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Contents

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 1995-2007. 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 2007 assessment.

- The fishing mortality (F_{5-10}) in 2006 was 0.63, which is slightly lower than the value of 0.66 from last year's assessment. F decreased to 0.40 in 2007, the lowest value since the early 1990s. The current assessment estimated the total stock to be about 13 % higher and SSB 8 % higher in 2007, compared to the previous assessment.
- New model for prediction of recruitment were used. In the projections of age 3 recruitment the "hybrid" model, which takes into account environmental parameters, was used, resulting in 714 million in 2008, 509 million in 2009 and 152 million in 2010.
- A catch in 2009 corresponding to the evaluated and implemented HCR is 473,000 t. This catch corresponds to a fishing mortality of 0.34 in 2009. SSB is estimated to increase from 844,000 t at the beginning of 2009 to 1,098,000 t in 2010.

Difficulties in estimating initial stock size are the major problem in the forecast. One reason is uncertainties in IUU values. The unreported catches are large, but have decreased considerably from 2006 to 2007. The survey results from the last year are not consistent with the results from the previous year. Further analysis of the survey time series is needed.

Haddock in Sub-areas I and II (Northeast Arctic) was assessed using XSA with the same settings as in the 2007 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 two years appears stable and has been estimated slightly above 0.3. The current assessment estimated the total stock to be about 16 % higher and SSB 25 % higher in 2007, compared to the previous assessment.
- In the projection RCT3 was used to estimate recruiting year classes from 2005 and onwards, and resulted in an estimate of slightly less than 1 billon three year olds 2008, but will decrease in the next two years.
- A catch in 2009 corresponding to the evaluated and agreed HCR is 194,000 t. This catch is likely to lower the fishing mortality in 2009 to approximately 0.2. 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 2007.

Saithe in Sub-areas I and II (Northeast Arctic) was assessed using XSA with the same settings as in the 2006 assessment.

- Compared to 2006 the total CPUE increased by 20%, while the total survey index declined by 20% and the WG decided to exclude the 2007 CPUE data in the final assessment.
- The fishing mortality (F_{4-7}) in 2006 was 0.19, which is slightly lower than the value of 0.22 from last year's assessment. The corresponding figure for 2007 was 0.20. The current assessment estimated the total stock to be about 3 % higher and SSB 4 % higher in 2007, compared to the previous assessment.
- In the projections the GM age 3 recruitment of 175 million was used for the 2004 and subsequent year classes.
- A catch in 2009 corresponding to the evaluated and implemented HCR is 225,000 t. This catch corresponds to a fishing mortality of 0.29 in 2009. SSB is estimated to decrease from 670,000 t at the beginning of 2009 to 645,000 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.

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

0 Introduction

0.1 Participants

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0.2 Terms of reference

a) compile, update, analyse and document time-series of relevant fisheries, environmental data and regulatory changes (see generic ToRs)

b) update assessments for 2009 and beyond for the following stocks (Generic ToR (5))

i) North East Arctic cod;

ii) Norwegian coastal cod;

iii) North East Arctic haddock;

iv) North East Arctic saithe.

c) update data on Barents Sea capelin and oversee the process of providing inter-sessional assessments and advice on this stock.

Generic ToR for fish stock assessment working groups

Applies to AFWG, HAWG, NWWG, NIPAG, WGWDS

(1) Assemble national data on relevant fisheries and environmental data

- a) Input and quality check all input data and where possible input into the InterCatch database
- b) Produce an overview of the sampling activities on a national basis (if possible derived from the InterCatch database)
- c) Recommend specific actions to be taken to improve the basis for the advice in future (including improvements in data collection).
- d) When appropriate, conduct a Data Compilation Workshop as part of the expert group meeting where stakeholders are invited to contribute data including data from nontraditional sources. At these workshops stakeholders can also contribute to data preparation and evaluation of data quality. Data that are to be included in the analysis of the Expert Group shall satisfy quality criteria established by ACOM.

(2) Update time-series of relevant fisheries and environmental data:

- a) catches (landings, discards, bycatch) - (by fisheries/fleets). Where misreporting is considered significant, provide qualitative and where possible quantitative information and the describe the methods used to obtain the information.
- b) fishing effort (by fisheries/fleets)
- c) surveys
- d) environmental drivers

(3) Update the agreed analytical method to assess the state of the stocks and short term outlooks or update the agreed indicator(s) of stock trends

(4) Update description of major regulatory changes (technical measures, TACs, effort control and management plans) and report on evaluations of their (potential) effects.

(5) Produce a brief report of the work carried out by the working Group. It should be possible to summarize the report as the basis for the advice.

(6) Prepare draft advice on the fish stocks and fisheries under considerations according to the guidelines by the Advisory Committee. Advice should take account of:

- a. Mixed fisheries
- b. Ecosystem effects of fisheries
- c. Regulatory changes
- d. Agreed or proposed management plans
- e. Species interaction effects where appropriate

0.3 Unreported landings

Two analyses of potential unreported landings of cod and haddock in 2007, provided to ICES by national delegates from Russia and Norway, were made available to the AFWG for consideration. In addition, the Norwegian report also included revised estimates for 2006, resulting from consultations with Russian specialists.

The estimates for 2007, stated in both documents, were derived based on the methodological approaches, which had been tested previously when performing the analysis of similar data referring to 2002-2006.

The Norwegian method was based on the following: information from inspections at sea of fishing and transport vessels in the Norwegian Economic Zone, including species composition of catches and amounts of transhipped fish products, analysis of data on landings in the Norwegian ports and ports of third countries; information on transhipments at sea and VMS data on operations of fishing and transport vessels in the Barents and Norwegian Seas. However, this year a more comprehensive analysis of trips with no information on species composition was carried out, utilizing tracking data in combination with the Norwegian coastguard's aircraft and vessel observations, to exclude vessels where other species than cod and haddock were caught and transported. According to Norwegian estimates in 2007 unreported catches made up 40 000 tonnes of cod and 21 000 tonnes of haddock.

The Russian method included the following: VMS data on operations of fishing and transport vessels in the Barents and Norwegian Seas, information on landings in Russian and Norwegian ports and ports of third countries; daily reports by fishing vessels, including on species composition of catches, amounts of transhipped fish products, time of fishing, daily catch by vessel type and fishing area, as well as data provided by the State Customs Service. Such information is available from all areas of cod and haddock fisheries, as well as with regards to all transport and fishing vessels delivering fish products to the ports of Russia, Norway and third countries. The Russian estimation takes into account, that a considerable amount (57-59%) of resources fished in the Barents Sea (polar cod, Kamchatka crab) and Norwegian Sea (herring, blue whiting, mackerel, redfish) and, correspondingly, produce carried through NEZ, are not cod and haddock. As per Russian estimates, in 2007 overfishing of national quotas amounted to 7 500 tonnes of cod and 3 300 tonnes of haddock.

The AFWG notes with satisfaction that the both methods indicate a noticeable decline in the 2007 IUU estimations as compared with previous years. However, AFWG was not able to agree on which of the estimates to use in 2007, and found no justification for combining the two estimates in any way. The AFWG, therefore, decided to do as was done last year: to undertake a double sets of stock assessments and prognostic runs for cod and haddock. Hence, the numbers for IUU used by AFWG for 2007 was 41 000 t and 15 000 t for cod and haddock in the Norwegian IUU series and 9 000 t and 3 000 t for cod and haddock in the Russian IUU series (here the total estimated catch is compared to reported landings). For 2006, AFWG decided to use the revised number for cod provided in the Norwegian report, taking into account the documentation provided in form of customs declarations of landings, giving an IUU of 67 000 t.

The WG highly regrets the current situation, where different estimates of total catches of cod and haddock are provided by Norwegian and Russian authorities. Having no access to basic information the WG is not in a position to determine which of these estimates are the most reliable. Moreover, the WG does not consider this a task for an assessment expert group. An absolute demand for the WG to be able to give reliable advice is correct input data on quantity fished by each nation each year. The WG acknowledged that, following the decision of the 35th session of JRNFC, a special Working Group on analysis of information on overfishing of the quotas of cod and haddock in the Barents Sea was established with a mandate to analyze data provided by the two Parties on catches, transportations and transhipments of cod and haddock in order to come to an agreed estimate, that could be as close as possible to the actual catch. The AFWG expects that Working Group to provide AFWG with correct catch figures in the future, not only for the last year but also for a reasonable number of years back in history.

0.4 Intercatch

The stock coordinators for 34 focus stocks were asked to import catch data and sample information to InterCatch in 2008. For AFWG saithe and cod (Northeast Arctic only) in Sub-areas I and II were chosen as focus stocks. Catch data from all countries having catches of the two species were uploaded together with sample information from the main countries, and sample information was then allocated to catches reported in tonnes only. Finally the data were aggregated and information on total catch in numbers at age (CANUM) and weight at age (WECA) was exported from the InterCatch data base. The text table below shows comparisons between 2007 data from InterCatch and data provided with the spreadsheets previously used (% discrepancy).

	Cod			**Saithe**	
Age	**CANUM**	**WECA**	**Age**	**CANUM**	**WECA**
1	0.00	0.63	1		
2	0.00	0.13	2		
3	0.00	-0.37	3	0.10	-0.06
4	0.00	-0.42	4	0.04	-0.03
5	0.00	-0.17	5	0.00	-0.21
6	0.00	-0.09	6	0.02	-0.09
7	0.00	-0.07	7	-0.02	0.04
8	0.00	0.02	8	0.00	-0.07
9	0.00	-0.06	9	-0.01	0.03
10	0.00	0.03	10	0.03	0.02
11	0.01	-0.14	11+	-0.10	-0.01
12	-0.19	-0.54			
13	0.12	-0.02			
14	0.48	-0.06			
15+	-0.03	-0.10			

All discrepancies were less than 1%, and in most cases close to zero.

0.5 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.

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 (WD # 20, Yaragina et al. 2008). Later, a similar exchange program has been established for haddock, Greenland halibut and capelin otoliths. Once a year the age readers come together and evaluate discrepancies, which are seldom more than 1 year, and the results show an improvement over the time period, despite still observing discrepancies for cod in the magnitude of 15-30%. An even more positive development is seen for haddock age readings showing that the frequency of a different reading (usually ±1 year) has decreased from above 25% in 1996-1997 to about 10% at present. The discrepancies are always discussed and a final agreement on the exchanged cod and haddock otoliths is at present achieved for all otoliths except ca. 2-5%. 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. 2008). 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.

The otoliths of Greenland halibut are not easy to read especially for older fish. Consequently the readers have difficulties in interpreting real age zones when the fish become older than 5 years (e.g., AFWG2005, WD 8). Comparative readings among three Norwegian age readers, and also between Russian and Norwegian age readers show good agreement and low CV. However, even with acceptable between reader precisions, there are strong evidences of low accuracy of the age estimates. Since last year, validation work has been continued and 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.

From 2008 onwards, an exchange of *Sebastes mentella* otoliths will be 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.

0.6 Climate included in advice of NEA cod

For the first time climate information has been applied in the advice from AFWG. In this year's 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, were used for prediction of recruitment at age 3. However, it should be acknowledged that the WGNPBW for some years has used the climatic NAO index in the historical stock calculations as part of the prediction of herring growth rates. 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.

0.7 ICES Quality Handbook

Following the guidelines as adopted by ACFM in October 2002, in 2004 WG a stock specific template was filled out for all AFWG stocks, describing how the annual assessment calculations and projections are performed, as well as the biological stock dynamic, ecosystem aspect, and the fisheries relevant for fisheries management, and the report has been re-structured accordingly. In this report there are no changes in Quality Handbooks. They were not included in this report. The final versions are presented as appendices to the 2006 working group report (ICES 2006/ACFM:25).

0.8 Scientific Presentations

WD 2 (presented by C. Kvamme). The by-catch of cod by length in the Barents Sea shrimp fishery has been estimated. To incorporate these by-catch estimates into stock assessment, the data need to be age-structured. Thus, an age-length key is required. For this purpose, we choose a finite mixture model (lognormal) to estimate the quarterly age-specific length distributions of data for Northeast Arctic cod taken in the shrimp fishery as a by-catch species during 1984-2006. The method applied to fit the length distributions is maximum likelihood estimation (MLE), and the calculation algorithms for MLE are via EM (Expectation and Maximization). This study shows that using a mixture model is a suitable approach and appears to provide a good fit to the by-catch data. The estimation approach provided a comprehensive data set of estimated cod by-catch at age in the Barents Sea shrimp fishery covering more than two decades.

WD 5 (presented by Y. Kovalev) describes an attempt to do the work on assessment of the Northeast Arctic cod on the base of FLR code. It was concluded that using FLR in NEA cod assessment allows reducing substantially routine work. It is especially useful for estimation of cod cannibalism, where a lot of XSA and cod consumption calculations repetitions are needed. FLR produce a comprehensive diagnostic from XSA tuning but it needs some development and check with VPA95 XSA diagnostic version, which seems to be more detailed and useful. It was observed that using FLR script in different version of FLR could be problematic. In practice it will be important to use standard, checked FLR version adopted by ICES and develop stock assessment script before WG meeting.

WD 9 (presented by T. Bulgakova) is an updated version of the cod recruitment model suggested earlier (2004). This model is a modification of Ricker's "stock-recruitment" model when cannibalism mortality is proportional to SSB, but the first multiplier is index of population fecundity PF in place of SSB, and index of established inflow of Atlantic waters N(Y) is included in natural mortality rate (in exponent) decreasing this mortality. Index N(Y) is calculated as an amount of months with positive temperature anomalies (TA) on the Kola Section in a birth year of the year-class Y. In the last model version for year interval after 1998 TA are calculated relatively of very remarkable linear trend of temperature in this interval. This recruitment model is fitted on results of two cohort methods (XSA run in 2007 with IUU-R and TISVPA run with IUU-R) which are considered as true ones. The model describes 76% and 75% of recruitment variability correspondingly and fitting correlation rate for the same models is equal to 0.90 and 0.89.

WD 10 (presented by D. Vasilyev). An attempt is made to apply a triple-separable model TISVPA to NEA cod data. The TISVPA (Triple Instantaneous Separable VPA) model 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 results reveal recent rise in biomass of spawning and total stock, generally being similar to the results of the XSA model.

WD 11 (presented by D. Klochkov) demonstrates that determining of periods relatively stable in terms of hydrology and zones relatively permanent by bioproductivity, enables not only to forecast the areas and terms of the largest concentrations of commercial species, but also through taking into account the density of these concentrations to make assessments of the biomass.

WD 12 (presented by S. Mehl) presents a way to model the maturity ogive for Saithe in Subareas I and II, taking abundance by area into account. In later years there has been a southwards shift in the distribution of saithe and the biological sampling from the southern part of the distribution area has increased somewhat. A higher maturation for ages 4 and 5 have been observed in theses samples 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. The maturity at age is modelled as a function of the TSB. Annual maturity ogive data based on spawning rings is applied in the modelling. The proportion of mature saithe in each age group is calculated as the proportion of saithe where the spawning zone is determined vs. the total number of specimen in that age group. The proportion is weighted vs. the number of fish sampled by two main areas in the Norwegian coastal survey.

WD 13 (presented by T. Vollen) presents two studies on Greenland halibut catchability. The studies have been done within the frame of the Joint Russian Norwegian project on Greenland halibut. The first study demonstrates that Greenland halibut can be caught in the water column both by vertical longline and pelagic trawl. Individuals were caught up to an upper limit of 400-600 m depth, over a wide range of bottom depths (600-1200 m). These findings are supported by other data sources, both individual depth trajectories from archival tags, and prey distribution from acoustic surveys. The second study investigates the effect of the herding area on trawl catches with Alfredo-5 cod trawl using sweep lengths of 99, 133 and 180 m, respectively. The effect was shown to differ between species. For Greenland halibut catches increases when changing from 99 to 133 m sweeps, but not from 133 to 180 m. This means the point of zero increase lies within the sweeping widths as achieved by 133 m sweeps.

WD 14 (presented by B. Bogstad) describes a method for 'tuning' the yearly bottom trawl winter survey of Northeast Arctic cod (*Gadus morhua*) using converged VPA-type abundance estimates during a calibration period (1981-1995). For the two age groups considered in this paper (4-6 and 7+), it was found that a regression with intercept gave the best fit to the data.

WD 18 (presented by N. Yaragina) demonstrates inter-annual and monthly variation in the condition of Northeast Arctic (NEA) cod. Temperature was shown to positively impact condition at both inter- and intra-annual timescales. 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 (a latency effect). Indirect effects of competition for energy rich resources have been shown to have a negative effect upon condition.

WD 19 (presented by N.Yaragina) analysis of environmental influences on stock reproductive potential (SRP) was shown using the intrinsic rate of population increase r, derived from life table analysis. Trends in r were compared among nine Atlantic cod *Gadus morhua* stocks (Northern Gulf of St. Lawrence, Northeast Arctic, Georges Bank, Gulf of Maine, Baltic, Icelandic, Irish Sea, Flemish Cap, and West of Scotland) with time series varying in length between 22 and 56 years for the time period 1946-2005. Cod west of Scotland had the highest r over the observed period while Northern Gulf of St. Lawrence cod had the lowest r. Tests for significant differences of mean r between stocks indicated six distinct groups, for example, cod from Northern Gulf of St. Lawrence and West of Scotland were significantly different from each other and the other four stock-groups. Stock specific environmental variables, including a global climatic variable (Northwest Atlantic Oscillation) and life history characteristics relative to r were analyzed to further investigate the environmental influences on SRP.

WD 20 (presented by K.H. Nedreaas) describes the status of the PINRO - IMR's routine exchange program of cod and haddock otoliths which started in 1992. The age reading procedure has to a great extent been standardized except for the fact that the IMR readers prefer reading the opaque summer growth while the PINRO readers read the hyaline winter growth. This may cause a bias, and when this occurs, PINRO usually reads one year more than IMR, and this seems to be area/season related. The results show increased percentage agreement in age readings over the whole time period both for cod and haddock. But differences in the age determination vary by years, showing 80-85% agreement for cod in recent period (2007). The percentage of haddock age readings shows better results with full agreement in 85-90% of the otoliths. All in all, the effort invested by PINRO and IMR in harmonizing the age readings among the readers has given positive results, is a necessary quality check of important input data for assessment, and should thus be continued.

WD 21 (presented by O. Bulatov) contain new version of GIS method. Assessment of fishable stock biomass in April-August 2001-2007 based on CPUE, density of cod, observed length frequency and average weight of fish in each size classes from 40 to 95 cm. The total fish abundance obtained by using the new approach, that include the data about catchability coefficient adjusted for each size group. Study of herding effect of trawl wires and trawl doors shown that effect was extremely low. Fishable biomass values corresponding well with CPUE data (January-December 2001-2007, except 2003). In 2006/2007 the fishable stock increase from 3 038 000 t to 3 548 600 t.

WD 24 (presented by S. Aanes). This work is two folded. Firstly: it describes the results from using FLR for XSA tuning in the assessment of Northeast Arctic haddock compared to VPA95. The results are not exactly equal, but it was concluded that the differences are negligible and to use FLR for the assessment of haddock. Secondly: A sensitivity analysis of the assessment to settings in XSA is performed. It is shown that XSA is extremely sensitive to settings for the haddock data and small adjustments of settings results in rather large changes in perceived stock dynamics. The reasons for this is not fully understood, but part of the reason is due to conflicting signals in catch and survey data.

WD 25 (presented by S. Aanes) presents results from using a stochastic time series model to data for Northeast Arctic haddock. This is accomplished by using an already established age-structured model of population dynamics based on catch at age data and indices of abundance. This model is in the class of state space models, where the input data are treated as noisy observations from the population. This approach also attempts to separate unobserved mortality and fishing mortality. The fitted model shows that temporal variability in unobserved mortality strongly affects perceived variability in stock sizes. Using estimation procedures that neglect temporal fluctuations in unobserved mortality may therefore give biased estimates of fluctuations in haddock stock sizes.

WD 26 (presented by J.E. Stiansen and A. Filin) describes the status of the Barents Sea ecosystem. It includes a general description, monitoring overview, the present and expected situation, risk factors, description of mixed fisheries, and impact of the fisheries on the ecosystem. The working document includes relevant ecosystem factors for the AFWG assessment, such as conditions in climate, pollution, phytoplankton, bottom fauna, marine mammals and seabirds, as well as trophic relations and mixed fisheries information.

WD 27 (presented by S. Subbey) covers a comparative study on the ability of proposed models in predicting stock recruitment for NEA cod (Age 3), conditioned on the 2007 VPA 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 (prognosis) time series were then compared to the VPA values between 1999–2006, and evaluated on the basis of fit and how well they follow the trend in the VPA values. In general, there are models among the ensemble studied, which give good indications to the trend and level in future fish recruitment. The results indicate that more accurate prognosis is obtained by averaging over a selected number of such models. The working document does not make judgment on the appropriateness of the conceptual or biological assumptions underlying the models investigated.

WD 30 (presented by R. Tallman) presents an overview of the development and possible future of Canadian Arctic fisheries. These fisheries are heavily influenced by the long duration of ice cover and historical cultural fishing practices of the aboriginal peoples of the Canadian north. Freshwater fisheries for Coregonidae and coastal fisheries for Arctic charr, *Salvelinus* alpinus were the first commercial ventures. More recently, fisheries for Greenland halibut, *Reinhardtius hippoglossoides*, in NAFO area 0 and northern shrimp, *Pandalus borealis* and *P. montagui* off the southeast of Baffin Island and in Hudson Strait have developed. Changing attitudes of the Inuit towards offshore marine fishing and the possibility of climate warming could eventually result in the development of other commercial marine fisheries.

WD 31 (Presented by J.E. Stiansen) describes an assessment of the future assessment site. Several methods have been evaluated, such as latitude and longitude approaches, time series analysis and wavelet, taken into account general principles of precautionary ecosystem approach. The most trustworthy method was proven to be the combination of wavelet and earth nutation theory, using the 3rd sub-harmonic cycle. This approach concluded that the next assessment location will be San Sebastian, Spain.

0.9 Comment on the establishment of a joint redfish group

Considering the common features in the biology, fishing patterns and assessment methods of redfish (*Sebastes* spp.) in the North Atlantic, the AFWG and NWWG discussed the possibility of establishing a joint ICES/NAFO redfish working group. There are examples of species-related joint working groups, such as the *Pandalus* Assessment Working Group, the Joint EIFAC/ICES Working Group on Eels and the ICES/NAFO Working Group on Harp and Hooded Seals. The advantages and disadvantages of merging redfish expertise in one group instead of three (AFWG, NWWG, NAFO SC) could not be evaluated during the NWWG/AFWG meetings. One of the advantages is the concentration of redfish expertise in one group which is then counter to the idea of regional expert groups. This issue needs further development by all involved parties before a firm proposal can be put forward.

0.10 Time of Next Meeting

The Working Group proposes to meet next time in San Sebastian (Spain) at April 21 – 30, 2009.

1 Ecosystem considerations (Figures 1.1–1.23, Tables 1.1–1.19)

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

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

A new element in fishery management policy is the "ecosystem approach". The ecosystem approach 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).

Changes in the Barents Sea ecosystem are, together with fishery, 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. In addition to climatic conditions that govern the formation of primary biological production and feeding conditions for fish, as well as the survival of their offspring, 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):

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

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

This chapter has in general been based on WD 26 ("Preliminary version of the Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2007, with expected situation and considerations for management"). Text, figures and tables taken from this WD are not further cited in this chapter.

1.1 General description of the Barents Sea ecosystem (Figures 1.1–1.12, Tables 1.1–1.9)

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 this water masses, local heat exchange with the atmosphere and the density difference in the ocean itself. The volume flux into the Barents Sea from the Norwegian Sea is influenced by the wind conditions in the western Barents Sea, which again is related to the Norwegian Sea wind field (Ingvaldsen *et al.*, 2004). Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered when describing the variation in the 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 (Figure 1.2-Figure 1.6).

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* (Drobysheva 1994). The two latter species make up 80-98% of the total euphausiids abundance. Species ratio in the Barents Sea euphausiid community is characterized by year-to-year variability, most probably due to climatic changes (Drobysheva 1994). Observations have shown that after a cooling period the abundance of *Th. raschii* increases and of *Th. inermis* – decreases, and contrary after a period of warm years the abundance of *Th. inermis* grows and the number of cold-water species becomes smaller (Drobysheva, 1967). The advection of species brought from the Norwegian Sea is determined by the intensity of the Atlantic water inflow (Drobysheva 1967, Drobysheva *et al*. 2003).

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

The results from long-term investigations of macroplankton in autumn-winter indicate that the abundance of euphausiids (Figure 1.9), 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 the lower trophic levels in the ecosystem. Plankton is always subject to the surrounding physical environment. Limited self-motion compared to surrounding currents sets strong limitations on the ability to avoid or seek better climate condition. This is especially the case for climatic factors, which vary slowly and/or over large scale in space and time (*e.g.* temperature in the open waters). However, many plankton organisms have mechanisms allowing some kind of vertical motion and may thereby move to more profitable vertical layers. The influences on plankton from climatic factors with strong vertical gradients (*e.g.* turbulence and light) are therefore also dependent on the individual's behaviour. Different climatic factors may also affect individual plankton differently at different stages of its life cycle, and for fish also in nekton stages. Climate variation also affects the trophic interactions on different scales in time and space. The total effect of climate variation on plankton (and also nekton) is therefore a complicated matter.

Fish

The Barents Sea is a relatively simple ecosystem with few fish species of potentially high abundance. These are Northeast Arctic cod, haddock, Barents Sea capelin, polar cod and immature Norwegian Spring-Spawning herring. There have been 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. The last few years there has in addition been a relatively strong increase of blue whiting migrating into the Barents Sea. 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 (Table 1.1-Table 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, including cod 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 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 (Figure 1.12, 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 (Figure 1.12). Ontogenetic shift in prey preference was clear with decreasing proportion of small prey (shrimps and small capelin) and increasing proportion of larger fish with increasing predator length. The largest Greenland halibut (length more than 65-70 cm) had a rather big portion of cod and haddock in the diet.

The blue whiting has its main distribution area in the Norwegian Sea and Northeast Atlantic, and the marginal northern distribution is at the entrance to the Barents Sea. Usually the blue whiting population in the Barents Sea is small. In years with warm Atlantic water masses the blue whiting may enter the Barents Sea in large numbers, and the blue whiting is a dominant species in the western areas. This situation occurred in 2001, and the blue whiting has since been present in high numbers. In general these four species have minor overlapping distributions; with the blue whiting in the west, the herring in the south, the polar cod in the east (except for an overlapping part of the stock in the Svalbard region) and the capelin in the north. In southwestern areas blue whiting and herring partly overlap. However, they occupy different parts of the water column.

The analysis of diet dynamics in blue whiting from different length groups showed a clear downward trend in the proportion of zooplankton by weight (copepods, hyperiids and euphausiids) and an increasing importance of fish. It should be noted that fish became the dominant part of blue whiting diet when it reached a length of about 27 cm. (Dolgov, WD 29, AFWG 2006). Cod juveniles occurred in the stomachs of blue whiting with a length of approximately 25 cm.

When present in the western Barents Sea the blue whiting is not the main prey for any other fish species. In these periods the blue whiting can account for approximately 2-7% (Dolgov, WD 29, AFWG 2006) of the diet of cod and Greenland halibut. Due to the high numbers of cod, this is then the main fish predator on blue whiting. Other fishes, like larger saithe and haddock, may also prey on blue whiting, but the proportion of the diet is low (<1%). Information on predation of mammals on blue whiting in the Barents Sea is at present lacking.

Long rough dab is a typical ichthyobenthophage, which main food is benthos (ophiura, polychaetes etc.) and different fish species (Dolgov, WD 29, AFWG 2006). At older stages the proportion of fish 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 fish and 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. Mean annual biomass of food consumed by thorny skate during 1994–2000 was calculated at 165.7 thousand tonnes, of which 73.7 thousand tonnes comprised commercial fishes and invertebrates. The major items of food were northern shrimp and cod at 31.8 and 16.4 thousand tonnes, respectively. Round skate fed mainly on benthos, especially Polychaeta and *Gammaridae*. Northern shrimp and fisheries waste are also major components of their diets. Fish (mostly capelin and young cod) occurred in small quantities. Arctic skate feed mainly on fish and shrimp (herring, capelin, redfish and northern shrimp). Blue skate diet consists largely of fish, mainly young cod and haddock, redfish, and long rough dab). Spinytail skate also prey mostly on fish, which included haddock, redfish and long rough dab. Total food consumption by all skate species, except thorny skate, was 31.4 thousand tonnes, of which 18.2 thousand tonnes was commercial species (Dolgov, WD 29, AFWG 2006).

Mammals

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

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

The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 1.9. These consumption estimates are based on stock size estimates of 85 000 minke whales in the Barents Sea and Norwegian coastal waters (Schweder *et al*. 1997) and of 2 223 000 harp seals in the Barents Sea (ICES 1999/ACFM:7). The consumption by harp seal is calculated both for situations with high and low capelin stock, while the consumption by minke whale is calculated for a situation with a high herring stock and a low capelin stock. Food consumption by harp seals and minke whales combined is at about the same level as the food consumption by cod, and the predation by these two species needs to be considered when calculating the mortality of capelin and young herring in the Barents Sea.

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

Seabirds

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

Benthos

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. Decapods (i.e. crabs and lobsters) are known predators of benthic bivalves, including epibenthic species such as the commercial Iceland scallop *Chlamys islandica*. Both the red king crab and the scallop have a sub-Arctic distribution, and as the Iceland scallop has a life span of 30 years, and matures after 3-6 years, it might be particularly exposed to risk of local extinction with increasing numbers of king crabs (Jørgensen 2005).

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.

1.2 State and expected situation of the ecosystem

1.2.1 Climate (Figures 1.2–1.6)

Current atmospheric situation

In the first half of 2007, the air temperature over the Barents Sea was well above normal, with maximum positive anomalies (6.0-7.0 ºC) in the eastern sea in February-April. In summer and early autumn temperature anomalies decreased to their long-term means. In November-December, over most of the sea, air temperature was, on average, 2.0-3.0 ºC higher than the long-term mean.

Current situation of temperature, salinity and oxygen

In general the temperatures in the entire Barents Sea is among the warmest ever observed.

Sea surface temperature (SST) in the Barents Sea was above normal throughout the year. In the beginning of the year higher-than-normal, with maximum anomalies of 0.2-1.1 ºC, but decreased in the summer. In the second half of the year, SST anomalies increased again to well above normal values all over the sea with maximum in October (0.5-1.7 ºC).

In the coastal water the temperature was well above average throughout the year. At the fixed station Ingøy the highest deviations were in 250 m depth January-March 2006 when the anomalies were more than 2ºC.

At the Fugløya-Bear Island section (Figure 1.3), a positive temperature anomaly of 1.55°C was observed in January 2007, and this is an all time high since the time series started in 1977. The temperature stayed high throughout 2007, but as has been usual for the last years the anomalies decreased through the year and in October the temperature were 0.6°C above the long-term mean. The annual mean temperature for 2007 was a little lower than for 2006, the warmest year ever observed in the Barents Sea. In March 2007 the anomaly at Vardø-N was 1.58°C above the long-term mean, which again is a new all time high. The salinity variations are similar to those in temperature, and there has been a high salinity in the last 6 years.

At the Kola section (Figure 1.2) sea temperature was significantly higher than the long-term means throughout the year. From February through May, the temperature of the coastal waters as well as in the Murman Current was about 1.2-1.3 ºC warmer-than-normal. In March and April it was the highest since 1951. In the coastal waters, positive anomalies of temperature decreased to 0.7-0.8 ºC in August-September and rose to 1.0-1.2 ºC in October-December. In the Murman Current a decrease of temperature anomaly (to 0.9-1.0 ºC) was observed from June to December. Water salinity was typical for warm years. Both in the coastal waters and in the Murman Current salinity was higher than the long-term means. Some decrease in positive salinity anomalies was observed in September-December.

Bottom temperatures (Figure 1.4) in August-September 2007 was in general between 1-1.5 ºC above average in the Barents Sea, with the highest anomalies (>2 ºC) in the North Cape and Murman Currents. Waters with positive anomaly of bottom temperature occupied more than 90% of the surveyed area), and at about 35% of the area, the anomalies were the highest since 1951.

Hydrochemical observations in the Kola section show that 2007 in the Barents Sea is a continuation of the period characterized by a gradual increase in oxygen saturation of bottom layers in the southern Barents Sea, which has started in 2002.

Current situation of 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 year of 2006 was a special year as the volume flux both had a maximum (in winter 2006) and minimum (in fall 2006). During winter 2007 the volume flux increased to just below the average, but then it showed a rapid decrease during spring 2007 (Figure 1.5). The observational time series has only data until June 2007, but the atmospheric wind field indicate a low inflow during summer 2007 and thereafter an increase toward the normal conditions during fall 2007. There is no significant trend in the observed volume flux from 1997 to summer 2007.

According to a wind-driven numerical model (Trofimov, 2000) the general circulation in 2007 was weaker in the western part of the Barents Sea, stronger in the eastern part and near normal in the central one compared to the long term mean. Compared with the previous year, the general circulation was weaker all over the sea. In 2007 the total flux through the section crossing the Novaya Zemlya Current was above normal throughout the year but it was less than in 2006.

Current situation of ice conditions

During the year, the sea ice extent was generally much less than the long-term mean (Figure 1.6). The greatest ice coverage was observed in February, 36% of the sea area, that was 21% less than normal. Minimum ice extent was in September when there was no ice in the sea. Ice edge was located to the north of 81°N. In October ice coverage amounted only 1% of the sea area, i.e. 16% lower-than-normal. In November it was the lowest for the corresponding month since 1951.

Expected situation

The natural first environmental parameter to try to forecast is sea temperature. Because the ocean has a "long memory", as compared to the atmosphere, it is feasible, at least a priori, to realistically predict ocean temperature much further ahead than the typical weather forecast. The prediction 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 is often seen 2-3 years later in the Barents Sea. As the temperature in the Norwegian Sea has increased since 2005, and because the inflow is expected to increase from the low inflow in 2007, the temperatures in 2008 are expected to be at least as high as in 2007.

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 southern Barents Sea in 2008 is expected to be higher than the long-term mean, but most likely lower than in 2007.

Due to the extremely warm Atlantic waters in the latest years, in combination with the fact that the ice often lag the temperature variations with a few years, and the extreme ice minimum the recent years, the ice conditions in 2008 is expected to be low.

1.2.2 Phytoplankton

Current situation

In 2007, the seasonal distribution of phytoplankton was more or less similar to what has been observed in earlier years.

1.2.3 Zooplankton (Figures 1.7 and 1.9)

Current situation

The average zooplankton biomass measured in August–September 2007 was near identical to the long-term mean, but has dropped significantly compared to 2006.

However, there were observed high zooplankton concentrations in the northeastern areas (Figure 1.7).

The macroplankton survey conducted in autumn and winter showed that the abundance of pre-spawning euphausiids at the beginning of 2007 was higher than the long-term mean, but less than in 2006 (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+). The rest of species: *T. longicaudata*, *M. norvegica* and *N. megalops* made up a minor supplement.

Expected situation

It is expected that the zooplankton situation in 2008 will be similar to 2007, concerning feeding conditions for planktivorus fish.

1.2.4 Northern shrimp

Based on the most recent estimates the fishing mortality has been below the upper limit reference (F_{lim}) throughout the exploitation history of the stock. The risk that F exceeded F_{lim} is estimated at about 2% for 2007. The stock is harvested sustainable. Indices of stock size have increased from 2004 to 2006. A decrease of 18% was observed from 2006 to 2007. The estimated risk of stock biomass being below B_{msy} at the end of 2007 was 3%, but less than 1% of being below B_{lim}.

According to the preliminary data from trawl survey the northern shrimp stock in the Barents Sea and Spitsbergen area in 2007 decreased compared to 2006.

1.2.5 Fish (Tables 1.3 – 1.6)

Current and expected situation

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

NEA cod diet

Food composition of cod in 1984-2007 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, herring, polar cod, cod and shrimp. In comparison with 2006 the importance of blue whiting has decreased, while the role of hyperiids and redfish has increased.

The consumption calculations made by IMR show that the total consumption by age 1 and older cod in 2007 was about 5 million tonnes (Table 1.3), while similar calculations by PINRO (Table 1.4) gave about 3 million tonnes. According to the calculation by IMR the consumption per cod increased for the young age groups (1 – 5 year old) (

Table **1.5)** but decreased for the old age groups (8 year and older). According to the calculation by PINRO (WD 6) the consumption per cod decreased for the youngest age groups (1-2 year old). For the other age groups the consumption per cod was close to the estimations for 2006 (Table 1.6).

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 unsustainably. SSB increased to a historical high in 2003 but has decreased in 2004-2007.

The high abundance of blue whiting in the Barents Sea in recent years may be due to increased temperature. Blue whiting has been observed in the western and southern Barents Sea for many years, but never in such quantities as now, and never as far east and north in this area as in 2004-2007. In autumn 2007, the acoustic abundance of blue whiting was estimated to 0.7 million tonnes, which is about the same level as in 2006. However, 1-group blue whiting was hardly found in the Barents Sea in 2007. Thus, the abundance of blue whiting is expected to decline in 2008, unless there is recruitment from the 2007 year class.

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 2007, the stock size was measured to about 1.2 million tonnes.

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 reduced reproductive capacity. The maturing component in autumn 2007 was estimated to be 0.8 mill tonnes. SSB 1st April 2008 is predicted to be at 0.33 mill tonnes. The spawning stock in 2008 will consist of fish from the 2004 and 2005 year classes, but the 2005 year class will dominate. The survey estimate at age 1 of the 2006 year class is below the long-term average, but is the strongest since year 2000. Observations during the international 0-group survey in August-September 2007 indicated that the size of the 2007 year class is above the long term mean.

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 1998, 1999 and 2002 year classes dominate the current spawning stock which is estimated to 11.9 million t in 2007. The 2004 year class is also estimated to be strong. Parts of this year class were found in the Barents Sea in autumn 2007, but will probably leave the Barents Sea in 2008. 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 2008.

Non-commercial species

Snake pipefish (*Entelurus aequoreus*) was first registered in the Barents Sea ecosystem survey in 2005 following an expansion of the species range from the North Sea and northward through the Norwegian Sea. In 2006, the intrusion expanded north to 80˚N and east to 35˚E with scattered observations further east. In 2007 the distribution area remained largely the same as in 2006.

1.2.6 Marine mammals (Figures 1.13–1.14)

Current situation of distribution and abundance

In 2007, observations from 20 marine mammal species were recorded by observers during the ecosystem cruises and reported as incidental observations from a variety of vessels. 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), with aggregations along the shelf edge and around Bear Island, in the south-east and in the north. Compared to last year, more white-beaks were observed in the northern areas, which may be a response to increasing capelin abundance. This is in contrast to 2006, where no observations of its sibling species, the white-sided dolphin, were recorded, and no observations of the common or striped dolphins were recorded. White-sided dolphins are more oceanic than the white-beaks, and common and striped dolphins are boreal species occasionally occurring in the Barents Sea. Being a coastal species, harbor porpoises are not well covered by the cruises in the Barents Sea. However, the few observations recorded of harbour porpoises were within it's traditional range (Figure 1.13).

Of the baleen whales, minke, humpback and fin whales were most numerous, and their distributions are shown in Figure 1.14. Minke whales were observed in most parts of the Barents Sea, with aggregations along the shelf edge, around Bear Island, west of Spitsbergen and in northern areas. Fin whales have a more restricted distribution, but are still continuing the recent trend of occupying central and northern Barents Sea. However, the densities seem still highest in the traditional fin whale area along the shelf edge. 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.

Blue, sei and bowhead whales are rarer and occasionally observed in the Barents Sea. Three observations of blue whales were recorded west and north of Spitsbergen, two observations of sei whales were recorded south of bear Island and north of Spitsbergen, while no observations were recorded of the bowhead whale.

Also 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.

Predation by mammals

Analyses of consumptions by marine mammals in the Barents Sea for 2007 are not available.

Harp seal diet data was collected in spring and early summer over three years (2004-2006) in southwestern, central and northwestern Barents Sea. The data obtained supplement similar data obtained in open waters east of Svalbard in July and August in 1996 and 1997. The results indicate a 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 both 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

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 ^oC 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 ^oC. 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 ^oC 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 1.15-1.20)

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 2007, 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 7% 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 $1-e^{-F}$) 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 1.15). The major pelagic stocks are capelin, herring, and polar cod. There was no fishery for capelin in the area in 2004-2007 due to the stock's poor condition, and there was no directed fishery for herring in the area. The highly migratory species blue whiting and mackerel extend their feeding migrations into this region, but there is no directed fishery for these species in the area. Species with relatively small landings include salmon, halibut, hake, pollack, whiting, Norway pout, anglerfish, lumpsucker, argentines, grenadiers, flatfishes, horse mackerel, dogfishes, skates, crustaceans, and molluscs.

The most widespread gear used in the central Barents Sea is bottom trawl, but also long line and gillnets 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.

The demersal fisheries are highly mixed, usually with a clear target species dominating, and with low linkage to the pelagic fisheries (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). 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 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 1.16). There is also a significant relationship between saithe and Greenland halibut although the linkage in these fisheries is believed to be low (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). 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. 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 1.16) 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 1.17-Figure 1.20 shows the 2007 catches. For the catch distributions in 2005 and 2006, see last year’s report). In the north eastern 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 main reason for this disparity is the difference in spatial resolution of the data; the Norwegian strata system extends further west and thus covers the fishing grounds for Greenland halibut, whereas the Russian strata do not. The Norwegian trawl fishery along the Norwegian coast includes areas closer to the coast and is also more southerly distributed where other species are more dominant in the catches (e.g. saithe).

Estimates of unreported catches of cod and haddock in 2002-2007 indicate that this is a considerable problem (section 0.5). Discarding of cod, haddock and saithe is thought to be significant in periods although discarding of these, and a number of other species, is illegal in Norway and Russia. Data on discards are scarce, but attempts to obtain better quantification is 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.

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. 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

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

Management of fisheries is always based on decision making under 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.

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 incorporating of ecosystem information into stock assessment and harvest control rules.

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. A brief descriptions of the multispecies models are given below.

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 model that describes stock dynamics of cod in the Barents Sea, taking into account trophic interactions and environmental influence (Filin, 2005). It can be used for prediction and historical analysis of the cod stock as well as for estimation of effectiveness of different harvest and rebuilding strategies.

STOCOBAR model is not spatially structured, and the time step can be set to either one or a half year. The model includes cod as predator of seven prey species (capelin, shrimp, polar cod, herring, krill and juveniles of haddock and cod). All species except, for shrimp and krill are divided in age groups. The recruitment function is used for cod only. Long-term estimation of the influence of ecosystem factors on the cod stock development are realized in the model by using stochastic ecosystem scenarios (Filin and Tjelmeland, 2005).

The first version of STOCOBAR was developed at PINRO in 2001. The current work on improvement of this model continues. The last updated version of the model was presented in AFWG 2006 WD 13. 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 Program of Estimation of Maximum Long-Term Yield of North-East Arctic Cod taking into account the effect of ecosystem factors (2005-2007).

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.

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 1.5.5 (*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. The Barents Sea is currently showing a warming trend (see this chapter), which suggests that this is likely to benefit NEA cod. However, this cold-adapted population may not prosper if temperatures continue to rise. Additionally, capelin are an arcto-boreal species, therefore the effects of climate warming may affect them more dramatically, with an indirect negative impact on cod condition.

Growth of fish

Large interannual variations in growth rate are observed for all commercial 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. This needs to be taken into account when setting fishing targets and reference points. Variation in growth and condition can have a large impact on reproductive output.

Cod. The Northeast arctic cod is characterized by significant year-to-year variations in its growth rate. In different years the mean weight of fish at the same age may vary by a factor of 2-3. Regressions of weight at age of cod on temperature, capelin and the cod stock itself are used in EcoCod model.

Capelin. By using the data from the winter macro-plankton survey conducted by PINRO the most statistically significant relationship between length/weight of capelin and euphausid abundance indices was revealed for fish at age 2. The closest relationships between indices of euphausid abundance and absolute/relative increments in length and weight of capelin were registered in fish at the fourth year of life (age 3+). For younger age groups no statistically significant correlations were detected. However, all regression equations had low determination coefficient.

By using the data from the autumn ecosystem survey, capelin growth in a given year is more closely correlated with the estimate of zooplankton abundance in the previous autumn than with that in the present autumn (Gjøsæter et al., 2002). Growth of the youngest capelin is well correlated with abundance of the smallest zooplankton, whereas growth of older capelin is more closely correlated with abundance of the larger zooplankton. Mean growth in length during the last growth season shows positive relationships with total zooplankton density for all age-classes. The correlation coefficients are generally low, but they are statistically significant for 1-, 2- and 4-year-olds. Growth rates of 3-year-old capelin during their last season do not correlate well with estimated total zooplankton density but the length of 1-year-olds, weight and growth were all significantly correlated with zooplankton density. Growth of 1- and 2-year-old capelin was negatively related to total capelin biomass.

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:

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

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

As shown in Johannesen *et al*, WD 20, 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 dynamics of stock parameters in the Barents Sea (Tables 1.12–1.17, Figures 1.21–1.22)

Prediction of NEA cod growth rate by STOCOBAR model

Table 1.12 presents the prognosis of cod growth parameters by cod for 2007-2010 from the STOCOBAR model, where 2006 was used as initial year. The model parameters were estimated from historical data (1984-2006). Prognoses of the current and expected capelin stock were derived using data from the capelin assessment. The PINRO prognosis on annual temperature on Kola section for 2008 and 2009 (4.7°C and 4.5°C, respectively) was used in model runs. For the period 2008-2009 an average of the previous three years were used for the fishing mortality and recruitment of cod at age 1.

According to the model results the weight of cod is expected to increase, due to an increasing capelin stock and still high temperature.

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 (Table A3), 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).

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 intervals after 1998, the TA was calculated with relatively linear trend of temperature.

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 (table A2):

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

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

TITOV3: $R3^3$~ $OxSat^2$(t -44) + ITa(t -39) + Cod0(t-28)

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

Where DOxSat(t-13)~ Exp(OxSat(t-13)) − OxSat(t−38), ITa(t-39) ~ 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).

At AFWG 2008, Subbey et al. presented a comparative study (AFWG WD#27) 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 between 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 1.15, 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 1.15 refer to models described above (JES2 and JES3 were not available for the 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 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 Figure 1.21 and Figure 1.22 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 1.13.

Cannibalism mortality for cod

Table 1.14 shows the proportion of cod in the cod diet for the period 1984-2007, by predator age and year. This proportion increases by predator age.

An alternative approach for prediction of NEA cod cannibalism was proposed by Kovalev (2004), 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. Using this approach the predicted natural mortality coefficient for cod including cannibalism for recent years seems to be higher compared to "the standard" assessment and prediction (sec. 3.3.7). Values for the years 2008 to 2010, predicted by the regression, are given in Table 1.16.

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

Expected stock parameters based on qualitative analysis of ecosystem impact factors

An alternative approach for looking at the future development of the commercial fish stocks is to give qualitative assignments to different stock parameters based on major impact factors. Then an overall effect on the specific stock can be given. The overall effect, together with the impact factors and the stock parameters are shown in Table 1.17.

1.4.6 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 fisheries induced evolution most likely take into consideration (are included) also, 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. Since then monitoring of ecosystem components in the Barents Sea on a regular basis have been conducted by IMR and PINRO at several standard sections and fixed stations as well as by area covering surveys. In addition there are conducted many short time special investigation, designed to study specific processes or knowledge gaps. Also the quality of large hydrodynamical numeric models are now at 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, Tables 1.19)

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 1.18.

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 1.19)

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 1.19. 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.

Russian Autumn-winter trawl-acoustic survey

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

Norwegian Greenland halibut survey

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

1.5.3 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 2007.
- The sea temperature in the entire Barents Sea was among the warmest ever observed in 2007. In 2008 the temperatures are expected to at least as high as in 2007.
- Salinity in the Atlantic water was above average in 2007, as the last few years
- Inflow of Atlantic waters at the western entrance was low in 2007
- Oxygen levels were about normal in 2007
- In 2007 the extent of sea ice was generally much less than the long-term mean, with no ice in the summer. The ice coverage in 2008 is expected to continue to be low.

Phytoplankton, zooplankton and northern shrimp

- The phytoplankton situation in 2007 was similar to 2006.

- The average zooplankton biomass was near identical to the long-term mean, but has dropped compared to 2006.
- Abundance indices of krill in the beginning of 2007 were higher 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 2007 decreased compared to 2006 but is still at a high level.

Fish

- Capelin was at a low level in 2007 but with signs of recovery. The size of 2006 year class is below the long-term average, but is the strongest since year 2000 and the size of the 2007 year class is above the long term mean.
- Young herring was at a high level in 2007 in the Barents Sea. However, the strong 2004 year class will probably leave the Barents Sea in 2008. 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 2008.
- Blue whiting is still abundant in the western areas in 2007. However, 1-group blue whiting was hardly found in the Barents Sea in 2007. Thus, the abundance of blue whiting is expected to decline in 2008 unless there is recruitment from the 2007 year class.
- The polar cod stock is presently at a high level

Mammals

- In 2007 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.
- Both high temperatures and increasing of capelin abundance are likely to have influenced the marine mammal distributions in 2007 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.
- 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 results (STOCOBAR) show that the weight of cod is expected to increase, due to an increasing capelin stock and still high temperature.
- The cod recruitment (age 3) in 2008 is expected to be somewhat above the long-term mean, while it is expected to be below the long-term mean both in 2009 and 2010.
- According to qualitative analysis of impact of ecosystem factors the growth, maturation and cannibalism in cod stock and capelin the growth, maturation and natural mortality are expected to be around the long term mean in the Barents Sea in 2008.

1.7 Response to technical minutes and SGFIAC

To review group

The AFWG is thankful for the thorough work, and hence the fruitful comments, from the review group (AFWG 2007). According to suggestions from the review group chapter 1 have been slightly restructured. Main conclusions are gathered at the end, and the “state and expected situation” section is moved to section 1.2. Monitoring has been moved to section 1.5, and the chapter in total has been reduced. However, the general description of the ecosystem is still kept in the beginning of the chapter (section 1.1). “The state and expected situation” is in many aspects based on deviations from the general situation, and hence is a natural follow-up of the “general description”. Also, we feel that it is important for a non-expert reader to have the possibility to quickly get into the complex structure and interactions in the ecosystem, which form the basis of knowledge for the management of the fisheries. This is also in line with current ICES policy on transparency.

The length of the “general description”-section is about 6 pages. In this chapter we have tried to recognise all parts of the ecosystem in a balanced way. The rest of the chapter is, as the noted by the reviewers, heavily focused on cod. This reflects the research effort, but it is the hope of the group that in the future other species will be addressed in a better way. Still, it is a bit strange that the review group wants to reduce the part (section 1.1) that is trying to do just that.

Chapter 1 is mostly based on a preliminary version of the “Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2007, with expected situation and considerations for management”, which will be published in august 2008 in the “IMR/PINRO joint report series”. The report has been written by 68 scientists gathered from all fields of ecosystem research. Next year (2009) this report will be succeeded by a Norwegian-Russian environmental report for the Barents Sea, incorporating the knowledge of 16 Norwegian and 6 Russian institutions. A preliminary version of this will be available for AFWG2009, as the predecessor report has been. It is to hope that more knowledge on other species then will be enlightened.

To the Study Group on Fisheries Induced Adaptive Change (SGFIAC)

The 2008 Study Group on Fisheries Induced Adaptive Change (SGFIAC) has recommended the following: “To facilitate dialogue with scientists closely involved in producing advice for exploited fish stocks, SGFIAC recommends that members of

ICES assessment working groups (such as AFWG and WGNSSK) also participate in the meeting of SGFIAC in 2009".

In section 1.5.6 AFWG addresses the response to this request.

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	Confidence limit		Abundance	Confidence limit		Abundance	Confidence limit		Abundance	Confidence limit		Abundance	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
Mean	66164			17746			3765			29377			66635		

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	Confidence limit		Abundance	Confidence limit		Abundance	Confidence limit		Abundance	Confidence limit		Abundance	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
Mean	192			30			591			37383			8871		

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

Year	Capelin			Cod			Haddock			Herring		
	Abundance	Confidence limit		Abundance	Confidence limit		Abundance	Confidence limit		Abundance	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
Mean	226405			67149			10504			170344		

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
Mean	550			305082			73108		

Table 1.3. The North-east arctic cod stock's consumption of various prey species in 1984-2007 (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

Table 1.4. The North-east arctic COD stock's consumption of various prey species in 1984-2007 (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
Mean	318,7	209,0	244,3	97,3	1178,8	145,6	129,2	90,2	27,4	17,7	73,2	38,6	1,6	178,7	240,4	2990,6

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

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

Table 1.7. Capelin stock history from 1973 and prognosis for capelin biomass in 2008. 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*		3643	858	

*** Prognosis, includes the 2007 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. Prognoses of NEA cod growth rate for 2008 – 2010 from the STOCOBAR model.

Age	Weight in stock at the beginning year			Weight in catch		
	2008	2009	2010	2008	2009	2010
2	0,09	0,10	0,10			
3	0,24	0,26	0,30	0,75	0,78	0,80
4	0,91	0,61	0,63	1,30	1,19	1,17
5	1,27	1,81	1,25	1,79	1,92	1,63
6	2,14	2,32	3,22	2,52	2,66	3,10
7	3,18	3,32	3,60	3,58	3,63	3,67
8	4,40	4,47	4,60	5,26	5,30	5,20
9	7,29	7,25	7,27	7,47	7,38	7,12
10	9,88	10,67	10,47	8,90	9,54	9,07

Table 1.13. Overview of available prognoses of NEA cod recruitment (million age 3 fish) from different models (sections 1.5.5) together with the 2007 assessment estimates (AFWG 2007 Table 1.18). Note that the given month in the third column indicates when the prognoses can be extended for another year.

Model	Prognostic years	Prognoses available	2008 Prognoses	2009 Prognoses	2010 Prognoses
Titov1	1 (2 [1])	At assessment	618 *	579	
Titov2	2	At assessment	760	556 *	
Titov3	3	At assessment	817 *	180 *	152 *
Titov4	4	At assessment	826	332	264
TB	3	Before assessment	705	790	624
JES1	2 (3 [2])	November (March [1])	706 *	792 *	722
JES2	1 (2 [2])	November (March [1])	691	637	
JES3	0 (1 [2])	November (March [1])	600		
SV	3	Februar	624	642	
RCT3 Assessment 2008	3	At assessment	607	428	373
Hybrid model			714	509	152
RCT3 Assessment 2007 (Nor-IUU-Run/Rus-IUU-Run)	3	At assessment	535/ 476	461/ 406	

[1] Based on calculation of data from 2008.

[2] Based on prognosis estimate of capelin maturing biomass for October 1 2008, thereby allowing for an additional year.

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

Table 1.14. 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
Average	0.0013	0.0206	0.0313	0.0302	0.0358	0.0504	0.0684	0.0872	0.1467	0.1465	0.1464

Table 1.15. Comparison of NEA cod recruitment models. Prognoses between 1999—2006, based on VPA2007. C is correlation coefficient and σ^2 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 1.16. Cannibalism in cod.

Year	M2 age 3	M2 age 4
	by regression	
2007	0.4059	0.2755
2008	0.3895	0.2694
2009	0.3826	0.2669
2010	0.3933	0.2708
	values used in assessment	
2008-2010	0.2957	0.2115

Table 1.17. Qualitative analysis of effects of ecosystem impact factors on some stocks in the Barents Sea for 2008.

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

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

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

+ – Influence of ecosystem parameter on stock parameter without clear positive or negative effects;

– negative (-- strongly negative) influence of ecosystem parameters on stock parameters;

? Knowledge is not available.

Table 1.18. 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 1.19. 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	-	-

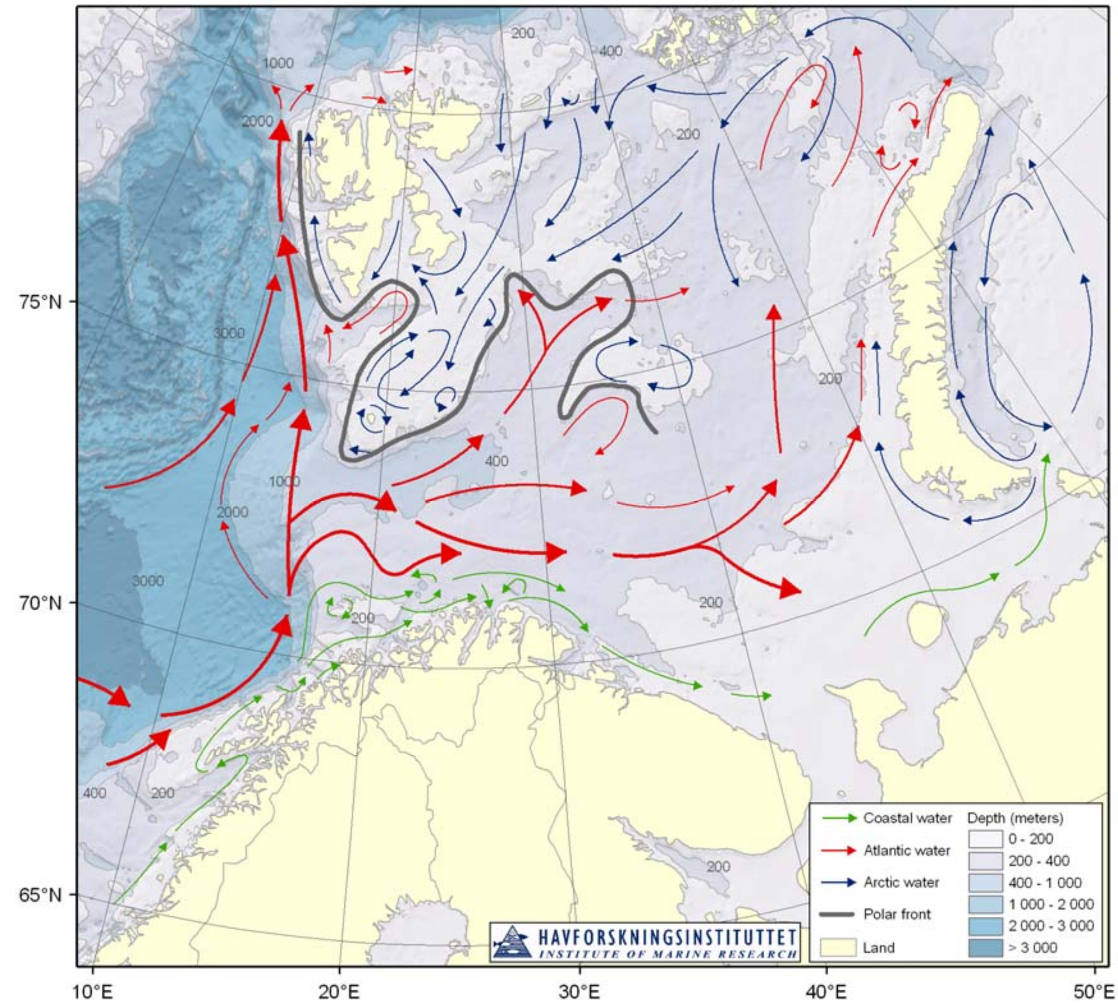


Figure 1.1. The main features of the circulation and bathymetry of the Barents Sea.

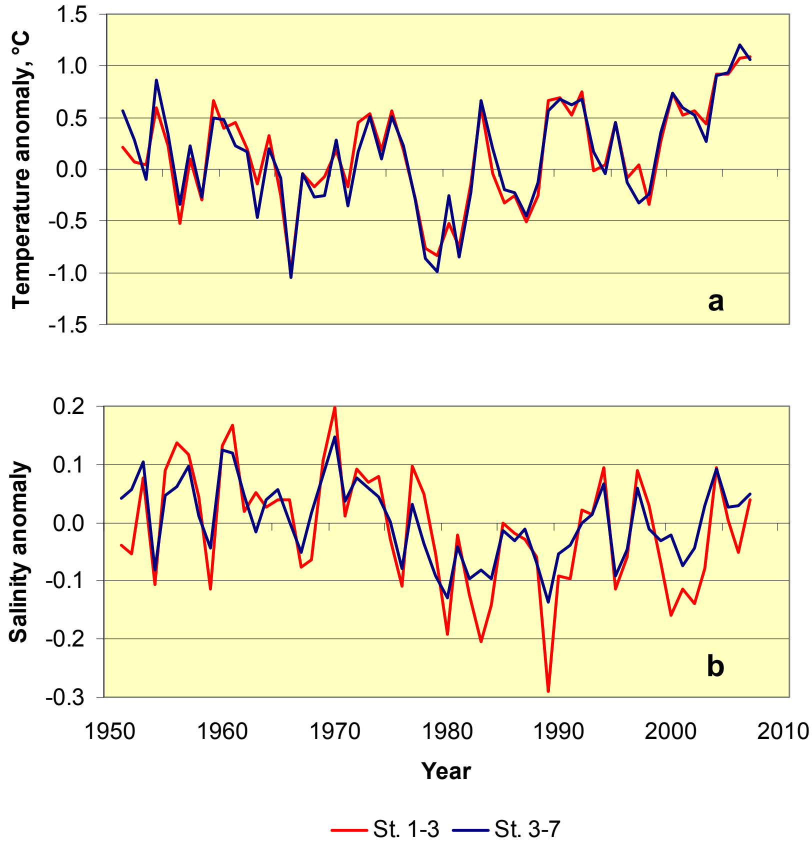


Figure 1.2. Mean annual temperature (a) and salinity (b) anomalies in the 0-200 m of the Kola section in 1951-2006. Coastal waters (red line). The Murmansk Current (blue line) (Anon. 2008).

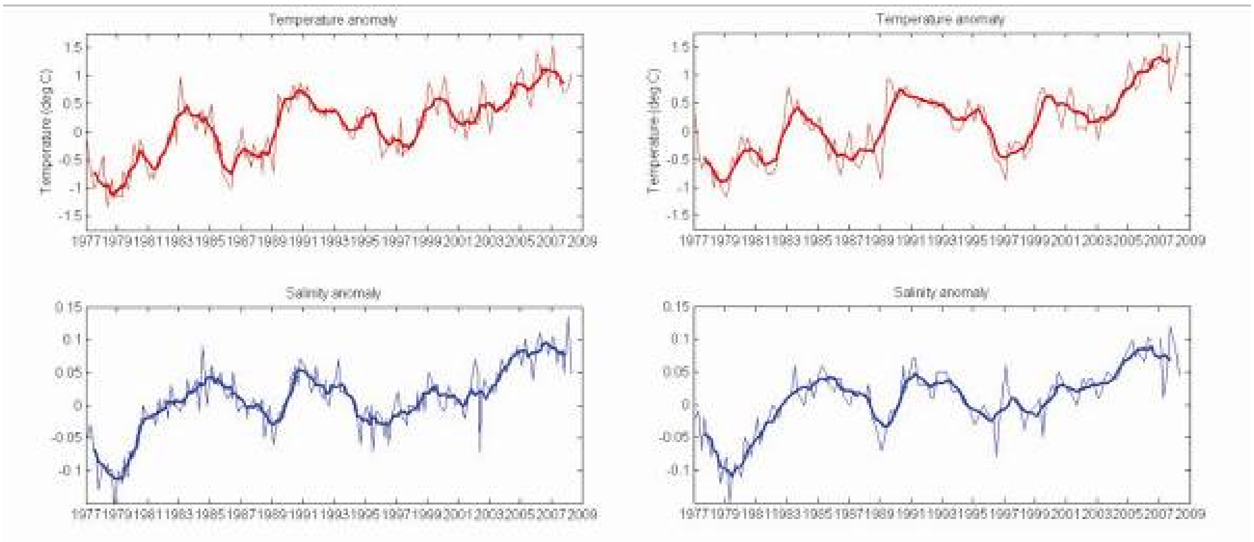


Figure 1.3. Temperature (upper) and salinity (lower) anomalies in the 50-200 m layer of the Fugløya-Bear Island section (left) and the Vardø-North section (right).

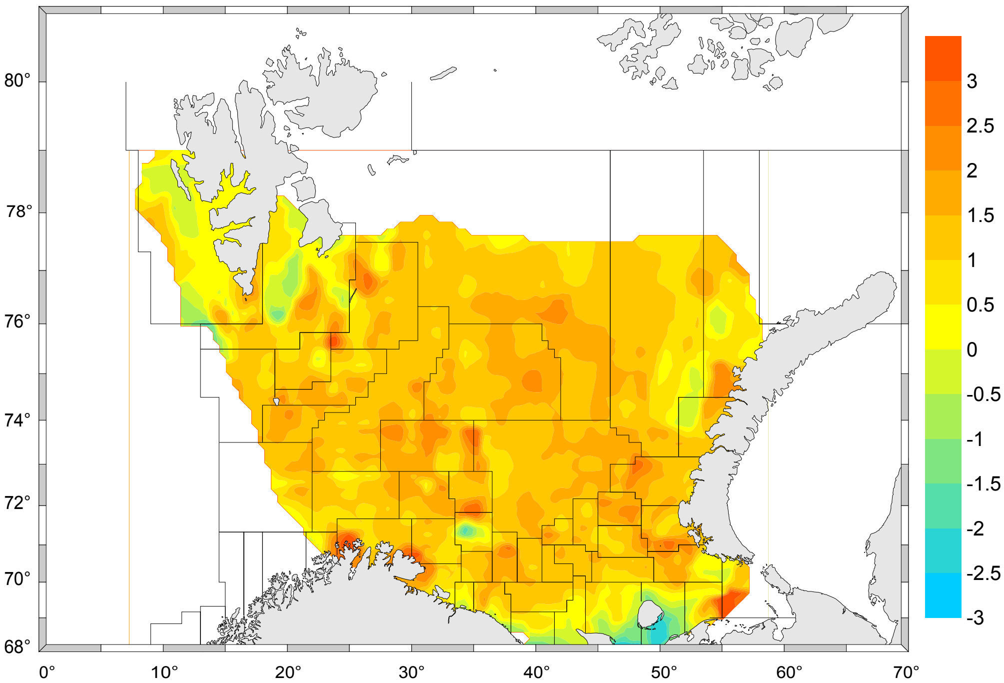


Figure 1.4. Bottom temperature anomalies in the Barents Sea in August-September 2007 (Anon. 2008)

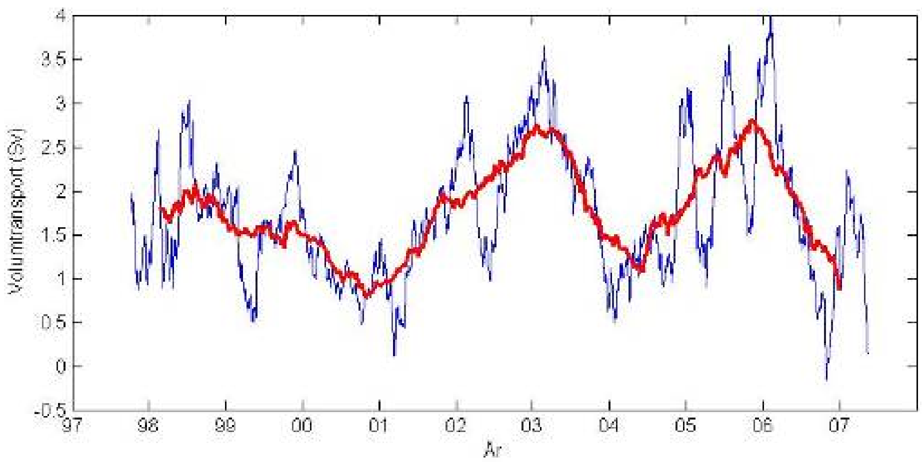


Figure 1.5. Observed Atlantic Water volume flux through the Fugløya-Bear Island section in 1998-2007 estimated from current meter moorings. Three months (blue line) and 12-months (red line) running means are shown.

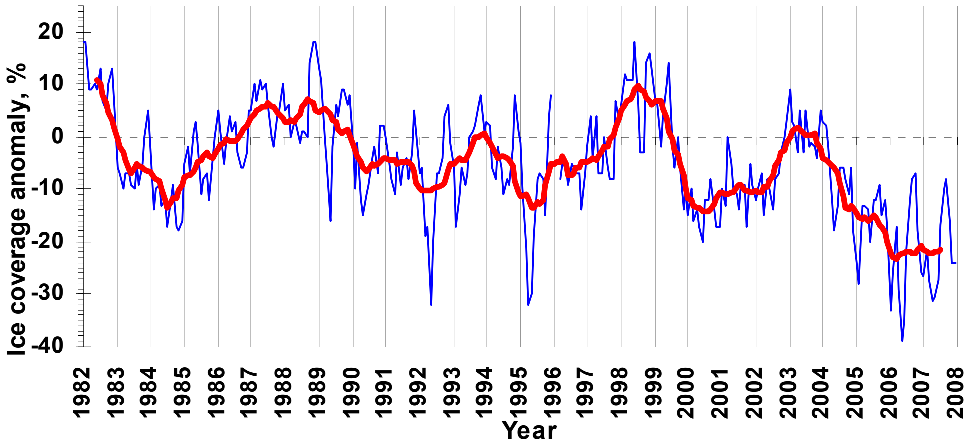


Figure 1.6. Anomalies of mean monthly ice extent in the Barents Sea in 1982-2007. The blue line shows monthly values, the red one – 11-month moving average values (Anon., 2008)

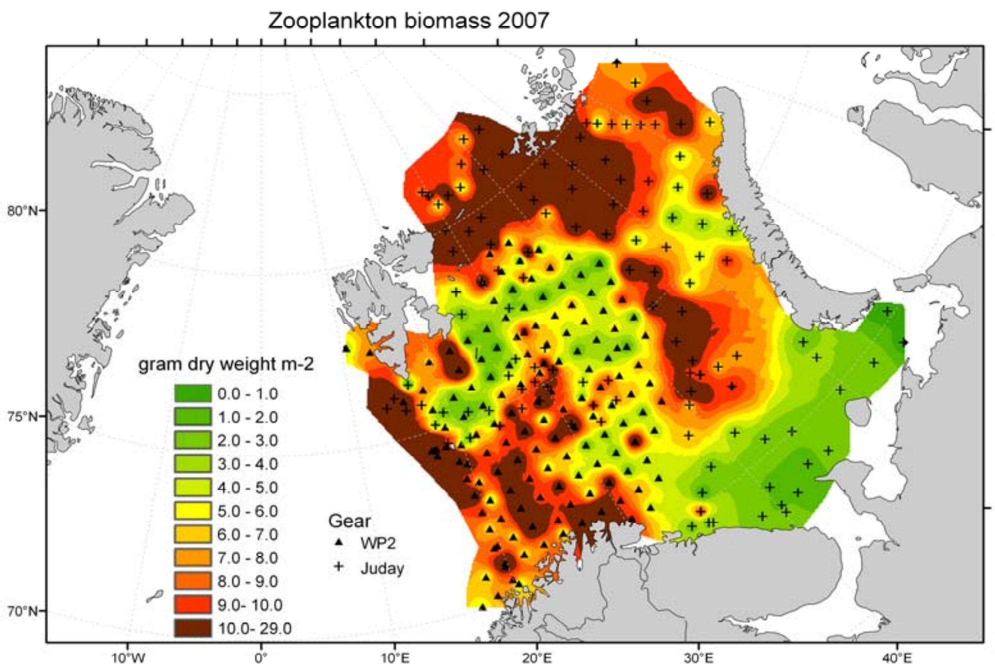


Figure 1.7. Horizontal distribution of zooplankton in 2007 (g m^{-2} of dry weight from bottom-0 m).

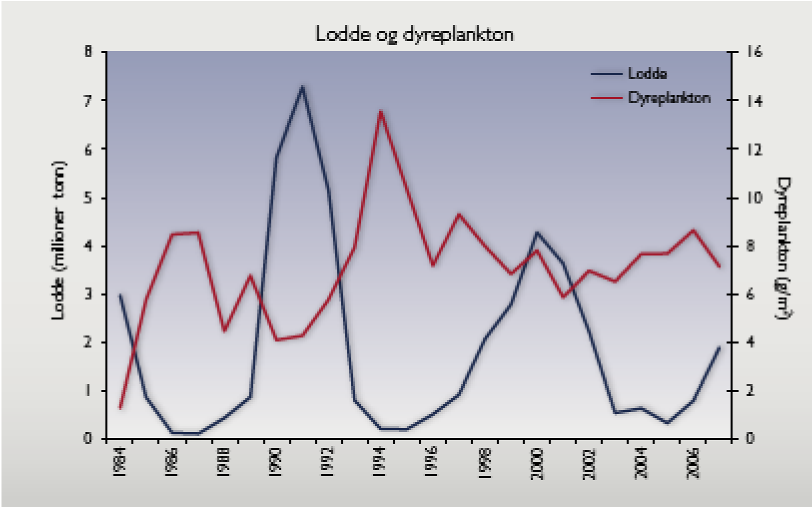


Figure 1.8. Average zooplankton biomass (dry weight, g m^{-2}, red line) together with biomass of one year old and older capelin (million tonnes, blue line) during 1984 – 2007, in the Barents Sea (from Dalpadado et al. 2002, updated with data for 2001-2007).

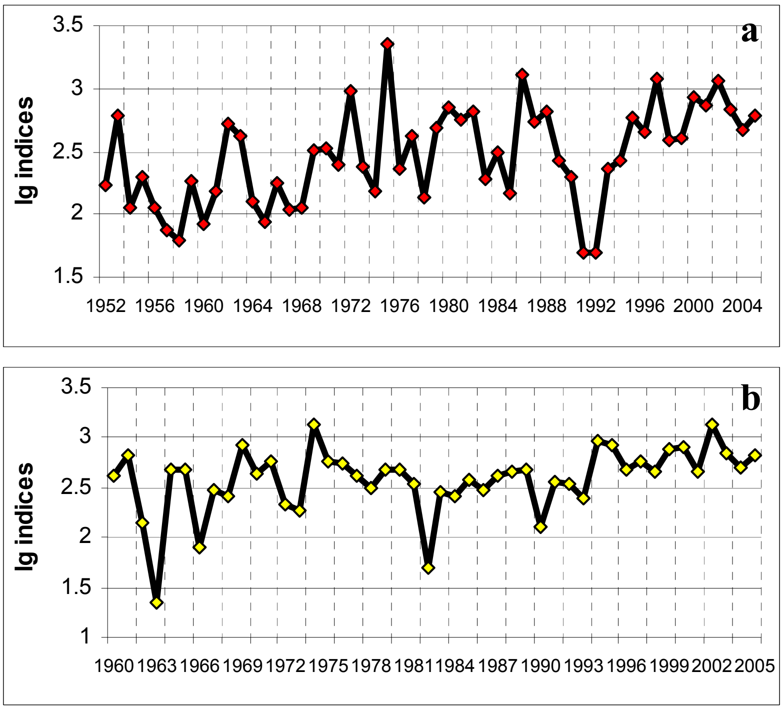


Figure 1.9. Indices of krill abundance in the southern (A) and in the northwestern part of the Barents Sea (B). More details of area definitions can be found in Drobysheva et al. (2003).

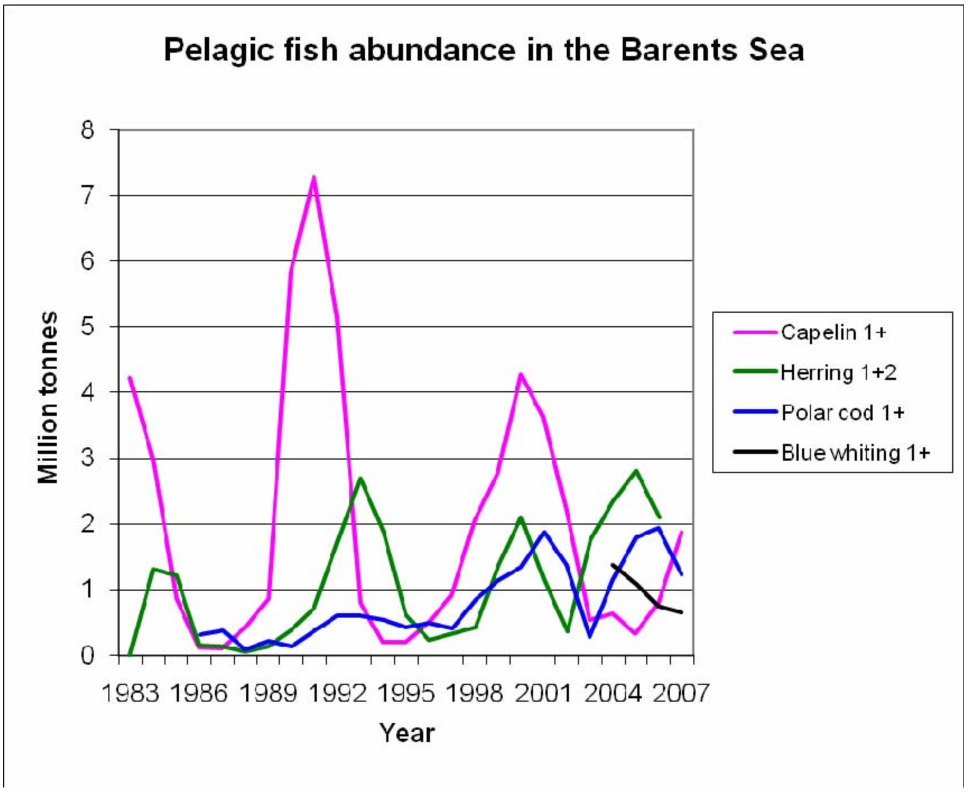


Figure 1.10. Abundance of pelagic fish species in the Barents Sea. The data are taken from; capelin: Acoustic estimates in September-October, age 1+ (ICES AFWG 2007;, herring: VPA estimates of age 1 and 2 herring (ICES WGNPBW 2007) using standard weights at age (9 g for age 1 and 20g for age 2); polar cod: Acoustic estimates in September-October, age 1+ (Anon., 2007); blue whiting: Acoustic estimates in September-October, age 1+ (Anon., 2007).

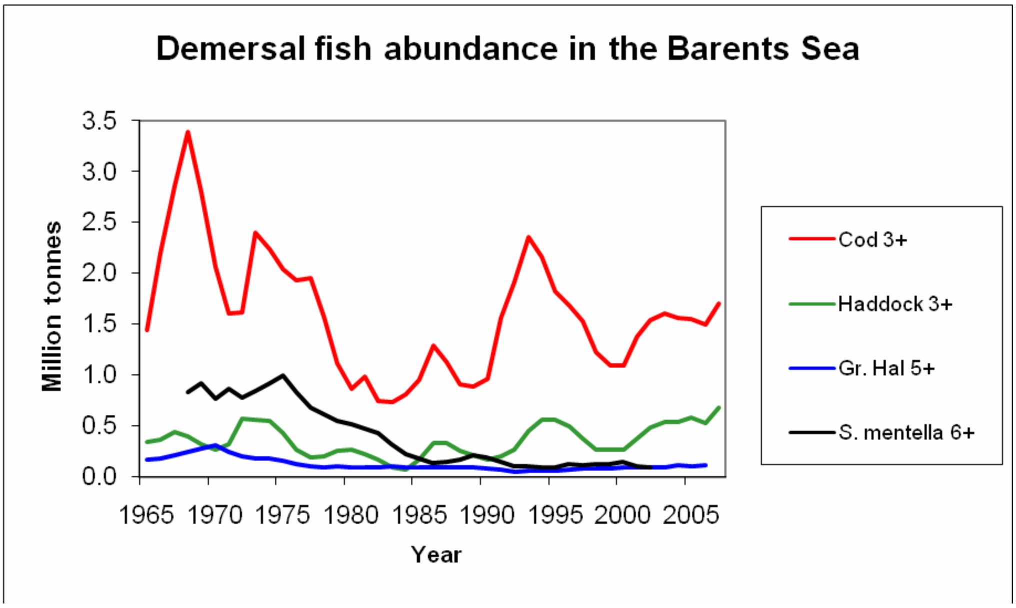


Figure 1.11. Abundance of demersal fish species in the Barents Sea. The data are taken from; cod: VPA estimates, age 3+ (ICES, 2008); haddock: VPA estimates, age 3+ (ICES, 2008); Greenland halibut: VPA estimates, age 5+ (ICES, 2007); *Sebastes mentella*: VPA estimates, age 6+ (ICES, 1995 for the years 1968-1990; ICES, 2003 for the years 1991-2002).

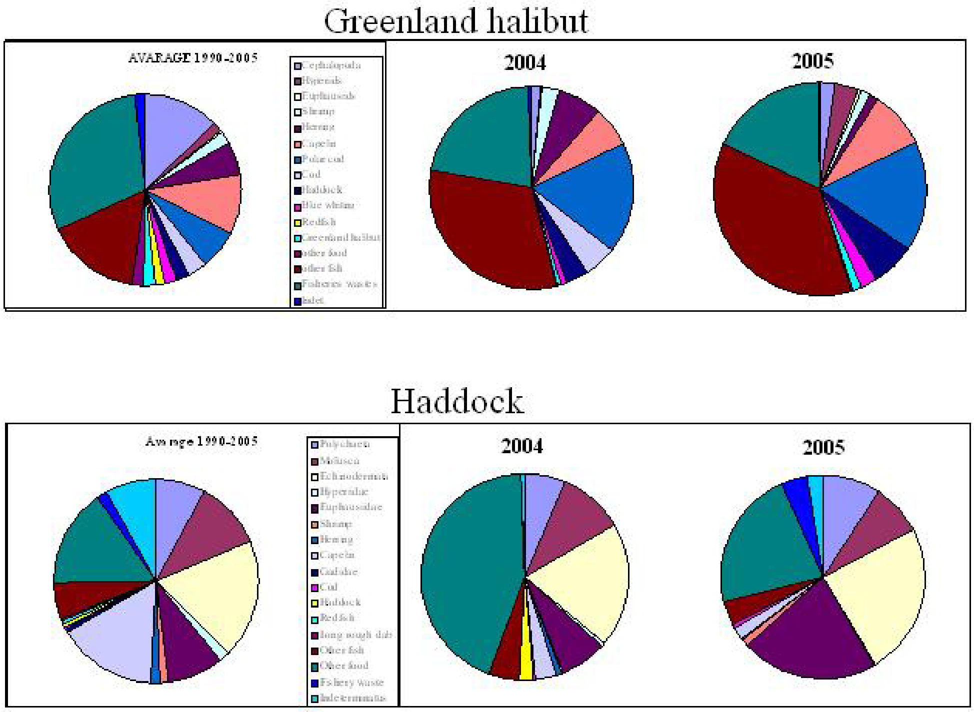


Figure 1.12. Stomach contents in Greenland halibut and Haddock from Russian data.

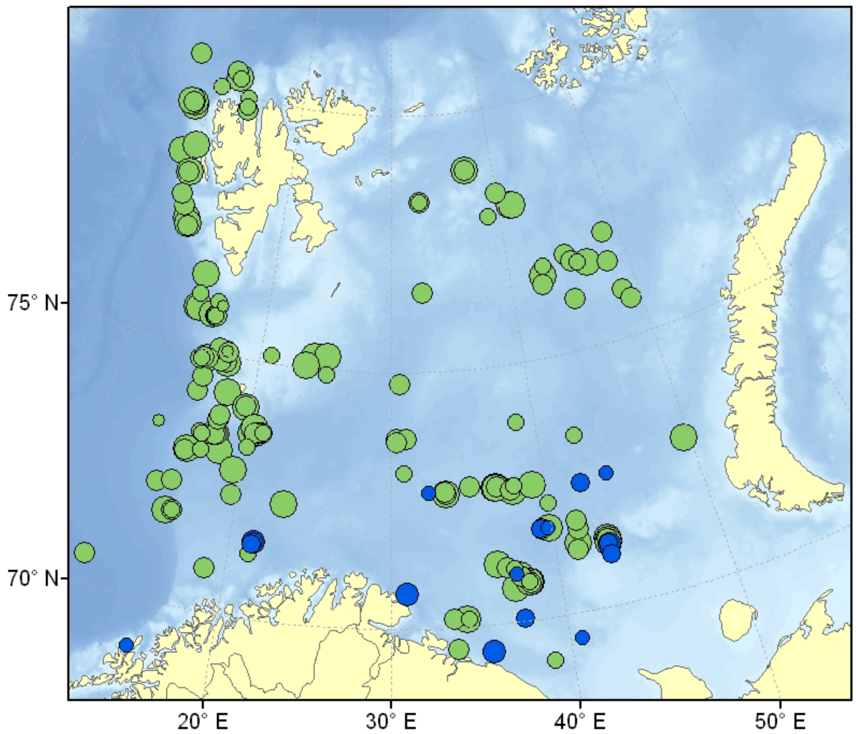


Figure 1.13.Distribution of white-beaked dolphins (green dots) and harbor porpoises (blue dots) as observed in 2007. Dot sizes reflect number of individuals observed.

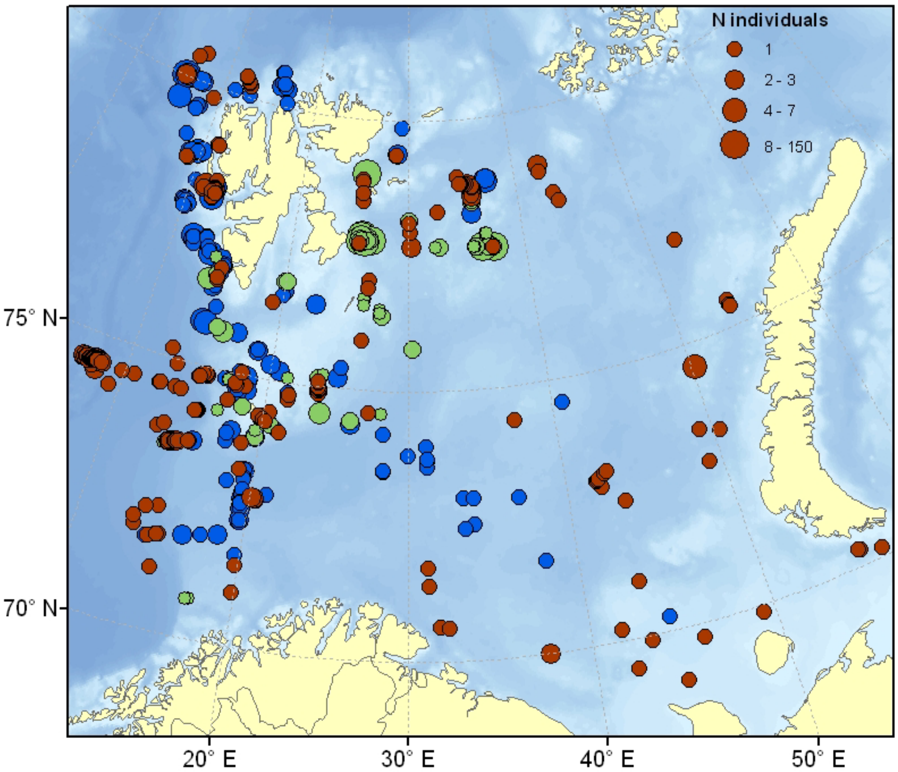


Figure 1.14. Distribution of minke (red dots), humpback (green dots) and fin whales (blue dots) as observed in 2007. Dot sizes reflect number of individuals observed.

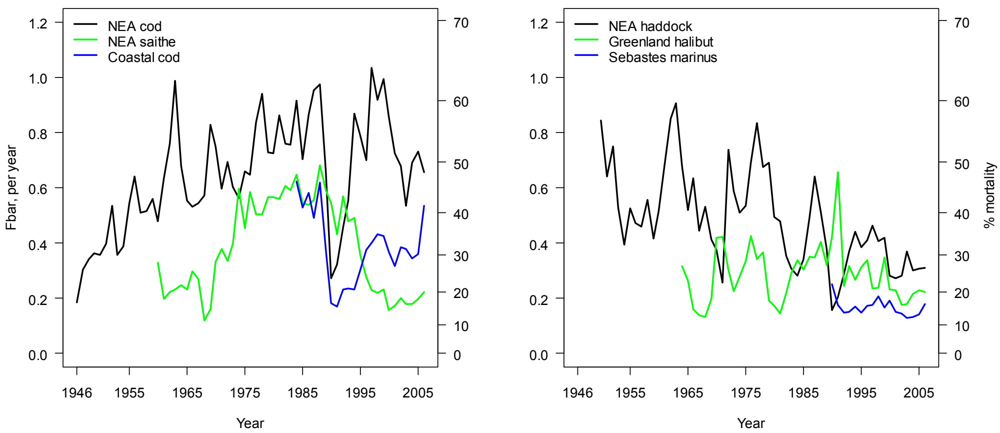


Figure 1.15. Time series of annual average fishing mortalities for Northeast Arctic cod (time period 1946-2006, average for ages 5-10), Northeast Arctic saithe (time period 1960-2006, average for ages 4-7), coastal cod (1984-2006, average for ages 4-7), Northeast Arctic haddock (time period 1950-2006, average for ages 4-7), Greenland halibut (time period 1964-2006, average for ages 6-10) and *Sebastes marinus* (time period 1990-2006, average for ages 12-19).

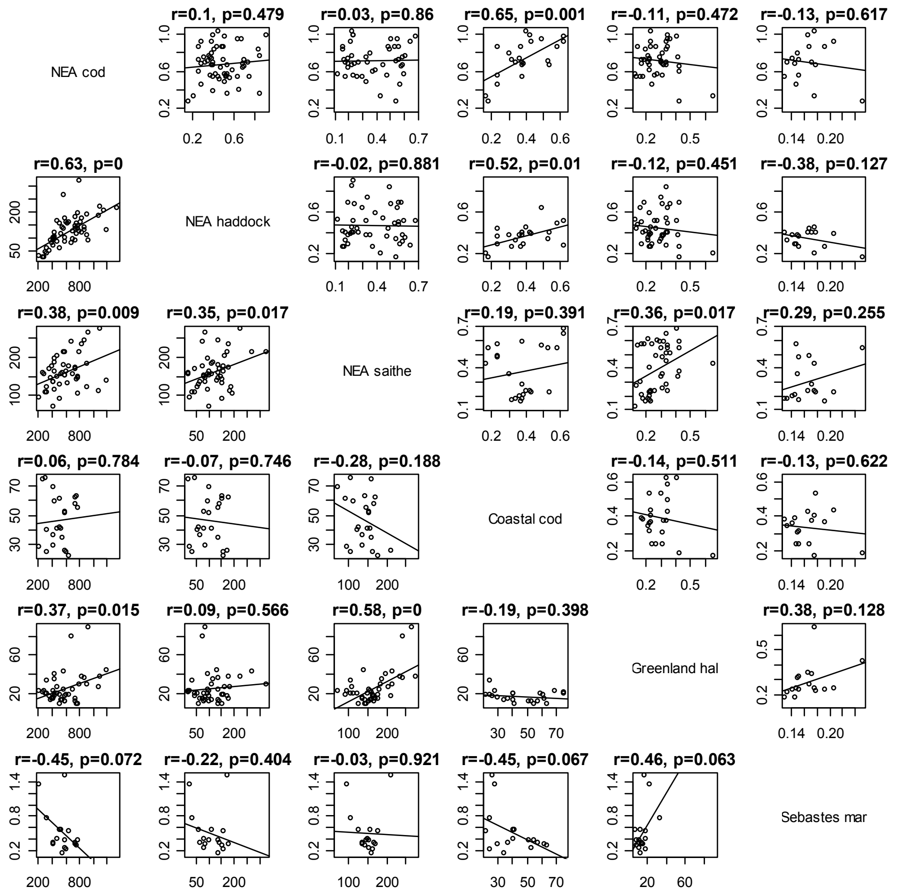


Figure 1.16. Pair-wise plots of annual average fishing mortalities (above diagonal) and landings (below diagonal) for overlapping time periods for Northeast Arctic cod (time period 1946-2006, average for ages 5-10), Northeast Arctic haddock (time period 1950-2006, average for ages 4-7), Northeast Arctic saithe (time period 1960-2006, average for ages 4-7), coastal cod (1984-2006, average for ages 4-7), Greenland halibut (time period 1964-2006, average for ages 6-10) and Sebastes marinus (time period 1987-2006, average for ages 12-19). The correlation and the corresponding p-value are given in the legend.

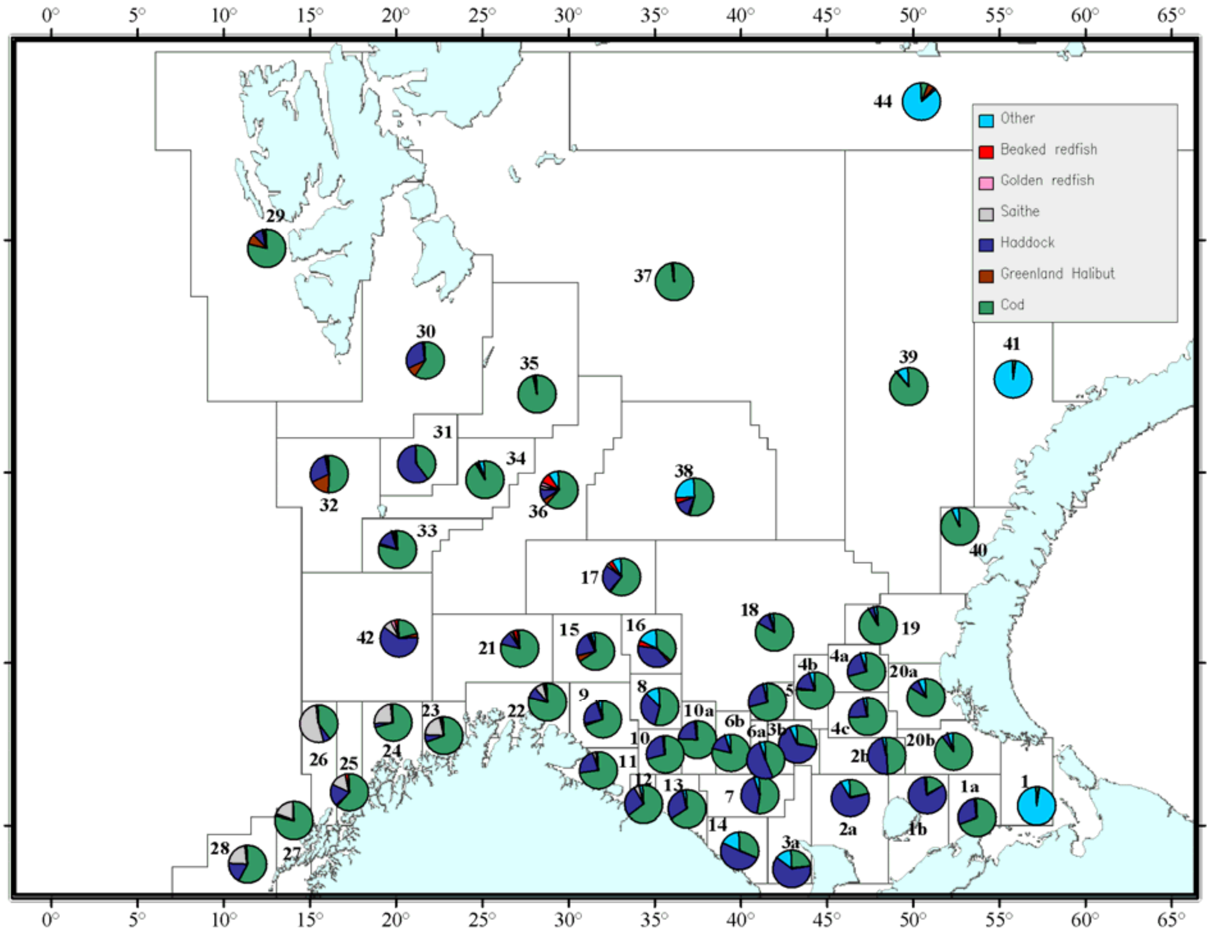


Figure 1.17. Relative distribution by weight of cod, haddock, saithe, Greenland halibut, golden redfish (*Sebastes marinus*), beaked redfish (*Sebastes mentella)* and other species taken by Russian bottom trawl in 2007 per main area for the Russian strata system.

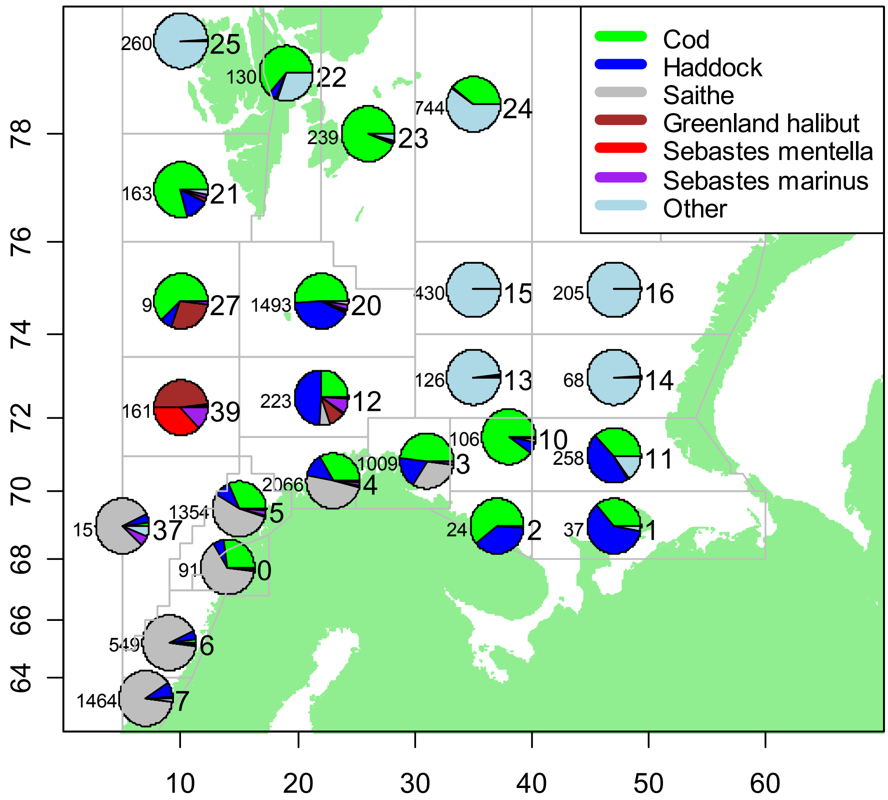


Figure 1.18. Relative distribution by weight of cod, haddock, saithe, Greenland halibut, *Sebastes marinus (golden redfish)*, *Sebastes mentella* (beaked redfish) and other species taken by Norwegian bottom trawl in 2007 per main area for the Norwegian strata system. The large number to the right of 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.

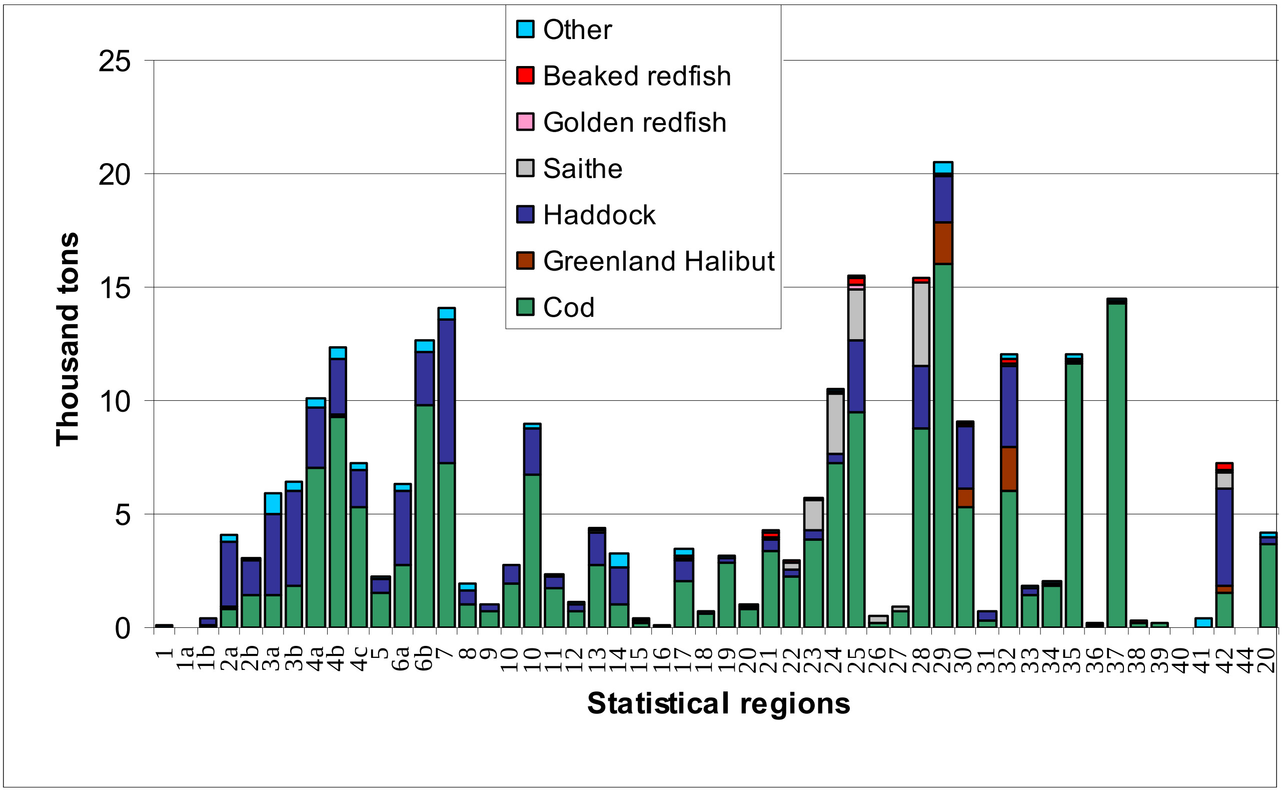


Figure 1.19. The Russian catch of cod, haddock, saithe, Greenland halibut, *Sebastes marinus*, *Sebastes mentella* and other species taken by bottom trawl by main statistical areas in 2007, thousand tonnes. The statistical areas correspond to the areas shown in Figure 1.17.

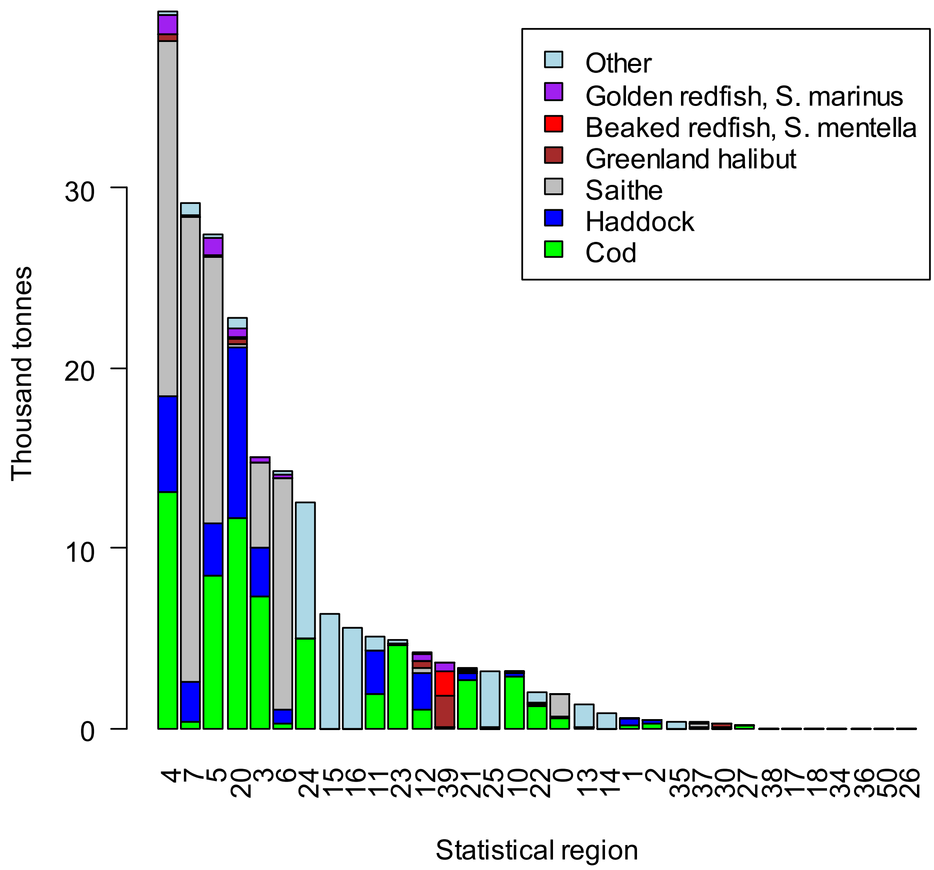


Figure 1.20. The Norwegian catch of cod, haddock, saithe, Greenland halibut, *Sebastes marinus*, *Sebastes mentella* and other species taken by bottom trawl by main statistical areas in 2007, thousand tonnes. The statistical areas correspond to the areas shown in Figure 1.18.

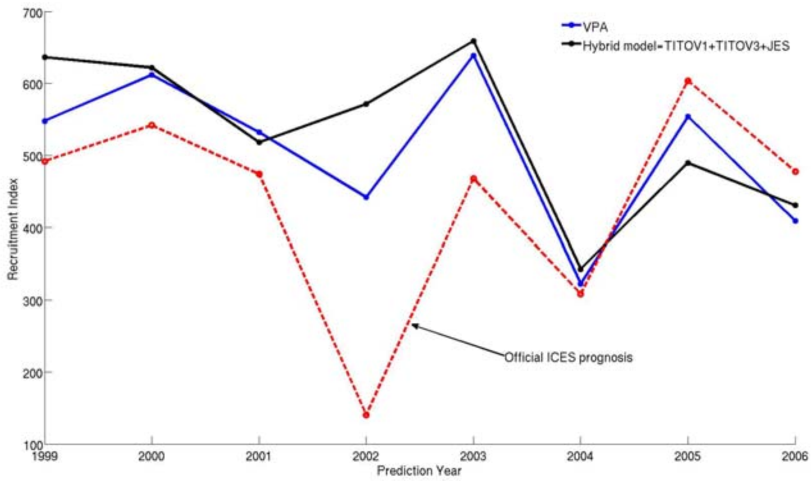


Figure 1.21. Comparison of NEA cod recruitment models. Prognosis for 1-year ahead. Hybrid model is an arithmetic mean of models with correlation coefficient greater than 0.5.

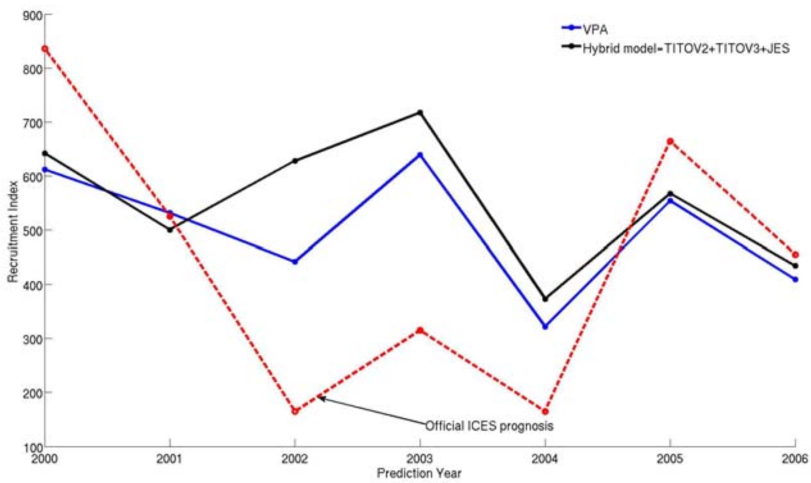


Figure 1.22. Comparison of NEA cod recruitment models. Prognosis for 2- years ahead. Hybrid model is an arithmetic mean of models with correlation coefficient greater than 0.5.

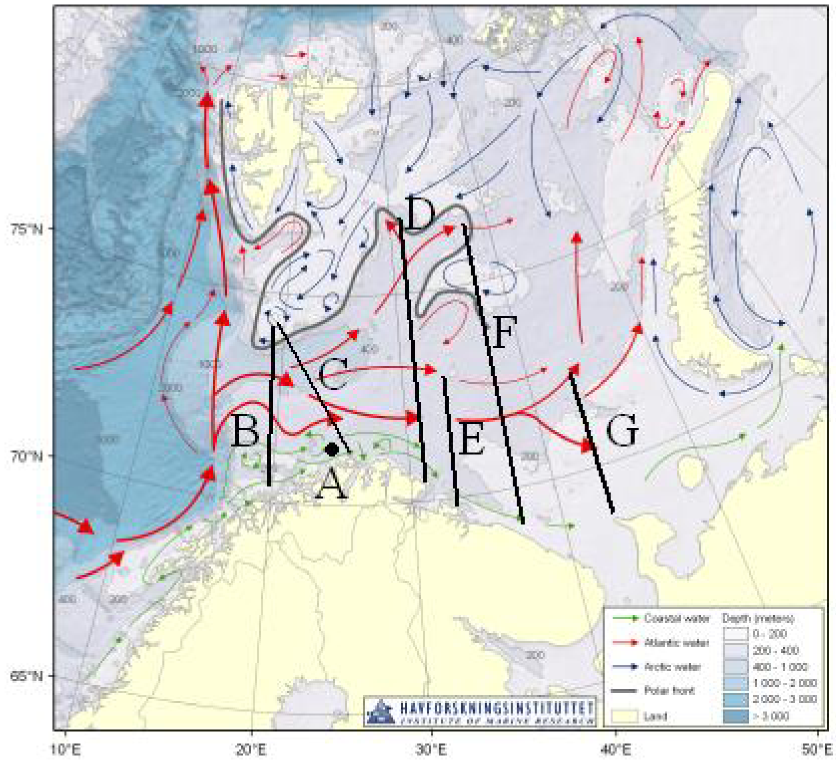


Figure 1.23. Positions of the standard sections monitored in the Barents Sea. A is fixed station Ingøy, B is Fugløya-Bear Island, C is North cape-Bear Island, D is Vardø-North, E is Kola, F is Sem Island-North and G is Kanin section.

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

Type of assessment: Update

No data revisions

The data explorations made last year revealed inconsistencies between survey indices at age and landings at age. These problems have not been resolved and, as last year, the current assessment is based on a survey time series. Estimated landings at age are updated with 2007 data. General information regarding the stock and earlier assessments are given in the Quality Handbook Stock Annex of the 2006 report.

This chapter is now rearranged somewhat in line with proposals from the last Review Group.

Further topics raised by last Review Group:

-confusion regarding TAC and allocation of catches to stock: The catches are not counted against a separate TAC for coastal cod. The Norwegian cod TAC includes both coastal cod and NEA cod. Landings are split between the stocks when all sampling data are worked up, which means 2-3 months after the fishing year is ended.

-information on sampling levels; section 2.1.1

-otolith structure; section 2.1.1

-cannibalism; section 2.3.3

-survey based biomass estimates is the sum of products of survey estimates of numbers at age and weights at age. A calculation error has been discovered in the 4+ biomass presented last year.

-use of SURBA; section 2.4.

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% gillnet, 20% Danish seine, 20% long-line/hand-line and less than 5% bottom trawl.

2.1.1 Sampling fisheries and estimating catches by stock (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 2006 are 26,134 t and the estimate for 2007 is 23,841 t (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-eastArctic 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 could, the catches of coastal cod would 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 2007. The total number of age samples was 344, and in addition 1438 length samples were taken. 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 14,000 fish were aged. Nearly 4000 of these otoliths were classified as coastal cod. The table shows that samples were missing in area 00 in quarter 2 and 3. Here the quarter 1 samples were used for quarter 2 and the quarter 4 samples for quarter 3.

Table 2.4 shows the estimated catches of coastal cod by statistical area and quarter for the years 2004-2007. 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 2004-2007 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. 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 2007.

2.1.2 Regulations

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

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 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%.

The regulations in 2008 are as in 2007.

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 are calculated the same way as previous years using the same covering area as for previous surveys.

2.2.1 Indices of abundance and biomass (Tables 2.5–2.11)

The results of the 2007 survey (Aglen *et al*. WD 15 2008) are presented in Tables 2.5-2.11 for the area inside 12 n.miles 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 slightly higher in 2007 compared to the 2006 and 2005 surveys. The 2007 estimate of survey biomass is about 48,000 t (Table 2.9). The estimated spawning biomass is 25,000 t (Tables 2.11). The bulk of the spawning biomass is comprised of ages 5-8. 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 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 some variation without a clear 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-ies 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 2.2b, 2.4, 2.8-2.10)

A total of 1174 cod otoliths were sampled during the 2007 survey, and separated into NCC type (923) and NEA cod (251).

As in previous years, NCC was found throughout the survey area. The 2007 survey data shows the same pattern as the 1995-2006 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 2007. 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 4 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

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 (Tables 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 and 2007 surveys (Table 2.10). Both the estimated weights at age and the estimated 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

The estimated catch at age (2-10+) for the period 1984-2007 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. This sums up to almost 30% of the official landings of coastal cod in 2003. There have also been conducted two investigations trying two estimate the level of discarding and misreporting from the coastal vessels in two periods (2000 and 2002-2003, WD 14 at 2002 WG). The amount of the discard was calculated and the report from the 2000-investigation concluded there was both discard and misreport by species in 2000. Landings of cod with gillnet should be increased by approximately 8-10%. 1/3 of this is probably Coastal cod. The last report concluded that misreporting in the Norwegian coastal gillnet fisheries have been reduced significantly since 2000.

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 in catch

Weights at age in catches are derived from the commercial sampling and is shown in Table 2.16.

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.

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 2007 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 two 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 2.15–23)

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 for most year classes the observed values for ages 2 and 3 are below the modelled values, and that this pattern increases for the most recent cohorts. This might indicate that the survey catchability is reduced in the later part of the time series. The residual plots (Figures 2.19-2.21) and retrospective plots (Figure 2.23) seem reasonable. The estimated average catchabitlies by age (Figure 2.22) are dome shaped (similar to the shape observed in the xsa when assuming a plateau at age 8).

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 1/3 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 2007 are still quite low, but not quite as low as in the period 2003-2005. For age 1 the 2007 value is about 1/10 of the 1995-1998 average, and for ages 2 and 3 the 2007 value is 1/5 of the 1995-1998 average. 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 values of the stock size 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 extended in 2005 and further extended in 2007 (see chapter 2.1.2). These regulations have reduced the fishing effort from vessels larger than 15 m in the inner coastal areas and fjords. The estimated catch has declined somewhat over those years with additional regulations. As described there are uncertainties in catch estimation. It seems, however, rather clear that the fisheries have to be much more restricted to bring the catches down towards zero.

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

	Age									Tonne
	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

Table 2.1b. Esimated catch of coastal cod in 2007 by gear and area.

Year	2007					
Area	03	04	00	05	06/07	Total
Gillnet	1 106	1 913	3 204	1 291	4 814	**12 328**
L.line/Jig	1 623	1 017	1 248	1 006	814	**5 708**
Danish seine	1 282	1 090	880	1 396	244	**4 893**
Trawl	587	291	17	16	2	**912**
Total	**4 599**	**4 311**	**5 349**	**3 709**	**5 873**	**23 841**

Table 2.2. Sampling from cod fisheries in 2007 in the statistical areas 00, 03,04,05, 06+07. Number of age samples of cod by quarter, total number of cod otoliths and number of additional length samples of cod.

Quarter\Area	03	04	00	05	06+07	Total
1	26	39	32	63	25	185
2	24	19	0	26	13	82
3	9	14	0	8	4	35
4	13	13	2	13	1	42
Total #samples	72	85	34	110	43	344
Total #otoliths	3625	2988	1774	4911	855	14153
#coastal cod otoliths	711	599	1045	873	723	3951
Additional length samples	183	425	58	506	266	1438

Table 2.3Number of otoliths sampled by quarter from commercial catches in the period 1985-2007. 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

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	2004 Landings					
Qu./Area	03	04	00	05	06-07	Total
1	616	4693	3516	3942	2622	**15389**
2	1104	989	608	315	1315	**4330**
3	360	951	431	438	439	**2619**
4	182	611	881	204	331	**2209**
Total	**2262**	**7243**	**5436**	**4899**	**4707**	**24547**

Year	2005 Landings					
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 Landings					
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 Landings					
Qu./Area	03	04	00	05	06-07	Total
1	664	1812	3787	2274	3847	**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	2004 Proportion CC in landings					
Qu./Area	03	04	00	05	06-07	Total
1	0.08	0.23	0.12	0.14	0.68	**0.17**
2	0.09	0.12	0.12	0.09	0.78	**0.14**
3	0.32	0.53	0.78	0.52	0.89	**0.55**
4	0.09	0.49	0.78	0.39	0.96	**0.42**
Total	**0.10**	**0.23**	**0.16**	**0.15**	**0.74**	**0.19**

Year	2005 Proportion CC in landings					
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 Proportion CC in landings					
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 Proportion CC in landings					
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**	**0.81**	**0.20**

Table 2.5. Coastal cod. Acoustic abundance indices by sub areas and in total in 2007 (in thousands).

	Age (Year class)										
Area	1 (06)	2 (05)	3 (04)	4 (03)	5 (02)	6 (01)	7 (00)	8 (99)	9 (98)	10+ (97+)	Total
03	696	745	935	1541	921	543	431	3			5815
04	1059	917	886	2136	1472	1171	689	605	174	21	9130
05	47	528	554	398	364	151	149	26			2217
00	152	40	473	599	36	221		92	4	7	1624
06	224	1016	1168	774	388	312	117				3999
07	24	54	64	70	78	49	58	34	19	6	456
Total	2202	3300	4080	5518	3259	2447	1444	760	197	34	23241

Table 2.6. Coastal cod. Acoustic abundance indices by age 1995 – 2007 (in thousands).

	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

Table 2.7. Coastal cod. Mean length (cm) at age 1995 – 2007.

	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

Table 2.8. Coastal cod. Mean weight (grams) at age 1995-2007.

	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

Table 2.9. Coastal cod. Acoustic biomass indices (1000 tonnes) in 1995 – 2007.

	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

Table 2.10. Coastal cod. Maturity ogives by age in the period 1995 – 2007.

Year	Age									
	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

Table 2.11. Coastal cod. Acoustic spawning biomass indices (1000 tonnes) in 1995 – 2007.

	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

Table 2.12. Proportion coastal cod among sampled cod during the coastal survey by age and statistical areas in the years 2003-2007.

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

Table 2.13. Inputs for SURBA analysis.

SURBA 2.1

Run performed at 16:41:04 on 28.04.2008
Working directory: C:\afwg08\co cod\surba\sur 2.1

Analysis will use data from fleet.txt

Survey: Norw. Coast. survey tot.

Index dimensions

Number of years 13 (1995-2007)
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	1	1	1	1	1	1	1

Default catchabilities

Age	2	3	4	5	6	7	8	9
q	1	1	1	1	1	1	1	1

Survey index data

	Age							
Year	2	3	4	5	6	7	8	9
1995	20191	13633	15636	16219	9550	3174	1158	781
1996	17378	22815	12382	12514	6817	3180	754	242
1997	18827	28913	17334	12379	10612	3928	1515	26
1998	13659	15003	13239	7415	3136	1577	316	169
1999	11309	12171	10123	7197	3052	850	242	112
2000	11528	11612	8974	7984	5451	1365	488	85
2001	6729	7993	7578	4751	2565	1493	487	190
2002	2990	4103	4940	3617	2593	1470	408	29
2003	2144	3545	3880	2788	2389	1144	589	364
2004	3541	3697	4320	2759	1941	782	448	99
2005	1843	3525	3198	3217	1700	1120	552	330
2006	2525	4049	3783	3472	2509	1811	399	229
2007	3300	4080	5518	3259	2447	1444	760	197

Table 2.13. continued…

Natural mortality

Year	Age 2	3	4	5	6	7	8	9
1995	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1998	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2000	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2001	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2002	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2004	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2005	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2006	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2007	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Proportion mature

Year	Age 2	3	4	5	6	7	8	9
1995	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
1996	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
1997	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
1998	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
1999	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2000	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2001	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2002	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2003	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2004	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2005	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2006	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1
2007	0.01	0.06	0.24	0.49	0.72	0.88	0.95	1

Stock weights

Year	Age 2	3	4	5	6	7	8	9
1995	0.298	0.7	1.338	1.973	2.649	4.164	7.051	6.413
1996	0.27	0.717	1.435	2.044	2.694	4.817	6.28	11.365
1997	0.232	0.677	1.363	1.903	2.816	3.833	5.849	9.6
1998	0.323	0.834	1.366	2.075	3.013	4.255	5.305	8.35
1999	0.318	0.804	1.559	2.042	2.798	4.678	7.151	8.959
2000	0.346	0.777	1.458	2.296	2.735	4.048	7.011	9.224
2001	0.347	0.878	1.543	2.213	2.862	3.321	4.849	7.339
2002	0.43	0.88	1.698	2.452	3.538	4.397	4.191	7.046
2003	0.308	0.686	1.299	2.149	3.135	4.048	5.008	5.789
2004	0.339	0.834	1.614	2.269	3.29	4.124	4.718	4.976
2005	0.407	0.846	1.748	2.2	2.693	3.817	3.797	5.344
2006	0.49	1.125	1.812	2.559	3.579	3.964	4.822	7.332
2007	0.518	1.185	2.011	2.5	3.16	4.241	6.806	11.051

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

Survey index data (mean-standardised)

	Age							
Year	2	3	4	5	6	7	8	9
1995	3.8984	2.63221	3.01894	3.1315	1.84388	0.61282	0.22358	0.15079
1996	3.35527	4.40503	2.39067	2.41615	1.3162	0.61398	0.14558	0.04672
1997	3.63504	5.58241	3.34678	2.39009	2.04892	0.7584	0.29251	0.00502
1998	2.63723	2.89672	2.55613	1.43166	0.60549	0.30448	0.06101	0.03263
1999	2.1835	2.34993	1.95451	1.38957	0.58927	0.16411	0.04672	0.02162
2000	2.22578	2.242	1.73266	1.54152	1.05246	0.26355	0.09422	0.01641
2001	1.29921	1.54326	1.46313	0.9173	0.49524	0.28826	0.09403	0.03668
2002	0.5773	0.79219	0.9538	0.69836	0.50065	0.28382	0.07878	0.0056
2003	0.41395	0.68445	0.74913	0.5383	0.46126	0.22088	0.11372	0.07028
2004	0.68368	0.7138	0.83409	0.5327	0.37476	0.15099	0.0865	0.01911
2005	0.35584	0.68059	0.61746	0.62113	0.32823	0.21625	0.10658	0.06372
2006	0.48752	0.78176	0.73041	0.67036	0.48443	0.34966	0.07704	0.04421
2007	0.63715	0.78775	1.06539	0.62923	0.47246	0.2788	0.14674	0.03804

Scaling factor = 5179.30769

Smoothing indices by cohorts

	Smoothed	index	by	age									
YC	N	a1	a2	IFAIL	RSS	2	3	4	5	6	7	8	9
1986	1	9	9	9	0	NA	NA	NA	NA	NA	NA	NA	0.151
1987	2	8	9	9	0	NA	NA	NA	NA	NA	NA	0.224	0.047
1988	3	7	9	9	0	NA	NA	NA	NA	NA	0.613	0.146	0.005
1989	4	6	9	0	0.298	NA	NA	NA	NA	2.052	0.656	0.186	0.043
1990	5	5	9	0	0.601	NA	NA	NA	3.728	1.354	0.411	0.095	0.021
1991	6	4	9	0	0.624	NA	NA	4.019	2.425	1.099	0.311	0.069	0.015
1992	7	3	9	0	0.407	NA	3.242	2.411	1.454	0.622	0.229	0.089	0.036
1993	8	2	9	0	0.613	4.716	3.991	2.839	1.565	0.69	0.236	0.055	0.009
1994	8	2	9	0	0.577	4.432	3.863	2.71	1.559	0.752	0.301	0.121	0.056
1995	8	2	9	0	0.235	3.881	2.903	2.033	1.238	0.615	0.259	0.088	0.024
1996	8	2	9	0	0.092	2.944	2.252	1.553	0.914	0.47	0.223	0.108	0.057
1997	8	2	9	0	0.157	2.547	1.959	1.321	0.762	0.396	0.192	0.094	0.046
1998	8	2	9	0	0.053	2.292	1.498	0.955	0.591	0.35	0.185	0.086	0.039
1999	7	2	8	0	0.144	1.23	0.909	0.693	0.521	0.38	0.266	0.169	NA
2000	6	2	7	0	0.045	0.628	0.701	0.716	0.618	0.458	0.309	NA	NA
2001	5	2	6	0	0.084	0.483	0.589	0.635	0.606	0.527	NA	NA	NA
2002	4	2	5	0	0.007	0.692	0.692	0.683	0.655	NA	NA	NA	NA
2003	3	2	4	9	0	0.356	0.782	1.065	NA	NA	NA	NA	NA
2004	2	2	3	9	0	0.488	0.788	NA	NA	NA	NA	NA	NA
2005	1	2	2	9	0	0.637	NA	NA	NA	NA	NA	NA	NA

Smoothed index

	Age							
Year	2	3	4	5	6	7	8	9
1995	4.71582	3.2421	4.01859	3.72848	2.0517	0.61282	0.22358	0.15079
1996	4.4323	3.99114	2.41121	2.42515	1.35432	0.6556	0.14558	0.04672
1997	3.88128	3.86329	2.83862	1.45385	1.09879	0.41121	0.18622	0.00502
1998	2.94425	2.90308	2.71036	1.56512	0.62238	0.31056	0.09479	0.04314
1999	2.54728	2.25163	2.03291	1.55926	0.68984	0.22937	0.06865	0.02095
2000	2.2924	1.95924	1.5534	1.23779	0.75171	0.23645	0.08902	0.01528
2001	1.23011	1.49782	1.32109	0.91385	0.61471	0.30103	0.05538	0.03577
2002	0.62844	0.90882	0.95496	0.76184	0.46968	0.25911	0.12098	0.00891
2003	0.48327	0.70149	0.69311	0.59126	0.39552	0.22295	0.08795	0.0564
2004	0.69157	0.58921	0.71637	0.52068	0.34978	0.19163	0.10773	0.02441
2005	0.35584	0.692	0.63533	0.6178	0.3799	0.18479	0.09426	0.05655
2006	0.48752	0.78176	0.68264	0.60605	0.45822	0.26643	0.08623	0.04574
2007	0.63715	0.78775	1.06539	0.65462	0.52704	0.30925	0.16938	0.03876

Catchability estimation

IFAIL from E04JYF = 0
RSS = 3.063

Estimated catchabilities

Age	Catchability
2	0.352
3	0.608
4	0.927
5	0.998
6	0.99
7	0.886
8	0.397
9	0.42

Table 2.14. continued…

Analysis definitions and results

Indices smoothed before analysis
Estimated catchabilities
User-defined age weighting
Unconstrained parameter estimation

Index	smoother	=		2			
SSQ	smoother	=		0			
IFAIL	on	exit	from	E04FYF	=		5
Residual	sum-of-squares	=	3.0633				
Number	of	observations	=		115		
Number	of	parameters	=		38		
IFAIL	on	exit	from	E04YCF	=		0

Catchabilities used in analysis

Age	2	3	4	5	6	7	8	9
q	0.352	0.608	0.927	0.998	0.99	0.886	0.397	0.42

Age weightings used in analysis

Age	2	3	4	5	6	7	8	9
w	1	1	1	1	1	1	1	1

Parameter estimates

		Estimate	s.e.	Initial
Temporal trend	1995	1.1852	0.1623	1
	1996	2.3605	0.1542	1
	1997	1.1916	0.1467	1
	1998	1.2013	0.1417	1
	1999	1.4768	0.1402	1
	2000	0.7745	0.1401	1
	2001	1.6823	0.1433	1
	2002	0.5835	0.1413	1
	2003	0.8949	0.1395	1
	2004	0.2734	0.1388	1
	2005	0.0918	0.139	1
	2006	0.2842	NA	NA
Age effects:	2	0.3831	0.0623	0.5
	3	0.4337	0.0558	0.5
	4	0.2813	0.0552	0.5
	5	0.4024	0.056	0.5
	6	0.5404	0.0588	0.5
	7	0.0699	0.0639	0.5
	8	1.2581	0.0722	0.5
	9	1.2581	NA	NA

Table 2.14. continued..

Cohort effects				
	1986	-1.0247	0.1995	-0.9591
	1987	-0.5399	0.1808	-0.5652
	1988	-0.6879	0.1391	0.4431
	1989	0.5862	0.1363	1.6514
	1990	1.1693	0.1263	2.2488
	1991	1.4613	0.1181	2.3237
	1992	1.8404	0.12	2.109
	1993	2.7111	0.1184	2.2441
	1994	2.834	0.1394	2.1821
	1995	2.2606	0.1048	2.0493
	1996	2.0378	0.1063	1.773
	1997	1.7018	0.1134	1.6282
	1998	1.3615	0.104	1.5227
	1999	1.2126	0.12	0.9003
	2000	0.7151	0.0998	0.2286
	2001	0.5342	0.1085	-0.034
	2002	0.4374	0.1098	0.3244
	2003	0.3978	0.1217	-0.3401
	2004	0.4458	0.1442	-0.0253
	2005	0.5921	0.1995	0.2424

Fishing mortality-at-age

	Age							
Year	2	3	4	5	6	7	8	9
1995	0.45407	0.51404	0.33342	0.47698	0.64046	0.0828	1.49107	1.49107
1996	0.90435	1.02378	0.66405	0.94998	1.27559	0.16491	2.96969	2.96969
1997	0.45654	0.51683	0.33523	0.47957	0.64395	0.08325	1.49917	1.49917
1998	0.46024	0.52102	0.33795	0.48346	0.64916	0.08393	1.51132	1.51132
1999	0.5658	0.64052	0.41546	0.59435	0.79806	0.10318	1.85796	1.85796
2000	0.29673	0.33592	0.21789	0.3117	0.41854	0.05411	0.97441	0.97441
2001	0.64451	0.72962	0.47325	0.67702	0.90908	0.11753	2.11643	2.11643
2002	0.22354	0.25306	0.16414	0.23482	0.31531	0.04076	0.73406	0.73406
2003	0.34286	0.38814	0.25175	0.36016	0.4836	0.06252	1.12587	1.12587
2004	0.10475	0.11858	0.07692	0.11003	0.14775	0.0191	0.34397	0.34397
2005	0.03516	0.0398	0.02582	0.03693	0.04959	0.00641	0.11545	0.11545
2006	0.10887	0.12324	0.07994	0.11436	0.15356	0.01985	0.3575	0.3575
2007	0	0	0	0	0	0	0	0

Log fitted survey index

	Age							
Year	2	3	4	5	6	7	8	9
1995	2.71113	1.84044	1.46126	1.16926	0.58625	-0.68793	-0.53994	-1.02469
1996	2.83405	2.05706	1.12641	0.92785	0.49229	-0.25422	-0.97073	-2.231
1997	2.26062	1.7297	0.83328	0.26235	-0.22213	-0.9833	-0.61913	-4.14042
1998	2.0378	1.60408	1.01287	0.29805	-0.41722	-1.06608	-1.26655	-2.3183
1999	1.70183	1.37756	0.88306	0.47492	-0.3854	-1.26638	-1.35	-2.97787
2000	1.36154	0.93603	0.53704	0.2676	-0.31942	-1.38346	-1.56956	-3.40797
2001	1.2126	0.8648	0.40011	0.11915	-0.2441	-0.93797	-1.63757	-2.74397
2002	0.71506	0.3681	-0.06482	-0.27314	-0.75787	-1.35318	-1.2555	-3.954
2003	0.53417	0.29152	-0.08497	-0.42896	-0.70796	-1.27318	-1.59394	-2.18956
2004	0.43743	-0.00869	-0.29662	-0.53672	-0.98912	-1.39156	-1.5357	-2.91981
2005	0.3978	0.13268	-0.32727	-0.57353	-0.84675	-1.33687	-1.61066	-2.07967
2006	0.44579	0.16264	-0.10712	-0.55309	-0.81046	-1.09634	-1.54328	-1.92611
2007	0.59212	0.13693	-0.16061	-0.38706	-0.86745	-1.16402	-1.3162	-2.10078

Fitted survey index

	Age							
Year	2	3	4	5	6	7	8	9
1995	15.0463	6.2993	4.3114	3.2196	1.7972	0.5026	0.5828	0.3589
1996	17.0142	7.823	3.0845	2.5291	1.6361	0.7755	0.3788	0.1074
1997	9.589	5.6389	2.3009	1.3	0.8008	0.3741	0.5384	0.0159
1998	7.6737	4.9733	2.7535	1.3472	0.6589	0.3444	0.2818	0.0984
1999	5.484	3.9652	2.4183	1.6079	0.6802	0.2818	0.2592	0.0509
2000	3.9022	2.5498	1.7109	1.3068	0.7266	0.2507	0.2081	0.0331
2001	3.3622	2.3745	1.492	1.1265	0.7834	0.3914	0.1945	0.0643
2002	2.0443	1.445	0.9372	0.761	0.4687	0.2584	0.2849	0.0192
2003	1.706	1.3385	0.9185	0.6512	0.4926	0.2799	0.2031	0.112
2004	1.5487	0.9913	0.7433	0.5847	0.3719	0.2487	0.2153	0.0539
2005	1.4885	1.1419	0.7209	0.5635	0.4288	0.2627	0.1998	0.125
2006	1.5617	1.1766	0.8984	0.5752	0.4447	0.3341	0.2137	0.1457
2007	1.8078	1.1467	0.8516	0.679	0.42	0.3122	0.2682	0.1224

Table 2.14. continued..

Fitted catch-at-age

Year	Age 2	3	4	5	6	7	8	9
1995	5.01461	2.31432	1.11407	1.11574	0.77858	0.03625	0.41914	0.25813
1996	9.31514	4.61965	1.37149	1.42768	1.09093	0.10716	0.33999	0.09641
1997	3.20964	2.0804	0.59728	0.45243	0.34828	0.02712	0.38819	0.01148
1998	2.5851	1.84627	0.71968	0.47186	0.28823	0.02516	0.20392	0.07123
1999	2.16784	1.71788	0.75028	0.65942	0.34341	0.02509	0.20415	0.04009
2000	0.91257	0.66308	0.3047	0.31884	0.22678	0.01198	0.11933	0.01898
2001	1.4632	1.12808	0.51385	0.50785	0.43032	0.03942	0.16014	0.05297
2002	0.37254	0.29405	0.12894	0.14491	0.11548	0.00936	0.13593	0.00915
2003	0.45138	0.39275	0.18607	0.17956	0.17259	0.01539	0.12668	0.06983
2004	0.13984	0.10067	0.04994	0.05532	0.04641	0.00427	0.05712	0.01431
2005	0.04663	0.04041	0.01666	0.01853	0.01882	0.00152	0.01978	0.01237
2006	0.14627	0.12391	0.06264	0.05644	0.05751	0.00595	0.05856	0.03993
2007	0	0	0	0	0	0	0	0

Log residuals

Year	Age 2	3	4	5	6	7	8	9
1995	-0.11734	-0.16736	0.00591	0.14915	0.14277	0.31969	-0.03468	0
1996	-0.30226	-0.17613	-0.17004	-0.03953	-0.17864	-0.04655	-0.03294	0.03468
1997	0.13842	0.11868	0.28628	0.11428	0.32669	0.2161	-0.13833	-0.28674
1998	0.08493	-0.04145	0.06045	0.15233	-0.04664	0.01813	-0.16618	0.04212
1999	0.27606	-0.06905	-0.09735	-0.0283	0.02446	-0.08458	-0.40534	-0.02042
2000	0.51093	0.23338	-0.02035	-0.05186	0.04436	0.0629	0.07397	0.09417
2001	0.03737	0.03607	-0.04542	-0.20682	-0.23215	-0.14114	-0.3326	0.28042
2002	-0.1367	0.03315	0.09497	0.00354	0.01252	0.1241	0.06676	0.10018
2003	-0.21849	-0.14921	-0.20536	-0.09411	-0.20924	-0.10618	0.08633	0.18151
2004	0.23665	-0.02343	0.03929	-0.11347	-0.051	-0.13917	0.2309	0.07402
2005	-0.38821	-0.004	-0.05009	0.09436	-0.11076	-0.23023	0.17234	0.07412
2006	-0.12136	0.08802	-0.19843	0.05471	0.04041	-0.10485	0.01592	-0.29145
2007	0	0.12136	0.30019	-0.03422	0.23731	0.11186	0.46395	-0.28251

Index by year-class

YCls	Age 2	3	4	5	6	7	8	9
1986	NA	NA	NA	NA	NA	NA	NA	0.1508
1987	NA	NA	NA	NA	NA	NA	0.2236	0.0467
1988	NA	NA	NA	NA	NA	0.6128	0.1456	0.005
1989	NA	NA	NA	NA	1.8439	0.614	0.2925	0.0326
1990	NA	NA	NA	3.1315	1.3162	0.7584	0.061	0.0216
1991	NA	NA	3.0189	2.4162	2.0489	0.3045	0.0467	0.0164
1992	NA	2.6322	2.3907	2.3901	0.6055	0.1641	0.0942	0.0367
1993	3.8984	4.405	3.3468	1.4317	0.5893	0.2635	0.094	0.0056
1994	3.3553	5.5824	2.5561	1.3896	1.0525	0.2883	0.0788	0.0703
1995	3.635	2.8967	1.9545	1.5415	0.4952	0.2838	0.1137	0.0191
1996	2.6372	2.3499	1.7327	0.9173	0.5006	0.2209	0.0865	0.0637
1997	2.1835	2.242	1.4631	0.6984	0.4613	0.151	0.1066	0.0442
1998	2.2258	1.5433	0.9538	0.5383	0.3748	0.2162	0.077	0.038
1999	1.2992	0.7922	0.7491	0.5327	0.3282	0.3497	0.1467	NA
2000	0.5773	0.6845	0.8341	0.6211	0.4844	0.2788	NA	NA
2001	0.414	0.7138	0.6175	0.6704	0.4725	NA	NA	NA
2002	0.6837	0.6806	0.7304	0.6292	NA	NA	NA	NA
2003	0.3558	0.7818	1.0654	NA	NA	NA	NA	NA
2004	0.4875	0.7878	NA	NA	NA	NA	NA	NA
2005	0.6372	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	0.3589
1987	NA	NA	NA	NA	NA	NA	0.5828	0.1074
1988	NA	NA	NA	NA	NA	0.5026	0.3788	0.0159
1989	NA	NA	NA	NA	1.7972	0.7755	0.5384	0.0984
1990	NA	NA	NA	3.2196	1.6361	0.3741	0.2818	0.0509
1991	NA	NA	4.3114	2.5291	0.8008	0.3444	0.2592	0.0331
1992	NA	6.2993	3.0845	1.3	0.6589	0.2818	0.2081	0.0643
1993	15.0463	7.823	2.3009	1.3472	0.6802	0.2507	0.1945	0.0192
1994	17.0142	5.6389	2.7535	1.6079	0.7266	0.3914	0.2849	0.112
1995	9.589	4.9733	2.4183	1.3068	0.7834	0.2584	0.2031	0.0539
1996	7.6737	3.9652	1.7109	1.1265	0.4687	0.2799	0.2153	0.125
1997	5.484	2.5498	1.492	0.761	0.4926	0.2487	0.1998	0.1457
1998	3.9022	2.3745	0.9372	0.6512	0.3719	0.2627	0.2137	0.1224
1999	3.3622	1.445	0.9185	0.5847	0.4288	0.3341	0.2682	NA
2000	2.0443	1.3385	0.7433	0.5635	0.4447	0.3122	NA	NA
2001	1.706	0.9913	0.7209	0.5752	0.42	NA	NA	NA
2002	1.5487	1.1419	0.8984	0.679	NA	NA	NA	NA
2003	1.4885	1.1766	0.8516	NA	NA	NA	NA	NA
2004	1.5617	1.1467	NA	NA	NA	NA	NA	NA
2005	1.8078	NA	NA	NA	NA	NA	NA	NA

Stock summary

Year	Yield	TSB	SSB	Recruits	Mean F (4-7)
1995	11.051	34.279	16.282	15.046	0.383
1996	18.368	31.542	13.919	17.014	0.764
1997	7.115	18.643	8.246	9.589	0.385
1998	6.211	18.95	7.507	7.674	0.389
1999	5.908	17.517	7.47	5.484	0.478
2000	2.576	13.593	6.217	3.902	0.251
2001	4.296	13.004	6.037	3.362	0.544
2002	1.21	9.732	4.845	2.044	0.189
2003	1.594	8.379	4.756	1.706	0.29
2004	0.468	7.412	4.01	1.549	0.088
2005	0.175	7.655	4.076	1.489	0.03
2006	0.551	10.203	5.557	1.562	0.092
2007	NA	11.534	6.541	1.808	NA

Table 2.14. continued..

Fitted index by year-class

	Age							
YCls	2	3	4	5	6	7	8	9
1986	NA	NA	NA	NA	NA	NA	NA	0.3589
1987	NA	NA	NA	NA	NA	NA	0.5828	0.1074
1988	NA	NA	NA	NA	NA	0.5026	0.3788	0.0159
1989	NA	NA	NA	NA	1.7972	0.7755	0.5384	0.0984
1990	NA	NA	NA	3.2196	1.6361	0.3741	0.2818	0.0509
1991	NA	NA	4.3114	2.5291	0.8008	0.3444	0.2592	0.0331
1992	NA	6.2993	3.0845	1.3	0.6589	0.2818	0.2081	0.0643
1993	15.0463	7.823	2.3009	1.3472	0.6802	0.2507	0.1945	0.0192
1994	17.0142	5.6389	2.7535	1.6079	0.7266	0.3914	0.2849	0.112
1995	9.589	4.9733	2.4183	1.3068	0.7834	0.2584	0.2031	0.0539
1996	7.6737	3.9652	1.7109	1.1265	0.4687	0.2799	0.2153	0.125
1997	5.484	2.5498	1.492	0.761	0.4926	0.2487	0.1998	0.1457
1998	3.9022	2.3745	0.9372	0.6512	0.3719	0.2627	0.2137	0.1224
1999	3.3622	1.445	0.9185	0.5847	0.4288	0.3341	0.2682	NA
2000	2.0443	1.3385	0.7433	0.5635	0.4447	0.3122	NA	NA
2001	1.706	0.9913	0.7209	0.5752	0.42	NA	NA	NA
2002	1.5487	1.1419	0.8984	0.679	NA	NA	NA	NA
2003	1.4885	1.1766	0.8516	NA	NA	NA	NA	NA
2004	1.5617	1.1467	NA	NA	NA	NA	NA	NA
2005	1.8078	NA	NA	NA	NA	NA	NA	NA

Stock summary

Year	Yield	TSB	SSB	Recruits	Mean F (4-7)
1995	11.051	34.279	16.282	15.046	0.383
1996	18.368	31.542	13.919	17.014	0.764
1997	7.115	18.643	8.246	9.589	0.385
1998	6.211	18.95	7.507	7.674	0.389
1999	5.908	17.517	7.47	5.484	0.478
2000	2.576	13.593	6.217	3.902	0.251
2001	4.296	13.004	6.037	3.362	0.544
2002	1.21	9.732	4.845	2.044	0.189
2003	1.594	8.379	4.756	1.706	0.29
2004	0.468	7.412	4.01	1.549	0.088
2005	0.175	7.655	4.076	1.489	0.03
2006	0.551	10.203	5.557	1.562	0.092
2007	NA	11.534	6.541	1.808	NA

Table 2.14. continued…

Retrospective analyses

Mean F

	Last	year					
Year	2007	2006	2005	2004	2003	2002	2001
1995	0.38342	0.38549	0.38551	0.3873	0.38969	0.39215	0.40156
1996	0.76363	0.76659	0.76526	0.76879	0.76921	0.77609	0.79165
1997	0.3855	0.38494	0.38466	0.38528	0.38041	0.3849	0.38944
1998	0.38862	0.3923	0.39315	0.39433	0.40199	0.41033	0.42326
1999	0.47776	0.47928	0.47841	0.48474	0.48556	0.49463	0.50705
2000	0.25056	0.24736	0.24588	0.24534	0.24367	0.24833	0.25635
2001	0.54422	0.54639	0.5443	0.54377	0.54617	0.52865	NA
2002	0.18876	0.18653	0.18318	0.18897	0.19014	NA	NA
2003	0.28951	0.28295	0.28313	0.28626	NA	NA	NA
2004	0.08845	0.09184	0.09854	NA	NA	NA	NA
2005	0.02969	0.08412	NA	NA	NA	NA	NA
2006	0.09193	NA	NA	NA	NA	NA	NA
2007	NA	NA	NA	NA	NA	NA	NA

Spawning stock biomass

	Last	year					
Year	2007	2006	2005	2004	2003	2002	2001
1995	16.2815	16.2823	16.2697	16.2884	16.3572	16.5933	16.7765
1996	13.9194	13.9191	13.903	13.9171	13.949	14.1479	14.2757
1997	8.2461	8.1968	8.1968	8.1833	8.1294	8.1436	8.1008
1998	7.5071	7.506	7.5038	7.5139	7.5666	7.5745	7.5894
1999	7.47	7.4377	7.4195	7.4387	7.4118	7.3678	7.3015
2000	6.2168	6.1813	6.1689	6.1419	6.1078	6.0549	5.9812
2001	6.0369	6.0495	6.0533	6.0347	6.0161	6.0111	5.9716
2002	4.8447	4.8619	4.8798	4.8852	4.8741	5.0647	NA
2003	4.7562	4.7977	4.8385	4.8249	4.8463	NA	NA
2004	4.0097	4.0598	4.0769	4.0749	NA	NA	NA
2005	4.0761	4.0691	4.02	NA	NA	NA	NA
2006	5.5574	5.0771	NA	NA	NA	NA	NA
2007	6.5407	NA	NA	NA	NA	NA	NA

Recruitment

	Last	year					
Year	2007	2006	2005	2004	2003	2002	2001
1995	15.0463	15.2082	15.2747	15.2077	15.3354	14.8204	14.5371
1996	17.0142	17.2725	17.5437	17.5654	17.7862	16.9135	16.4022
1997	9.589	9.5989	9.6563	9.664	9.5608	9.2053	8.9314
1998	7.6737	7.7481	7.8155	7.6809	7.5004	7.471	7.3936
1999	5.484	5.6248	5.7609	5.6868	5.8709	6.1812	6.5371
2000	3.9022	4.0694	4.0861	4.2913	4.4929	4.7754	5.1587
2001	3.3622	3.1811	3.1835	3.214	3.2937	3.4827	3.4902
2002	2.0443	2.0208	1.9674	1.8882	1.7838	1.7831	NA
2003	1.706	1.6279	1.5616	1.5186	1.3712	NA	NA
2004	1.5487	1.6115	1.7545	1.9622	NA	NA	NA
2005	1.4885	1.3241	1.0096	NA	NA	NA	NA
2006	1.5617	1.3833	NA	NA	NA	NA	NA
2007	1.8078	NA	NA	NA	NA	NA	NA

Table 2.14. continued..

Temporal trends

	Last	year					
Year	2007	2006	2005	2004	2003	2002	2001
1995	1.1852	1.10204	1.02474	0.94597	0.91508	0.84852	0.87001
1996	2.36051	2.19151	2.03418	1.87776	1.80627	1.67929	1.71519
1997	1.19164	1.10047	1.02248	0.94104	0.89329	0.83285	0.84377
1998	1.2013	1.12152	1.04505	0.96315	0.94396	0.88787	0.91704
1999	1.47683	1.37015	1.27169	1.18396	1.14021	1.07027	1.09857
2000	0.77452	0.70714	0.65358	0.59924	0.57218	0.53732	0.55542
2001	1.68227	1.562	1.44684	1.32815	1.28252	1.14387	NA
2002	0.58348	0.53325	0.48693	0.46156	0.44649	NA	NA
2003	0.89492	0.8089	0.75259	0.69917	NA	NA	NA
2004	0.27341	0.26254	0.26192	NA	NA	NA	NA
2005	0.09177	0.24047	NA	NA	NA	NA	NA
2006	0.28416	NA	NA	NA	NA	NA	NA
2007	NA	NA	NA	NA	NA	NA	NA

Age effects

	Last	year					
Ages	2007	2006	2005	2004	2003	2002	2001
2	0.38312	0.42076	0.46437	0.50353	0.53046	0.56336	0.55462
3	0.43371	0.47114	0.5042	0.54159	0.56985	0.59579	0.56155
4	0.28132	0.30343	0.32634	0.36207	0.35232	0.35363	0.32867
5	0.40245	0.42961	0.46405	0.49142	0.52319	0.56514	0.57991
6	0.54039	0.57562	0.61691	0.67107	0.68264	0.74854	0.73548
7	0.06986	0.09054	0.0975	0.11313	0.14527	0.1813	0.20214
8	1.25808	1.34681	1.449	1.5685	1.62029	1.74993	1.69537
9	1.25808	1.34681	1.449	1.5685	1.62029	1.74993	1.69537

Cohort effects

	Last	year					
YCls	2007	2006	2005	2004	2003	2002	2001
1985	-1.02469	-1.02469	-1.02469	-1.02469	-1.02469	-1.02469	-1.02469
1986	-0.53994	-0.54336	-0.54305	-0.54359	-0.54412	-0.54304	-0.54797
1987	-0.68793	-0.68266	-0.68391	-0.67992	-0.66884	-0.65092	-0.64649
1988	0.58625	0.59415	0.59234	0.59998	0.6102	0.6416	0.65954
1989	1.16926	1.16436	1.16286	1.15945	1.1674	1.19575	1.22645
1990	1.46126	1.45494	1.45494	1.45267	1.44769	1.45076	1.47438
1991	1.84044	1.84292	1.83977	1.84315	1.8291	1.80564	1.79265
1992	2.71113	2.72183	2.7262	2.7218	2.73016	2.696	2.67671
1993	2.83405	2.84912	2.8647	2.86593	2.87842	2.82811	2.79742
1994	2.26062	2.26165	2.26761	2.26841	2.25767	2.21978	2.18958
1995	2.0378	2.04745	2.05611	2.03874	2.01496	2.01102	2.00061
1996	1.70183	1.72719	1.75109	1.73816	1.77001	1.82151	1.87749
1997	1.36154	1.40349	1.40758	1.4566	1.50249	1.56347	1.64069
1998	1.2126	1.15724	1.15799	1.16753	1.192	1.24782	1.24997
1999	0.71506	0.70351	0.67673	0.63561	0.57876	0.57836	NA
2000	0.53417	0.48731	0.44574	0.41781	0.31568	NA	NA
2001	0.43743	0.47715	0.56219	0.67408	NA	NA	NA
2002	0.3978	0.28071	0.00959	NA	NA	NA	NA
2003	0.44579	0.32444	NA	NA	NA	NA	NA
2004	0.59212	NA	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA	NA

Mohn's rho index = -0.0415

Table 2.15 Diagnostics from trial xsa

Lowestoft VPA Version 3.1

23/04/2008 17:08

Extended Survivors Analysis

Norwegiai COMBSEX PLUSGROUP

CPUE data from file coast-9.txt

Catch data for 24 years. 1984 to 2007. Ages 2 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Norw. Coa	1995	2007	0	8	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 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 = .00505

Final year F values

Age	2	3	4	5	6	7	8	9
Iteration 2	0.0073	0.0657	0.2122	0.4452	0.5041	0.4126	0.2607	0.5106
Iteration 3	0.0073	0.0656	0.2121	0.4448	0.5034	0.4118	0.26	0.5083

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2	0.02	0.011	0.008	0.002	0.012	0.006	0.001	0.001	0.007	0.007
3	0.128	0.061	0.054	0.03	0.057	0.086	0.03	0.048	0.035	0.066
4	0.262	0.15	0.239	0.136	0.191	0.185	0.096	0.175	0.234	0.212
5	0.4	0.394	0.386	0.312	0.32	0.324	0.227	0.278	0.364	0.445
6	0.451	0.534	0.462	0.359	0.531	0.434	0.415	0.302	0.45	0.503
7	0.645	0.675	0.42	0.476	0.521	0.56	0.588	0.487	0.468	0.412
8	0.812	0.771	0.274	0.375	0.66	0.393	0.522	0.426	0.618	0.26
9	0.612	1.047	0.287	0.249	0.406	0.389	0.251	0.299	0.532	0.508

Table 2.15 continued…

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9
1998	3.08E+04	2.59E+04	2.29E+04	1.35E+04	6.92E+03	3.60E+03	3.63E+03	2.35E+03
1999	2.54E+04	2.47E+04	1.87E+04	1.45E+04	7.41E+03	3.61E+03	1.54E+03	1.32E+03
2000	2.29E+04	2.05E+04	1.90E+04	1.31E+04	7.98E+03	3.56E+03	1.50E+03	5.85E+02
2001	2.17E+04	1.86E+04	1.59E+04	1.23E+04	7.32E+03	4.11E+03	1.91E+03	9.37E+02
2002	1.84E+04	1.77E+04	1.48E+04	1.14E+04	7.36E+03	4.18E+03	2.09E+03	1.08E+03
2003	1.38E+04	1.49E+04	1.37E+04	1.00E+04	6.77E+03	3.54E+03	2.03E+03	8.85E+02
2004	1.37E+04	1.13E+04	1.12E+04	9.33E+03	5.92E+03	3.59E+03	1.66E+03	1.12E+03
2005	1.25E+04	1.12E+04	8.94E+03	8.33E+03	6.08E+03	3.20E+03	1.63E+03	8.04E+02
2006	1.10E+04	1.02E+04	8.77E+03	6.15E+03	5.17E+03	3.68E+03	1.61E+03	8.74E+02
2007	1.33E+04	8.96E+03	8.07E+03	5.68E+03	3.50E+03	2.70E+03	1.89E+03	7.10E+02

Estimated population abundance at 1st Jan 2008

0.00E+00	1.08E+04	6.87E+03	5.35E+03	2.98E+03	1.73E+03	1.47E+03	1.20E+03

Taper weighted geometric mean of the VPA populations:

2.00E+04	1.75E+04	1.48E+04	1.12E+04	7.38E+03	4.44E+03	2.33E+03	1.16E+03

Standard error of the weighted Log(VPA populations) :

	0.4489	0.4553	0.4245	0.4295	0.4342	0.454	0.4872	0.5012
1								

Log catchability residuals.

Fleet : Norw. Coast. survey

Age	1995	1996	1997
2	0.74	0.43	0.71
3	0.43	0.71	0.81
4	0.46	0.47	0.6
5	0.24	0.73	0.8
6	-0.1	-0.09	1.22
7	-0.07	-0.4	0.36
8	-0.02	-0.27	0.2

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2	0.44	0.44	0.56	0.07	-0.57	-0.62	-0.12	-0.67	-0.23	-0.15
3	0.36	0.14	0.27	-0.02	-0.62	-0.57	-0.29	-0.32	-0.1	0.07
4	0.25	0.09	0.03	-0.05	-0.36	-0.53	-0.29	-0.3	-0.07	0.38
5	0.19	0.09	0.28	-0.23	-0.42	-0.55	-0.57	-0.26	0.19	0.27
6	0.01	-0.02	0.43	-0.32	-0.18	-0.25	-0.34	-0.59	0.08	0.49
7	0.31	-0.29	-0.01	-0.02	-0.01	-0.07	-0.44	-0.04	0.28	0.32
8	-0.79	-0.23	0.1	-0.06	-0.1	0.08	0.12	0.26	0.11	0.31

Table 2.15 continued..

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	-1.0777	-0.642	-0.4264	-0.3074	-0.2798	-0.4561	-0.8477
S.E(Log q)	0.5014	0.4321	0.3515	0.4326	0.455	0.2636	0.2816

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	0.51	4.218	5.39	0.89	13	0.16	-1.08
3	0.61	2.262	4.14	0.79	13	0.22	-0.64
4	0.77	0.978	2.55	0.66	13	0.27	-0.43
5	0.88	0.351	1.38	0.49	13	0.4	-0.31
6	1.2	-0.441	-1.39	0.36	13	0.57	-0.28
7	1.12	-0.513	-0.47	0.68	13	0.31	-0.46
8	1.25	-1.041	-0.87	0.66	13	0.35	-0.85
1							

Terminal year survivor and F summaries :

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

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. su	9301	0.524	0	0	1	0.784	0.009
F shrinkage m	18725	1				0.216	0.004

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10822	0.46	0.33	2	0.702	0.007

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

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. su	6478	0.342	0.147	0.43	2	0.889	0.069
F shrinkage m	11048	1				0.111	0.041

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6875	0.32	0.16	3	0.493	0.066

Table 2.15 continued…

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

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. su	5337	0.25	0.293	1.17	3	0.927	0.212
F shrinkage m	5538	1				0.073	0.205

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5351	0.24	0.23	4	0.946	0.212

Age 5 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
Norw. Coast. su	2882	0.221	0.122	0.55	4	0.917	0.457
F shrinkage m	4389	1				0.083	0.323

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2985	0.22	0.12	5	0.54	0.445

1

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

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. su	1675	0.205	0.194	0.95	5	0.911	0.517
F shrinkage m	2461	1				0.089	0.379

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1734	0.21	0.17	6	0.837	0.503

Age 7 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
Norw. Coast. su	1485	0.179	0.152	0.85	6	0.938	0.407
F shrinkage m	1206	1				0.062	0.481

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1466	0.18	0.14	7	0.761	0.412

Table 2.15 continued…

Age 8 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
Norw. Coast. su	1246	0.162	0.158	0.97	7	0.953	0.25
F shrinkage m	511	1				0.047	0.526

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1195	0.16	0.16	8	0.993	0.26

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norw. Coast. su	340	0.169	0.09	0.54	7	0.889	0.52
F shrinkage m	460	1				0.111	0.408

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
352	0.19	0.09	8	0.469	0.508

Table 2.16. Summary output of trial xsa.

Run title : N COMBSEX PLUSGROUP

At 23/04/2008 17:12

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUI Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1984	87922	310160	152150	74824	0.4918	0.6221
1985	74464	293939	128243	75451	0.5883	0.5276
1986	35581	290581	134021	68905	0.5141	0.5807
1987	36696	254739	125197	60972	0.487	0.4918
1988	39981	230549	125549	59294	0.4723	0.62
1989	43614	196132	100563	40285	0.4006	0.3759
1990	42132	209779	109610	28127	0.2566	0.184
1991	60347	245305	131764	24822	0.1884	0.1709
1992	49077	287142	163972	41690	0.2543	0.2347
1993	30470	299963	177567	52557	0.296	0.2363
1994	25609	300076	186092	54562	0.2932	0.237
1995	33890	262447	171144	57207	0.3343	0.3064
1996	40185	265219	183227	61776	0.3372	0.3795
1997	33094	205558	134818	63319	0.4697	0.4052
1998	30796	180675	103791	51572	0.4969	0.4393
1999	25372	156806	84608	40732	0.4814	0.4381
2000	22911	142217	74511	36715	0.4927	0.3767
2001	21698	133236	69905	29699	0.4248	0.3207
2002	18414	156680	90923	40994	0.4509	0.3909
2003	13843	108040	61551	34635	0.5627	0.3759
2004	13737	109272	63687	24547	0.3854	0.3314
2005	12487	96660	55102	22432	0.4071	0.3104
2006	11023	104470	60908	26134	0.4291	0.379
2007	13308	99179	57678	23841	0.4133	0.393
Arith. Mean	34027	205784	114441	45629	0.4137	0.3803
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

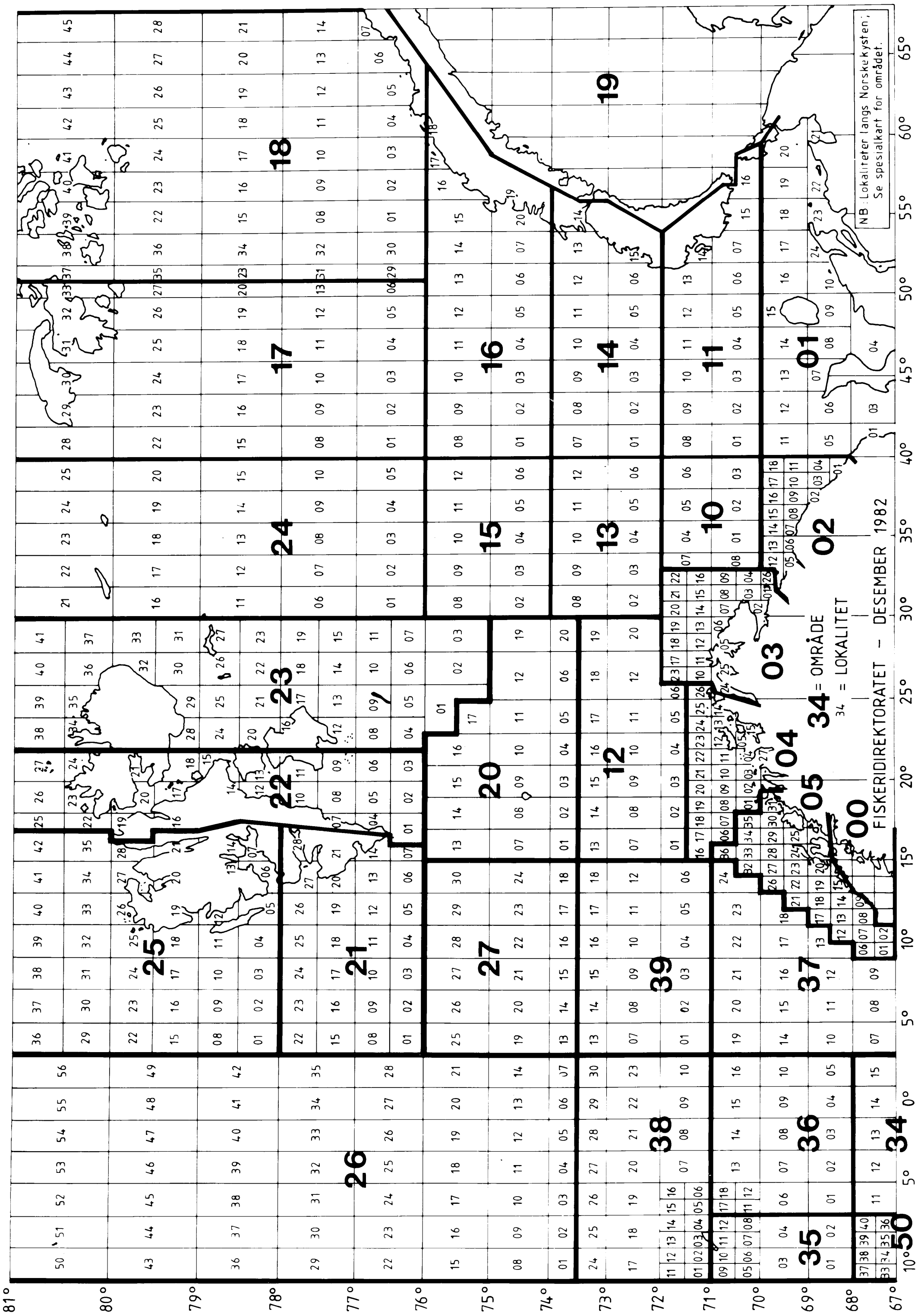


Figure 2.1. Norwegian statistical rectangles in the Barents Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 03 and 04. The same areas are also referred to in the survey results (sec. 2.3).

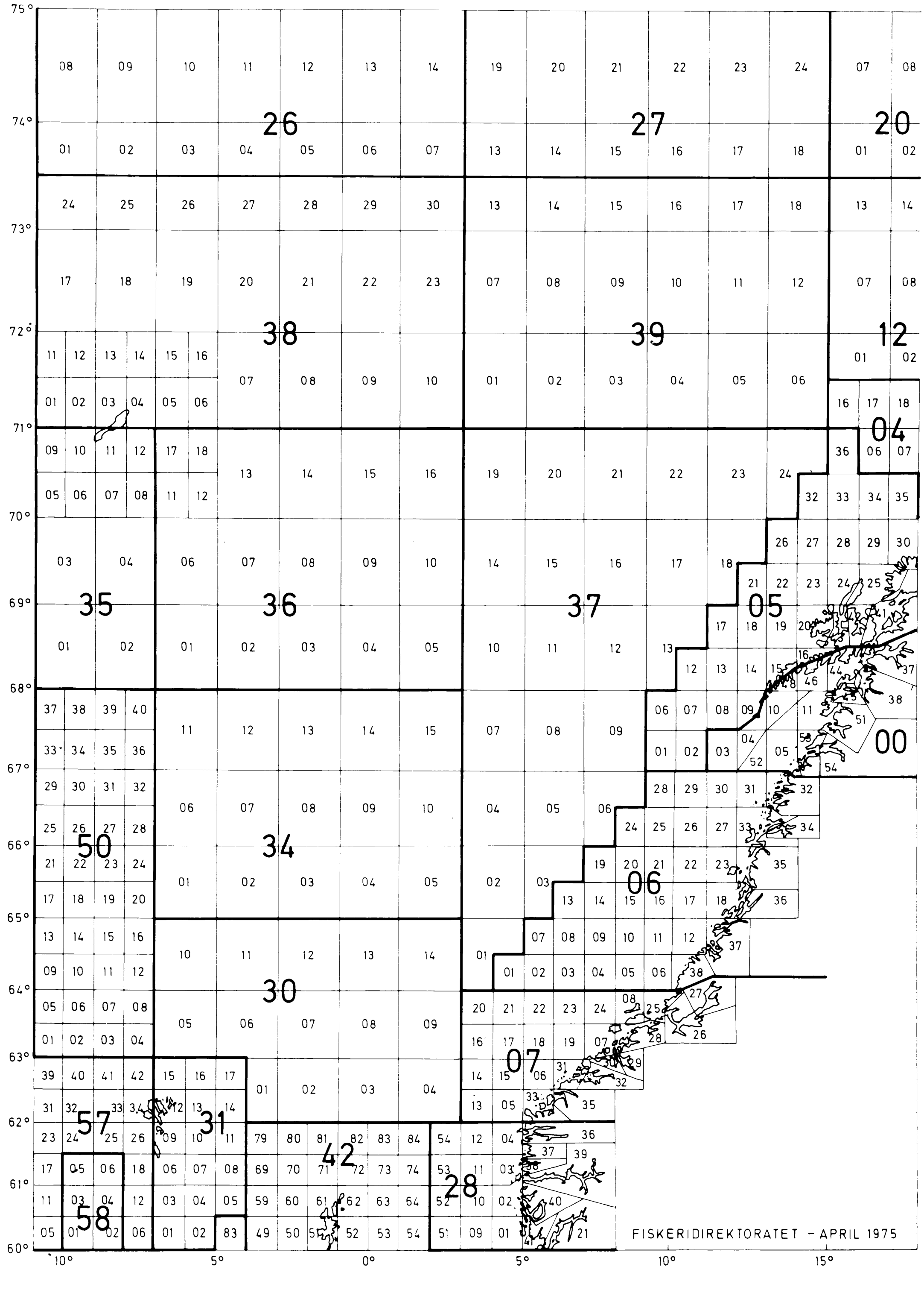


Figure 2.2. Norwegian statistical rectangles in the Norwegian Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 05, 00, 06 and 07. The same areas are also referred to in the survey results (sec. 2.3).

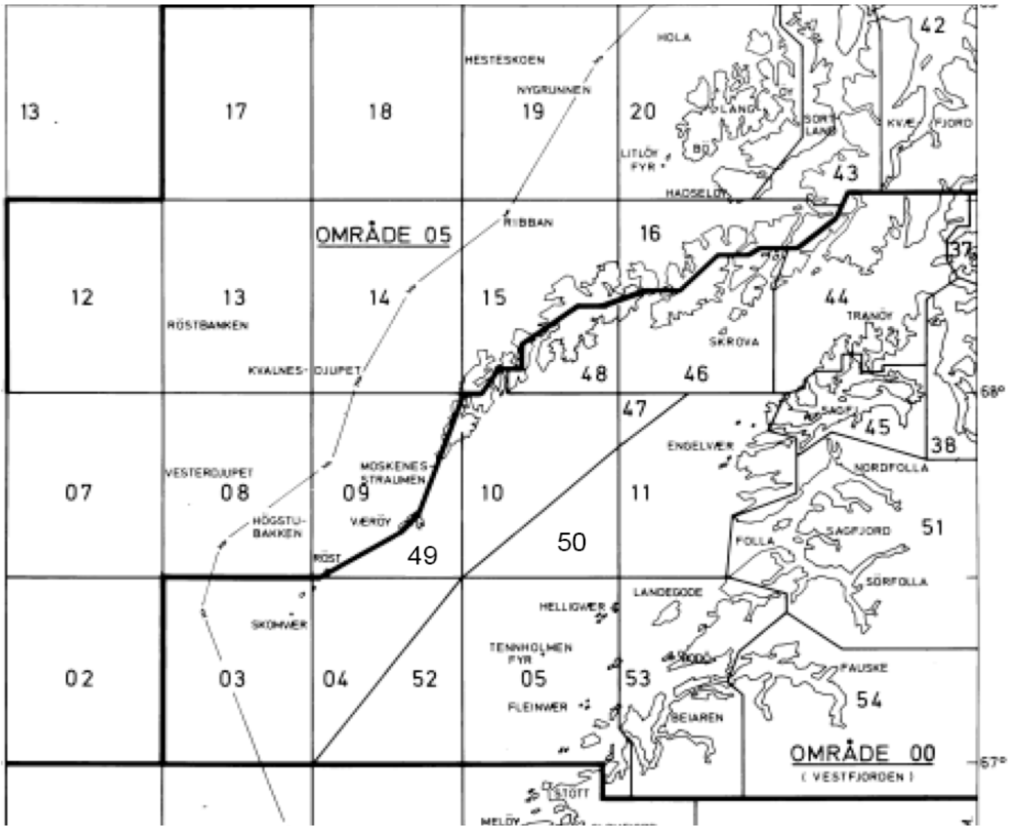


Figure 2.3. Map showing Vestfjorden, the Norwegian statistical area 00 ("OMRÅDE 00") with the south-western location 03 and 04 and the north-eastern locations 46 and 48.

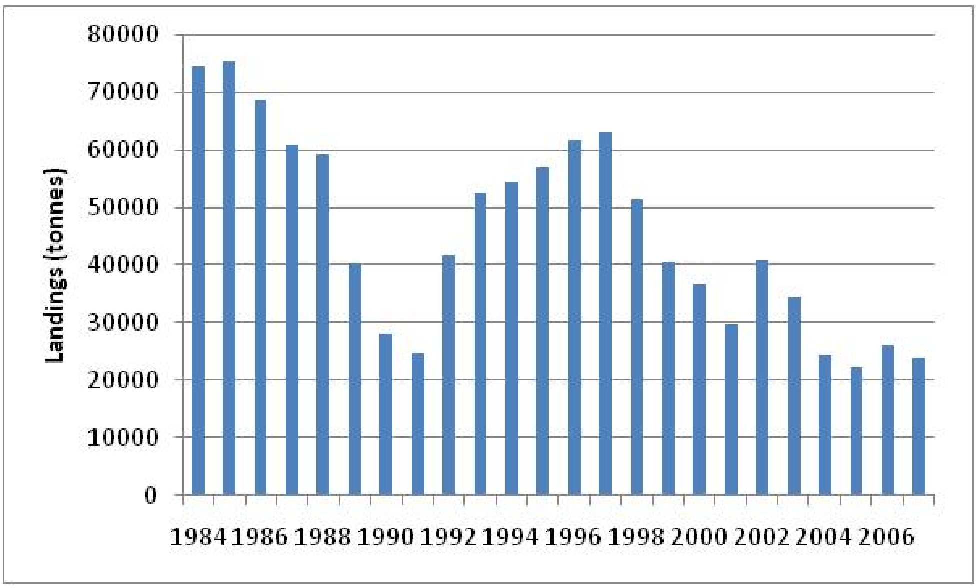


Figure 2.4. Estimated landings of Norwegian coastal cod.

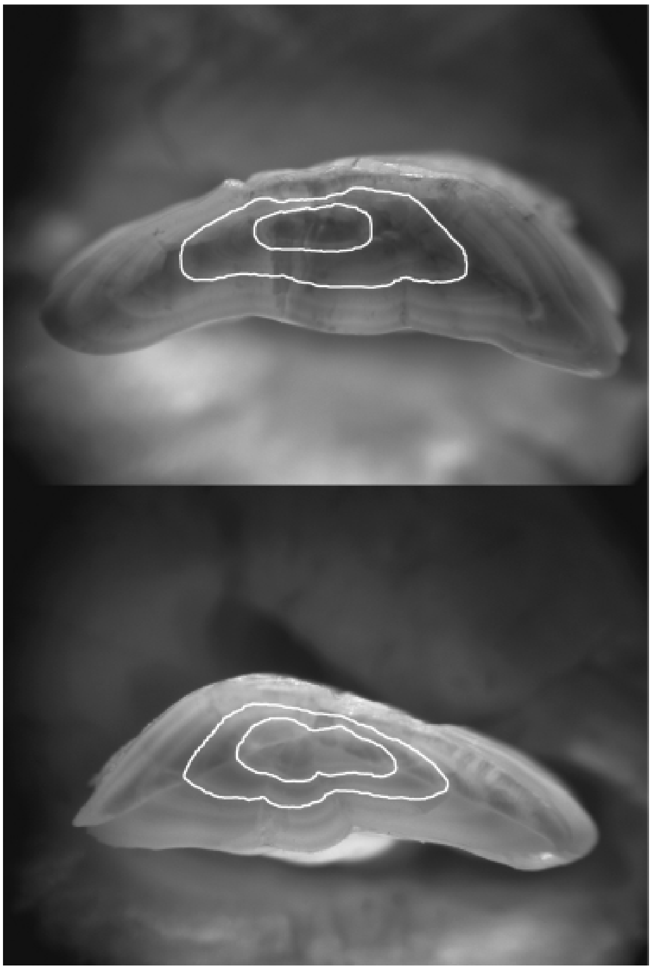
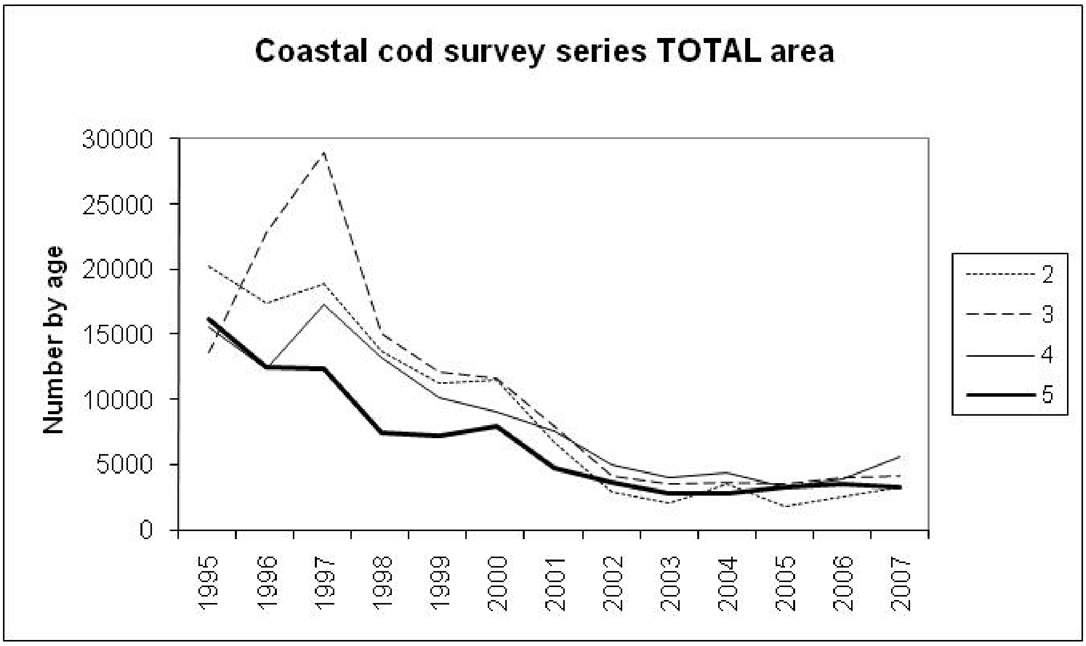


Figure 2.5. An image of a coastal cod otolith (top) and a north-east Arctic cod otolith (bottom). The two first translucent zones are highlighted. (from Berg *et al*. 2005)



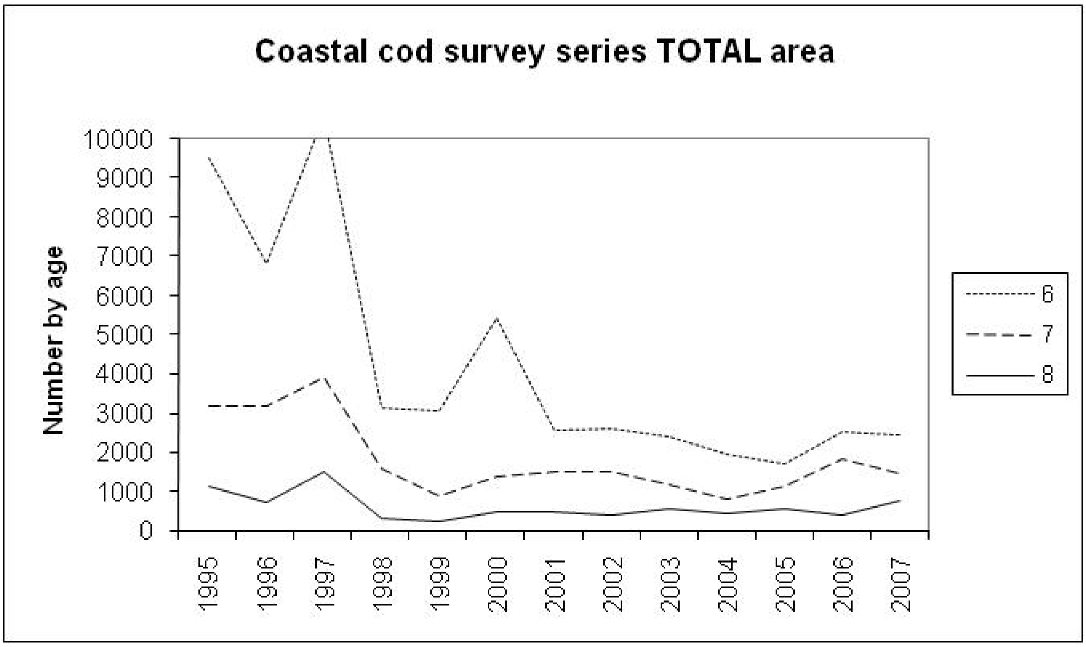
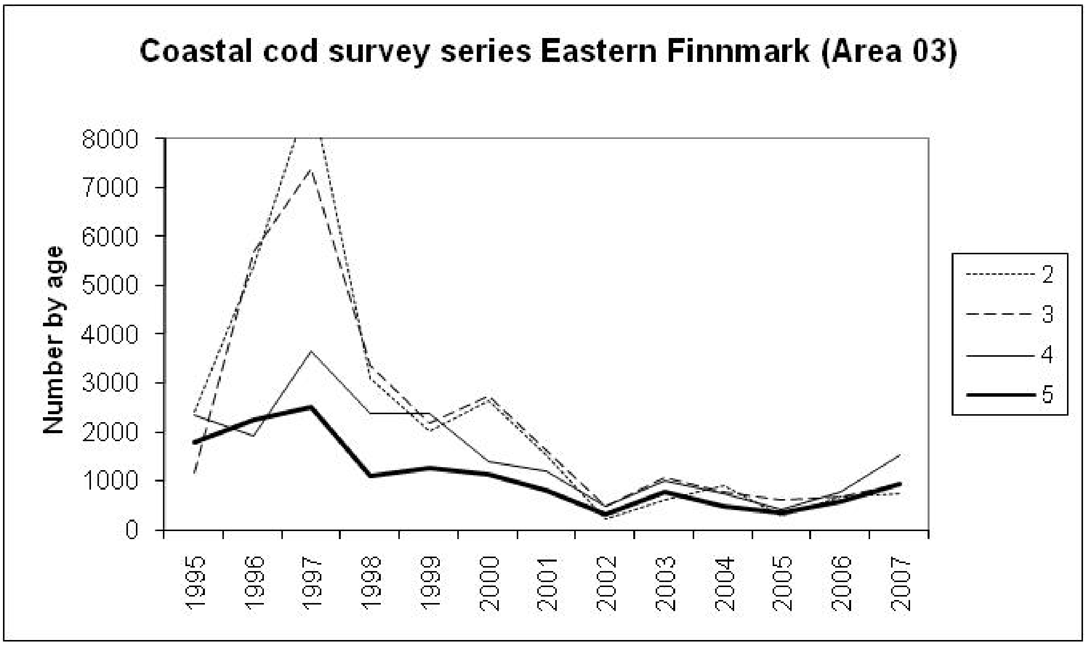


Figure 2.6 Coastal cod. Abundance at age in the total survey.

Upper: ages 2-5, Lower: ages 6-8.



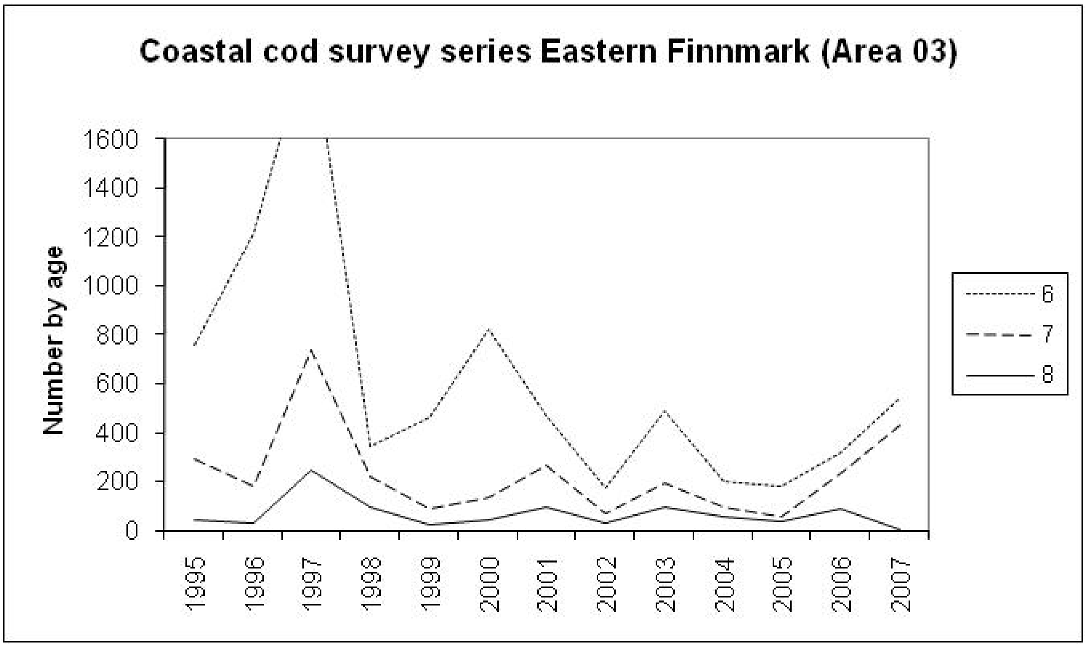
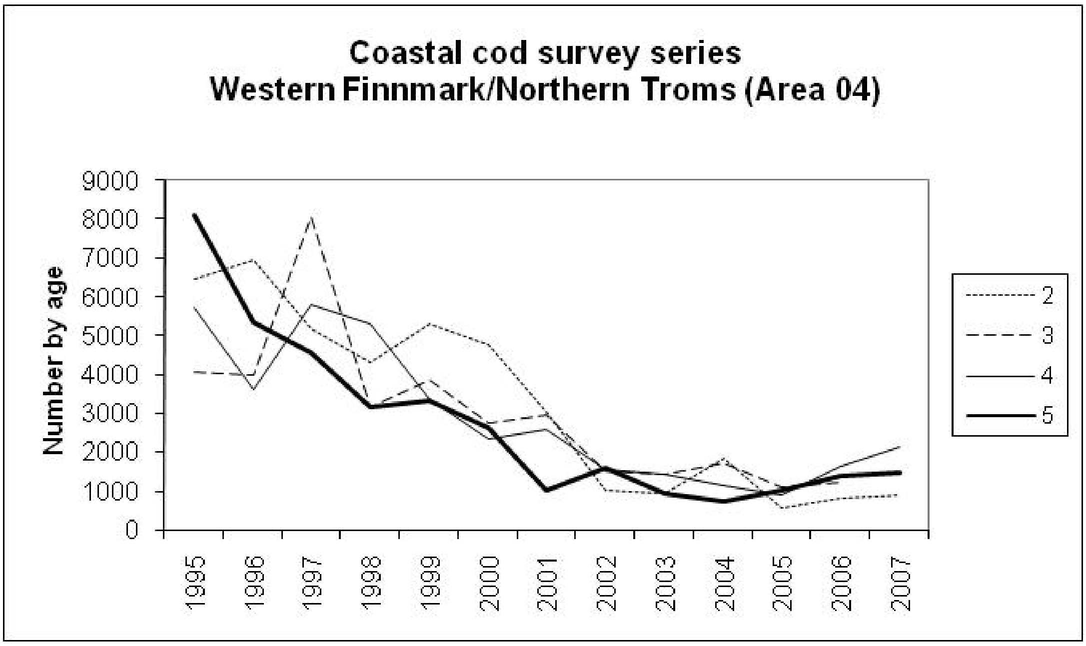


Figure 2.7 Coastal cod. Abundance at age in the survey, statistical area 03.

Upper: ages 2-5, Lower: ages 6-8.



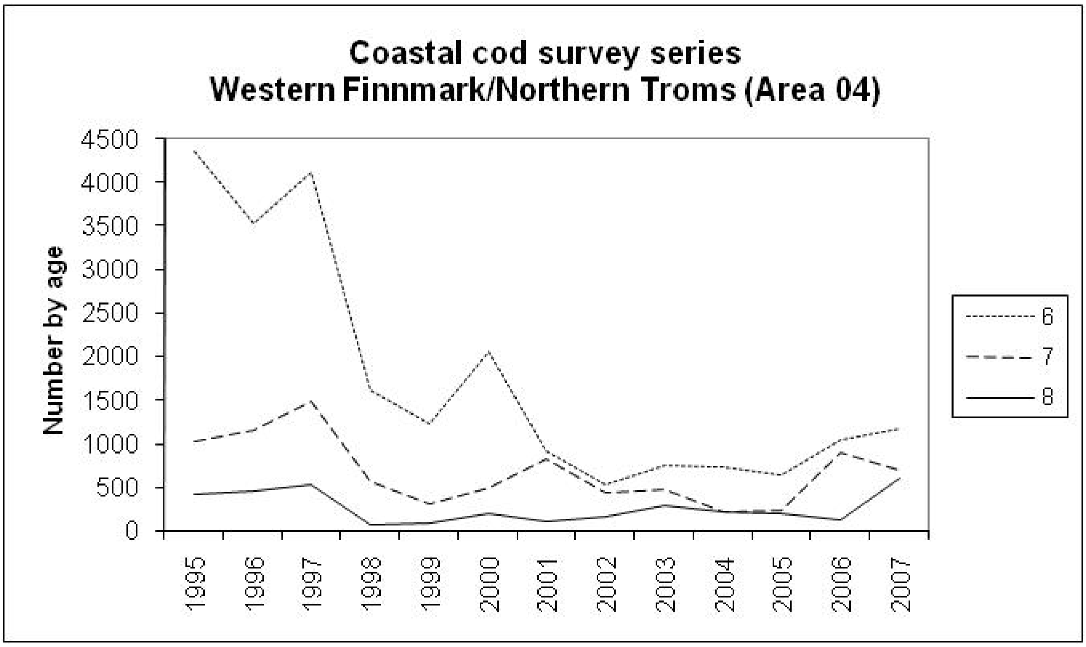
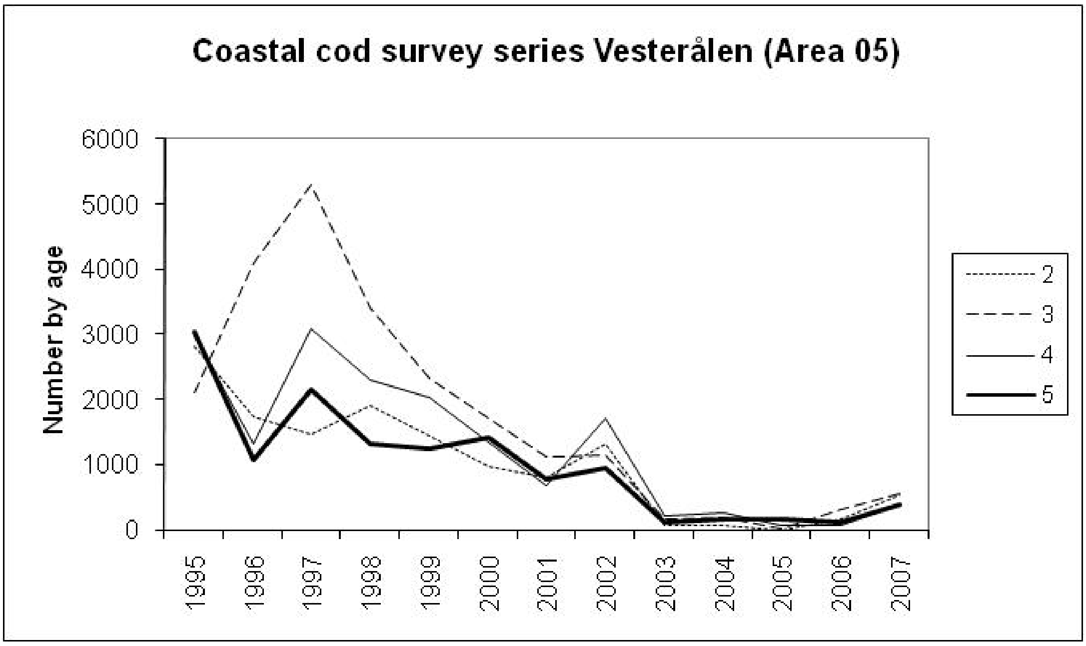


Figure 2.8 Coastal cod. Abundance at age in the survey, statistical area 04.

Upper: ages 2-5, Lower: ages 6-8.



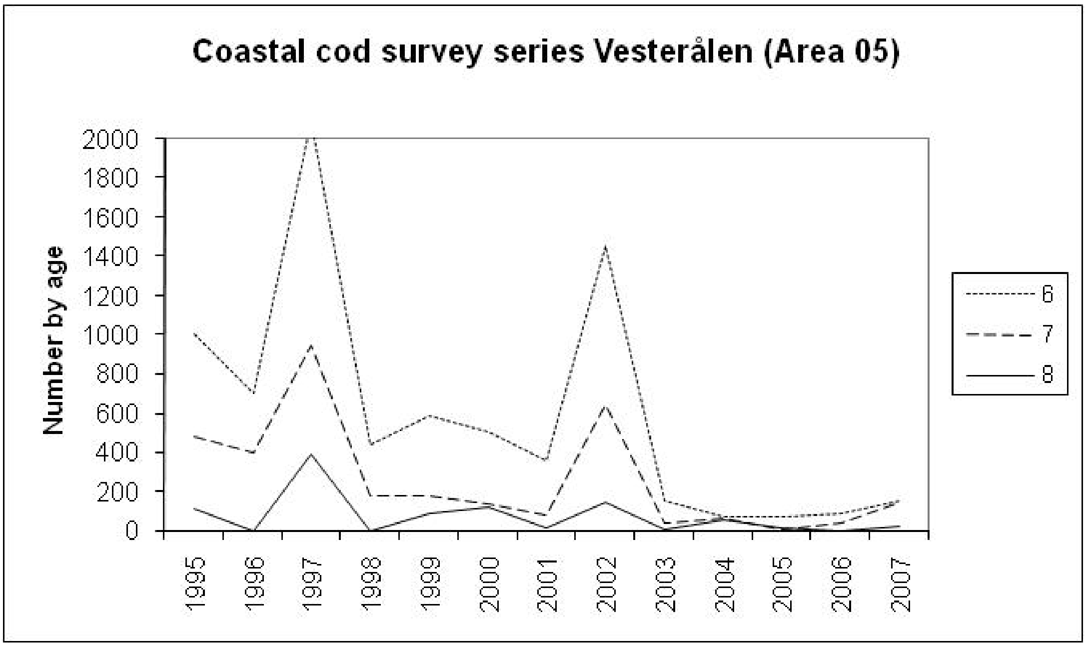
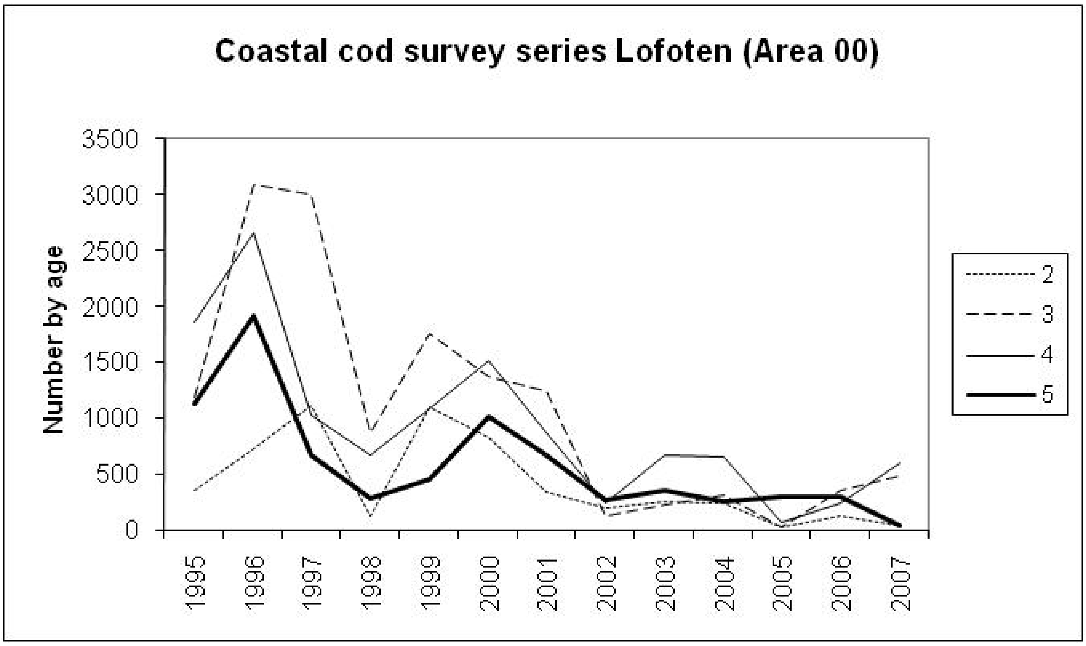


Figure 2.9 Coastal cod. Abundance at age in the survey, statistical area 05.

Upper: ages 2-5, Lower: ages 6-8.



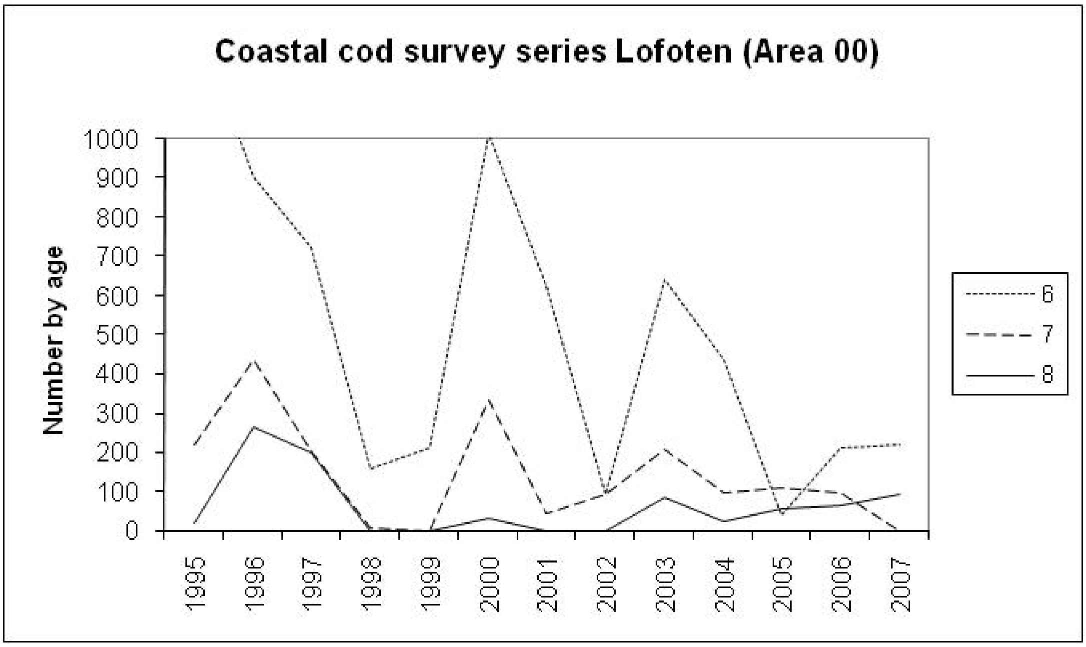
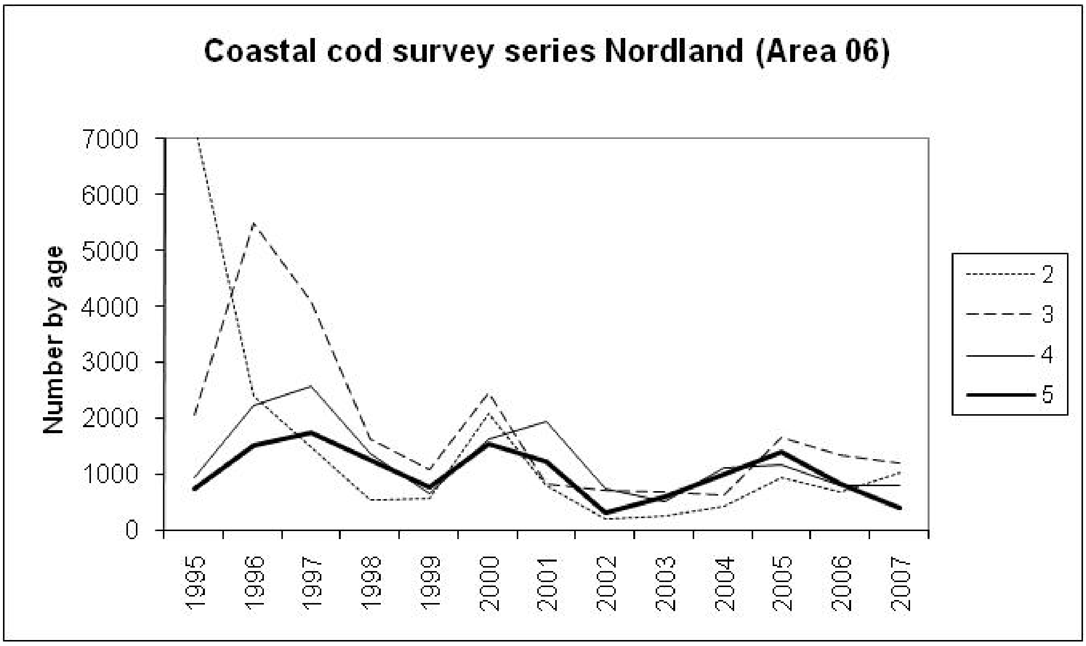


Figure 2.10 Coastal cod. Abundance at age in the survey, statistical rectangle 00.

Upper: ages 2-5, Lower: ages 6-8.



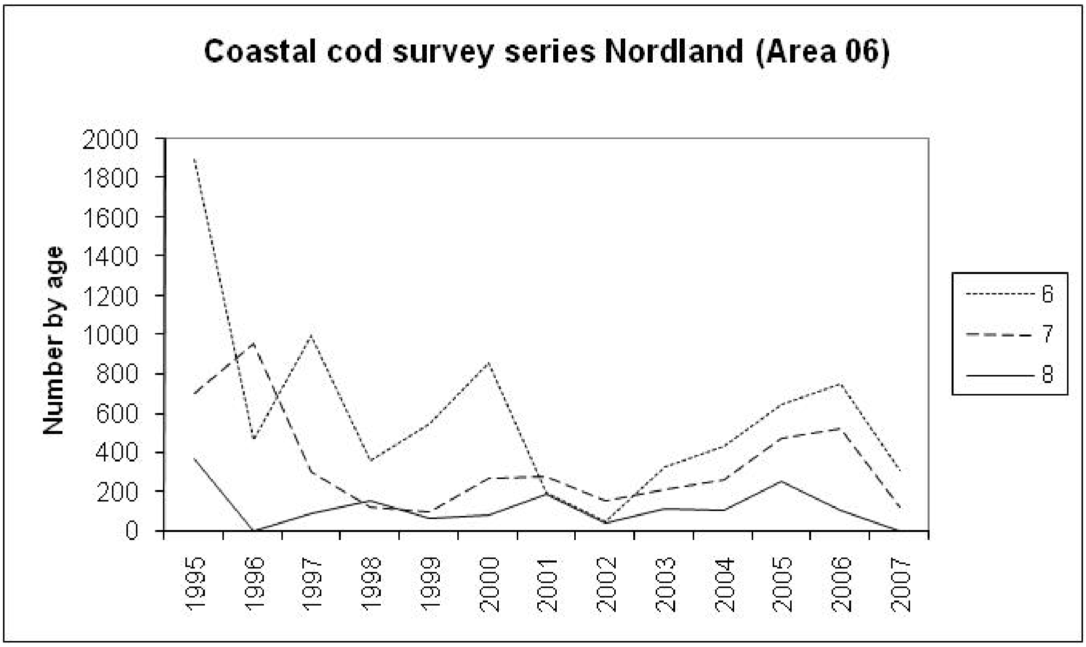
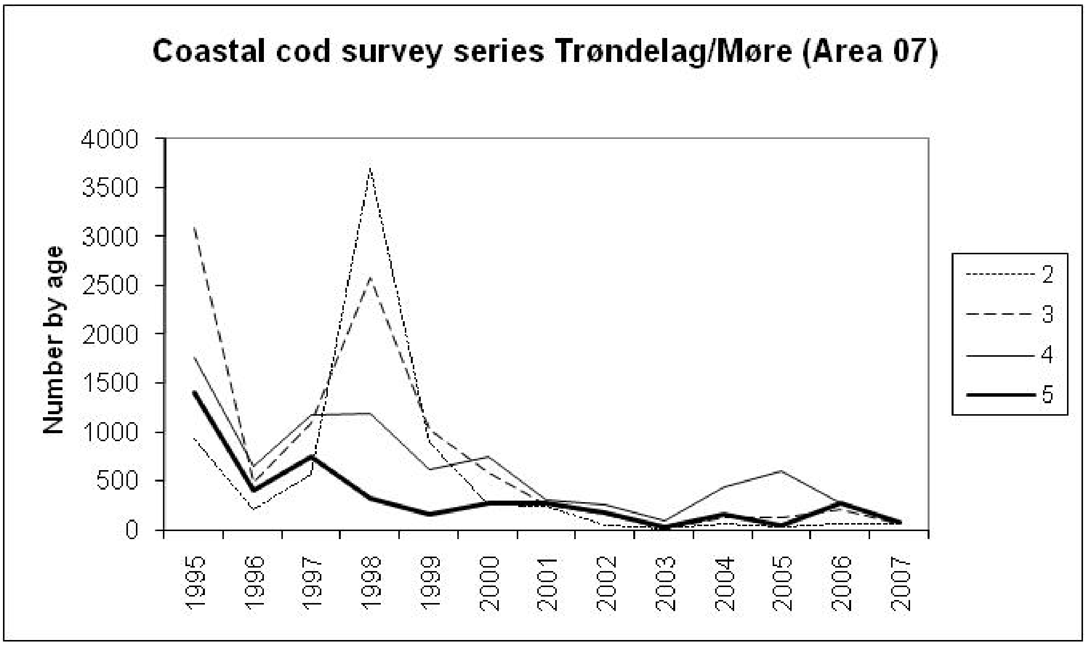


Figure 2.11 Coastal cod. Abundance at age in the survey, statistical area 06.

Upper: ages 2-5, Lower: ages 6-8.



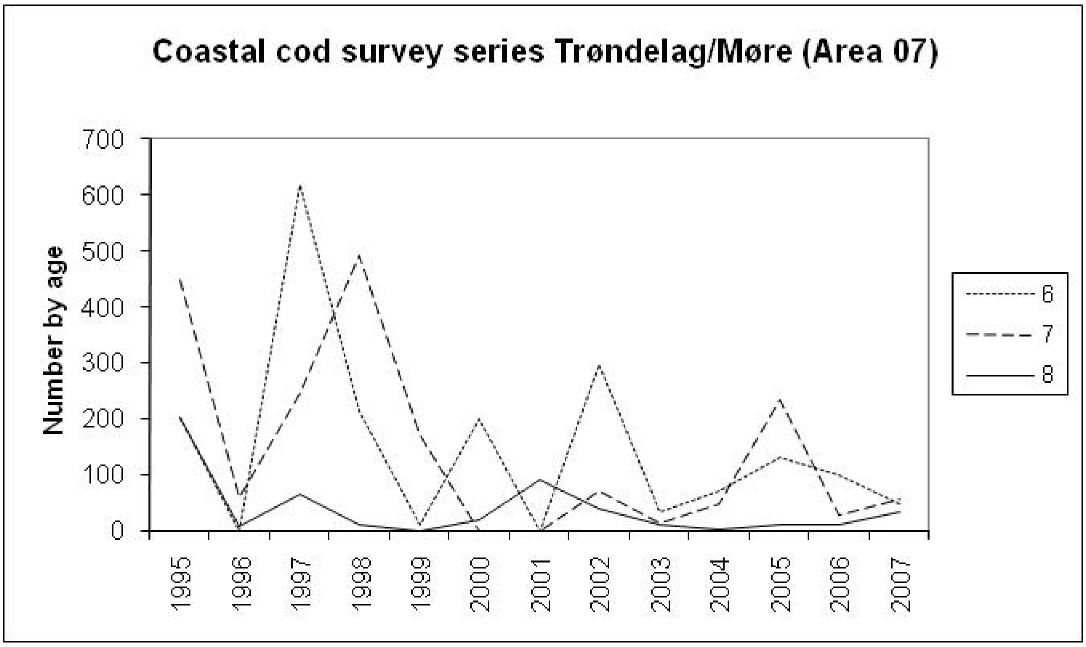


Figure 2.12 Coastal cod. Abundance at age in the survey, statistical area 07.

Upper: ages 2-5, Lower: ages 6-8.

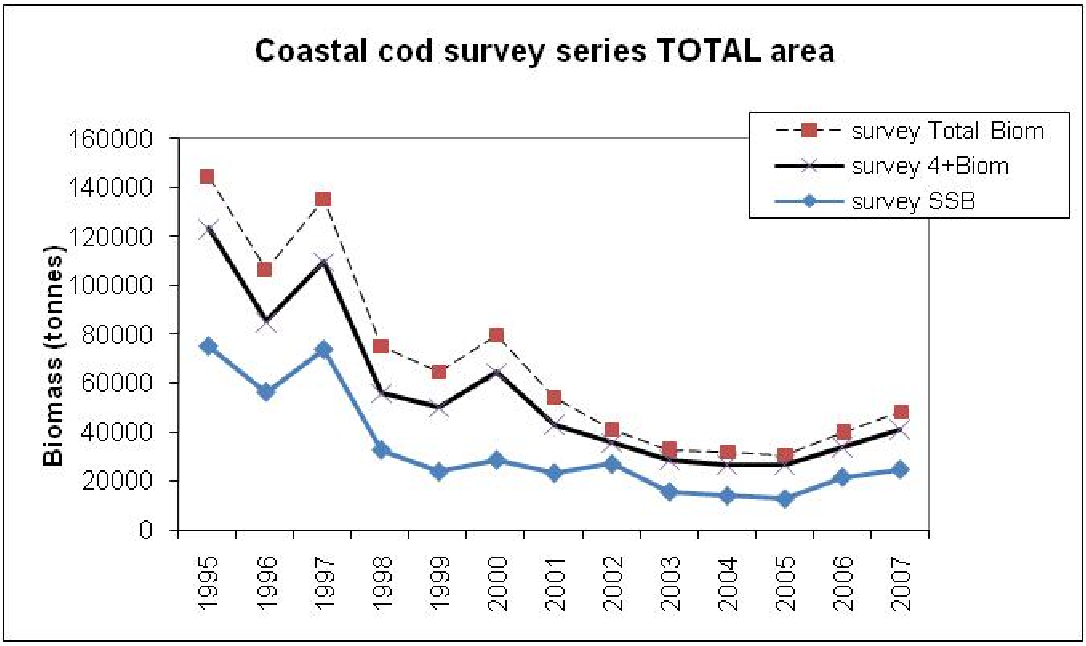


Figure 2.13 Coastal cod. Biomass in the total survey: Total biomass, 4+ biomass, and spawning biomass.

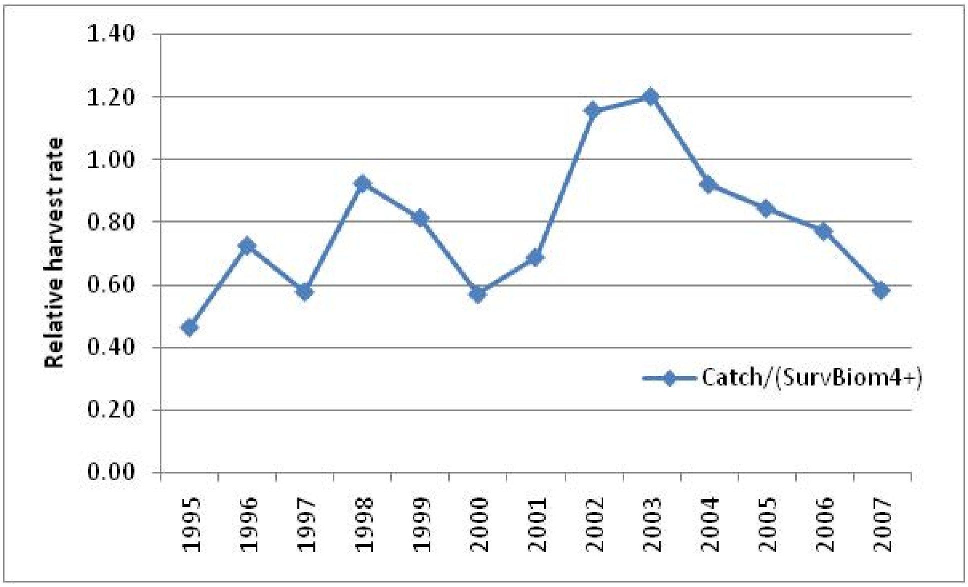


Figure 2.14. Relative harvest rate; Catch relative to the 4+ biomass estimated from the survey.

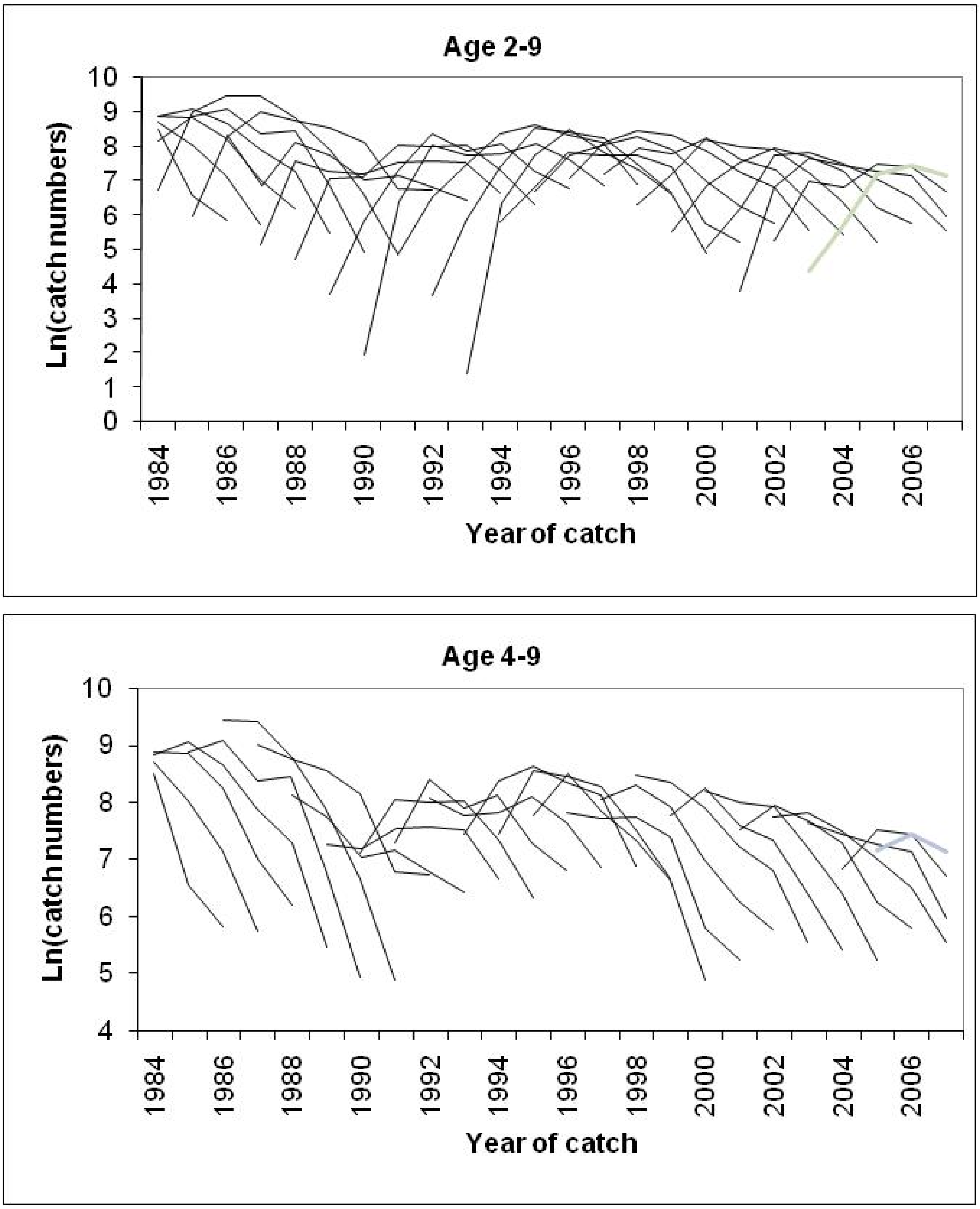


Figure 2.15. Log catch number at age by cohort and catch year. The plot starts with the 1977 year-classes in 1984 and ends with the 2001 yea-rclass in 2007.

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

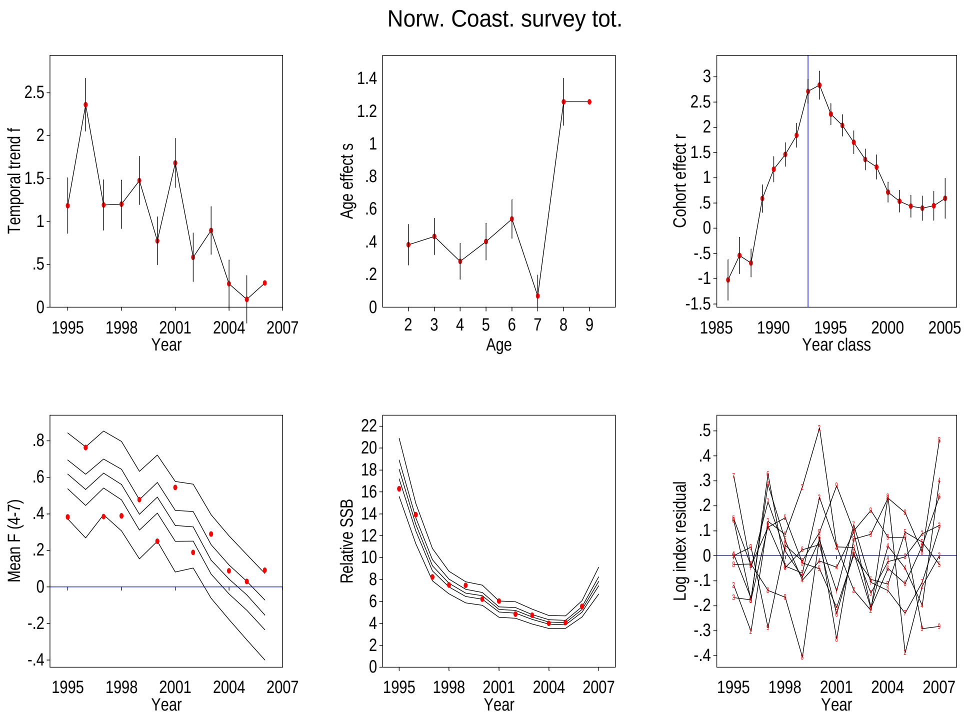


Figure 2.16. Summaries of results from SURBA analysis.

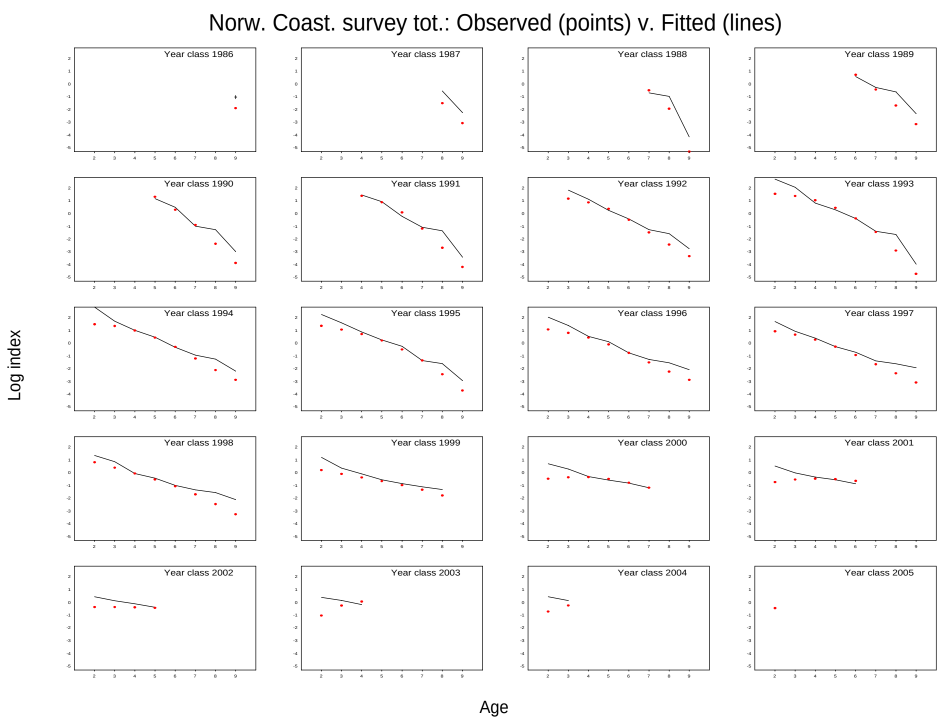


Figure 2.17. SURBA. Modelled values by compared to observations.

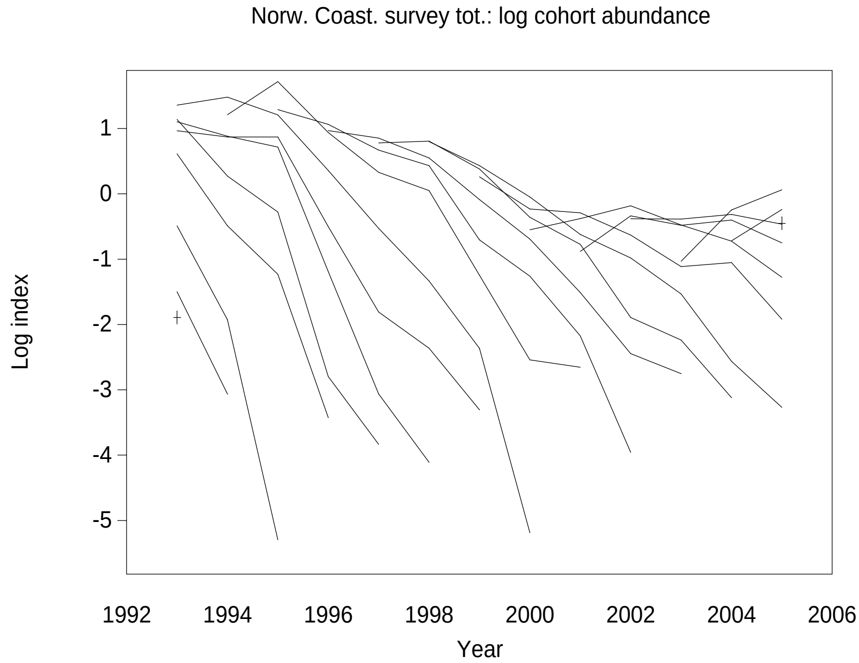


Figure 2.18. SURBA. Survey indicies by cohort.

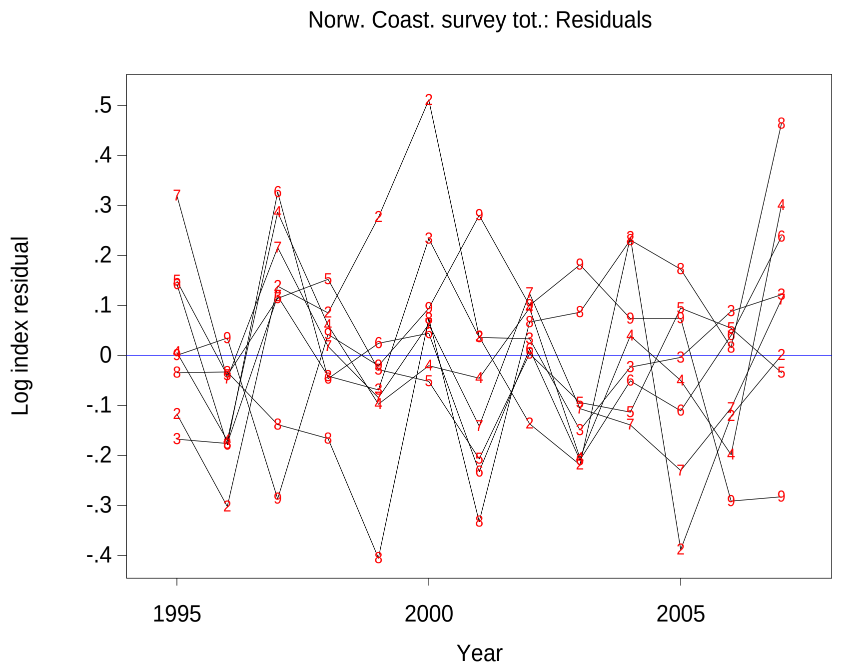


Figure 2.19. SURBA. Residuals by years labelled by age.

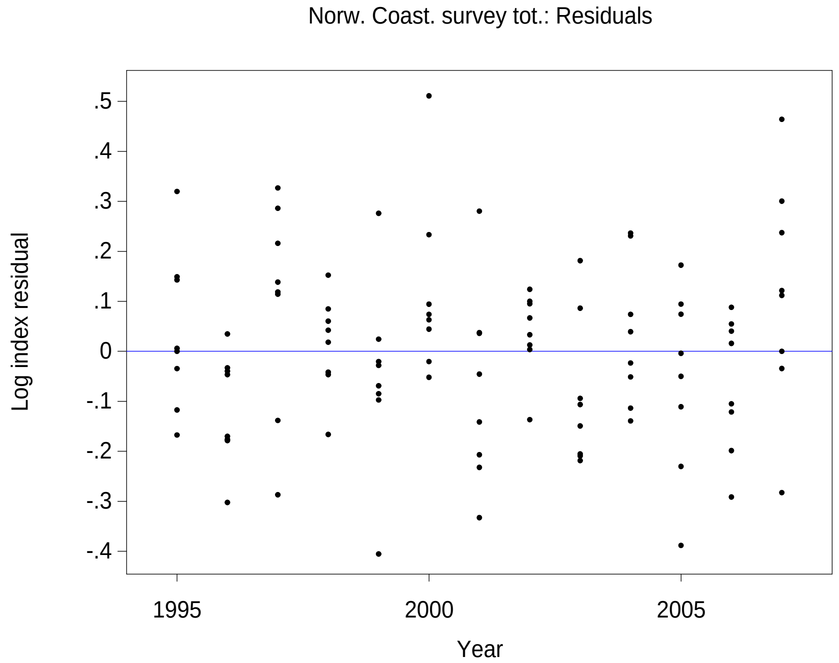


Figure 2.20. SURBA. Residuals by age and years (not labelled)

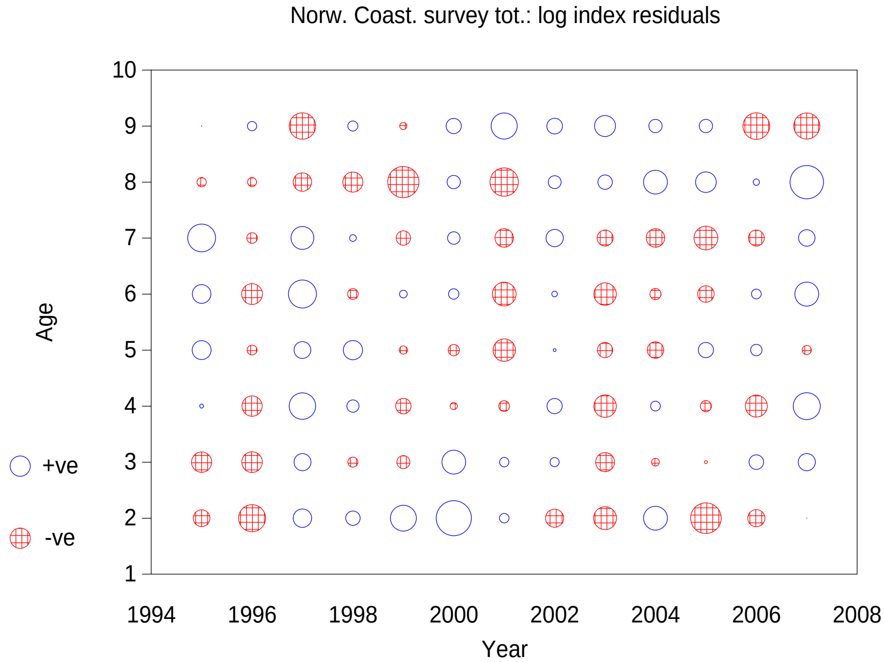


Figure 2.21. SURBA. Bubble plot of residuals.

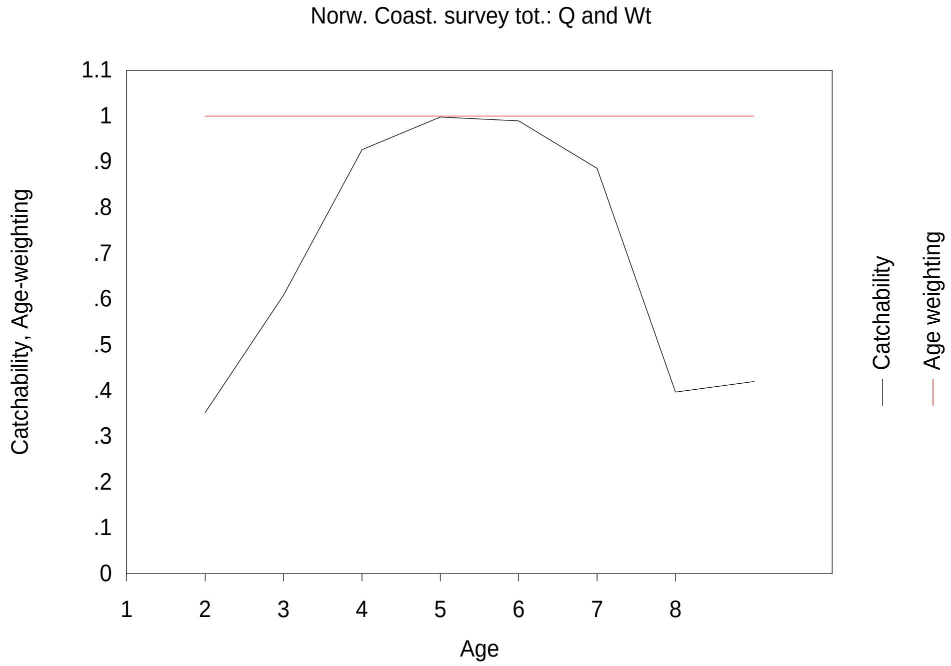


Figure 2.22. SURBA. Fitted survey catchability by age.

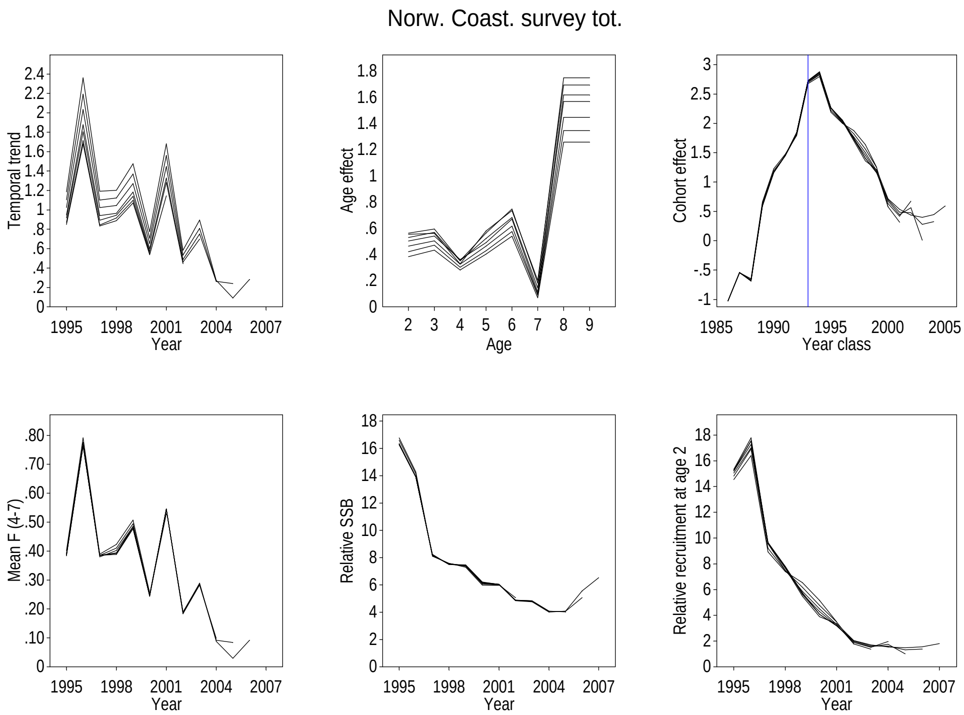


Figure 2.23. SURBA. Summary of retrospective runs.

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 2008 (Tables 3.1–3.3, Figure 3.1)

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

Final official landings for 2006 amount to 486,508 t. The provisional official landings for 2007 are 458,160 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 official landings of North-East Arctic cod of 470,528 t in 2006 and 445,796 t in 2007 (Table 3.1a). The coastal cod catches calculated this way in 2006 and 2007 were 15,980 t and 12,364 t, respectively. The catches of coastal cod calculated this way for the period 1960-2007 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, split into trawl and other gears, are given in Table 3.2 and the nominal landings by country are given in Table 3.3. Compared to 2006, the landings in 2007 decreased slightly in all areas (Table 3.1a).

3.1.3 Unreported catches of Northeast Arctic cod in 2002–2007

In recent years certain quantities of unreported catches (IUU catches) have been added to the reported landings from 2002-2007. 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. It was decided to make runs both with the Norwegian IUU estimates (Nor-IUU-run) and Russian IUU estimates (RUS-IUU-run). AFWG was not able to agree on which of the estimates to use in 2007, and found no justification for combining the two estimates in any way. The AFWG, therefore, decided to do as was done last year: to undertake a double sets of stock assessments and prognostic runs. This year’s advice is based on the Norwegian IUU estimates (Nor-IUU-run), because that run was the basis for last year’s advice. Full output is given for the Nor-IUU-run, while only summary tables are included for the RUS-IUU-run. If tables are given for both runs, they are labelled N and R, respectively.

3.1.4 Catch advice for 2007 and 2008

The Joint Norwegian-Russian Fisheries Commission (JNRFC) agreed on a TAC of 445,000 t for 2007, including 21,000 t Norwegian coastal cod. The total reported catch of 458,160 t in 2007 was 13,160 t above the agreed TAC. Of the TAC, 16,000 t (8,000 t for Norway and 8,000 t for Russia) was set aside for research and management purposes.

The advice given and quota set for 2008 – summary:

The advice given by ACFM in 2007 was based on the 'Nor-IUU' assessment made by AFWG in 2007. In the prediction, F_{sq} (=$F_{2004-2006}$) was assumed for 2007, this corresponded to a catch in 2007 of 530,000 tonnes, which was 106,000 tonnes above the agreed TAC for 2007. The agreed harvest control rule then gave a TAC for 2008 of 409,000 tonnes.

However, the JNRFC noted that there were indications that the IUU fishery was reduced in 2007 compared to 2006, partly due to the 'port state control regime' introduced by NEAFC from 1 May 2007. Thus the JNRFC stated (unofficial translation of protocol):

"Due to the reduction in IUU catches, the parties asked the scientists to calculate values of TAC for 2008 corresponding to various catch levels for 2007, overfishing included. These calculations are given in Appendix 14 of the JNRFC protocol (Tables with TAC levels for 2008 corresponding to various catch constraints in 2007). The parties agreed to determine the TAC for cod for 2008 according to the agreed HCR. After an evaluation of the situation in the fisheries in 2007, the parties agreed that the TAC for 2008 according to the HCR could be set to 430,000 tonnes".

A TAC for 2008 of 430,000 tonnes corresponds to a catch in 2007 of 460,000 tonnes, which is 36,000 tonnes above the TAC (assuming the coastal cod TAC to be taken exactly). This figure is between the estimated catch in 2007 including the Norwegian IUU estimate (486,883 t) and the estimated catch in 2007 including the Russian IUU estimate (454,553 t) (details in Section 0.3, Table 3.1a).

Of 2008 the TAC, 22,000 t (11,000 t for Norway and 11,000 t for Russia) was set aside for research and management purposes.

The Working Group has no information on the size of expected unreported landings in 2008.

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 A2-A4, A9-A10, A13-A14, Figure 3.2-3.4)

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 2008 are given in Tables A2 and

A3. More details on this survey are given in Aglen (WD 16). The Russian zone was covered satisfactorily this year except for some areas in the south-east.

Before 2000 this survey was made without participation from Russian vessels, while in 2001-2005 and 2008 Russian vessels have covered important parts of the Russian zone. In 2006-2007 the survey was again 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 last year's report. The amount of maturing fish found in this survey was higher than in previous years.

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).

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 Sub-area I survey indices were calculated based on actual swept 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 2007 survey was conducted in the standard period and under the standard methods. An area of 215 991 sq. miles was covered, which is somewhat larger than the standard area. The 2007 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). Substantial increase of cod numbers was observed in the last survey, especially for the age groups, beginning with cod at age 3. Rather wide and uncommon distribution of cod was registered, especially in shallow waters southwards of Spitsbergen and Edge Islands including adult (older) fish; a delay of the return migrations of maturing fish from the feeding grounds was observed.

Joint Ecosystem survey

Swept area bottom trawl estimates from the joint Norwegian-Russian ecosystem survey in August-September (data from 2004 onwards) are given in Table A14.

General comments

Both the Russian autumn and Norwegian winter surveys showed a sharp decrease in the mortality of the main age groups compared to previous years (Fig 3.2a-c). The reason for this is unknown. The internal consistency within surveys is also illustrated in the plots from the "surba" program (Needle, 2003 and Needle, 2004) in Figure 3.3. Fig 3.4 shows the correspondence between year class abundances at age 2-9 years in the Russian bottom trawl survey.

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 Norwegian winter survey in 2008 and the Russian autumn survey in 2007 show a slight increase in size-at-age compared to the previous year (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).

3.3 Data used in the assessment

3.3.1 Catch at age (Tables 3.8 and 3.10)

The Norwegian catch at age data for 2006 were revised due to the inclusion of samples from the coast guard. For 2007, age compositions from all areas were available from Russia, Spain and Norway. Germany provided age compositions from Divisions IIa and IIb. Unreported catches in 2007 were distributed using total international trawl catch age distribution in Division IIb on half the unreported catch and total international trawl catch age distribution in Sub-area I on the other half. Table 3.8 show available catch at age data for all ages 1-15+. The 2007 catch at age data were calculated using Intercatch, see section 0.4.

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

Catch weights

For 2007, the mean weight at age in the catch (Table 3.11) was calculated as a weighted average of the weight at age in the catch for Norway, Russia, Germany and Spain. The weight at age in the catch for these countries is given in Table 3.4.

Stock weights

Since ages 12 and 13+ are scarce in the survey samples, fixed values for ages 12 to 15+ has formerly been used (set equal to typical weights for these ages observed in catches). Since the 2000 working group the assessment has applied 13 as plus group. For the years 1946-1984 the 13+ weights are calculated year by year as a weighted mean of the former fixed values for older ages. For later years they are calculated from the average observed weight for age 11 in the years 1995-2007 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 1983-2008 (Table 3.12) were calculated as follows:

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

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 3.13)

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 1985-2008, Norwegian maturity at age ogives have been obtained by combining the Barents Sea and Lofoten surveys. 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. In the years 1985-1988 another maturity scale was in use and some further work is required to recalculate for those years.

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 1984-2007. The consumption calculations this year have been updated by data for 2007 as well as revised data for 2004-2006. 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	1985-2007
Fleet 15	Fleet2	Joint bottom trawl survey	Barents Sea	Feb-Mar	3-8	1981-2008
Fleet 16	Fleet3	Joint acoustic survey	Barents Sea+Lofoten	Feb-Mar	3-9	1985-2008
Fleet 18	Fleet4	Russian bottom trawl surv.	Total area	Oct-Dec	3-9	1994-2007

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 2008 could be included in the assessment. The tuning fleet file is shown in Table 3.14. 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 3.9)

The catch numbers shown in Table 3.10 together with cannibalism numbers (Tables 3.9) 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 lead to new estimates of consumption. This procedure was repeated until the consumed numbers for the latest year (2007) differed less than 1% from the previous iteration. This procedure has also been implemented in the FLR version of the XSA, see WD 5. The final numbers of cod eaten by cod are given in Table 3.9.

3.4.3 XSA Tuning diagnostics (Table 3.15–3.16, Figure 3.5–3.8)

The tuning diagnostics from XSA with cannibalism are given in Table 3.16. Figure 3.5 shows the residuals of various 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.

Figure 3.6 and Table 3.15 compares the estimated survivors (by end of 2007) and Fs before shrinkage in single fleet tunings. For most ages there is a fair agreement between the single fleets, and the combined fleet (ALL, after shrinkage) are located in-between the individual fleet estimates for ages 4 and older.

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 3.15). 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.

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

The diagnostics (Table 3.16) show, at least for some of the fleets, that the t-values for the log-log regression slopes are significantly different from 1 for some of the younger ages. Figure 3.7 shows xsa values vs. survey values for ages 3-6 for the entire survey series. Points indicating a line through the origin fulfils the assumption of stock size independent q. Cases indicating a large intercept or an asymptotic pattern would be better described by a stock size dependent q. Even in this short series there are several cases where the dependent version would be preferable. The problem is of course the parameter estimation with a short tuning series. Probably it is better to estimate relevant parameters at low precision than less relevant parameters with higher precision. For the above mentioned reasons the former setting with stock size dependant q for ages 3-5 was kept.

Retrospective plots of F, SSB and recruitment, going back to 1999 as the last year in the assessment, are shown in Figure 3.8. 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 3.17-3.27)

The total fishing mortalities (true fishing mortality plus mortality from cannibalism) and population numbers in Tables 3.17 and 3.18.

In order to build a matrix of natural mortality which includes predation, the fishing mortality estimated in the final XSA analyses was split into the mortality caused by the fishing fleet (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 3.19) was used together with the new real Fs (Table 3.21) to run the final VPA on ages 3-13+. M2 and F values for ages 1-6 in 1984-2007 are given in Tables 3.20 and 3.22.

The stock numbers from the final run are given in Tables 3.23, while the corresponding stock biomass at age and the spawning stock biomass at age are given in Tables 3.24-3.25. In these tables, the figures for the RUS-IUU-run are given for the last 10 years (1998-2007). Summaries of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment since 1946 runs are given in Table 3.26 (N and R) and Figure 3.1 (NOR-IUU-run only).

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

3.4.5 TISVPA (Fig 3.9-3.18)

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). The model is an extension of the ISVPA model (Kizner and Vasilyev, 1997; Vasilyev, 2005).

The TISVPA model was applied to NEA cod data including both Norwegian and Russian estimates of unreported catches. Natural mortality values from cannibalism 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 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.

For the simplest measures of closeness of fit of the model to the data - sum of squares of residuals in logarithmic catch-at-age or abundance-at-age (Figure 3.9) - apparent minima of respective components of the model loss function were revealed only for "fleets" 2, 3, and 4.

Change from standard sum of squared residuals to more robust absolute median deviations (AMD - the median of distribution of absolute deviations of residuals from their median value) somewhat improved the situation: for fleet 1 and catch-at-age the minima had appeared, while local (Figure 3.10). But now we can say that all sources of information gave more-or less coherent signals about the stock.

An additional experiment was done to reveal what was the main source of signal in age-structured "fleet" data: overall trend in abundance or age structure? Figure 3.11 shows that if to measure residuals between model-derived stock estimates and stock-at-age indices not in logarithmic abundance -at-age, but in logarithmic age proportions (relative values, independent on information about total stock size in "fleet" data), the signal survives only for "fleet" 4. This may indicate that this "fleet" contains more reliable information about the stock age structure in comparison to the others, which supply information mostly about the overall trend in the stock abundance.

Another experimental run was done with "fleet" data restricted by last 10 years. As it can be seen from Figure 3.12 (to be compared to Figure 3.10), the signal from fleet 1 became much less pronounced (signals from other fleets remained almost unchanged). This may indicate that some valuable information from fleet 1 is lost by this shortening.

Figure 3.13 represents the estimates of generation-dependent factors (represented as 1-G(a,y)) and selection matrix. As it can be seen, some generations reveal apparent deviations from overall mean selection pattern. Residuals in logarithmic catch-at-age and in abundance-at-age (for fleets) are shown on Fig.3.14. Results of retrospective runs (Figure 3.15) show a reasonable historical stability of the estimates and the absence of systematic shifting tendency. 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 3.16.

It is necessary to underline that extremely high estimates of abundance at age 3 in 2007 in the results are due to high catch of this age group. This generation is first time to appear in catch-at-age matrix and the abundance estimate is directly comes from the catch value and average selection. That is why this estimate always is the least reliable one. Figure 3.17 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 estimate of abundance at age 3 in 2007 by the mean abundance estimate for 1985, 1986, 1992 and 1998. Accordingly, the estimates of biomass B(3+) were also corrected.

Application of the TISVPA model to the data containing Russian estimates of unreported catches gave the results very similar to results for data containing Norwegian estimates of unreported catches (Fig. 3.18).

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 2007 from the TISVPA (NOR-IUU) runs totaled 2,135 thousand tonnes, while the spawning stock biomass was 712 thou. t and F_{5-10} in 2007 was 0.35. The corresponding results from the TISVPA (RUS-IUU) runs were 2250 thou. t, 768 thou. t, and 0.30.

3.4.6 Comparison of TISVPA and XSA results (Figure 3.19)

A comparison of the results from the TISVPA and XSA are given in Figure 3.19N (NOR-IUU-run) and 3.19R (RUS-IUU-run). The trends are similar. TISVPA gives a somewhat higher current stock size than XSA, particularly for the 2002-2003 year classes (the value for the 2004 year class 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 RUS-IUU run gives a slightly higher stock size in the last year than the NOR-IUU-run, while for the XSA, the opposite is the case.

3.5 Results of the assessment

3.5.1 Fishing mortalities and VPA (Tables 3.21–3.26, Figure 3.1)

The estimated F_{5-10} in 2007 from the XSA (NOR-IUU-run) is 0.40 (=F_{pa}), while the spawning stock biomass in 2007 is estimated to be 612,000 t. The RUS-IUU run gives F=0.42 in 2007 and a spawning stock biomass in 2007 of 566,000 t. The fishing mortality in 2007 is the lowest since the beginning of the 1990s.

3.5.2 Recruitment (Table 1.13, 3.6– 3.7)

Previously, the RCT3 program has been used for estimating the abundance of ages 1,2 and 3, which cannot be estimated by the XSA. Survey data for ages 0,1 and 2 (Russian autumn survey) and ages 1, 2 and 3 (Joint winter survey) have been used for regressions with the VPA estimates of recruitment at age 3. Input data and results of the RCT3 analysis made this year are given in Tables 3.6-3.7. Recruitment was calculated using the VPA estimates from the XSA NOR-IUU-run.

This year, several models for cod recruitment 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. Prognosis for all the models, including the hybrid is presented in Table 1.13. The number at age 3 calculated by the hybrid method were: 714 million for the 2005 year-class, 509 million for the 2006 year-class and 152 million for the 2007 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. 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 3.28–3.30)

3.7.1 Prediction input (Tables 3.28, Figure 3.20a–b)

The input data to the short-term prediction with management option table (2008-2010) are given in Table 3.28(N,R). The initial stock size, F status quo, exploitation pattern and cannibalism mortality differs between the NOR-IUU and RUS-IUU run, while the other input is equal.

For 2008 stock weights and maturity were taken from surveys as described in Sections 3.3.2 and 3.3.4.

Catch weights in 2008 onwards and stock weights in 2009 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 (1997-2006) for averaging the increments. Figures 3.20a and 3.20b show how these predictions perform back in history.

The maturity ogive for the years 2009 and 2010 was predicted by using the 2006-2008 average. The exploitation pattern in 2008 and later years was set equal to the 2005-2007 average.

The stock number at age in 2008 was taken from the final VPA (Table 3.23) for ages 4 and older. The recruitment at age 3 in year 2008-2010 was estimated as described in 3.5.2. Fig. 3.21 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 1984-2007. The recent 3 years average M was used as input for the years 2008-2010 in the prediction.

For years 2011 and later, the 2010 values were used for all input data, except for recruitment, where the long-term mean (600 million at age 3).

This year, there is a clear decrease in F from 2006 to 2007, and thus $F_{status\ quo}$ (F_{sq}) in the intermediate year (2008) was set equal to the F in the last year (F_{2007}). The catches corresponding to F_{sq} in 2008 (463 000 tonnes in NOR-IUU-run and 413 000 tonnes in RUS-IUU-run) are both close to the TAC for 2008 (430 000 tonnes).

3.7.2 Prediction results

Table 3.28 (N,R) shows input data to the predictions. Table 3.29 (N,R) shows the short-term consequences over a range of F-values in 2008 for the before-mentioned runs. The detailed outputs corresponding to F_{sq} in 2008, the F corresponding to the HCR in 2009 and F_{pa} in 2010-2011 is given in Table 3.30(N,R).

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 text table below shows the TAC for 2009 derived from the HCR, as well as the F_{sq} catch in 2008 and the SSB in 2009, for the two assumptions about IUU fishing.

IUU figures	C2008 (1000 tonnes)	SSB 2009 (1000 tonnes)	TAC 2009 derived from HCR (1000 tonnes)	F2009 derived from HCR	Comments regarding advice in 2009 (can be derived from Table 3.30N,R)
Norwegian	463	843	473	0.34	TAC in 2009 would be 610 000 tonnes without 10% constraint on annual change of TAC. F=0.40 in 2009 corresponds to a catch of 551 000 tonnes
Russian	413	725	473	0.40	TAC in 2009 would be 537 000 tonnes without 10% constraint on annual change of TAC. F=0.40 in 2009 corresponds to a catch of 475 000 tonnes

3.8 Comparison with last year's assessment

The text table below compares this year's estimates (Nor-IUU-run) with last year's estimate for the year 2007 for number at age (millions), total biomass, spawning biomass (thousand tonnes), as well as reference F for the year 2006.

		N(2007)										
Assessment yr (specification)	F(2006)	age3	age4	age5	age6	age7	age8	age9	age10	TSB	SSB	F(2007)
2007 WG	0.66	565*	320	254	113	78	26.5	14.6	6.0	1504	574	0.69**
2008 WG	0.63	777	397	284	104	103	28.9	12.3	4.9	1701	613	0.40
Ratio 2008 WG/ 2007 WG	0.96	1.38	1.24	1.12	0.92	1.33	1.09	0.84	0.81	1.13	1.07	

*estimated by rct3 **assuming F_{sq}

The final assessment values for ages 5,6 and 8 are fairly close to the 2007 assessment, while ages 3,4 and 7 seem to have been underestimated in last year's assessment. Ages 9 and 10 were overestimated last year. The F in 2006 is 0.03 below last year's estimate, and the SSB in 2007 is revised up by 7%. The new estimate of SSB in 2008 (647,000 tonnes) is 22% above the prediction from last year (531,000 tonnes).

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). The regression is done for ages 4-6 and 7+ separately. The results, using a regression method with intercept, are shown in Fig 3.22-3.23 and in the text table in Section 3.12. The figures show that the survey calibration method gives comparable trends with the VPA both for ages 4-6 and 7+.

3.9.2 Gadget

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. The latest survey results show an extremely low level of fishing mortality (section 3.2.2). Using these surveys as tuning data gave an unrealistic stock for the last few years of the model run. Gadget uses the detailed length and age-length distributions in the survey data. Since it was not clear what the reason was for the unusual survey results, it was also unclear what correction could be made to the data, and it was decided to exclude this data from the Gadget run. The current Gadget cod model was therefore run without the latest year in the surveys, relying on the age-length distribution in the catch in 2007. Figure 3.24 shows the total stock biomass, spawning stock biomass and recruitment (age 3) from this year's Gadget run compared to last year's run. It is seen that there is only a small change in the perception of the historical stock compared to the previous year, which would be expected since relatively little new data was used. There is slight improvement in the perceived current state of the stock. However it must be borne in mind that there was no survey data for 2007 used in the current model run, and the results for 2008 must therefore be seen as rather uncertain.

Earlier results (WD 24, 2006) presented showed that in principle, Gadget is capable of modelling missing catches for a stock characterized by constant recruitment.

3.9.3 GIS method

Cod stock size assessment in the area where Russian trawlers were operating was made on the basis of Russian vessels' daily reports (VDR). During the 2000-2007 period 35 types of fishing gear and 17 types of fishing vessels were used for cod catch. The authors selected 9 types of bottom trawl (catch in 2007 is about 70% of quota) and 10 types of fishing vessels (catch in 2007 is about 80% of quota). Total numbers of VDRs in 2000-2007 was 202,812. A study of herding effect of trawl wires and trawl doors has shown that this effect was extremely low (Bulatov et al., 2008). The total fish abundance obtained by using of the new approach, included data on catchability coefficient adjusted for each size group from 40 to 95 cm (Bulatov et al., 2008). The determination of biomass was made through multiplication of fish abundance in each size group by average weight in each size group observed at sea. More detailed information is presented in Manual guide (Bulatov et al., 2008).

Bulatov et al. (WD # 21) presented new data for assessment of fishable stock in April-August 2001-2007 based on this new version of the GIS method. Fishable biomass values corresponded well with CPUE data dynamics (January-December 2001-2007, except 2003). From 2006 to 2007 the fishable stock increased from 3 038 000 t to 3 548 600 t.

The WG noted that the enhancements made to the method since last year have improved two of the shortcomings that were identified by some group members last year, namely the use of a constant trawl catchability factor and the ignoring of herding effects.

Some members of the working group consider that still more work probably has to be done before these weak points of the method are overcome. After further method amendments, a biomass index series like this could be used for tuning some VPA models, e.g. TISVPA. However, the main criticism raised by some group members last year, that the method violates the condition that swept-area estimates must be based on random samples, has not been met by the revised method. This fundamental problem still remains, and prevents the Working Group from treating these biomass estimates as absolute estimates of stock size.

Some other members of the working group consider that all the methods based on the fishery statistics data including the GIS method and analytical approaches, are not based on random samples. The data on biomass and CPUE, obtained by GIS method can be used as biomass index for TISVPA tuning.

3.9.4 "Synoptic" method

This method is a logical and advanced development of synoptic monitoring of fish productive zones in the North-Eastern Atlantic used for instance for mackerel, redfish, herring and blue whiting (Shatokhin, 2004). Regarding cod, the actual results of fishery in three relatively separated feeding areas associated with certain branches of the Barents Sea current system are used. The total assessment of cod biomass is made up of the sum of assessments of the maximum biomasses, which occur at different time periods in every area depending on the time of the highest fish filling of "its" feeding area. The time and absolute values of the maxima are determined in the course of synoptic monitoring of the three above mentioned feeding areas.

The biomass assessment is founded on VDRs on each trawling, the vessels' positions being confirmed by the satellite monitoring system, with calculation of average catches per trawling and fish aggregations' density by 1-sq.mile squares. While proceeding from aggregations' density to biomass the fishing vessel's characteristics, parameters of its fishing gear (trawling speed, vertical and horizontal trawl opening) are taken into account, enabling to estimate the volume of strained water.

Klochkov et al. (WD #11) presented the data for the 2003-2007 period the fishable cod biomass is assessed at 2.3 – 2.6 million tons. The accepted catchability coefficient (0.27) is somewhat above the coefficients used previously for the Barents Sea cod – 0.21 – 0.22 (Serebrov and Popkov, 1982) and biomass is assessed directly only at fishing areas. Both factors underestimate the actual cod biomass.

Some members of the working group note that there are disputable points in the model. It refers in particular to the assumption of randomization of trawlings, use of catchability coefficient equal to 0.27 for all the size groups and lack of adjustment for herding trawl effect. It is also questionable whether the assumption of no migration between areas is valid. In addition, the method of adding the maximum amount of fish in those areas found at different periods to obtain a total estimate, is questionable.

3.10 Comments to the assessment

IUU catches are still a problem, and agreement on the levels of such catches has not been reached. However, the magnitude of such catches is decreasing. This reduction is connected with the 'port state control regime' introduced by NEAFC from 1 May 2007.

The survey results from the last year are not consistent with the results from the previous year. Some of this inconsistency may be explained by inadequate spatial coverage of surveys in 2006/2007, but further analysis of the survey time series is needed. These issues makes the assessment rather uncertain.

Two VPA models (XSA and TISVPA) were used, giving similar results for the abundance of older ages but different results for ages 3-5. Both models indicate a marked decrease in F from 2006 to 2007, and all methods (also survey calibration, GIS and synoptic methods) indicate that the stock abundance is increasing. Fig 3.25 shows that the trend in F and in effort (Norwegian and Russian) in the last year are consistent.

For 2009 the two different estimates of IUU lead to the same advice (Section 3.7.2). This causes the advice to be rather precautionary (F below F_{pa} for the advice based on the NOR-IUU-run, F at F_{pa} for the advice based on the RUS-IUU-run).

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 3.31, 3.32) should be updated and then included in the catch at age matrix. Table 3.32 (taken from Ajiad et al., WD2) is new and 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).

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. 2008).

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 and 21, based on vessels' daily reports, may in the future be included in the tuning of assessment models.

3.12 Answering 2007 ACFM comments:

The minutes of the review of the 2007 AFWG report contained a number of comments to the NEA cod assessment. Below, we answer these comments and describe how they have been taken into account (*in italics*):

Review group comments

Cannibalism:

The whole procedure leading to a natural mortality (M) taking into account cannibalism should be fully explained and the various steps clearly identified. The RG advises that the process of including cannibalism needs clarification. The RG attempted to carry this out: Before starting, all the raw information (% of ages eaten by age groups) and actual catch at age matrix should be presented. They should replace current Tables 3.9 and 3.8 (or 3.10).

The explanation of how cannibalism is included in the assessment, has been rewritten. The raw information on per capita cod consumption by predator age, prey age and time step is not included in the report, but is available on the sharepoint site. It should be noted that the XSA with cannibalism has been successfully implemented in FLR. The actual catch matrix is given in tables 3.8 and 3.10, as was also the case last year.

There may be a conflict between using a CPUE and the current cannibalism approach.

This comment was not clear to the WG.

The RG still felt that there where many issues around the inclusion of cannibalism in the assessment that need to be resolved (eg the veracity of surveys and CPUE using this method, why is this method better than an approach that tries to adjust M at first, how sensitive it is to annual noise?).

These issues were not explored by the WG, but the FLR implementation makes it easier to explore such issues.

Surveys

The treatment of surveys needs to be further considered. The Norwegian survey, which takes place in the first quarter, is back-shifted. This RG commented about the disadvantage of this practice (bias due to mortalities at the beginning of the year, prior to the survey, not taken into account in the backshift procedure), compared to advantages (having indices for the end of the preceding year).

*The WG considers the advantage of having indices for the end of the previous ear to more than outweigh the problem of back-shifting the Norwegian survey*s.

The review group is worried about the integrity of the surveys. The methods used to maintain the time series by the inclusion of the 2006 survey index, accounting for different spatial coverage, were different for different surveys. Although the RG accepted the outcomes, they were not happy with the approach. More attention should be given to adjusting the time series based on the spatial distribution and inherent variability in the surveys.

The WG is also worried about the integrity of the surveys, and the spatial coverage of the surveys needs to be re-considered before next year's surveys are carried out to ensure as complete spatial coverage as possible.

Other issues

There is a lack of transparency in the input data– discrepancy between abundance indices in table A3 and table 3.14.

The indices in Table 3.14 (FLT 15) are equivalent to those in Table A3 (They are multiplied by 10 and shifted one year)

Retro-plot goes 20 years back – but the tuning is using tricubic time taper, meaning that only the last 6-7 years of data are used in the assessment (not using the first 10 years of data).

The retro-plot is given for 1999-2007 as the assessment year, and in all cases a 10-year tuning window with tricubic taper is used.

RCT3 assumes there should be good information (better than there is) on the young year classes. This should be considered when doing the next benchmark assessment.

It is not clear to the WG why the RG considers the information on the young year classes not to be good for NEA cod compared to other stocks, and whether use of RCT3 or of some time series-average for recruiting year classes should be based on some criteria for level of noise in the data. See also the discussion of recruitment models for cod in Section 1.4.6.

The chapter in general

The chapter is still difficult to read and follow. Criticism of lack of explanation to the process used has been stated in the technical minutes for a few years. The chapter needs to be rewritten using a different approach. The RG group advises that the AFWG use the chapters to “tell a story”. Begin with fisheries and TAC, then the raw data, then the adjusted data, then the data exploration (including all models used), then the agreed assessment followed by predictions and management considerations etc.

The comment has been partially taken into account, and some rearrangement of the chapter has been made. The chapter reflects that data exploration was rather limited at this update assessment.

The RG does not like each chapter having two blocks of tables.

As long as one block is only survey data the WG does not see this as a problem.

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	90000/25509	535045/470554
2003 [2]	163 109	222 052	51 829	115000/32595	551990/469585
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]	159 261	206 421	104 846	67114/28000	537642/498528
2007 [1,2]	152 522	195 383	97 891	41087/8757	486883/454553

[1] **Provisional figures.**

[2] **two alternative estimates of unreported catches (see Chapter 0.3 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	Landings in '000 t: By area and time of capture
1960	-	43
1961	-	32
1962	-	30
1963	-	40
1964	-	46
1965	-	24
1966	-	29
1967	-	33
1968	-	47
1969	-	52
1970	-	49
1971	-	*)
1972	-	*)
1973	-	*)
1974	-	*)
1975	-	*)
1976	-	*)
1977	-	*)
1978	-	*)
1979	-	*)
1980	-	40
1981	-	49
1982	-	42
1983	-	38
1984	74	33
1985	75	28
1986	69	26
1987	61	31
1988	59	22
1989	40	17
1990	28	24
1991	25	25
1992	42	35
1993	53	44
1994	55	48
1995	57	39
1996	62	32
1997	63	36
1998	52	29
1999	41	23
2000	37	19
2001	30	14
2002	41	20
2003	35	19
2004	33	14
2005	31	13
2006	26	16
2007	24	12
Average 1984-2007	46	26

*) 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	141.2	18.1	92.8	113.6	100.2	4.6
2007 [1]	129.6	22.9	84.8	110.6	91.6	6.3

[1] Provisional figures.

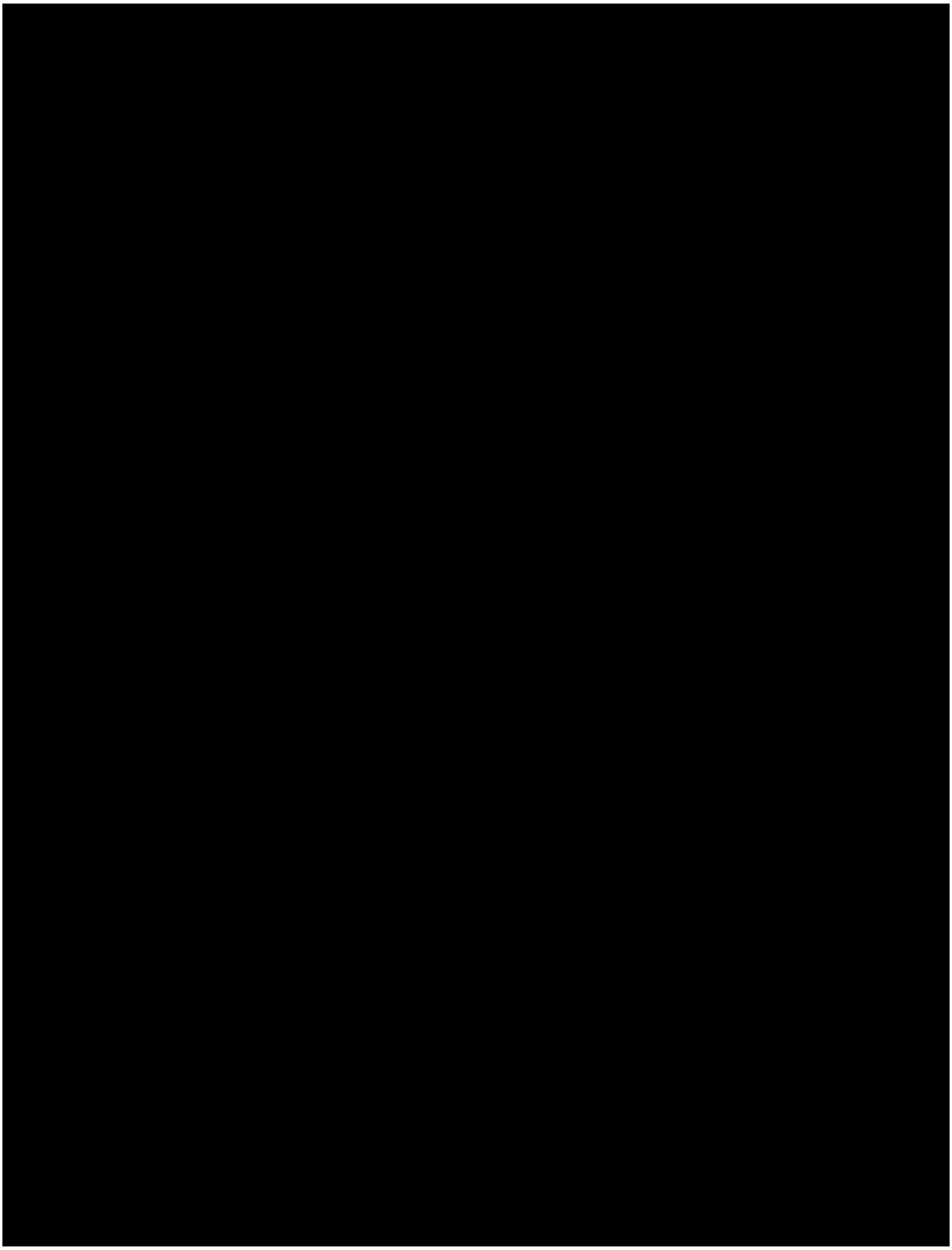


Table 3.4 North-east Arctic COD. Weights at age (kg) in landings from various countries

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

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		

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	4.00	4.95	6.55	7.54	9.71	11.40	11.57	23.34	15.61

[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	

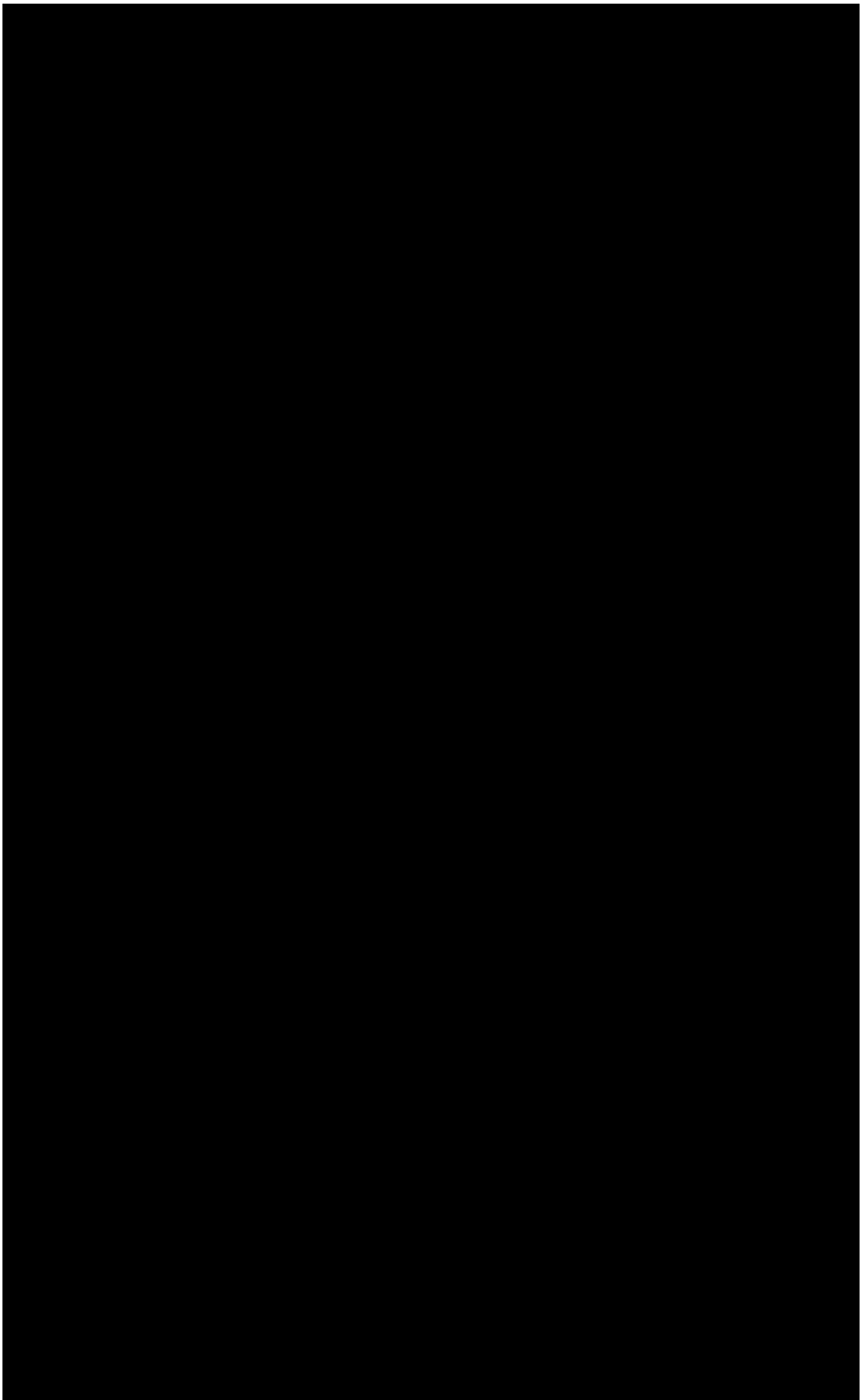


Table 3.6. Northeast Arctic cod recruitment indices, input for the RCT3-analysis. VPA numbers from runs with Norwegian figures for IUU.

```
NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,
9,23,2             (No. of surveys, No. of years, VPA Column No.),,
1985,   205,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1986,   173,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1987,   243,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1988,   412,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1989,   721,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1990,   895,    -11,  -11, -11,    -11,     -11,     -11,  -11,   -11,  -11
1991,   810,    -11,  -11, -11,    -11,     -11,     -11    -11, 296.5, 349.8
1992,   657,    -11,  -11, 699,    -11,     -11,   535.8, 577.2, 274.6, 166.2
1993,   438,    -11, 8332, 369, 1035.9,   858.3,   541.5, 292.9, 170.0,  92.9
1994,   716,  16066, 4719,1285, 5253.1,  2619.2,   707.6, 339.8, 238.0, 188.3
1995,   845,  57035, 3965,1353, 5768.5,  2396.0,  1045.1, 430.5, 396.0, 427.7
1996,   548,  26603, 3539, 896, 4815.5,  1623.5,   643.7, 632.9, 211.8, 150.0
1997,   606,  13714, 2768,1184, 2418.5,  3401.3,   340.1, 304.3, 235.2, 245.1
1998,   518,   3048,  401,1036,  484.6,   358.3,   248.3, 221.4, 191.1, 138.2
1999,   441,   2669,  377, 773,  128.8,   154.1,    76.6,  63.9,  88.3,  69.3
2000,   678,  14365, 2338,1356,  657.9,   629.9,   443.9, 215.1, 377.0, 303.4
2001,   293,   3216,  267, 268,   35.3,    18.2,    79.1,  61.5,  76.6,  33.6
2002,   585,  17979, 5175, 875, 2991.7,  1693.9,   235.4, 105.2, 246.9, 123.9
2003,   500,   4895, 1584, 617,  328.5,   157.6,   224.6, 119.6, 118.1,  79.8
2004,   777,  17704, 3239, 895,  824.3,   465.3,   288.4, 216.6, 367.7,  80.3
2005,   -11,  22980,  858,1486,  862.7,   544.6,   393.9,  61.7, 190.2, 210.2
2006,   -11,   6838,  370, -11,  485.9,   125.0,    92.1,  97.6,   -11,   -11
2007,   -11,   1775,  -11, -11,   70.4     68.8,     -11,   -11,   -11,   -11
R-0      Russian Swept area trawl survey, area I+IIb,   age 0
R-1      Russian Swept area  trawl survey, area I+IIb,   age 1
R-2      Russian Swept area  trawl survey, area I+IIb,   age 2
N-BST1     Norwegian Barents Sea, Bottom trawl survey, age 1
N-BSA1     Norwegian Barents Sea Acoustic survey age 1
N-BST2     Norwegian Barents Sea, Bottom trawl survey, age 2
N-BSA2     Norwegian Barents Sea Acoustic survey age 2
N-BST3     Norwegian Barents Sea, Bottom trawl survey, age 3
N-BSA3     Norwegian Barents Sea Acoustic survey age 3
```

Table 3.7. Northeast Arctic Cod. Recruitment predictions based on survey indices shrunk towards the VPA mean. Based on VPA numbers from runs with Norwegian figures for IUU.

```
Analysis by RCT3 ver3.1 of data from file :
 rec2007
 NORTHEAST ARCTIC COD : recruits as 3 year-olds (inc. data for ages 0,1),,,,
 Data for    9 surveys over   23 years :  1985 - 2007
 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 =   2001
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 R-0        .24   4.18    .16   .685      7   8.08    6.10     .227     .201
 R-1        .52   2.43    .58   .157      8   5.59    5.31     .863     .014
 R-2        .74   1.33    .23   .528      9   5.59    5.46     .394     .067
 N-BST1     .25   4.57    .27   .456      8   3.59    5.47     .470     .047
 N-BSA1     .32   4.15    .29   .430      8   2.95    5.10     .588     .030
 N-BST2     .42   3.88    .25   .476      9   4.38    5.70     .374     .074
 N-BSA2     .62   2.87    .39   .269      9   4.14    5.44     .596     .029
 N-BST3     .61   3.11    .15   .735     10   4.35    5.75     .225     .205
 N-BSA3     .43   4.17    .10   .857     10   3.54    5.69     .165     .260
                                        VPA Mean =    6.35     .380     .072
Yearclass =   2002
          I-----------Regression----------I  I-----------Prediction---------I

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

 R-0        .37   2.91    .28   .623      8   9.80    6.53     .349     .060
 R-1        .39   3.38    .41   .407      9   8.55    6.74     .523     .027
 R-2        .63   2.09    .18   .766     10   6.78    6.34     .217     .154
 N-BST1     .21   4.85    .22   .706      9   8.00    6.55     .275     .096
 N-BSA1     .22   4.88    .21   .732      9   7.44    6.51     .256     .111
 N-BST2     .42   3.86    .24   .663     10   5.47    6.15     .283     .091
 N-BSA2     .52   3.45    .31   .530     10   4.67    5.88     .389     .048
 N-BST3     .63   2.96    .15   .839     11   5.51    6.46     .173     .182
 N-BSA3     .43   4.16    .09   .926     11   4.83    6.24     .111     .182
                                        VPA Mean =    6.31     .388     .048

Yearclass =   2003
         I-----------Regression----------I  I-----------Prediction---------I

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

 R-0        .37   2.92    .26   .617      9   8.50    6.03     .325     .064
 R-1        .37   3.49    .38   .414     10   7.37    6.25     .456     .033
 R-2        .63   2.09    .17   .772     11   6.43    6.12     .203     .165
 N-BST1     .21   4.86    .21   .699     10   5.80    6.07     .257     .103
 N-BSA1     .22   4.89    .20   .732     10   5.07    5.99     .241     .116
 N-BST2     .43   3.85    .24   .639     11   5.42    6.16     .279     .087
 N-BSA2     .54   3.41    .35   .450     11   4.79    5.99     .417     .039
 N-BST3     .63   2.99    .14   .837     12   4.78    5.99     .172     .169
 N-BSA3     .43   4.17    .10   .911     12   4.39    6.06     .120     .169
                                        VPA Mean =    6.32     .352     .055
```

Yearclass = 2004

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.36	2.99	.25	.614	10	9.78	6.52	.300	.069
R-1	.37	3.54	.35	.430	11	8.08	6.51	.418	.035
R-2	.62	2.16	.16	.780	12	6.80	6.36	.185	.155
N-BST1	.20	4.91	.20	.697	11	6.72	6.28	.236	.111
N-BSA1	.21	4.96	.19	.717	11	6.14	6.25	.225	.122
N-BST2	.42	3.89	.22	.650	12	5.67	6.27	.255	.095
N-BSA2	.53	3.51	.33	.457	12	5.38	6.34	.379	.043
N-BST3	.60	3.13	.15	.811	13	5.91	6.70	.180	.155
N-BSA3	.42	4.23	.10	.896	13	4.40	6.09	.123	.155
					VPA Mean =		6.32	.320	.060

Yearclass = 2005

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.38	2.79	.25	.616	11	10.04	6.65	.305	.090
R-1	.38	3.45	.34	.456	12	6.76	6.03	.406	.051
R-2	.70	1.65	.19	.714	13	7.30	6.74	.239	.147
N-BST1	.24	4.71	.26	.595	12	6.76	6.33	.300	.093
N-BSA1	.25	4.76	.26	.594	12	6.30	6.32	.301	.093
N-BST2	.49	3.53	.27	.558	13	5.98	6.46	.317	.083
N-BSA2	.60	3.17	.36	.416	13	4.14	5.64	.462	.039
N-BST3	.59	3.21	.14	.834	14	5.25	6.30	.159	.210
N-BSA3	.53	3.77	.24	.620	14	5.35	6.59	.284	.104
					VPA Mean =		6.34	.309	.088

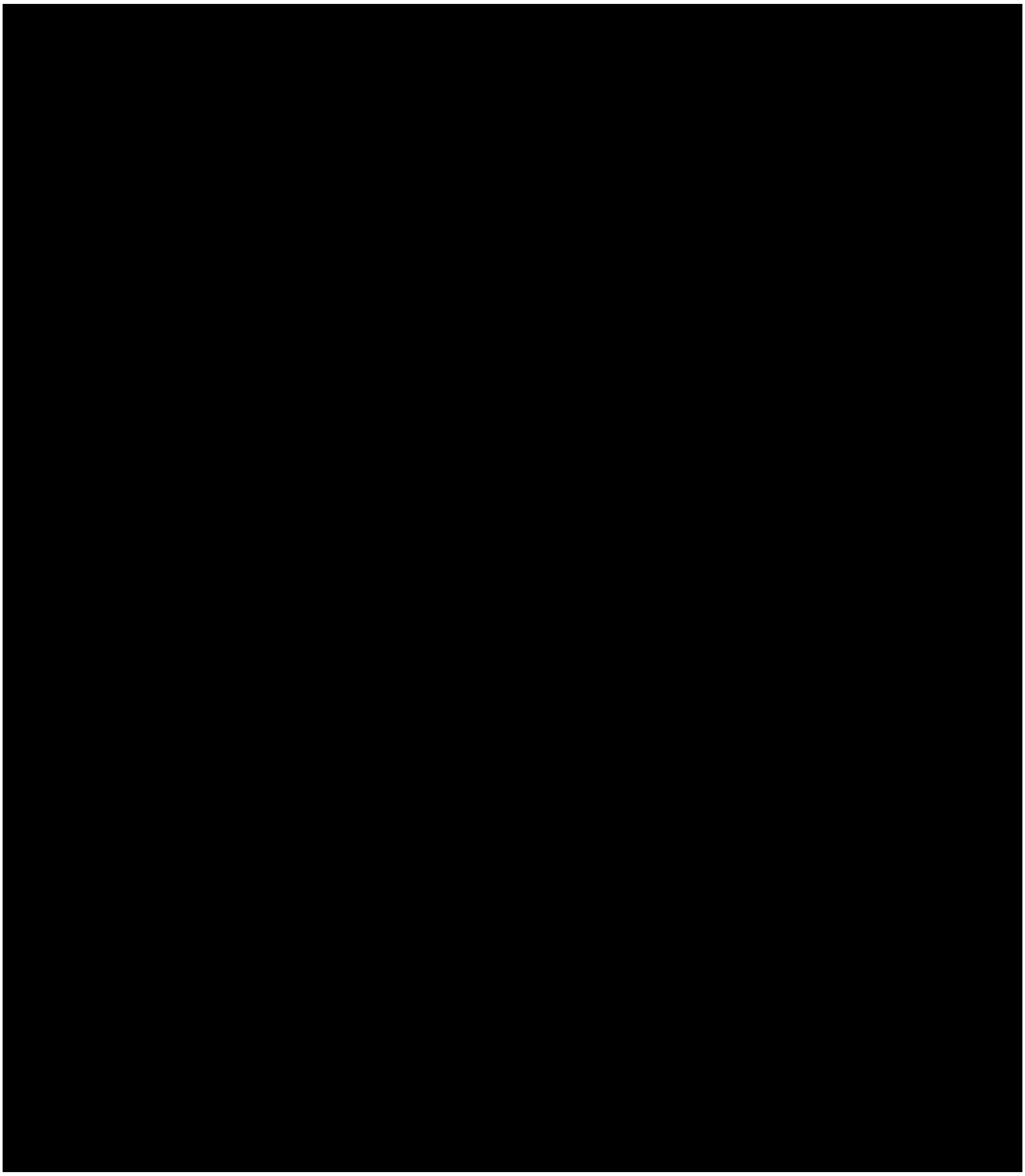
Yearclass = 2006

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.39	2.76	.25	.615	11	8.83	6.19	.302	.178
R-1	.38	3.51	.33	.478	12	5.92	5.73	.422	.091
R-2									
N-BST1	.24	4.71	.26	.597	12	6.19	6.20	.306	.173
N-BSA1	.25	4.77	.26	.599	12	4.84	5.97	.316	.163
N-BST2	.49	3.53	.27	.565	13	4.53	5.76	.348	.134
N-BSA2	.60	3.17	.36	.423	13	4.59	5.92	.439	.084
N-BST3									
N-BSA3									
					VPA Mean =		6.34	.303	.177

Yearclass = 2007

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
R-0	.39	2.71	.26	.615	11	7.48	5.66	.354	.219
R-1									
R-2									
N-BST1	.24	4.71	.26	.599	12	4.27	5.74	.345	.231
N-BSA1	.25	4.79	.26	.603	12	4.25	5.83	.333	.248
N-BST2									
N-BSA2									
N-BST3									
N-BSA3									
					VPA Mean =		6.33	.302	.301

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2001	322	5.78	.10	.09	.84	294	5.68
2002	581	6.36	.09	.06	.47	585	6.37
2003	435	6.08	.08	.03	.13	501	6.22
2004	573	6.35	.08	.06	.63	777	6.66
2005	607	6.41	.09	.08	.79		
2006	428	6.06	.13	.09	.46		
2007	373	5.92	.17	.16	.91		



1 – Nor IUU inputs, 2 – Rus IUU inputs

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

Year	Age						
	0	1	2	3	4	5	6
1984	0	417	21	0	0	0	0
1985	1497	376	67	0	0	0	0
1986	53	966	392	99	0	0	0
1987	681	182	281	14	0	0	0
1988	29	411	22	2	0	0	0
1989	916	144	0	0	0	0	0
1990	0	126	28	0	0	0	0
1991	123	151	214	2	0	0	0
1992	4305	1027	155	4	0	0	0
1993	3833	20282	512	52	1	0	0
1994	8344	6947	647	131	52	8	0
1995	8315	15380	758	251	87	4	0
1996	9905	21734	1502	143	56	20	1
1997	2936	15988	1857	174	17	1	0
1998	79	4853	536	211	25	2	1
1999	593	1833	295	52	4	0	0
2000	1671	2228	171	37	14	4	0
2001	89	2254	113	24	12	2	1
2002	7444	455	393	41	6	1	0
2003	5499	4340	105	23	0	0	0
2004	5614	1484	498	18	10	1	0
2005	2168	2720	149	81	3	5	1
2006	1671	2085	116	5	2	0	0
2007	1692	1217	192	72	4	0	0

Table 3.10N. Northeast Arctic Cod. Catch numbers at age

Run title : Arctic Cod (run: SVPASA15/V15)
At 23/04/2008 9:59

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

YEAR,	1946,	1947,
AGE		
3,	4008,	710,
4,	10387,	13192,
5,	18906,	43890,
6,	16596,	52017,
7,	13843,	45501,
8,	15370,	13075,
9,	59845,	19718,
10,	22618,	47678,
11,	10093,	31392,
12,	9573,	9348,
+gp,	8137,	18055,
0 TOTALNUM,	189376,	294576,
TONSLAND,	706000,	882017,
SOPCOF %,	103,	91,

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

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	140,	991,	1281,	24687,	24099,	47413,	11473,	3902,	10614,	17321,
4,	3872,	6808,	10954,	77924,	120704,	107659,	155171,	37652,	24172,	33931,
5,	31054,	35214,	29045,	64013,	113203,	112040,	146395,	201834,	129803,	27182,
6,	55983,	100497,	45233,	46867,	73827,	55500,	100751,	161336,	250472,	70702,
7,	77375,	83283,	62579,	37535,	49389,	22742,	40635,	84031,	86784,	87033,
8,	21482,	29727,	30037,	33673,	20562,	16863,	10713,	30451,	51091,	39213,
9,	15237,	13207,	19481,	23510,	24367,	10559,	11791,	13713,	14987,	17747,
10,	9815,	5606,	9172,	10589,	15651,	10553,	8557,	9481,	7465,	6219,
11,	30041,	8617,	6019,	4221,	8327,	5637,	6751,	4140,	3952,	3232,
12,	7945,	13154,	4133,	1288,	3565,	1752,	2370,	2406,	1655,	1220,
+gp,	12595,	7719,	9862,	4935,	2158,	797,	1287,	1350,	1906,	819,
0 TOTALNUM,	265539,	304823,	227796,	329242,	455852,	391515,	495894,	550296,	582901,	304619,
TONSLAND,	774295,	800122,	731982,	827180,	876795,	695546,	826021,	1147841,	1343068,	792557,
SOPCOF %,	89,	99,	109,	115,	93,	105,	93,	106,	105,	100,

Run title : Arctic Cod (run: SVPASA15/V15)
At 23/04/2008 9:59

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	31219,	32308,	37882,	45478,	42416,	13196,	5298,	15725,	55937,	34467,
4,	133576,	77942,	97865,	132655,	170566,	106984,	45912,	25999,	55644,	160048,
5,	71051,	148285,	64222,	123458,	167241,	205549,	97950,	78299,	34676,	69235,
6,	40737,	53480,	67425,	51167,	89460,	95498,	58575,	68511,	42539,	22061,
7,	38380,	18498,	23117,	38740,	28297,	35518,	19642,	25444,	37169,	26295,
8,	35786,	17735,	8429,	17376,	21996,	16221,	9162,	8438,	18500,	25139,
9,	13338,	23118,	7240,	5791,	7956,	11894,	6196,	3569,	5077,	11323,
10,	10475,	9483,	11675,	6778,	2728,	3884,	3553,	1467,	1495,	2329,
11,	3289,	3748,	4504,	5560,	2603,	1021,	783,	1161,	380,	687,
12,	1070,	997,	1843,	1682,	1647,	1025,	172,	131,	403,	316,
+gp,	433,	513,	682,	1298,	775,	784,	782,	337,	156,	279,
0 TOTALNUM,	379354,	386107,	324884,	429983,	535685,	491574,	248025,	229081,	251976,	352179,
TONSLAND,	769313,	744607,	622042,	783221,	909266,	776337,	437695,	444930,	483711,	572605,
SOPCOF %,	112,	93,	104,	110,	124,	102,	103,	129,	123,	109,

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	3709,	2307,	7164,	7754,	35536,	294262,	91855,	45282,	85337,	39594,
4,	174585,	24545,	10792,	13739,	45431,	131493,	437377,	59798,	114341,	168609,
5,	267961,	238511,	25813,	11831,	26832,	61000,	203772,	226646,	79993,	136335,
6,	107051,	181239,	137829,	9527,	12089,	20569,	47006,	118567,	118236,	52925,
7,	26701,	79363,	96420,	59290,	7918,	7248,	12630,	29522,	47872,	61821,
8,	16399,	26989,	31920,	52003,	34885,	8328,	4370,	9353,	13962,	23338,
9,	11597,	13463,	8933,	12093,	22315,	19130,	2523,	2617,	4051,	5659,
10,	3657,	5092,	3249,	2434,	4572,	4499,	5607,	1555,	936,	1521,
11,	657,	1913,	1232,	762,	1215,	677,	2127,	1928,	558,	610,
12,	122,	414,	260,	418,	353,	195,	322,	575,	442,	271,
+gp,	240,	190,	180,	216,	476,	195,	296,	283,	218,	268,
0 TOTALNUM,	612679,	574026,	323792,	170067,	191622,	547596,	807885,	496126,	465946,	490951,
TONSLAND,	1074084,	1197226,	933246,	689048,	565254,	792685,	1102433,	829377,	867463,	905301,
SOPCOF %,	108,	105,	112,	124,	118,	130,	137,	115,	127,	107,

Table 3.10N (continued).

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

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	78822	8600	3911	3407	8948	3108	6942	24634	28968	13648
4	45400	77484	17086	9466	20933	19594	14240	45769	70993	137106
5	88495	43677	81986	20803	19345	20473	18807	27806	78672	98210
6	56823	31943	40061	63433	28084	17656	20086	19418	25215	61407
7	25407	16815	17664	21788	42496	17004	15145	11369	11711	13707
8	31821	8274	7442	9933	8395	18329	8287	3747	4063	3866
9	9408	10974	3508	4267	2878	2545	5988	1557	976	910
10	1227	1785	3196	1311	708	646	783	768	726	455
11	913	427	678	882	271	229	232	137	557	187
12	446	103	79	109	260	74	153	36	136	227
+gp	847	142	58	41	37	83	69	71	76	100
0 TOTALNUM	339609	200224	175669	135440	132355	99741	90732	135312	222093	329823
TONSLAND	698715	440538	380434	399038	363730	289992	277651	307920	430113	523071
SOPCOF %	109	121	127	118	125	90	95	102	102	102

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	9828	5085	1911	4963	21835	10094	6531	4879	7655	12827
4	22774	17313	7551	10933	36015	46182	59444	42587	28782	36491
5	135347	32165	12999	16467	27494	63578	102548	115329	80711	69633
6	54379	81756	17827	20342	23392	33623	59766	98485	100509	83017
7	21015	27854	30007	19479	18351	14866	32504	32036	54590	65768
8	3304	5501	6810	25193	13541	9449	10019	7334	10545	28392
9	1236	827	828	3888	18321	6571	6163	3014	2023	4651
10	519	290	179	428	2529	12593	3671	1725	930	1151
11	106	41	59	48	264	1749	7528	1174	462	373
12	69	13	15	12	82	377	995	1920	230	213
+gp	62	28	13	4	13	86	144	264	894	383
0 TOTALNUM	248639	170873	78199	101757	161837	199168	289313	308747	287331	302899
TONSLAND	434939	332481	212000	319158	513234	581611	771086	739999	732228	762403
SOPCOF %	100	99	101	95	103	101	101	100	101	100

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
3	31887	7501	4701	5044	2348	7263	2090	5815	8548	25473
4	88874	77714	33094	35019	31033	20885	38226	19768	47207	43817
5	48972	92816	93044	62139	76175	64447	50826	113144	33625	62877
6	40493	31139	47210	62456	67656	71109	68350	61665	78150	26303
7	34513	15778	12671	22794	42122	36706	50838	44777	31770	34392
8	26354	15851	6677	5266	11527	14002	18118	20553	15667	11240
9	6583	8828	4787	1773	1801	2887	6239	6285	7245	4080
10	965	1837	1647	1163	529	492	1746	2348	1788	1381
11	197	195	321	343	223	142	295	562	737	505
12	69	40	71	85	120	97	127	100	210	285
+gp	117	72	26	35	36	65	63	52	226	92
0 TOTALNUM	279024	251771	204249	196117	233570	218095	236918	275069	225173	210445
TONSLAND	592624	484910	414868	426471	535045	551990	606445	641276	537642	486883
SOPCOF %	101	100	100	100	100	100	100	100	100	100

1

Table 3.10R

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
3	31887	7501	4701	5044	2032	5933	1738	4450	7757	22850
4	88874	77714	33094	35019	26583	17045	31356	15182	42892	39414
5	48972	92816	93044	62139	65030	52719	41892	86226	30716	56955
6	40493	31139	47210	62456	58380	59164	57012	47652	71624	24476
7	34513	15778	12671	22794	37428	31534	43436	36044	29405	32465
8	26354	15851	6677	5266	10471	12494	16141	17356	14763	10788
9	6583	8828	4787	1773	1652	2637	5722	5612	6914	3999
10	965	1837	1647	1163	495	443	1597	2138	1729	1357
11	197	195	321	343	207	129	268	506	699	492
12	69	40	71	85	115	91	118	92	204	279
+gp	117	72	26	35	34	61	59	47	216	90
0 TOTALNUM	279024	251771	204249	196117	202427	182250	199339	215305	206919	193165
TONSLAND	592624	484910	414868	426471	470554	469585	519445	516276	498528	454553
SOPCOF %	101	100	100	100	100	100	101	101	104	100

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Table 3.11. Northeast Arctic Cod. Catch weights at age

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

At 23/04/2008 9:59

Table 2 Catch weights at age (kg)

YEAR,	1946,	1947,
AGE		
3,	.3500,	.3200,
4,	.5900,	.5600,
5,	1.1100,	.9500,
6,	1.6900,	1.5000,
7,	2.3700,	2.1400,
8,	3.1700,	2.9200,
9,	3.9800,	3.6500,
10,	5.0500,	4.5600,
11,	5.9200,	5.8400,
12,	7.2000,	7.4200,
+gp,	8.1460,	8.8480,
0 SOPCOFAC,	1.0300,	.9143,

Table 2 Catch weights at age (kg)

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	.3400,	.3700,	.3900,	.4000,	.4400,	.4000,	.4400,	.3200,	.3300,	.3300,
4,	.5300,	.6700,	.6400,	.8300,	.8000,	.7600,	.7700,	.5700,	.5800,	.5900,
5,	1.2600,	1.1100,	1.2900,	1.3900,	1.3300,	1.2800,	1.2600,	1.1300,	1.0700,	1.0200,
6,	1.9300,	1.6600,	1.7000,	1.8800,	1.9200,	1.9300,	1.9700,	1.7300,	1.8300,	1.8200,
7,	2.4600,	2.5000,	2.3600,	2.5400,	2.6400,	2.8100,	3.0300,	2.7500,	2.8900,	2.8900,
8,	3.3600,	3.2300,	3.4800,	3.4600,	3.7100,	3.7200,	4.3300,	3.9400,	4.2500,	4.2800,
9,	4.2200,	4.0700,	4.5200,	4.8800,	5.0600,	5.0600,	5.4000,	4.9000,	5.5500,	5.4900,
10,	5.3100,	5.2700,	5.6200,	5.2000,	6.0500,	6.3400,	6.7500,	7.0400,	7.2800,	7.5100,
11,	5.9200,	5.9900,	6.4000,	7.1400,	7.4200,	7.4000,	7.7900,	7.2000,	8.0000,	8.2400,
12,	7.0900,	7.0800,	7.9600,	8.2200,	8.4300,	8.6700,	10.6700,	8.7800,	8.3500,	9.2500,
+gp,	8.4300,	8.2180,	8.8910,	9.3890,	10.1850,	10.2380,	9.6800,	10.0770,	9.9440,	10.6050,
0 SOPCOFAC,	.8915,	.9920,	1.0880,	1.1483,	.9348,	1.0485,	.9294,	1.0634,	1.0455,	1.0004,

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

At 23/04/2008 9:59

Table 2 Catch weights at age (kg)

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	.3400,	.3500,	.3400,	.3100,	.3200,	.3200,	.3300,	.3800,	.4400,	.2900,
4,	.5200,	.7200,	.5100,	.5500,	.5500,	.6100,	.5500,	.6800,	.7400,	.8100,
5,	.9500,	1.4700,	1.0900,	1.0500,	.9300,	.9600,	.9500,	1.0300,	1.1800,	1.3500,
6,	1.9200,	2.6800,	2.1300,	2.2000,	1.7000,	1.7300,	1.8600,	1.4900,	1.7800,	2.0400,
7,	2.9400,	3.5900,	3.3800,	3.2300,	3.0300,	3.0400,	3.2500,	2.4100,	2.4600,	2.8100,
8,	4.2100,	4.3200,	4.8700,	5.1100,	5.0300,	4.9600,	4.9700,	3.5200,	3.8200,	3.4800,
9,	5.6100,	5.4500,	6.1200,	6.1500,	6.5500,	6.4400,	6.4100,	5.7300,	5.3600,	4.8900,
10,	7.3500,	6.4400,	8.4900,	8.1500,	7.7000,	7.9100,	8.0700,	7.5400,	7.2700,	7.1100,
11,	8.6700,	7.1700,	7.7900,	8.6800,	9.2700,	9.6200,	9.3400,	8.4700,	8.6300,	9.0300,
12,	9.5800,	8.6300,	8.3000,	9.6000,	10.5600,	11.3100,	10.1600,	11.1700,	10.6600,	10.5900,
+gp,	11.6310,	11.6210,	11.4220,	11.9520,	12.7170,	12.7370,	12.8860,	13.7220,	14.1480,	13.8290,
0 SOPCOFAC,	1.1232,	.9305,	1.0416,	1.0970,	1.2356,	1.0226,	1.0277,	1.2903,	1.2327,	1.0911,

Table 2 Catch weights at age (kg)

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	.3300,	.4400,	.3700,	.4500,	.3800,	.3800,	.3200,	.4100,	.3500,	.4900,
4,	.7000,	.7900,	.9100,	.8800,	.7700,	.9100,	.6600,	.6400,	.7300,	.9000,
5,	1.4800,	1.2300,	1.3400,	1.3800,	1.4300,	1.5400,	1.1700,	1.1100,	1.1900,	1.4300,
6,	2.1200,	2.0300,	2.0000,	2.1600,	2.1200,	2.2600,	2.2200,	1.9000,	2.0100,	2.0500,
7,	3.1400,	2.9000,	3.0000,	3.0700,	3.2300,	3.2900,	3.2100,	2.9500,	2.7600,	3.3000,
8,	4.2100,	3.8100,	4.1500,	4.2200,	4.3800,	4.6100,	4.3900,	4.3700,	4.2200,	4.5600,
9,	5.2700,	5.0200,	5.5900,	5.8100,	5.8300,	6.5700,	5.5200,	5.7400,	5.8800,	6.4600,
10,	6.6500,	6.4300,	7.6000,	7.1300,	7.6200,	8.3700,	7.8600,	8.7700,	9.3000,	8.6300,
11,	9.0100,	8.3300,	8.9700,	8.6200,	9.5200,	10.5400,	9.8200,	9.9200,	10.2800,	9.9300,
12,	9.6600,	10.7100,	10.9900,	10.8300,	12.0900,	11.6200,	11.4100,	11.8100,	11.8600,	10.9000,
+gp,	14.8480,	14.2110,	14.0740,	12.9450,	13.6730,	13.9040,	13.2420,	13.1070,	13.5440,	13.6680,
0 SOPCOFAC,	1.0785,	1.0520,	1.1170,	1.2405,	1.1822,	1.3003,	1.3660,	1.1520,	1.2688,	1.0683,

Table 3.11 (continued).

Table 2 Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	.4900,	.3500,	.2700,	.4900,	.3700,	.8400,	1.4200,	.9400,	.6400,	.4900,
4,	.8100,	.7000,	.5600,	.9800,	.6600,	1.3700,	1.9300,	1.3700,	1.2700,	.8800,
5,	1.4500,	1.2400,	1.0200,	1.4400,	1.3500,	2.0900,	2.4900,	2.0200,	1.8800,	1.5500,
6,	2.1500,	2.1400,	1.7200,	2.0900,	1.9900,	2.8600,	3.1400,	3.2200,	2.7900,	2.3300,
7,	3.0400,	3.1500,	3.0200,	2.9800,	2.9300,	3.9900,	3.9100,	4.6300,	4.4900,	3.4400,
8,	4.4600,	4.2900,	4.2000,	4.8500,	4.2400,	5.5800,	4.9100,	6.0400,	5.8400,	5.9200,
9,	6.5400,	6.5800,	5.8400,	6.5700,	6.4600,	7.7700,	6.0200,	7.6600,	6.8300,	8.6000,
10,	7.9800,	8.6100,	7.2600,	9.1600,	8.5100,	9.2900,	7.4000,	9.8100,	7.6900,	9.6000,
11,	10.1500,	9.2200,	8.8400,	10.8200,	12.2400,	11.5500,	8.1300,	11.8000,	9.8100,	12.1700,
12,	10.8500,	10.8900,	9.2800,	10.7700,	10.7800,	16.2000,	8.5700,	14.1600,	10.7100,	13.7200,
+gp,	13.1770,	14.3440,	14.4480,	13.9320,	14.0410,	17.0340,	8.6090,	14.0080,	12.0510,	13.3800,
0 SOPCOFAC,	1.0890,	1.2139,	1.2723,	1.1809,	1.2521,	.8953,	.9483,	1.0182,	1.0160,	1.0224,

Table 2 Catch weights at age (kg)

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	.5400,	.7400,	.8100,	1.0500,	1.1600,	.8100,	.8200,	.7700,	.7900,	.6700,
4,	.8500,	.9600,	1.2200,	1.4500,	1.5700,	1.5200,	1.3000,	1.2000,	1.1100,	1.0400,
5,	1.3200,	1.3100,	1.6400,	2.1500,	2.2100,	2.1600,	2.0600,	1.7800,	1.6100,	1.5300,
6,	2.2400,	1.9200,	2.2200,	2.8900,	3.1000,	2.7900,	2.8900,	2.5900,	2.4600,	2.2200,
7,	3.5200,	2.9300,	3.2400,	3.7500,	4.2700,	4.0700,	3.2100,	3.8100,	3.8200,	3.4200,
8,	5.3500,	4.6400,	4.6800,	4.7100,	5.1900,	5.5300,	5.2000,	4.9900,	5.7200,	5.2000,
9,	8.0600,	7.5200,	7.3000,	6.0800,	6.1400,	6.4700,	6.8000,	6.2300,	6.7400,	7.1900,
10,	9.5100,	9.1200,	9.8400,	8.8200,	7.7700,	7.1900,	7.5700,	8.0500,	8.0400,	7.7300,
11,	11.3600,	11.0800,	13.2500,	11.8000,	10.1200,	7.9800,	8.0100,	8.7400,	9.2800,	8.6100,
12,	14.0900,	11.4700,	16.8800,	16.5800,	11.5400,	10.1100,	9.4800,	9.2200,	10.4000,	11.0700,
+gp,	16.7060,	16.4840,	11.6170,	16.6900,	14.3320,	14.1830,	11.9780,	12.3190,	10.9660,	11.1170,
0 SOPCOFAC,	1.0001,	.9879,	1.0108,	.9521,	1.0270,	1.0127,	1.0090,	1.0030,	1.0147,	1.0004,

Table 2 Catch weights at age (kg)

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	.6800,	.6300,	.5720,	.6600,	.7230,	.6720,	.7200,	.6930,	.7210,	.7360,
4,	1.0500,	1.0100,	1.0360,	1.0500,	1.1330,	1.1190,	1.1300,	1.0810,	1.1450,	1.2140,
5,	1.6200,	1.5400,	1.6090,	1.6200,	1.5600,	1.8270,	1.6070,	1.5660,	1.6030,	1.8320,
6,	2.3000,	2.3400,	2.3440,	2.5100,	2.3060,	2.4990,	2.4290,	2.2050,	2.3880,	2.5110,
7,	3.3000,	3.2100,	3.3410,	3.5100,	3.5200,	3.5750,	3.2740,	3.2630,	3.3180,	3.8220,
8,	4.8600,	4.2900,	4.4760,	4.7800,	4.7840,	5.0390,	4.7250,	4.4430,	4.5350,	5.0430,
9,	6.8700,	6.0000,	5.7240,	6.0400,	6.2000,	6.3550,	6.7120,	6.2280,	5.4660,	6.5840,
10,	9.3000,	6.7300,	7.5230,	7.5400,	7.6590,	8.1960,	7.9840,	8.1870,	6.7770,	8.0770,
11,	10.3000,	10.0800,	8.0210,	9.0000,	9.1400,	10.7110,	9.1920,	9.7240,	7.6990,	8.9430,
12,	15.0500,	13.8800,	12.4780,	10.4800,	8.1970,	11.9580,	12.0240,	11.4960,	8.5780,	10.1730,
+gp,	14.5240,	14.0360,	17.2410,	16.1800,	10.3250,	10.6570,	14.2450,	14.4170,	10.1550,	13.3640,
0 SOPCOFAC,	1.0072,	.9967,	1.0039,	.9994,	1.0025,	1.0014,	1.0017,	.9993,	.9981,	.9978,

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Table 3.12. Northeast Arctic Cod. Stock weights at age

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

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Table 3 Stock weights at age (kg)

YEAR,	1946,	1947,
AGE		
3,	.3500,	.3200,
4,	.5900,	.5600,
5,	1.1100,	.9500,
6,	1.6900,	1.5000,
7,	2.3700,	2.1400,
8,	3.1700,	2.9200,
9,	3.9800,	3.6500,
10,	5.0500,	4.5600,
11,	5.9200,	5.8400,
12,	7.2000,	7.4200,
+gp,	8.1460,	8.8480,

Table 3 Stock weights at age (kg)

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	.3400,	.3700,	.3900,	.4000,	.4400,	.4000,	.4400,	.3200,	.3300,	.3300,
4,	.5300,	.6700,	.6400,	.8300,	.8000,	.7600,	.7700,	.5700,	.5800,	.5900,
5,	1.2600,	1.1100,	1.2900,	1.3900,	1.3300,	1.2800,	1.2600,	1.1300,	1.0700,	1.0200,
6,	1.9300,	1.6600,	1.7000,	1.8800,	1.9200,	1.9300,	1.9700,	1.7300,	1.8300,	1.8200,
7,	2.4600,	2.5000,	2.3600,	2.5400,	2.6400,	2.8100,	3.0300,	2.7500,	2.8900,	2.8900,
8,	3.3600,	3.2300,	3.4800,	3.4600,	3.7100,	3.7200,	4.3300,	3.9400,	4.2500,	4.2800,
9,	4.2200,	4.0700,	4.5200,	4.8800,	5.0600,	5.0600,	5.4000,	4.9000,	5.5500,	5.4900,
10,	5.3100,	5.2700,	5.6200,	5.2000,	6.0500,	6.3400,	6.7500,	7.0400,	7.2800,	7.5100,
11,	5.9200,	5.9900,	6.4000,	7.1400,	7.4200,	7.4000,	7.7900,	7.2000,	8.0000,	8.2400,
12,	7.0900,	7.0800,	7.9600,	8.2200,	8.4300,	8.6700,	10.6700,	8.7800,	8.3500,	9.2500,
+gp,	8.4300,	8.2180,	8.8910,	9.3890,	10.1850,	10.2380,	9.6800,	10.0770,	9.9440,	10.6050,

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

At 23/04/2008 9:59

Table 3 Stock weights at age (kg)

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	.3400,	.3500,	.3400,	.3100,	.3200,	.3200,	.3300,	.3800,	.4400,	.2900,
4,	.5200,	.7200,	.5100,	.5500,	.5500,	.6100,	.5500,	.6800,	.7400,	.8100,
5,	.9500,	1.4700,	1.0900,	1.0500,	.9300,	.9600,	.9500,	1.0300,	1.1800,	1.3500,
6,	1.9200,	2.6800,	2.1300,	2.2000,	1.7000,	1.7300,	1.8600,	1.4900,	1.7800,	2.0400,
7,	2.9400,	3.5900,	3.3800,	3.2300,	3.0300,	3.0400,	3.2500,	2.4100,	2.4600,	2.8100,
8,	4.2100,	4.3200,	4.8700,	5.1100,	5.0300,	4.9600,	4.9700,	3.5200,	3.8200,	3.4800,
9,	5.6100,	5.4500,	6.1200,	6.1500,	6.5500,	6.4400,	6.4100,	5.7300,	5.3600,	4.8900,
10,	7.3500,	6.4400,	8.4900,	8.1500,	7.7000,	7.9100,	8.0700,	7.5400,	7.2700,	7.1100,
11,	8.6700,	7.1700,	7.7900,	8.6800,	9.2700,	9.6200,	9.3400,	8.4700,	8.6300,	9.0300,
12,	9.5800,	8.6300,	8.3000,	9.6000,	10.5600,	11.3100,	10.1600,	11.1700,	10.6600,	10.5900,
+gp,	11.6310,	11.6210,	11.4220,	11.9520,	12.7170,	12.7370,	12.8860,	13.7220,	14.1480,	13.8290,

Table 3 Stock weights at age (kg)

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	.3300,	.4400,	.3700,	.4500,	.3800,	.3800,	.3200,	.4100,	.3500,	.4900,
4,	.7000,	.7900,	.9100,	.8800,	.7700,	.9100,	.6600,	.6400,	.7300,	.9000,
5,	1.4800,	1.2300,	1.3400,	1.3800,	1.4300,	1.5400,	1.1700,	1.1100,	1.1900,	1.4300,
6,	2.1200,	2.0300,	2.0000,	2.1600,	2.1200,	2.2600,	2.2200,	1.9000,	2.0100,	2.0500,
7,	3.1400,	2.9000,	3.0000,	3.0700,	3.2300,	3.2900,	3.2100,	2.9500,	2.7600,	3.3000,
8,	4.2100,	3.8100,	4.1500,	4.2200,	4.3800,	4.6100,	4.3900,	4.3700,	4.2200,	4.5600,
9,	5.2700,	5.0200,	5.5900,	5.8100,	5.8300,	6.5700,	5.5200,	5.7400,	5.8800,	6.4600,
10,	6.6500,	6.4300,	7.6000,	7.1300,	7.6200,	8.3700,	7.8600,	8.7700,	9.3000,	8.6300,
11,	9.0100,	8.3300,	8.9700,	8.6200,	9.5200,	10.5400,	9.8200,	9.9200,	10.2800,	9.9300,
12,	9.6600,	10.7100,	10.9900,	10.8300,	12.0900,	11.6200,	11.4100,	11.8100,	11.8600,	10.9000,
+gp,	14.8480,	14.2110,	14.0740,	12.9450,	13.6730,	13.9040,	13.2420,	13.1070,	13.5440,	13.6680,

Table 3.12 (continued).

Table 3 Stock weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	.4900,	.3500,	.2700,	.4900,	.3700,	.3700,	.4200,	.4130,	.3110,	.2110,
4,	.8100,	.7000,	.5600,	.9800,	.6600,	.9200,	1.1600,	.8750,	.8800,	.4980,
5,	1.4500,	1.2400,	1.0200,	1.4400,	1.3500,	1.6000,	1.8100,	1.6030,	1.4700,	1.2540,
6,	2.1500,	2.1400,	1.7200,	2.0900,	1.9900,	2.4400,	2.7900,	2.8100,	2.4670,	2.0470,
7,	3.0400,	3.1500,	3.0200,	2.9800,	2.9300,	3.8200,	3.7800,	4.0590,	3.9150,	3.4310,
8,	4.4600,	4.2900,	4.2000,	4.8500,	4.2400,	4.7600,	4.5700,	5.8330,	5.8100,	5.1370,
9,	6.5400,	6.5800,	5.8400,	6.5700,	6.4600,	6.1700,	6.1700,	7.6850,	6.5800,	6.5230,
10,	7.9800,	8.6100,	7.2600,	9.1600,	8.5100,	7.7000,	7.7000,	10.1170,	6.8330,	9.3000,
11,	10.1500,	9.2200,	8.8400,	10.8200,	12.2400,	9.2500,	9.2500,	14.2900,	11.0040,	13.1500,
12,	10.8500,	10.8900,	9.2800,	10.7700,	10.7800,	10.8500,	10.8500,	12.7310,	12.7310,	12.7310,
+gp,	13.1770,	14.3440,	14.4480,	13.9320,	14.0410,	12.9880,	13.0330,	14.3110,	14.3110,	14.3110,

Table 3 Stock weights at age (kg)

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	.2120,	.2990,	.3980,	.5180,	.4400,	.3440,	.2350,	.2010,	.1950,	.2020,
4,	.4040,	.5200,	.7050,	1.1360,	.9310,	1.1720,	.7530,	.4850,	.4870,	.5210,
5,	.7900,	.8680,	1.1820,	1.7430,	1.8120,	1.8200,	1.4200,	1.1400,	.9710,	1.0790,
6,	1.9030,	1.4770,	1.7190,	2.4280,	2.7160,	2.8230,	2.4130,	2.1180,	2.0540,	1.8780,
7,	2.9770,	2.6860,	2.4580,	3.2140,	3.8950,	4.0310,	3.8250,	3.4700,	3.5270,	3.3690,
8,	4.3920,	4.6280,	3.5650,	4.5380,	5.1760,	5.4970,	5.4160,	4.9380,	5.5030,	5.2630,
9,	7.8120,	7.0480,	4.7100,	6.8800,	6.7740,	6.7650,	6.6310,	7.1600,	7.7670,	8.9270,
10,	12.1120,	9.9800,	7.8010,	10.7190,	9.5980,	8.5710,	7.6300,	9.1190,	10.1590,	12.1540,
11,	13.1070,	9.2500,	8.9560,	9.4450,	12.4270,	10.8470,	8.1120,	10.1010,	10.6690,	11.2040,
12,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,
+gp,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,

Table 3 Stock weights at age (kg)

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	.2170,	.2030,	.1940,	.2850,	.2510,	.2300,	.2500,	.2310,	.2560,	.2620,
4,	.5330,	.5200,	.4650,	.5220,	.6050,	.5370,	.5460,	.6240,	.6020,	.6990,
5,	1.1610,	1.1740,	1.2080,	1.1960,	1.1890,	1.3100,	1.0870,	1.1180,	1.2010,	1.3410,
6,	1.9390,	2.0310,	1.9720,	2.2390,	2.1380,	2.0090,	2.0350,	1.9320,	2.0090,	2.1210,
7,	2.9450,	3.0340,	3.0480,	3.3130,	3.3330,	3.2410,	2.9210,	3.0460,	3.1140,	3.1670,
8,	4.5740,	4.4640,	4.0960,	5.1180,	4.7660,	4.9710,	4.3840,	3.9550,	4.4270,	4.6400,
9,	7.4230,	6.4820,	5.7240,	6.3760,	6.8590,	6.7390,	6.2540,	5.8110,	6.0300,	6.4950,
10,	10.3670,	10.2690,	7.4570,	9.2410,	9.3330,	8.7060,	8.5430,	8.2890,	8.0370,	9.1230,
11,	11.7380,	10.8820,	9.5820,	11.3220,	10.1860,	15.0260,	9.7350,	13.4400,	9.9280,	11.7800,
12,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	12.7310,	15.7840,	17.2550,
+gp,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	14.3110,	17.5330,	14.3110,

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Table 3.13. Northeast Arctic cod. Proportion mature at age.

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

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Table 5 Proportion mature at age

YEAR,	1946,	1947,
AGE		
3,	.0000,	.0000,
4,	.0000,	.0000,
5,	.0100,	.0100,
6,	.0300,	.0300,
7,	.0600,	.0600,
8,	.1100,	.1300,
9,	.1800,	.1600,
10,	.4400,	.4200,
11,	.6500,	.7500,
12,	.8600,	.9100,
+gp,	.9600,	.9500,

Table 5 Proportion mature at age

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
5,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.0700,	.0900,	.0900,	.1000,	.0800,	.0700,	.0800,	.0700,	.0600,	.0600,
8,	.1300,	.1700,	.2300,	.2400,	.2200,	.1900,	.1600,	.1300,	.1200,	.0900,
9,	.2500,	.2900,	.3500,	.4000,	.4100,	.4000,	.3700,	.2600,	.1400,	.1200,
10,	.4700,	.5400,	.5200,	.5800,	.6300,	.6400,	.6800,	.5300,	.4100,	.2200,
11,	.7300,	.7900,	.7900,	.7200,	.8200,	.8400,	.8700,	.8300,	.6700,	.6000,
12,	.9100,	.8800,	.9500,	.8500,	.9200,	.9400,	.9300,	.9200,	.9100,	.8200,
+gp,	.9700,	.9700,	.9700,	.9600,	.9700,	.9700,	.9600,	.9700,	.9600,	.9700,

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

At 23/04/2008 9:59

Table 5 Proportion mature at age

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0100,	.0000,	.0000,	.0100,	.0000,	.0000,	.0000,	.0000,
5,	.0100,	.0100,	.0300,	.0100,	.0100,	.0100,	.0000,	.0000,	.0100,	.0000,
6,	.0300,	.0400,	.0600,	.0600,	.0500,	.0300,	.0300,	.0100,	.0200,	.0300,
7,	.0600,	.1200,	.1000,	.1200,	.1500,	.0700,	.1300,	.0600,	.0600,	.0700,
8,	.1000,	.3400,	.1900,	.3100,	.3400,	.2800,	.3700,	.2000,	.2200,	.1400,
9,	.1000,	.4900,	.4500,	.6500,	.6100,	.4200,	.6600,	.5500,	.3500,	.3800,
10,	.3000,	.6700,	.6900,	.9100,	.8100,	.8100,	.8900,	.7300,	.7400,	.6400,
11,	.5000,	.8400,	.7700,	.9800,	.9200,	.9800,	.9500,	.9900,	.9400,	.8900,
12,	.8200,	.8700,	.8500,	.9800,	.9700,	.9800,	.9900,	.9800,	.9400,	.9000,
+gp,	.9700,	1.0000,	.9900,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0100,	.0000,	.0200,	.0000,	.0000,	.0000,	.0000,	.0000,
5,	.0300,	.0000,	.0000,	.0100,	.0200,	.0000,	.0000,	.0100,	.0000,	.0200,
6,	.0500,	.0200,	.0100,	.0500,	.0100,	.0200,	.0100,	.0200,	.0500,	.0800,
7,	.0900,	.0400,	.0700,	.1100,	.1000,	.1600,	.0300,	.0900,	.1200,	.2600,
8,	.1900,	.1200,	.2300,	.3000,	.3400,	.5300,	.2100,	.2100,	.2900,	.5400,
9,	.3900,	.3400,	.5800,	.5900,	.6400,	.8100,	.5000,	.5600,	.4500,	.7600,
10,	.5800,	.5500,	.8100,	.7900,	.8100,	.9200,	.9600,	.7800,	.8400,	.8700,
11,	.8200,	.7400,	.8900,	.8600,	.9400,	.9500,	1.0000,	.7900,	.8300,	.9300,
12,	1.0000,	.9500,	.9100,	.8800,	1.0000,	.9800,	.9600,	.9500,	1.0000,	.9400,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	.9000,

Table 3.13 (continued).

Table 5 Proportion mature at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0100,	.0000,	.0000,	.0000,	.0000,
4,	.0000,	.0000,	.0000,	.0000,	.0500,	.0800,	.0500,	.0100,	.0500,	.0100,
5,	.0000,	.0000,	.0000,	.0200,	.1000,	.1000,	.1800,	.0900,	.0800,	.0700,
6,	.0200,	.0300,	.0200,	.0700,	.3400,	.3000,	.3100,	.3600,	.1900,	.1800,
7,	.1300,	.1300,	.1300,	.2000,	.6500,	.7300,	.5600,	.5500,	.5300,	.2200,
8,	.4400,	.3900,	.3500,	.5400,	.8200,	.8800,	.9000,	.8500,	.7100,	.4600,
9,	.7100,	.7700,	.6500,	.8000,	.9200,	.9700,	.9900,	.9600,	.6200,	.5000,
10,	.7700,	.8900,	.8200,	.9700,	1.0000,	1.0000,	1.0000,	.9000,	.9000,	.7500,
11,	.8100,	.8300,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	.8900,	.7800,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	.8000,	.9000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	.0000,	.0080,	.0080,	.0010,	.0010,	.0000,	.0030,	.0000,	.0000,	.0000,
4,	.0200,	.0030,	.0130,	.0320,	.0140,	.0280,	.0070,	.0030,	.0000,	.0000,
5,	.0500,	.0290,	.0510,	.0750,	.1450,	.0870,	.1190,	.0610,	.0190,	.0120,
6,	.3300,	.2280,	.2100,	.3050,	.4190,	.3680,	.3350,	.3720,	.2580,	.1400,
7,	.5300,	.5470,	.5220,	.7080,	.8000,	.7040,	.5890,	.6240,	.6310,	.6070,
8,	.6200,	.7050,	.7150,	.8610,	.9430,	.9310,	.8620,	.7810,	.8200,	.8300,
9,	1.0000,	.9150,	.9050,	.9570,	.9740,	.9720,	.9630,	.9600,	.9750,	.9460,
10,	1.0000,	1.0000,	.9750,	1.0000,	1.0000,	.9940,	.9900,	.9790,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	.0010,	.0020,	.0000,	.0030,	.0020,	.0010,	.0010,	.0000,	.0000,	.0000,
4,	.0030,	.0020,	.0010,	.0030,	.0130,	.0010,	.0100,	.0040,	.0010,	.0040,
5,	.0260,	.0140,	.0710,	.0650,	.0840,	.0880,	.0910,	.0680,	.0600,	.0720,
6,	.1520,	.1870,	.2470,	.3590,	.3880,	.3260,	.4420,	.3970,	.3690,	.3430,
7,	.4720,	.5440,	.6430,	.6240,	.6830,	.6720,	.7260,	.7160,	.6470,	.7230,
8,	.8140,	.8470,	.8300,	.8190,	.8410,	.8880,	.8720,	.8920,	.8970,	.8760,
9,	.9570,	.9650,	.9780,	.9520,	.9510,	.9570,	.9760,	.9670,	.9650,	.9760,
10,	.9800,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9770,	.9910,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

1

Table 3.14. Northeast 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)(Effort:Unknown)
1985    2007
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
FLT15:  NorBarTrSur     rev99   (Catch: Unknown)        (Effort:        Unknown)
1980    2007
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
```

Table 3.14 (continued)

	FLT16:	NorBarLofAcSur		rev99	(Catch:	Unknown)		(Effort:		Unknown)
1984	2007									
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		

FLT18:	RusSweptArea		rev05	(ages	3-9)	(Catch:	Unknown)		(	(Catch:	Unknown)
	(Effort:		Unknown)								
1982	2007										
1	1	0.9	1								
3	9	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	877	1380	557	1182	482	301	101			
	1	2579	1617	1903	846	1525	553	226			

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

		FLT 09 Rus trawl CPUE	FLT 15 Joint BT survey	FLT 16 Joint+Lof Ac survey	FLT 18 Rus BT survey	Final run ALL Fleets
Min. SE for shrinkage		1.0	1.0	1.0	1.0	1.0
SS-ind.Q for age>		6	6	6	6	6
ages with fleet data		9 to 11	3 to 8	3 to 9	3 to 9	3 to 11
# of iterations to convergence		>30	26	>30	>30	>30
age3	PshrinkW	**0.89**	**0.57**	**0.74**	**0.55**	**0.34**
	FshrinkW	0.11	0.04	0.07	0.04	0.03
age4	PshrinkW	**0.87**	**0.39**	**0.42**	**0.37**	0.19
	FshrinkW	0.13	0.03	0.04	0.03	0.02
age5	PshrinkW	**0.849**	**0.36**	**0.36**	**0.32**	0.16
	FshrinkW	0.151	0.03	0.04	0.03	0.01
age6	FshrinkW	**1.00**	0.04	0.07	0.04	0.02
age7	FshrinkW	**1.00**	0.06	0.07	0.05	0.02
age8	FshrinkW	**1.00**	0.07	0.10	0.05	0.03
age9	FshrinkW	0.15	0.16	0.08	0.07	0.03
age10	FshrinkW	0.09	**0.50**	0.14	0.25	0.04
age11	FshrinkW	0.09	**0.64**	**0.32**	**0.44**	0.06
age12	FshrinkW	0.18	**0.78**	**0.44**	**0.57**	0.13
N2007	age3	56230	67991	65200	68952	78626
N*10^-4	age4	36230	37593	41409	41855	39942
	age5	24200	26530	25458	30471	28550
	age6	6487	10369	8876	10836	10472
	age7	6864	9231	9215	11659	10421
	age8	2149	2837	2323	3552	2917
	age9	935	1064	1106	1484	1244
	age10	454	272	516	350	497
F2007	age 4	0.158	0.152	0.137	0.136	0.143
	age5	0.339	0.304	0.319	0.259	0.279
	age6	0.594	0.329	0.397	0.312	0.325
	age7	0.807	0.531	0.532	0.395	0.454
	age8	0.863	0.576	0.765	0.430	0.555
	age9	0.658	0.551	0.524	0.362	0.450
	age10	0.409	0.822	0.351	0.573	0.367
2007	F(5-10)	0.612	0.519	0.481	0.389	0.405
	F(4-8)	0.552	0.378	0.430	0.306	0.351
TSB2007	incl Age1-2	1406128	1659963	1643223	1906796	1816455
SSB2007	('000 T)	447353	546797	548868	676471	618518
N2008	age3					52701
N*10^-4	age4	37225	46854	44571	47642	55562
	age5	25320	26436	29562	29927	28360
	age6	14123	16030	15153	19258	17684
	age7	2931	6109	4888	6492	6194
	age8	2508	4446	4433	6435	5420
	age9	742	1306	885	1891	1372
	age10	396	502	537	847	650
Survivors	age3		626497	782567	575096	
end of 07	age4		257353	321728	305322	
direct	age5		161555	149964	208515	
predic.	age6		62744	50358	66560	
by the	age7		45914	46103	66990	
survey	age8		13622	8965	19872	
N*10^-3	age9	4154	5698	5630	9243	
	age10	2661	946	3492	1869	
F2007	age3		0.132	0.107	0.143	
	age4		0.156	0.127	0.133	
direct	age5		0.302	0.322	0.241	
predic.	age6		0.322	0.387	0.306	
by the	age7		0.517	0.516	0.382	
survey	age8		0.558	0.758	0.413	
	age9	0.636	0.500	0.504	0.336	
	age10	0.385	0.842	0.306	0.512	

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

Lowestoft VPA Version 3.1

23/04/2008 9:49

Extended Survivors Analysis

Arctic Cod (run: XSAASA01/X01)

CPUE data from file fleet

Catch data for 24 years. 1984 to 2007. Ages 1 to 13.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT09: Russian trawl,	1998,	2007,	9,	11,	.000,	1.000
FLT15: NorBarTrSur r,	1998,	2007,	3,	8,	.990,	1.000
FLT16: NorBarLofAcSu,	1998,	2007,	3,	9,	.990,	1.000
FLT18: RusSweptAre,	1998,	2007,	3,	9,	.900,	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 10 years

Catchability analysis :

Catchability dependent on stock size for ages < 6

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

Catchability independent of age for ages >= 10

Terminal population estimation :

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

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

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

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00083

Final year F values

Age ,	1,	2,	3,	4,	5,	6,	7,	8,	9,	10
Iteration 29,	.8352,	.2887,	.1472,	.1425,	.2790,	.3252,	.4537,	.5548,	.4500,	.3667
Iteration 30,	.8352,	.2887,	.1472,	.1425,	.2790,	.3252,	.4537,	.5548,	.4500,	.3666

Age ,	11,	12
Iteration 29,	.4807,	.6122
Iteration 30,	.4805,	.6119

Regression weights

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

Fishing mortalities

Age,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007
1,	1.627,	1.099,	1.391,	.958,	.616,	1.409,	1.001,	1.181,	1.162,	.835
2,	.630,	.362,	.259,	.207,	.418,	.277,	.568,	.239,	.126,	.289
3,	.377,	.127,	.078,	.062,	.114,	.050,	.079,	.179,	.030,	.147
4,	.352,	.210,	.140,	.118,	.106,	.074,	.106,	.118,	.145,	.142
5,	.520,	.547,	.411,	.285,	.291,	.275,	.265,	.407,	.256,	.279
6,	.779,	.720,	.604,	.519,	.557,	.478,	.527,	.585,	.518,	.325
7,	.773,	.809,	.742,	.670,	.806,	.680,	.767,	.809,	.686,	.454
8,	1.042,	1.061,	1.032,	.818,	.891,	.699,	.884,	.842,	.760,	.555
9,	1.171,	1.389,	1.193,	.881,	.753,	.579,	.799,	.921,	.841,	.450
10,	1.240,	1.422,	1.159,	1.143,	.724,	.470,	.866,	.827,	.745,	.367
11,	1.336,	.931,	1.112,	.812,	.694,	.429,	.578,	.779,	.679,	.481
12,	1.304,	1.188,	1.151,	1.055,	.766,	.760,	.879,	.392,	.773,	.612

Table 3.16 N (continued)

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9	10
1998	6.68E+06	1.27E+06	8.54E+05	4.23E+05	1.38E+05	8.37E+04	7.09E+04	4.50E+04	1.05E+04	1.50E+03
1999	3.04E+06	1.07E+06	5.54E+05	4.79E+05	2.43E+05	6.71E+04	3.14E+04	2.68E+04	1.30E+04	2.68E+03
2000	3.28E+06	8.29E+05	6.13E+05	4.00E+05	3.18E+05	1.15E+05	2.67E+04	1.15E+04	7.59E+03	2.65E+03
2001	4.04E+06	6.68E+05	5.24E+05	4.64E+05	2.85E+05	1.73E+05	5.16E+04	1.04E+04	3.35E+03	1.89E+03
2002	1.09E+06	1.27E+06	4.44E+05	4.03E+05	3.38E+05	1.75E+05	8.41E+04	2.16E+04	3.76E+03	1.13E+03
2003	6.35E+06	4.83E+05	6.84E+05	3.25E+05	2.97E+05	2.07E+05	8.22E+04	3.08E+04	7.26E+03	1.45E+03
2004	2.59E+06	1.27E+06	3.00E+05	5.32E+05	2.47E+05	1.85E+05	1.05E+05	3.41E+04	1.25E+04	3.33E+03
2005	4.34E+06	7.80E+05	5.89E+05	2.27E+05	3.92E+05	1.55E+05	8.92E+04	3.99E+04	1.15E+04	4.61E+03
2006	3.35E+06	1.09E+06	5.03E+05	4.03E+05	1.65E+05	2.14E+05	7.07E+04	3.25E+04	1.41E+04	3.76E+03
2007	2.38E+06	8.59E+05	7.86E+05	3.99E+05	2.85E+05	1.05E+05	1.04E+05	2.92E+04	1.24E+04	4.97E+03

Estimated population abundance at 1st Jan 2008

	0.00E+00	8.45E+05	5.27E+05	5.56E+05	2.84E+05	1.77E+05	6.19E+04	5.42E+04	1.37E+04	6.50E+03

Taper weighted geometric mean of the VPA populations:

	3.11E+06	8.86E+05	5.35E+05	3.78E+05	2.75E+05	1.62E+05	7.90E+04	2.75E+04	9.11E+03	2.87E+03

Standard error of the weighted Log(VPA populations) :

	.5167	.3407	.3231	.2814	.2900	.2985	.3642	.4207	.5343	.5621

YEAR	AGE 11	12
1998	2.95E+02	1.05E+02
1999	3.56E+02	6.36E+01
2000	5.29E+02	1.15E+02
2001	6.82E+02	1.42E+02
2002	4.92E+02	2.48E+02
2003	4.50E+02	2.01E+02
2004	7.42E+02	2.40E+02
2005	1.15E+03	3.41E+02
2006	1.65E+03	4.31E+02
2007	1.46E+03	6.86E+02

Estimated population abundance at 1st Jan 2008

	2.82E+03	7.41E+02

Taper weighted geometric mean of the VPA populations:

	8.67E+02	2.92E+02

Standard error of the weighted Log(VPA populations) :

	.5443	.5927

Log catchability residuals.

Fleet : FLT09: Russian trawl

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
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	-.71	-.32	.38	.12	.41	-.08	-.12	-.20	.24	-.26
10	-.46	-.25	.15	.01	.01	.26	.35	-.26	-.22	-.08
11	.25	99.99	-.26	-.10	-.39	-.06	.19	-.16	-.01	.12

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

Age	9	10	11
Mean Log q	-3.5344	-3.6554	-3.6554
S.E(Log q)	.2623	.2433	.1974

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
9	1.34	-1.232	1.66	.76	10	.33	-3.53
10	1.24	-1.053	2.60	.81	10	.30	-3.66
11	.88	.889	4.09	.92	9	.17	-3.70

Table 3.16 N (continued)

Fleet : FLT15: NorBarTrSur r

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	-.11	-.01	.06	.02	.19	-.10	.10	-.15	-.25	.24
4	-.08	.10	.07	.09	.10	.00	-.13	-.05	-.11	.13
5	.24	.11	-.03	.07	.17	.05	-.13	-.17	-.04	.12
6	.09	-.16	-.09	-.05	.17	.32	-.08	-.27	-.09	.11
7	.23	.14	-.36	-.31	.05	.39	-.29	.00	.08	.07
8	-.26	.27	-.01	-.41	.14	.12	-.23	-.19	.19	.19
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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

Age	6	7	8
Mean Log q	-6.2792	-6.4980	-6.7292
S.E(Log q)	.1979	.2392	.2272

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	.63	1.320	8.47	.75	10	.21	-5.72
4	.63	1.999	8.50	.87	10	.12	-5.99
5	.60	1.919	8.73	.84	10	.14	-6.16

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	.95	.160	6.56	.72	10	.21	-6.28
7	.87	.491	7.13	.76	10	.22	-6.50
8	.90	.447	7.09	.82	10	.22	-6.73

Fleet : FLT16: NorBarLofAcSu

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	-.25	.32	.23	.16	.36	-.22	.09	-.24	-.41	.32
4	-.10	.25	.13	.09	.33	-.11	-.27	-.07	-.31	.39
5	.16	.31	.05	.17	.39	-.07	-.10	-.37	-.12	.23
6	-.16	.15	-.08	-.01	.63	.07	.15	-.55	-.02	-.05
7	.31	.16	-.79	-.15	.30	.24	-.17	-.07	-.08	.18
8	.28	.25	-.80	-.51	-.02	.28	.20	.16	.12	-.23
9	-.29	-.10	-.45	-.12	-.37	.28	-.24	.25	.35	-.14
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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

Age	6	7	8	9
Mean Log q	-5.4859	-5.2829	-5.2388	-5.3073
S.E(Log q)	.3369	.2653	.3107	.3007

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	.53	1.030	9.47	.53	10	.34	-6.16
4	.46	1.115	9.77	.50	10	.31	-6.21
5	.50	1.176	9.22	.57	10	.28	-5.95

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	.83	.389	6.61	.54	10	.30	-5.49
7	.71	1.375	7.00	.84	10	.17	-5.28
8	.62	3.091	7.13	.94	10	.12	-5.24
9	.82	.884	6.00	.85	10	.25	-5.31

1

Table 3.16 N (continued)

Fleet : FLT18: RusSweptAre

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	-.03	.16	.11	.06	.13	-.21	-.04	.06	-.09	.06
4	.14	.24	-.02	-.03	.05	-.03	-.17	-.06	.03	.17
5	.55	.14	.17	-.01	-.09	-.12	-.12	-.03	-.02	.24
6	.21	-.07	.22	.06	-.09	-.04	.04	-.13	-.05	.14
7	-.64	-.53	-.51	-.26	.06	-.15	.06	.02	-.10	.45
8	-.82	-.61	-.38	-.52	.11	-.15	.07	-.26	.08	.60
9	-.11	-.25	-.50	-.47	.02	-.49	.02	.16	.03	.58
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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

Age	6	7	8	9
Mean Log q	-4.4647	-4.0510	-3.8494	-3.9756
S.E(Log q)	.1115	.2686	.3614	.3766

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	.50	2.876	9.55	.89	10	.13	-5.90
4	.83	.868	6.68	.86	10	.13	-5.40
5	.64	1.529	7.65	.81	10	.16	-4.95

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	1.25	-1.325	2.57	.87	10	.13	-4.46
7	.63	2.862	6.75	.93	10	.11	-4.05
8	.78	.738	5.28	.72	10	.29	-3.85
9	.73	1.293	5.37	.84	10	.26	-3.98

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1.	.000	.000	.00	0	.000	.000
FLT15: NorBarTrSur r	1.	.000	.000	.00	0	.000	.000
FLT16: NorBarLofAcSu	1.	.000	.000	.00	0	.000	.000
FLT18: RusSweptAre	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	886038.	.34				.896	.809
F shrinkage mean	561383.	1.00				.104	1.087

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
844968.	.32	13.65	2	42.320	.835

1

Age 2 Catchability dependent on age and year class strength

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT09: Russian trawl	1.	.000	.000	.00	0	.000	.000
FLT15: NorBarTrSur r	1.	.000	.000	.00	0	.000	.000
FLT16: NorBarLofAcSu	1.	.000	.000	.00	0	.000	.000
FLT18: RusSweptAre	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	535173.	.32				.905	.285
F shrinkage mean	454863.	1.00				.095	.328

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
527010.	.31	13.18	2	42.850	.289

Table 3.16 N (continued)

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

Year class = 2004

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,    704808.,   .300,       .000,    .00,   1,  .257,     .118
FLT16: NorBarLofAcSu,    768546.,   .435,       .000,    .00,   1,  .122,     .109
  FLT18: RusSweptAre,    591149.,   .300,       .000,    .00,   1,  .257,     .139

  P shrinkage mean  ,    377950.,    .28,,,,                        .338,     .210

  F shrinkage mean  ,    928169.,   1.00,,,,                        .027,     .091

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   555620.,       .16,      .17,    5,   1.104,   .147

Age  4   Catchability dependent on age and year class strength

Year class = 2003

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,    267920.,   .212,       .193,    .91,   2,  .303,     .150
FLT16: NorBarLofAcSu,    291860.,   .270,       .395,   1.46,   2,  .187,     .139
  FLT18: RusSweptAre,    296219.,   .212,       .127,    .60,   2,  .303,     .137

  P shrinkage mean  ,    275225.,    .29,,,,                        .190,     .147

  F shrinkage mean  ,    372622.,   1.00,,,,                        .016,     .110

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   283598.,       .12,      .08,    8,    .700,   .142

Age  5   Catchability dependent on age and year class strength

Year class = 2002

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,    171763.,   .175,       .086,    .49,   3,  .298,     .286
FLT16: NorBarLofAcSu,    167909.,   .199,       .180,    .90,   3,  .235,     .292
  FLT18: RusSweptAre,    199452.,   .175,       .067,    .38,   3,  .298,     .251

  P shrinkage mean  ,    161708.,    .30,,,,                        .155,     .302

  F shrinkage mean  ,    162578.,   1.00,,,,                        .014,     .300

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   176842.,       .10,      .05,   11,    .539,   .279

1
Age  6   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
FLT09: Russian trawl,         1.,   .000,       .000,    .00,   0,  .000,     .000
FLT15: NorBarTrSur r,     64145.,   .154,       .042,    .27,   4,  .373,     .316
FLT16: NorBarLofAcSu,     58975.,   .195,       .039,    .20,   4,  .238,     .339
  FLT18: RusSweptAre,     63292.,   .154,       .051,    .33,   4,  .373,     .319

  F shrinkage mean  ,     33458.,   1.00,,,,                        .015,     .537

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    61938.,       .10,      .03,   13,    .348,   .325
```

Table 3.16 N (continued)

Age 7 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
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	51804.,	.152,	.048,	.31,	5,	.343,	.470
FLT16: NorBarLofAcSu,	52273.,	.167,	.109,	.65,	5,	.296,	.467
FLT18: RusSweptAre,	60731.,	.152,	.135,	.89,	5,	.343,	.414
F shrinkage mean ,	27503.,	1.00,,,,				.019,	.757

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
54204.,	.09,	.06,	16,	.678,	.454

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

Year class = 1999

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT15: NorBarTrSur r,	14731.,	.159,	.071,	.45,	6,	.367,	.525
FLT16: NorBarLofAcSu,	11476.,	.174,	.078,	.45,	6,	.306,	.635
FLT18: RusSweptAre,	15780.,	.164,	.144,	.88,	6,	.301,	.497
F shrinkage mean ,	7955.,	1.00,,,,				.026,	.824

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
13717.,	.10,	.06,	19,	.670,	.555

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

Year class = 1998

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	5012.,	.300,	.000,	.00,	1,	.198,	.552
FLT15: NorBarTrSur r,	7116.,	.169,	.045,	.27,	6,	.188,	.418
FLT16: NorBarLofAcSu,	6238.,	.190,	.053,	.28,	7,	.327,	.465
FLT18: RusSweptAre,	8458.,	.198,	.112,	.57,	7,	.259,	.362
F shrinkage mean ,	3088.,	1.00,,,,				.028,	.786

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
6498.,	.11,	.06,	22,	.555,	.450

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

Year class = 1997

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT09: Russian trawl,	2871.,	.228,	.146,	.64,	2,	.461,	.361
FLT15: NorBarTrSur r,	2545.,	.178,	.092,	.52,	6,	.116,	.399
FLT16: NorBarLofAcSu,	3535.,	.201,	.071,	.35,	7,	.214,	.303
FLT18: RusSweptAre,	2714.,	.210,	.048,	.23,	7,	.168,	.379
F shrinkage mean ,	1155.,	1.00,,,,				.042,	.733

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2822.,	.13,	.06,	23,	.444,	.367

Age 11 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
FLT09: Russian trawl,	730.,	.203,	.116,	.57,	3,	.687,	.486
FLT15: NorBarTrSur r,	736.,	.194,	.117,	.60,	6,	.055,	.483
FLT16: NorBarLofAcSu,	948.,	.211,	.033,	.16,	7,	.112,	.393
FLT18: RusSweptAre,	791.,	.228,	.049,	.21,	7,	.085,	.456
F shrinkage mean ,	512.,	1.00,,,,				.060,	.638

Table 3.16 N (continued)

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
741.,	.16,	.04,	24,	.270,	.481

1

Age 12 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
FLT09: Russian trawl,	278.,	.206,	.076,	.37,	3,	.637,	.655
FLT15: NorBarTrSur r,	331.,	.228,	.026,	.12,	6,	.051,	.575
FLT16: NorBarLofAcSu,	292.,	.223,	.102,	.46,	7,	.105,	.631
FLT18: RusSweptAre,	303.,	.247,	.035,	.14,	7,	.078,	.615
F shrinkage mean ,	483.,	1.00,,,,				.130,	.427

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
305.,	.19,	.05,	24,	.256,	.612

1

Table 3.17

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 23/04/2008 9:49

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,
AGE				
1,	.2457,	.3591,	.9368,	.5267,
2,	.0373,	.0577,	.8027,	.8028,
3,	.0199,	.0533,	.1451,	.1137,
4,	.1235,	.1701,	.2122,	.2285,
5,	.3075,	.3763,	.4933,	.5097,
6,	.6274,	.6051,	.7052,	.9363,
7,	1.1361,	.9248,	.9480,	1.1398,
8,	1.2111,	1.0189,	1.0909,	1.0143,
9,	1.2623,	.7786,	.8281,	.7784,
10,	.9579,	.5057,	1.1120,	1.3241,
11,	1.0876,	.4205,	.8745,	1.0270,
12,	1.0345,	.4665,	1.0045,	1.1899,
+gp,	1.0345,	.4665,	1.0045,	1.1899,
0 FBAR 5-10,	.9171,	.7016,	.8629,	.9504,

Table 8 Fishing mortality (F) at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
1,	.8044,	.2157,	.0962,	.1019,	.4666,	2.5650,	1.7145,	1.8671,	1.9949,	2.5162,
2,	.1102,	.0020,	.0594,	.2364,	.1451,	.4493,	.6303,	.9349,	1.0579,	1.0884,
3,	.0629,	.0327,	.0086,	.0182,	.0405,	.0790,	.2053,	.5531,	.4707,	.3369,
4,	.1270,	.1284,	.0622,	.0624,	.1265,	.0961,	.1986,	.3042,	.3528,	.2988,
5,	.3704,	.2660,	.1342,	.1875,	.2205,	.3465,	.3391,	.3381,	.4118,	.5691,
6,	.5971,	.4016,	.2310,	.3210,	.4428,	.4597,	.6456,	.5772,	.5426,	.7241,
7,	1.0446,	.7156,	.2504,	.4259,	.5396,	.5663,	1.1681,	.8908,	.7496,	.8426,
8,	.9834,	.8891,	.3742,	.3451,	.5993,	.5976,	.9863,	.9434,	.8622,	1.2345,
9,	1.1591,	.7166,	.3058,	.3805,	.4558,	.6665,	1.0542,	.9617,	.7519,	1.3360,
10,	1.7180,	.9855,	.3242,	.2560,	.4586,	.6631,	1.0399,	1.0193,	.9393,	1.5098,
11,	1.5371,	.5821,	.5400,	.1340,	.2482,	.6763,	1.1611,	1.2531,	.8661,	1.4409,
12,	1.6497,	.7917,	.4352,	.1959,	.3556,	.6759,	1.1136,	1.1499,	.9125,	1.4949,
+gp,	1.6497,	.7917,	.4352,	.1959,	.3556,	.6759,	1.1136,	1.1499,	.9125,	1.4949,
0 FBAR 5-10,	.9788,	.6624,	.2700,	.3193,	.4528,	.5500,	.8722,	.7884,	.7095,	1.0360,

1

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

At 23/04/2008 9:49

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	FBAR **-**
AGE											
1,	1.6265,	1.0989,	1.3909,	.9582,	.6164,	1.4094,	1.0015,	1.1813,	1.1619,	.8352,	1.0595,
2,	.6301,	.3619,	.2592,	.2074,	.4185,	.2767,	.5684,	.2389,	.1264,	.2887,	.2180,
3,	.3770,	.1265,	.0780,	.0624,	.1142,	.0504,	.0785,	.1790,	.0301,	.1472,	.1188,
4,	.3525,	.2099,	.1397,	.1177,	.1062,	.0738,	.1064,	.1182,	.1448,	.1425,	.1352,
5,	.5201,	.5475,	.4108,	.2852,	.2907,	.2746,	.2647,	.4065,	.2555,	.2790,	.3137,
6,	.7792,	.7199,	.6037,	.5195,	.5565,	.4782,	.5269,	.5852,	.5179,	.3252,	.4761,
7,	.7726,	.8088,	.7423,	.6702,	.8057,	.6798,	.7666,	.8092,	.6858,	.4537,	.6496,
8,	1.0420,	1.0607,	1.0318,	.8182,	.8907,	.6987,	.8839,	.8419,	.7604,	.5548,	.7190,
9,	1.1712,	1.3891,	1.1926,	.8814,	.7530,	.5790,	.7992,	.9208,	.8409,	.4500,	.7372,
10,	1.2398,	1.4217,	1.1588,	1.1433,	.7243,	.4698,	.8658,	.8268,	.7448,	.3666,	.6461,
11,	1.3357,	.9313,	1.1117,	.8121,	.6942,	.4287,	.5782,	.7794,	.6793,	.4805,	.6464,
12,	1.3041,	1.1877,	1.1515,	1.0553,	.7663,	.7602,	.8787,	.3918,	.7735,	.6119,	.5924,
+gp,	1.3041,	1.1877,	1.1515,	1.0553,	.7663,	.7602,	.8787,	.3918,	.7735,	.6119,	
0 FBAR 5-10,	.9208,	.9913,	.8567,	.7196,	.6702,	.5300,	.6845,	.7317,	.6342,	.4049,	

1

Table 3.18 . Stock number at age

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

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1984	1985	1986	1987
AGE				
1	211680	137713	175527	49253
2	67035	135548	78736	56317
3	40282	52874	104751	28886
4	13543	32331	41043	74177
5	7852	9800	22329	27180
6	4763	4727	5507	11163
7	2465	2082	2113	2227
8	1304	648	676	670
9	923	318	192	186
10	140	214	120	69
11	39	44	106	32
12	26	11	24	36
+gp	12	21	13	16
0 TOTAL	350065	376330	431137	250213

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	82174	81811	151780	172784	304762	2428266	936321	2010546	2780246	1922264
2	23815	30098	53985	112870	127757	156488	152927	138027	254450	309649
3	20660	17463	24593	41651	72956	90468	81751	66667	44368	72324
4	21109	15883	13838	19962	33487	57362	68440	54508	31394	22688
5	48326	15222	11438	10646	15355	24158	42660	45940	32921	18062
6	13366	27319	9552	8188	7226	10083	13987	24883	26823	17856
7	3583	6023	14969	6207	4863	3800	5213	6004	11439	12765
8	583	1032	2411	9541	3320	2321	1766	1327	2017	4426
9	199	179	347	1358	5532	1493	1045	539	423	697
10	70	51	71	209	760	2871	628	298	169	163
11	15	10	16	42	133	393	1211	182	88	54
12	9	3	5	7	30	85	164	311	42	30
+gp	8	6	4	2	5	19	23	42	162	53
0 TOTAL	213918	195099	283009	383468	576186	2777808	1306135	2349275	3184543	2381032

1

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

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 84-**	AMST 84-**
AGE													
1	667552	303834	327864	404143	109294	634745	259278	433706	335389	237911	0	345328	662979
2	127115	107457	82899	66798	126919	48310	126953	77977	108971	85914	84497	94200	111915
3	85375	55420	61266	52374	44447	68381	29993	58873	50277	78626	52701	49859	55265
4	42277	47943	39983	46398	40287	32464	53235	22701	40303	39942	55562	33579	37503
5	13778	24332	31822	28468	33771	29661	24689	39186	16515	28550	28360	22448	25345
6	8371	6706	11522	17278	17524	20675	18453	15513	21365	10472	17684	12004	13704
7	7087	3144	2672	5158	8414	8224	10493	8920	7074	10421	6194	5287	6267
8	4500	2679	1146	1041	2161	3078	3412	3991	3251	2917	5420	1883	2457
9	1054	1300	759	335	376	726	1253	1154	1408	1244	1372	626	927
10	150	268	265	189	113	145	333	461	376	497	650	205	353
11	30	36	53	68	49	45	74	115	165	146	282	62	129
12	10	6	11	14	25	20	24	34	43	69	74	21	42
+gp	17	11	4	6	7	13	12	18	46	22	40		
0 TOTAL	957317	553136	560268	622270	383388	846487	528203	662649	585184	496733	252836		

1

Table 3.19. Northeast Arctic Cod. Natural mortality used in final VPA.

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

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Table 4 Natural Mortality (M) at age

YEAR,	1946,	1947,
AGE		
3,	.2000,	.2000,
4,	.2000,	.2000,
5,	.2000,	.2000,
6,	.2000,	.2000,
7,	.2000,	.2000,
8,	.2000,	.2000,
9,	.2000,	.2000,
10,	.2000,	.2000,
11,	.2000,	.2000,
12,	.2000,	.2000,
+gp,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

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

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Table 4 Natural Mortality (M) at age

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 3.19 (continued).

Table 4 Natural Mortality (M) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2006,	.2004,	.3123,	.2584,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	.2087,	.2000,	.2000,	.2050,	.2067,	.2660,	.3997,	.7412,	.6450,	.5145,
4,	.2000,	.2000,	.2000,	.2000,	.2000,	.2028,	.2939,	.4038,	.4321,	.2932,
5,	.2000,	.2000,	.2000,	.2000,	.2000,	.2024,	.2258,	.2111,	.2812,	.2103,
6,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2046,	.2014,	.2060,	.2020,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

Table 4 Natural Mortality (M) at age

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	.5273,	.3104,	.2689,	.2510,	.3102,	.2381,	.2681,	.3666,	.2111,	.3095,
4,	.2768,	.2113,	.2416,	.2292,	.2167,	.2000,	.2234,	.2162,	.2058,	.2124,
5,	.2163,	.2000,	.2167,	.2079,	.2034,	.2000,	.2057,	.2182,	.2005,	.2001,
6,	.2095,	.2000,	.2006,	.2073,	.2002,	.2000,	.2003,	.2049,	.2000,	.2000,
7,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
8,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
9,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
10,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
11,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
12,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,
+gp,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,	.2000,

1

Table 3.20 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	0.5266	0.8017	0.0584	0.0000	0.0000	0.0000
1988	0.8044	0.1094	0.0087	0.0000	0.0000	0.0000
1989	0.2145	0.0011	0.0000	0.0000	0.0000	0.0000
1990	0.0961	0.0590	0.0000	0.0000	0.0000	0.0000
1991	0.1038	0.2373	0.0050	0.0000	0.0000	0.0000
1992	0.4681	0.1450	0.0067	0.0000	0.0000	0.0000
1993	2.5644	0.4482	0.0660	0.0028	0.0024	0.0000
1994	1.7157	0.6312	0.1997	0.0939	0.0258	0.0046
1995	1.8681	0.9350	0.5412	0.2038	0.0111	0.0014
1996	1.9892	1.0545	0.4450	0.2321	0.0812	0.0060
1997	2.5175	1.0927	0.3145	0.0932	0.0103	0.0020
1998	1.6266	0.6280	0.3273	0.0768	0.0163	0.0095
1999	1.0971	0.3609	0.1104	0.0113	0.0000	0.0000
2000	1.3924	0.2579	0.0689	0.0416	0.0167	0.0006
2001	0.9618	0.2057	0.0510	0.0292	0.0079	0.0073
2002	0.6367	0.4183	0.1102	0.0167	0.0034	0.0002
2003	1.4256	0.2815	0.0381	0.0000	0.0000	0.0000
2004	1.2107	0.5350	0.0681	0.0234	0.0057	0.0003
2005	1.1375	0.3136	0.1666	0.0162	0.0182	0.0049
2006	1.1733	0.1267	0.0111	0.0058	0.0005	0.0000
2007	0.8402	0.2885	0.1095	0.0124	0.0001	0.0000

Table 3.21. Northeast Arctic cod. Fishing mortality, final VPA

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1946,	1947,
AGE		
3,	.0061,	.0018,
4,	.0200,	.0249,
5,	.0532,	.1101,
6,	.0973,	.2024,
7,	.1781,	.4160,
8,	.1932,	.2545,
9,	.3125,	.4047,
10,	.2798,	.4405,
11,	.3432,	.7827,
12,	.3120,	.6182,
+gp,	.3120,	.6182,
0 FBAR 5-10,	.1857,	.3047,

Table 8 Fishing mortality (F) at age

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	.0003,	.0023,	.0020,	.0254,	.0225,	.0334,	.0199,	.0159,	.0270,	.0240,
4,	.0124,	.0209,	.0321,	.1612,	.1667,	.1325,	.1457,	.0840,	.1291,	.1128,
5,	.0751,	.1484,	.1167,	.2637,	.3700,	.2299,	.2676,	.2859,	.4568,	.2094,
6,	.1997,	.3662,	.2882,	.2787,	.5501,	.3125,	.3333,	.5297,	.6900,	.4862,
7,	.5201,	.5101,	.4096,	.4122,	.5311,	.3243,	.3969,	.5139,	.6129,	.5494,
8,	.3536,	.3869,	.3480,	.4046,	.4175,	.3469,	.2494,	.5880,	.6880,	.6287,
9,	.5286,	.3832,	.4741,	.5057,	.5790,	.3932,	.4364,	.5805,	.6551,	.5463,
10,	.3617,	.3766,	.5031,	.5149,	.7613,	.5364,	.6441,	.7645,	.7380,	.6333,
11,	.5536,	.6259,	.9031,	.4585,	1.0260,	.6980,	.8035,	.7621,	.8756,	.8584,
12,	.4604,	.5039,	.7111,	.4879,	.9056,	.6217,	.7304,	.7704,	.8152,	.7529,
+gp,	.4604,	.5039,	.7111,	.4879,	.9056,	.6217,	.7304,	.7704,	.8152,	.7529,
0 FBAR 5-10,	.3398,	.3619,	.3566,	.3966,	.5348,	.3572,	.3879,	.5437,	.6401,	.5089,

1

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

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Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	.0718,	.0535,	.0543,	.0562,	.0663,	.0313,	.0174,	.0226,	.0398,	.0298,
4,	.2589,	.2564,	.2266,	.2717,	.3063,	.2366,	.1449,	.1110,	.1037,	.1525,
5,	.3626,	.5093,	.3477,	.4944,	.6498,	.7420,	.3537,	.3909,	.2119,	.1814,
6,	.5517,	.5121,	.4607,	.5168,	.8279,	1.0069,	.4854,	.4494,	.3818,	.2026,
7,	.5357,	.5251,	.4363,	.5279,	.6094,	.9764,	.5787,	.4033,	.4713,	.4320,
8,	.4593,	.5111,	.4855,	.6931,	.6564,	.8798,	.7409,	.5303,	.5797,	.6844,
9,	.4535,	.6141,	.4053,	.7389,	.8167,	.9416,	1.0674,	.7389,	.7183,	.8781,
10,	.7388,	.6860,	.7381,	.8379,	.9855,	1.3731,	.8476,	.8074,	.8182,	.8850,
11,	.8415,	.6511,	.8449,	1.0011,	.9522,	1.4366,	1.2968,	.7617,	.5024,	1.2253,
12,	.7990,	.6734,	.7981,	.9284,	.9756,	1.4264,	1.0883,	.7927,	.6634,	1.0696,
+gp,	.7990,	.6734,	.7981,	.9284,	.9756,	1.4264,	1.0883,	.7927,	.6634,	1.0696,
0 FBAR 5-10,	.5169,	.5596,	.4789,	.6348,	.7576,	.9866,	.6789,	.5533,	.5302,	.5439,

Table 8 Fishing mortality (F) at age

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	.0251,	.0230,	.0409,	.0214,	.0394,	.1959,	.2141,	.0837,	.1660,	.1338,
4,	.2064,	.2292,	.1422,	.1028,	.1673,	.1996,	.4959,	.2106,	.3121,	.5671,
5,	.4087,	.4792,	.4004,	.2285,	.2976,	.3536,	.5375,	.5211,	.4800,	.7544,
6,	.4683,	.5382,	.5680,	.2517,	.3849,	.3917,	.5078,	.7021,	.5715,	.6857,
7,	.4019,	.7725,	.6211,	.5144,	.3427,	.4210,	.4451,	.7050,	.6973,	.6763,
8,	.5291,	.9302,	.8479,	.8330,	.6583,	.7375,	.4863,	.7032,	.8908,	.9121,
9,	.8041,	1.1783,	.9682,	.9584,	1.1338,	.9698,	.5192,	.6109,	.7746,	1.2298,
10,	.8105,	1.0769,	1.0900,	.7876,	1.3393,	.7386,	.8842,	.7149,	.4600,	.7689,
11,	.6772,	1.5554,	.8533,	.8388,	1.2904,	.7222,	.9905,	.9079,	.6132,	.6231,
12,	.7458,	1.3377,	.9829,	.8179,	1.3377,	.7358,	.9492,	.8218,	.5389,	.6958,
+gp,	.7458,	1.3377,	.9829,	.8179,	1.3377,	.7358,	.9492,	.8218,	.5389,	.6958,
0 FBAR 5-10,	.5704,	.8292,	.7493,	.5956,	.6928,	.6020,	.5633,	.6595,	.6457,	.8379,

Table 3.21 N (continued).

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	.1460,	.0489,	.0318,	.0252,	.0672,	.0208,	.0194,	.0533,	.0330,	.0555,
4,	.2234,	.2090,	.1296,	.1003,	.2121,	.2050,	.1247,	.1716,	.2133,	.2293,
5,	.6703,	.3475,	.3562,	.2300,	.3045,	.3308,	.3096,	.3788,	.4960,	.5104,
6,	.8497,	.5478,	.6225,	.5163,	.5518,	.5033,	.6301,	.6078,	.7078,	.9362,
7,	.8581,	.6643,	.6766,	.8475,	.7996,	.7821,	1.1350,	.9264,	.9487,	1.1362,
8,	.9296,	.7789,	.7123,	1.0788,	.9846,	1.0295,	1.2083,	1.0191,	1.0910,	1.0143,
9,	1.3057,	1.0352,	.9390,	1.2764,	1.1588,	.9701,	1.2572,	.7818,	.8325,	.7841,
10,	1.0301,	.9848,	1.0380,	1.2299,	.7507,	.9203,	.9564,	.5088,	1.1134,	1.3245,
11,	1.8042,	1.4314,	1.4798,	.9557,	.9516,	.5853,	1.0810,	.4237,	.8774,	1.0329,
12,	1.4375,	1.2219,	1.2775,	1.1082,	.8607,	.7590,	1.0345,	.4665,	1.0045,	1.1899,
+gp,	1.4375,	1.2219,	1.2775,	1.1082,	.8607,	.7590,	1.0345,	.4665,	1.0045,	1.1899,
0 FBAR 5-10,	.9406,	.7264,	.7241,	.8632,	.7583,	.7560,	.9161,	.7038,	.8649,	.9510,

Table 8 Fishing mortality (F) at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	.0546,	.0330,	.0087,	.0134,	.0341,	.0129,	.0098,	.0106,	.0240,	.0232,
4,	.1277,	.1292,	.0627,	.0631,	.1276,	.0942,	.1065,	.1008,	.1209,	.2067,
5,	.3710,	.2671,	.1352,	.1888,	.2226,	.3463,	.3153,	.3290,	.3324,	.5605,
6,	.5974,	.4024,	.2324,	.3228,	.4449,	.4635,	.6433,	.5785,	.5394,	.7237,
7,	1.0411,	.7142,	.2518,	.4277,	.5417,	.5693,	1.1663,	.8922,	.7535,	.8452,
8,	.9788,	.8851,	.3755,	.3470,	.6013,	.6009,	.9867,	.9447,	.8660,	1.2341,
9,	1.1546,	.7134,	.3067,	.3823,	.4585,	.6697,	1.0542,	.9632,	.7577,	1.3342,
10,	1.7027,	.9791,	.3242,	.2572,	.4612,	.6668,	1.0410,	1.0203,	.9436,	1.5073,
11,	1.5282,	.5810,	.5377,	.1345,	.2497,	.6797,	1.1610,	1.2493,	.8716,	1.4394,
12,	1.6497,	.7917,	.4352,	.1959,	.3556,	.6759,	1.1136,	1.1499,	.9125,	1.4948,
+gp,	1.6497,	.7917,	.4352,	.1959,	.3556,	.6759,	1.1136,	1.1499,	.9125,	1.4948,
0 FBAR 5-10,	.9743,	.6602,	.2710,	.3210,	.4550,	.5528,	.8678,	.7880,	.6988,	1.0342,

Table 8 Fishing mortality (F) at age

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	FBAR **-**
AGE											
3,	.0497,	.0160,	.0089,	.0111,	.0062,	.0121,	.0080,	.0119,	.0191,	.0388,	.0233,
4,	.2767,	.1997,	.0987,	.0890,	.0904,	.0743,	.0841,	.1024,	.1392,	.1302,	.1239,
5,	.5051,	.5484,	.3954,	.2788,	.2887,	.2761,	.2602,	.3887,	.2553,	.2787,	.3076,
6,	.7705,	.7201,	.6042,	.5138,	.5578,	.4799,	.5279,	.5806,	.5175,	.3252,	.4744,
7,	.7753,	.8101,	.7422,	.6713,	.8050,	.6811,	.7665,	.8075,	.6848,	.4537,	.6486,
8,	1.0445,	1.0615,	1.0296,	.8165,	.8891,	.6992,	.8831,	.8400,	.7578,	.5548,	.7175,
9,	1.1723,	1.3851,	1.1906,	.8799,	.7506,	.5807,	.7983,	.9179,	.8365,	.4500,	.7348,
10,	1.2374,	1.4149,	1.1549,	1.1389,	.7243,	.4698,	.8650,	.8242,	.7425,	.3666,	.6444,
11,	1.3341,	.9333,	1.1033,	.8117,	.6948,	.4312,	.5769,	.7793,	.6770,	.4805,	.6456,
12,	1.3041,	1.1877,	1.1515,	1.0553,	.7663,	.7602,	.8787,	.3918,	.7735,	.6119,	.5924,
+gp,	1.3041,	1.1877,	1.1515,	1.0553,	.7663,	.7602,	.8787,	.3918,	.7735,	.6119,	
0 FBAR 5-10,	.9175,	.9900,	.8528,	.7165,	.6693,	.5311,	.6835,	.7265,	.6324,	.4048,	

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Table 3.21 R Fishing mortality (F) at age, R

Table 8 Fishing mortality (F) at age

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	FBAR **-**
AGE											
3,	.0511,	.0174,	.0101,	.0130,	.0063,	.0114,	.0075,	.0103,	.0198,	.0421,	.0241,
4,	.2801,	.2074,	.1083,	.1030,	.0914,	.0711,	.0798,	.0880,	.1439,	.1344,	.1221,
5,	.5082,	.5589,	.4164,	.3131,	.2877,	.2657,	.2500,	.3341,	.2596,	.2893,	.2943,
6,	.7728,	.7283,	.6251,	.5584,	.5486,	.4623,	.5114,	.5028,	.5197,	.3399,	.4541,
7,	.7765,	.8154,	.7599,	.7164,	.7934,	.6566,	.7436,	.7213,	.6781,	.4742,	.6245,
8,	1.0457,	1.0654,	1.0468,	.8599,	.8818,	.6824,	.8636,	.7728,	.7521,	.5717,	.6989,
9,	1.1736,	1.3903,	1.2044,	.9182,	.7407,	.5753,	.7907,	.8732,	.8363,	.4664,	.7253,
10,	1.2395,	1.4207,	1.1699,	1.1810,	.7231,	.4481,	.8502,	.7981,	.7462,	.3796,	.6413,
11,	1.3360,	.9377,	1.1186,	.8394,	.6826,	.4146,	.5397,	.7332,	.6709,	.4895,	.6312,
12,	1.3060,	1.1934,	1.1670,	1.0986,	.7744,	.7448,	.8439,	.3579,	.7602,	.6280,	.5820,
+gp,	1.3060,	1.1934,	1.1670,	1.0986,	.7744,	.7448,	.8439,	.3579,	.7602,	.6280,	
0 FBAR 5-10,	.9194,	.9965,	.8704,	.7579,	.6626,	.5150,	.6683,	.6671,	.6320,	.4202,	

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Table 3.22. 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	0.0192	0.1235	0.3075	0.6275
1985	0.0001	0.0015	0.0529	0.1701	0.3764	0.6052
1986	0.0000	0.0017	0.0328	0.2121	0.4933	0.7054
1987	0.0000	0.0011	0.0552	0.2285	0.5098	0.9364
1988	0.0000	0.0009	0.0543	0.1270	0.3704	0.5971
1989	0.0000	0.0009	0.0327	0.1283	0.2660	0.4016
1990	0.0000	0.0004	0.0086	0.0622	0.1343	0.2311
1991	0.0000	0.0007	0.0136	0.0624	0.1875	0.3210
1992	0.0004	0.0011	0.0338	0.1265	0.2206	0.4427
1993	0.0000	0.0006	0.0128	0.0932	0.3441	0.4597
1994	0.0000	0.0003	0.0100	0.1072	0.3132	0.6410
1995	0.0000	0.0003	0.0105	0.1000	0.3269	0.5757
1996	0.0000	0.0006	0.0238	0.1200	0.3305	0.5366
1997	0.0000	0.0007	0.0231	0.2057	0.5587	0.7221
1998	0.0000	0.0019	0.0495	0.2756	0.5037	0.7697
1999	0.0000	0.0004	0.0159	0.1986	0.5475	0.7202
2000	0.0000	0.0003	0.0088	0.0979	0.3940	0.6032
2001	0.0000	0.0004	0.0109	0.0881	0.2772	0.5121
2002	0.0001	0.0001	0.0063	0.0910	0.2873	0.5564
2003	0.0000	0.0005	0.0121	0.0738	0.2746	0.4782
2004	0.0000	0.0002	0.0077	0.0858	0.2587	0.5266
2005	0.0000	0.0010	0.0119	0.1023	0.3888	0.5805
2006	0.0001	0.0013	0.0192	0.1391	0.2551	0.5180
2007	0.0010	0.0039	0.0388	0.1302	0.2787	0.3252

Table 3.23 N. Northeast Arctic Cod. Stock number at age. Final VPA

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

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

AGE / YEAR	1946	1947
3	728139	425311
4	577860	592530
5	402060	463732
6	197212	312115
7	93323	146496
8	96213	63939
9	244722	64933
10	101777	146581
11	38117	62991
12	39205	22142
+gp	33324	42765
0 TOTAL	2551952	2343535

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

AGE / YEAR	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
3	442592	468348	704908	1083753	1193111	1590377	641584	272778	439602	804781
4	347574	362238	382556	575973	865011	955076	1259285	514924	219807	350332
5	473210	281072	290427	303320	401364	599477	684912	891184	387619	158175
6	340097	359415	198391	211595	190765	226975	389987	429102	548181	200984
7	208708	228044	204032	121764	131099	90099	135956	228785	206850	225110
8	79121	101579	112107	110900	66016	63110	53333	74845	112048	91748
9	40588	45487	56484	64808	60583	35603	36525	34028	34036	46105
10	35470	19586	25387	28785	32000	27799	19673	19329	15591	14474
11	77255	20227	11003	12568	14083	12237	13311	8459	7368	6103
12	23578	36361	8856	3651	6506	4133	4985	4880	3232	2513
+gp	37377	21337	21133	13989	3938	1880	2707	2738	3722	1687
0 TOTAL	2105569	1943694	2015284	2531108	2964476	3606766	3242259	2481052	1978057	1902013

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

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

AGE / YEAR	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
3	496824	683690	789653	916842	728338	472064	338678	776941	1582560	1295416
4	643259	378598	530599	612324	709603	558039	374580	272501	621906	1245195
5	256234	406511	239862	346346	382037	427678	360621	265306	199663	458995
6	105033	145989	199996	138702	172949	163321	166726	207288	146941	132256
7	101196	49529	71623	103298	67732	61876	48854	84015	108284	82121
8	106395	48488	23986	37908	49883	30149	19083	22424	45954	55340
9	40060	55027	23813	12084	15518	21185	10240	7448	10803	21072
10	21860	20840	24380	13000	4726	5614	6764	2883	2913	4313
11	6291	8550	8592	9541	4605	1444	1164	2373	1053	1052
12	2118	2220	3650	3022	2871	1455	281	261	907	522
+gp	857	1142	1351	2332	1351	1113	1278	670	351	461
0 TOTAL	1780129	1800584	1917505	2195401	2139612	1743938	1328269	1642109	2721334	3296742

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

AGE / YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
3	164955	112039	197105	404774	1015319	1818949	523916	621616	613942	348054
4	1029477	131705	89647	154909	324399	799193	1224278	346265	468089	425778
5	875269	685697	85743	63671	114439	224670	535936	610486	229669	280485
6	313440	476187	347649	47037	41482	69576	129164	256342	296843	116349
7	88421	160667	227600	161288	29940	23112	38504	63643	104000	137232
8	43651	48433	60756	100131	78947	17401	12421	20199	25746	42398
9	22854	21054	15642	21306	35642	33463	6815	6253	8186	8650
10	7170	8373	5306	4863	6690	9391	10388	3320	2779	3089
11	1457	2610	2335	1461	1811	1435	3673	3513	1330	1436
12	253	606	451	815	517	408	571	1117	1160	590
+gp	498	278	312	421	697	408	525	550	572	583
0 TOTAL	2547445	1647648	1032545	960676	1649883	2998007	2486189	1933304	1752317	1364643

Table 3.23N (continued).

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

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	638490	198490	137735	150868	151830	166831	397831	523674	1038824	286344
4	249276	451722	154747	109237	120444	116234	133783	319254	406348	735513
5	197708	163230	300088	111295	80899	79769	77525	96695	220157	268787
6	108004	82807	94414	172067	72401	48848	46916	46570	54207	109763
7	47987	37806	39202	41481	84063	34138	24176	20455	20763	21867
8	57130	16658	15929	16316	14551	30937	12785	6362	6632	6583
9	13943	18463	6259	6397	4542	4451	9048	3127	1880	1824
10	2070	3093	5368	2004	1461	1167	1381	2107	1171	669
11	1172	605	946	1557	480	565	381	435	1037	315
12	631	158	118	176	490	152	258	106	233	353
+gp	1198	218	87	66	70	170	116	209	130	156
0 TOTAL	1317608	973250	754893	611465	531231	483261	704200	1018993	1751381	1432173

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	204644	172782	242748	411781	721090	894895	810420	657041	437976	715933
4	209193	157267	136871	197020	330985	566792	677074	538093	309817	224347
5	478806	150744	113154	105246	151440	238524	421161	453655	324877	178205
6	132093	270500	94492	80926	71340	99244	137790	245168	264332	175887
7	35238	59509	148105	61322	47980	37433	51114	59016	112396	125438
8	5747	10186	23854	94265	32734	22853	17344	13036	19799	43317
9	1954	1768	3442	13417	54551	14689	10259	5294	4150	6818
10	682	504	709	2074	7495	28238	6156	2927	1654	1593
11	146	102	155	420	1313	3869	11868	1780	864	527
12	92	26	47	74	301	837	1605	3043	418	296
+gp	82	56	40	25	48	191	232	418	1624	532
0 TOTAL	1068678	823444	763617	966569	1419276	1907564	2145023	1979470	1477907	1472893

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 46-**	AMST 46-**
AGE													
3	845050	548307	606242	518389	441092	678163	297261	585363	500369	777477	0	496857	602951
4	418185	474582	395599	459206	398882	321451	528045	225532	400895	397470	548811	375831	455150
5	136089	240419	314641	281493	334040	293422	244339	388266	164007	283913	282173	261939	313842
6	82446	66147	113751	170603	173019	204204	182283	153336	211613	103973	175891	149860	180527
7	69698	30943	26359	50867	82949	81079	103462	88000	69907	103260	61493	73526	91267
8	44107	26282	11269	10274	21282	30362	33594	39358	32132	28858	53707	32271	43303
9	10323	12707	7444	3295	3718	7162	12355	11373	13912	12330	13566	13414	23594
10	1470	2617	2604	1853	1119	1437	3281	4553	3718	4934	6437	5203	12443
11	289	349	521	672	486	444	735	1131	1635	1449	2800	1934	6377
12	102	62	112	141	244	199	236	338	425	680	734	706	3245
+gp	173	112	41	58	73	133	117	176	457	220	399		
0 TOTAL	1607933	1402527	1478584	1496851	1456904	1618055	1405707	1497427	1399071	1714565	1146013		

Table 3.23 R Stock number at age (start of year), R Numbers*10-3**

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 46-**	AMST 46-**
AGE													
3	825609	508164	534106	444198	381174	587434	266467	525440	437871	647608	0	489439	595333
4	413933	458722	362714	400159	338254	273690	455651	200247	353321	347191	449882	370447	449824
5	135453	236983	301711	254703	286072	248221	208699	336031	147643	248960	245224	258526	310089
6	82284	65628	110952	160085	151184	175004	155814	132237	193302	93189	152611	148139	178648
7	69628	30808	25938	48591	74422	71500	90244	76473	65157	94115	54311	72820	90504
8	44078	26225	11160	9932	19434	27560	30360	35125	30435	27078	47958	32030	43092
9	10317	12684	7398	3208	3442	6588	11404	10481	13278	11746	12516	13335	23547
10	1469	2612	2586	1816	1048	1343	3034	4234	3584	4710	6032	5176	12430
11	289	348	517	657	457	417	703	1062	1561	1391	2638	1925	6374
12	102	62	112	138	232	189	225	335	417	653	698	704	3244
+gp	173	112	41	57	69	127	113	171	442	211	378		
0 TOTAL	1583336	1342349	1357235	1323544	1255788	1392072	1222714	1321837	1247009	1476853	972249		

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Table 3.24. Northeast Arctic Cod. Stock biomass at age. Final VPA

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

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

YEAR,	1946,	1947,
AGE		
3,	254849,	136099,
4,	340937,	331817,
5,	446286,	440545,
6,	333289,	468173,
7,	221176,	313502,
8,	304996,	186702,
9,	973994,	237005,
10,	513974,	668411,
11,	225651,	367868,
12,	282275,	164292,
+gp,	271456,	378386,
0 TOTALBIO,	4168882,	3692801,

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

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	150481,	173289,	274914,	433501,	524969,	636151,	282297,	87289,	145069,	265578,
4,	184214,	242699,	244836,	478058,	692009,	725857,	969649,	293507,	127488,	206696,
5,	596245,	311990,	374651,	421615,	533814,	767331,	862989,	1007038,	414753,	161338,
6,	656387,	596629,	337265,	397799,	366270,	438062,	768275,	742347,	1003170,	365792,
7,	513421,	570111,	481515,	309280,	346101,	253178,	411947,	629160,	597796,	650567,
8,	265846,	328099,	390132,	383714,	244919,	234769,	230934,	294890,	476204,	392683,
9,	171279,	185131,	255308,	316264,	306548,	180151,	197233,	166739,	188902,	253117,
10,	188345,	103218,	142673,	149682,	193600,	176245,	132792,	136079,	113501,	108698,
11,	457348,	121160,	70420,	89737,	104495,	90555,	103693,	60902,	58944,	50286,
12,	167165,	257435,	70497,	30013,	54844,	35831,	53190,	42844,	26988,	23247,
+gp,	315087,	175349,	187892,	131347,	40110,	19247,	26204,	27591,	37015,	17892,
0 TOTALBIO,	3665819,	3065111,	2830103,	3141009,	3407679,	3557376,	4039204,	3488383,	3189831,	2495895,

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	168920,	239291,	268482,	284221,	233068,	151061,	111764,	295238,	696327,	375671,
4,	334495,	272591,	270606,	336778,	390282,	340404,	206019,	185301,	460210,	1008608,
5,	243423,	597571,	261449,	363663,	355294,	410571,	342590,	273265,	235602,	619644,
6,	201664,	391251,	425991,	305145,	294013,	282545,	310111,	308859,	261555,	269803,
7,	297518,	177809,	242086,	333654,	205229,	188104,	158775,	202475,	266378,	230760,
8,	447924,	209470,	116810,	193710,	250910,	149537,	94841,	78931,	175545,	192584,
9,	224738,	299899,	145737,	74320,	101645,	136428,	65640,	42675,	57905,	103040,
10,	160673,	134210,	206985,	105953,	36390,	44408,	54588,	21740,	21174,	30662,
11,	54540,	61300,	66934,	82819,	42684,	13894,	10875,	20098,	9087,	9500,
12,	20287,	19159,	30297,	29013,	30314,	16454,	2856,	2911,	9669,	5524,
+gp,	9967,	13275,	15429,	27875,	17178,	14173,	16470,	9201,	4967,	6369,
0 TOTALBIO,	2164149,	2415826,	2050805,	2137149,	1957006,	1747579,	1374529,	1440693,	2198418,	2852164,

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	54435,	49297,	72929,	182148,	385821,	691201,	167653,	254863,	214880,	170547,
4,	720634,	104047,	81578,	136320,	249787,	727266,	808024,	221610,	341705,	383200,
5,	1295399,	843407,	114895,	87866,	163647,	345992,	627045,	677639,	273307,	401093,
6,	664492,	966659,	695298,	101599,	87943,	157241,	286743,	487049,	596655,	238515,
7,	277642,	465934,	682799,	495154,	96707,	76038,	123596,	187748,	287041,	452865,
8,	183771,	184531,	252138,	422555,	345787,	80219,	54527,	88269,	108649,	193334,
9,	120443,	105690,	87437,	123791,	207793,	219854,	37616,	35894,	48132,	55876,
10,	47678,	53839,	40323,	34676,	50977,	78601,	81651,	29113,	25849,	26656,
11,	13129,	21742,	20948,	12590,	17245,	15127,	36074,	34848,	13669,	14264,
12,	2444,	6492,	4958,	8822,	6248,	4742,	6512,	13192,	13760,	6427,
+gp,	7389,	3953,	4396,	5449,	9529,	5674,	6947,	7206,	7750,	7970,
0 TOTALBIO,	3387455,	2805591,	2057698,	1610969,	1621485,	2401955,	2236387,	2037430,	1931396,	1950748,

Table 3.24 N(continued).

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	312860,	69471,	37188,	73926,	56177,	61727,	167089,	216277,	323074,	60419,
4,	201913,	316206,	86659,	107052,	79493,	106936,	155188,	279347,	357586,	366286,
5,	286676,	202406,	306090,	160265,	109213,	127630,	140320,	155003,	323630,	337058,
6,	232208,	177208,	162392,	359620,	144077,	119188,	130896,	130862,	133728,	224685,
7,	145879,	119088,	118389,	123613,	246304,	130406,	91385,	83027,	81286,	75026,
8,	254800,	71461,	66900,	79133,	61698,	147262,	58429,	37111,	38530,	33816,
9,	91184,	121484,	36552,	42028,	29340,	27463,	55823,	24029,	12370,	11896,
10,	16521,	26635,	38975,	18354,	12436,	8986,	10636,	21316,	8004,	6226,
11,	11898,	5579,	8362,	16843,	5870,	5224,	3521,	6210,	11412,	4142,
12,	6843,	1720,	1099,	1899,	5283,	1645,	2794,	1346,	2965,	4496,
+gp,	15783,	3124,	1256,	924,	979,	2209,	1514,	2984,	1863,	2226,
0 TOTALBIO,	1576565,	1114381,	863862,	983658,	750871,	738675,	817596,	957513,	1294448,	1126275,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	43385,	51662,	96614,	213302,	317280,	307844,	190449,	132065,	85405,	144619,
4,	84514,	81779,	96494,	223814,	308147,	664280,	509837,	260975,	150881,	116885,
5,	378257,	130846,	133748,	183444,	274410,	434113,	598049,	517166,	315456,	192284,
6,	251374,	399529,	162432,	196489,	193759,	280167,	332488,	519265,	542939,	330317,
7,	104902,	159840,	364042,	197088,	186881,	150891,	195511,	204786,	396422,	422600,
8,	25242,	47139,	85040,	427775,	169433,	125623,	93935,	64373,	108952,	227975,
9,	15268,	12462,	16210,	92306,	369527,	99373,	68029,	37906,	32230,	60868,
10,	8256,	5034,	5534,	22227,	71933,	242024,	46970,	26691,	16806,	19356,
11,	1910,	941,	1389,	3966,	16313,	41966,	96270,	17976,	9216,	5906,
12,	1169,	330,	593,	944,	3826,	10659,	20437,	38739,	5318,	3766,
+gp,	1181,	798,	578,	354,	682,	2733,	3325,	5988,	23237,	7612,
0 TOTALBIO,	915458,	890359,	962672,	1561711,	1912190,	2359674,	2155298,	1825929,	1686862,	1532187,

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

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	183376,	111306,	117611,	147741,	110714,	155977,	74315,	135219,	128094,	203699,
4,	222893,	246783,	183954,	239705,	241324,	172619,	288313,	140732,	241339,	277832,
5,	158000,	282251,	380086,	336666,	397174,	384382,	265597,	434082,	196973,	380727,
6,	159862,	134344,	224317,	381980,	369914,	410247,	370945,	296246,	425130,	220527,
7,	205260,	93880,	80342,	168521,	276468,	262777,	302211,	268047,	217692,	327025,
8,	201745,	117321,	46159,	52581,	101430,	150930,	147276,	155663,	142249,	133903,
9,	76630,	82365,	42610,	21010,	25500,	48264,	77266,	66087,	83888,	80086,
10,	15241,	26877,	19418,	17123,	10445,	12510,	28027,	37737,	29885,	45017,
11,	3390,	3800,	4988,	7606,	4947,	6673,	7159,	15200,	16231,	17067,
12,	1303,	793,	1431,	1800,	3110,	2527,	3008,	4305,	6704,	11736,
+gp,	2483,	1604,	589,	833,	1049,	1904,	1677,	2517,	8015,	3142,
0 TOTALBIO,	1230183,	1101326,	1101505,	1375566,	1542075,	1608810,	1565794,	1555835,	1496200,	1700760,

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Table 3.24 R. Stock biomass at age (start of year)

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

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	179157,	103157,	103617,	126596,	95675,	135110,	66617,	121377,	112095,	169673,
4,	220627,	238536,	168662,	208883,	204644,	146971,	248785,	124954,	212699,	242686,
5,	157261,	278218,	364467,	304625,	340139,	325170,	226856,	375682,	177319,	333856,
6,	159548,	133291,	218798,	358430,	323232,	351583,	317081,	255482,	388343,	197654,
7,	205054,	93472,	79060,	160983,	248049,	231731,	263603,	232936,	202898,	298063,
8,	201614,	117068,	45712,	50834,	92622,	136998,	133099,	138920,	134736,	125644,
9,	76583,	82215,	42348,	20452,	23606,	44396,	71319,	60904,	80065,	76291,
10,	15228,	26824,	19282,	16786,	9785,	11696,	25921,	35099,	28801,	42972,
11,	3388,	3789,	4950,	7440,	4650,	6259,	6841,	14267,	15494,	16387,
12,	1302,	791,	1421,	1759,	2959,	2404,	2868,	4270,	6590,	11273,
+gp,	2481,	1600,	585,	814,	983,	1812,	1612,	2452,	7750,	3016,
0 TOTALBIO,	1222243,	1078962,	1048902,	1257602,	1346345,	1394131,	1364601,	1366344,	1366790,	1517515,

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

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

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

YEAR,	1946,	1947,
AGE		
3,	0,	0,
4,	0,	0,
5,	4463,	4405,
6,	9999,	14045,
7,	13271,	18810,
8,	33550,	24271,
9,	175319,	37921,
10,	226148,	280733,
11,	146673,	275901,
12,	242756,	149506,
+gp,	260598,	359467,
0 TOTSPBIO,	1112776,	1165059,

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

YEAR,	1948,	1949,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
5,	5962,	3120,	3747,	4216,	5338,	7673,	8630,	10070,	4148,	1613,
6,	19692,	17899,	10118,	11934,	10988,	13142,	23048,	22270,	30095,	10974,
7,	35939,	51310,	43336,	30928,	27688,	17722,	32956,	44041,	35868,	39034,
8,	34560,	55777,	89730,	92091,	53882,	44606,	36949,	38336,	57144,	35341,
9,	42820,	53688,	89358,	126506,	125685,	72060,	72976,	43352,	26446,	30374,
10,	88522,	55738,	74190,	86815,	121968,	112796,	90299,	72122,	46535,	23914,
11,	333864,	95716,	55632,	64611,	85686,	76066,	90213,	50549,	39492,	30172,
12,	152120,	226543,	66972,	25511,	50457,	33681,	49467,	39416,	24559,	19063,
+gp,	305634,	170088,	182256,	126093,	38907,	18670,	25156,	26763,	35534,	17356,
0 TOTSPBIO,	1019114,	729879,	615339,	568705,	520599,	396417,	429694,	346919,	299823,	207840,

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

At 23/04/2008 9:59

Traditional vpa using file input for terminal F

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
3,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
4,	0,	0,	2706,	0,	0,	3404,	0,	0,	0,	0,
5,	2434,	5976,	7843,	3637,	3553,	4106,	0,	0,	2356,	0,
6,	6050,	15650,	25559,	18309,	14701,	8476,	9303,	3089,	5231,	8094,
7,	17851,	21337,	24209,	40038,	30784,	13167,	20641,	12149,	15983,	16153,
8,	44792,	71220,	22194,	60050,	85309,	41870,	35091,	15786,	38620,	26962,
9,	22474,	146950,	65582,	48308,	62004,	57300,	43323,	23471,	20267,	39155,
10,	48202,	89921,	142819,	96417,	29476,	35970,	48583,	15870,	15669,	19624,
11,	27270,	51492,	51539,	81163,	39269,	13616,	10332,	19897,	8542,	8455,
12,	16635,	16668,	25753,	28433,	29404,	16125,	2828,	2853,	9089,	4972,
+gp,	9668,	13275,	15274,	27875,	17178,	14173,	16470,	9201,	4967,	6369,
0 TOTSPBIO,	195377,	432489,	383479,	404228,	311678,	208207,	186570,	102315,	120722,	129784,

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
3,	0,	0,	0,	0,	3858,	0,	0,	0,	0,	0,
4,	0,	0,	816,	0,	4996,	0,	0,	0,	0,	0,
5,	38862,	0,	0,	879,	3273,	0,	0,	6776,	0,	8022,
6,	33225,	19333,	6953,	5080,	879,	3145,	2867,	9741,	29833,	19081,
7,	24988,	18637,	47796,	54467,	9671,	12166,	3708,	16897,	34445,	117745,
8,	34917,	22144,	57992,	126766,	117567,	42516,	11451,	18536,	31508,	104400,
9,	46973,	35935,	50714,	73036,	132988,	178082,	18808,	20100,	21659,	42466,
10,	27653,	29611,	32662,	27394,	41292,	72313,	78385,	22708,	21713,	23191,
11,	10766,	16089,	18644,	10827,	16210,	14370,	36074,	27530,	11345,	13266,
12,	2444,	6167,	4512,	7763,	6248,	4647,	6251,	12532,	13760,	6041,
+gp,	7389,	3953,	4396,	5449,	9529,	5674,	6947,	7206,	6975,	7173,
0 TOTSPBIO,	227215,	151870,	224482,	311662,	346511,	332913,	164491,	142028,	171238,	341385,

Table 3.25 N (continued).

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
3,	0,	0,	0,	0,	0,	617,	0,	0,	0,	0,
4,	0,	0,	0,	0,	3975,	8555,	7759,	2793,	17879,	3663,
5,	0,	0,	0,	3205,	10921,	12763,	25258,	13950,	25890,	23594,
6,	4644,	5316,	3248,	25173,	48986,	35756,	40578,	47110,	25408,	40443,
7,	18964,	15481,	15391,	24723,	160097,	95196,	51176,	45665,	43081,	16506,
8,	112112,	27870,	23415,	42732,	50592,	129590,	52586,	31544,	27356,	15555,
9,	64741,	93543,	23759,	33622,	26992,	26639,	55265,	23068,	7669,	5948,
10,	12721,	23705,	31960,	17804,	12436,	8986,	10636,	19184,	7204,	4670,
11,	9637,	4630,	8362,	16843,	5870,	5224,	3521,	6210,	11412,	4142,
12,	6090,	1342,	989,	1899,	5283,	1645,	2794,	1346,	2965,	4496,
+gp,	12626,	2812,	1130,	924,	979,	2209,	1514,	2984,	1863,	2226,
0 TOTSPBIO,	241536,	174699,	108253,	166926,	326133,	327181,	251087,	193856,	170729,	121243,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
3,	0,	413,	773,	213,	317,	0,	571,	0,	0,	0,
4,	1690,	245,	1254,	7162,	4314,	18600,	3569,	783,	0,	0,
5,	18913,	3795,	6821,	13758,	39789,	37768,	71168,	31547,	5994,	2307,
6,	82953,	91093,	34111,	59929,	81185,	103101,	111383,	193167,	140078,	46244,
7,	55598,	87433,	190030,	139538,	149504,	106227,	115156,	127786,	250142,	256518,
8,	15650,	33233,	60804,	368314,	159775,	116955,	80972,	50275,	89341,	189219,
9,	15268,	11403,	14670,	88337,	359919,	96591,	65512,	36389,	31424,	57581,
10,	8256,	5034,	5395,	22227,	71933,	240572,	46500,	26130,	16806,	19356,
11,	1910,	941,	1389,	3966,	16313,	41966,	96270,	17976,	9216,	5906,
12,	1169,	330,	593,	944,	3826,	10659,	20437,	38739,	5318,	3766,
+gp,	1181,	798,	578,	354,	682,	2733,	3325,	5988,	23237,	7612,
0 TOTSPBIO,	202589,	234716,	316417,	704744,	887559,	775173,	614863,	528780,	571556,	588510,

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

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	183,	223,	0,	443,	221,	156,	74,	0,	0,	0,
4,	669,	494,	184,	719,	3137,	173,	2883,	563,	241,	1111,
5,	4108,	3952,	26986,	21883,	33363,	33826,	24169,	29518,	11818,	27412,
6,	24299,	25122,	55406,	137131,	143526,	133740,	163958,	117610,	156873,	75641,
7,	96883,	51071,	51660,	105157,	188828,	176586,	219405,	191922,	140847,	236439,
8,	164221,	99371,	38312,	43064,	85303,	134026,	128425,	138851,	127598,	117299,
9,	73335,	79482,	41672,	20002,	24251,	46189,	75412,	63907,	80952,	78163,
10,	14937,	26877,	19418,	17123,	10445,	12510,	27382,	37397,	29885,	45017,
11,	3390,	3800,	4988,	7606,	4947,	6673,	7159,	15200,	16231,	17067,
12,	1303,	793,	1431,	1800,	3110,	2527,	3008,	4305,	6704,	11736,
+gp,	2483,	1604,	589,	833,	1049,	1904,	1677,	2517,	8015,	3142,
0 TOTSPBIO,	385810,	292789,	240647,	355761,	498180,	548309,	653553,	601789,	579164,	613028,

1

Table 3.25 R. Spawning stock biomass at age (spawning time)

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

YEAR,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,
AGE										
3,	179,	206,	0,	380,	191,	135,	67,	0,	0,	0,
4,	662,	477,	169,	627,	2660,	147,	2488,	500,	213,	971,
5,	4089,	3895,	25877,	19801,	28572,	28615,	20644,	25546,	10639,	24038,
6,	24251,	24925,	54043,	128676,	125414,	114616,	140150,	101426,	143299,	67795,
7,	96785,	50849,	50835,	100453,	169418,	155723,	191375,	166782,	131275,	215500,
8,	164114,	99156,	37941,	41633,	77895,	121655,	116062,	123917,	120858,	110064,
9,	73290,	79338,	41417,	19470,	22449,	42487,	69608,	58895,	77262,	74460,
10,	14924,	26824,	19282,	16786,	9785,	11696,	25325,	34783,	28801,	42972,
11,	3388,	3789,	4950,	7440,	4650,	6259,	6841,	14267,	15494,	16387,
12,	1302,	791,	1421,	1759,	2959,	2404,	2868,	4270,	6590,	11273,
+gp,	2481,	1600,	585,	814,	983,	1812,	1612,	2452,	7750,	3016,
0 TOTSPBIO,	385465,	291852,	236520,	337839,	444977,	485549,	577039,	532838,	542181,	566475,

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Table 3.26N. Northeast Arctic cod. Summary Table. Final VPA.

Run title : Arctic Cod (run: SVPASA15/V15)
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At 23/04/2008 9:59

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-10,
1946,	728139,	4168882,	1112776,	706000,	.6344,	.1857,
1947,	425311,	3692801,	1165059,	882017,	.7571,	.3047,
1948,	442592,	3665819,	1019114,	774295,	.7598,	.3398,
1949,	468348,	3065111,	729879,	800122,	1.0962,	.3619,
1950,	704908,	2830103,	615339,	731982,	1.1896,	.3566,
1951,	1083753,	3141009,	568705,	827180,	1.4545,	.3966,
1952,	1193111,	3407679,	520599,	876795,	1.6842,	.5348,
1953,	1590377,	3557376,	396417,	695546,	1.7546,	.3572,
1954,	641584,	4039204,	429694,	826021,	1.9223,	.3879,
1955,	272778,	3488383,	346919,	1147841,	3.3087,	.5437,
1956,	439602,	3189831,	299823,	1343068,	4.4795,	.6401,
1957,	804781,	2495895,	207840,	792557,	3.8133,	.5089,
1958,	496824,	2164149,	195377,	769313,	3.9376,	.5169,
1959,	683690,	2415826,	432489,	744607,	1.7217,	.5596,
1960,	789653,	2050805,	383479,	622042,	1.6221,	.4789,
1961,	916842,	2137149,	404228,	783221,	1.9376,	.6348,
1962,	728338,	1957006,	311678,	909266,	2.9173,	.7576,
1963,	472064,	1747579,	208207,	776337,	3.7287,	.9866,
1964,	338678,	1374529,	186570,	437695,	2.3460,	.6789,
1965,	776941,	1440693,	102315,	444930,	4.3486,	.5533,
1966,	1582560,	2198418,	120722,	483711,	4.0068,	.5302,
1967,	1295416,	2852164,	129784,	572605,	4.4120,	.5439,
1968,	164955,	3387455,	227215,	1074084,	4.7272,	.5704,
1969,	112039,	2805591,	151870,	1197226,	7.8832,	.8292,
1970,	197105,	2057698,	224482,	933246,	4.1573,	.7493,
1971,	404774,	1610969,	311662,	689048,	2.2109,	.5956,
1972,	1015319,	1621485,	346511,	565254,	1.6313,	.6928,
1973,	1818949,	2401955,	332913,	792685,	2.3811,	.6020,
1974,	523916,	2236387,	164491,	1102433,	6.7021,	.5633,
1975,	621616,	2037430,	142028,	829377,	5.8395,	.6595,
1976,	613942,	1931396,	171238,	867463,	5.0658,	.6457,
1977,	348054,	1950748,	341385,	905301,	2.6518,	.8379,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,
1979,	198490,	1114381,	174699,	440538,	2.5217,	.7264,
1980,	137735,	863862,	108253,	380434,	3.5143,	.7241,
1981,	150868,	983658,	166926,	399038,	2.3905,	.8632,
1982,	151830,	750871,	326133,	363730,	1.1153,	.7583,
1983,	166831,	738675,	327181,	289992,	.8863,	.7560,
1984,	397831,	817596,	251087,	277651,	1.1058,	.9161,
1985,	523674,	957513,	193856,	307920,	1.5884,	.7038,
1986,	1038824,	1294448,	170729,	430113,	2.5193,	.8649,
1987,	286344,	1126275,	121243,	523071,	4.3142,	.9510,
1988,	204644,	915458,	202589,	434939,	2.1469,	.9743,
1989,	172782,	890359,	234716,	332481,	1.4165,	.6602,
1990,	242748,	962672,	316417,	212000,	.6700,	.2710,
1991,	411781,	1561711,	704744,	319158,	.4529,	.3210,
1992,	721090,	1912190,	887559,	513234,	.5783,	.4550,
1993,	894895,	2359674,	775173,	581611,	.7503,	.5528,
1994,	810420,	2155298,	614863,	771086,	1.2541,	.8678,
1995,	657041,	1825929,	528780,	739999,	1.3994,	.7880,
1996,	437976,	1686862,	571556,	732228,	1.2811,	.6988,
1997,	715933,	1532187,	588510,	762403,	1.2955,	1.0342,
1998,	845050,	1230183,	385810,	592624,	1.5361,	.9175,
1999,	548307,	1101326,	292789,	484910,	1.6562,	.9900,
2000,	606242,	1101505,	240647,	414868,	1.7240,	.8528,
2001,	518389,	1375566,	355761,	426471,	1.1988,	.7165,
2002,	441092,	1542075,	498180,	535045,	1.0740,	.6693,
2003,	678163,	1608810,	548309,	551990,	1.0067,	.5311,
2004,	297261,	1565794,	653553,	606445,	.9279,	.6835,
2005,	585363,	1555835,	601789,	641276,	1.0656,	.7265,
2006,	500369,	1496200,	579164,	537642,	.9283,	.6324,
2007,	777477,	1700760,	613028,	486883,	.7942,	.4048,
Arith. Mean ,	604111,	1990738,	396393,	656319,	2.3079,	.6428,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

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Table 3.26R. Northeast Arctic cod. Summary Table.

Run title : Arctic Cod (run: SVPASA15/V15)
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At 24/04/2008 10:13

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-10,
1946,	728139,	4168882,	1112776,	706000,	.6344,	.1857,
1947,	425311,	3692801,	1165059,	882017,	.7571,	.3047,
1948,	442592,	3665819,	1019114,	774295,	.7598,	.3398,
1949,	468348,	3065111,	729879,	800122,	1.0962,	.3619,
1950,	704908,	2830103,	615339,	731982,	1.1896,	.3566,
1951,	1083753,	3141009,	568705,	827180,	1.4545,	.3966,
1952,	1193111,	3407679,	520599,	876795,	1.6842,	.5348,
1953,	1590377,	3557376,	396417,	695546,	1.7546,	.3572,
1954,	641584,	4039204,	429694,	826021,	1.9223,	.3879,
1955,	272778,	3488383,	346919,	1147841,	3.3087,	.5437,
1956,	439602,	3189831,	299823,	1343068,	4.4795,	.6401,
1957,	804781,	2495895,	207840,	792557,	3.8133,	.5089,
1958,	496824,	2164149,	195377,	769313,	3.9376,	.5169,
1959,	683690,	2415826,	432489,	744607,	1.7217,	.5596,
1960,	789653,	2050805,	383479,	622042,	1.6221,	.4789,
1961,	916842,	2137149,	404228,	783221,	1.9376,	.6348,
1962,	728338,	1957006,	311678,	909266,	2.9173,	.7576,
1963,	472064,	1747579,	208207,	776337,	3.7287,	.9866,
1964,	338678,	1374529,	186570,	437695,	2.3460,	.6789,
1965,	776941,	1440693,	102315,	444930,	4.3486,	.5533,
1966,	1582560,	2198418,	120722,	483711,	4.0068,	.5302,
1967,	1295416,	2852164,	129784,	572605,	4.4120,	.5439,
1968,	164955,	3387455,	227215,	1074084,	4.7272,	.5704,
1969,	112039,	2805591,	151870,	1197226,	7.8832,	.8292,
1970,	197105,	2057698,	224482,	933246,	4.1573,	.7493,
1971,	404774,	1610969,	311662,	689048,	2.2109,	.5956,
1972,	1015319,	1621485,	346511,	565254,	1.6313,	.6928,
1973,	1818949,	2401955,	332913,	792685,	2.3811,	.6020,
1974,	523916,	2236387,	164491,	1102433,	6.7021,	.5633,
1975,	621616,	2037430,	142028,	829377,	5.8395,	.6595,
1976,	613942,	1931396,	171238,	867463,	5.0658,	.6457,
1977,	348054,	1950748,	341385,	905301,	2.6518,	.8379,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,
1979,	198490,	1114381,	174699,	440538,	2.5217,	.7264,
1980,	137735,	863862,	108253,	380434,	3.5143,	.7241,
1981,	150868,	983658,	166926,	399038,	2.3905,	.8632,
1982,	151830,	750871,	326133,	363730,	1.1153,	.7583,
1983,	166831,	738675,	327181,	289992,	.8863,	.7560,
1984,	397831,	817596,	251087,	277651,	1.1058,	.9161,
1985,	523674,	957513,	193856,	307920,	1.5884,	.7038,
1986,	1038824,	1294448,	170729,	430113,	2.5193,	.8649,
1987,	286344,	1126275,	121243,	523071,	4.3142,	.9510,
1988,	204644,	915458,	202589,	434939,	2.1469,	.9743,
1989,	172781,	890359,	234716,	332481,	1.4165,	.6602,
1990,	242747,	962672,	316417,	212000,	.6700,	.2710,
1991,	411775,	1561707,	704744,	319158,	.4529,	.3210,
1992,	721067,	1912174,	887558,	513234,	.5783,	.4550,
1993,	894800,	2359610,	775171,	581611,	.7503,	.5528,
1994,	810163,	2155151,	614855,	771086,	1.2541,	.8678,
1995,	656391,	1825617,	528759,	739999,	1.3995,	.7880,
1996,	436349,	1686143,	571496,	732228,	1.2812,	.6989,
1997,	708821,	1529746,	588360,	762403,	1.2958,	1.0347,
1998,	825609,	1222243,	385465,	592624,	1.5374,	.9194,
1999,	508164,	1078962,	291852,	484910,	1.6615,	.9965,
2000,	534106,	1048902,	236520,	414868,	1.7541,	.8704,
2001,	444198,	1257602,	337839,	426471,	1.2623,	.7579,
2002,	381174,	1346345,	444977,	470554,	1.0575,	.6626,
2003,	587434,	1394131,	485549,	469585,	.9671,	.5150,
2004,	266467,	1364601,	577039,	519445,	.9002,	.6683,
2005,	525440,	1366344,	532838,	516276,	.9689,	.6671,
2006,	437871,	1366790,	542181,	498528,	.9195,	.6320,
2007,	647608,	1517515,	566475,	454553,	.8024,	.4202,
Arith. Mean ,	593637,	1969474,	390449,	649378,	2.3066,	.6426,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

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Table 3.27. Northeast Arctic cod. Summary Table, run without cannibalism.

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 Run         title        :         Arctic        Cod        (run:         SVPASA15/V15)
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    At 28/04/2008   9:22

        Table 16    Summary     (without SOP correction)

                   Traditional vpa  using file input  for terminal F
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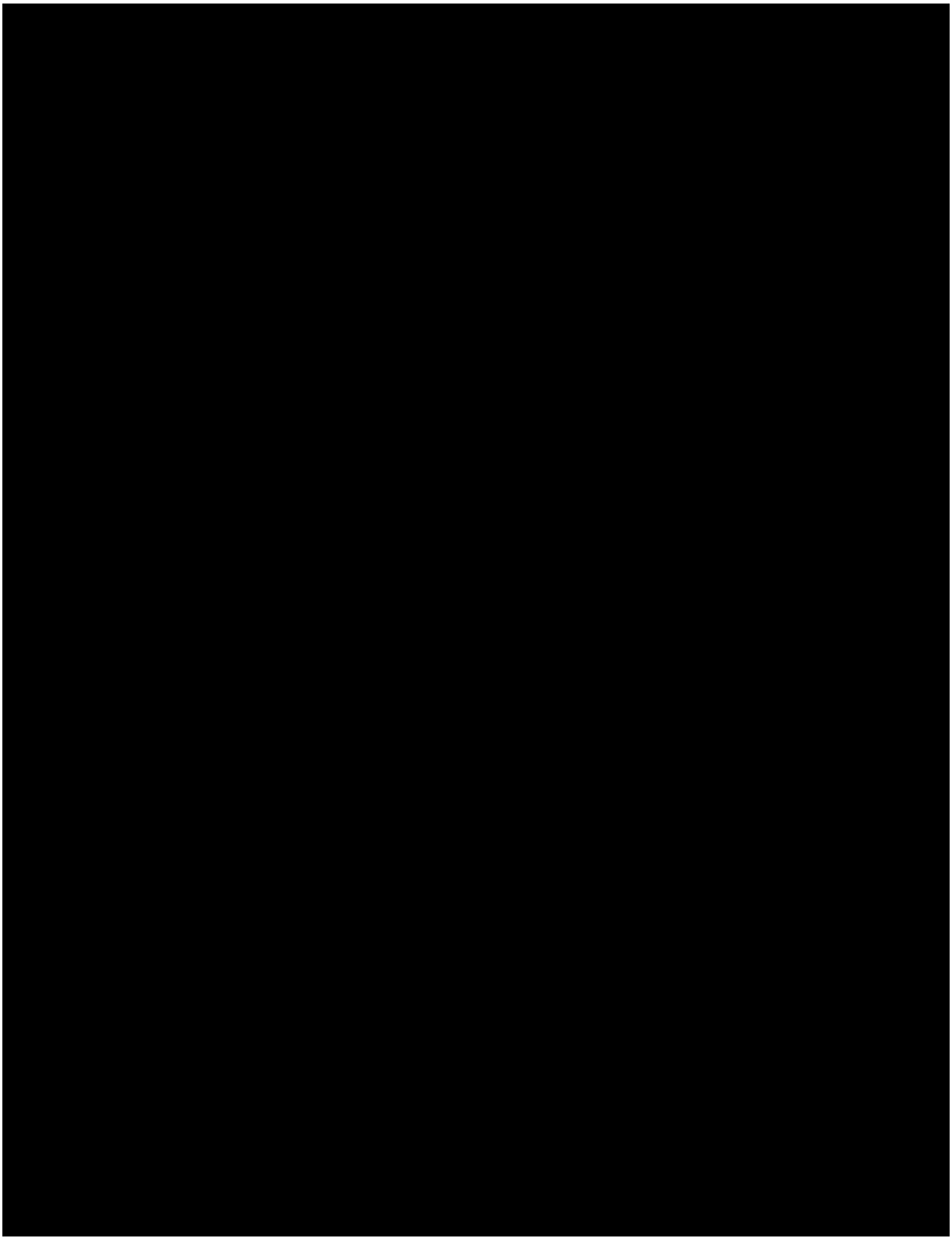
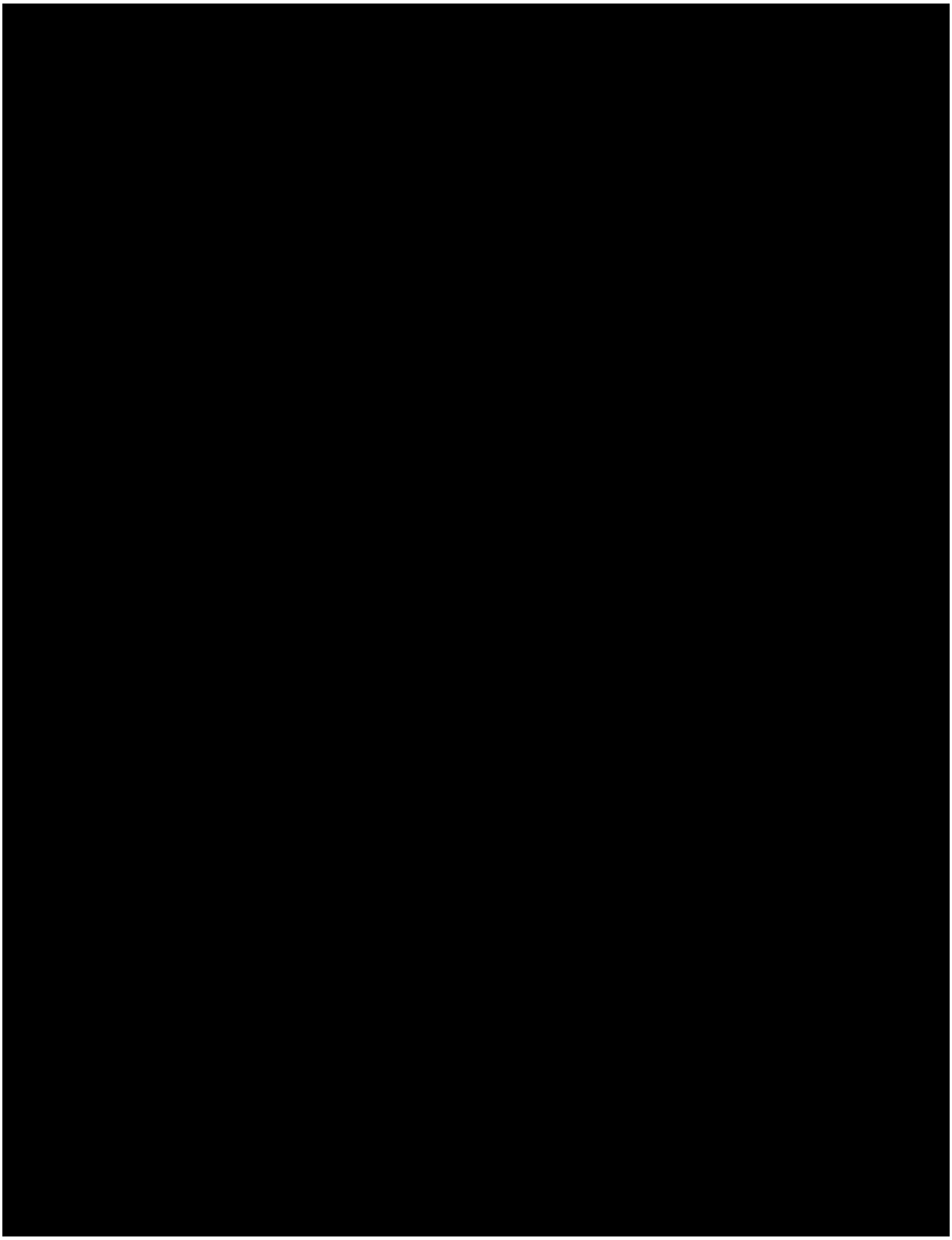
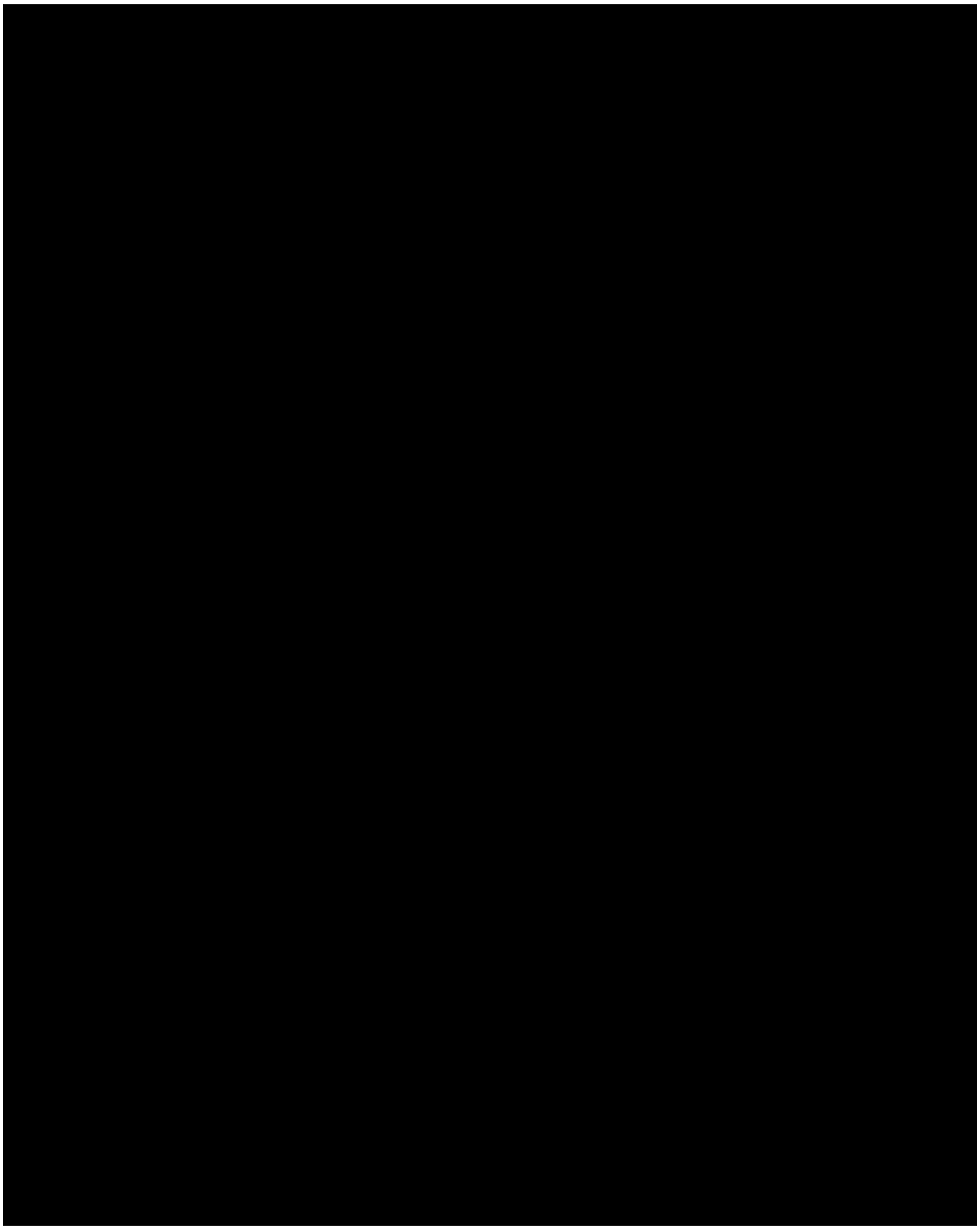
,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-10,
1946,	728139,	4168882,	1112776,	706000,	.6344,	.1857,
1947,	425311,	3692801,	1165059,	882017,	.7571,	.3047,
1948,	442592,	3665819,	1019114,	774295,	.7598,	.3398,
1949,	468348,	3065111,	729879,	800122,	1.0962,	.3619,
1950,	704908,	2830103,	615339,	731982,	1.1896,	.3566,
1951,	1083753,	3141009,	568705,	827180,	1.4545,	.3966,
1952,	1193111,	3407679,	520599,	876795,	1.6842,	.5348,
1953,	1590377,	3557376,	396417,	695546,	1.7546,	.3572,
1954,	641584,	4039204,	429694,	826021,	1.9223,	.3879,
1955,	272778,	3488383,	346919,	1147841,	3.3087,	.5437,
1956,	439602,	3189831,	299823,	1343068,	4.4795,	.6401,
1957,	804781,	2495895,	207840,	792557,	3.8133,	.5089,
1958,	496824,	2164149,	195377,	769313,	3.9376,	.5169,
1959,	683690,	2415826,	432489,	744607,	1.7217,	.5596,
1960,	789653,	2050805,	383479,	622042,	1.6221,	.4789,
1961,	916842,	2137149,	404228,	783221,	1.9376,	.6348,
1962,	728338,	1957006,	311678,	909266,	2.9173,	.7576,
1963,	472064,	1747579,	208207,	776337,	3.7287,	.9866,
1964,	338678,	1374529,	186570,	437695,	2.3460,	.6789,
1965,	776941,	1440693,	102315,	444930,	4.3486,	.5533,
1966,	1582560,	2198418,	120722,	483711,	4.0068,	.5302,
1967,	1295416,	2852164,	129784,	572605,	4.4120,	.5439,
1968,	164955,	3387455,	227215,	1074084,	4.7272,	.5704,
1969,	112039,	2805591,	151870,	1197226,	7.8832,	.8292,
1970,	197105,	2057698,	224482,	933246,	4.1573,	.7493,
1971,	404774,	1610969,	311662,	689048,	2.2109,	.5956,
1972,	1015319,	1621485,	346511,	565254,	1.6313,	.6928,
1973,	1818949,	2401955,	332913,	792685,	2.3811,	.6020,
1974,	523916,	2236387,	164491,	1102433,	6.7021,	.5633,
1975,	621616,	2037430,	142028,	829377,	5.8395,	.6595,
1976,	613942,	1931396,	171238,	867463,	5.0658,	.6457,
1977,	348054,	1950748,	341385,	905301,	2.6518,	.8379,
1978,	638490,	1576565,	241536,	698715,	2.8928,	.9406,
1979,	198490,	1114381,	174699,	440538,	2.5217,	.7264,
1980,	137735,	863862,	108253,	380434,	3.5143,	.7241,
1981,	150868,	983658,	166926,	399038,	2.3905,	.8632,
1982,	151830,	750871,	326133,	363730,	1.1153,	.7583,
1983,	166831,	738675,	327181,	289992,	.8863,	.7560,
1984,	397595,	817497,	251087,	277651,	1.1058,	.9161,
1985,	523470,	957429,	193856,	307920,	1.5884,	.7038,
1986,	930300,	1260697,	170729,	430113,	2.5193,	.8649,
1987,	270553,	1122943,	121243,	523071,	4.3142,	.9510,
1988,	202920,	915093,	202589,	434939,	2.1469,	.9743,
1989,	172782,	890359,	234716,	332481,	1.4165,	.6602,
1990,	242748,	962672,	316417,	212000,	.6700,	.2710,
1991,	408178,	1559845,	704742,	319158,	.4529,	.3210,
1992,	700365,	1901880,	887533,	513234,	.5783,	.4550,
1993,	759309,	2295780,	774578,	581611,	.7509,	.5530,
1994,	516606,	2023086,	612339,	771086,	1.2592,	.8687,
1995,	306872,	1689761,	528002,	739999,	1.4015,	.7886,
1996,	257898,	1597406,	570510,	732228,	1.2835,	.7012,
1997,	491913,	1473779,	588419,	762403,	1.2957,	1.0351,
1998,	600758,	1159730,	385503,	592624,	1.5373,	.9186,
1999,	469814,	1079339,	292744,	484910,	1.6564,	.9900,
2000,	549173,	1075492,	240146,	414868,	1.7276,	.8537,
2001,	484978,	1354326,	354784,	426471,	1.2021,	.7170,
2002,	392364,	1524767,	497985,	535045,	1.0744,	.6693,
2003,	630062,	1596427,	548291,	551990,	1.0067,	.5311,
2004,	273462,	1547445,	653218,	606445,	.9284,	.6838,
2005,	493412,	1524846,	600908,	641276,	1.0672,	.7272,
2006,	492066,	1492679,	579157,	537642,	.9283,	.6324,
2007,	738026,	1688785,	613021,	486883,	.7942,	.4048,
Arith. Mean ,	571723,	1978413,	396259,	656319,	2.3082,	.6430,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1







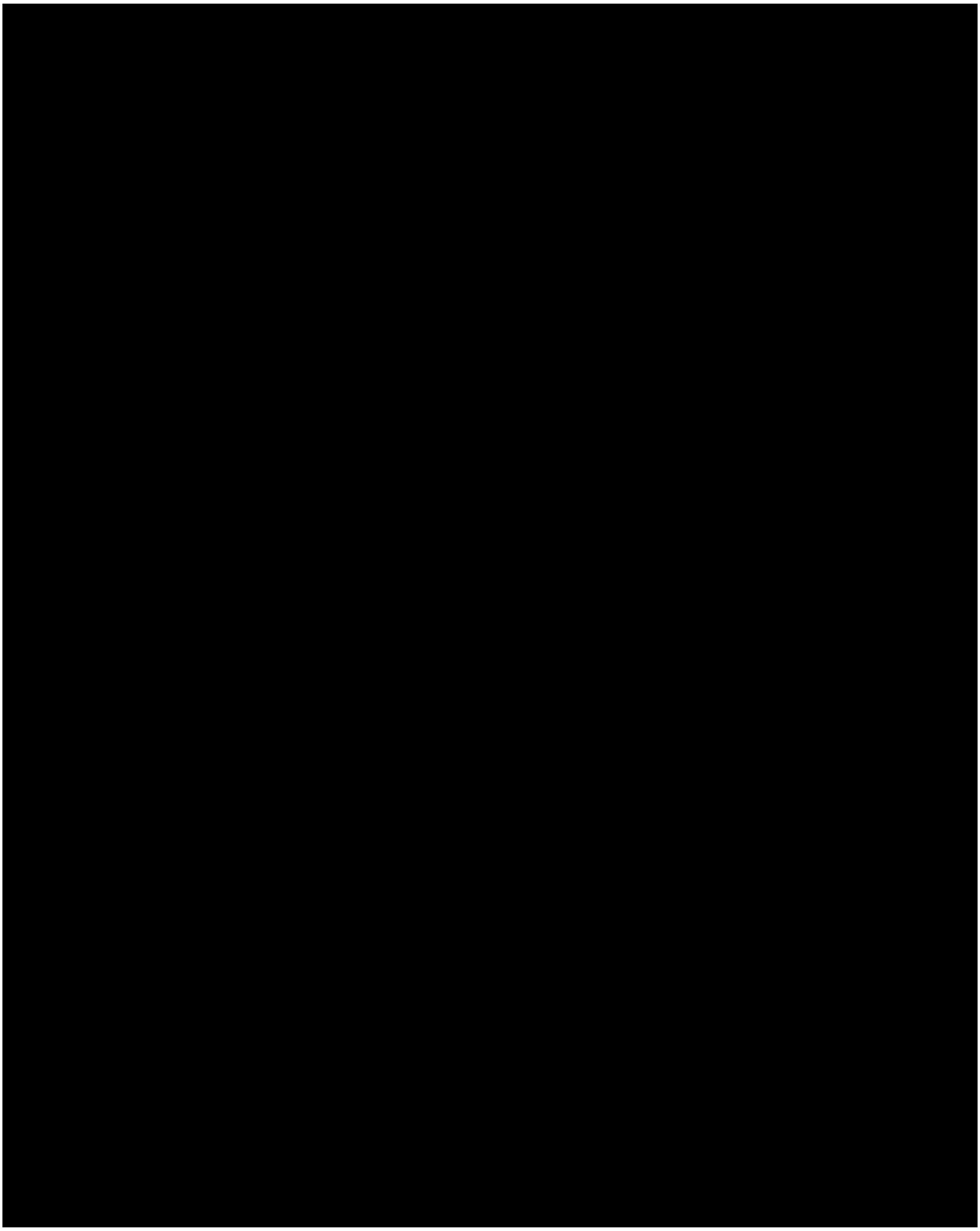


Table 3.30N. Detailed prediction output, NOR-IUU-run

MFDP version 1a
Run: run3
Time and date: 11:53 29.04.2008
Fbar age range: 5-10

Year:	2008	F multiplier	1	Fbar:	0.4048				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.016	9815	7401	714000	204204	0	0	0	0
4	0.0853	40506	48323	548811	402827	2195	1611	2195	1611
5	0.2118	48844	82009	282173	386577	17495	23968	17495	23968
6	0.3266	44627	107373	175891	416334	49601	117406	49601	117406
7	0.4466	20224	68945	61493	202312	33083	108844	33083	108844
8	0.494	19131	88672	53707	258868	46349	223403	46349	223403
9	0.5059	4923	31151	13566	88830	12589	82434	12589	82434
10	0.4437	2106	16768	6437	54605	6398	54277	6398	54277
11	0.4445	917	8588	2800	24926	2800	24926	2800	24926
12	0.4079	224	2432	734	6929	734	6929	734	6929
13	0.4079	122	1501	399	5710	399	5710	399	5710
Total		191440	463165	1860011	2052122	171644	649508	171644	649508

Year:	2009	F multiplier	0.9883	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0158	6916	5214	509000	151173	0	0	0	0
4	0.0843	38152	43989	522792	373273	1568	1120	1568	1120
5	0.2093	69857	122319	407872	569390	26512	37010	26512	37010
6	0.3228	46659	114362	185753	430205	61670	142828	61670	142828
7	0.4414	33791	117052	103717	366743	65964	233248	65964	233248
8	0.4882	11369	53843	32211	154937	28314	136190	28314	136190
9	0.5	9648	59361	26831	183441	25650	175369	25650	175369
10	0.4385	2171	17030	6697	60160	6684	60039	6684	60039
11	0.4393	1098	10405	3382	34503	3382	34503	3382	34503
12	0.4031	445	4840	1470	16107	1470	16107	1470	16107
13	0.4031	187	2308	617	7093	617	7093	617	7093
Total		220291	550725	1800342	2347024	221830	843508	221830	843508

Year:	2010	F multiplier	0.9883	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0158	2065	1557	152000	42712	0	0	0	0
4	0.0843	27203	31365	372760	270624	1118	812	1118	812
5	0.2093	66611	112307	388923	535547	25280	34811	25280	34811
6	0.3228	67612	170585	269167	630389	89363	209289	89363	209289
7	0.4414	35822	125701	109952	383182	69929	243704	69929	243704
8	0.4882	19276	92350	54614	276128	48006	242717	48006	242717
9	0.5	5820	36397	16185	110497	15473	105635	15473	105635
10	0.4385	4318	33126	13324	123540	13297	123292	13297	123292
11	0.4393	1148	10749	3537	37855	3537	37855	3537	37855
12	0.4031	540	5940	1784	21878	1784	21878	1784	21878
13	0.4031	346	4284	1142	14861	1142	14861	1142	14861
Total		230762	624361	1383388	2447213	268930	1034854	268930	1034854

Year:	2011	F multiplier	0.9883	Fbar:	0.4				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0158	8152	6147	600000	168600	0	0	0	0
4	0.0843	8123	9366	111315	80815	334	242	334	242
5	0.2093	47495	80077	277309	381855	18025	24821	18025	24821
6	0.3228	64471	162660	256662	601102	85212	199566	85212	199566
7	0.4414	51909	182148	159326	555252	101331	353140	101331	353140
8	0.4882	20435	97902	57897	292728	50892	257308	50892	257308
9	0.5	9867	61710	27442	187346	26234	179102	26234	179102
10	0.4385	2605	19983	8038	74524	8021	74375	8021	74375
11	0.4393	2284	21385	7036	75314	7036	75314	7036	75314
12	0.4031	565	6212	1866	22880	1866	22880	1866	22880
13	0.4031	485	6007	1601	20838	1601	20838	1601	20838
Total		216390	653597	1508492	2461253	300553	1207586	300553	1207586

Year:	2012	F multiplier	1	Fbar:	0.4048				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.016	8248	6219	600000	168600	0	0	0	0
4	0.0853	32431	37393	439403	319007	1318	957	1318	957
5	0.2118	14335	24168	82811	114031	5383	7412	5383	7412
6	0.3266	46432	117148	183005	428597	60758	142294	60758	142294
7	0.4466	49966	175332	151924	529455	96624	336733	96624	336733
8	0.494	29885	143178	83896	424178	73745	372853	73745	372853
9	0.5059	10557	66021	29092	198608	27811	189869	27811	189869
10	0.4437	4459	34202	13627	126354	13600	126101	13600	126101
11	0.4445	1391	13023	4244	45433	4244	45433	4244	45433
12	0.4079	1135	12479	3713	45521	3713	45521	3713	45521
13	0.4079	580	7187	1897	24690	1897	24690	1897	24690
Total		199417	636349	1593612	2424474	289092	1291864	289092	1291864

Year:	2013	F multiplier	1	Fbar:	0.4048				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.016	8248	6219	600000	168600	0	0	0	0
4	0.0853	32425	37386	439321	318947	1318	957	1318	957
5	0.2118	56527	95305	326561	449675	21226	29229	21226	29229
6	0.3266	13831	34897	54514	127673	18099	42387	18099	42387
7	0.4466	35491	124538	107911	376072	68632	239181	68632	239181
8	0.494	28348	135814	79581	402364	69952	353678	69952	353678
9	0.5059	15209	95117	41912	286135	40068	273545	40068	273545
10	0.4437	4699	36044	14361	133159	14333	132893	14333	132893
11	0.4445	2346	21965	7159	76631	7159	76631	7159	76631
12	0.4079	681	7489	2228	27318	2228	27318	2228	27318
13	0.4079	934	11573	3054	39758	3054	39758	3054	39758
Total		198738	606347	1676604	2406330	246069	1215577	246069	1215577

Table 3.30R. Detailed prediction results, RUS-IUU-run.

MFDP version 1a
Run: run3
Time and date: 12:42 29.04.2008
Fbar age range: 5-10

Year:		2008 F multipl	1	Fbar:	0.4202				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0177	10791	8137	714000	204204	0	0	0	0
4	0.0895	34760	41468	449882	330213	1800	1321	1800	1321
5	0.2158	43165	72475	245224	335957	15204	20829	15204	20829
6	0.333	39363	94706	152611	361230	43036	101867	43036	101867
7	0.4579	24432	83290	72820	239578	39177	128893	39177	128893
8	0.5125	11740	54417	32030	154385	27642	133234	27642	133234
9	0.5319	4721	29873	12516	81955	11615	76054	11615	76054
10	0.47	2066	16451	6032	51169	5996	50862	5996	50862
11	0.4629	893	8357	2638	23483	2638	23483	2638	23483
12	0.4268	221	2400	698	6589	698	6589	698	6589
13	0.4268	120	1476	378	5410	378	5410	378	5410
Total		172272	413049	1688829	1794173	148183	548542	148183	548542

Year:		2009 F multipl	0.9518	Fbar:	0.3999				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0168	7325	5523	509000	151173	0	0	0	0
4	0.0852	38027	43845	516039	368452	1548	1105	1548	1105
5	0.2054	56019	98089	332748	464516	21629	30194	21629	30194
6	0.3169	39754	97438	160753	372305	53370	123605	53370	123605
7	0.4358	28834	99882	89406	316141	56862	201066	56862	201066
8	0.4878	13303	63002	37716	181415	33153	159464	33153	159464
9	0.5063	5703	35092	15708	107396	15017	102670	15017	102670
10	0.4473	1983	15556	6020	54079	6008	53971	6008	53971
11	0.4406	1004	9520	3087	31493	3087	31493	3087	31493
12	0.4062	414	4505	1360	14899	1360	14899	1360	14899
13	0.4062	175	2165	575	6610	575	6610	575	6610
Total		192542	474616	1672413	2068478	192608	725076	192608	725076

Year:		2010 F multipl	0.9518	Fbar:	0.3999				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0168	2187	1649	152000	42712	0	0	0	0
4	0.0852	27132	31283	368191	267306	1105	802	1105	802
5	0.2054	64535	108806	383330	527846	24916	34310	24916	34310
6	0.3169	54507	137522	220409	516199	73176	171378	73176	171378
7	0.4358	30864	108302	95700	333516	60865	212116	60865	212116
8	0.4878	16697	79996	47340	239353	41612	210391	41612	210391
9	0.5063	6884	43051	18959	129435	18125	123740	18125	123740
10	0.4473	2553	19583	7752	71874	7736	71730	7736	71730
11	0.4406	1025	9600	3151	33730	3151	33730	3151	33730
12	0.4062	495	5449	1627	19944	1627	19944	1627	19944
13	0.4062	321	3984	1055	13733	1055	13733	1055	13733
Total		207201	549225	1299515	2195647	233369	891874	233369	891874

Year:		2011 F multipl	0.9518	Fbar:	0.3999				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0168	8635	6511	600000	168600	0	0	0	0
4	0.0852	8102	9342	109951	79824	330	239	330	239
5	0.2054	46045	77632	273504	376615	17778	24480	17778	24480
6	0.3169	62793	158427	253915	594668	84300	197430	84300	197430
7	0.4358	42318	148493	131215	457284	83453	290833	83453	290833
8	0.4878	17873	85628	50673	256203	44542	225202	44542	225202
9	0.5063	8640	54036	23797	162463	22750	155315	22750	155315
10	0.4473	3081	23636	9356	86750	9337	86576	9337	86576
11	0.4406	1320	12361	4057	43431	4057	43431	4057	43431
12	0.4062	506	5563	1661	20361	1661	20361	1661	20361
13	0.4062	446	5523	1463	19038	1463	19038	1463	19038
Total		199758	587152	1459591	2265238	269670	1062906	269670	1E+06

Year:		2012 F multipl	1	Fbar:	0.4202				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0177	9068	6837	600000	168600	0	0	0	0
4	0.0895	33534	38664	434017	315096	1302	945	1302	945
5	0.2158	14377	24239	81675	112466	5309	7310	5309	7310
6	0.333	46728	117894	181167	424292	60147	140865	60147	140865
7	0.4579	50717	177967	151162	526798	96139	335043	96139	335043
8	0.5125	25467	122010	69478	351280	61071	308775	61071	308775
9	0.5319	9608	60087	25472	173900	24352	166249	24352	166249
10	0.47	4023	30857	11744	108886	11720	108668	11720	108668
11	0.4629	1657	15520	4897	52421	4897	52421	4897	52421
12	0.4268	678	7456	2138	26217	2138	26217	2138	26217
13	0.4268	540	6696	1703	22173	1703	22173	1703	22173
Total		196396	608228	1563452	2282129	268779	1168667	268779	1E+06

Year:		2013 F multipl	1	Fbar:	0.4202				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0177	9068	6837	600000	168600	0	0	0	0
4	0.0895	33505	38631	433646	314827	1301	944	1301	944
5	0.2158	56506	95269	321013	442035	20866	28732	20866	28732
6	0.333	13810	34842	53541	125393	17776	41630	17776	41630
7	0.4579	35610	124956	106136	369882	67502	235245	67502	235245
8	0.5125	28697	137489	78292	395846	68819	347948	68819	347948
9	0.5319	12852	80375	34073	232617	32574	222382	32574	222382
10	0.47	4197	32193	12252	113601	12228	113374	12228	113374
11	0.4629	2034	19043	6009	64323	6009	64323	6009	64323
12	0.4268	800	8801	2524	30945	2524	30945	2524	30945
13	0.4268	651	8069	2053	26718	2053	26718	2053	26718
Total		197730	586507	1649540	2284789	231651	1112243	231651	1E+06

Input units are thousands and kg - output in tonnes

Table 3.31. North East arctic cod. Stock numbers at age (in thousands) estimated by VPA including discard estimates, and % increase in stock numbers relative to a VPA without discards. From Dingsør (2001). The discard numbers applied correspond to method II (1946-1982) and IIIb (1983-1998) mentioned in Dingsør (2001).

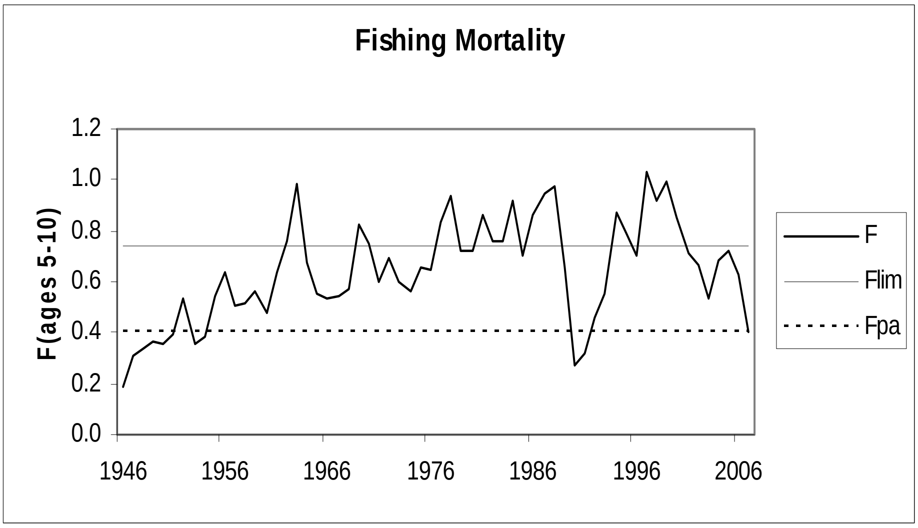
	Estimated stock numbers (thousands)			Percent increase		
Year	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5
1946	875 346	602 579	407 163	20 %	4 %	1 %
1947	531 993	676 806	465 099	27 %	14 %	0 %
1948	570 356	392 309	497 476	29 %	14 %	5 %
1949	589 367	416 668	285 459	26 %	16 %	3 %
1950	799 732	414 016	291 200	13 %	9 %	1 %
1951	1 235 322	586 054	302 346	14 %	2 %	0 %
1952	1 388 731	889 509	401 768	17 %	3 %	0 %
1953	1 801 114	975 004	600 908	13 %	2 %	0 %
1954	830 653	1 321 053	684 303	29 %	5 %	0 %
1955	381 489	615 696	907 875	40 %	19 %	2 %
1956	567 555	274 235	399 344	29 %	25 %	3 %
1957	914 850	387 496	161 710	14 %	10 %	2 %
1958	552 600	672 221	262 135	11 %	4 %	2 %
1959	757 567	391 906	406 694	11 %	3 %	0 %
1960	855 470	534 350	240 047	8 %	1 %	0 %
1961	1 041 570	620 707	347 043	13 %	1 %	0 %
1962	894 728	739 196	382 556	23 %	4 %	0 %
1963	551 938	614 025	429 068	17 %	10 %	0 %
1964	389 151	396 165	361 790	15 %	5 %	0 %
1965	845 469	293 844	266 134	9 %	8 %	0 %
1966	1 618 188	647 435	203 168	2 %	4 %	2 %
1967	1 404 569	1 249 506	465 035	9 %	0 %	1 %
1968	210 875	1 088 071	876 095	24 %	6 %	0 %
1969	143 791	155 947	699 033	28 %	15 %	2 %
1970	222 635	104 415	92 541	13 %	17 %	4 %
1971	462 474	164 397	65 112	14 %	6 %	2 %
1972	1 221 559	358 357	115 892	20 %	10 %	1 %
1973	1 858 123	947 409	249 400	2 %	19 %	11 %
1974	598 555	1 246 499	583 612	14 %	2 %	9 %
1975	654 442	382 692	627 793	5 %	10 %	3 %
1976	622 230	477 390	233 608	1 %	2 %	1 %
1977	397 826	426 386	280 645	14 %	0 %	0 %
1978	653 256	277 410	198 204	2 %	11 %	0 %
1979	225 935	460 104	164 243	14 %	2 %	1 %
1980	152 937	171 954	300 312	11 %	11 %	0 %
1981	161 752	116 964	116 337	7 %	7 %	4 %
1982	151 642	125 307	81 780	0 %	4 %	1 %
1983	166 310	115 423	82 423	0 %	-1 %	3 %
1984	408 525	133 333	77 728	3 %	0 %	0 %
1985	543 828	324 072	96 327	4 %	2 %	0 %
1986	1 114 252	412 683	219 993	7 %	2 %	0 %
1987	307 425	767 656	268 642	7 %	4 %	0 %
1988	222 819	215 720	490 161	9 %	3 %	2 %
1989	180 066	166 955	151 576	4 %	6 %	0 %
1990	249 968	139 922	114 006	3 %	2 %	1 %
1991	418 955	200 700	105 559	2 %	2 %	0 %
1992	748 962	333 517	151 973	4 %	1 %	0 %
1993	1 002 933	576 112	238 980	10 %	2 %	0 %
1994	896 184	744 062	420 039	9 %	8 %	0 %
1995	733 664	584 808	476 048	10 %	6 %	3 %
1996	467 093	341 918	344 124	3 %	7 %	3 %
1997	765 234	238 202	193 102	3 %	0 %	4 %
1998	836 301	429 147	144 629	2 %	1 %	-1 %

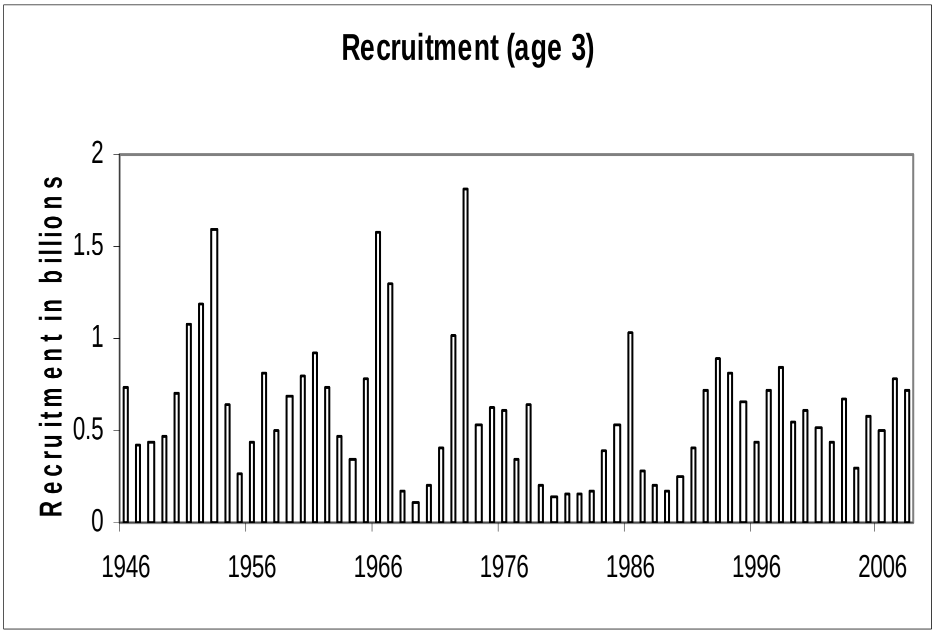
Table 3.32. Northeast Arctic cod. Number (thousands) of cod by age groups taken as by-catch in the Norwegian shrimp fishery (1984-2006)

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





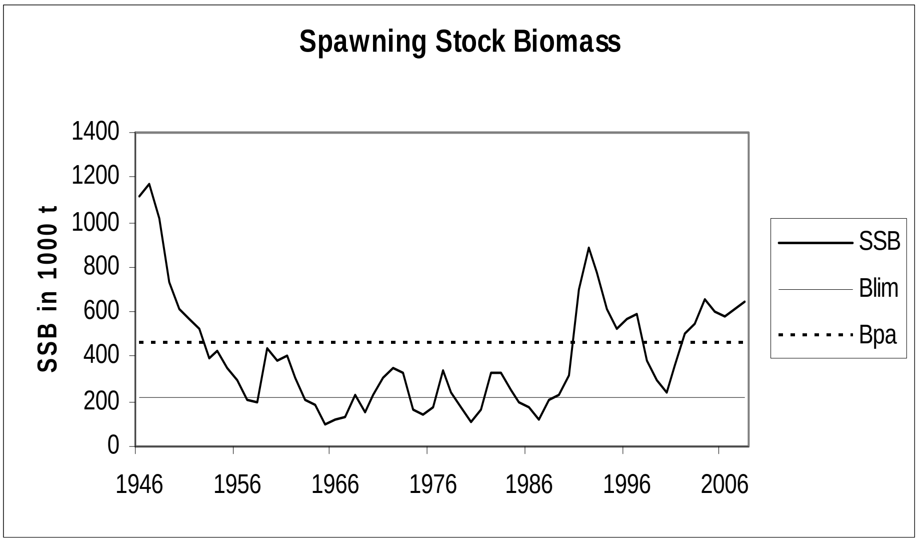
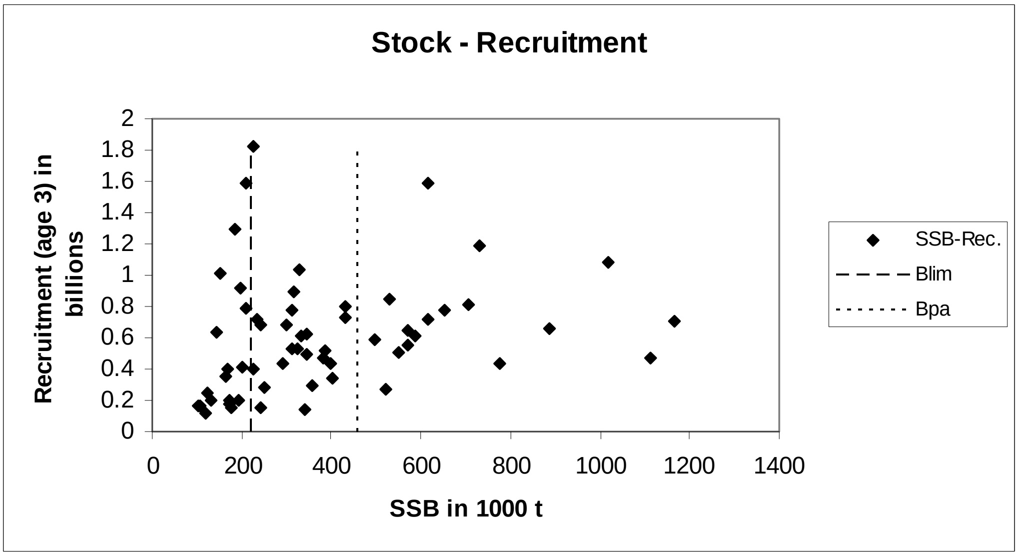
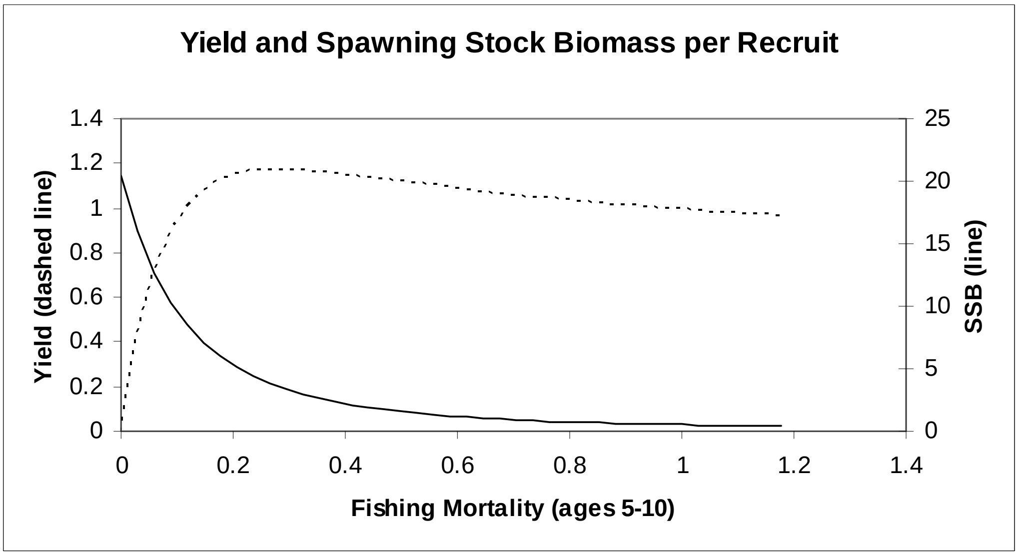


Figure 3.1. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)





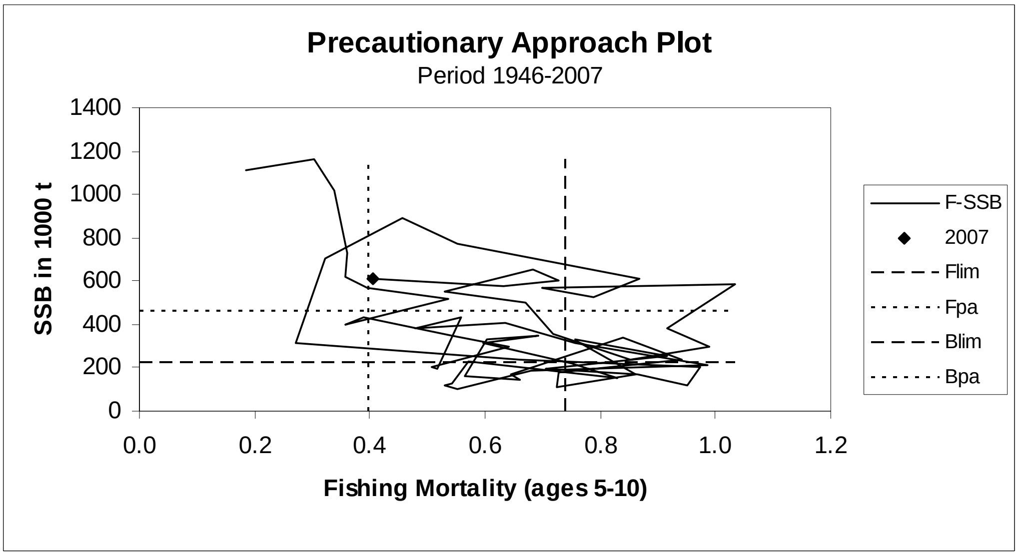


Figure 3.1. Continued. ICES Standard plots for North-East Arctic cod (Sub-areas I and II)

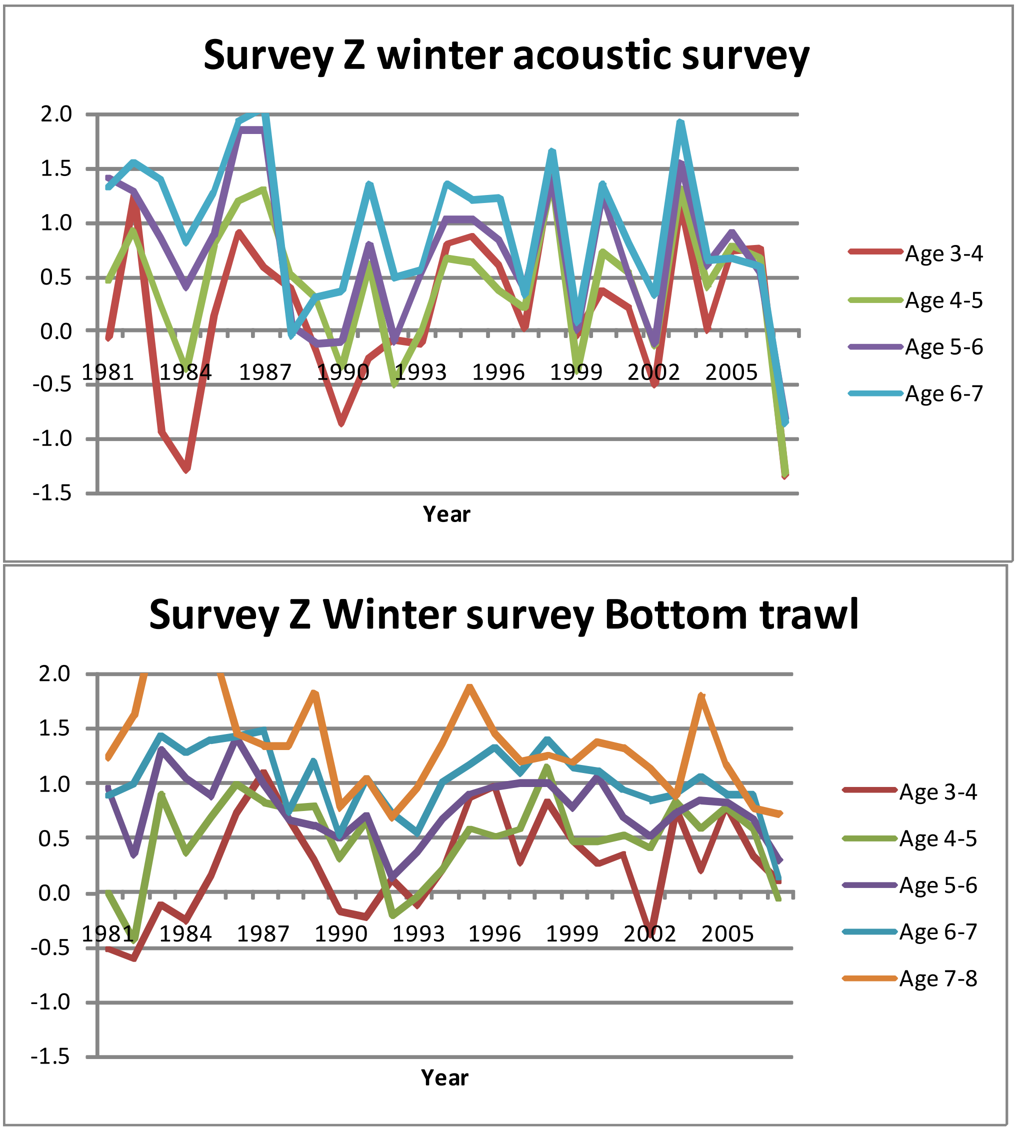


Figure 3.2. Northeast Arctic cod. Survey mortalities.

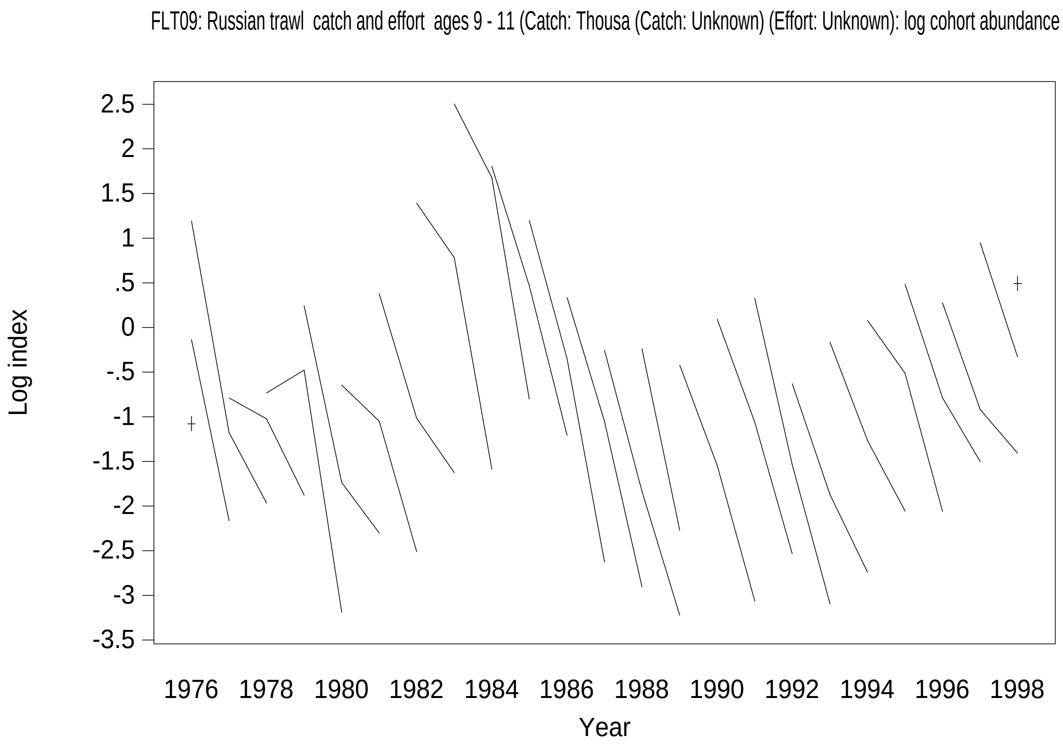


Figure 3.3. Northeast Arctic cod. Standard SURBA plot for fleet 09.

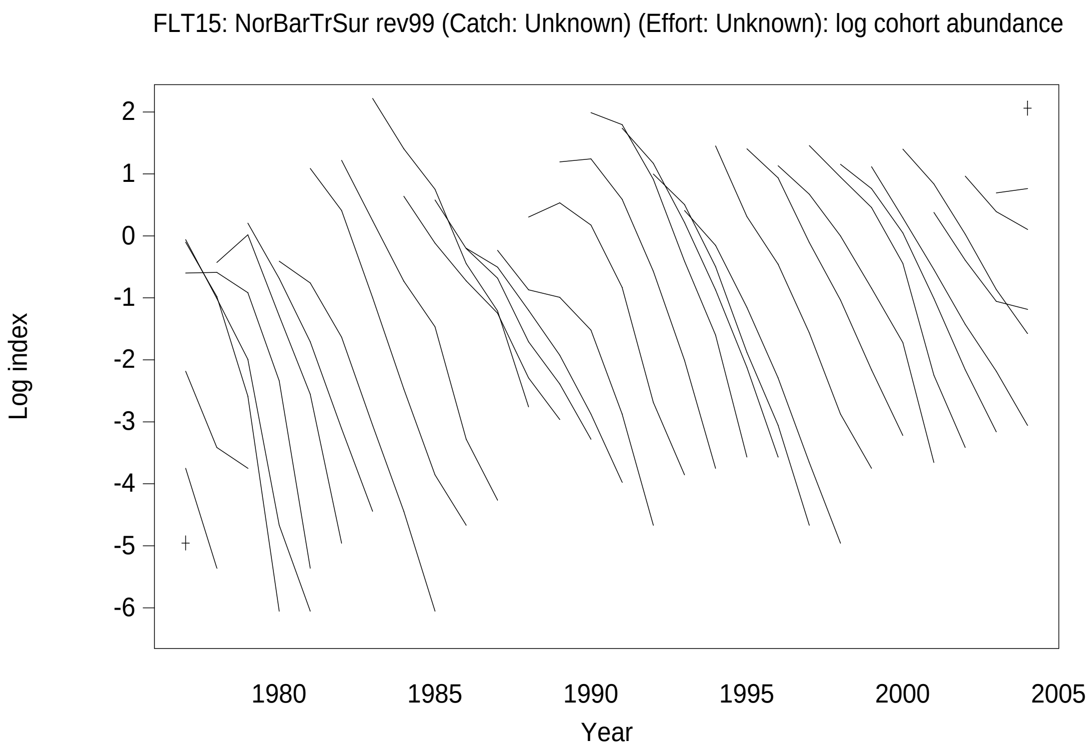


Figure 3.3 (continued). Northeast Arctic cod. Standard SURBA plot for fleet 15.

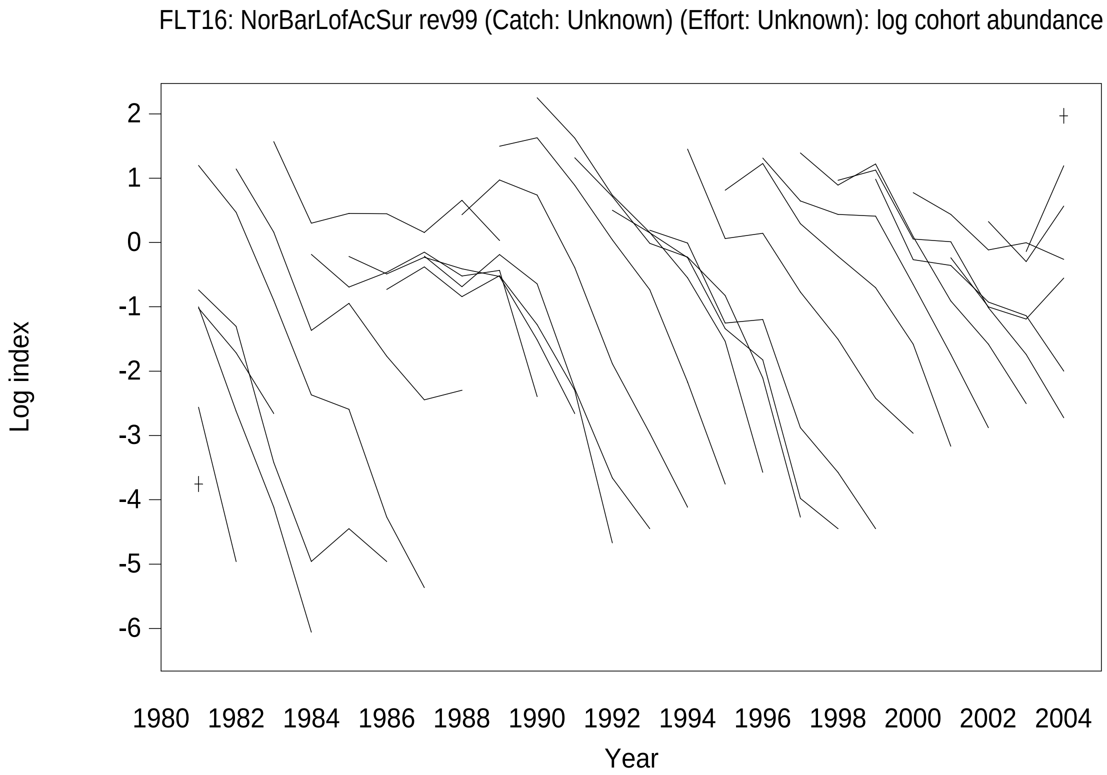


Figure 3.3 (continued). Northeast Arctic cod. Standard SURBA plot for fleet 16.

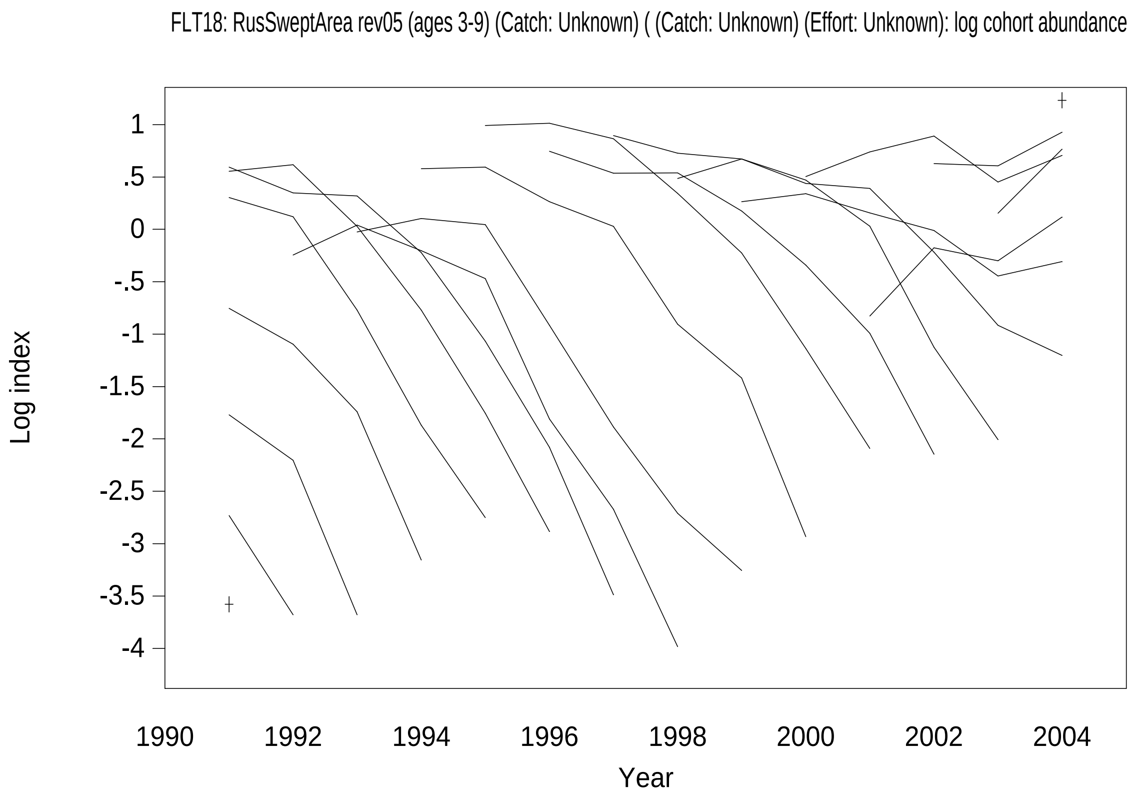


Figure 3.3 (continued). Northeast Arctic cod. Standard SURBA plot for fleet 18.

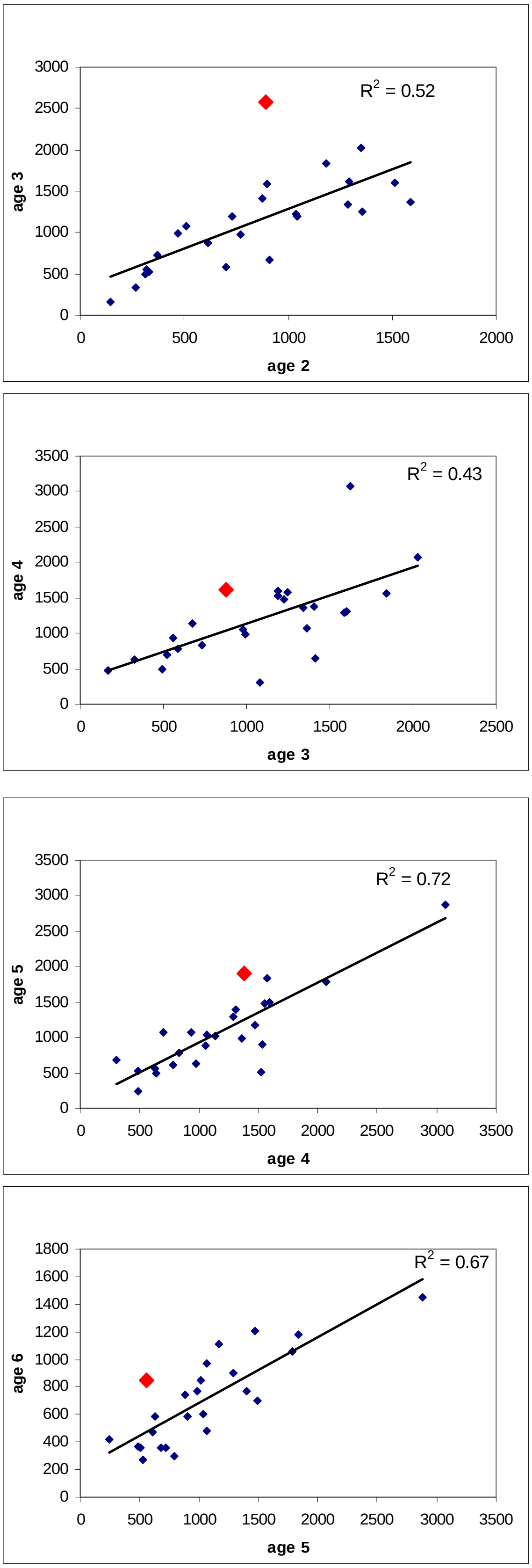


Figure 3.4. Northeast Arctic cod. Relationships between abundance indices of adjacent age groups for 1982-2007 in the Russian autumn survey. The last index is shown in red.

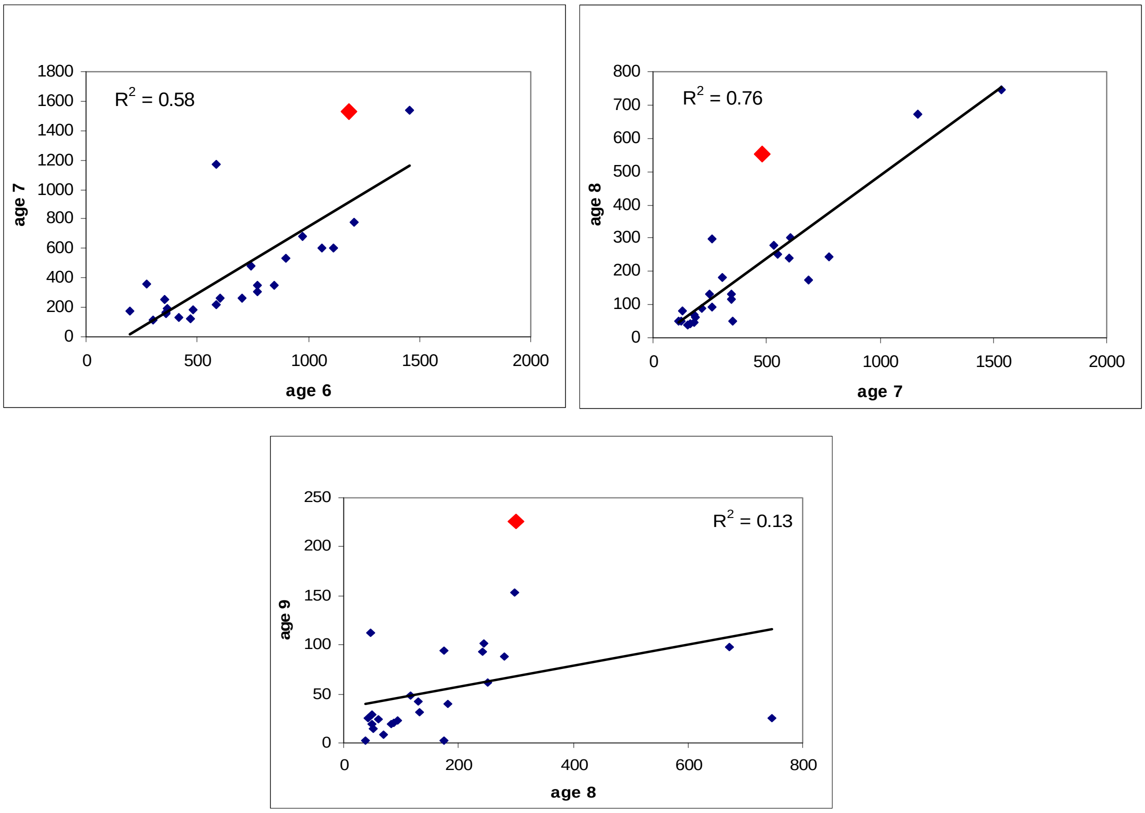


Figure 3.4 continued). Northeast Arctic cod. Relationships between abundance indices of adjacent age groups for 1982-2007 in the Russian autumn survey. The last index is shown in red.

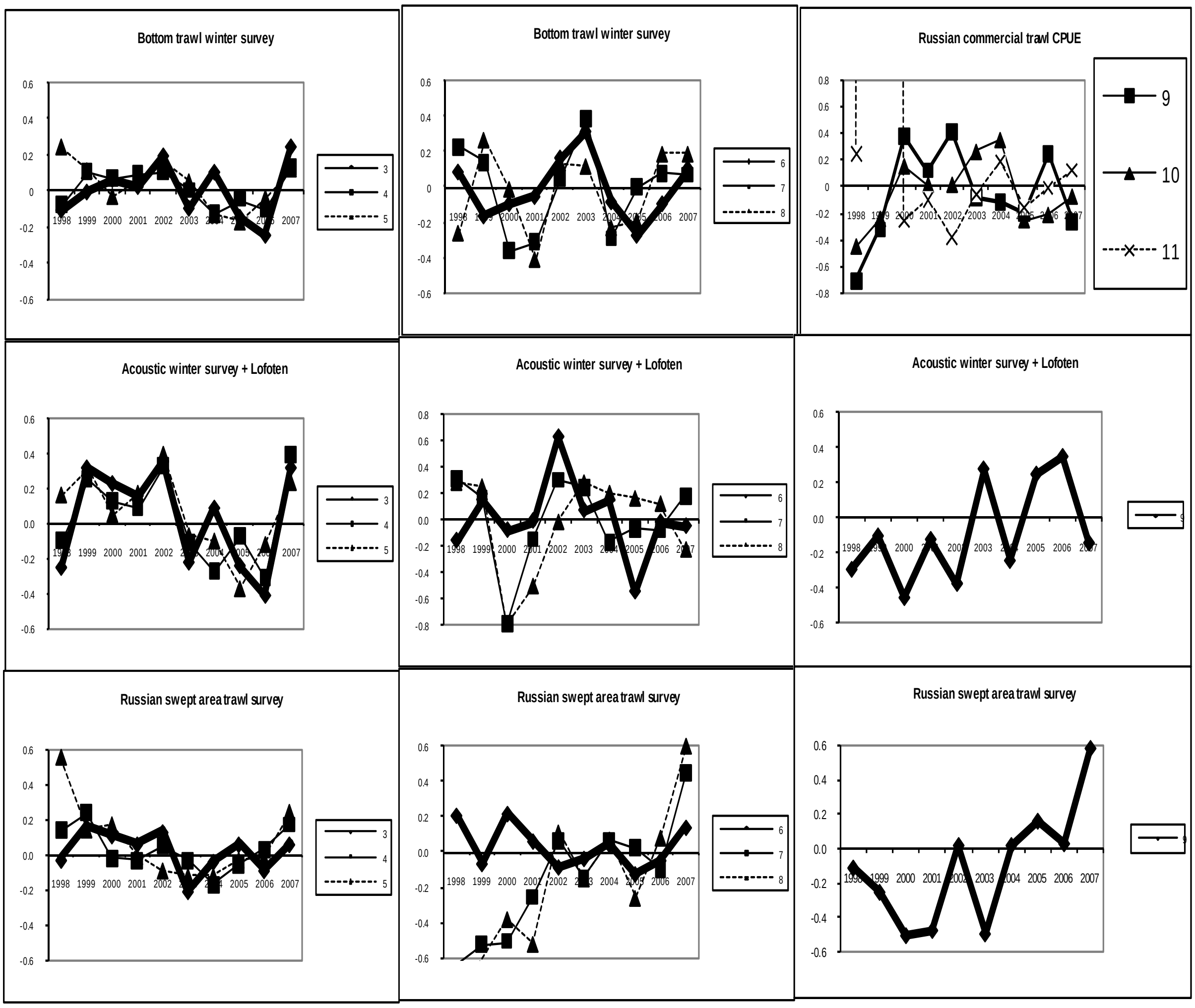


Figure 3.5. Northeast Arctic Cod. Residual log catchability by fleets and ages from the final XSA output in the 2008 assessment (run NOR-IUU).

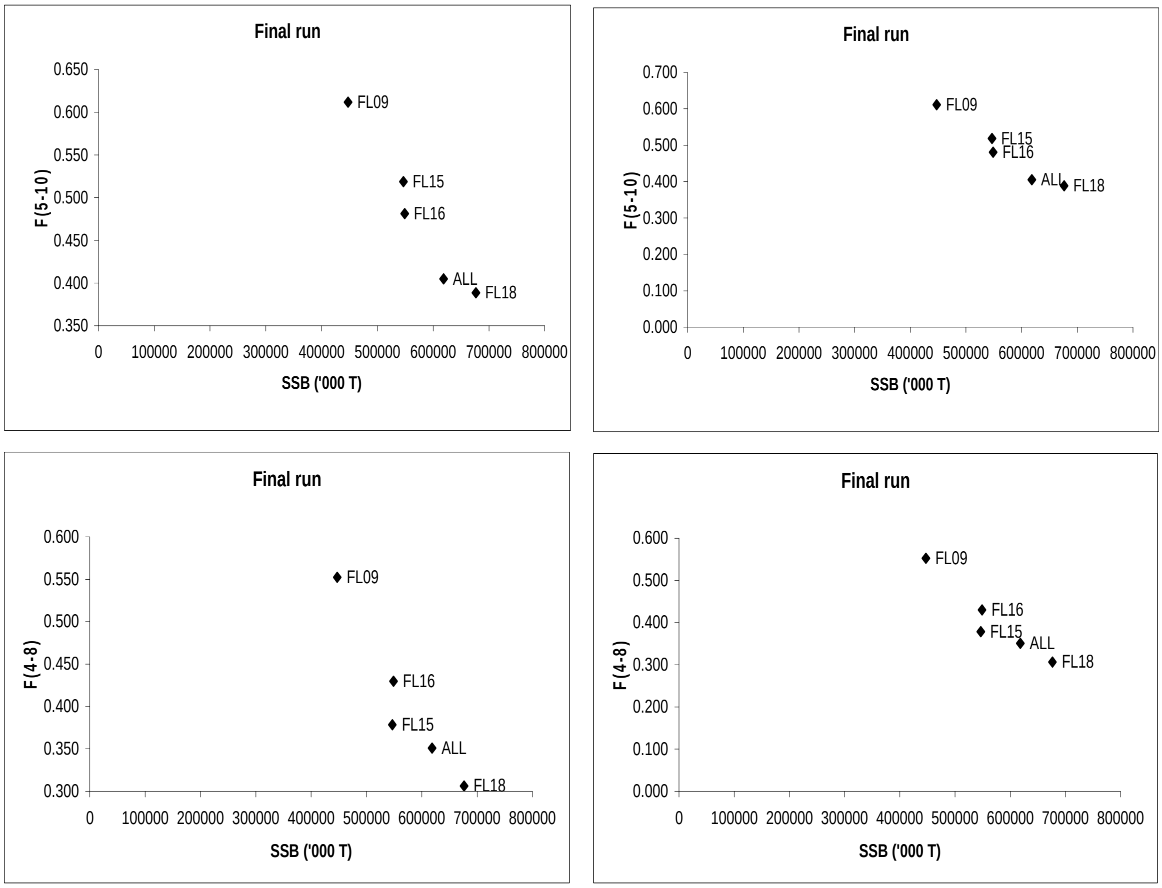


Figure 3.6. Northeast Arctic Cod. Single fleet tuning results (F in 2007) before shrinkage by ages plotted against the final run (ALL) (run NOR-IUU)

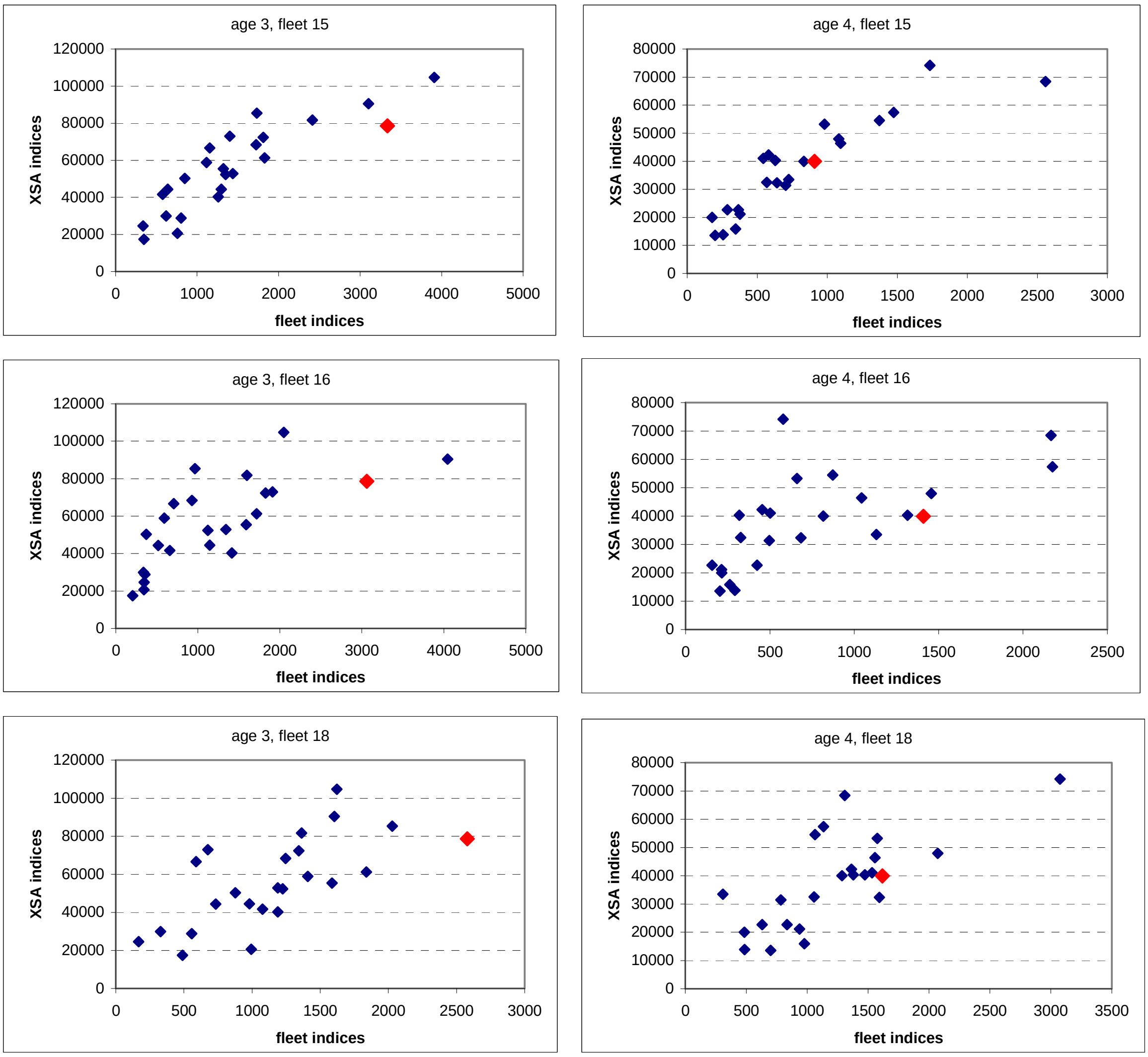


Figure 3.7. Northeast Arctic Cod. Fleet indices for ages 3 and 4 plotted against XSA indices in the 2008 assessment (run NOR-IUU). 2007 values in red.

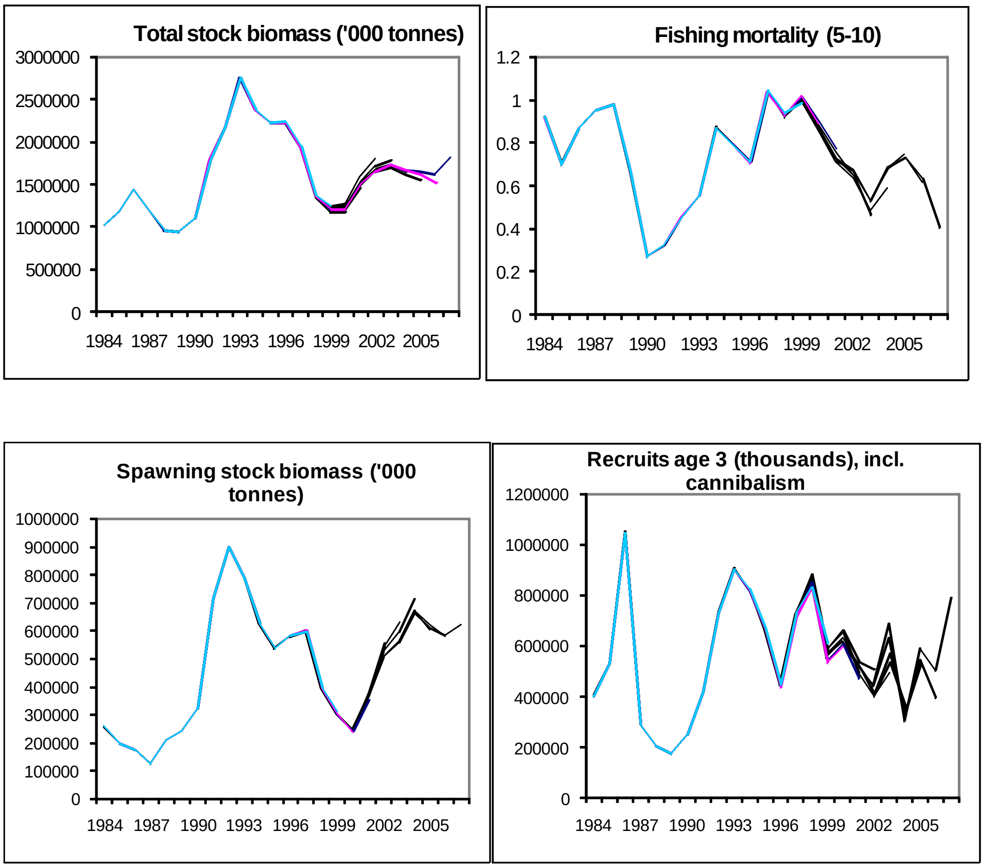


Figure 3.8. Northeast Arctic cod. Retrospective plots with catchability dependent on stock size for ages < 6.

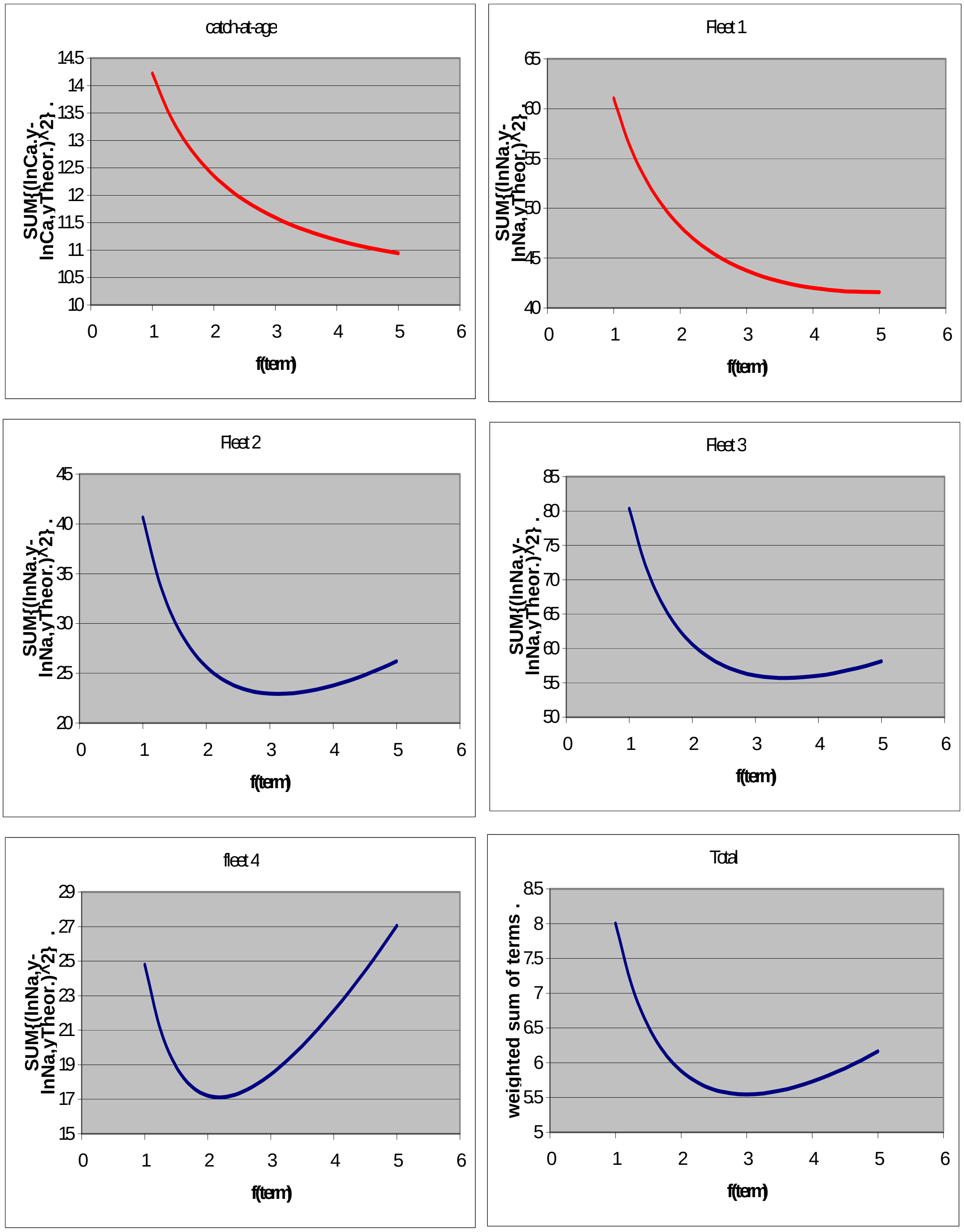


Figure 3.9. Northeast Arctic cod. Profiles of the components of the TISVPA loss function (simplest settings)

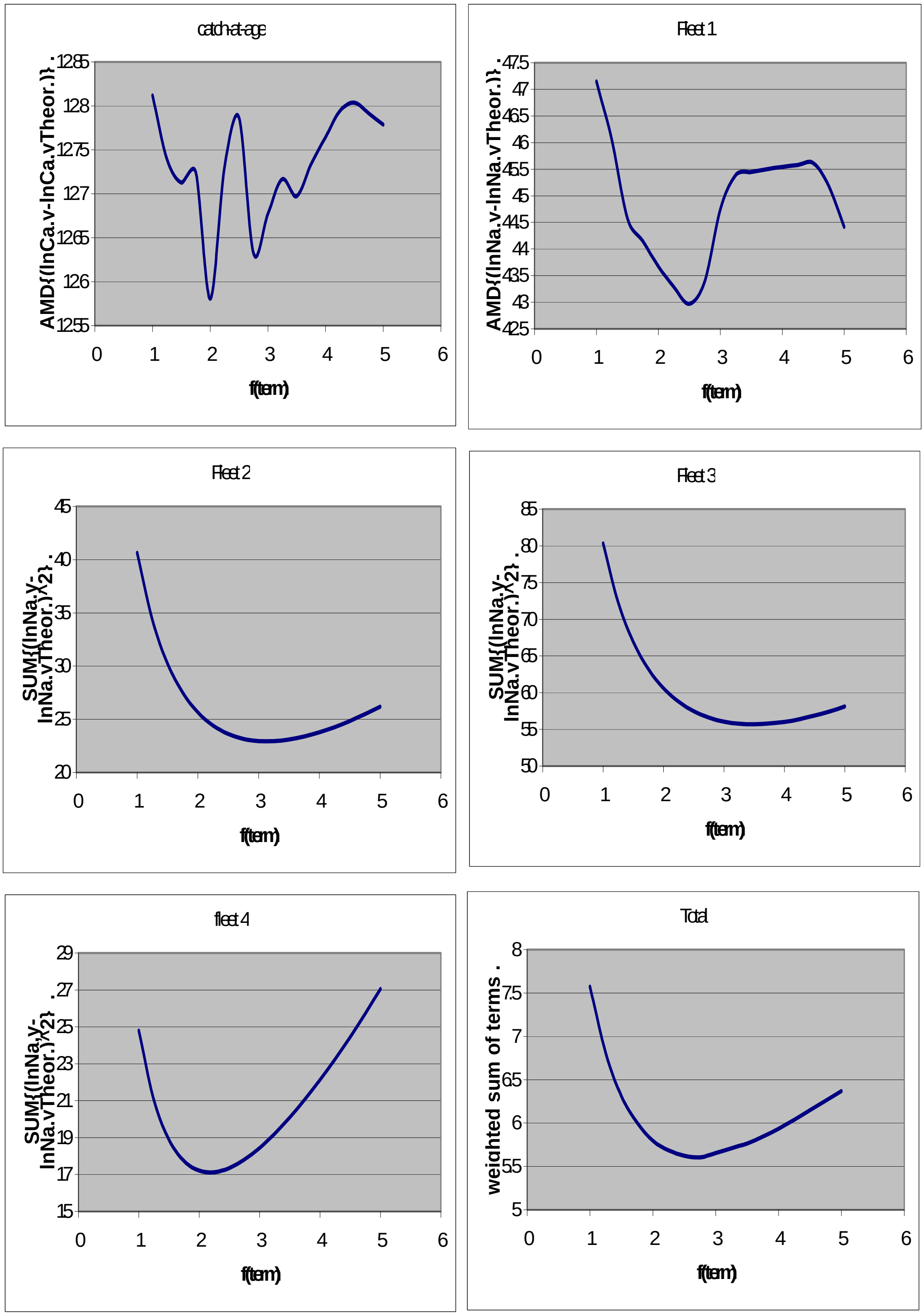


Figure 3.10. Northeast Arctic cod. Profiles of the components of the TISVPA loss function (improved settings)

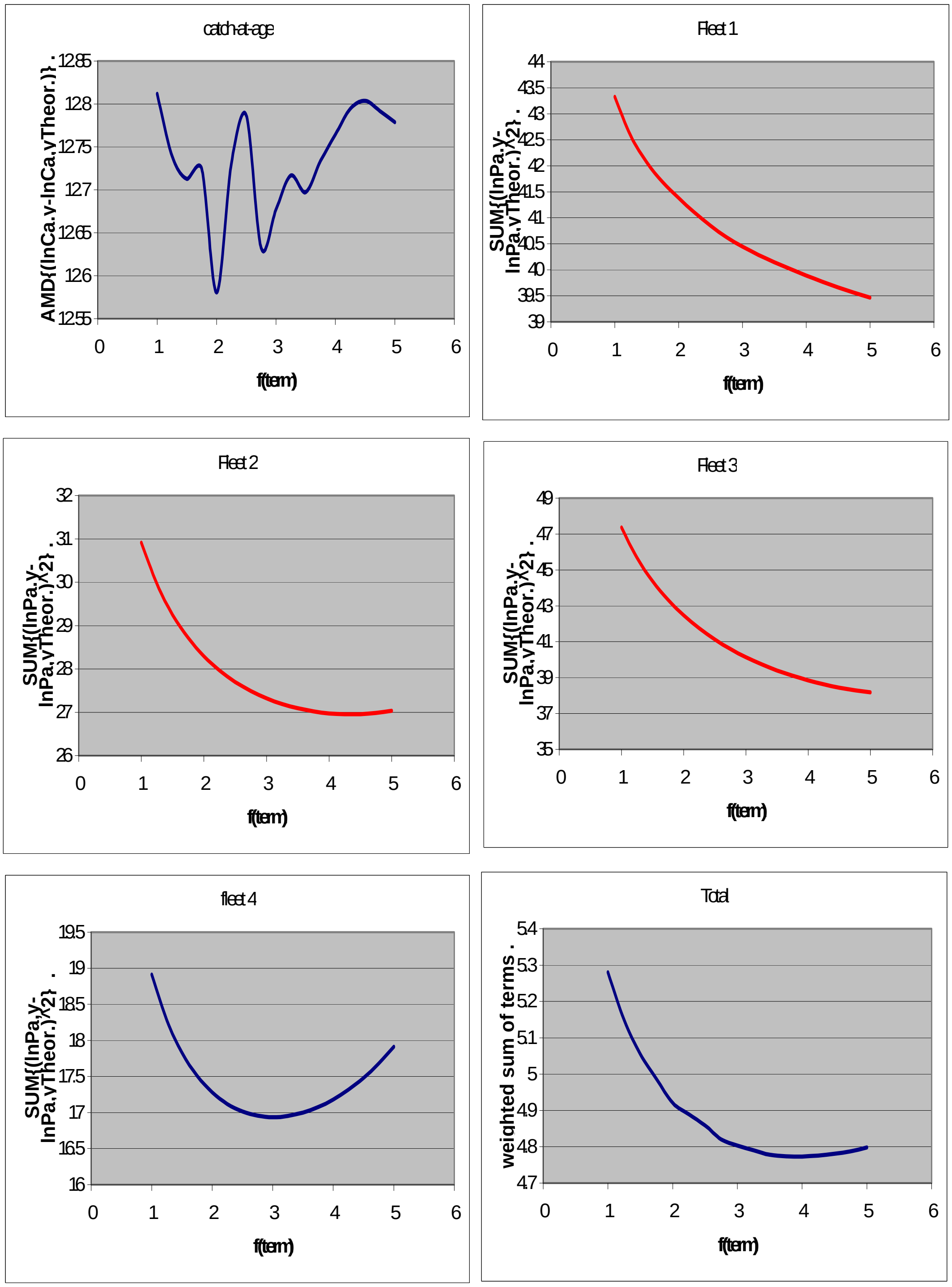


Figure 3.11 Northeast Arctic cod. Profiles of the components of the TISVPA loss function: fleets are "tuned" by minimization of residuals in the stock age structure.

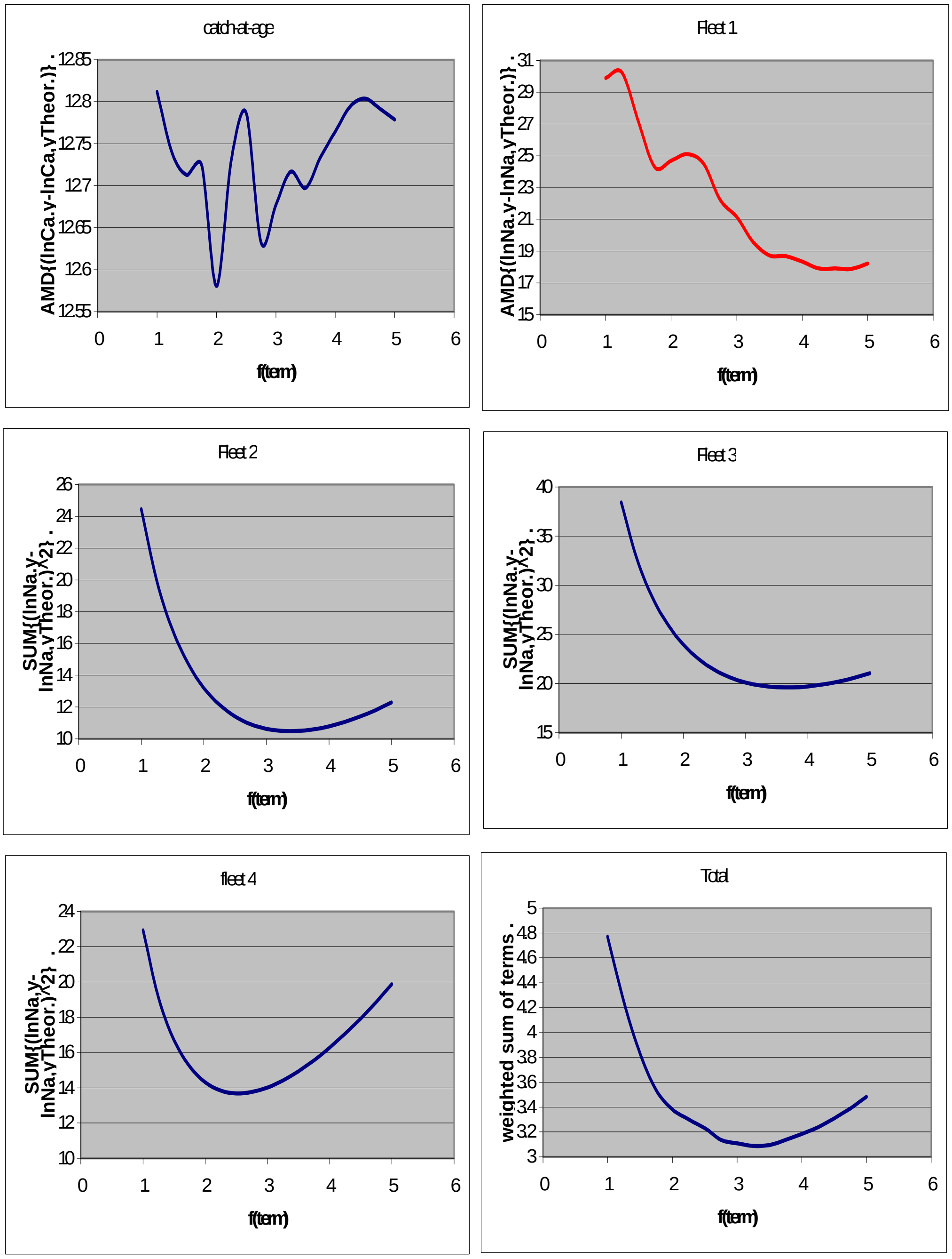
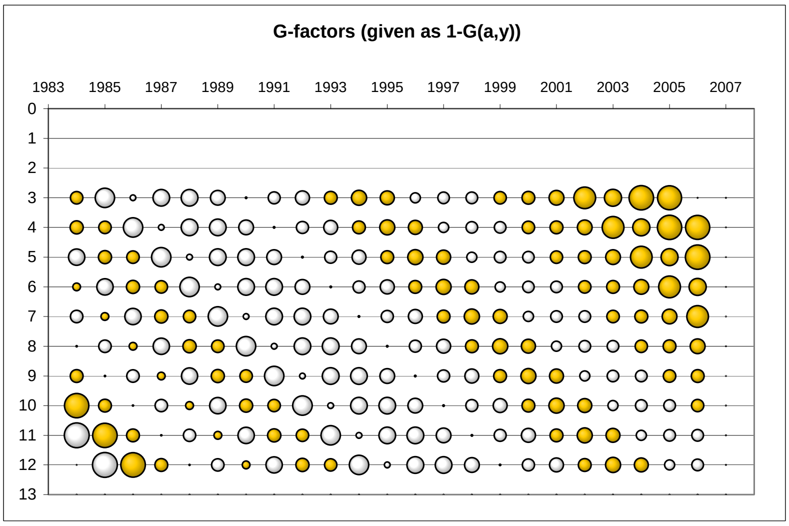


Figure 3.12 Northeast Arctic cod. Profiles of the components of the TISVPA loss function: only 10 last years of "fleet" data are used.



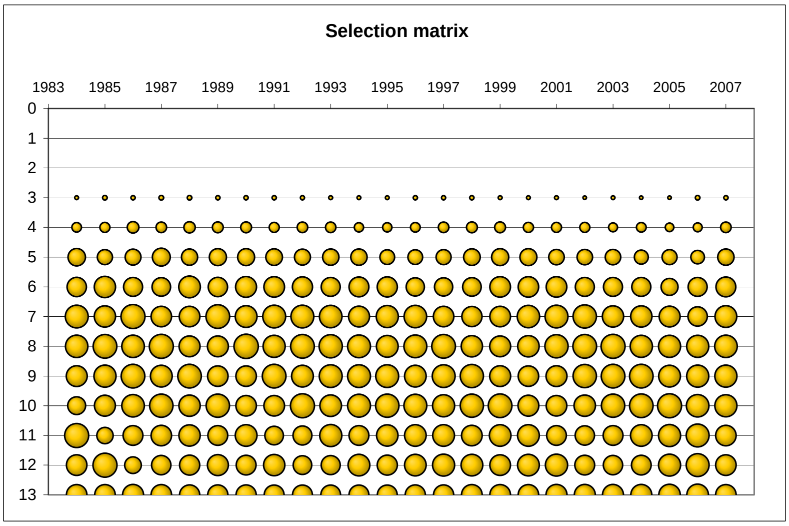
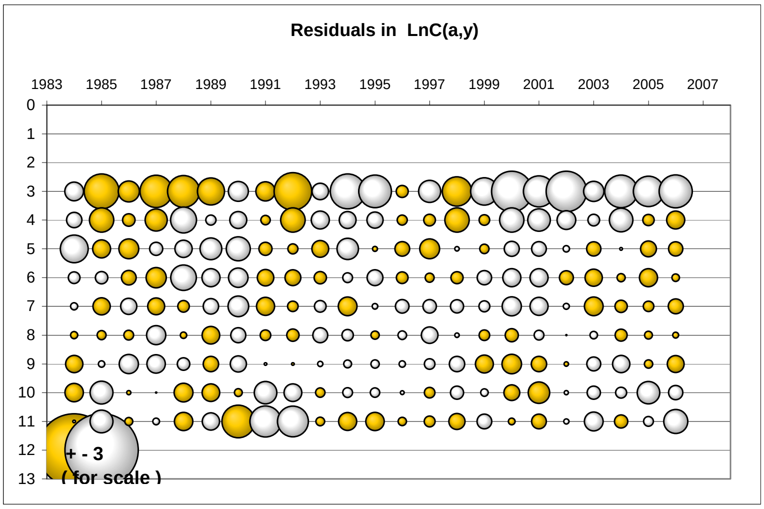
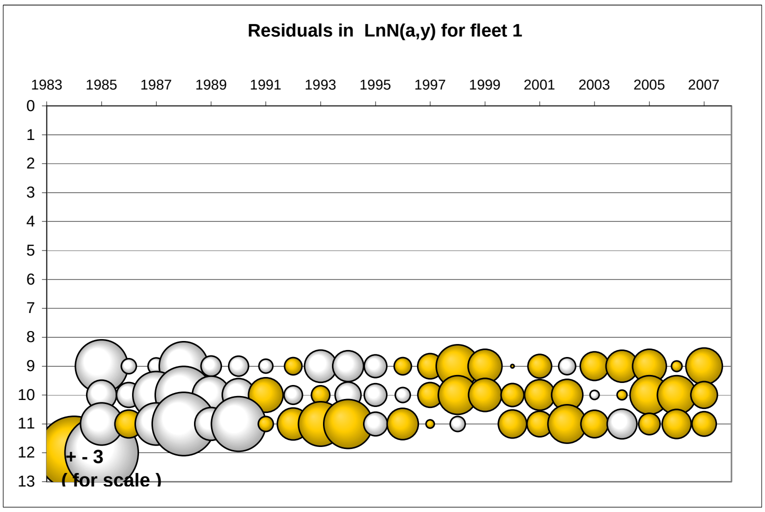


Figure 3.13. Northeast Arctic cod. TISVPA-derived estimates of generation-dependent factors and selection matrix





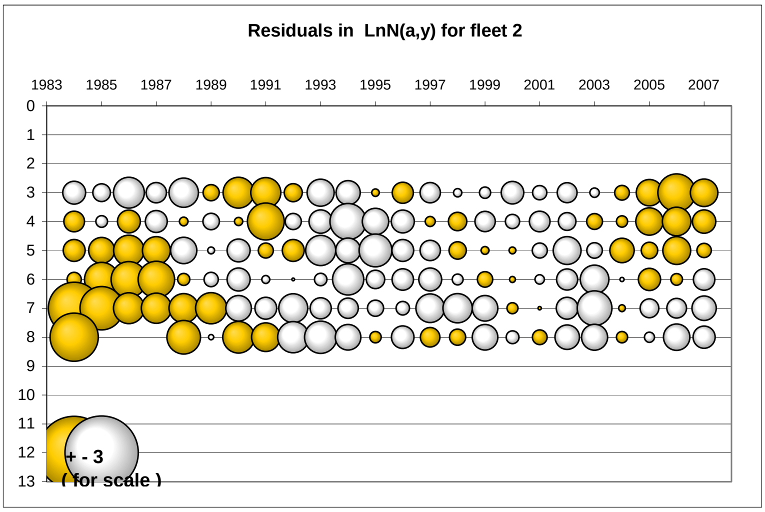
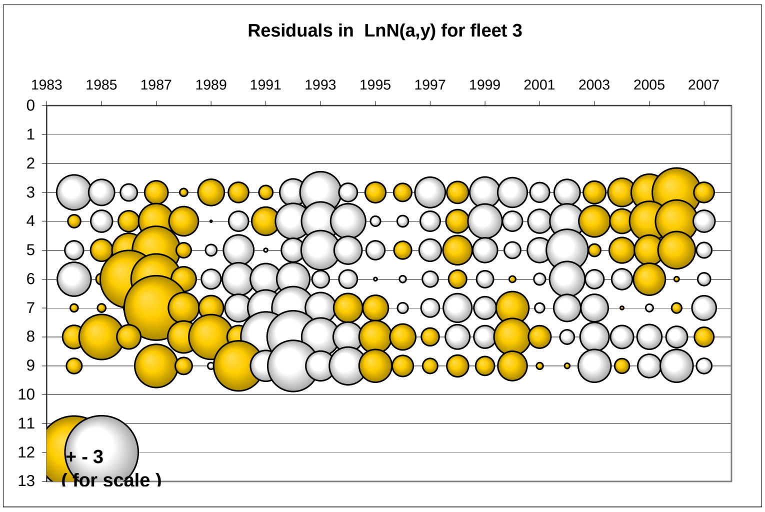


Figure 3.14 Northeast Arctic cod. TISVPA Residuals in logarithmic catch-at-age and abundance-at-age



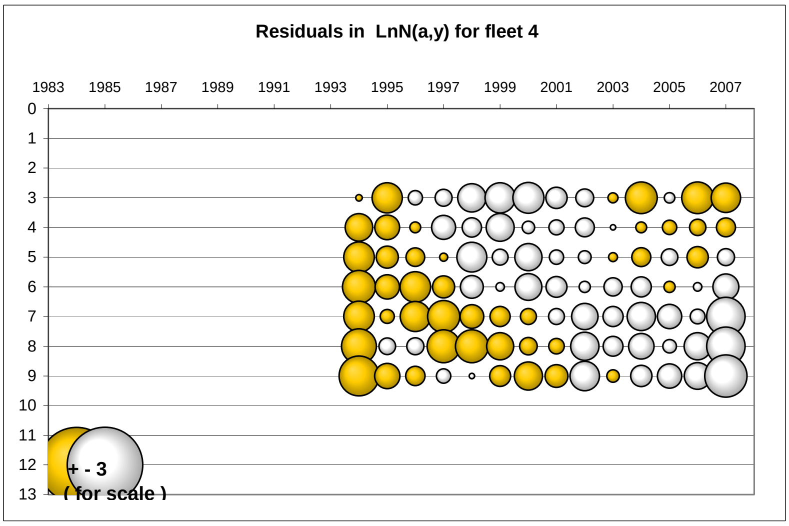


Figure 3.14 (continued). Northeast Arctic cod. TISVPA residuals in logarithmic catch-at-age and abundance-at-age

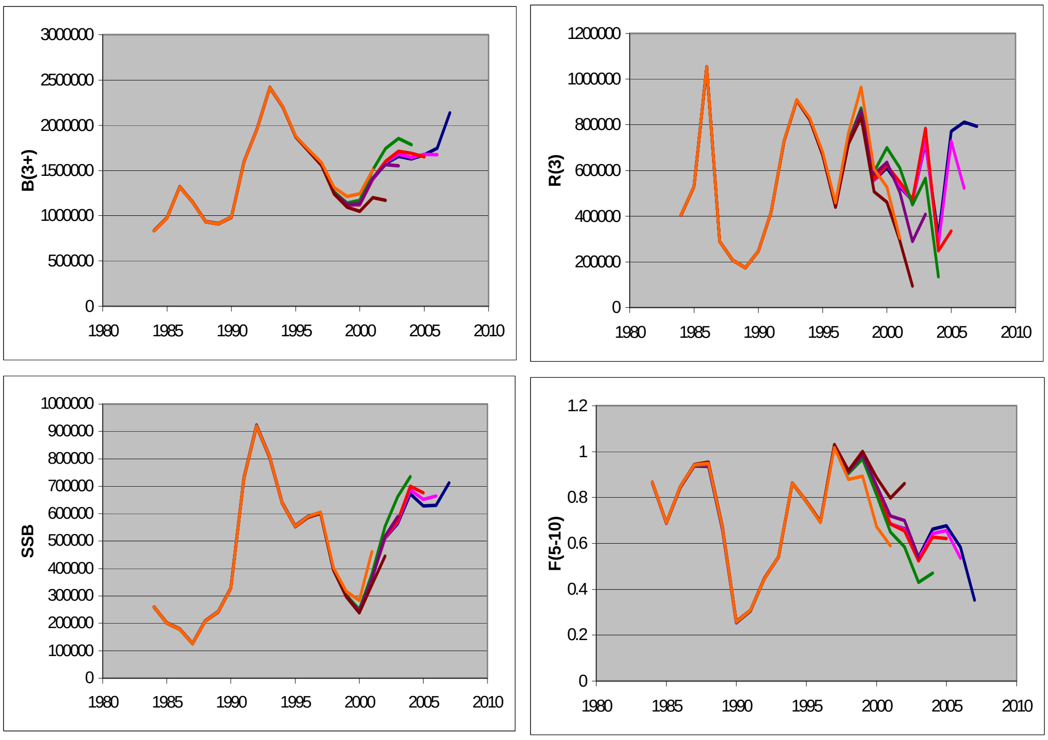


Figure 3.15. Northeast Arctic cod. TISVPA retrospective runs.

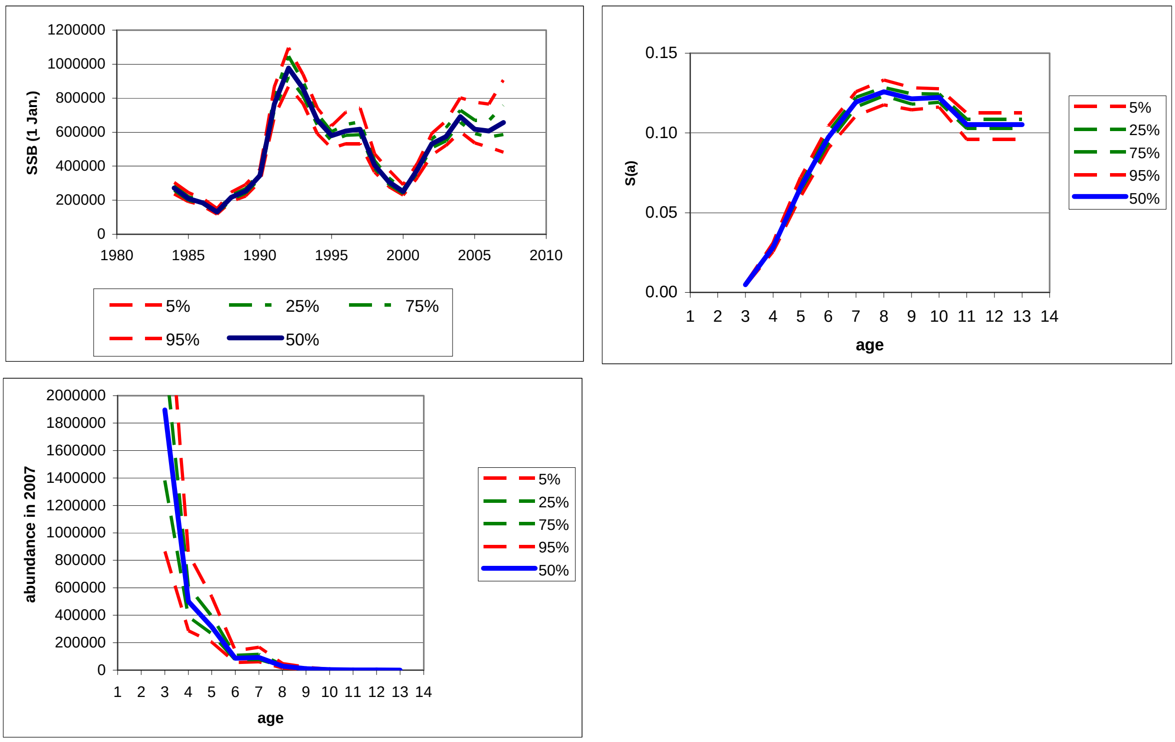


Figure 3.16. Northeast Arctic cod. Bootstrap- estimates of uncertainty in the TISVPA results.

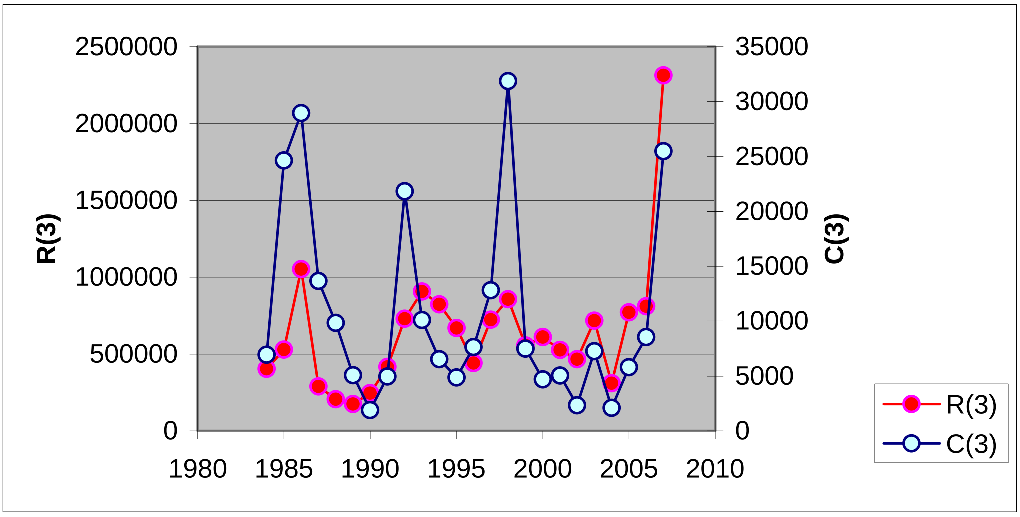


Figure 3.17. Northeast Arctic cod. Comparison of catches at age 3 to the TISVPA-derived estimates of abundance

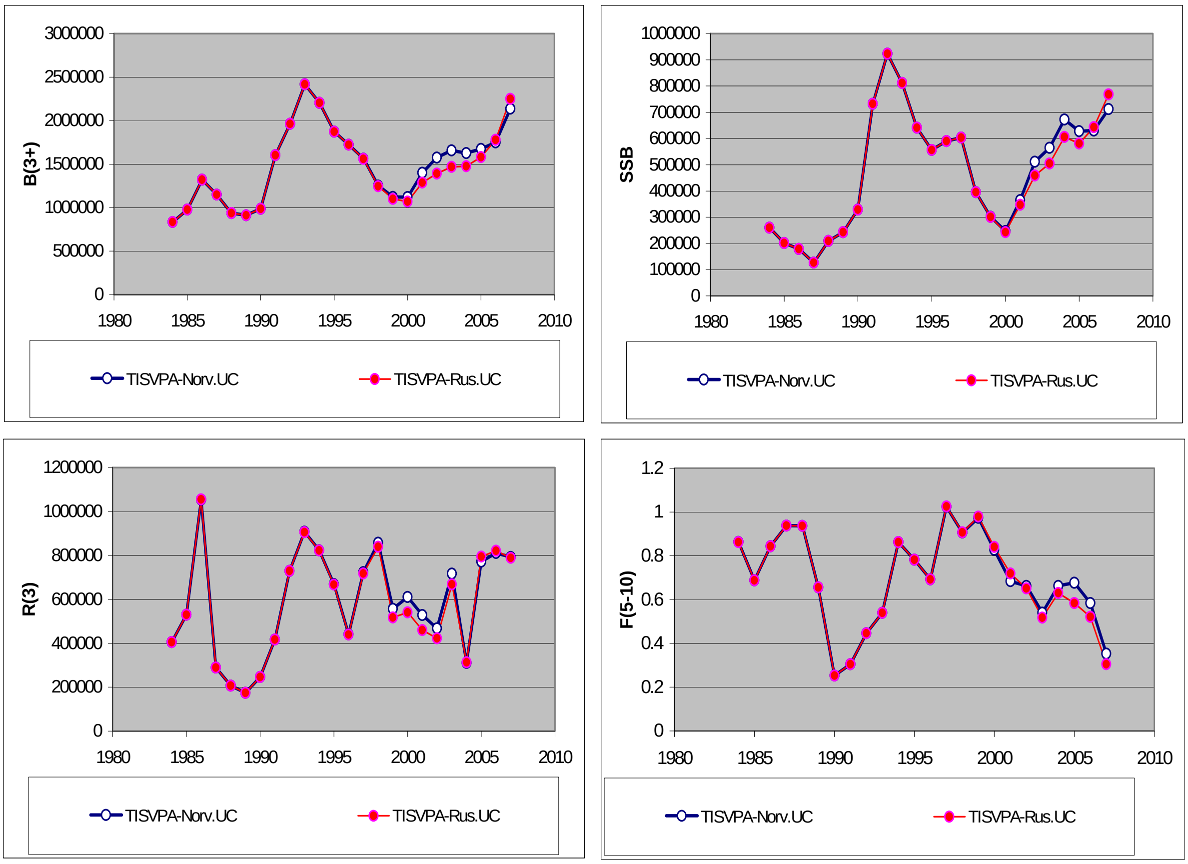


Figure 3.18. Northeast Arctic cod. Comparison of the TISVPA- derived estimate obtained for data with Norwegian and Russian estimates of unreported catches. (estimates of R(3) in 2007 are substituted by mean estimate of abundance with similar extremely high catches at age 3)

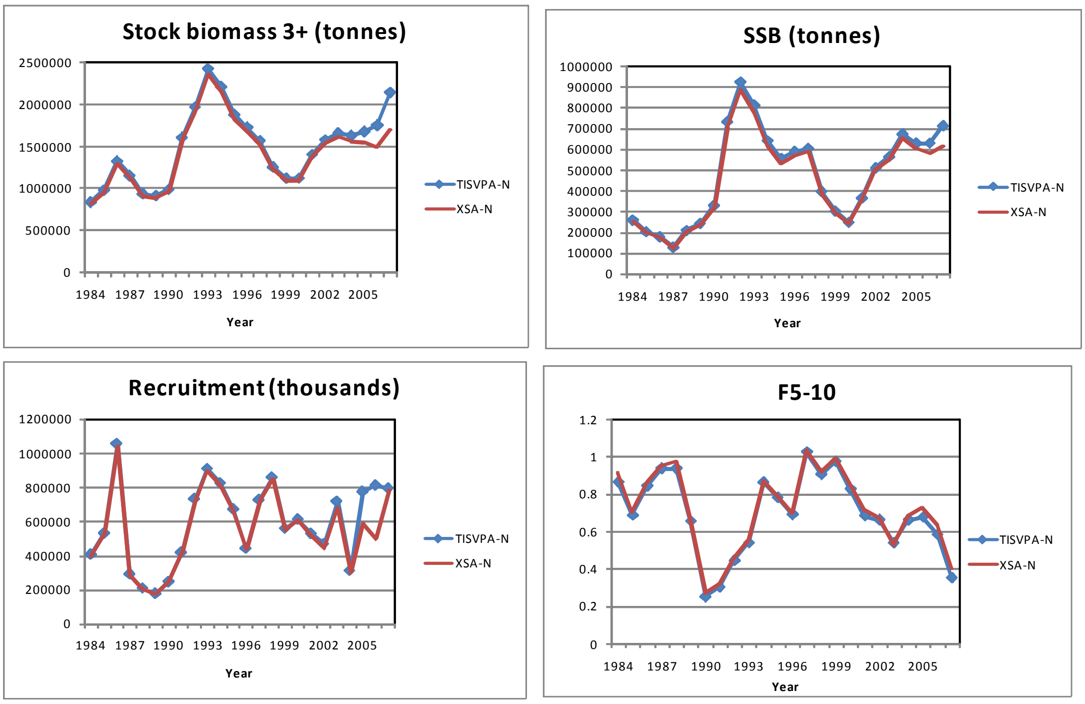


Figure 3.19a. Northeast Arctic Cod. Comparison of XSA and TISVPA. Nor-IUU-run.

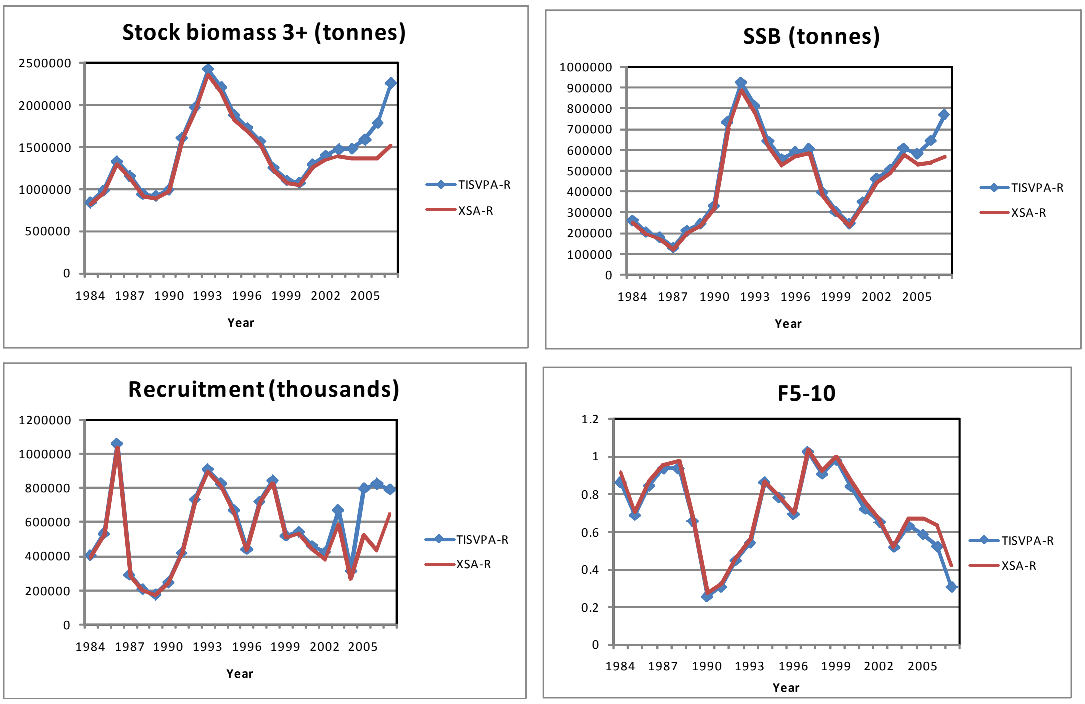


Figure 3.19b. Northeast Arctic Cod. Comparison of XSA and TISVPA. Rus-IUU-run.

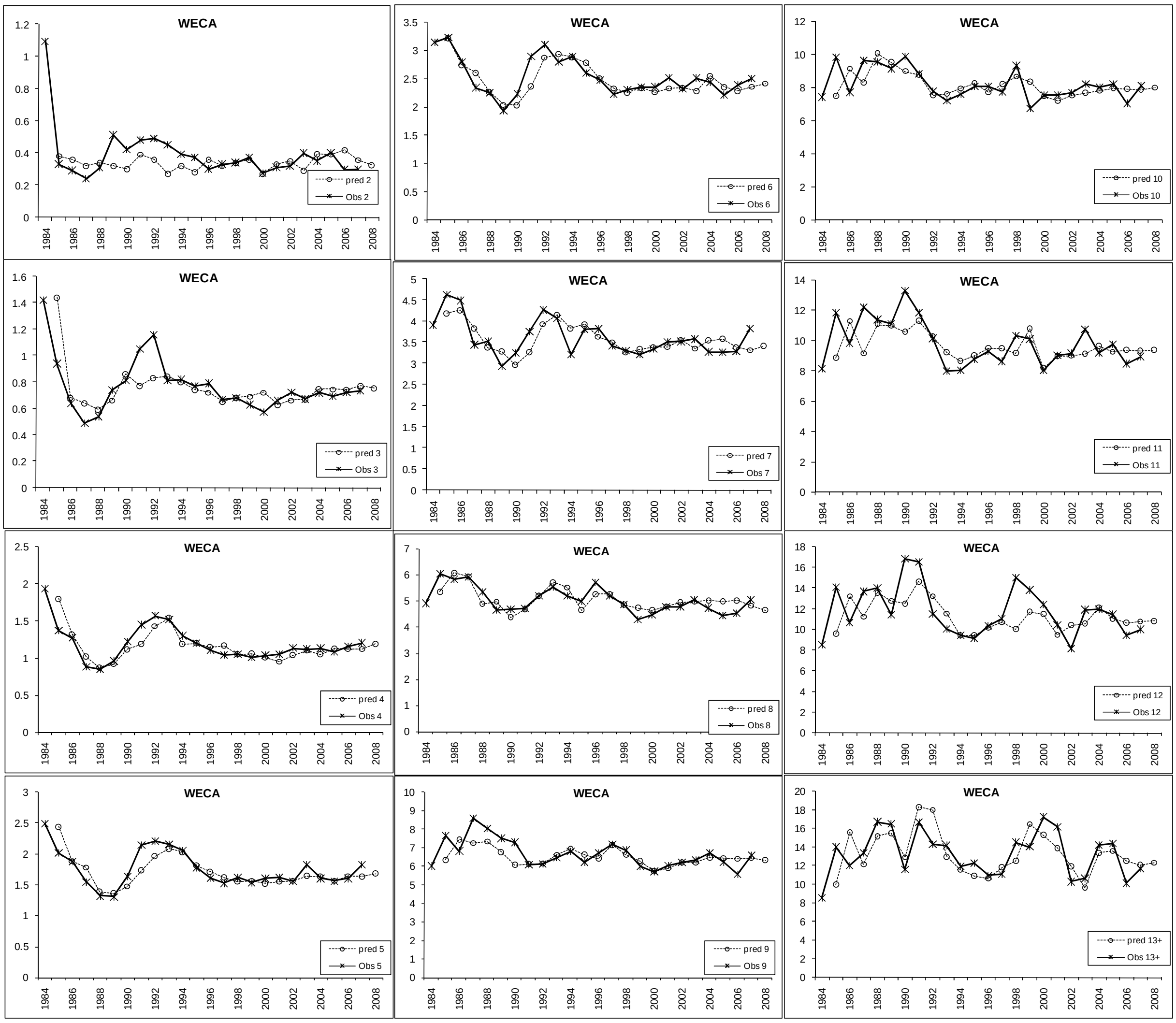


Figure 3.20a. Northeast Arctic cod. Weight in catch predictions.

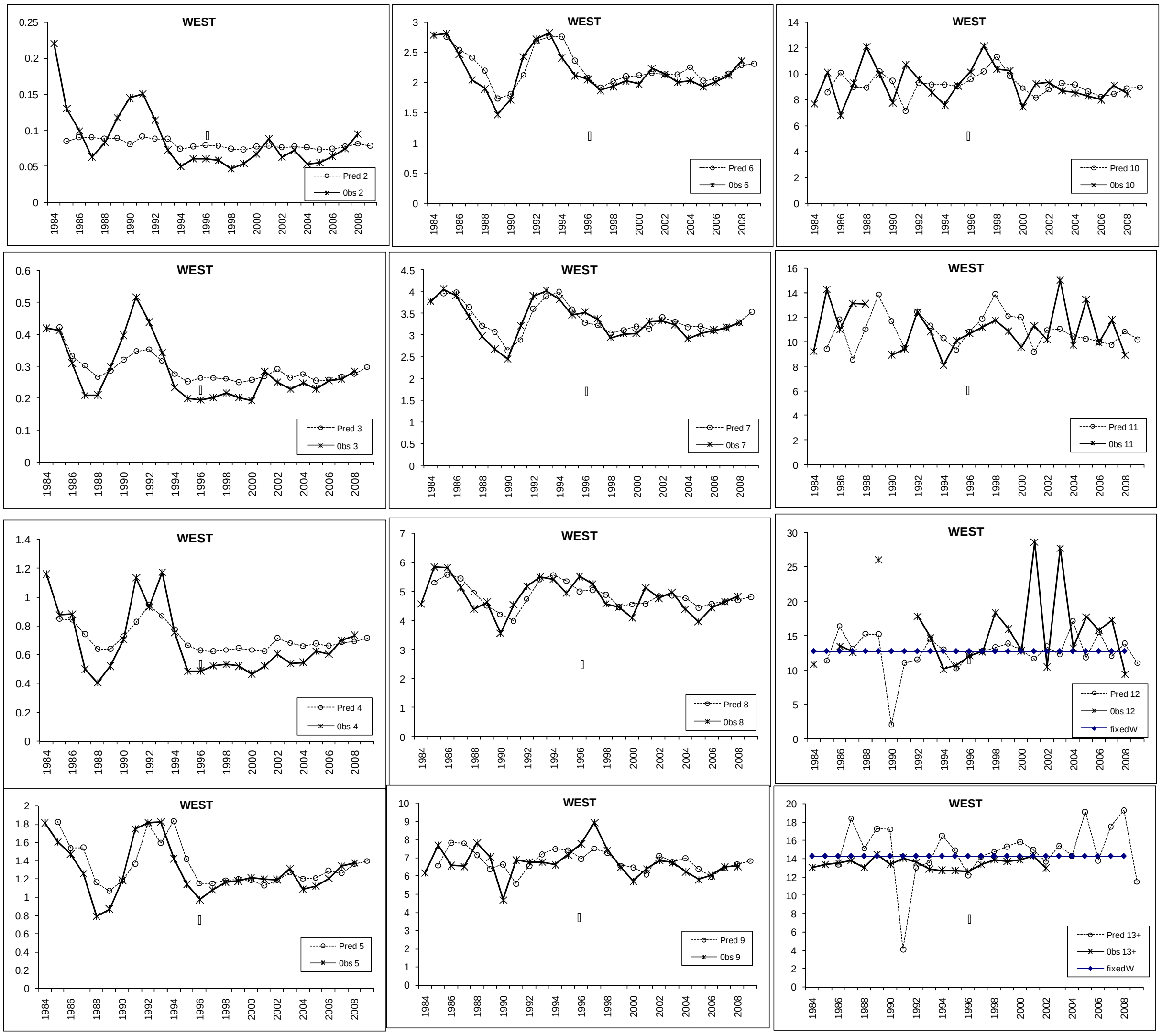


Figure 3.20b. Northeast Arctic cod. Weight in stock projections

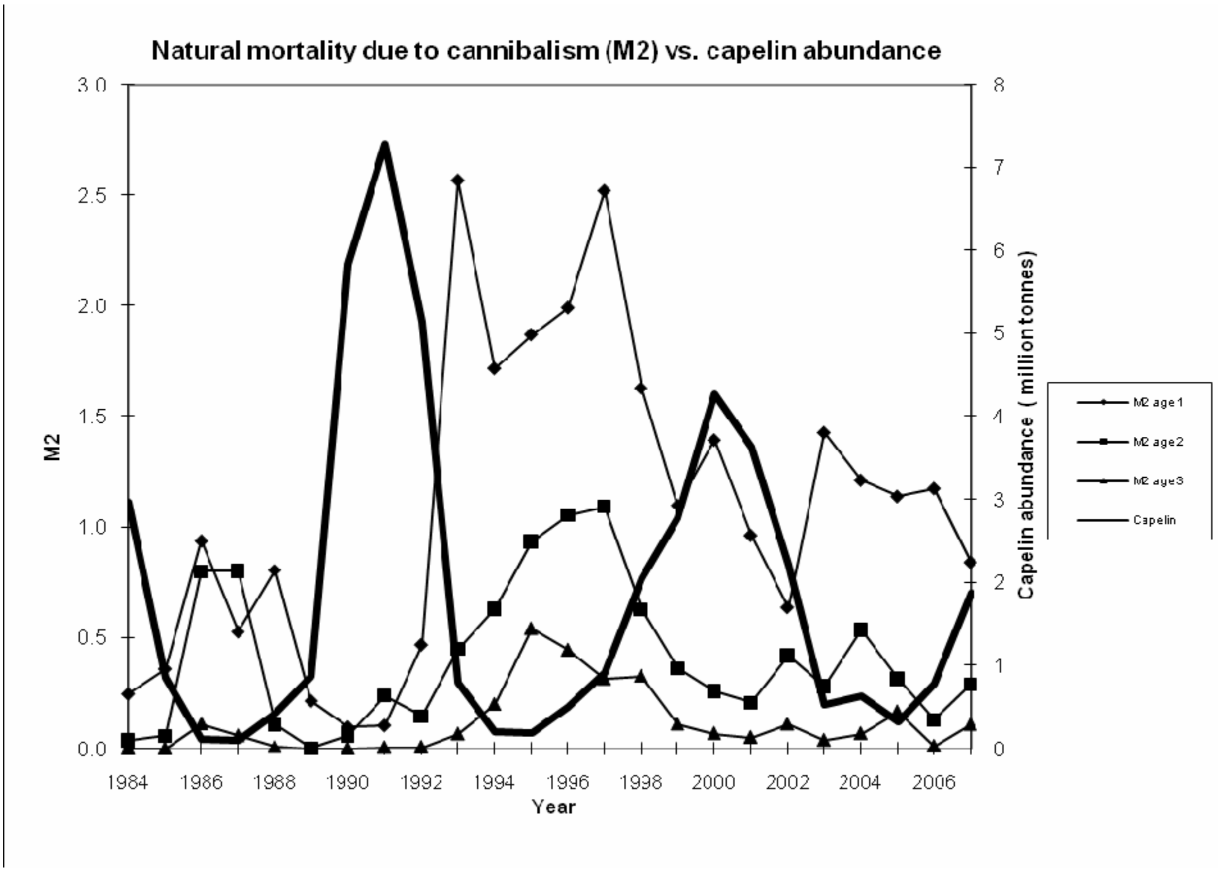


Figure 3.21. Northeast Arctic cod. Temporal trends of cod M2 (cannibalism mortality) for ages 1-3 vs. capelin stock size.

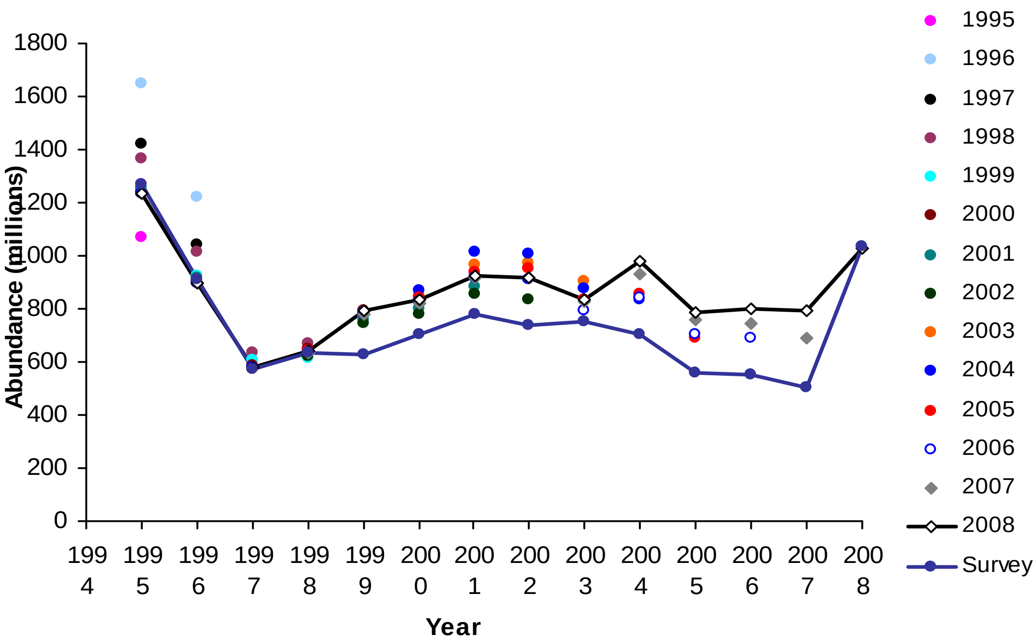


Figure 3.22. Northeast Arctic Cod. Calibrated (with intercept) bottom trawl survey estimates (connected solid circles), ICES 2008 estimates (connected open diamonds) and the 1995- 2007 ICES annual assessments (unconnected symbols) of the total number of Northeast Arctic cod ages 4 through 6.

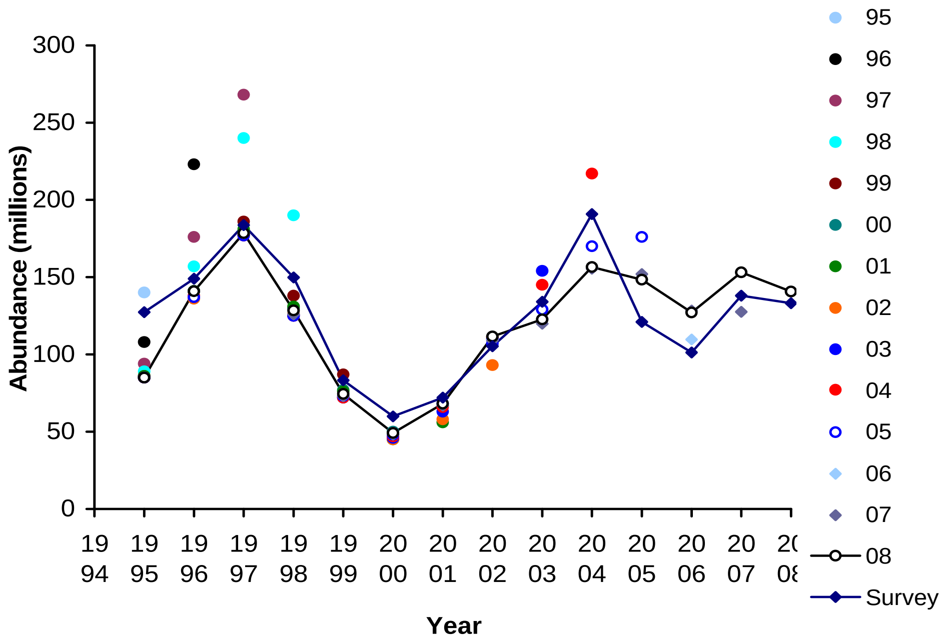


Figure 3.23. Northeast Arctic Cod. Calibrated (with intercept) bottom trawl survey estimates (connected solid diamonds), ICES 2008 estimates (connected open circles) and the 1995- 2007 ICES annual assessments (unconnected symbols) of the total number of Northeast Arctic cod ages 7 and older.

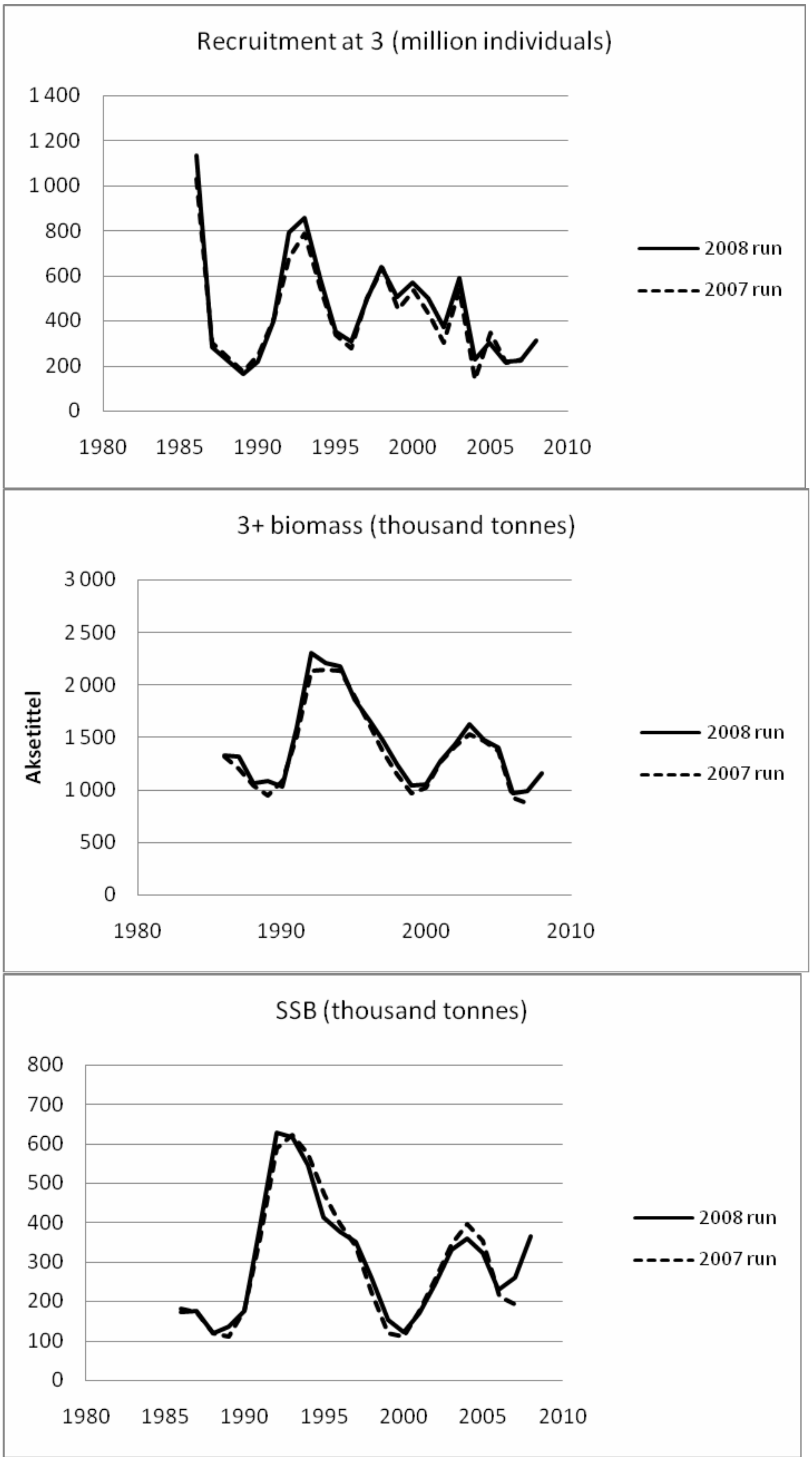


Fig 3.24. Northeast Arctic Cod. Results of Gadget run.

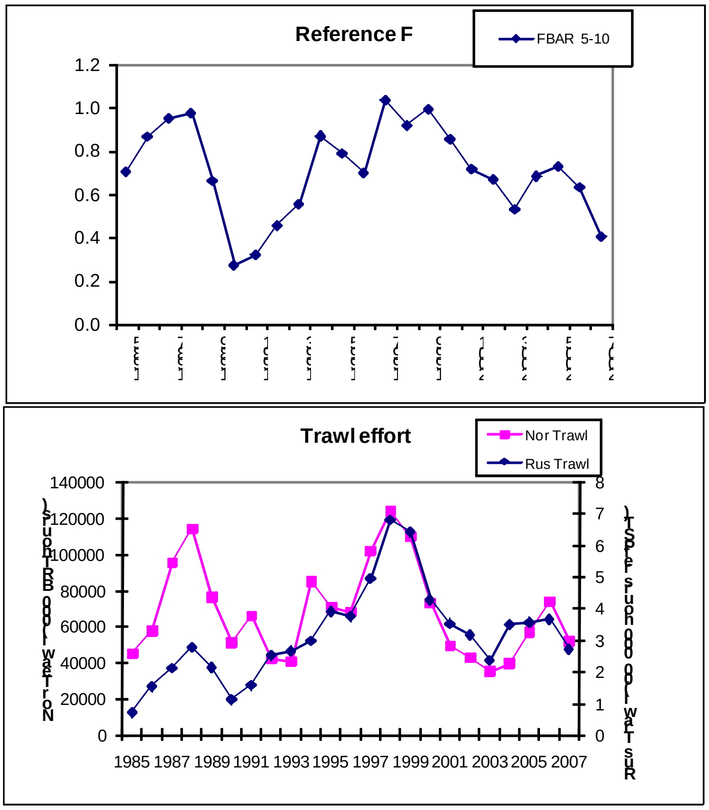


Figure 3.25. Northeast Arctic cod. Fishing mortality (F_{5-10}) (top panel) and trawl efforts in 1985-2007 (bottom panel).

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	0.88
2007[1]			0.71			0.51		0.88	1.16

[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

[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	92.1	190.2	333.6	91.0	47.2	13.0	8.8	2.0	0.4	848.7

[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

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

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

[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

Table A8. Northeast Arctic COD. Mean weight at age (kg) in the Lofoten surv

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

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	8493	19053	332	1413	1525	721	198	551	174	37	19	32516
1983	18722	20034	732	520	642	506	358	179	252	94	0	42039
1984	3633	1805	1044	1189	700	489	357	154	69	61	17	9518
1985	2846	156	1290	1188	1592	1068	365	165	37	8	16	8731
1986	3299	76	317	1622	1532	1493	481	189	42	2	6	9059
1987	77	13	469	557	3076	900	701	184	60	25	4	6066
1988	925	29	313	993	938	2879	583	260	47	24	1	6992
1989	3558	30	147	490	978	1062	1454	1167	299	112	47	9344
1990	12484	311	510	167	487	627	972	1538	673	153	49	17971
1991	9740	640	911	1077	484	532	583	685	747	98	14	15511
1992	12048	1577	1511	675	308	239	273	218	175	25	4	17053
1993	4848	380	1586	1604	1135	681	416	354	87	3	7	11101
1994	16066	8332	699	1363	1309	1019	354	128	49	21	11	29351
1995	57035	4719	369	589	1065	1395	849	251	83	19	18	66392
1996	26603	3965	1285	733	784	1035	773	348	132	19	5	35682
1997	13714	3539	1353	1342	835	613	602	348	116	32	15	22509
1998	3048	2768	896	2028	1363	788	470	259	130	48	5	11803
1999	2669	401	1184	1587	2072	980	301	123	94	42	4	9457
2000	14365	377	1036	1839	1286	1786	773	114	52	23	9	21660
2001	3216	2338	773	1224	1557	1290	1061	304	50	14	5	11832
2002	17979	267	1356	980	1473	1473	896	600	182	29	8	25243
2003	4895	5175	268	1246	1057	1166	1203	535	241	40	9	15835
2004	17704	1584	875	329	1576	880	1111	776	279	93	23	25230
2005	22980	3239	617	1408	631	1832	744	605	244	88	28	32416
2006	6838	858	895	877	1380	557	1182	482	301	101	6	13477
2007	1775	370	1486	2579	1617	1903	846	1525	553	226	153	13033

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

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

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

Table A14. Swept area estimates (millions) of Northeast Arctic Cod from the Joint Norwegian-Russian ecosystem survey in August-September

	Age									
Year	1	2	3	4	5	6	7	8	9	10+
2004	392.46	341.78	109.40	419.04	151.41	77.74	39.38	10.32	1.82	1.04
2005	425.76	160.30	262.88	57.07	114.60	32.87	16.75	6.44	1.14	0.88
2006	588.34	547.15	176.09	184.95	45.95	54.42	15.35	6.79	2.84	0.67
2007	362.47	512.96	500.32	147.19	65.78	16.80	24.97	5.11	1.71	1.06

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 2008 (Tables 4.1–4.3, Figure 4.1A)

The official landings for 2006 amount to 131,706 t, and the provisional official landings for 2007 are 146,830 t.

In the last two years, estimates of unreported catches (IUU catches) of haddock have been added to reported landings for the years 2002 and onwards. In 2007, two assessments were presented, based on Norwegian and Russian estimates of IUU catches, respectively. This year, the Working Group decided that the focus in the presentation of the assessments should be on the Norwegian IUU estimates, while only summary tables are included for the Russian IUU estimates. If tables are given for both runs, they are labelled N and R, respectively. More details on this issue are given in Sections 0.3 and 3.1.3.

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 2002-2007. 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 the last three years. The Russian estimates of IUU haddock are obtained by applying the same ratio, but using the Russian estimate of IUU catches of cod. Both approaches show an increase from 2002 to 2005 followed by a decline.

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 Fisheries of Directorate (ratio 2), estimated unreported landings of haddock applying ratio 1 to Norwegian estimates of IUU for cod (N-IUU), estimated unreported landings of haddock applying ratio 1 to Russian estimates of IUU for cod (R-IUU), and estimates of unreported landings of haddock provided by the Norwegian Directorate of Fisheries (IUU2). No data from Directorate of Fisheries is available for 2002 through 2004, and is denoted NA (not available).

Year	Ratio 1	Ratio 2	N-IUU	R-IUU	IUU 2
2002	0,21	NA	19	5	NA
2003	0,29	NA	33	9	NA
2004	0,29	NA	34	9	NA
2005	0,24	0,23	40	10	38
2006	0,32	0,43	21	9	29
2007	0,35	0,45	15	3	19

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 2007 and 2008

ACFM recommended to set a TAC lower than 130 000 t for 2007, while the agreed TAC for 2007 was 150,000 t by applying the agreed harvest control rule. The provisional reported catch is 146,830 t. The assessment of haddock in 2007 was, as the year before, rejected by ACFM, and the advice was again to set a TAC lower than 130,000 t for 2008 based on the increase in SSB 2001-2004 being associated with this catch level. The mixed Norwegian-Russian Fisheries Commission agreed on a TAC of 155,000 t which corresponds to the agreed 1-year harvest control rule (see Section 4.7.2) based on the rejected assessment. The reported catch in 2008 is expected to be close to agreed TAC, but IUU fishing may give a higher total catch.

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 2008 are given in Aglen (WD 16).

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. This adjustment is described in detail in last year's report. However, in 2008 permit to enter the Russian zone was again given and the survey was conducted according to the standard area coverage. The survey indices 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 2007 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 last year's report for details. In the 2007 survey 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.

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 are about the same as last year, whereas the Russian survey shows an increase for ages 3 and older.

4.3 Data Used in the Assessment

4.3.1 Estimates of unreported catches (Tables 4.1-4.3)

There are two estimates of unreported NEA Haddock catches in 2002-2007 based on two methods of estimating IUU catches (see Section 0.3 and Section 4.1.2), but as explained above, only one assessment, using the N-IUU estimates, is presented in detail. If tables or figures are given for both runs they are labelled N and R, respectively.

4.3.2 Catch-at-age (Table 4.4)

The Norwegian catch at age data for 2006 was revised due to inclusion of samples from the Norwegian coast guard. Age and length compositions of the landings in

2007 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 Sub-area 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 2007. Estimated catch at age is listed in Table 4.4 (including N-IUU catches), while estimated catch at age not including IUU catches are listed in Table 4.4b.

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 2007 have decreased for all age groups compared to 2006. For the main ages in the catch (3-8) the decrease is on average 7%.

Stock weights (Table 4.6) used from 1985 to 2007 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 2007 actual data from predation for cod have been used (see table below) while for the previous years (1950-1983) the average natural mortality for 1984-2007 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)

The new estimates of the unreported catches are presented in Tables 4.1-4.3.

Although only one assessment is presented in detail, it should be noted that in addition to, and partly due to, the difference in IUU estimates, the alternative assessment presented as a summary uses different values of total catches, catch matrix, weights in the catch and natural mortality while maturity at age and weights in the stock are the same.

Weights in the catch in 2002-2007 have been changed slightly in both runs. 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 1985-2007. 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 main assessment method was also this year XSA, but an alternative method was also explored (see Section 4.8).

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	1983–2007	1
Norwegian bottom trawl	Barents Sea	Winter	1–8	1982–2008	1
Norwegian acoustic	Barents Sea	Winter	1–7	1980–2008	1

The indices for the Russian BT survey in the 1990 were not used for tuning the XSA. However, the data for the 1996 cohort was reintroduced in the assessment (WD 24). 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). This year, FLR was used for the assessment of haddock (WD 24), and thus all results concerning XSA is obtained using FLR. The settings used by the AFWG in 2007 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 (1984–2007). 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	1203,5	5,2	0,0	0,0	0,0	0,0
1986	563,9	244,9	168,0	0,0	0,0	0,0
1987	766,7	0,0	0,0	0,0	0,0	0,0
1988	17,1	0,5	9,1	0,0	0,2	0,0
1989	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	909,0	23,6	0,3	0,0	0,0	0,0
2000	1213,8	65,1	2,1	1,2	0,2	0,1
2001	552,0	52,8	5,0	0,1	0,0	0,0
2002	2372,8	228,9	38,1	2,5	0,4	0,2
2003	3589,2	220,2	38,8	12,3	1,1	0,0
2004	2258,9	296,8	43,7	9,0	2,5	0,0
2005	5734,0	259,3	66,7	12,0	3,5	1,2
2006	7723,9	324,8	3,2	4,3	1,2	0,5
2007	8142,6	544,8	21,2	2,2	2,4	0,3

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 2005-2007 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
2000	197*	237*	236*	249*
2001	176*	219*	224*	257*
2002	295	313*	339*	367*
2003	156	183	135*	161*
2004	462	755	672	665*
2005		521	731	978
2006			463	832
2007				202

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 2008-2010 is given in Table 4.19.
- The average fishing pattern observed in the 3 last years.
- Smoothed observed maturity for 2008, smoothed average maturity for the 1982-
  1985, 1990-1993 and 2000-2006 year classes for 2009-2010.
- Smoothed observed weights at age in the stock for 2008, smoothed average weights for the 1982-1985, 1990-1993 and 2000-2006 year classes for 2009-2010.
- The average weights in the catch for the 1982-1985, 1990-1993 and 2000-2006 year classes for 2008-2010.
- Natural mortality – average for the 3 last years (2005-2007).
- 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 both assessment (N-IUU, R-IUU), the differences between them seem insignificant and are unlikely to give cause for different management actions (Figure 4.6). Both runs show the same trends, but the assessment based on R 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 biomass derived 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. Fishing mortality is currently estimated well below the long term mean and also below Fpa in both assessments.

The dominating feature of the updated assessments is the rapid increase in biomass in 2007 and further in 2008, which is mainly the effect of a vastly improved recruitment.

4.5.3 Catch options for 2009–2010 (Tables 4.19 – 4.21)

Input to the predictions is given in Table 4.19. The estimated catch in 2007 gives F=0.31 and F=0.28, respectively and the corresponding spawning stock biomasses are 289 000 and 314 000 t at the beginning of 2008, which in both cases is well above the highest recorded.

In both runs, the average F for the last three years was used for 2008. The deterministic projection shows a further increase in SSB for both runs in the beginning of 2009 (Table 4.20).

Fishing at $\mathbf{F}_{pa}$ in 2009 corresponds to total landings of just above 300 000 t in both runs, raising the SSB at the beginning of 2010 further to more than 400 000 t (Table 4.21).

Fishing in 2009 with F corresponding to the agreed harvest control rule (0.35) is equal to landings of more than 305 000 and 348 000t for N IUU and R IUU. But the 25 % limitation restricting the TAC (see Section 4.7.2) results in a TAC on 193 750 t for 2009 independent of the considered levels of IUU catches (+25% compared to TAC for 2008 equal to 155 000 t).

4.6 Comments to the assessment and forecasts

This table 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 WD 8 and 4.2.2).
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. Last year catches of haddock in Norwegian statistical areas 06 and 07 were 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 2002-2007.	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.

4.6.1 Uncertainty in the assessment

The problems with using XSA on the Northeast Arctic haddock stock are discussed in a working document (WD 24). The main conclusion is that the XSA output is rather sensitive to the XSA settings (Figure 4.10), but the reasons for this are not fully understood.

4.7 Reference points and harvest control rules

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 will therefore recommend that this work should be done intersessionally. A plot of SSB versus recruitment is shown in Figure 4.2. Yield and SSB per recruit (YPR and SPR) are presented in Table 4.22 and Figure 4.3.

4.7.2 Suggested harvest control rule

Until 2007 the suggested HCR for haddock was based on a three year rule similar to that of cod, but that rule was evaluated by the WG, and not found to correspond to the precautionary approach (see last year's report). On this basis, in the 36st Session of the Joint Russian-Norwegian Fishery Commission (JRNFC) in autumn 2007 the parties agreed to modify the former three year rule to a one year rule.

The current suggested HCR for haddock is as follows (unofficial translation from the JRNFC protocol, which is available in Russian and Norwegian only):

– *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 Assessment of NEA haddock using a stochastic time series model

4.8.1 Stochastic time series model

The stochastic time series model fitted to the data for haddock (WD 24) is based on the model described in Aanes et al. (2007). This is a state space model which treats the data as noisy observations from a hidden dynamical system (the population). The essential features of the model are that fishing mortality is modelled as a stochastic time series model, where both effort and selectivity in a separable model is allowed to change through time according to a random walk. The model for fishing mortality is similar to that of Gudmundsson (1994). Furthermore, the model uses survey series to extract signals about fluctuation in unobserved mortality. This contrasts many other approaches, where deviation from survey and catch is interpreted as variability in catchability in the survey. Not surprisingly, it turns out that it is difficult to estimate the absolute level of unobserved mortality, but that the model is able to estimate the temporal dynamics in unobserved mortality. Therefore the median unobserved mortality is fixed to 0.2 for the haddock data, and instead estimates temporal fluctuation in unobserved mortality for ages that are included in the survey. For older ages unobserved mortality is set constant 0.2. The model is fitted to data without IUU catches since the model attempts to estimate unobserved mortality from surveys. For further details about this model see Aanes et al. (2007) and WD 25.

4.8.2 Data

The data used for fitting the model is basically the same as for the XSA (Catch at age without estimates of IUU catches, three survey series: one from the Russian autumn series, and two from joint winter survey), but only data from 1985-2008 is used. Since we do not present results on biomass or spawning stock, weight at age and maturity at age is not used. Note that the survey series from the joint winter survey are not back shifted one year and age as in XSA. Instead, the model runs through the current year without data on catch at age since future catches are predicted through the time series model for fishing mortality.

4.8.3 Results

The results are compared to XSA and the stochastic analogue fixing unobserved mortality to 0.2. The stochastic model show larger temporal fluctuation in stock size than the version fixing M and in particular XSA (Figure 4.11). The most obvious reason for that is that the estimated temporal fluctuation in unobserved mortality is large, with mean ranging from 0.1-0.9 through the period. Another reason is that the surveys are given equal weight throughout the time period. As a consequence, the estimates of fishing mortality differ somewhat from the XSA estimates, although they are correlated. The most recent estimates of fishing mortality is stable around 0.25 (95% credibility set approximately 0.15-0.35), and the total stock size show a large increase during the last three years, which is the same short time trend shown by

XSA. The estimates of unobserved mortality increases from 2002 with a top in 2004, and decreases until 2006. This dynamic is similar to that of estimates of IUU catches, except that the estimates of IUU catches are largest in 2005. Comparing estimates of fishing mortality and unobserved mortality it is apparent that the fluctuation in unobserved mortality is as big as fluctuations in fishing mortality.

Figure 4.12 show that the mean selection pattern in reported catches is rather variable; but that the catch rates of 3 and 4 year old haddock have decreased through time. Figures 4.13 through 4.15 show residuals and retrospective plots for this model.

4.9 Comments to Technical Minutes from ACFM

Our comments to Technical Minutes from ACFM are in *italics* below each comment from ACFM.

General comments

The RG did not accept the estimates of IUU for NEA haddock. The methods used by both Norway and Russia assumed that the fishing behaviour, catchability, the distribution of the fish and illegal behaviour are the same for haddock as for cod. In other words that “cod equals haddock”. This assumption was not backed up by any evidence, in fact it is often argued to the contrary in the AFWG report, and the RG did not accept the assumption without further analysis. Thus the RG did not accept the adjusted catch information as sound. Apparently independent estimates of IUU of haddock have been made, but are very noisy. These should be compared with the “cod equals haddock” approach.

This is not a correct interpretation of the basis for the estimates. The assumption is simply that the haddock/cod ratio in landings from areas and fisheries where the IUU catches are reported are the same as in the IUU catches (see Section 4.1.2).

The use of both sets of IUU data in the catch matrix (Norwegian and Russia) gave a strange result, in that the F in recent years differs greatly but the SSB in the last year is the same. This appears to conflict with the “normal” outcomes in an assessment where changes in F are reflected in inverse change in SSB. However does a lower F result in the same SSB? This was not explained in the AFWG report, or even considered unusual. The RG briefly considered the issue and could not find a solution. The RG felt that this problem lead to the quality of the assessment being questioned.

Although opposite change in F and SSB may be considered a “normal” outcome of an assessment, the two are not directly linked, as F and stock numbers in a single cohort would be. The SSB contains more age groups than those the average F is based on, and the trend in SSB is in addition to the exploitation rate, dependent on the size of the maturing year classes with first time spawners. Hence, there is no reason that the outcome should warrant any question about the quality of the assessment.

The surveys and the catch do give a different perception of stock dynamics. Different methods, without explanation, were used for adjusting the survey results of haddock, compared to cod. The method of reducing the 2006 estimates to the series maximum will impact of on the estimation of q. This was not further analysed by AFWG and thus the impact on the assessment is unknown.

The XSA time series of biomass shows a smoother development than any of the survey indices, i.e. it does not pick up the peaks and throughs seen in the surveys. The reasons for this are *unclear, but unreported catches around 1990 may explain part of the failure of the XSA to reach the same level as the surveys around 1995. Another factor may be density dependent catchability and the fact that the surveys do not always vary in the same way.*

It appears strange that for the IUU estimates "cod equals haddock" but for the surveys "cod doesn't equal haddock".

The Working Group refers to the comment above concerning the estimate of IUU catches.

The 1996 year class is excluded from the survey, the RG would like to see more explanation in the report about why this is done. There seems to be a tendency to exclude anything that doesn't look good in the diagnostics, which may not be the right approach.

A valid comment. The 1996 year class is now back in the assessment (see WD24).

Reviewers would like to see a retrospective plot without a taper.

Cfr WD 24.

An 0-group survey has been taken place but the index is not used in the assessment – there should be an explanation why it is not used.

The 0-group estimate for haddock is not precise enough to be given any weight in the recruitment estimate, and there are already by the time the assessment is made two more indices of the year class abundance available other from surveys.

In table 4.10 the Russian bottom survey label should be age 0 instead of age 1.

Duly noted.

There was still no accounting or discussion of the change in input data carried out last year.

True, but at present this is hardly a crucial problem in the assessment.

The conclusion of the RG was not to accept the assessment (with either IUU from Norway or from Russia) as a basis for advice. The RG felt that the issues about the catch matrix (inclusion of IUU), the treatment of surveys and the strange lack of interaction between F and SSB between the two IUU estimates combined to make them question the whole assessment. After discussion the RG decided that it did not trust the current assessments and felt that more explanation was needed, but was not available. Thus assessment and surveys should only be used as indicators of stock trends. This poses problems with regard to the management rule, but it is clear that the stock is currently being harvested sustainably, and thus a role over TAC should cause no problems to the stock.

The Working Group accepts the conclusion of the review group and regrets that this may have been caused by inadequate explanations.

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	125026	27781	1844	-	-	154651	154651	6000
1961	165156	25641	2427	-	-	193224	193224	4000
1962	160561	25125	1723	-	-	187409	187409	3000
1963	124332	20956	936	-	-	146224	146224	4000
1964	79262	18784	1112	-	-	99158	99158	6000
1965	98921	18719	943	-	-	118583	118583	6000
1966	125009	35143	1626	-	-	161778	161778	5000
1967	107996	27962	440	-	-	136398	136398	3000
1968	140970	40031	725	-	-	181726	181726	3000
1969	89948	40306	566	-	-	130820	130820	2000
1970	60631	27120	507	-	-	88258	88258	-
1971	56989	21453	463	-	-	78905	78905	-
1972	221880	42111	2162	-	-	266153	266153	-
1973	285644	23506	13077	-	-	322227	322227	-
1974	159051	47037	15069	-	-	221157	221157	10000
1975	121692	44337	9729	-	-	175758	175758	6000
1976	94054	37562	5648	-	-	137264	137264	2000
1977	72159	28452	9547	-	-	110158	110158	2000
1978	63965	30478	979	-	-	95422	95422	2000
1979	63841	39167	615	-	-	103623	103623	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	-	-	100563	100563	4021
1987	97091	41084	16741	-	-	154916	154916	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	-	-	135186	135186	6311
1995	75860	53460	13128	-	-	142448	142448	5444
1996	112749	61722	3657	-	-	178128	178128	5126
1997	78128	73475	2756	-	-	154359	154359	5987
1998	45640	53936	1054	-	-	100630	100630	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	114794	100582	6898
2003	53653	43564	8483	33226	9417	138945	113722	4279
2004	64873	47483	12146	33777	8661	157854	133054	3743
2005	53518	48081	16416	40283	9949	158299	127965	5538
2006[1]	51124	47291	33291	21451	8949	172173	140746	5410
2007[1]	62764	58131	25935	14553	3102	161383	149932	7092

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	[1]	40.1	11	22	25.3	30.1	3.2	21.5	8.9
2007	[1]	51.7	11.1	30.5	27.7	20.4	5.5	14.6	3.1

1 Provisional 2 Figures based on Norwegian IUU estimates 3 Figures based on Russian IUU estimates

Table 4.3 North-East Arctic HADDOCK. Nominal catch (t) by countries. Sub-area I and Divisions IIa and IIb combined. (Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Re.	Fed. Re. Germ.	Norway	Poland	United Kingdom	Russia[2]	Others	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[1]	2390	883	1830	989	69272	703	1164	53313	1162	21451	8949	153157	140655
2007[1]	2593	296	1464	1160	70947	299	23	66306	3742	14553	3102	161383	149932

1 Provisional figures. **2 USSR prior to 1991.** **3 Figures based on Norwegian IUU estimates**

4 Figures based on Russian IUU estimates

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).

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

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

age	2000	2001	2002	2003	2004	2005	2006	2007
3	1520	12971	7132	6803	7993	11452	4539	29648
4	29986	5230	46335	31448	21116	19369	35040	16367
5	6496	32049	11084	56480	41310	22887	27571	49367
6	5149	5279	21985	11736	41226	37067	15033	16400
7	2406	2941	2602	14541	4939	24461	16023	7447
8	1657	1137	1602	1637	4914	2393	8567	9886
9	1570	1161	482	2178	598	2997	1259	2707
10	1744	1169	448	858	1252	990	1298	1079
11+	437	1204	1029	1219	901	1524	718	1747
TOTNU	50965	63141	92699	126900	124249	123140	110048	134648
TONS	68944	89640	114798	138926	158279	158298	153157	161383
SOPCOF%	97	100	99	98	98	99	100	100

Table 4.4b. Northeast Arctic haddock. Catch numbers at age (numbers, thousands spec.) not including estimates of IUU catches 2002-2007.

	year					
age	2002	2003	2004	2005	2006	2007
3	5491	4743	5232	8378	3483	24847
4	35584	20251	13764	12774	27900	13946
5	9290	44162	28539	15349	23069	43869
6	19917	10353	34811	24910	12736	15132
7	2269	13653	4567	19911	13732	6982
8	1425	1521	4767	2101	7806	9565
9	443	2128	569	2774	1206	2597
10	409	829	1215	887	1267	1062
11+	917	1137	857	1523	694	1737
TOTNU	75745	98777	94321	88607	91893	119737
TONS	96062	105700	124502	118015	131706	146830
SOPCOF%	99	98	98	100	100	100

Table 4.5. Northeast Arctic haddock. Catch weights at age (kg)

Age	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%	61.000	79.000	54.000	67.000	66.000	63.000	77.000	78.000	86.000	102.000

Age	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%	92.000	97.000	92.000	85.000	72.000	84.000	83.000	98.000	98.000	110.000

Age	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%	100.000	124.000	88.000	83.000	108.000	107.000	84.000	83.000	105.000	127.000

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	0.550	0.684
4	1.065	1.065	1.065	1.408	1.632	1.290	1.064	0.765	0.908	0.840
5	1.353	1.353	1.353	1.710	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	3.250	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	2.140
11+	3.177	3.177	3.177	4.516	4.667	4.416	5.283	4.213	2.571	2.685
SOPCOF%	129.000	136.000	135.000	94.000	92.000	100.000	95.000	101.000	100.000	102.000

	year									
Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.793	0.941	0.906	0.940	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	1.710	1.637	1.641	1.634
8	2.112	2.079	2.200	2.237	2.059	2.234	1.886	1.856	1.863	1.798
9	2.653	2.311	2.298	2.417	2.390	2.416	2.214	2.073	2.069	2.032
10	3.102	2.788	2.494	2.654	2.545	2.602	2.370	2.500	2.335	2.237
11+	3.338	3.219	2.652	3.026	2.893	3.130	2.675	2.554	2.810	2.712
SOPCOF%	97.000	96.000	100.000	99.000	99.000	98.000	98.000	95.000	98.000	97.000

	year							
Age	2000	2001	2002	2003	2004	2005	2006	2007
3	0.853	0.751	0.687	0.594	0.636	0.722	0.745	0.647
4	1.186	1.104	1.001	0.875	0.886	0.906	1.041	0.918
5	1.395	1.459	1.363	1.113	1.183	1.121	1.287	1.206
6	1.588	1.709	1.643	1.364	1.508	1.343	1.504	1.427
7	1.808	1.921	1.975	1.361	1.821	1.619	1.720	1.637
8	1.989	2.182	2.086	1.972	2.075	2.036	2.082	1.843
9	2.264	2.331	2.294	1.636	2.339	2.177	2.377	2.073
10	2.415	2.609	2.487	1.877	2.580	2.382	2.738	2.284
11+	2.892	2.981	2.778	2.409	2.991	2.768	3.212	2.635
SOPCOF%	97.000	100.000	99.000	98.000	98.000	99.000	100.000	100.000

Table 4.6. Northeast Arctic haddock. Stock weights at age (kg)

	year									
Age	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358
4	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657
5	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021
6	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431
7	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871
8	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338
9	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
10	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223
11+	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639

	year									
Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358
4	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657
5	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021
6	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431
7	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871
8	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338
9	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
10	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223
11+	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639

	year									
Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358
4	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657
5	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021	1.021
6	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431	1.431
7	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871	1.871
8	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338	2.338
9	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794	2.794
10	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223	3.223
11+	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639	3.639

Table 4.6 (continued).

	year									
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	0.446	0.597	0.622	0.516	0.386	0.374	0.307	0.327	0.379	0.440
4	0.864	0.793	1.041	1.086	0.914	0.692	0.675	0.563	0.597	0.682
5	1.165	1.299	1.204	1.551	1.618	1.381	1.059	1.039	0.880	0.929
6	1.686	1.593	1.765	1.650	2.090	2.184	1.886	1.463	1.444	1.240
7	2.309	2.136	2.035	2.239	2.110	2.630	2.753	2.402	1.885	1.870
8	3.158	2.754	2.579	2.475	2.705	2.567	3.152	3.306	2.911	2.310
9	3.345	3.545	3.176	3.006	2.902	3.152	3.006	3.642	3.830	3.399
10	3.598	3.725	3.899	3.571	3.410	3.309	3.570	3.422	4.094	4.317
11+	4.086	3.961	4.074	4.223	3.937	3.788	3.692	3.958	3.808	4.503

	year									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	0.408	0.397	0.335	0.275	0.259	0.279	0.296	0.326	0.343	0.333
4	0.781	0.729	0.713	0.609	0.507	0.480	0.515	0.544	0.594	0.625
5	1.046	1.183	1.110	1.091	0.943	0.793	0.754	0.810	0.851	0.921
6	1.304	1.449	1.620	1.527	1.508	1.318	1.121	1.070	1.149	1.200
7	1.628	1.707	1.873	2.072	1.961	1.944	1.716	1.475	1.413	1.517
8	2.304	2.031	2.122	2.304	2.522	2.395	2.383	2.122	1.843	1.772
9	2.726	2.733	2.436	2.540	2.729	2.959	2.819	2.814	2.525	2.214
10	3.857	3.125	3.149	2.836	2.950	3.140	3.375	3.225	3.227	2.916
11+	4.762	4.281	3.502	3.545	3.224	3.346	3.532	3.766	3.607	3.618

	year							
	2000	2001	2002	2003	2004	2005	2006	2007
3	0.294	0.298	0.301	0.281	0.298	0.323	0.324	0.306
4	0.606	0.540	0.546	0.555	0.519	0.548	0.591	0.592
5	0.967	0.940	0.843	0.851	0.871	0.815	0.857	0.920
6	1.289	1.352	1.315	1.188	1.197	1.232	1.154	1.209
7	1.577	1.682	1.761	1.714	1.560	1.568	1.623	1.521
8	1.901	1.968	2.085	2.180	2.123	1.945	1.952	2.030
9	2.136	2.292	2.362	2.489	2.599	2.530	2.333	2.336
10	2.581	2.499	2.681	2.751	2.884	3.007	2.926	2.715
11+	3.290	2.938	2.854	3.060	3.129	3.264	3.399	3.306

Table 4.7. Northeast Arctic haddock. Natural mortality (M) at age

age	year 1950-1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	0.3171	0.2074	0.2000	0.6466	0.2000	0.4044	0.2000	0.3191	0.2000	0.2058
4	0.2283	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
5	0.2157	0.2000	0.2000	0.2000	0.2000	0.2023	0.2000	0.2000	0.2000	0.2000
6	0.2034	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11+	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

age	year 1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.2613	0.2947	0.3437	0.7514	0.4697	0.2364	0.2016	0.2239	0.2145	0.3174
4	0.2253	0.2173	0.3650	0.2971	0.2428	0.2492	0.2000	0.2080	0.2012	0.2100
5	0.2679	0.2114	0.3043	0.2242	0.2230	0.2203	0.2000	0.2075	0.2000	0.2088
6	0.2000	0.2005	0.2081	0.2225	0.2095	0.2000	0.2000	0.2041	0.2000	0.2040
7	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
11+	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000

age	year 2003	2004	2005	2006	2007
3	0.4005	0.4157	0.4302	0.2218	0.2447
4	0.2547	0.2721	0.2926	0.2231	0.2203
5	0.2075	0.2172	0.2461	0.2149	0.2218
6	0.2000	0.2000	0.2153	0.2108	0.2070
7	0.2000	0.2000	0.2000	0.2000	0.2000
8	0.2000	0.2000	0.2000	0.2000	0.2000
9	0.2000	0.2000	0.2000	0.2000	0.2000
10	0.2000	0.2000	0.2000	0.2000	0.2000
11+	0.2000	0.2000	0.2000	0.2000	0.2000

Table 4.8. Northeast Arctic haddock. Proportion mature at age

age	year 1950-1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	0.028	0.025	0.053	0.051	0.055	0.042	0.025	0.020	0.020	0.023	0.030	0.044
4	0.106	0.074	0.100	0.157	0.179	0.195	0.146	0.100	0.074	0.073	0.088	0.125
5	0.325	0.239	0.298	0.328	0.470	0.508	0.523	0.452	0.291	0.239	0.249	0.304
6	0.635	0.650	0.544	0.573	0.664	0.802	0.799	0.764	0.717	0.578	0.536	0.580
7	0.849	0.862	0.860	0.766	0.799	0.864	0.930	0.931	0.922	0.902	0.825	0.802
8	0.947	0.952	0.951	0.949	0.906	0.922	0.954	0.979	0.978	0.977	0.968	0.939
9	0.983	0.985	0.985	0.984	0.985	0.967	0.974	0.985	0.993	0.993	0.993	0.991
10	0.995	0.996	0.996	0.996	0.996	0.996	0.990	0.992	0.994	0.998	0.998	0.997
11+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

age	year 1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.039	0.029	0.017	0.016	0.015	0.019	0.024	0.031	0.041	0.028	0.029	0.022
4	0.161	0.144	0.110	0.071	0.057	0.068	0.072	0.091	0.115	0.144	0.099	0.109
5	0.357	0.449	0.395	0.327	0.226	0.212	0.203	0.255	0.304	0.347	0.393	0.313
6	0.625	0.706	0.745	0.706	0.636	0.498	0.496	0.503	0.584	0.623	0.668	0.712
7	0.825	0.859	0.882	0.907	0.890	0.859	0.764	0.753	0.763	0.801	0.859	0.884
8	0.929	0.939	0.953	0.962	0.971	0.966	0.951	0.911	0.901	0.904	0.930	0.951
9	0.981	0.978	0.980	0.985	0.988	0.992	0.990	0.985	0.971	0.968	0.969	0.979
10	0.997	0.995	0.993	0.994	0.995	0.997	0.998	0.997	0.996	0.991	0.990	0.990
11+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

age	year 2003	2004	2005	2006	2007
3	0.023	0.026	0.027	0.024	0.016
4	0.093	0.083	0.091	0.097	0.083
5	0.327	0.266	0.265	0.285	0.317
6	0.640	0.636	0.582	0.594	0.610
7	0.899	0.846	0.857	0.825	0.841
8	0.961	0.969	0.954	0.955	0.942
9	0.985	0.988	0.991	0.986	0.985
10	0.993	0.996	0.997	0.997	0.996
11+	1.000	1.000	1.000	1.000	1.000

Table 4.9. Northeast Arctic haddock. Survey indices used in tuning XSA

North-East Arctic haddock

103

FLT01: Russian BT survey, total area, Nov-Dec, age 1-7

1983 2007

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	NA	NA	NA	NA	NA	NA	NA
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

FLT02: Norwegian acoustic, age 1-7, shifted

1980 2007

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

Table 4.9 (continued).

FLT04: Norwegian BT survey, age 1-8, shifted
1982 2007
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

Table 4.10. Northeast Arctic haddock. Input data for recruitment prediction (RCT3)

NORTHEAST ARCTIC HADDOCK: recruits as 3 year-olds
9 18 2

'Year-class'	'VPA'	'NT1'	'NT2'	'NT3'	'NAK1'	'NAK2'	'NAK3'	'RT1'	'RT2'	'RT3'
1990	693	2006	1375.5	507.7	1890	868	563	-11.0	42.9	128.6
1991	309	1659.4	599	339.5	1135	626	255	16.7	28.2	35.7
1992	100	727.9	228	53.6	947	193	36	16.4	4.8	5.8
1993	105	603.2	179.3	52.5	562	285	44	3.5	4.9	4.2
1994	119	1463.6	263.6	86.1	1379	229	51	9.1	7.2	5.7
1995	60	309.5	67.9	22.7	249	24	20	6.4	2.3	1.9
1996	229	1268	137.9	59.8	693	122	57	6	4.6	11.5
1997	94	212.9	57.6	27.2	220	46	32	1.8	2.9	6.1
1998	355	1244.9	452.2	296	856	509	210	10.7	28.9	26.2
1999	350	847.2	460.3	314.7	1024	316	216	11.7	20.7	26.1
2000	229	1220.5	534.7	317.4	976	282	145	15.1	14.9	18.9
2001	240	1680.3	513.1	188.1	2062	279	127	20.8	19.3	25.1
2002	347	3332.1	711.2	346.5	2394	474	219	33.2	32.8	20.6
2003	157	715.9	420.4	77.4	752	209	54	19.8	11	13.6
2004	612	4630.2	1313.1	507.7	3364	804	379	50	79.2	122.7
2005	-11.0	5141.3	1593.8	1522.4	2767	868	723.4	62	79.2	214.2
2006	-11.0	3874.4	2129.4	-11.0	3197	1835.2	-11.0	53.4	83.9	-11.0
2007	-11.0	860.2	-11.0	-11.0	1266.6	-11.0	-11.0	6.5	-11.0	-11.0

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

```
Analysis by RCT3 ver3.1 of data from file
 NORTHEAST ARCTIC HADDOCK: recruits as 3 year-olds

 Data for    9 surveys over   18 years :  1990 - 2007

 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 =   2002
         I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights
 NT1       1.37  -4.02    .70   .534     12   8.11    7.07     .935     .021
 NT2        .92    .15    .48   .710     12   6.57    6.16     .584     .055
 NT3        .72   1.83    .33   .838     12   5.85    6.06     .400     .116
 NAK1      1.48  -4.60    .82   .456     12   7.78    6.89    1.050     .017
 NAK2       .87    .64    .56   .640     12   6.16    6.00     .672     .041
 NAK3       .76   1.87    .21   .927     12   5.39    5.96     .253     .291
 RT1       1.86    .93   1.06   .296     11   3.53    7.49    1.458     .009
 RT2        .89   3.14    .33   .838     12   3.52    6.26     .410     .110
 RT3        .74   3.31    .21   .926     12   3.07    5.60     .248     .302
 VPA Mean =    5.27     .705     .037

 Yearclass =   2003
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights
 NT1       1.19  -2.91    .66   .551     13   6.57    4.93     .766     .028
 NT2        .89    .29    .45   .727     13   6.04    5.66     .519     .061
 NT3        .71   1.90    .31   .847     13   4.36    4.98     .360     .127
 NAK1      1.31  -3.54    .74   .493     13   6.62    5.12     .854     .023
 NAK2       .85    .73    .52   .664     13   5.35    5.30     .598     .046
 NAK3       .76   1.88    .20   .932     13   4.01    4.91     .231     .308
 RT1       1.47   1.72    .88   .379     12   3.03    6.19    1.060     .015
 RT2        .85   3.21    .32   .841     13   2.48    5.31     .365     .123
 RT3        .78   3.25    .23   .910     13   2.68    5.34     .265     .235
 VPA Mean =    5.33     .691     .035
Yearclass =   2004
         I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights
 NT1       1.16  -2.69    .62   .554     14   8.44    7.13     .832     .029
 NT2        .91    .12    .47   .679     14   7.18    6.65     .608     .055
 NT3        .70   1.95    .29   .847     14   6.23    6.30     .363     .153
 NAK1      1.29  -3.39    .69   .496     14   8.12    7.05     .911     .024
 NAK2       .86    .72    .49   .662     14   6.69    6.44     .611     .054
 NAK3       .75   1.92    .19   .927     14   5.94    6.38     .244     .338
 RT1       1.53   1.49    .94   .327     13   3.93    7.49    1.275     .012
 RT2        .85   3.17    .31   .830     14   4.38    6.92     .430     .109
 RT3        .80   3.17    .23   .896     14   4.82    7.04     .335     .179

                                        VPA Mean =    5.32     .654     .047
```

Table 4.11 (continued).

Yearclass = 2005

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
NT1	1.02	-1.72	.54	.654	15	8.55	6.97	.695	.041
NT2	.88	.28	.44	.739	15	7.37	6.77	.560	.063
NT3	.72	1.85	.29	.863	15	7.33	7.14	.405	.120
NAK1	1.14	-2.42	.60	.603	15	7.93	6.60	.735	.037
NAK2	.86	.72	.46	.720	15	6.77	6.52	.566	.062
NAK3	.77	1.84	.19	.939	15	6.59	6.92	.252	.312
RT1	1.24	2.15	.76	.479	14	4.14	7.29	.997	.020
RT2	.78	3.32	.29	.866	15	4.38	6.76	.376	.140
RT3	.73	3.33	.24	.903	15	5.37	7.27	.345	.166
VPA Mean =		5.42	.705	.040					

Yearclass = 2006

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
NT1	.99	-1.54	.53	.660	15	8.26	6.66	.665	.115
NT2	.88	.31	.44	.736	15	7.66	7.02	.593	.145
NT3									
NAK1	1.11	-2.21	.59	.612	15	8.07	6.73	.741	.093
NAK2	.85	.77	.45	.732	15	7.52	7.16	.612	.136
NAK3									
RT1	1.22	2.20	.75	.487	14	4.00	7.07	.973	.054
RT2	.78	3.34	.29	.866	15	4.44	6.79	.382	.351
RT3									
VPA Mean =		5.44	.698	.105					

Yearclass = 2007

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
NT1	.96	-1.34	.52	.668	15	6.76	5.17	.610	.326
NT2									
NT3									
NAK1	1.08	-1.99	.57	.624	15	7.14	5.70	.671	.269
NAK2									
NAK3									
RT1	1.19	2.25	.74	.494	14	2.01	4.66	.892	.152
RT2									
RT3									
VPA Mean =		5.46	.691	.253					

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2002	378	5.93	.14	.12	.79	368	5.91
2003	176	5.17	.13	.09	.46	161	5.09
2004	709	6.56	.14	.14	.97	666	6.50
2005	978	6.89	.14	.12	.76		
2006	834	6.73	.23	.19	.72		
2007	202	5.31	.35	.20	.32		

Table 4.12. Northeast Arctic haddock. Extended Survivors Analysis

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FLR XSA Diagnostics 2008-04-29 14:23:53

CPUE data from indices

Catch data for 58 years. 1950 to 2007. Ages 1 to 11.

fleet                      first age last age first year last year alpha beta
1 FLT01: Russian BT survey,      1        7      1983        2007   0.9    1
  total area, Nov-Dec, age 1-7
2 FLT02: Norwegian acoustic,     1        7      1980        2007  0.99    1
  age 1-7, shifted
3 FLT04: Norwegian BT survey,    1        8       1982       2007  0.99    1
  age 1-8, shifted


 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
     year
age    1998 1999  2000  2001  2002  2003 2004  2005 2006 2007
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
    year
age   1998  1999  2000  2001  2002  2003  2004  2005  2006  2007
  1  0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
  2  0.005 0.005 0.001 0.004 0.002 0.002 0.002 0.003 0.003 0.003
  3  0.032 0.083 0.018 0.037 0.022 0.034 0.039 0.039 0.032 0.052
  4  0.193 0.211 0.209 0.079 0.184 0.136 0.163 0.148 0.187 0.158
  5  0.376 0.448 0.266 0.364 0.241 0.363 0.279 0.285 0.345 0.450
  6  0.477 0.462 0.264 0.361 0.460 0.438 0.496 0.443 0.318 0.361
  7  0.519 0.487 0.334 0.237 0.303 0.641 0.332 0.626 0.352 0.258
  8  0.691 0.482 0.335 0.260 0.196 0.318 0.464 0.265 0.466 0.383
  9  0.625 0.491 0.207 0.416 0.167 0.446 0.183 0.579 0.217 0.260
  10 0.604 0.393 0.245 0.234 0.279 0.503 0.502 0.520 0.535 0.293
  11 0.604 0.393 0.245 0.234 0.279 0.503 0.502 0.520 0.535 0.293
```

Table 4.12 (continued).

XSA population number (thousands)

year \ age	1	2	3	4	5	6	7	8	9	10	11
1998	1835379	318771	60981	73107	32951	25171	37685	43112	5023	804	1180
1999	1691993	144261	234078	46629	47004	18144	12797	18366	17681	2201	1505
2000	2033007	553744	96682	176110	30903	24581	9360	6436	9287	8862	2208
2001	1324492	541466	393208	75930	116008	19256	15394	5487	3770	6183	6333
2002	3348111	566741	392909	305634	57364	65980	10989	9942	3463	2036	4647
2003	4941444	562087	248888	279966	206020	36568	33951	6642	6691	2399	3375
2004	2952871	779802	257378	161179	189329	116503	19320	14640	3957	3507	2499
2005	9146786	470379	367221	163351	104351	115301	58082	11349	7539	2699	4112
2006	12109160	1246886	160853	229591	105182	61346	59683	25420	7126	3461	1894
2007	15686916	1743187	664958	124797	152340	60082	36156	34366	13060	4695	7553

Estimated population abundance at 1st Jan 2008

year \ age	1	2	3	4	5	6	7	8	9	10	11
2008	20631	1847431	847172	494420	85474	77865	34071	22871	19200	8251	2871

Fleet: FLT01: Russian BT survey, total area, Nov-Dec, age 1-7

Log catchability residuals.

age \ year	1983	1984	1985	1986	1987
1	1.001	0.708	0.165	0.018	0.102
2	1.614	0.427	0.387	0.088	0.115
3	0.657	0.886	0.585	-0.054	0.105
4	0.091	0.117	0.203	0.109	0.159
5	-1.377	-0.162	0.126	-0.096	0.131
6	NA	-1.788	-0.046	-1.301	-1.524
7	NA	NA	NA	-1.589	-1.248

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-0.152	-0.247	NA	0.310	0.273	-0.092	-0.299	-0.242	-0.184	-0.285
2	0.224	0.504	NA	0.164	0.161	0.115	0.081	-0.156	-0.101	-0.007
3	-0.030	-0.249	NA	0.040	0.351	0.347	0.225	-0.184	-0.089	-0.237
4	-0.256	-0.176	NA	-0.189	-0.037	0.649	0.352	-0.229	0.116	0.113
5	-0.094	0.054	NA	-0.260	-0.251	0.236	0.234	-0.090	0.585	-0.404
6	-0.069	0.577	NA	-0.322	0.348	0.506	0.114	0.170	0.546	-0.307
7	-1.911	1.289	NA	0.473	0.662	0.855	-0.441	0.333	1.283	-1.032

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.179	0.421	0.204	0.084	0.037	0.079	-0.160	0.195	-0.046	-0.100
2	-0.071	0.210	-0.086	-0.081	-0.050	0.048	-0.240	0.030	0.107	0.147
3	0.196	0.038	0.081	-0.084	0.033	0.114	-0.200	-0.094	0.029	-0.005
4	0.047	0.281	-0.124	-0.165	0.311	0.123	-0.136	-0.198	-0.283	-0.125
5	-0.285	0.268	0.302	-0.131	0.152	0.109	-0.259	-0.226	-0.130	0.107
6	-0.538	0.039	-0.120	0.140	-0.279	0.424	0.144	-0.157	-0.252	0.046
7	0.236	-0.323	-0.561	-0.457	-0.057	0.522	-0.371	0.376	0.088	-0.038

Table 4.12 (continued).

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
-7.3828	0.8625

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 1	0.7546067	9.823680
Age 2	0.6183778	9.441713
Age 3	0.6696207	8.704622
Age 4	0.7890887	7.907313
Age 5	0.7145380	8.112806
Age 6	0.8216230	7.628176

Fleet: FLT02: Norwegian acoustic, age 1-7, shifted

Log catchability residuals.

year age	1980	1981	1982	1983	1984	1985	1986	1987
1	0.275	-0.679	-0.270	-0.086	0.624	0.174	-0.416	-0.993
2	0.506	0.062	0.263	0.629	0.281	0.251	-0.037	-0.251
3	0.865	0.524	0.190	0.446	0.665	0.345	0.060	-0.218
4	0.545	0.149	-0.051	-0.100	NA	NA	-0.035	-0.226
5	0.461	0.093	0.100	NA	NA	NA	NA	-0.219
6	0.791	0.884	0.370	NA	NA	NA	NA	NA
7	NA	NA	0.970	NA	NA	NA	NA	NA

year age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-0.745	-0.512	0.595	0.393	0.521	0.436	0.439	0.161	-0.658	-0.178
2	0.127	-0.471	0.147	0.262	0.138	0.263	0.013	0.020	0.018	0.086
3	0.027	-0.254	0.110	-0.143	0.345	0.369	-0.013	0.141	-0.010	0.017
4	-0.076	-0.305	-0.029	-0.457	-0.250	0.485	0.295	0.054	-0.136	0.118
5	-0.106	-0.112	0.056	NA	NA	0.172	0.248	-0.054	0.065	-0.015
6	0.194	0.314	-0.171	NA	NA	NA	-0.004	0.207	0.168	0.275
7	NA	1.020	0.645	-0.994	NA	NA	NA	NA	0.054	0.884

year age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.351	0.451	0.091	0.025	-0.090	0.014	-0.158	-0.016	-0.241	0.241
2	-0.275	0.044	0.035	0.055	0.076	-0.011	0.026	-0.182	-0.090	0.059
3	-0.045	-0.125	-0.080	-0.056	0.161	0.006	0.164	-0.198	0.036	-0.126
4	-0.074	0.431	-0.496	-0.197	0.261	-0.141	-0.130	-0.244	0.108	0.304
5	0.100	0.278	-0.419	-0.271	0.245	0.013	-0.148	-0.219	0.012	0.277
6	-0.291	0.314	-0.386	-0.157	-0.138	0.462	-0.222	-0.235	-0.060	0.262
7	-0.341	0.015	NA	NA	NA	-0.115	NA	-0.667	-0.050	0.506

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
-6.4851	0.6531

Table 4.12 (continued).

```
Regression statistics
 Ages with q dependent on year class strength
          slope intercept
Age 1 0.8622911  6.546733
Age 2 0.7308064  7.433468
Age 3 0.7634869  7.038609
Age 4 0.7646589  6.988283
Age 5 0.6083740  7.962070
Age 6 0.7337835  7.552697
```

Fleet: FLT04: Norwegian BT survey, age 1-8, shifted

Log catchability residuals.

year age	1982	1983	1984	1985	1986	1987
1	-0.462	0.428	0.839	0.145	0.464	-0.227
2	0.524	1.054	0.411	-0.042	0.306	0.301
3	0.098	0.316	1.154	-0.091	0.157	0.289
4	-0.110	-0.227	-0.058	-0.284	-0.031	0.278
5	0.444	0.211	0.495	0.465	NA	0.071
6	0.174	-0.241	0.140	0.257	NA	0.311
7	0.697	-0.476	-0.644	0.176	NA	NA
8	NA	-0.048	0.592	0.492	NA	NA

year age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-0.418	-0.385	0.465	0.442	0.196	0.277	-0.162	-0.017	-0.142	-0.325
2	0.526	-0.127	-0.060	0.152	-0.140	0.160	0.101	-0.015	0.118	0.100
3	0.331	-0.134	-0.128	-0.152	0.088	-0.038	0.079	0.277	0.177	0.030
4	0.207	-0.184	0.156	-0.429	-0.387	-0.012	0.175	0.405	0.122	0.154
5	0.078	0.075	0.157	0.068	-0.041	-0.138	0.181	0.073	0.103	-0.018
6	0.405	0.245	-0.243	-0.109	0.161	-0.131	0.211	0.297	0.126	-0.004
7	0.293	1.691	1.065	0.253	-0.534	-0.622	NA	0.841	1.390	0.980
8	NA	NA	NA	1.389	-0.212	0.086	0.539	NA	0.226	1.169

year age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.422	0.094	0.096	0.229	0.075	0.021	0.078	0.036	-0.101	0.025
2	-0.290	-0.068	0.013	0.043	0.218	-0.003	0.023	-0.129	-0.170	0.094
3	-0.098	-0.510	-0.004	-0.076	-0.042	0.044	0.158	-0.058	0.044	0.155
4	-0.273	-0.061	-0.437	-0.081	-0.252	-0.137	0.199	0.005	0.062	0.510
5	0.101	0.028	-0.043	-0.274	-0.044	-0.085	-0.026	0.022	0.076	0.121
6	-0.077	0.034	-0.175	-0.038	-0.360	0.323	-0.087	-0.018	0.060	0.022
7	0.273	-0.413	-1.351	-0.846	-0.849	0.064	-0.286	0.548	0.425	0.445
8	0.363	0.556	-0.488	NA	-1.061	0.157	-0.488	-1.124	0.908	-0.011

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	-7.2616	-7.7498
S.E_Logq	0.7812	0.6828

```
 Regression statistics
 Ages with q dependent on year class strength
          slope intercept
Age 1 0.8357625  6.490122
Age 2 0.6324390  7.975198
Age 3 0.7008984  7.323560
Age 4 0.7554449  7.012909
Age 5 0.5346270  8.492689
Age 6 0.5992640  8.222009
```

Table 4.12 (continued).

Terminal year survivor and F summaries:

Age 1 Year class = 2006

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	1618144	1	0.297
FLT02: Norwegian acoustic, age 1-7, shifted	2442329	1	0.177
FLT04: Norwegian BT survey, age 1-8, shifted	1903514	1	0.347
fshk	2790236	1	0.125
nshk	490039	1	0.054

Age 2 Year class = 2005

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	932913	2	0.323
FLT02: Norwegian acoustic, age 1-7, shifted	800979	2	0.275
FLT04: Norwegian BT survey, age 1-8, shifted	859323	2	0.341
fshk	1164797	1	0.062

Age 3 Year class = 2004

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	566756	3	0.327
FLT02: Norwegian acoustic, age 1-7, shifted	440761	3	0.296
FLT04: Norwegian BT survey, age 1-8, shifted	491701	3	0.333
fshk	775046	1	0.043

Age 4 Year class = 2003

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	79903	4	0.349
FLT02: Norwegian acoustic, age 1-7, shifted	83305	4	0.291
FLT04: Norwegian BT survey, age 1-8, shifted	94439	4	0.321
fshk	82040	1	0.039

Age 5 Year class = 2002

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	67413	5	0.327
FLT02: Norwegian acoustic, age 1-7, shifted	81056	5	0.276
FLT04: Norwegian BT survey, age 1-8, shifted	83064	5	0.346
fshk	124101	1	0.051

Age 6 Year class = 2001

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	31242	6	0.317
FLT02: Norwegian acoustic, age 1-7, shifted	35996	6	0.275
FLT04: Norwegian BT survey, age 1-8, shifted	37127	6	0.357
fshk	27186	1	0.051

Table 4.12 (continued).

Age 7 Year class = 2000

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	21049	7	0.318
FLT02: Norwegian acoustic, age 1-7, shifted	23140	7	0.287
FLT04: Norwegian BT survey, age 1-8, shifted	27313	7	0.339
fshk	11717	1	0.056

Age 8 Year class = 1999

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	19045	7	0.295
FLT02: Norwegian acoustic, age 1-7, shifted	18392	7	0.271
FLT04: Norwegian BT survey, age 1-8, shifted	19322	8	0.340
fshk	21793	1	0.094

Age 9 Year class = 1998

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	9945	7	0.256
FLT02: Norwegian acoustic, age 1-7, shifted	7568	7	0.240
FLT04: Norwegian BT survey, age 1-8, shifted	8712	8	0.319
fshk	6490	1	0.185

Age 10 Year class = 1997

source	survivors	N	scaledWts
FLT01: Russian BT survey, total area, Nov-Dec, age 1-7	3076	7	0.295
FLT02: Norwegian acoustic, age 1-7, shifted	3120	6	0.228
FLT04: Norwegian BT survey, age 1-8, shifted	2596	8	0.341
fshk	2768	1	0.136

Table 4.13. Northeast Arctic haddock. Fishing mortality at age

age \ year	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
3	0.0495	0.1279	0.1060	0.0652	0.0558	0.0229	0.1036	0.0409	0.0258	0.0652	0.1839
4	0.5804	0.2130	0.5359	0.3825	0.2383	0.1309	0.1696	0.2427	0.1700	0.1692	0.3693
5	0.8177	0.6279	0.5804	0.5314	0.3052	0.4841	0.2748	0.3705	0.5735	0.3332	0.5133
6	0.8104	0.9119	0.8893	0.4886	0.4111	0.4675	0.8114	0.4039	0.5195	0.5560	0.6502
7	1.1580	0.8026	0.9968	0.7142	0.6141	1.0146	0.6250	0.8164	0.9655	0.6009	0.5177
8	1.0019	1.0019	1.2555	0.6549	0.8635	0.6215	0.9362	0.4499	0.8697	0.4285	0.7005
9	0.6471	1.4279	1.3781	0.5133	1.3660	0.4287	0.3972	0.6280	0.7440	0.8451	1.1504
10	0.9460	1.0901	1.2251	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976
11+	0.9460	1.0901	1.2251	0.6331	0.9584	0.6948	0.6588	0.6371	0.8688	0.6304	0.7976
FBAR4-7	0.8416	0.6388	0.7506	0.5292	0.3922	0.5243	0.4702	0.4584	0.5571	0.4148	0.5126

age \ year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
3	0.1553	0.1830	0.1110	0.0736	0.0609	0.1187	0.0559	0.0380	0.0919	0.1554	0.0212
4	0.4746	0.5823	0.6650	0.3104	0.2331	0.3779	0.3007	0.3872	0.1652	0.2275	0.2607
5	0.6897	1.0565	0.9320	0.6877	0.4632	0.5918	0.4185	0.5748	0.4937	0.2449	0.1784
6	0.7501	1.0614	1.0284	0.8724	0.6977	0.7442	0.5196	0.4587	0.5817	0.5032	0.1801
7	0.8315	0.6982	1.0018	0.8462	0.6772	0.8262	0.5325	0.7044	0.4045	0.5302	0.4022
8	0.8803	0.9005	0.6493	0.9610	0.5958	0.5276	0.5812	0.7179	0.5030	0.4131	0.3889
9	0.9639	1.1829	1.3618	1.3891	1.0533	0.5931	0.3826	0.4947	0.5019	0.3946	0.2964
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	0.6865	0.8496	0.9068	0.6792	0.5178	0.6350	0.4428	0.5313	0.4113	0.3764	0.2554

age \ year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.2632	0.3114	0.2063	0.2355	0.2973	0.7077	0.3238	0.1341	0.0263	0.0461	0.0670
4	0.3811	0.5907	0.3328	0.5759	0.6300	1.2604	0.6059	0.4693	0.2821	0.1546	0.1218
5	1.0676	0.9876	0.4157	0.5116	0.6349	0.9167	0.8755	0.8880	0.6196	0.5002	0.3213
6	0.9525	0.4762	0.6949	0.4440	0.7046	0.5366	0.4291	0.9296	0.6778	0.7315	0.5824
7	0.5513	0.2963	0.5911	0.5973	0.8008	0.6318	0.7905	0.4834	0.3979	0.5324	0.3917
8	0.5807	0.2712	0.4800	0.3482	0.8745	0.5332	0.4447	0.6813	0.6371	0.4890	0.3364
9	0.6956	0.2754	0.8031	0.2000	0.8112	0.5547	0.6621	0.4882	0.6979	0.4305	0.4410
10	0.6145	0.2825	0.6304	0.3844	0.8375	0.5781	0.6381	0.5555	0.5826	0.4877	0.3924
11+	0.6145	0.2825	0.6304	0.3844	0.8375	0.5781	0.6381	0.5555	0.5826	0.4877	0.3924
FBAR4-7	0.7381	0.5877	0.5086	0.5322	0.6926	0.8364	0.6753	0.6926	0.4943	0.4797	0.3543

age \ year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.1652	0.1233	0.1183	0.0620	0.0489	0.0323	0.0937	0.0331	0.0475	0.0623	0.0224
4	0.3169	0.2258	0.2416	0.4376	0.4598	0.1647	0.1669	0.1549	0.1662	0.1688	0.1441
5	0.2803	0.4046	0.1878	0.3684	1.0014	0.4979	0.3309	0.1001	0.2127	0.2929	0.3221
6	0.4031	0.2137	0.3910	0.4314	0.4061	1.0954	0.5396	0.1285	0.2208	0.3805	0.5380
7	0.2214	0.2758	0.5407	0.7317	0.6977	0.2917	0.4790	0.2417	0.2130	0.3075	0.4684
8	0.5131	0.3802	0.4490	0.4542	0.8048	0.4581	0.1663	0.2195	0.2386	0.2334	0.3376
9	0.4766	0.1746	0.4786	0.7951	0.4762	0.3527	0.0040	0.2249	0.1798	0.3442	0.2271
10	0.4065	0.2784	0.4932	0.6664	0.6657	0.3699	0.2175	0.2299	0.2117	0.2926	0.3311
11+	0.4065	0.2784	0.4932	0.6664	0.6657	0.3699	0.2175	0.2299	0.2117	0.2926	0.3311
FBAR4-7	0.3054	0.2800	0.3403	0.4923	0.6413	0.5124	0.3791	0.1563	0.2031	0.2874	0.3681

year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	0.0127	0.0241	0.0233	0.0244	0.0319	0.0829	0.0177	0.0374	0.0215	0.0340	0.0390
4	0.1075	0.0888	0.1214	0.1410	0.1925	0.2114	0.2094	0.0792	0.1844	0.1365	0.1626
5	0.4463	0.2534	0.3316	0.3701	0.3764	0.4483	0.2655	0.3643	0.2414	0.3626	0.2787
6	0.6252	0.4551	0.4783	0.5792	0.4765	0.4619	0.2639	0.3610	0.4604	0.4380	0.4961
7	0.5733	0.7203	0.6844	0.7122	0.5188	0.4873	0.3342	0.2372	0.3034	0.6412	0.3320
8	0.4735	0.4199	0.8945	0.7007	0.6913	0.4819	0.3348	0.2601	0.1961	0.3180	0.4636
9	0.4747	0.3505	0.6724	0.6288	0.6253	0.4907	0.2068	0.4160	0.1670	0.4459	0.1827
10	0.5270	0.4996	0.7308	0.6947	0.6042	0.3929	0.2452	0.2344	0.2786	0.5029	0.5018
11+	0.5270	0.4996	0.7308	0.6947	0.6042	0.3929	0.2452	0.2344	0.2786	0.5029	0.5018
FBAR4-7	0.4381	0.3794	0.4039	0.4506	0.3910	0.4022	0.2683	0.2604	0.2974	0.3946	0.3174

age \ year	2005	2006	2007	FBAR2005-2007
3	0.0394	0.0320	0.0517	0.0411
4	0.1476	0.1871	0.1583	0.1643
5	0.2851	0.3451	0.4495	0.3599
6	0.4432	0.3179	0.3606	0.3739
7	0.6263	0.3520	0.2583	0.4120
8	0.2653	0.4660	0.3826	0.3713
9	0.5786	0.2172	0.2602	0.3520
10	0.5199	0.5352	0.2930	0.4494
11+	0.5199	0.5352	0.2930	
FBAR4-7	0.3756	0.3005	0.3067	

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	77366	640886	70068	1198567	141818	59770	195721	60655	79397	377309
4	96608	53620	410701	45896	817779	97677	42542	128505	42402	56346
5	70483	43035	34488	191277	24920	512863	68205	28576	80238	28472
6	37577	25076	18512	15556	90618	14801	254733	41762	15901	36445
7	46516	13635	8220	6208	7787	49017	7567	92336	22753	7717
8	16065	11963	5003	2484	2488	3450	14550	3316	33416	7094
9	4591	4830	3596	1167	1056	859	1517	4671	1731	11465
10	1975	1968	948	742	572	221	458	835	2041	674
11+	5287	2201	1348	2339	957	218	418	408	1126	1168
TOTAL	356468	797213	552886	1464237	1087995	738876	585712	361064	279005	526689

year

age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	278352	125723	276786	317633	369377	117639	275925	342881	20659	20349
4	257433	168649	78390	167856	207021	249912	80604	178458	236126	14484
5	37864	141628	83506	34852	68707	120795	157550	43963	105149	127596
6	16445	18266	57273	23399	11060	27839	61266	70262	23316	47698
7	17055	7004	7040	16168	6827	3772	11306	23751	34098	12026
8	3465	8321	2497	2867	4861	2398	1569	4052	11418	13803
9	3784	1408	2825	831	1226	1522	1082	758	1855	4560
10	4032	980	440	709	174	250	435	490	423	926
11+	1201	2624	1350	638	1040	1609	550	751	657	316
TOTAL	619629	474603	510106	564954	670295	525736	590285	665365	433701	241758

year

age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	190846	110714	1169542	309565	60878	56064	63755	129300	200448	163796
4	13518	118975	78939	654629	165122	36069	32263	34487	46401	105601
5	9772	8570	72962	42920	288602	94214	16139	13675	7783	20148
6	62767	6165	5778	20218	12884	153491	45525	6894	4407	2614
7	21755	30965	4201	1819	10247	5247	80337	18361	3289	2341
8	6571	10482	16956	1982	1107	4645	2364	29529	7992	1221
9	6834	3559	5817	7768	1237	561	2685	807	14184	4194
10	2260	3771	2166	2375	4829	454	376	977	380	5990
11+	887	1916	3930	2606	4367	3209	3078	943	926	828
TOTAL	315209	295117	1360291	1043881	549273	353954	246521	234973	285810	306733

year

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	28259	12647	15975	9026	12149	293351	530896	116458	55492	26659
4	104315	20044	8795	10880	5572	8728	213370	261366	90795	35857
5	52564	62614	13669	6197	6308	3640	5612	112776	135114	63047
6	6682	22799	30603	7989	3774	3446	2470	3179	33920	67081
7	842	2768	8951	13947	4356	2495	1908	1314	1734	9287
8	1182	463	1331	4953	9151	2707	1190	752	535	1060
9	506	512	232	778	2428	5123	1415	618	275	277
10	2108	206	272	122	396	1669	2599	523	315	158
11+	3613	2731	2192	958	348	790	2214	1657	1582	996
TOTAL	200071	124785	82020	54851	44482	321949	761674	498642	319763	204423

year

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	36593	105390	212217	694414	309492	99989	104955	119816	60981	234078
4	19875	25730	82286	162301	522891	227579	69217	48367	73107	46629
5	24846	13938	17841	56904	112171	377866	144568	45548	32951	47004
6	37076	18404	9225	10898	31544	58111	216326	82925	25171	18144
7	32017	26695	12083	5162	5210	13814	29939	107339	37685	12797
8	4710	20584	17664	7274	2646	2405	5504	12364	43112	18366
9	735	3096	13276	11451	4249	1349	1294	1842	5023	17681
10	226	481	2118	7705	7471	2164	778	541	804	2201
11+	380	311	364	1257	5634	4385	3989	1629	1180	1505
TOTAL	156458	214629	367074	957367	1001308	787662	576569	420371	280015	398405

Table 4.14 (continued).

age	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	96682	393208	392909	248888	257378	367221	160853	664958	0
4	176110	75930	305634	279966	161179	163351	229591	124797	494385
5	30903	116008	57364	206020	189329	104351	105182	152340	85464
6	24581	19256	65980	36568	116503	115301	61346	60082	77853
7	9360	15394	10989	33951	19320	58082	59683	36156	34063
8	6436	5487	9942	6642	14640	11349	25420	34366	22864
9	9287	3770	3463	6691	3957	7539	7126	13060	19191
10	8862	6183	2036	2399	3507	2699	3461	4695	8244
11+	2208	6333	4647	3375	2499	4112	1894	7553	7481
TOTAL	364429	641567	852965	824500	768311	834004	654557	1098008	749544

(year)

age	GMST 50-07	AMST 50-07
3	131895	226944
4	84482	142608
5	49676	84063
6	24272	41688
7	11381	19873
8	5190	8796
9	2380	3966
10		
11+		
TOTAL		

Table 4.15. Northeast Arctic haddock. Spawning stock numbers at age (spawning time). Numbers *10-3**

age	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
3	2166	17945	1962	33560	3971	1674	5480	1698	2223	10565
4	10240	5684	43534	4865	86685	10354	4509	13622	4495	5973
5	22907	13986	11209	62165	8099	166680	22167	9287	26077	9253
6	23861	15924	11755	9878	57542	9399	161756	26519	10097	23143
7	39492	11576	6979	5270	6611	41616	6424	78393	19317	6552
8	15214	11329	4738	2352	2356	3267	13778	3140	31645	6718
9	4513	4747	3535	1147	1038	844	1491	4591	1702	11270
10	1965	1958	944	738	569	220	456	831	2030	670
11+	5287	2201	1348	2339	957	218	418	408	1126	1168

age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	7794	3520	7750	8894	10343	3294	7726	9601	578	570
4	27288	17877	8309	17793	21944	26491	8544	18917	25029	1535
5	12306	46029	27139	11327	22330	39259	51204	14288	34173	41469
6	10442	11599	36368	14859	7023	17678	38904	44616	14806	30288
7	14480	5946	5977	13726	5796	3202	9599	20164	28949	10210
8	3281	7880	2364	2715	4603	2271	1486	3837	10812	13071
9	3719	1384	2777	816	1205	1496	1064	745	1824	4482
10	4012	976	437	705	173	249	433	487	421	922
11+	1201	2624	1350	638	1040	1609	550	751	657	316

age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	5344	3100	32747	8668	1705	1570	1785	3620	5613	4586
4	1433	12611	8368	69391	17503	3823	3420	3656	4919	11194
5	3176	2785	23713	13949	93796	30620	5245	4444	2529	6548
6	39857	3915	3669	12839	8181	97467	28908	4377	2798	1660
7	18470	26290	3567	1544	8700	4455	68206	15588	2792	1988
8	6222	9927	16058	1877	1049	4399	2239	27964	7568	1157
9	6717	3498	5718	7636	1216	551	2639	794	13943	4123
10	2249	3752	2156	2364	4805	451	374	972	378	5960
11+	887	1916	3930	2606	4367	3209	3078	943	926	828

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	706	670	815	496	510	7334	10618	2329	1276	800
4	7719	2004	1381	1947	1087	1274	21337	19341	6628	3155
5	12563	18659	4483	2913	3204	1904	2537	32818	32292	15699
6	4343	12403	17535	5305	3027	2753	1887	2279	19606	35955
7	726	2381	6857	11144	3764	2321	1777	1211	1564	7662
8	1125	440	1263	4488	8438	2582	1165	735	523	1027
9	498	504	229	767	2348	4990	1393	614	273	275
10	2099	205	271	122	394	1652	2578	520	314	158
11+	3613	2731	2192	958	348	790	2214	1657	1582	996

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	1610	4110	6154	11805	4952	1500	1994	2876	1890	9597
4	2484	4143	11849	17853	37125	12972	4707	3482	6653	5362
5	7553	4976	8011	22477	36680	85398	30648	9246	8403	14289
6	21504	11502	6513	8119	22270	36958	107730	41131	12661	10596
7	25678	22023	10379	4553	4726	12294	25718	82007	28377	9764
8	4422	19123	16586	6932	2545	2335	5316	11758	39275	16548
9	729	3037	12984	11222	4185	1333	1283	1824	4948	17168
10	225	479	2107	7651	7426	2153	776	540	802	2192
11+	380	311	364	1257	5634	4385	3989	1629	1180	1505

age	2000	2001	2002	2003	2004	2005	2006	2007
3	2707	11403	8644	5724	6692	9915	3860	10639
4	25360	7517	33314	26037	13378	14865	22270	10358
5	10723	45591	17955	67368	50361	27653	29977	48292
6	15314	12863	46978	23403	74096	67105	36440	36650
7	7498	13223	9714	30522	16345	49776	49238	30407
8	5818	5102	9455	6383	14186	10827	24276	32373
9	8990	3653	3390	6590	3910	7472	7027	12865
10	8783	6121	2016	2382	3493	2691	3451	4677
11+	2208	6333	4647	3375	2499	4112	1894	7553

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	16844	181085	13623	286598	33474	13574	53736	16965	24481	138059
4	38601	27804	146540	20140	354237	40711	21435	65961	23994	37837
5	43766	34679	19123	130442	16775	332187	53405	22794	70559	29711
6	32703	28322	14387	14868	85496	13436	279555	46690	19598	53305
7	52930	20134	8353	7757	9606	58181	10857	134972	36665	14758
8	22843	22075	6352	3879	3835	5117	26088	6057	67289	16951
9	7801	10650	5457	2178	1946	1523	3251	10196	4166	32741
10	3871	5006	1660	1598	1215	451	1132	2103	5665	2219
11+	11701	6322	2664	5686	2295	503	1168	1159	3529	4342
TOTBIO	231059	336078	218158	473147	508880	465684	450626	306897	255945	329924

age \ year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	91922	43473	90789	96177	94760	35263	82304	119799	7233	8024
4	156017	107020	47188	93275	97466	137481	44123	114426	151725	10481
5	35662	139667	78117	30097	50269	103269	134027	43806	104997	143490
6	21707	25246	75092	28321	11342	33357	73048	98126	32632	75179
7	29435	12656	12068	25585	9153	5909	17625	43368	62396	24783
8	7472	18790	5348	5670	8144	4694	3056	9245	26108	35544
9	9752	3799	7232	1963	2455	3561	2519	2067	5069	14031
10	11987	3052	1298	1932	402	676	1167	1540	1334	3288
11+	4031	9224	4502	1964	2713	4901	1667	2666	2338	1268
TOTBIO	367985	362928	321633	284984	276705	329112	359536	435043	393832	316088

age \ year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	68021	49133	369394	91963	23549	21478	19285	38455	75170	74461
4	8842	96897	45756	356892	117218	25359	17910	18823	31934	88099
5	9933	10846	65723	36363	318381	102938	13923	11599	8324	26121
6	89423	10936	7295	24008	19921	235050	55045	8195	6606	4749
7	40523	71819	6935	2824	20715	10506	127004	28539	6446	5562
8	15294	30379	34976	3845	2797	11622	4670	57355	19573	3626
9	19009	12327	14338	18009	3735	1677	6338	1874	41514	14881
10	7252	15065	6160	6353	16816	1565	1024	2615	1281	24513
11+	3212	8642	12617	7869	17170	12496	9463	2852	3529	3828
TOTBIO	261509	306044	563194	548125	540301	422692	254662	170308	194377	245841

age \ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	16200	10249	13419	4400	4331	109553	154503	38374	21109	11941
4	115847	21577	12365	11161	4704	6031	136530	148277	54404	24895
5	78712	110410	22225	9080	9426	5019	5634	118072	119336	59625
6	14480	49301	72945	12452	7285	7515	4416	4686	49161	84678
7	2498	8027	24600	29499	8489	6553	4980	3179	3281	17679
8	4798	1731	4635	11581	22864	6939	3555	2504	1564	2494
9	2176	2463	997	2210	6507	16124	4031	2270	1058	959
10	9747	1042	1435	413	1246	5515	8796	1803	1292	696
11+	18978	14683	12061	3822	1265	2988	7749	6608	6045	4564
TOTBIO	263435	219484	164682	84619	66117	166236	330193	325774	257249	207532

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	14554	39975	71016	189534	79642	27216	30508	37109	20460	75932
4	15132	17922	58606	98101	263398	106572	35006	24998	42478	28389
5	25335	15754	19783	61617	105096	292336	107045	35051	27430	42171
6	47131	25479	14929	16517	47262	74721	238142	84298	28291	21210
7	50812	43537	22607	10617	10152	26199	50452	150418	52088	18910
8	10578	39944	37442	16634	6630	5618	12879	24926	77723	31703
9	1954	8084	32306	28869	11521	3895	3581	4925	12407	38133
10	850	1435	6661	21687	21897	6629	2579	1657	2538	6251
11+	1764	1273	1272	4424	18047	14315	13834	5830	4164	5303
TOTBIO	168109	193402	264621	447999	563645	557502	494026	369212	267579	268003

age \ year	2000	2001	2002	2003	2004	2005	2006	2007
3	27527	116635	116714	68512	74974	117878	51932	202646
4	103354	40813	164687	152215	81771	88962	135209	73578
5	28940	108544	47723	171750	161197	84520	89823	139580
6	30684	25913	85626	42557	136318	141171	70544	72343
7	14295	25773	19097	57006	29461	90508	96523	54769
8	11849	10748	20458	14185	30381	21937	49445	69478
9	19210	8601	8073	16314	10053	18957	16567	30385
10	22152	15379	5387	6466	9887	8065	10091	12696
11+	7035	18519	13090	10117	7643	13338	6417	24867
TOTBIO	265047	370924	480855	539122	541687	585335	526550	680342

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	472	5070	381	8025	937	380	1505	475	685	3866
4	4092	2947	15533	2135	37549	4315	2272	6992	2543	4011
5	14224	11271	6215	42394	5452	107961	17357	7408	22932	9656
6	20766	17984	9136	9441	54290	8532	177517	29648	12445	33849
7	44937	17094	7092	6586	8155	49396	9218	114592	31129	12530
8	21633	20905	6016	3673	3632	4846	24705	5736	63722	16053
9	7668	10469	5364	2141	1913	1497	3196	10022	4095	32184
10	3851	4981	1651	1590	1209	449	1127	2092	5636	2208
11+	11701	6322	2664	5686	2295	503	1168	1159	3529	4342
TOTSP	129344	97044	54052	81671	115433	177878	238063	178124	146717	118698

age \ year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	2574	1217	2542	2693	2653	987	2305	3354	203	225
4	16538	11344	5002	9887	10331	14573	4677	12129	16083	1111
5	11590	45392	25388	9782	16337	33562	43559	14237	34124	46634
6	13784	16031	47683	17984	7202	21182	46385	62310	20721	47739
7	24991	10745	10245	21722	7771	5017	14963	36820	52974	21041
8	7076	17794	5064	5369	7712	4446	2894	8755	24724	33660
9	9586	3735	7109	1929	2414	3501	2476	2031	4983	13793
10	11927	3037	1292	1922	400	672	1162	1532	1328	3271
11+	4031	9224	4502	1964	2713	4901	1667	2666	2338	1268
TOTSP	102096	118520	108828	73252	57534	88841	120088	143835	157477	168742

age \ year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	1905	1376	10343	2575	659	601	540	1077	2105	2085
4	937	10271	4850	37831	12425	2688	1898	1995	3385	9339
5	3228	3525	21360	11818	103474	33455	4525	3770	2705	8489
6	56783	6944	4632	15245	12650	149257	34953	5204	4195	3016
7	34404	60974	5887	2398	17587	8919	107826	24230	5473	4722
8	14484	28769	33122	3641	2649	11006	4423	54315	18536	3434
9	18685	12117	14095	17703	3671	1649	6231	1842	40808	14628
10	7215	14990	6130	6321	16731	1557	1019	2602	1275	24391
11+	3212	8642	12617	7869	17170	12496	9463	2852	3529	3828
TOTSP	140855	147608	113036	105400	187017	221629	170878	97887	82011	73932

age \ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3	405	543	684	242	182	2739	3090	767	486	358
4	8573	2158	1941	1998	917	881	13653	10972	3971	2191
5	18812	32902	7290	4268	4788	2625	2547	34359	28521	14847
6	9412	26820	41798	8268	5842	6004	3373	3360	28415	45388
7	2153	6903	18844	23570	7335	6094	4637	2931	2959	14585
8	4568	1646	4399	10492	21080	6619	3480	2449	1528	2414
9	2143	2426	981	2177	6292	15704	3970	2254	1050	952
10	9708	1038	1429	411	1241	5460	8725	1792	1290	694
11+	18978	14683	12061	3822	1265	2988	7749	6608	6045	4564
TOTSP	74751	89119	89426	55249	48944	49114	51225	65494	74266	85993

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	640	1559	2059	3222	1274	408	580	891	634	3113
4	1891	2885	8439	10791	18701	6075	2380	1800	3866	3265
5	7702	5624	8882	24339	34367	66068	22693	7115	6995	12820
6	27336	15924	10540	12305	33367	47523	118595	41812	14230	12387
7	40751	35918	19419	9364	9207	23317	43339	114920	39222	14429
8	9933	37108	35158	15852	6378	5455	12441	23705	70806	28565
9	1936	7930	31595	28291	11348	3848	3553	4875	12220	37028
10	847	1431	6628	21535	21766	6596	2571	1653	2531	6226
11+	1764	1273	1272	4424	18047	14315	13834	5830	4164	5303
TOTSP	92801	109653	123993	130123	154456	173605	219986	202600	154668	123134

age \ year	2000	2001	2002	2003	2004	2005	2006	2007
3	771	3382	2568	1576	1949	3183	1246	3242
4	14883	4040	17951	14156	6787	8096	13115	6107
5	10042	42658	14937	56162	42878	22398	25599	44247
6	19116	17310	60966	27237	86699	82161	41903	44129
7	11451	22139	16882	51249	24924	77566	79632	46061
8	10711	9995	19456	13632	29439	20928	47220	65448
9	18596	8334	7903	16069	9932	18786	16335	29929
10	21953	15225	5333	6421	9847	8040	10061	12645
11+	7035	18519	13090	10117	7643	13338	6417	24867
TOTSP	114557	141604	159085	196618	220100	254495	241528	276676

Table 4.18N. Northeast Arctic haddock. Summary.

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR4_7
1950	77366	231059	129344	132125	1,0215	0,6082	0,8416
1951	640886	336078	97044	120077	1,2373	0,7893	0,6388
1952	70068	218158	54052	127660	2,3618	0,5431	0,7506
1953	1198567	473147	81671	123920	1,5173	0,6679	0,5292
1954	141818	508880	115433	156788	1,3583	0,6593	0,3922
1955	59770	465684	177878	202286	1,1372	0,6344	0,5243
1956	195721	450626	238063	213924	0,8986	0,7669	0,4702
1957	60655	306897	178124	123583	0,6938	0,7813	0,4584
1958	79397	255945	146717	112672	0,768	0,8613	0,5571
1959	377309	329924	118698	88211	0,7432	1,0221	0,4148
1960	278352	367985	102096	154651	1,5148	0,9224	0,5126
1961	125723	362928	118520	193224	1,6303	0,9659	0,6865
1962	276786	321633	108828	187408	1,7221	0,9162	0,8496
1963	317633	284984	73252	146224	1,9962	0,8458	0,9068
1964	369377	276705	57534	99158	1,7235	0,7166	0,6792
1965	117639	329112	88841	118578	1,3347	0,8373	0,5178
1966	275925	359536	120088	161778	1,3472	0,8332	0,635
1967	342881	435043	143835	136397	0,9483	0,9759	0,4428
1968	20659	393832	157477	181726	1,154	0,978	0,5313
1969	20349	316088	168742	130820	0,7753	1,1014	0,4113
1970	190846	261509	140855	88257	0,6266	0,9956	0,3764
1971	110714	306044	147608	78905	0,5346	1,2396	0,2554
1972	1169542	563194	113036	266153	2,3546	0,8822	0,7381
1973	309565	548125	105400	322226	3,0572	0,8298	0,5877
1974	60878	540301	187017	221157	1,1826	1,0805	0,5086
1975	56064	422692	221629	175758	0,793	1,0701	0,5322
1976	63755	254662	170878	137264	0,8033	0,8449	0,6926
1977	129300	170308	97887	110158	1,1254	0,8308	0,8364
1978	200448	194377	82011	95422	1,1635	1,0475	0,6753
1979	163796	245841	73932	103623	1,4016	1,2698	0,6926
1980	28259	263435	74751	87889	1,1757	1,2854	0,4943
1981	12647	219484	89119	77153	0,8657	1,3575	0,4797
1982	15975	164682	89426	46955	0,5251	1,3505	0,3543
1983	9026	84619	55249	24600	0,4453	0,9447	0,3054
1984	12149	66117	48944	20945	0,4279	0,9236	0,28
1985	293351	166236	49114	45052	0,9173	0,9985	0,3403
1986	530896	330193	51225	100563	1,9632	0,948	0,4923
1987	116458	325774	65494	154916	2,3653	1,0077	0,6413
1988	55492	257249	74266	95255	1,2826	1,0037	0,5124
1989	26659	207532	85993	58518	0,6805	1,018	0,3791
1990	36593	168109	92801	27182	0,2929	0,9748	0,1563
1991	105390	193402	109653	36216	0,3303	0,9554	0,2031
1992	212217	264621	123993	59922	0,4833	0,9989	0,2874
1993	694414	447999	130123	82379	0,6331	0,9925	0,3681
1994	309492	563645	154456	135186	0,8752	0,9936	0,4381
1995	99989	557502	173605	142448	0,8205	0,9756	0,3794
1996	104955	494026	219986	178128	0,8097	0,982	0,4039
1997	119816	369212	202600	154359	0,7619	0,9501	0,4506
1998	60981	267579	154668	100630	0,6506	0,9782	0,391
1999	234078	268003	123134	83195	0,6756	0,9741	0,4022
2000	96682	265047	114557	68944	0,6018	0,9684	0,2683
2001	393208	370924	141604	89640	0,633	0,9954	0,2604
2002	392909	480855	159085	114798	0,7216	0,9869	0,2974
2003	248888	539122	196618	138926	0,7066	0,9796	0,3946
2004	257378	541687	220100	158279	0,7191	0,9775	0,3174
2005	367221	585335	254495	158298	0,622	0,9938	0,3756
2006	160853	526550	241528	153157	0,6341	0,9965	0,3005
2007	664958	680342	276676	161383	0,5833	0,9959	0,3067
Mean	226944	348286	130858	125259	1,0539	0,9487	0,4815
Units	Thousands	Tonnes	Tonnes	Tonnes			

Table 4.18R. Northeast Arctic haddock. Summary.

YEAR	RECR_a3	TOTBIO	TOTSPB	LANDINGS	YIELDSSB	SOPCOFAC	FBAR4_7
1950	77315	231032	129339	132125	1,0215	0,6082	0,8417
1951	640517	335959	97037	120077	1,2374	0,7893	0,6389
1952	70025	218113	54047	127660	2,362	0,5431	0,7506
1953	1197792	472931	81657	123920	1,5176	0,6679	0,5292
1954	141720	508752	115418	156788	1,3584	0,6593	0,3922
1955	59729	465599	177856	202286	1,1374	0,6344	0,5243
1956	195599	450560	238049	213924	0,8987	0,7669	0,4702
1957	60614	306860	178119	123583	0,6938	0,7813	0,4584
1958	79343	255908	146711	112672	0,768	0,8613	0,5572
1959	377078	329820	118690	88211	0,7432	1,0221	0,4148
1960	278201	367891	102088	154651	1,5149	0,9224	0,5126
1961	125655	362858	118508	193224	1,6305	0,9659	0,6865
1962	276639	321560	108820	187408	1,7222	0,9162	0,8497
1963	317437	284900	73246	146224	1,9963	0,8458	0,9069
1964	369141	276610	57527	99158	1,7237	0,7166	0,6792
1965	117565	329032	88829	118578	1,3349	0,8373	0,5178
1966	275757	359447	120075	161778	1,3473	0,8332	0,6351
1967	342667	434924	143823	136397	0,9484	0,9759	0,4428
1968	20645	393769	157466	181726	1,1541	0,978	0,5313
1969	20335	316049	168730	130820	0,7753	1,1014	0,4113
1970	190735	261460	140849	88257	0,6266	0,9956	0,3765
1971	110646	305988	147603	78905	0,5346	1,2396	0,2554
1972	1168926	562980	113026	266153	2,3548	0,8822	0,7382
1973	309399	547991	105388	322226	3,0575	0,8298	0,5878
1974	60845	540196	186993	221157	1,1827	1,0805	0,5087
1975	56035	422643	221613	175758	0,7931	1,0701	0,5322
1976	63726	254644	170875	137264	0,8033	0,8449	0,6927
1977	129249	170288	97885	110158	1,1254	0,8308	0,8364
1978	200346	194331	82008	95422	1,1636	1,0475	0,6753
1979	163697	245773	73927	103623	1,4017	1,2698	0,6926
1980	28240	263380	74745	87889	1,1758	1,2854	0,4944
1981	12639	219449	89111	77153	0,8658	1,3575	0,4797
1982	15967	164665	89423	46955	0,5251	1,3505	0,3543
1983	9023	84616	55248	24600	0,4453	0,9447	0,3054
1984	12155	66121	48945	20945	0,4279	0,9236	0,2799
1985	293358	166242	49117	45052	0,9172	0,9985	0,3402
1986	530927	330210	51228	100563	1,963	0,948	0,4922
1987	116493	325806	65500	154916	2,3651	1,0077	0,6412
1988	55487	257290	74278	95255	1,2824	1,0037	0,5123
1989	26657	207588	86021	58518	0,6803	1,018	0,3789
1990	36586	168163	92843	27182	0,2928	0,9748	0,1563
1991	105353	193439	109703	36216	0,3301	0,9554	0,2031
1992	212040	264590	124041	59922	0,4831	0,9989	0,2875
1993	693127	447577	130144	82379	0,633	0,9925	0,3683
1994	308598	562792	154396	135186	0,8756	0,9936	0,4386
1995	99890	556333	173330	142448	0,8218	0,9756	0,3801
1996	104620	492555	219366	178128	0,812	0,982	0,4054
1997	119233	367485	201585	154359	0,7657	0,9501	0,4533
1998	60449	265470	153272	100630	0,6565	0,9782	0,3938
1999	229413	264203	121373	83195	0,6854	0,9741	0,4051
2000	94205	259719	112237	68944	0,6143	0,9684	0,2722
2001	355165	353586	138139	89640	0,6489	0,9954	0,2667
2002	350064	445869	153083	101372	0,6622	0,9877	0,277
2003	228866	499070	187970	115117	0,6124	0,9774	0,3646
2004	240086	509206	211455	133163	0,6297	0,976	0,2777
2005	346761	568216	252414	127964	0,507	0,9961	0,2964
2006	156896	534971	255155	140655	0,5513	0,9983	0,2629
2007	612267	686433	300413	149932	0,4991	0,998	0,2778
Mean	223309	345757	130875	123248	1,0458	0,9487	0,4778
Units	Thousands	Tonnes	Tonnes	Tonnes			

Table 4.19. Northeast Arctic haddock. Prediction with management option table: Input data

Fbar age range: 4-7

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	978000	0,2989	0,014	0	0	0,31	0,0411	0,678
4	494385	0,2453	0,072	0	0	0,562	0,1643	0,9115
5	85464	0,2276	0,289	0	0	0,919	0,3599	1,1682
6	77853	0,211	0,633	0	0	1,292	0,3739	1,4535
7	34063	0,2	0,846	0	0	1,588	0,4122	1,7639
8	22864	0,2	0,944	0	0	1,904	0,3713	2,0575
9	19191	0,2	0,981	0	0	2,442	0,352	2,2921
10	8244	0,2	0,996	0	0	2,714	0,4494	2,4604
11	7481	0,2	1	0	0	3,086	0,4494	2,8604

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	834000	0,2989	0,0208	0	0	0,3098	0,0411	0,678
4	NA	0,2453	0,0798	0	0	0,5677	0,1643	0,9115
5	NA	0,2276	0,2587	0	0	0,8813	0,3599	1,1682
6	NA	0,211	0,5604	0	0	1,234	0,3739	1,4535
7	NA	0,2	0,8037	0	0	1,6201	0,4122	1,7639
8	NA	0,2	0,9257	0	0	2,0306	0,3713	2,0575
9	NA	0,2	0,9764	0	0	2,4303	0,352	2,2921
10	NA	0,2	0,9926	0	0	2,8234	0,4494	2,4604
11	NA	0,2	1	0	0	3,2035	0,4494	2,8604

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	202000	0,2989	0,0208	0	0	0,3098	0,0411	0,678
4	NA	0,2453	0,0798	0	0	0,5677	0,1643	0,9115
5	NA	0,2276	0,2587	0	0	0,8813	0,3599	1,1682
6	NA	0,211	0,5604	0	0	1,234	0,3739	1,4535
7	NA	0,2	0,8037	0	0	1,6201	0,4122	1,7639
8	NA	0,2	0,9257	0	0	2,0306	0,3713	2,0575
9	NA	0,2	0,9764	0	0	2,4303	0,352	2,2921
10	NA	0,2	0,9926	0	0	2,8234	0,4494	2,4604
11	NA	0,2	1	0	0	3,2035	0,4494	2,8604

Table 4.20. Northeast Arctic haddock. Prediction with management option table for 2008-2010

Fbar	age	range:	4-7	
Biomass2008	SSB2008	FMult	FBar2008	Landings2008
950101	288820	1	0,3276	201999

Biomass2009	SSB2009	FMult	FBar2009	Landings2009	Biomass2010	SSB2010
1198166	323703	0	0	0	1467898	567143
1198166	323703	0,1	0,0328	32600	1437441	549528
1198166	323703	0,2	0,0655	64285	1407904	532528
1198166	323703	0,3	0,0983	95085	1379256	516123
1198166	323703	0,4	0,131	125030	1351466	500289
1198166	323703	0,5	0,1638	154146	1324505	485006
1198166	323703	0,6	0,1965	182462	1298345	470254
1198166	323703	0,7	0,2293	210004	1272958	456013
1198166	323703	0,8	0,2621	236796	1248320	442265
1198166	323703	0,9	0,2948	262864	1224403	428992
1198166	323703	1	0,3276	288230	1201184	416176
1198166	323703	1,1	0,3603	312918	1178640	403800
1198166	323703	1,2	0,3931	336949	1156747	391849
1198166	323703	1,3	0,4259	360345	1135485	380308
1198166	323703	1,4	0,4586	383125	1114831	369160
1198166	323703	1,5	0,4914	405310	1094766	358393
1198166	323703	1,6	0,5241	426918	1075270	347992
1198166	323703	1,7	0,5569	447968	1056324	337944
1198166	323703	1,8	0,5896	468478	1037910	328236
1198166	323703	1,9	0,6224	488465	1020010	318856
1198166	323703	2	0,6552	507944	1002608	309792

Table 4.21. Northeast Arctic haddock. Prediction single option table for 2008-2010

Year:	2008	Fbar=0,328					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0,0411	34927	23681	978000	303180	13692	4245
4	0,1643	67449	61480	494385	277844	35596	20005
5	0,3599	23322	27244	85464	78541	24699	22698
6	0,3739	22078	32090	77853	100586	49281	63671
7	0,4122	10500	18522	34063	54092	28817	45761
8	0,3713	6467	13306	22864	43533	21584	41095
9	0,352	5191	11899	19191	46865	18827	45975
10	0,4494	2725	6704	8244	22373	8211	22284
11	0,4494	2473	7073	7481	23087	7481	23087
Total		175132	201999	1727545	950101	208188	288821

Year:	2009	Fbar=0,35					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0,0439	30983	21006	834000	258412	17386	5387
4	0,1756	99794	90962	696140	395233	55517	31520
5	0,3846	94409	110287	328210	289243	84917	74835
6	0,3996	14202	20643	47494	58607	26615	32844
7	0,4405	14110	24888	43377	70275	34860	56478
8	0,3968	5518	11354	18467	37500	17096	34716
9	0,3762	3692	8463	12913	31383	12608	30641
10	0,4803	3850	9473	11050	31200	10969	30969
11	0,4803	2862	8186	8214	26314	8214	26314
Total		269420	305262	1999865	1198167	268182	323704

Year:	2010	Fbar=0,35					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos	SSB
3	0,0439	7504	5088	202000	62589	4211	1305
4	0,1756	84861	77350	591968	336090	47209	26803
5	0,3846	131444	153550	456962	402708	118228	104191
6	0,3996	53209	77339	177937	219574	99716	123049
7	0,4405	8389	14798	25791	41784	20727	33580
8	0,3968	6831	14055	22860	46421	21163	42974
9	0,3762	2907	6664	10168	24710	9927	24126
10	0,4803	2529	6222	7258	20492	7204	20341
11	0,4803	3400	9724	9757	31257	9757	31257
Total		301074	364790	1504701	1185625	338142	407626

Table 4.22. Northeast Arctic haddock.Yield per recruit. Input data and results.

MFYPR version 2a
Run: test
North-East Arctic haddock
Time and date: 14:28 28.04.2008
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0,2447	0,016	0	0	0,317667	3,84E-02	0,704667
4	0,2203	0,083	0	0	0,577	0,153845	0,955
5	0,2218	0,317	0	0	0,864	0,336929	1,204667
6	0,207	0,61	0	0	1,198333	0,350035	1,424667
7	0,2	0,841	0	0	1,570667	0,385891	1,658667
8	0,2	0,942	0	0	1,975667	0,347601	1,987
9	0,2	0,985	0	0	2,399667	0,329533	2,209
10	0,2	0,996	0	0	2,882667	0,420685	2,468
11	0,2	1	0	0	3,323	0,420685	2,871667

Weights in kilograms

MFYPR version 2a
Run: test
Time and date: 14:28 28.04.2008
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5,1711	7,8944	2,7544	6,4087	2,7544	6,4087
0,1	0,0307	0,1082	0,2	4,6365	6,3797	2,2494	4,9299	2,2494	4,9299
0,2	0,0613	0,1865	0,3272	4,2514	5,3384	1,8923	3,9221	1,8923	3,9221
0,3	0,092	0,2462	0,4124	3,9591	4,5845	1,6267	3,1996	1,6267	3,1996
0,4	0,1227	0,2935	0,4717	3,7285	4,0174	1,4214	2,6619	1,4214	2,6619
0,5	0,1533	0,3321	0,5142	3,5413	3,5778	1,2583	2,2501	1,2583	2,2501
0,6	0,184	0,3643	0,5455	3,3859	3,2291	1,1258	1,9274	1,1258	1,9274
0,7	0,2147	0,3917	0,569	3,2543	2,9468	1,0162	1,6697	1,0162	1,6697
0,8	0,2453	0,4153	0,5871	3,1413	2,7146	0,9242	1,4607	0,9242	1,4607
0,9	0,276	0,4359	0,6012	3,0431	2,5208	0,846	1,2889	0,846	1,2889
1	0,3067	0,4542	0,6124	2,9567	2,3572	0,7788	1,146	0,7788	1,146
1,1	0,3373	0,4705	0,6214	2,8801	2,2175	0,7206	1,026	0,7206	1,026
1,2	0,368	0,4851	0,6288	2,8116	2,097	0,6698	0,9243	0,6698	0,9243
1,3	0,3987	0,4983	0,6349	2,7499	1,9923	0,6251	0,8373	0,6251	0,8373
1,4	0,4293	0,5103	0,6399	2,694	1,9005	0,5855	0,7625	0,5855	0,7625
1,5	0,46	0,5214	0,6442	2,643	1,8195	0,5503	0,6976	0,5503	0,6976
1,6	0,4907	0,5315	0,6478	2,5963	1,7476	0,5187	0,6411	0,5187	0,6411
1,7	0,5213	0,5409	0,651	2,5533	1,6833	0,4904	0,5915	0,4904	0,5915
1,8	0,552	0,5496	0,6537	2,5136	1,6255	0,4648	0,5478	0,4648	0,5478
1,9	0,5827	0,5577	0,656	2,4768	1,5733	0,4416	0,5091	0,4416	0,5091
2	0,6134	0,5653	0,6581	2,4425	1,526	0,4205	0,4747	0,4205	0,4747

Reference point	F multiplier	Absolute F
Fbar(4-7)	1	0,3067
FMax	6,1483	1,8855
F0.1	0,6223	0,1909
F35%SPR	0,5019	0,1539
Fmed	2,4934	0,7647
Fhigh	1,9542	0,5993

Weights in kilograms

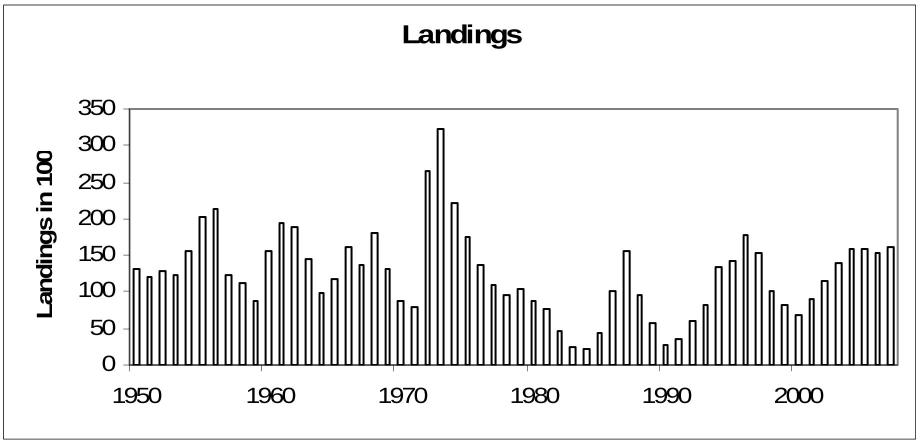


Figure 4.1A Landings of Northeast Arctic Haddock 1950-2007

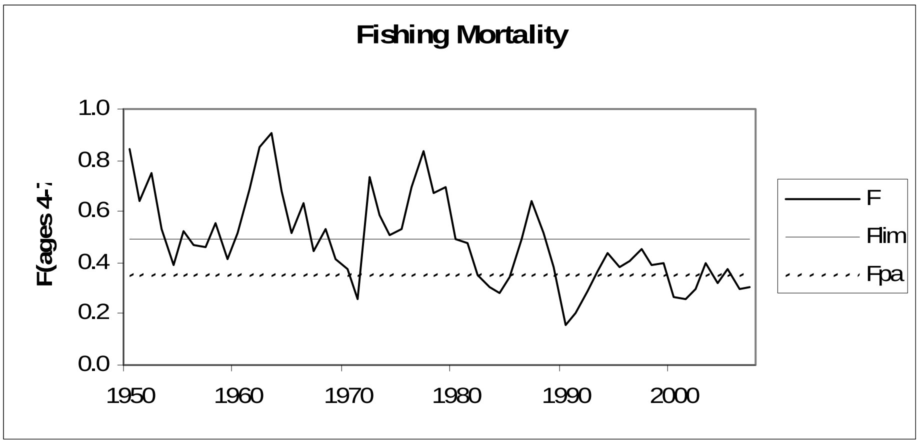


Figure 4.1B Fishing mortality of Northeast Arctic Haddock 1950-2007

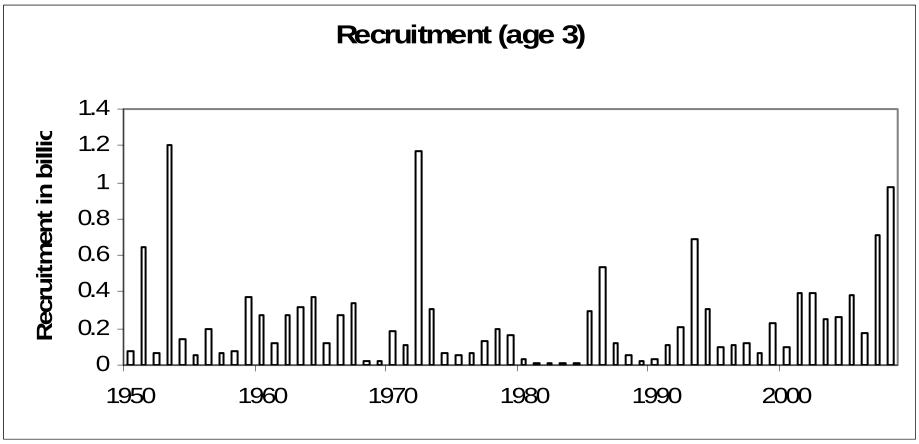


Figure 4.1C Recruitment of Northeast Arctic Haddock 1950-2008

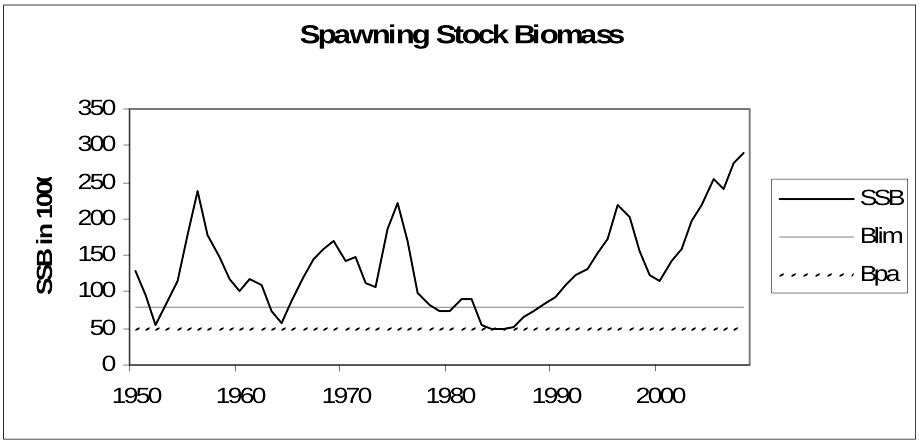


Figure 4.1D Spawning stock biomass of Northeast Arctic haddock 1950-2008

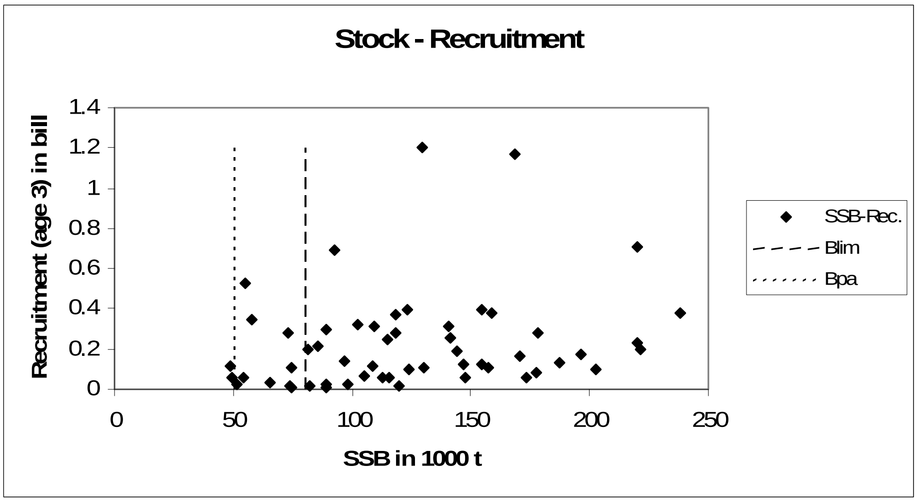


Figure 4.2 Northeast Arctic haddock

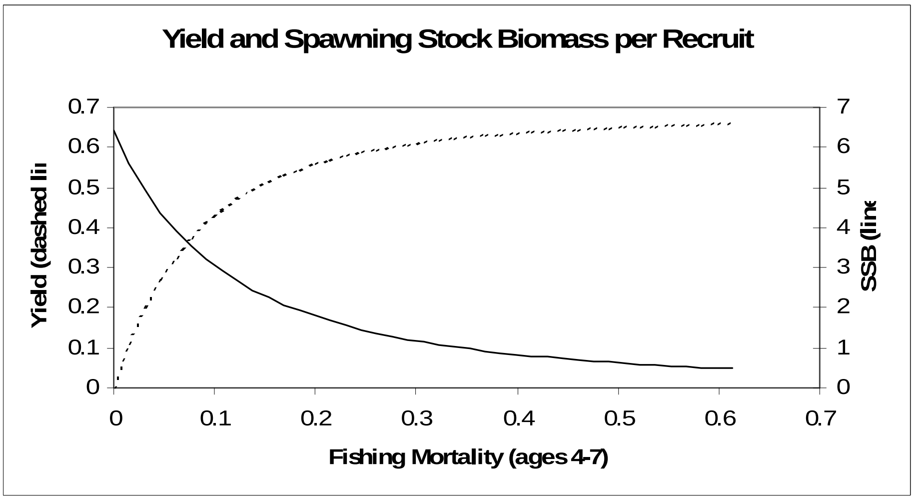


Figure 4.3 Northeast Arctic haddock

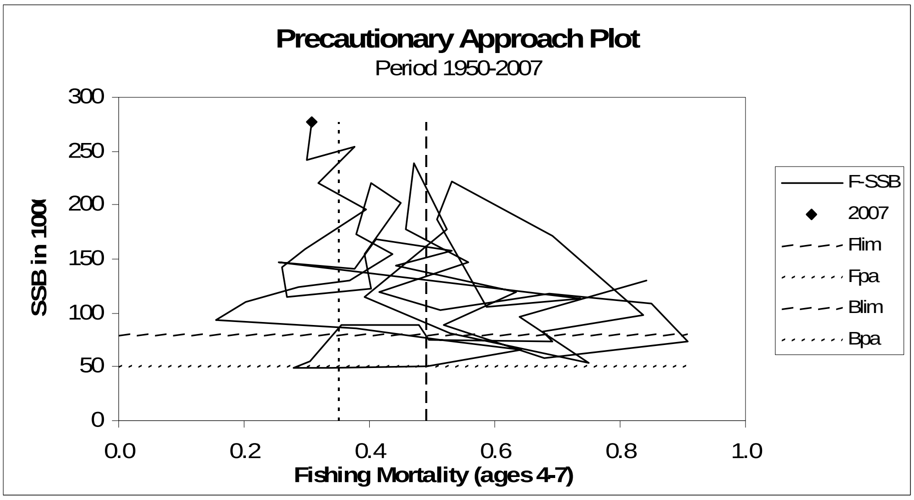


Figure 4.4 Northeast Arctic haddock

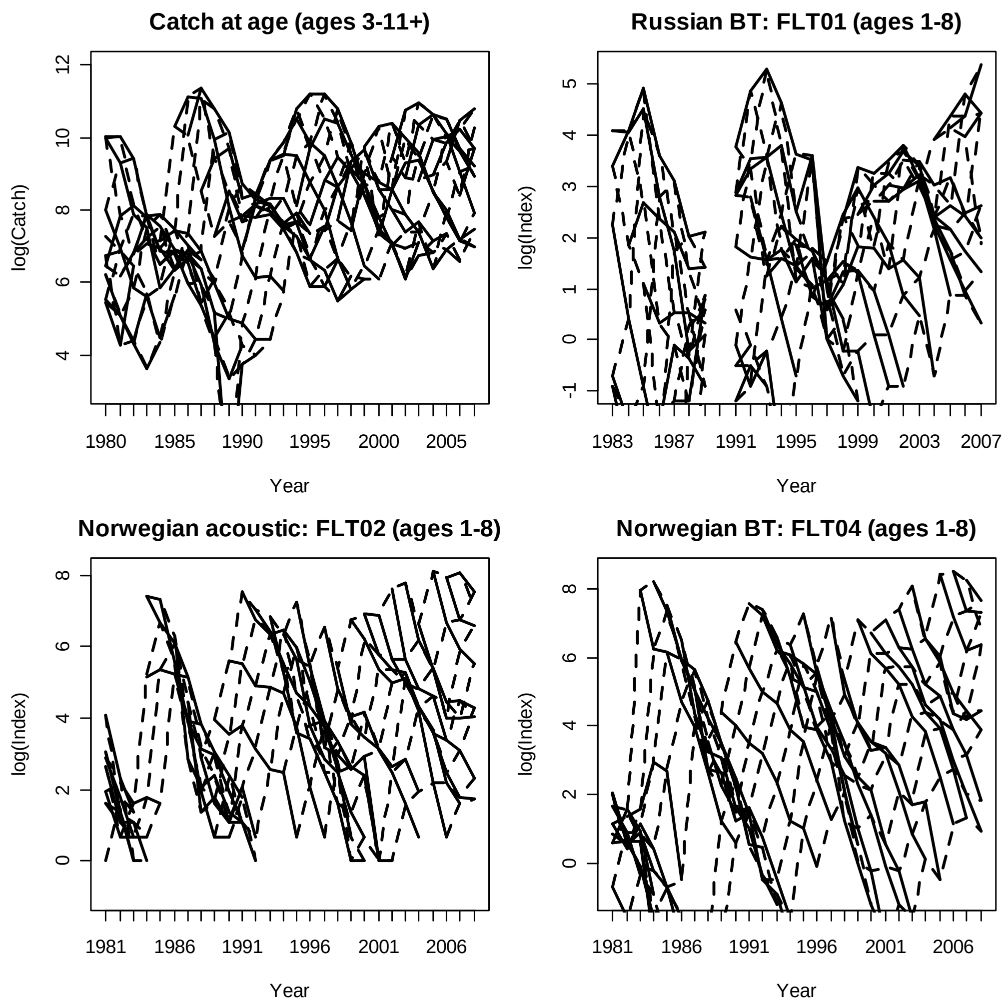


Figure 4.5. Northeast Arctic haddock. Surface of log catch (ages 3-11+) and survey indices (ages 1-8) used for tuning of the XSA and fitting the stochastic time series model. Solid lines trace cohorts, while dotted follow age. The year 1990 is removed from the Russian bottom trawl series.

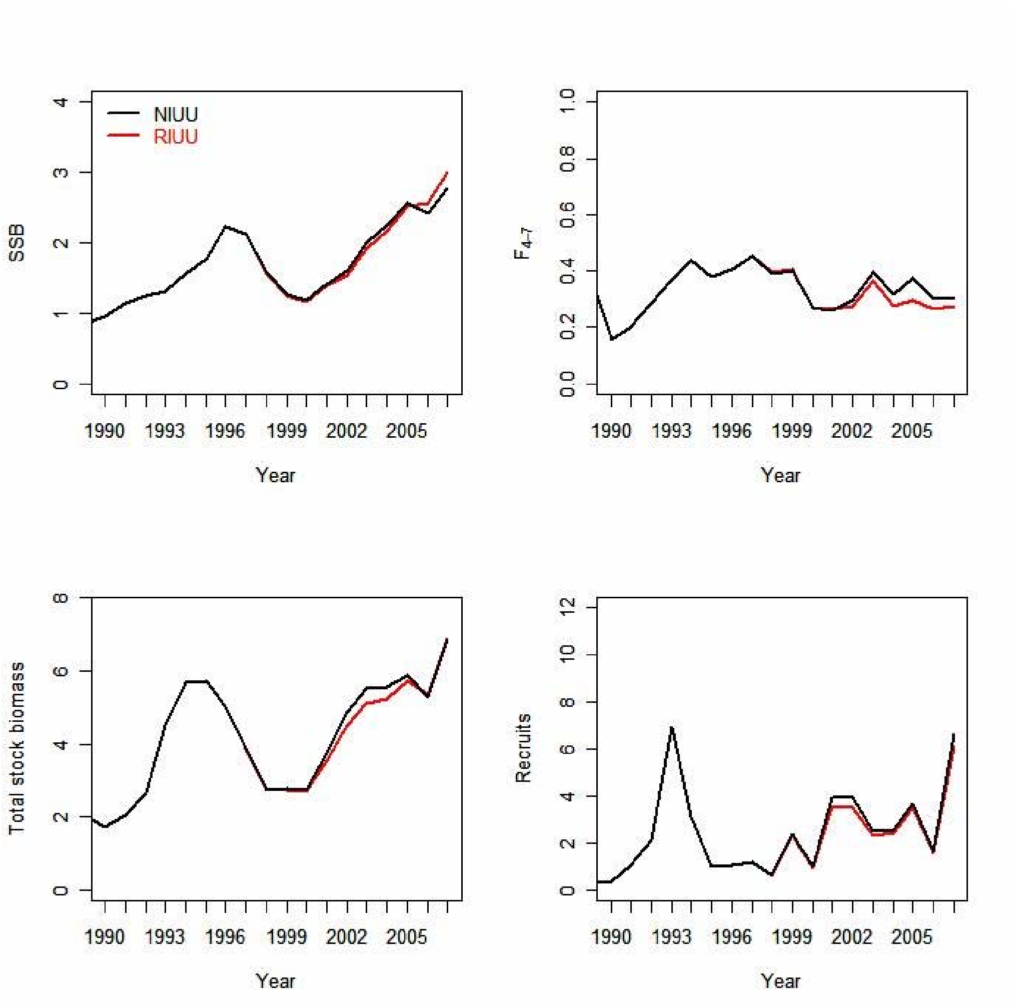


Figure 4.6. Northeast Arctic haddock. Dynamics of spawning stock biomass fishing mortality, total stock biomass and recruitment in two runs corresponding to different estimates of IUU catches of haddock and different numbers of eaten haddock by cod (N IUU and R IUU catches of cod and haddock, respectively).

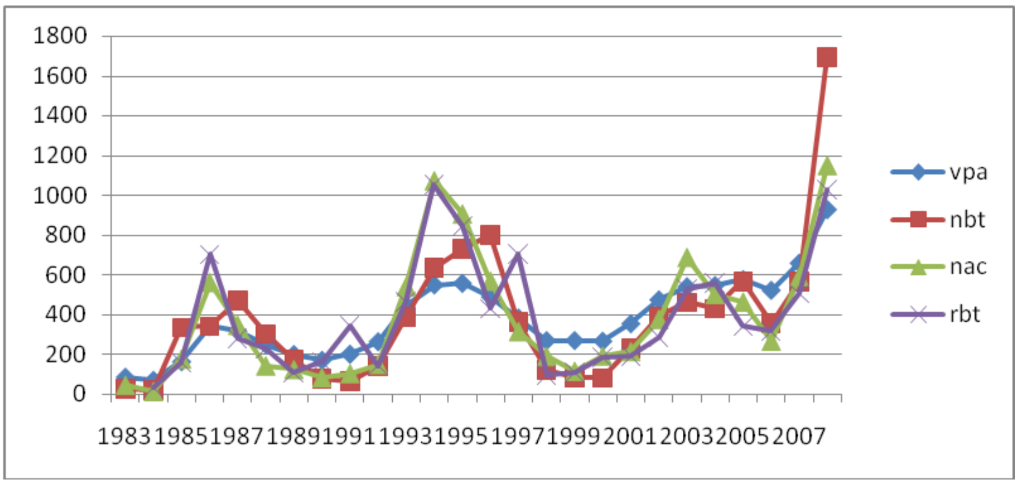


Figure 4.7. Northeast Arctic haddock. Comparing survey trends in biomass 3-10 years with XSA. The surveys are adjusted with catchability derived from XSA.

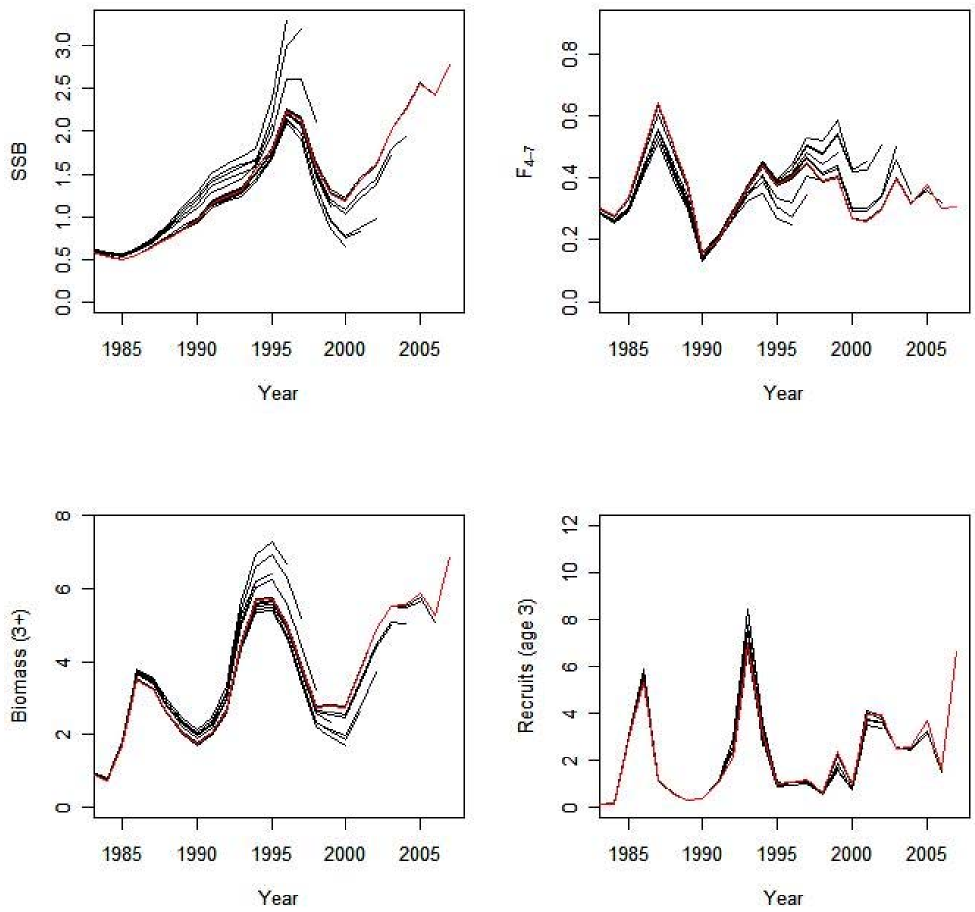
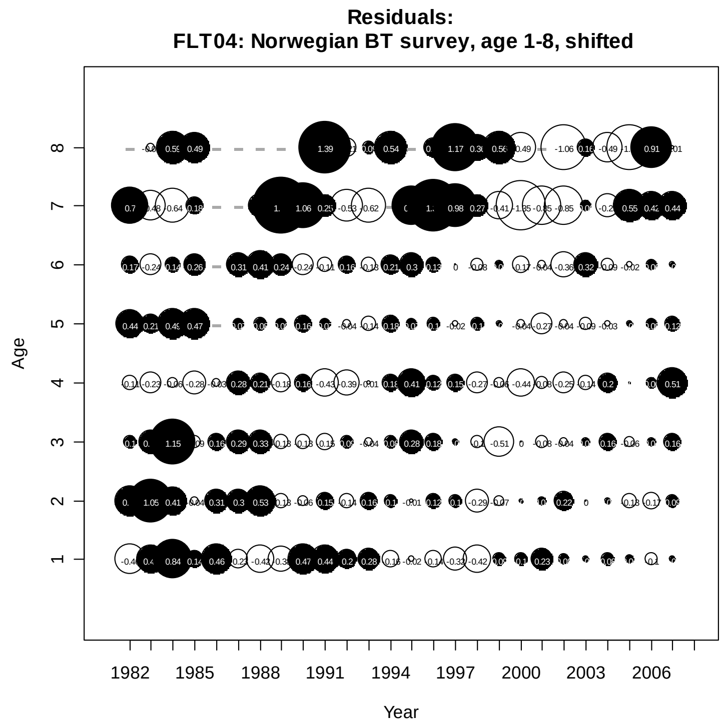


Figure 4.8. Retrospective plots for assessment years 1994-2008 using standard settings in the XSA runs and keeping weight, maturity and natural mortality as estimated in 2008 for all runs.



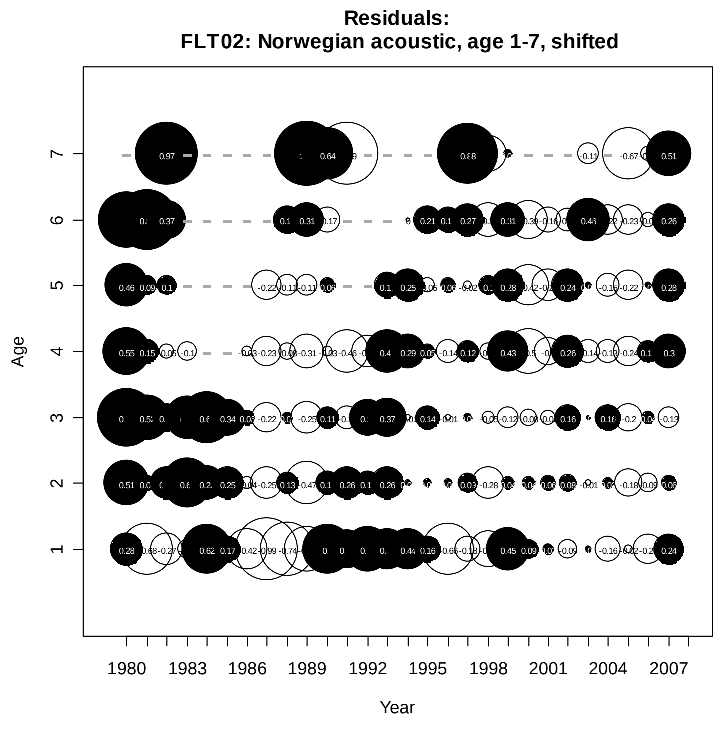


Figure 4.9. Northeast Arctic haddock; log catchability residuals plot, fleets combined, with shrinkage 0.5

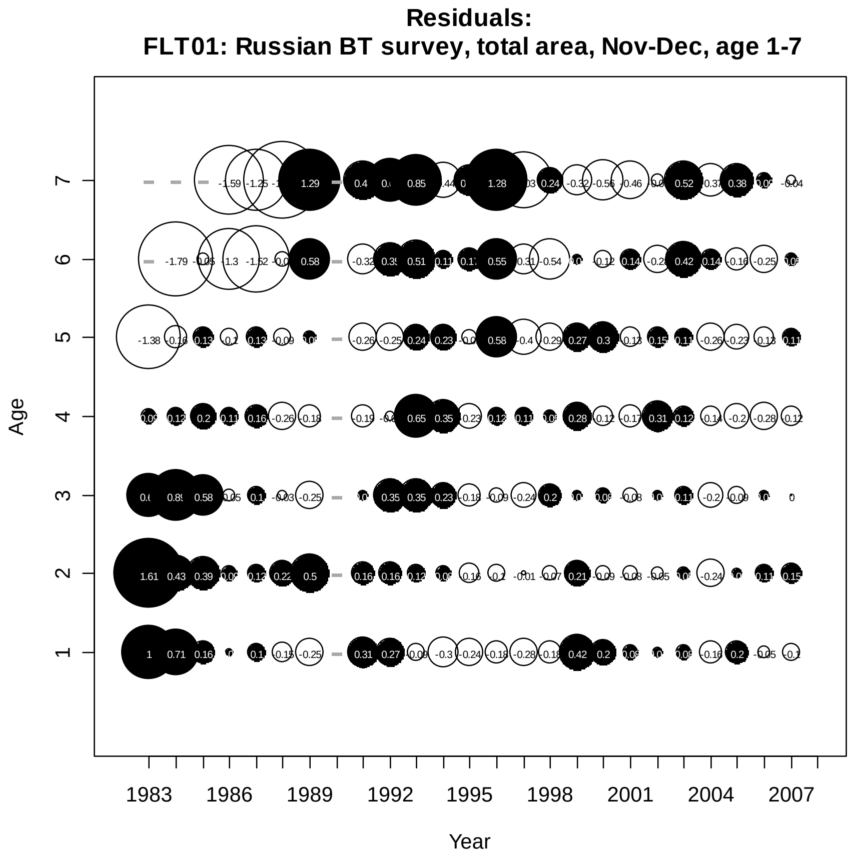


Figure 4.9 (continued).

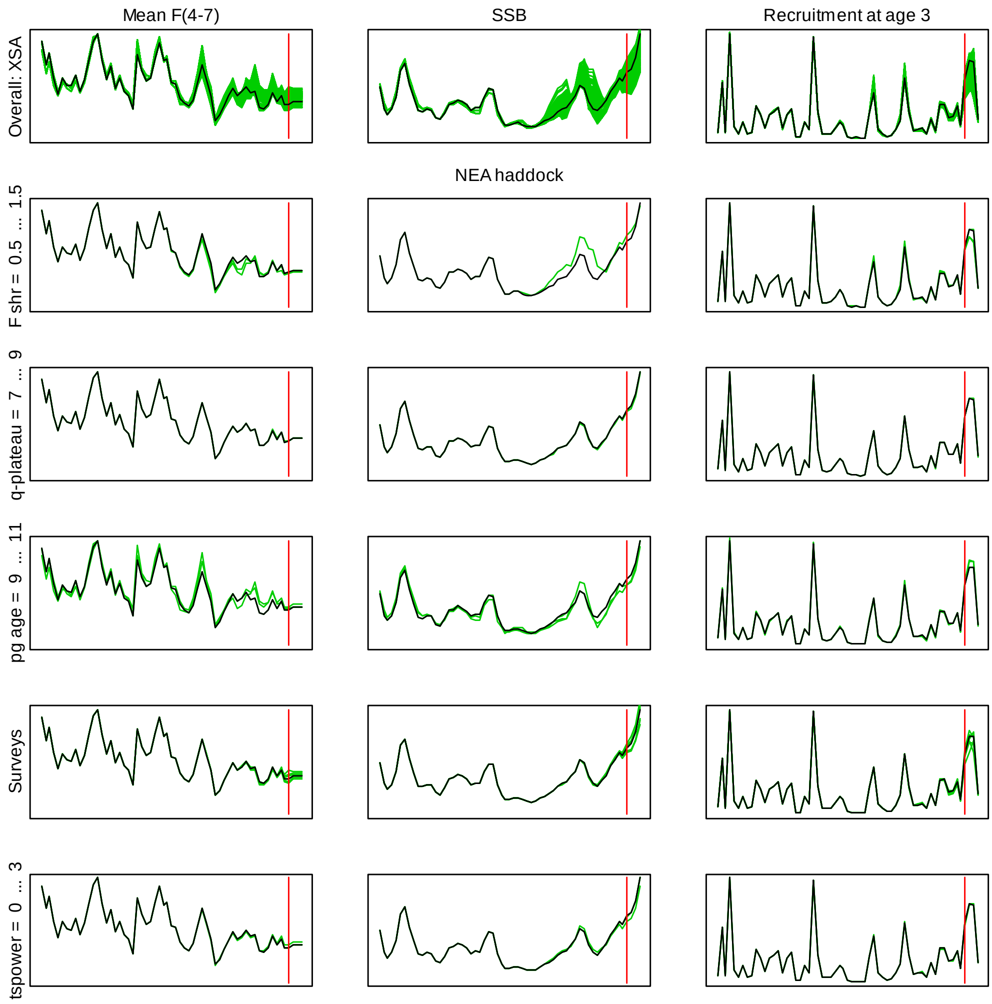


Figure 4.10. Northeast Arctic haddock. Sensitivity analysis of XSA to settings for Northeast Arctic Haddock for Fishing mortality, Spawning stock biomass, and Recruitment at age 3 for the time period 1950 to 2007 indicated by the red line. A Status quo (three year) forecast for 2008 through 20010 is 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.

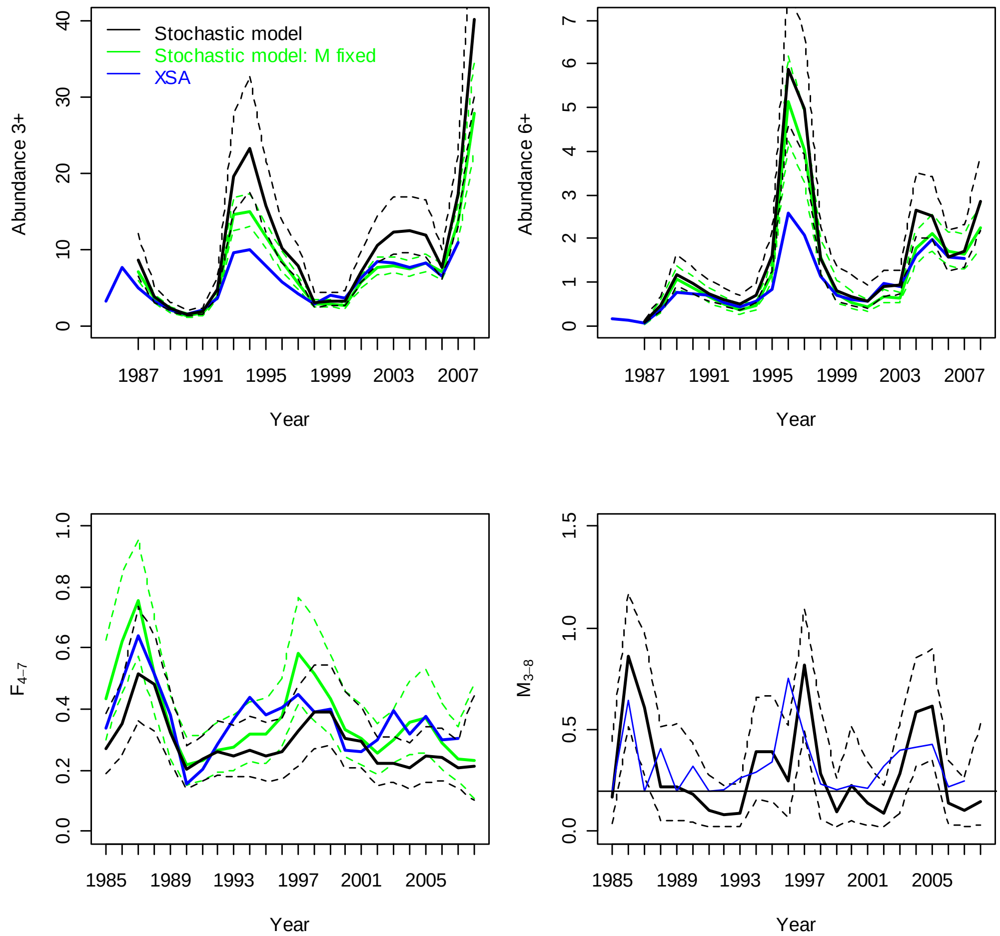


Figure 4.11. NEA haddock, stochastic time series model: Estimated total stock numbers (3+)$\times 10^8$, total numbers for 6+, mean fishing mortality ages 4-7 and estimated unobserved mortality, for the stochastic model estimating temporal fluctuations in M (black lines), stochastic model for fixed M (green lines), and XSA (blue lines), for 1985 through 2008. The solid lines are the mean, and the dotted lines are the 95% credibility sets.

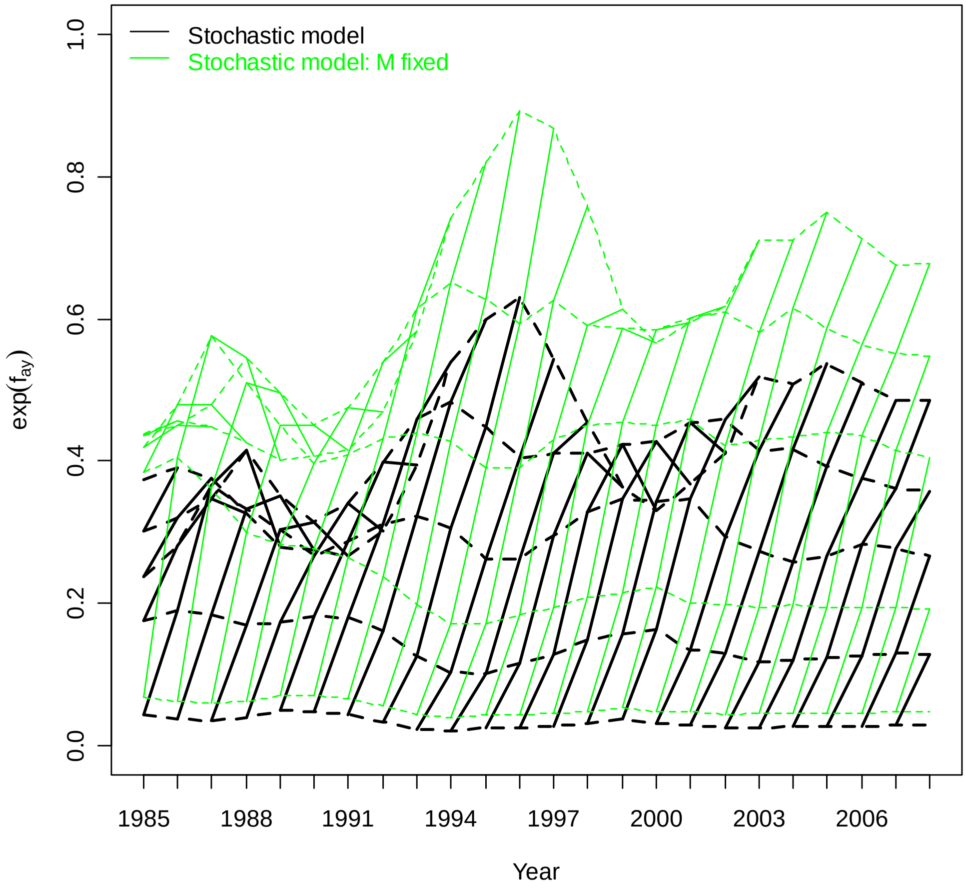


Figure 4.12. NEA haddock, stochastic time series model: Estimated mean selection pattern $\exp(f_{a,y})$ for the fishing mortality where $\log(F_{a,y}) \sim N(f_{a,y} + e_y, \sigma_F^2)$ and $f_{a,y} \mid f_{a,y-1} \sim N(f_{a,y-1}, \sigma_f^2)$. The dotted lines follows the age group, starting at age 3 as the lowest, and the solid lines traces the cohorts, ending at age 7 as the oldest. For ages above 7, the mean selection is set constant as age 7. The corresponding estimates for fixed M are included for comparison (green lines).

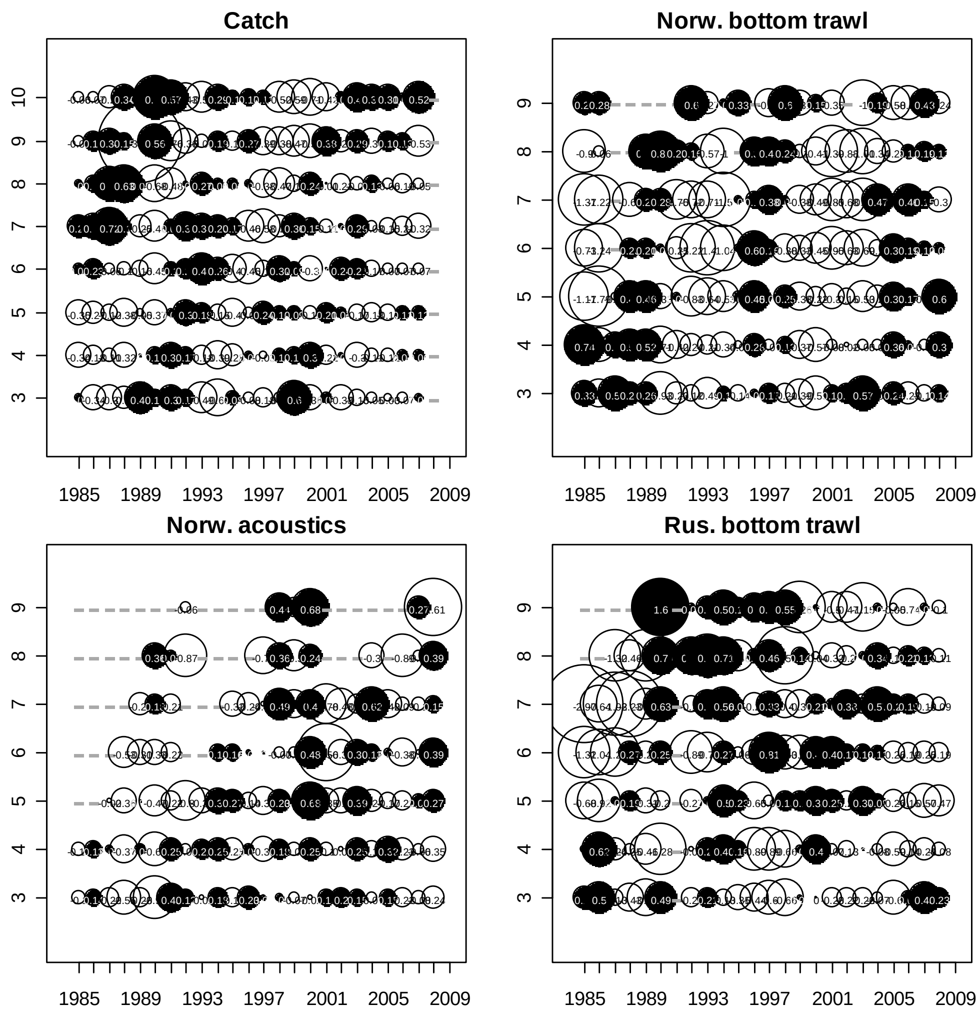


Figure 4.13. NEA haddock, stochastic time series model: Plot of the residuals fitting the stochastic time series model to the haddock data.

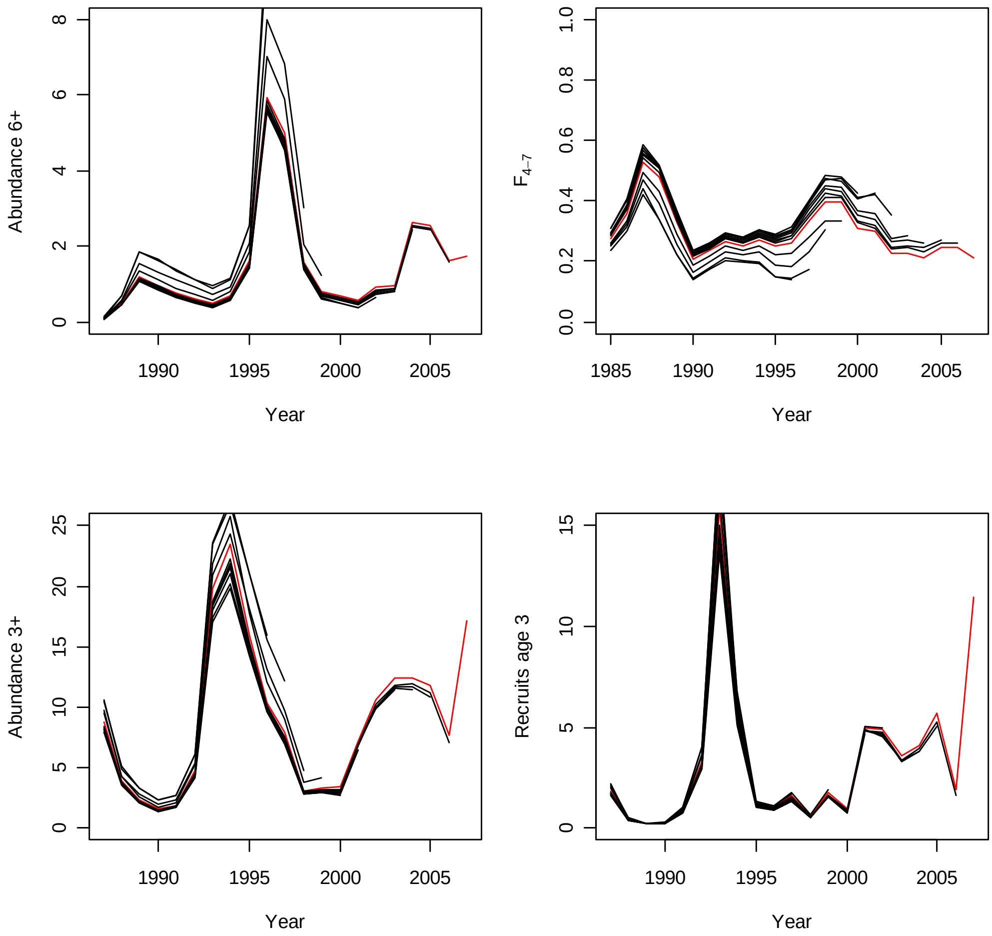


Figure 4.14. NEA haddock, stochastic time series model: Retrospective plots.

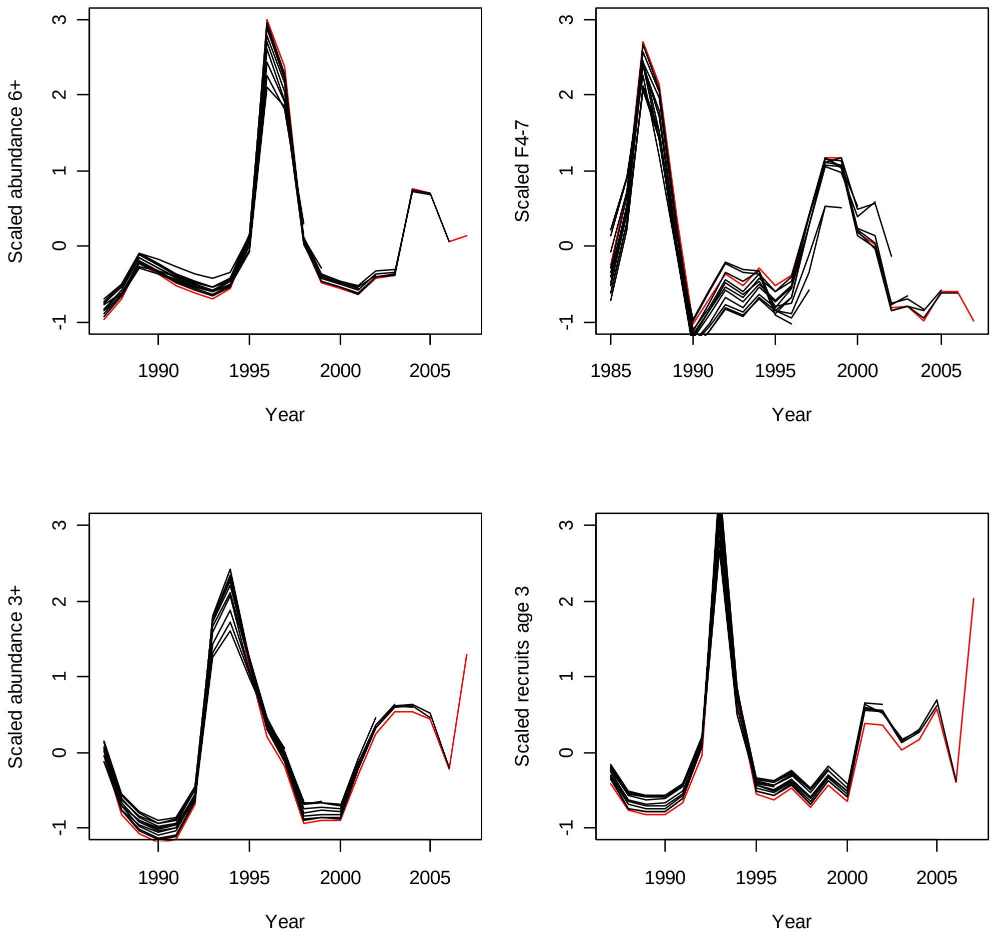


Figure 4.15. NEA haddock, stochastic time series model: Retrospective plots. The time series of estimates are scaled.

Table B1 North-East Arctic HADDOCK. Results from the Norwegian bottom trawl survey in the Barents Sea in January-March. Index of number of fish at age. Indices for 1983-1998 revised August 1999.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	3.1	7.3	2.3	7.8	1.8	5.3	0.5	0.2	0	0	28.3
1982	3.9	1.5	1.7	1.8	1.9	4.8	2.4	0.2	0	0	18.2
1983	2919.3	4.8	3.1	2.4	0.9	1.9	2.5	0.7	0	0	2935.6
1984	3832.6	514.6	18.9	1.5	0.8	0.2	0.1	0.4	0.1	0	4369.2
1985	1901.1	1593.8	475.9	14.7	0.5	0.5	0.1	0.1	0.4	0.3	3987.4
1986	665.0	370.3	384.6	110.8	0.6	0.2	0.1	0.1	0.1	0.1	1531.9
1987	163.8	79.9	154.4	290.2	52.9	0.0	0	0	0	0.3	741.5
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	0	0	0	275.2
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	0	0	196.6
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	0	0	734.4
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	0	0	2357.6
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3	0	3217.1
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1953.5
1994	603.2	228.0	339.5	436.6	49.7	3.4	0.2	0.1	0.2	0.6	1661.5
1995	1463.6	179.3	53.6	171.1	339.5	34.5	2.8	0	0.1	0	2244.5
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	0	0.1	1087.7
1997[1]	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	0	1581.9
1998[1]	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440.2
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1	0	1391.3
2000	847.2	452.2	27.2	35.4	8.4	4.0	0.8	0.3	0.7	0.2	1376.4
2001	1220.5	460.3	296.0	29.3	25.1	1.7	0.9	0.1	0.1	0.3	2034.3
2002	1680.3	534.7	314.7	185.3	17.6	8.2	0.8	0.3	0	0.3	2742.2
2003	3332.1	513.1	317.4	182	73.6	5.5	2.3	0.2	0.1	0.2	4426.5
2004	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.1	1852
2005	4630.2	420.4	346.5	133.3	66.8	52.2	12.3	0.6	0.2	0	5662.4
2006	5141.3	1313.1	77.4	140.5	48.2	19.6	15.2	3.1	0.1	0.3	6758.8
2007[1]	3874.4	1593.8	507.7	66	86	23.3	7.5	3.7	1.4	0.2	6164
2008	860.2	2129.4	1522.4	600.9	86.8	48.9	6.27	2.51	0.82	0.13	5258.3

[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
					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

Table B2 (continued)

Year	0	1	2	3	4	5	6	7	8	9	Age 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
					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

[1]Adjuusted data based on average 1985-1995 distribution.

[2]Adjusted based on 2001 distribution.

[3]Adjusted based on 2004-2006 distribution.

Table B3 North-East Arctic HADDOCK. Results from the Norwegian acoustic survey in the Barents Sea in January-March. Stock numbers in millions. New TS and rock-hopper gear (1981-1988 back-calculated from bobbins gear). Corrected for length dependent effective spread of the trawl.

	Age										
Year	1	2	3	4	5	6	7	8	9	10	Total
1981	7	14	5	21	60	18	1	+	+	+	126
1982	9	2	3	4	4	10	6	+	+	+	38
1983	0	5	2	3	1	1	4	2	+	+	18
1984	1685	173	6	2	1	+	+	+	+	+	1867
1985	1530	776	215	5	+	+	+	+	+	+	2526
1986	556	266	452	189	+	+	+	+	+	+	1463
1987	85	17	49	171	50	+	+	+	-	+	372
1988	18	4	8	23	46	+	+	-	-	+	106
1989	52	5	6	11	20	21	2	-	-	-	117
1990	270	35	3	3	4	7	11	2	+	+	335
1991	1890	252	45	8	3	3	3	6	+	-	2210
1992	1135	868	134	23	2	+	+	1	2	+	2165
1993	947	626	563	130	13	+	+	+	+	3	2282
1994	562	193	255	631	111	12	+	+	+	+	1764
1995	1379	285	36	111	387	42	2	+	+	+	2242
1996	249	229	44	31	76	151	8	+	-	+	788
1997[1]	693	24	51	17	12	43	43	2	+	+	885
1998[1]	220	122	20	28	12	5	13	16	1	+	437
1999	856	46	57	13	14	4	1	2	2	+	994
2000	1024	509	32	65	19	11	2	1	2	+	1664
2001	976	316	210	23	22	1	1	+	+	1	1549
2002	2062	282	216	149	14	12	1	+	+	1	2737
2003	2394	279	145	198	169	17	5	+	+	1	3208
2004	752	474	127	76	76	66	7	2	+	+	1580
2005	3364	209	219	102	36	40	9	+	+	0	3979
2006	2767	804	54	86	30	12	9	2	+	+	3764
2007[1]	3197	868	379	54	88	22	6	5	2	0	4621
2008	1267	1835	723	252	57	74	10	6	+	1	4226

[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 1985-2001 (old method). Index of number of fish at age

	Age										
Year	0	1	2	3	4	5	6	7	8	9+	Total
1985[1]	194	434	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	-	-	-	-	-	-	-	-	-	-	-

Table B4b. North-East HADDOCK. Results from the Russian trawl-acoustic survey in the Barents Sea and adjacent waters in late autumn 1996-2007 (nes method). Index of number of fish at age

	Age											
Year	0	1	2	3	4	5	6	7	8	9	10+	Total
1995[5]	163	170	79	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[7]	9396	1286	308	30	31	10	-	5	5	4	1	11075
2007	812	1473	2226	745	53	75	22	8	7	2	1	5423

[1]October-December

[2]September-October

[3]November-January

[4]Adjusted based on average 1985-1995 distribution

[5]Adjusted based on 2001 distribution

[6]Adjusted data in 2004

[7]Not 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.

Norway

	Age						
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

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[2]	15.8	22.8	28.4	33.7	42.0	48.7	54.8	63.4	69.3	72.0
1997[2]	13.8	23.5	29.3	36.1	45.3	50.0	54.6	58.9	69.4	66.0
1998	15.0	22.0	29.0	38.3	47.7	52.1	54.5	57.8	63.4	-
1999	-	22.8	27.4	40.1	47.4	50.9	54.6	55.9	58.0	61.6
2000	15.0	22.7	30.4	35.2	49.3	55.1	57.8	62.4	63.3	63.6
2001	15.1	22.4	29.8	37.8	48	55.3	58.8	62.1	63.6	65.4
2002	14.6	23.8	30.1	35.6	48.2	55.1	60.2	60.5	63.3	66.8
2003	14.0	22.9	28.9	35.3	44.8	52.2	57.5	63.1	66.3	69.6
2004	14.4	23.1	30.4	37.7	44.2	49.4	56.4	61.6	66.4	69.1
2005	14.9	23.5	30.0	36.9	44.8	49.9	54.7	59.2	65.9	66.6
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

[1]Limited 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

	Age						
Year	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

Russia

	Age										
Year	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	-

[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. 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 197 000 t in 2007.

There is known to be a discarding problem in the saithe fishery. Undocumented observations and comparisons by people having taken scientific samples from commercial trawlers for many years indicate a substantial discarding in certain areas and seasons. There are also records of discard in the purse seine fishery. At the moment it is not possible to estimate the total level of discarding and use the information quantitatively in the assessment.

5.1.1 ICES advice applicable to 2007 and 2008

The advice from ICES for 2007 was as follows:

Exploitation boundaries in relation to precautionary limits: In the absence of an agreed management plan, which has been evaluated to be in agreement with the Precautionary Approach, ICES proposes that in order to harvest the stock within precautionary limits, fishing mortality should be kept below Fpa. This corresponds to landings of less than 247,000 t in 2007.

Exploitation boundaries in relation to proposed management plan: The proposed management plan implies a TAC of 194,000 t in 2007.

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 (0.19) is just above the lowest fishing mortality that would lead to high long-term yields ($F_{0.1}$=0.14).

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 Fpa. This corresponds to landings of no more than 290 000 t in 2008.

Conclusion: The proposed 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.

5.1.2 Management applicable in 2007 and 2008

Management of Saithe in Subareas I and II is by TAC and technical measures. Norwegian authorities set the TACs for 2007 and 2008 to 222,525 t and 247,000 t, respectively. The Institute of Marine Research, Bergen, Norway, advised a TAC for 2008 of 235,000 t, corresponding to the highest long-term yield obtained at an exploitation level of 0.32, i.e. a little below the target F used in the HCR (Fpa). ICES also recommended using a lower value in the HCR.

5.1.3 The fishery in 2007 and expected landings in 2008

Provisional figures show that the landings in 2007 were approximately 197,000 t, which is about 25,000 t. less than the TAC and what was expected by the WG last year (222,525 t).

Official landings in 2008 will also probably be less than the TAC of 247,000 t, which is 11 % higher than the 2007 TAC and 25 % higher than the 2007 landings. However, since the WG does not have any prognosis of total landings in 2008 available, the TAC of 247,000 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. These numbers have been raised to the total purse seine catch (Table 5.2.1). There was an increase in purse seine effort in 2003, a decrease in 2004, a new increase in 2005 and 2006 to the 2003 level and a decline in 2007 to the 2004 level. These variations may be explained both by better availability of schooling saithe in some years with strong recruiting year classes and by transfer of quota, allowing for a longer fishing season. The 2005 WG decided not to apply the series in the further analysis.

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 was excluded from the data because this trawl has a much higher efficiency and the use of it has increased over the last few years. First all CPUE observations for each quarter were averaged, and then a yearly index was calculated by averaging over the year. Due to a large increase in quarter one 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). There was an increase in total CPUE from 1998 to 2001, then a stable period until 2006 and a 20% increase in 2007 (Table 5.2.2, Figure 5.2.1). The total CPUE index was finally divided on age groups applying yearly catch in numbers and weight at age data from the trawl fishery.

In 2005 German freezer trawler CPUE data was made available for the WG (Table 5.2.3). No data for 2007 were available. 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 new time series can be established, the estimation of abundance indices is done very much in the same way as before and the results should be comparable. The total index for 2007 (Aglen *et al.*, WD 15) decreased by almost 20% compared to 2006, and is the lowest since 1991. Age groups 5 and 7+ were above average level, the others below. In later years the proportion of saithe in the southern half of the survey area (sub areas C+D) has increased from about 30% to over 50%.

5.2.3 Recruitment indices

Good recruitment indices are crucial for reliable predictions. Attempts at establishing year class strength at age 0 or 1 have so far failed. The accuracy of the survey recruitment indices varies from year to year according to the extent to which 2 - 4 year old saithe have migrated out from the near coast areas and become available to the acoustic saithe survey on the banks. An observer program for establishing a 0-group index series started in 2000 (Borge and Mehl, WD 21 2002. However, these observations do not seem to pick up the year class strength very well, and the program will be evaluated in 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 2006 was updated applying the same method as used until the 2006 WG. The reason for this was that the new method (ECA, Hirst *et al.* 2004, 2005), applied for the 2007 WG 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 changes in catch numbers-at-age and weight-at-age. Age composition data for 2007 was available from Norway, Russia (Subareas 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.

The 2006 and 2007 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 were used for the period 1960-1979. For subsequent years, annual estimates of weight at age in the catches were used. Weight at age in the stock was assumed to be the same as weight at age in the catch. There were only small differences in weight at age in 2007 compared to the previous years.

5.3.3 Natural mortality

A fixed natural mortality of 0.2 was used both in the assessment and the forecast.

5.3.4 Maturity at age (Table 5.3.3)

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 southwards shift in the distribution of saithe (Figure 5.2.2) and the biological sampling from the southern part of the distribution area has increased somewhat. A higher maturation for ages 4 and 5 have been observed in theses samples 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 the increased number of samples in the south has contributed more in later years. Both maturation at age 4 and 5 and SSB might therefore have been overestimated in later years. WD 12 (Fotland and Mehl) presents a way to model the maturity ogive for Saithe in Subareas I and II, taking abundance by area into account. The WG appreciated the work done, but found it premature to apply new modelled ogives. Alternative methods should be investigated, as well as the consequences for the reference points.

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, 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 are used since 2005:

- Fleet 12: CPUE data from the Norwegian trawl fisheries (start 1994, age groups 4 to 8, only quarter 2-4 since 2006 WG)
- 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. The abundance indices are widely divergent. In the CPUE data a rather large increase in numbers at age is observed in the last year (2007), especially for strong year classes but also for weak ones. Figure 5.3.2 shows comparative scatter plots at age in the CPUE series and in 2007 all age groups are above the trend line. Compared to 2006 the total CPUE increased by 20%, while the total survey index declined by 20%. The effect of this is analysed below (section 5.4.2).

5.4 Exploratory runs

The settings of the different runs are shown in Table 5.4.1.

5.4.1 XSA runs based on data until 2006 (Table 5.4.1, Figure 5.4.1)

Based on the update of Norwegian catch statistics and the “old” method for allocations of biological samples, a SPALY (Same Procedure As Last Year) XSA (run 1) was performed, giving somewhat different results as in the 2006 assessment. Due to lower catch weights but higher numbers at age, the estimated historical stock numbers and biomasses increased and the fishing mortalities decreased for the last fifteen years compared to the 2006 assessment. F_{4-7} in 2006 is now estimated to 0.21 compared to 0.22, while SSB 1 Jan. 2006 increased from 788,000 t to 834,000 t (Figure 5.4.1).

5.4.2 XSA runs based on data with 2007 included (Table 5.4.1, Figures 5.4.1–5.4.3).

Singe fleet tuning runs

Three single fleet tuning runs were performed; two with the Norwegian trawl CPUE, one without 2007 data (run 2 and 3), and one with the Norwegian acoustic survey (run 4). Figure 5.4.1 compares estimates of SSB and F_{4-7} in 2007 from the three single fleet XSA-runs as well as from the two combined tuning runs (run 5 and 6). SSB and F_{4-7} in 2006 from the updated 2006-data run (run1) is also presented. The single fleet tuning runs based on the CPUE give the lowest F_{4-7} and highest SSB in the last assessment year (2007), especially the one with 2007 data included (run 2).

Figure 5.4.2 present 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 much lower S.E. log q for age 4, similar for age 5, much higher for age 6 and a little lower 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 data, and all residuals change from negative to positive in the last year.

Combined fleet tuning runs

The combined fleet runs (run 5 and 6) results in a higher F_{4-7} and a lower SSB than the three single fleet tuning runs due to the shrinkage. The one without 2007 CPUE data (run 6) gives the highest F_{4-7} and the lowest SSB, very close to the values obtained in the 2006 update assessment (run 1), while the run with 2007 CPUE data gave an almost 10% higher SSB in the last year.

5.5 Final assessment run (Tables 5.5.1–5.5.7, Figure 5.5.1–5.5.3)

The 2007 CPUE data seems to be an outlier in the time series. The survey (Aglen *et al.*, WD 15) 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. 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. This may be the reason for way all age groups are above the trend line in Figure 5.3.2. Due to this and the 20% decline in total survey index the WG decided to exclude the 2007 CPUE data in the final assessment.

Extended Survivors Analysis (XSA) was used for the final assessment with settings shown in Table 5.4.1 (run 6). The settings for this update assessment are the same as in the 2006 assessment since diagnostics of initial runs were similar to last year's. 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 scaled weights. The survey gets the highest weights for the youngest year classes, the CPUE for older ones (age group six and older). Figure 5.5.3a-b shows plots of the tuning indices versus stock numbers from the XSA. The correlation is poor for age three in the survey but somewhat better for the other age groups, especially age four and five. For the CPUE the correlation is best for age groups five, seven and eight.

5.5.1 Fishing mortalities and VPA (Tables 5.5.2–5.5.7, Figure 5.5.4)

The fishing mortality (F_{4-7}) in 2006 was 0.19, which is slightly lower than the value of 0.22 from last year's assessment. The fishing mortality (F_{4-7}) in 2007 was 0.20, i.e. just a little above the corresponding figure for 2006 and well below the F_{pa} of 0.35. Fishing mortalities and stock size has in the last decade been over- and underestimated, respectively, in the assessment year as is illustrated by the retrospective plots in Figure 5.5.4.

The XSA-estimates of the 2004-2005 year classes are not considered to be valid and these estimates are therefore shaded (Tables 5.5.3 and 5.5.5). The summary table (Table 5.5.7) presents the recalculated recruitment figures and total biomass. The 1996-year class was well represented in the catches over several years, and also appear to be strong in the current assessment, while the 1997-year class is at average level and the 1998-year class is somewhat above average strength. The 1999-year class now comes out to be of the same strength as the 1996-year classes, while the 2000-year class is weak and the 2001-year class is of average strength. The 2002-year class has been the most numerous in the landings the three last years and is presently estimated to be of the same strength as the very strong 1989 and 1992-year classes. The 2003-year class so far seems to be one of the weakest in the time series. No information is available on the strength of recent year classes.

The total biomass (ages 3+) has been at a high and increasing level above the long-term (1960-2007) mean since 1995. Likewise, the SSB has been above the long-term mean since 1996 and above B_{pa} since 1994 (Tables 5.5.5-5.5.7).

5.5.2 Recruitment (Table 5.3.1, Figure 5.1.1)

Estimates of the recruiting year classes up to the 2003-year class (4 year olds) from the XSA were accepted. Catches of age group 3 have to a large extent declined to low levels in recent years (Table 5.3.1). Until the 2005 WG RCT3-runs were conducted to estimate the corresponding year classes, with 2 and 3 year olds from the acoustic survey as input together with VPA numbers. These estimates were, however, strongly weighted towards the mean value of the input XSA-numbers, which due to the short survey time series also contained year classes that 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 1960-2006 is 175 million 3 year olds, and this value is used for the 2004-year class. The value is lower than the GM recruitment 1994-2006 (219 million 3 year olds), a period where the SSB has been well above B_{pa}. Preliminary data from the Norwegian 0-group observer program indicate slightly above average recruitment since 2000. Due to few overlapping years it is still too early to use these data in recruitment models together with XSA-data on year class strength.

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 Subareas 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 0.14 and 0.32, respectively, which are the same values as obtained the two previous assessments. 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 σ = 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 Subareas 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 (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

5.7 Predictions

5.7.1 Input data (Table 5.7.1)

The input data to the predictions based on results from the final XSA-analysis are given in Table 5.7.1. The stock number at age in 2008 was taken from the XSA for age 5 (2003 year class) and older. The recruitment at ages 3 in the last assessment year (2007) was calculated as the long-term GM (geometric mean) recruitment 1960-2006 (Section 5.5.2), and the corresponding numbers at age 4 in the intermediate year (2008) was calculated applying a natural mortality of 0.2 and the F value estimated by XSA (as recommended by the ACFM reviewers in 2004). The GM age 3 recruitment of 175 million was also used for the 2004 and subsequent year classes. The natural mortality of 0.2 is the same as used in the assessment. For exploitation pattern the average of 2005-2007, scaled to the 2007 level since there is a small increasing trend in F over the period, 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 2006-2007 annual determinations was applied.

5.7.2 Catch options for 2009 (short-term predictions) (Tables 5.7.2-5.7.5)

The management option table (Table 5.7.2) shows that the expected catch of 247,000 t in 2008 will increase the fishing mortality compared to 2007 from 0.20 to 0.27, which is still well below the F_{pa} of 0.35. A catch in 2009 corresponding to $F_{status\ quo}$ level of 0.20 will be 160,000 t, while a catch at F_{pa} level in 2009 is 263,000 t. A catch in 2009 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 225,000 t. This catch corresponds to a fishing mortality of 0.29 in 2009. 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 2009 corresponding to an exploitation level of 0.32 in the HCR is 214,000 t. The SSB is expected to decrease from about 810,000 t at the beginning of 2008 to 670,000 t at the beginning of 2009, which is close to the prediction made by last year's working group for a catch in 2008 corresponding to the HCR. At $F_{status\ quo}$ in 2009 SSB is estimated to decrease to 645,000 t at the beginning of 2010, for a catch corresponding to the HCR it will decrease to about 582,000 t, for an exploitation level of 0.32 in the HCR SSB will decline to 593,000 t, while at F_{pa} in 2009 SSB will decrease to about 545,000 t in 2010. This predicted reduction in SSB may be explained by higher fishing mortalities and incoming year classes of average strength or below. Table 5.7.4 presents detailed output for fishing according to the HCR in 2009.

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. No improved recruitment estimates are available and the problem with bias in the assessment has not been resolved. 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 175,000 t in 2012, while the SSB will be reduced to about 455,000 t.

5.8 Comparison of the present and last year's assessment

The current assessment estimated the total stock to be about 3 % higher and SSB 4 % higher in 2007, compared to the previous assessment. The F in 2006 was estimated to be slightly lower than in the previous assessment, and the realized F in 2007 is also a little lower than the predicted one.

	Total stock (3+) by 1 January 2007 (tonnes)	SSB by 1 January 2007 (tonnes)	F_{4-7} in 2007	F_{4-7} in 2006
WG 2007	1150939	799029	0.24 (prediction)	0.22
WG 2008	1185240	834010	0.20	0.19

5.9 Comments on the assessment and the forecast

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.

5.10 Response to ACFM technical minutes

Most of the comments from the review group regarded the next benchmark assessment. There were no comments on the XSA assessment.

Regarding the short-term prediction the reviewers commented "... perhaps GM over the more recent period should be used because of variability and the poor recruitment during lower biomass time period. This would however, result in a more optimistic forecast". In section 5.2.2 of the WG report this figure is presented, and the value is somewhat higher than the GM recruitment 1997-2006 (219 million compared to 175 million 3 year olds). The WG is also worried about a too optimistic forecast and like in the past years chose the long term GM recruitment figure as input for the predictions.

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	89	339	9 823	21 [2]	532		7 [2]	212 670
2007 [1]	1 043	671	810 [2]	3 019 [6]	215 [2]	178 548	99	413	12 009	53 [2]	453		1	197 334

[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 [1]	41.8	99.4	33.2	23.0	197.3

[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 Saithe in Sub-areas I and II (Northeast Arctic). 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	221	78	299	74 %	26 %	2 637.0	39 411.0	42 048.0	6 %	94 %	11.9	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 [1]	152	70	222	68 %	32 %	1 943.2	39 844.1	41 787.3	5 %	95 %	12.8	569.2	73.4
Mean	145.5	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.

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	71.6	330.2	418.5	58.6	23.6	23.6	12.7	17.7	957
1994	1	5.1	124.7	420.1	261.0	36.0	8.0	2.5	5.0	862
1995	1	39.3	210.0	291.6	316.8	50.3	8.3	0.3	2.1	919
1996	1	20.6	102.3	136.7	198.8	262.2	30.1	6.5	0.6	758
1997	1	14.6	38.7	201.3	205.0	263.7	166.0	17.5	1.7	908
1998	1	3.1	31.7	53.2	234.9	89.5	54.4	15.7	7.3	490
1999	1	15.7	38.1	107.3	81.4	188.5	43.2	31.7	9.1	515
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	0.3	68.6	127.3	111.6	260.0	149.6	131.2	124.9	973
2007 [1]	1	4.9	17.3	310.1	234.5	163.1	225.5	108.8	90.6	1155

[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	CPUE	Agegroup												
		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]														

[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									
	2	3	4	5	6/6+	7	8	9	10+	Total
1985	3.1	4.9	2.4	0.5	0.0					10.9
1986	19.5	40.8	3.6	1.8	1.8					67.5
1987	1.8	22.0	48.4	1.8	1.7					75.7
1988	15.7	22.5	19.0	7.1	0.6					64.9
1989	24.8	28.4	17.0	10.1	12.4					92.7
1990	99.6	31.9	14.7	5.1	7.4					158.7
1991	87.8	104.0	4.6	4.0	7.1					207.5
1992	163.5	273.6	57.5	6.2	8.8					509.6
1993	106.9	227.7	103.9	12.7	3.2					454.4
1994	35.1	87.1	108.9	41.4	8.1	0.7	1.0	0.5	1.0	283.8
1995	38.4	166.1	86.5	46.5	16.5	2.4	0.0	0.0	1.0	357.5
1996	48.8	122.6	207.4	31.7	15.1	4.0	0.5	0.0	0.0	430.0
1997	5.5	38.0	184.8	79.8	50.6	9.6	1.2	0.0	0.3	369.8
1998	44.0	96.7	202.6	69.3	84.3	6.6	3.8	0.7	0.1	508.1
1999	61.1	233.8	72.9	62.2	21.0	19.2	5.9	1.4	0.4	477.8
2000	164.8	142.5	176.3	11.6	11.5	8.0	4.0	1.0	2.0	521.7
2001	104.7	275.9	45.9	53.8	5.6	6.1	3.2	3.4	1.9	500.5
2002	25.5	230.2	92.6	18.9	10.6	2.2	0.9	0.8	1.2	382.9
2003	31.0	87.5	151.7	26.1	6.2	6.4	1.2	0.7	1.3	312.1
2004	152.2	212.4	118.7	49.1	19.2	4.7	3.0	3.1	3.1	565.5
2005	22.2	228.1	67.2	20.3	16.5	7.7	2.2	1.7	0.9	366.7
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

Table 5.3.1 Catch numbers at age
Run title : North-East Arctic saithe

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

YEAR	1960	1961	1962	1963	1964	1965	1966	1967
AGE								
3	10509	17824	37266	42050	9001	37115	22392	29664
4	13083	9131	11131	28925	59601	5001	54537	24836
5	13545	12506	4421	5888	13154	26300	13124	35956
6	5064	3799	8290	4650	2718	10142	12899	4125
7	4883	1332	2427	3861	3472	2861	4652	5616
8	2401	968	1024	1099	2655	2110	1374	2916
9	1315	520	938	1075	1251	2733	933	1413
10	743	405	451	697	1221	699	965	1397
+gp	1525	1229	1728	1777	3559	3593	2900	3493
0 TOTAL	53068	47714	67676	90022	96632	90554	113776	109416
TONSL	133515	105951	120707	148627	197426	185600	203788	181326
SOPCC	129	142	123	122	121	115	112	96

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

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	25196	77333	43540	77019	65178	76296	36782	60832	125030	99049
4	18384	11949	62846	59280	52389	25206	44027	11691	30576	34317
5	5101	16939	13987	26961	29146	26911	15671	16366	7947	10140
6	8282	4747	16189	9556	10186	16031	20419	4436	8712	2062
7	787	4798	5122	9592	5616	7114	12148	7808	3435	4332
8	1913	1126	7950	2901	3547	3935	4802	6789	3212	1456
9	900	1711	2504	4352	1865	2871	3258	2914	2679	1606
10	577	675	3697	2195	2140	2610	2505	2350	1724	963
+gp	1166	511	2799	5490	3149	3924	3821	4140	2880	1134
0 TOTAL	62306	119789	158634	197346	173216	164898	143433	117326	186195	155059
TONSL	110247	140060	264924	241272	214334	213859	274121	233453	242486	182817
SOPCC	119	98	101	80	85	82	104	115	108	107

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

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	48969	61963	40796	83954	34733	17244	41466	48917	22115	17869
4	27685	23328	36644	21822	65052	23768	33233	11974	12895	49829
5	12476	14122	9211	21528	13060	32700	12064	7189	6062	4339
6	4534	4400	6379	3619	8212	3226	11204	5279	4525	3118
7	1468	2901	3200	2550	1054	3008	1135	3740	2805	3490
8	1848	963	1338	2008	1251	1177	1772	775	1399	755
9	938	1356	147	369	461	760	560	878	351	620
10	976	438	730	279	263	247	557	134	454	257
+gp	2150	1192	1629	629	448	760	897	701	285	797
0 TOTAL	101044	110663	100074	136758	124534	82890	102888	79587	50891	81074
TONSL	154464	164180	144554	175516	168034	156936	158786	107183	70458	92391
SOPCC	115	122	99	102	103	106	105	100	101	104

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	8126	12550	23792	68681	44608	22614	7058	17178	10510	11789
4	35847	19285	16930	13630	33266	61398	35593	52109	54886	11698
5	32827	33233	9054	5752	5982	30848	49248	40145	18499	35011
6	4560	18479	10238	4883	5408	3716	18999	30451	18357	13567
7	2328	1751	7341	3877	4748	1744	2053	4177	17834	13452
8	1219	350	1076	2381	3173	1366	723	483	2849	7058
9	966	176	160	383	1461	1018	421	125	485	812
10	320	187	112	61	286	790	278	259	214	55
+gp	102	204	269	179	442	146	655	293	474	146
0 TOTAL	86295	86215	68972	99827	99374	123640	115028	145220	124108	93588
TONSL	114242	122310	95848	107326	127516	153584	146544	168378	171348	143629
SOPCC	100	105	102	101	105	101	98	100	100	100

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
3	3091	9655	9175	3833	6614	2335	991	26083	1975	2145
4	16215	12236	22767	7979	17554	50447	6111	12478	68651	4018
5	11946	22872	7747	27071	11592	13374	33548	9696	11805	40691
6	31818	10347	10676	8802	25702	7008	10441	22822	10087	15995
7	8376	18930	6123	7147	5323	9467	7321	10640	16806	8343
8	5539	3374	8303	3158	4284	5411	8133	5595	8059	11216
9	2873	3343	2530	4706	2390	3497	2742	7745	5602	7012
10	727	2290	2652	1943	3443	2492	3026	2644	5097	4455
+gp	394	597	1219	1942	2392	4102	5336	2276	4275	2536
0 TOTAL	80979	83644	71192	66581	79294	98133	77649	99979	132357	96411
TONSL	153327	150373	135945	136402	155246	159757	162140	176678	212670	197334
SOPCC	100	100	101	100	100	100	100	100	100	100

Table 5.3.2 Catch weight at age
Run title : North-East Arctic saithe

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Table 2 Catch weights at age (kg)

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967
	AGE								
	3	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
	5	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
	7	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
	9	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
	+gp	8.03	8.039	7.924	7.851	7.781	7.959	8.106	7.994
0	SOPC(	1.2863	1.4159	1.2326	1.2169	1.2138	1.1472	1.1222	0.9593

Table 2 Catch weights at age (kg)

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
	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	7.716	7.479	7.404	7.052	7.477	7.385	7.217	7.127	7.32	7.394
0	SOPC(	1.1889	0.9829	1.0067	0.8017	0.8492	0.8246	1.0407	1.1549	1.0845	1.0695

Table 2 Catch weights at age (kg)

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
	3	0.71	0.71	0.79	0.73	0.77	1.05	0.71	0.75	0.59	0.53
	4	1.11	1.11	1.27	1.4	1.12	1.33	1.26	1.33	1.22	0.84
	5	1.63	1.63	2.03	2.05	2.02	1.86	2.02	2.07	1.97	1.66
	6	2.33	2.33	2.55	2.76	2.61	2.8	2.7	2.63	2.3	2.32
	7	3.16	3.16	3.29	3.3	3.27	4	3.88	3.28	2.87	2.97
	8	4.03	4.03	4.34	4.38	3.91	4.18	4.47	3.96	3.72	4
	9	4.87	4.87	5.15	5.95	4.69	5.33	5.36	4.54	4.3	4.72
	10	5.63	5.63	5.75	6.39	5.63	5.68	6.06	5.55	4.69	5.44
	+gp	7.527	7.809	6.937	6.841	7.558	8.665	7.19	8.012	6.597	6.904
0	SOPC(	1.1465	1.2199	0.9879	1.0237	1.0323	1.0564	1.051	1.0011	1.0079	1.0384

Table 2 Catch weights at age (kg)

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
	3	0.62	0.74	0.71	0.68	0.67	0.61	0.52	0.56	0.59	0.62
	4	0.87	0.95	1	1.05	1.01	0.99	0.76	0.79	0.82	0.95
	5	1.31	1.4	1.45	1.85	1.92	1.65	1.24	1.19	1.33	1.24
	6	2.43	1.78	2.09	2.39	2.28	2.46	2.12	1.71	1.84	1.72
	7	3.87	2.96	2.49	3.08	2.77	2.85	3.22	2.87	2.48	2.35
	8	5.38	3.73	3.75	3.35	3.2	3.03	3.83	3.78	3.73	3.1
	9	5.83	4.62	3.9	4.48	3.73	3.71	4.69	4.06	4.32	4.19
	10	5.36	4.67	6.74	4.66	6.35	4.49	5.31	5.3	5.34	5.79
	+gp	7.448	7.19	6.27	6.58	7.63	6.29	5.97	7.56	7.07	7.44
0	SOPC(	1.0023	1.0484	1.0226	1.0085	1.0517	1.0106	0.9848	0.999	1.0018	1.0011

Table 2 Catch weights at age (kg)

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	AGE										
	3	0.68	0.67	0.6	0.75	0.69	0.66	0.71	0.59	0.59	0.76
	4	1	1.05	1.03	1.12	1.01	0.91	1.03	0.89	0.83	1.07
	5	1.48	1.45	1.63	1.54	1.5	1.42	1.37	1.49	1.46	1.41
	6	1.87	1.93	2.1	2.04	1.97	1.9	1.9	2.09	1.78	1.86
	7	2.58	2.27	2.67	2.6	2.54	2.54	2.42	2.16	2.26	2.4
	8	3.07	2.97	3.14	3.14	3.25	2.59	2.99	3	2.73	2.92
	9	4.13	3.61	3.81	3.63	3.77	3.49	3.45	3.24	3.02	3.26
	10	5.44	4.1	4.41	4.54	4.31	3.75	3.73	3.82	3.89	3.75
	+gp	8.07	5.58	6.13	5.36	5.62	4.9	4.9	5.49	5.08	4.64
0	SOPC(	1.0014	1.0009	1.0053	1.001	1.0013	1.0018	1.0026	1.0033	1.0042	1.0009

Table 5.3.3. Saithe in Subareas I and II (Northeast Arctic). 3-year running average maturity ogive

	Age group									
Year	2	3	4	5	6	7	8	9	10	11+
1985	0	0	0.04	0.73	0.88	0.88	1	1	1	1
1986	0	0	0.03	0.74	0.90	0.92	1	1	1	1
1987	0	0	0.04	0.63	0.88	1	1	1	1	1
1988	0	0	0.09	0.56	0.74	1	1	1	1	1
1989	0	0	0.16	0.56	0.64	1	1	1	1	1
1990	0	0	0.17	0.66	0.62	0.91	1	1	1	1
1991	0	0	0.12	0.72	0.75	0.90	1	1	1	1
1992	0	0	0.05	0.64	0.84	0.89	1	1	1	1
1993	0	0	0.04	0.56	0.90	0.98	1	1	1	1
1994	0	0	0.09	0.52	0.86	0.97	1	1	1	1
1995	0	0	0.14	0.55	0.81	0.90	0.98	1	1	1
1996	0	0	0.14	0.50	0.74	0.84	0.97	1	1	1
1997	0	0	0.11	0.42	0.59	0.74	0.82	1	1	1
1998	0	0	0.08	0.26	0.53	0.69	0.76	1	1	1
1999	0	0	0.04	0.28	0.54	0.72	0.75	0.99	1	1
2000	0	0	0.05	0.27	0.70	0.81	0.87	0.87	1	1
2001	0	0	0.06	0.38	0.78	0.94	0.93	0.87	1	1
2002	0	0	0.07	0.45	0.86	0.94	0.96	0.86	1	1
2003	0	0	0.10	0.46	0.87	0.95	0.93	0.98	1	1
2004	0	0	0.13	0.55	0.84	0.92	0.90	1	1	1
2005	0	0	0.17	0.61	0.85	0.92	0.87	1	1	1
2006	0	0	0.13	0.62	0.88	0.93	0.92	1	1	1
2007	0	0	0.10	0.54	0.92	0.97	0.95	1	1	1

Table 5.3.4 Tuning data sets applied in final XSA run (flt12 CPUE from Quarter 2,3,4)

```
Saithe in Subareas I and II (North-East Arctic)
102
FLT12: Nor new trawl revised 2006 (Catch: Unknown) (Effort: 
Unknown)
1994 2006
1 1 0.00 1.00
4  8
   1   124.7   420.1   261.0    36.0     8.0
   1   210.0   291.6   316.8    50.3     8.3
   1   102.3   136.7   198.8   262.2    30.1
   1    38.7   201.3   205.0   263.7   166.0
   1    31.7    53.2   234.9    89.5    54.4
   1    38.1   107.3    81.4   188.5    43.2
   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    68.6   127.3   111.6   260.0   149.6
FLT13: Norway Ac Survey extended 2000 (Catch: Unknown) (Effort: 
Unknown)
1994 2007
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
```

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	1960-06	1960-07	1960-07	1960-07	1960-07	1960-07
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	1994-07 age 4-8 Q2-4	1994-06 age 4-8 Q2-4		1994-07 age 4-8 Q2-4	1994-06 age 4-8 Q2-4
Fleet 13 ac. survey	1994-06 age 3-7			1994-07 age 3-7	1994-07 age 3-7	1994-07 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
24/04/2008 10:52

Extended Survivors Analysis

North-East Arctic saithe

CPUE data from file flt-1206-13re51.dat

Catch data for 48 years. 1960 to 2007. Ages 3 to 11.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
FLT12: Nc	1994	2007	4	8	0	1
FLT13: Nc	1994	2007	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 86 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	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	0.024	0.031	0.059	0.018	0.019	0.018	0.006	0.063	0.041	0.02
4	0.109	0.123	0.096	0.067	0.104	0.195	0.058	0.095	0.235	0.109
5	0.136	0.22	0.106	0.159	0.13	0.108	0.193	0.124	0.122	0.212
6	0.251	0.167	0.151	0.169	0.223	0.108	0.115	0.194	0.183	0.241
7	0.214	0.232	0.141	0.143	0.147	0.119	0.158	0.164	0.214	0.226
8	0.144	0.125	0.151	0.1	0.12	0.218	0.143	0.174	0.18	0.217
9	0.109	0.121	0.13	0.12	0.102	0.136	0.164	0.196	0.264	0.236
10	0.143	0.119	0.133	0.14	0.121	0.147	0.167	0.235	0.191	0.348

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10
1998	1.46E+05	1.74E+05	1.04E+05	1.58E+05	4.80E+04	4.58E+04	3.08E+04	6.03E+03
1999	3.45E+05	1.17E+05	1.28E+05	7.45E+04	1.01E+05	3.17E+04	3.24E+04	2.26E+04
2000	1.77E+05	2.74E+05	8.48E+04	8.40E+04	5.16E+04	6.55E+04	2.29E+04	2.35E+04
2001	2.44E+05	1.37E+05	2.04E+05	6.24E+04	5.91E+04	3.67E+04	4.61E+04	1.65E+04
2002	3.91E+05	1.96E+05	1.05E+05	1.42E+05	4.32E+04	4.19E+04	2.72E+04	3.35E+04
2003	1.48E+05	3.14E+05	1.45E+05	7.54E+04	9.31E+04	3.05E+04	3.05E+04	2.01E+04
2004	1.88E+05	1.19E+05	2.11E+05	1.06E+05	5.54E+04	6.77E+04	2.01E+04	2.18E+04
2005	4.72E+05	1.53E+05	9.22E+04	1.43E+05	7.77E+04	3.87E+04	4.80E+04	1.40E+04
2006	5.45E+04	3.63E+05	1.14E+05	6.67E+04	9.62E+04	5.40E+04	2.67E+04	3.23E+04
2007	1.17E+05	4.29E+04	2.35E+05	8.25E+04	4.55E+04	6.36E+04	3.69E+04	1.68E+04

Estimated population abundance at 1st Jan 2008

0.00E+00	9.42E+04	3.15E+04	1.56E+05	5.31E+04	2.97E+04	4.19E+04	2.39E+04

Taper weighted geometric mean of the VPA populations:

2.06E+05	1.69E+05	1.32E+05	8.24E+04	5.07E+04	3.05E+04	1.70E+04	9.21E+03

Standard error of the weighted Log(VPA populations) :

0.6158	0.6191	0.5038	0.5833	0.7783	1.0253	1.2492	1.4961

1

Log catchability residuals.

Fleet : FLT12: Nor new trawl

Age	1994	1995	1996	1997
3	No data for this fleet at this age			
4	0.61	1.5	0.12	0
5	0.7	0.51	0.17	-0.2
6	1.22	0.29	-0.06	0.35
7	1.35	-0.03	0.36	0.4
8	0.45	0.65	-0.04	0.4

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	No data for this fleet at this age									
4	-0.41	0.18	0.06	0.26	0.33	0.46	-1.47	-0.14	-0.31	99.99
5	-0.75	-0.22	-0.08	0.22	0.07	0.23	-0.16	-0.02	0.03	99.99
6	-0.27	-0.61	-0.06	0.44	0.31	-0.16	-0.45	0.03	-0.18	99.99
7	-0.31	-0.3	-0.08	0.18	-0.28	-0.25	0.22	-0.37	0.06	99.99
8	-0.75	-0.62	0.02	-0.19	-0.2	0.51	0.28	-0.2	0.11	99.99

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	-8.0499	-6.6652	-6.0291	-5.7784	-5.8181
S.E(Log q)	0.6536	0.3182	0.4112	0.383	0.4104

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	0.68	0.894	9.36	0.49	13	0.45	-8.05
5	0.8	0.825	7.69	0.67	13	0.26	-6.67
6	1.37	-0.701	4.03	0.3	13	0.58	-6.03
7	1.54	-2.138	2.99	0.65	13	0.5	-5.78
8	1.18	-1.08	5.01	0.82	13	0.48	-5.82

1

Fleet : FLT13: Norway Ac Sur

Age		1994	1995	1996	1997
	3	-0.59	-0.53	0.06	-1.33
	4	-0.28	-0.08	0.08	0.78
	5	-0.1	0.18	0.18	0.34
	6	0.53	0.01	0.01	1.6
	7	0.8	0.16	-0.57	0.31
	8	No data for this fleet at this age			

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	3	0.01	0.04	0.23	0.54	-0.11	-0.11	0.53	-0.27	0.19	0.36
	4	0.67	0.05	0.07	-0.61	-0.24	-0.14	0.47	-0.32	-0.31	0.06
	5	0.97	0.72	-0.64	0.06	-0.35	-0.36	-0.04	-0.15	-0.41	0.09
	6	1.36	0.66	-0.07	-0.48	-0.63	-0.62	0.17	-0.21	-0.74	-0.36
	7	0.31	0.65	0.37	-0.03	-0.74	-0.46	-0.22	-0.06	-0.13	0.24
	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	-7.1523	-7.1779	-8.0127	-8.5402	-8.8693
S.E(Log q)	0.4727	0.3956	0.4434	0.7129	0.4274

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	1.35	-1.091	5.39	0.51	14	0.63	-7.15
4	1.17	-0.688	6.35	0.64	14	0.47	-7.18
5	0.79	0.709	8.83	0.54	14	0.36	-8.01
6	0.8	0.382	9.13	0.27	14	0.59	-8.54
7	1.26	-0.958	8.33	0.6	14	0.54	-8.87
1							

Terminal year survivor and F summaries :

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

Year class = 2004

Fleet	l :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	1	0	0	0	0	0	0
FLT13: Nc	135641	0.493	0	0	1	0.502	0.014
F shrinka	65303	0.5				0.498	0.029

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
94249	0.35	0.52	2	1.469	0.02

1

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

Year class = 2003

Fleet	l :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	1	0	0	0	0	0	0
FLT13: Nc	35179	0.317	0.064	0.2	2	0.688	0.098
F shrinka	24589	0.5				0.312	0.138

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
31455	0.27	0.15	3	0.547	0.109

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

Year class = 2002

Fleet	l :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	113622	0.684	0	0	1	0.089	0.281
FLT13: Nc	133651	0.263	0.133	0.5	3	0.651	0.243
F shrinka	253337	0.5				0.26	0.136

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
155599	0.22	0.19	5	0.83	0.212

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

Year class = 2001

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	52945	0.3	0.062	0.21	2	0.338	0.242
FLT13: Nc	45684	0.248	0.219	0.88	4	0.485	0.275
F shrinka	80496	0.5				0.177	0.165

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
53090	0.18	0.14	7	0.787	0.241

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

Year class = 2000

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	23251	0.247	0.32	1.3	3	0.366	0.281
FLT13: Nc	31911	0.219	0.174	0.79	5	0.488	0.212
F shrinka	43189	0.5				0.146	0.161

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
29703	0.16	0.15	9	0.958	0.226

1

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

Year class = 1999

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT12: Nc	42039	0.214	0.09	0.42	4	0.458	0.216
FLT13: Nc	37168	0.224	0.024	0.11	5	0.385	0.241
F shrinka	55610	0.5				0.158	0.168

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
41903	0.15	0.06	10	0.397	0.217

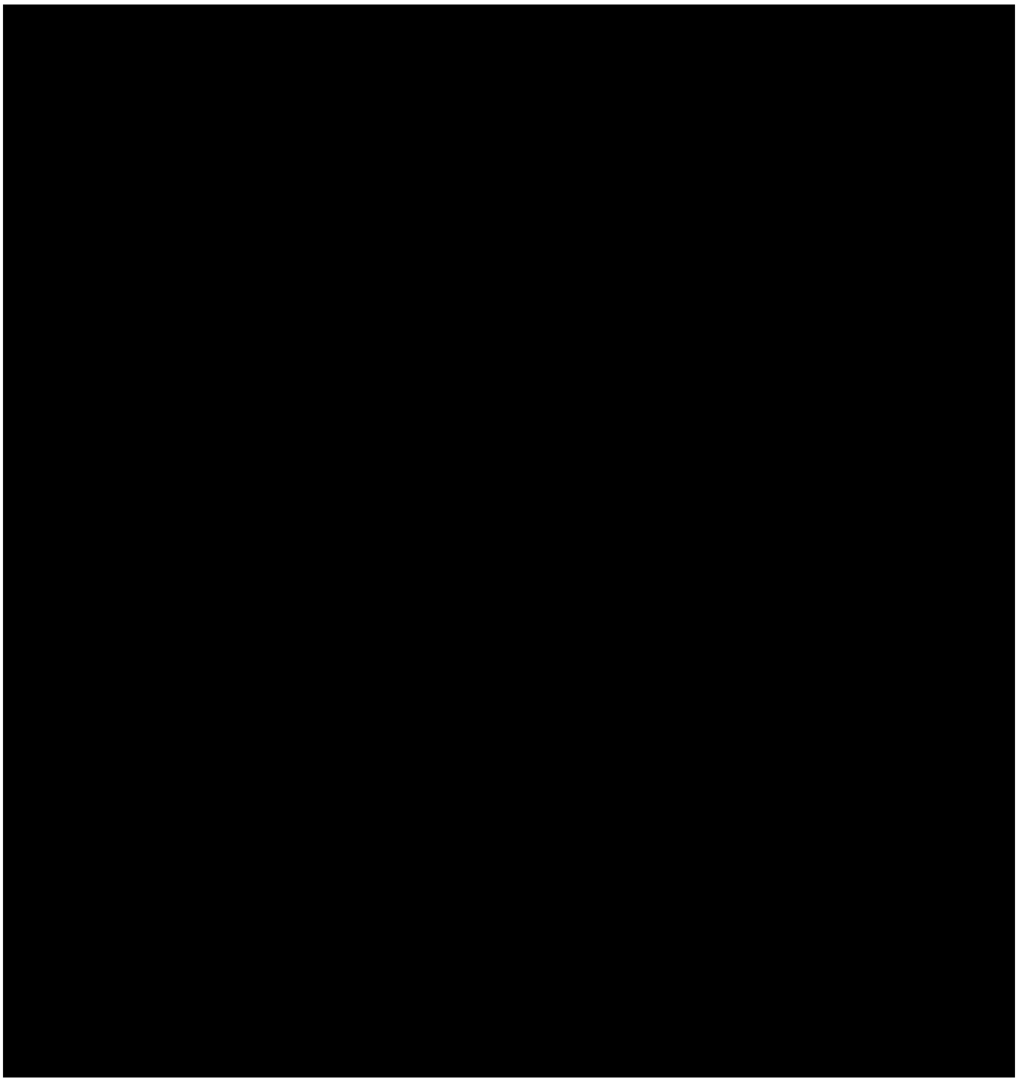


Table 5.5.2

Run title : North-East Arctic saithe

At 24/04/2008 10:53

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1960	1961	1962	1963	1964	1965	1966	1967
AGE								
3	0.1412	0.2383	0.2772	0.1747	0.108	0.1562	0.1876	0.1886
4	0.1843	0.1755	0.2297	0.3606	0.4012	0.0805	0.3616	0.3278
5	0.5007	0.2695	0.1204	0.1825	0.276	0.3093	0.3131	0.4319
6	0.2407	0.2519	0.2882	0.1797	0.1198	0.3557	0.2447	0.1522
7	0.3847	0.0915	0.253	0.2108	0.1978	0.1786	0.2736	0.1595
8	0.4184	0.1206	0.0942	0.1734	0.2195	0.1772	0.1219	0.2757
9	0.3585	0.1479	0.1645	0.1355	0.3055	0.369	0.1106	0.1777
10	0.3832	0.177	0.1849	0.1771	0.2248	0.2795	0.2138	0.2406
+gp	0.3832	0.177	0.1849	0.1771	0.2248	0.2795	0.2138	0.2406
0 FBAR 4	0.3276	0.1971	0.2228	0.2334	0.2487	0.231	0.2983	0.2679

Table 8 Fishing mortality (F) at age

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	0.2041	0.3402	0.188	0.3511	0.5893	0.4905	0.6669	0.5962	0.9054	0.786
4	0.1709	0.1406	0.5146	0.4216	0.4299	0.4766	0.5911	0.459	0.6942	0.6807
5	0.1024	0.2354	0.2432	0.4348	0.3782	0.411	0.6231	0.4556	0.661	0.5207
6	0.1649	0.1307	0.3709	0.261	0.2894	0.3693	0.637	0.3552	0.4704	0.3522
7	0.0391	0.1356	0.2034	0.3929	0.2409	0.3373	0.5334	0.5379	0.5163	0.4538
8	0.0747	0.0721	0.348	0.1697	0.2451	0.2654	0.4017	0.656	0.4431	0.4306
9	0.1274	0.0885	0.2271	0.3262	0.1569	0.321	0.3673	0.4563	0.592	0.4163
10	0.102	0.133	0.28	0.3188	0.2635	0.3429	0.5166	0.496	0.541	0.4379
+gp	0.102	0.133	0.28	0.3188	0.2635	0.3429	0.5166	0.496	0.541	0.4379
0 FBAR 4	0.1193	0.1606	0.333	0.3776	0.3346	0.3986	0.5961	0.4519	0.5855	0.5019

Table 8 Fishing mortality (F) at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	0.6157	0.4447	0.5173	0.4113	0.4036	0.2139	0.7553	0.7848	0.1167	0.1237
4	0.524	0.6834	0.5184	0.5845	0.6568	0.5371	0.8242	0.5074	0.4841	0.4166
5	0.5675	0.5606	0.6404	0.6683	0.8687	0.8443	0.5812	0.4128	0.5255	0.2957
6	0.467	0.3991	0.5357	0.5632	0.5852	0.5404	0.8098	0.547	0.499	0.5696
7	0.4574	0.6257	0.5721	0.4246	0.3134	0.4398	0.3682	0.7106	0.6395	0.9404
8	0.3556	0.6249	0.6731	0.8956	0.3812	0.6971	0.5067	0.464	0.6405	0.3488
9	0.5508	0.4825	0.1766	0.3908	0.5213	0.4221	0.8812	0.5097	0.3954	0.6651
10	0.4833	0.543	0.5237	0.5936	0.5383	0.5938	0.6351	0.5331	0.5444	0.5687
+gp	0.4833	0.543	0.5237	0.5936	0.5383	0.5938	0.6351	0.5331	0.5444	0.5687
0 FBAR 4	0.504	0.5672	0.5666	0.5601	0.606	0.5904	0.6459	0.5444	0.537	0.5556

Table 8 Fishing mortality (F) at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	0.1158	0.2295	0.4529	0.3513	0.1183	0.0779	0.0327	0.0442	0.0657	0.0595
4	0.3896	0.44	0.5533	0.5123	0.2864	0.2371	0.1692	0.3559	0.1938	0.0968
5	0.5375	0.7752	0.3812	0.3662	0.4443	0.471	0.304	0.293	0.205	0.1823
6	0.5826	0.6721	0.5809	0.3648	0.7091	0.5523	0.6025	0.3124	0.2109	0.2279
7	1.2041	0.4634	0.6256	0.453	0.7398	0.5218	0.6882	0.251	0.3042	0.2359
8	1.0966	0.5596	0.5842	0.4222	0.8507	0.486	0.4261	0.3348	0.2714	0.1886
9	1.056	0.4333	0.5426	0.4231	0.5003	0.7457	0.2687	0.119	0.6689	0.1149
10	0.9051	0.5857	0.5474	0.4087	0.6548	0.56	0.4613	0.2634	0.3068	0.1414
+gp	0.9051	0.5857	0.5474	0.4087	0.6548	0.56	0.4613	0.2634	0.3068	0.1414
0 FBAR 4	0.6785	0.5877	0.5352	0.4241	0.5449	0.4456	0.441	0.3031	0.2285	0.1857

Table 8 Fishing mortality (F) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	FBAR
AGE											
3	0.0236	0.0314	0.0588	0.0175	0.0189	0.0175	0.0059	0.063	0.0409	0.0204	0.0414
4	0.1086	0.1227	0.0964	0.0665	0.1041	0.1955	0.0582	0.0946	0.2345	0.1094	0.1462
5	0.1356	0.2202	0.1064	0.159	0.1302	0.1077	0.1928	0.1235	0.1217	0.2124	0.1526
6	0.251	0.1667	0.1514	0.1694	0.223	0.1084	0.1148	0.1944	0.1828	0.2411	0.2061
7	0.2144	0.2323	0.1406	0.1434	0.1465	0.1192	0.1578	0.1642	0.2145	0.2265	0.2017
8	0.1436	0.1252	0.151	0.0999	0.1198	0.2181	0.1425	0.1739	0.1804	0.2169	0.1904
9	0.1089	0.1209	0.1302	0.1197	0.1022	0.1357	0.1635	0.1962	0.2643	0.2358	0.2321
10	0.1429	0.1188	0.133	0.1398	0.1206	0.1473	0.1668	0.2347	0.1915	0.3479	0.258
+gp	0.1429	0.1188	0.133	0.1398	0.1206	0.1473	0.1668	0.2347	0.1915	0.3479	
0 FBAR 4	0.1774	0.1855	0.1237	0.1346	0.151	0.1327	0.1309	0.1442	0.1884	0.1973	

Table 5.5.3

Run title : North-East Arctic saithe

At 24/04/2008 10:53

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967
	AGE								
	3	88173	92920	170143	289935	97186	283653	144689	190738
	4	85921	62681	59948	105582	199330	71425	198653	98200
	5	38001	58508	43057	39010	60271	109269	53953	113296
	6	26165	18857	36586	31252	26611	37443	65664	32298
	7	16897	16840	12001	22453	21379	19328	21479	42090
	8	7761	9416	12582	7630	14890	14362	13236	13376
	9	4823	4181	6833	9375	5252	9788	9850	9593
	10	2580	2759	2953	4746	6703	3168	5541	7220
	+gp	5253	8334	11260	12044	19432	16183	16565	17951
0	TOT/	275574	274496	355364	522026	451054	564620	529629	524762

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

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
	AGE										
	3	150801	296371	280751	287484	161777	217484	83523	149692	231999	201095
	4	129322	100667	172675	190463	165682	73477	109025	35101	67514	76813
	5	57927	89245	71607	84509	102299	88246	37350	49425	18160	27610
	6	60225	42811	57741	45971	44794	57383	47899	16400	25657	7677
	7	22711	41814	30755	32626	28991	27458	32476	20741	9413	13123
	8	29379	17882	29893	20546	18033	18655	16044	15597	9916	4599
	9	8313	22322	13622	17281	14197	11554	11713	8790	6627	5212
	10	6576	5992	16728	8887	10210	9936	6862	6641	4560	3001
	+gp	13243	4518	12585	22073	14934	14828	10361	11585	7538	3503
0	TOT/	478496	621623	686356	709838	560918	519020	355252	313973	381385	342634

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

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
	3	117719	190765	111635	275155	115593	98965	86443	99417	221864	169720
	4	75019	52071	100118	54485	149313	63211	65423	33254	37134	161636
	5	31838	36370	21524	48813	24864	63386	30247	23493	16391	18735
	6	13430	14778	16999	9288	20486	8539	22308	13848	12730	7935
	7	4420	6893	8118	8146	4330	9342	4072	8126	6561	6328
	8	6825	2290	3018	3751	4362	2591	4927	2307	3269	2834
	9	2448	3916	1004	1261	1254	2439	1057	2430	1188	1411
	10	2814	1155	1979	689	698	610	1309	358	1195	655
	+gp	6140	3111	4370	1535	1177	1854	2083	1855	742	2009
0	TOT/	260653	311349	268767	403123	322076	250938	217869	185089	301074	371262

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

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
	3	82112	67647	72188	256207	441937	333656	242715	439450	182774	225677
	4	122787	59875	44029	37575	147619	321464	252712	192332	344248	140133
	5	87250	68094	31572	20729	18431	90760	207637	174698	110318	232183
	6	11413	41731	25680	17656	11767	9677	46396	125438	106706	73582
	7	3675	5218	17446	11761	10037	4741	4560	20795	75147	70753
	8	2023	903	2688	7641	6121	3922	2303	1876	13246	45388
	9	1637	553	422	1227	4102	2141	1975	1232	1099	8267
	10	594	466	294	201	658	2036	831	1236	895	461
	+gp	186	503	698	585	1004	372	1941	1390	1969	1219
0	TOT/	311676	244989	195016	353582	641676	768769	761071	958444	836401	797662

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

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 60-**	AMST 60-**
	AGE													
	3	146480	345007	177451	243859	390821	148384	187759	472092	54530	117483	0	179070	203520
	4	174101	117131	273731	136982	196186	313992	119374	152828	362915	42858	94249	107667	129158
	5	104146	127870	84827	203512	104932	144740	211429	92206	113834	235012	31455	60106	77668
	6	158416	74459	83996	62441	142126	75422	106402	142748	66718	82518	155599	32912	46475
	7	47968	100910	51599	59110	43158	93107	55409	77667	96222	45497	53090	17951	27217
	8	45756	31694	65490	36706	41928	30518	67664	38741	53961	63573	29703	9645	16404
	9	30774	32450	22896	46106	27194	30452	20090	48039	26656	36888	41903	5293	10400
	10	6034	22596	23543	16456	33490	20102	21767	13967	32323	16755	23858	2910	6351
	+gp	3257	5869	10780	16382	23182	32954	38214	11957	26979	9467	15161		
0	TOT/	716932	857986	794312	821553	1003017	889672	828109	1050244	834139	650051	445017		

Table 5.5.4

Run title : North-East Arctic saithe

At 24/04/2008 10:53

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
AGE								
3	0	0	0	0	0	0	0	0
4	859	627	599	1056	1993	714	1987	982
5	20901	32179	23681	21455	33149	60098	29674	62313
6	22240	16028	31098	26564	22619	31827	55815	27453
7	16559	16503	11761	22004	20952	18941	21049	41248
8	7761	9416	12582	7630	14890	14362	13236	13376
9	4823	4181	6833	9375	5252	9788	9850	9593
10	2580	2759	2953	4746	6703	3168	5541	7220
+gp	5253	8334	11260	12044	19432	16183	16565	17951

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

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	1293	1007	1727	1905	1657	735	1090	351	675	768
5	31860	49085	39384	46480	56265	48535	20543	27184	9988	15185
6	51191	36389	49080	39076	38075	48776	40714	13940	21809	6526
7	22256	40978	30140	31973	28412	26909	31826	20326	9225	12861
8	29379	17882	29893	20546	18033	18655	16044	15597	9916	4599
9	8313	22322	13622	17281	14197	11554	11713	8790	6627	5212
10	6576	5992	16728	8887	10210	9936	6862	6641	4560	3001
+gp	13243	4518	12585	22073	14934	14828	10361	11585	7538	3503

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

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	750	521	1001	545	1493	632	654	1330	1114	4849
5	17511	20004	11838	26847	13675	34862	16636	17855	12457	11803
6	11415	12561	14449	7895	17413	7258	18961	12048	11329	6983
7	4331	6755	7956	7983	4243	9155	3991	7476	6233	6328
8	6825	2290	3018	3751	4362	2591	4927	2307	3269	2834
9	2448	3916	1004	1261	1254	2439	1057	2430	1188	1411
10	2814	1155	1979	689	698	610	1309	358	1195	655
+gp	6140	3111	4370	1535	1177	1854	2083	1855	742	2009

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	11051	9580	7485	4509	7381	9644	22744	26926	48195	15415
5	48860	38132	20837	14925	11796	49011	103819	92590	55159	97517
6	8445	26708	15922	13242	9884	8806	39436	101605	77895	43413
7	3675	5218	15876	10585	8933	4646	4424	18715	63123	52357
8	2023	903	2688	7641	6121	3922	2303	1839	12848	37218
9	1637	553	422	1227	4102	2141	1975	1232	1099	8267
10	594	466	294	201	658	2036	831	1236	895	461
+gp	186	503	698	585	1004	372	1941	1390	1969	1219

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

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
3	0	0	0	0	0	0	0	0	0	0
4	13928	4685	13687	6849	13733	31399	15519	25981	47179	4286
5	28120	35804	22903	77334	47219	66581	116286	56245	70577	126906
6	83961	40208	58797	48704	122229	65617	89378	121336	58712	75916
7	33098	72655	41795	55563	40568	88452	50977	71454	89486	44132
8	34774	23770	57631	34136	40251	28382	60897	33705	49644	60394
9	30774	32450	22896	46106	27194	30452	20090	48039	26656	36888
10	6034	22596	23543	16456	33490	20102	21767	13967	32323	16755
+gp	3257	5869	10780	16382	23182	32954	38214	11957	26979	9467

Table 5.5.5

Run title : North-East Arctic saithe

At 24/04/2008 10:53

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967
	AGE								
	3	62603	65973	120802	205854	69002	201394	102729	135424
	4	95372	69576	66543	117196	221257	79282	220505	109002
	5	61942	95368	70183	63586	98241	178108	87943	184672
	6	60964	43936	85246	72817	62003	87243	152998	75254
	7	53395	53214	37924	70952	67559	61076	67874	133004
	8	31275	37946	50706	30748	60005	57880	53339	53906
	9	23490	20363	33278	45655	25578	47668	47968	46718
	10	14524	15534	16625	26719	37736	17837	31196	40649
	+gp	42179	66999	89226	94556	151201	128799	134275	143497
0	TOTAL	445745	468910	570532	728082	792583	859287	898826	922127

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

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
	AGE										
	3	107069	210424	199333	204113	114862	154414	59301	106281	164719	142777
	4	143548	111741	191669	211414	183907	81559	121018	38962	74941	85263
	5	94421	145470	116720	137749	166748	143840	60881	80563	29600	45004
	6	140323	99749	134536	107113	104371	133702	111605	38212	59782	17888
	7	71766	132132	97187	103098	91613	86767	102624	65541	29746	41470
	8	118396	72064	120468	82800	72671	75178	64656	62856	39962	18533
	9	40485	108710	66337	84157	69137	56270	57040	42809	32272	25384
	10	37021	33734	94177	50032	57485	55938	38634	37392	25674	16898
	+gp	102186	33793	93178	155657	111662	109506	74774	82569	55176	25902
0	TOTAL	855213	947816	1113607	1136133	972456	897174	690533	555184	511872	419119

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

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
	3	83581	135443	88192	200863	89006	103913	61375	74563	130900	89952
	4	83271	57799	127150	76280	167231	84071	82433	44227	45303	135775
	5	51896	59283	43695	100067	50224	117897	61099	48631	32291	31100
	6	31291	34433	43348	25636	53467	23910	60231	36421	29278	18409
	7	13966	21781	26708	26881	14159	37366	15801	26654	18831	18793
	8	27504	9230	13100	16429	17055	10832	22021	9137	12161	11336
	9	11921	19069	5169	7501	5881	13001	5664	11033	5107	6658
	10	15844	6505	11378	4401	3931	3463	7935	1989	5605	3562
	+gp	46215	24293	30318	10502	8895	16067	14979	14865	4897	13867
0	TOTAL	365490	367836	389058	468560	409850	410522	331537	267519	284374	329451

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

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
	3	50910	50059	51253	174221	296098	203530	126212	246092	107837	139920
	4	106825	56881	44029	39453	149096	318250	192061	151942	282283	133126
	5	114297	95331	45779	38349	35387	149754	257470	207890	146722	287907
	6	27733	74281	53671	42199	26829	23805	98359	214499	196338	126561
	7	14223	15445	43440	36224	27804	13511	14685	59681	186363	166270
	8	10883	3367	10079	25597	19588	11883	8821	7092	49406	140703
	9	9544	2556	1647	5496	15299	7941	9262	5000	4748	34638
	10	3183	2177	1979	936	4178	9142	4415	6551	4780	2669
	+gp	1387	3616	4375	3847	7662	2341	11586	10507	13924	9067
0	TOTAL	338984	303712	256252	366324	581938	740158	722872	909252	992402	1040860

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

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	AGE										
	3	99607	231154	106470	182894	269666	97934	133309	278534	32173	89287
	4	174101	122988	281943	153420	198148	285733	122955	136017	301220	45858
	5	154137	185412	138268	313408	157398	205531	289657	137386	166198	331367
	6	296238	143705	176391	127379	279989	143302	202164	298343	118759	153483
	7	123757	229066	137770	153686	109621	236492	134091	167761	217461	109193
	8	140470	94130	205637	115255	136267	79042	202314	116223	147314	185633
	9	127097	117144	87233	167363	102523	106276	69311	155647	80501	120253
	10	32822	92644	103824	74711	144341	75384	81193	53355	125737	62832
	+gp	26282	32751	66079	87809	130280	161474	187250	65642	137055	43927
0	TOTAL	1174511	1248994	1303616	1375926	1528234	1391169	1422244	1408909	1326416	1141834

Table 5.5.6

Run title : North-East Arctic saithe

At 24/04/2008 10:53

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1960	1961	1962	1963	1964	1965	1966	1967
	AGE								
	3	0	0	0	0	0	0	0	0
	4	954	696	665	1172	2213	793	2205	1090
	5	34068	52452	38601	34972	54033	97959	48369	101570
	6	51820	37346	72459	61894	52703	74156	130048	63966
	7	52327	52150	37165	69533	66207	59854	66516	130344
	8	31275	37946	50706	30748	60005	57880	53339	53906
	9	23490	20363	33278	45655	25578	47668	47968	46718
	10	14524	15534	16625	26719	37736	17837	31196	40649
	+gp	42179	66999	89226	94556	151201	128799	134275	143497
0	TOTSF	250637	283486	338725	365249	449676	484948	513916	581740

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

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	1435	1117	1917	2114	1839	816	1210	390	749	853
	5	51931	80009	64196	75762	91711	79112	33484	44310	16280	24752
	6	119275	84787	114356	91046	88715	113647	94864	32480	50814	15205
	7	70330	129489	95243	101036	89781	85032	100571	64230	29151	40641
	8	118396	72064	120468	82800	72671	75178	64656	62856	39962	18533
	9	40485	108710	66337	84157	69137	56270	57040	42809	32272	25384
	10	37021	33734	94177	50032	57485	55938	38634	37392	25674	16898
	+gp	102186	33793	93178	155657	111662	109506	74774	82569	55176	25902
0	TOTSF	541059	543703	649873	642603	583002	575498	465235	367035	250079	168167

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

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	833	578	1272	763	1672	841	824	1769	1359	4073
	5	28543	32606	24032	55037	27623	64844	33604	36959	24541	19593
	6	26598	29268	36846	21790	45447	20324	51196	31686	26058	16200
	7	13687	21346	26174	26344	13876	36619	15485	24521	17889	18793
	8	27504	9230	13100	16429	17055	10832	22021	9137	12161	11336
	9	11921	19069	5169	7501	5881	13001	5664	11033	5107	6658
	10	15844	6505	11378	4401	3931	3463	7935	1989	5605	3562
	+gp	46215	24293	30318	10502	8895	16067	14979	14865	4897	13867
0	TOTSF	171144	142894	148289	142767	124381	165990	151709	131960	97618	94082

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

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	9614	9101	7485	4734	7455	9547	17286	21272	39520	14644
	5	64006	53385	30214	27611	22648	80867	128735	110182	73361	120921
	6	20522	47540	33276	31649	22536	21663	83605	173744	143327	74671
	7	14223	15445	39530	32602	24745	13240	14244	53713	156545	123040
	8	10883	3367	10079	25597	19588	11883	8821	6950	47924	115376
	9	9544	2556	1647	5496	15299	7941	9262	5000	4748	34638
	10	3183	2177	1979	936	4178	9142	4415	6551	4780	2669
	+gp	1387	3616	4375	3847	7662	2341	11586	10507	13924	9067
0	TOTSF	133363	137186	128585	132474	124110	156626	277955	387918	484129	495025

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

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	AGE										
	3	0	0	0	0	0	0	0	0	0	0
	4	13928	4920	14097	7671	13870	28573	15984	23123	39159	4586
	5	41617	51915	37332	119095	70829	94544	159312	83806	103043	178938
	6	157006	77601	123474	99356	240791	124673	169818	253591	104508	141205
	7	85392	164927	111594	144465	103044	224668	123363	154340	202239	105918
	8	106757	70598	180961	107188	130816	73509	182083	101114	135529	176352
	9	127097	117144	87233	167363	102523	106276	69311	155647	80501	120253
	10	32822	92644	103824	74711	144341	75384	81193	53355	125737	62832
	+gp	26282	32751	66079	87809	130280	161474	187250	65642	137055	43927
0	TOTSF	590902	612500	724593	807657	936495	889102	988313	890619	927769	834010
	1										

Table 5.5.7

Run title : North-East Arctic saithe

At 24/04/2008 10:53

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	575498	213859	0.3716	0.3986
1974	83523	690533	465235	274121	0.5892	0.5961
1975	149692	555184	367035	233453	0.6361	0.4519
1976	231999	511872	250079	242486	0.9696	0.5855
1977	201095	419119	168167	182817	1.0871	0.5019
1978	117719	365490	171144	154464	0.9025	0.504
1979	190765	367836	142894	164180	1.149	0.5672
1980	111635	389058	148289	144554	0.9748	0.5666
1981	275155	468560	142767	175516	1.2294	0.5601
1982	115593	409850	124381	168034	1.351	0.606
1983	98965	410522	165990	156936	0.9455	0.5904
1984	86443	331537	151709	158786	1.0466	0.6459
1985	99417	267519	131960	107183	0.8122	0.5444
1986	221864	284374	97618	70458	0.7218	0.537
1987	169720	329451	94082	92391	0.982	0.5556
1988	82112	338984	133363	114242	0.8566	0.6785
1989	67647	303712	137186	122310	0.8916	0.5877
1990	72188	256252	128585	95848	0.7454	0.5352
1991	256207	366324	132474	107326	0.8102	0.4241
1992	441937	581938	124110	127516	1.0274	0.5449
1993	333656	740158	156626	153584	0.9806	0.4456
1994	242715	722872	277955	146544	0.5272	0.441
1995	439450	909252	387918	168378	0.4341	0.3031
1996	182774	992402	484129	171348	0.3539	0.2285
1997	225677	1040860	495025	143629	0.2901	0.1857
1998	146480	1174511	590902	153327	0.2595	0.1774
1999	345007	1248994	612500	150373	0.2455	0.1855
2000	177451	1303616	724593	135945	0.1876	0.1237
2001	243859	1375926	807657	136402	0.1689	0.1346
2002	390821	1528234	936495	155246	0.1658	0.151
2003	148384	1391169	889102	159757	0.1797	0.1327
2004	187759	1422244	988313	162140	0.1641	0.1309
2005	472092	1408909	890619	176678	0.1984	0.1442
2006	54530	1326416	927769	212670	0.2292	0.1884
2007	174596	1185240	834010	197334	0.2366	0.1973
Arith. Mean	198623	770500	418433	162034	0.5736	0.3646
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 5.6.1 Yield per recruit

MFYPR version 2a
Run: ypr
Time and date: 13:37 24.04.2008
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	13.0574	3.3957	11.1098	3.3957	11.1098
0.1000	0.0197	0.0857	0.2385	5.0899	11.2579	2.9826	9.3319	2.9826	9.3319
0.2000	0.0395	0.1536	0.4044	4.7516	9.8835	2.6577	7.9784	2.6577	7.9784
0.3000	0.0592	0.2091	0.5221	4.4756	8.8036	2.3947	6.9187	2.3947	6.9187
0.4000	0.0789	0.2555	0.6071	4.2453	7.9355	2.1770	6.0701	2.1770	6.0701
0.5000	0.0987	0.2949	0.6691	4.0496	7.2245	1.9936	5.3778	1.9936	5.3778
0.6000	0.1184	0.3290	0.7147	3.8807	6.6328	1.8367	4.8043	1.8367	4.8043
0.7000	0.1381	0.3587	0.7484	3.7331	6.1338	1.7008	4.3229	1.7008	4.3229
0.8000	0.1579	0.3851	0.7733	3.6028	5.7081	1.5819	3.9142	1.5819	3.9142
0.9000	0.1776	0.4085	0.7916	3.4866	5.3411	1.4769	3.5638	1.4769	3.5638
1.0000	0.1974	0.4297	0.8050	3.3823	5.0220	1.3834	3.2607	1.3834	3.2607
1.1000	0.2171	0.4488	0.8147	3.2880	4.7422	1.2997	2.9964	1.2997	2.9964
1.2000	0.2368	0.4662	0.8215	3.2022	4.4952	1.2243	2.7645	1.2243	2.7645
1.3000	0.2566	0.4821	0.8261	3.1237	4.2757	1.1560	2.5596	1.1560	2.5596
1.4000	0.2763	0.4967	0.8290	3.0516	4.0794	1.0938	2.3775	1.0938	2.3775
1.5000	0.2960	0.5103	0.8306	2.9850	3.9030	1.0370	2.2150	1.0370	2.2150
1.6000	0.3158	0.5228	0.8312	2.9234	3.7437	0.9848	2.0691	0.9848	2.0691
1.7000	0.3355	0.5345	0.8310	2.8661	3.5992	0.9369	1.9377	0.9369	1.9377
1.8000	0.3552	0.5454	0.8302	2.8127	3.4675	0.8926	1.8187	0.8926	1.8187
1.9000	0.3750	0.5556	0.8289	2.7627	3.3471	0.8515	1.7107	0.8515	1.7107
2.0000	0.3947	0.5652	0.8272	2.7159	3.2365	0.8135	1.6123	0.8135	1.6123

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.1974
FMax	1.6212	0.32
F0.1	0.7018	0.1385
F35%SPR	0.8069	0.1592

Weights in kilograms

Table 5.7.1 Prediction input data

MFDP version 1a
Run: stp
Time and date: 13:26 24.04.2008
Fbar age range: 4-7

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	174596	0.2	0	0	0	0.646667	4.63E-02	0.646667
4	140061	0.2	0.1	0	0	0.93	0.16331	0.93
5	31455	0.2	0.54	0	0	1.453333	0.170423	1.453333
6	155599	0.2	0.92	0	0	1.91	0.230273	1.91
7	53090	0.2	0.97	0	0	2.273333	0.225394	2.273333
8	29703	0.2	0.95	0	0	2.883333	0.212731	2.883333
9	41903	0.2	1	0	0	3.173333	0.259322	3.173333
10	23858	0.2	1	0	0	3.82	0.288297	3.82
11	15161	0.2	1	0	0	5.07	0.288297	5.07

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	174596	0.2	0	0	0	0.646667	4.63E-02	0.646667
4	.	0.2	0.1	0	0	0.93	0.16331	0.93
5	.	0.2	0.54	0	0	1.453333	0.170423	1.453333
6	.	0.2	0.92	0	0	1.91	0.230273	1.91
7	.	0.2	0.97	0	0	2.273333	0.225394	2.273333
8	.	0.2	0.95	0	0	2.883333	0.212731	2.883333
9	.	0.2	1	0	0	3.173333	0.259322	3.173333
10	.	0.2	1	0	0	3.82	0.288297	3.82
11	.	0.2	1	0	0	5.07	0.288297	5.07

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	174596	0.2	0	0	0	0.646667	4.63E-02	0.646667
4	.	0.2	0.1	0	0	0.93	0.16331	0.93
5	.	0.2	0.54	0	0	1.453333	0.170423	1.453333
6	.	0.2	0.92	0	0	1.91	0.230273	1.91
7	.	0.2	0.97	0	0	2.273333	0.225394	2.273333
8	.	0.2	0.95	0	0	2.883333	0.212731	2.883333
9	.	0.2	1	0	0	3.173333	0.259322	3.173333
10	.	0.2	1	0	0	3.82	0.288297	3.82
11	.	0.2	1	0	0	5.07	0.288297	5.07

Input units are thousands and kg - output in tonnes

Table 5.7.2 Short term prediction

MFDP version 1a
Run: stp
00MFDP Index file 24.04.2008
Time and date: 13:26 24.04.2008
Fbar age range: 4-7

2008 Biomass	SSB	FMult	FBar	Landings
1093382	810538	1.3689	0.2702	247000

2009 Biomass	SSB	FMult	FBar	Landings	2010 Biomass	SSB
971981	671414	0.0000	0.0000	0	1135280	805709
.	671414	0.1000	0.0197	17697	1115324	787959
.	671414	0.2000	0.0395	35009	1095810	770620
.	671414	0.3000	0.0592	51944	1076726	753681
.	671414	0.4000	0.0789	68513	1058063	737132
.	671414	0.5000	0.0987	84722	1039810	720965
.	671414	0.6000	0.1184	100582	1021959	705170
.	671414	0.7000	0.1381	116099	1004500	689738
.	671414	0.8000	0.1579	131281	987424	674661
.	671414	0.9000	0.1776	146137	970722	659930
.	671414	1.0000	0.1974	160674	954385	645537
.	671414	1.1000	0.2171	174900	938405	631474
.	671414	1.2000	0.2368	188821	922773	617733
.	671414	1.3000	0.2566	202445	907481	604306
.	671414	1.4000	0.2763	215778	892522	591186
.	671414	1.5000	0.2960	228827	877887	578366
.	671414	1.6000	0.3158	241599	863570	565838
.	671414	1.7000	0.3355	254100	849563	553596
.	671414	1.8000	0.3552	266336	835858	541633
.	671414	1.9000	0.3750	278314	822450	529942
.	671414	2.0000	0.3947	290039	809330	518516

Input units are thousands and kg - output in tonnes

Table 5.7.3. Short term projection output HCR landings

MFDP version 1a
Run: 00
North-East Arctic saithe
Time and date: 13:13 24.04.2008
Fbar age range: 4-7

2008

Biomass	SSB	FMult	FBar	Landings
1093382	810538	1.3689	0.2702	247000

2009

Biomass	SSB	FMult	FBar	Landings	HCR landings
971981	671414	1.7739	0.3501	263174	224984

2010

Biomass	SSB	FMult	FBar	Landings
839400	544723	1.7739	0.3501	220525

2011

Biomass	SSB	FMult	FBar	Landings
739235	451630	1.7739	0.3501	191253

Table 5.7.4. Detailed short term projection output

MFDP version 1a
Run: 01
Time and date: 14:25 24.04.2008
Fbar age range: 4-7

Year:	2008	F multiplier	1.3689	Fbar:	0.2702				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0634	9727	6290	174596	112905	0	0	0	0
4	0.2236	25526	23739	140061	130257	14006	13026	14006	13026
5	0.2333	5955	8655	31455	45715	16986	24686	16986	24686
6	0.3152	38331	73212	155599	297194	143151	273419	143151	273419
7	0.3086	12840	29191	53090	120691	51497	117071	51497	117071
8	0.2912	6835	19706	29703	85644	28218	81361	28218	81361
9	0.355	11416	36227	41903	132972	41903	132972	41903	132972
10	0.3947	7098	27113	23858	91138	23858	91138	23858	91138
11	0.3947	4510	22867	15161	76866	15161	76866	15161	76866
Total		122238	247000	665426	1093382	334780	810538	334780	810538

Year:	2009	F multiplier	1.4703	Fbar:	0.2902				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
3	0.0681	10424	6741	174596	112905	0	0	0	0
4	0.2401	26062	24238	134169	124777	13417	12478	13417	12478
5	0.2506	18498	26884	91699	133270	49518	71966	49518	71966
6	0.3386	5339	10197	20394	38953	18763	35837	18763	35837
7	0.3314	23895	54321	92949	211304	90161	204965	90161	204965
8	0.3128	7813	22526	31927	92055	30330	87452	30330	87452
9	0.3813	5255	16677	18175	57674	18175	57674	18175	57674
10	0.4239	7586	28978	24055	91892	24055	91892	24055	91892
11	0.4239	6789	34421	21529	109150	21529	109150	21529	109150
Total		111662	224984	609493	971981	265947	671414	265947	671414

Input units are thousands and kg - output in tonnes

Table 5.7.5. Short term projection output HCR F_{max} landings

MFDP version 1a
Run: 00
North-East Arctic saithe
Time and date: 09:40 27.04.2008
Fbar age range: 4-7

2008

Biomass	SSB	FMult	FBar	Landings
1093382	810538	1.3689	0.2702	247000

2009

Biomass	SSB	FMult	FBar	Landings	HCR F_{max} landings
971981	671414	1.6219	0.3201	244359	213964

2010

Biomass	SSB	FMult	FBar	Landings
860477	563133	1.6219	0.3201	210758

2011

Biomass	SSB	FMult	FBar	Landings
770445	479727	1.6219	0.3201	186776

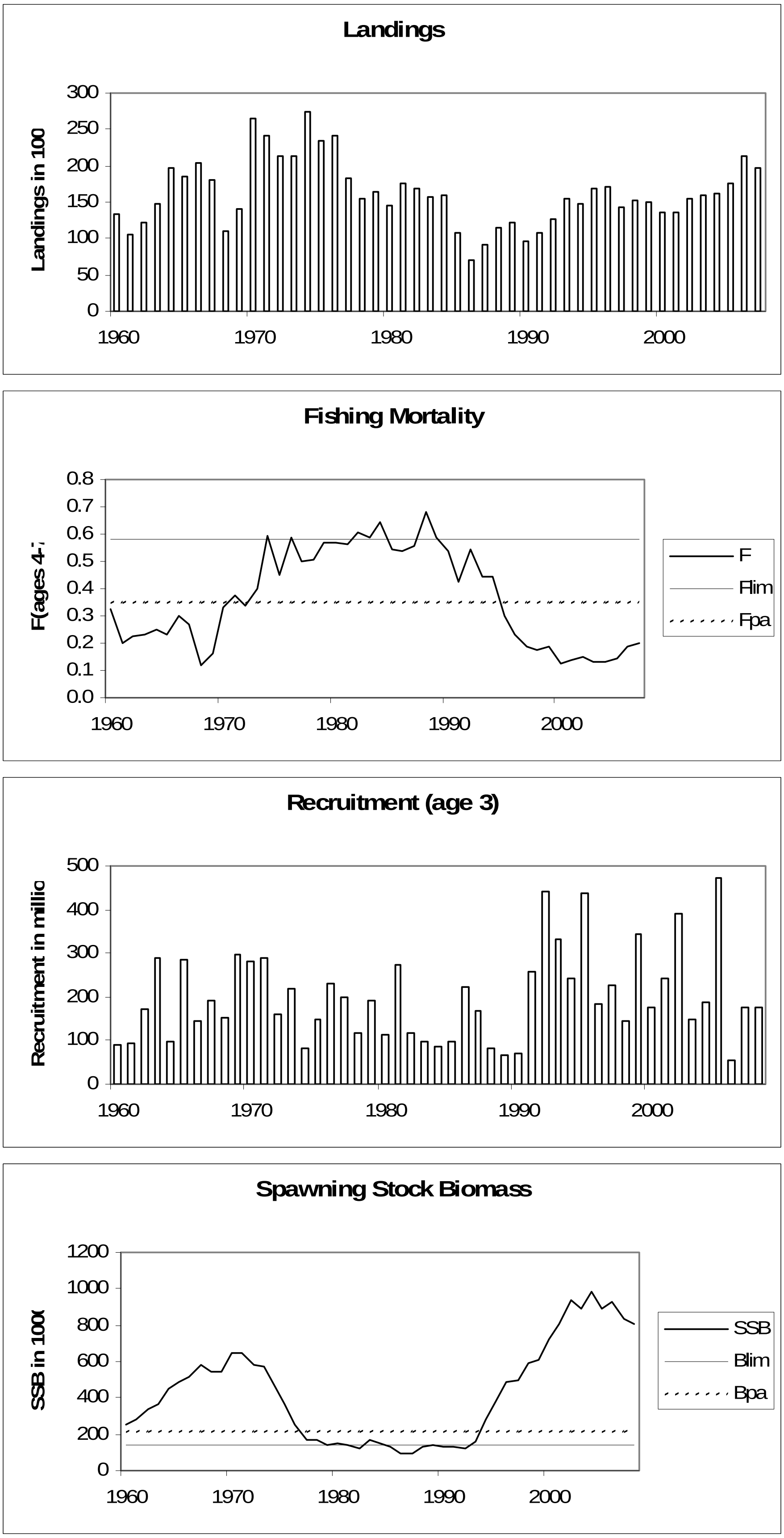
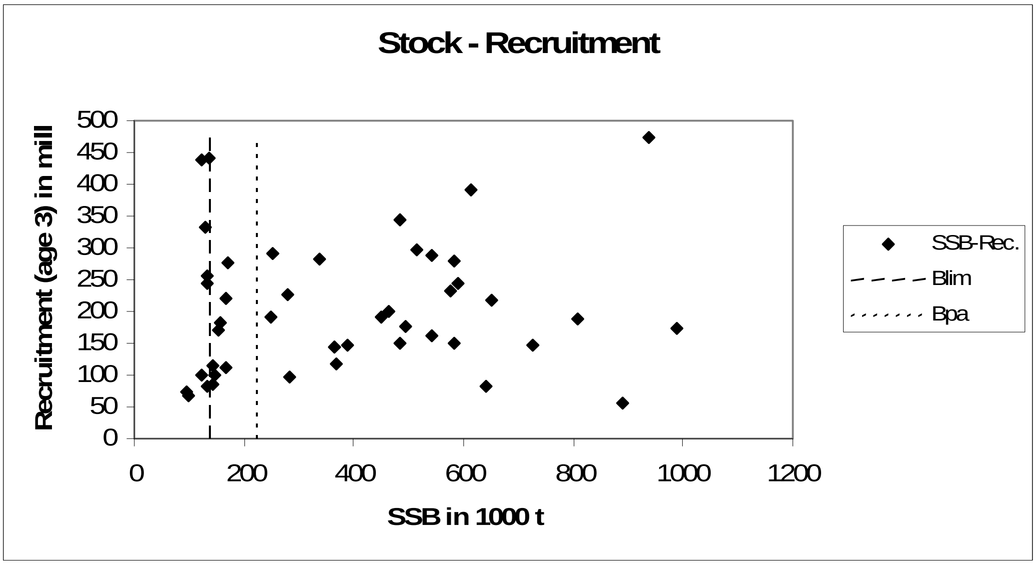
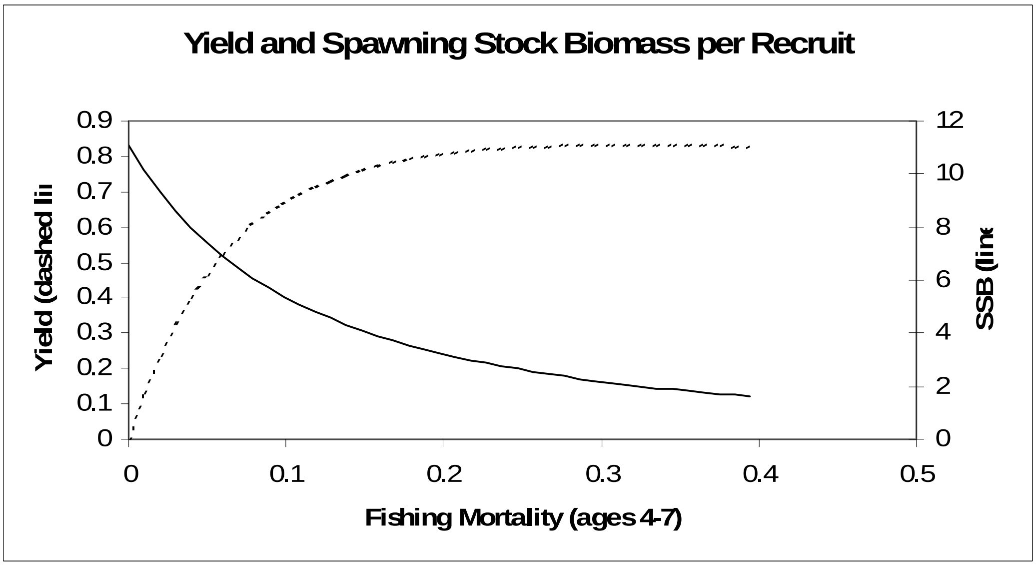


Figure 5.1.1 Saithe in Subareas I and II (North-East Arctic)





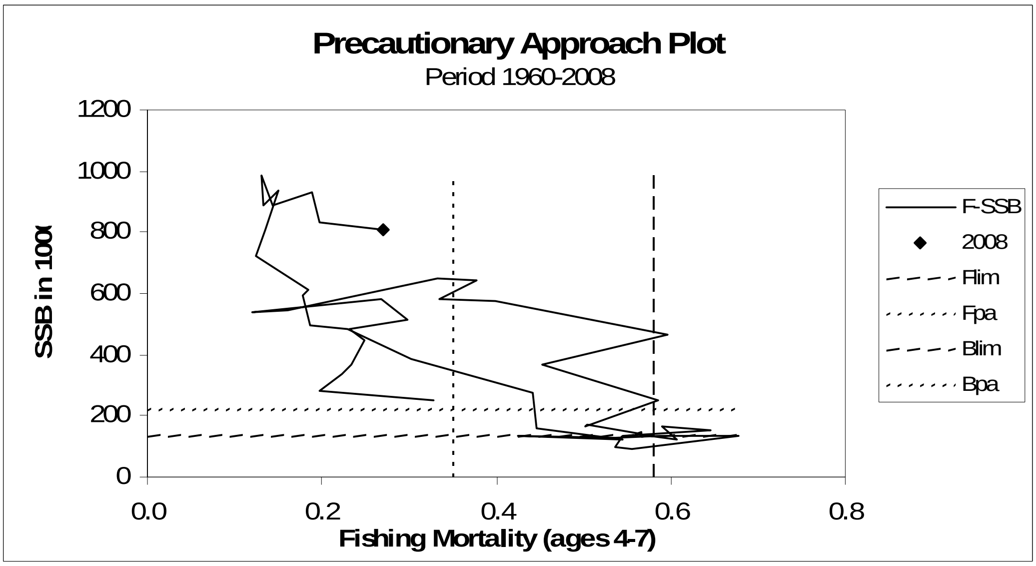


Figure 5.1.1 (continued)

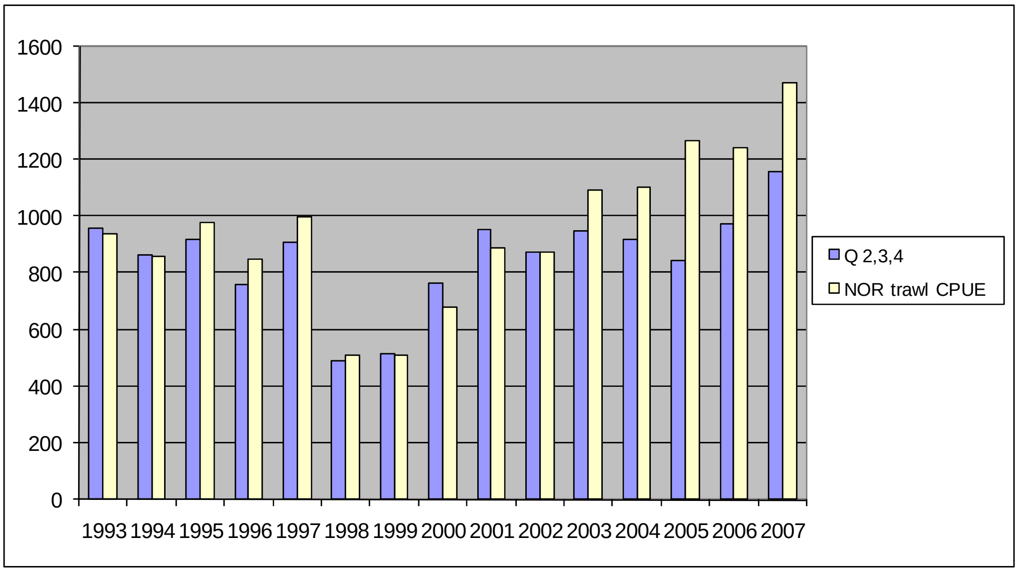


Figure 5.2.1. Norwegian trawl CPUE by year, averaged over quarter 1-4 (old) and over quarter 2-4 (new, applied from AFWG 2006)

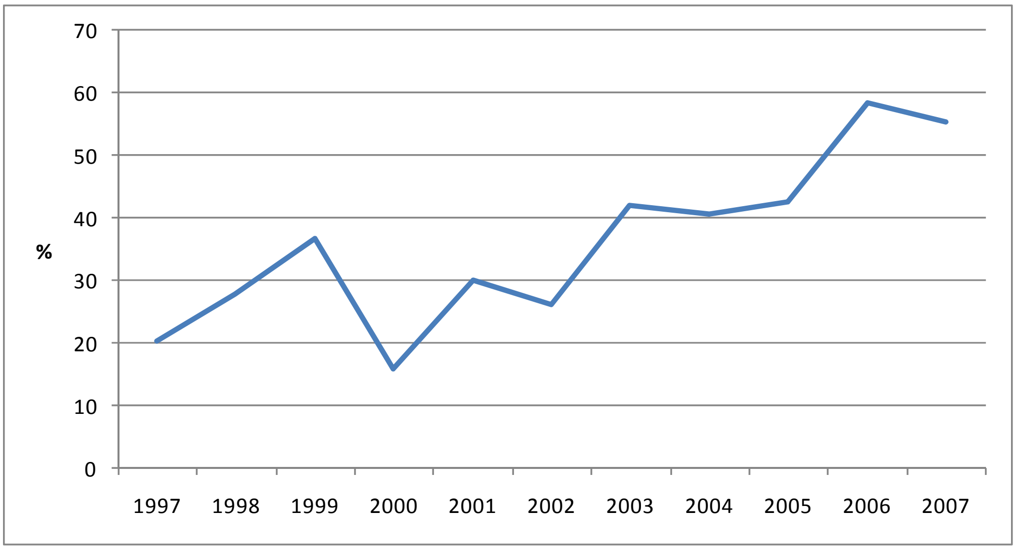


Figure 5.2.2. Proportion of saithe in the southern half of the survey area (sub area C+D).

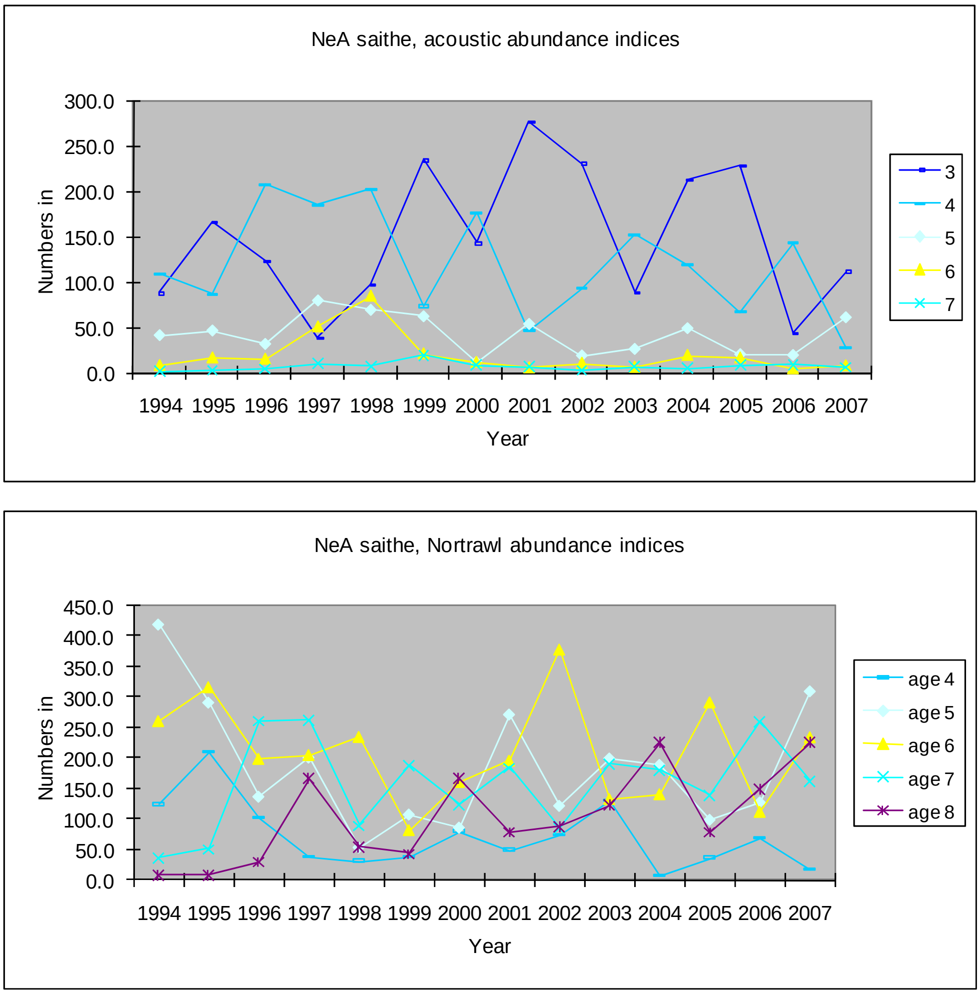


Figure 5.3.1 Saithe in Subareas I and II tuning abundance indices

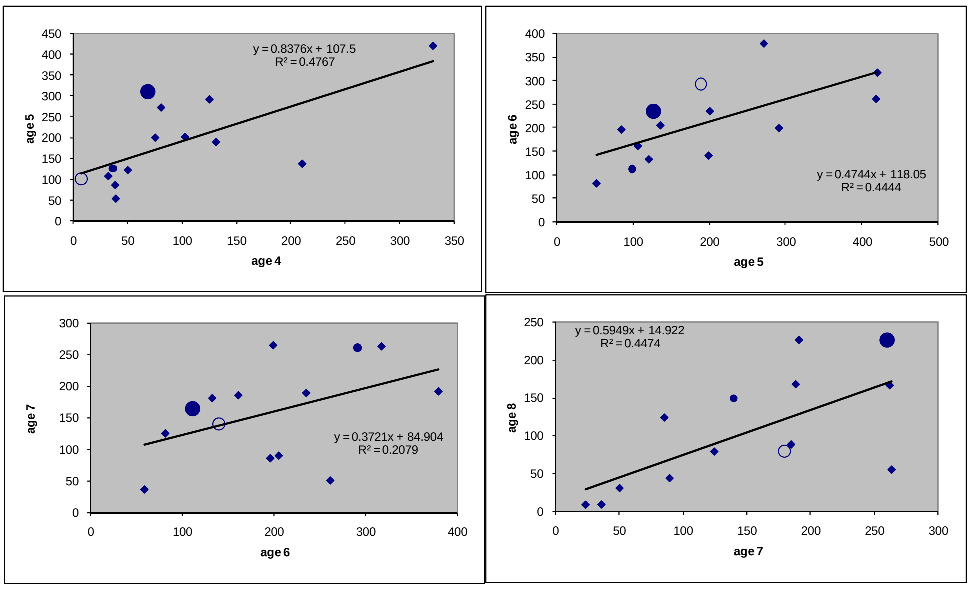


Figure 5.3.2 Comparative scatter plots at age of in the CPUE series. 2007 indicated.

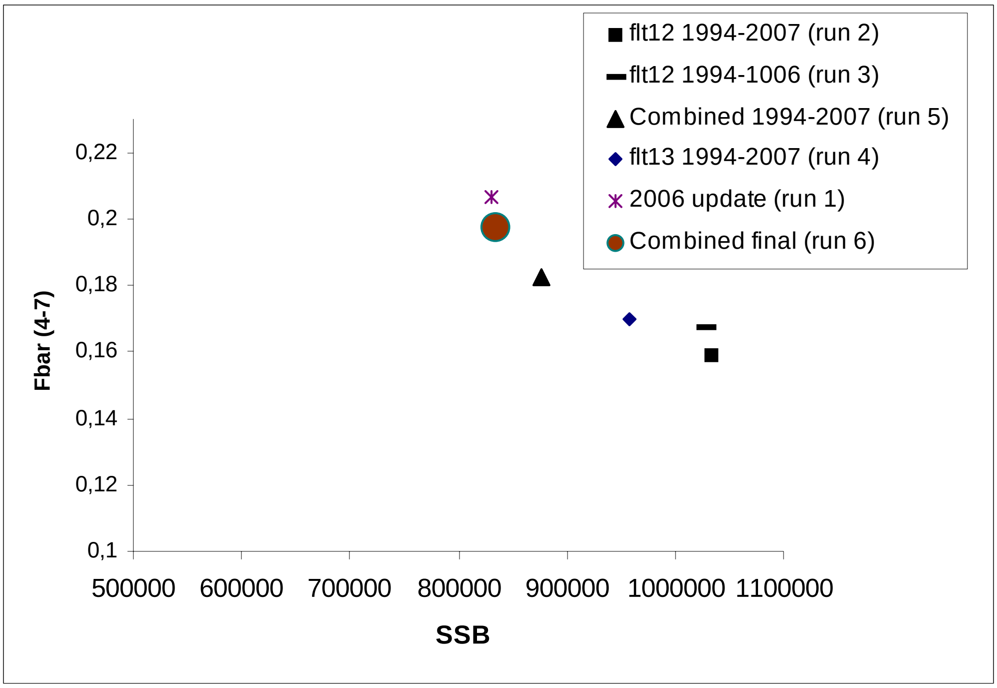


Figure 5.4.1 Comparison of SSB and F_{4-7} in 2007 from single fleet and combined XSA runs. SSB and F_{4-7} in 2006 from an updated 2006-data run is also presented.

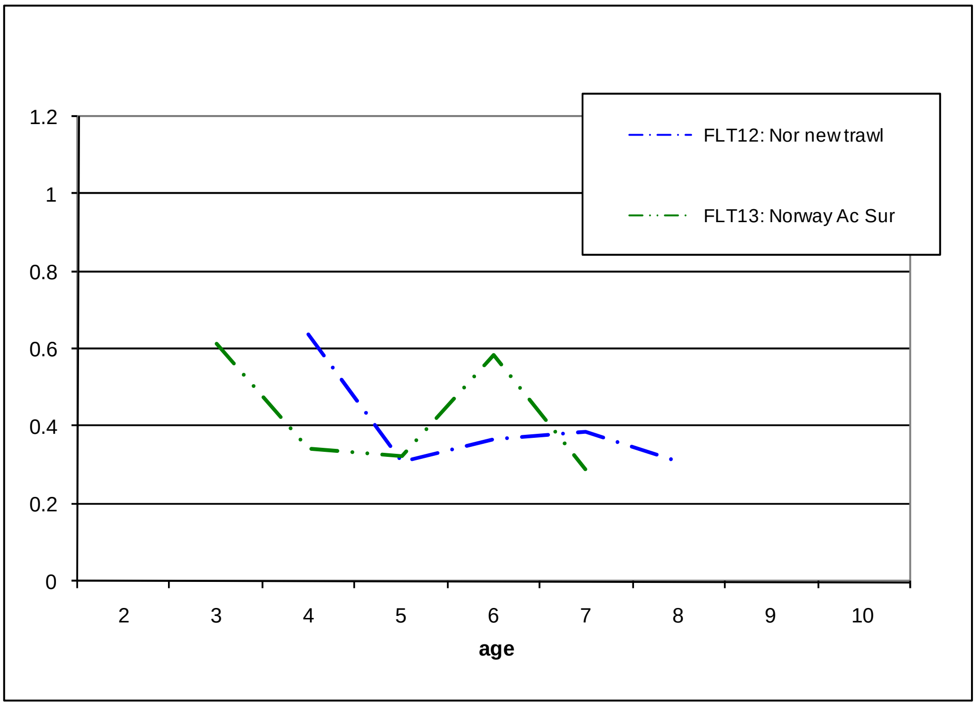


Figure 5.4.2. S.E. log catchability from two XSA single fleet tuning runs

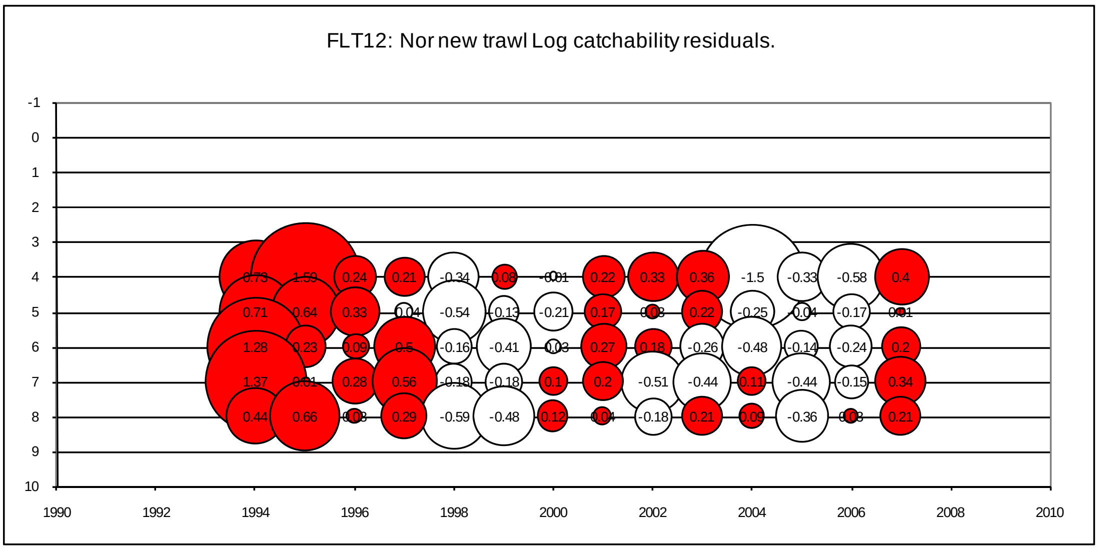


Figure 5.4.3 Log Q residuals from the 2007 CPUE data single fleet tuning run

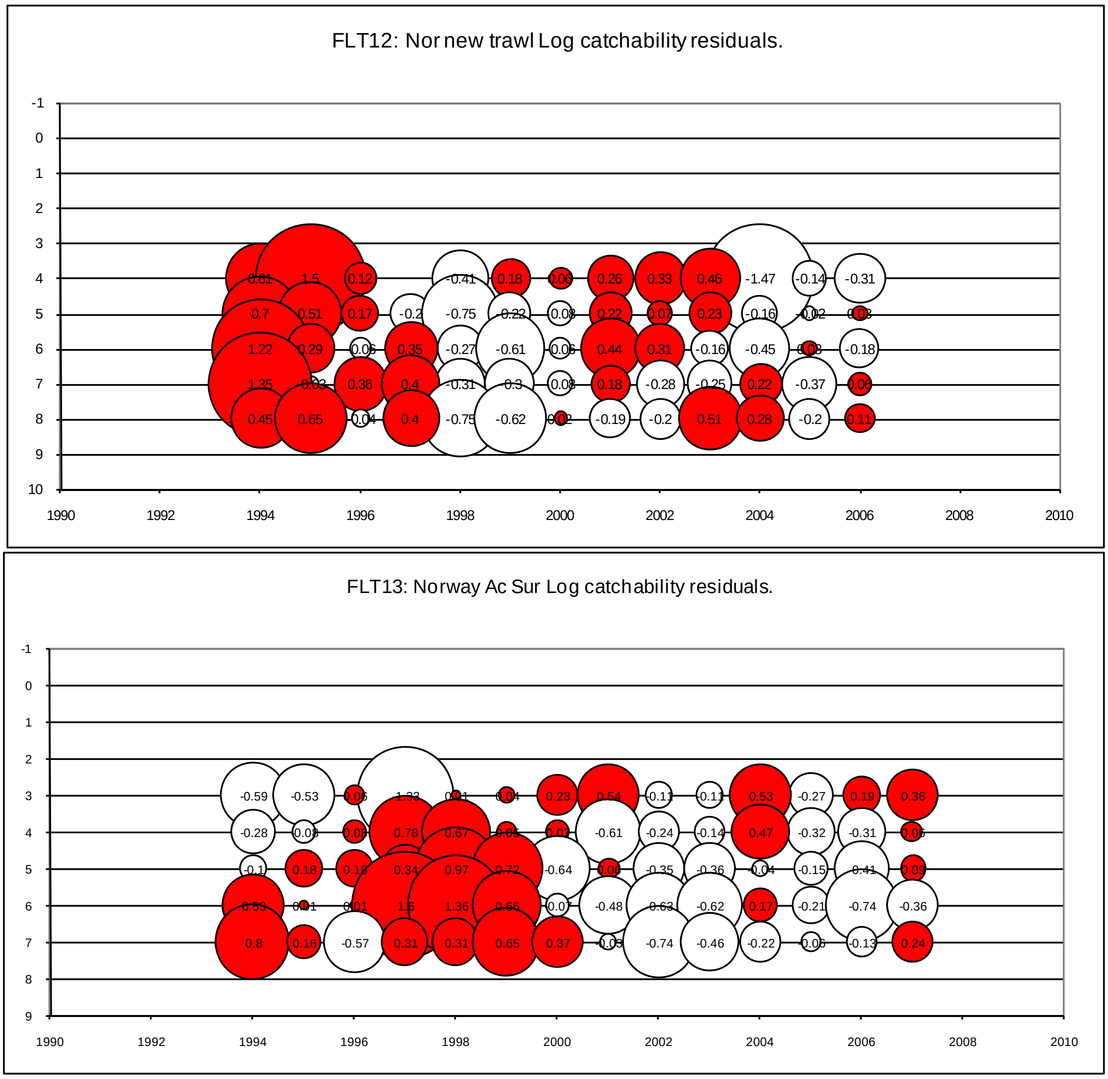


Figure 5.5.1 Log Q residuals from the final XSA run.

Figure 5.5.2 Scaled weights at age from the final XSA run

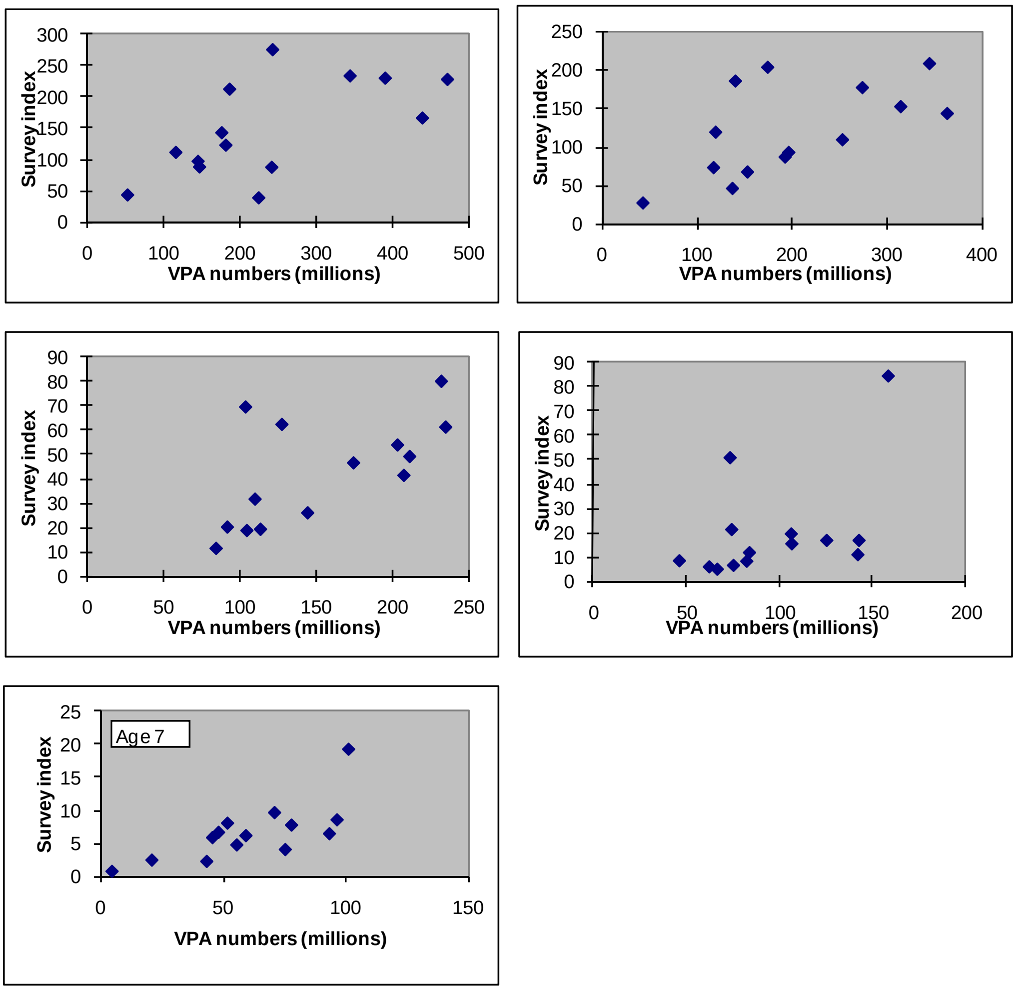


Figure 5.5.3A. Saithe in Subareas I and II (North-East Arctic) - Acoustic survey vs VPA

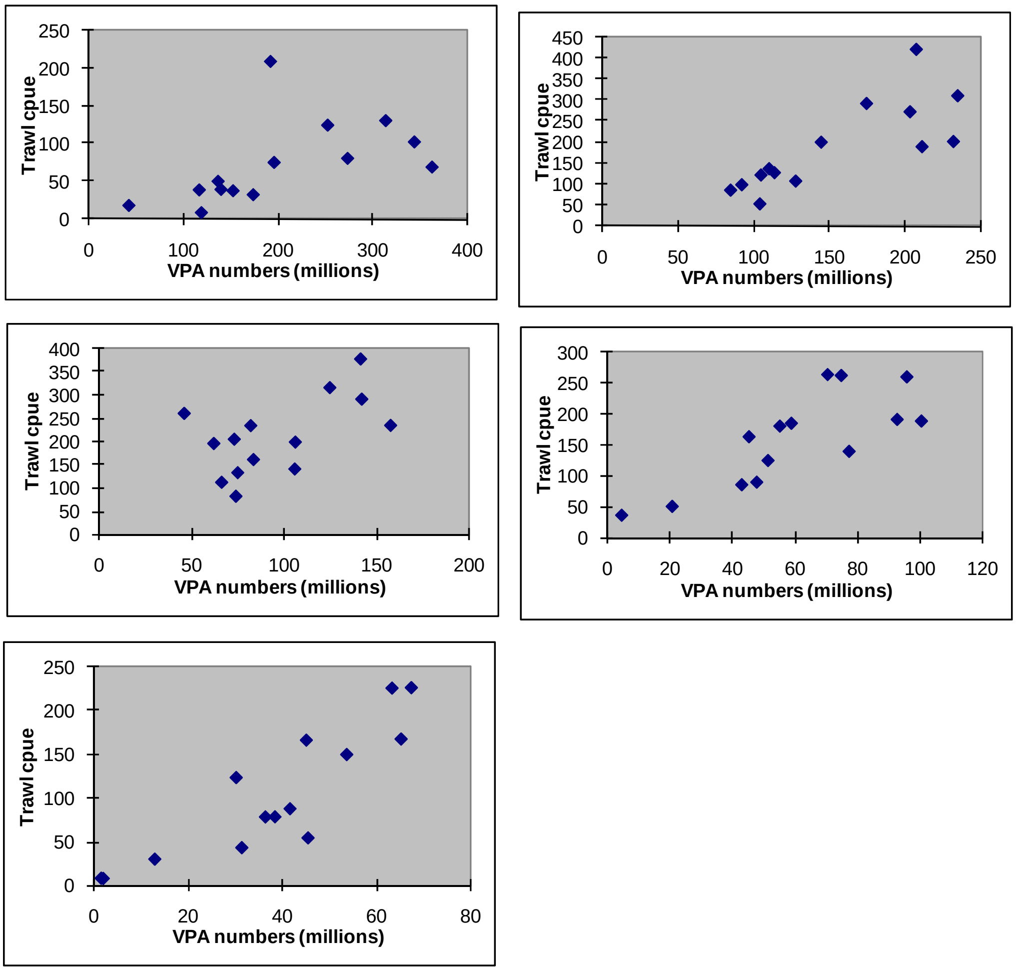


Figure 5.5.3B. Saithe in Subareas I and II (North-East Arctic)-Norwegian trawl vs VPA

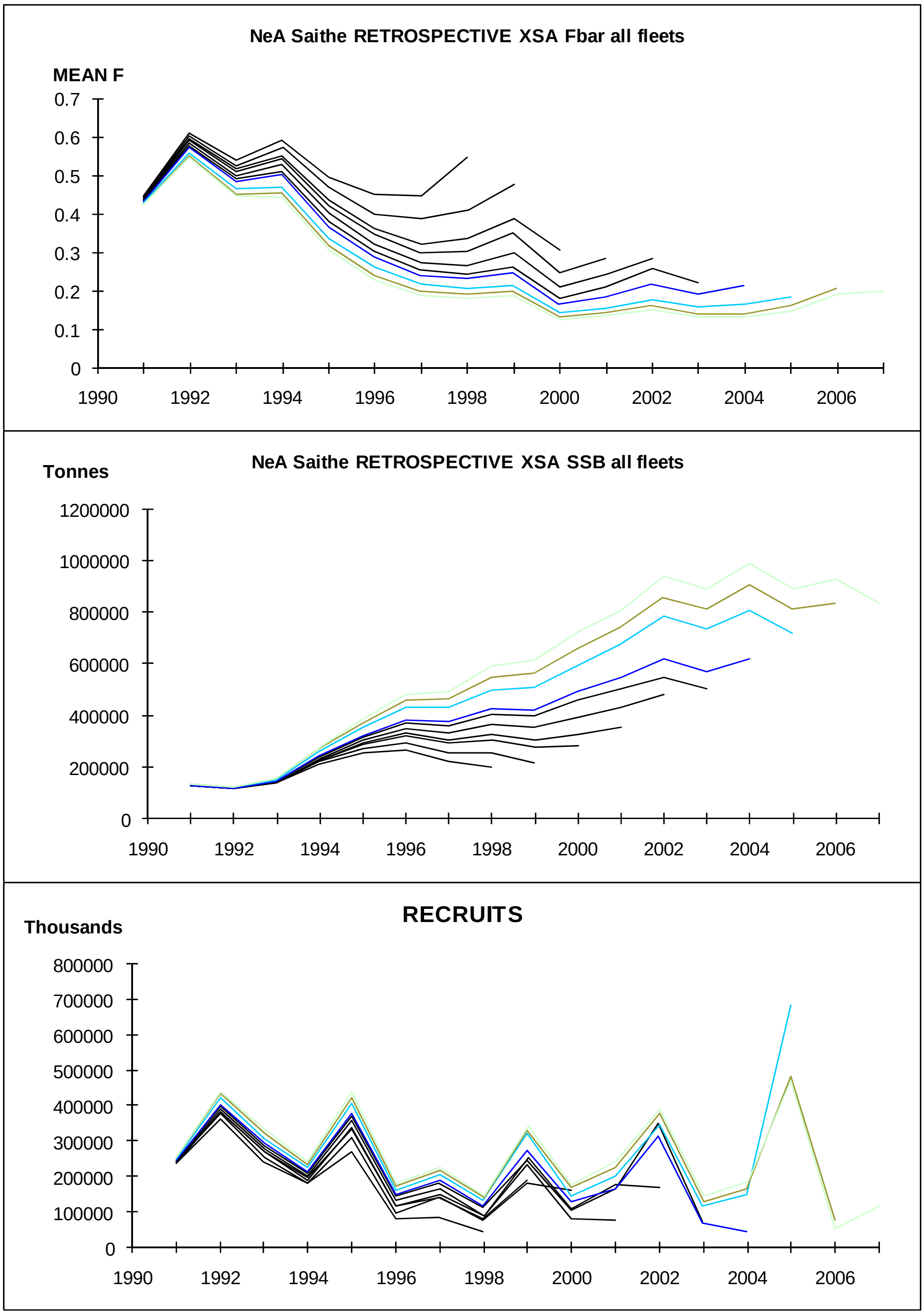


Figure 5.5.4 Saithe in Subareas I and II (North-East Arctic) RETROSPECTIVE XSA $F_{4\text{-}7}$, SSB and recruits for all fleets

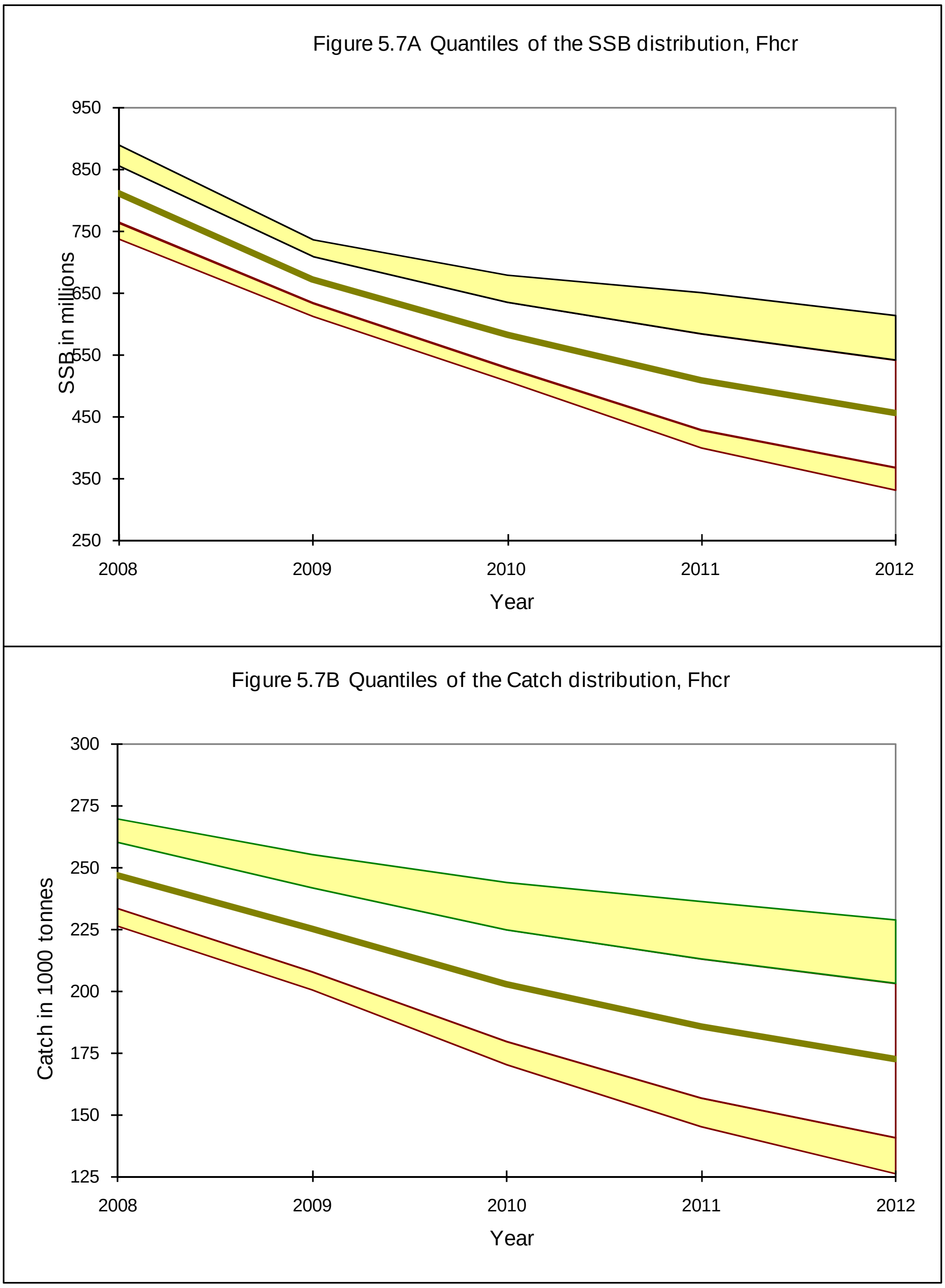


Figure 5.7.1A-b. Quantiles of SSB and catch distribution from medium term risk analyses, F_{hcr}

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 Sub-areas I and II except the pelagic fishery is found in the Quality handbook for this stock (see Annex "AFWG-S.mentella"2006). The Handbook will be updated later.

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 is further described in Chapter 6.8.

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 size groups are not sufficiently protected by the sorting grid.

6.1.3 Landings prior to 2008 (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* <u>and</u> *S. marinus*) in Table D1. The nominal catches by country for Subarea I and Divisions IIa and IIb are shown in Tables 6.2–6.5. Total international landings in 1965-2006 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 2004-2007 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. Despite the recent years' ICES advice of no directed trawlfishery, the Northeast Atlantic Fisheries Commission (NEAFC) set a TAC of 15,500 t, incl. all by-catches, to be taken in the pelagic trawl fisheries in international waters of the Norwegian Sea in 2007. According to reports to ICES, 15,981 t were caught. This quantity is somewhat different from the provisional landings statistics reported to NEAFC (14,583 t). The difference seems to be caused by different national reportings and mixing of demersal by-catches and pelagic directed catches. A similar difference in the reported quantities to ICES (28,458 t) and NEAFC (26,080 t) is also observed for 2006.

The redfish population in Sub-area IV (North Sea) is believed to belong to the North-east Arctic stock. Since this area is outside the traditional areas handled by this Working Group, the catches are not included in the assessment. The total redfish landings from Sub-area IV have up to 2003 been 1,000–3,000 t per year. Since then the annual landings from this area have been about 200-300 t (Table D2).

6.1.4 Expected landings in 2008

It is clear that a directed fishery for beaked redfish has begun, despite the recent ICES advice. This fishery has resulted in three to four times higher landings in recent year although some bycatch has also increased.

In 2008 there will be no directed demersal fishery for *S. mentella* , and all the current regulations will be continued in 2008, including the protection of juveniles from being caught in the shrimp fisheries. Based on the present regulations, and reports from the first months in 2008, the total landings of *S. mentella* for 2008 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 14,500 t for an olympic fishery in these international waters starting 1 September 2008. During an international trawl-acoustic survey in the Norwegian Sea in August 2008, another 2,000 t may be taken. In total this may lead to expected landings in 2008 of more than 20,000 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 2007.

6.2.1 Catch at age (Tables 6.6 and 6.8)

Catch at age for 2004-2006 was revised according to new catch data. Age data for 2007 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 Poland for pelagic *S.mentella* in 2007.. Russian total catch-at-length in Division IIa was converted to catch-at-age by using the Norwegian age-length key from Division IIa (northern part). The available length distribution from Germany catches in Division IIa was converted to catch-at-age by using the Norwegian age-length key from Division IIa (southern part). Other countries were assumed to have the same relative age distribution and mean weight as Norway.

6.2.2 Weight at age (Tables 6.7 and 6.9)

Catch weight-at-age data for 2007 were available from Norway for all areas, and from Russia from demersal fishery in Division IIb and Poland from 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 (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 a, b). A new method to calculate the 0-group series has been adopted (Figure 6.2b). These new indices are calculated by the method of stratified sample mean, and this method allows for confidence limits to be calculated (Anon. 2005).
2) Russian bottom trawl survey in the Svalbard and Barents Sea areas in October-December from 1978–2007 in fishing depths of 100–900 m (Table D3, Figure 6.3).
3) Norwegian Svalbard (Division IIb) bottom trawl survey (August-September) from 1986–2007 in fishing depths of 100–500 m (swept area down to 800 m). Data disaggregated by age only for the years 1992–2007 (Table D4a,b).
4) Norwegian Barents Sea bottom trawl survey (February) from 1986–2008 (joint with Russia since 2000, except 2006 and 2007) in fishing depths of 100–500 m. Data disaggregated by age only for the years 1992–2007 (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 1996-2007 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, and although the 2001-2006 year classes are among the lowest on record, a promising increase is observed since 2002 with the 2007 year class being the strongest observed and estimated since 1990 (Figures 6.2 a,b)

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 6.2a,b), 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 yearclasses borned 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 changing behaviour returning from the pelagic and back to the continental slope. The adult biomass (age 10 and older) has by the Ecosystem survey been estimated to about 200 000 t.

In the Russian bottom trawl survey the estimates for the 2003- and later year classes confirm an improved recruitment(Table D3, Figure 6.3). 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 as the abundance of larvae and juveniles in the Barents Sea currently is increasing.

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 Results of the Assessment

The signals of the various surveys are in agreement. The improved recruitment of 0-group and juveniles are confirmed by a couple of surveys. 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 those prior to 1991 as the following fifteen year classes are very poor. ICES gave last year the advice that 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.

6.4 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 surveys, no experimental analytical assessment has been attempted. However, the WG is concerned about that this may not hold true anymore as the fish show changes in its pelagic behaviour and are thus not properly covered by demersal survey trawls. As we manage to rebuild the stock, requests of allowing a fishery will come, and the stock may then suffer from lacking an analytical assessment which management plans and harvesting strategies may be based upon.

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 conduct pelagic surveys that as synoptically as possible cover the whole distribution area, incl. the areas where the bulk of the catches have been taken in recent years.

6.5 Biological reference points

Until an analytical assessment will be available and used as basis for reference points calculations for this stock, candidate reference points for the biomass could be set at the average biomass level, or at a certain percentage of this level, estimated by the Russian and Norwegian trawl surveys since 1986. ACFM is supporting this 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).

6.6 Management advice

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 (e.g. >10-15 years old) and surveys indicate failure of recruitment over a long time period. However, positive signs are seen. The year-classes born before 1991 seem to have been rather well protected and has led to an increased spawning stock and improved recruitment of larvae and juveniles.

The measures introduced in 2003 should, however, be continued, i.e. there should be no directed trawl fishery on this stock and the area closures and low by-catch limits should be retained, until a significant increase in the spawning stock biomass (and a subsequent increase in the number of juveniles) has been detected in surveys. Recruitment failure has been observed in surveys for more than a decade. In this connection it is of vital importance that the juvenile age classes be given the strongest protection from being caught as by-catch in any fishery, e.g., the shrimp fisheries in the Barents Sea and Svalbard area. This will ensure that the recruiting year classes can contribute as much as possible to the stock rebuilding.

Several of the WG members find the presented documentation and the development of the *S. mentella* stock in Sub-area I and II in recent years sufficient to relate the pelagic *S. mentella* in the Norwegian Sea outside EEZ to the northeast Arctic stock population extruding their larvae along the continental slope (at 400-600 m) from south of 62°N to the Svalbard area, and that advice on stock and fishery should be given accordingly. It can not be excluded that the several years' protection and growth of the year-classes born before 1991 could have caused the higher pelagic abundance and densities in the Norwegian Sea. The ICES advices that also these adult year classes need to be protected as they offer the only opportunity of increasing the spawning stock for a number of years to come, and it is the view of the same WG members that this therefore also should include the pelagic fisheries in the Norwegian Sea.

As a full consensus was not reached, the WG supports that ICES has given the Working Group on Stock Identity (SIMWG) the task to further investigate the stock structure and make final conclusion.

As long as there are uncertainties in linking the pelagic occurrence outside the EEZ to the pelagic and demersal occurrence inside the EEZ, a precautious approach should be applied in management.

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.

Furthermore, 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.

6.7 Response to ACFM technical minutes

ACFM considers it not necessary to assess the stock every year, and that updating of the tables and figures would be sufficient. The working group takes this into account, but sees the need for a more analytical assessment to base future catch advice and management plans on.

The working group plan to update all unreported by-catch information annually from all fisheries, and to present an account of the sampling levels.

ICES and NEAFC should exchange and preferably harmonize the catch statistics from the NEAFC regulatory areas in ICES Sub-area I and II

6.8 Description of the pelagic redfish and fishery in the Norwegian Sea outside the EEZs

6.8.1 Description of the fishery (Figures 6.7–6.8)

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 2007, eleven countries and more than 40 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 by several countries. Working Documents were available from Germany (WD 1), Spain (WD 3), Portugal (WD 7), Poland (WD 8) and Russia (WD 17). Figure 6.7 shows where *S. mentella* occurred in the Russian pelagic catches in the Norwegian Sea in 2007, either as by-catch or during the directed olympic fishery. A total catch of 15 981 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).

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.

Figure 6.8 shows the areas outside the EEZ where the German and Polish pelagic fisheries targeting *S. mentella* were conducted in 2007. During the directed fishery in 2006 and 2007 the fleets have been fishing in the same area, i.e., around 72°N, and mainly in the eastern part of the international waters.

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.

6.8.2 Length- and age composition from the fishery (Figures 6.9–6.12)

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 6.9. 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 6.10. 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 6.11). Similar results were presented from the 2006 fishery in last year's WG 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 6.12 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.

6.8.3 Surveys in 2007 (Figures 6.13–6.19).

During 2007, three attempts were made to investigate the distribution and abundance of pelagic *Sebastes mentella* in the Norwegian Sea:

Norwegian part (RV G.O.Sars, 27.4-31.5.07) of the international ecosystem survey in the Nordic Seas in spring 2007 (PGNAPES).

Russian survey by RV "Smolensk" in the period 12–21.6 .07 to acoustically investigate the distribution of herring and redfish in the Norwegian Sea.

Norwegian acoustic survey with rented trawler MTr "Atlantic Star" 3-19.9.07. Another part of this survey (6-20.8.07) was dedicated to investigating the pelagic behaviour of S. mentella and Greenland halibut in two transects out from the continental slope.

This was the first year that the Norwegian ecosystem survey in the Norwegian Sea in May 2007, as part of the international PGNAPES survey aiming at measuring the abundance of herring and blue whiting, also focused on identifying and acoustically measuring the abundance of pelagic *S. mentella* in the surveyed region. Figure 6.13 shows the acoustic registrations (sA-values, m2/n.mile2) of pelagic *S. mentella* along the survey tracks and as a separate distribution map. The scrutinizing south of 70°N is considered more uncertain than north of this latitude. A preliminary acoustic estimate of the pelagic component gives about 92 000 tonnes of adult *S. mentella* within the area shown on the distribution map.

An attempt was made by the Russian research vessel RV "Smolensk" during 12-21 June 2007 to estimate the biomass of the pelagic *S. mentella* in the Norwegian Sea using trawl-acoustic method while also investigating the distribution on herring. According to data from searching works in the open Norwegian Sea between 65°45′ and 73° N and adjacent waters of the respective EEZs of Norway and Iceland (Figure 6.14), the biomass of redfish constituted about 200 000 tonnes.

During 6-20 August 2007 the vertical (pelagic) distribution of fish, incl. *S. mentella*, along the continental slope was investigated by using a multi-codend trawl (Figure 6.18). The catch-rates of pelagic *S. mentella* were highest at 400-600 meters depth, but *S. mentella* specimens were caught down to 800 m close to the slope. Then, during 3-19 September 2007 a trawl-acoustic survey directed for pelagic *S. mentella* in the Norwegian Sea incl. international waters, was conducted (Figure 6.15). This coincided with the timing of the NEAFC Olympic fishery in international waters. Some of the results are shown in Figures 6.15-6.18. With reservations that the procedures and results will be further reviewed and revised by ICES, the preliminary and best point biomass estimate would be about 335.000 tonnes of adult and pelagic *S. mentella* withing the surveyed area showed in Figure 6.15. In September, about ¼ of the total pelagic registrations were done in international waters. A clear seasonality in pelagic migration and distribution is seen when comparing the spring survey results with those from autumn. The depth distribution of pelagic redfish as scrutinized from the acoustic registrations is shown in Figure 6.16. More information about this survey is found in a Norwegian report from the survey (Gamst *et al.* 2007).

Some comments should be added to the above investigations and results. The acoustic estimates above are not directly comparable since different target strengths are used for S. mentella in the Norwegian and Russian surveys. While the Russian estimate is based on the target strength currently used in the Irminger Sea, i.e., TS = 20logL -71.3 (Reynisson 1992, ICES 2007), the Norwegian estimations are based on the target strength used for redfish in the Barents Sea (TS = 20logL -68), and which according to recent publications is considered to be the most appropriate to use for redfish (Gauthier and Rose 2001, 2002; Kang and Hwang 2003). A target strength difference of -3dB will result in a doubling/halving of the abundance estimate dependent on which target strength is being used.

Compared to the Irminger Sea international pelagic survey, the deep-sea scattering layer seems not to create any scrutinizing problems in the Norwegian Sea, but separating the redfish acoustically from blue whiting and herring inhabiting the same areas (Figure 6.19) needs good procedures. In some catches done with the survey trawl (40 mm mesh size), up to 30% (in weight) herring was caught as bycatch when targetting redfish. Even with 100 mm mesh size (as was used in the olympic/commercial fishery) mixed catches of herring could be a problem during day-time. The bycatch of blue whiting was much less.

The hydrographical conditions in the Norwegian Sea is also quite different compared with the Irminger Sea, and it is rather unlikely that noteworthy abundance of redfish will be found deeper than about 600 meters in the central part of the Sea. This should, however, be better investigated in future surveys.

6.8.4 Planned surveys in 2008

The Norwegian part of the international ecosystem survey in the Nordic Seas in spring 2008 (PGNAPES) will continue to focuse on *Sebastes mentella* in addition to the other target species, herring and blue whiting.

A new international survey is planned for August 2008. The objective of this survey is defined in the NEAFC document AM 2007/58 which states that the Contracting

Parties agreed to conduct a scientific survey for pelagic *Sebastes mentella* in ICES Sub-areas I and II during August-September 2008 to measure the horizontal and vertical stock distribution and provide an abundance estimate.

To conform to NEAFC request, the proposed survey design should cover the known distribution area of *S. mentella* in the Norwegian Sea (as observed through past scientific surveys and commercial catches). Originally, the survey plan involved 5 vessels (one by each contracting parties: Russia, Iceland, Faeroes, EU and Norway) for a duration of 15 days. The survey is planned to start on the 11th August 2008. The survey will be organized by scientists appointed by the contracting parties and chaired by Norway. A survey plan has been presented to ICES who is requested to evaluate and advice on the appropriateness of the plan not later than 10 May 2008. A report from the survey will be submitted to ICES not later than 10 October 2008. ICES is requested to evaluate the outcome of the survey not later than 10 November 2008.

Future pelagic *S. mentella* surveys in the Norwegian Sea may be planned by the ICES Study Group on Redfish Stocks [SGRS] which next time will meet at ICES Headquarters, Copenhagen, from 27–29 January 2009 and in Reykjavík, Iceland, from 28–30 July 2009.

6.8.5 Feeding and parasite infestation (*Sphyrion lumpi*)

According to Vinnichenko (WD 9, AFWG 2007), the most intensive feeding of pelagic S. mentella in the Norwegian Sea, when the mean index of stomach fullness was 1.4-1.9, took place in July-October. Different species of fish (mostly blue whiting), themisto and euphausiids were the main food items. In addition, *Calanus* spp, hyperiids, hammarids, shrimp, squid and *Sagitta* spp. were found in the stomach content. Stomachs from demersal *S. mentella* in Sub-areas I and II collected and analysed during 1968-1991 the highest frequency of occurrence was observed for zooplankton, shrimp and smaller fish (capelin and own juveniles) (Dolgov and Drevetnyak, 1992).

According to Vinnichenko (WD 9, AFWG 2007) the mean prevalence of infestation of *S. mentella* with the copepod *Sphyrion lumpi* in the northern part of the Norwegian Sea, including traces of its presence, was 36.9% with an abundance index of 0.7 per redfish, i.e., about the average infestation rate in the North Atlantic. Among the more dispersed redfish in the south of the sea these indices were 65.6% and 1.3, respectively, which is a lot more than the average. According to findings in Russian catches in 2007 prevalence of infestation of *S. mentella* with the copepod *Sphyrion lumpi* in the area of the directed fishery, including traces of its presence, was 61% with an abundance index of 1.8 per redfish (WD 17). Analyses of a smaller material (617 fish) by Norway in 2006-2007 from both inside (demersal) and outside (pelagic) the EEZ showed a generally lower infestation rate in both the pelagic and demersal fish, but did also show a general higher infestation rate in southern demersal areas than in northern. For the fishery in 2006, Germany reported that almost all of the sampled fish were infested by this parasitic copepod, while only few of the sampled fish in 2007 were infested by this parasitic copepod (mostly old cephalothoraxes) (WD 1).

6.8.6 Analyses and results from other biological data collected from the fisheries in 2006/2007

6.8.6.1 Genetics

WD 19 (AFWG 2007), "Population structure of *S. mentella* in the North Atlantic with regard to international waters in the Norwegian Sea" by Stefansson *et al.* presents the results from international genetic analyses of 1,146 *S. mentella* that were sampled at sea in late 2006 or early 2007 (Table 6.10 and Figures 6.16, 6.17). The samples from the Icelandic shelf west, Faroe Islands, Norwegian shelf and Barents Sea were collected using demersal trawls while samples from the Irminger Sea and the international waters in the Norwegian Sea outside EEZ were collected using pelagic trawl (Figures 6.16, 6.17). A summary of this work and results are given in Chapter 0.8 Scientific Presentations.

6.8.6.2 Otolith shapes

In WD 20 (AFWG 2007), "Geographic variation in otolith shapes of deep-sea redfish (Sebastes mentella) in ICES Sub-areas I and II and Sub-areas V, XII and XIV: preliminary results" by Stransky et al. a total of about 700 otoliths from various areas in the Barents Sea, on the Norwegian shelf, in the Norwegian Sea and Irminger Sea were used in a shape analysis (Table 6.11, Figures 6.18, 6.19). Only fish of 30-40 cm length were included to minimise extreme morphometric variation. From digital pictures of the otoliths, the contours were extracted and used in an Elliptical Fourier Analysis (EFA). The Fourier Descriptors (FDs) were tested for differences between areas and samples by Linear Discriminant Analysis (DA). For details on these methods, see Stransky (2005). A summary of this work and results are given in Chapter 0.8 Scientific Presentations.

It is the view of the AFWG that the presented WDs and the description above make an important contribution to the necessary stock identity work to come. The information above should thus be passed on to the ICES Working Group on Stock Identity (SIMWG). This Group is tasked to compile relevant information, and especially new information, and in cooperation with redfish experts evaluate the available information and whether a re-evaluation of the stock structure is warranted.

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	France	Germany[2]	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]	1,779	684	2,056	226	544	29	6

Year	Norway	Poland	Portugal	Russia[3]	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[4]	10,075
2001	13,937	5	179	3,775	90		120[4]	18,418
2002	2,152	8	242	3,904	190	Sweden	188[4]	6,993
2003	1,210	7	44	952	47	-	124[4]	2,520
2004	1,375	42	235	2,879	257	1	76[4]	5,493
2005	1,760[1]	-	140	5,023	163	Netherl -7	95[4]	8,465
2006	4,680[1]	2,496	1,804	11,413	710	Lithu -845 Can - 433	1,027[4]	32,895
2007[1]	3,108	1,079	1,452	5,660	2,210	Lithu -794	202[4]	19,828

[1] Provisional figures.

[2] Includes former GDR prior to 1991.

[3] USSR prior to 1991.

[4] 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[1]	11[6]	-	-	11	210	20	-	252

[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] Split on species according to reports to Russian authorities.

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	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[1]
2007[1]	684	2,010	218	543	29[2]	5[2]	2,952

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[6]	1,731	2,467	10,110	589	2,513	958[2,5]	32,895
2007[1]	Lithu -794	1,395	1,079	5,061	2,159	1,779	120[2,5]	18,827

[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[1]	-	-	35[2]	8[2]	1	-	1[2]

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[1]	145	-	57	389	51[2]	-	62[2,6]	749

[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	Estonia	Faroe Islands	France	Germany	Lithuania	Iceland	Norway
2002				9			
2003				40			
2004		500		2			
2005		1,083		20			
2006	396	3,766	192	2,475	845	2,510	2,862
2007[1]	684	1,968	218	497	794	1,751	1,813

Year	Poland	Portugal	Russia	Spain	UK	Can	Total
2002							9
2003							40
2004			1,510				1,512
2005			3,299				3,319
2006[1]	2,476	1,697	9,390	575	841	433[2]	28,458
2007[1]	1,079	1,377	3,645	2,155	-	-	15,981

[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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE																	
6	1653	1873	159	738	662	223	125	37	9	1	117	2	6	11	5		
7	5453	2498	159	730	941	634	533	882	83	24	372	40	37	24	44	10	1
8	7994	1898	174	722	1279	1699	1287	2904	441	390	542	252	103	108	128	8	5
9	6781	1622	512	992	719	1554	1247	4236	1511	1235	976	572	93	148	347	89	33
10	8226	1780	2094	2561	740	1236	1297	3995	2250	2460	925	709	132	427	540	153	54
11	5344	1531	3139	2734	1230	1078	1244	2741	3262	2149	1712	532	220	624	567	256	155
12	6227	2108	2631	3060	2013	1146	876	1877	1867	1816	2651	1382	384	931	432	877	320
13	9880	2288	2308	1535	4297	1413	1416	1373	1454	1205	2660	1893	391	580	1607	1980	1049
14	10824	2258	2987	2253	3300	1865	1784	1277	1447	1001	1911	1617	434	1385	1332	2774	2514
15	4049	2506	1875	2182	2162	880	1217	1595	1557	993	1773	855	466	1047	3174	4580	2892
16	2105	2137	1514	3336	1454	621	537	1117	1418	932	1220	629	513	937	1041	5154	3639
17	9603	1512	1053	1284	757	498	1177	784	1317	505	714	163	199	927	1216	4823	4072
18	6522	677	527	734	794	700	342	786	658	596	814	237	231	549	1024	4261	2918
+gp	19299	9258	6022	3257	2404	2247	3568	6241	3919	5705	16234	4082	1193	2055	4266	35350	17493
TOTALNUM	103960	33946	25154	26118	22752	15794	16650	29845	21193	19012	32621	12965	4400	9754	15725	60313	12757
TONSLAND	48727	15590	12866	12721	10284	8075	8597	14045	11209	10075	18418	6993	2520	5493	8466	32895	19828

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
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
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
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
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
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
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
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
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
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
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
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
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
+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

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

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

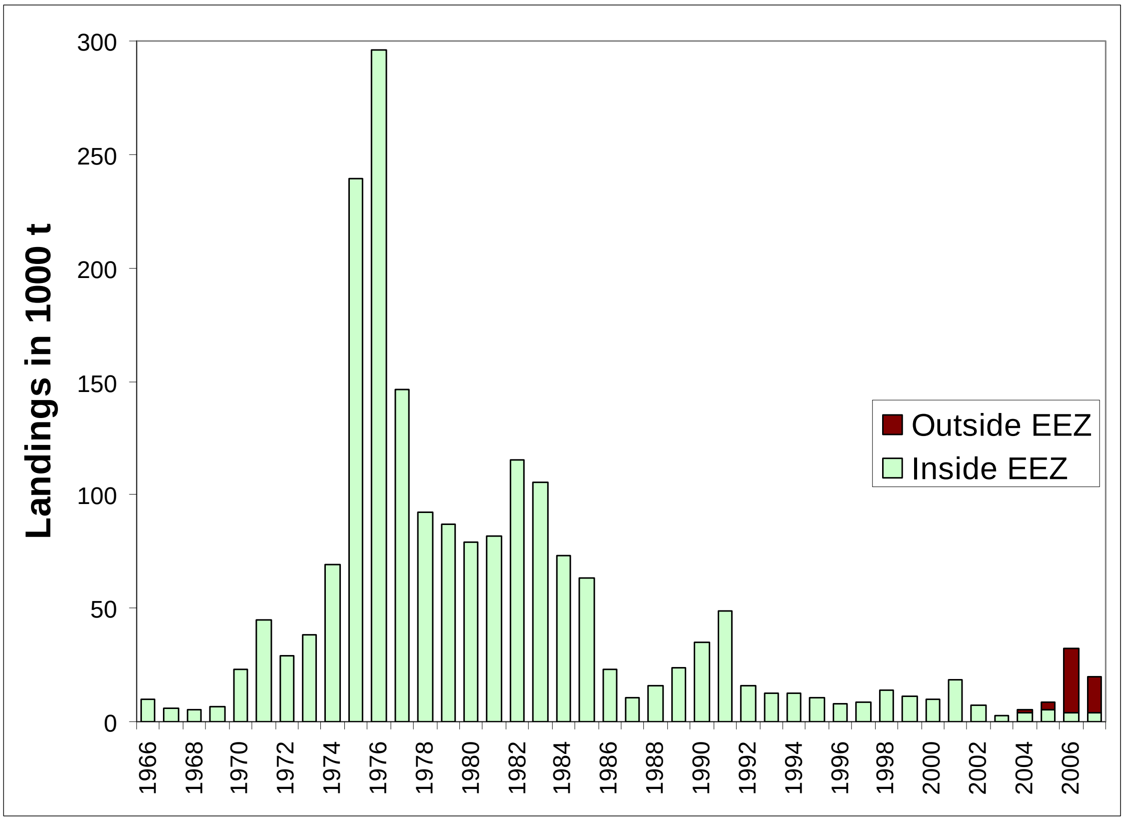


Figure. 6.1. ***Sebastes mentella*** **in Sub-areas I and II. Total international landings 1965-2007 (thousand tonnes).**

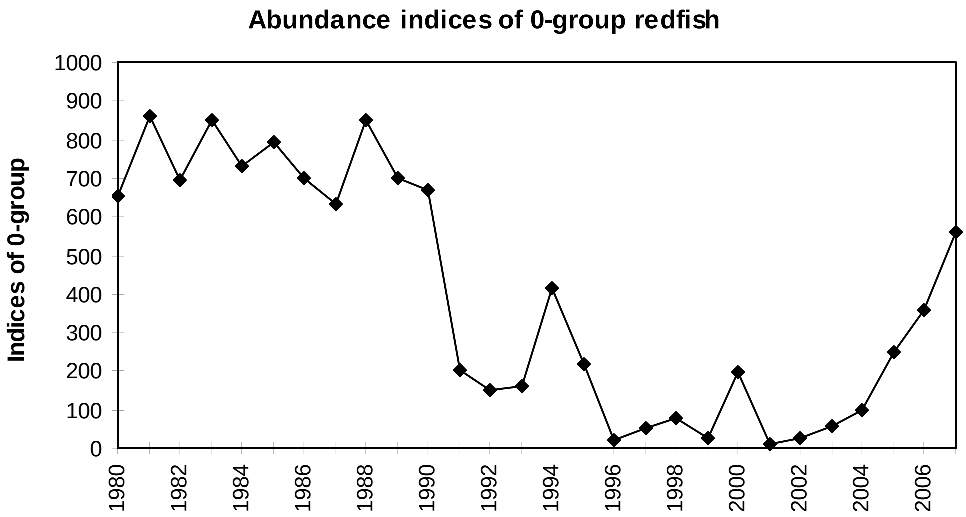


Figure 6.2a. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices of 0-group redfish (believed to be mostly** ***S.mentella*****) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2007.**

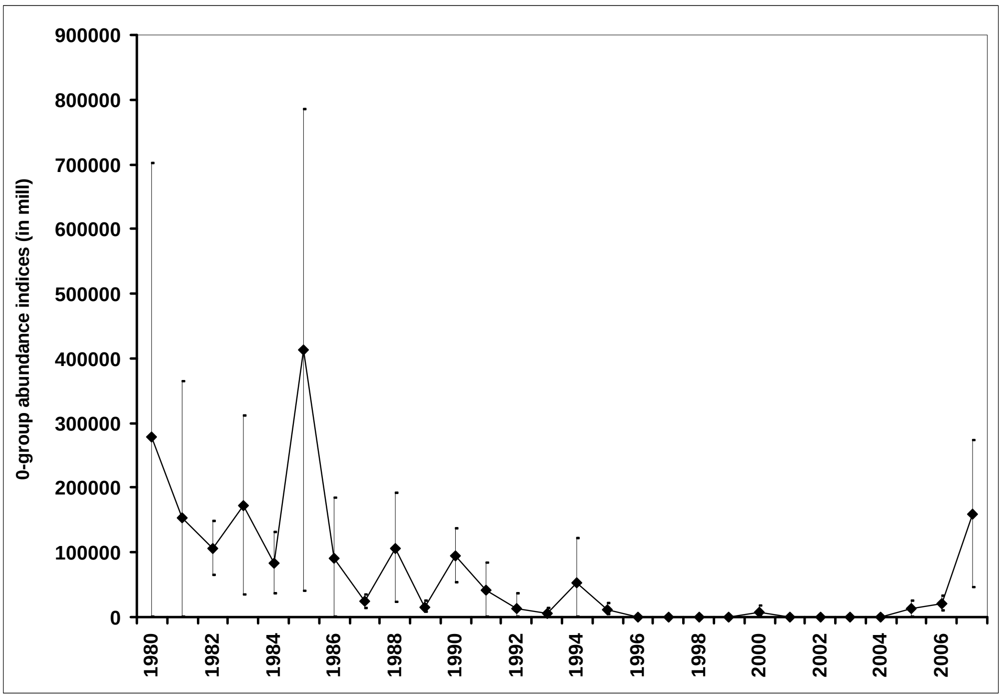


Figure 6.2b. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (in millions) with 95% confidence limits of 0-group redfish (believed to be mostly** ***S.mentella*****) in the international 0-group survey in the Barents Sea and Svalbard areas in August-September 1980-2007, as calculated by the new method, and not corrected for catching efficiency.**

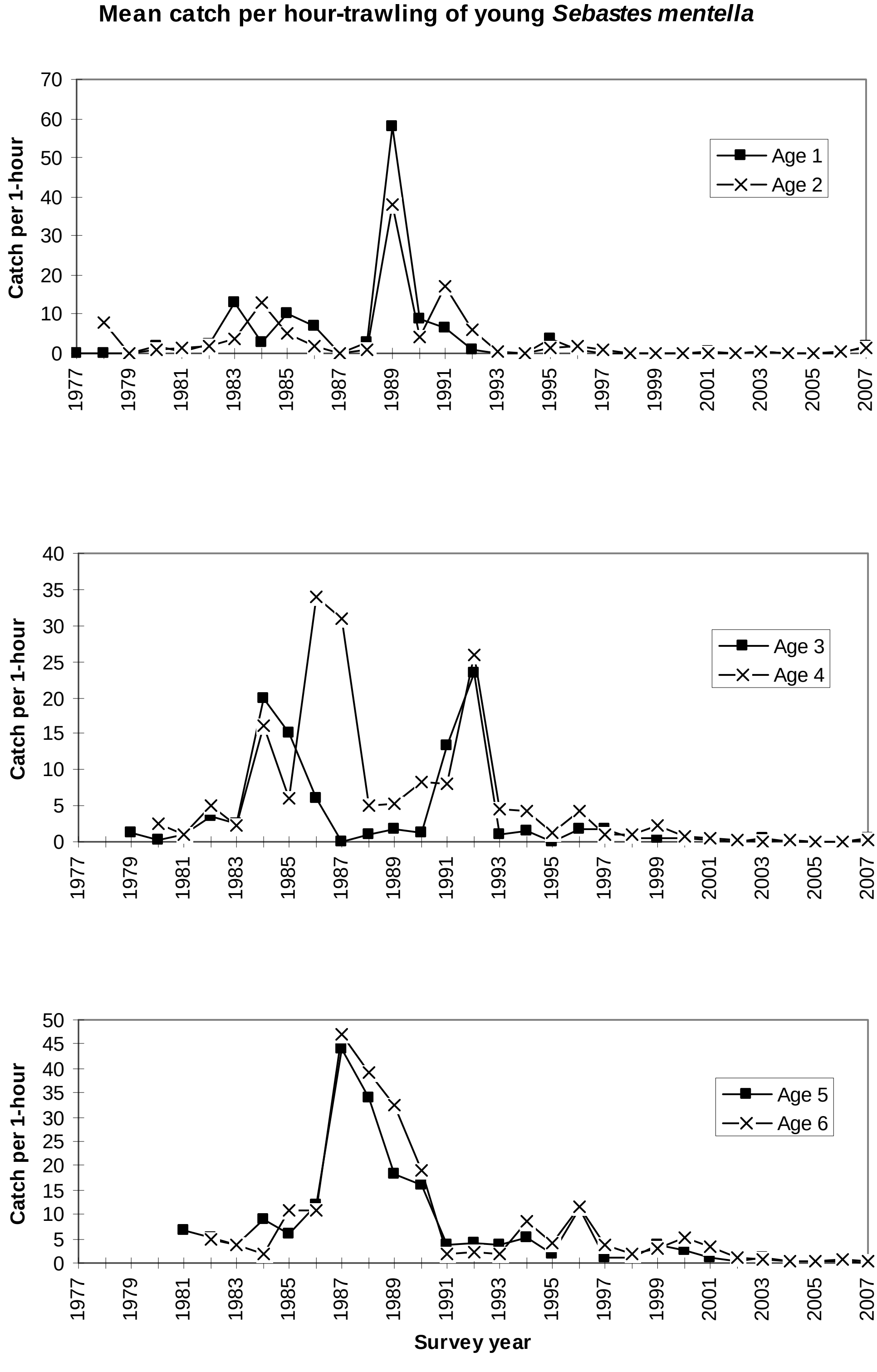
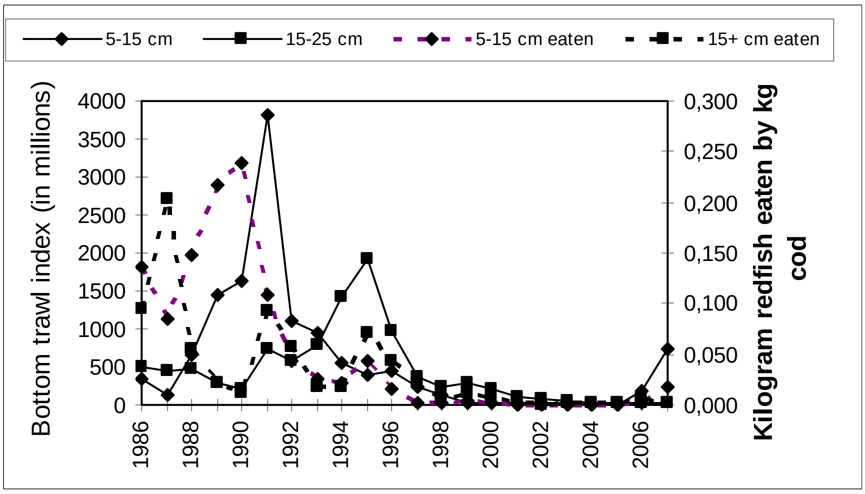


Figure 6.3. ***Sebastes mentella*** **in Sub-areas I and II. Catch (numbers of specimens) per hour trawling of different ages of** ***S. mentella*** **in the Russian groundfish survey in the Barents Sea and Svalbard areas (ref. Table D3).**



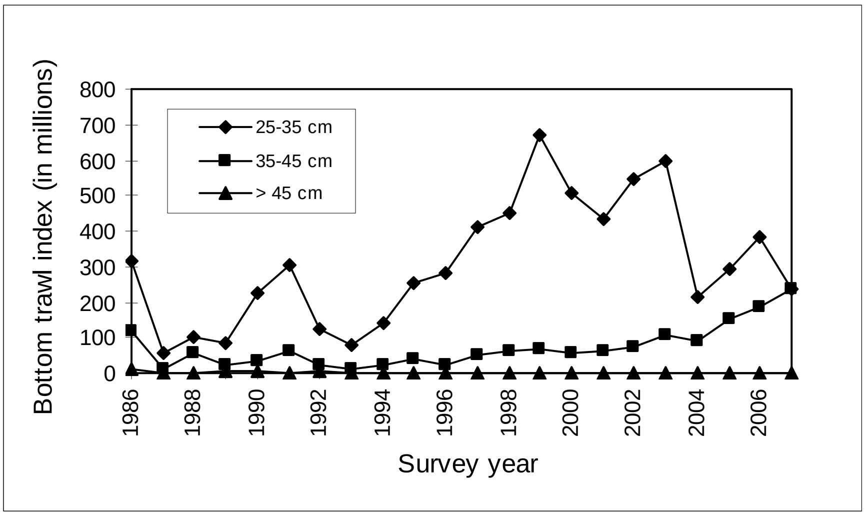
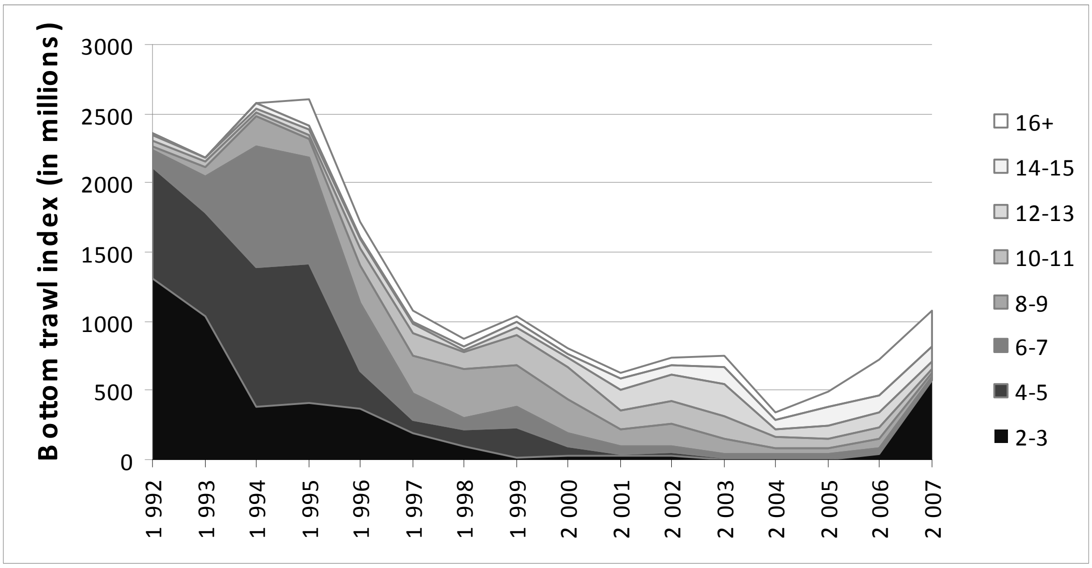


Figure 6.4a. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (on length) when combining the Norwegian bottom trawl surveys 1986-2007 at Svalbard (summer/fall) and in the Barents Sea (winter).**



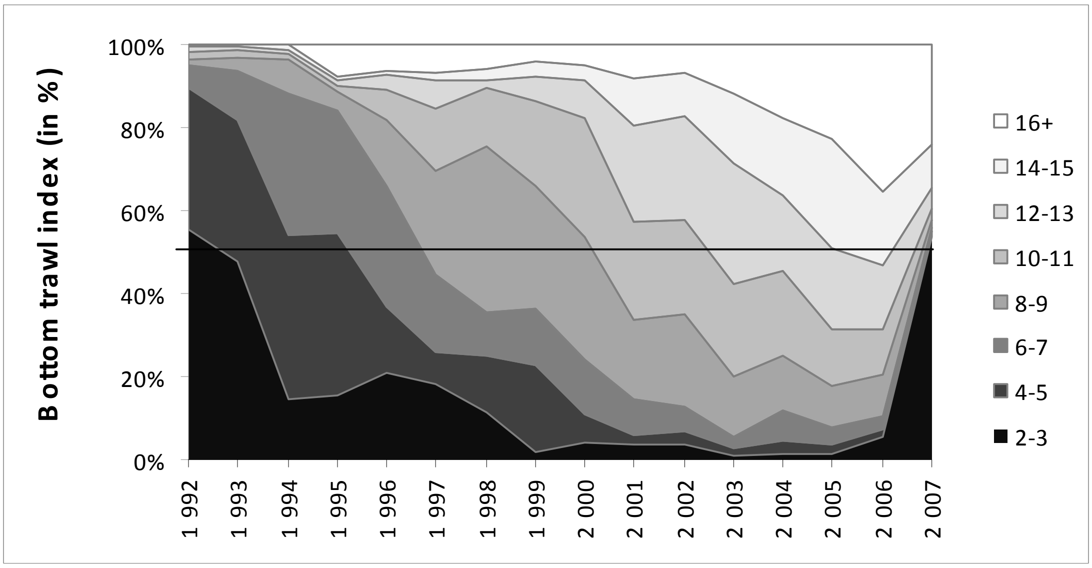


Figure 6.4b. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (on age) when combining the Norwegian bottom trawl surveys 1992-2007 at Svalbard (Division IIb, summer/fall) and in the Barents Sea (Division IIa, winter).**

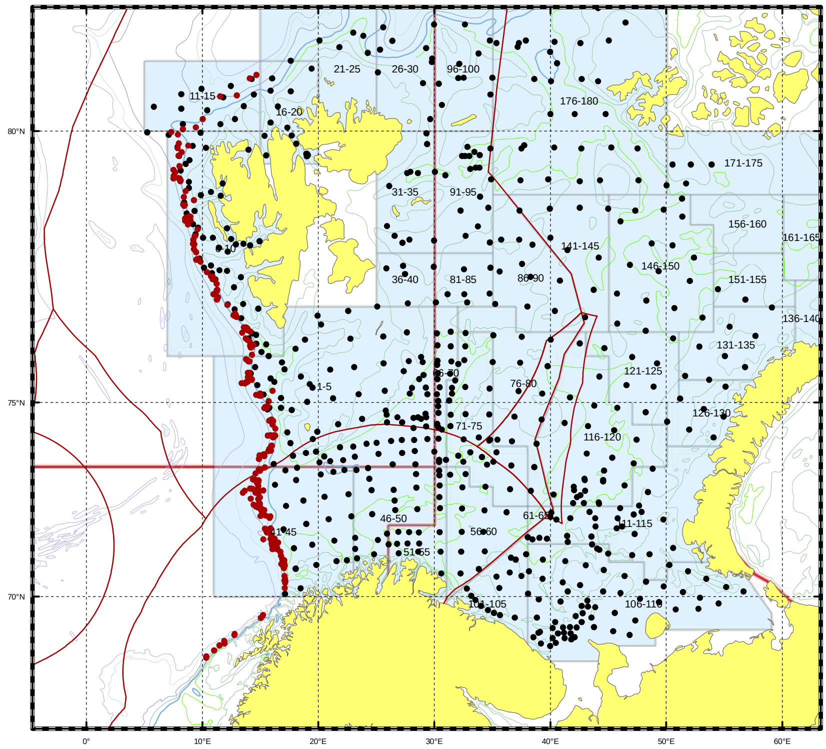
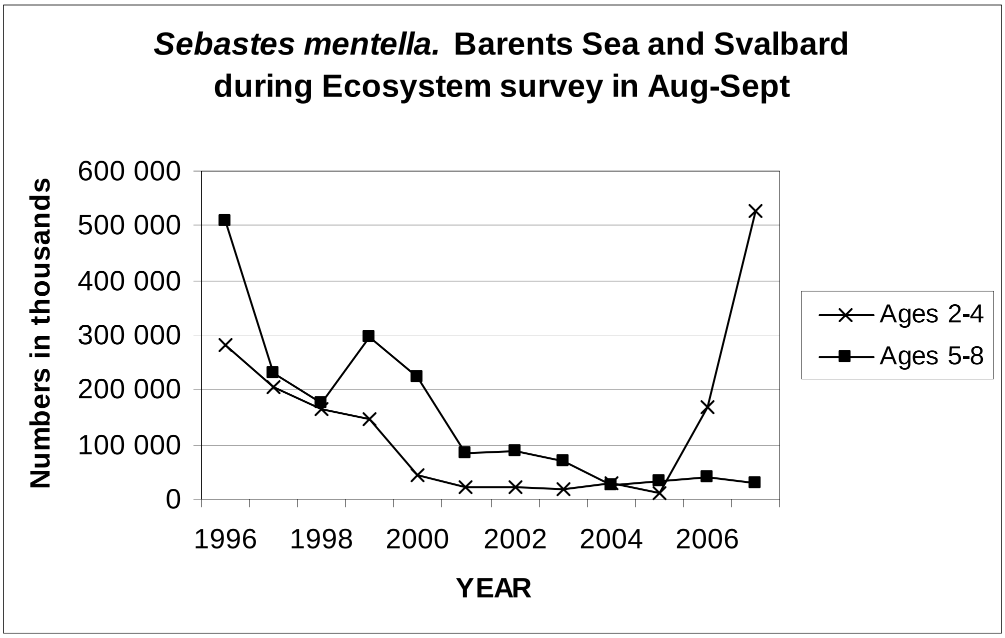


Figure 6.5. Survey regions and subareas in the ecosystem survey in the Barents Sea and adjacent areas as covered in August-September 2007 by the standard 1800 Campelen research trawl (22 mm codend) shallower than about 500 m, and the Alfredo 5 trawl (60 mm codend) from 500-1500 m along the continental slope from 68-80°N. The sub-areas are further depth stratified (ref. Table D6).



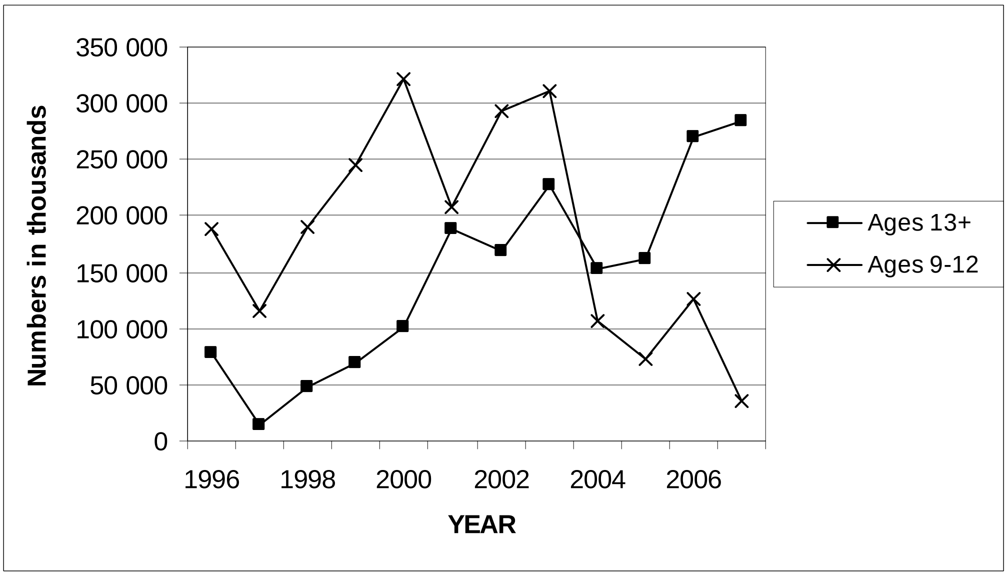


Figure 6.6. ***Sebastes mentella*** **in Sub-areas I and II. Abundance indices (on age) from the Ecosystem survey in August-September 1996-2007 covering the Norwegian Economic Zone (NEZ) and Svalbard incl. the area north and east of Spitsbergen (ref. Table D6).**

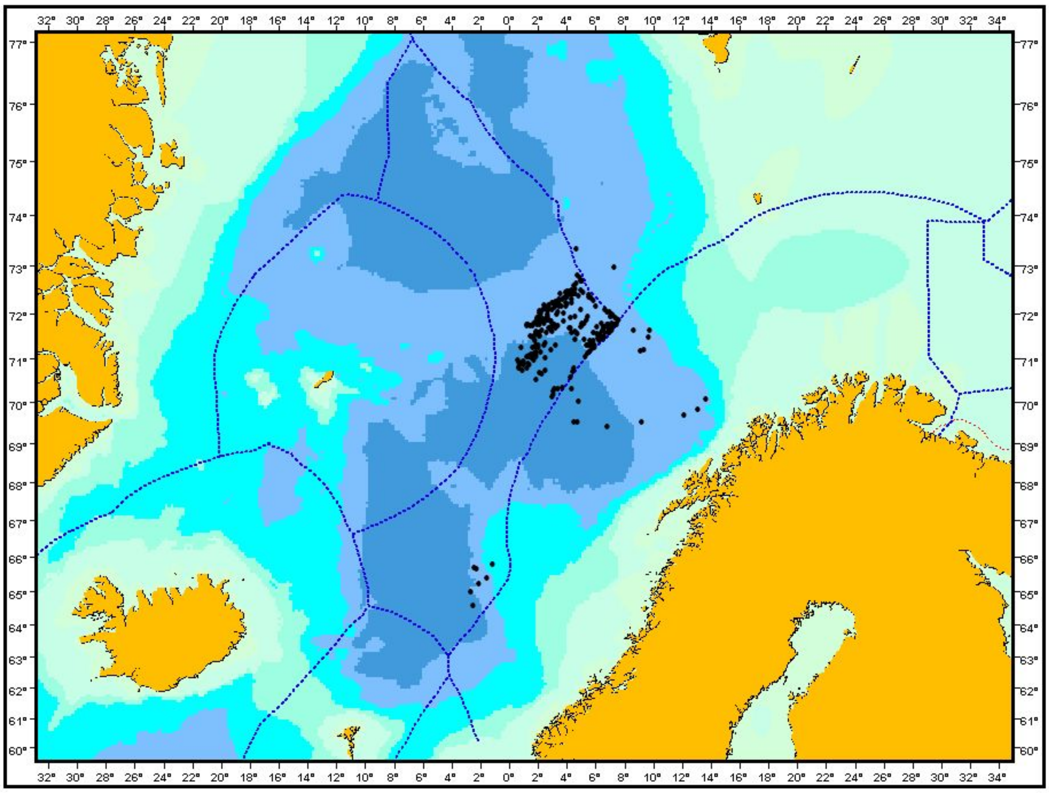
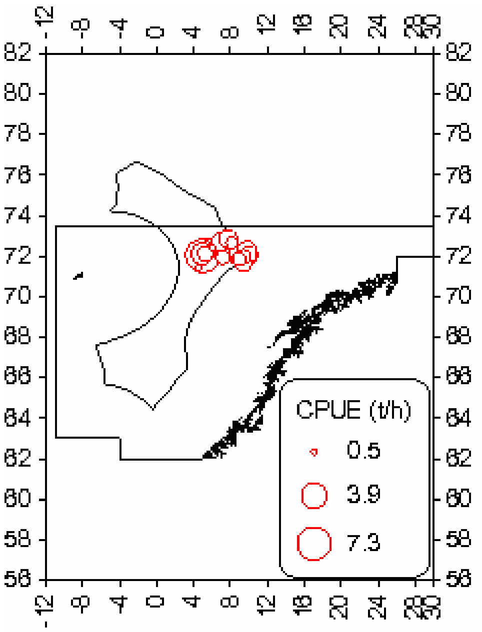
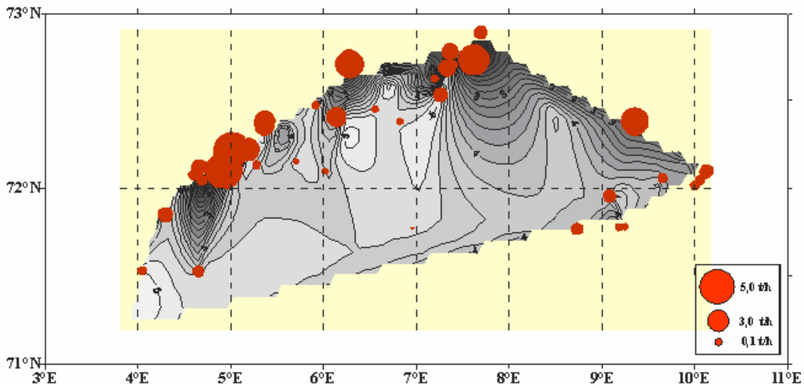


Figure 6.7. Frequency of occurrence of pelagic redfish in the Norwegian Sea in 2007 in catches by Russian fishing vessels.

Germany 497 tons



Poland 1079 tons



In addition:

Estonia	684	tons
Faroes	1968	tons
France	218	tons
Iceland	1751	tons
Lithuania	794	tons
Norway	1813	tons
Portugal	1377	tons
Russia	3645	tons
Spain	2155	tons

TOTAL 15,981 tons

Figure 6.8. The pelagic *S.mentella* fishery in the Norwegian Sea in 2007

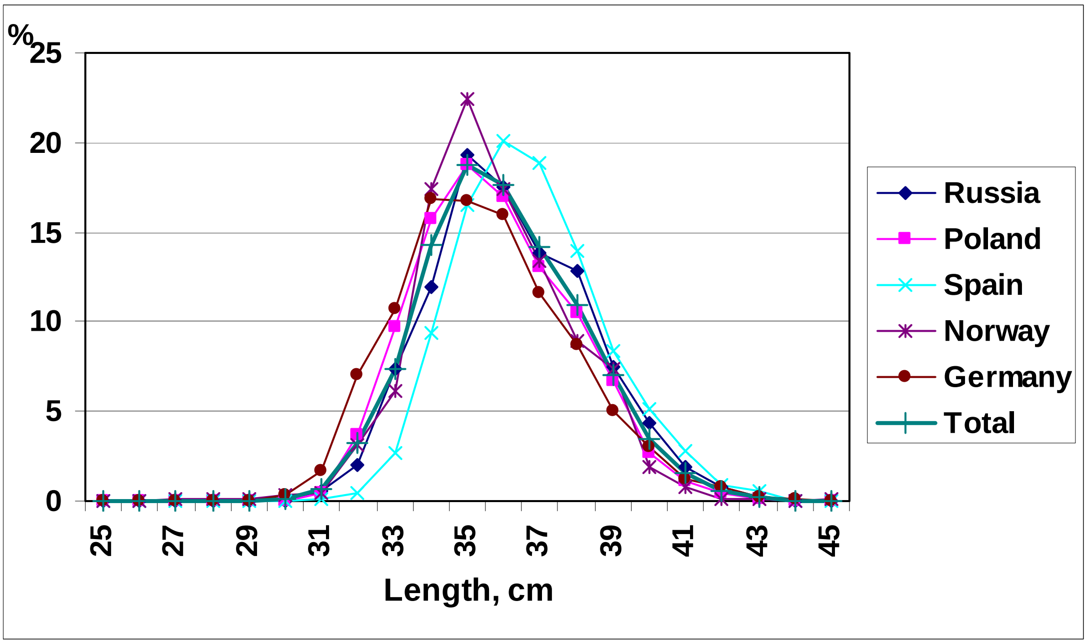


Figure 6.9. Length-distributions of the commercial pelagic catches in the Norwegian Sea outside EEZ in ICES Sub-area IIa by those countries providing length data from their pelagic fisheries in 2007.

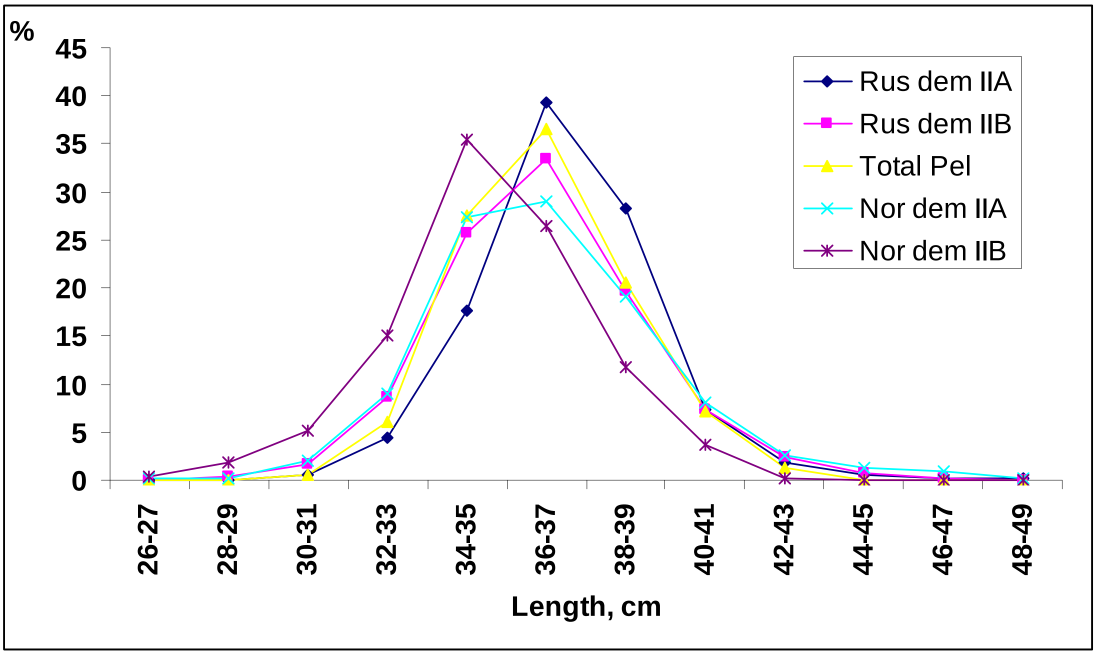


Figure 6.10. Length-distributions of the commercial demersal catches inside EEZ in ICES Sub-areas IIa and IIb by those countries providing length data from their demersal by-catches of *S. mentella* in 2007. The combined international length distribution from the pelagic fishery in international waters is shown for comparison.

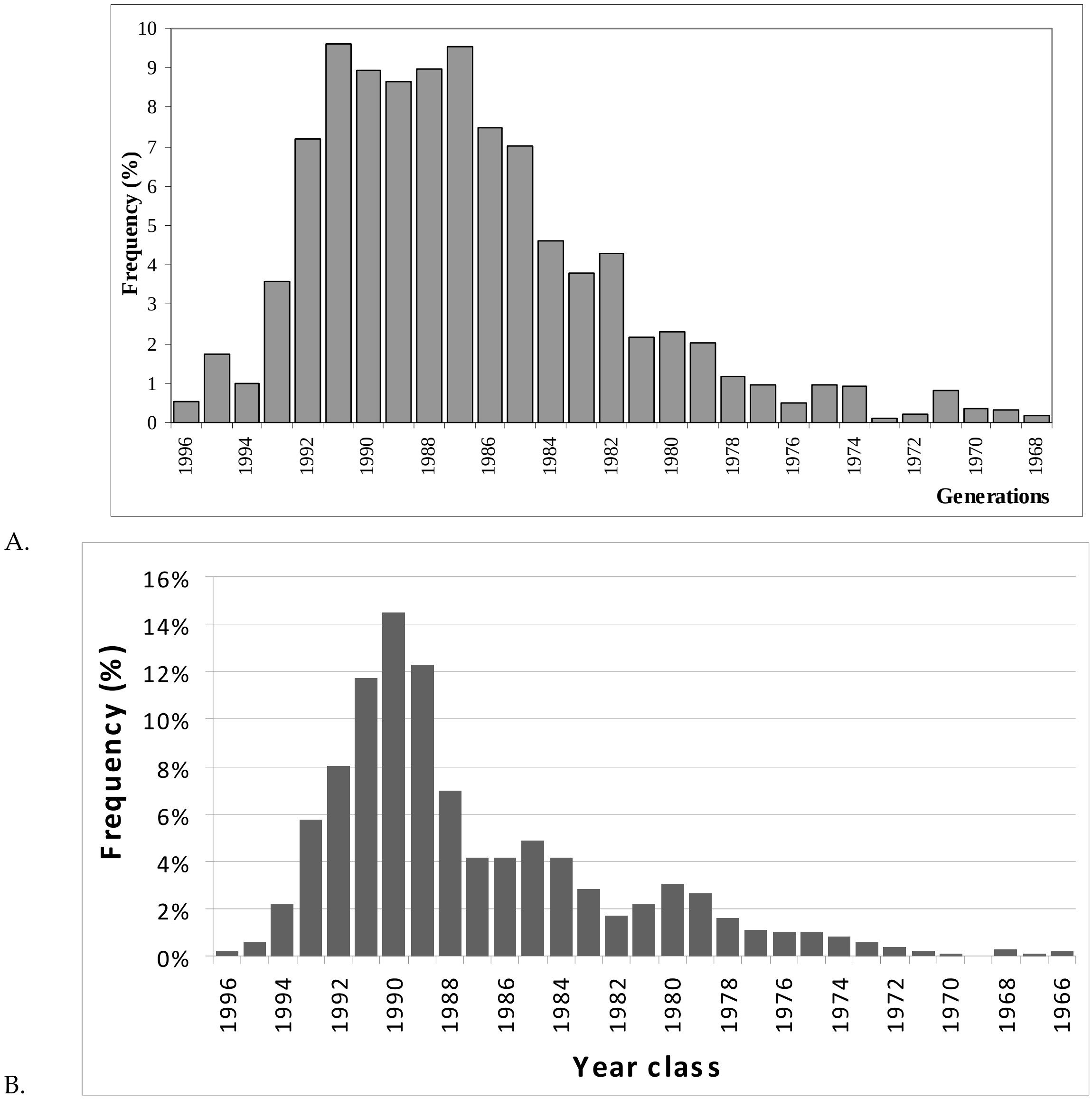


Figure 6.11. ***Sebastes mentella*** **in Sub-areas I and II. Age distributions of the (A) Polish and (B) Norwegian catches of pelagic** ***S. mentella*** **in the Norwegian Sea (Sub-area II) outside EEZ in 2007.**

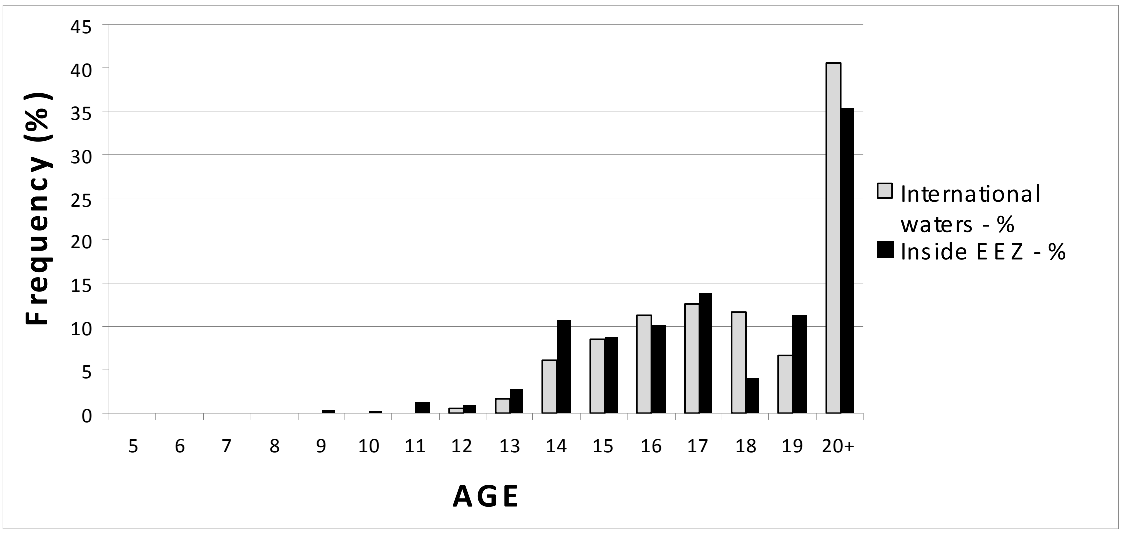


Figure 6.12. Age distributions of the Sebastes mentella caught as bycatch inside the economic zone (EEZ) (demersal) and outside in international waters (pelagic olympic fishery) as shown by the age distribution of the Norwegian catches in 2007

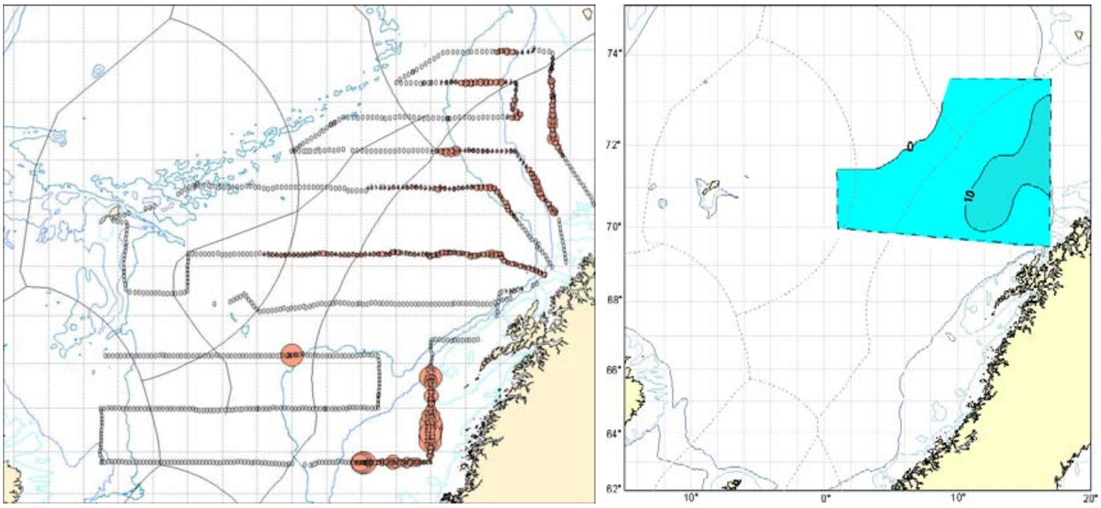


Figure 6.13. Acoustic registration (expressed in sA-values) of *Sebastes* species during the Norwegian PGNAPES survey with RV "G.O.Sars" in May 2007 (left panel) and the resulting estimated acoustic abundance and distribution of pelagic *S. mentella* during the same survey (right panel).

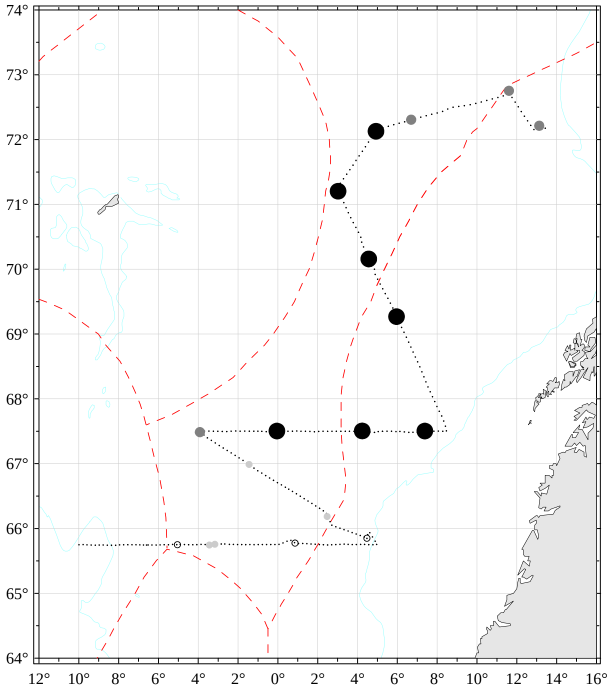


Figure 6.14. Distribution of pelagic redfish expressed in sA (m²/naut.mile²) based on data from R/V "Smolensk" in the period 12-20 June 2007.

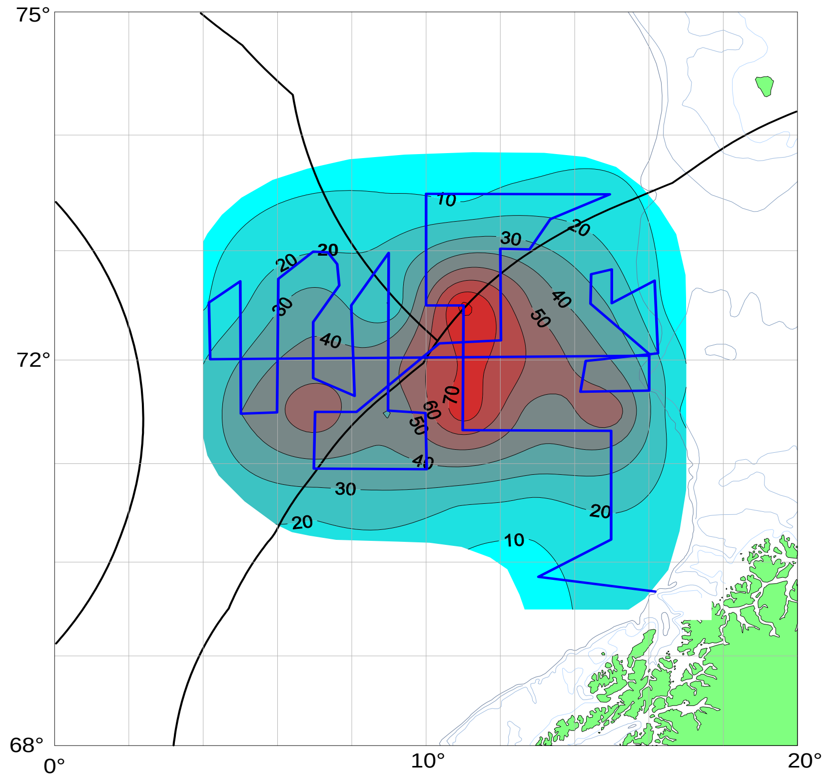


Figure 6.15. Acoustic abundance and distribution of pelagic *S. mentella* during the Norwegian survey with the rented trawler M/Tr "Atlantic Star" 3-19 September 2007. The survey tracks are included in the figure to show how the areas have been extrapolated/interpolated in the final estimation. The numbers shown on the isolines denote the acoustic s_A-values (m²/naut.mile²).

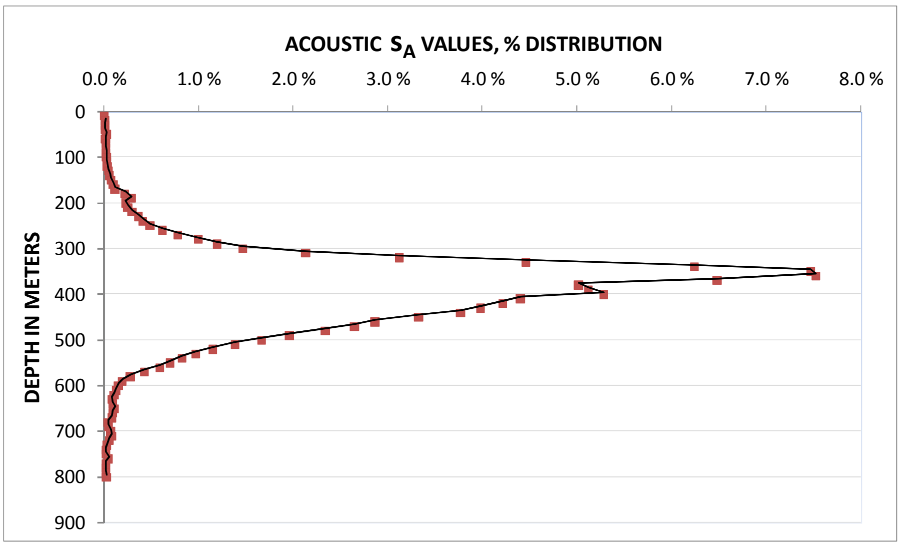


Figure 6.16. Vertical distribution of *S. mentella* observed by acoustics during the Norwegian Sea survey in September 2007. Vertical axis: depth in meter. Horizontal axis: relative frequency of redfish area backscattering coefficient (s_A) per 10m depth layers. Highest redfish densities where observed between 300 and 500m.

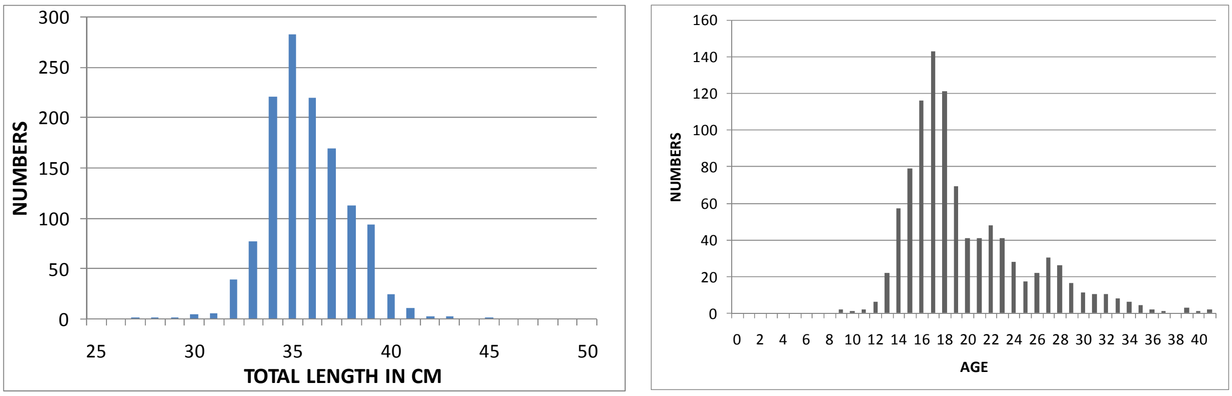


Figure 6.17. Length- (N=1262) and age (N=986) distribution of the pelagic *S. mentella* collected during the survey in September 2007. Not scaled/weighted by the acoustic estimate.

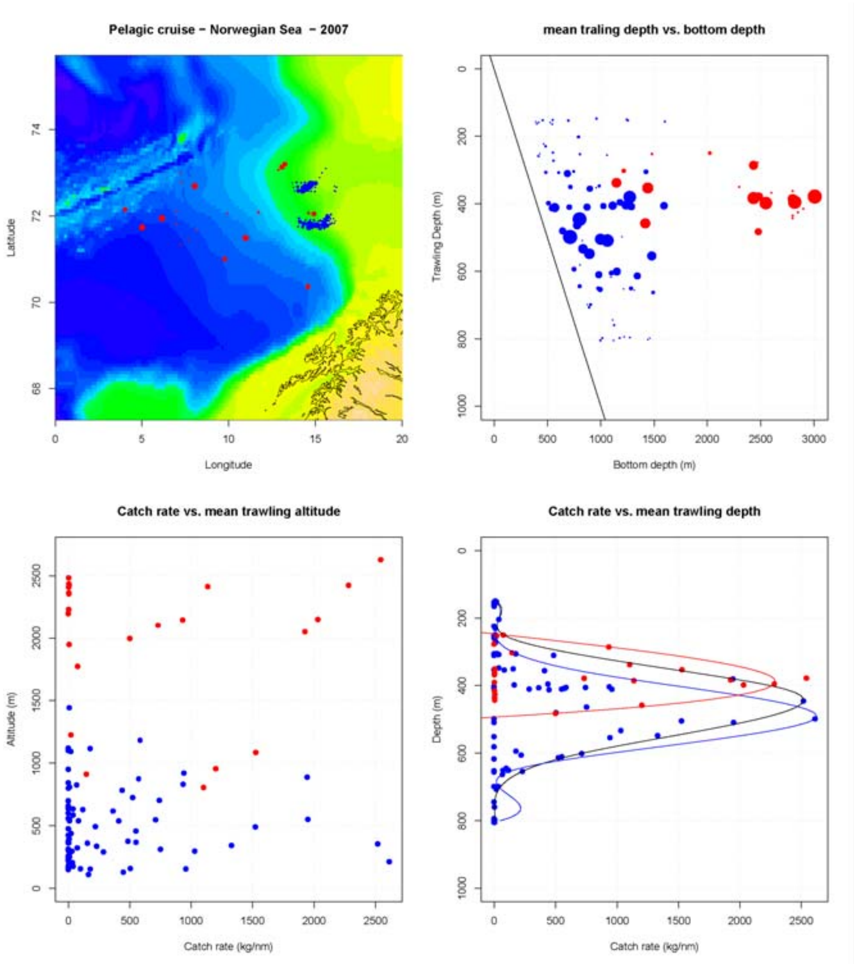


Figure 6.18. Top-left: spatial distribution of survey trawl hauls during the August-September survey 2007. Blue: first period (August), red: second period (September). Size of dots is proportional to *S. mentella* catch rate. Background colour indicates bathymetry. Top-right depth of trawling vs. Bottom depth . Bottom-left: vertical distribution of catch rates against trawling altitude. Bottom-right: vertical distribution of catch rates against trawling depth. Lines are the maximum catch rates for the first (blue), second (red) or both (black) periods, fitted using quantile regression splines (τ=0.9).

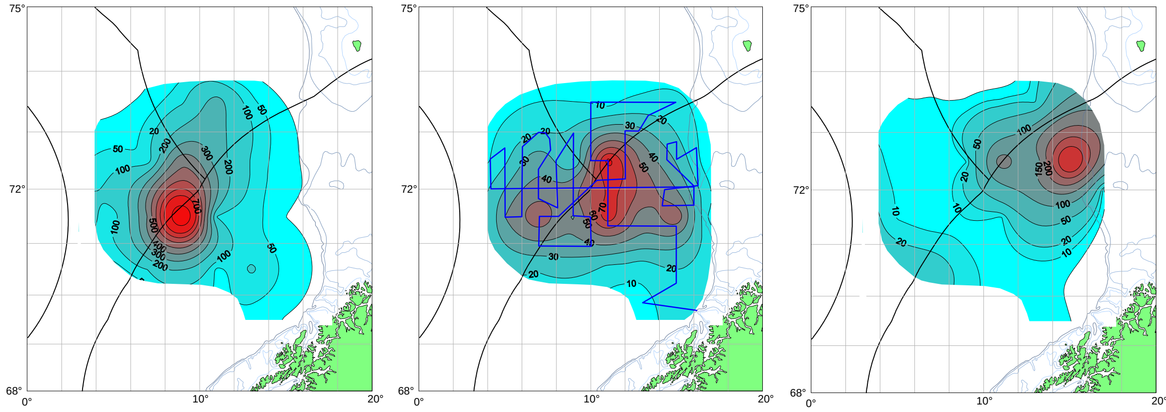


Figure 6.19. Comparison of the distribution charts of herring (left), *S. mentella* (middle) and blue whiting (right) during the September 2007 survey indicating the challenges met when splitting these species during the acoustic scrutinization process.

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	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[3]	845	3,919	223	2,518	107[3]	2,544	12[3]	21	10,945[2]	2,496	1,873	12,126	719[2]	396	1,066[6]	40,243
2007[1]	-	794	2,188[2]	248	612[2]	84[3]	1,829[2]	7[3]	14[3]	8,832[2]	1,079[2]	1,622	6,550[2]	2,215[2]	684	257[2,6]	27,015

[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	Nether-lands	Norway	Sweden	UK (England & Wales)	UK (Scotl)	Total
1986	-	24	-	578	183	-	-	1,048	-	35	1	1,869
1987	-	16	3	833	70	-	-	411	-	16	55	1,404
1988	-	32	90	915	188	-	-	696	-	125	9	2,055
1989	1	23	13	554	111	-	-	500[2]	-	134	6	1,342
1990	+	41	25	554	47	-	-	483[2]	-	369	6	1,525
1991	5	29	144	914	213	-	2	415[2]	-	43	38	1,803
1992	4	22	23	1,960	170	-	1	416	-	65	122	2,783
1993	28	14	4	1,211	33	-	1	373	-	138	71	1,873
1994	4	13	1	863	324	-	8	371	-	38	66	1,688
1995	16	12	65	1,120	80	-	16	297	-	46	241	1,893
1996	20	20	1	932	74	-	41	363	-	37	146	1,634
1997	16	23	-	1,049	45	-	53	595	-	21	528	2,330
1998	2	27	12	570	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

1 Provisional figures.

2 Working Group figure.

3 UK(E/W/)+UK(Scotl)

Table D3Sebastes 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	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	
1998	-	0.1	0.2	0.3	0.2	1.1	0.5	0.7	1	0.4		
1999	0.1	-	0.1	+	0.1	0.3	0.5	0.8	0.5			
2000	-	0.6	0.1	0.5	0.3	0.3	0.6	0.4				
2001	-	0.1	0.4	-	0.1	0.2	0.2					
2002[3]	0.1	0.5	0.1	-	-	0.1						
2003	-	-	0.1	-	0.3							
2004	-	0.2	0.3	0.5								
2005	-	-	1.4									
2006[4]	0.1	1.8										
2007	2.5											

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 1986-2006 (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

[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

[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

[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

[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

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	Age																		Total Numbers	Biomass	SSN	SSB	Area in
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-	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-	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-	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-	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																							

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

ACFM considers the analytical assessments for this stock to be experimental for time being. The status of the stock can clearly be deducted from the surveys.

7.1 Status of the Fisheries

7.1.1 Recent regulations of the fishery

A description of the historical development of the fishery and regulations is found in the Quality handbook for this stock (see Annex in AFWG 2006 report). The Handbook has not been updated since then.

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 2008 (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. 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 (1908-2007) mean of 16,939 t.

The Norwegian landings are presented by gear and month in Figure 7.2. Landings per gear type are similar to those observed in 2006.. 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, while the trawl (by)catches have varied between 1,800 and 3,500 t during the last five years. Trawl catches of *S. marinus* >20 cm in the northern areas in 2007 have sharply increased in the scientific survey (Table D13a).

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 2006 and 2007 Russia reported a catch of *S. marinus* of 713 t and 890 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 put an extra mortality on the *S. marinus* in the coastal areas before the sorting grid was enforced in 1990. From 1 January 2006, the maximum 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 2008

In 2007, total Norwegian catch (5,724 t, provisional figure) and total Russian catch (890 t) are close to the values expected in the previous year (5,500 t and 700 t respectively, Table 7.1). 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 2008 are expected to be similar to those reported in 2007.

7.2 Data Used in the Assessment (Figure D1)

An illustrative way of presenting the sampling levels has been presented in Figure D1. Figure legends etc. will later be translated to English. Recent data includes additional age- and length-samples from the commercial Norwegian fisheries in 2007, in addition to the establishment of a new sampling program along the Norwegian coast.

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 is presented from 1992 onwards (Table D11). Only data from days with more than 10% *S. marinus* in the catches (in weight) are included in the annual averages. Mean CPUEs with standard errors together with number of vessel days meeting the 10% criterion are presented in Table D11 and Figure 7.3. Provisional figures for 2006 and 2007 indicate an important reduction in effort in 2006 (98 vessel days) in comparison with the previous decade (average 590 vessel days per year). In 2007 the reported effort has increased by 50% compared to 2006.

Although the trawl fishery until 2003 was almost unregulated, the trawlers experienced fewer and fewer fishing days with more than 10% of their catches composed of *S. marinus*. From 1996 until 2001, Figure 7.3 shows an inverse correlation between catch-rates and number of vessel-days. Since 2001, however, both the catch-rates and the number of vessel-days are decreasing, and this is worrying since the criterion for defining it to be a *S. marinus* vessel-day since 2003 (due to regulations) have not been more than 20% or 15% (since 2004) *S. marinus* in each trawl haul. In 2005 a slight increase in numbers of vessel-days led to a further decrease in the catch-rates. With some variation, the average annual catch-rates have decreased from an average level of 350 kg/trawl hour during mid 1990ies to less 150 kg/h in 2003-2005, i.e., less than 40% of the former recent level. The decrease may have halted as the catch rate have slightly (although not significantly) increased in 2007 to reach an average of 167 kg/trawl hour.

Figure D2 presents more information about the trawl fishery, e.g., comparing two different catch criteria, freezer trawlers versus the bigger factory trawlers, and how the use of double trawl has developed, i.e., more for the factory trawlers than the smaller freezer trawlers.

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.

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 1986–2008 (joint with Russia 2000-2006) in fishing depths of 100–500 m. Length compositions for the years 1986–2008 are shown in Table D12a and Fig 7.4a. Age compositions for the years 1992–2007 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 1985–2007 and age compositions for the years 1992–2007 are shown in Table D13a and D13b, respectively. This survey covers the northernmost part of the species' distribution.

Data on length and age from both these surveys have been combined and are shown in Figures 7.5a,b.

1) 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 2006 and 2007. Observations in 2006 and 2007 indicate maximum catch rate of 178 ind/nm[2] for the 40-44 cm length group.

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 which This is expected to lead to poorer recruitment to the fishable biomass in the coming years. The surveys in 2006 and 2007 confirm the historic low abundance and especially the poor recruitment. However observation from the Barents Sea survey in winter 2008 suggest an increase in abundance of the smallest group (5-9 cm). This increase has not yet been confirmed by additional survey results from the coastal and fjord survey and the Svalbard area survey.

Results from the Norwegian Coastal and Fjord survey confirm poor recruitment up to 2007 Variation in the results from year to year may be due to a variable number of trawl stations taken in some of the areas from year to year, and annual variations in local fish migrations (Table D14).

7.3 Assessment by use of the GADGET model

Description of the model

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. (2004b). 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, K=0.11, L-inf=50.2, and t0=0.08 (Nedreaas 1990). The length-weight relationship w=0.000015*l^3.0 (where w is in kilogram and l in cm) was used and kept constant between seasons and years.

There has been no cannibalism or modelled predation – mortality has been exclusively due to fishing and residual natural mortality was set initially at 0.1. Recruitment was handled as a number of recruits estimated per year, and no attempt at closure of the life cycle was attempted. 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 1990–2006 (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 1995-2005 from Finnmark to Møre (Division IIa) (Table D14; at the AFWG 2007 for the first time).

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.

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 2007. However, the Norwegian coastal and fjord survey series has been revised for 2003-2005 to account for an additional research vessel taking part in the survey and has been updated for years 2006-2007. Commercial catch data have been revised for years 2005-2006 and updated with year 2007. The recent data includes additional age- and length-samples from the commercial Norwegian fisheries in 2007, in addition to the establishment of a new sampling program along the Norwegian coast.

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	232 628	0.41	89 322	101 686	0.69	66 121
WG	179 313	0.39	64 019	71 013	0.71	38 927
WG	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

1) Since WG2007 based on modeled maturation and not 15+.

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 may be unreliable.
- The estimated fishing mortality has declined from 1990 to present and current values are around 0.13 (Figure 7.8). This is slightly less than estimated during the 2007 AFWG (where recent fishing mortality estimates were around 0.15).
- According to the model the total stock biomass (3+) of *S. marinus* has decreased from about 160.000 tonnes in 1993-1994 to less than 50.000 tonnes in 2006 (Figure 7.10, Table 7.8). The stock in numbers is declining faster than stock biomass due to fewer recruits.
- The spawning stock biomass of *S. marinus* has decreased from a maximum of about 72,000 tonnes in 1994 to approximately 34,000 tonnes in 2007 (-54%, Figure 7.10, Table 7.8). The decline in spawning stock in numbers (SSN) is declining faster than spawning stock biomass (SSB) with a reduction of approximately 69% during the same period of time.

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 current management actions because year-classes recruit in the SSB at old age (~12 years) and surveys indicate failure of recruitment over a period of more than a decade. There are however some direct indications that new recruits (<15cm) may be entering the population in 2008 (Fig 7.4a) and Gadget model outputs also suggest an increase in numbers in recent year classes. This will need to be confirmed by future survey results.

The analytical assessment using the Gadget model confirms the poor stock situation, and quantifies the serious development of this stock during the last decade. It is also meant to be an aid for managers to better quantify necessary stronger regulations.

Clearly the stock has at present a reduced reproductive potential and the model suggest that the declining trend in number and biomass is still going on. Nevertheless there is an apparent recent increase in younger age groups. 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.

The addition of new data (see section 7.2) to the input of the Gadget model may be a reason for the differences observed in current assessment compared with last year's.

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 tonnes.

7.7 Management advice

There is no revision of the advice provided in 2007. 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 ACFM Technical Minutes (ACFM TM *in italics*)

The RGAF is still reiterate its last years proposal to consider use of more simple model eg SURBA. Also the sampling levels have not been presented.

As for last year, 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 sampling levels were presented in detail in last working group report, Figure D1. This figure has been updated in the present report for the sampling in 2007.

It will be difficult to model F when M is of a similar size (0.1 and 0.15).

It is certainly true that where F and M are similar there is a difficulty in separating the two, especially if there are trends in one or both. This would be true in any model, especially if F (or some equivalent) is used as an internal parameter. In the Gadget model used here it is the magnitude of the reported catch that is used as an input, assuming it to be accurate. It is also assumed that natural mortality remains constant over time. There may be a difficulty if either of these assumptions were to be significantly flawed. However this approach has the advantage that F is never used within the model, and much of the difficulty is thus avoided. F has been reported in the report only as an output from the model.

Table 7.1 ***Sebastes marinus*. Nominal catch (t) by countries in Sub-area I and Divisions IIa and IIb combined.**

Year	Faroe Islands	France	Germany[2]	Greenland	Iceland	Ireland	Netherlands
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[1]	132	22	68	55	50	1	14

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[1]	5,724	170	890	5		55[4]	7,187

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[2,6]	1,469
2005	10	-	-	-	1,002[1]	61	1	4[2,6]	1,078
2006	46	-	France		685	136	-	-	867
2007[1]	3[7]	13	7		1,035	49	**Spain**- 2	20[2,6]	1,129

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	59[2]	293	9[2]	31	39[2, 6]	4,978
2007[1]	119[2]	15[2]	55[2]	55[2]	1[2]	14[2]	4,036	70	599	3[2]	50[2]	35[2, 6]	5,052

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	-	-	-	1368
1991	-	303	-	44	-	426	-	-	-	773
1992	-	319	9[2]	2	5[2]	180	2	35[2]	-	552
1993	-	177	-	-	-	43	8[3]	10[2]	-	238
1994	-	282	-	18	-	60	4[3]	6[2]	1[2]	371
1995	-	187	-	103	7	33	-	-	-	330
1996	4	51[2]	-	27	5	136	76[2]	3[2]	-	302
1997	-	20	-	43	-	225	-	-	-	288
1998	-	10[2]	-	105	-	246	-	3[2]	-	364
1999	-	-	-	38	-	355	-	2[2]	-	395
2000	-	-	-	10	-	308	-	-	-	318
2001	-	-	-	79	1[2]	223	-	-	-	303
2002	-	-	-	107	16[2]	420	1[2]		5[2, 7]	549
2003	-	-	-	68	-	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[1]	10[2]	-	-	653	100	242	-		-	1,005

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.**

Year/Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
7	5	0	46	60	9	9	28	78	4	23	14	22	19	40	47	15
8	22	24	7	85	119	98	51	593	13	23	36	25	47	55	34	21
9	78	193	292	230	313	156	206	855	70	44	71	30	46	94	59	30
10	114	359	640	672	361	321	470	572	245	199	143	44	65	80	73	67
11	394	406	816	908	879	686	721	1006	902	347	414	204	198	165	256	136
12	549	1036	1930	1610	1234	1065	968	1230	958	482	686	359	277	173	213	301
13	783	1022	2096	2038	1638	1781	1512	1618	1782	1120	1199	705	504	393	210	441
14	1718	1523	2030	2295	2134	2276	1736	1480	1409	1342	1943	1687	590	779	847	487
15	3102	2353	1601	1783	1675	2172	1582	1612	2121	1674	1377	1338	677	741	575	514
16	2495	1410	2725	1406	1614	1848	1045	1239	2203	1653	1274	1071	963	916	815	626
17	2104	1655	2668	785	1390	1421	1277	1407	1715	1243	1196	937	1059	926	831	877
18	1837	1678	1409	563	952	851	970	1558	753	568	388	481	787	743	782	606
19	998	745	617	670	679	804	1018	1019	483	119	313	367	436	376	519	501
20	858	716	733	593	439	608	846	394	458	183	99	146	169	210	347	389
21	688	534	514	419	560	511	443	197	132	154	104	84	183	189	324	221
22	547	528	256	368	334	205	764	459	230	112	117	51	108	129	197	317
23	268	576	177	250	490	334	486	174	224	135	113	18	79	111	173	167
+gp	3110	3482	1508	3232	3135	2131	3389	2131	895	254	253	69	186	220	416	619
TOTALNUM	**19670**	**18240**	**20065**	**17967**	**17955**	**17277**	**17512**	**17622**	**14597**	**9675**	**9740**	**7637**	**6390**	**6338**	**6718**	**6335**
TONSLAND	16185	16651	18120	15616	18043	17511	19155	18986	14460	10547	9643	7841	7320	7037	7690	7184

Table 7.6. ***Sebastes marinus*** **in Sub-areas I and II. Catch weights at age (kg)**

Year/Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
7	0.18	0.20	0.25	0.33	0.22	0.23	0.37	0.14	0.19	0.15	0.17	0.19	0.21	0.16	0.13	0.15
8	0.29	0.33	0.37	0.43	0.49	0.51	0.21	0.26	0.24	0.26	0.25	0.22	0.26	0.21	0.15	0.21
9	0.48	0.36	0.38	0.64	0.56	0.53	0.47	0.44	0.32	0.45	0.33	0.31	0.36	0.36	0.28	0.33
10	0.42	0.43	0.49	0.61	0.65	0.74	0.62	0.57	0.44	0.55	0.42	0.39	0.45	0.45	0.41	0.39
11	0.50	0.51	0.51	0.59	0.71	0.72	0.67	0.69	0.53	0.58	0.54	0.49	0.51	0.52	0.51	0.50
12	0.59	0.51	0.64	0.65	0.81	0.78	0.77	0.78	0.64	0.67	0.67	0.58	0.59	0.58	0.58	0.59
13	0.58	0.64	0.74	0.74	0.84	0.80	0.77	0.86	0.73	0.80	0.72	0.69	0.68	0.68	0.66	0.65
14	0.65	0.64	0.76	0.79	0.88	0.86	0.85	1.04	0.84	0.89	0.84	0.84	0.80	0.82	0.74	0.77
15	0.65	0.76	0.86	0.84	0.96	0.91	1.05	1.07	0.96	1.01	0.98	0.96	0.96	0.94	0.83	0.90
16	0.71	0.86	0.95	0.92	1.00	0.99	0.96	1.12	1.11	1.14	1.09	1.05	1.07	1.03	1.00	1.00
17	0.82	0.89	1.03	1.12	1.02	1.16	1.25	1.18	1.25	1.33	1.20	1.29	1.22	1.16	1.14	1.09
18	0.84	0.98	1.07	1.01	1.01	1.18	1.28	1.71	1.32	1.43	1.30	1.36	1.34	1.36	1.27	1.27
19	0.94	1.00	1.11	1.01	1.00	1.21	1.30	1.09	1.53	1.62	1.44	1.65	1.57	1.46	1.39	1.42
20	1.02	1.03	1.16	1.21	1.03	1.34	1.23	1.18	1.06	1.60	1.78	1.74	1.67	1.51	1.46	1.32
21	1.03	1.21	1.15	1.14	1.04	1.28	1.87	1.04	1.29	1.47	1.68	2.09	1.75	1.67	1.37	1.53
22	1.15	1.03	1.13	1.09	1.14	1.54	1.46	1.34	1.32	2.00	1.88	1.85	2.09	1.91	1.47	1.47
23	1.27	1.20	1.02	1.30	1.09	1.19	1.73	1.18	1.12	2.70	2.12	2.30	1.90	2.23	1.64	1.69
+gp	1.27	1.14	1.36	1.01	1.16	1.29	1.29	1.34	1.20	2.31	1.84	2.38	2.04	2.27	2.03	1.81

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
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
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
6	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
7	0.007	0.005	0.004	0.004	0.004	0.006	0.004	0.004	0.005	0.003	0.004	0.003	0.003	0.002	0.003	0.003	0.004	0.004
8	0.049	0.015	0.013	0.013	0.013	0.015	0.013	0.013	0.015	0.011	0.012	0.009	0.009	0.007	0.008	0.009	0.012	0.013
9	0.082	0.060	0.029	0.029	0.030	0.031	0.030	0.029	0.034	0.025	0.028	0.021	0.021	0.017	0.018	0.021	0.027	0.029
10	0.106	0.085	0.076	0.052	0.055	0.053	0.055	0.054	0.062	0.047	0.052	0.039	0.039	0.033	0.034	0.037	0.049	0.053
11	0.133	0.102	0.095	0.102	0.085	0.079	0.084	0.083	0.096	0.073	0.081	0.062	0.061	0.051	0.053	0.058	0.074	0.081
12	0.163	0.121	0.109	0.120	0.136	0.107	0.114	0.113	0.130	0.099	0.111	0.085	0.082	0.070	0.072	0.078	0.099	0.109
13	0.195	0.141	0.124	0.132	0.151	0.138	0.140	0.140	0.161	0.124	0.139	0.107	0.102	0.088	0.089	0.096	0.121	0.134
14	0.227	0.161	0.138	0.144	0.162	0.147	0.175	0.162	0.186	0.145	0.163	0.125	0.119	0.103	0.103	0.110	0.138	0.154
15	0.259	0.180	0.151	0.155	0.173	0.154	0.183	0.188	0.206	0.161	0.183	0.140	0.132	0.115	0.114	0.121	0.151	0.168
16	0.289	0.199	0.164	0.166	0.182	0.161	0.189	0.194	0.228	0.173	0.197	0.152	0.142	0.123	0.122	0.129	0.160	0.179
17	0.317	0.216	0.176	0.175	0.190	0.167	0.195	0.198	0.232	0.186	0.207	0.160	0.149	0.130	0.128	0.134	0.166	0.186
18	0.330	0.231	0.186	0.183	0.197	0.172	0.199	0.202	0.235	0.188	0.217	0.165	0.154	0.134	0.132	0.138	0.170	0.190
19	0.341	0.238	0.195	0.191	0.204	0.176	0.203	0.205	0.238	0.190	0.219	0.170	0.157	0.137	0.135	0.140	0.172	0.193
20	0.351	0.244	0.199	0.197	0.209	0.179	0.206	0.207	0.241	0.192	0.221	0.171	0.160	0.139	0.136	0.142	0.174	0.195
21	0.360	0.249	0.203	0.199	0.213	0.182	0.209	0.209	0.243	0.193	0.222	0.172	0.161	0.141	0.137	0.143	0.175	0.196
22	0.367	0.254	0.206	0.202	0.215	0.184	0.211	0.211	0.244	0.194	0.223	0.173	0.161	0.141	0.138	0.143	0.176	0.197
23	0.373	0.257	0.208	0.203	0.216	0.185	0.213	0.212	0.245	0.195	0.224	0.173	0.161	0.142	0.139	0.144	0.176	0.197
24	0.378	0.260	0.211	0.205	0.218	0.186	0.214	0.213	0.246	0.196	0.225	0.174	0.162	0.142	0.139	0.144	0.177	0.198
25	0.381	0.263	0.212	0.206	0.219	0.187	0.214	0.214	0.247	0.196	0.225	0.174	0.162	0.142	0.139	0.144	0.177	0.198
26	0.384	0.265	0.214	0.207	0.220	0.187	0.215	0.214	0.247	0.197	0.226	0.174	0.162	0.142	0.139	0.144	0.177	0.198
27	0.386	0.266	0.215	0.208	0.220	0.188	0.215	0.215	0.248	0.197	0.226	0.175	0.162	0.142	0.139	0.144	0.177	0.198
28	0.388	0.267	0.215	0.209	0.221	0.188	0.215	0.215	0.248	0.197	0.226	0.175	0.162	0.142	0.139	0.144	0.177	0.198
29	0.389	0.268	0.216	0.209	0.221	0.188	0.216	0.215	0.248	0.197	0.226	0.175	0.162	0.143	0.139	0.144	0.177	0.198
30	0.390	0.269	0.217	0.210	0.222	0.137	0.216	0.215	0.248	0.197	0.226	0.175	0.163	0.143	0.139	0.145	0.177	0.198

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	546,396	0.32	176,801	79,582	0.34	27,399	466,813	0.32	149,402	88,528
1987	533,831	0.32	171,520	97,845	0.47	45,574	435,986	0.29	125,946	67,480
1988	506,364	0.33	168,315	107,041	0.53	57,055	399,323	0.28	111,260	49,270
1989	474,647	0.35	164,492	109,478	0.58	63,103	365,169	0.28	101,389	42,567
1990	449,003	0.35	158,851	106,998	0.61	64,838	342,005	0.27	94,013	46,910
1991	434,698	0.36	158,123	105,666	0.64	67,272	329,032	0.28	90,851	48,989
1992	411,923	0.39	158,882	104,873	0.67	69,860	307,049	0.29	89,022	35,878
1993	388,763	0.41	158,444	103,234	0.69	71,724	285,530	0.30	86,720	33,044
1994	359,697	0.43	155,439	100,228	0.72	72,242	259,469	0.32	83,197	25,835
1995	325,287	0.46	151,076	96,618	0.75	72,166	228,669	0.35	78,910	17,108
1996	287,884	0.51	145,479	92,413	0.78	71,658	195,470	0.38	73,821	10,088
1997	254,122	0.54	137,185	86,663	0.80	69,687	167,459	0.40	67,498	10,795
1998	216,687	0.58	126,508	79,692	0.83	66,290	136,995	0.44	60,218	4,243
1999	180,168	0.63	113,135	71,207	0.86	61,076	108,961	0.48	52,059	2,312
2000	149,655	0.68	101,219	63,644	0.89	56,568	86,010	0.52	44,651	1,742
2001	124,227	0.72	89,261	56,113	0.92	51,788	68,114	0.55	37,472	2,574
2002	107,963	0.76	82,054	51,444	0.97	49,943	56,519	0.57	32,111	3,889
2003	96,299	0.78	74,717	46,753	1.02	47,693	49,547	0.55	27,024	6,111
2004	107,176	0.63	67,589	42,100	1.07	44,913	65,076	0.35	22,676	26,841
2005	101,624	0.60	61,345	38,394	1.09	42,018	63,230	0.31	19,327	10,500
2006	104,337	0.53	55,217	34,579	1.11	38,319	69,757	0.24	16,898	18,142
2007	100,982	0.49	49,024	30,762	1.09	33,683	70,220	0.22	15,341	12,500

Proportion mature						
age	1991-1993	1994-1996	1997-1999	2000-2002	2003-2005	all
4	0.07	0.07	0.07	0.07	0.07	0.07
5	0.11	0.11	0.11	0.11	0.11	0.11
6	0.15	0.15	0.15	0.15	0.15	0.15
7	0.20	0.20	0.20	0.20	0.20	0.20
8	0.24	0.25	0.25	0.25	0.25	0.25
9	0.31	0.31	0.31	0.31	0.31	0.31
10	0.40	0.37	0.37	0.37	0.37	0.37
11	0.50	0.42	0.43	0.43	0.43	0.44
12	0.56	0.50	0.49	0.49	0.49	0.51
13	0.61	0.59	0.56	0.56	0.56	0.57
14	0.67	0.67	0.62	0.62	0.62	0.64
15	0.69	0.73	0.69	0.69	0.69	0.70
16	0.70	0.78	0.76	0.75	0.75	0.75
17	0.73	0.82	0.82	0.80	0.80	0.79
18	0.75	0.85	0.87	0.85	0.85	0.83
19	0.79	0.87	0.90	0.90	0.89	0.87
20	0.81	0.89	0.93	0.93	0.92	0.90
21	0.84	0.92	0.95	0.96	0.95	0.92
22	0.87	0.94	0.96	0.97	0.97	0.94
23	0.90	0.95	0.97	0.98	0.98	0.96
24	0.93	0.97	0.98	0.99	0.99	0.97
25	0.95	0.98	0.99	0.99	1.00	0.98
26	0.96	0.99	0.99	1.00	1.00	0.99
27	0.98	0.99	1.00	1.00	1.00	0.99
28	0.99	1.00	1.00	1.00	1.00	1.00
29	0.99	1.00	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00	1.00	1.00

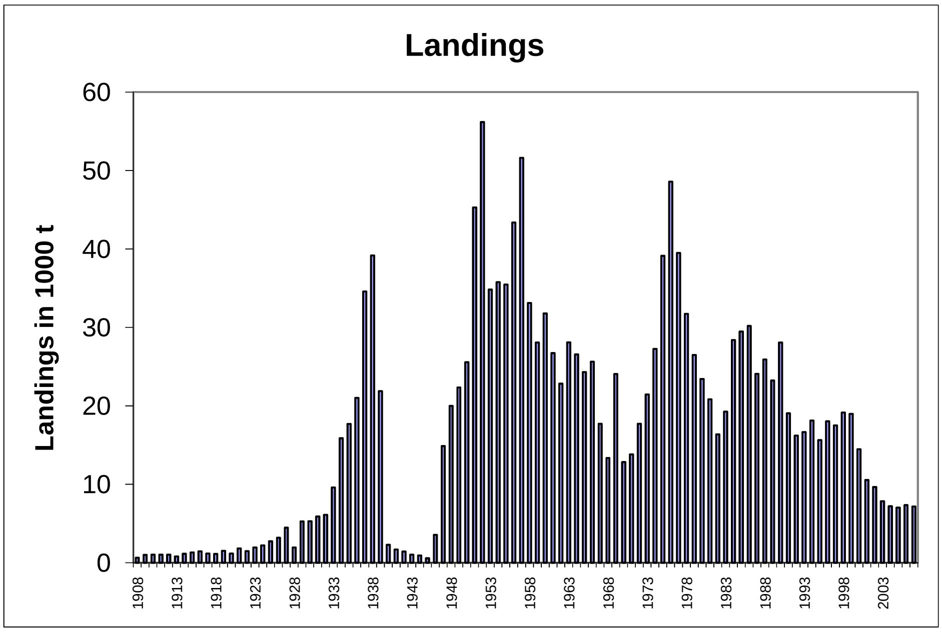


Figure 7.1. ***Sebastes marinus*** **in Sub-areas I and II. Total international landings 1965-2007 (in thousand tonnes)**

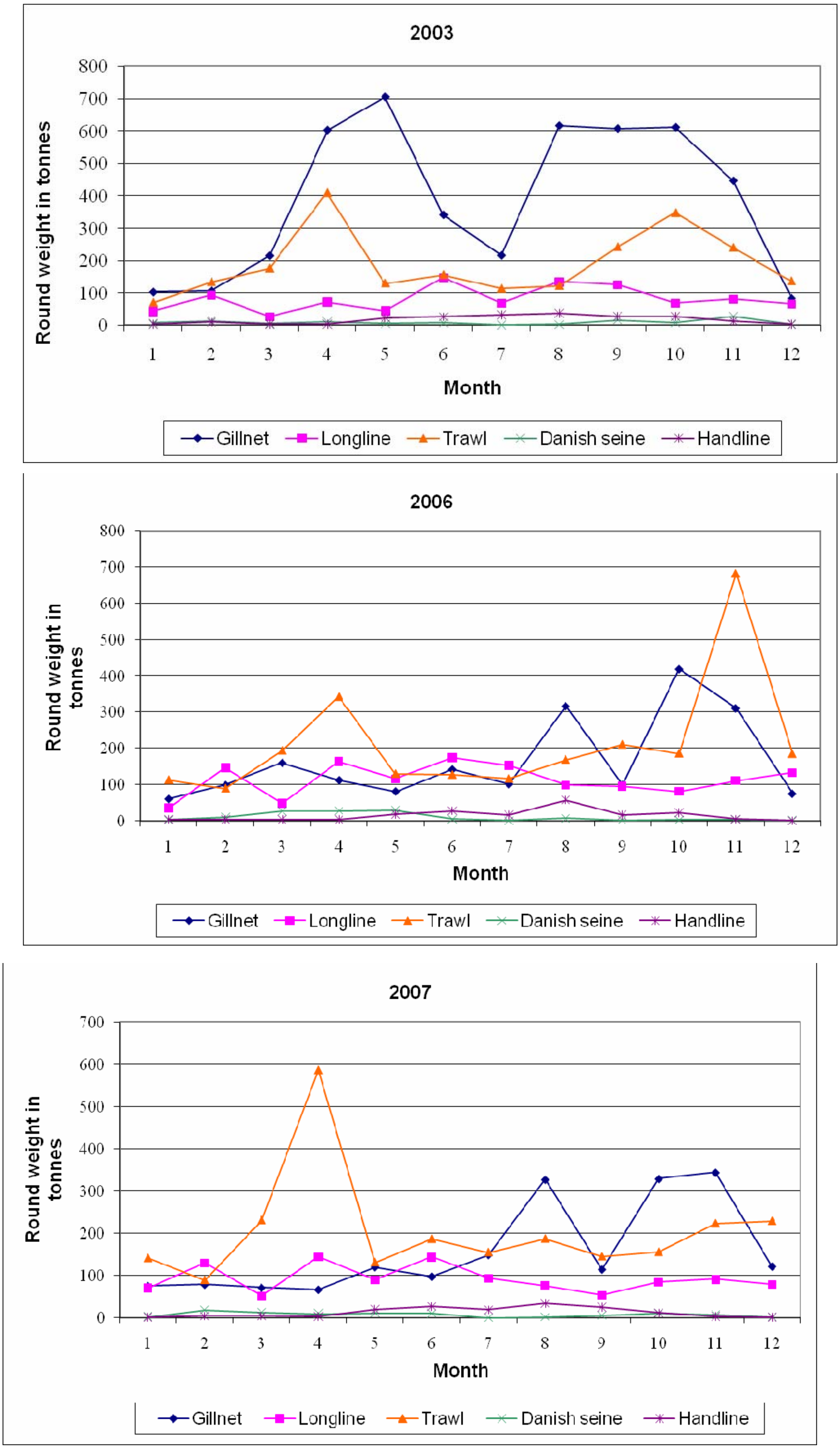


Figure 7.2a. ***Sebastes marinus*** **in Sub-areas I and II. Illustration of the seasonality in the different Norwegian** ***S. marinus*** **fisheries in 2003, 2006 and 2007.**

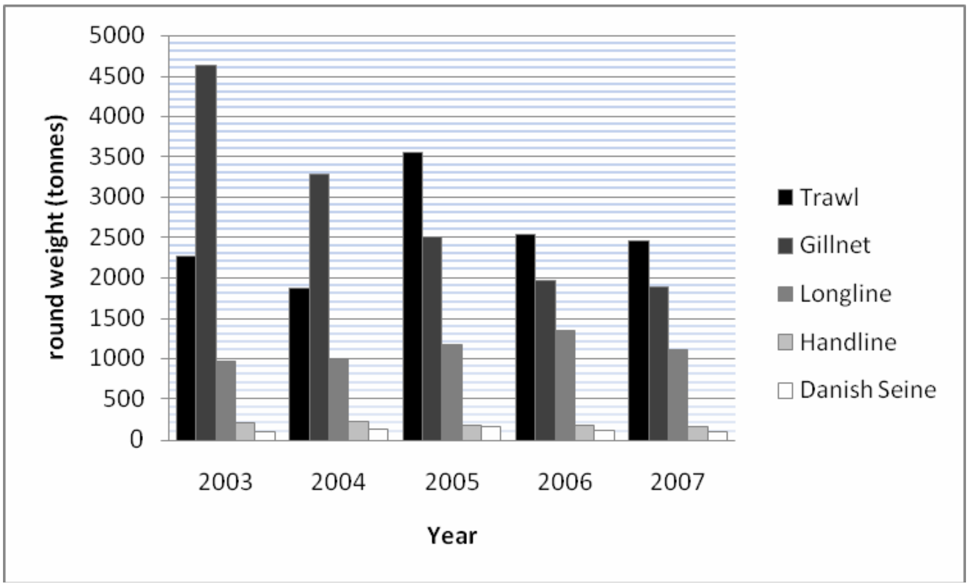


Figure 7.2b. Inter annual changes in the catches reported by different Norwegian *S. marinus* fisheries (2003-2007).

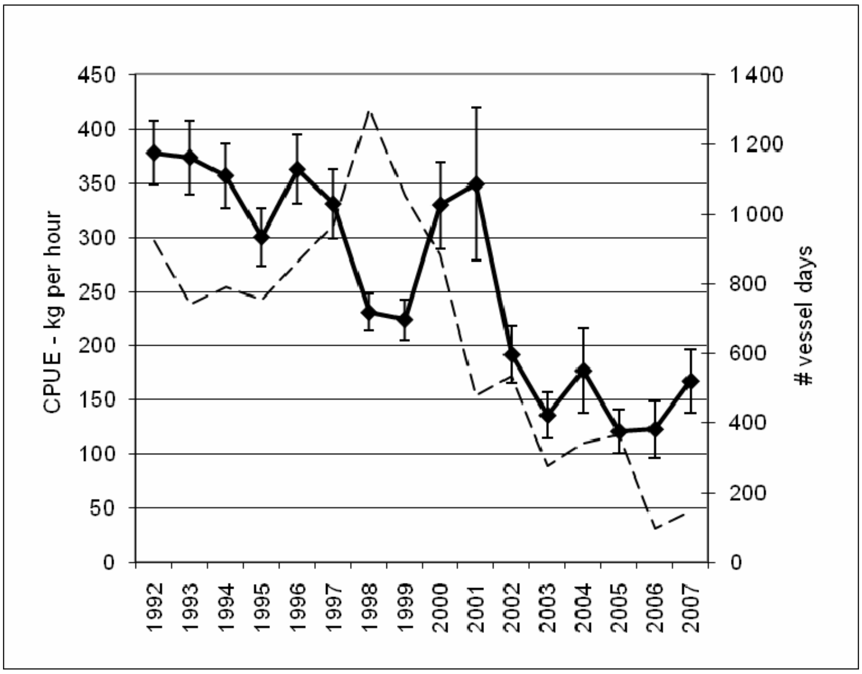


Figure 7.3. *Sebastes marinus* in Sub-areas I and II. **Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery, and numbers of vessel days (stippled curve) meeting the criterium of minimum 10% *S. marinus* in the catch per day. The figure is an illustration of the data given in Table D11.**

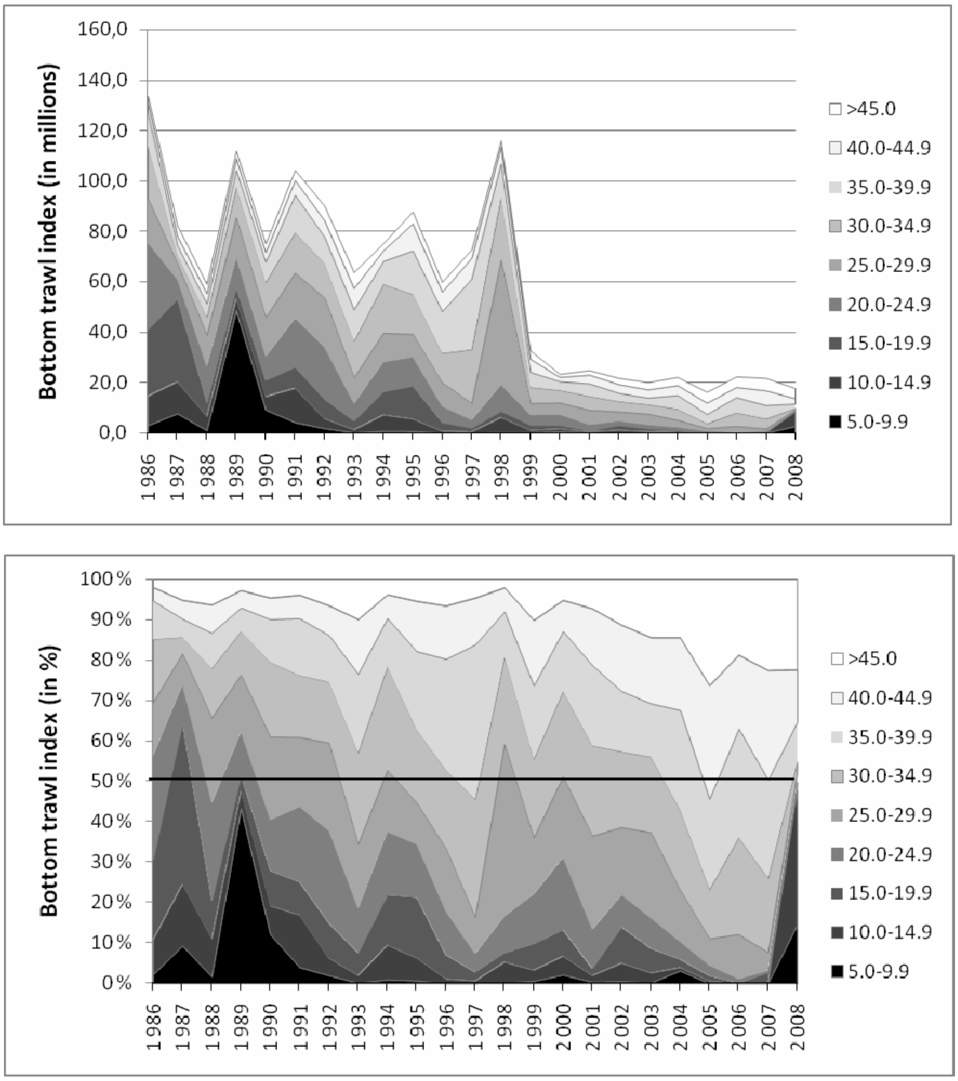


Figure 7.4a. ***Sebastes marinus.*** **Abundance indices disaggregated by length for the Norwegian bottom trawl survey in the Barents Sea in winter 1986-2008 (ref. Table D12a). Top: absolute index values, bottom: relative frequencies. Horizontal lines indicates the median length in the surveyed population.**

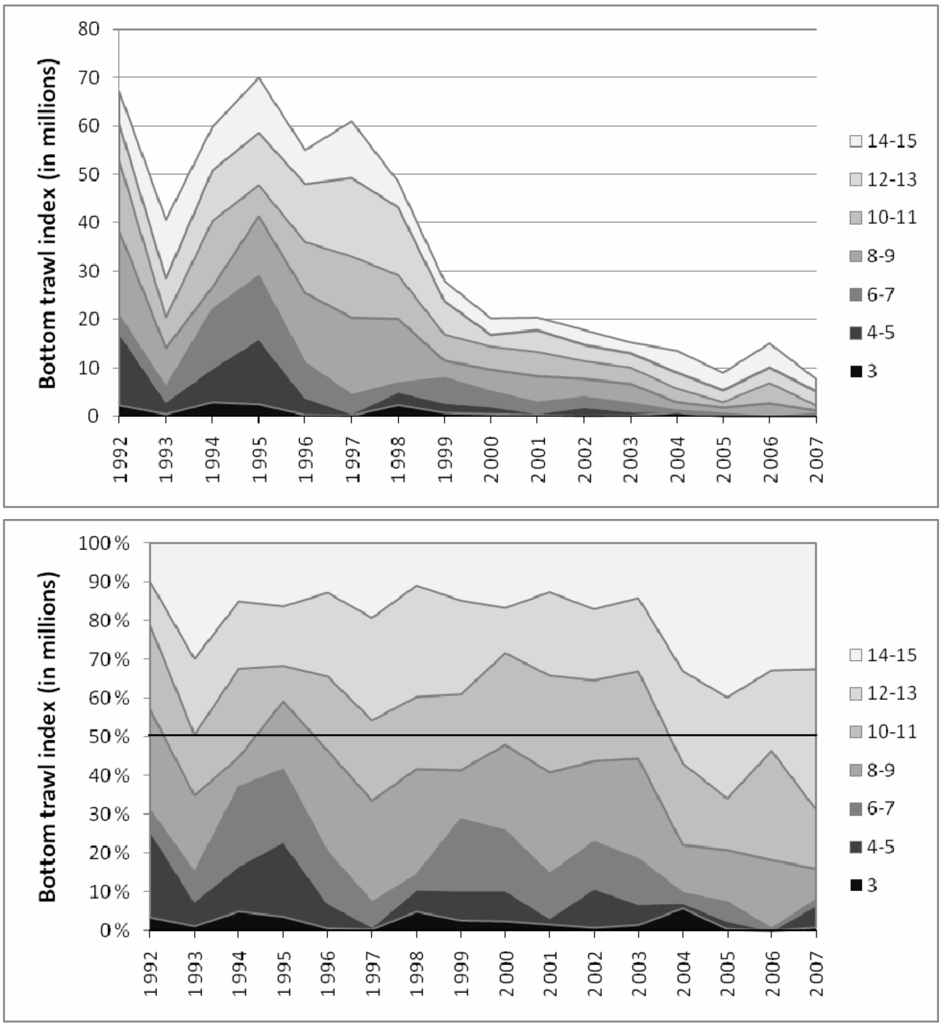


Figure 7.4b. ***Sebastes marinus.*** **Abundance indices (by age) from the Norwegian bottom trawl surveys 1992-2007 in the Barents Sea (ref. Table D12b). Top: absolute index, bottom: relative frequencies. Horizonla line indicate the median age of the surveyed population.**

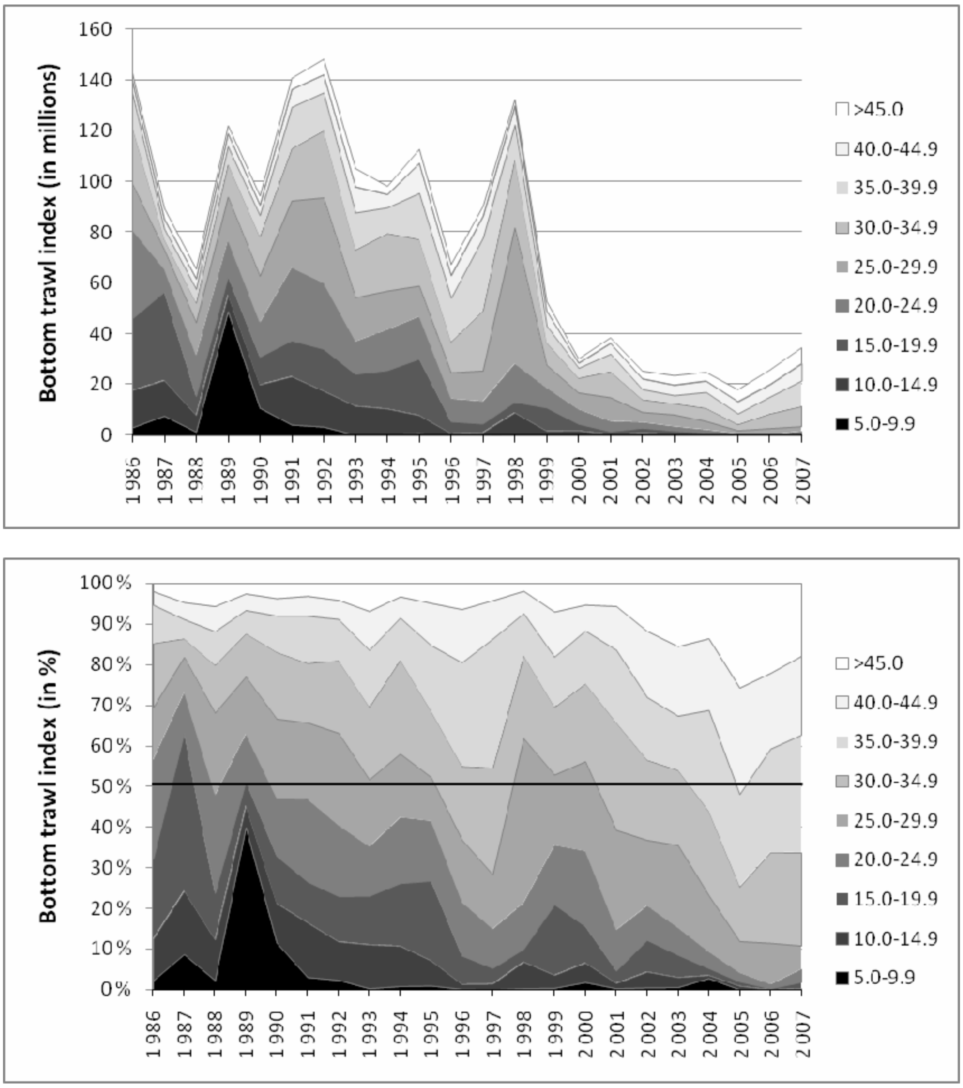


Figure 7.5a. *Sebastes marinus*. Abundance indices disaggregated by length when combining the Norwegian bottom trawl surveys 1986-2007 in the Barents Sea (winter) and at Svalbard (summer/fall). Top: absolute index values. Bottom: relative frequencies. Horizontal line indicate the median length in the surveyed population.

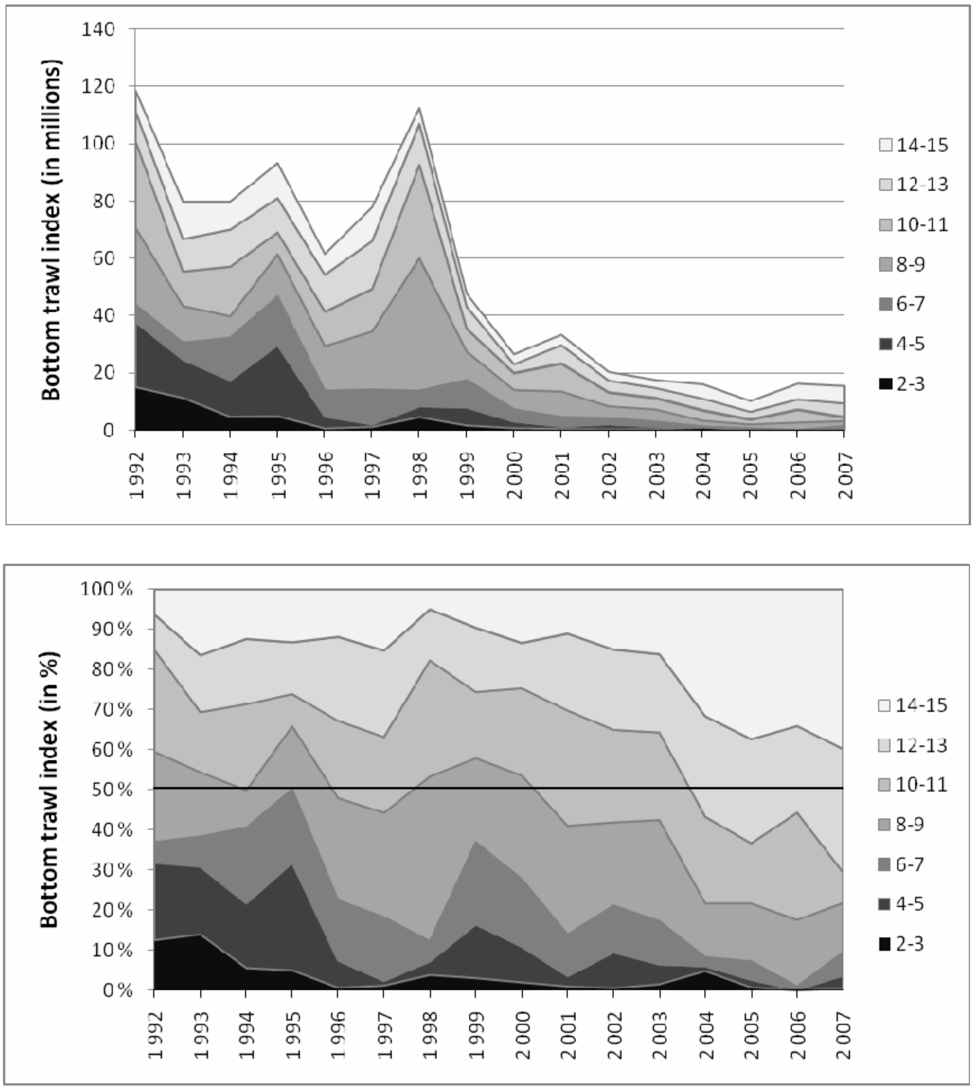
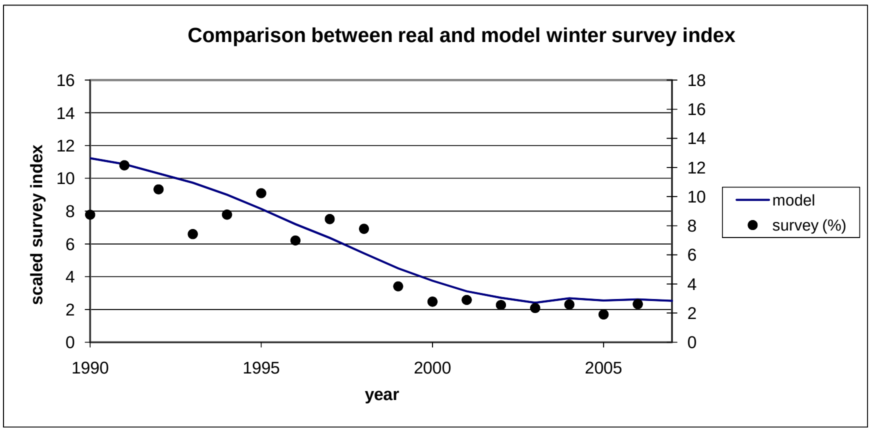


Figure 7.5b. ***Sebastes marinus*****. Abundance indices disaggregated by age. Combined Norwegian bottom trawl surveys 1992-2007 in the Barents Sea (winter) and Svalbard survey (summer/fall). Top: absolute index values, bottom: relative frequencies. Horizontal line indicates median age of the surveyed population.**



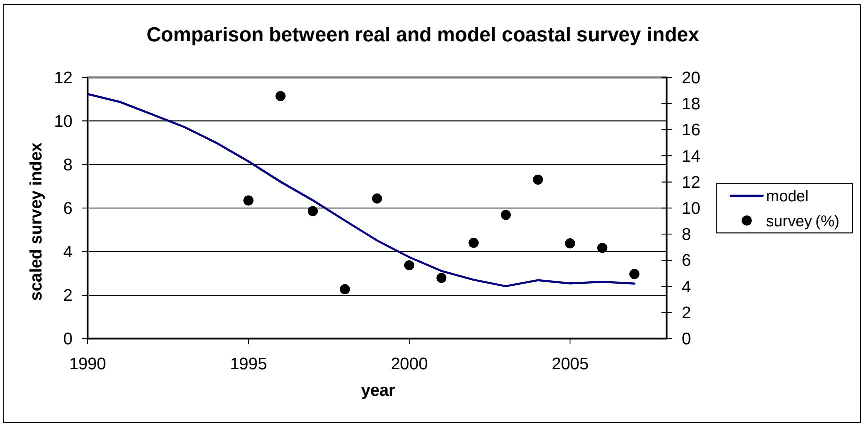


Figure 7.6. ***Sebastes marinus*** **in Sub-areas I and II. Results from the Gadget assessment using two scientific surveys as input. The Figure shows comparison of observed and modelled survey indices (total number scaled to sum=100 during the time period) – the traditional Barents Sea February survey to the left, and the coastal and fjord survey to the right. Dots: survey indices. Plain lines: survey indices estimated by the model. Dashed lines: survey indices estimated from model runs in 2007.**

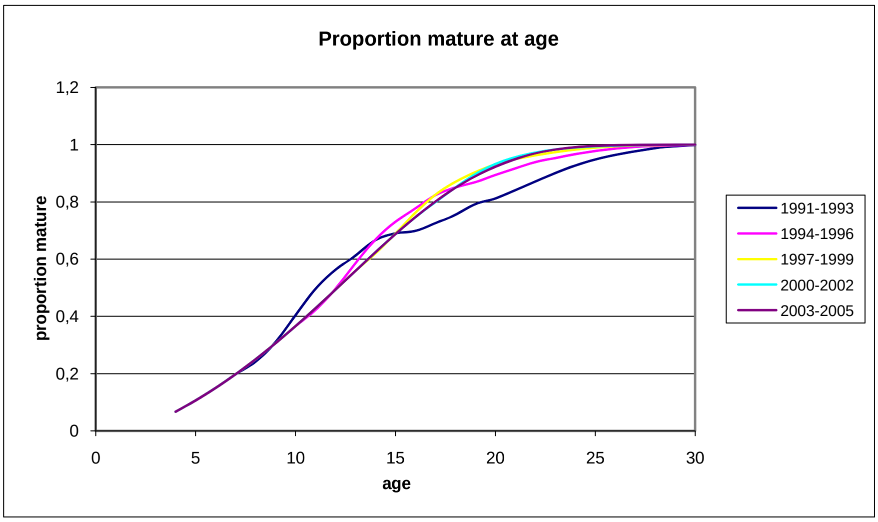


Figure 7.7. Sebastes marinus in Sub-areas I and II. Estimates of maturity at age by Gadget. Input data have been proportions of S. marinus mature both at age and length as collected and classified from Norwegian commercial landings and surveys. Fewer data together with being the beginning of the modelled time period have caused the more varying pattern for 1991-1996.

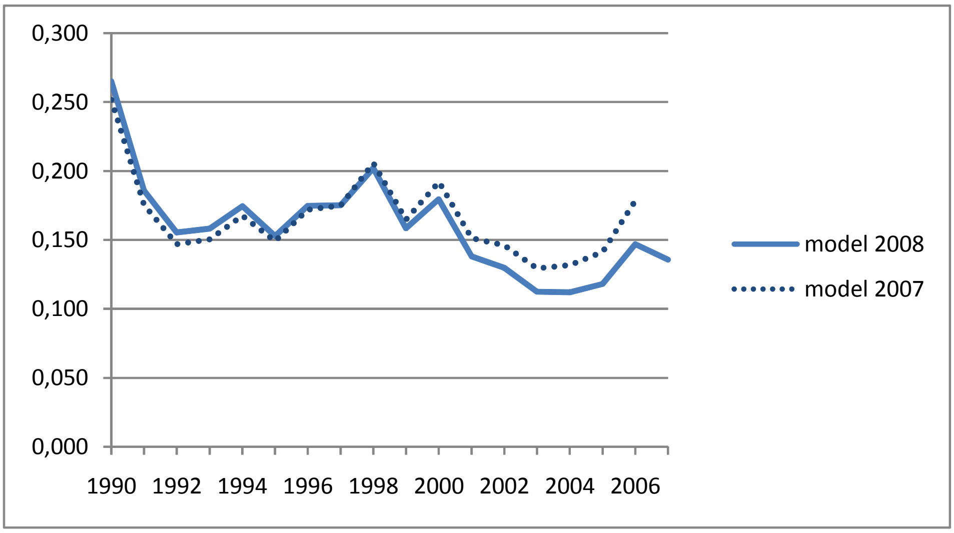


Figure 7.8. *Sebastes marinus* in sub-areas I & II. Unweighted average fishing mortality of ages 12-19 as estimated by Gadget in 2008 and in 2007.

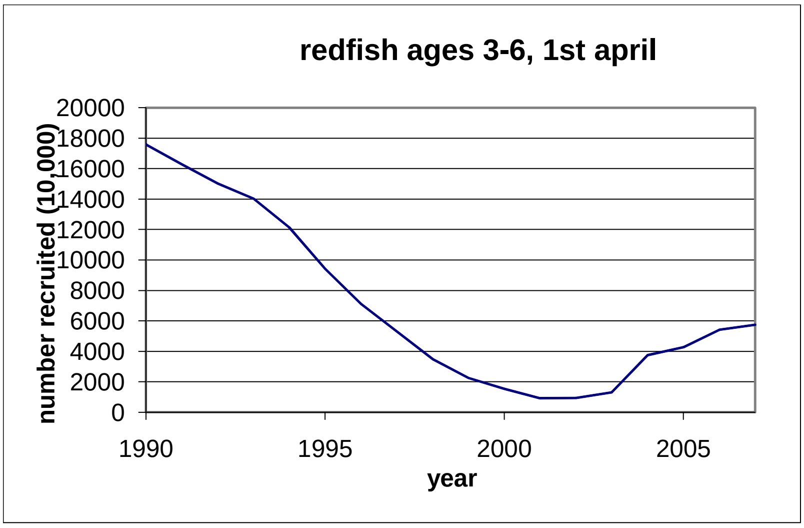


Figure 7.9. ***Sebastes marinus*** **in Sub-areas I and II. Estimates of abundance at age 3-6 by Gadget using two surveys as input.**

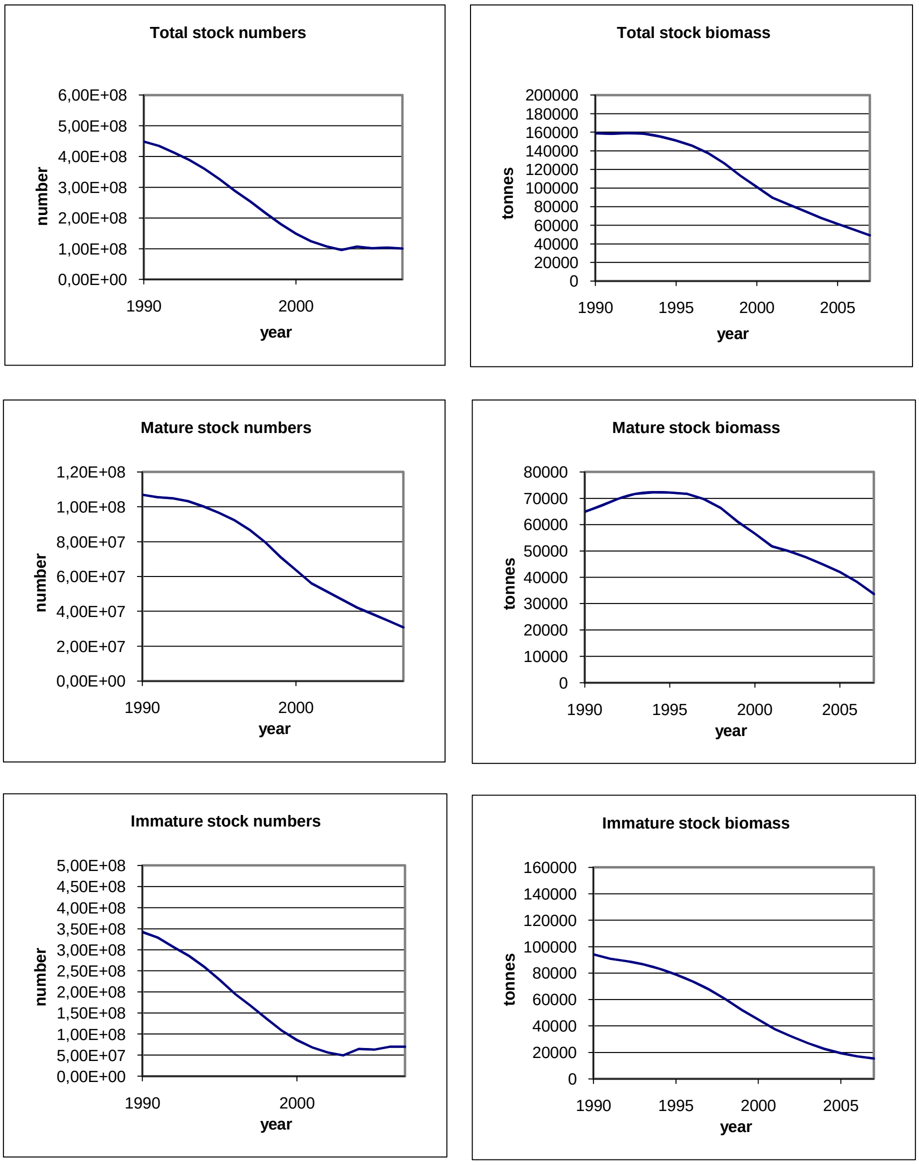


Figure 7.10. ***Sebastes marinus*** **in Sub-areas I and II. Stock numbers (in thousands) and biomass (in tonnes) for the total stock (3+) (upper panel), and the fishable and mature stock, and the immature stock, as estimated by Gadget using two surveys as input.**

Table D11. *Sebastes marinus*. Effort (vessel days) and catch per unit effort (kg per trawl hour) with 2 x st.error for Norwegian freezer trawlers (32-50 meters long).[1]

Year	Number of vessel days meeting the 10% requirement	Mean CPUE per year (kg/hour)	2 x standard error of the mean
1992	926	378	29.4
1993	743	374	34.4
1994	793	357	30.1
1995	754	300	26.7
1996	864	363	32.1
1997	972	331	31.9
1998	1 303	230	17.2
1999	1 054	224	18.8
2000	884	330	39.9
2001	481	349	70.5
2002	536	192	26.0
2003	276	136	21.4
2004	344	177	38.5
2005	368	120	20.2
2006[2]	98	123	26.0
2007[2]	147	167	29.4

[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 1986-2008 (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	2.6	6.0	0.2	0.1	0.4	0.5	1.8	2.3	4.0	17.9

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

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 Sub-area I and II. Abundance indices (on length) from the bottom trawl survey in the Svalbard area (Division IIb) in summer/fall 1985-2006 (numbers in thousands).

	Length (cm)									
Year	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	>45.0	Total
1985[1]	158	1,307	795	1,728	2,273	1,417	311	142	194	8,325
1986[1]	200	2,961	1,768	547	643	1,520	639	467	196	8,941
1987[1]	124	1,343	1,964	1,185	1,367	652	352	29	44	7,060
1988[1]	520	1,001	1,953	1,609	684	358	158	68	95	6,450
1989	197	1,629	2,963	2,374	1,320	846	337	323	104	10,100
1990	1,673	3,886	4,478	4,047	2,972	1,509	365	140	122	19,185
1991	127	5,371	5,821	9,171	8,523	4,499	1,531	982	395	36,420
1992	1,689	10,228	8,858	5,330	13,960	12,720	4,547	494	346	58,172
1993	205	10,160	9,078	5,855	7,071	4,327	2,088	1,552	948	41,284
1994	51	3,340	5,883	4,185	3,922	3,315	1,021	845	423	22,985
1995	470	2,000	9,100	5,070	3,060	2,400	1,040	920	780	24,840
1996	80	130	1,260	2,480	1,030	480	550	990	400	7,400
1997	40	810	1,980	5,470	5,560	2,340	590	190	450	17,430
1998	210	2,698	1,741	4,620	4,053	1,761	535	545	241	16,403
1999	0	794	7,057	3,698	4,563	2,449	467	619	369	20,017
2000	40	360	1,240	1,390	2,010	760	400	160	390	6,750
2001	10	110	790	1,470	3,710	4,600	1,880	680	370	13,660
2002	0	0	64	415	459	880	620	565	519	3,522
2003	90	90	108	83	525	565	447	760	769	3,437
2004	0	0	10	50	650	740	670	430	190	2,740
2005	0	45	0	30	315	384	307	159	274	1,513
2006	0	0	70	64	167	376	473	735	1,514	3,398
2007	0	32	58	1,003	1,049	3,875	4,656	811	1,267	12,751

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 1992-2007 (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

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 1995-2005 within 100-350 m depth. Catch rates for the total area.**

Length (cm)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0-4	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
10-14	118	87	9	0	19	2	2	0	3	3	5	3	0
15-19	59	124	12	4	242	13	11	0	10	5	5	0	0
20-24	54	151	64	12	160	7	14	2	44	20	30	2	4
25-29	38	67	112	16	34	10	22	6	72	61	46	3	7
30-34	69	210	96	17	43	30	15	29	53	42	48	29	17
35-39	214	415	178	110	151	160	83	259	222	265	190	144	127
40-44	157	209	190	96	117	155	160	213	225	407	171	254	178
45-49	21	64	45	18	15	30	30	26	61	44	37	65	28
50-54	2	0	2	3	4	4	2	4	5	3	1	9	1
55-59	1	0	1	0	2	0	0	1	0	1	0	0	0
60-64	0	0	0	0	0	0	0	0	0	0	0	0	0
# Hauls									126	112	99	114	138
Total trawling distance (nm)									164	138	132	113	149
# Fish Caught									1368	1364	833	771	652
# Fish Sampled									1054	977	780	680	639

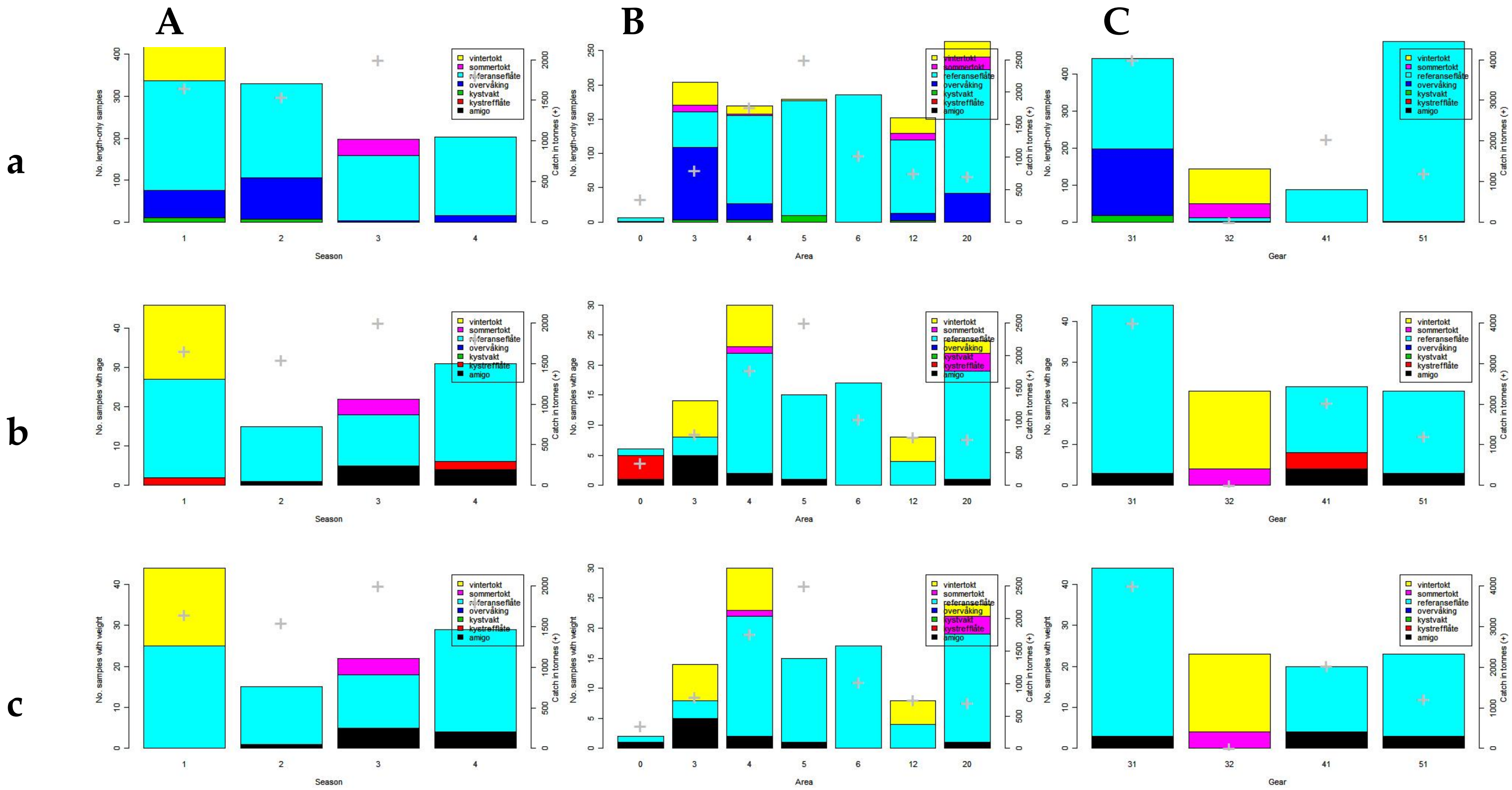


Figure D 1. Overview of the Norwegian biological samples from the commercial fisheries for *S. marinus* in 2007 representing 80% of the catches, and the scientific survey (gear code 32, yellow), and which the input data to the Gadget model are based upon. Column A, B and C show the number of samples per season, area and gear, respectively. Row a, b and c show the number of length samples, age (otolith) samples and weight samples, respectively. The colours denote which sampling platform that has been used, e.g., port sampling (black), Reference fleet (turquoise and red), inspectors (blue), and the Coastguard (green). Yellow and violet colours denote samples from scientific surveys. The crosses show the catch in tonnes for the different gears, quarters and areas.

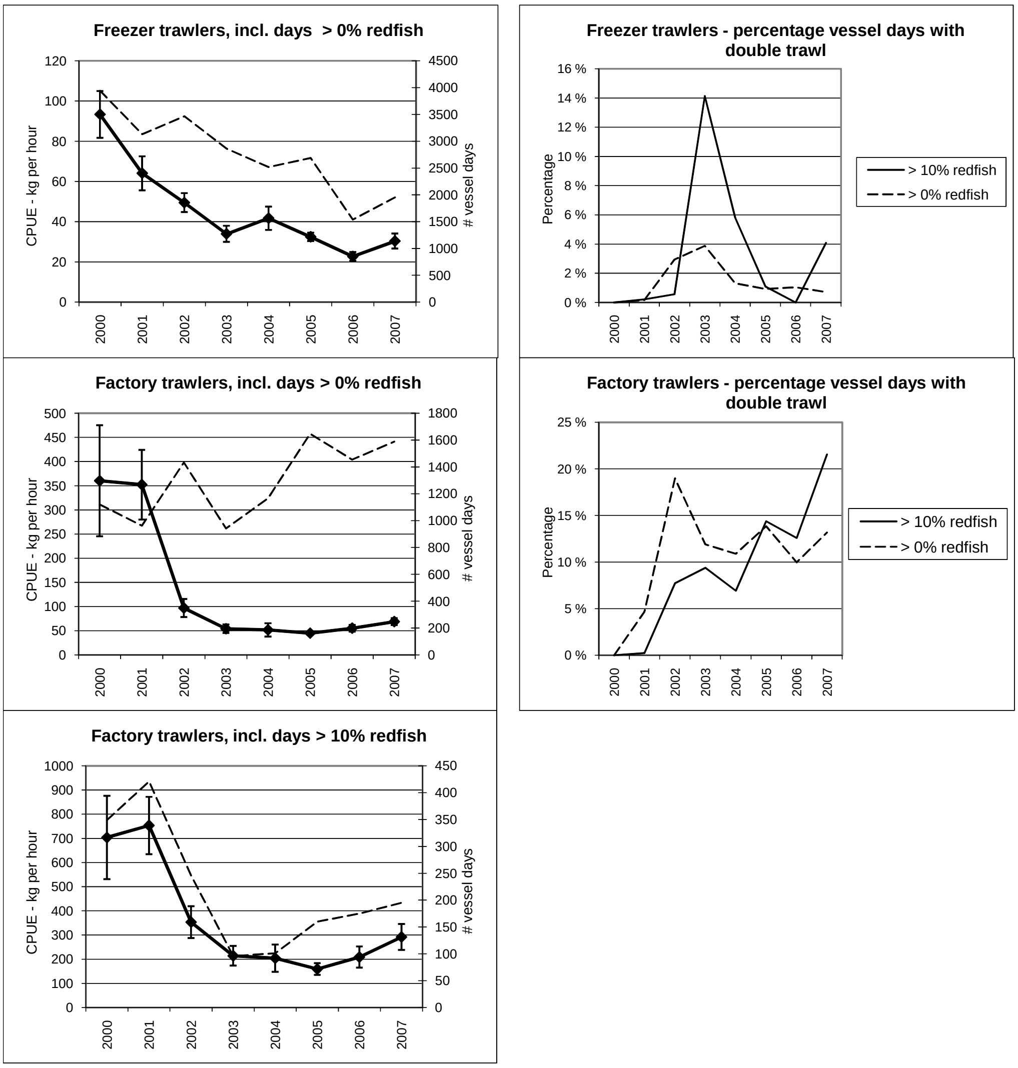


Figure D2. ***Sebastes marinus.*** **Plot of simple mean CPUEs with 2 st. errors from the Norwegian trawl fishery presented for two trawler categories, i.e., freezer trawlers less than 50 meters and factory trawlers above 54 meters, and two criteria for which vessel days to use, i.e., only vessel days with minimum 10%** ***S. marinus*** **in the total catch per day or incl. all vessel days where** ***S. marinus*** **were caught. In the left panel, the numbers of vessel days (stippled curve) meeting the criterium of minimum %** ***S. marinus*** **in the catch per day are shown. The right panel shows how the use of double trawl has developed. The figure is meant to be a supplement to Figure 7.3.**

8 Greenland halibut in subareas I and II

An update assessment is presented for this stock. 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 2008 (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. Russian official reportings to the ICES in 2007 were not complete, but correct landings were presented to the Working Group during the meeting. The tables also incorporate data presented to the Working Group on Polish survey catches from March 2007.

The preliminary estimate of the total catch for 2007 is 14,828 t. This is substantially lower than the projected catch for 2007 estimated by the Working Group during its 2007 meeting (18,000 t). It is also 3,000-4,000 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 2007 is mainly due to Norwegian catches being more than 3,000 t 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 below 100 t, and in 2007 it was 129 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 2007 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 2007 should be below 13 000 t as advised in 2005; 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.*

The advice for 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.*

8.1.3 Management applicable in 2007 and 2008

Target Greenland halibut fishery is forbidden since 1992. Management of Greenland halibut is by bycatch regulations and a limited coastal Norwegian fishery using longline and gillnet. From 2001 the bycatch regulations in each haul was not to exceed 12% in each haul and 7% of the landed catch. From early 2004 the Norwegian Department of Fisheries decided that for Norwegian vessels in the NEEZ allowable bycatch at any time on board and by landing should not exceed 7 %. In addition, the annual catch for each trawler are not allowed to exceed 4 % of the sum of the vessels quota on cod, haddock and saithe, and limited by a maximum annual catch of 40 t pr. vessel.

The Norwegian conventional fleet, vessels smaller than 28 m, are allowed to conduct a limited target fishery with longlines and gillnets in a limited area in approximately one month each year. For these vessels the TAC is set to 10, 12 and 14 t, dependent of size of the vessel. This fishery is supposed to keep the total catch at a level which these vessels landed historically (ca. 2,500 t).

The 30. Session of the joint Russian-Norwegian Fisheries Commission (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.

8.1.4 Expected landings in 2008

For 2008 the total Norwegian catch is expected to be at the same level as in 2007, i.e. about 8,000 t. In addition, 6,000 t is expected to be caught by Russian vessels, and 500 t by other countries. Consequently, the official landings in 2008 are expected to be 14,500 t. Discards is not regarded as a problem, but it is believed that there may be additional landings that are not reported. The catches from Division IVa are expected to be maintained at a low level (below 500 t).

8.2 Status of research

8.2.1 Survey results (Tables A14, E1–E8)

Over the last several years the Working Group has been concerned about trends in catchability within individual surveys used for tuning of the XSA. The trends were seen for younger ages of year classes in the late 80's and early 90's that were initially estimated very low in abundance. With increasing age these year classes were estimated much closer to the mean abundance. In previous meetings the Working Group therefore increased the lower age used in tuning to five years in order to reduce the problem. This only partly solved the problem, 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 show that there was a small 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 2005 (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 index was 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

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, Russian age-length keys were used on the total catch matrix and the Russian survey was the only tuning fleet updated for 2007. 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 2006 were updated using revised catch figures. Catch-at-age data for 2006 and 2007 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 and 2007 (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 1984–2007, 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 2004-2007 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 1992-2007 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 2007 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 14,500 t by 1995-96 but has been increasing since then to an estimate of 48,000 by 2004, which is the highest value estimated since 1976 and close to the long-term average for the whole period 1964-2006. The female spawning stock has decreased in 2005-2006 and increased again in 2007, and the total stock has the same trend. 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 0.66. After the reduction the fishing mortality has averaged around 0.25. The high catch in 1999 resulted in an increase in fishing mortality to 0.35 but since then has declined to 0.17 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 (0.20-0.22) but remained lower than average. For the 2007 Fbar was estimated at 0.12 – the lowest level in history. It was conditioned by 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 1990-2004 average is about 83% of the average during the 1980's. The estimate for 2007 is the highest after 1970 and above the long-term average.

8.6.2 Biological reference points

Given the continuing levels of uncertainty in the current assessment no further attempts were made to develop reference points for this stock.

8.6.3 Catch options for 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 2006 has increased while SSB has been reduced, fishing mortality remained at the same level.

	Total stock (5+) by 1 January 2007	SSB by 1 January 2007	F6-10 in 2007	F6-10 in 2006
WG 2007	111734	35749	0.19*	0.22
WG 2008	126661	39584	0.13	0.20

*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 2006 and new data for 2007. 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 2004-2006 the SSB show a decreasing signal, whereas it has a slight increase in 2007. 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 high catch in 2004-2007 and expected catch of 2008 will most likely lead to reduction in the spawning stock size, as in the period 1983 to 1990.

8.9 Response to ACFM technical minutes

AFCM technical minutes are not commented on because the 2007 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	Den	Esto-	Faro	Franc	Fed.	Gre	Ice-	Ire-	Lithu	Norway	Po-	Portu-	Russi	Spain	UK	UK	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[1]	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	26[2]	6,055	27[2]	6	0	17,897
2007[1]	0	0	197	41	8	0	0	+	0	8,183[3]	200	29	6,149[2]	7[2]	14	0	14,828

[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]	-	12	-	1	-	-	-	588[3]	-	438	+	+	-	1,039

[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	Green-land	Ice-land	Ire-land	Norway	Poland	Portu-gal	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[1]	-	-	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	-	-	-	8,897[3]	-[2]	6	950	+	2	-	10,075
2007[1]	-	162	2	38	-	-	-	6,522[3]	-[2]	2	489[2]	-	10	-	7,224

[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[1]	-	-	-	-	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	2	6	+	-	1,073[3]	200[2]	27	5,222[2]	7[2]	5	-	6,566

[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	4 497	9 216	119	14 829

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]	-	-	-	-	-	-	-	-

[1] Side trawlers, 800-1000 hp. From 1983 onwards, side trawlers (SRTM), 1,000 hp. From 1997 based on research fishing.
[2] Stern trawlers, up to 2,000 HP.
[3] Arithmetic average of CPUE from USSR RT (or SRTM trawlers) and Norwegian trawlers.
[4] Arithmetic average of CPUE from USSR PST and Norwegian trawlers.
[5] For the years 1981-1990, based on average CPUE type B. For 1991-1993, based on the Norwegian CPUE, type A.
[6] Total catch (t) of seven years and older fish divided by total effort.
[7] For the years 1988-1989, frost-trawlers 995 BRT (FAO Code 095). For 1990, factory trawlers FVS IV, 1943 BRT (FAO Code 090).
[8] Norwegian trawlers, ISSCFV-code 07, 250-499.9 GRT.
[9] Norwegian factory trawlers, ISSCFV-code 09, 1000-1999.9 GRT.
[10] From 1992 based on research fishing. 1992-1993: two weeks in May/June and October; 1994-1995: 10 days in May/June.
[11] Based on fishery from april-october only, a period with relatively low CPUE. In previous years fishery was carried out throughout the whole year.
[12] Based on fishery from october-december only, a period with relatively high CPUE.
[13] Based on fishery from october-november only.

Table 8.7

Run title : Arctic Green.halibut (run: 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
AGE											
5	1672	1212	907	2080	2139	3312	1098	1140	631	846	1034
6	3335	2972	2540	4453	5163	3889	1195	1088	708	992	2083
7	2712	3572	3141	3655	4642	4716	1069	1608	1252	1719	3795
8	1531	1746	2096	1657	1932	2355	778	1118	817	990	1426
9	1128	752	1182	801	1221	1031	360	140	310	405	262
10	997	828	860	318	499	1284	600	976	642	726	655
11	530	362	481	228	264	774	188	444	416	461	270
12	434	202	313	126	314	673	150	144	330	371	132
13	314	186	133	120	42	177	79	36	88	154	29
14	305	63	140	140	96	266	89	20	39	56	22
+gp	239	7	47	28	44	517	56	4	3	8	1
0 TOTALNUM	13197	11902	11840	13606	16356	18994	5662	6718	5236	6728	9709
TONSLAND	22875	19112	19587	20138	23183	33320	8602	11933	9226	11734	14347
SOPCOF %	98	101	100	103	102	105	95	102	99	101	101

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

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
5	330	359	433	380	441	277	397	290	429	548	914
6	921	1116	1905	735	1347	921	1025	1016	1072	1347	1441
7	1822	2466	3955	1926	2338	1475	1827	2316	1962	2067	1954
8	953	1464	1810	1464	1325	983	928	1392	1766	1584	1030
9	342	527	914	743	788	631	632	1087	936	1034	624
10	822	924	1905	1318	1140	1097	1045	778	991	691	442
11	231	237	380	457	519	563	520	675	616	485	429
12	150	122	237	330	372	301	311	607	622	548	457
13	18	15	67	49	115	132	77	199	376	466	231
14	41	29	42	37	54	59	107	155	244	209	155
+gp	1	15	7	14	12	42	26	105	328	230	207
0 TOTALNUM	5631	7274	11655	7453	8451	6481	6895	8620	9342	9209	7884
TONSLAND	9410	11893	19517	14437	16307	13161	13578	18800	18834	17897	14828
SOPCOF %	99	100	102	101	100	100	100	99	97	100	99

Table 8.8

Run title : Arctic Green.halibut (run: 2008/1)

At 24/04/2008 11:48

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	0.9943

Table 8.9

Run title : Arctic Green.halibut (run: 2008/1)

At 24/04/2008 11:48

Table 5 Proportion mature at age

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE											
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
7	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
8	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210
9	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670
10	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860
11	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
12	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 5 Proportion mature at age

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.040	0.040
7	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.040
8	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.180	0.180	0.190
9	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.600	0.610	0.650
10	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.820	0.830	0.850
11	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.960	0.970	0.970
12	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.990
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 8.9 (Continued)

Table 5 Proportion mature at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE											
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.000
6	0.030	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.000
7	0.030	0.020	0.010	0.020	0.020	0.040	0.060	0.080	0.070	0.080	0.070
8	0.240	0.220	0.210	0.180	0.170	0.150	0.280	0.320	0.340	0.290	0.250
9	0.740	0.660	0.530	0.490	0.510	0.540	0.660	0.680	0.690	0.580	0.580
10	0.910	0.900	0.870	0.800	0.770	0.770	0.860	0.830	0.810	0.790	0.880
11	0.990	0.950	0.890	0.890	0.910	0.890	0.870	0.880	0.950	0.960	0.970
12	0.980	0.980	0.980	1.000	1.000	1.000	1.000	0.940	0.940	0.890	0.940
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 5 Proportion mature at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
5	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.010	0.030	0.030	0.020	0.010	0.020	0.010	0.020
7	0.070	0.040	0.020	0.030	0.060	0.100	0.110	0.080	0.030	0.050	0.040
8	0.210	0.100	0.070	0.100	0.190	0.310	0.340	0.280	0.200	0.180	0.170
9	0.530	0.450	0.330	0.370	0.490	0.660	0.720	0.660	0.630	0.500	0.570
10	0.850	0.820	0.660	0.630	0.650	0.790	0.880	0.910	0.890	0.740	0.670
11	0.940	0.920	0.860	0.870	0.840	0.910	0.920	0.940	0.960	0.850	0.870
12	0.940	1.000	0.990	0.960	0.960	0.960	0.970	0.960	0.970	0.930	0.930
13	1.000	1.000	1.000	1.000	1.000	0.990	0.980	0.980	1.000	0.980	0.970
14	1.000	1.000	1.000	1.000	1.000	1.000	0.980	0.980	1.000	0.990	0.980
+gp	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 8.10.

Lowestoft VPA Version 3.1

24/04/2008 11:41

Extended Survivors Analysis

Arctic Green.halibut (run: 2008/1)

CPUE data from file fleet

Catch data for 44 years. 1964 to 2007. Ages 5 to 15.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT04: Norw. Exp. CP	1992	2007	5	14	0.38	0.44
FLT07: Russ.Surv. ne	1992	2007	5	14	0.75	0.92
FLT08: Norw.Comb.Sur	1996	2007	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 2006
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 51 iterations

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
5	0.02	0.031	0.026	0.031	0.017	0.027	0.018	0.019	0.022	0.025
6	0.071	0.136	0.065	0.113	0.079	0.076	0.085	0.079	0.072	0.071
7	0.249	0.361	0.188	0.283	0.164	0.21	0.233	0.222	0.205	0.135
8	0.235	0.276	0.207	0.181	0.174	0.14	0.231	0.265	0.265	0.141
9	0.118	0.214	0.164	0.155	0.116	0.153	0.229	0.227	0.231	0.15
10	0.507	0.742	0.51	0.383	0.317	0.271	0.27	0.318	0.247	0.138
11	0.349	0.38	0.366	0.363	0.312	0.23	0.266	0.336	0.239	0.225
12	0.474	0.664	0.627	0.542	0.349	0.268	0.433	0.396	0.532	0.35
13	0.118	0.489	0.257	0.435	0.352	0.132	0.259	0.494	0.549	0.422
14	0.308	0.521	0.519	0.47	0.393	0.506	0.402	0.547	0.532	0.332

Table 8.10 (Continued)

XSA population numbers (Thousands)

	AGE									
YEAR	5	6	7	8	9	10	11	12	13	14
1998	1.91E+04	1.75E+04	1.21E+04	7.53E+03	5.12E+03	2.50E+03	8.67E+02	3.48E+02	1.46E+02	1.18E+02
1999	1.52E+04	1.61E+04	1.41E+04	8.09E+03	5.12E+03	3.92E+03	1.30E+03	5.26E+02	1.87E+02	1.11E+02
2000	1.63E+04	1.27E+04	1.21E+04	8.43E+03	5.29E+03	3.56E+03	1.61E+03	7.64E+02	2.33E+02	9.85E+01
2001	1.57E+04	1.36E+04	1.02E+04	8.62E+03	5.90E+03	3.86E+03	1.84E+03	9.59E+02	3.51E+02	1.55E+02
2002	1.78E+04	1.31E+04	1.05E+04	6.63E+03	6.19E+03	4.35E+03	2.26E+03	1.10E+03	4.80E+02	1.96E+02
2003	1.60E+04	1.51E+04	1.04E+04	7.66E+03	4.80E+03	4.74E+03	2.72E+03	1.43E+03	6.69E+02	2.91E+02
2004	1.79E+04	1.34E+04	1.20E+04	7.27E+03	5.73E+03	3.54E+03	3.11E+03	1.86E+03	9.39E+02	5.04E+02
2005	2.46E+04	1.51E+04	1.06E+04	8.18E+03	4.97E+03	3.92E+03	2.33E+03	2.05E+03	1.04E+03	6.24E+02
2006	2.70E+04	2.08E+04	1.20E+04	7.33E+03	5.41E+03	3.41E+03	2.46E+03	1.43E+03	1.19E+03	5.46E+02
2007	3.98E+04	2.27E+04	1.66E+04	8.43E+03	4.84E+03	3.69E+03	2.29E+03	1.67E+03	7.24E+02	5.91E+02

Estimated population abundance at 1st Jan 2008

	0.00E+00	3.34E+04	1.82E+04	1.25E+04	6.30E+03	3.59E+03	2.77E+03	1.57E+03	1.01E+03	4.09E+02

Taper weighted geometric mean of the VPA populations:

	1.95E+04	1.50E+04	1.11E+04	6.96E+03	4.51E+03	3.14E+03	1.65E+03	9.00E+02	4.04E+02	2.15E+02

Standard error of the weighted Log(VPA populations) :

	0.3003	0.2381	0.2488	0.2678	0.3379	0.3643	0.5185	0.6562	0.7829	0.8163

Log catchability residuals.

Fleet : FLT04: Norw. Exp. CP

Age	1992	1993	1994	1995	1996	1997
5	0.27	0.84	0.59	0.71	0.96	0.87
6	-0.21	0.04	0.17	-0.11	0.72	0.14
7	-0.51	0.07	0.09	0.1	0.32	0.01
8	-0.19	0.18	0.27	0.28	0.17	-0.22
9	-1.51	-1.49	-0.99	0.22	-0.29	-0.07
10	-0.42	0.11	0.31	0.77	0.04	0.5
11	-0.19	-0.11	-0.19	0.21	-0.65	0.54
12	0.11	-0.17	-0.81	0.18	-0.76	0.47
13	-0.36	-0.06	-0.75	-0.19	99.99	0.08
14	-1.37	-0.27	-0.57	0.1	-0.23	-0.14

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
5	-0.67	-0.23	0.3	-0.4	-0.28	-0.07	-0.12	-0.75	99.99	99.99
6	-0.2	-0.16	0.02	-0.06	-0.17	-0.05	-0.05	0.09	99.99	99.99
7	0	-0.18	0.25	-0.16	0.22	-0.08	-0.17	-0.08	99.99	99.99
8	-0.13	-0.21	-0.17	0.28	-0.09	-0.5	0.04	0.5	99.99	99.99
9	-0.27	-1.21	0.04	0.27	0.17	0.58	0.6	0.78	99.99	99.99
10	-1.04	0.22	0.37	-0.12	-0.04	0.09	-0.44	-0.02	99.99	99.99
11	-0.99	-1.13	-1.14	-0.79	-0.77	-0.36	-0.48	-0.24	99.99	99.99
12	-0.87	0.53	-0.13	-0.12	-0.69	0	-0.02	0.18	99.99	99.99
13	99.99	-0.65	0.29	-0.89	-1.65	-0.28	-0.28	0.24	99.99	99.99
14	99.99	-0.12	99.99	-0.47	-0.04	-0.17	-0.07	0.04	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	-5.0426	-4.0458	-3.246	-3.7082	-4.4756	-3.628	-3.628	-3.628	-3.628	-3.628
S.E(Log q)	0.5706	0.2208	0.1875	0.2961	0.6852	0.4388	0.7475	0.4818	0.747	0.3323

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	4.26	-0.658	-10.4	0.01	14	2.51	-5.04
6	1.07	-0.15	3.65	0.36	14	0.25	-4.05
7	0.97	0.104	3.42	0.62	14	0.19	-3.25
8	1.25	-0.567	2.41	0.39	14	0.39	-3.71
9	0.56	1.334	6.21	0.53	14	0.37	-4.48
10	1.26	-0.535	2.48	0.35	14	0.58	-3.63
11	1.24	-0.61	3.41	0.46	14	0.63	-4.16
12	0.89	0.491	4.07	0.73	14	0.43	-3.76
13	0.98	0.054	4.06	0.59	12	0.65	-4.02
14	0.91	0.794	3.95	0.92	12	0.25	-3.81
1							

Fleet : FLT07: Russ.Surv. ne

Age	1992	1993	1994	1995	1996	1997
5	1.89	0.75	0.05	-0.46	-0.33	-0.99
6	0.95	0.65	0.24	-0.14	0.01	-0.53
7	0.49	0.52	0.02	0	0.06	-0.29
8	0.36	0.35	0.09	0.33	0.2	-0.01
9	-0.61	-0.06	0.02	0.33	0.75	-0.14
10	-0.46	-0.03	0.24	0.19	-0.86	-0.04
11	0.34	-0.16	-0.49	-0.09	-0.68	0.29
12	0.24	0.36	-0.07	0.03	-0.92	-0.44
13	-0.49	-0.36	-0.44	-0.32	-0.46	0.37
14	-5.07	0.65	0.46	-1.8	-0.41	-0.41

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
5	-0.24	-0.27	0.24	0.76	99.99	99.99	0.02	-0.09	0.3	-0.25
6	-0.43	-0.53	-0.11	0.74	99.99	99.99	0.18	-0.14	0.2	-0.12
7	-0.31	-0.54	-0.26	0.38	99.99	99.99	-0.02	-0.01	0.45	0.05
8	0.05	-0.08	0.1	-0.35	99.99	99.99	-0.14	-0.23	0.25	-0.08
9	0.16	0.04	0.11	-0.34	99.99	99.99	-0.01	-0.45	-0.04	0.21
10	0.15	0.07	0.15	0.07	99.99	99.99	0	-0.21	-0.03	0.32
11	0.71	-0.27	0.49	0.03	99.99	99.99	-0.27	-0.24	-0.08	0.72
12	0.54	0.2	0.52	0.75	99.99	99.99	0.01	-0.22	0.64	1.14
13	0.37	0.62	-0.84	1.05	99.99	99.99	0.02	-0.15	0.51	1.22
14	-0.36	-0.26	0.45	0.44	99.99	99.99	0.52	0.05	0.43	0.84

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	-0.5127	0.5009	0.9809	1.1265	0.7044	0.4125	0.4125	0.4125	0.4125	0.4125
S.E(Log q)	0.531	0.4098	0.3166	0.2146	0.3094	0.2803	0.4433	0.6186	0.6883	0.9819

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	2.58	-1.12	-14.34	0.06	14	1.35	-0.51
6	3.14	-1.334	-22.15	0.05	14	1.23	0.5
7	1.73	-1.104	-8.48	0.22	14	0.54	0.98
8	1.88	-2.375	-9.91	0.48	14	0.33	1.13
9	1.52	-1.205	-5.39	0.41	14	0.46	0.7
10	0.77	1.144	1.51	0.76	14	0.21	0.41
11	1.03	-0.098	-0.69	0.58	14	0.48	0.46
12	0.79	1.035	0.9	0.75	14	0.43	0.67
13	0.84	0.744	0.45	0.72	14	0.56	0.62
14	0.75	0.909	1.03	0.62	14	0.74	0.43
1							

Fleet : FLT08: Norw.Comb.Sur

Age	1992	1993	1994	1995	1996	1997
5	99.99	99.99	99.99	99.99	0.19	-0.18
6	99.99	99.99	99.99	99.99	0.27	0.12
7	99.99	99.99	99.99	99.99	0.29	0.02
8	99.99	99.99	99.99	99.99	0.46	-0.39
9	99.99	99.99	99.99	99.99	-0.04	-0.49
10	99.99	99.99	99.99	99.99	0.76	0.31
11	99.99	99.99	99.99	99.99	0.05	0.01
12	99.99	99.99	99.99	99.99	0.19	0.37
13	99.99	99.99	99.99	99.99	-0.44	-1.15
14	99.99	99.99	99.99	99.99	0.15	0.04

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
5	-0.36	-0.29	0.08	-0.14	0.03	0.26	-0.01	0.3	99.99	99.99
6	-0.38	-0.09	-0.1	0.07	-0.06	0.11	0	0.1	99.99	99.99
7	0.12	-0.1	-0.22	0.18	0.18	0.12	0.01	-0.44	99.99	99.99
8	-0.22	0.24	-0.13	-0.05	0.13	0	0.04	-0.04	99.99	99.99
9	-0.72	-0.44	0.36	-0.26	0.33	0.4	0.1	0.38	99.99	99.99
10	0.28	0.34	-0.33	0.08	-0.29	-0.1	-0.32	-0.22	99.99	99.99
11	0.01	-0.41	-1	-0.77	-0.2	-0.82	-0.94	-0.29	99.99	99.99
12	0.73	0.74	-0.35	-0.13	0.11	-0.17	0.11	-0.25	99.99	99.99
13	-2.99	0.04	-0.62	-0.65	-0.17	-0.32	-0.05	-0.16	99.99	99.99
14	0.26	0.17	-0.6	-0.21	-0.13	-0.47	0.14	-0.45	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	-0.188	0.3466	0.9696	0.4974	-0.0826	0.7475	0.7475	0.7475	0.7475	0.7475
S.E(Log q)	0.2267	0.1653	0.2247	0.213	0.4148	0.3431	0.6535	0.3979	1.0697	0.3441

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	0.68	0.87	3.29	0.53	10	0.16	-0.19
6	1.92	-0.77	-9.43	0.1	10	0.33	0.35
7	1.46	-0.37	-5.67	0.09	10	0.35	0.97
8	3.97	-1.317	-28.5	0.03	10	0.81	0.5
9	0.74	0.553	2.23	0.42	10	0.32	-0.08
10	3.46	-2.717	-22.58	0.16	10	0.87	0.75
11	2.04	-2.403	-8.29	0.45	10	0.65	0.27
12	1.56	-2.196	-5.09	0.7	10	0.48	0.85
13	0.61	1.739	2.2	0.76	10	0.47	0.15
14	1.13	-0.728	-1.36	0.83	10	0.36	0.61
1							

Terminal year survivor and F summaries :

Age 5 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	25942	0.557	0	0	1	0.44	0.032
FLT08: Norw.Comb.Sur	1	0	0	0	0	0	0
F shrinkage mean	40757	0.5				0.56	0.021

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
33410	0.37	0.34	2	0.908	0.025

Table 8.10 (Continued)

Age 6 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	18890	0.34	0.2	0.59	2	0.666	0.068
FLT08: Norw.Comb.Sur	1	0	0	0	0	0	0
F shrinkage mean	16905	0.5				0.334	0.076

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18202	0.28	0.12	3	0.441	0.071

Age 7 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	5904	0.6	0	0	1	0.074	0.268
FLT07: Russ.Surv. ne	13375	0.238	0.071	0.3	3	0.497	0.127
FLT08: Norw.Comb.Sur	16849	0.3	0	0	1	0.295	0.102
F shrinkage mean	7595	0.5				0.134	0.214

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12494	0.17	0.15	6	0.899	0.135

Age 8 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	6610	0.269	0.081	0.3	2	0.184	0.135
FLT07: Russ.Surv. ne	6821	0.188	0.141	0.75	4	0.442	0.131
FLT08: Norw.Comb.Sur	6597	0.213	0.052	0.24	2	0.292	0.135
F shrinkage mean	3136	0.5				0.082	0.266

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6303	0.12	0.1	9	0.799	0.141

Table 8.10 (Continued)

Age 9 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	3355	0.201	0.01	0.05	3	0.224	0.159
FLT07: Russ.Surv. ne	4261	0.173	0.056	0.32	4	0.411	0.127
FLT08: Norw.Comb.Sur	3323	0.174	0.208	1.19	3	0.293	0.161
F shrinkage mean	2242	0.5				0.072	0.23

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3586	0.1	0.08	11	0.748	0.15

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	3043	0.171	0.176	1.03	4	0.24	0.126
FLT07: Russ.Surv. ne	2920	0.162	0.127	0.78	4	0.404	0.131
FLT08: Norw.Comb.Sur	2822	0.153	0.032	0.21	4	0.293	0.136
F shrinkage mean	1252	0.5				0.062	0.283

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2769	0.09	0.09	13	0.905	0.138

Age 11 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	1549	0.168	0.129	0.77	5	0.232	0.229
FLT07: Russ.Surv. ne	1603	0.166	0.206	1.24	5	0.385	0.222
FLT08: Norw.Comb.Sur	1668	0.147	0.082	0.56	5	0.309	0.214
F shrinkage mean	1190	0.5				0.075	0.289

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1574	0.1	0.08	16	0.844	0.225

Table 8.10 (Continued)

Age 12 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	961	0.162	0.144	0.88	6	0.249	0.366
FLT07: Russ.Surv. ne	1144	0.179	0.204	1.14	6	0.316	0.315
FLT08: Norw.Comb.Sur	1029	0.14	0.061	0.44	6	0.341	0.345
F shrinkage mean	714	0.5				0.095	0.466

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1010	0.1	0.08	19	0.83	0.35

Age 13 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	362	0.165	0.094	0.57	7	0.228	0.465
FLT07: Russ.Surv. ne	537	0.198	0.207	1.04	7	0.299	0.336
FLT08: Norw.Comb.Sur	395	0.142	0.103	0.72	7	0.313	0.433
F shrinkage mean	311	0.5				0.16	0.525

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
409	0.12	0.08	22	0.732	0.422

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT04: Norw. Exp. CP	396	0.167	0.093	0.56	8	0.242	0.31
FLT07: Russ.Surv. ne	344	0.213	0.165	0.78	8	0.25	0.349
FLT08: Norw.Comb.Sur	309	0.144	0.098	0.68	8	0.334	0.382
F shrinkage mean	489	0.5				0.174	0.258

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
365	0.12	0.07	25	0.579	0.332

Table 8.11

Run title : Arctic Green.halibut (run: 2008/1)

At 24/04/2008 11:48

Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 8 Fishing mortality (F) at age

YEAR	1964	1965	1966	1967
AGE				
5	0.0094	0.0053	0.0032	0.0024
6	0.0484	0.0255	0.0138	0.0072
7	0.1146	0.0699	0.0397	0.018
8	0.2531	0.216	0.1411	0.0891
9	0.4566	0.2848	0.3476	0.2356
10	0.7003	0.7254	0.2583	0.3382
11	0.6375	0.7606	0.5421	0.2684
12	0.5666	0.8214	0.8585	0.8373
13	0.4065	0.391	0.4515	1.0092
14	0.5568	0.6004	0.4943	0.5409
+gp	0.5568	0.6004	0.4943	0.5409
0 FBAR 6-10	0.3146	0.2643	0.1601	0.1376

Table 8 Fishing mortality (F) at age

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
AGE										
5	0.0019	0.0207	0.0139	0.0027	0.0363	0.0074	0.0378	0.041	0.0413	0.0972
6	0.0051	0.0484	0.0659	0.1491	0.151	0.0442	0.1079	0.1211	0.1895	0.2135
7	0.0116	0.0691	0.2864	0.4473	0.511	0.237	0.3447	0.4197	0.4665	0.4176
8	0.0694	0.2081	0.6556	0.6021	0.4033	0.3335	0.3623	0.3818	0.6251	0.3557
9	0.2381	0.2332	0.5603	0.4391	0.2444	0.2597	0.2744	0.3558	0.5	0.3927
10	0.3302	0.435	0.5339	0.4738	0.1999	0.2516	0.3041	0.4017	0.3508	0.3249
11	0.5684	0.4571	0.4457	0.4037	0.2511	0.2585	0.3297	0.5023	0.3824	0.4847
12	0.1802	0.3905	0.4362	0.5627	0.3063	0.3191	0.3546	0.5617	0.6828	0.7081
13	0.2945	0.0686	0.5465	0.7562	0.4414	0.2765	0.3346	0.5355	0.5073	0.818
14	0.3237	0.3182	0.5074	0.5302	0.2898	0.2741	0.3208	0.474	0.4874	0.5489
+gp	0.3237	0.3182	0.5074	0.5302	0.2898	0.2741	0.3208	0.474	0.4874	0.5489
0 FBAR 6-10	0.1309	0.1988	0.4204	0.4223	0.3019	0.2252	0.2787	0.336	0.4264	0.3409

Table 8.11 (Continued)

Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 8 Fishing mortality (F) at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
5	0.1046	0.1293	0.0432	0.1213	0.0771	0.0914	0.0569	0.0682	0.095	0.0695
6	0.2345	0.2395	0.0859	0.1446	0.1257	0.1428	0.31	0.2405	0.254	0.2305
7	0.4304	0.2657	0.1814	0.1932	0.1282	0.2141	0.3865	0.3459	0.3539	0.4459
8	0.4141	0.2074	0.191	0.1387	0.1695	0.3352	0.3431	0.2921	0.3383	0.3821
9	0.352	0.1332	0.2292	0.0924	0.3238	0.3076	0.2424	0.2725	0.3386	0.261
10	0.398	0.1094	0.1722	0.1532	0.3458	0.4548	0.4069	0.372	0.4672	0.4211
11	0.4737	0.1957	0.2423	0.2517	0.4459	0.3175	0.3975	0.3577	0.3114	0.2893
12	0.355	0.2023	0.2656	0.2703	0.4252	0.4783	0.232	0.4185	0.4357	0.1765
13	0.6671	0.1238	0.3004	0.6804	0.3674	0.3609	0.2872	0.1551	0.7388	0.3173
14	0.4515	0.1533	0.2428	0.2907	0.3834	0.3856	0.3145	0.3165	0.4608	0.2942
+gp	0.4515	0.1533	0.2428	0.2907	0.3834	0.3856	0.3145	0.3165	0.4608	0.2942
0 FBAR 6-10	0.3658	0.191	0.172	0.1444	0.2186	0.2909	0.3378	0.3046	0.3504	0.3481

Table 8 Fishing mortality (F) at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
5	0.0434	0.1142	0.1725	0.3305	0.1188	0.0993	0.0377	0.0521	0.062	0.0173
6	0.1928	0.2919	0.4291	0.5072	0.1793	0.1569	0.0783	0.0727	0.1659	0.0685
7	0.3832	0.4393	0.5284	0.841	0.237	0.3669	0.2577	0.2612	0.4085	0.2026
8	0.4831	0.3372	0.4136	0.5283	0.2914	0.3929	0.3033	0.3148	0.3392	0.1592
9	0.4557	0.3226	0.4206	0.3821	0.132	0.0733	0.1685	0.2282	0.1208	0.1194
10	0.5045	0.199	0.3224	1.0183	0.3779	0.5875	0.52	0.6917	0.6573	0.631
11	0.4361	0.2258	0.2387	1.1568	0.3579	0.5022	0.5041	0.8416	0.5636	0.4794
12	0.4111	0.182	0.5198	1.6024	0.6749	0.4828	0.8286	1.1369	0.5783	0.6706
13	0.1598	0.2568	0.0804	0.5913	0.7782	0.313	0.581	1.2021	0.2135	0.1324
14	0.3953	0.2381	0.3177	0.958	0.6369	0.4252	0.621	0.8734	0.4882	0.4959
+gp	0.3953	0.2381	0.3177	0.958	0.6369	0.4252	0.621	0.8734	0.4882	0.4959
0 FBAR 6-10	0.4039	0.318	0.4228	0.6554	0.2435	0.3155	0.2656	0.3137	0.3383	0.2361

Table 8.11 (Continued)

Table 8 Fishing mortality (F) at age

YEAR		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	FBAR **-**
	AGE											
5		0.0205	0.0312	0.0255	0.0308	0.0169	0.027	0.0176	0.019	0.0221	0.0251	0.0221
6		0.0711	0.1364	0.0646	0.1126	0.0788	0.0762	0.085	0.0795	0.0725	0.0709	0.0743
7		0.249	0.3613	0.1884	0.2829	0.1644	0.2095	0.2331	0.2218	0.2049	0.1355	0.1874
8		0.2353	0.2759	0.2072	0.1812	0.1741	0.1399	0.2311	0.2647	0.2652	0.1412	0.2237
9		0.1176	0.2138	0.1643	0.1554	0.1164	0.1532	0.2287	0.227	0.2309	0.1497	0.2025
10		0.5074	0.7421	0.5097	0.3833	0.3175	0.2712	0.2702	0.3177	0.2467	0.1381	0.2341
11		0.349	0.3796	0.3663	0.3626	0.312	0.2304	0.2663	0.3359	0.239	0.2254	0.2668
12		0.474	0.6641	0.627	0.5419	0.3488	0.2678	0.433	0.3956	0.5322	0.3504	0.4261
13		0.1177	0.4892	0.2568	0.4355	0.3517	0.1324	0.2592	0.4942	0.5488	0.4217	0.4883
14		0.308	0.5213	0.519	0.4697	0.3935	0.5057	0.4023	0.5473	0.5324	0.3321	0.4706
	+gp	0.308	0.5213	0.519	0.4697	0.3935	0.5057	0.4023	0.5473	0.5324	0.3321	
0	FBAR 6-10	0.2361	0.3459	0.2268	0.2231	0.1702	0.17	0.2096	0.2221	0.204	0.1271	

Table 8.12

Run title : Arctic Green.halibut (run: 2008/1)

At 24/04/2008 11:48

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	41112	31551	33556	31062	26644
6		33792	36528	44252	49616	60486	55221	47154	34898	27082	27853	26539
7		27961	27712	30648	37565	42397	51798	45284	37996	25875	20043	22937
8		27353	21461	22243	25353	31755	36072	41607	29268	20910	13360	13612
9		14559	18279	14883	16626	19961	25498	25214	18591	13796	12024	8238
10		8521	7938	11833	9049	11307	13541	17381	12393	10314	9300	7983
11		4237	3641	3307	7867	5554	6995	7544	8771	6641	7269	6224
12		2537	1928	1465	1656	5177	2707	3812	4158	5042	4447	4831
13		1175	1239	730	534	617	3721	1577	2121	2039	3195	2782
14		634	673	721	400	168	395	2990	786	857	1129	2085
	+gp	190	118	77	49	27	118	756	372	341	564	844
0	TOTAL	163799	171203	187988	219157	241728	251999	234431	180904	146453	130245	122719

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		22542	22101	23695	20596	19709	18618	17888	18944	19039	17826	19936
6		22082	18623	18252	18504	15967	14906	15347	13637	15095	14955	14494
7		20505	16838	13262	12690	12597	10816	11774	11431	10352	11263	9441
8		13987	11600	9089	7519	7102	8312	7765	8354	8655	7192	6587
9		8155	8218	5344	5482	4277	4968	5910	5817	6069	5327	4393
10		5389	4918	4290	3106	3318	3222	3400	4638	3622	3841	3598
11		5069	3104	2980	2668	1795	2560	2334	2511	2825	1978	2201
12		3852	2640	1823	1580	1430	1271	1729	1562	1384	1770	1144
13		2917	1891	1148	773	953	1005	839	1136	879	738	1208
14		1713	1470	980	436	341	725	641	366	677	527	477
	+gp	1044	993	456	330	386	388	264	155	214	282	249
0	TOTAL	107255	92395	81319	73683	67876	66792	67891	68550	68810	65701	63727

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		19880	19447	23009	20773	14548	12685	10564	12997	18388	17973	18546
6		16028	15560	15614	18963	15949	10537	7846	8074	10129	15241	14685
7		9809	10702	10635	11082	12190	8938	5461	5644	5940	8061	12198
8		5750	5926	5897	6240	6148	6185	3318	3709	3366	3951	5344
9		4233	3529	3481	3131	3833	3499	3139	2134	2155	2139	2482
10		2879	2597	2340	1900	1952	2167	2055	2368	1707	1567	1466
11		2135	1553	1467	1216	1340	1217	674	1212	1132	873	675
12		1325	1346	1001	816	835	908	329	405	631	589	324
13		648	737	971	571	586	427	157	144	215	237	163
14		890	266	462	712	380	465	204	62	91	104	61

	+gp	693	29	154	142	173	893	127	12	7	15	3
0	TOTAL	64270	61692	65031	65545	57935	47922	33874	36762	43762	50751	55946

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		20733	19092	15191	16255	15691	17788	16049	17888	24587	26965	39802
6		15003	17539	16100	12673	13639	13097	15053	13445	15128	20764	22701
7		10707	12059	14060	12090	10226	10489	10418	12005	10630	12026	16622
8		6978	7525	8091	8432	8619	6632	7660	7272	8184	7329	8433
9		3276	5122	5119	5285	5900	6189	4797	5732	4967	5406	4838
10		1893	2503	3920	3558	3860	4347	4742	3542	3925	3407	3694
11		654	867	1297	1606	1840	2264	2724	3112	2327	2459	2292
12		331	348	526	764	959	1102	1427	1862	2052	1431	1666
13		156	146	187	233	351	480	669	939	1039	1189	724
14		113	118	111	99	155	196	291	504	624	546	591
	+gp	3	61	18	37	34	138	70	340	832	596	786
0	TOTAL	59847	65379	64620	61032	61273	62722	63898	66641	74296	82119	102149

	Table 10	Stock number at age (start of year)			Numbers*10**-3
	YEAR	2008	GMST 64-**	AMST 64-**	
	AGE				
5		0	22910	25712	
6		33410	18834	21562	
7		18202	14323	17013	
8		12494	9506	12009	
9		6303	6179	7899	
10		3586	4166	5195	
11		2769	2380	3054	
12		1574	1370	1805	
13		1010	703	1007	
14		409	399	598	
	+gp	850			
0	TOTAL	80608			

Table 8.13

Run title : Arctic Green.halibut (run: 2008/1)

At 24/04/2008 11:48

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

	YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE											
5		17993	21708	24288	29586	26998	23491	23311	17889	19026	17612	15107
6		21627	23378	28321	32250	39921	35341	34752	25720	19959	20528	19559
7		25165	24941	27890	34936	40701	47137	48862	40997	27919	21626	24749
8		32824	26182	27581	32199	41599	45090	59124	41590	29712	18984	19342
9		23731	30343	25301	28430	34732	41817	46595	34356	25495	22221	15224
10		19258	17701	26270	19908	24762	30467	39647	28268	23527	21213	18208
11		13178	10923	9724	22342	15494	20915	21779	25322	19172	20985	17969
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	274336	312355	242816	196240	180307	173133

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

	YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE											
5		12781	12531	13435	11678	17738	13070	11806	13071	14279	11230	11962
6		16274	13725	13452	13638	19160	12998	12891	11455	15699	14357	12900
7		22125	18168	14310	13693	18896	12341	13540	11774	13871	13291	11329
8		19875	16484	12916	10684	12784	12203	12113	10943	13588	11004	12185
9		15070	15187	9875	10130	9410	8833	12057	10122	11956	12306	11377
10		12292	11217	9785	7084	8627	7417	8739	10390	9888	11023	11442
11		14634	8961	8604	7703	5386	6820	6957	6955	9294	6845	7967
12		12509	8573	5918	5130	5005	3871	5931	5264	5839	6673	4519
13		12552	8136	4940	3325	3909	3386	3463	4907	4139	2946	5412
14		8449	7247	4832	2150	1638	3107	2999	1956	4117	2294	2026
	+gp	6168	5884	2747	1949	2382	2077	1582	903	1312	1277	1202
0	TOTALBIO	152730	126112	100813	87163	104935	86122	92078	87740	103983	93245	92321

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
5		12326	13788	17027	15787	10329	9768	7184	10268	13239	13121	14280
6		14746	15606	15020	19531	16906	11064	7610	8236	9521	14327	14244
7		12555	13548	13283	14629	15725	12334	6936	7620	7544	10077	15979
8		10925	9974	9589	11231	10451	10824	5839	6973	5790	6875	9298
9		10498	8759	7533	7577	8050	7698	6937	5249	4720	4471	5560
10		8954	7744	6778	5946	5094	5633	5261	6322	4301	3934	3796
11		7152	5509	4996	4098	3846	3396	2095	4158	3363	2576	2222
12		4927	5114	3664	3306	2881	2979	1183	1739	2077	1967	1302
13		2592	3363	4124	2450	2179	1663	603	733	827	909	772
14		3722	1333	1935	3205	1555	2038	865	393	450	516	383
	+gp	3137	175	688	670	784	4723	610	110	46	119	17
0	TOTALBIO	91534	84912	84637	88430	77800	72119	45123	51800	51878	58891	67855

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
	AGE											
5		15964	13937	10634	12354	11612	12273	11475	13774	16449	17177	24916
6		14103	16311	15295	12293	14048	12311	15806	14722	14401	17857	20499
7		13705	15677	17856	16080	14214	14265	14877	17984	13882	13818	21825
8		11444	12116	12542	13745	15083	11143	13389	13838	13529	11213	14218
9		6782	10858	10238	11152	13510	13493	11119	14117	10586	11471	11230
10		4904	6432	9642	9286	10344	11650	12400	9830	9985	8934	9430
11		2157	2818	4176	5381	6126	7223	8288	9734	6627	6636	6703
12		1327	1362	2027	3032	3757	4286	5270	7092	6842	4745	5314
13		755	714	861	1159	1689	2140	3055	4031	3881	4754	2711
14		673	667	651	573	902	1026	1618	2751	2735	2533	2684
	+gp	17	298	110	267	254	874	446	2159	4820	4019	7131
0	TOTALBIO	71831	81190	84030	85321	91539	90685	97742	110031	103737	103158	126661

Table 8.14

Run title : Arctic Green.halibut (run: 2008/1)

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

	YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	AGE											
5		0	0	0	0	0	0	0	0	0	0	0
6		649	701	850	968	1198	1060	1043	772	599	616	587
7		755	748	837	1048	1221	1414	1466	1230	838	649	742
8		6893	5498	5792	6762	8736	9469	12416	8734	6240	3987	4062
9		15900	20330	16952	19048	23270	28018	31219	23018	17082	14888	10200
10		16562	15223	22592	17121	21295	26201	34096	24310	20233	18243	15659
11		12914	10704	9529	21895	15184	20496	21344	24816	18789	20565	17610
12		9298	6594	4866	5354	16185	9631	12129	13231	16043	14150	15373
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	76709	90723	116540	139621	111284	94881	95796	91521

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	574	516
7		664	545	429	411	567	370	406	353	416	399	453
8		4174	3462	2712	2244	2685	2563	2544	2298	2446	1981	2315
9		10097	10175	6616	6787	6304	5918	8078	6782	7174	7507	7395
10		10571	9647	8416	6092	7419	6379	7515	8935	8108	9149	9726
11		14342	8782	8432	7549	5278	6683	6818	6816	8923	6639	7728
12		12259	8401	5800	5027	4905	3793	5813	5159	5723	6540	4474
13		12552	8136	4940	3325	3909	3386	3463	4907	4139	2946	5412
14		8449	7247	4832	2150	1638	3107	2999	1956	4117	2294	2026
	+gp	6168	5884	2747	1949	2382	2077	1582	903	1312	1277	1202
0	TOTSPBIO	79763	62690	45327	35944	35663	34666	39605	38453	42828	39304	41247

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

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE											
5		0	0	0	0	0	0	0	103	132	131	0
6		442	156	150	195	169	111	76	82	95	143	0
7		377	271	133	293	315	493	416	610	528	806	1119
8		2622	2194	2014	2022	1777	1624	1635	2231	1968	1994	2324
9		7768	5781	3992	3713	4105	4157	4579	3569	3257	2593	3225
10		8148	6969	5897	4756	3923	4337	4525	5247	3484	3108	3340
11		7080	5233	4447	3647	3500	3022	1822	3659	3195	2473	2156
12		4829	5012	3591	3306	2881	2979	1183	1634	1953	1750	1224
13		2592	3363	4124	2450	2179	1663	603	733	827	909	772
14		3722	1333	1935	3205	1555	2038	865	393	450	516	383
	+gp	3137	175	688	670	784	4723	610	110	46	119	17
0	TOTSPBIO	40717	30487	26970	24257	21186	25146	16314	18373	15935	14543	14560

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	116	123	115	0	0	0	0
6		0	0	0	123	421	369	316	147	288	179	410
7		959	627	357	482	853	1427	1636	1439	416	691	873
8		2403	1212	878	1374	2866	3454	4552	3875	2706	2018	2417
9		3594	4886	3378	4126	6620	8905	8005	9317	6669	5736	6401
10		4168	5274	6364	5850	6724	9203	10912	8945	8887	6611	6318
11		2028	2593	3591	4681	5146	6573	7625	9150	6362	5641	5831
12		1247	1362	2007	2910	3607	4115	5112	6808	6636	4413	4942
13		755	714	861	1159	1689	2119	2994	3950	3881	4659	2630
14		673	667	651	573	902	1026	1586	2696	2735	2507	2630
	+gp	17	298	110	267	254	874	446	2159	4820	4019	7131
0												
TOTSPBIO		15846	17633	18196	21547	29197	38189	43299	48485	43401	36474	39584
1												

Table 8.15

Run title : Arctic Green.halibut (run: 2008/1)

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Table 16 Summary (without SOP correction)

	RECRUITS Age 5	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 6-10
1964	42840	172936	72644	40391	0.556	0.3146
1965	51686	171359	69254	34751	0.5018	0.2643
1966	57829	181480	68558	26321	0.3839	0.1601
1967	70443	209628	76709	24267	0.3163	0.1376
1968	64281	244356	90723	26168	0.2884	0.1309
1969	55932	274336	116540	43789	0.3757	0.1988
1970	41112	312355	139621	89484	0.6409	0.4204
1971	31551	242816	111284	79034	0.7102	0.4223
1972	33556	196240	94881	43055	0.4538	0.3019
1973	31062	180307	95796	29938	0.3125	0.2252
1974	26644	173133	91521	37763	0.4126	0.2787
1975	22542	152730	79763	38172	0.4786	0.336
1976	22101	126112	62690	36074	0.5754	0.4264
1977	23695	100813	45327	28827	0.636	0.3409
1978	20596	87163	35944	24617	0.6849	0.3658
1979	19709	104935	35663	17312	0.4854	0.191
1980	18618	86122	34666	13284	0.3832	0.172
1981	17888	92078	39605	15018	0.3792	0.1444
1982	18944	87740	38453	16789	0.4366	0.2186
1983	19039	103983	42828	22147	0.5171	0.2909
1984	17826	93245	39304	21883	0.5568	0.3378
1985	19936	92321	41247	19945	0.4835	0.3046
1986	19880	91534	40717	22875	0.5618	0.3504
1987	19447	84912	30487	19112	0.6269	0.3481
1988	23009	84637	26970	19587	0.7262	0.4039
1989	20773	88430	24257	20138	0.8302	0.318
1990	14548	77800	21186	23183	1.0942	0.4228
1991	12685	72119	25146	33320	1.325	0.6554
1992	10564	45123	16314	8602	0.5273	0.2435
1993	12997	51800	18373	11933	0.6495	0.3155
1994	18388	51878	15935	9226	0.579	0.2656
1995	17973	58891	14543	11734	0.8068	0.3137
1996	18546	67855	14560	14347	0.9853	0.3383
1997	20733	71831	15846	9410	0.5939	0.2361
1998	19092	81190	17633	11893	0.6745	0.2361
1999	15191	84030	18196	19517	1.0726	0.3459
2000	16255	85321	21547	14437	0.67	0.2268
2001	15691	91539	29197	16307	0.5585	0.2231
2002	17788	90685	38189	13161	0.3446	0.1702
2003	16049	97742	43299	13578	0.3136	0.17
2004	17888	110031	48485	18800	0.3877	0.2096
2005	24587	103737	43401	18834	0.434	0.2221
2006	26965	103158	36474	17897	0.4907	0.204
2007	39802	126661	39584	14828	0.3746	0.1271
Arith. Mean	26061	120616	48258	24812	0.5726	0.2802
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

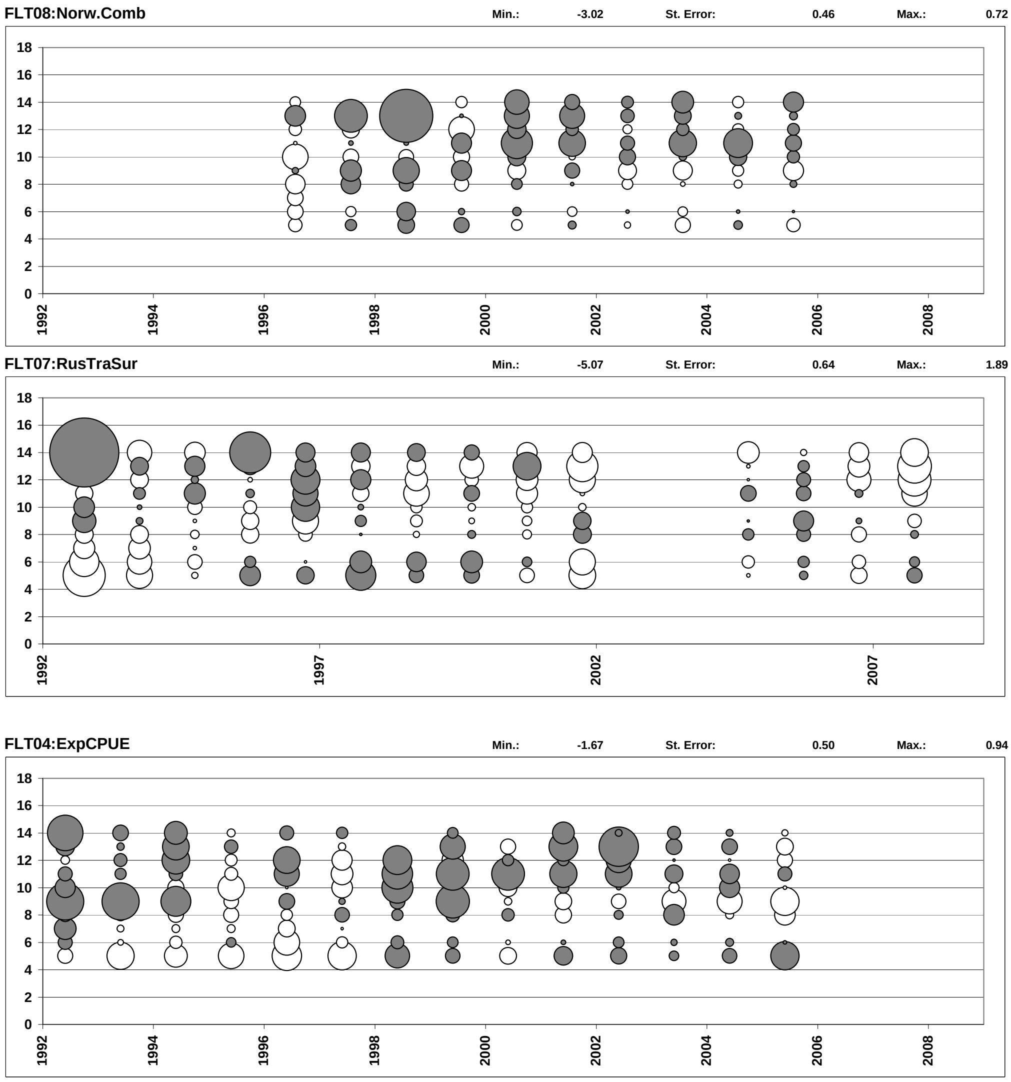

Figure 8.1. <u>NEA Greenland halibut</u>. Log catchability residuals by age and year for the tuning fleets included in the assessments. For each graph all bubbles are normalized to the same maximum bubble-size. Open bubbles represent positive values; filled bubbles represent negative values.

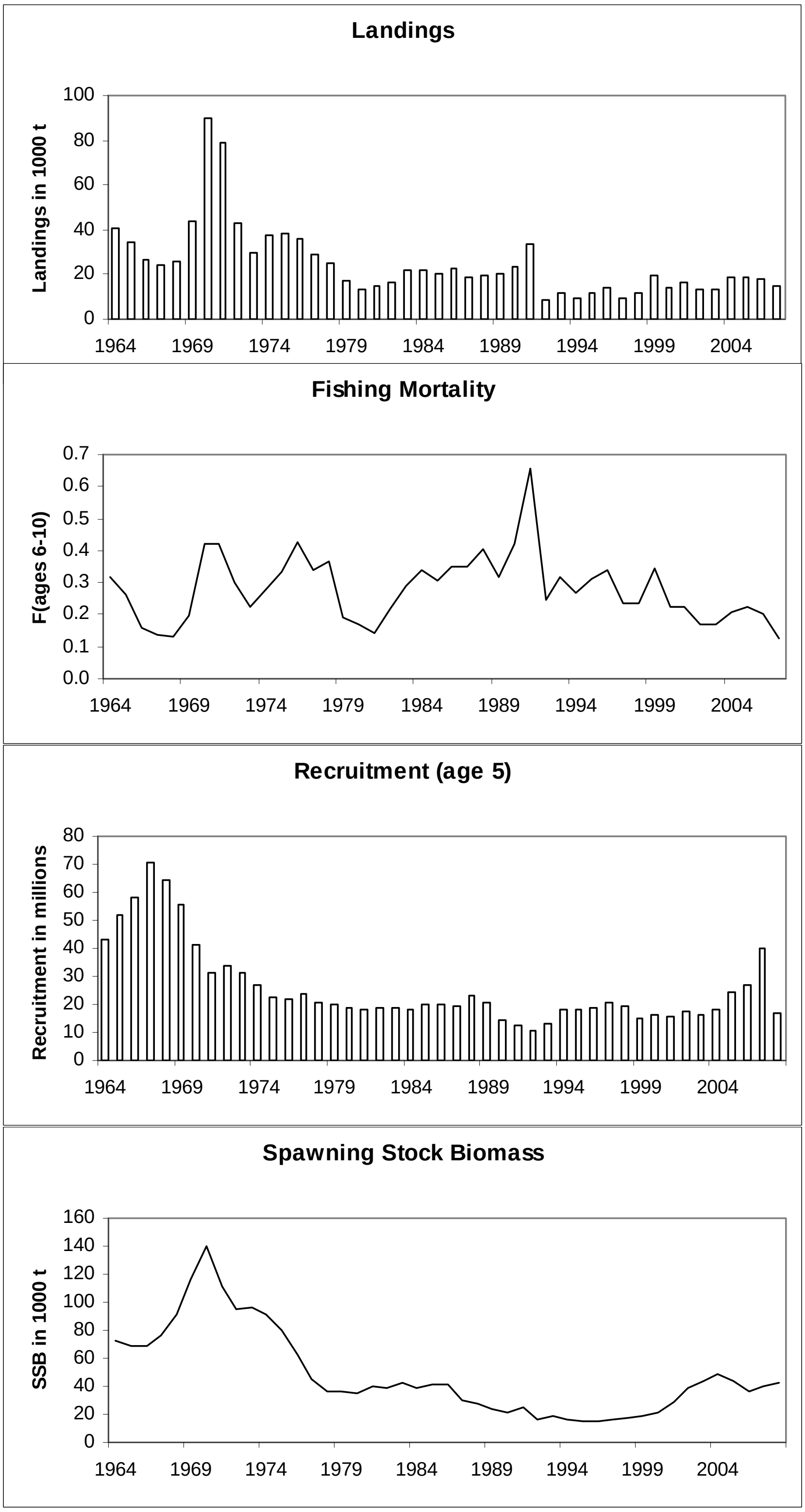

Figure 8.2. <u>NEA Greenland halibut</u>. Historical landings, recruitment, fishing mortality and spawning stock biomass.

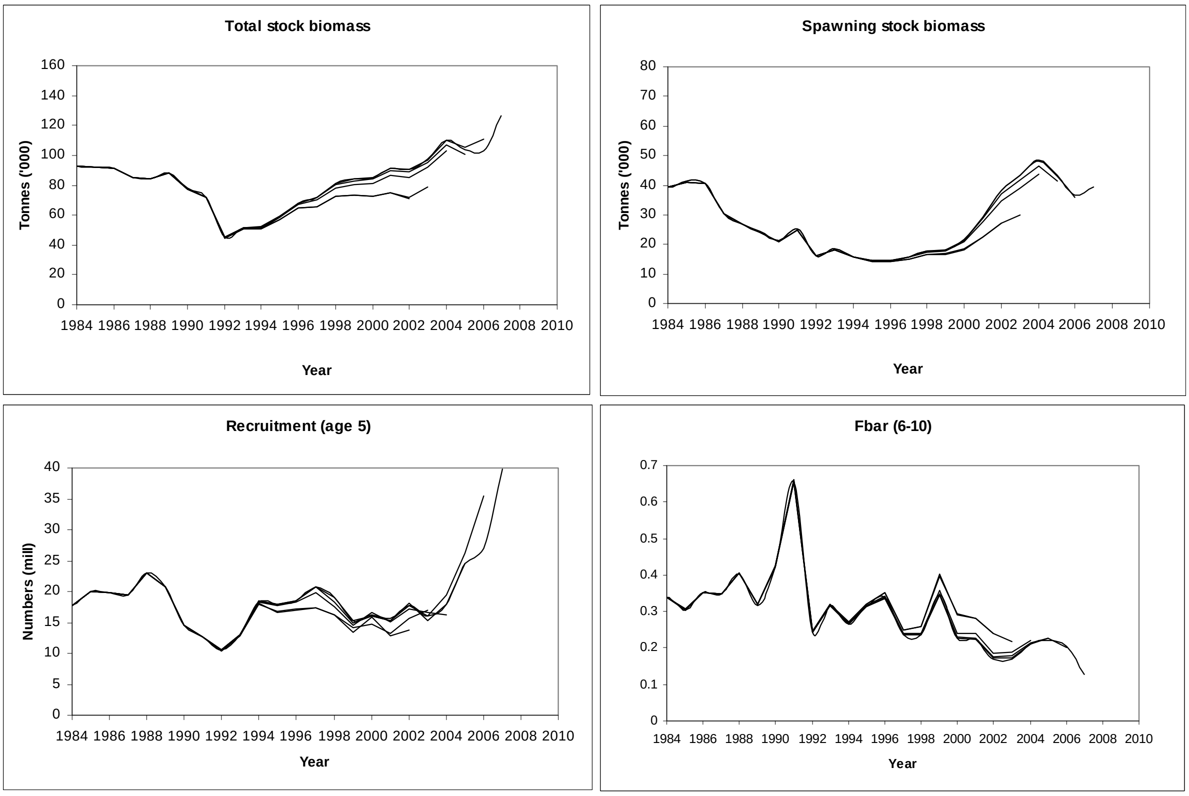

Figure 8.3. <u>NEA Greenland halibut</u>. Retrospective plots.

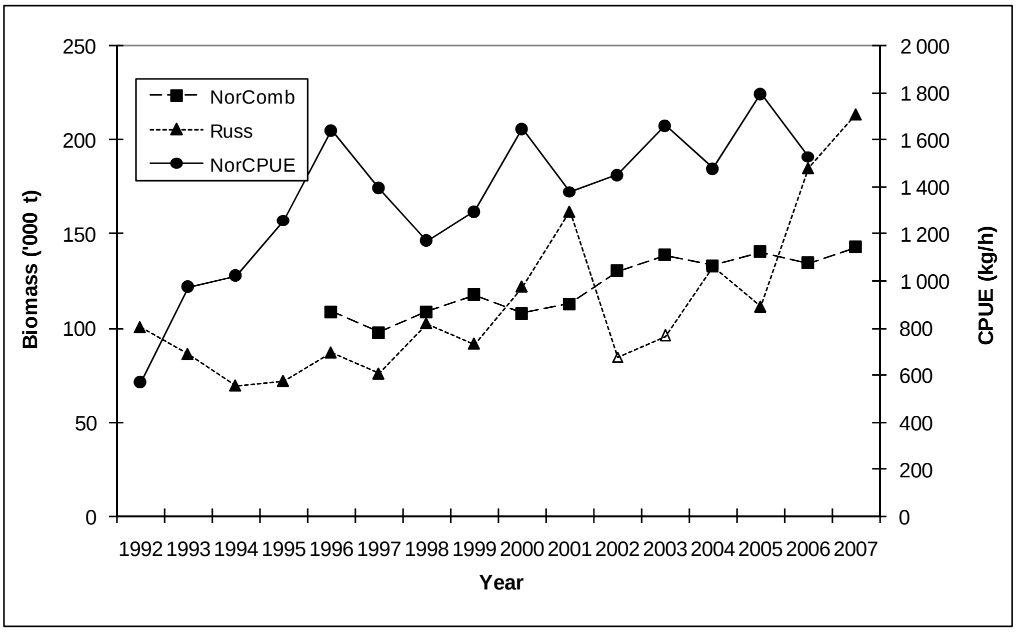

Figure 8.4. <u>NEA Greenland halibut</u>. Biomass estimates from the tuning series used in the assessment. Years with open symbols in the Russian series excluded from the tuning. The Norwegian CPUE Survey was ended in 2006.

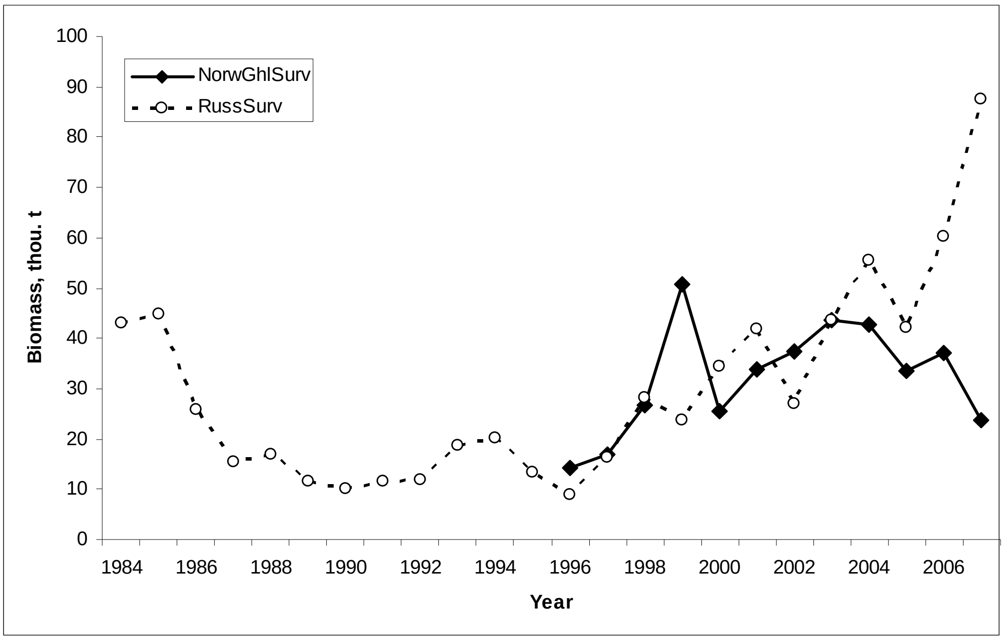

Figure 8.5. <u>NEA Greenland halibut</u>. Swept area estimate of the mature female biomass based on the data from the Norwegian Greenland halibut survey along the continental slope and Russian trawl survey.

Table E1. GREENLAND HALIBUT in Sub-area I and II. Norwegian bottom trawl survey indices (numbers in thousands) in the Svalbard area (Division IIb).

Year	Fish<20 cm[2]	Age 1	2	3	4	5	6	7	8	9+	Total
1981	2.1										20 100
1982	0.7				No age data						2 600
1983	5.9										26 690
1984	3.2	550	3 042	2 924	8 573	6 847	5 657	4 345	2 796	1 896	36 630
1985	1.6	884	3 921	4 294	6 674	8 793	8 622	3 920	1 817	525	39 450
1986	0.1	49	1 005	1 967	7 314	4 671	1 754	2 301	372	37	19 470
1987	1	630	1 014	3 076	4 409	4 786	3 141	964	364	116	18 500
1988	2.5	818	4 298	6 191	6 696	12 289	2 396	6 015	338	1 277	40 318
1989 [1]	1.4	712	3 232	8 158	7 493	7 069	2 374	1 753	353	744	31 888
1990 [1]	0.4	115	336	5 050	7 130	7 730	4 490	2 330	918	544	28 643
1991 [1]	0.1	71	877	3 080	6 720	9 270	5 450	2 800	1 660	524	30 452
1992 [1]	+	33	30	338	1 190	3 520	4 420	2 280	1 280	474	13 565
1993 [1]	+	25	60	51	1 049	2 369	2 056	2 772	1 114	665	10 161
1994 [1]	+	4	238	296	652	2 775	2 371	2 593	531	844	10 304
1995 [1]	0.1	76	+	+	322	886	1 200	1 950	487	497	5 418
1996 [1]	0.4	410	61	104	171	881	2 052	2 587	862	976	8 104
1997 [1]	0.4	268	484	21	65	284	2 089	2 143	379	295	6 028
1998 [1]	2.5	1 999	2 351	2 715	493	609	2 192	2 814	1 252	822	15 247
1999 [1]	1.3	126	+	995	1 789	415	709	2 501	507	674	7 716
2000 [1]	2	2 009	540	323	1 347	2 135	2 634	1 784	1 197	530	12 499
2001 [1]	4.3	4 258	1 235	873	1 506	2 456	1 718	1 504	558	1 079	15 187
2002 [1]	2.3	1 435	2 019	1 176	2 437	3 413	2 685	3 304	847	2 229	19 545
2003 [1]	0.8	410	638	901	2 937	2 630	3 146	2 602	452	684	14 400

[1]New standard trawl equipment (rockhopper gear and 40 meter sweep length).

[2]In millions.

Not updated, new ecosystem survey

Table E2. GREENLAND HALIBUT in Sub-area I and II. Abundance indices from bottom trawl surveys in the Barents Sea and Svalbard area in August (in thousands).

A: The Barents Sea area; **B**: The expanded Svalbard area.

A		Age													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, 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 1	2	3	4	5	6+	Total
1996	15 655	14 510	10 025	3 487	1 593	3 349	48 619
1997	3 415	15 271	14 140	2 803	403	434	36 466
1998	8 482	18 718	9 463	5 161	1 166	932	43 922
1999	5 370	9 074	3 328	2 271	1 492	954	22 489
2000	9 529	16 844	8 007	6 274	1 746	722	43 122
2001	26 206	15 765	4 515	1 767	802	465	49 520
2002	40 186	34 065	15 441	3 862	1 320	556	95 430
2003	49 146	37 344	6 336	3 188	1 035	327	97 376
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 1	2	3	4	5	6+	Total
1998	10 210	28 020	17 186	6 380	1 551	932	64 279
1999	7 514	16 159	8 045	3 067	2 401	954	38 140
2000			No coverage in Russian EEZ				
2001	38 112	40 377	7 960	4 300	1 215	510	92 475
2002	96 231	58 113	31 500	5 665	1 576	556	193 641
2003			No coverage in Russian EEZ				
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	970	5 727	15 992	27 749	36 544	18 917	9 382	6 033	5 219	5 169	2 295	1 388	1 125	136 510

[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 1997-2005.

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

No survey in 2006-2007

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

[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.

9.2 Catch Statistics (Table 9.1, 9.2)

The international catch by country and season in the years 1965-2007 is given in Table 9.1. No commercial catches were taken during 2007 and spring 2008. In spring 2008, a research quota of 10 000 tonnes (5 000 tonnes to Norway and 5 000 tonnes to Russia) was fished in connection with methodological research on the prespawning capelin approaching the coast to spawn (Tables 9.2). The age composition of the Norwegian catches (taken further west than the Russian catches), differed somewhat from the age composition in the Russian catches.

9.3 Stock Size Estimates

9.3.1 Larval and 0-group estimates in 2007 (Table 9.3)

Norwegian larval surveys based on Gulf III plankton samples have been carried out in June each year since 1981. The estimated total number of larvae is shown in Table 9.3. These larval abundance estimates do not show a high correlation with year class strength at age one, but should reflect the amount of larvae produced each year (Gundersen and Gjøsæter, 1998). The year 1986 was exceptional, in that no larvae were found. This may have been due to late spawning that year, and eggs may have hatched after the survey was carried out. Also in other years some spawning is known to have taken place during the summer, and offspring from such late spawning is not reflected in the larval abundance estimates in Table 9.3. Since 1997, permission has not been granted to enter the Russian EEZ during the larval survey or permission has been granted so late that it could not be employed to good purpose, and consequently the total larval distribution area has not been covered. In 2007, however, no larval survey was carried out, but hopefully the survey will be run as usual again in 2008.

A swept volume index (Dingsør, 2005; Eriksen et al., 2007) of abundance of 0-group capelin in August-September is given in Table 9.3 (see also general description, chapter 1). This index is calculated both without correction and with correction for catching efficiency (Anon. 2007). Both 0-group indices for 2007 indicate that the abundance of 0-group is above average; and very close to the 2006 value.

9.3.2 Acoustic stock size estimates in 2007 (Table 9.4–9.5)

Two Russian and three Norwegian vessels jointly carried out the 2007 acoustic survey as part of an ecosystem survey during autumn (Anon., 2007). The geographical coverage of the total stock was considered complete. However, the coverage of the main area of distribution for maturing fish this year was carried out during a longer period than in most other years. The geographical distribution of capelin is shown in Figure 9.1.

The results from the survey are given in Table 9.4, and are compared to previous years' results in Table 9.5. The stock size was estimated at 1.88 million tonnes. Almost 50% (0.84 million tonnes) of the stock biomass consisted of maturing fish (>14.0 cm).

9.3.3 Other surveys and information from 2007–2008

During the winter period from 25.01 to 30.02 2008 a joint Russian-Norwegian capelin investigation was carry out. Data from 10 vessels were collected and analyzed.

A reasonably good coverage of the distribution of the spawning stock of capelin was obtained.

Wintering capelin were distributed in western, central and eastern areas between 73º-76º N, 25º-53º E. Maturing capelin started to aggregate in prespawning concentrations in the beginning of February. Inside the Norwegian EEZ maturing capelin migrated from Bear Island and central areas to Sørøy and Fugløy banks near the Norwegian coast. In the eastern areas maturing capelin migrated towards Rybachy and Varanger peninsulas (Figure 9.4). Based on joint Norwegian and Russian data, an acoustic estimation of prespawning capelin yielded about 0.36 million tonnes of capelin, somewhat lower than the median of the prognosis from the autumn 2007 assessment at mid-February. But there was a significantly higher portion of older spawners (age 4 and 5) with respect to younger spawners (age 3) than was the case for the same year classes in the autumn survey. Similar differences were noted in many previous years and could be due to bottom distribution of older fish during autumn period or due to errors in the maturation model. This "bottom component" was for the first time estimated in the ecosystem survey in 2004, by a swept area method. It is not included in the total official acoustic estimation, because it is difficult to convert the swept-area index to an absolute value, and because no historical time series exists. The size of the "bottom component" estimated during the autumn survey is closely related to the winter acoustic assessment.

Whether a capelin winter survey can be used to adjust a preliminary capelin quota depends on solving issues like measuring a possible depth-dependent TS value both under winter and autumn conditions, finding means for an effective splitting of acoustic measurements on capelin and herring (e.g. frequency response), adjusting the estimate for capelin migration and solving timing problems connected to a possible earlier spawning of capelin. Also, research that would enable a prediction of westerly or easterly spawning, which might help in the planning winter surveys, should be encouraged. During the winter 2008 near-surface TS measurements were conducted. These measurements should be supplemented with TS measurements in the whole water column during the autumn survey of 2008 or 2009.

9.4 Historical stock development (Tables 9.6–9.12)

An overview of the development of the Barents Sea capelin stock in the period 1998-2007 is given in Tables 9.6-9.12. The methods and assumptions used for constructing the tables are explained in Appendix A to ICES CM1995/Assess: 9. In that report, the complete time series back to 1973 can also be found. It should be noted that several of the assumptions and parameter values used in constructing these tables differ from those used in the assessment. For instance, in the assessment model the M-values for immature capelin are calculated using new estimates of the length at maturity and M-values for mature capelin are calculated taking the predation by cod into account.

This will also affect the estimates of spawning stock biomass given in the stock summary table (Table 9.12). It should be noted that these values, coming from a deterministic model cannot directly be compared to those coming from the probabilistic assessment model (Bifrost, Gjøsæter *et al*. 2002) used for this stock. However, as a crude overview of the development of the Barents Sea capelin stock the tables may be adequate.

Estimates of stock in number by age group and total biomass for the period are shown in Table 9.6. Catch in numbers at age and total landings are shown for the spring and autumn seasons in Tables 9.7 and 9.8. Natural mortality coefficients by age group for immature and mature capelin are shown in Table 9.9. Stock size at 1 January in numbers at age and total biomass is shown in Table 9.10. Spawning stock biomass per age group is shown in Table 9.11. Table 9.12 gives an aggregated summary for the entire period 1973-2007.

9.5 Reference points

A B_{lim} (SSB_{lim}) management approach has been suggested for this stock (Gjøsæter et al. 2002). In 2002, the Mixed Russian-Norwegian Fishery Commission agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 t of capelin should be allowed to spawn. Consequently, 200 000 t was used as a B_{lim}. There is clearly also a need for a target biomass reference point for capelin, and calculations of B_{target} are also in progress.

9.6 Stock assessment autumn 2007

As decided by the Arctic Fisheries Working Group at its 2007 meeting (ICES 2007a), 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 Murmansk after the survey. The list of participants is given in Appendix 1. The assessment was an update assessment, without changes in the methodology.

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2008 was made using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL). The projection was based on a maturation and predation model with parameters estimated by the model Bifrost and data on cod abundance and size at age from the 2007 Arctic Fisheries Working Group. The methodology is described in "Stock assessment methodology for the Barents Sea capelin", WD1. The predation model for the period January-March was based on data from the period 1983-2002, and the model for natural mortality during October-December was drawn randomly from data for the same period. These models have been unchanged since 2003.

Probabilistic prognoses for the maturing stock from October 1 2007 until April 1 2008 were made, with a CV of 0.20 on the abundance estimate (Fig. 9.2). With no catch, the estimated mean spawning stock size in 2008 is 330 000 tonnes. The simulations also indicate that with no catch, the probability for the spawning stock in 2008 to be below 200 000 t, the $\mathbf{B}_{lim}$ value used by ACFM in recent years, is about 15 %. If the CV is set to zero, this probability decreases to 11%. A run was also made where the mortality during October-December was drawn from randomly from the period 1995-2001. This was the approach taken during the 2002 capelin assessment. The mortality in this period was lower than in the period 1983-2002, but the probability for the spawning stock in 2008 to be below 200 000 t was still above 5%. Thus selecting this period would not change the advice.

Capelin recruitment could be negatively affected if the stock of young herring in the Barents Sea is large. The 0-group index for herring in 2007 was low. Both the herring survey in May-June 2007 (ICES 2007b) and the ecosystem survey in 2007 showed that the abundance of age 1-2 herring in the Barents Sea is low, while the abundance of age 3 herring is high. It is rather likely that this age 3 herring will leave the Barents Sea in early 2008. In that case, the total abundance of herring in the Barents Sea in 2008 will be low, and the recruitment conditions for capelin can then be expected to be good in 2008.

9.7 Regulation of the fishery for 2008

During its Autumn 2007 meeting, the Joint Russian-Norwegian Fishery Commission decided that no commercial fishing should take place on Barents Sea capelin for the winter season 2008, and only research quota of 10 000 tonnes (5 000 tonnes to Norway and 5 000 tonnes to Russia) were set.

9.8 Management advice for the fishery in 2008

Since the probability of SSB < B_{lim} is larger than 5% (15%), the harvest control rule shows that the advice for 2008 should be no fishing.

9.9 Predicting the capelin stock 1.5 year ahead

9.9.1 Introduction

Previously, the CapTool model gave a prognosis for the mature part of the stock from the survey in September in year *Y* until the spawning next spring (1 April year *Y+1*). In 2002, this model was enhanced, by including a prognosis of the immature part of the capelin stock up to 1 October in year *Y+1*, to be able to give a forecast of the spawning stock at 1 April in year *Y+2*. This prognosis was made by repeating the first step but basing the calculations on the stock prognosis by 1 October year *Y+1* instead of the survey. As a by-product of this model enhancement, a prognosis of the total stock at 1 January year *Y+2* is produced.

The method for predicting the stock by 1 October in year *Y+1* from the stock at 1 October in year *Y* was evaluated by Bogstad et al. (2005a). In 18 out of the 23 years the observed stock sizes are within the 90% confidence interval of the predictions. It is found that there is a tendency for overestimating stock size in periods when the stock decreases and vice versa. The ratio between predicted and observed stock sizes is variable and some times quite high for stock sizes below one million tonnes (collapsed stock size) but varies between about 0.5 and 1.5 and is unrelated to stock size for larger stock sizes. The model can be further improved by relating capelin growth to capelin stock size, prey abundance or environmental conditions (Bogstad et al. 2005b).

9.9.2 Methodology

The 1.5-year prognosis is based on a number of assumptions, of which the most important are:

- The parameters in the maturation function (needed to split the total stock measured in autumn into an immature and a mature part) were estimated based on data from the time series 1972-1980, a period where the natural mortality was rather constant.
- Annual values of the natural mortality of immature capelin is estimated together with the parameters in the maturation function (because these

are interdependent) from survey data. For prognostic runs, natural mortality for immature capelin is drawn randomly from historic values. Natural mortality of mature capelin during the autumn period is set equal to that of immature capelin.

- The natural mortality of mature capelin during the period 1 January to 1 April is estimated from the predicted consumption by cod, in the same way as for 0.5 year prognostic runs.
- Total spawning mortality is assumed.
- The recruitment (number of one-year-olds in year *Y+1*) is estimated from a regression between the number of 1-group of capelin and the 0-group index (see section 9.9.3)
- The length growth and weight-at-length in prognostic runs are randomly drawn from the time series for the period 1981-2007. The length distribution of age 1 capelin in year *Y+1* is drawn at random from the time series of length distributions of 1-year-olds. The individual growth in length (cm/year) for each age group is calculated from values obtained by comparing the mean length at age of immature capelin one year with the mean length at age of the total stock next year. The length growth is implemented by shifting the distribution of immature capelin upwards with the number of 0.5cm length intervals, which corresponds to the growth in length, for each age group and year.
- The capelin length-weight relationship for use in the 1-year prediction is drawn randomly from historical data for the period 1981-2007.
- No weight increase during winter (1 October to 1 April) is assumed.
- Zero catch is assumed.

9.9.3 Recruitment (Figure 9.1)

Gundersen and Gjøsæter (1998) established a linear regression between the logarithms of the 0-group area based indices and the logarithm of the 1-group acoustic abundance 1 year later. The period after 1981 was chosen. The reason for this is that before 1981, the coverage of 1-group capelin during the acoustic survey was incomplete (Gjøsæter et al., 1998). This regression has been annually updated with new data, and used in the predictions of capelin stock size. Revised 0-group indices (Eriksen et al., 2007; Anon. 2007) are now available for the period 1980-2007. Using these indices (without or with correction for length-dependent selectivity in the trawl), we found that a linear regression gave better fit than a log-log regression. The new regressions, using data from the 1981-2006 year classes, are shown in Fig. 9.3. They both gave the same coefficient of determination (0.5), and since the index series without correction for length-dependent selectivity is at present considered as the official one, that series was used in the further calculations. To include uncertainty into the prognosis for 1-group capelin, the replicates of capelin of age 1 in 2008 were constructed by bootstrapping. From the 26 pairs of 0-group/1-group data from the year classes 1981-2006 26 new pairs of data were drawn at random with equal probability. These data were used in a new regression, and from the new regression the number of 1-year-old capelin in 2008 was calculated from the 0-group value in 2007. This procedure was repeated 1000 times. In order to avoid bias, the regressions were forced through the origin.

9.9.4 Results (Table 9.13, Figure 9.2)

The total stock size will, according to this prognosis, increase from 1.88 million tonnes in autumn 2007 to 2.95 million tonnes (5-95% C. I.:1.41-5.48 million tonnes) in autumn

2008. The 1.5 year-prognosis was not presented this year because that method should be revised during a benchmark assessment.

9.10 Sampling

The sampling from scientific surveys and exploratory fishing of capelin in 2007 is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Young herring surv. in the BarS, June-July 2007 (Russia)	11	1409	373
Ecosystem survey autumn 2007 (Norway)	235	14198	2661
Ecosystem survey autumn 2007 (Russia)	267	18964	2217
Russian bottom fish survey, November 2006	1	5509	25
Norwegian capelin investigations winter 2007	201	5461	1186
Exploratory fishing winter 2007 (Norway)	23	2182	325
Exploratory fishing winter 2007 (Russia)	15	12959	750
Russian capelin investigations winter 2008	120	11905	584
Norwegian capelin investigations winter 2008	293	7621	1979
Exploratory fishing winter 2008 (Norway)	unknown	unknown	unknown
Exploratory fishing winter 2008 (Russia)	126	32477	1150

9.11 The need for a Barents Sea capelin benchmark assessment

The 2007 assessment of Barents Sea capelin is an update assessment, where the most recent capelin stock, cod stock and 0-group data are used to update the spreadsheet that is used for calculating the distribution of the spawning stock conditional on the catch. The latest update of the underlying population dynamics model Bifrost was made in 2003 and resulted in new replicates for the predation, maturation and natural mortality (on immature capelin) parameters used in CapTool.

A benchmark assessment for capelin in 2008 is suggested, with the following tasks:

- Incorporating data since 2003 in the estimation of population dynamics parameters

- Modelling consumption of capelin the year around, thus reducing the non-modelled mortality on immature capelin, and thereby reducing errors connected to the natural mortality on mature capelin in the period October-December.

- Looking into possibilities for modelling the residual mortality of immature capelin as a function of capelin stock size, other predators (harp seal) geographical distributions or other observable entities.

- Establishing methodology for incorporating a winter survey in the assessment, that could be used to adjust a possible quota set in the autumn.

- Looking into possibilities for quantifying survey uncertainty caused by non-synoptic coverage and limited acoustic and biological sampling, both for the autumn and winter surveys, and implementing survey uncertainty based on the actual measurements in the assessment.

- Reviewing methodology for 1.5-year prognosis

Table 9.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	156	20	704	31	195	226	929
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997*	0	0	0	0	0	1	1	1
1998*	0	0	0	0	0	1	1	1
1999	50	32	0	82	0	23	23	105
2000	279	95	8	382	0	28	28	410
2001	376	180	8	564	0	11	11	575
2002	398	228	17	643	0	16	16	659
2003	180	93	9	282	0	0	0	282
2004	0	0	0	0	0	0	0	0
2005*	1	0	0	1	0	0	0	1
2006	0	0	0	0	0	0	0	0
2007*	2	2	0	4	0	0	0	4
2008*	5	5	0	10				

*Catches in 1997, 1998, 2005, 2007 and 2008 were based on research quotas.

Table 9.2 Barents Sea Capelin. Catch in number (billions) and biomass (tonnes) by age and length during the Russian-Norwegian research activities in February-March 2008

Length, cm	2 years		3 years		4 years		5+ years		Sum			
	N	B	N	B	N	B	N	B	N	%	B	%
12.0-12.4	0.0003	1.569							0.0003	0.06	1.569	0.02
12.5-12.9	0.0005	3.688	0.0001	1.550					0.0006	0.15	5.238	0.05
13.0-13.4	0.0004	4.604	0.0002	2.980					0.0006	0.14	7.584	0.08
13.5-13.9	0.0001	1.420	0.0020	22.694					0.0021	0.49	24.114	0.24
14.0-14.4	0.0014	20.490	0.0046	58.177	0.0002	3.110			0.0062	1.44	81.777	0.82
14.5-14.9	0.0014	20.360	0.0137	187.696	0.0009	12.320			0.0160	3.71	220.376	2.20
15.0-15.4	0.0024	39.440	0.0321	479.964	0.0011	17.250			0.0356	8.26	536.654	5.37
15.5-15.9	0.0027	48.260	0.0429	729.442	0.0052	84.258	0.0001	2.200	0.0509	11.80	864.160	8.64
16.0-16.4	0.0045	90.680	0.0467	900.979	0.0092	173.638	0.0003	7.000	0.0607	14.08	1172.296	11.72
16.5-16.9	0.0044	100.810	0.0433	937.315	0.0183	391.219	0.0005	12.511	0.0665	15.42	1441.855	14.42
17.0-17.4	0.0035	86.660	0.0330	812.771	0.0159	379.242	0.0010	22.830	0.0534	12.38	1301.503	13.01
17.5-17.9	0.0018	51.500	0.0286	794.145	0.0204	538.072	0.0022	60.476	0.0530	12.29	1444.194	14.44
18.0-18.4	0.0014	40.090	0.0171	529.751	0.0141	431.738	0.0031	93.236	0.0357	8.28	1094.816	10.95
18.5-18.9	0.0006	18.940	0.0130	446.109	0.0140	474.829	0.0018	62.770	0.0294	6.82	1002.648	10.03
19.0-19.4	0.0002	8.170	0.0029	116.838	0.0054	201.333	0.0028	110.998	0.0113	2.62	437.340	4.37
19.5-19.9	0.0002	9.470	0.0024	89.720	0.0048	192.542	0.0004	17.276	0.0078	1.81	309.008	3.09
20.0-20.4			0.0001	5.570	0.0006	28.713	0.0002	11.410	0.0009	0.21	45.693	0.46
20.5-20.9					0.0001	4.800			0.0001	0.02	4.800	0.05
21.0-21.4									0	0.00	0	0.00
21.5-21.9					0.0001	5.5700			0.0001	0.02	5.570	0.06
Sum	0.026	546.151	0.283	6115.702	0.110	2938.635	0.012	400.708	0.431	100.00	10001.1947	100.00

Table 9.3 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group indices (10^9) in August-September. The 0-group indices were revised in 2007, and differ slightly from those presented earlier.

Year	Larval abundance	New 0-group Index (10^9 ind.) without K eff	with K eff
1980	-	197.3	740.3
1981	9.7	123.9	477.3
1982	9.9	168.1	599.6
1983	9.9	100.0	340.2
1984	8.2	68.1	275.2
1985	8.6	21.3	63.8
1986	0.0	11.4	41.8
1987	0.3	1.2	4.0
1988	0.3	19.6	65.1
1989	7.3	251.5	862.4
1990	13.0	36.5	115.6
1991	3.0	57.4	169.5
1992	7.3	1.0	2.3
1993	3.3	0.3	1.0
1994	0.1	5.4	13.9
1995	0.0	0.9	2.9
1996	2.4	44.3	136.7
1997	6.9	54.8	189.4
1998	14.1	33.8	113.4
1999	36.5	85.3	287.8
2000	19.1	39.8	140.8
2001	10.7	33.6	90.2
2002	22.4	19.4	67.1
2003	11.9	94.9	340.9
2004	2.5	16.7	53.9
2005	8.8	41.8	148.5
2006	17.1	166.4	515.8
2007	-	157.9	480.1
Average	9.0	66.2	228.4

Table 9.4. Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September 2007.

Length (cm)			Age/Year class				Sum	Biomass	Mean
			1	2	3	4+	(10^9)	(10^3 t)	weight (g)
			2006	2005	2004	2003-			
6.5	-	7.0	0.156				0.226	0.2	1.0
7.0	-	7.5	0.455				0.455	0.6	1.3
7.5	-	8.0	2.784				2.784	4.9	1.7
8.0	-	8.5	7.058				7.058	14.6	2.1
8.5	-	9.0	12.132				12.132	30.9	2.6
9.0	-	9.5	26.687				26.687	79.0	3.0
9.5	-	10.0	37.728				37.728	125.0	3.3
10.0	-	10.5	48.732	0.508			49.24	191.5	3.9
10.5	-	11.0	33.232	0.666			33.898	149.3	4.4
11.0	-	11.5	21.693	1.160			22.853	114.0	5.0
11.5	-	12.0	16.009	2.198			18.208	105.8	5.8
12.0	-	12.5	6.019	1.679	0.027		7.725	54.0	7.0
12.5	-	13.0	3.278	3.377			6.655	54.5	8.2
13.0	-	13.5	2.501	3.475			5.976	57.1	9.6
13.5	-	14.0	1.130	3.721			4.852	54.5	11.2
14.0	-	14.5	1.475	3.783	0.113		5.371	70.3	13.1
14.5	-	15.0	0.483	5.168	0.028		5.679	83.9	14.8
15.0	-	15.5	0.109	7.628	0.051		7.788	128.4	16.5
15.5	-	16.0	0.009	7.499	0.139		7.646	141.3	18.5
16.0	-	16.5		7.164	0.705		7.869	161.0	20.5
16.5	-	17.0		3.970	0.436		4.406	100.5	22.8
17.0	-	17.5		1.246	0.713	0.108	2.067	56.8	27.5
17.5	-	18.0		1.008	0.267	0.017	1.292	38.5	29.8
18.0	-	18.5		0.289	0.643	0.009	0.941	32.3	34.4
18.5	-	19.0		0.084	0.391		0.476	18.0	37.9
19.0	-	19.5		0.119	0.168	0.001	0.288	10.6	36.9
TSN (10^9)			222	55	4	0	280		
TSB (10^3 t)			928.1	848.2	101.3	3.8		1881.6	
Mean length (cm)			10.3	14.8	17.2	17.4	11.3		
Mean weight (g)			4.2	15.5	27.5	28.1			6.7
SSN (10^9)			2.076	37.970	3.674	0.135	43.855		
SSB (10^3 t)			28.4	710.3	101.1	3.8		843.7	

Based on TS value: 19.1 log L - 74.0, corresponding to $\sigma = 5.0 \cdot 10^{-7} \cdot L^{1.9}$

Table 9.5 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass and biomass of the maturing component. Stock in numbers (unit:10^9) and stock and maturing stock biomass (unit:10^3 tonnes) are given at 1. October.

Year	Stock in numbers (10^9)						Stock in weight (10^3 t)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290
2003	82	10	11	1	0	104	533	280
2004	51	25	6	1	0	82	628	294
2005	27	13	2	0	0	42	324	174
2006	60	22	6	0	0	88	787	437
2007	222	55	4	0	0	280	1882	844

Table 9.6 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. August, back-calculated from the survey in September-October.

[redacted]

Table 9.8 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the autumn season.

[redacted]

Table 9.9 Barents Sea CAPELIN. Natural mortality coefficients (per month) for immature fish (Mimm), used for the whole year, and for mature fish (per season) (Mmat) used January to March, by age group and average for age groups 1-5.

[redacted]

Table 9.9 (Continued)

[redacted]

Table 9.10 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. January.

[redacted]

Table 9.11 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

[redacted]

Table 9.12 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1 year old fish, unit:10^9) and stock biomass ('000 t) given at 1. August. Spawning stock ('000 t) at time of spawning (1. April). Landings ('000 t) are the sum of the total landings in the two fishing seasons within the year indicated.

Year	Stock biomass August 1	Maturing biomass survey Oct. 1	Recruit-ment Age 1,August 1	Spawning stock biomass, assessment model, April 1	Landings	Herring biomass age 1 and 2
1965					224	
1966					389	
1967					409	
1968					537	
1969					680	
1970					1314	
1971					1392	
1972	5831	2182			1592	
1973	6630	1350	1140	33	1336	2
1974	7121	907	737	*	1149	48
1975	8841	2916	494	*	1439	74
1976	7584	3200	433	253	2587	39
1977	6254	2676	830	22	2987	46
1978	6119	1402	855	*	1916	51
1979	6576	1227	551	*	1783	39
1980	8219	3913	592	*	1648	66
1981	4489	1551	466	316	1986	46
1982	4205	1591	611	106	1760	9
1983	4772	1329	612	100	2358	12
1984	3303	1208	183	109	1477	1191
1985	1087	285	47	*	868	1111
1986	157	65	9	*	123	166
1987	107	17	46	34	0	137
1988	361	200	22	*	0	52
1989	771	175	195	84	0	121
1990	4901	2617	708	92	0	329
1991	6652	2248	415	643	929	644
1992	5214	2228	396	302	1123	1556
1993	991	330	3	293	586	2433
1994	259	94	30	139	0	1583
1995	189	118	8	60	0	424
1996	467	248	89	60	0	139
1997	866	312	112	85	1	247
1998	1860	931	188	94	1	336
1999	2580	1718	171	382	106	1109
2000	3840	2099	475	599	414	1628
2001	3480	2019	128	626	568	822
2002	2145	1290	62	496	651	190
2003	638	280	112	427	282	1127
2004	643	293	63	94	0	1569
2005	349	174	34	122	1	2030
2006	715	437	62	72	0	1313
2007	1626	844	225	189	4	
Average	3377	1247	320	216	824	609

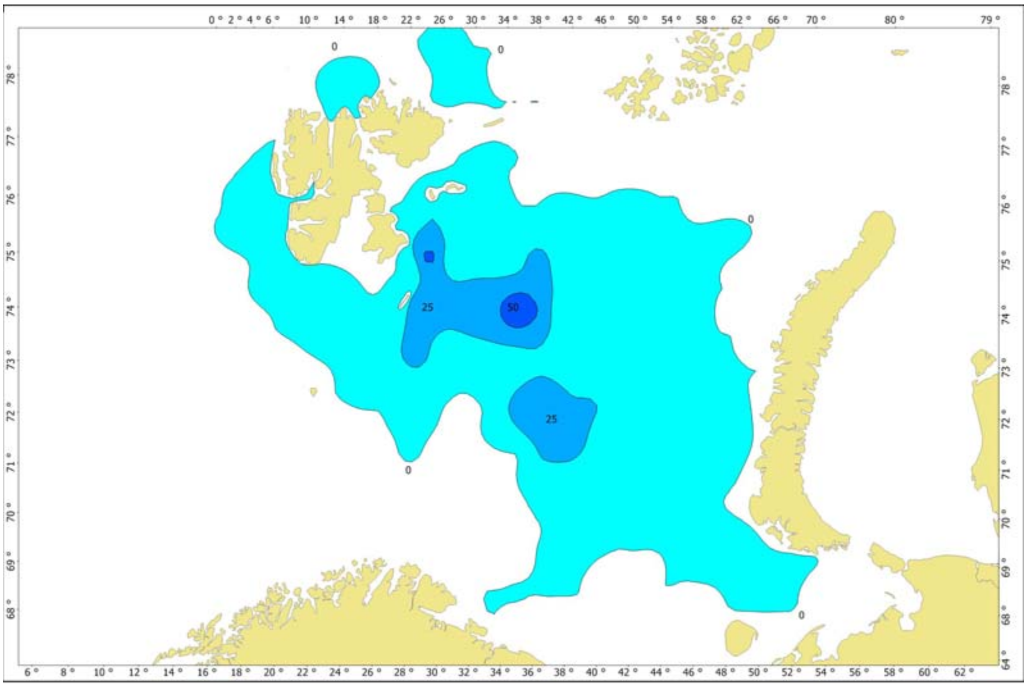

Figure 9.1. Geographical distribution of capelin during the acoustic survey in autumn 2007 (t/nm²)

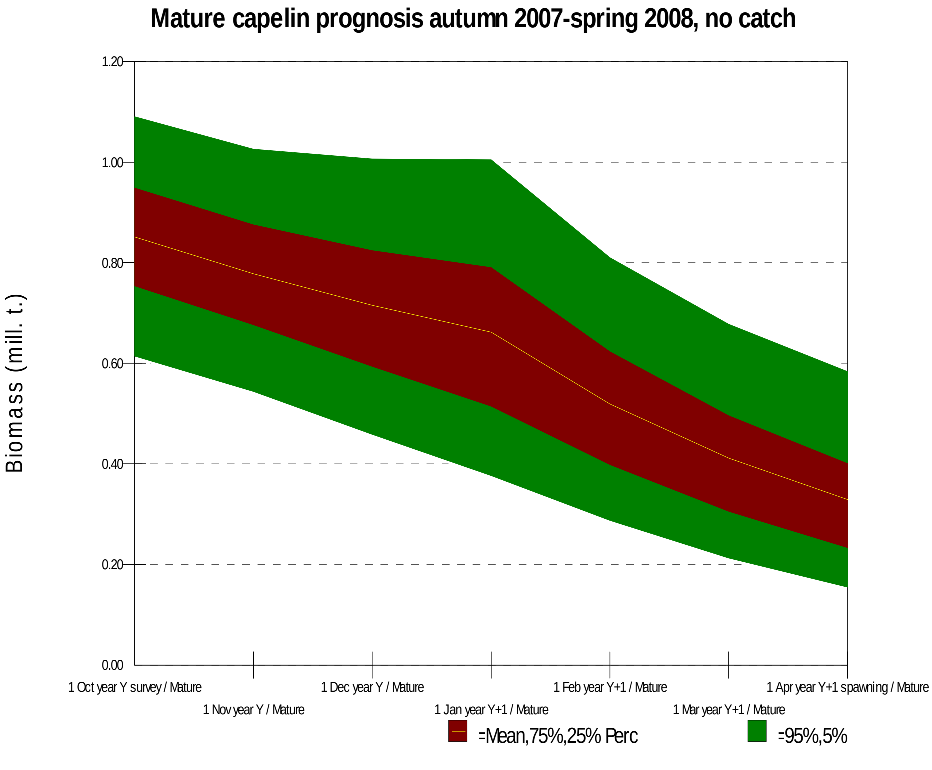

Figure 9.2. Capelin prognosis from 1 October 2007 to 1 April 2008 with no catch during the period.

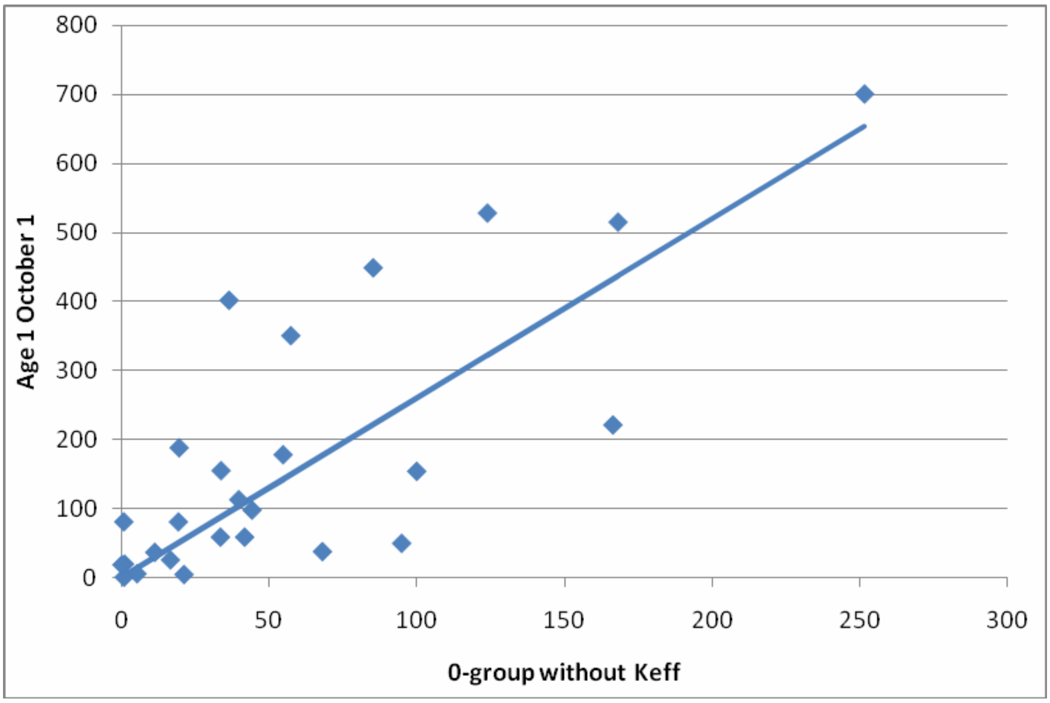

Figure 9.3. Regression of abundance of capelin at age 0 (0-group index without K_{eff}) and age 1 (acoustic estimate) of year classes 1981-2006. The regression line is forced through the origin, to avoid systematic overestimation of weak year classes.

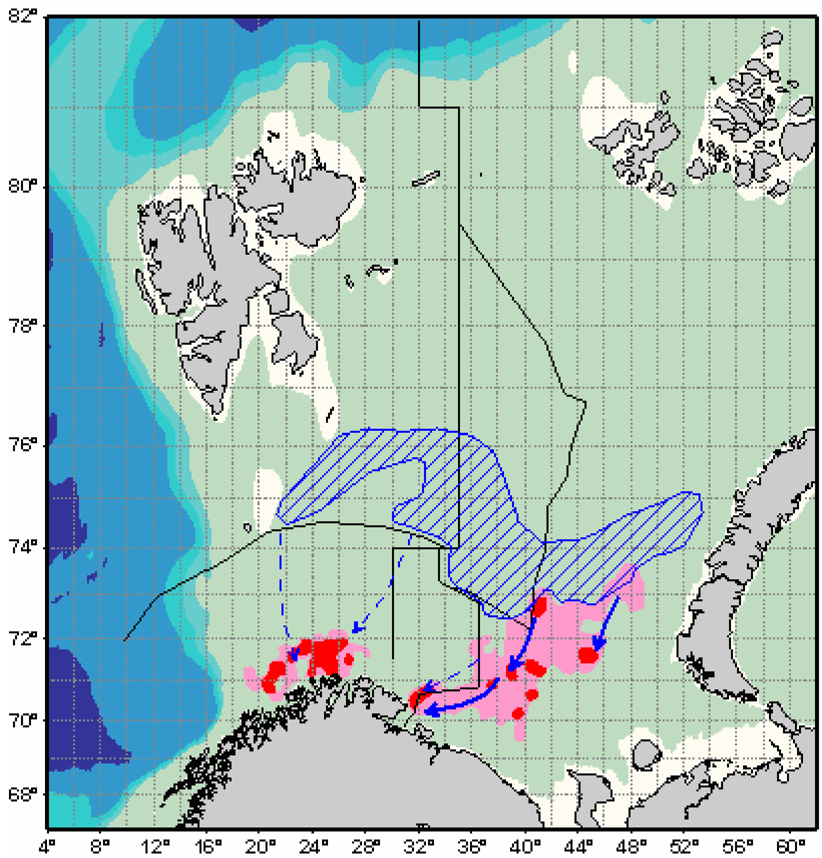

Figure 9.4. Distribution of wintering capelin, spawning stock and migration of prespawning capelin to the coast based on joint Norwegian and Russian data.

10 Working documents

WD#	Title	Orally presented	Authors
1	German redfish landings and biological data of deep-sea redfish (Sebastes mentella) in ICES Sub-areas I and II in 2002-2007	no	Stransky C.
2	Estimating by-catch at age of Northeast Arctic cod from the Barents Sea shrimp fishery during 1984-2006	yes	Ajiad, A., Aglen, A., Nedreaas, K., and Kvamme, C.
3	Spanish Pelagic Redfish Fisheries in ICES Division IIa 2007	no	Casas, J.M
4	The Spanish NE Arctic Cod Fishery in 2007	no	Casas, J.M
5	NEA cod assessment using FLR	yes	Kovalev Y. and Chetyrkin A.
6	Consumption of various prey species by cod in 1984-2007	no	Dolgov A.
7	Report of the Portuguese fishery in 2007: ICES Div. I, IIa and IIb.	no	R. Alpoim, J. Vargas and E. Santos
8	Report on Polish fishing activity and survey on redfish(Sebastes mentella) in the NEAFC Regulatory Area (ICES IIa) in 2007	no	J.Janusz, K.Trella and T.Nermer
9	Updated recruitment model for the NEA cod	yes	Bulgakova T.
10	NEA cod stock assessment by means of the TISVPA model	yes	Vasilyev D, Bulgakova T.
11	Russian experience in application of satellite monitoring in fisheries studies and assessment of the fishing stock biomass	yes	Borisov V.M., Kotenev B.N., Klochkov D.N., Shatokhin B.M.
12	Modelling maturity ogive for Northeast Arctic saithe	yes	Fotland, Å and Mehl, S.
13	Greenland halibut catchability	yes	Vollen T., Hallfredsson E., Albert OT and Huse I.
14	Timely evaluation of stock status – 2008 update	yes	Pennington, M., and Nakken, O.
15	Acoustic abundance of saithe, coastal cod and juvenile herring Finnmark – Møre autumn 2007	no	Aglen, A., Berg, E., Mehl, S. and Sunnanå, K.

16	Results from the Joint IMR-PINRO Barents Sea demersal fish survey 25 January – 14 March 2008	no	A.Aglen, Å. Høines, S. Mehl, D. Prosorkevich, O. Smirnov, T. de Lange Wenneck
17	Russian investigations and fishery for pelagic redfish in the Norwegian Sea in 2007	no	V.I. Vinnichenko
18	Factors contributing to inter- and intra-annual variation in condition of cod *Gadus morhua* in the Barents Sea	yes	L. R. Sandeman, N. A. Yaragina, C. T. Marshall
19	Using Life-History Models to Explore Environmental Effects on Stock Reproductive Potential of Several Cod Stocks	yes	L. O'Brien , N. Yaragina, Y. Lambert, G. Kraus, T. Marshall, G. Marteinsdottir, H. Murua, F. Saborido-Rey, J. Tomkiewicz , and P.Wright
20	Short status of the results from the Norwegian-Russian cod and haddock comparative age readings	yes	K.H. Nedreaas, N.A.Yaragina and age readers M. Baltykova (haddock), Else Holm (haddock), V. Koloskova (cod), H. Mjanger (cod), H. Senneset (cod), N. Zuykova (cod), and P. Ågotnes (cod)
21	Stock Assessment of North-East Arctic Cod by Improve Version of GIS Technology Method	yes	Bulatov O.A., Kotenev B.N., Moiseenko G.S., Borisov V.M., Vasilyev D.A, Babayan V.K., Bulgakova T.I., Tatarnikov V.A., Kuznetsova E.N.
22	Stock assessment methodology for the Barents Sea capelin	no	Alvarez, J., Bogstad, B., Dolgolenko, I., Drevetnyak, K. V., Eriksen, E., Gjøsæter, H., Kovalev, Yu. A., Prozorkevich, D. V., Røttingen, B., Tjelmeland, S., Ushakov, N. G.
23	Assessment of population recruitment abundance of Northeast Arctic cod and the Barents Sea capelin considering the environment data	yes	Titov O. V.
24	Assessment of Northeast Arctic haddock using XSA	yes	Aanes, S., and Jakobsen, T.
25	Estimation of population parameters of Northeast Arctic Haddock using a stochastic time series model	yes	Aanes, S.

26	Preliminary version of the Joint PINRO/IMR report on the state of the Barents Sea ecosystem in 2007, with expected situation and considerations for management.	yes	Stiansen, J.E., A.A. Filin, A. Aglen, N.A. Anisimova, P. Arneberg, B. Bogstad, S. Boitsov, V.D. Boitsov, P. Budgell, I. Byrkjedal, P. Dalpadado, A.V. Dolgov, K.V. Drevetnyak, K. Drinkwater, H. Gjøsæter, A. A. Grekov, D. Howell, G. Huse, Å. Høines, R. Ingvaldsen, V.A. Ivshin, E. Johannesen, L.L. Jørgensen, A.L. Karsakov, J. Klungsøyr, A.I. Krysov, T. Knutsen, C. Kvamme, P.A. Liubin, N.N. Lukin, L.J. Naustvoll, K. Nedreaas, I.E. Manushin, M. Mauritzen, S. Mehl, K. Michalsen, N.V. Muchina, M.A. Novikov, E. Olsen, I.A. Oganin, E.L. Orlova, G. Ottersen, V.K. Ozhigin, V.A. Pavlov, A.P. Pedchenko, M.A. Pinchukov, N.F. Plotitsina, G.B. Rudneva, I. Røttingen, M. Skogen, O.V. Smirnov, K.M. Sokolov, E.K. Stenevik, S. Sundby, J. Sundet, O.V. Titov, S. Tjelmeland, A.G. Trofimov, I.A. Trofimov, A.S. Yurko, V.B. Zabavnikov, A. Yu. Zhilin, S.V. Ziryanov, P.N. Zolotariov, N. Øien, B. Ådlandsvik, S. Aanes and J. Aars
27	Evaluating recruitment models for (Age 3) NEA cod	yes	S. Subbey, J.E. Stiansen, B. Bogstad, T. Bulgakova and O. Titov
28	Information about Russian research on population structure of redfish *S. mentella* in the pelagic waters of the Norwegian Sea	no	S.P. Melnikov, K.V. Drevetnyak and A.N. Stroganov
29	Age comparisons of capelin otoliths by Norwegian and Russian age readers 2004-2007 – a review	no	J. Alvarez[1], H. Gjøsæter, R. Maslova, T. Prokhorova, D. Prozorkevich, B. Røttingen, J. H. Nilsen, E. Tereshchenko, N. Ushakov
30	Canadian Arctic Fisheries: Past, Present and Future	yes	R. Tallman
31	An assessment of the future assessment site	yes	Stiansen,J.E., A.A. Filin, S. Subbey, S. Mehl and T. Vollen

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21 - 29 April 2008

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Annex 2: Technical Minutes RGAFNW

REVIEW OF ICES AFWG REPORT 2008

9-10 May 2008

Reviewers:	Jan Horbowy (Poland, Chair) Pablo Abaunza (Spain) Olga Moura (Portugal) Noel Cardigan (Canada, by correspondence)
Chair WG:	Yuri Kovalev (Russia)
Observer:	Jan Ivar Maråk (Norwegian Fishermen's As sociation)
ICES Secretariat:	Barbara Schoute

General

The Working Group report was rather clear and well structured, however, in a few places part of the tables were missing or presented in a way difficult to read. Example of such situation was section on NEA cod, where some tables were not formatted in a readable way (RCT3 results, XSA diagnostic, and data at age). The Working Group chair was very well prepared and informed.

RG urges the WG to update the quality handbook next year.

All stocks should have a table with meta data on survey coverage and quality.

Part of review was obtained by correspondence from Noel Cardigan after the RG work on Arctic stocks. This was only partly discussed during RG work due to time constrain, however, it is incorporated directly into RG comments.

Timing of next years WG:

Benchmark assessment proposal

Benchmarks to be performed **before the next assessment**

STOCK	PROBLEM	LAST BENCHMARK
Saithe		
Haddock		

Overview section

This part of the report was greatly reduced.

Currently used in the assessment includes more integrated assumptions:

NEA cod cannibalism and environmentally related recruitment estimates

NEA haddock takes predation of cod on haddock into account

Capelin prediction done taking into account cod predation

Cod in area I and II (Norwegian coastal cod)

1) **Assessment type** update,
2) **Assessment**: not presented
3) **Forecast**: not presented
4) **Assessment model**: try outs with XSA and Surba
5) **Consistency**: no data revisions
6) **Stock status**: SSB and recruitment are stable at very low level, F very high in recent years
7) **Man. Plan.**: none

General comments

Uncertain catch statistics (not accounted for recreational and tourist fishing, uncertain catch at age data) are dealt with.

Last year the basis for the separation between coastal and NEA cod was requested. The report clarifies the difference in otolith typing. There is genetic difference between both components as well.

Year effects in survey have been noticed and that results in difficulties in cohort tracking.

Former analytical assessments were stopped after apparent friction between survey and catch (at age) data. RG judges that last years' analysis would be interesting to present, including Surba runs (survey only). RG sees the necessity to scrutinize Surba inputs in the same fashion as the XSA input data were looked at. Such exploratory work can be done intersessionally until information is sufficient to design a new assessment methodology for this stock. Then a benchmark assessment can be planned.

Technical comments

1. RG urges the WG to update the quality handbook next year. The assessment approach (SURBA) is different from that specified in the Quality Handbook (XSA), although apparently the same as the WG used last year. This causes confusion. Either the report describes the differences with an (attached) QH, or the QH is updated. The QH should also describe how the lengths-, weights-, and maturities-at-age are computed for the survey. Are they simple averages, or are they weighted by abundance in areas.
2. The SURBA stock weights are different from Table 2.8. The most recent (i.e. best ?) values should be used to provide advice.
3. The caption to Table 2.1b refers to catch by quarter, but the information is not presented in the Table. This information is given in Table 2.4.
4. Pg 76, last paragraph. ‘The catch reporting has not been sufficiently accurate to split the catches between those locations.’ It is probably the catch sampling, and not reporting, that is the problem. Are only the samples from the south-western part of area 00 for Quarter 1 reported in Table 2.2? If so, this should be noted briefly in Table 2.2 (e.g. use a *, and a note: see text).

5. Text in the 1st paragraph of Section 2.1.1 is confusing. On the one hand the text says 'There are no separate quotas for the coastal areas', but it then goes on to talk about the coastal part of the TAC? This should be clarified.
6. Section 2.2. It would be useful to give the km^2 of the survey area before and after 2003. Also, are coastal cod found in the 'new' survey area not included in the indices? If so, how much, and does the proportion annually vary.
7. Section 2.2.1. 'The period since 2002 shows some variation without a clear trend.' This text is too vague. Suggestion: 'The 2007 spawning biomass index doubled compared to the low value for 2005, but is about 40% of the values observed in 1995-1997'.
8. Section 2.2.2. In the title, there is no Table 2.2b? What does Table 2.4 have to do with this section?
9. A minor comment about Section 2.2.2. One could fit a Binomial logistic regression model to the sampling data (i.e. #coastal/#total) and estimate effects for age, region, year, and interactions. This could be used to statistically test if the proportion is stable between years, etc.
10. It would be useful to describe (perhaps more appropriately in the Quality Handbook Annex) how the lengths-, weights-, and maturities-at-age are computed for the survey. Are they simple averages, or are they weighted by abundance in areas.
11. Section 2.3.2. RG could not find commercial weights-at-age in Table 2.16.
12. The maturities used in SURBA seem too large at ages 3 and 4. The average maturity at age 4 in Table 2.10 is around 17%, which is less than the 24% used by SURBA.
13. The SURBA stock weights are different from Table 2.8. The most recent (i.e. best?) values should be used to provide advice.
14. Section 2.5.1. 'Figure 2.17 shows that for most year classes the observed values for ages 2 and 3 are below the modelled values, and that this pattern increases for the most recent cohorts. This might indicate that the survey catchability is reduced in the later part of the time series.' This does not make sense. The SURBA predictions are greater than observed for all years. SURBA should estimate a smaller Q for these ages to correct for these differences. The same thing happens for ages 8-9. However, these systematic differences are not apparent in the residuals (see Fig. 2.21). This should be resolved.
15. Section 2.5.1. A dome in Q's is worrying, because it reflects a 'cryptic' biomass that is not sampled by the survey. It is more useful when this pattern can be corroborated with other knowledge. Such a pattern in Q's is often associated in VPA's with a domed pattern in fishery selectivity. However, this is not the case for this stock. The age-effects in F tend to increase, except for the odd age 7 value. It would be useful to better understand what is going on here. A sensitivity run with Q's fixed to be flat may assist in this regard.

Conclusions

RG agrees with the WG that SSB and R are such, that no quick recovery of the stock is to be expected.

Cod in area I and II (North East Arctic)

1) **Assessment type** officially an update, but very worked on
2) **Assessment**: accepted
3) **Forecast**: accepted
4) **Assessment model**: XSA spaly, alternatively Gadget (MSVPA), TISVPA
5) **Consistency**: surveys are not consistent with last year, assessment is rather uncertain.
6) **Stock status**: B > Bpa, F = Fpa, R in 2008 is expected to be above the long-term mean, while it is expected to be below the long-term mean both in 2009 and 2010.
7) **Man. Plan.**: in place and evaluated by ICES

General comments

Unreported landings were an issue, as last year. The WG decided to follow the same approach as last year. It is difficult to decide which of 2 IUU interpretations is correct, but the results in the assessment are similar. The group decided to use the same IUU assumption as last year.

Technical comments

1. Some output tables are difficult to read (RCT3, XSA diagnostics), the RG urges the WG to make better readable tables. At the same time some usually not necessary output was presented (e.g. XSA biomass at age by years).
2. Table 3.15: unclear what is in the top panel: this needs better explanation next year.
3. Table 3.17 is confusing: there are many tables with different IUU basis or incorporated/not incorporated cannibalism, it is too difficult to find out which is which.
4. For predictions of recruitment a hybrid model is introduced, averaging chosen results of a range of 8 different models that incorporate environmental aspects. Choice of appropriate models is based on the correlation with the VPA recruitment estimates in the last 10 years. To ensure consistency, the WG has set basic criteria for incorporating or not results of the different models (e.g. take all R > 0.5 into account). According to the WG the RTC3 information proved to have much less correlation with VPA recruitment than the developed models. The hybrid model incorporates many ecosystem variables and the RG is worried that it will be untransparent to the weighting of these different variables in the estimation results. The RG would propose to use a few models and average the results of these for the recruitment estimate over a couple of years instead of varying the models used over the years.
5. The RG also indicates that there is a possibility in RCT3 approach to include environmental variables, although only simple power relationship between R and index is allowed. Advantage of RCT3 is the use of calibration regression,

which is appropriate in situation where explanatory variables have higher variance (error) than the predicted variable (VPA/XSA recruitment estimates are usually considered to have lower error than the survey or environmental indices). The RG encourages the WG to explore the RCT3 possibilities with environmental variables to predict recruitment.

6. RG urges the WG to update the quality handbook next year.
7. The question was raised during the RG if the option of "catchability dependent of stock size" for selected (user defined) ages in XSA is consistent with the approach in RCT3 (valid question if survey indices and XSA estimates are used to predict recruitment). The answer is yes, the RCT3 calibrates recruitment using power model, so both approaches are consistent.
8. It would be useful to have a table that gives the annual area covered by the survey's, the total unadjusted abundance/biomass, and the total adjusted abundance/biomass. This would help us understand the adjustments.
9. Is there any information on the age-composition of IUU catches? Is the large increase in catch at age 3 in 2007 relative to 2002-2006 is real, or just better reporting ? However, the survey indices for age 3 in 2007 are all high, so perhaps the increase catch@3 is real. But could this be a year-effect for younger age's? For example, for FLT15 and FLT16, survey indices for cohorts at age 4 usually are much lower than at age 3; except that in 2007 the indices at age 4 are greater than the indices at age 3 in 2006. This is not the case for FLT18. This seems linked to the retrospective differences in 2006 recruitment at age 3 (Fig. 3.8). In Table A.2, the 2004 year-class (YC) is very strong at age 4 relative to other recent YC's, but the 2004 YC appears to be relatively weak at age 3 and strong but not exceptional at age 2. The **conclusion** from all of this is that the 2008 recruitment value in Table 3.28N is considered uncertain..
10. There have been some fairly large changes in the maturities at age 6 recently, and this should be considered. This is reflected to some extent in the different trends in the biomass panels of Fig. 3.8. It would be useful to examine the average age of the SSB. Sometimes SSB is taken as a proxy for exploitable biomass, but for this stock that may be a little misleading.

Conclusions

RG is pleased with the work on Recruitment, but questioned some elements of the approach (e.g. selecting each year different models for averaging, depending on change in correlation from year to year) and would like to see the comparison with the RTC3 model with environmental input next year. The WG is asked to provide information on the weighting of the ecosystem impacts and on how to make the modeling reviewable next year. The RG considers that a way of analysing the prediction ability of environmental variables to estimate recruitment in a statistical framework is through predictor screening within cross-validation. This technique is well described in Francis (2006) and the RG encourages to expert group to incorporate this analysis in future recruitment studies.

Reference: Francis, RIIC. 2006. Measuring the strength of environment-recruitment relationship: the importance of including predictor screening within cross-validations. ICES Journal of Marine Science, 63: 594-599.

Haddock North East Arctic

1) **Assessment type** update, but extra exercises were carried out
2) **Assessment**: accepted this year (not last year)
3) **Forecast**: accepted
4) **Assessment model**: XSA, same as last year but done in FLR
5) **Consistency**: same as last year, though last year was not accepted
6) **Stock status**: B > Bpa, F < Fpa, R increase
7) **Man. Plan.**: in place and evaluated by ICES

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.

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.

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.
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.
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.

4. Tables B1-B4: please improve table headings: it is unclear what +/- signs mean.
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.
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.
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.
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.
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.
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.

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.

Saithe in subareas I and II

1) **Assessment type** Update
2) **Assessment**: accepted
3) **Forecast**: accepted
4) **Assessment model**: XSA
5) **Consistency**: same as last year with some small data corrections (5.3.1)
6) **Stock status**:
7) **Man. Plan.**: in place and evaluated by ICES

General comments

WG noted 20% increase in NO trawl CPUE from 2006/2007, while 20% decrease in total survey index (lowest since 1991). CPUE is probably not reflecting stock size, but is caused by redistribution. WG considers this a reason to leave out these CPUE data for 2007. This is also backed up by logbook and verbal industry information.

There is limited (anecdotal) information on discarding for this stock, extended surveys to collect data on discards will improve the accuracy of the assessment greatly.

Technical comments

1. Recruitment estimates are very hard to get by, a geometric mean was used.
2. The retrospective pattern is slightly better than last year, probably due to a change in trend within the stock, but this still leaves room for improvement. The retrospective patterns are severe for this stock. There are many possible explanations for this. The surveys have not seen the increase in stock size suggested by the XSA (see Fig. 5.5.1). Fishing mortalities are fairly low which suggests that the VPA is not well-converged. It is probably sensitive to reasonable changes to M, and there has been substantial discarding. Handbook Annex text suggests the assessment boundaries to not cover the stock range. The WG should consider if XSA, given its quality, can be use to provide advice.
3. Particularly for the next benchmark assessment, the RG would like to see a plot for weights-at-age (1 plot, stacked lines), and also lengths at age – both commercial and survey. Changes in growth rates, and the corresponding change in catchability, may be an explanation for the retrospective problems.
4. Figure 5.3.1: RG notes a certain 'mirroring' of ages 3 and 4, which is strange. The WG is asked to look at this pattern next year.
5. In light of the comments on substantial discarding, are the catch data reliable enough for XSA?
6. As survivors at age 3 (2004 y-c) are not well estimated in the assessment model the WG replaced age 3 in 2007 by GM and recalculated it to age 4 at the beginning of 2008 as input to prediction. However, in this recalculation the fishing mortality estimated by XSA for age 3 in 2007 was used which is

inconsistent (N rejected, F used). The RG proposes to use 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)

Conclusions

The RG accepts the assessment, taking into account the fact that there is some more consistency with last year. Forecast has a TAC constrained F, like last year. The forecast is deemed pessimistic as regards to intermediate year assumption but still the catches will probably not be taken.

Median term predictions are produced, but based on a geometric mean assumption for recruitment. The HCR has to be worked out on the same basis, if no S-R relation is observed.

Both redfish stocks and Greenland halibut have not been reviewed because these stocks will only be advised on the basis of last years assessment and advice. Capelin was not reviewed. Advice for capelin will be provided in Autumn ACOM meeting.

Annex to the RGAFNW report

Haddock North East Arctic – XSA diagnostics

```
Lowestoft VPA Version 3.1
   10/05/2008  15:56
 Extended Survivors Analysis
 NEA Haddock (Final XSA AFWG08   in VPA95  made by RG)
 CPUE data from file fleet
 Catch data for  58 years. 1950 to 2007. Ages  1 to  11.
      Fleet,           First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FLT01: Russian BT su,   1983, 2007,   1,     7,   .900,  1.000
 FLT02: Norwegian aco,   1980, 2007,   1,     7,   .990,  1.000
 FLT04: Norwegian BT ,   1982, 2007,   1,     8,   .990,  1.000

 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years

 Catchability analysis :

      Catchability dependent on stock size for ages <    7
         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  7

      Catchability independent of age for ages >=    9

 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =    .500

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

      Prior weighting not applied

 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00219

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6,      7,      8,      9,     10
 Iteration 29, 1.9394,  .5224,  .1073,  .1704,  .4753,  .3791,  .2835,  .4223,  .2930,  .2615
 Iteration 30, 1.9394,  .5223,  .1073,  .1703,  .4752,  .3789,  .2833,  .4220,  .2926,  .2608


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

 Fishing mortalities
    Age,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006,  2007

      1, 2.344,  .917, 1.123,  .649, 1.585, 1.647, 1.637, 1.793, 1.738, 1.939
      2,  .109,  .200,  .142,  .121,  .623,  .581,  .553,  .873,  .429,  .522
      3,  .068,  .085,  .041,  .052,  .139,  .236,  .255,  .270,  .052,  .107
      4,  .240,  .208,  .218,  .079,  .197,  .195,  .241,  .243,  .211,  .170
      5,  .392,  .445,  .268,  .365,  .244,  .376,  .305,  .346,  .367,  .475
      6,  .478,  .454,  .265,  .351,  .465,  .422,  .509,  .478,  .351,  .379
      7,  .535,  .489,  .326,  .234,  .292,  .643,  .315,  .656,  .376,  .283
      8,  .708,  .507,  .337,  .251,  .193,  .302,  .466,  .247,  .505,  .422
      9,  .649,  .512,  .222,  .420,  .160,  .435,  .171,  .583,  .198,  .293
     10,  .623,  .418,  .261,  .256,  .282,  .474,  .482,  .474,  .542,  .261
```

XSA population numbers (Thousands)

	AGE									
YEAR ,	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,
1998 ,	1.88E+06,	3.19E+05,	6.18E+04,	7.35E+04,	3.33E+04,	2.51E+04,	3.68E+04,	4.24E+04,	4.89E+03,	7.86E+02,
1999 ,	1.67E+06,	1.47E+05,	2.34E+05,	4.73E+04,	4.73E+04,	1.84E+04,	1.28E+04,	1.77E+04,	1.71E+04,	2.09E+03,
2000 ,	1.99E+06,	5.48E+05,	9.88E+04,	1.76E+05,	3.14E+04,	2.48E+04,	9.57E+03,	6.40E+03,	8.71E+03,	8.39E+03,
2001 ,	1.28E+06,	5.29E+05,	3.89E+05,	7.76E+04,	1.16E+05,	1.97E+04,	1.56E+04,	5.65E+03,	3.74E+03,	5.71E+03,
2002 ,	3.30E+06,	5.47E+05,	3.84E+05,	3.02E+05,	5.87E+04,	6.59E+04,	1.13E+04,	1.01E+04,	3.60E+03,	2.01E+03,
2003 ,	4.91E+06,	5.54E+05,	2.40E+05,	2.74E+05,	2.03E+05,	3.77E+04,	3.39E+04,	6.94E+03,	6.82E+03,	2.51E+03,
2004 ,	3.10E+06,	7.75E+05,	2.53E+05,	1.55E+05,	1.84E+05,	1.14E+05,	2.02E+04,	1.46E+04,	4.20E+03,	3.62E+03,
2005 ,	7.60E+06,	4.94E+05,	3.65E+05,	1.61E+05,	9.99E+04,	1.11E+05,	5.62E+04,	1.21E+04,	7.50E+03,	2.90E+03,
2006 ,	1.04E+07,	1.04E+06,	1.69E+05,	2.28E+05,	1.03E+05,	5.79E+04,	5.65E+04,	2.39E+04,	7.73E+03,	3.43E+03,
2007 ,	1.05E+07,	1.49E+06,	5.52E+05,	1.31E+05,	1.51E+05,	5.85E+04,	3.34E+04,	3.17E+04,	1.18E+04,	5.19E+03,

Estimated population abundance at 1st Jan 2008

,	0.00E+00,	1.24E+06,	7.24E+05,	4.06E+05,	9.06E+04,	7.70E+04,	3.28E+04,	2.06E+04,	1.71E+04,	7.22E+03,

Taper weighted geometric mean of the VPA populations:

,	3.21E+06,	4.76E+05,	2.17E+05,	1.35E+05,	8.81E+04,	4.71E+04,	2.36E+04,	1.13E+04,	5.32E+03,	2.65E+03,

Standard error of the weighted Log(VPA populations) :

,	.7624,	.7102,	.6840,	.6955,	.7510,	.7777,	.7939,	.7798,	.7517,	.8375,

Log catchability residuals.

Fleet : FLT01: Russian BT su

Age ,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
6 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
7 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
8 ,	No data for this fleet at this age							

Age ,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997
1 ,	.18,	-.13,	99.99,	.38,	.28,	-.10,	-.36,	-.36,	-.23,	-.30
2 ,	.46,	.87,	99.99,	.26,	.18,	.15,	.14,	-.25,	-.17,	.03
3 ,	.01,	-.26,	99.99,	.08,	.49,	.42,	.30,	-.24,	-.11,	-.33
4 ,	-.31,	-.20,	99.99,	-.21,	-.04,	.81,	.42,	-.29,	.16,	.15
5 ,	-.14,	.07,	99.99,	-.32,	-.32,	.33,	.31,	-.16,	.80,	-.55
6 ,	-.08,	.66,	99.99,	-.36,	.45,	.63,	.14,	.19,	.60,	-.37
7 ,	-1.92,	1.28,	99.99,	.46,	.65,	.84,	-.45,	.32,	1.28,	-1.03
8 ,	No data for this fleet at this age									

Age ,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007
1 ,	-.23,	.52,	.26,	.18,	.00,	.00,	-.28,	.25,	-.10,	.06
2 ,	-.11,	.34,	-.16,	-.14,	-.08,	.05,	-.42,	-.03,	.27,	.28
3 ,	.31,	.04,	.12,	-.15,	.03,	.18,	-.29,	-.17,	-.01,	.12
4 ,	.06,	.35,	-.16,	-.22,	.39,	.17,	-.13,	-.23,	-.35,	-.21
5 ,	-.39,	.36,	.41,	-.19,	.18,	.14,	-.35,	-.27,	-.17,	.14
6 ,	-.62,	.04,	-.14,	.15,	-.35,	.46,	.16,	-.17,	-.24,	.07
7 ,	.26,	-.33,	-.60,	-.49,	-.11,	.51,	-.45,	.42,	.15,	.05
8 ,	No data for this fleet at this age									

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

Age ,	7
Mean Log q,	-7.3695,
S.E(Log q),	.5632,

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
1,	.67,	3.011,	10.33,	.89,	19,	.27,	-8.06,
2,	.59,	4.109,	9.61,	.91,	19,	.24,	-7.15,
3,	.64,	3.620,	8.87,	.91,	19,	.22,	-6.91,
4,	.78,	1.676,	7.97,	.85,	19,	.30,	-6.86,
5,	.70,	2.018,	8.17,	.82,	19,	.37,	-6.79,
6,	.80,	1.469,	7.71,	.84,	19,	.36,	-6.94,

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7,	.92,	.403,	7.59,	.71,	19,	.54,	-7.37,

Fleet : FLT02: Norwegian aco

Age ,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
6 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
7 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
8 ,	No data for this fleet at this age							

Age ,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997
1 ,	-.47,	-.40,	.75,	.42,	.50,	.46,	.45,	.10,	-.71,	-.16
2 ,	.30,	-.49,	.23,	.35,	.11,	.31,	.04,	.02,	.01,	.16
3 ,	.09,	-.22,	.21,	-.16,	.42,	.39,	-.04,	.20,	.00,	.03
4 ,	-.09,	-.36,	.00,	-.55,	-.31,	.62,	.35,	.07,	-.16,	.16
5 ,	-.19,	-.18,	.11,	99.99,	99.99,	.28,	.39,	-.12,	.10,	-.02
6 ,	.26,	.40,	-.22,	99.99,	99.99,	99.99,	.00,	.27,	.17,	.36
7 ,	99.99,	.98,	.60,	-1.03,	99.99,	99.99,	99.99,	99.99,	.02,	.86
8 ,	No data for this fleet at this age									

Age ,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007
1 ,	-.39,	.49,	.11,	.09,	-.14,	-.08,	-.26,	.01,	-.28,	.44
2 ,	-.36,	.08,	.02,	.06,	.10,	-.04,	-.02,	-.31,	-.02,	.13
3 ,	-.02,	-.17,	-.10,	-.10,	.18,	.02,	.19,	-.28,	-.01,	-.04
4 ,	-.09,	.56,	-.64,	-.26,	.33,	-.17,	-.13,	-.30,	.13,	.33
5 ,	.16,	.45,	-.68,	-.45,	.37,	.01,	-.23,	-.31,	.03,	.44
6 ,	-.37,	.42,	-.51,	-.22,	-.20,	.57,	-.30,	-.30,	-.02,	.36
7 ,	-.35,	-.02,	99.99,	99.99,	99.99,	-.15,	99.99,	-.65,	-.01,	.57
8 ,	No data for this fleet at this age									

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

Age ,	7
Mean Log q,	-6.4417,
S.E(Log q),	.5024,

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.78,	1.600,	7.31,	.84,	20,	.35,	-5.13,
2,	.69,	4.342,	7.75,	.95,	20,	.17,	-5.32,
3,	.72,	3.665,	7.29,	.95,	20,	.17,	-5.39,
4,	.75,	1.618,	7.09,	.80,	20,	.36,	-5.50,
5,	.60,	2.527,	8.03,	.80,	18,	.37,	-5.72,
6,	.71,	1.800,	7.64,	.80,	17,	.37,	-6.35,

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7,	.87,	.395,	6.97,	.66,	11,	.47,	-6.44,

Fleet : FLT04: Norwegian BT

Age ,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987
1 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
2 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
3 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
6 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
7 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99
8 ,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99,	99.99

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-.10	-.26	.64	.49	.17	.30	-.18	-.09	-.16	-.31
2	.92	-.07	-.05	.23	-.28	.21	.17	-.03	.17	.20
3	.49	-.12	-.12	-.19	.11	-.11	.09	.40	.25	.04
4	.28	-.21	.24	-.52	-.49	-.02	.20	.52	.17	.21
5	.13	.14	.30	.15	-.06	-.25	.33	.11	.19	-.03
6	.66	.38	-.40	-.16	.29	-.19	.35	.48	.17	-.01
7	.28	1.68	1.05	.24	-.55	-.63	99.99	.83	1.39	.98
8	99.99	99.99	99.99	1.38	-.23	.07	.53	99.99	.22	1.18

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-.47	.12	.12	.32	.04	-.07	-.01	.06	-.15	.20
2	-.43	-.07	-.01	.05	.32	-.03	-.02	-.27	-.15	.19
3	-.11	-.72	-.01	-.13	-.07	.07	.21	-.11	.01	.34
4	-.35	-.08	-.57	-.12	-.33	-.17	.30	.02	.08	.61
5	.18	.05	-.09	-.52	-.11	-.16	-.04	.08	.15	.22
6	-.12	.05	-.29	-.08	-.60	.48	-.14	-.01	.15	.05
7	.30	-.42	-1.39	-.88	-.91	.05	-.36	.60	.49	.54
8	.38	.60	-.50	99.99	-1.10	.08	-.50	-1.22	.99	.09

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

Age	7	8
Mean Log q	-7.2479	-7.7329
S.E(Log q)	.7990	.7781

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.75	2.778	7.34	.92	20	.23	-4.75
2	.59	4.475	8.27	.92	20	.22	-4.97
3	.67	2.709	7.51	.87	20	.27	-5.18
4	.74	1.692	7.11	.81	20	.35	-5.46
5	.53	5.378	8.53	.93	20	.22	-5.96
6	.59	3.536	8.27	.88	20	.30	-6.51

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	.55	3.621	8.53	.87	19	.30	-7.25
8	.79	.746	8.11	.58	15	.63	-7.73

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	1307504.	.310	.000	.00	1	.151	1.892
FLT02: Norwegian aco	1924709.	.420	.000	.00	1	.082	1.574
FLT04: Norwegian BT	1516036.	.300	.000	.00	1	.162	1.768
P shrinkage mean	476051.	.71				.200	2.802
F shrinkage mean	1640829.	.50				.404	1.703

Weighted prediction :

Survivors, at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1237555.	.26	.26	5	1.017	1.939

Age 2 Catchability dependent on age and year class strength

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: Russian BT su	909113.	.260	.135	.52	2	.267	.436
FLT02: Norwegian aco	789320.	.273	.121	.44	2	.253	.488
FLT04: Norwegian BT	830546.	.259	.120	.46	2	.268	.469
P shrinkage mean	217059.	.68				.074	1.190
F shrinkage mean	581237.	.50				.138	.617

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    723989.,       .15,      .16,    8,   1.057,   .522

 Age  3   Catchability dependent on age and year class strength

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01: Russian BT su,    486276.,   .205,       .053,    .26,   3,  .307,     .090
 FLT02: Norwegian aco,    395173.,   .209,       .008,    .04,   3,  .300,     .110
 FLT04: Norwegian BT ,    461245.,   .210,       .169,    .81,   3,  .286,     .095

   P shrinkage mean  ,    134877.,    .70,,,,                        .036,     .293

   F shrinkage mean  ,    218083.,    .50,,,,                        .070,     .191

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    406126.,       .12,      .11,   11,    .919,   .107

Age  4   Catchability dependent on age and year class strength

 Year class = 2003

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01: Russian BT su,     81952.,   .181,       .058,    .32,   4,  .331,     .187
 FLT02: Norwegian aco,     93834.,   .192,       .134,    .70,   4,  .289,     .165
 FLT04: Norwegian BT ,    103968.,   .190,       .189,   1.00,   4,  .292,     .150

   P shrinkage mean  ,     88063.,    .75,,,,                        .027,     .175

   F shrinkage mean  ,     68894.,    .50,,,,                        .061,     .218

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     90575.,       .11,      .07,   14,    .669,   .170

 Age  5   Catchability dependent on age and year class strength

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01: Russian BT su,     64046.,   .166,       .104,    .63,   5,  .303,     .549
 FLT02: Norwegian aco,     81534.,   .177,       .138,    .78,   5,  .264,     .454
 FLT04: Norwegian BT ,     82523.,   .164,       .067,    .41,   5,  .328,     .449

   P shrinkage mean  ,     47103.,    .78,,,,                        .031,     .690

   F shrinkage mean  ,    119946.,    .50,,,,                        .075,     .330

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     76998.,       .10,      .07,   17,    .698,   .475

Age  6   Catchability dependent on age and year class strength

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FLT01: Russian BT su,     29397.,   .160,       .067,    .42,   6,  .295,     .415
 FLT02: Norwegian aco,     35991.,   .168,       .103,    .61,   6,  .264,     .351
 FLT04: Norwegian BT ,     35988.,   .153,       .033,    .22,   6,  .345,     .351

   P shrinkage mean  ,     23586.,    .79,,,,                        .027,     .495

   F shrinkage mean  ,     26717.,    .50,,,,                        .069,     .448
```

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
32834.,	.09,	.04,	20,	.481,	.379

Age 7 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
FLT01: Russian BT su,	18842.,	.157,	.068,	.43,	7,	.308,	.306
FLT02: Norwegian aco,	21393.,	.166,	.111,	.67,	7,	.287,	.274
FLT04: Norwegian BT ,	24774.,	.150,	.052,	.35,	7,	.328,	.241
F shrinkage mean ,	11544.,	.50,,,,				.077,	.460

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
20587.,	.09,	.06,	22,	.658,	.283

Age 8 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
FLT01: Russian BT su,	16368.,	.153,	.076,	.50,	7,	.282,	.436
FLT02: Norwegian aco,	15820.,	.161,	.070,	.44,	7,	.269,	.448
FLT04: Norwegian BT ,	17200.,	.151,	.053,	.35,	8,	.329,	.419
F shrinkage mean ,	21740.,	.50,,,,				.120,	.345

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
17056.,	.10,	.04,	23,	.400,	.422

Age 9 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
FLT01: Russian BT su,	8382.,	.159,	.097,	.61,	7,	.242,	.256
FLT02: Norwegian aco,	6238.,	.166,	.129,	.77,	7,	.235,	.331
FLT04: Norwegian BT ,	7559.,	.163,	.153,	.94,	8,	.304,	.281
F shrinkage mean ,	6706.,	.50,,,,				.219,	.311

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
7216.,	.13,	.07,	23,	.509,	.293

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1997

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT01: Russian BT su,	3593.,	.156,	.124,	.79,	7,	.291,	.240
FLT02: Norwegian aco,	3777.,	.164,	.137,	.83,	6,	.233,	.230
FLT04: Norwegian BT ,	3113.,	.151,	.162,	1.08,	8,	.335,	.273
F shrinkage mean ,	2456.,	.50,,,,				.141,	.335

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
3284.,	.11,	.08,	22,	.756,	.261