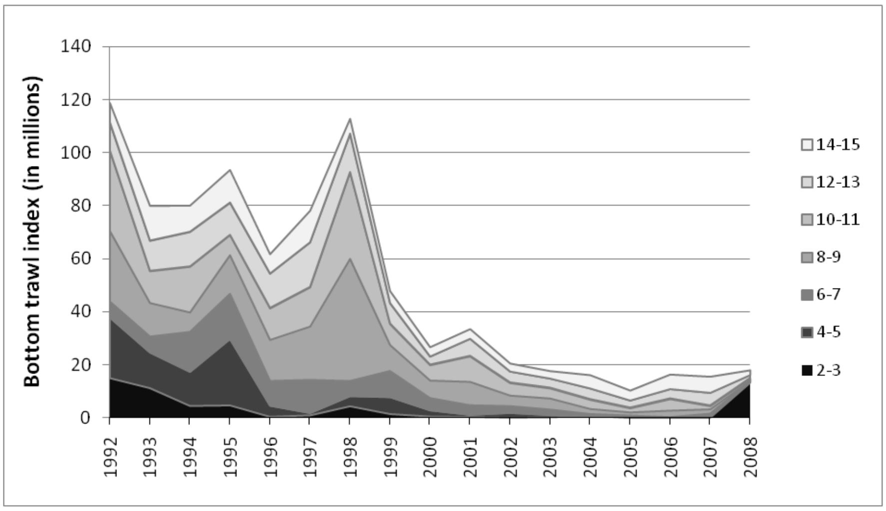


Figure 7.5a. ***Sebastes marinus.*** **Abundance indices disaggregated by length when combining the Norwegian bottom trawl surveys 1986-2008 in the Barents Sea (winter) and at Svalbard (summer/fall). Top: absolute index values. Bottom: relative frequencies. Horizontal line indicate the median length in the surveyed population.**



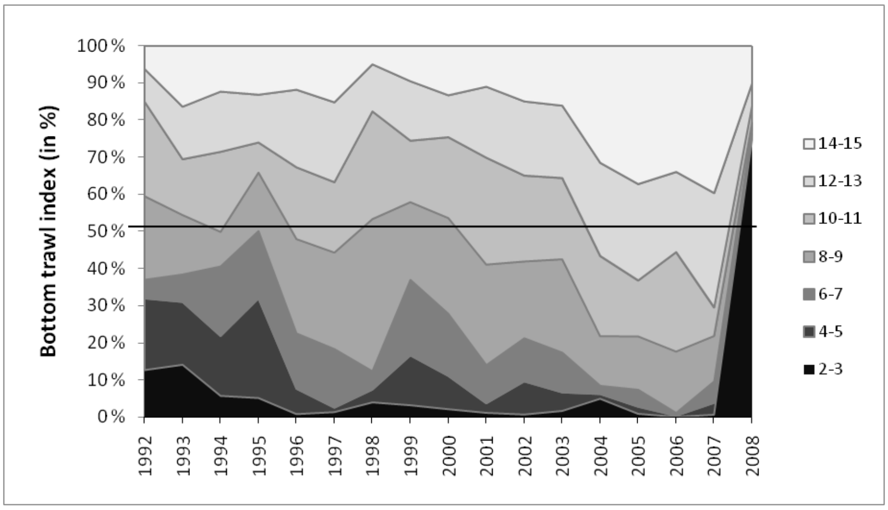
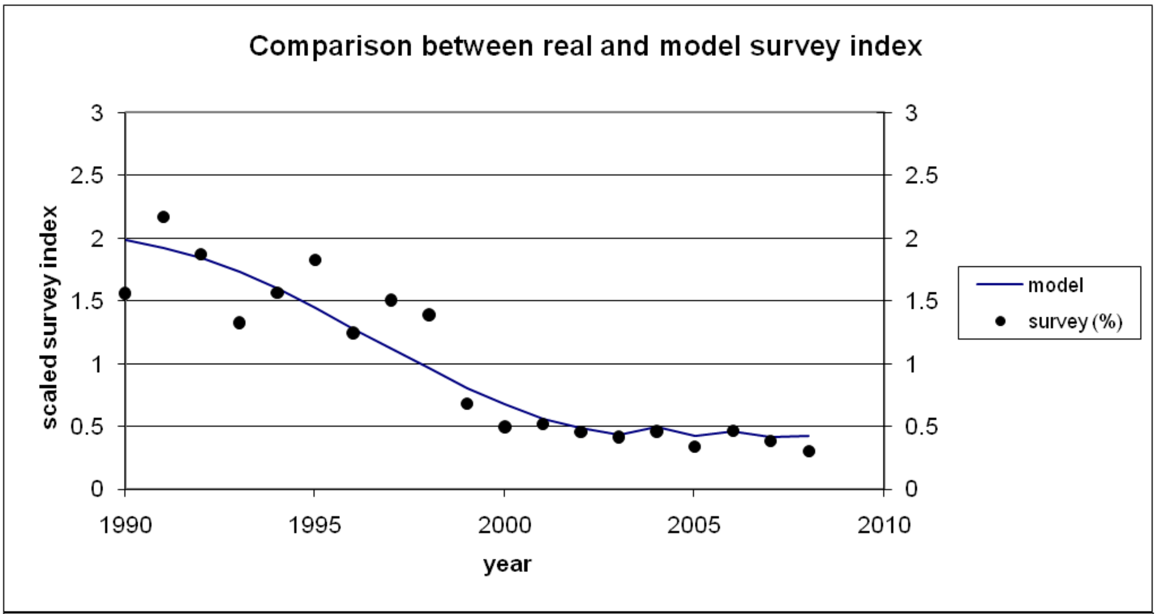


Figure 7.5b. *Sebastes marinus*. Abundance indices disaggregated by age. Combined Norwegian bottom trawl surveys 1992-2008 in the Barents Sea (winter) and Svalbard survey (summer/fall). Top: absolute index values, bottom: relative frequencies. Horizontal line indicates median age of the surveyed population.



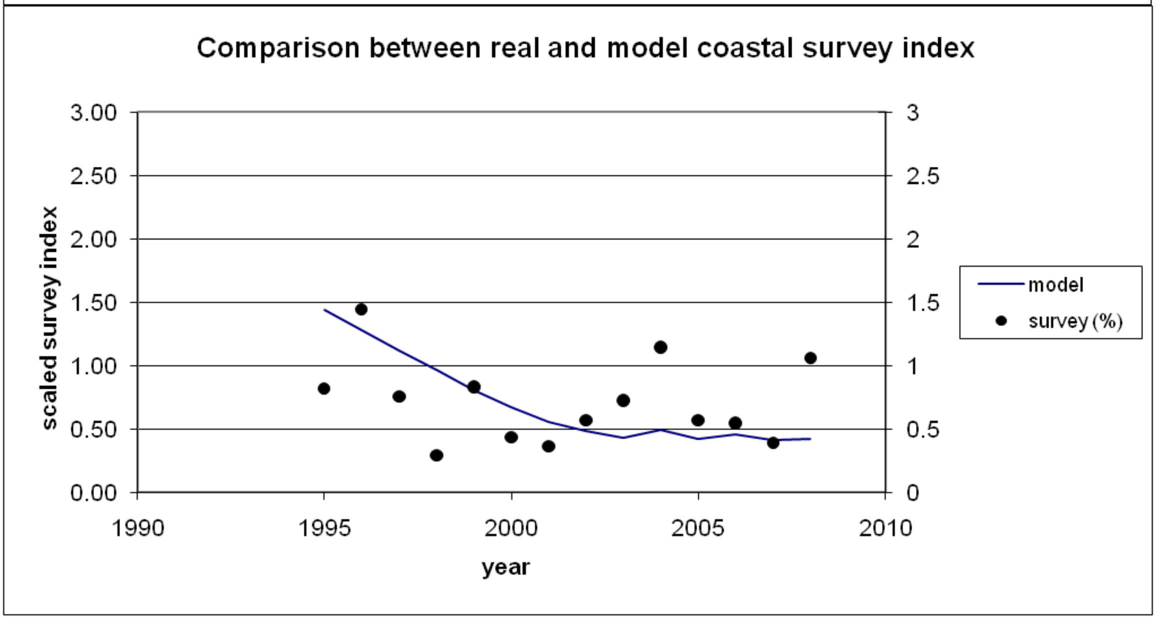


Figure 7.6. Sebastes marinus in Sub-areas I and II. Results from the Gadget assessment using two scientific surveys as input. The Figure shows comparison of observed and modelled survey indices (total number scaled to sum=100 during the time period) – the traditional Barents Sea February survey (top), and the coastal and fjord survey (bottom). Dots: survey indices. Plain lines: survey indices estimated by the model.

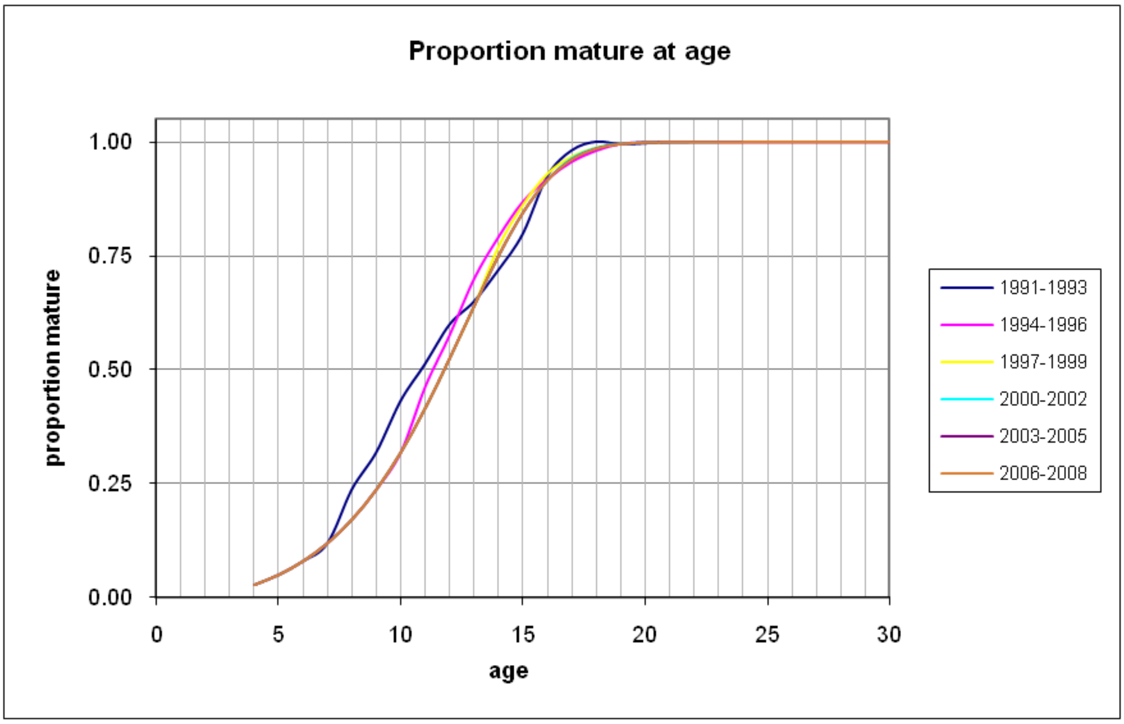


Figure 7.7. Sebastes marinus in Sub-areas I and II. Estimates of maturity at age by Gadget. Input data have been proportions of S. marinus mature both at age and length as collected and classified from Norwegian commercial landings and surveys. Fewer data together with being the beginning of the modelled time period have caused the more varying pattern for 1991-1996.

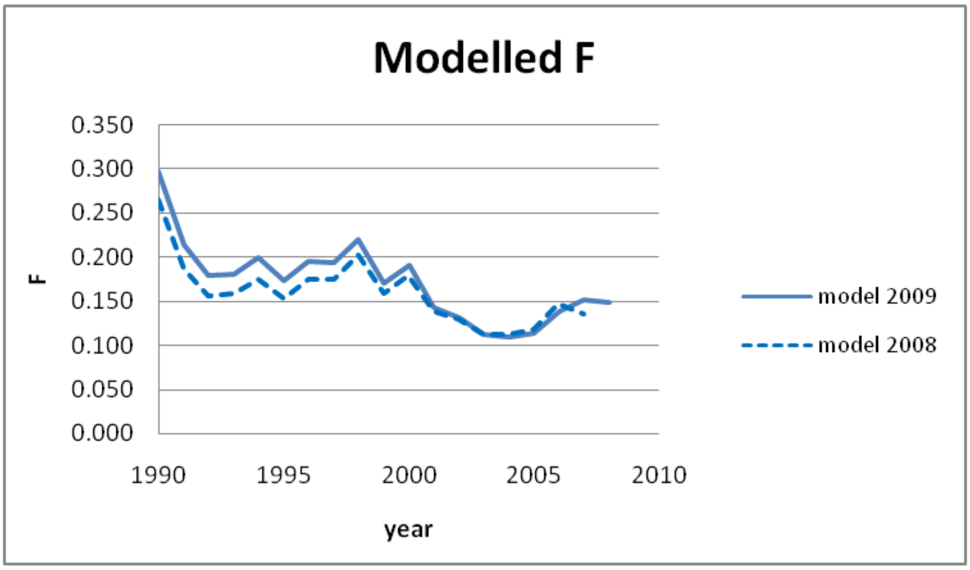


Figure 7.8. ***Sebastes marinus*** **in sub-areas I & II. Unweighted average fishing mortality of ages 12-19 as estimated by Gadget in 2009 and in 2008.**

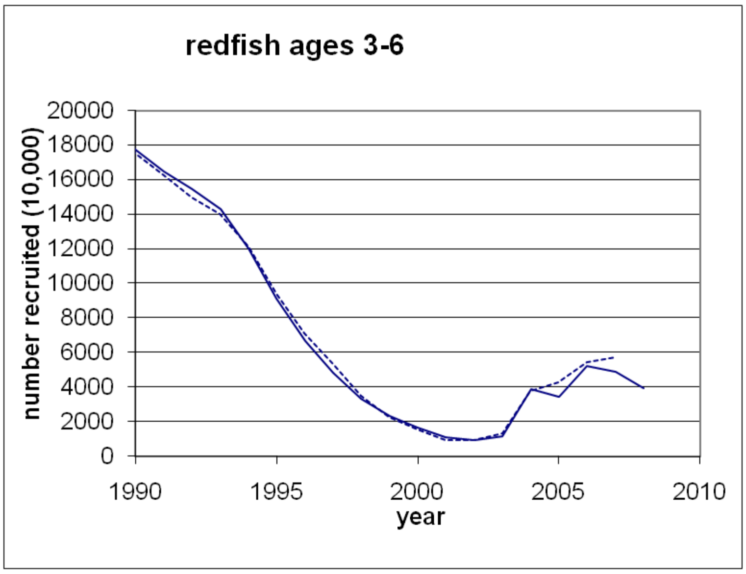


Figure 7.9. *Sebastes marinus* in Sub-areas I and II. Estimates of abundance at age 3-6 by Gadget using two surveys as input. Gadget output provide at the 2008 AFWG are shown as dotted line. Current results are shown as plain lines.

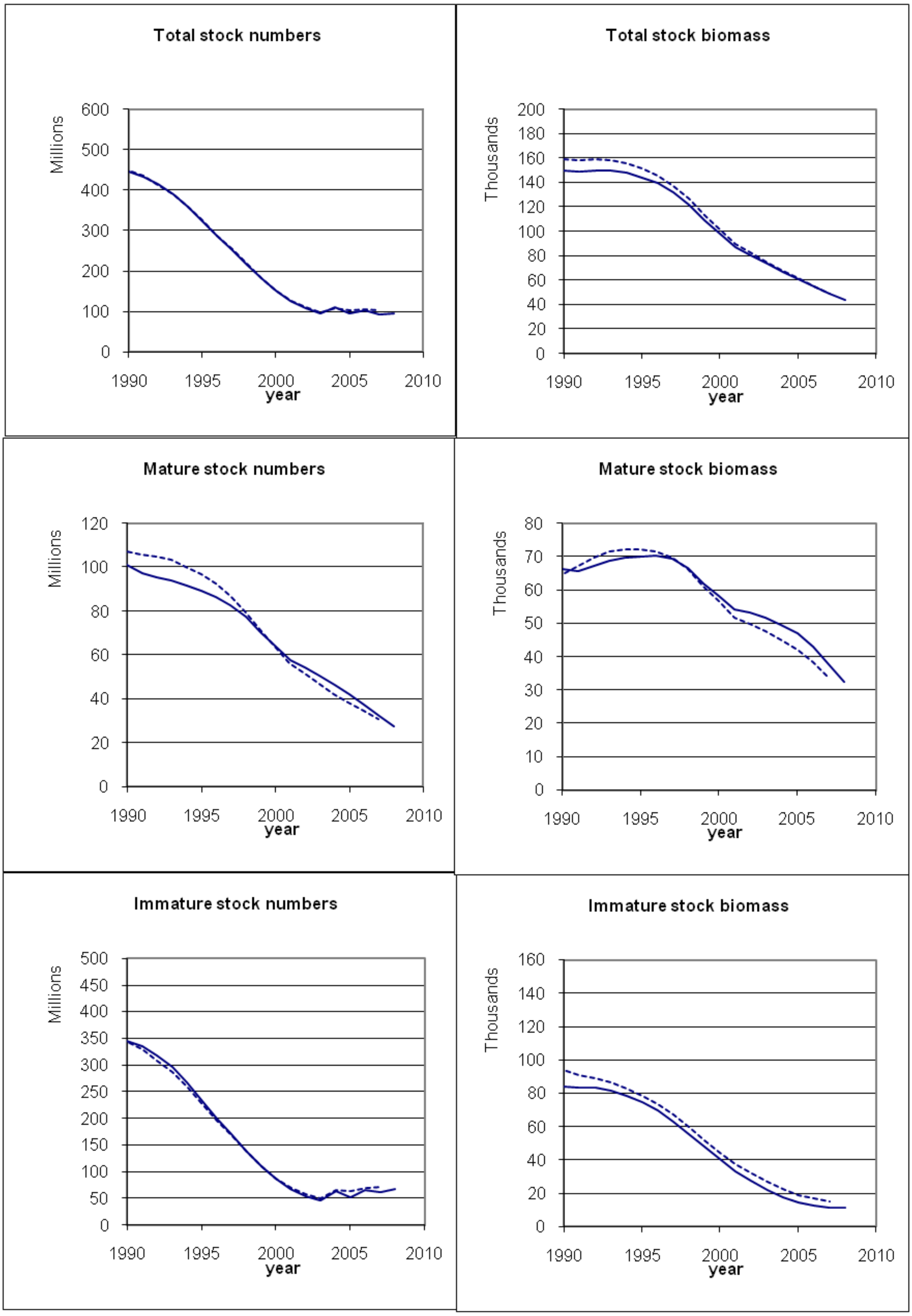


Figure 7.10. ***Sebastes marinus*** **in Sub-areas I and II. Stock numbers (in thousands) and biomass (in tonnes) for the total stock (3+) (upper panel), and the fishable and mature stock (middle panel), and the immature stock (lower panel), as estimated by Gadget using two surveys as input. Gadget output provide at the 2008 AFWG are shown as dotted line. Current results are shown as plain lines.**

Table D11. ***Sebastes marinus*****. Effort (vessel days) and catch per unit effort (kg per trawl hour) with 2 x st.error for Norwegian trawlers.**[1]

	Freezer trawlers (32-50m)			Factory trawlers (>53m)		
Year	Number of vessel days meeting the 10% requirement	Mean CPUE per year (kg/hour)	2 x standard error of the mean	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	545	596	53.1
1993	743	374	34.4	411	495	68.9
1994	793	357	30.1	516	522	53.9
1995	754	300	26.7	343	323	35.9
1996	864	363	32.1	395	638	78.4
1997	972	331	31.9	291	402	60.3
1998	1 303	230	17.2	631	465	62.1
1999	1 054	224	18.8	486	540	93.1
2000	884	330	39.9	349	703	172.6
2001	481	349	70.5	421	753	118.4
2002	536	192	26.0	246	353	65.8
2003	276	136	21.4	96	214	40.7
2004	344	177	38.5	101	204	56.2
2005	368	120	20.2	160	160	24.2
2006	98	123	26.0	175	209	43.9
2007	147	167	29.4	194	292	53.5
2008[2]	76	205	84.7	151	293	53.8

[1] Only including days with more than 10% *S. marinus* in the catches. Only including areas with low mixing of *S. mentella.*

[2] Provisional figures.

Table D12a. Sebastes marinus in Sub-areas I and II. Abundance indices - on length - from the bottom trawl surveys in the Barents Sea (Division IIa) in the winter 1986-2009 (numbers in millions). The area coverage was extended from 1993.

Year	Length group (cm)									Total
	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	
1986	3.0	11.7	26.4	34.3	17.7	21.0	12.8	4.4	2.6	133.9
1987	7.7	12.7	32.8	7.7	6.4	3.4	3.8	3.8	4.2	82.5
1988	1.0	5.6	5.5	14.2	12.6	7.3	5.2	4.1	3.7	59.2
1989	48.7	4.9	4.3	11.8	15.9	12.2	6.6	4.8	3.0	112.2
1990	9.2	5.3	6.5	9.4	15.5	14.0	8.0	4.0	3.4	75.3
1991	4.2	13.6	8.4	19.4	18.0	16.1	14.8	6.0	4.0	104.5
1992	1.8	3.9	7.7	20.6	19.7	13.7	10.5	6.6	5.8	90.3
1993	0.1	1.2	3.5	6.9	10.3	14.5	12.5	8.6	6.3	63.9
1994	0.7	6.5	9.3	11.7	11.5	19.4	9.1	4.4	2.8	75.4
1995	0.6	5.0	13.1	11.5	9.1	15.9	17.2	10.9	4.7	88.0
1996	+	0.7	3.5	6.4	9.4	11.7	16.6	7.9	3.9	60.1
1997[1]	-	0.5	1.3	2.7	6.9	21.4	28.2	8.5	3.3	72.7
1998[1]	0.1	3.9	2.0	7.4	5.8	25.3	13.2	7.0	2.3	67.0
1999	0.2	0.9	2.1	4.0	4.6	6.4	6.0	5.3	3.5	33.0
2000	0.5	1.1	1.5	4.2	4.7	5.0	3.5	1.8	1.2	24.0
2001	0.1	0.4	0.4	2.4	5.8	5.6	5.0	3.5	1.8	25.0
2002	0.1	1.0	1.9	1.7	3.7	4.1	3.3	3.6	2.5	22.0
2003	0.0	0.5	1.2	1.5	4.3	3.8	2.7	3.3	2.9	20.2
2004	0.7	0.2	0.4	1.0	2.9	4.4	5.5	4.0	3.2	22.3
2005	+	0.1	0.2	0.4	1.1	2.0	3.7	4.6	4.3	16.4
2006	0.0	0.0	0.0	0.2	2.5	5.4	6.1	4.1	4.2	22.5
2007	0.0	0.1	0.5	0.1	1.0	4.0	5.4	5.9	4.9	21.9
2008	1.8	2.6	0.2	0.2	0.4	0.7	1.9	2.5	4.4	14.8
2009	0.1	0.2	0.1	0.0	0.0	0.6	1.8	3.7	11.8	18.5

1 - Adjusted indices to account for not covering the Russian EEZ in Subarea I

2 – Indices NOT adjusted 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 1992-2008 (numbers in thousands). The area coverage was extended from 1993 onwards.**

	Age													
Year	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1992	2,295	4,261	10,760	2,043	1,474	13,178	4,230	6,302	8,251	3,751	3,865	3,064	3,568	67,042
1993	468	1,218	1,424	2,020	979	5,048	2,968	4,230	2,142	4,634	3,338	2,951	9,148	40,568
1994	2,951	4,485	2,573	3,801	8,338	3,254	1,297	7,231	6,443	248	10,192	6,341	2,612	59,766
1995	2,540	7,450	6,090	7,150	5,820	6,590	5,670	2,000	4,440	6,500	4,320	5,330	6,030	69,930
1996	310	1,300	2,340	3,520	3,660	8,720	5,650	3,960	6,590	5,730	6,230	4,070	2,950	55,030
1997	190	80	360	1,320	2,530	5,370	10,570	6,840	5,810	7,390	8,790	9,740	1,980	60,980
1998	2,380	1,930	850	660	1,140	7,090	6,124	4,962	4,091	5,190	8,790	2,730	2,560	48,487
1999	737	916	1,246	3,469	1,650	1,826	1,679	3,084	2,371	2,953	3,837	2,132	1,979	27,879
2000	490	720	900	1,310	1,800	2,440	2,020	2,710	2,090	940	1,440	2,940	430	20,230
2001	320	170	190	940	1,360	2,220	3,110	2,400	2,690	2,230	2,180	1,200	1,370	20,380
2002	130	910	902	1,590	544	1,546	2,153	1,822	1,900	2,220	1,073	1,294	1,730	17,814
2003	220	250	590	1,080	680	1,020	2,910	1,180	2,250	1,370	1,530	840	1,310	15,230
2004	780	100	100	90	240	540	1,130	1,260	1,590	1,740	1,490	2,570	1,890	13,520
2005	39	85	107	110	321	524	669	497	697	820	1,517	1,905	1,653	8,944
2006	0	0	0	24	52	1,011	1,641	1,999	2,246	1,578	1,550	3,487	1,444	15,030
2007	58	202	248	50	51	185	422	582	592	1,747	1,030	1,127	1,359	7,652
2008	2,637	0	0	0	203	72	175	272	476	369	553	850	700	6,306

1 - Adjusted indices to account for not covering the Russian EEZ in Subarea I

2 – Indices NOT adjusted to account for not covering the Russian EEZ in Subarea I

Table D13a. ***Sebastes marinus*** **in Subarea I and II. Abundance indices - on length - from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1985-2008 (numbers in thousands).**

	Length (cm)								
Year	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]	1,307	795	1,728	2,273	1,417	311	142	194	8,325
1986[1]	2,961	1,768	547	643	1,520	639	467	196	8,941
1987[1]	1,343	1,964	1,185	1,367	652	352	29	44	7,060
1988[1]	1,001	1,953	1,609	684	358	158	68	95	6,450
1989	1,629	2,963	2,374	1,320	846	337	323	104	10,100
1990	3,886	4,478	4,047	2,972	1,509	365	140	122	19,185
1991	5,371	5,821	9,171	8,523	4,499	1,531	982	395	36,420
1992	10,228	8,858	5,330	13,960	12,720	4,547	494	346	58,172
1993	10,160	9,078	5,855	7,071	4,327	2,088	1,552	948	41,284
1994	3,340	5,883	4,185	3,922	3,315	1,021	845	423	22,985
1995	2,000	9,100	5,070	3,060	2,400	1,040	920	780	24,840
1996	130	1,260	2,480	1,030	480	550	990	400	7,400
1997	810	1,980	5,470	5,560	2,340	590	190	450	17,430
1998	2,698	1,741	4,620	4,053	1,761	535	545	241	16,403
1999	794	7,057	3,698	4,563	2,449	467	619	369	20,017
2000	360	1,240	1,390	2,010	760	400	160	390	6,750
2001	110	790	1,470	3,710	4,600	1,880	680	370	13,660
2002	0	64	415	459	880	620	565	519	3,522
2003	90	108	83	525	565	447	760	769	3,437
2004	0	10	50	650	740	670	430	190	2,740
2005	45	0	30	315	384	307	159	274	1,513
2006	0	70	64	167	376	473	735	1,514	3,398
2007	32	58	1,003	1,049	3,875	4,656	811	1,267	12,751
2008	3,573	175	21	42	142	475	162	529	12,130

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 1992-2008 (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	20,155
1995	600	1,600	6,400	5,100	1,800	2,200	1,800	700	700	400	700	500	400	500	23,400
1996	40	110	+	560	1,050	940	930	400	1,050	280	320	590	160	70	6,500
1997	320	490	+	480	1,500	6,950	2,720	1,680	800	1,310	550	30	+	120	16,950
1998	210	1,817	881	202	1,555	2,187	4,551	1,913	1,010	797	49	264	73	187	15,696
1999	0	760	2,893	1,339	3,534	1,037	3,905	2,603	762	1,663	481	361	258	152	19,748
2000	40	20	400	350	840	480	730	1,670	620	340	510	100	80	70	6,250
2001	0	40	50	450	330	790	1,760	1,970	3,300	1,200	1,810	150	660	430	12,940
2002	0	0	+	+	65	160	204	326	364	614	442	328	15	0	2,518
2003	30	30	30	+	108	+	219	263	126	259	306	199	248	411	2,229
2004	0	0	0	+	+	20	360	120	430	160	410	360	370	200	2,430
2005	0	45	0	0	0	30	48	228	138	187	194	93	105	109	1,177
2006	0	0	23	23	23	21	22	21	84	0	84	279	194	376	1,148
2007	0	33	19	19	19	764	764	525	0	0	21	1,927	1,927	1,683	7,702
2008	10583	44	88	44	11	11	0	42	88	13	13	118	63	174	11,292

Table D14. ***Sebastes marinus*** **in Sub-area I and II. Mean catch rates (N/nm2) of** ***Sebastes marinus*** **from Norwegian Coastal Surveys (Division IIa) in 1995-2008 within 100-350 m depth. Catch rates for the total area.**

Length range (cm)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-9	41	34	4	0	0	0	0	0	0	1	1	0	0	4
10-14	118	87	9	0	19	2	2	0	6	3	5	3	0	5
15-19	59	124	12	4	242	13	11	0	10	6	5	0	0	1
20-24	54	151	64	12	160	7	14	2	43	21	30	2	4	4
25-29	38	67	112	16	34	10	22	6	66	66	46	3	7	5
30-34	69	210	96	17	43	30	15	29	49	35	48	30	17	17
35-39	214	415	178	110	151	160	83	259	219	351	190	145	129	363
40-44	157	209	190	96	117	155	160	213	225	552	171	256	177	490
45-49	21	64	45	18	15	30	30	26	55	42	37	66	29	99
50-54	2	0	2	3	4	4	2	4	6	3	1	9	1	12
55-59	1	0	1	0	2	0	0	1	1	1	0	0	0	2
60-64	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Hauls									123	104	99	112	131	110
Total.Distance (nm)									160	130	132	112	140	139
Fish Caught									1367	1290	833	771	637	1156
Fish Sampled									1053	950	780	680	637	850

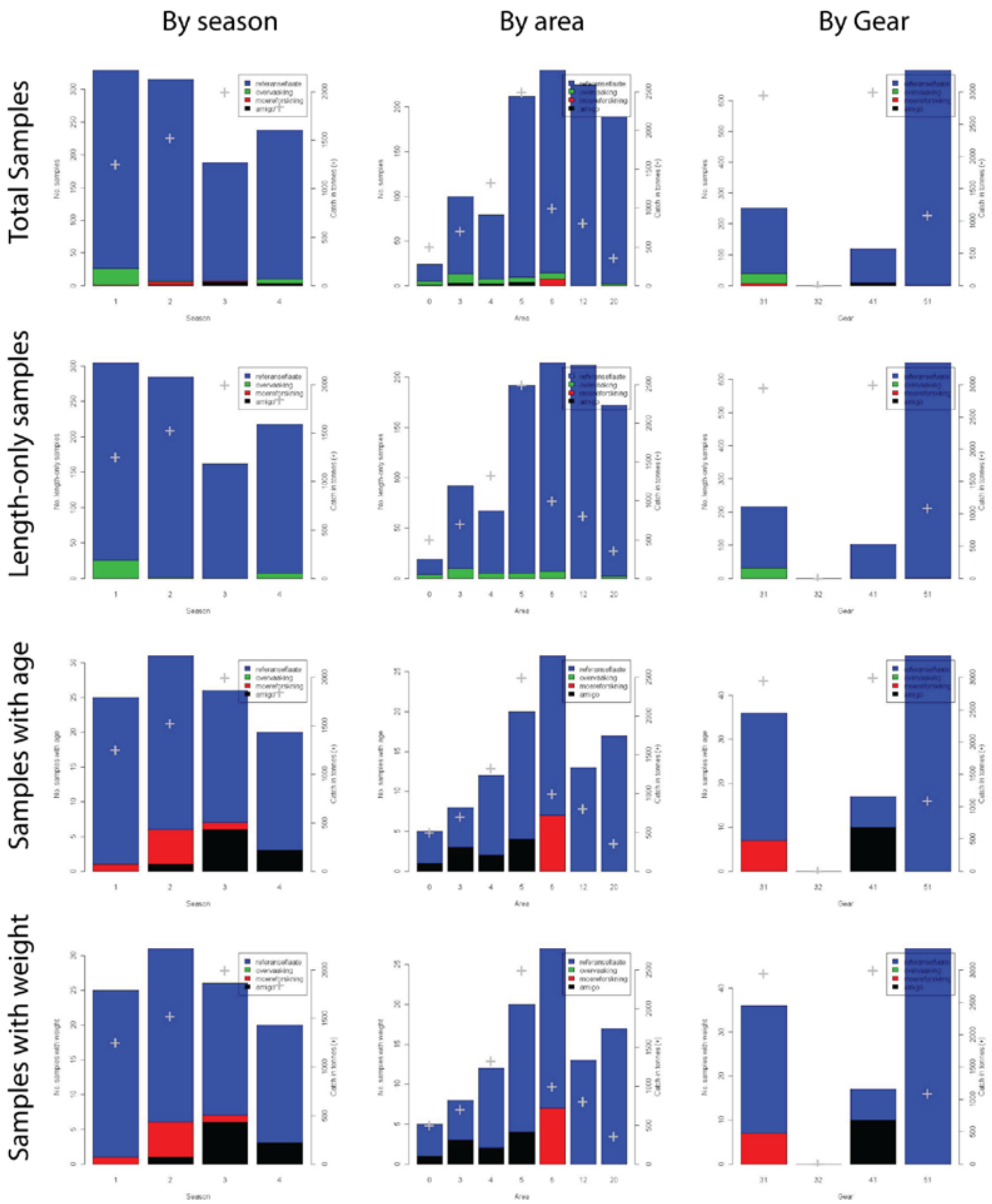


Figure D 1. Overview of the Norwegian biological samples from the commercial fisheries for *S. marinus* in 2008 representing more than 80% of the catches and which the input data to the Gadget model are based upon. The colours denote which sampling platform that has been used, e.g., port sampling (black), Reference fleet (blue) and inspectors/observers (green). The crosses show the catch in tonnes for the different gears, quarters and areas.

8 Greenland halibut in subareas I and II

An update assessment is presented for this stock. This should be regarded as an exploratory run and just used to view trends in the stock. The work on the age reading problems are continued, but we still need time before a thorough benchmark assessment can be carried out. The joint Russian-Norwegian program on Greenland halibut is planned to end in 2009. General information about this stock is located in the Quality Handbook.

8.1 Status of the fisheries

8.1.1 Landings prior to 2009 (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, and landings separated by gear type are presented in Table 8.5. 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 catches from Polish and Spanish surveys conducted in 2008.

The preliminary estimate of the total catch for 2008 is 13,144 t. This is substantially lower than the projected catch for 2008 estimated by the Working Group during its 2008 meeting (14,500 t). It is also much (about 4-5 thou. t) lower than total catch for each of the previous years 2004-2006. The difference between projected catch and preliminary estimate of total catch for 2008 is mainly due to both Norwegian and Russian catches being unexpectively lower than projected.

Some fishing for Greenland halibut has taken place in the northern part of Division IVa during the past 20-30 years, varying between a few tonnes and up to 2,500 t in 1999. Since 2005 this catch has been mostly below 100 t, and in 2008 it was 46 t. (Table E10). 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. 21 t were reported from this area in 2006, whereas in 2007 no catches reported. 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 2007 and 2008

The advice from ICES for 2008 was as follows:

Exploitation boundaries in relation to precautionary limits: The stock has remained at a relatively low size in the last 25 years at catch levels of 15 000 25 000 t. In order to increase the SSB, catches should be kept well below that range. Catches for 2008 should be below 13 000 t as advised since 2003; this is the level below which SSB has increased in the past.

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: *There is no estimate of high-yield reference points.*

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Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: *There is no estimate of high-yield reference points.*

8.1.3 Management applicable in 2008 and 2009

Target Greenland halibut fishery is forbidden since 1992. Management of Greenland halibut is by bycatch regulations and a limited coastal Norwegian fishery using longline and gillnet. From 2001 the bycatch regulations in each haul was not to exceed 12% in each haul and 7% of the landed catch. From early 2004 the Norwegian Department of Fisheries decided that for Norwegian vessels in the NEEZ allowable bycatch at any time on board and by landing should not exceed 7 %. In addition, the annual catch for each trawler are not allowed to exceed 4 % of the sum of the vessels quota on cod, haddock and saithe, and limited by a maximum annual catch of 40 t pr. vessel.

The Norwegian conventional fleet, vessels smaller than 28 m, are allowed to conduct a limited target fishery with longlines and gillnets in a limited area in approximately one month each year. For these vessels the TAC is set to 10, 12 and 14 t, dependent of size of the vessel. This fishery is supposed to keep the total catch at a level which these vessels landed historically (ca. 2,500 t).

The 30th Session of the joint Russian-Norwegian Fisheries Commission (JRNFC) in 2001 stated that both the Russian and the Norwegian party could catch up to 1,500 t of Greenland halibut for research and surveillance purposes in 2002. This research quota was increased in the commission meeting the year after to 3,000 t for each party, and stayed at this level until 2005. The JRNFC then increased the quota to 4,500 t for each party in 2006, and 4,900 t for each party in 2007. During the 36th Session of the JRNFC it was decided to decrease quotas for 2008 to 4,000 t for each party. The 37th JRNFC' Session remained research quotas for 2009 at the same level.

8.1.4 Expected landings in 2009

Due to regulation measures unchanging, for 2009 the total Norwegian catch is expected to be at the same level as in 2008, i.e. about 7,400 t. In addition, 5,200 t is expected to be caught by Russian vessels, and 400 t by other countries. Consequently, the official landings in 2009 are expected to be about 13,000 t. Discards is not regarded as a problem, but it is believed that there may be additional landings that are not reported. The catches from Division IVa are expected to be maintained at a low level (below 100 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, and in all subsequent assessments estimated recruitment of the last 2-3 years 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 was attributed to shortcomings in survey coverage. At previous meetings, the Working Group had noted the need for annual surveys that sample most of the population within a short period of time. Prior to the 2002 Working Group meeting, effort was therefore made to combine some of these surveys into a new total index. The new index was termed the Norwegian Combined Survey Index and was 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 were from 2004 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. 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. The Working Group has later advised that further work should be done to improve the combined index with regards to pooling different surveys using different gears.

Also in the Russian bottom trawl surveys in October-December (Table E6) it has been 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. However, it has been considered imprudent to use the 2002 and 2003 data from this survey series. During the 2002 survey, no observations were available from the Exclusive Economic Zone of Norway (NEEZ). In 2003, observations on the main spawning grounds 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.

The Norwegian CPUE survey (Table E9) was stopped from 2005. This was one of the tuning fleets, but an evaluation of this survey revealed a lot of inconsistencies in the series. Since 2006, none of the age structured tables of the Norwegian surveys have been updated due to change in age reading procedure.

The joint Russian-Norwegian research program on Greenland halibut will end in 2009 and will eventually contribute by increasing the understanding of the processes involved. The main objectives of the program is 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. The project has developed a new age reading procedure which has been used since 2006. This will eventually end up in total revision of the input data to the assessment.

During the last ten years there is a slowly increasing trend in biomass estimates both from the Norwegian CPUE survey (ended in 2006), the Norwegian Combined Index and the Russian Index (Figure 8.4). Data from 2007-2008 show that there was an increase both from the Norwegian and Russian surveys. However, the biomass indices of mature females from different surveys showed opposite trends in last years (Figure 8.5).

The Spanish bottom trawl survey from 1997 to 2008 (Table E7) showed an increase of Greenland halibut abundance and biomass in the Svalbard-Bear Island area from 2002 after three years with a declining trend.

Abundance indices of 0-group Greenland halibut are shown in Table 1.1. The increase in 0-group abundance after 1996 seems to have stopped, and the 2007-2008 indices were very low. It should be noted that the Ecosystem survey is not optimal for surveying 0-group Greenland halibut.

8.2.2 Commercial catch-per-unit-effort (Table 8.6 and E9)

The CPUE from the experimental fishery was found to be considerably higher than in the traditional fishery and has exhibited an increasing trend from 1992–1996. After 1996 the Norwegian CPUE series has varied between 1200 and 1800 kg/h with the highest value in 2005 (Table E9). The Russian experimental CPUE series shows an increasing trend since 1997, and this series shows the highest value in 2003. In 2004-2007 a significant decline was observed (Table 8.6) and this was probably caused by the reduced fishing period. The Norwegian CPUE survey was terminated in 2006.

8.2.3 Age readings

Based on scientific evidence that the species is more slow growing and vulnerable than the previous age readings suggest, the Norwegian age reading were changed in 2006 causing a situation which is not comparable with older data or the Russian age readings. This is a part of the joint research program where the age reading problems are addressed, and this will lead to revised age structure in the input data in the future.. There are some uncertainties to when these revised age readings can be used in the assessment, but the research program is planned to end in 2009. In 2007-2009, Russian age-length keys were used on the total catch matrix and the Russian survey was the only tuning fleet updated for 2008. The two Norwegian surveys were used as before as tuning series until 2005.

8.3 Data used in the assessment

Based on the arguments in Section 8.2.1 the Working Group also this year considers the survey indices for ages below age 5 not appropriate for inclusion in the tuning data. Consequently, a standard XSA was run for age 5 and above.

8.3.1 Catch-at-age (Table 8.7)

The catch-at-age data for 2007 were updated using revised catch figures. Catch-at-age data for 2006-2008 were available only from the Russian fisheries. The Russian catch-at-age were used to allocate catches from the 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 Russian weight-at-age data was used in the catch in 2006-2008 (Table 8.8). 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 1984–2008, 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 2004-2008 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 2002 and 2004.

8.3.5 Tuning data

The XSA was run with the same tuning series as used in last year's assessment:

Fleet 4: Experimental commercial fishery CPUE from 1992–2005 for ages 5–14.

Fleet 7: Russian trawl survey from 1992-2008 for ages 5-14. The 2002 and 2003 data was not included in this series due to the problems mentioned in section 8.2.1

Fleet 8: Norwegian Combined Survey from 1996-2005 for ages 5-15.

The software XXSA.exe were used.

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 2008 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 mid 1980's after which it declined markedly. It reached an all time low of 14,700 t by 1995-96 but has been increasing since then to an estimate of 54,000 by 2004, which is the highest value estimated since 1976 and higher than the long-term average for the whole period 1964-2008. The female spawning stock has decreased in 2005-2007 and increased again in 2008. The total stock decreased from 312,000 t in 1970 to the historical minimum at 45,000 t in 1992 and than shows the positive trend with the highest estimates at about 127,000 t in 2008. The maturity ogives used has shown a very variable maturity by age in the recent years and this affects the SSB.

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 0.65. After the reduction the fishing mortality has averaged around 0.25. The high catch in 1999 resulted in an increase in fishing mortality to 0.34 but since then has declined to 0.15-0.16 by 2002 and 2003, the lowest value estimated for the last 20 years. Due to the increased catch in 2004-2006 the fishing mortality again slightly raised (0.18-0.19) but remained lower than average. For the 2008 Fbar was estimated at 0.09 – the lowest level in history. It was conditioned by stock growth and significant reducing of total catch.

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 1990-2008 average is about 93% 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 2007

Given the uncertainty around the absolute values of population size at age no catch options are provided.

8.7 Comparison of this years assessment with last years assessment

Compared to last year assessment stock size for 2007 has reduced while SSB has been increased, fishing mortality remained at the same level.

	Total stock (5+) by 1 January 2008	SSB by 1 January 2008	F6-10 in 2008	F6-10 in 2007
WG 2008	126661	39584	0.18*	0.13
WG 2009	125803	41125	0.09	0.12

*prediction

8.8 Comments to the assessment (Figures 8.3 – 8.4)

The assessment was classified as an update assessment. The current assessment was using the same catch matrix, surveys series and settings as in the previous year with updated data for 2007 and new data for 2008. Fishing mortalities tend to be overestimated while SSB tends to be underestimated in the assessment year as illustrated by the retrospective plots in Figure 8.3.

The assessment is considered to be still uncertain due to the age-reading and survey data quality problems. Nevertheless the assessment may be accepted as indicative for stock trends. Although many aspects of the assessment remain uncertain, most fishery independent indices of stock size indicate positive trends in recent years. However, the biomass indices from the two Norwegian survey series seem to level out in the last years. (Figure 8.4).

The main result from the assessment is that the total stock has an increasing trend since 1992 and this is also seen in the SSB from 1995 to 2004. In 2004-2007 the SSB show a decreasing signal, whereas it has a slight increase in 2008. The estimate of the SSB is based on maturity ogives from the Russian survey. Other sources indicates no decreasing trend in the maturity of Greenland halibut in recent years. Biomass indices of mature females from the slope area (main adult area) have opposite trends in this period (Figure 8.5).

The working group have stated in several previous reports that catches above the mean in the period 1992-2003 (ca. 13,000 t) reduces the stocks ability to rebuild. The quite low catch in 2008 and expected catch of 2009 will most likely lead to further growth of the both total and spawning stock size.

8.9 Response to ACFM technical minutes

AFCM technical minutes are not commented on because the 2009 advice should be "same as previous year" and the report will not be reviewed.

Table 8.1. GREENLAND HALIBUT in Sub-areas I and II. Nominal catch (t) by countries (Sub-area I, Divisions IIa and IIb combined) as officially reported to ICES.

Year	Denmark	Estonia	Faroe Isl.	France	Fed. Rep. Germany	Gre enland	Ice land	Ire land	Lithu ania	Norway	Poland	Portugal	Russia[4]	Spain	UK (England & Wales)	UK (Scotland)	Total
1984	0	0	0	138	2,165	0	0	0	0	4,376	0	0	15,181	0	23	0	21,883
1985	0	0	0	239	4,000	0	0	0	0	5,464	0	0	10,237	0	5	0	19,945
1986	0	0	42	13	2,718	0	0	0	0	7,890	0	0	12,200	0	10	2	22,875
1987	0	0	0	13	2,024	0	0	0	0	7,261	0	0	9,733	0	61	20	19,112
1988	0	0	186	67	744	0	0	0	0	9,076	0	0	9,430	0	82	2	19,587
1989	0	0	67	31	600	0	0	0	0	10,622	0	0	8,812	0	6	0	20,138
1990	0	0	163	49	954	0	0	0	0	17,243	0	0	4,764[2]	0	10	0	23,183
1991	11	2,564	314	119	101	0	0	0	0	27,587	0	0	2,490[2]	132	0	2	33,320
1992	0	0	16	111	13	13	0	0	0	7,667	0	31	718	23	10	0	8,602
1993	2	0	61	80	22	8	56	0	30	10,380	0	43	1,235	0	16	0	11,933
1994	4	0	18	55	296	3	15	5	4	8,428	0	36	283	1	76	2	9,226
1995	0	0	12	174	35	12	25	2	0	9,368	0	84	794	1 106	115	7	11,734
1996	0	0	2	219	81	123	70	0	0	11,623	0	79	1,576	200	317	57	14,347
1997	0	0	27	253	56	0	62	2	0	7,661	12	50	1,038	157[2]	67	25	9,410
1998	0	0	57	67	34	0	23	2	0	8,435	31	99	2,659	259[2]	182	45	11,893
1999	0	0	94	0	34	38	7	2	0	15,004	8	49	3,823	319[2]	94	45	19,517
2000	0	0	0	45	15	0	16	1	0	9,083	3	37	4,568	375[2]	111	43	14,297
2001	0	0	0	122	58	0	9	1	0	10,896[2]	2	35	4,694	418[2]	100	30	16,365
2002	0	219	0	7	42	22	4	6	0	7,011[2]	5	14	5,584	178[2]	41	28	13,161
2003	0	0	459	2	18	14	0	1	0	8,347[2]	5	19	4,384	230[2]	41	58	13,578
2004	0	0	0	0	9	0	9	0	0	13,840[2]	1[2]	50	4,662	186[2]	43	0	18,800
2005[1]	0	170	0	32	8	0	0	0	0	13,011[3]	0[2]	23	4,883	660[2]	29	18	18,834
2006[1]	0	0	204	46	8	0	8	0	196	11,119[3]	201[2]	26[2]	6,055	27[2]	6	0	17,897
2007[1]	0	0	203	40	8	0	15	+	0	8,229[3]	200[2]	47[2]	6,484	11[2]	0	0	15,237
2008[1]	0	0	0	46	5	0	0	0	0	7,434[3]	201	46[2]	5,294	92[2]	26	0	13,144

[1] Provisional figures.

[2] Working Group figures.

[3] As reported to Norwegian authorities.

[4] 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[4]	Spain	UK (E & W)	UK (Scot.)	Total
1984	-	-	-	-	-	-	-	593	-	81	-	17	-	691
1985	-	-	-	-	-	-	-	602	-	122	-	1	-	725
1986	-	-	1	-	-	-	-	557	-	615	-	5	1	1,179
1987	-	-	2	-	-	-	-	984	-	259	-	10	+	1,255
1988	-	9	4	-	-	-	-	978	-	420	-	7	-	1,418
1989	-	-	-	-	-	-	-	2,039	-	482	-	+	-	2,521
1990	-	7	-	-	-	-	-	1,304	-	321[2]	-	-	-	1,632
1991	164	-	-	-	-	-	-	2,029	-	522[2]	-	-	-	2,715
1992	-	-	+	-	-	-	-	2,349	-	467	-	-	-	2,816
1993	-	32	-	-	-	56	-	1,754	-	867	-	-	-	2,709
1994	-	17	217	-	-	15	-	1,165	-	175	-	+	-	1,589
1995	-	12	-	-	-	25	-	1,352	-	270	84	-	-	1,743
1996	-	2	+	-	-	70	-	911	-	198	-	+	-	1,181
1997	-	15	-	-	-	62	-	610	-	170	-[2]	+	-	857
1998	-	47	+	-	-	23	-	859	-	491	-[2]	2	-	1,422
1999	-	91	-	-	13	7	-	1,101	-	1,203	-[2]	+	-	2,415
2000	-	-	+	-	-	16	-	1,021	+	1,169	-[2]	1	-	2,206
2001	-	-	-	-	-	9	-	925[2]	+	951	-[2]	2	-	1,887
2002	-	-	3	-	-	+	-	791[2]	-	1,167	-[2]	+	-	1,961
2003	-	48	+	+	2	+	1	949[2]	1	735	+[2]	+	+	1,736
2004[1]	-	-	-	-	-	+	-	812[2]	-	633	-[2]	3	-	1,449
2005[1]	-	-	-	1	-	-	-	572[3]	-	595	-[2]	3	-	1,171
2006[1]	-	17	1	-	-	1	-	575[3]	-	626	-[2]	2	-	1,222
2007[1]	-	18	+	+	+	3	-	514[3]	-	438	+	+	-	973
2008[1]	-	-	-	+	-	-	-	648[3]	-	390	-	-	-	1,038

[1] Provisional figures.

[2] Working Group figures.

[3] As reported to Norwegian authorities.

[4] USSR prior to 1991.

Table 8.3. GREENLAND HALIBUT in Sub areas I and II. Nominal catch (t) by countries in Division IIa as officially reported to ICES.

Year	Estonia	Faroe Islands	Fed. Rep. Germ.	France	Greenland	Iceland	Ireland	Norway	Poland	Portugal	Russia[5]	Spain	UK (E & W)	UK (Scot.)	Total
1984	-	-	265	138	-		-	3,703	-	-	5,459	-	1	-	9,566
1985	-	-	254	239	-		-	4,791	-	-	6,894	-	2	-	12,180
1986	-	6	97	13	-		-	6,389	-	-	5,553	-	5	1	12,064
1987	-	-	75	13	-		-	5,705	-	-	4,739	-	44	10	10,586
1988	-	177	150	67	-		-	7,859	-	-	4,002	-	56	2	12,313
1989	-	67	104	31	-		-	8,050	-	-	4,964	-	6	-	13,222
1990	-	133	12	49	-		-	8,233	-	-	1,246[2]	-	1	-	9,674
1991	1,400	314	21	119	-		-	11,189	-	-	305[2]	-	+	1	13,349
1992	-	16	1	108	13[4]		-	3,586	-	15[3]	58	-	1	-	3,798
1993	-	29	14	78	8[4]		-	7,977	-	17	210	-	2	-	8,335
1994	-	-	33	47	3[4]		4	6,382	-	26	67	+	14	-	6,576
1995	-	-	30	174	12[4]		2	6,354	-	60	227	-	83	2	6,944
1996	-	-	34	219	123[4]		-	9,508	-	55	466	4	278	57	10,744
1997	-	-	23	253	-[4]		-	5,702	-	41	334	1[2]	21	25	6,400
1998	-	-	16	67	-[4]		1	6,661	-	80	530	5[2]	74	41	7,475
1999	-	-	20	-	25[4]		2	13,064	-	33	734	1[2]	63	45	13,987
2000	-	-	10	43	-[4]		+	7,536	-	18	690	1[2]	65	43	8,406
2001	-	-	49	122	-[4]	9	1	8,740	-	13	726	5[2]	56	30	9,751
2002	-	-	9	7	22[4]	4	-	5,780[2]	-	3	849	-[2]	12	28	6,714
2003	-	390	5	2	12[4]	+	+	6,778[2]	+	10	1,762	14[2]	5	58	9,036
2004	-	-	4	-	-[4]	9	-	11,633[2]	-	24	810	4[2]	1	-	12,485
2005[1]	-	-	3	31	-[4]	-	-	11,216[3]	-	11	1,406	+	5	18	12,690
2006[1]	-	175	-	38	-	7	-	8,897[3]	-[2]	6	950	+	2	-	10,075
2007[1]	-	162	2	37	+	12	-	6,760[3]	-[2]	2	489[2]	-	+	+	7,463
2008[1]	-	-	4	46	-	-		5,269[3]	1	1	1,170	-	16	-	6,507

[1]Provisional figures. [2]Working Group figure. [3]As reported to Norwegian authorities.

[4]Includes Division Iib. [5] USSR prior to 1991.

Table 8.4. GREENLAND HALIBUT in Sub-areas I and II. Nominal catch (t) by countries in Division IIb as officially reported to ICES.

Year	Denmark	Estonia	Faroe Isl.	France	Fed. Rep. Germ.	Ireland	Lithuania	Norway	Poland	Portugal	Russia[4]	Spain	UK (E&W)	UK (Scot.)	Total
1984	-	-	-	-	1,900	-	-	80	-	-	9,641	-	5	-	11,626
1985	-	-	-	-	3,746	-	-	71	-	-	3,221	-	2	-	7,040
1986	-	-	36	-	2,620	-	-	944	-	-	6,032	-	+	-	9,632
1987	+	-	-	-	1,947	-	-	572	-	-	4,735	-	7	10	7,271
1988	-	-	-	-	590	-	-	239	-	-	5,008	-	19	+	5,856
1989	-	-	-	-	496	-	-	533	-	-	3,366	-	-	-	4,395
1990	-	-	23[2]	-	942	-	-	7,706	-	-	3,197[2]	-	9	-	11,877
1991	11	1,000	-	-	80	-	-	14,369	-	-	1,663[2]	132	+	1	17,256
1992	-	-	-	3[2]	12	-	-	1,732	-	16	193	23	9	-	1,988
1993	2[3]	-	-	2[3]	8	-	30[3]	649	-	26	158	-	14	-	889
1994	4	-	1[3]	8[3]	46	1	4[3]	881	-	10	41	1	62	2	1,061
1995	-	-	-	-	5	-	-	1,662	-	24	297	1,022	32	5	3,047
1996	+	-	-	-	47	-	-	1,204	-	24	912	196	39	+	2,422
1997	-	-	12	-	33	2	-	1,349	12	9	534	156[2]	46	+	2,153
1998	-	-	10	-	18	1	-	915	31	19	1,638	254[2]	106	4	2,996
1999	-	-	3	-	14	-	-	839	8	16	1,886	318[2]	31	-	3,115
2000	-	-	-	2	5	-	-	526	3	19	2,709	374[2]	46	-	3,685
2001	-	-	-	+	9	-	-	1,231[2]	2	22	3,017	413[2]	42	-	4,736
2002	-	219	-	+	30	6	-	440[2]	5	11	3,568	178[2]	29	-	4,486
2003	+	+	21	-	13	-	-	620[2]	4	9	1,887	216	35	+	2,805
2004	-	-	-	-	5	-	-	1,395[2]	1	26	3,219	182[2]	39	-	4,866
2005[1]	-	170	-	-	5	-	-	1,223[3]	-	12	2,882	660[2]	21	-	4,973
2006[1]	-	-	12	8	7	-	196	1,647[3]	201[2]	20	4,479	27[2]	2	-	6,600
2007[1]	-	-	23	3	6	+	-	955[3]	200[2]	45	5,557	11[2]	+	+	6,800
2008[1]	-	-	-	+	1	-	-	1,517	200	45	3,734	92[2]	10	-	5,599

[1]Provisional figures.

[2]Working Group figure.

[3]As reported to Norwegian authorities.

[4] USSR prior to 1991.

Table 8.5. GREENLAND HALIBUT in the Sub-areas I and II. Landings by gear (tonnes). Approximate figures, the total may differ slightly from Table 8.1

Year	Gillnet	Longline	Trawl	Danish seine	Total
1980	1 189	336	11 759		13 284
1981	730	459	13 829		15 018
1982	748	679	15 362		16 789
1983	1 648	1 388	19 111		22 147
1984	1 200	1 453	19 230		21 883
1985	1 668	750	17 527		19 945
1986	1 677	497	20 701		22 875
1987	2 239	588	16 285		19 112
1988	2 815	838	15 934		19 587
1989	1 342	197	18 599		20 138
1990	1 372	1 491	20 325		23 188
1991	1 904	4 552	26 864		33 320
1992	1 679	1 787	5 787		9 253
1993	1 497	2 493	7 889		11 879
1994	1 403	2 392	5 353		9 148
1995	1 500	4 034	5 494		11 028
1996	1 480	4 616	7 977		14 073
1997	998	3 378	5 198		9 574
1998	1 327	3 891	6 664		11 882
1999	2 565	6 804	10 177		19 546
2000	1 707	5 029	7 700		14 437
2001	2 041	6 303	7 968		16 312
2002	1 737	5 309	6 115		13 161
2003	2 046	5 483	6 049		13 578
2004	2 290	7 135	8 778	599	18 801
2005	1 842	7 539	9 420	447	19 248
2006	1 503	6 146	10 042	205	17 896
2007	997	4503	9618	119	15237
2008	900	3584	8651	9	13144

Table 8.6. GREENLAND HALIBUT in Sub-areas I and II. Catch per unit effort and total effort.

Year	USSR catch/hour trawling (t)		Norway[10] catch/hour trawling (t)		Average CPUE		Total effort (in '000 hrs trawling)[5]	CPUE 7+[6]	GDR[7] (catch/day tonnage (kg)
	RT[1]	PST[2]	A[8]	B[9]	A[3]	B[4]			
1965	0.80	-	-	-	0.80	-	-	-	-
1966	0.77	-	-	-	0.77	-	-	-	-
1967	0.70	-	-	-	0.70	-	-	-	-
1968	0.65	-	-	-	0.65	-	-	-	-
1969	0.53	-	-	-	0.53	-	-	-	-
1970	0.53	-	-	-	0.53	-	169	0.50	-
1971	0.46	-	-	-	0.46	-	172	0.43	-
1972	0.37	-	-	-	0.37	-	116	0.33	-
1973	0.37	-	0.34	-	0.36	-	83	0.36	-
1974	0.40	-	0.36	-	0.38	-	100	0.36	-
1975	0.39	0.51	0.38	-	0.39	0.45	99	0.37	-
1976	0.40	0.56	0.33	-	0.37	0.45	100	0.34	-
1977	0.27	0.41	0.33	-	0.30	0.37	96	0.26	-
1978	0.21	0.32	0.21	-	0.21	0.27	123	0.17	-
1979	0.23	0.35	0.28	-	0.26	0.32	67	0.19	-
1980	0.24	0.33	0.32	-	0.28	0.33	47	0.25	-
1981	0.30	0.36	0.36	-	0.33	0.36	42	0.28	-
1982	0.26	0.45	0.41	-	0.34	0.43	39	0.37	-
1983	0.26	0.40	0.35	-	0.31	0.38	58	0.32	-
1984	0.27	0.41	0.32	-	0.30	0.37	59	0.30	-
1985	0.28	0.52	0.37	-	0.33	0.45	44	0.37	-
1986	0.23	0.42	0.37	-	0.30	0.40	57	0.32	-
1987	0.25	0.50	0.35	-	0.30	0.43	44	0.35	-
1988	0.20	0.30	0.31	-	0.26	0.31	63	0.26	4.26
1989	0.20	0.30	0.26	-	0.23	0.28	73	0.19	2.95
1990	-	0.20	0.27	-	-	0.24	95	0.16	1.66
1991	-	-	0.24	-	-	-	134	0.18	-
1992	-	-	0.46	0.72	-	-	20	0.29	-
1993	-	-	0.79	1.22	-	-	15	0.65	-
1994	-	-	0.77	1.27	-	-	11	0.70	-
1995	-	-	1.03	1.48	-	-	-	-	-
1996	-	-	1.45	1.82	-	-	-	-	-
1997	0.71	-	1.23	1.60	-	-	-	-	-
1998	0.71	-	0.98	1.35	-	-	-	-	-
1999	0.84	-	0.82	1.77	-	-	-	-	-
2000	0.94	-	1.38	1.92	-	-	-	-	-
2001	0.82 [11]	-	1.18	1.57	-	-	-	-	-
2002	0.85	-	1.07	1.82	-	-	-	-	-
2003	0.97 [12]	-	0.86	2.45	-	-	-	-	-
2004	0.63 [13]	-	1.16	1.79	-	-	-	-	-
2005	0.61 [12]	-	1.30	2.29	-	-	-	-	-
2006	0.57 [12]	-	0.96	2.09	-	-	-	-	-
2007	0.64 [12]	-	-	-	-	-	-	-	-
2008	0.48 [12]	-	-	-	-	-	-	-	-

[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. Catch numbers at age Numbers*10-3**

Run title : Arctic Green.halibut (run: 2008/1)

At 24/04/2008 11:48

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

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	372	253	170	156	114	1064	526	80	1109	212	917
6	1480	853	563	332	283	2420	2792	4486	3521	1117	2519
7	2808	1735	1106	623	452	3208	10464	12712	9605	3923	6204
8	5674	3868	2715	2006	1976	6288	18562	12283	6438	3515	3838
9	4951	4203	4054	3237	3923	4921	10034	6130	2775	2551	1834
10	3981	3799	2499	2409	2950	4431	6671	4339	1734	1919	1942
11	1853	1799	1284	1718	2234	2381	2517	2703	1368	1536	1622
12	1018	1002	783	871	792	812	1250	1660	1234	1127	1338
13	364	372	246	315	146	229	616	1044	675	716	734
14	251	282	261	155	43	100	1104	300	200	251	531
+gp	76	50	28	19	7	30	281	143	80	126	216
0 TOTALNUM	22828	18216	13709	11841	12920	25884	54817	45880	28739	16993	21695
TONSLAND	40391	34751	26321	24267	26168	43789	89484	79034	43055	29938	37763
SOPCOF %	100	100	101	100	100	103	94	104	98	92	98

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

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	840	830	2037	1897	2218	731	1896	1304	1543	915	1219
6	2337	2982	3255	3589	3155	1138	1917	1494	1864	3698	2874
7	6520	5824	4200	4118	2727	1665	1919	1276	1851	3350	2561
8	4118	5002	2524	2365	1234	1341	933	1208	2287	1938	1548
9	2265	3000	1610	1509	495	944	484	1493	1491	1064	972
10	1654	1350	1104	946	319	473	448	1258	1228	1191	1037
11	1857	915	1062	934	296	511	482	838	713	602	614
12	1536	1212	858	438	243	275	380	502	488	340	363
13	1122	698	595	349	103	242	384	324	247	171	161
14	600	526	384	147	45	145	150	108	201	132	120
+gp	368	358	180	112	51	78	62	46	64	71	63
0 TOTALNUM	23217	22697	17809	16404	10886	7543	9055	9851	11977	13472	11532
TONSLAND	38172	36074	28827	24617	17312	13284	15018	16789	22147	21883	19945
SOPCOF %	88	93	101	105	104	109	107	100	98	100	99

Table 8.7 (Continued)

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE												
5		1672	1212	907	2080	2139	3312	1098	1140	631	846	1034	330
6		3335	2972	2540	4453	5163	3889	1195	1088	708	992	2083	921
7		2712	3572	3141	3655	4642	4716	1069	1608	1252	1719	3795	1822
8		1531	1746	2096	1657	1932	2355	778	1118	817	990	1426	953
9		1128	752	1182	801	1221	1031	360	140	310	405	262	342
10		997	828	860	318	499	1284	600	976	642	726	655	822
11		530	362	481	228	264	774	188	444	416	461	270	231
12		434	202	313	126	314	673	150	144	330	371	132	150
13		314	186	133	120	42	177	79	36	88	154	29	18
14		305	63	140	140	96	266	89	20	39	56	22	41
	+gp	239	7	47	28	44	517	56	4	3	8	1	1
0	TOTALNUM	13197	11902	11840	13606	16356	18994	5662	6718	5236	6728	9709	5631
	TONSLAND	22875	19112	19587	20138	23183	33320	8602	11933	9226	11734	14347	9410
	SOPCOF %	98	101	100	103	102	105	95	102	99	101	101	99

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

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE											
5		359	433	380	441	277	397	290	429	548	987	427
6		1116	1905	735	1347	921	1025	1016	1072	1347	1598	717
7		2466	3955	1926	2338	1475	1827	2316	1962	2067	2202	1184
8		1464	1810	1464	1325	983	928	1392	1766	1584	1134	1225
9		527	914	743	788	631	632	1087	936	1034	629	755
10		924	1905	1318	1140	1097	1045	778	991	691	436	299
11		237	380	457	519	563	520	675	616	485	426	348
12		122	237	330	372	301	311	607	622	548	464	392
13		15	67	49	115	132	77	199	376	466	246	324
14		29	42	37	54	59	107	155	244	209	169	196
	+gp	15	7	14	12	42	26	105	328	230	224	235
0	TOTALNUM	7274	11655	7453	8451	6481	6895	8620	9342	9209	8515	6102
	TONSLAND	11893	19517	14437	16307	13161	13578	18800	18834	17897	15237	13144
	SOPCOF %	100	102	101	100	100	100	99	97	100	96	101

Table 8.8. Catch weights at age (kg)

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:24

Table 2 Catch weights at age (kg)

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	0.42	0.42	0.42	0.42	0.42	0.42	0.567	0.567	0.567	0.567	0.567
6	0.64	0.64	0.64	0.65	0.66	0.64	0.737	0.737	0.737	0.737	0.737
7	0.9	0.9	0.91	0.93	0.96	0.91	1.079	1.079	1.079	1.079	1.079
8	1.2	1.22	1.24	1.27	1.31	1.25	1.421	1.421	1.421	1.421	1.421
9	1.63	1.66	1.7	1.71	1.74	1.64	1.848	1.848	1.848	1.848	1.848
10	2.26	2.23	2.22	2.2	2.19	2.25	2.281	2.281	2.281	2.281	2.281
11	3.11	3	2.94	2.84	2.79	2.99	2.887	2.887	2.887	2.887	2.887
12	3.74	3.49	3.39	3.3	3.19	3.63	3.247	3.247	3.247	3.247	3.247
13	4.57	4.4	4.38	4.27	4.27	4.68	4.303	4.303	4.303	4.303	4.303
14	5.01	4.91	4.84	4.88	5	5.38	4.931	4.931	4.931	4.931	4.931
+gp	5.94	5.89	5.88	5.8	5.99	5.99	5.794	5.841	6.037	6.006	5.964
0 SOPCOFAC	0.9986	1.0046	1.0054	1.0024	0.9994	1.0262	0.9436	1.0434	0.9752	0.9231	0.9825

Table 2 Catch weights at age (kg)

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	0.567	0.567	0.567	0.567	0.9	0.702	0.66	0.69	0.75	0.63	0.6
6	0.737	0.737	0.737	0.737	1.2	0.872	0.84	0.84	1.04	0.96	0.89
7	1.079	1.079	1.079	1.079	1.5	1.141	1.15	1.03	1.34	1.18	1.2
8	1.421	1.421	1.421	1.421	1.8	1.468	1.56	1.31	1.57	1.53	1.85
9	1.848	1.848	1.848	1.848	2.2	1.778	2.04	1.74	1.97	2.31	2.59
10	2.281	2.281	2.281	2.281	2.6	2.302	2.57	2.24	2.73	2.87	3.18
11	2.887	2.887	2.887	2.887	3	2.664	2.98	2.77	3.29	3.46	3.62
12	3.247	3.247	3.247	3.247	3.5	3.046	3.43	3.37	4.22	3.77	3.95
13	4.303	4.303	4.303	4.303	4.1	3.368	4.13	4.32	4.71	3.99	4.48
14	4.931	4.931	4.931	4.931	4.8	4.285	4.68	5.35	6.08	4.35	4.25
+gp	5.91	5.923	6.027	5.906	6.176	5.346	5.999	5.833	6.122	4.525	4.825
0 SOPCOFAC	0.8805	0.9255	1.0095	1.0485	1.0364	1.0894	1.068	1.0038	0.9783	1.0009	0.9858

Table 8.8 (Continued)

Table 2 Catch weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0.62	0.709	0.74	0.76	0.71	0.77	0.68	0.79	0.72	0.73	0.77
6	0.92	1.003	0.962	1.03	1.06	1.05	0.97	1.02	0.94	0.94	0.97
7	1.28	1.266	1.249	1.32	1.29	1.38	1.27	1.35	1.27	1.25	1.31
8	1.9	1.683	1.626	1.8	1.7	1.75	1.76	1.88	1.72	1.74	1.74
9	2.48	2.482	2.164	2.42	2.1	2.2	2.21	2.46	2.19	2.09	2.24
10	3.11	2.982	2.897	3.13	2.61	2.6	2.56	2.67	2.52	2.51	2.59
11	3.35	3.547	3.406	3.37	2.87	2.79	3.11	3.43	2.97	2.95	3.29
12	3.72	3.8	3.661	4.05	3.45	3.28	3.59	4.29	3.29	3.34	4.02
13	4	4.56	4.247	4.29	3.72	3.89	3.83	5.08	3.84	3.83	4.75
14	4.18	5.002	4.187	4.5	4.09	4.38	4.25	6.33	4.95	4.98	6.24
+gp	4.526	5.953	4.463	4.72	4.52	5.29	4.8	8.91	6.68	8.15	6.09
0 SOPCOFAC	0.9782	1.0116	0.9973	1.0346	1.0204	1.047	0.9519	1.0183	0.9937	1.0095	1.0066

Table 2 Catch weights at age (kg)

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
5	0.77	0.73	0.7	0.76	0.74	0.69	0.715	0.77	0.669	0.637	0.626
6	0.94	0.93	0.95	0.97	1.03	0.94	1.05	1.095	0.952	0.86	0.903
7	1.28	1.3	1.27	1.33	1.39	1.36	1.428	1.498	1.306	1.149	1.313
8	1.64	1.61	1.55	1.63	1.75	1.68	1.748	1.903	1.653	1.53	1.686
9	2.07	2.12	2	2.11	2.29	2.18	2.318	2.463	2.131	2.122	2.321
10	2.59	2.57	2.46	2.61	2.68	2.68	2.615	2.775	2.544	2.622	2.553
11	3.3	3.25	3.22	3.35	3.33	3.19	3.043	3.128	2.848	2.699	2.925
12	4.01	3.91	3.85	3.97	3.92	3.89	3.694	3.809	3.334	3.315	3.189
13	4.83	4.9	4.61	4.97	4.81	4.46	4.566	4.291	3.734	3.998	3.747
14	5.95	5.66	5.84	5.82	5.81	5.25	5.568	5.453	4.384	4.641	4.539
+gp	6.26	4.91	5.98	7.22	7.41	6.32	6.365	6.355	5.791	6.743	9.078
0 SOPCOFAC	0.9851	0.9983	1.0172	1.0055	1.0014	1	0.996	0.9853	0.9655	1.0042	0.9592

Table 2 Catch weights at age (kg)

YEAR	2008
AGE	
5	0.695
6	0.919
7	1.359
8	1.756
9	2.231
10	2.378
11	2.855
12	3.23
13	3.546
14	3.915
+gp	7.453
0 SOPCOFAC	1.0081

Table 8.9. Proportion mature at age

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:24

Table 5 Proportion mature at age

YEAR AGE	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
5	0	0	0	0	0	0	0	0	0	0	0
6	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
7	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
8	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
9	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
10	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
11	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
12	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
13	1	1	1	1	1	1	1	1	1	1	1
14	1	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 AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
5	0	0	0	0	0	0	0	0	0	0	0
6	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
7	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
8	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.18	0.18	0.19
9	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.6	0.61	0.65
10	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.82	0.83	0.85
11	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.96	0.97	0.97
12	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99
13	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1	1

Table 8.9 (Continued)

Table 5 Proportion mature at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0	0	0	0	0	0	0	0.01	0.01	0.01	0
6	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0
7	0.03	0.02	0.01	0.02	0.02	0.04	0.06	0.08	0.07	0.08	0.07
8	0.24	0.22	0.21	0.18	0.17	0.15	0.28	0.32	0.34	0.29	0.25
9	0.74	0.66	0.53	0.49	0.51	0.54	0.66	0.68	0.69	0.58	0.58
10	0.91	0.9	0.87	0.8	0.77	0.77	0.86	0.83	0.81	0.79	0.88
11	0.99	0.95	0.89	0.89	0.91	0.89	0.87	0.88	0.95	0.96	0.97
12	0.98	0.98	0.98	1	1	1	1	0.94	0.94	0.89	0.94
13	1	1	1	1	1	1	1	1	1	1	1
14	1	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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
5	0	0	0	0	0.01	0.01	0.01	0	0	0	0
6	0	0	0	0.01	0.03	0.03	0.02	0.01	0.01	0.01	0.01
7	0.07	0.04	0.02	0.03	0.06	0.1	0.11	0.08	0.05	0.05	0.04
8	0.21	0.1	0.07	0.1	0.19	0.31	0.34	0.28	0.22	0.18	0.13
9	0.53	0.45	0.33	0.37	0.49	0.66	0.72	0.66	0.57	0.5	0.34
10	0.85	0.82	0.66	0.63	0.65	0.79	0.88	0.91	0.88	0.74	0.53
11	0.94	0.92	0.86	0.87	0.84	0.91	0.92	0.94	0.91	0.85	0.66
12	0.94	1	0.99	0.96	0.96	0.96	0.97	0.96	0.95	0.93	0.8
13	1	1	1	1	1	0.99	0.98	0.98	0.99	0.98	0.86
14	1	1	1	1	1	1	0.98	0.98	0.98	0.99	0.96
+gp	1	1	1	1	1	1	1	1	1	1	0.99

Table 5 Proportion mature at age

YEAR	2008
AGE	
5	0
6	0.01
7	0.02
8	0.12
9	0.38
10	0.57
11	0.67
12	0.78
13	0.82
14	0.95
+gp	0.99

Table 8.10. Extended Survivors Analysis

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

Arctic Green.halibut (run: 2009/1)

CPUE data from file fleet

Catch data for 45 years. 1964 to 2008. Ages 5 to 15.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT04: Norw. Exp. CP	1992	2008	5	14	0.38	0.44
FLT07: Russ.Surv. ne	1992	2008	5	14	0.75	0.92
FLT08: Norw.Comb.Sur	1996	2008	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 2008
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 50 iterations

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
5	0.028	0.023	0.029	0.016	0.025	0.015	0.018	0.026	0.06	0.032
6	0.131	0.057	0.103	0.073	0.07	0.079	0.068	0.067	0.095	0.054
7	0.352	0.18	0.244	0.148	0.192	0.212	0.204	0.172	0.142	0.09
8	0.269	0.201	0.171	0.145	0.124	0.208	0.235	0.238	0.127	0.104
9	0.209	0.159	0.15	0.109	0.124	0.199	0.199	0.198	0.132	0.111
10	0.731	0.494	0.368	0.302	0.251	0.209	0.265	0.209	0.114	0.081
11	0.371	0.357	0.346	0.294	0.216	0.241	0.24	0.19	0.182	0.118
12	0.651	0.602	0.52	0.326	0.248	0.396	0.345	0.33	0.264	0.24
13	0.464	0.249	0.407	0.331	0.122	0.235	0.431	0.445	0.228	0.281
14	0.492	0.475	0.45	0.356	0.46	0.361	0.472	0.427	0.269	0.27

Table 8.10 (Continued)

XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12	13	14
1999	1.71E+04	1.67E+04	1.44E+04	8.27E+03	5.22E+03	3.96E+03	1.32E+03	5.34E+02	1.95E+02	1.16E+02
2000	1.77E+04	1.43E+04	1.26E+04	8.68E+03	5.44E+03	3.64E+03	1.64E+03	7.86E+02	2.40E+02	1.05E+02
2001	1.68E+04	1.48E+04	1.16E+04	9.06E+03	6.12E+03	4.00E+03	1.91E+03	9.88E+02	3.70E+02	1.61E+02
2002	1.92E+04	1.41E+04	1.15E+04	7.86E+03	6.57E+03	4.53E+03	2.38E+03	1.17E+03	5.06E+02	2.12E+02
2003	1.72E+04	1.63E+04	1.13E+04	8.55E+03	5.85E+03	5.07E+03	2.88E+03	1.53E+03	7.24E+02	3.13E+02
2004	2.07E+04	1.44E+04	1.31E+04	8.00E+03	6.50E+03	4.45E+03	3.40E+03	2.00E+03	1.03E+03	5.51E+02
2005	2.64E+04	1.75E+04	1.15E+04	9.10E+03	5.60E+03	4.58E+03	3.11E+03	2.30E+03	1.16E+03	6.98E+02
2006	2.26E+04	2.23E+04	1.41E+04	8.07E+03	6.19E+03	3.95E+03	3.03E+03	2.10E+03	1.40E+03	6.48E+02
2007	1.82E+04	1.90E+04	1.80E+04	1.02E+04	5.47E+03	4.37E+03	2.76E+03	2.15E+03	1.30E+03	7.72E+02
2008	1.47E+04	1.48E+04	1.48E+04	1.34E+04	7.75E+03	4.13E+03	3.36E+03	1.98E+03	1.42E+03	8.92E+02

Estimated population abundance at 1st Jan 2009

	0.00E+00	1.23E+04	1.21E+04	1.17E+04	1.04E+04	5.97E+03	3.27E+03	2.57E+03	1.34E+03	9.25E+02

Taper weighted geometric mean of the VPA populations:

	1.88E+04	1.58E+04	1.22E+04	8.05E+03	5.18E+03	3.55E+03	1.96E+03	1.09E+03	5.21E+02	2.74E+02

Standard error of the weighted Log(VPA populations) :

	0.1731	0.1954	0.2442	0.3095	0.3579	0.3741	0.569	0.7133	0.8845	0.9085

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992	1993	1994	1995	1996	1997	1998
5	0.37	0.94	0.69	0.81	1.05	0.95	-0.6
6	-0.14	0.11	0.24	-0.04	0.78	0.19	-0.15
7	-0.45	0.13	0.16	0.15	0.38	0.07	0.05
8	-0.13	0.24	0.34	0.35	0.23	-0.16	-0.07
9	-1.5	-1.47	-0.97	0.24	-0.27	-0.06	-0.25
10	-0.34	0.19	0.38	0.85	0.1	0.57	-0.97
11	-0.12	-0.04	-0.12	0.27	-0.58	0.6	-0.92
12	0.18	-0.1	-0.74	0.23	-0.71	0.52	-0.82
13	-0.3	0	-0.69	-0.13	99.99	0.11	99.99
14	-1.36	-0.22	-0.52	0.14	-0.19	-0.12	99.99

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
5	-0.25	0.32	-0.37	-0.26	-0.03	-0.16	-0.72	99.99	99.99	99.99
6	-0.12	-0.03	-0.08	-0.17	-0.06	-0.05	0.01	99.99	99.99	99.99
7	-0.14	0.26	-0.24	0.18	-0.1	-0.2	-0.1	99.99	99.99	99.99
8	-0.17	-0.14	0.3	-0.2	-0.55	0.01	0.45	99.99	99.99	99.99
9	-1.21	0.03	0.26	0.13	0.39	0.49	0.67	99.99	99.99	99.99
10	0.28	0.41	-0.08	0	0.09	-0.61	-0.12	99.99	99.99	99.99
11	-1.07	-1.09	-0.76	-0.75	-0.35	-0.5	-0.49	99.99	99.99	99.99
12	0.59	-0.09	-0.08	-0.67	0	-0.03	0.12	99.99	99.99	99.99
13	-0.62	0.34	-0.88	-1.63	-0.28	-0.3	0.19	99.99	99.99	99.99
14	-0.09	99.99	-0.43	-0.06	-0.18	-0.09	-0.02	99.99	99.99	99.99

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

Age	5	6	7	8	9	10	11	12	13	14
Mean Log q	-5.1463	-4.1183	-3.3102	-3.7789	-4.4979	-3.7072	-3.7072	-3.7072	-3.7072	-3.7072
S.E(Log q)	0.5823	0.224	0.2035	0.3102	0.6171	0.4693	0.7435	0.4662	0.7509	0.2903

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	-3.93	-1.024	28.35	0.01	14	2.28	-5.15
6	1.26	-0.422	2.68	0.27	14	0.3	-4.12
7	1.13	-0.344	2.5	0.49	14	0.24	-3.31
8	1.37	-0.697	1.86	0.33	14	0.44	-3.78
9	0.57	1.385	6.2	0.6	14	0.33	-4.5
10	1.5	-0.828	1.52	0.29	14	0.72	-3.71
11	1.26	-0.702	3.42	0.51	14	0.62	-4.25
12	0.94	0.286	4	0.74	14	0.45	-3.81
13	1	-0.005	4.09	0.59	12	0.68	-4.1
14	0.94	0.558	3.96	0.94	12	0.23	-3.87
1							

Fleet : FLT07: Russ.Surv. ne

Age	1992	1993	1994	1995	1996	1997	1998
5	1.79	0.65	-0.05	-0.56	-0.44	-1.1	-0.37
6	0.99	0.69	0.27	-0.1	0.03	-0.51	-0.42
7	0.56	0.59	0.09	0.06	0.12	-0.24	-0.27
8	0.43	0.42	0.16	0.41	0.27	0.06	0.11
9	-0.59	-0.04	0.04	0.35	0.78	-0.12	0.17
10	-0.39	0.03	0.3	0.24	-0.81	0.02	0.2
11	0.4	-0.1	-0.44	-0.04	-0.63	0.33	0.76
12	0.29	0.42	-0.01	0.06	-0.89	-0.41	0.57
13	-0.45	-0.32	-0.39	-0.29	-0.43	0.39	0.39
14	-5.09	0.67	0.48	-1.79	-0.4	-0.41	-0.35

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
5	-0.49	0.07	0.6	99.99	99.99	-0.22	-0.26	0.39	0.46	0.41
6	-0.53	-0.2	0.69	99.99	99.99	0.14	-0.26	0.16	0.12	0.07
7	-0.5	-0.24	0.28	99.99	99.99	-0.05	-0.04	0.33	0.04	0.07
8	-0.03	0.14	-0.33	99.99	99.99	-0.18	-0.29	0.21	-0.2	0.09
9	0.05	0.1	-0.35	99.99	99.99	-0.14	-0.57	-0.18	0.1	0.47
10	0.12	0.18	0.09	99.99	99.99	-0.21	-0.34	-0.14	0.2	0.27
11	-0.22	0.53	0.05	99.99	99.99	-0.31	-0.54	-0.26	0.57	0.65
12	0.25	0.54	0.77	99.99	99.99	-0.02	-0.3	0.16	0.88	1.25
13	0.62	-0.81	1.04	99.99	99.99	-0.02	-0.24	0.33	0.54	1.36
14	-0.26	0.41	0.46	99.99	99.99	0.47	-0.06	0.24	0.6	1.3

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	-0.4199	0.463	0.9128	1.0487	0.6753	0.3437	0.3437	0.3437	0.3437	0.3437
S.E(Log q)	0.5343	0.3749	0.2614	0.2317	0.3518	0.2852	0.4903	0.6601	0.7019	0.8974

Table 8.10 (Continued)

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	-2.87	-1.508	36.89	0.02	15	1.44	-0.42
6	2.42	-0.99	-14.9	0.06	15	0.91	0.46
7	1.31	-0.714	-4.16	0.39	15	0.35	0.91
8	1.56	-1.773	-6.71	0.55	15	0.33	1.05
9	1.27	-0.683	-3.19	0.44	15	0.46	0.68
10	0.91	0.385	0.43	0.69	15	0.27	0.34
11	1.07	-0.224	-0.95	0.58	15	0.55	0.42
12	0.82	0.88	0.72	0.75	15	0.48	0.65
13	0.83	0.926	0.56	0.78	15	0.54	0.6
14	0.73	1.317	1.18	0.74	15	0.62	0.48
1							

Fleet : FLT08: Norw.Comb.Sur

Age	1992	1993	1994	1995	1996	1997	1998
5	99.99	99.99	99.99	99.99	0.24	-0.13	-0.32
6	99.99	99.99	99.99	99.99	0.33	0.18	-0.33
7	99.99	99.99	99.99	99.99	0.36	0.08	0.17
8	99.99	99.99	99.99	99.99	0.53	-0.32	-0.15
9	99.99	99.99	99.99	99.99	0.03	-0.43	-0.66
10	99.99	99.99	99.99	99.99	0.84	0.4	0.36
11	99.99	99.99	99.99	99.99	0.13	0.09	0.1
12	99.99	99.99	99.99	99.99	0.26	0.43	0.79
13	99.99	99.99	99.99	99.99	-0.39	-1.1	-2.94
14	99.99	99.99	99.99	99.99	0.19	0.07	0.3

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
5	-0.34	0.07	-0.14	0.02	0.26	-0.08	0.3	99.99	99.99	99.99
6	-0.05	-0.15	0.06	-0.06	0.1	0.01	0.02	99.99	99.99	99.99
7	-0.05	-0.19	0.1	0.15	0.11	-0.02	-0.46	99.99	99.99	99.99
8	0.29	-0.08	-0.02	0.02	-0.04	0.01	-0.09	99.99	99.99	99.99
9	-0.4	0.39	-0.24	0.33	0.25	0.02	0.31	99.99	99.99	99.99
10	0.42	-0.27	0.13	-0.24	-0.08	-0.49	-0.31	99.99	99.99	99.99
11	-0.34	-0.93	-0.72	-0.17	-0.79	-0.95	-0.54	99.99	99.99	99.99
12	0.81	-0.3	-0.08	0.14	-0.15	0.12	-0.29	99.99	99.99	99.99
13	0.08	-0.56	-0.62	-0.14	-0.3	-0.05	-0.21	99.99	99.99	99.99
14	0.21	-0.59	-0.16	-0.14	-0.47	0.13	-0.51	99.99	99.99	99.99

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

Age	5	6	7	8	9	10	11	12	13	14
Mean Log q	-0.2604	0.2697	0.8927	0.4175	-0.1491	0.6494	0.6494	0.6494	0.6494	0.6494
S.E(Log q)	0.2313	0.1605	0.228	0.2025	0.368	0.398	0.6591	0.4255	1.0206	0.3638

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	0.64	0.934	3.7	0.53	10	0.15	-0.26
6	1.68	-0.57	-7.02	0.1	10	0.28	0.27
7	1.25	-0.177	-3.47	0.08	10	0.31	0.89
8	3.12	-1.239	-20.36	0.05	10	0.61	0.42
9	0.71	0.779	2.6	0.54	10	0.27	-0.15
10	5.68	-2.983	-42.07	0.06	10	1.55	0.65
11	2.12	-2.752	-8.8	0.5	10	0.64	0.17
12	1.64	-2.384	-5.66	0.7	10	0.51	0.78
13	0.64	1.551	2.1	0.76	10	0.49	0.1
14	1.17	-0.905	-1.53	0.82	10	0.4	0.51
1							

Terminal year survivor and F summaries :

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

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	1	0	0	0	0	0	0
FLT07: Russ.Surv. ne	18422	0.56	0	0	1	0.436	0.021
FLT08: Norw.Comb.Sur	1	0	0	0	0	0	0
F shrinkage mean	8945	0.5				0.564	0.043

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12254	0.37	0.54	2	1.455	0.032

Table 8.10 (Continued)

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

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	1	0	0	0	0	0	0
FLT07: Russ.Surv. ne	14603	0.322	0.185	0.57	2	0.692	0.045
FLT08: Norw.Comb.Sur	1	0	0	0	0	0	0
F shrinkage mean	7847	0.5				0.308	0.081

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12059	0.27	0.27	3	0.986	0.054

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

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	1	0	0	0	0	0	0
FLT07: Russ.Surv. ne	13320	0.22	0.075	0.34	3	0.819	0.079
FLT08: Norw.Comb.Sur	1	0	0	0	0	0	0
F shrinkage mean	6451	0.5				0.181	0.157

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11682	0.2	0.19	4	0.925	0.09

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

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	5081	0.617	0	0	1	0.048	0.202
FLT07: Russ.Surv. ne	11009	0.178	0.061	0.35	4	0.651	0.098
FLT08: Norw.Comb.Sur	14049	0.302	0	0	1	0.2	0.078
F shrinkage mean	5654	0.5				0.101	0.183

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10413	0.14	0.13	7	0.877	0.104

Table 8.10 (Continued)

Age 9 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	5826	0.271	0.065	0.24	2	0.154	0.114
FLT07: Russ.Surv. ne	6475	0.162	0.157	0.97	5	0.525	0.103
FLT08: Norw.Comb.Sur	5786	0.214	0.05	0.24	2	0.247	0.114
F shrinkage mean	3885	0.5				0.074	0.166

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5967	0.11	0.09	10	0.779	0.111

Age 10 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	3042	0.203	0.019	0.09	3	0.189	0.087
FLT07: Russ.Surv. ne	3838	0.15	0.055	0.37	5	0.5	0.07
FLT08: Norw.Comb.Sur	3022	0.176	0.212	1.21	3	0.248	0.088
F shrinkage mean	1579	0.5				0.063	0.162

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3274	0.1	0.08	12	0.849	0.081

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	2709	0.175	0.165	0.94	4	0.225	0.113
FLT07: Russ.Surv. ne	2689	0.156	0.147	0.94	5	0.426	0.113
FLT08: Norw.Comb.Sur	2561	0.154	0.04	0.26	4	0.286	0.119
F shrinkage mean	1575	0.5				0.063	0.186

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2568	0.09	0.08	14	0.801	0.118

Table 8.10 (Continued)

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	1299	0.172	0.123	0.72	5	0.226	0.247
FLT07: Russ.Surv. ne	1384	0.169	0.234	1.39	6	0.373	0.233
FLT08: Norw.Comb.Sur	1402	0.147	0.074	0.51	5	0.318	0.231
F shrinkage mean	1047	0.5				0.084	0.298

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1339	0.1	0.09	17	0.929	0.24

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	856	0.167	0.144	0.87	6	0.242	0.301
FLT07: Russ.Surv. ne	1061	0.183	0.246	1.34	7	0.319	0.25
FLT08: Norw.Comb.Sur	918	0.142	0.065	0.46	6	0.336	0.283
F shrinkage mean	748	0.5				0.103	0.338

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
925	0.1	0.09	20	0.919	0.281

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	471	0.169	0.103	0.61	7	0.234	0.326
FLT07: Russ.Surv. ne	626	0.186	0.189	1.02	8	0.316	0.255
FLT08: Norw.Comb.Sur	523	0.144	0.108	0.75	7	0.324	0.298
F shrinkage mean	1001	0.5				0.126	0.167

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
586	0.11	0.09	23	0.845	0.27

Table 8.11. Fishing mortality (F) at age

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:25

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	0.2369	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	0.4391	0.2444	0.2596	0.2744
10	0.7003	0.7254	0.2583	0.3382	0.3302	0.435	0.5339	0.4738	0.1999	0.2516	0.3041
11	0.6375	0.7606	0.5421	0.2684	0.5684	0.4571	0.4457	0.4037	0.2511	0.2585	0.3297
12	0.5666	0.8214	0.8585	0.8372	0.1802	0.3905	0.4362	0.5627	0.3063	0.3191	0.3545
13	0.4065	0.391	0.4515	1.0092	0.2945	0.0686	0.5465	0.7562	0.4414	0.2765	0.3346
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	0.0972	0.1045	0.1293	0.0432	0.1212	0.077	0.0912	0.0569	0.0681
6	0.1211	0.1894	0.2134	0.2345	0.2395	0.0858	0.1445	0.1256	0.1427	0.3091	0.2403
7	0.4197	0.4665	0.4175	0.4304	0.2656	0.1814	0.1931	0.1281	0.2139	0.3862	0.3445
8	0.3818	0.6251	0.3556	0.414	0.2073	0.1909	0.1387	0.1693	0.3348	0.3427	0.2918
9	0.3558	0.5	0.3927	0.3519	0.1332	0.2291	0.0923	0.3237	0.3074	0.242	0.272
10	0.4017	0.3508	0.3248	0.3979	0.1094	0.1722	0.1531	0.3455	0.4546	0.4064	0.3711
11	0.5023	0.3824	0.4846	0.4736	0.1956	0.2422	0.2516	0.4456	0.3172	0.3972	0.3571
12	0.5617	0.6828	0.708	0.3549	0.2023	0.2656	0.2702	0.425	0.4778	0.2316	0.418
13	0.5354	0.5073	0.8179	0.667	0.1238	0.3003	0.6801	0.3672	0.3606	0.2869	0.1548
14	0.4739	0.4873	0.5489	0.4515	0.1532	0.2427	0.2906	0.3832	0.3853	0.3141	0.3159
+gp	0.4739	0.4873	0.5489	0.4515	0.1532	0.2427	0.2906	0.3832	0.3853	0.3141	0.3159
0 FBAR 6-10	0.336	0.4264	0.3408	0.3657	0.191	0.1719	0.1443	0.2184	0.2907	0.3373	0.304

Table 8.11 (Continued)

Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0.095	0.0695	0.0434	0.1141	0.1723	0.3297	0.1186	0.0988	0.0375	0.0515	0.061
6	0.2538	0.2304	0.1927	0.2915	0.4285	0.5062	0.1788	0.1566	0.0779	0.0724	0.164
7	0.3536	0.4456	0.3829	0.4389	0.5275	0.8386	0.2363	0.3653	0.257	0.2594	0.4059
8	0.3364	0.3817	0.4825	0.3368	0.4131	0.5268	0.2899	0.3913	0.3015	0.3136	0.3361
9	0.3381	0.259	0.4551	0.322	0.4198	0.3815	0.1314	0.0729	0.1676	0.2265	0.1202
10	0.4661	0.4201	0.4989	0.1986	0.3216	1.0143	0.377	0.5842	0.5157	0.686	0.6494
11	0.3104	0.2883	0.4345	0.2222	0.2382	1.1506	0.3552	0.5003	0.4992	0.8279	0.555
12	0.4346	0.1757	0.4091	0.1811	0.5078	1.592	0.6662	0.4773	0.8224	1.1109	0.5597
13	0.737	0.3161	0.159	0.2551	0.08	0.568	0.763	0.3065	0.5697	1.1769	0.2046
14	0.4597	0.293	0.3932	0.2366	0.3148	0.9489	0.5919	0.4105	0.6005	0.8384	0.466
+gp	0.4597	0.293	0.3932	0.2366	0.3148	0.9489	0.5919	0.4105	0.6005	0.8384	0.466
0 FBAR 6-10	0.3496	0.3474	0.4024	0.3176	0.4221	0.6535	0.2427	0.3141	0.2639	0.3116	0.3351

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
5	0.017	0.0197	0.0277	0.0235	0.0286	0.0157	0.0252	0.0152	0.0177	0.0264	0.0601
6	0.0673	0.0697	0.1312	0.0569	0.103	0.0731	0.0702	0.0789	0.0681	0.0673	0.0952
7	0.1999	0.2441	0.3525	0.1799	0.2438	0.1485	0.1921	0.212	0.2035	0.1719	0.1417
8	0.1579	0.2313	0.2689	0.2006	0.1715	0.1449	0.1244	0.2077	0.2347	0.2379	0.1274
9	0.118	0.1164	0.2092	0.1592	0.1495	0.1092	0.1238	0.1989	0.1988	0.1984	0.1323
10	0.6264	0.4996	0.731	0.4942	0.3675	0.3023	0.2512	0.2088	0.2653	0.2091	0.1137
11	0.4695	0.3449	0.3705	0.357	0.3459	0.2942	0.2162	0.2412	0.2404	0.1897	0.1822
12	0.6517	0.4583	0.6512	0.6025	0.5204	0.3264	0.2478	0.3964	0.3453	0.3297	0.2641
13	0.1265	0.1129	0.4635	0.2491	0.4075	0.3305	0.1218	0.2345	0.4309	0.4447	0.2277
14	0.4666	0.291	0.4923	0.4754	0.4496	0.3565	0.4602	0.361	0.4725	0.4275	0.2691
+gp	0.4666	0.291	0.4923	0.4754	0.4496	0.3565	0.4602	0.361	0.4725	0.4275	0.2691
0 FBAR 6-10	0.2339	0.2322	0.3386	0.2181	0.2071	0.1556	0.1524	0.1812	0.1941	0.1769	0.122

Table 8.11 (Continued)

Table 8 Fishing mortality (F) at age

	YEAR	2008	FBAR **-**
	AGE		
5		0.0318	0.0395
6		0.0537	0.072
7		0.0899	0.1345
8		0.1036	0.1563
9		0.111	0.1472
10		0.0813	0.1347
11		0.1184	0.1634
12		0.2404	0.278
13		0.2814	0.3179
14		0.2702	0.3223
	+gp	0.2702	
0	FBAR 6-10	0.0879	

Table 8.12. Stock number at age (start of year) Numbers*10-3**

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:25

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	57829	70443	64281	55932	41113	31552	33557	31063	26646
6	33792	36528	44252	49616	60486	55221	47154	34898	27082	27854	26539
7	27961	27712	30648	37565	42397	51799	45284	37996	25875	20043	22938
8	27353	21461	22243	25353	31755	36072	41607	29269	20910	13360	13612
9	14559	18279	14883	16626	19961	25498	25214	18591	13796	12024	8238
10	8521	7938	11834	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	1129	2085
+gp	190	118	77	49	27	118	756	372	341	564	844
0 TOTAL	163799	171203	187988	219158	241729	252000	234432	180905	146455	130248	122723

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	22544	22104	23701	20599	19717	18633	17899	18954	19081	17833	19945
6	22083	18625	18255	18510	15970	14913	15360	13647	15104	14992	14500
7	20506	16839	13264	12692	12602	10818	11780	11442	10360	11271	9473
8	13987	11600	9090	7520	7104	8317	7767	8359	8664	7200	6593
9	8155	8218	5344	5483	4278	4970	5914	5819	6074	5335	4399
10	5389	4918	4290	3106	3319	3223	3402	4641	3624	3844	3605
11	5069	3104	2981	2669	1796	2561	2335	2512	2828	1980	2204
12	3853	2640	1823	1580	1430	1271	1730	1563	1385	1772	1145
13	2917	1891	1148	773	954	1006	839	1136	879	739	1210
14	1713	1470	980	436	341	725	641	366	678	528	478
+gp	1044	993	456	330	386	389	264	155	215	283	249
0 TOTAL	107261	92403	81332	73698	67897	66825	67930	68594	68891	65777	63801

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	19890	19456	23030	20795	14567	12712	10585	13061	18473	18154	18833
6	16036	15569	15621	18981	15969	10554	7869	8092	10184	15315	14841
7	9814	10708	10643	11089	12206	8955	5476	5664	5956	8109	12261
8	5777	5931	5903	6246	6153	6199	3332	3721	3383	3964	5384
9	4239	3552	3485	3136	3839	3504	3151	2146	2166	2154	2494
10	2884	2602	2360	1903	1956	2171	2059	2378	1717	1576	1478
11	2141	1558	1471	1233	1343	1221	678	1216	1141	883	683
12	1327	1351	1005	820	850	911	332	409	634	596	332
13	649	740	975	575	589	440	160	147	218	240	169
14	892	267	464	716	383	468	215	64	93	106	64
+gp	694	30	155	143	175	898	134	13	7	15	3
0 TOTAL	64344	61762	65112	65636	58030	48032	33990	36911	43973	51112	56542

Table 8.12 (Continued)

	Table 10	Stock number at age (start of year)			Numbers*10**-3						
	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	AGE											
5		17111	17650	16836	19224	17204	20694	26397	22635	18240	17111	17650
6		16700	14326	14839	14082	16290	14439	17542	22322	18974	16700	14326
7		14351	12607	11649	11523	11266	13070	11485	14104	17963	14351	12607
8		8275	8683	9064	7857	8549	8002	9100	8065	10222	8275	8683
9		5218	5443	6115	6572	5851	6497	5596	6194	5472	5218	5443
10		3960	3643	3995	4532	5071	4449	4584	3948	4372	3960	3643
11		1323	1641	1913	2381	2883	3395	3108	3026	2757	1323	1641
12		534	786	988	1165	1527	1999	2296	2103	2155	534	786
13		195	240	370	506	724	1026	1158	1399	1302	195	240
14		116	105	161	212	313	551	698	648	772	116	105
	+gp	19	40	35	150	75	371	933	708	1019	19	40
0	TOTAL	67802	65164	65967	68204	69753	74495	82898	85154	83248	67802	65164

	Table 10	Stock number at age (start of year)			Numbers*10**-3
	YEAR	2008	2009	GMST 64-**	AMST 64-**
	AGE				
5		14697	0	23301	25958
6		14784	12254	19214	21816
7		14848	12059	14515	17100
8		13418	11682	9613	12034
9		7746	10413	6274	7942
10		4126	5967	4222	5224
11		3359	3274	2431	3090
12		1978	2568	1400	1828
13		1424	1339	726	1025
14		892	925	411	604
	+gp	1065	1286		
0	TOTAL	78338	61768		

Table 8.13. Stock biomass at age (start of year) Tonnes

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:25

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	23492	23311	17890	19027	17613	15108
6		21627	23378	28321	32250	39921	35342	34753	25720	19960	20528	19559
7		25165	24941	27890	34936	40701	47137	48862	40997	27919	21627	24750
8		32824	26182	27581	32199	41599	45090	59124	41591	29713	18985	19343
9		23731	30343	25301	28430	34732	41818	46595	34356	25495	22221	15224
10		19258	17701	26270	19908	24762	30467	39647	28268	23527	21213	18209
11		13178	10923	9724	22342	15494	20915	21779	25323	19173	20985	17970
12		9488	6728	4965	5463	16515	9828	12376	13501	16371	14439	15687
13		5368	5452	3196	2281	2634	17415	6786	9127	8773	13747	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	209628	244356	274337	312356	242818	196243	180310	173138

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

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE											
5		12783	12533	13439	11680	17745	13080	11814	13078	14311	11235	11967
6		16275	13726	13454	13642	19164	13004	12902	11464	15708	14392	12905
7		22126	18169	14312	13695	18903	12344	13547	11785	13883	13300	11367
8		19876	16484	12918	10686	12787	12209	12116	10950	13603	11016	12197
9		15071	15188	9876	10132	9412	8836	12065	10126	11965	12325	11393
10		12292	11218	9786	7085	8629	7420	8742	10397	9893	11033	11464
11		14635	8961	8605	7704	5387	6822	6959	6958	9303	6850	7978
12		12509	8573	5918	5131	5006	3871	5934	5267	5844	6682	4524
13		12552	8136	4940	3325	3910	3387	3464	4909	4142	2949	5421
14		8449	7248	4832	2151	1639	3108	3000	1956	4119	2296	2029
	+gp	6168	5884	2747	1950	2383	2077	1582	903	1313	1278	1204
0	TOTALBIO	152736	126121	100826	87179	104965	86158	92125	87794	104084	93355	92451

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
5		12332	13794	17042	15804	10343	9788	7198	10318	13301	13253	14502
6		14753	15615	15028	19550	16927	11082	7632	8254	9573	14396	14395
7		12562	13556	13293	14637	15745	12358	6954	7646	7564	10136	16062
8		10977	9981	9598	11243	10461	10848	5865	6996	5819	6898	9369
9		10512	8817	7541	7589	8062	7708	6963	5280	4743	4502	5586
10		8971	7758	6837	5956	5105	5646	5272	6349	4328	3957	3828
11		7172	5525	5011	4156	3854	3405	2108	4170	3389	2604	2248
12		4938	5134	3679	3321	2932	2987	1194	1755	2087	1991	1334
13		2596	3373	4143	2465	2190	1713	611	747	839	919	803
14		3729	1337	1943	3223	1567	2049	913	405	461	530	397
	+gp	3143	176	691	673	790	4750	643	113	47	122	18
0	TOTALBIO	91684	85068	84805	88618	77976	72334	45352	52032	52150	59307	68542

Table 8.13 (Continued)

	Table 12	Stock biomass at age (start of year)			Tonnes							
	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	AGE												
5		16267	14447	11978	13414	12459	13265	12301	15934	17660	14419	11418	10214
6		14336	16625	15865	13896	15284	13237	17104	15811	16700	19197	17133	13586
7		13877	15954	18226	16767	16191	15671	16088	19578	15000	16206	23586	20179
8		11533	12301	12826	14153	15862	13200	14944	15227	15043	12340	17234	23562
9		6855	10958	10436	11485	14004	14327	13562	16003	11924	13145	12701	17282
10		4930	6509	9741	9509	10708	12147	13261	12347	11661	10351	11163	9813
11		2193	2846	4259	5497	6371	7596	8774	10621	8851	8167	8064	9589
12		1354	1399	2055	3120	3874	4532	5642	7616	7655	6973	6871	6388
13		788	742	897	1191	1781	2255	3304	4403	4323	5594	4879	5049
14		705	701	680	613	934	1113	1741	3006	3062	3006	3504	3494
	+gp	18	313	115	286	263	949	480	2361	5401	4776	9250	7940
0	TOTALBIO	72855	82794	87080	89932	97732	98292	107200	122906	117281	114173	125803	127097

Table 8.14. Spawning stock biomass at age (spawning time) Tonnes

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:25

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	743
8		6893	5498	5792	6762	8736	9469	12416	8734	6240	3987	4062
9		15900	20330	16952	19048	23270	28018	31219	23019	17082	14888	10200
10		16562	15223	22593	17121	21295	26202	34096	24310	20233	18244	15659
11		12914	10704	9529	21895	15184	20496	21344	24816	18789	20566	17610
12		9298	6594	4866	5354	16185	9631	12129	13231	16043	14150	15374
13		5368	5452	3196	2281	2634	17415	6786	9127	8773	13747	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	68558	76710	90724	116540	139621	111284	94882	95798	91523

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	404	409	575	390	387	344	471	576	516
7		664	545	429	411	567	370	406	354	416	399	455
8		4174	3462	2713	2244	2685	2564	2544	2299	2448	1983	2317
9		10098	10176	6617	6788	6306	5920	8083	6784	7179	7518	7406
10		10572	9647	8416	6093	7421	6381	7518	8941	8112	9158	9745
11		14342	8782	8433	7550	5279	6685	6820	6819	8931	6644	7739
12		12259	8401	5800	5028	4906	3794	5815	5162	5727	6548	4479
13		12552	8136	4940	3325	3910	3387	3464	4909	4142	2949	5421
14		8449	7248	4832	2151	1639	3108	3000	1956	4119	2296	2029
	+gp	6168	5884	2747	1950	2383	2077	1582	903	1313	1278	1204
0	TOTSPBIO	79765	62693	45330	35949	35671	34677	39621	38472	42860	39349	41311

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
5		0	0	0	0	0	0	0	103	133	133	0
6		443	156	150	196	169	111	76	83	96	144	0
7		377	271	133	293	315	494	417	612	529	811	1124
8		2635	2196	2015	2024	1778	1627	1642	2239	1978	2000	2342
9		7779	5819	3997	3718	4112	4163	4595	3590	3273	2611	3240
10		8163	6982	5948	4765	3931	4347	4534	5269	3506	3126	3369
11		7100	5249	4459	3699	3507	3031	1834	3670	3220	2499	2181
12		4839	5031	3605	3321	2932	2987	1194	1649	1962	1772	1254
13		2596	3373	4143	2465	2190	1713	611	747	839	919	803
14		3729	1337	1943	3223	1567	2049	913	405	461	530	397
	+gp	3143	176	691	673	790	4750	643	113	47	122	18
0	TOTSPBIO	40804	30591	27085	24376	21292	25272	16459	18479	16044	14667	14728

Table 8.14 (Continued)

	Table 13	Spawning stock biomass at age (spawning time)			Tonnes						
	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	AGE											
5		0	0	0	0	125	133	123	0	0	0	0
6		0	0	0	139	459	397	342	158	167	192	171
7		971	638	365	503	971	1567	1770	1566	750	810	943
8		2422	1230	898	1415	3014	4092	5081	4264	3309	2221	2240
9		3633	4931	3444	4249	6862	9456	9764	10562	6797	6572	4318
10		4190	5338	6429	5991	6960	9596	11670	11236	10262	7660	5916
11		2062	2618	3663	4782	5351	6913	8072	9983	8054	6942	5322
12		1273	1399	2035	2996	3719	4351	5473	7311	7273	6485	5497
13		788	742	897	1191	1781	2232	3238	4315	4280	5482	4196
14		705	701	680	613	934	1113	1706	2946	3001	2976	3364
	+gp	18	313	115	286	263	949	480	2361	5401	4776	9157
0	TOTSPBIO	16062	17909	18526	22165	30439	40799	47719	54701	49294	44116	41125

	Table 13	Spawning stock biomass at age (spawning time) Tonnes
	YEAR	2008
	AGE	
5		0
6		136
7		404
8		2827
9		6567
10		5593
11		6425
12		4983
13		4141
14		3319
	+gp	7861
0	TOTSPBIO	42255

Table 8.15. Summary (without SOP correction)

Run title : Arctic Green.halibut (run: 2009/1)

At 25/04/2009 14:25

	RECRUITS Age 5	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 6-10
1964	42840	172936	72644	40391	0.556	0.3146
1965	51686	171360	69254	34751	0.5018	0.2643
1966	57829	181480	68558	26321	0.3839	0.1601
1967	70443	209628	76710	24267	0.3163	0.1376
1968	64281	244356	90724	26168	0.2884	0.1309
1969	55932	274337	116540	43789	0.3757	0.1988
1970	41113	312356	139621	89484	0.6409	0.4204
1971	31552	242818	111284	79034	0.7102	0.4223
1972	33557	196243	94882	43055	0.4538	0.3019
1973	31063	180310	95798	29938	0.3125	0.2252
1974	26646	173138	91523	37763	0.4126	0.2787
1975	22544	152736	79765	38172	0.4786	0.336
1976	22104	126121	62693	36074	0.5754	0.4264
1977	23701	100826	45330	28827	0.6359	0.3408
1978	20599	87179	35949	24617	0.6848	0.3657
1979	19717	104965	35671	17312	0.4853	0.191
1980	18633	86158	34677	13284	0.3831	0.1719
1981	17899	92125	39621	15018	0.379	0.1443
1982	18954	87794	38472	16789	0.4364	0.2184
1983	19081	104084	42860	22147	0.5167	0.2907
1984	17833	93355	39349	21883	0.5561	0.3373
1985	19945	92451	41311	19945	0.4828	0.304
1986	19890	91684	40804	22875	0.5606	0.3496
1987	19456	85068	30591	19112	0.6247	0.3474
1988	23030	84805	27085	19587	0.7232	0.4024
1989	20795	88618	24376	20138	0.8261	0.3176
1990	14567	77976	21292	23183	1.0888	0.4221
1991	12712	72334	25272	33320	1.3184	0.6535
1992	10585	45352	16459	8602	0.5226	0.2427
1993	13061	52032	18479	11933	0.6457	0.3141
1994	18473	52150	16044	9226	0.5751	0.2639
1995	18154	59307	14667	11734	0.8	0.3116
1996	18833	68542	14728	14347	0.9741	0.3351
1997	21126	72855	16062	9410	0.5858	0.2339
1998	19790	82794	17909	11893	0.6641	0.2322
1999	17111	87080	18526	19517	1.0535	0.3386
2000	17650	89932	22165	14437	0.6513	0.2181
2001	16836	97732	30439	16307	0.5357	0.2071
2002	19224	98292	40799	13161	0.3226	0.1556
2003	17204	107200	47719	13578	0.2845	0.1524
2004	20694	122906	54701	18800	0.3437	0.1812
2005	26397	117281	49294	18834	0.3821	0.1941
2006	22635	114173	44116	17897	0.4057	0.1769
2007	18240	125803	41125	15237	0.3705	0.122
2008	14697	127097	42255	13144	0.3111	0.0879
Arith. Mean	25536	122395	48848	24562	0.5586	0.272
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

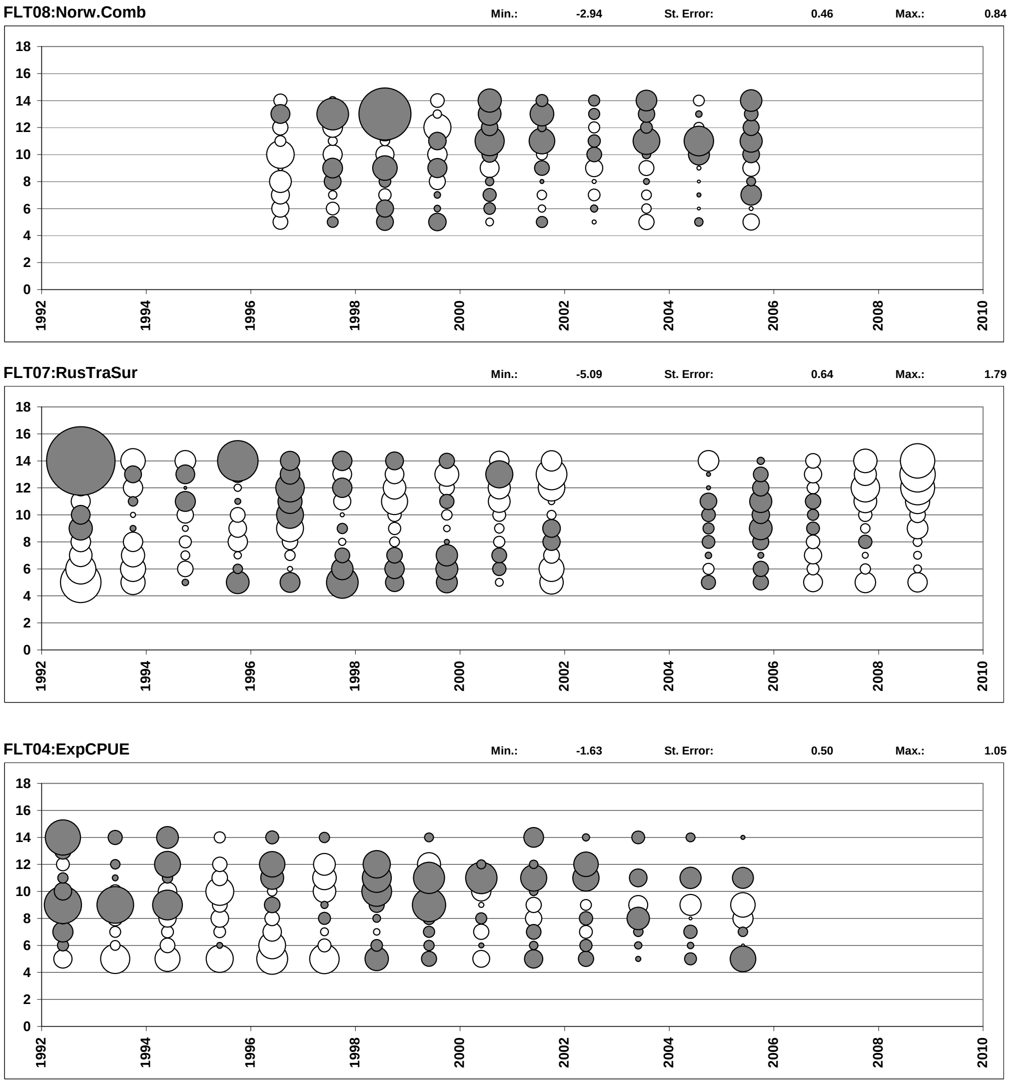

Figure 8.1. <u>NEA Greenland halibut</u>. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.

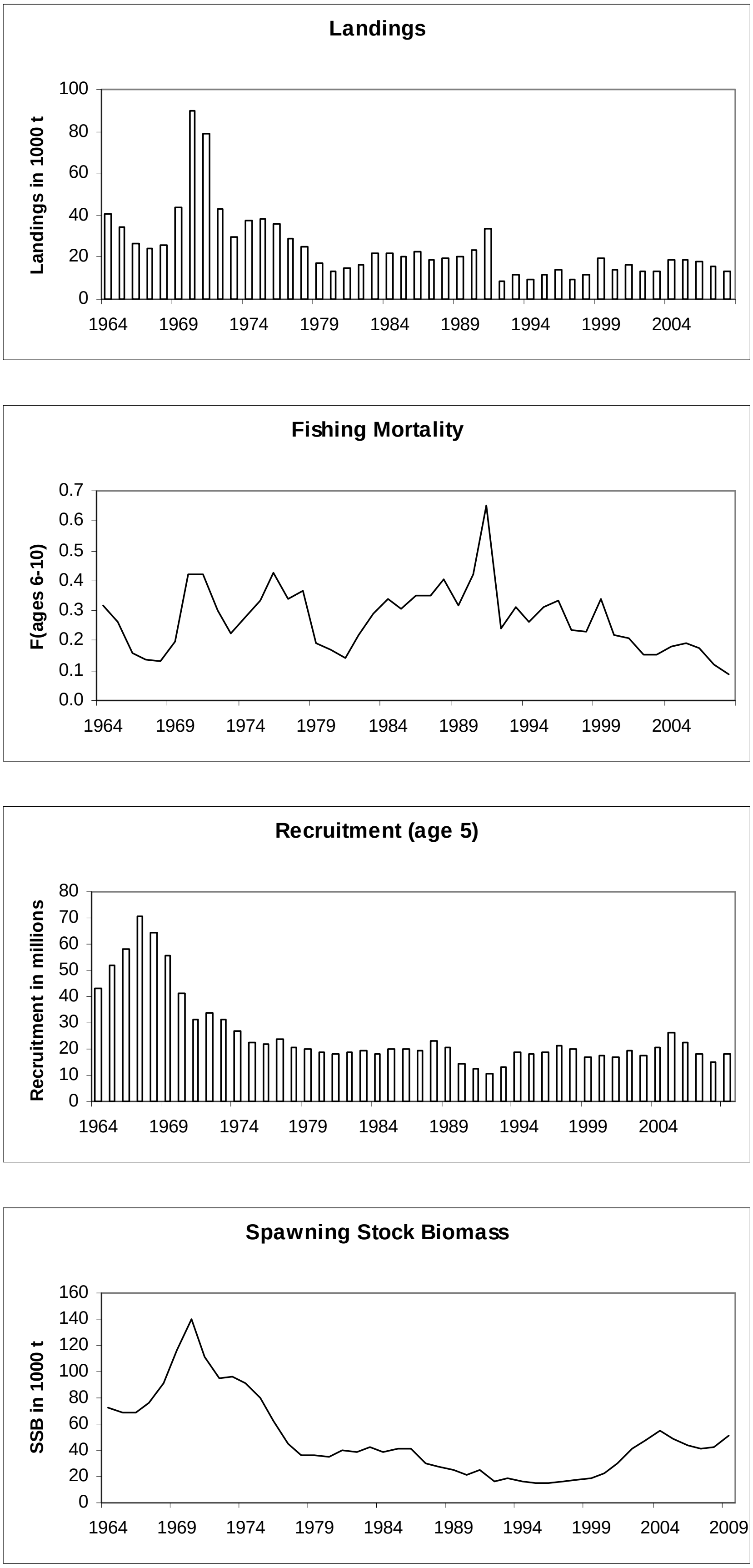

Figure 8.2. NEA Greenland halibut. Historical landings, recruitment, fishing mortality and spawning stock biomass.

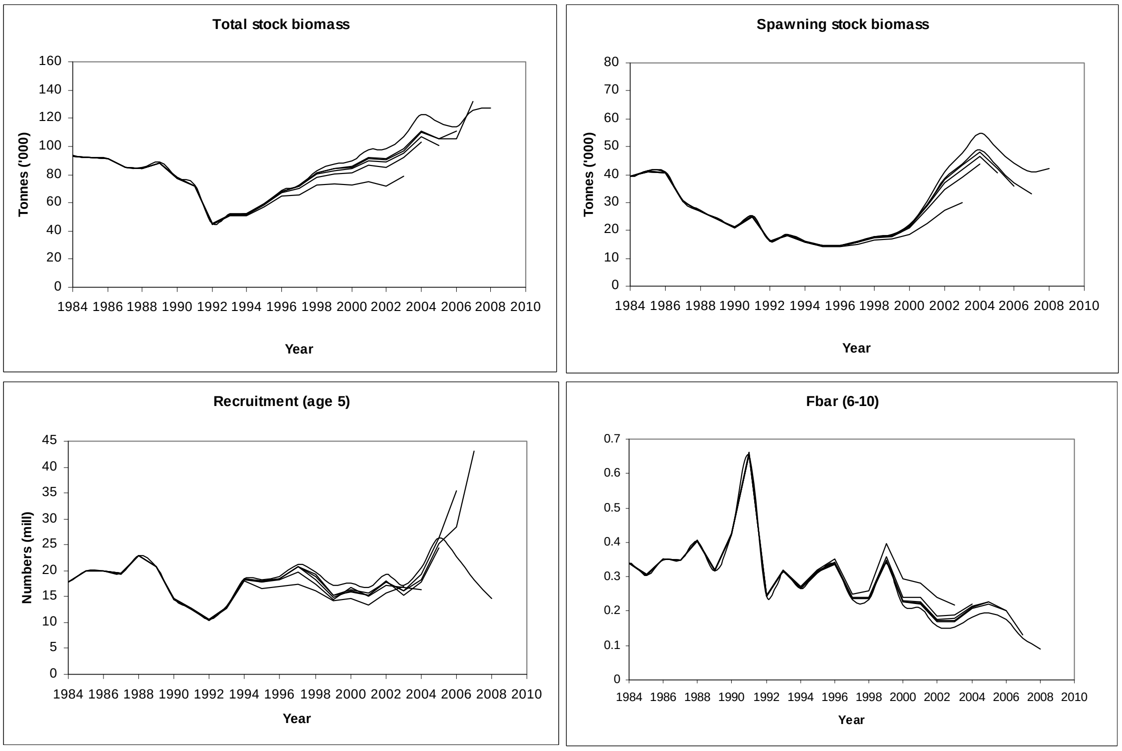

Figure 8.3. <u>NEA Greenland halibut</u>. Retrospective plots.

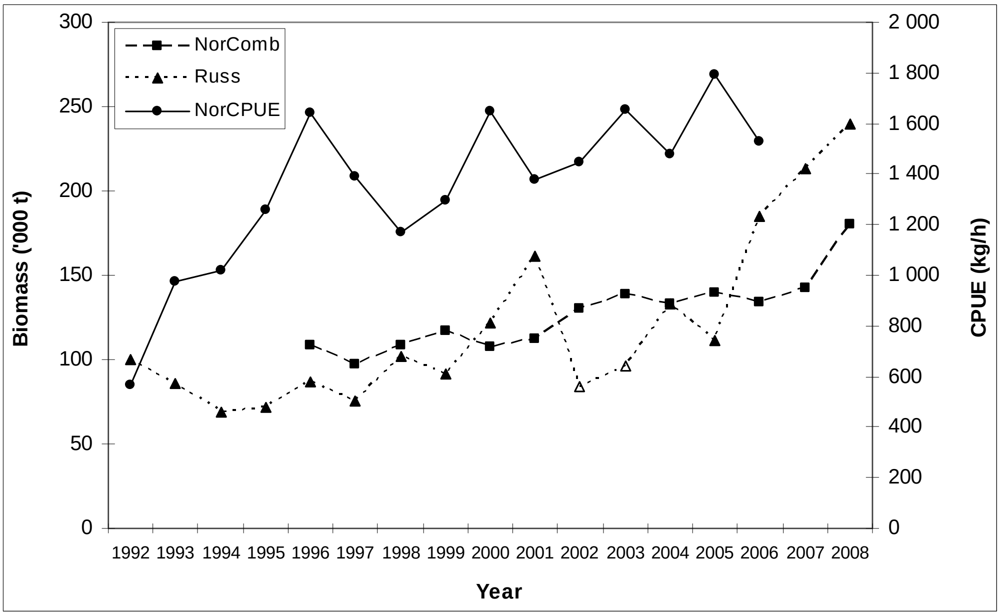

Figure 8.4. <u>NEA Greenland halibut</u>. Biomass estimates from the tuning series used in the assessment. Years with open symbols in the Russian series excluded from the tuning. The Norwegian CPUE Survey was ended in 2006.

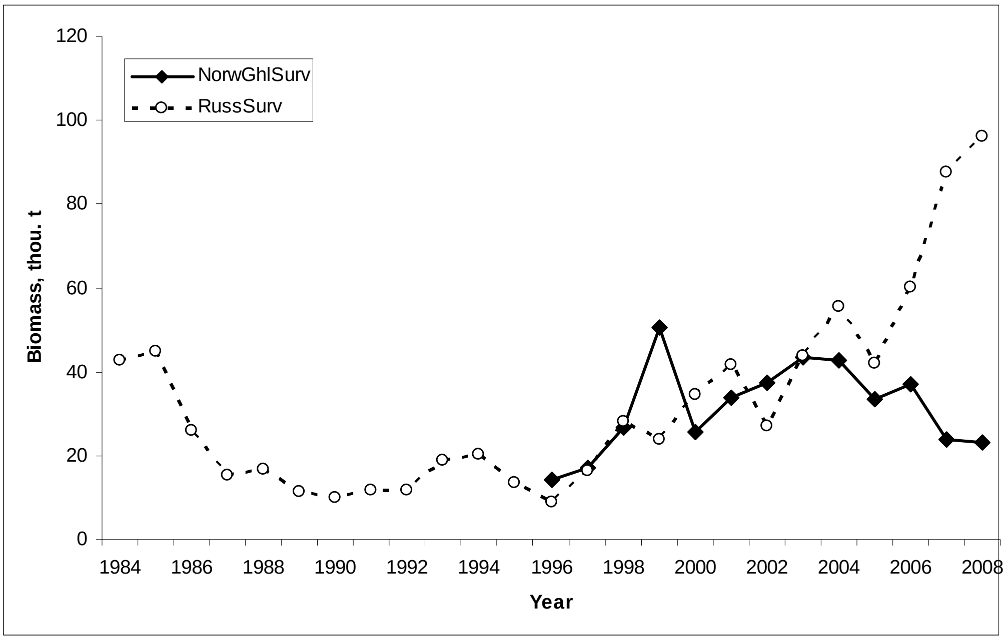

Figure 8.5. <u>NEA Greenland halibut</u>. Swept area estimate of the mature female biomass based on the data from the Norwegian Greenland halibut survey along the continental slope (August) and Russian trawl survey (October-December).

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 from 2004, 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												Total
Year		1	2	3	4	5	6	7	8	9	10	11	12	13+	
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												Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
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 from 2004, 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
2005	3	24	2 036	9 170	10 195	13 477	8 785	7 683	4 611	4 388	2 500	2 250	995	401	693	67 210

Not updated from 2006 due to new age reading method

Table E4. GREENLAND HALIBUT in Sub-area I and II. Abundance indices on age from the Norwegian bottom trawl survey north and east of Spitsbergen in September (numbers in thousands).

A: Survey area, Russian EEZ excluded **B:** Including Russian EEZ

A Year	Age						Total
	1	2	3	4	5	6+	
1996	15 655	14 510	10 025	3 487	1 593	3 349	48 619
1997	3 415	15 271	14 140	2 803	403	434	36 466
1998	8 482	18 718	9 463	5 161	1 166	932	43 922
1999	5 370	9 074	3 328	2 271	1 492	954	22 489
2000	9 529	16 844	8 007	6 274	1 746	722	43 122
2001	26 206	15 765	4 515	1 767	802	465	49 520
2002	40 186	34 065	15 441	3 862	1 320	556	95 430
2003	49 146	37 344	6 336	3 188	1 035	327	97 376
2004 [1]	15 257	28 540	48 286	12 598	3 562	1 153	109 396
2005 [1]	138 248	23 689	25 989	32 052	6 735	893	227 606

B Year	Age						Total
	1	2	3	4	5	6+	
1998	10 210	28 020	17 186	6 380	1 551	932	64 279
1999	7 514	16 159	8 045	3 067	2 401	954	38 140
2000			No coverage in Russian EEZ				
2001	38 112	40 377	7 960	4 300	1 215	510	92 475
2002	96 231	58 113	31 500	5 665	1 576	556	193 641
2003			No coverage in Russian EEZ				
2004 [1]	23 560	47 023	77 374	14 081	3 719	1 232	166 989
2005 [1]	253 127	40 975	40 231	40 858	6 955	893	383 039

[1] From 2004 part of the new joint ecosystem survey.

Not updated from 2006 due to new age reading method

Table E5. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from three Norwegian bottom trawl surveys in the Barents Sea in August - September (from 2004 two of them are part of the joint ecosystem survey covering the whole Barents Sea) combined to one index (in thousands).

A: Old strata system used B: Ecosystem survey combined with Norw. GrHal survey

A	Age															Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
1996	17 926	14 906	10 134	4 486	16 194	22 217	30 014	10 163	1 857	3 954	957	523	175	100	2	133 608
1997	4 050	18 107	14 547	4 481	12 917	20 753	22 984	6 362	1 563	3 312	936	600	87	165	16	110 880
1998	10 704	21 705	12 521	7 603	9 915	14 680	27 784	7 800	1 937	4 586	1 353	1 027	13	241	14	121 883
1999	5 895	9 451	5 200	7 116	8 412	17 437	24 175	12 857	2 407	6 595	1 294	1 387	273	183	144	102 826
2000	11 474	17 755	9 870	11 359	13 093	14 139	20 608	9 704	5 707	3 548	901	695	204	75	16	119 148
2001	30 631	17 452	6 521	5 115	10 077	17 548	24 465	10 973	3 440	6 280	1 302	1 147	267	180	67	135 464
2002	42 348	36 537	17 472	9 105	13 649	15 040	27 076	10 130	6 679	5 104	2 909	1 893	619	257	183	188 999
2003	50 512	37 972	8 298	11 410	15 428	20 553	24 664	10 521	5 437	6 958	1 992	1 955	861	253	125	196 939
2004	17 233	29 072	50 471	17 112	13 233	16 459	24 970	9 753	4 568	4 170	1 963	3 042	1 460	865	726	195 096
2005	153 834	29 173	32 072	46 345	24 680	20 381	14 189	9 919	5 261	4 929	2 709	2 392	1 242	540	776	348 443

B	Age															Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	
2004	16 513	37 564	56 050	12 858	11 967	18 047	25 933	10 060	4 974	4 413	2 151	3 600	1 276	865	641	206 912
2005	182 754	40 350	40 139	40 760	25 334	21 739	15 320	10 504	5 594	5 131	2 967	2 494	1 249	686	758	395 780

Not updated from 2006 due to new age reading method

Table E6. GREENLAND HALIBUT in Sub-area I and II. Russian autumn bottom trawl surveys: Abundance indices at different age (numbers in thousands).

Year	Age-group													Total
	≤ 3	4	5	6	7	8	9	10	11	12	13	14	15+	
1984	4 124	5 359	7 788	24 951	19 863	11 499	6 750	5 416	2 420	1 196	247	146	143	89 902
1985	3 331	4 371	17 076	35 648	27 826	11 717	5 722	4 090	1 937	895	311	31	131	113 086
1986	2 687	6 600	15 853	25 696	16 468	5 436	3 811	2 660	974	539	184	72	6	80 986
1987	289	6 761	9 724	12 703	7 633	3 867	1 903	1 627	721	416	110	0	38	45 792
1988	2 591	4 409	7 891	14 181	11 311	4 308	2 253	1 756	820	307	125	163	54	50 169
1989	1 429	11 310	13 124	25 881	12 782	5 989	2 381	1 285	334	271	98	102	118	75 104
1990	2 820	8 360	16 252	15 621	11 393	4 120	1 911	1 158	307	198	58	36	0	62 234
1991[1]	1 422	8 455	25 408	21 843	15 235	9 419	2 369	1 211	655	142	95	16	26	86 296
1992	685	7 461	33 341	25 498	17 272	10 178	2 720	1 262	938	318	67	0	0	99 740
1993	114	2 166	13 317	19 752	16 528	10 305	3 370	1 868	903	519	103	111	111	69 167
1994	49	1 604	9 868	17 549	11 533	7 746	3 401	1 876	605	394	114	114	57	54 910
1995	19	467	5 759	18 222	15 296	11 539	4 393	1 413	529	312	84	11	32	58 076
1996[2]	0	1 670	6 680	18 722	21 714	13 354	8 512	476	284	106	115	36	20	71 689
1997	235	1 575	4 023	12 165	15 919	16 452	4 591	1 432	779	162	271	66	88	57 758
1998	3 917	5 542	7 768	15 589	16 842	17 727	9 676	2 548	1 752	535	254	85	72	82 307
1999	4 057	4 961	5 951	12 350	14 255	16 078	7 952	3 009	965	494	307	74	-	70 453
2000	2 841	5 327	10 718	15 719	18 694	21 235	9 155	3 593	2 580	1 011	108	133	120	91 234
2001	1 592	6 884	17 365	37 881	27 661	14 163	6 576	3 988	1 875	1 713	929	217	180	121 024
2002[3]	2 145	7 127	10 771	44 220	33 675	18 747	5 947	5 477	1 216	1 877	1 973	60	120	133 355
2003	1 735	6 479	10 029	19 751	14 160	7 592	3 519	2 555	2 200	1 664	831	141	470	71 126
2004	3 305	8 342	9 461	21 834	22 876	14 187	8 331	3 776	2 544	1 745	1031	811	966	99 209
2005	2 096	7 668	11 657	17 933	20 555	14 140	4 658	3 264	1 844	1 585	789	554	420	87 164
2006	3 099	13 954	18 873	34 869	37 481	20 542	7 631	3 586	2 489	2 329	1 663	720	785	148 021
2007	995	5 713	15 982	27 722	36 544	18 917	9 382	6 033	5 221	5 171	2 297	1 399	1 134	136 510
2008	1 483	11 642	12 475	21 157	32 551	33 844	19 618	6 297	7 262	6 994	5 474	3 240	4 092	166 129

[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 (in tonnes) and abundance (in thousands) estimated from Spanish survey 1997-2008.

Year	Catch (Kg)	Catch (numbers)	Biomass™	Abundance ('000)
1997	195 056	211 533	344 014	379 444
1998	180 974	187 259	351 466	373 149
1999	198 781	172 687	436 956	377 792
2000	169 389	140 355	340 619	291 265
2001	152 681	129 289	283 511	249 219
2002	144 335	115 213	256 460	207 466
2003	151 952	132 117	283 644	256 327
2004	153 859	135 631	320 485	283 965
2005	144 573	134 566	317 320	313 459
2006*				
2007*				
2008	91 573	101 578	379 456 / 129 221**	424 822 / 144 561**

***No survey in 2006-2007**

**** New swept area estimation method**

Table E8. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from bottom trawl surveys in the Barents Sea in winter (in thousands).

A: Restricted area surveyed every year; **B**: Enlarged area (includes the restricted one) surveyed since 1993

A	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
1989	1 078	788	1 056	2 284	3 655	2 655	864	971	210	-	19	76	56	13 712
1990	66	907	2 071	1 716	1 996	2 262	1 046	365	175	-	30	119	165	10 918
1991	-	279	755	1 323	1 257	1 526	2 440	906	450	457	-	55	127	9 575
1992	63	128	719	897	1 554	543	1 069	791	-	648	135	40	53	6 640
1993	-	17	168	502	1 730	868	1 490	758	88	655	382	31	35	6 724
1994	-	16	142	1 178	2 259	1 644	1 750	885	-	506	38	25	-	8 443
1995	-	-	-	168	786	749	1 331	760	359	486	60	199	-	4 898
1996	1 816	-	28	40	709	1 510	2 964	1 000	307	808	154	152	45	9 533
1997	-	21	-	21	176	812	1 788	1 440	653	209	94	73	-	5 287
1998	-	-	-	67	474	1 172	2 491	1 144	302	401	89	19	4	6 163
1999	-	77	276	243	495	485	1 058	555	408	152	75	56	-	3 880
2000	-	40	56	396	719	519	1 187	261	290	531	131	23	55	4 208
2001	19	36	112	558	517	260	497	697	267	478	43	42	30	3 556
2002	-	-	32	609	1 019	1 148	989	362	139	591	106	54	54	5 103

B	Age													Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13+	
1993	-	17	279	1 002	3 129	2 818	3 895	1 632	309	1 406	616	31	35	15 169
1994	-	16	152	1 482	3 768	2 698	3 420	1 615	-	1 171	135	25	-	14 482
1995	-	-	-	216	2 824	6 229	10 624	2 727	1 250	1 902	172	718	57	26 719
1996	3 149	-	28	102	1 547	3 043	4 991	1 599	472	1 211	317	250	72	16 781
1997[1]	-	163	-	203	624	2 742	5 759	4 170	1 653	562	240	181	66	16 363
1998[1]	220	501	2 797	1 011	1 847	3 477	6 539	3 057	867	1 179	301	96	57	21 949
1999	41	195	691	825	829	1 531	3 130	1 496	1 011	500	115	129	101	10 594
2000	169	482	947	5 425	2 575	1 310	3 035	553	796	1 109	284	27	55	16 767
2001	69	250	363	2 046	4 250	2 730	2 983	1 123	416	1 148	111	137	94	15 720
2002	233	104	248	1 373	2 748	3 265	3 641	932	449	1 714	365	177	178	15 427
2003	50	89	151	785	1 786	2 860	5 411	1 313	289	951	356	189	92	14 322
2004	67	118	128	527	1 294	1 099	3 207	1 220	624	504	201	281	266	9 536
2005	259	300	2 318	1 512	4 106	3 554	5 373	2 072	862	278	372	305	824	22 135
2006	45	46	1 119	5 518	6 912	5 640	1 353	603	562	321	365	61	115	22 660

[1]Adjusted (according to the 1996 distribution) to include the Russian EEZ which was not covered by the survey.

Not updated from 2007 due to new age reading method

Table E9 GREENLAND HALIBUT in Sub-areas I and II. Results from a research program using trawlers in a limited commercial fishery 1992-2005. All areas combined. Spring and autumn combined in 1992-1993, otherwise only spring-data.

	Catch in numbers on age (%)													
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0.1			0.1		0.0	0.0	0.0					0.1	0.2
4	4.6	4.2	3.2	0.7	0.5	0.9	0.2	0.7	1.2	1.3	0.7	1.8	1.4	1.8
5	19.1	25.0	24.7	22.5	19.5	24.8	6.6	7.7	10.8	6.3	7.7	8.5	8.9	5.4
6	23.0	18.4	23.8	22.6	31.6	22.9	25.5	23.0	17.1	20.2	16.8	21.7	18.9	20.4
7	25.9	27.1	26.8	30.2	35.6	30.5	44.5	39.6	43.0	28.5	42.5	30.5	31.3	25.4
8	13.3	12.4	11.2	11.0	8.7	10.1	15.5	14.5	12.3	24.5	12.4	9.6	14.8	21.5
9	1.7	0.7	1.0	2.7	1.3	2.6	4.5	1.6	4.5	7.8	7.1	8.1	9.5	8.2
10	6.8	7.4	5.9	6.6	2.0	5.0	2.0	9.7	8.5	7.3	8.8	11.0	4.7	6.5
11	2.9	3.1	2.4	2.0	0.5	1.9	0.8	1.0	0.9	1.9	2.2	4.1	4.0	3.1
12	1.7	1.0	0.6	1.1	0.2	0.8	0.3	1.8	1.1	1.7	1.2	3.1	3.5	4.0
13	0.5	0.4	0.2	0.3	0.0	0.3		0.2	0.6	0.3	0.2	1.2	1.5	2.1
14	0.2	0.2	0.1	0.2	0.1	0.2		0.2	0.0	0.2	0.4	0.5	0.9	1.0
15	0.1					0.0		0.0	0.0	0.2	0.1	0.0	0.4	0.5

	Mean individual weight (kg)													
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0.26			0.40		0.39							0.27	0.24
4	0.50	0.53	0.52	0.47	0.48	0.45	0.41	0.51	0.50	0.60	0.44	0.48	0.44	0.48
5	0.71	0.76	0.73	0.70	0.74	0.69	0.76	0.74	0.69	0.66	0.69	0.68	0.65	0.64
6	0.96	0.98	0.95	0.94	0.94	0.88	0.96	0.92	0.98	0.94	0.93	1.00	0.88	0.84
7	1.29	1.33	1.28	1.24	1.23	1.15	1.19	1.25	1.23	1.12	1.22	1.28	1.17	1.14
8	1.77	1.85	1.79	1.71	1.66	1.55	1.79	1.64	1.57	1.48	1.39	1.67	1.43	1.40
9	2.00	2.28	2.23	2.03	2.00	1.87	2.26	2.18	1.90	1.84	1.69	1.97	1.73	1.67
10	2.46	2.65	2.55	2.50	2.50	2.34	2.54	2.38	2.40	2.30	2.31	2.37	2.14	2.26
11	3.10	3.43	3.37	3.28	3.16	2.95	3.47	3.17	3.13	2.92	3.19	3.20	2.34	2.62
12	3.86	4.32	4.22	3.71	3.70	3.46	4.16	3.79	4.04	3.82	3.91	3.48	2.77	2.87
13	4.44	5.18	5.01	4.62		4.52		5.07	4.47	3.68	5.20	4.28	2.92	2.98
14	6.00	6.44	6.29	5.59		5.47		5.60	6.00	5.74	5.59	4.74	3.89	3.30
15	5.22								8.79	5.52	7.03	9.17	4.65	3.32

Not updated from 2006 due to new age reading method

Table E9 (Continued) GREENLAND HALIBUT in Sub-areas I and II. Results from a research program using trawlers in a limited commercial fishery 1992-2005. All areas combined. Spring and autumn combined in 1992-1993, otherwise only spring-data.

	CPUE (N) on age													
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0			1	0	0	0	0	0	0	0	0	1	2
4	19	30	26	7	7	11	2	7	14	12	7	19	15	24
5	80	176	198	219	286	298	59	72	132	63	81	90	96	70
6	97	130	191	220	463	275	229	214	208	201	176	229	203	263
7	109	191	215	294	521	366	400	369	524	284	447	322	337	328
8	56	87	90	107	127	121	139	135	150	244	130	101	159	278
9	7	5	8	26	19	31	40	15	55	78	75	86	102	106
10	29	52	47	64	29	60	18	90	104	73	92	116	51	84
11	12	22	19	19	7	23	7	9	11	18	23	43	43	40
12	7	7	5	11	3	10	3	17	13	17	12	32	38	52
13	2	3	2	3	0	4	0	2	7	3	2	12	16	27
14	1	1	1	2	1	2	0	2	0	2	4	5	10	13
15	0			0	0	0	0	0	0	2	1	0	4	6

	CPUE (kg) on age													
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1														
2														
3	0			0	0	0	0	0	0	0	0	0	0	1
4	10	16	13	3	4	5	1	3	7	7	3	9	6	11
5	57	134	145	153	211	207	45	53	91	41	56	61	63	44
6	93	127	182	207	435	243	220	197	204	189	164	229	179	220
7	140	254	276	364	641	423	476	461	645	318	543	411	396	373
8	99	162	161	183	211	189	249	221	236	361	181	169	228	389
9	14	11	18	53	38	59	91	32	105	143	127	169	177	176
10	70	138	121	161	73	141	46	215	250	167	213	275	109	189
11	38	75	65	64	23	68	25	30	33	54	74	138	101	104
12	28	30	20	40	11	33	11	64	53	66	48	113	105	150
13	9	15	8	13	0	16	0	9	32	11	9	52	48	79
14	5	9	5	11	0	13		10	2	10	24	23	38	43
15	2			0	0	0		0	3	11	4	4	20	20

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Overall mean individual weight (kg)	1.35	1.38	1.27	1.29	1.12	1.16	1.30	1.39	1.35	1.38	1.38	1.57	1.37	1.39
CPUE (kg round weight per trawlhour)**	567	973	1020	1255	1640	1393	1169	1294	1647	1377	1449	1657	1475	1795
CPUE (Number fish per trawlhour)**	420	705	803	973	1464	1201	899	931	1220	998	1050	1055	1077	1291
Catch (in tonnes)	695	862	811	368	436	274	272	269	295	297	288	298	304	292

***) Preliminary**

*** *) Average for freezer- and factorytrawler**

Not updated from 2006 due to new age reading method

Table E10. GREENLAND HALIBUT in ICES Sub-area IV (North Sea. Nominal catch (t) by countries as officially reported to ICES. Not included in the assessment .

Year	Denmark	Faroe Islands	France	Germany	Green-land	Ire-land	Norway	Russia	UK England & Wales	UK Scotland	Total
1973	-	-	-	4	-	-	9	8	28	-	49
1974	-	-	-	2	-	-	2	-	30	-	34
1975	-	-	-	1	-	-	4	-	12	-	17
1976	-	-	-	1	-	-	2	-	18	-	21
1977	-	-	-	2	-	-	2	-	8	-	12
1978	-	-	2	30	-	-	-	-	1	-	33
1979	-	-	2	16	-	-	2	-	1	-	21
1980	-	177	-	34	-	-	5	-	-	-	216
1981	-	-	-	-	-	-	7	-	-	-	7
1982	-	-	2	26	-	-	17	-	-	-	45
1983	-	-	1	64	-	-	89	-	-	-	154
1984	-	-	3	50	-	-	32	-	-	-	85
1985	-	1	2	49	-	-	12	-	-	-	64
1986	-	-	30	2	-	-	34	-	-	-	66
1987	-	28	16	1	-	-	35	-	-	-	80
1988	-	71	62	3	-	-	19	-	1	-	156
1989	-	21	14[1]	1	-	-	197	-	5	-	238
1990	-	10	30[1]	3	-	-	29	-	4	-	76
1991	-	48	291[1]	1	-	-	216	-	2	-	558
1992	1	15	416[1]	3	-	-	626	-	+	1	1 062
1993	1	-	78[1]	1	-	-	858	-	10	+	948
1994	+	103	84[1]	4	-	-	724	-	6	-	921
1995	+	706	165	2	-	-	460	-	52	283	1 668
1996	+	-	249	1	-	-	1 496	-	105	159	2 010
1997	+	-	316	3	-	-	873	-	1	162	1 355
1998	+	-	71[1]	10	-	10	804	-	35	435	1 365
1999	+	-		1	-	18	2 157	-	43	358	2 577
2000	+		41	10	-	19	498[1]	-	67	192	827
2001	+		43	-	-	10	470	-	122	202	847
2002[1]	+		8	+	-	2	200	-	10	246	466
2003[1]	-	-	1	+	+	+	453	-	+	122	576
2004[1]	-	-	-	-	-	-	413	-	90	-	503
2005 [1]	-	-	2	-	-	-	58	-	4	-	64
2006 [1]	-	-	3	-	-	-	89	-	7	-	99
2007 [1]	-	+	+	-	-	-	129	-	+	+	129
2008	-	-	10	-	-	-	14	-	22	-	46

[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 (from 1999) no autumn fishery has taken place, except for a small Russian experimental fishery. The fishery was closed from 1 May to 15 August until 1984. After 1984, the fishery was closed from 1 May to 1 September. A minimum landing size of 11 cm has been in force for years of regulating fishery. From the autumn of 1986 to the winter of 1991, from the autumn 1993 to the winter 1999, and in 2004-2008, no commercial fishery took place. In 2009 a commercial fishery has been revived in the wintering-spring period.

9.2 Catch Statistics (Table 9.1, 9.2)

The total catches that were taken during spring 2009 amounted to 233 140 tonnes to Norway and 72 932 tonnes to Russia (Tables 9.1). The age-length composition showed a big variation in time and place of fishery and also between national fleets. Five regions for length-age calculation of catch statistic were used. Joint data of age-length composition is presented in Table 9.1. The international historical catch by country and seasons in the years 1972-2009 is given in Table 9.2.

9.3 Sampling

The sampling from scientific surveys, exploratory fishing and observers of capelin from September 2008 – September 2009 is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Ecosystem survey autumn 2008 (Norway)	360	41350	3165
Ecosystem survey autumn 2008 (Russia)	160	8286	1064
Bottom fish survey, November 2008 (Russia)	189	11879	175
Exploratory fishing autumn 2008 (Russia)	77	15714	500
Capelin winter investigations 2009 (Norway)	103	26805	3137
Capelin winter investigations 2009 (Russia)	46	5529	710
Observer on fishing vessels in winter-spring 2009 (Russia)	71	16665	650
Bottom survey winter 2009 (Norway)	116	6263	779
Bottom survey winter 2009 (Russia)	26	1511	-
Ecosystem survey autumn 2009 (Norway)	243	16928	3807
Ecosystem survey autumn 2009 (Russia)	193	9157	1142
Total	**1478**	**182404**	**14500**

9.4 Stock Size Estimates

9.4.1 Acoustic stock size estimates in 2009 (Table 9.3)

One Russian and three Norwegian vessels jointly carried out the 2009 acoustic survey as part of an ecosystem survey during autumn (Anon., 2009). The geographical coverage of the total stock was considered complete. It was more synoptic than in the previous year and the results of estimation are considered to be representative. The geographical distribution of capelin is shown in Figure 9.1.

The total capelin stock is 3.8 million tonnes, which is slightly lower than last year. About 60% (2.3 million tonnes) of the stock biomass consisted of maturing fish (>14.0 cm). The results from the survey are given in Table 9.3.

9.4.2 Recruitment estimation in 2009 (Table 9.4)

The historical estimated total number of larvae is shown in Table 9.4. These larval abundance estimates should reflect the amount of larvae produced each year (Gundersen and Gjøsæter, 1998). There were some problems with this survey in 1986, 1995 and since 1997 when permission has not been granted to enter the Russian EEZ . During the last two years the larval surveys based on Gulf III plankton samples, which have been carried out in June each year since 1981, were not conducted.

A swept volume index (Dingsør, 2005; Eriksen et al., 2007) of abundance of 0-group capelin in August-September is given in Table 9.4. This index is calculated both without correction and with correction for catching efficiency (Anon. 2007). The 2009 index shows a strong year class, but it is less than half the value of the record high 2008 year class at the 0-group stage. The relationship between 0-group and 1-group abundance is shown in Fig 9.7. The 2008 year class is an outlier in this plot.

Table 9.4 also shows the number of fish in the various year classes, and their "survey mortality" from age one to age two. As there has been no fishing on these age groups, the figures for total mortality constitute natural mortality only, and probably reflect quite well the predation on capelin. There has been a substantial increase in the survey mortality the recent year.

9.5 Other surveys and information from 2009

9.5.1 Russian capelin spring investigation

Data on capelin prespawning concentrations in the wintering grounds, the pattern of prespawning migrations, periods and areas of fish approaches to the coasts for spawning were obtained using the results of fishing vessel activity as well as the data from the cruise by RV "Vilnyus" M-0102 (26.02-15.03 and 21-25.03) and from the scientific observers onboard fishing vessels "Demyansk" (17.02-09.04) and "Admiral Shabalin" (01.03-06.04).

The research conducted by RV "Vilnyus" (26.02-15.03) corroborated the availability of prespawning capelin fishing concentrations in the areas, which were banned for trawl fishery. The fish migration southwestwards favored a good fishing situation to the west from the banned area to the beginning of March. A more northward survey for wintering areas in the southern part of the Central Deep to 73ºN (figure 9.3) showed the presence of residual aggregations of maturing capelin. In the mixed wintering concentrations the average length of capelin was 13.9-14.2 cm. The percentage of maturing fish at Maturity Stages 4 and 3 were 20.2% and 27.3%, respectively. At that, more mature capelin approached the coast to spawn and recruited the coastal fishing areas till the end of March-the beginning of April. Less mature fish will spawn later, possibly even in summer.

In the studied area, within RF EEZ, capelin spawning stock was estimated at 4.3 billion ind. or 80.03 thousand t. Fish aged 3 with the predominant length of 15.2 cm prevailed. About 19% of individuals were 4 years old and some fish were older. Unconditionally, the obtained estimate only characterizes capelin concentration during the third eastern approach, which was studied in the survey and accounted for 10% of the total spawning stock expected according to calculations for 1 April 2009. More details and information about fishery and spring investigation is given in WD 9.1.

9.5.2 Norwegian capelin spring investigation.

An acoustic survey was carried out during February-March 2009 to test methodology for mapping and abundance estimation of the capelin spawning stock during spawning migration in the Barents Sea during winter. The objectives was: acoustic abundance estimation and mapping the distribution of the spawning migration of capelin and immature capelin; mapping the distribution of juvenile herring to assess the mixture of capelin and juvenile herring as a problem for acoustic abundance estimation of capelin; estimation of acoustic target strength of capelin in the spawning period. Estimate speed and direction of the spawning migration of capelin towards the coast with sonar, so that this can be implemented as a correction factor in the acoustic abundance estimation. The survey was finished earlier than planned due to lack of license to cover areas in the Russian Exclusive Economic Zone. The survey was conducted with MS "Eros" (20 January–14 February), MS "Libas" (20 January–14 February). The survey covered the area south of 75˚N, between 18 and 36˚E during the first period (20 January–06 February) and an area along the Norwegian coast, east of 17˚E during the second period (06–14 February). During the commercial fishery onboard "Libas", (period 1: 14–24 February, and period 2: 15–20 March) biological samples were taken from pre-spawning capelin during period 2, and eggs were artificial fertilized for later investigation of embryo development and egg mortality during different temperature conditions and under pollution.

During this survey the temperature in 50 m depth decreased gradually from west (5–6.5 °C) to east (3–4.5 °C) and from south to north in the survey area. The temperature near the bottom decreased in the same way, but was lower in the central and northern parts. Along the Norwegian coast, warmer water masses (4.5–6.5 °C) were observed from the bottom to the surface, with highest temperature in the west.

In the first period of the survey capelin were observed near the bottom in mix with other fish throughout the survey area. In the western area, this capelin was dominated by 3 years old individuals. This year class also dominated in the eastern area, but 1, 2, 4 and 5 years old individuals also occurred. In the pelagic, capelin were also observed in schools dominated by 3 years old individuals in the western area. The schools migrated in south-eastern direction towards the Norwegian coast. Almost all capelin was in special stadium 4 and egg percentage was approximately 6% of the body weight. In the eastern area capelin were observed in a pelagic mixed layer with krill, shrimp and 1 year old cod and haddock. Immature capelin dominated this layer in an area between approximately 73°N–74°N and 30°E–36°E. During the second period, the capelin were generally observed near the bottom mixed with larger (> 15 cm) fish like young herring, haddock, cod, redfish and other species. The capelin was dominated by 3 years old females. Almost all capelin was in special stadium 4, like in period 1, and egg percentage of body weight varied between 8% in west and 10% in east. Pelagic schools of young herring were observed in the south-western part of survey area.

Reasonable abundance estimation of the capelin spawning migration depends on being at the right place at the right time. This year, the spawning stock of Barents Sea capelin was most probably largely underestimated. There are several possible explanations of this, and they might all have acted in concert. This includes the early start of the survey, limited coverage of the area, and early start of the capelin fishery. The acoustic abundance estimate of spawning capelin in 2009 is 100 000 tons. Note that this is an underestimate, only based on the Norwegian survey.

9.6 Stock development assessment

As decided by the Arctic Fisheries Working Group at its 2009 meeting (ICES 2009a), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk. In accordance with this, the assessment was made during a meeting in Kirkenes after the survey. The assessment was an update assessment, without changes in the methodology.

The WKSHORT benchmark meeting 31 August – 4 September 2009 in Bergen scrutinized the methodology used for assessing the stock. Although the methodology was endorsed, the documentation provided was not endorsed, as it was found incomplete. For this reason the assessment made in October 2009 is an update assessment. Further advancements in the methodology will rest until the description of the present methodology has been approved by ICES.

Estimates of stock in number by age group and total biomass for the historical period are shown in Table 9.5. Other data which were used for stock development assessment are shown in Table 9.6.

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2010 was made using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL, 15000 simulations were used). The projection was based on a maturation and predation model with parameters estimated by the model Bifrost and data on cod abundance and size at age from the 2009 Arctic Fisheries Working Group. The methodology is described in "Stock assessment methodology for the Barents Sea capelin", WD22, AFWG 2008. The predation model for the period January-March was based on data from the period 1983-2002. It was decided to draw the natural mortality during October-December randomly from estimates for the period 1995-2001. This is consistent with previous years assessment. Also, drawing from the entire period 1983-2002 would include some years with very high estimated natural mortality based on low stock sizes. The models for maturation, predation and mortality are unchanged since 2003.

Probabilistic prognoses for the maturing stock from October 1 2009 until April 1 2010 were made, with a CV of 0.20 on the abundance estimate. A CV of 0.20 is slightly higher than the value calculated for most years in Tjelmeland (WD1, 2008), the effect of the CV on the uncertainty in the SSB estimate at 1st April is, however, small. With no catch, the estimated median spawning stock size in 2010 is 770 000 tonnes (Fig. 9.3). With a catch of 360 000 tonnes, the probability for the spawning stock in 2010 to be below 200 000 t, the $\mathbf{B}_{\mathrm{lim}}$ value used by ACFM in recent years, is 5 % (Fig. 9.4). The median spawning stock size in 2010 will then be 517 000 tonnes. Fig 9.5 shows the 95 % percentile of the spawning stock biomass 1 April 2010 as a function of the quota, while Fig 9.6 shows the probability of SSB < B_{lim} as a function of the catch. The monthly distribution of the catch was assumed to be 20 % in January, 30 % in February and 50 % in March.

A 1.5-year prognosis has previously been made for this stock. Due to time constraints, such a prognosis was not carried out this year. Instead, we will give a qualitative view on how the stock will develop in the coming years. This view is to a large extent based on the observation that the three capelin stock collapses observed during the last 30 years have all been preceded by a period of high herring abundance in the Barents Sea. However, some years with good capelin recruitment despite high young herring abundance have also been observed (Fig. 9.8).

The 0-group index for herring in 2009 is low, and the ecosystem survey in 2009 also showed that the abundance of age 1-2 herring in the Barents Sea is low. The total abundance of 1 year and older herring in the Barents Sea in 2010 will thus be low, and the recruitment conditions for capelin can then be expected to be good in 2010.

The 2007-2009 year classes are all strong, and altogether this indicates that the capelin stock will stay at a high level at least until 2011-2012.

It should also be noted that the biomass of haddock at present is at a record high level (ICES 2009a). The diet of medium-sized haddock (20-60cm) consists on average of about 15% capelin (Dolgov *et al*. 2007). As the cod and haddock stocks both are at a high level, the total mortality due to predation may be high in the near future.

9.7 Reference points

A B_{lim} (SSB_{lim}) management approach has been suggested for this stock (Gjøsæter et al. 2002). In 2002, the Mixed Russian-Norwegian Fishery Commission agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 t of capelin should be allowed to spawn. Consequently, 200 000 t was used as a B_{lim}. There is clearly also a need for a target biomass reference point for capelin, and calculations of B_{target} are also in progress.

9.8 Regulation of the fishery for 2009

During its Autumn 2008 meeting, the Joint Russian-Norwegian Fishery Commission decided that the commercial quota according to the harvest control rule will in 2009 year 380 000 tonnes. Research quota of 10 000 tonnes (5 000 tonnes to Norway and 5 000 tonnes to Russia) were set also.

Table 9.1 Barents Sea Capelin. Catch statistic table. Catch in number (10^6 sp.) and biomass (tonnes) by age and length during the fishery in January-April 2009.

Length, cm	Age/year class													
	1(2008)		2(2007)		3(2006)		4(2005)		5(2004)		Total(2008-2004)			
	N	B	N	B	N	B	N	B	N	B	N	B	N(%)	B (%)
4.0	5.47	0.61									5.47	0.61	0.04	0.00
4.5	5.73	0.99									5.73	0.99	0.04	0.00
5.0	37.95	14.29									37.95	14.29	0.27	0.00
5.5	39.58	31.60									39.58	31.60	0.28	0.01
6.0	53.72	44.27									53.72	44.27	0.38	0.01
6.5	73.36	62.86									73.36	62.86	0.52	0.02
7.0	30.19	28.45									30.19	28.45	0.21	0.01
7.5	5.60	5.85									5.60	5.85	0.04	
8.0	0.11	0.19	9.44	17.91							9.55	18.10	0.07	0.01
8.5	1.18	2.35	18.55	37.11							19.73	39.46	0.14	0.01
9.0			32.05	65.90							32.05	65.90	0.23	0.02
9.5			18.80	41.75							18.80	41.75	0.13	0.01
10.0	0.57	1.85	31.80	85.19							32.36	87.05	0.23	0.03
10.5			21.41	71.65							21.41	71.65	0.15	0.02
11.0			30.29	125.82							30.29	125.82	0.22	0.04
11.5			17.35	89.22							17.35	89.22	0.12	0.03
12.0			6.43	39.31	3.42	20.92					9.85	60.23	0.07	0.02
12.5			6.31	45.81	2.68	18.81					8.99	64.62	0.06	0.02
13.0			0.48	4.11	15.14	143.71					15.62	147.82	0.11	0.05
13.5					94.01	1006.46					94.01	1006.45	0.67	0.33
14.0			3.86	44.98	375.30	4390.93					379.15	4435.92	2.69	1.45
14.5			22.81	307.88	1005.57	13487.20	2.64	35.62			1031.01	13830.69	7.32	4.52
15.0					1499.38	22409.81	123.83	1853.50			1623.21	24263.32	11.53	7.93
15.5					1589.82	26942.06	197.85	3379.55			1787.67	30321.62	12.70	9.91
16.0					1157.25	22397.30	346.43	6784.32			1503.68	29181.61	10.68	9.54
16.5					1199.26	25986.78	504.07	11010.02	20.79	457.35	1724.12	37454.15	12.24	12.24
17.0					897.69	22364.68	554.63	13895.55	22.37	568.19	1474.69	36828.43	10.47	12.04
17.5					764.97	20406.68	604.18	16364.13	41.72	1138.60	1410.87	37909.40	10.02	12.39
18.0					447.27	13403.52	460.52	14075.18	32.04	972.11	939.83	28450.82	6.67	9.30
18.5					433.35	14633.36	351.94	12016.81	6.62	211.09	791.91	26861.25	5.62	8.78
19.0					176.46	6887.53	341.07	13386.05	12.62	473.10	530.15	20746.68	3.76	6.78
19.5					88.23	3534.94	185.68	7804.48			273.91	11339.41	1.95	3.71
20.0					6.97	278.63	36.21	1663.24			43.18	1941.87	0.31	0.63
20.5									4.85	249.12	4.85	249.12	0.03	0.08
21.0							1.42	64.11			1.42	64.11	0.01	0.02
Sum	253.46	193.32	219.57	976.64	9756.74	198313.32	3710.48	102332.56	141.01	4069.56	**14081.26**	**305885.39**		
%	1.80	0.06	1.56	0.32	69.29	64.83	26.35	33.45	1.00	1.33				

Table 9.2 Barents Sea CAPELIN. Catch statistic table. Catch 1972-2009. Thousand tonnes.

Year	TAC	Catch					
		spring		autumn			total
		Russia	Norway	Russia	Norway	Others	
1972		24	1208	13	347		1592
1973		34	1078	12	213		1336
1974		63	749	99	237		1149
1975		301	559	131	407		1440*
1976		228	1252	368	739		2587
1977		317	1441	504	722		2987*
1978		429	784	318	360		1915*
1979	1800	342	539	326	570		1783*
1980	1600	253	539	388	459		1648*
1981	1900	429	784	292	454		1986*
1982	1700	260	568	336	591		1760*
1983	2300	373	751	439	758		2358*
1984	1400	257	330	368	481		1478*
1985	1100	234	340	164	113		868*
1986	120**	51	72				123
1987							
1988							
1989							
1990							
1991	1100	159	528	195	31		933*
1992	1099	247	620	159	73		1123*
1993	600**	170	402				586*
1994							
1995							
1996							
1997				0,5			0,5
1998		2		1			3
1999	80**	33	50	21		0	104
2000	435**	94	279	29		8	410
2001	630**	180	376	14		8	578
2002	650**	228	398	18		16	660
2003	310**	93	180	+		9	282
2004							
2005	2		0.7	0.5			1.2
2006							
2007	4	2	2				4
2008	14	5	5	2			12
2009	390	73	233				306

*Include catch by other countries.

**Recommended for spring season only.

Table 9.3. Barents Sea CAPELIN. Stock size estimation table. Estimated stock size from the acoustic survey in August-October 2009.

Length (cm)	Age/Year class, number 10^9				Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
	1(2008)	2(2007)	3(2006)	4+(2005)			
6.0	0.022				0.022	0.0	1.0
6.5	0.211				0.211	1.1	1.0
7.0	9.695				0.695	7.8	1.2
7.5	1.932				1.932	29.6	1.7
8.0	9.910	0.068			9.979	62.7	2.0
8.5	19.592				19.592	100.6	2.4
9.0	22.901	0.808			23.709	156.3	2.8
9.5	24.444	0.360			24.804	165.2	3.3
10.0	25.150	1.673			26.824	187.6	4.0
10.5	11.826	3.296			15.112	118.0	4.8
11.0	4.929	5.089			10.018	83.6	5.5
11.5	1.400	16.871			18.271	114.1	6.4
12.0	0.437	16.257			16.694	89.2	7.3
12.5	0.420	26.085	0.009		26.513	215.8	8.5
13.0	0.062	24.569	0.140		24.770	276.5	9.8
13.5	0.024	24.103	0.325		24.452	355.2	11.1
14.0	0.015	13.755	1.494		15.263	525.1	12.6
14.5	0.051	9.958	1.581		11.592	350.8	14.2
15.0		6.002	3.677		9.679	376.1	16.4
15.5		5.313	6.720		12.033	257.4	18.5
16.0		5.065	8.415		13.479	252.9	21.0
16.5		3.255	12.818	0.029	16.101	204.3	23.4
17.0		1.151	9.490	0.061	10.702	182.3	26.8
17.5		1.996	7.073	0.161	9.230	119.7	30.2
18.0		0.650	6.439		7.089	107.4	33.1
18.5		0.068	1.952		2.020	60.1	35.7
19.0			1.206		1.206	27.3	38.9
19.5			0.127		0.127	1.9	43.4
TSN (10^9)	124.021	166.382	61.465	0.251	352.118		
TSB (10^3 t)	417.4	1821.8	1510.2	7.1		3755.7	
Mean length (cm)	9.6	13.4	16.8	17.5	11.7		
Mean weight (g)	3.4	10.9	24.6	28.4			10.7
SSN (10^6)	0.07	47,213	60,992	0,251	108,522		
SSB (10^3 t)	0,91	809,0	1505,7	7,1		2322,9	

Based on TS value: 19.1 log L - 74.0, corresponding to σ = 5.0 · 10-7 · L1.9

Table 9.4 Barents Sea CAPELIN. Recruitment and natural mortality table. Larval abundance estimate in June, 0-group indices and acoustic assessment in August-September, natural mortality from age 1+ to age 2+.

Year class	Larval Abundance (10^{12})	0-group Index (10^9 ind.) without Keff	with Keff	Survey assesment (10^9 ind.) 1+ (Y+1)	2+ (Y+2)	M (by survey) %
1980	-	197.3	740.3			
1981	9.7	123.9	477.3			
1982	9.9	168.1	599.6	514,9	186,5	64
1983	9.9	100.0	340.2	154,8	48,3	69
1984	8.2	68.1	275.2	38,7	4,7	88
1985	8.6	21.3	63.8	6,0	1,7	72
1986	0.0	11.4	41.8	37,6	28,7	24
1987	0.3	1.2	4.0	21,0	17,7	16
1988	0.3	19.6	65.1	189,2	177,6	6
1989	7.3	251.5	862.4	700,4	580,2	17
1990	13.0	36.5	115.6	402,1	196,3	51
1991	3.0	57.4	169.5	351,3	53,4	85
1992	7.3	1.0	2.3	2,2	3,4	-- *
1993	3.3	0.3	1.0	19,8	8,1	59
1994	0.1	5.4	13.9	7,1	11,5	--*
1995	0.0	0.9	2.9	81,9	39,1	52
1996	2.4	44.3	136.7	98,9	72,6	27
1997	6.9	54.8	189.4	179,0	101,5	43
1998	14.1	33.8	113.4	156,0	110,6	29
1999	36.5	85.3	287.8	449,2	218,7	51
2000	19.1	39.8	140.8	113,6	90,8	20
2001	10.7	33.6	90.2	59,7	9,6	84
2002	22.4	19.4	67.1	82,4	24,8	70
2003	11.9	94.9	340.9	51,2	13,03	75
2004	2.5	16.7	53.9	26,94	21,7	19,3
2005	8.8	41.8	148.5	60,1	54,7	9,0
2006	17.1	166.4	515.8	277,2	231,4	17
2007	-	157.9	480.1	313,0	166.4	47
2008	-	288.8	995.1	124.0		
2009	-	189.8	423.3			
Average	9.0	77.7	266.9			

Table 9.5 Barents Sea CAPELIN. Stock size in numbers by age. Total stock biomass and biomass of the maturing component. Stock in numbers and maturing stock biomass at 1. October.

Year	Stock in numbers (10^9)						Stock in weight	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290
2003	82	10	11	1	0	104	533	280
2004	51	25	6	1	0	82	628	294
2005	27	13	2	0	0	42	324	174
2006	60	22	6	0	0	88	787	437
2007	222	55	4	0	0	280	1882	844
2008	313	231	25	2	0	571	4427	2468
2009	124	166	61	0	0	352	3756	2323

Table 9.6 Barents Sea CAPELIN. Summary stock and data for prognoses table.

Year	Estimated stock by autumn acoustic survey (10^3 t) 1 October		*Spawning stock biomass, median of assessment model, April 1 (10^3 t)	Recruitment Age 1+, survey assessment 1 October 10^9 sp.	Landing, (10^3 t)
	TSB	SSB			
1972	6600	2727			1592
1973	5144	1350	*33*	528	1336
1974	5733	907	*	305	1149
1975	7806	2916	*	190	1440
1976	6417	3200	*253*	211	2587
1977	4796	2676	*22*	360	2987
1978	4247	1402	*	84	1915
1979	4162	1227	*	12	1783
1980	6715	3913	*	270	1648
1981	3895	1551	*316*	403	1986
1982	3779	1591	*106*	528	1760
1983	4230	1329	*100*	514,9	2358
1984	2964	1208	*109*	154,8	1478
1985	860	285	*	38,7	868
1986	120	65	*	6,0	123
1987	101	17	*34*	37,6	0
1988	428	200	*	21,0	0
1989	864	175	*84*	189,2	0
1990	5831	2617	*92*	700,4	0
1991	7287	2248	*643*	402,1	933
1992	5150	2228	*302*	351,3	1123
1993	796	330	*293*	2,2	586
1994	200	94	*139*	19,8	0
1995	193	118	*60*	7,1	0
1996	503	248	*60*	81,9	0
1997	909	312	*85*	98,9	0,5
1998	2056	932	*94*	179,0	3,02
1999	2775	1718	*382*	156,0	104
2000	4273	2098	*599*	449,2	410
2001	3630	2019	*626*	113,6	577,6
2002	2210	1291	*496*	59,7	660,3
2003	533	280	*427*	82,4	281,54
2004	628	294	*94*	51,2	0
2005	324	174	*122*	26,94	1,21
2006	787	437	*72*	60,1	0
2007	2119	844	*189*	221.7	4,0
2008	4428	2468	*330*	313,0	12,0
2009	3755	2323	*517*	124	306,14

*-this data will revise after capelin Benchmark assessment in September 2009.

**-tis data should be revised because new assessment model for herring be used.

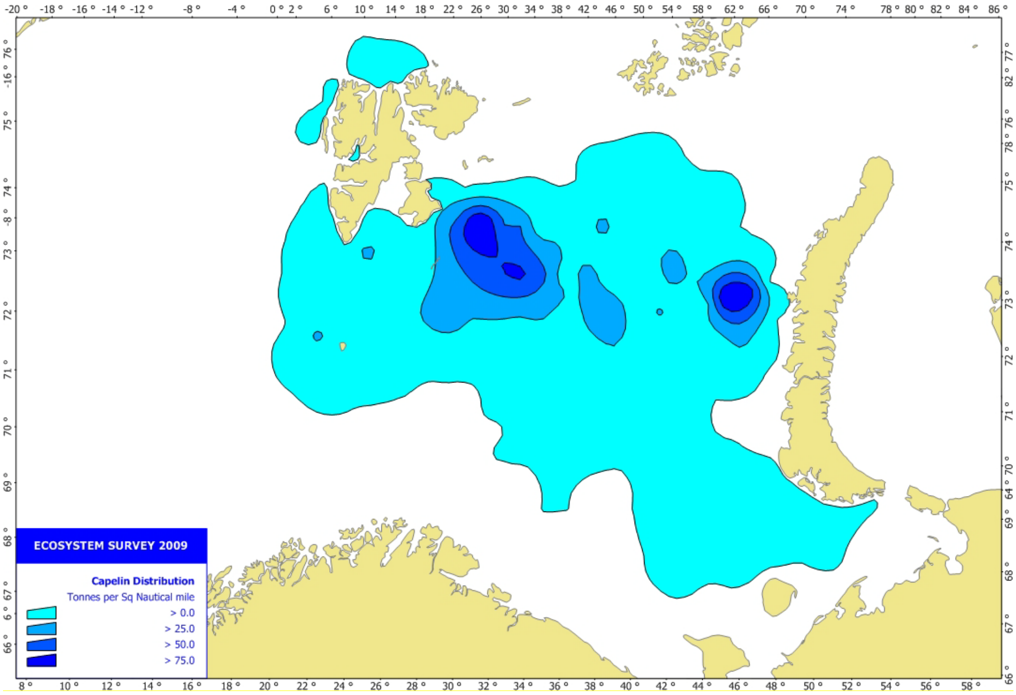

Figure 9.1. Geographical distribution of capelin during the acoustic survey in autumn 2009 (1:<25, 2: 25-50, 3: 50-75, 4: >75 t/nm²)

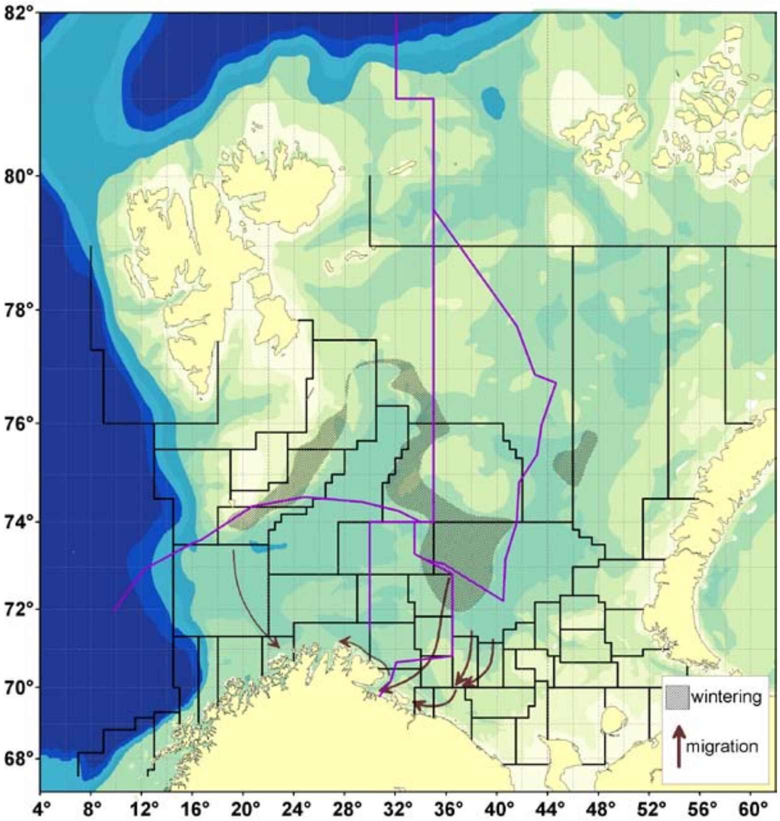

Figure 9.2. Distribution of wintering capelin, and migration of prespawning capelin to the coast based on joint Norwegian and Russian data.

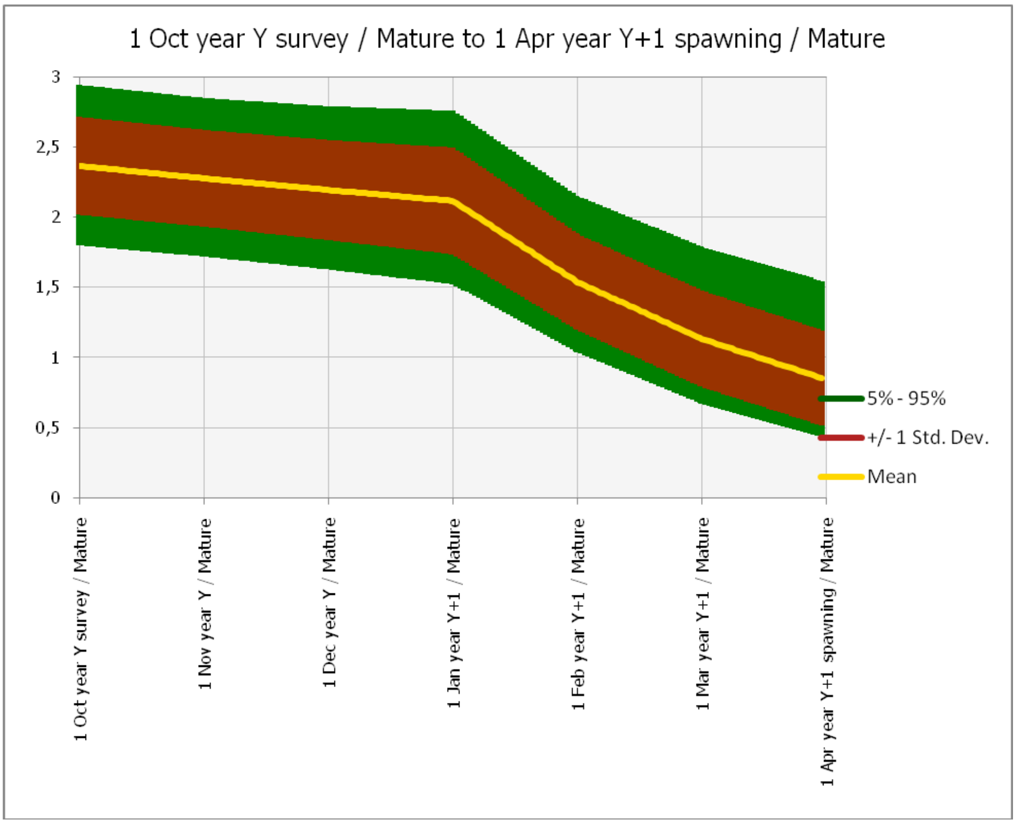

Figure 9.3. Capelin prognosis from 1 October 2009 to 1 April 2010 with no catch during the spring period. CV=0.2.

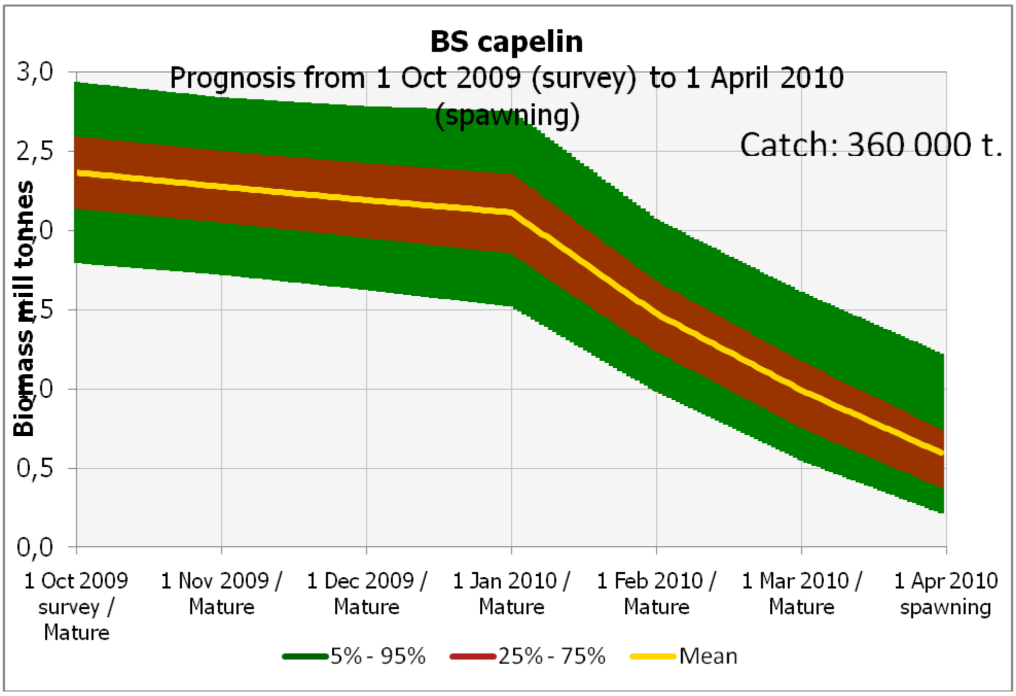

Figure 9.4. Capelin prognosis from 1 October 2009 to 1 April 2010 with a catch of 360 000 tonnes during the spring period.

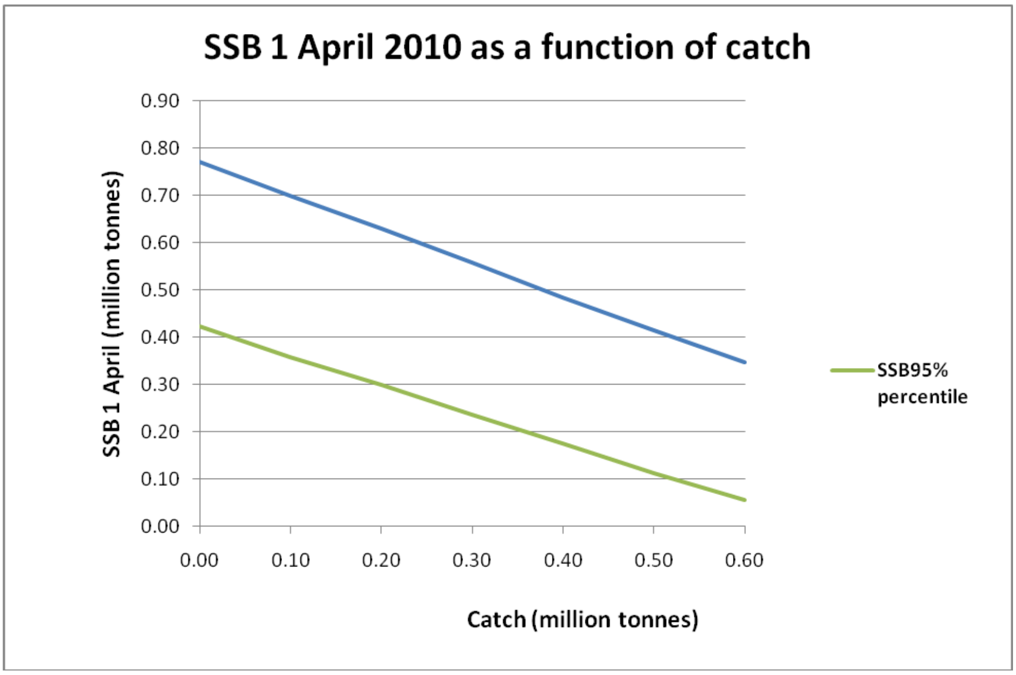

Figure 9.5. 95% percentile and median of spawning biomass of capelin (1 April 2010) as a function of catch.

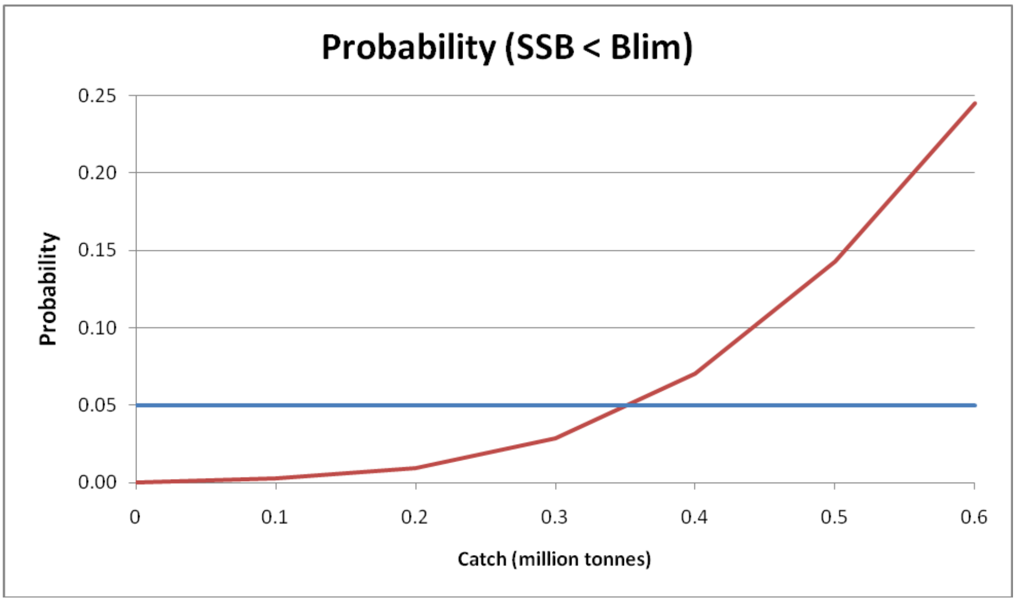

Figure 9.6. Probability of spawning biomass of capelin (1 April 2010) being below B_{lim} (200 000 tonnes), as a function of catch.

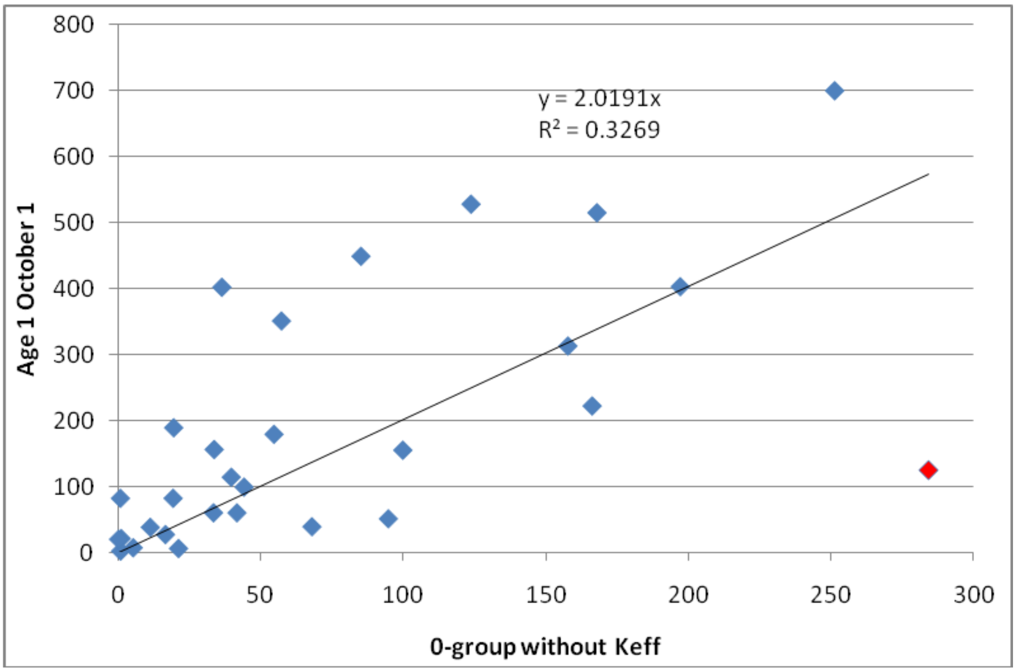

Figure 9.7. Regression of abundance of capelin at age 0 (0-group index without K_{eff}) and age 1 (acoustic estimate) of year classes 1980-2008. The regression line is forced through the origin, to avoid systematic overestimation of weak year classes. The 2008 year class (in red) is an outlier in this plot.

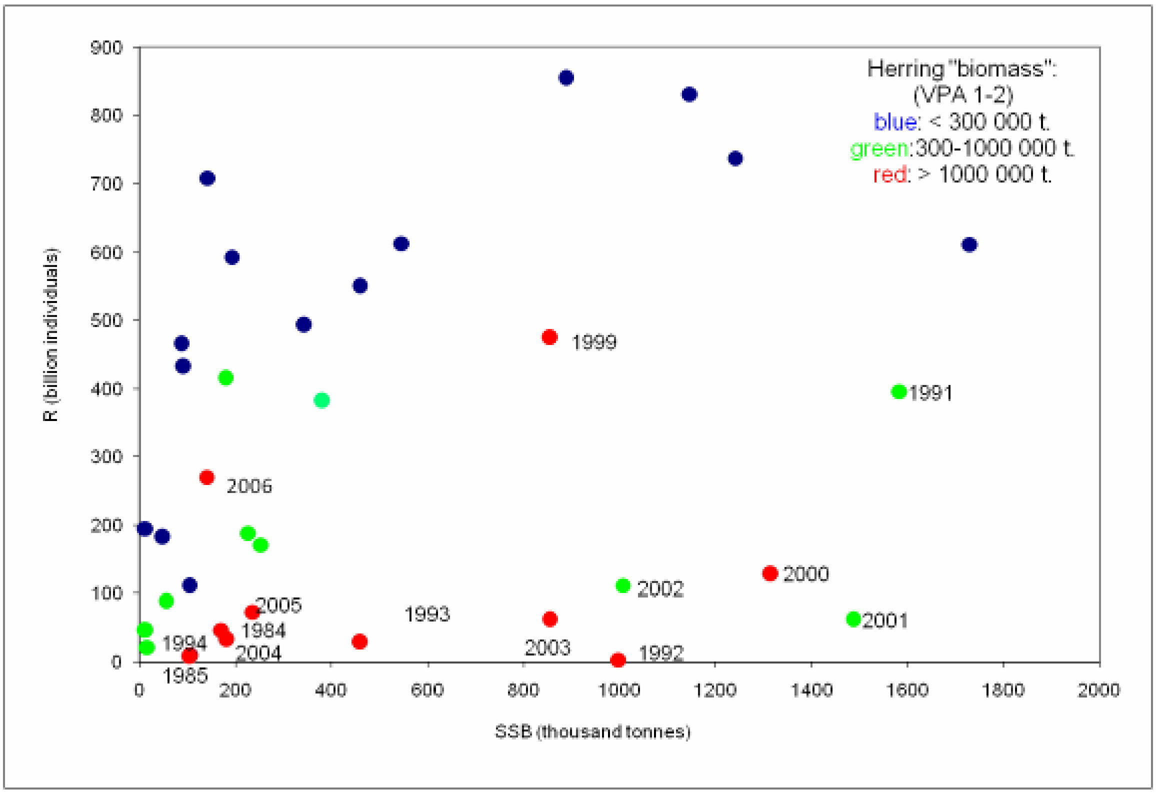

Figure 9.8. Spawning stock-recruitment plot for capelin, with colours of points indicating different levels of young herring abundance.

10 Working documents

WD#	Title	Orally presented	Authors
1	Consumption of various prey species by cod in 1984-2008	no	Dolgov A.V.
2	Report of the Portuguese fishery in 2008: ICES Div. I, IIa and IIb. With Appendix Revision of the length frequencies of the Portuguese fishery in 2007: ICES Div. I, IIa and IIb.	no	Alpoim, R., J. Vargas and E. Santos
3	Acoustic abundance of saithe, coastal cod and haddock Finnmark – Møre autumn 2008.	no	Aglen, A., Berg, E., Mehl, S. and Sunnanå, K.
4	New data on Greenland halibut (Reinhardtius hippoglossoides, Walbaum 1792) distribution in the northern Eurasian seas	no	Smirnov O.V.
5	Results of the Russian survey of Greenland halibut in the Barents Sea and adjacent waters in 2008	no	Smirnov O.V.
6	Report of Northeast Arctic cod otolith exchange between Russia, Norway and Germany 2008.	no	Høie, H., Bernreuther, M., Ågotnes, P., Beußel, F., Koloskova, V., Mjanger, H., Schröder, D., Senneset, H. and Zuykova, N.
7	Spanish bottom trawl survey FLETÁN ÁRTICO 2008 in the slope of Svalbard area, ICES Division IIb.	no	Ruiz J. & Mugerza E.
8	Satellite monitoring, inspection, and port control of fishing and carrier vessels aimed at resolving the IUU fishing problem	no	JRNC Working Group
9	Distribution, migrations and Russian fishery of capelin in winter-spring 2009	no	Ushakov N.G., Prozorkevich D.V.
10	Results of the Polish fishing survey of Greenland halibut in the Svalbard Protection Zone (ICES IIb) in April 2008	no	Janusz, J. and Trella, K.
11	Barents Sea winter survey	no	A.Aglen et al.
12	Assessment of population recruitment abundance of Northeast Arctic cod considering the environment data	no	Titov O.V.
13	Results from the Spanish NE Arctic cod sampling in 2008	no	José M. Casas
14	Indices of abundance from bottom trawl surveys in the Barents Sea: the Joint Russian Norwegian Ecosystem Survey in autumn	yes	S. Aanes and J.-H. Vølstad
15	An assessment of the future assessment site	yes	Stiansen,J.E., A.A. Filin, S. Aanes and B. Bogstad

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Annex 1 - List of Participants

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21 - 27 April 2009

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Annex 2: Quality Handbook ANNEX:_*Smentella*

Stock specific documentation of standard assessment procedures used by ICES. Since ACFM (now ACOM) considers it not necessary to assess this stock every year since the status of the stock can clearly be deducted from the surveys, no analytical assessment has been made since 2003.

Stock: *Sebastes mentella* (Beaked Redfish) in Subareas I and II

Working Group: Arctic Fisheries Working Group (AFWG)

Date: 28.04.09

A. General

A.1. Stock definition

The stock of *Sebastes mentella* (beaked redfish) in ICES Subareas I and II, also called the Norwegian-Barents Sea stock, 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 and out in the pelagic Norwegian Sea as it grows and becomes adult. In the Norwegian Sea and along the slope south of 70°N only few specimens less than 28 cm are observed, and on the shelf 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. Recent genetic studies revealed no differentiation between *S. mentella* in the Norwegian Sea and the Barents Sea.

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 Subarea 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 Subarea 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 Subarea IV along the northern slope of the North Sea. Approximately 80% of the Norwegian catches are considered to be *S. mentella*.

Strong regulations were enforced in the fishery in 1997. Since then it has been forbidden to fish redfish (both *S.marinus* and *S. mentella*) in the Norwegian EEZ north and west of straight lines through the positions:

1. N 7000′ E 0521′
2. N 7000′ E 1730′
3. N 7330′ E 1800′
4. N 7330′ E 3556′

and in the Svalbard area (Division IIb). When fishing for other species in these areas, a maximum 25% by-catch (in weight) of redfish in each trawl haul is allowed.

To provide additional protection of the adult *S. mentella* stock, two areas south of Lofoten have been closed for all trawl fishing since 1 March 2000. The two areas (A and B) are delineated by straight lines between the following positions:

A	**B**
1. N 6630′ E 0659′	1. N 6236′ E 0300′
2. N 6621′ E 0644′	2. N 6210′ E 0115′
3. N 6543′ E 0600′	3. N 6240′ E 0052′
4. N 6520′ E 0600′	4. N 6300′ E 0300′
5. N 6520′ E 0530′	
6. N 6600′ E 0530′	
7. N 6630′ E 0634.27′	

Area A has recently been enlarged to include the continental slope north to N 67º10′.

Since 1 January 2003 all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N. When fishing for other species it is legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and on board at any time. Since 1 January 2005 the bycatch percentage has been reduced to 15% (both species together).

From 1 January 2000 until 31 December 2005 a maximum legal by-catch criterion of 10 juvenile redfish (both *S.marinus*, *S. mentella* and *S. viviparus*) per 10 kg shrimp has been enforced in the shrimp fishery. Since 1 January 2006 this by-catch criterion has been reduced to 3 juvenile redfish (both *S.marinus*, *S. mentella* and *S. viviparus*) per 10 kg shrimp.

A directed pelagic fishery for *S. mentella* in international waters of the Norwegian Sea outside EEZ has developed since 2004. Landings of *S. mentella* taken in the pelagic fishery for blue whiting and herring in the Norwegian Sea have been reported to the working group in 2004 and 2005. Since 2006 this fishery developed further to become a directed fishery (7 countries and 31 trawlers in 2008). Vinnichenko (WD 9, AFWG 2007) gives a good and comprehensive description of the previous abundance of pelagic *S. mentella* in the international waters of the Norwegian Sea, and how by-catches and exploratory fishing have developed during 1979-2006. This fishery is managed by the North-East Atlantic Fisheries Commission, and during its annual meetings in November since 2006 the Commission has adopted by consensus annual TACs for international waters (15,500 t for 2007, 14,500 t for 2008 and 10,500 t for 2009).

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 supplies 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 (86-01)	x
Germany	x	x[3)]				x[3)]
United Kingdom	x	[1)]				
France	x	[1)]				
Spain	x	[1)]				
Portugal	x	[1)]				
Ireland	x	[1)]				
Greenland	x	[1)]				
Faroe Islands[1)]						
Iceland	x	[1)]				

[1)] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)

[2)] For main fishing area until 2001

[3)] Irregularly

The Norwegian, Russian and German input files are Excel spreadsheet files. The data should be found in the national laboratories and with the stock co-ordinator. The data will soon be included in InterCatch

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 stock co-ordinator and for the current and previous year in the ICES AFWG Sharepoint under 'Data'.

Historic result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smn_arct** or **w:\ifapdata\eximport\afwg\smn_arct**.

B.2. Biological

Since 1991, the catch in numbers at age of *S. mentella* from Russia is based on otolith readings. The Norwegian catch-at-age is based on otoliths back to 1990. Before 1990, when the Norwegian catches of *S. mentella* were smaller, Russian scale-based age-length keys were used to convert the Norwegian length distribution to age.

As input to trial analytical assessments, weight at age in the stock is assumed to be the same as weight at age in the catch.

A fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Age-based maturity ogives for *S. mentella* (sexes combined) are available for 1986–1993, 1995 and 1997–2001 from Russian research vessel observations in spring. Average ogives for 1966-1972 and 1975-1983 have been used for the periods 1965-1975 and 1976-1983, respectively. Average ogives for 1975-1983, 1984-1985 and data for 1986-1993 (Table D8) were used to generate a smoothed maturity ogive for 1984-1992 (3 year running average). The 1992-1993 average was used for 1993 and 1994, the 1995 data for 1995, the average for 1995 and 1997 for 1996, and the collected material for the subsequent years up to 2001 were taken as representative for these years.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the AFWG:

1) The international 0-group survey (since 2004 part of the Ecosystem survey) in the Svalbard and Barents Sea areas in August-September since 1980 (incl.).

2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December since 1978 (incl.) in fishing depths of 100–900 m.

3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since1992.

4) Norwegian Barents Sea bottom trawl survey (February) since 1986 (incl.) in fishing depths of 100–500 m. Data disaggregated on age only since 1992.

Although the Norwegian Svalbard (August-September) and Barents Sea (February) groundfish surveys are conducted at different times of the year and may overlap in the south of Bear Island area, the two series can be combined to get an approximate total estimate for the whole area.

1) The Norwegian survey initially designed for redfish and Greenland halibut is now part of the ecosystem survey and covers the Norwegian Economic Zone (NEZ) and Svalbard incl. north and east of Spitsbergen during August 1996-2008 from less than 100 m to 800 m depth. This survey includes survey no. 3 above, and has been a joint survey with Russia since 2003, and since then called the Ecosystem survey.

2) Russian acoustic survey in April-May since 1992 (except 1994, 1996 and 2002-2004) on spawning grounds in the western Barents Sea .

The international 0-group fish survey carried out in the Barents Sea in August-September since 1965 does not distinguish between the species of redfish but it is believed to be mostly *S. mentella*. The survey design has improved and the indices earlier than 1980 are not directly comparable with subsequent years.

Russian acoustic surveys estimating the commercially sized and mature part of the *S. mentella* stock have been conducted in April-May on the Malangen, Kopytov, and Bear Island Banks since 1986. In 1992 the area covered was extended, and data on age are available for 1992–1993, 1995 and 1997–2001. This is the only survey targeting commercially sized *S. mentella*, but only a limited area of its distribution.

In order to investigate the distribution and abundance of pelagic *Sebastes mentella* in the Norwegian Sea the following surveys are/have been conducted:

i. Norwegian part of the international ecosystem survey in the Nordic Seas in spring 2007-2009 (PGNAPES).

ii. Norwegian trawl and acoustic survey in September 2007, and ICES coordinated international trawl and acoustic survey conducted by Norway, Russia and the Faroes in August 2008.

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	1965-2008	6-19+	yes
Canum	Catch at age in numbers	1965-2008[1]	6-19+	yes
Weca	Weight at age in the commercial catch	1965-2008	6-19+	yes
West	Weight at age of the spawning stock at spawning time.	1965-2008	6-19+	yes
Mprop	Proportion of natural mortality before spawning	1965-2008	6-19+	Constant=0
Fprop	Proportion of fishing mortality before spawning	1965-2008	6-19+	Constant=0
Matprop	Proportion mature at age	1965-2008	6-19+	1965-1975, const. 1976-1983, const. 1984-2001,variable 2002-, const
Natmor	Natural mortality	1965-2008	6-19+	Constant=0.1

[1] **Based on otoliths since 1991**

Tuning data: files not updated since 2005, but data/results exist also for recent years

Type	Name	Year range	Age range
Tuning fleet 1	FLT10 Rus young	1991-2005	6-8
Tuning fleet 2	FLT13 Rus acous	1995-2001	6-14
Tuning fleet 3	FLT14 Norw bottom	1996-2005	2-11
….			

D. Short-Term Projection

Model used: Visual analysis of survey results.

Software used: none

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Model used: Visual analysis of survey results.

Software used: none

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:

6. Weight at age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

H. Other Issues

I. References

Annex 3 – Stock Annex

Quality Handbook **ANNEX:cod-coastal**

Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Norwegian Coastal cod
Working Group:	Arctic Fisheries Working Group
Date:	24-04-2009

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 clear differences (Árnason and Pálsson 1996, Mork, et al. 1984, Artemjeva and Novikov, 1990). Investigations also indicate that NCC probably consists of several separate populations.

Ongoing microsatellite studies on the genetic structure of cod along the entire Norwegian coast have revealed considerable genetic differences. Two main clusters were indicated: one north of 64 deg north (Trondheimsfjord) and one to the south of this. Differences were also observed between regions within these clusters. The conclusion is that NCC is not a single stock.

A.2. Fishery

Coastal cod is mainly fished by small coastal vessels using traditional fishing gears like gillnet, longline, hand line and danish seine, but some is also fished by trawlers and larger longliners fishing at the coastal banks. 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. Before 1995 the portion taken by longline and hand line was higher, while the portion taken by danish seine was lower. 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.

The TAC set for coastal cod is added to the Norwegian TAC for North-east Arctic cod, giving a total, combined TAC to distribute on fishing vesslels. Cod catches are not identified to stock at landing, and therefore no landings are counted against a separate coastal cod quota. When the fishing year is finished the catches of coastal cod are estimated from otholit sampling. All regulations for North-east Arctic cod also applies to coastal cod. This includes minimum catch size, minimum mesh size , maximum by-catch of undersized fish, and closure of areas having high densities of juveniles. In addition, trawl fishing for cod is not allowed inside the 6-n.mile, and since the mid 90-ies the fjords in Finnmark and northern Troms (areas 03 and 04) has been closed for fishing with Danish seine, and since 2000 the large longliners have been given restrictions, now only allowed to fish outside the 4 n.mile. Since 2004 additional restrictions on coastal fisheries have been introduced to reduce catches of coastal cod. In these new regulations "fjord-lines" are drawn along the coast to close the fjords for direct cod fishing with vessels larger than 15 meter. A box closed for all fishing gears except hand-line and fishing rod is defined in the Henningsvær-Svolvær area. This is an area where spawning concentrations of coastal cod is usually observed and where the catches of coastal cod has been high. Since the coastal cod is fished under a combined coastal cod/north-east arctic cod quota, these regulations are supposed to turn parts of the traditional coastal fishery over from catching coastal cod in the fjords to catch more cod outside the fjords where the proportion of North-east Arctic cod is higher. Further restrictions were introduced in 2007 by not allowing pelagic gill net fishing for cod and by reducing the allowed by-catch of cod when fishing for other species inside fjord lines from 25% to 5%, and outside fjord-lines from 25% to 20%. In 2009 a fjord area off Ålesund was closed in the spawning season for fishing with all gears except handline and fishing rod.

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 North-east 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 1984using available data on otolith typing. During this period the catches have been between 22,000 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. The sampling intensity is determined by knowledge on the distribution of the combined cod catches.

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. The mean values are weighted by catches in the respective areas.

Proportions mature at age from 1984 to 1994 are obtained from the commercial catch data. From 1995 onwards the proportions mature at age are obtained from the Norwegian coastal survey.

Norway is assumed to account for all 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

B.2. Biological

Weight at age in the stock is obtained from the Norwegian coastal survey in from 1995 onwards. 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. The mean values are weighted by biomass in the respective areas. In 2007 a weight at age series of unweighted mean values from the survey was calculated and used in the SURBA analysis.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast. Some fjord studies (Pedersen and Pope, 2003a and b, Mortensen 2007, Pedersen *et al*., 2007). indicate that the main predators on young cod is larger cod, cormorants and saithe. There are no estimates of annual predation mortality for the stock complex.

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 September (prior to 2003) and 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. Ages 2 – 9 are used in a SURBA analysis.

B.4. Commercial CPUE

No commercial CPUE are available for this stock.

B.5. Other relevant data

A number of bottom trawl tows are made during the coastal survey, and since 2003 the survey has aimed for towing at the same fixed positions each year. This might be used to calculate a bottom trawl index.

C. Historical stock development

Acoustic survey

The total acoustic biomass varies between 144,000t (1995) and 30,300t (2005), showing a decline from 1995 until 2003, and flat level since 2003. The indices show considerable year to year variations. The acoustic spawning biomass vary between 75,000t (1995) and 12,700t (2005), showing the same type of trend as the total biomass. The recruitment of 2 year old fish vary from 20 million individuals in 1995 to 2 million in 2005, also showing the same, but stronger trend as the total stock.

SURBA analysis

The SURBA analysis (SURBA 2.10) is run with the same data as input to the XSA (se below). However, the age span is 2 – 9 year in the SURBA analysis. The settings are set similar to the XSA settings. The weight at age for the stock is calculated as unweighted mean values to avoid some of the large fluctuations in the weight at age from the survey calculations.

The history of the stock is reflected in the same way in this analysis as in the survey, showing a drop to a level in the later years about 25% of the level in 1995. The recruitment is down to a 10% level.

VPA analysis

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 fleet	Norwegian coastal survey	1995 – last data year	2 – 8	

The results show a variation of the total biomass between 310,000t (1984) and 87,000t (2008) with the value in 1995 being 260,000t. The spawning stock is estimated to 170,000t in 1995, falling to 50,000t in 2008. The fishing mortality is estimated to 0.38 on average. The pattern of stock decline is fairly similar to that of the survey.

D. Short-term projection

No quantative projection but trends in stock biomass, mortality and recruitment obtained from surba (and xsa) are used to indicate stock development. t

E. Medium-term projections

Not done.

F. Long-term projections

Not done.

G. Biological reference points

Not available.

H. Other issues

I. References

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Annex 4 Quality Handbook ANNEX:_afwg-ghl-arct

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North-East Arctic Greenland Halibut
Working Group:	Arctic Fisheries Working Group
Date:	27-04-09

A. General

A.1 Stock definition

Greenland halibut (*Reinhardtius hippoglossoides,* Walbaum) is distributed in the Arctic and boreal waters in the North Atlantic and in the North Pacific (Fedorov 1971; Godø and Haug 1989; Bowering and Brodie 1995; Bowering and Nedreaas 2000). In the northeastern Atlantic the distribution is more or less continuous along the continental slope from the Faeroe Islands and Shetland to north of Spitsbergen (Whitehead et al. 1986; Godø and Haug 1989), with the highest concentrations from 500 to 800 m depth between Norway and Bear Island, which is also regarded as the main spawning area (Godø and Haug 1987; Albert et al. 2001b). Peak spawning occurs in December in the main spawning area, but also in nearby localities during summer (Albert et al. 2001b). Atlantic currents transport eggs and larvae northwards and the juveniles are distributed around Svalbard and in the northeastern Barents Sea, to the waters around Franz Josef Land and Novaja Zemlya area (Godø and Haug 1987; Godø and Haug 1989; Albert et al. 2001a). As they grow older they gradually move southwards and eventually alternate between the spawning area and feeding areas in the central-western Barents Sea (Nizovtsev, 1989).

The Northeast arctic Greenland halibut stock is a pragmatically defined management unit. The degree of exchange with other stocks is not resolved, but is believed to be low. Potential routes of exchange may be drift of larvae towards Greenland and migration of adults between the Barents Sea and the Iceland-Faeroe Islands area.

A.2 Fishery

Before the mid 1960s the fishery for Greenland halibut was mainly a coastal long line fishery off the coasts of eastern Finnmark and Vesterålen in Norway. The annual catch of the coastal fishery was about 3,000 t. In recent years this fishery has landed 3,000–6,000 t although now gillnets are also used in the fishery. In 1964 dense Greenland halibut concentrations were found by Soviet trawlers in the slope area to the west of the Bear Island (Nizovtsev, 1989). Following the introduction of international trawlers in the fishery in the mid 1960s, the total landings increased to about 80,000 t in the early 1970s.The total Greenland halibut landings decreased steadily to about 20,000 t during the early 1980s. This level was maintained until 1991, when the catch increased sharply to 33,000 t. From 1992 total landings varied between 9 000-19 000 t with a peak in 1999.

From 1992 the fishery has been regulated by allowing only the long line and gillnet fisheries by vessels smaller than 28 m to be directed for Greenland halibut. This fishery is also regulated by seasonal closure. Target trawl fishery has been prohibited and trawl catches are limited to bycatch only. From 1992 to autumn 1994 bycatch in each haul was not to exceed 10% by weight. In autumn 1994 this was changed to 5% by-catch 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	x				
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 and Russian input files are 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 and Norwegian catch-at-age data based on national landings, length composition of catches, age-length-keys (ALK) and weight at age data. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian landings. From 2006 Norway stopped to determine the age using the traditional method. Since than the common catch-at-age files constructed on the base of the Russian ALK and weight at age data.

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:\acom\afwg\year\data\ghl_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 (from 2000 Joint) 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 1.1).

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 Barents 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 1.1. 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. Than the increase in 0-group abundance seems to have stopped, and the 2007-2008 indices were very low. It should be noted that the Ecosystem survey is not optimal for surveying 0-group Greenland halibut.

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.

Since 2006, none of the age structured tables of the Norwegian surveys have been updated due to change in age reading procedure.

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. The Norwegian CPUE survey was stopped from 2005. This was one of the tuning fleets, but an evaluation of this survey revealed a lot of inconsistencies in the series.

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.

Other issues

None

I References

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Annex 5 – Stock Annex – Northeast Arctic Saithe

Quality Handbook	**Annex: Saithe in Subareas I and II**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Saithe in Subareas I and II (Northeast Arctic)
Working Group:	Arctic Fisheries Working Group
Date:	15.02.2009 / 26.04.2009
Revised by:	Sigbjørn Mehl / Åge Fotland

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

Norway accounts for more than 90% of the landings. Over the last ten years about 40% of the Norwegian catch originates from bottom trawl, 25% from purse seine, 20% from gill net and 15% from other conventional gears (long line, Danish sine and hand line). The gill net fishery is most intense during winter, purse seine in the summer months while the trawl fishery takes place more evenly all year around. 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. 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 171,000 t in 1996, followed by a new decline to 136,000 t in 2000. Since then the annual landings have increased gradually to 212,000 t in 2006, followed by a decline to 199 000 t in 2007 and 183 000 t in 2008. Quotas can be transferred between gears 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.

The number of vessels taking part in the purse seine fishery has varied between 110 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 66°33’ 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:

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 countries 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	x				
Spain[1]	x				
Portugal	x				
Poland	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 are normally available from Norway, Russia (some areas) and Germany (Division IIA). In some areas 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. 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. Since 2007 the national data have also been uploaded to the ICES Intercatch database.

The result files (FAD data) can be found with the stock co-ordinator and at ICES as ASCII files on the Lowestoft format under **w:\acom\afwg\year\Stock\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 maturity at age had decreased somewhat in the last part of the period, and the WG decided to use a 3-year running average for the period from 1985 and onwards (2-year average for the first and last year) (ICES 2005). The average for the period 1985-2004 is presented in the text table below together with the ogive applied until 2005.

AGE GROUP	2	3	4	5	6	7	8	9	10	11+
Until 2005	0	0	0.01	0.55	0.85	0.98	1	1	1	1
1985-2004	0	0	0.08	0.51	0.76	0.90	0.94	1	1	1

B.3. Surveys

Since 1985 a Norwegian acoustic survey specially designed for saithe has been conducted annually in October-November (Nedreaas 1997). The survey covers the near coastal banks from the Varangerfjord close to the Russian border and southwards to 62° N. The whole area has been covered since 1992, and the major parts since 1988. The aim of conducting an acoustic survey targeting Northeast Arctic saithe has been to support the stock assessment with fishery-independent data of the abundance of the youngest saithe. The survey mainly covers the grounds where the trawl fishery takes place, normally dominated by 3 - 5(6) year old fish. 2-year-old saithe, mainly inhabiting the fjords and more coastal areas, are also represented in the survey, although highly variable from year to year. In 1997 and 1998 there was a large increase in the abundance of age 5 and older saithe, confirming reports from the fishery. In 1999 the abundance of these age groups decreased somewhat, but was still at a high level compared to years before 1997 (Mehl 2000). Abundance indices for ages 2-5 from 1988 and onwards have traditionally been used for tuning, but including older ages as a 6+ group in the tuning series improved the scaled weights a little and at the 2000 WG meeting it was decided to apply the extended series in the assessment. The results from the survey autumn 2000 showed a further decrease in the abundance of age 5 and older saithe (Korsbrekke and Mehl 2000). It is not known how well the survey covers the oldest age groups from year to year, but at least for precautionary reasons the 6+ group was kept in the tuning series. Before the 2005 WG the 6+ group from the Norwegian acoustic survey was split into individual age groups 6 – 9 by rerunning the original acoustic abundance estimates. This was only possible to do for the years back to 1994

Since 1995 a Norwegian acoustic survey for coastal cod has been conducted along the coast and in the fjords from Varanger to Stad in September, just prior to the saithe survey described above. This survey covers coastal areas not included in the regular saithe survey. Because saithe is also acoustically registered, this survey provides supplementary information, especially about 2- and 3-year-old saithe that have not yet migrated out to the banks. At the WG meeting in 2000 analyses were done on combining these indices with indices from the regular saithe survey in the tuning series, but it did not influence the assessment much. The WG therefore decided, for the time being, to only apply indices from the regular saithe survey in the assessment since this series is longer.

Autumn 2003 the saithe- and coastal cod surveys were combined. However, until new time series can be established, the estimation of abundance indices is done very much in the same way as before and the results should be comparable.

B.4. Commercial CPUE

Two CPUE data series are used, one from the Norwegian purse seine fishery and one from the Norwegian trawl fishery.

Until 1999 indices of fishing effort in the purse seine fishery was based on the number of vessels of 20-24.9 m length and the effort (number of vessels) of this length category was raised by the catches to represent the total purse seine effort. The number of vessels taking part in the fishery almost doubled from 1997 to 1998, but due to regulations the catches were almost the same as in 1997. In such a situation the total number of vessels participating in a fishery is perhaps not a good measure of effort. Many of the vessels that have taken part in the fishery the last decade have accounted for only a small fraction of the purse seine catches. Roughly half of the vessels have caught less than 100 tonnes per year, and the sum of these catches represents only about 5 – 10% of the total purse seine catch. Therefore the number of vessels catching more than 100 tonnes annually seems to be a more representative and more stable measure of effort in the purse seine fishery. These numbers are raised to the total purse seine catch. The new effort series show a smaller decrease in later years than the old one and in XSA runs it gets higher scaled weights. The 2000 WG meeting therefore decided to use the new CPUE data series in the assessment.

The quality and performance of the purse seine tuning fleet has been discussed several times in the WG. The effort, measured as number of vessels participating, has been highly variable from year to year. This has been partly taken care of by only including vessels with total catch > 100 tonnes. However, with a restricting and changing TAC and transfer of quota, the CPUE may change much from year to year without really reflecting trends in the saithe availability. This is also reflected in the tuning diagnostics of exploratory runs. There are rather large and variable log q residuals and large S.E. log q for all age groups except age 4, which is the dominant age group in the purse seine landings in many years. And even the S.E. log q for age 4 is higher than in the Norwegian trawl CPUE and acoustic survey indices single fleet tunings. There are strong year effects, and in the combined tuning the purse seine series get low scaled weights. Mainly based on this the 2005 WG decided to not include the purse seine tuning fleet in the further and final analysis (ICES 2005).

Catch and effort data for Norwegian trawlers were until 2000 taken from hauls where the effort almost certainly had been directed towards saithe, i.e., days with more than 50% saithe and only on trips with more than 50% saithe in the catch. The effort estimated for the directed fishery was raised by the catches to give the total effort of Norwegian trawlers. From 1997 to 1998 the effort increased by more than 50%, but due to regulations the catches were slightly lower in 1998 and the CPUE decreased by almost 40% from 1997 to 1998 and stayed low in 1999. This may at least partly be explained by change in fishing strategies in a period with increasing problems with bycatch of saithe in the declining cod fishery due to good availability of saithe. In 2001 new CPUE indices by age were estimated based on the logbook database of the Directorate of Fisheries, which has a daily resolution (Salthaug and Godø 2000). After some initial analyses it was decided to only include data from vessels larger than the median length since they showed the least noisy trends. One single CPUE observation from a given vessel is the total catch per day divided by the duration of all the trawl hauls that day. To increase the number of observations during a time period with decreasing directed saithe fishery, all days with 20% or more saithe were included. The effort (hours trawling) for each CPUE observation is standardised or calibrated to a standard vessel. Until 2002, first averaging all CPUE observations for each month, and then averaging over the year calculated a yearly index. The CPUE indices were splitted on age groups by quarterly weight, length and age data from the trawl fishery. From 2003, first averaging all CPUE observations for each quarter, and then averaging over the year calculate a yearly index. There was an increase in the total CPUE from 1999 to 2003, when it reached the highest level in the time series going back to 1980. In 2004 the total CPUE was almost exactly the same as in 2003, while there was about a 30 % increase from 2004 to 2005. This was caused by an increase in the quarter one CPUE. This increase started already in 2003, but was most pronounced in 2005. The increase may be explained by increased availability and catchability of saithe in spawning areas of Norwegian spring spawning herring, where the saithe feeds on herring during quarter one. A similar increase was not seen in the other areas and quarters. AT the 2005 WG annual CPUE was also calculated without quarter one data. This CPUE series showed much less variations over the last four years, and the WG decided to use a CPUE time series averaged over quarters 2-4 for tuning (ICES 2005). The 2007 CPUE data seemed to be an outlier in the time series. The survey (Aglen *et al*., WD 15 2008) shows a higher proportion of saithe in the southern half of the distribution area in the last years, and logbook data show that the trawl catches included in the CPUE calculations also have become gradually more southerly distributed, i.e. the trawlers follow saithe aggregations that may have become extra available in 2007. The biological samples used for dividing total CPUE on age groups are, however, from the whole saithe fishery and therefore include age groups that are not numerous in these aggregations. Due to this and the 20% decline in total survey index the WG decided to exclude the 2007 CPUE data in the final assessment (ICES 2008).

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: Lowestoft VPA suite. In afwg 2009 exploratory assessment runs were conducted in FLR version 2.8.1.

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+	Yes/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	1994 – last data year	3 – 7
Tuning fleet 12	Nor new trawl quarter 2-4	1994 – last data year 2007 omitted	4 - 8

For analysis of alternative procedures see WG reports from AFWG 1997-2008.

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, (adviced by RG in 2004).

From afwg 2009 the numbers at age 4 in the intermediate year is calculated applying a natural mortality of 0.2 and the F value estimated by standard Pope's equation for calculation of this y-c at age 4, i.e. N(4)=[N(3)*exp(-M/2)-C(3)] *exp(-M/2), (adviced by RG in 2009).

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, 5000 replications, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM (mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 3, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: Constant ogive 1960-1984, three year running average since 1985
- F and M before spawning: Set to 0 for all ages in all years
- Weight at age in the stock: Assumed to be the same as weight at age in the catch
- Weight at age in the catch: Average weight of the three last years

- Exploitation pattern: Average of the three last years, scaled by the Fbar (4-7) to the level of the last year if there is a trend
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC
- Stock recruitment model used: specified as a PERT distribution (as special form of the beta distribution) with a *minimum* and *maximum* value as specified. The shape parameter is calculated from the defined *most likely* value.

  RiskPertAlt(*arg1type, arg1value, arg2type,arg2value, arg3type,arg3value*). Specifies a PERT distribution with three arguments of the type *arg1type to arg3type*. These arguments can be either a *percentile* between 0 and 1 or *"min", "m. likely"* or *"max"*.

  Examples: *RiskPertAlt(2%; min; 50%; geomean; 98%; max) specifies a PERT distribution with a* minimum *of min and a most likely value of geomean and a 98th percentile of max*

F. Long-Term Projections

Not done

G. Biological Reference Points

Due to the change of Fbar from 3-6 to 4-7 and age at recruitment from 2 to 3, the **lim** and **pa** reference points were re-estimated at the 2005 WG. The **lim** reference points were estimated according to the new methodology outlined in ICES CM 2003/ACFM:15. Saithe retrospective XSA-analyses show that in later years there have been an overestimation of F and underestimation of SSB in the assessment year. The trend may have been the opposite in earlier years, but the length of the tuning series do not allow for long enough retrospective analysis to verify this. The new methodology (ICES CM 2003/ACFM:15) does not give any advise on how to deal with such situations. The **pa** reference point estimation was therefore based on the old procedure, applying the "magic formula" $\mathbf{B}_{pa} = \mathbf{B}_{lim} \exp(1.645*\sigma)$ and $\mathbf{F}_{pa}=\mathbf{F}_{lim}*\exp(-1.645*\sigma)$, where σ is a measure of the uncertainty of F estimates (ICES CM 1998/ACFM:10). For NEA saithe a value of 0.3 was applied in both estimates.

In 1994 the WG proposed a MBAL of 150,000 t, based on the frequent occurrence of poor year classes below this level of SSB. The new maturity ogive introduced in 1995 gave somewhat higher historical SSB estimates. 150,000 t was considered to represent a less restrictive MBAL and 170,000 t was found to correspond better with the arguments used in 1994 (ICES 1996/Assess: 4). The Study Group on the Precautionary Approach to Fisheries Management (SGPAFM, ICES 1998/ACFM: 10) also found this to be a suitable level for B_{pa}. However, based on a visual examination of the stock-recruitment plot ACFM later reduced the B_{pa} to 150,000 t (ICES 1998b).

At the 2005 WG parameter values, including the change-point ($\mathbf{S^*} = \mathbf{B}_{lim}$), slope in the origin ($\hat{\alpha}$) and recruitment plateau (**R***), were computed using segmented regression on the 1960-2000 time series of SSB-recruitment pairs. The values are presented in the text table below. Applying the "magic formula" $\mathbf{B}_{pa} = \mathbf{B}_{lim} \exp(1.645*\sigma)$, gives a $\mathbf{B}_{pa}$ of 223,392 t, rounded to 220,000 t. The WG proposed this as the new $\mathbf{B}_{pa}$ for Northeast Arcic saithe.

From algorithm in Julious (2001)		
S*	$\hat{\alpha}$	R*
136378	1.27	173200

$F_{0.1}$ and F_{max} are estimated by the MFDP yield per recruit routine, and increased from 0.08 to 0.15 and from 0.14 to 0.3 for $F_{0.1}$ and F_{max}, respectively, in the 1999 - 2005 assessments, in 2009 assessment to 0.16 and 0.39 for $F_{0.1}$ and F_{max} respectively.

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" $F_{pa} = F_{lim} \exp(-1.645*\sigma)$, gives a F_{pa} of 0.35. The 2005 WG proposed this as the new F_{pa} for Northeast Arcic saithe.

H. Other Issues

Harvest control rule

In 2007 Norway asked ICES to evaluate whether a proposal for a harvest control rule for setting the annual fishing quota (TAC) for Northeast Arctic saithe was consistent with the precautionary approach. The harvest control rule contains the following elements:

- estimate the average TAC level for the coming 3 years based on $\mathbf{F}_{pa}$. 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 +/- 15% compared with the previous year's TAC.
- if the spawning stock biomass (SSB) in the beginning of the year for which the quota is set (first year of prediction), is below $\mathbf{B}_{pa}$, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from $\mathbf{F}_{pa}$ at SSB=$\mathbf{B}_{pa}$ to 0 at SSB equal to zero. At SSB levels below $\mathbf{B}_{pa}$ in any of the operational years (current year and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.

ICES concluded that the HCR is consistent with the precautionary approach for all simulated data and settings, including a rebuilding situation under the condition that the assessment uncertainty and error are not greater than those calculated from historic data (ICES 2007). This also holds true when an implementation error (difference between TAC and catch) equal to the historic level of 3% is included.

The highest long-term yield was obtained for an exploitation level of 0.32, i.e. a little below the target F used in the HCR (Fpa), and ICES recommended using a lower value in the HCR.

The HCR is expected to rebuild a depleted stock to a level above $\mathbf{B}_{lim}$ within three years.**I.**

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Annex 6 – Stock Annex – Haddock in Subareas I and II

Quality Handbook **Haddock in Subareas I and II**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Haddock in Subareas I and II (Northeast Arctic)
Working Group:	Arctic Fisheries Working Group
Date:	26.04.2009
Revised by:	Alexey Russkikh / Sondre Aaanes

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.

Since 2007, estimates of unreported catches (IUU catches) of haddock have been added to reported landings for the years 2002 and onwards. In 2007-2008, two assessments were presented, based on Norwegian and Russian estimates of IUU catches, respectively. The basis for the Norwegian IUU estimates (N ‑ IUU) is the annual ratio between cod and haddock in the international reported landings from Sub ‑ area I and Division Iib in 2002 ‑ 2008. These ratios are assumed to be representative of the ratios in the IUU catches. The ratio is applied to the estimated IUU catches of cod in order to get the estimate for haddock. The estimates are similar to those made by the Norwegian Directorate of Fisheries for 2005-2008. The Russian estimates of IUU haddock are obtained by applying the same ratio, but using the Russian estimate of IUU catches of cod in 2002-2007. Both approaches show an increase from 2002 to 2005 followed by a decline. In 2009, the Working Group decided to follow the same procedure used as basis for advice in last year's, and only use the Norwegian IUU.

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

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.

The age distribution and weight at age for the Norwegian catches were estimated using the software based on the method of Hirst *et al*. (2005). In this method, the three different types of available samples (age and weight samples, age and weight stratified by length groups, and length samples) are modelled simultaneously using a previously developed Bayesian hierarchical model (Hirst *et al*., 2004). This method replaced the traditional method in 2006, and the time series of Norwegian catch at age (early 80's and onward) was updated based on the modelling approach. The old method involved allocating unsampled catches to sampled catches based on judgements on "distance criteria's" (in area, time and sometimes gear) and the use of ALK's to fill holes in the sampling frame.

Russia

Russian commercial catch in tonnes by seasons and area are derived from the Russian Federal Research Institute of Marine Fisheries and Oceanography (VNIRO, 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 125/135 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).

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) for the whole year. Catch at age are reported to ICES AFWG by sub-Division (I, IIa and IIb) for the whole year. 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	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 combined catch data were estimated by the SALLOC program (Patterson, 1998). The national data will soon be available in Intercatch, until then 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 catch.

The result files can be found at ICES (sharepoint) and with the stock co-ordinator as ASCII files on the Lowestoft format.

B.2. Biological

Stock weights used from 1985 and onwards are averages of values derived from Russian surveys in autumn (mostly October-December) and Norwegian surveys in January-March the following year. These averages are assumed to give representative values for the beginning of the year. In 2006 the Working group decided to model the stock weight-at-age data in order to remove some of the sampling variability in the estimates. The weight at age is modelled as follows: Mean length at age is modelled using a von Bertalanffy model with L_∞ and T_0 parameters estimated over the whole time series and a separate K parameter for each year class. Weight at age is estimated from a length-weight relationship using the smoothed (modelled) length at age. Estimates were produced separately for the Russian autumn survey and the joint winter survey and were later combined as plain average. For the earlier period (1950-1984) mean weight at age in stock is set equal to mean weight at age in the stock for 1985 and onwards.

In 2006 the Working Group revised the estimates of maturity at age. For the years 1980 onwards the series consists of predicted values using a logistic link function with age and length as explanatory variables from the joint winter survey combined with predicted proportions from the Russian autumn survey:

$$Mat = \frac{1}{1 + e^{(-a*(age-age50\%)}}$$

The new series is based on the data from the Russian autumn survey and the joint winter survey. For the period 1950-1979 an average of both data series is used.

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 Sea. 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. Historical Stock Development

Model used: XSA

Software used: FLR suite and 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 = 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	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: R and FLR suite, 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: R and FLR.

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 is not used.

Uncertainty models used: See AFWG 2007.

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. Other Issues

Harvest control rule

The harvest control rule (HCR) was evaluated by ICES in 2007 (AFWG 2007) and found to be in agreement with the precautionary approach. The agreed HCR for haddock is as follows (Protocol of the 36th Session of The Joint Norwegian Russian Fishery Commission, 10 October 2007):

- *TAC for the next year will be set at level corresponding to F_{pa}.*
- *The TAC should not be changed by more than +/- 25% compared with the previous year 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 and a year ahead) there should be no limitations on the year-to-year variations in TAC.*

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Annex 7 Quality Handbook ANNEX:afwg-smr

Stock specific documentation of standard assessment procedures used by ICES.

Stock:…	Golden redfish *Sebastes marinus* in ICES Subareas I and II
Working Group:…	Arctic Fisheries Working Group
Date:	22.04.2009

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* had only marginal effects on the *S. marinus* stock. After this date, all directed trawl fishery for redfish (both *S. marinus* and *S. mentella*) is forbidden in the Norwegian Economic Zone north of 62°N. During 2003 and 2004, when fishing for other species it was legal to have up to 20% redfish (both species together) in round weight as bycatch per haul and on board at any time. Since 1 January 2005 this percentage has been reduced to 15%.

A minimum legal catch size of 32 cm has been set for all fisheries (since 14 April 2004), with the allowance to have up to 10% undersized (i.e., less than 32 cm) specimens of *S.marinus* (in numbers) per haul.

Until April 2004 there were no regulations of the other gears/fleets than trawl fishing for *S. marinus*. Since then, different limited moratoriums have been enforced in all fisheries except trawl. These have been 1-31 May in 2004, 20 April-19 June in 2005 and during April-May and September in 2006. When fishing for other species (also during the moratorium) it is allowed for these fleets to have up to 15% (in 2004, 20%) bycatch of redfish (in round weight) summarized during a week fishery from Monday to Sunday.

Since 1 January 2006 it is forbidden to use gillnets with meshsize less than 120 mm when fishing for redfish.

Since 1 January 2006, the maximum bycatch of redfish (both *S. mentella and S. marinus*) juveniles in the international shrimp fisheries in the northeast Arctic has been reduced from ten to three redfish per 10 kg shrimp.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The landings statistics used by the Arctic Fisheries Working Group (AFWG) are those officially reported to ICES. In cases where such reportings to ICES do not exist, reportings made directly to Norwegian authorities during the fishery have been used as preliminary figures. Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated for the gears gill net, long line, hand line, Danish seine and bottom trawl. For bottom trawl the quarterly area distribution of the catches is area adjusted by logbook data from The Directorate of Fisheries. No discards are reported or accounted for. Reliable estimates of species breakdown (*S. mentella* vs. *S. marinus*) by area are available back to 1989. The national landings of redfish for Norway and Russia are split into species by the respective national laboratories. For other countries (and areas) the AFWG has split the landings into *S. mentella* and *S. marinus* based on reports from different fleets to the Norwegian fisheries authorities.

The Norwegian sampling strategy is to have age-length samples from all major gears in each area and quarter. There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in neighbouring areas, search in neighbouring quarters, first from the same gear in the same area, and than from neighbouring areas and similar gears. The last option is to search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. For some gears, areas and quarters length samples taken by the coast guard are applied and combined with an ALK from a neighbouring area, gear or quarter. ALKs from research surveys (shrimp trawl) are also used to fill holes.

For Norway, weights at age in the catch are estimated according to the formula which gives the best fit to the length-weight data pairs collected during the year and applied to the mean length at age.

The text table below shows which country supplies which kind of data:

	Kind of data					
Country	Caton (catch in weight) on unidentified redfish	Caton (catch in weight) on *S. marinus*	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway		x	x	x		x
Russia		x				x
Germany	x	x[2)]				x
United	x	[1)]				
Kingdom	x	[1)]				
France	x	[1)]				
Spain	x	[1)]				
Portugal	x	[1)]				
Ireland	x	[1)]				
Greenland						
Faroe Islands[1)]	x	[1)]				
Iceland						

[1)] As reported to Norwegian authorities during the fishery (only for the Norwegian Economic Zone and Svalbard)

[2)] Irregularly

The Norwegian and German input files are Excel spreadsheet files, while the Russian input data are supplied on paper and later punched into Excel spreadsheet files before aggregation to international data. The data should be found in the national laboratories and with the stock co-ordinator.

The national data have been aggregated to international data on Excel spreadsheet files. The Russian and German length composition has been applied on the Russian and German landings, respectively, using an age-length-key (ALK) and weight at age data from the Norwegian trawl landings. Catches from the other countries were assumed to have the same age composition and weight at age as the Norwegian trawl landings. In some years the final German and Russian numbers at age have been adjusted to remove SOP discrepancies before aggregation to international data. The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the Norwegian stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\afwg\<year>\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under **w:\acfm\afwg\<year>\data\smr-arct** or **w:\ifapdata\eximport\afwg\smr-arct**.

B.2. Biological

The total catch-at-age data back to 1991 are based on Norwegian otolith readings. In 1989–1990 it was a combination of the German scale readings on the German catches, and Norwegian otolith readings for the rest. In 1984–1989 only German scale readings were available, while in the years prior to 1984 Russian scale readings exist.

Weight at age in the stock is assumed to be the same as weight at age in the catch.

When an analytical assessment is made, a fixed natural mortality of 0.1 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A knife-edge maturity at age 15 (age 15 as 100% mature) has been used for this stock. Since 2006 a maturity ogive has been modelled and estimated by the GADGET model.

B.3. Surveys

The results from the following research vessel survey series have annually been evaluated by the Working Group:

1) Norwegian Barents Sea bottom trawl survey (February) from 1986–2009 in fishing depths of 100–500 m. Data are available on length for the years 1986–2009, and on age for the years 1992–2008. This survey covers important nursery areas for the stock
2) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1985–2008 in fishing depths of 100–500 m. This survey covers the northernmost part of the species' distribution.
3) Data on length and age from both these surveys have been simply added together and used in the assessments.
4) Catch rates (numbers/nautical mile) and acoustic indices of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2008 from Finnmark to Møre. Since 2003, only catch rates are available.

B.4. Commercial CPUE

The former (until 2002) CPUE-series for *S. marinus* from Norwegian 32-50 meter freezer trawlers has been improved (e.g., analysing the trawl data with regards to vessel length instead of vessel tonnage) and presented from 1992 onwards. Only data from days with more than 10% *S. marinus* in the catches (in weight) were included in the annual averages together with data on vessel days (i.e., effort) meeting the 10% criterion.

B.5. Other relevant data

None.

C. Historical Stock Development

The development of the stock has annually been discussed and evaluated based on the research survey series, and information from the fishery.

In some years trial analytical XSA assessments have been made and discussed by the Working Group.

Since WG2005, experimental analytical assessments have been conducted on this stock using GADGET, and results presented for the years 1990 – last year.

The GADGET model used for the assessment of *S. marinus* in areas I and II is closely related to the GADGET 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 used on this stock was for the first time presented to ACFM in 2005. The method was more thoroughly reviewed and described in AFWG report 2006. The main model period has been considered to be from 1990, with earlier years acting as a lead-in period to the model. *S. marinus* has been modelled with a single-species, single-area model, with mature and immature fish considered as two population groups. The fish were modelled in 1cm length categories. The age and length ranges were defined as 3-30+ and 1-59+ cm, respectively.

S. marinus was considered to have Von Bertanlanffy growth (Nedreaas 1990) with parameters estimated within the model.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. Maturity is explicitly modelled, allowing for a direct estimate of the spawning stock. Estimated parameters were: an L50 and slope parameters for the fleets, two growth parameters, annual recruitment, four parameters governing commercial selectivity (two per fleet), several parameters per survey governing selectivity (two per fleet), initial population numbers for mature and immature fish by age.

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 Barents Sea (Division IIa) bottom trawl survey (February) from 1990–2009 (Table D12a).
- Age-length keys from the same survey (Table D12b).
- Length disaggregated catch rates (numbers/nautical mile) of *Sebastes marinus* from the Norwegian Coastal and Fjord survey in 1995-2008 from Finnmark to Møre (Division IIa)

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.

The Barents Sea survey data were 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 1990-2006 was used, and the age-length key for 1992 was also used as age-length key for 1990-1991.

D. Short-Term Projection

Model used: Visual inspection/analysis of survey results together with information from the fishery and Gadget model outputs. 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 and Gadget model outputs. 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

Until an analytical assessment can be accepted and used as basis for reference points calculations for this stock, candidate reference points for the biomass could be set at the average biomass level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. ACFM is supporting this suggestions and states that U-type reference points could be developed provided that a sufficient long time series demonstrating a dynamic range is available. Also the reference point should be expressed in biomass units (SSB or fishable stock), and work has hence been initiated to present the survey time series also in biomass units (also as SSB and fishable stock).

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 mature biomass. A corresponding 5% harvest of this would yield not more than 2.500 tonnes.

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Annex 8 - Quality Handbook **ANNEX:_NEA Cod**

Standard Procedure for Assessment

XSA/ICA Type

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North-East Arctic Cod
Working Group:	Arctic Fisheries Working Group (AFWG)
Date:	27. April 2009.

A. General

A.1 Stock definition

The North-East Arctic cod (*Gadus morhua*) is distributed in the Barents Sea and adjacent waters, mainly in waters above 0° Celsius. The main spawning areas are along the Norwegian coast between N 67°30′ and 70°. The 0-group cod drifts from the spawning grounds eastwards and northwards and during the international 0-group survey in August it is observed over wide areas in the Barents Sea.

A.2 Fishery

The fishery for North-east Arctic cod is conducted both by an international trawler fleet operating in offshore waters and by vessels using gillnets, longlines, handlines and Danish seine operating both offshore and in the coastal areas. 60-80% of the annual landings are from trawlers. Catch quotas were introduced in the trawl fishery in 1978 and for the fisheries with conventional gears in 1989. In addition to quotas the fisheries are regulated by mesh size limitations including sorting grids, a minimum catching size, a maximum by-catch of undersized fish, maximum by-catch of non-target species, closure of areas with high densities of juveniles and by seasonal and area restrictions. Since January 1997 sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area. Discarding is prohibited. The minimum catching size of cod is 42 cm in the Russian Economic zone, 47 cm in Norwegian Economic zone; both minimum landing sizes are used by respective fleets in the Svalbard area pursuant to the Svalbard Treaty 1920. The fisheries are controlled by inspections at sea, requirement of reporting to catch control points when entering and leaving the EEZs and by inspections when landing the fish for all fishing vessels. Keeping a detailed fishing log-book on board is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis. There is some evidence that the present catch control and reporting systems are not sufficient to prevent discarding and under-reporting of catches, but it has considerably improved in comparison with historical period.

A.3 Ecosystem aspects

Considerable effort has been devoted to investigate multispecies interactions in the Northeast Arctic. Some of these investigations have reached the stage where quantitative results are available for use in assessments. Growth of cod depends on availability of prey such as capelin (*Mallotus villosus*), and variability in cod growth has had major impacts on the cod fishery. Cod are able to compensate only partially for low capelin abundance, by switching to other prey species. This may lead to periods of high cannibalism on young cod, and may result in impacts on other prey species which are greater than those estimated for periods when capelin is abundant. In a situation with low capelin abundance, juvenile herring (*Clupea harengus)* experience increased predation mortality by cod. The timing of cod spawning migrations is influenced by the presence of spawning herring in the relevant area. The interaction between capelin and herring is illustrated by the recruitment failure of capelin coinciding with years of high abundance of young herring in the Barents Sea. Herring predation on capelin larvae is believed to be partially responsible for the recruitment failure of capelin when young herring are abundant in the Barents Sea.

The composition and distribution of species in the Barents Sea depend considerably on the position of the polar front which separates warm and salty Atlantic waters from colder and fresher waters of arctic origin. Variation in the recruitment of some species including cod and capelin has been associated with the changes in the influx of Atlantic waters to the large areas of the Barents Sea shelf.

The annual consumption of herring, capelin and cod by marine mammals (mainly harp seals and minke whales) has been estimated to be in the order of 1.5-2.0 million t (Bogstad, Haug and Mehl, 2000; See also Section 1.3.4 AFWG Report 2003).

However, estimates of total annual food consumption of Barents Sea harp seals are in the range of about 3.3-5 million tons (depending on choice of input parameters, ICES 2000d). The applied model used different values for the field metabolic rate of the seals (corresponding to two or three times their predicted basal metabolic rate) and under two scenarios: with an abundant capelin stock and with a very low capelin stock.

1) If capelin was abundant the total harp seal consumption was estimated to be about 3.3 million tons (using lowest field metabolic rate). The estimated consumption of various commercially important species was as follows (in tons): capelin approximately 800,000, polar cod (*Boreogadus saida*) 600,000, herring 200,000 and Atlantic cod 100,000.

2) A low capelin stock in the Barents Sea (as it was in 1993-1996) led to switches in seal diet composition, with estimated increased consumption of polar cod (870,000 tons), other codfishes (mainly Atlantic cod; 360,000 tons), and herring (390,000 tons).

B. Data

B.1 Commercial catch

Norway

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from about 20 sub areas are aggregated on 6 main areas for the gears gill net, long line, hand line, purse seine, Danish seine, bottom trawl, shrimp trawl and trap. For bottom trawl the quarterly area distribution of the catches is adjusted by logbook data from The Directorate of Fisheries and the total bottom trawl catch by quarter and area is adjusted so that the total annual catch for all gears is the same as the official total catch reported to ICES.

No discards are reported or accounted for, but there are several reports of discards.

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 IMR reference fleet (fishing vessels contracted for sampling), and the coast guard.

A software (“ECA”, Hirst et al. 2005) has been developed to utilize all sampling information to estimate catch at age for areas (I, IIa and IIb), quarters and gears (bottom trawl, gill net, Danish seine and longline/handline).

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 (I, 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, Poland 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 Norwegian 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 2008:

	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	x				
Kingdom	x				
France[1]	x				
Spain	x				
Portugal	x				x
Poland	x	x	x		
Ireland[1]	x				
Greenland[1]	x				
Faroe Islands[1]	x				
Iceland[1]	x				

[1] As reported to Norwegian and Russian authorities

Since 2008 the catch data has been handled by Intercatch. Earlier the nations that sample the catches, provided the catch at age data and mean weights at age on Excel spreadsheet files, and the national catches were combined in Excel spreadsheet files. Historic 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).

Since 2008 the catch data has been handled by Intercatch.

B.2 Biological

For 1983 and later years weight at age in the stock and maturity at age is calculated as weighted averages from Russian and Norwegian surveys during the winter season. Stock weights at age a (W_a) at the start of year y are calculated as follows:

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

where

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

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

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

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

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

Maturity at age is estimated from the same surveys by the same formulae, replacing weight by proportion mature.

For age groups 12 and older, the stock weights is set equal to the catch weights, since most of this fish is taken during the spawning fisheries, and in most years considerably more fish from these ages are sampled from the catches than from the surveys.

For the earlier period (1946-1982) the maturity at age and weight at age in the stock is based on Russian sampling in late autumn (both from fisheries and from surveys) and Norwegian sampling in the Lofoten spawning fishery. These data were introduced and described in the 2001 assessment report (ICES 2001).

A fixed natural mortality of 0.2 is used both in the assessment and the forecast.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0. The peak spawning in the Lofoten area occurs most years in late March-early April.

B.3 Surveys

Russia

Russian surveys of cod in the southern Barents Sea started in the late 1940s as trawl surveys of young demersal fishes. Since 1957 such surveys have been conducted over the whole feeding area including the Bear Island - Spitbergen area (Baranenkova, 1964; Trambachev, 1981), both young and adult cod have been surveyed simultaneously. In 1984, acoustic methods started to be implemented during surveys of fish stocks (Zaferman, Serebrov, 1984; Lepesevich, Shevelev, 1997; Lepesevich *et al.*, 1999). In 1995 a new acoustic assessment method was applied for the first time, which allowed the differentiation and registration of echo intensities from fish of different length (Shevelev *et al.*, 1998). Methods of calculations of survey indices also changed, e.g. due to the necessity to derive length-based indices for the FLEKSIBEST model (Bogstad *et al.*1999; Gusev, Yaragina, 2000).

Time of survey conducting has reduced from 5-6 months (September-February) in 1946-1981 to 2-2.5 months (October-December) since 1982. The aim of conducting a survey is to investigate both the commercial size cod as well as the young cod and to receive reliable data to compose annual maturity ogives. 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 swept area indices, calculated as absolute numbers registered in survey standard area (Golovanov et al., 2006, 2007).

Ages 3-9 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 3-9. The survey is described in Jakobsen et al (1997) and Aglen et al. (2002).

Norwegian Lofoten survey

Acoustic estimates from the Lofoten survey extends back to 1984. The survey is described by Korsbrekke (1997).

B.4 Commercial CPUE

Russia

Two CPUE data series exist, one is historical series, based on RT vessel type (side trawler, 800-1000 HP), which stopped operating in the Barents Sea in the middle of the 1970-s, and other one is presently used, based on PST vessel type (stern trawler, 2000 HP). Information from each fishing trawler was daily transferred to PINRO, including data on each haul (timing, location, gear and catch by species). Yearly catch f cod by the PST trawlers as well as number of hour trawling were summarized and CPUE index (catch on tons per hour fishing) was calculated.

The effort (hours trawling) was scaled to the whole Russian catch. The CPUE indices are split on age groups by age data from the trawl fishery. Data on ages 9-11 are used in the XSA-tuning.

C. Estimation of historical stock development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 10 years

Catchability independent of stock size for ages >6

Catchability independent of age for ages >= 10

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

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

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1946 – last data year	3 – 13+	Yes
Canum	Catch at age in numbers	1946 – last data year	3 – 13+	Yes
Weca	Weight at age in the commercial catch	1982 – last data year	3 – 13+	Yes, set equal to west for 1946-1981
West	Weight at age of the spawning stock at spawning time.	1946 – last data year	3 – 13+	Yes
Mprop	Proportion of natural mortality before spawning	1946 – last data year	3 – 13+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1960 – last data year	3 – 13+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1960 – last data year	3 – 13+	yes
Natmor	Natural mortality	1960 – last data year	3 – 13+	Includes annual est. of cannibalism from 1984, otherwise set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Russian com. CPUE, trawl	1985 – last data year	9 –11
Tuning fleet 2	Joint Barents Sea trawl survey, feb-ruary	1981– last data year	3 - 8
Tuning fleet 3	Joint Barents Sea Acoustic, Febru-ary+ Lofoten Acoustic survey	1985 – last data year	3 -9
Tuning fleet 4	Russian bottom trawl survey, No-vember	1984 – last data year	3-9

XSA-settings

Type of setting	Settings last year	Used this year (why changed)
Time series weighting	Tapered time weighting power = 3 over 10 years	The same
Recruitment regression model (catchability analysis)	Catchability dependent of stock size for ages < 6 Regression type = C Min. 5 points used Survivor estimates shrunk to the population mean for ages < 6 Catchability independent of age for ages >= 10	The same
Terminal population estimation	Survivor estimates shrunk towards the mean F of the final 5 years or the 2 oldest ages. S.E. of the mean to which the estimate are shrunk = 1.0. Minimum standard error for population estimates derived from each fleet = 0.300.	The same
Prior fleet weighting	Prior weighting not applied	The same

D. Short-term projection

Model used: Age structured

Software used: MFDP (version 1a) prediction with management option table

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 environmental data using the "hybrid model" described in section 1.4.5 in ICES CM 2008/ACOM:01

Natural mortality: average of the three last years or 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 year's observation.

Weight at age in the catch: Predicted by applying (10yr average) annual increments by cohort on last year's observation.

Exploitation pattern: Average of the three last years, scaled by the Fbar (5-10) to the level of the last year, or to the average of the latest 3 years, if there is no clear trend in F and effort.

Intermediate year assumptions: F constraint

Stock recruitment model used: None

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

F. Long-term projections

SPR and YPR calculations

G. Biological reference points

Introduced 1998: Blim=112000t, Bpa=500000t, Flim=0.7, Fpa=0.42

Adopted in 2003: Blim=220000t, Bpa=460000t, Flim=0.74, Fpa=0.40

H. Other issues

Since the 1999 AFWG a new assessment model (Fleksibest-now Gadget) has been used to provide alternative assessments and to describe characteristics of the data for this stock.

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Annex 9 –Stock Data Problems Relevant to Data Collection – AFWG

Stock	Data Problem	How to be addressed	By who
Stock name	***Data problem identification***	***Description of data problem and recommend solution***	***Who should take care of the recommended solution and who should be notified on this data issue.***
NEA saithe	Lack of purse seine samples between 62-67N	The sampling should be improved from 2009 onwards	Norway
NEA saithe	Lack of useful recruitment indices of 1 year olds	The fishery exploits new year classes before the year class strength is known at an age of about 3 years	Norway
S. mentella in Sub-areas I and II	Reportings from the pelagic fishery should be done by country. Lack of biological sampling of the pelagic fishery	NEAFC should require this from those countries who will participate in the fishery	NEAFC; PGCCDBS to propose this for implementation in the EU-DCR and national sampling programs
Sebastes marinus, *Sebastes mentella,* *Sebastes viviparus*	Species identification Species subject to confusion	Proper identification keys and photos Training courses	PGCCDBS
Coastal cod	No specific sampling regime for Coastal cod Spatial coverage Time coverage	Improved and defined sampling regime for Coastal cod Proper spatial and temporal coverage	Norway
Coastal cod NEA cod	Identification Species Official Landings reported as Cod	Splitting of the cod stocks by suitable spatial and temporal sampling coverage. Modeling of distributions and catches of the two stocks by otolith structure	Norway
NEA cod NEA haddock Redfish Gr.halibut	No estimate of discards	Observer programs. Comparison of at sea versus port sampling	PGCCDBS to propose implementation in national sampling programs and the EU-DCR
Gr.halibut	Age reading methods	Method described and agreed on. Appropriate joint international reference set.	PGCCDBS

Annex 10 - Technical Minutes of a review of the ICES Artic Fisheries Working Group Report 2009 (by correspondence)

8 May 2009

Reviewers:	Frans van Beek (chair)
	Joachim Gröger
	Evgeny Shamray
	Krzysztof Radtke
Chair WG:	Yuri Kovalev
Secretariat:	Mette Bertlesen

Audience to write for: advice drafting group, ACOM, benchmark groups and next years EG.

General

The Review Group considered the following stocks:

- Cod in Subareas I and II (Northeast Arctic cod)
- Cod in Subareas I and II (Norwegian coastal cod)
- Greenland halibut in Subareas I and II
- Haddock in Subareas I and II (Northeast Arctic)
- Saithe in Subareas I and II (Northeast Arctic)
- Beaked Redfish (*Sebastes mentella)* in Subareas I and II
- Golden Redfish (*Sebastes marinus)* in Subareas I and II

And the following special requests:

- none

The RG acknowledges the intense effort expended by the working group to produce the report. The report is nicely structured and information is in general easy to find. The stocks listed above were all updates and were reviewed by the group. In most/all cases a quality handbook was available with instructions on the procedure to carry out the assessment. The reviewers met by correspondence and had limited contact through e-mail and share-point. For the purpose of evaluation the chair of the review group split the stocks between the reviewers. It was checked by the reviewers whether the procedures followed were according the procedures established in a previous bench mark assessment. In a number of cases the present assessments were also compared with those of last year. Given the time pressure where this has been done, no attention is given to the other chapters of the report. Also no draft stock summaries were considered by the review group.

FishStock	Name	Asstype in WG ToR	1st reviewer
cod-arct	Cod in Subareas I and II (Northeast Arctic cod)	Update	FVB
cod-coas	Cod in Subareas I and II (Norwegian coastal cod)	Update	FVB
ghl-arct	Greenland halibut in Subareas I and II	Same Advice saly	JG
had-arct	Haddock in Subareas I and II (Northeast Arctic)	Update	ES
sai-arct	Saithe in Subareas I and II (Northeast Arctic)	Update	KR
smn-arct	Beaked Redfish (*Sebastes mentella*) in Subareas I and II	Update	FVB
smr-arct	Golden Redfish (*Sebastes marinus*) in Subareas I and II	Update	JG

Stock: Cod in Subareas I and II (Norwegian coastal cod) (report section 2))

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type: update/SPALY**
2) **Assessment**: analytical
3) **Forecast**: not presented
4) **Assessment model**: SURBA (version 2.1) +XSA tentative
5) **Consistency**: Last years assessment was considered tentative and used as a basis for advice
6) **Stock status**: There are no reference points defined for this stock. SSB is estimated to be stable but the lowest values in the time series. Tentative assessments suggest that F has decreased after 2000 and is relatively stable
7) **Man. Plan.**: There is no management plan. Fishery is managed with annual TAC and technical measures such as closed areas for certain gears. A description of the technical measures and history is given in section 2.1.2: Regulations

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last year's report with relative little changes. The outcome of the tentative assessments gives the same perception of the stock and fishery as last year's assessments.

Technical comments

- The review was restricted to a check whether the procedures described in the technical annex (handbook) were applied. This was the case. No deviations were spotted.
- Also a comparison with last year's report was made. The procedures used were the same as last year. Also the results of the assessment were very similar.
- No checks on the calculation of the international age structure have been carried out by the reviewer.
- The main assessment Surba is based on an acoustic survey on low cod densities. Because cod contributes only a low fraction of the observed acoustic val-

ues, the estimates of the survey are more sensitive to allocation error. The WG is aware of this. This contributes to uncertainty in the point estimates of the analyses but not to the perception of the present stock size.

- There is no indication in the text or table for which time of the SSB is calculated.
- A section summarising recent ICES advice for last year is missing.
- A comparison of the results with previous assessments is missing.
- Table 3.1.b is consistent with Table 2.1.a but not with Table 3.1.b in last year's report. This is probably a small unmentioned correction.

Remarks by the reviewer

- The unchanged perception of the stock compared to last year gives no reason to change the present advice
- The WG indicates that total landings of coastal cod are expected to be severely underestimated. A considerable part of the catch is taken by recreational fisheries and tourist fishing. The estimate for 2003 was about 30%. There are no estimates for other years. Also misreporting occurs in the Norwegian gillnet fisheries, but the report indicates that this has been reduced significantly since 2000. Contributing to the uncertainty is the fact that NCC are caught together with NEAC and the proportions are estimated based on the otoliths structure. Given the difference in stock size this is a lesser problem to NEAC.
- Both Surba and XSA estimate SSB near historical low but relatively stable in the last 6 years.
- Also F(4-7) is stable and low compared to most other cod stocks. The estimates of F by XSA are about 2.5 higher than those of Surba
- Recruitment in 2007 and 2008 (age 2) are the lowest in the time series (about 0.3*average)

Conclusions

The assessment has been performed correctly. There is no urgent need for a benchmark in the short time. A benchmark assessment could be recommended if better estimates of the catches become available of new methodology on assessments based on survey data. The information given by the assessments is sufficient to provide advice.

Stock: Cod in Subareas I and II (Northeast Arctic cod) (report section 3))

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type: update/SPALY**
2) **Assessment**: analytical
3) **Forecast**: analytical forecast presented; ($F_{sq}=F_{(2006\text{-}2008)scaled}$)
4) **Assessment model**: XSA using 4 tuning fleets (3 surveys and 1 commercial cpue); maturity data are from surveys; M is estimated including estimates of cannibalism; additional models presented were TISVPA, Gadget, survey calibrated VPA, GIS and synoptic models. SSB calculated at Jan 1st.

5) **Consistency**: Last years assessment was accepted and used as a basis for advice. This year's assessment is consistent with last year.
6) **Stock status**: Stock is within safe biological limits. Fsq<Fpa and SSB>Bpa. Also recruitment is around average. Reference points have not been revised since 2003.
7) **Man. Plan.**: There is an agreed management plan but not adhered to in 2009 TAC for 2009 has been set higher than the MP. See also remarks below

General comments

This was a well documented, well ordered and considered section. The text in the report is an update from last year's report with relative little changes. The assessments give the perception of a significant increasing stock as a result of a reduction in fishing mortality.

Technical comments

- The review was restricted to a check whether the procedures described in the technical annex (handbook) were applied. This was the case. No deviations were spotted. Only little or no attention has been given to the additional models by the reviewer.
- Also a comparison with the assessment in last year's report was made. The procedures used were the same as last year. The results of the assessment are in line with last year's assessment.
- The results of the XSA assessment were robust to assumptions made on q on older age groups. This was tested by the WG
- There seems to be a small tendency to overestimate F and underestimate SSB. Because it is low, it should not be considered to be problematic.
- The assessment indicates that the increase in SSB is caused by an decrease in F and not in an increase in productivity (recruitment) of the stock
- Although the XSA is the standard method accepted in the benchmark, the TISVPA is run as an alternative. This year, a different loss function is chosen to find a minimum compared to last year. Such approach would be difficult to accept in a benchmark procedure since this may lead to great differences in the results of the assessment between years.
- The results of XSA and TISVPA are very similar except in the most recent years where TISVPA gives higher SB and SSB. This was also last year the case. I believe the difference is caused by differences in estimates of recruitment in recent years between both models which enter the stock and the spawning stock. Could be checked from comparison of tables with stock number on SharePoint, if they are there and there is time.
- The TISVPA is useful to demonstrate inconsistencies in the catch at age matrix. However, this would also be a reason to reconsider the choice of the "catch controlled" version.
- Reason for considering a TISVPA would be: suspecting an effect of cohort(size) on the exploitation. This, however, has not been discussed.
- Why not use the same codes for the same fleets used in XSA and TISVPA?

Remarks by the reviewer

- There is no mention of revision of data in previous years. It is assumed that only one extra year of data is added to the assessment. It could also be clearly stated that no discards are used in the assessment.
- The surveys in the last 2 years showed higher abundance as expected from previous surveys. Should be explored in a benchmark. Reasons could be, coverage of survey and/or shift in distribution of stock.
- Inspection of historical material indicate a different interpretation of age of 1st maturity by contemporary age readers. The WG notes this may affect the SR relationship and biological reference points. This point should get attention in the next benchmark assessment.
- There are different estimates of unreported catches by Norway and Russia. Norway estimates 15 kt in 2008. Russia comes with underutilization of 425 tonnes. The WG regret this. Last year, there were 2 different assessments and prognoses, based on different assumptions on unreported landings. This year, the (higher) Norwegian estimates were accepted for both the assessment and prediction. The Norwegian estimates were also used in the past for the final advice. The unreported catches have declined considerable in recent years from over 100 kt in early 2000's.
- WAAC in Norwegian landings has increased by about 1 kg in the last five years for age groups 6-10, but not in other nation's landings. This should be looked more closely.
- The catch forecast covers all catches. This means that if any overfishing takes place the forecasted TAC should be reduced.
- Non compliance with Management Plan: Note that the TAC in 2009 has been set higher that agreed in the MP. This may affect future performance of the MP if the provision of a maximum change of 10% between successive years is maintained.
- The estimation of M is not documented (also not in the Quality handbook).

Conclusions

The assessment has been performed correctly. There is no urgent need for a benchmark in the short time. If a future benchmark would support a TISVPA assessment as the preferred one, the effect of different choices of loss function between years should be investigated. Also attention should be given to an apparent increased catchability in the surveys and contradiction in trends of WAAC in landings by different nations.

The present management has lead to a reduction in F, a substantial increase in SSB and a reduction in unreported landing. There is a request by the Russian-Norwegian Fishery Commission to evaluate MSY (first steps have been taken intercessional, final evaluation need to be reviewed before used in advice). A revision of the MP could be considered after having dealt the MSY request. It should also be investigated how robust the MP is when there is non compliance if the stock is well within the reference points.

The information given by the assessments is sufficient to provide advice.

Stock: Haddock in Subareas I and II (Northeast Arctic) (report section 4)

1) **Assessment type: update/SPALY**
2) **Assessment**: analytical
3) **Forecast**: analytical forecast presented; (F_{sq}=$F_{(2006\text{-}2008)scaled}$)
4) **Assessment model**: XSA using 3 tuning fleets (3 surveys); maturity data are from surveys; M is estimated including predation by cod; now additional models were used. SSB calculated at Jan 1st.
5) **Consistency**: Last years assessment was accepted and used as a basis for advice. This year's assessment is consistent with last year.
6) **Stock status**: Stock is within safe biological limits. Fsq around Fpa and SSB>Bpa. The year classes 2004-2006 are very strong, however the year classes 2007 and 2008 preliminary estimated are below average. Reference points have not been revised since 2000.
7) **Man. Plan.**: In 2006 ICES evaluated the management plan that was agreed in 2004. Last year TAC was set within a management plan.

General comments

The report is well done and the text is an update from last years report with relative changes. The assessment gives the increasing stock as a result of a reduction in fishing mortality and good recruitment last years. The Quality Handbook was revised.

Technical comments

- The review was restricted to a check whether the procedures described in the technical annex (handbook) were applied. This was the case. No deviations were spotted.
- The procedures used were the same as last year.
- The values of stock weights have been changed in 1950-1984 and in 1985-2008 (see Chapter 4.3.3), estimates of consumption of NEA haddock by NEA cod (see chapter 4.4.2) and maturity at age (see chapter 4.3.5) were updated also.
- The results of the assessment show that in case of haddock the XSA is rather sensitive to the XSA settings and shows large deviations from last year. The WG discussed it and gives uncertainties in assessment and forecasts in the report. The main uncertainties derive from the biased catch statistics. There are no estimates of discarding. Both Russian (2006) and Norwegian (2007) bottom trawl surveys coverage were reduced compared to previous years.
- The assessment indicates that the increasing of the SSB is relative with decreasing F and due to the high level of recruitment.
- Decreasing of estimated IUU catches are explained in the Quality handbook. It should be placed in report.
- The precautionary reference points are set based on an assessment carried out in 2000. The present assessment indicates that the historical biomasses estimates have been revised and that the technical basis for the biomass reference points is no longer valid. ICES needs to reconsider the PA reference points in a benchmark assessment in 2010.

Remarks by the reviewer

- In the report not mentioned why in 2006 was decided to include Norwegian landings of haddock from Norwegian statistical areas 06 ad 07. Have to be referred where and when it was.
- Inspection of historical material raises questions for Norwegian statistical area 06 and 07 in table 4.1. The nominal catch for years 1960-1979 looks something erratically. Have to some explanations below table or in the text.
- No details provided for the sampling data for length and age that are used for estimating catch at age. Is it enough or not?
- There are different estimates of unreported catches by Norway and Russian. This assumes to make 3 different assessments and prognoses, based on different assumptions on unreported landings and without it. This year was only 2 assessments with the highest and zero unreported catches estimates were made. Seems to be some explanations why.
- Retrospective runs for the 2000-2002 and middle 90-th looks strange (figure 4.8). Such a retro needs additional investigation on next benchmark.
- Residuals for the ages 7-8 both for all surveys are too high (figure 4.9) and not discussed in the report. Seems that data is not fully correct or incomplete.
- Have no clear explanation why the CPUE data don't used in the assessment.

Conclusions

The assessment has been performed correctly. There is need for a benchmark in the short time. If a future benchmark the effect of different unreported (both IUU and discards) catches between years should be investigated. Surveys data to be revised again. Suggested to review data on weight at age matrix, seems that some problems with the age reading presented by different nations.

The present management plan is in accordance with a precautionary approach and the stock is harvested sustainable. However, unreported catches and discards an important issue for this stock and reduce the effect of management measures and the objectives of the harvest control rule.

The information given by the assessments is sufficient to provide advice.

Stock: Saithe in Subareas I and II (Northeast Arctic saithe) (report section 5)

Short description of the assessment: extremely useful for reference of ACOM!

8) **Assessment type:** update/SPALY
9) **Assessment**: analytical
10) **Forecast**: analytical forecast presented; TAC constraint,
11) **Assessment model**: XSA applied for the final assessment, using 2 tuning fleets (1 acoustic survey and 1 trawl commercial cpue); maturity ogive – 3-year running average; M fixed for all age groups, SSB calculated at Jan 1st.
12) **Consistency**: Update assessment with the same assessment settings as in the 2007. Last year's assessment was accepted and used as a basis for advice. 2009 year assessment estimated total stock in 2008 to 4% higher and the SSB 4% lower than previous assessment.

13) **Stock status**: Stock is within safe biological limits. Fbar<Fpa and Flim, SSB well above Blim and Bpa. Recruitment below average strength. New Fpa estimated in 2005 was accepted by ACFM.

14) **Man. Plan.**: There is a harvest control rule (HCR) used for setting the annual TAC which was in 2007 evaluated by ICES and concluded to be consistent with the precautionary approach. The implemented management plan implies a TAC based on the average catches for the coming 3 years based on Fpa.

General comments

This was a well documented, well ordered and considered section. The text was relevant to tables and figures presented, and the text was also easy to follow. The assessment is consistent with last year's assessment. The SSB has been declining in recent years but it is still maintained well above Bpa.

Technical comments

- The review was restricted to a check whether the procedures described in the technical annex (handbook) were applied. This was the case. No deviations were spotted.
- Comparison with the last year report indicates better retrospective pattern obtained this year than the one observed last year. The assessment procedures used were the same as last year. The results of the assessment are in line with last year's assessment.
- Tables and figures are correctly ordered and numbered in line with the text of the report. Tables and figures are correctly labeled and the units of measure always presented.

Remarks by the reviewer

- There is an indication in the sub-section "5.1 The Fishery" on saithe temporal substantial discarding occurring from non-Norwegian commercial trawlers. Although that issue was addressed last year by review group and this year's response made by AFWG specifies that discarding is a minor problem, it could however be of some importance to investigate the level of discarding (by age) as this might have some impact on the perception of the stock dynamics (recruitment). If saithe age 3 is important component of discarding (age 3 was important component in the catch matrix at least for 2008 year) than omitting it in the assessment gives underestimated recruitment level (age 3 is recruiting fish).
- Saithe has recently been more distributed southward and such was the biological sampling activity for estimating maturity ogives. Higher maturity rate in the southern area is observed. The 3-year running average ogive used in the assessment is not weighted by abundance and in consequence it probably results in biased estimate of maturity ogive in the context of the whole stock.
- Indices of stock size in the last 2 years from CPUE and survey show the opposite trend. For the consistency, the Working Group decided to rely on survey indices and in consequence excluded 2007 and 2008 CPUE data from the final run. The Group, however made a run with 2007 and 2008 included, what resulted in approximately 10% higher F. If the opposite trend in indices continues in 2009, then excluding also 2009 may further lead to overestimating of F and underestimating of SSB.

Conclusions

The assessment has been performed correctly. There is a need for a benchmark in the short time. The retrospective pattern is still the main problem in the assessment although it has become more stable in the last two years. The information given by the assessments is sufficient to provide advice.

Stock: Beaked Redfish (*Sebastes mentella)* in Subareas I and II (report section 6))

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** not relevant
2) **Assessment**: not carried out
3) **Forecast**: not presented (not possible
4) **Assessment model**: not relevant
5) **Consistency**: not relevant
6) **Stock status**: There are no reference points defined for this stock. All signals show that the stock has gradually declined and is at present near a low. Recruitment has failed since 1991.
7) **Man. Plan.**: There is no management plan. Fishery is managed with annual TAC and technical measures such as closed areas for certain gears. A description of the technical measures and history is given in section 2.1.2: Regulations

General comments

This was a well documented, well ordered and considered section. Most of the text was an update of last years report. The assessment part was deleted but a large new section on management advice has been included.

Technical comments

- The review was restricted to a check whether the procedures described in the technical annex (handbook) were applied. The handbook was updated this year.
- Also a comparison with last years report was made.
- No assessment was carried out and the WG restricted the work to updating tables. There were also changes in the text but most was revised from last year.

Remarks by the reviewer

- The unchanged perception of the stock compared to last year gives no reason to change previous advice
- The report contains several chapters with information relevant to the advice
- The continued poor recruitment (decades), slow growth and late maturation gives no expectation that the stock will recover within the next 12-15 years. The only year classes that can contribute to the spawning stock in near future are those prior to 1991 as the following fifteen year classes are very poor. There are signs of increased recruitment at least in some areas (see figure 6.4 and 6.6).
- Signals of increased recruitment have not been confirmed by present surveys

- A distinction is made between Barents Sea and Svalbard area and the Norwegian Sea. In the Barents Sea and Svalbard the stock is historically low. The estimated fishable biomass has decreased from 200 kt in 2007 to 88 kt in 2008. In the Norwegian Sea, no data is available to describe the historical development of the stock. Results from the pelagic survey conducted in 2008 indicate a possible spawning biomass of about 500 kt but such estimate is highly imprecise.
- The section management advice in the report states that an imprecise estimate of the SSB of 500 kt by a Norwegian survey suggest that a limited fishery could be supported. Tricky wording which may raise unnecessary questions.
- FISHERY: The catches are bycatches (juveniles in the shrimp fishery and adults in fishery for cod and haddock). There are also bycatches in the pelagic herring and blue whiting fisheries. In the last 5 years a new directed pelagic fishery has developed in international waters, responsible for an increase in total landings. Thereafter total landings declined fast.
- Advice of WG suggests strict measures in Barents Sea and Svalbard but limited fishery in Norwegian Sea could be allowed. Total catch in all areas including all bycatches 14 kt.

Conclusions

There are no indications that there are changes in the stock status. The development of a fishery in international waters may be a source of concern, since the fishable stock consists of year classes before 1991 and there was poor recruitment thereafter. The present advice is not very helpful. It is very unsatisfactory that there are no reference points for this depleted stock, which, because of its biological characteristics, is very vulnerable. Traditional PA reference points may be not appropriate, but a more general approach on management advice could be adopted towards stocks with similar characteristics.

Stock: Golden redfish in Subareas I and II (report section 07)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update
2) **Assessment**: Golden redfish (Sebastes marinus) in Sub-areas I and II was assessed on the basis of available trends in the fisheries and surveys and an experimental analytical assessment.

   The Gadget model was used for the fifth time as an experimental analytical assessment model
3) **Forecast**: not presented
4) **Assessment model**: Gadget model – tuning by 2 commercial fleets + 2 surveys
5) **Consistency**: Last year's assessment report was not commented by RGAFNW because it was a re-conduction of the previous year advice. In this year's update the model configuration and settings were identical to that of 2008. Commercial catch data have been revised for 2007 and updated with year 2008. The general patterns in the stock dynamics are very similar to those modelled in 2008.

6) **Stock status**: The stock is currently in a very poor situation as confirmed by survey observations and Gadget assessment update. Reference points have not been defined.

7) **Man. Plan.**: No Management Plan agreed

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret. The text in the report is an update from last years´ report. The tables and figures were unambiguous and clearly arranged. The survey observations and the Gadget model indicate that the stock is in a very poor situation.

Technical comments

- the data been used as specified in the stock annex
- the assessment model been applied as specified in the stock annex
- there is no **major** reason to deviate from the standard procedure for this stock

- the update assessment gives a valid basis for advice
- however, there are some issues:
    - the general problems of age reading in redfish should be addressed
    - the estimation of M needs to be explained
    - A constant selectivity through time was assumed in the model; the possibility of an extension with varying selectivity was mentioned by the group; this should be included in the next assessment

Conclusions

The assessment has been performed correctly. A benchmark assessment is needed for this stock (expected in 2012). Until then, due to the expected low recruitment, the advice for this stock can be based on the assessment of the working group.

Stock: Greenland halibut in Subareas I and II (report section 08)

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type:** update/SALY
2) **Assessment**: analytical
3) **Forecast**: not presented
4) **Assessment model**: XSA (ages 5 and above) using 3 tuning fleets (2 surveys and 1 experimental commercial CPUE)
5) **Consistency**: The current assessment was using the same catch matrix, survey series and settings as last year with updated data for 2007 and new data for 2008. Fishing mortalities tend to be overestimated while SSB tends to be underestimated.
6) **Stock status**: The stock is currently stable at a relatively low level. SSB in 2008 has slightly increased in comparison with 2007. There are no reference points defined for this stock.

7) **Man. Plan.**: No Management Plan agreed. The advice has not changed since 2003, yearly catches should be below 13 000t.

General comments

This was a well documented, well ordered and considered section. It was easy to follow and to interpret. However, due to age reading uncertainties in the past, age readings have to be revised and an evaluation of the state of the stock is uncertain.

Technical comments

- In 8.9 (Response to ACFM technical minutes) it is stated that the report regarding Greenland halibut "will not be reviewed".
- There is still some uncertainty concerning a potential exchange between the Greenland halibut stock in the NEA and another stock in the Faeroe Islands-Iceland area and Greenland.
- It remains unknown which age should be used for a reliable recruitment estimate.
- The assumption of M = 0.15 needs to be explained. Additionally, the proportion of natural mortality before spawning is set to 0. This also needs some explanation.
- Since no discards have been reported, discards are not accounted for in the catch statistics.
- The age structured tables of the Norwegian surveys have not been updated since 2006, due to change in age reading procedure.

Conclusions

The ongoing age reading issue needs to be solved and age reading revisions need to be completed before a reliable stock assessment can be performed. In general there is a large uncertainty about the stock size so that conservative measures concerning fishing pressure on this stock are appropriate.