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International Council for the Exploration of the Sea

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NAFO Headquarters,

Dartmouth, NS

CANADA

NAFO/ICES *Pandalus* Assessment Group
Meeting, 19–26 October 2011

Contents

Report of NIPAG Meeting

19–26 October 2011

Co-Chairs: Jean-Claude Mahé and Carsten Hvingel Rapporteurs: Various

I. OPENING

The NAFO/ICES *Pandalus* Assessment Group (NIPAG) met at the NAFO Headquarters, Dartmouth, NS, Canada, during 19-26 October 2011 to review stock assessments referred to it by the Scientific Council of NAFO and by the ICES Advisory Committee. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Denmark, Estonia, and Spain), Norway, Russian Federation and Sweden.

II. GENERAL REVIEW

1. Review of Research Recommendations in 2010

These are given under each stock in the "stock assessments" section of this report.

2. Review of Catches

Catches and catch histories were reviewed on a stock-by-stock basis in connection with each stock.

III. STOCK ASSESSMENTS

1. Northern Shrimp on Flemish Cap (NAFO Div. 3M)

SCS Doc 04/12; SCR 04/77, 11/13, 11/59, 11/60, and 11/62

Environmental Overview

The water masses characteristic of the Flemish Cap area are a mixture of Labrador Current Slope Water and North Atlantic Current Water, generally warmer and saltier than the sub-polar Newfoundland Shelf waters with a temperature range of 3-4°C and salinities in the range of 34-34.75. The general circulation in the vicinity of the Flemish Cap consists of the offshore branch of the Labrador Current which flows through the Flemish Pass on the Grand Bank side and a jet that flows eastward north of the Cap and then southward east of the Cap. To the south, the Gulf Stream flows to the northeast to form the North Atlantic Current and influences waters around the southern areas of the Cap. In the absence of strong wind forcing, the circulation over the central Flemish Cap is dominated by a topographically induced anti-cyclonic (clockwise) gyre. The entrainment of North Atlantic Current water around the Flemish Cap, rich in inorganic dissolved nutrients generally supports higher primary and secondary production compared with the adjacent shelf waters. The stability of this circulation pattern may also influence the retention of ichthyoplankton on the bank and is probably a factor in determining the year-class strength of various fish and invertebrate species, such as cod, redfish and shrimp.

Surface temperatures on the Flemish Cap were slightly above normal in 2010 while near-bottom temperatures on the remained above normal by > 1 standard deviation (SD). Surface salinities were also above normal by 0.4 SD. In the deeper (>1000 m) waters of the Flemish Pass and across the Flemish Cap, bottom temperatures generally range from 3°─ 4°C. The baroclinic transport in the offshore branch of the Labrador Current through the Flemish Pass increased from >2 SD below normal in 2008 to about normal in 2009-10 by about 0.8 SD. Primary and secondary productivity was enhanced in the Flemish Pass and Cap in 2010.

a) Introduction

The shrimp fishery in Div. 3M began in 1993. Initial catch rates were favorable and, shortly thereafter, vessels from several nations joined. The number of vessels participating in the fishery has decreased by more than 60% since 2004 to 13 vessels in 2010.

Catches peaked at 64 000 t in 2003 (Fig. 1.1). Since then catches have been lower, declining to 5 400 t in 2009. and 2 000 t in 2010. Information from the fishing industry suggests that catch rates, fuel prices, and low market prices for shrimp might have affected the participation in this fishery in recent years. Due to a moratorium, there was no shrimp fishing in Div. 3M during 2011.

NIPAG is concerned about suspected misreporting of catches since 2005, where catches from Div. 3L were reported as from Div. 3M.

Recent catches and TACs (metric tons) are as follows:

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Recommended TAC	45 000	45 000	45 000	48 000	48 000	17 000-32 000[1]	18 000-27 000[2]	0	0
STATLANT 21	62 761	45 842	27 651	15 191	17 642	11 671	5 374	1 975	0[3]
NIPAG	63 970	45 757	27 479	18 595[4]	20 741	13985[4]	5 448[4]	1 988[4]	

[1] SC recommended that exploitation level for 2008 should not exceed the 2005 and 2006 levels (17 000 to 32 000 t).
[2] SC recommended that exploitation level for 2009 should not exceed the levels that have occurred since 2005 (18 000 to 27 000 t).
[3] Preliminary catches from circular letters, to October 2011
[4] Catches revised in 2011

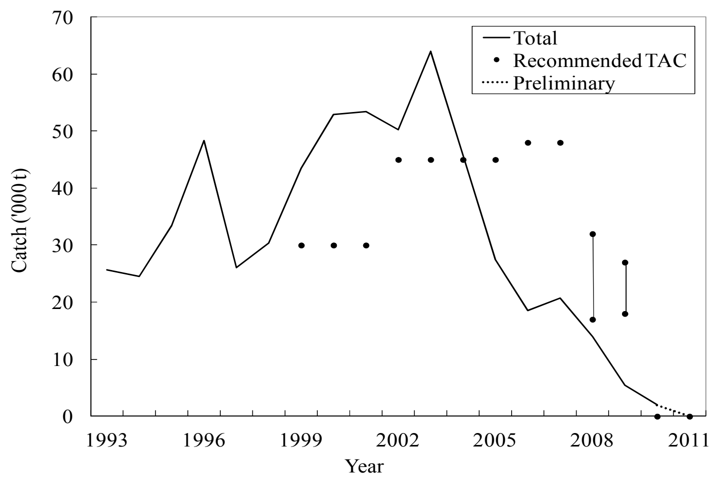


Fig. 1.1. Shrimp in Div. 3M: Catches (t) of shrimp on Flemish Cap and TACs recommended in the period 1993-2011. Due to a moratorium, the shrimp catch is expected to be zero in 2011.

b) Input Data

i) Commercial fishery data

Effort and CPUE. Logbook and/or observer data were available from Canadian, Greenlandic, Icelandic, Faroese, Norwegian, Russian, Estonian and Spanish vessels. From this information one international CPUE database for Div. 3M was constructed. There have been concerns that, since 2005, the reporting of some Div. 3L catches as coming from Div. 3M were affecting the CPUE data for some fleets. In order to avoid the uncertainty around the catch rate standardization model used for Div. 3M, all trips from 2005 to 2010 where fishing occurred in both Div. 3M and Div. 3L were eliminated and a standardized CPUE series was produced for 1993 to 2010. CPUE gradually increased from the mid-1990s to 2006. In 2007, 2008 and 2009 the standardized CPUE declined. In 2010 the CPUE seems to stabilize at 2008-2009 levels, however due to the scanty observations in 2009 and 2010 (only Spanish data were available) there is considerable uncertainty regarding these years. Effort levels have recently been low and NIPAG was concerned that the CPUE may not reflect the stock status in the same way as at higher levels of effort.

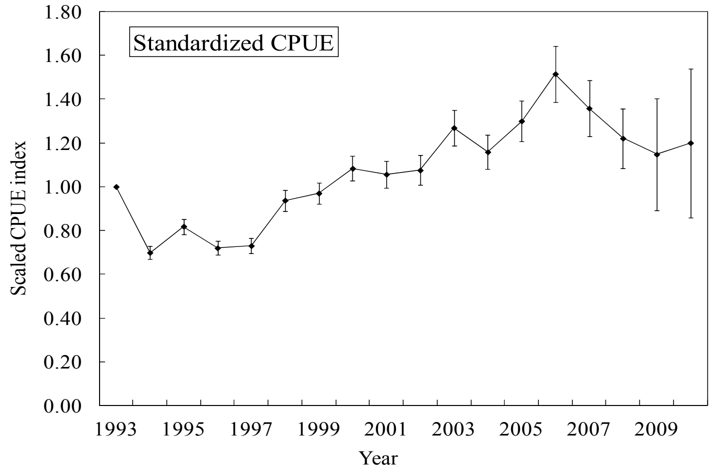


Fig. 1.2. Shrimp in Div. 3M: Standardized CPUE of shrimp on Flemish Cap, 1993-2010 (±1 SE).

Biological data. The age and sex composition was assessed from commercial samples obtained from Iceland from 2003 to 2005 and from Canada, Greenland, Russia and Estonia in previous years. For these years number/hour caught per age-class was calculated for each year by applying a weight/age relationship and age proportions in the catches to the annual standardized CPUE data. From 2006 the samples obtained from the fishery have been insufficient to assess the age of the catches and so was not possible to estimate the disaggregated CPUE (number/hour or kg/hour) by age and sex since 2006 to the present.

ii) Research survey data

Stratified-random surveys have been conducted on Flemish Cap by the EU in July from 1988 to 2011, using a Lofoten trawl. A new vessel was introduced in 2003 which continued to use the same trawl employed since 1988. In addition, there were differences in cod-end mesh sizes utilized in the 1994 and 1998 surveys that have likely resulted in biased estimates of total survey biomass. Nevertheless, for this assessment, the series prior to 2003 were converted into comparable units with the new vessel based on the methodology accepted by STACFIS in 2004 (NAFO 2004 SC Rep., SCR Doc. 04/77). The index was stable at a high level from 1998 to 2007. Since then the survey biomass index declined and in 2011 was the lowest in the survey series, well below B_{lim} (Fig. 1.3).

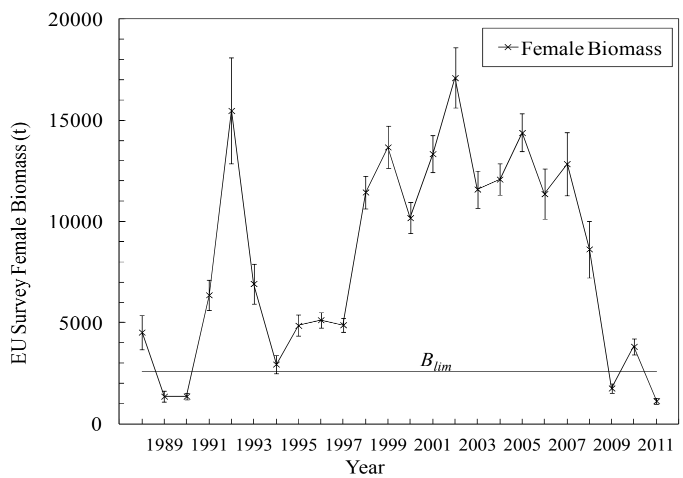


Fig. 1.3. Shrimp in Div. 3M: Female biomass index from EU trawl surveys, 1988-2011. Error bars are 1 std. err.

iii) Recruitment indices

EU bottom trawl surveys. From 1988 to 1995 shrimp at age 2 and younger were not captured by the survey. Beginning in 1996 the presence of this component increased in the surveys and it is believed that the introduction of the new vessel in 2003 greatly improved the catchability of age 2 shrimp due to technological advances in maintaining consistent performance of the fishing gear. In addition, since 2001, a small mesh juvenile bag was also attached to the net which was designed to provide an index of juvenile shrimp smaller than that typically retained by the survey codend. Both EU-survey indices show an exceptionally large 2002 year-class and very weak 2003-2009 year-classes (Fig. 1.4).

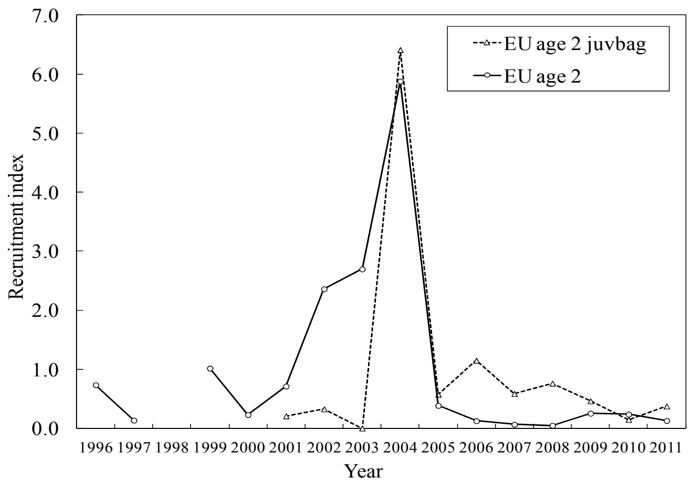


Fig. 1.4. Shrimp in Div. 3M: Abundance indices at age 2 from the EU survey. Each series was standardized to its mean. The 1998 value is not shown due to bias caused by the use of a smaller cod-end mesh size (25 mm.) in that year.

iv) Exploitation index

An index of exploitation was derived by dividing the nominal catch in a given year by the biomass index from the EU survey in the same year (Fig. 1.5). This was high in the years 1994-1997 when biomass was generally lower. From 2005 to 2008 exploitation indices remained stable at relatively low values and increased in 2009, as a consequence of decrease in the biomass estimated that year. The exploitation rate in 2010 was the lowest observed in the series as a result of the very low catches and the small increase in the biomass index estimated that year. The expected exploitation rate in 2011 will be zero or very close to zero due to the moratorium for this fishery.

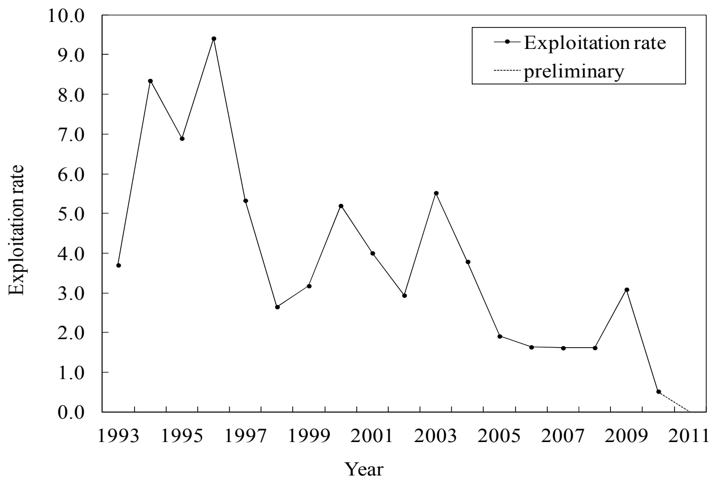


Fig. 1.5. Exploitation rate of shrimp in Div. 3M (catch divided by the EU survey biomass index of the same year).

c) Assessment Results

Commercial CPUE index. The CPUE index from the commercial fishery showed increasing trends from 1996 to 2006. This CPUE index has decreased from 2006 to 2010.

SSB. The survey female biomass index was at a high level from 1998 to 2007, and has declined to its lowest level in 2011.

Recruitment. Indices of age 2 abundance have been weak since 2002.

Exploitation rate. From 2005 to 2008 exploitation rates (nominal catch divided by the EU survey biomass index of the same year) remained stable at relatively low values and increased in 2009. Because catches in 2010 were low, while the female biomass estimate increased slightly, the exploitation rate declined to its lowest observed level.

State of the Stock. In 2009 the female biomass index was below B_{lim}, it was slightly above it in 2010 and it is again well below B_{lim} in 2011. Due to the continued poor recruitment, there are serious concerns that the stock will remain at low levels.

d) Precautionary Approach

Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for B_{lim}, 2 564 t for northern shrimp in Div. 3M (SCS Doc. 04/12). The index in 2011 is below B_{lim}. It is not possible to caluculate a limit reference point for fishing mortality (Fig. 1.6).

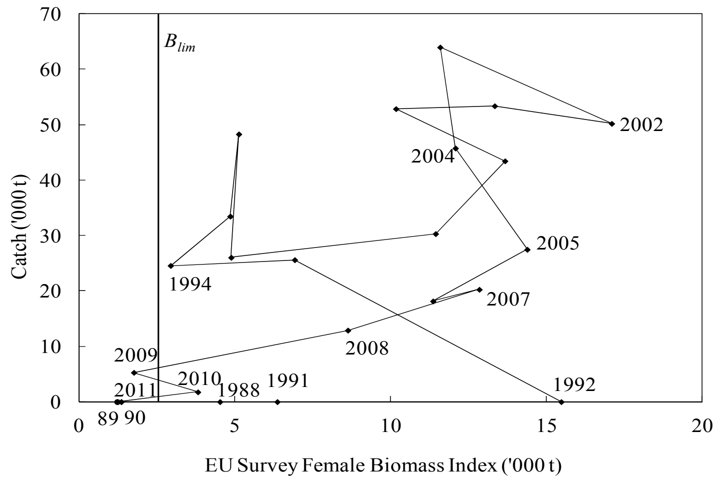


Fig. 1.6. Shrimp in Div. 3M: Catch plotted against female biomass index from EU survey. Line denoting Blim is drawn where biomass is 85% lower than the maximum point in 2002. Due to the moratorium on shrimp fishing the expected catch in 2011 is 0 t.

e) Ecosystem considerations

The drastic decline of shrimp biomass in 2009 and 2011 years coincided with the increase of the cod stock in recent years (SCR Doc. 11/62) (Fig. 1.7).

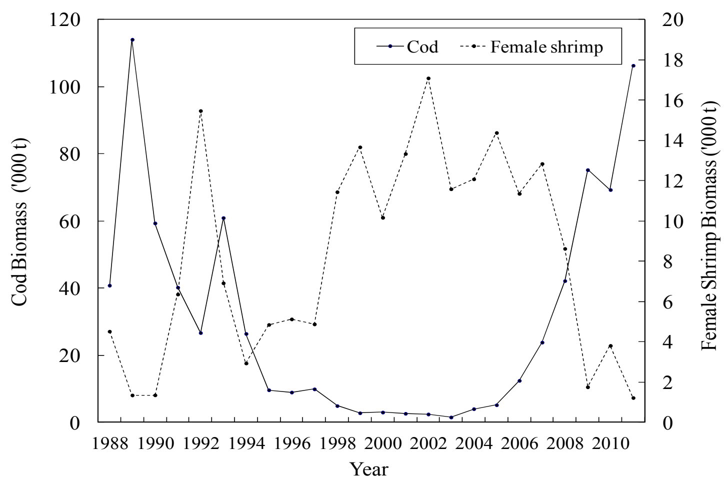


Fig. 1.7. Shrimp in Div. 3M: Cod and female shrimp biomass from EU trawl surveys, 1988-2011.

f) Review of Research Recommendations made in 2010

NIPAG **recommends** that *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 September 2011.*

STATUS: Data from 2010 year were submitted by this deadline.

NIPAG **recommends** that *for northern shrimp in Division 3M investigations be conducted into methods for demographic analyses of fishery CPUE.*

STATUS: In 2011 began the moratorium for shrimp fishery and no commercial sampling was possible.

Sources of Information: SCS Doc 04/12 , SCR Doc. 04/77, 11/ 13, 11/59, 11/60, 11/62.

2. Northern Shrimp (Div. 3LNO)

(SCR Doc. 11/13, 49, 59, 61)

Environmental Overview

The water mass characteristic of the Grand Banks are typical Cold-Intermediate-Layer (CIL) sub-polar waters which extend to the bottom in northern areas with average bottom temperatures generally <0°C during spring and through to autumn. The winter-formed CIL water mass is a reliable index of ocean climate conditions in this area. Bottom temperatures increase to 1-4°C in southern regions of Div. 3NO due to atmospheric forcing and along the slopes of the banks below 200 m depth due to the presence of Labrador Slope Water. On the southern slopes of the Grand Banks in Div. 3O bottom temperatures may reach 4-8°C due to the influence of warm slope water from the south. The general circulation in this region consists of the relatively strong offshore Labrador Current at the shelf break and a considerably weaker branch near the coast in the Avalon Channel. Currents over the banks are very weak and the variability often exceeds the mean flow. The proportion of bottom habitat on the Grand Banks covered by <0°C water has decreased from near 50% during the first half of the 1990s to <15% during the mid-2000s and to <10% in 2010.

The annual surface temperatures at Station 27 (Div. 3L) have been near-normal or above normal since 2002 and was about 1 standard deviation (SD) above normal in 2010. Bottom temperatures at Station 27 increased to the 3rd highest in 2010 at +1.7 SD above normal. Vertically averaged temperatures have increased to the 2nd highest on record in 2010 (+1.9 SD). Annual surface salinities at Station 27 decreased from +0.2 SD in 2009 to about -0.7 SD in 2010, the freshest since 1995. In 2010, the water column average salinity was the lowest since the early 1990s.

The annual average stratification index was below normal in the 2010. The mixed layer depth (MLD), estimated as the depth of maximum density gradient is highly variable on the inner NL Shelf, particularly during the winter months. During 2010 the annual averaged MLD and the winter (March only) values were shallower than normal while the spring values were deeper than normal. Spring bottom temperatures in Div. 3LNO during 2010 were above normal by up to 1 SD and as a result, the area of the bottom habitat covered by water <0°C was significantly below normal. During the autumn, bottom temperatures in 3LNO were >1 SD above normal. The volume of CIL water on the NL Shelf during the autumn was below normal (3rd lowest since 1980) for the 16th consecutive year. Bottom temperatures in Div. 3LNO generally ranged from <0°C on the northern Grand Bank and in the Avalon Channel to 3.5°C along the shelf edge. Over the southern areas, bottom temperatures ranged from 2° to 8°C with the warmest bottom waters found on the Southeast Shoal and along the edge of the Grand Bank in Div. 3O. Nutrient inventories for both shallow and deep layers were depleted in 2010 due to the enhanced primary and secondary productivity in the region. On the Grand Banks productivity was the highest observed in the 12-year time series.

a) Introduction

This shrimp stock is distributed around the edge of the Grand Bank mainly in Div. 3L. The fishery began in 1993 and came under TAC control in 2000 with a 6000 t TAC and fishing restricted to Div. 3L. Annual TACs were raised several times between 2000 and 2009 reaching a level of 30 000 t for 2009 and 2010 before decreasing to 19 200 t in 2011, 12 000 t in 2012 and 9 350 t in 2013. A total catch of 11 434 t was taken by October 2011 (Fig. 2.1).

Recent catches and TACs (t) for shrimp in Div. 3LNO (total) are as follows:

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TAC as set by FC	13 000[1]	13 000[1]	13 000[1]	22 000[1]	22 000[1]	25 000[1]	30 000[1]	30 000[1]	19 200[1]	12 000[1]
STATLANT 21	11 917	12 051	13 574	21 284	21 120	24 758[2]	25 621[2]	19 726[2]		
NIPAG	13 069	13 452	14 389	25 831	23 859	27 691	28 544[3]	21,187[2,3]	11 434[4]	

[1] Denmark with respect to Faroes and Greenland did not agree to the 2003 – 2011 quotas and have set autonomous TAC since 2003. These increases are not included in the table.
[2] Provisional catches.
[3] Revised in 2011.
[4] Estimated catches to October 2011.

Since this stock came under TAC regulation, Canada has been allocated 83% of the TAC. This allocation is split between a small-vessel (less than 500 GT and less than 65 ft) and a large-vessel fleet. By October 2011, the small- and large-vessel fleets had taken 6 506 t and 2 439 t of shrimp respectively in Div. 3L. In all years, most of the Canadian catch occurred along the northeast slope in Div. 3L. The annual quota within the NAFO Regulatory Area (NRA) is 17% of the total TAC.

The use of a sorting grid to reduce bycatches of fish is mandatory for all fleets in the fishery. The sorting grid cannot have a bar spacing greater than 22 mm.

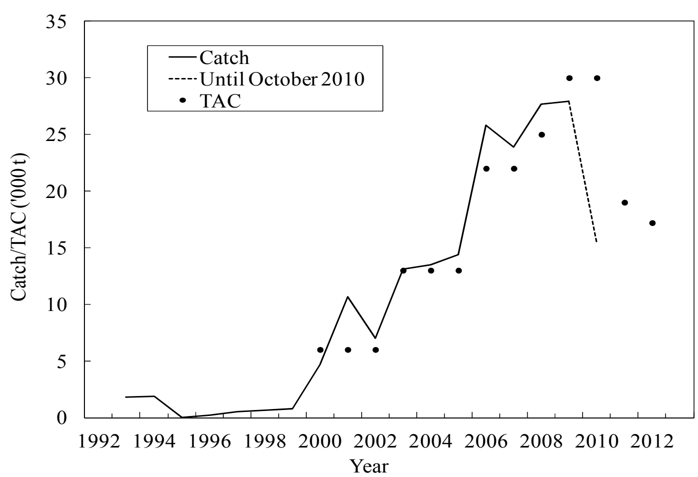


Fig. 2.1. Shrimp in Div. 3LNO: catches (to October 2011) and TAC as set by Fisheries Commission.

b) Input Data

i) Commercial fishery data

Effort and CPUE. Catch and effort data have been available from vessel logbooks and observer records since 2000. Data for the time series have been updated for these analyses. CPUE models were standardized to 2000 values rather than the last year of the fishery as had been done in previous years. The 2011 index for each of the large and small vessel CPUEs were significantly lower than the long term mean and were similar to the 2000 values for their respective series (Fig. 2.2).

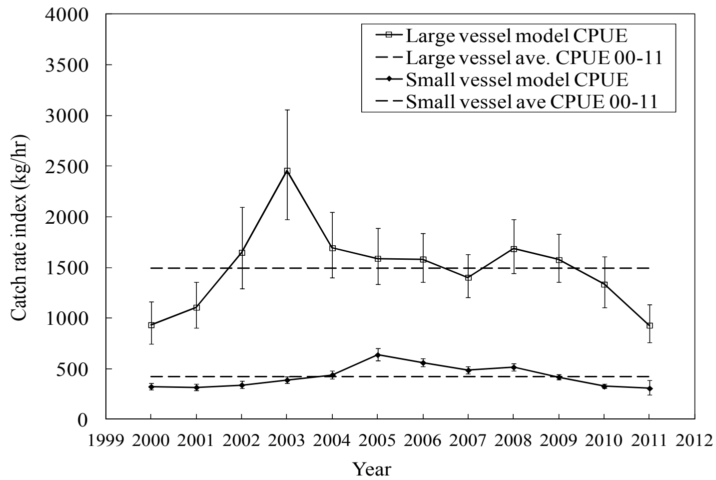


Fig. 2.2. Shrimp in Div. 3LNO: Standardized CPUE for the Canadian large-vessel (>500 t) and small-vessel (≤500 t; LOA<65') fleets fishing shrimp in Div. 3L within the Canadian EEZ.

Logbook data were available for the shrimp fishery within the NRA, in 2011, but this came from only Estonia. The data was insufficient to produce a standardized CPUE model.

Catch composition. Length compositions were derived from Canadian observer datasets from 2001 to 2010. Catches appeared to be represented by a broad range of size groups of both males and females. No new data were available from the 2011 fishery.

ii) Research survey data

Canadian multi-species trawl survey. Canada has conducted stratified-random surveys in Div. 3LNO, using a Campelen 1800 shrimp trawl, from which shrimp data is available for spring (1999–2011) and autumn (1996–2010). The autumn survey in 2004 was incomplete and therefore of limited use for the assessment.

Spanish multi-species trawl survey. EU-Spain has been conducting a spring stratified-random survey in Div. 3NO within the NRA since 1995; the survey has been extended to include the NRA in Div. 3L since 2003. From 2001 onwards data were collected with a Campelen 1800 trawl. There was no Spanish survey in 2005 in Div. 3L.

Biomass. In Canadian surveys, over 90% of the biomass was found in Div. 3L, distributed mainly along the northeast slope in depths from 185 to 550 m. There was an overall increase in the both spring and autumn indices to 2007 after which they decreased by about 75% to 2011 (Fig. 2.3). Confidence intervals from the spring surveys are usually broader than from the autumn surveys.

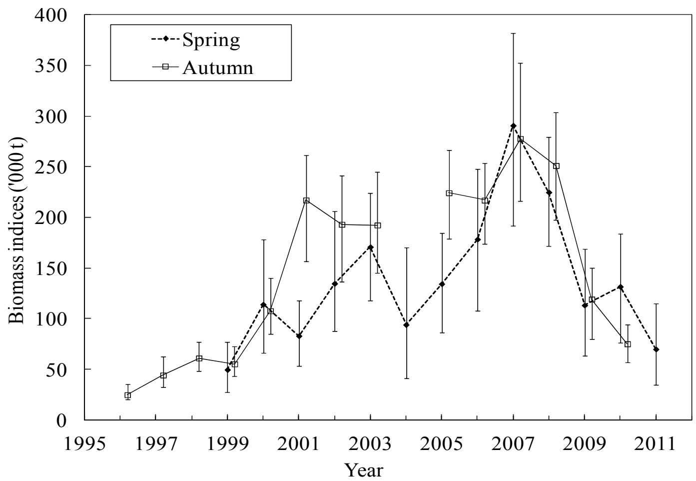


Fig. 2.3. Shrimp in Div. 3LNO: biomass index estimates from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

Spanish survey biomass indices for Div. 3L, within the NRA, increased from 2003 to 2008 followed by an 83% decrease by 2011 (Fig. 2.4).

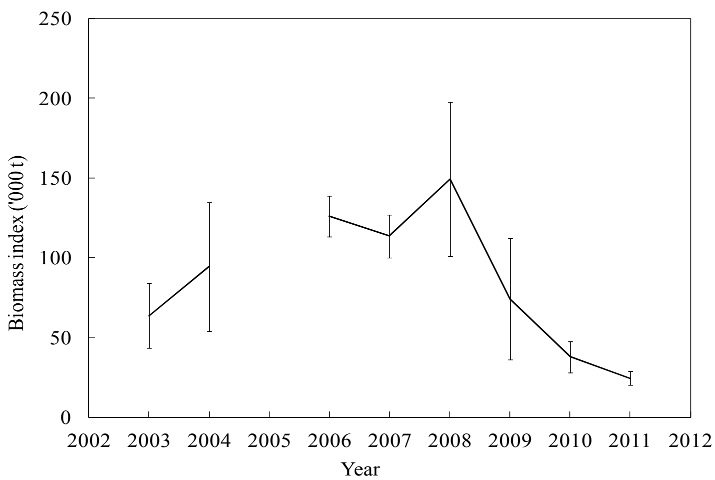


Fig. 2.4. Shrimp in Div. 3LNO: biomass index estimates from EU - Spanish multi-species surveys (± 1 s.e.) in the 3L NRA.

Female Biomass (SSB) indices. The autumn 3LNO female biomass index showed an increasing trend to 2007 but decreased 72% by 2010. The spring SSB index decreased by 82% between 2007 and 2011 (Fig. 2.5).

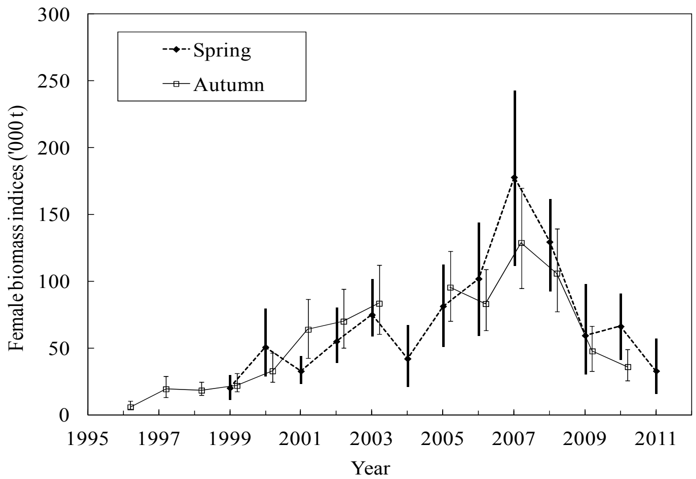


Fig. 2.5. Shrimp in Div. 3LNO: Female biomass indices from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

The Canadian autumn 2011 bottom trawl survey was ongoing while this meeting was taking place therefore the previous autumn female spawning stock biomass (SSB) index was regressed upon the spring female SSB index to predict an autumn 2011 female SSB index of 27 600 t.

Stock composition. The autumn surveys showed an increasing trend in the abundance of female (transitionals + females) shrimp up to 2007 and remained high in 2008 then decreased by 65% through to 2010. Similarly, spring female abundance series increased until 2007, remained high in 2008 then decreased by 74% through to 2011. Male autumn abundance index peaked in 2001 and remained high until 2008 before decreasing by 69% by 2010. The spring male abundance index followed trends similar to their respective female index (Fig. 2.6).

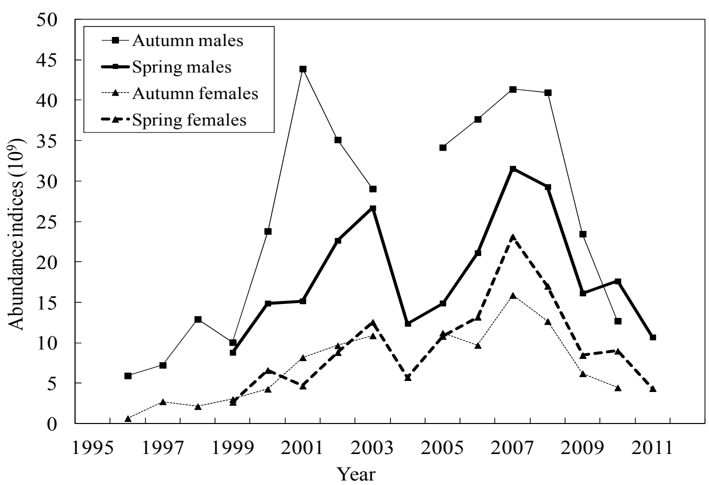


Fig. 2.6. Shrimp in Div. 3LNO: Abundance indices of male and female shrimp within Div. 3LNO as estimated from Canadian multi-species survey data.

Both males and females showed a broad distribution of lengths in recent surveys indicating the presence of more than one year class. It is worth reiterating that since 2008 the abundances at all length classes were greatly reduced from those found in previous Canadian surveys (Fig. 2.7).

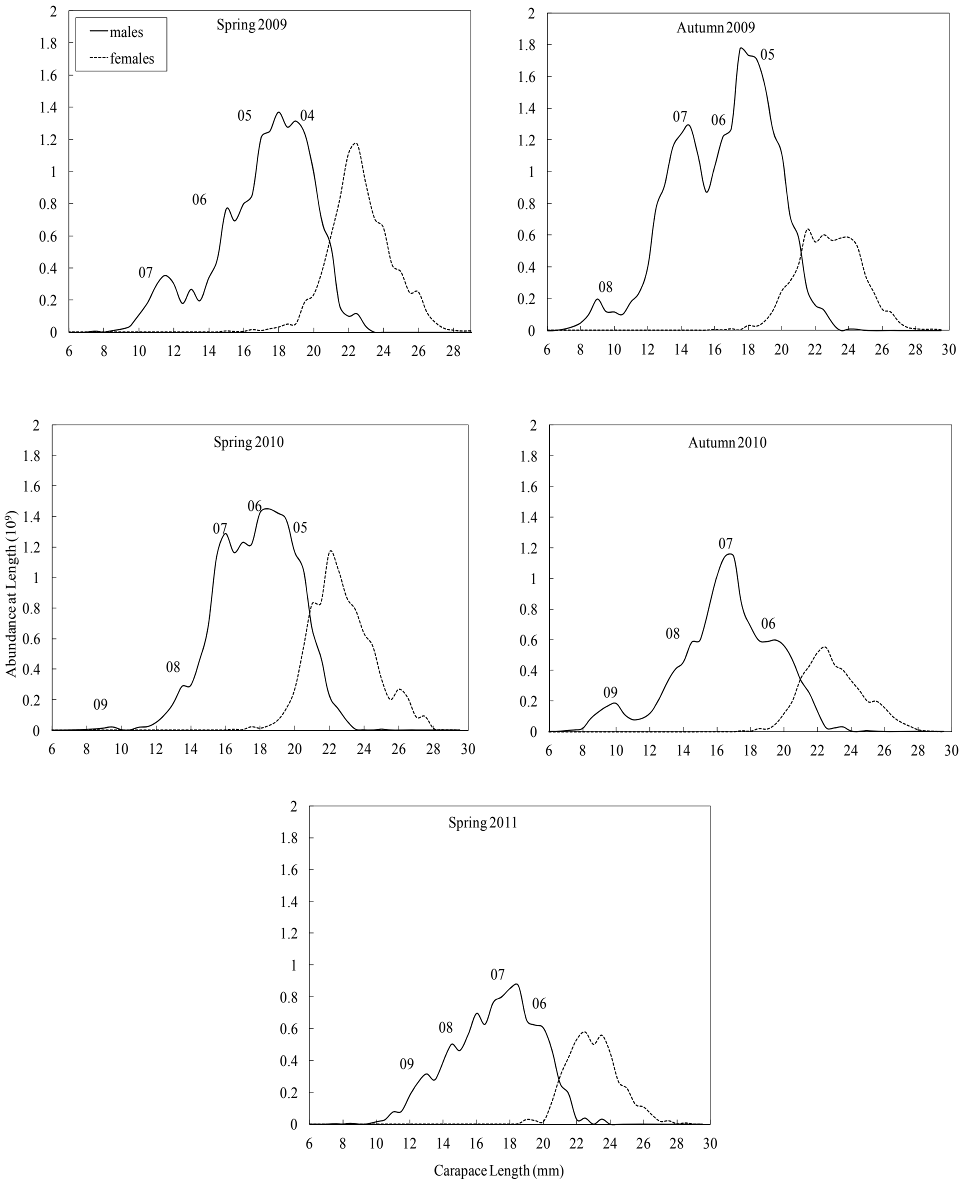


Fig. 2.7. Shrimp in Div. 3LNO: abundance at length for northern shrimp estimated from Canadian multi-species survey data. Numbers within charts denote year-classes.

Recruitment indices. The recruitment indices were based upon abundances of all shrimp with carapace lengths of 12 – 17 mm from Canadian survey data. The 2006 – 2008 recruitment indices were among the highest in both spring and autumn time series. The spring and autumn indices decreased to near their respective series means in 2009 then decreased further through to spring 2011 (Fig. 2.8).

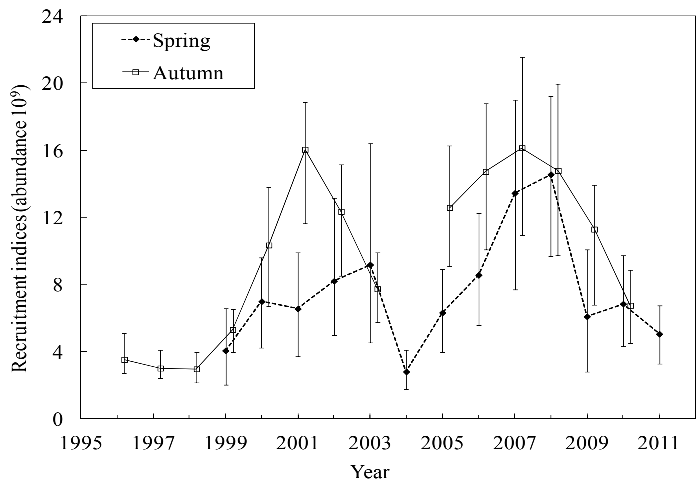


Fig. 2.8. Shrimp in Div. 3LNO: Recruitment indices derived from abundances of all shrimp with 12 – 17 mm carapace lengths from Canadian spring and autumn bottom trawl survey (1996–2011) data.

Fishable biomass and exploitation indices. There had been an increasing trend in Canadian spring and autumn survey fishable biomass indices (shrimp >17 mm carapace length) until 2007. The autumn fishable biomass showed an increasing trend until 2007 then decreased by 76% through to 2010. Similarly, the spring fishable biomass index increased to 2007 but has since decreased by 79 % through to 2011 (Fig. 2.9).

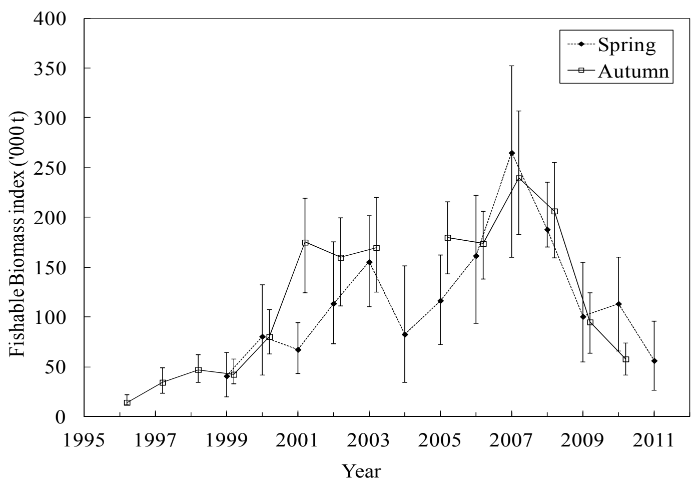


Fig. 2.9. Shrimp in Div. 3LNO: fishable biomass index. Bars indicate 95% confidence limits.

An index of exploitation was derived by dividing the catch in a given year by the fishable biomass index from the previous autumn survey. The catch series was updated in the 2011 analysis. The exploitation index has been below 0.15 until 2010 when it increased to 0.22. By October 2011, the 2011 exploitation rate index was 0.20. Based upon the autumn 2010 fishable biomass of 57 900 t, if the entire 19 200 t quota was to be taken, the exploitation rate index would increase to 0.33 (Fig. 2.10).

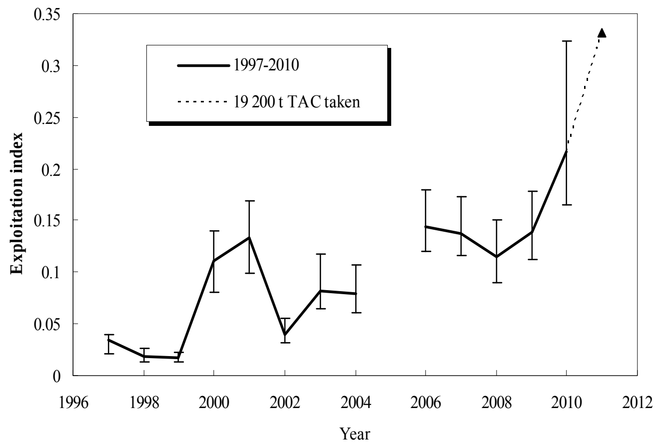


Fig. 2.10. Shrimp in Div. 3LNO: exploitation rates calculated as year's catch divided by the previous year's autumn fishable biomass index. The 2011 point is based upon the assumption that the full TAC will be taken. Bars indicate 95% confidence limits.

The Canadian autumn 2011 bottom trawl survey was ongoing while this meeting was taking place therefore the previous autumn fishable biomass index was regressed upon the spring fishable biomass index to predict an autumn 2011 fishable biomass index of 59 900 t. At TAC's accepted in Fisheries Commission for 2012 (12 000 t) and 2013 (9 350 t), assuming the fishable biomass index remains at 59 900 t, the projected exploitation rates would be19.61 % and 15.28 % respectively.

A TAC recommendation was determined using the inverse variance weighted fishable biomass from the latest three survey and predicted index values.

Variance weighting factor = fishable biomass/(measure of variance)^2÷Σ fishable biomass/(measure of variance)^2

Survey	Fishable biomass (t)	Fishable biomass - lower 95% C.I.= measure of variance	Fishable biomass/ (measure of variance^2)	1/measure of variance^2	Variance weighting factor
spring 2010	113,366	47,108	5.10845E-05	4.50617E-10	0.050
autumn 2010	57,891	15,464	2.42071E-04	4.18149E-09	0.463
spring 2011	56,280	29,852	6.31567E-05	1.12218E-09	0.124
predicted autumn 2011	59,900	17,473	1.96187E-04	3.27524E-09	0.363
Grand total			5.52499E-04	9.02953E-09	1.000

Inverse variance weighted average fishable biomass = 5.52499E-04/9.02953E-09

= 61 188 t

The inverse variance weighted average fishable biomass is calculated to be 61 188 t. Based upon this value, the following table provides exploitation rates at various catch levels for 2013:

TAC options at various percent exploitation rates (catch/ inverse variance weighted fishable biomass):

Inverse variance weighted average fishable biomass	5.00%	10.00%	14.00%
61 188	3 059	6 119	8 566

c) Assessment Results

Recruitment. Recruitment indices from 2006 – 2008 were among the highest in the spring and autumn time series but have decreased since and are now below the long-term mean.

Biomass. Spring and autumn biomass indices generally increased, to record levels by 2007, but decreased substantially by 2010. The spring biomass indices remained at a low level in 2011.

Exploitation. The index of exploitation remained below 0.15 through 2009 however it has since increased. If the entire TAC for 2011 is taken, it will be above 0.30. If the 12 000 t TAC is taken in 2012, the predicted exploitation rate is 0.20.

State of the Stock. Biomass levels peaked in 2007 then decreased substantially through to spring 2011. The female biomass index is estimated to be above B_{lim} (19 300 t). A continuous decrease of biomass in the past four years is a reason for concern. The predicted autumn 2011 female biomass index is 27 600 t – a decline of 23% from 2010. Given the level of uncertainty attached to survey estimates, there is a slight risk of the female biomass index being below B_{lim} by the end of 2011. If the 12 000 t TAC is taken in 2012, the predicted exploitation rate is 0.20.

d) Precautionary Approach Reference Points

Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for B_{lim} (19 330 t) for northern shrimp in Div. 3LNO (SCS Doc. 04/12). Currently, the female biomass index is estimated to be above but nearing B_{lim} (Fig. 2.11). It is not possible to calculate a limit reference point for fishing mortality. A “safe zone” has not been determined in the precautionary approach for this stock.

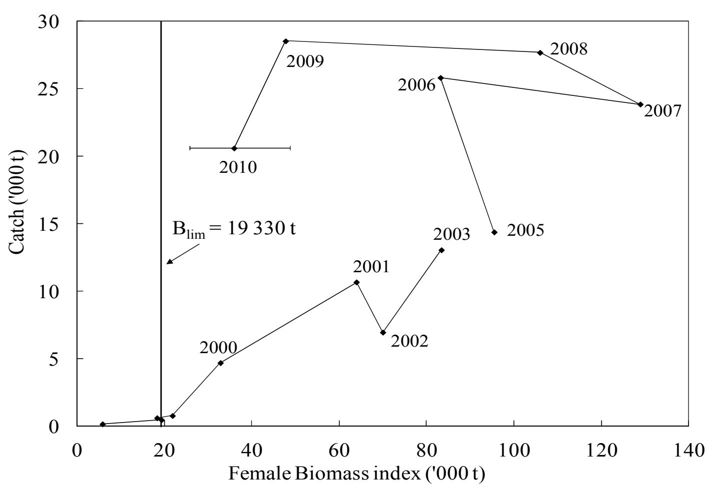


Fig. 2.11. Shrimp in Div. 3LNO: Catch against female biomass index from Canadian autumn survey. Line denoting B_{lim} (approximately 19,000 t) is drawn where female biomass is 85% lower than the maximum point in 2007. The bar on the 2010 data point indicates the 95% confidence limit.

e) Review of Research Recommendations

2010 NIPAG recommendations for research pertaining to Northern shrimp in Div. 3LNO:

- *biological and CPUE data from all fleets fishing for shrimp in the area be submitted to the Designated Expert, in the standard format, by 1 September 2011.*

STATUS: NIPAG drew attention to the late and inadequate submission of this information by a number of Contracting Parties, and reiterated its recommendations for improvements.

- *NIPAG recommended that research continue into fitting production models to data for northern shrimp in Div. 3LNO including studies of stock structure.*

STATUS: Work is ongoing on this topic. [See other studies]

- *Continued investigation of stock assessment models for Pandalus borealis in NAFO Div. 3LNO. This may help provide estimations of B_{msy} and F_{msy}.*

STATUS: Work is ongoing on this topic. [See other studies]

NIPAG recommendations for Northern shrimp in Div. 3LNO:

- *biological and CPUE data from all fleets fishing for shrimp in the area be submitted to the Designated Expert, in the standard format, by 1 September 2012.*

- *NIPAG recommended that research continue into fitting production models to data for northern shrimp in Div. 3LNO including studies of stock structure and continued investigation of stock assessment models for Pandalus borealis in NAFO Div. 3LNO. This may help provide estimations of B_{MSY} and F_{MSY}.*

g) Other studies

Assessment models and reference points for Div. 3LNO shrimp

Current scientific advice for the management of Div. 3LNO shrimp is based on the relationship between trends in research vessel survey indices and the commercial landings. There is no accepted assessment model. 15% of the highest survey observation of female biomass (SSB) is currently accepted as a proxy for B_{lim}. There is no current proxy for F_{lim}. Fisheries Commission has requested advice on the identification of F_{msy}, B_{msy} and advice on the appropriate selection of an upper reference point for biomass. Such advice is best provided using an accepted assessment model fit to the data. Progress has been made in fitting surplus production models using both maximum likelihood and Bayesian approaches. The Bayesian model will be further refined and presented in 2012 as a potential assessment model for the stock.

3. Northern shrimp (Subareas 0 and 1)

(SCR Docs 04/75, 04/76, 08/62, 11/50, 11/51, 11/52, 11/55, 11/57, 11/58, SCS Doc. 04/12)

a) Introduction

The shrimp stock off West Greenland is distributed mainly in NAFO Subarea 1 (Greenland EEZ), but a small part of the habitat, and of the stock, intrudes into the eastern edge of Div. 0A (Canadian EEZ). Canada has defined 'Shrimp Fishing Area 1' (Canadian SFA1), to be the part of Div. 0A lying east of 60°30'W, i.e. east of the deepest water in this part of Davis Strait.

The stock is assessed as a single population. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A–1F). Since 1981 the Canadian fishery has been limited to Div. 0A.

Three fleets, one from Canada and two from Greenland (offshore and coastal) have participated in the fishery since the late 1970s. The Canadian fleet and the Greenland offshore fleet have been restricted by areas and quotas since 1977. The Greenland coastal fleet has privileged access to inshore areas (primarily Disko Bay and Vaigat in the north, and Julianehåb Bay in the south). Coastal licences were originally given only to vessels under 80 tons, but in recent years much larger vessels have entered the coastal fishery. The coastal fishery was unrestricted until January 1997, when quota regulation was imposed. Greenland allocates a quota to EU vessels in Subarea 1; this quota is usually fished by a single vessel which for analyses is treated as part of the Greenland offshore fleet. Mesh size is at least 44 mm in Greenland, 40 mm in Canada. Sorting grids to reduce bycatch of fish are required in both of the Greenland fleets and in the Canadian fleet. Discarding of shrimps is prohibited.

The TAC advised for the entire stock for 2004–2007 was 130 000 t, reduced for 2008–2010 to 110 000 t but increased again for 2011 to 120 000 t. Greenland set a TAC for Subarea 1 for 2007 of 134 000 t, of which 74 100 t was allocated to the offshore fleet, 55 900 t to the coastal and 4000 t to EU vessels; these allocations were reduced for 2008 to 70 281, 53 019 and 4000 t (total 127 300 t) and for 2009 further to 59 025, 51 545 and 4000 t (total 114 570 t). This total TAC was kept for 2010, but following the increase in the advice the allocations were increased for 2011 to 68 400, 51 600 and 4000 t. Canada enacted TACs for SFA1 of 18 417 t for 2007–2010, increased to 18 597 t for 2011 (SCR Doc. 11/51).

Greenland requires that logbooks should record catch live weight. For shrimps sold to on-shore processing plants, a former allowance for crushed and broken shrimps in reckoning quota draw-downs was abolished in 2011 to bring the total catch live weight into closer agreement with the enacted TAC. However, the coastal fleet catching bulk shrimps does not log catch weights of *P. montagui* separately from *borealis;* weights are estimated by catch sampling at the point of sale and the price adjusted accordingly, but the weight of *montagui* is not deducted from the quota (SCR Doc. 11/53). Logbook-recorded catches can therefore still legally exceed quotas.

The table of recent catches was updated (SCR Doc. 11/51). Total catch increased from about 10 000 t in the early 1970s to more than 105 000 t in 1992 (Fig. 3.1). Moves by the Greenlandic authorities to reduce effort, as well as fishing opportunities elsewhere for the Canadian fleet, caused catches to decrease to about 80 000 t by 1998. Total catches then increased to over 155 000 t in 2005 and 2006. Total catch for 2008 at 152 749 t was more than 20 000 t higher than the projection, based on the first six months' data, used in the 2008 assessment; the 2009 total catch was also underestimated, by 26 000 t, for the 2009 assessment. Therefore the 2011 projection of total catch has been based not on projection formulas but on estimates provided by industry observers, as was done in 2010.

Recent catches, projected catches for 2011 and recommended and enacted TACs (t) for Northern Shrimp in Div. 0A east of 60°30'W and in Subarea 1 are as follows:

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
<u>TAC</u>										
Advised	85 000	100 000	130 000	130 000	130 000	130 000	110 000	110 000	110 000	120 000
Enacted	103 190	115 167	149 519	152 452	152 380	152 417	145 717	132 987	132 987	142 597
<u>Catches (NIPAG)</u>										
SA 1	128 925[1]	123 036[1]	142 311	149 978	153 188	142 245	153 889	135 029	135 029	*124 000*[2]
SA 0A	6247	7137	7021	6921	4127	1945	0	429	5882	*2000*[2]
TOTAL SA1–Div.0A	135 172	130 173	149 332	156 899	157 315	144 190	152 749	135 458	133 986	*126 000*
<u>STATLANT 21A</u>										
SA 1	103 645	78 436	142 311	149 978	153 188	142 245	148 550	133 561[3]	123 228[3]	
Div. 0A	6053	2170	6861	6410	3788	1878	0	429[3]	5206[3]	

[1] Catches before 2004 corrected for underreporting
[2] Total catches for the year as predicted by industry observers.
[3] Provisional

Until 1988 the fishing grounds in Div. 1B were the most important. The offshore fishery subsequently expanded southward, and after 1990 catches in Divs 1C–D, taken together, began to exceed those in Div. 1B. However, since about 1996 catch and effort in southern West Greenland have continually decreased, and since 2008 effort in Div. 1F has been virtually nil (SCR Doc. 11/52).

The Canadian catch in SFA1 was stable at 6000 to 7000 t in 2002–2005, about 4–5% of the total catch, but in 2006 was only 4100 t and in 2007 less than 2000 t. In 2008 there was no fishing and in 2009 very little. In 2010 5 vessels fished and catches were average, but in 2011 fishing has been difficult and catches are expected to be lower.

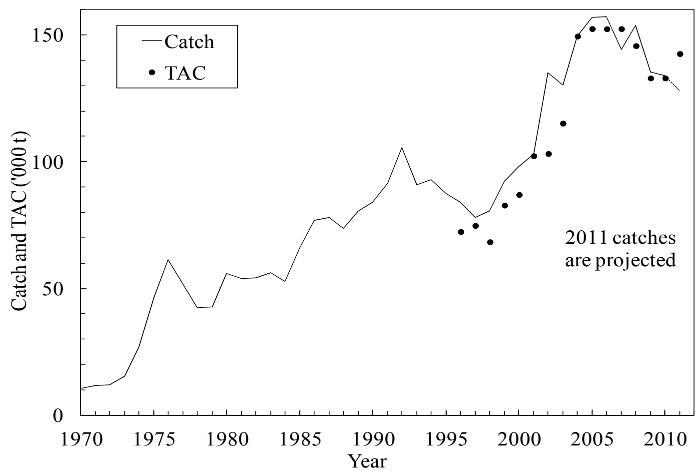


Fig. 3.1. Shrimp in Subarea 1 and Canadian SFA1: enacted TACs and total catches (2011 predicted for the year).

b) Input Data

i) Fishery data

Fishing effort and CPUE. Catch and effort data from the fishery were available from logbooks from Canadian vessels fishing in Canadian SFA 1 and from Greenland logbooks for Subarea 1 (SCR Doc. 11/52). In recent years both the distribution of the Greenland fishery and fishing power have changed significantly: for example, larger vessels have been allowed in coastal areas; the coastal fleet has fished outside Disko Bay; the offshore fleet now commonly uses double trawls; and the previously rigid division between the offshore and coastal quotas has been relaxed and quota transfers are now allowed. A change in legislation effective since 2004 requiring logbooks to record catch live weight in place of a previous practice of under-reporting would, by increasing the recorded catch weights, have increased apparent CPUEs since 2004; this discontinuity in the CPUE data was corrected in 2008.

CPUEs were standardised by linearised multiplicative models including terms for vessel effect, month, year, and statistical area; the fitted year effects were considered to be series of annual indices of total stock biomass. Series for the Greenland fishery after the end of the 1980s were divided into 2 fleets, a coastal and an offshore; for those ships of the present offshore fleet that use double trawls, only double-trawl data was used. A series for 1976–1990 was constructed for the KGH (Kongelige Grønlandske Handel) fleet of sister trawlers and a series for 1987–2007 and 2010 for the Canadian fleet fishing in SFA1. The CPUE indices from the Greenland coastal and the Greenland offshore fleets remained closely in step from 1988 to 2004 (Fig. 3.2), then diverged more from each other in 2005 and 2007, but in 2008–2011 their trajectories have again agreed. CPUE in the Canadian fishery in SFA1 has always varied more from year to year and has never stayed closely in step with the Greenland fleets, although over time its overall trend has been similar and it has also increased between the 1990s and the most recent values.

The four CPUE series were unified in a separate step to produce a single series that was input to the assessment model. This all-fleet standardised CPUE was variable, but on average moderately high, from 1976 through 1987, but then fell to lower levels until about 1997, after which it increased markedly to plateau in 2004–07 at about twice its 1997 value (Fig. 3.2). A lower value for 2008 based, in that year, on part-year's data was not confirmed when the full year's data was analysed in 2009, but values for 2009 and 2010 were both consecutively lower. However, this trend was not continued by the part-year value for 2011, which has returned to the levels of 2005–08 (SCR Doc. 11/52).

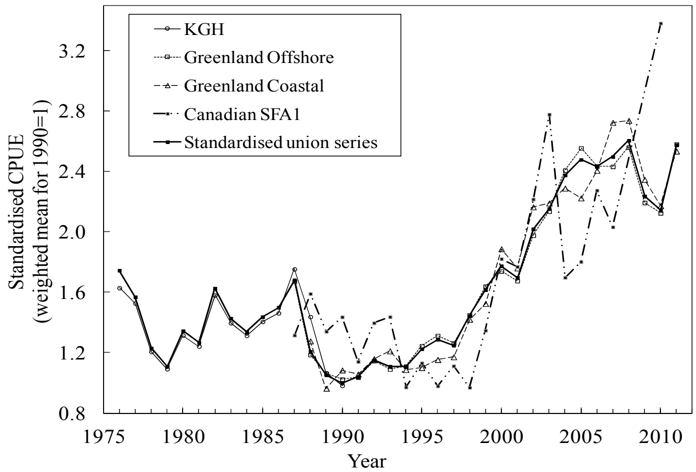


Fig. 3.2. Shrimp in Subarea 1 and Canadian SFA 1: standardised CPUE index series 1976–2010.

The distribution of catch and effort among NAFO Divisions was summarised using Simpson's diversity index to calculate an 'effective' number of Divisions being fished as an index of how widely the fishery is distributed (Fig 3.3). (In interpreting the index, it should be remembered that NAFO Divisions in Subarea 1, designed for the management of groundfish fisheries, are of unequal size with respect to shrimp grounds, and those recently abandoned by the fishery are the smaller ones.) The fishery area has contracted and continues to do so; NIPAG has for some years been concerned for effects of this contraction on the relationship between CPUE and stock biomass, and in particular that relative to earlier years biomass might be overestimated by recent CPUE values.

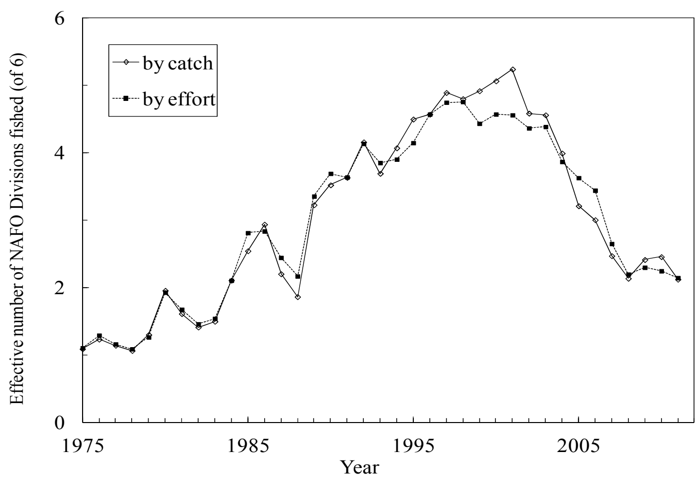


Fig. 3.3. Shrimp in Subarea 1 and Canadian SFA1: indices for the distribution of the Greenland fishery among NAFO Divisions in 1975–2011.

From the end of the 1980s there was a significant expansion of the fishery southwards and in 1996–98 areas south of Holsteinsborg Deep (66°00'N) accounted for 65% of the catch. The effective number of Divisions being fished peaked at about 4.5–5 in 1995–2003. Since then the range of the fishery has contracted northwards and the effective number of Divisions being fished has decreased. Since 2007 the areas south of Holsteinsborg Deep have yielded only about 10% of the catch, and Julianehåb Bay no longer supports a fishery.

Catch composition. There is no biological sampling program from the fishery that is adequate to provide catch composition data to the assessment.

ii) Research survey data

Greenland trawl survey. Stratified semi-systematic trawl surveys designed primarily to estimate shrimp stock biomass have been conducted since 1988 in offshore areas and since 1991 also inshore in Subarea 1 (SCR Doc. 11/55). From 1993, the survey was extended southwards into Div. 1E and 1F. A cod-end liner of 22 mm stretched mesh has been used since 1993. From its inception until 1998 the survey only used 60-min. tows, but since 2005, after several years of investigations into shorter tow durations, all tows have lasted 15 min. In 2005 the *Skjervøy 3000* survey trawl used since 1988 was replaced by a *Cosmos 2000* with rock-hopper ground gear, calibration trials were conducted, and the earlier data was adjusted.

The survey average bottom temperature increased from about 1.7°C in 1990–93 to about 3.1°C in 1997–20011 (SCR Doc. 11/55). About 80% of the survey biomass estimate is in water 200–400 m deep. In the early 1990s, about ¾ of this was deeper than 300 m, but after about 1995 this proportion decreased and since about 2001 has been about ¼, and most of the biomass has been in water 200–300 m deep (SCR Doc. 11/55). The proportion of survey biomass in Div. 1E–F has decreased in recent years and the distribution of survey biomass, like that of the fishery, has become more concentrated and more northerly.

Biomass. The survey index of total biomass remained fairly stable from 1988 to 1997 (c.v. 18%, downward trend 4%/yr). It then increased by, on average, 19%/yr until 2003, when it reached 316% of the 1997 value. Subsequent values were consecutively lower, by 2008–2009 less than half the 2003 maximum (Fig. 3.4) and 9% below the series mean. In 2010 the survey biomass index increased by nearly 24%, but in 2011 it returned to below the 2009 level[1] (SCR Doc. 11/55).

[1] area C and sub-stratum W1-4 were not surveyed in 2011 owing to sea ice. They provide on average about 3½% of the survey biomass.

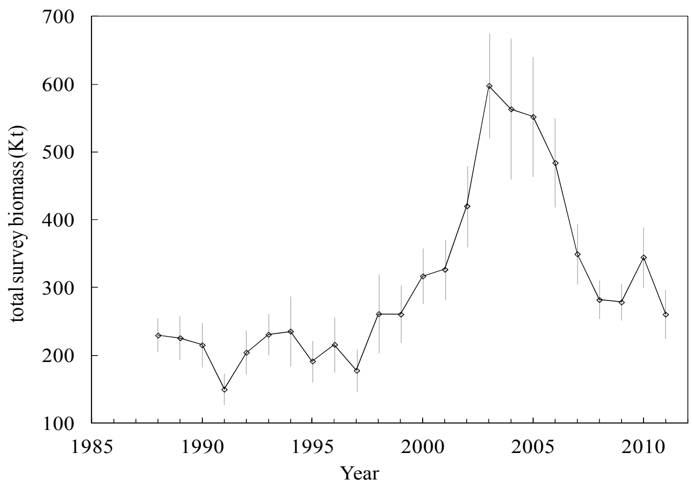


Fig. 3.4. Northern Shrimp in Subarea 1 and Canadian SFA 1: survey indices of total stock biomass 1988–2011 (SCR Doc. 11/55) (error bars 1 s.e.)

Length and sex composition (SCR 11/55). In 2008 modes at 12 mm and 15 mm CL could be observed suggesting two- and three-year-olds; the two-year-old class in particular appeared stronger than in 2007. The 2009 distribution of lengths appeared very similar to that for 2008; cohorts could be distinguished at 11–13 mm and at 15.5–18 mm. The supposed 2-year-old class appears to have numbered about the same in 2009 and 2010 as in 2008, but in 2011 numbers 68% of the 2008–10 mean and 55% of the series mean (Fig. 3.5).

Estimated numbers of males and females in 2009 - 41.5 and 12.2×10^9 - were close to those for 2008 and still below their series means. In 2010 the number of males was about 40% higher at 56.2×10^9 while the number of females increased by only about 16% to 14.4×10^9; in 2011 total numbers at 49.8×10^9 are 30% less than in 2010, but almost all the decrease is in numbers of males, while females remain at 96% of the 2010 number. In 2011 the stock is estimated to have its highest-ever proportion of females both by number (26%) and by weight (43%), but to be short of shrimps at 15–22 mm CPL. The fishable proportion is estimated at 91.4%, close to its average level.

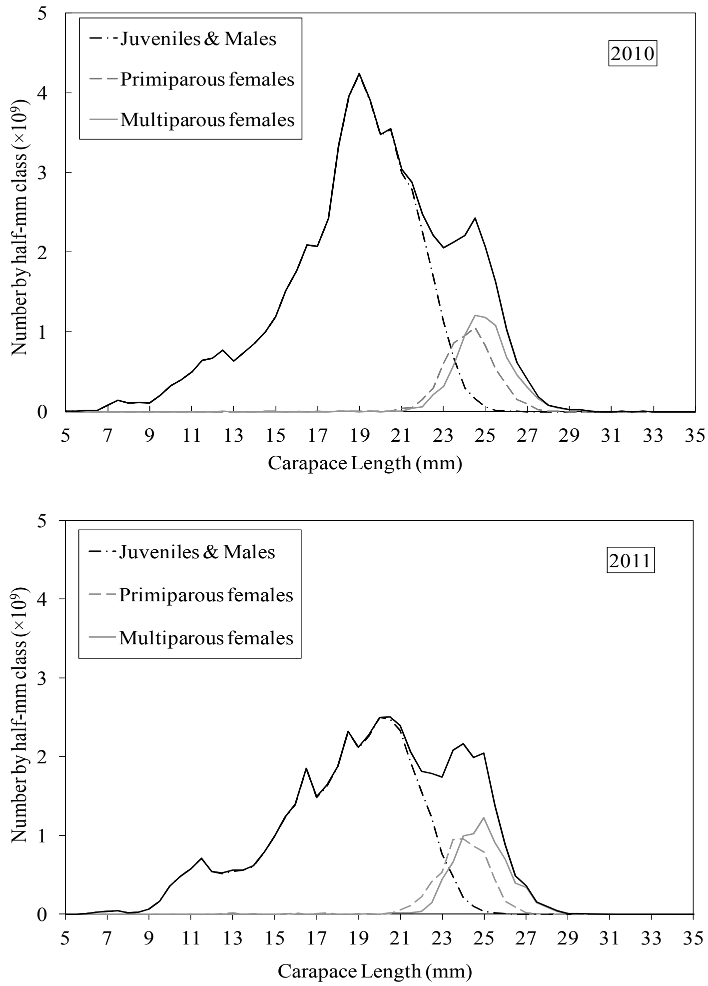


Fig. 3.5. Northern Shrimp in Subarea 1 and Canadian SFA 1: length frequencies in the West Greenland trawl survey in 2010–2011.

Recruitment Index. The number at age 2 is a predictor of fishable biomass 2–4 years later (SCR Doc. 03/76). This recruitment index was high in 2001, but decreased continually to 2007. From 2008 to 2010 estimated numbers at age 2 were higher than in 2007 and about stable near 78% of the series mean, but in 2011 decreased to 55% of the mean. A relative lack of shrimps at 15–22 mm CPL in 2011 presages poor immediate recruitment to both the fishable and the spawning stocks.

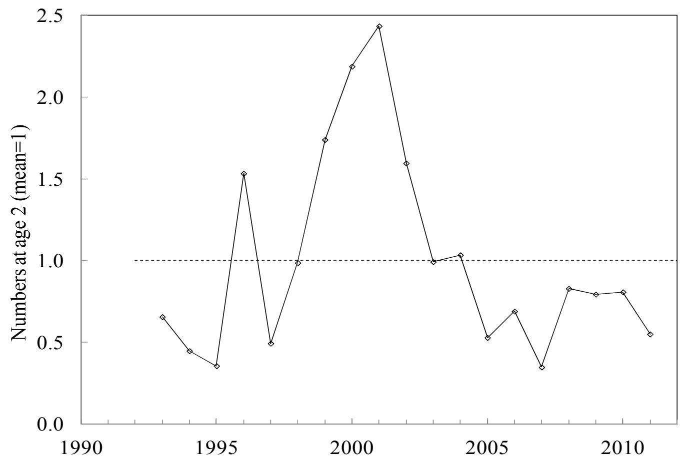


Fig. 3.6. Northern Shrimp in Subarea 1 and Canadian SFA 1: survey index of numbers at age 2, 1993–2011.

iii) Predation index

Estimates of cod biomass from the German groundfish survey at West Greenland are used in the assessment of shrimp in SA 1 and in Div. 0A east of 60°30′W, but the results from the German survey for the current year are not available in time for the assessment. Although the West Greenland trawl survey is not primarily directed towards groundfish, the cod biomass index it produces for West Greenland offshore waters is well correlated with that from the German groundfish survey (r^2 = 0.86). The index of cod biomass is adjusted by a measure of the overlap between the stocks of cod and shrimp in order to arrive at an index of 'effective' cod biomass, which is entered in the assessment model. In recent years cod stocks have fluctuated, and a great increase in biomass in 2006–07 was short-lived (Fig. 3.7). In 2011 cod was widely distributed along the West Greenland shelf and the index of overlap between the distributions of cod and shrimp increased to 88.8%, so although the cod biomass was not very large, the effective biomass as a predator on shrimps increased to 21.8 Kt, a value of the same order as those of 2006–07 when the biomass was much greater but the overlap less (SCR Doc. 11/50).

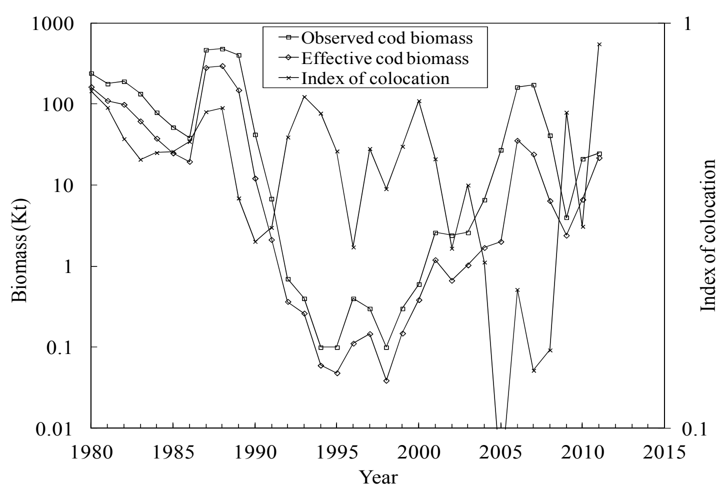


Fig. 3.7. Indices of the biomass of Atlantic cod, including its index of colocation with the stock of Northern shrimp, 1980–2011

c) Results of the Assessment

i) Estimation of Parameters

A Schaefer surplus-production model of population dynamics was fitted to series of CPUE, catch, and survey biomass indices (SCR Doc. 11/58). The model included a term for predation by Atlantic cod and the series of 'effective' cod biomass values was included in the input data. Total catches for 2011 were assumed to be 126 000 t.

After discussion by NIPAG, a model was accepted for the assessment in 2011 that was modified from that used in the foregoing years. The model has in the past consistently estimated a biomass trajectory that has closely followed the CPUE series while largely ignoring the survey series, apparently because such a trajectory, avoiding the large excursions of the survey series, could be fitted better to the assumed stock-dynamic model. NIPAG has been concerned that CPUE might not reliably index biomass if the amplitude of the fishery changes — contracts — as it has been doing in recent years. For 2011 the previously accepted assessment model was therefore constrained to fit the biomass trajectory at least as closely to the survey index as to the CPUE index: i.e. the survey CV should be no greater than the CPUE CV. The model was run with data series shortened to 30 years to speed up the running; the effect of shortening the data series was checked and found not significant.

The result of fitting this model was a biomass trajectory that tracked between the survey index and the CPUE index; the survey CV was estimated at 13% and that of the CPUE at 15%. The process error and the error associated with the predation term both increased considerably, so predictions became more uncertain. The biomass is now considered to have decreased, as the survey index did, between 2003 and 2011 under the influence of the high catches of 2004–2008, instead of staying high like the CPUE index. In consequence, the model estimates the MSY lower than in previous assessments, at 135 Kt/yr.

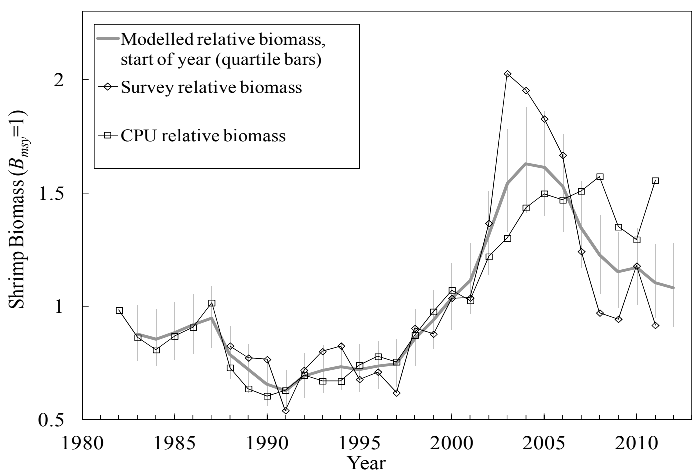


Fig. 3.8: Northern Shrimp in SA 1 and Canadian SFA1: trajectory of the median estimate of relative stock biomass at start of year 1983–2012, with median CPUE and survey indices; 30 years' data with constrained CVs.

Estimates of stock-dynamic and fit parameters from fitting a Schaefer stock-production model, with constrained CVs, to 30 years' data on the West Greenland stock of the northern shrimp in 2011, with median values from 2010 assessment:

	2011 assessment						2010 assessment
	Mean	S.D.	25%	Median	75%	Est. Mode	Median
Max.sustainable yield	142	60	114	135	160	122	147
B/Bmsy, end current year (proj.)	1.11	0.29	0.91	1.08	1.28	1.03	1.16
Z/Zmsy, current year (proj.)	—	—	0.84	1.11	1.44	—	0.92
Carrying capacity	3716	3406	1873	2725	4375	743	2123
Max. sustainable yield ratio (%)	10.9	6.0	6.5	10.3	14.6	9.2	13.9
Survey catchability (%)	22.6	14.4	11.7	19.6	30.2	13.6	28.0
CV of process (%)	11.4	2.6	9.5	11.1	12.9	10.5	8.9
CV of survey fit (%)	13.2	1.7	12.0	13.1	14.3	12.8	20.5
CV of CPUE fit (%)	15.3	2.1	13.7	15.0	16.5	14.4	3.6

ii) Assessment Summary

Recruitment. The stock structure in 2011 is deficient in shrimps of intermediate size 15–22 mm CPL, presaging poor short-term recruitment to both the fishable and spawning stocks; numbers at age 2 in 2011 have declined from the level of the 3 foregoing years to 55% of the series mean, so medium-term recruitment is also expected to be poor.

Biomass. A stock-dynamic model showed a maximum biomass at end 2003 with a continuing decline since; the probability that biomass will be below B_{msy} at end 2011 with projected catches at 126 000 t was estimated at 38%; of its being below B_{lim} at less than 1%.

Mortality. The mortality caused by fishing and cod predation (Z) is estimated to have stayed below the upper limit reference (Z_{msy}) from 1996 to 2005, but is now estimated to have averaged 6% over the limit value since 2006. With catches projected at 126 000 t the risk that total mortality in 2011 would exceed Z_{msy} was estimated at about 59%. Atlantic cod is widely distributed on the West Greenland shrimp grounds in 2011 and predation is expected to remain high.

State of the Stock. Modelled biomass is estimated to have been declining since 2004. At the end of 2011 biomass is projected to be still slightly above B_{msy}.Total mortality is projected to exceed Z_{msy}. Recruitment to the fishable stock, in both the short and the medium term, is expected to be low.

d) Precautionary Approach

The fitted trajectory of stock biomass showed that the stock had been below its MSY level until the late 1990s, with mortalities mostly near the MSY mortality level except for an episode of high mortality associated with a short-lived resurgence of cod in the late 1980s. In the mid-1990s, with cod stocks at low levels, biomass started to increase at low mortalities to reach about 1.6 times B_{msy} in 2003–05. Recent increases in the cod stock coupled with high catches have been associated with higher mortalities and continuing decline in the modelled biomass, although the biomass is still estimated above B_{msy}.

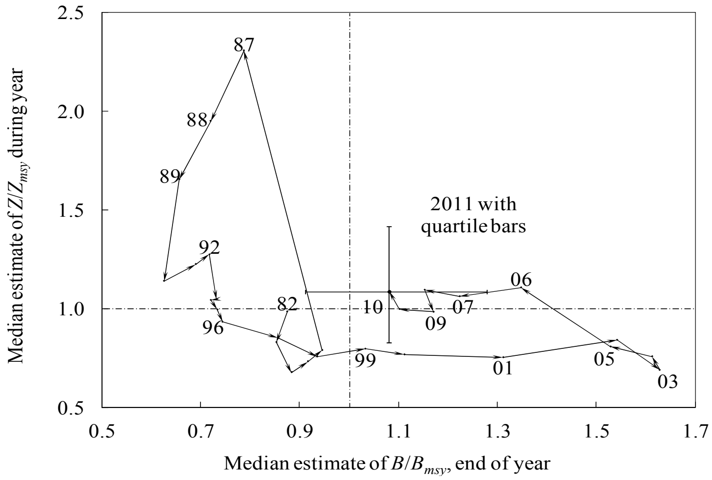


Fig. 3.9: Shrimp in SA 1 and Canadian SFA1: trajectory of past relative biomass and relative mortality.

e) Projections

Predicted probabilities of transgressing precautionary limits in 2012 (risk table) under seven catch options and subject to predation by a cod stock with an effective biomass of 20 000 t:

20 000 t cod	Catch option ('000 t)						
Risk of:	60	70	80	90	100	110	120
falling below B_{msy} end 2012 (%)	33.1	34.4	35.5	37.5	38.1	40.2	41.3
falling below B_{lim} end 2012 (%)	<1	<1	<1	<1	<1	<1	<1
exceeding Z_{msy} during 2012 (%)	13.4	17.0	22.7	30.7	38.7	47.8	55.1

In the medium term, with a 20 000 t effective biomass of cod, model results estimate catches of 100 000 t/yr to be associated with a stationary stock, above B_{msy}, and with mortality below Z_{msy}. At 30 000 t effective cod biomass, annual catches of 100 000 t are predicted to cause the stock status to deteriorate slowly.

Predicted probabilities of transgressing precautionary limits after 3 years in the fishery for Northern Shrimp on the West Greenland shelf with ‘effective’ cod stocks assumed at 20 000 t and 30 000 t.

Catch	Prob. biomass < B_{msy} (%)		Prob. biomass<B_{lim} (%)		Prob. mort > Z_{msy} (%)	
(Kt/yr)	20 Kt	30 Kt	20 Kt	30 Kt	20 Kt	30 Kt
60	27.4	29.2	1.5	2.0	14.0	18.4
70	30.0	31.9	1.5	2.1	17.7	22.7
80	32.2	34.9	1.6	2.2	22.7	29.0
90	36.1	38.8	1.8	2.3	30.7	37.2
100	38.0	41.3	1.8	2.4	38.8	45.8
110	42.2	44.5	1.8	2.4	48.3	54.8
120	44.6	47.8	1.8	2.6	56.2	61.8

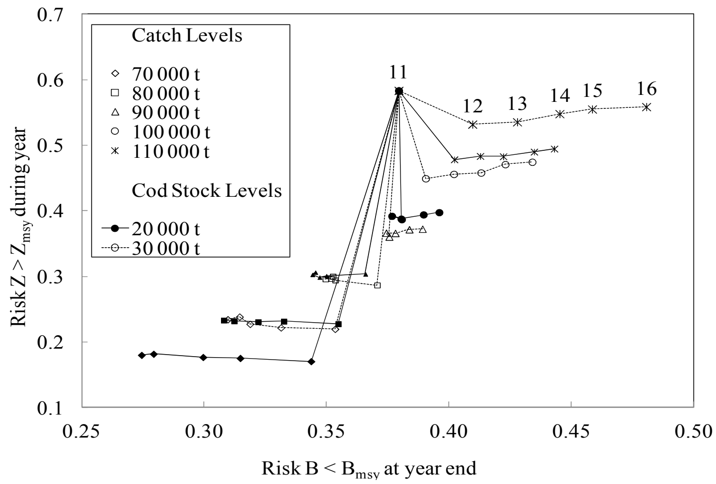


Fig. 3.10. Shrimp in SA 1 and Canadian SFA1: Risks of transgressing mortality and biomass precautionary limits for catches at 70 000–110 000 t projected over five years with an 'effective' cod stock assumed at 20 000 or 30 000 t.

Medium-term predictions were summarised by plotting the risk of exceeding Z_{msy} against the risk of falling below B_{msy} over 5 years for 5 catch levels, considering also two possible levels for the 'effective' cod stock (Fig. 3.9). The immediate biomass risk is relatively insensitive to catch level but changes with time, upwards or downwards depending on catch level and cod-stock level; the mortality risk depends immediately upon the assumed future catch and cod-stock levels, but changes little with time. A 10 000 t change in the cod stock is practically equivalent to a 10 000 t change in catch. For catches of 70 000 t to 90 000 t the mortality risk is 17–37% and nearly constant over the projection period, while the biomass risk decreases as the stock is projected to grow. At a catch level of 100 000 t the stock is nearly stationary above B_{msy} if the effective cod stock is assumed near 20 000 t, but if the cod stock increases to an effective biomass of 30 000 t catches of 100 000 t/yr are predicted to be associated with a decreasing biomass.

e) Review of Research Recommendations

NIPAG **recommended** in 2010 that, for shrimp off West Greenland (NAFO Subareas 0 and 1):

- *the estimate of the biomass of Atlantic cod from the W. Greenland trawl survey should be explicitly included in the stock-production model used for the assessment;*
    - no progress has been made on this recommendation.
- *estimating weight-length curves from length-sample data alone, and using them for partitioning the estimated stock biomass, should be further compared with the method based on weighing individuals and its usefulness and reliability further evaluated.*
    - this method of estimating weight-length curves was not further investigated in 2011. Instead, the procedure that relies on weighing and measuring individuals was developed further to ensure better agreement between the overall biomass estimate and the aggregate of sex- and length-class weights.
- *numbers at length for all the components of the stock identified by modal analysis should be tabulated, to allow confirmation that they tally to the estimated survey total numbers at length;*
    - correction factors, based on survey total numbers, were applied to the numbers at length output by the modal analysis (CMIX) for the stock components identified to bring their sum into agreement with survey totals.

- *demographic analyses of past survey data should be thoroughly revised, including adjustment for the 2005 gear change, with a view to obtaining a consistent series.*
  - demographic analyses, including calculations of numbers and biomasses by sex and length class and modal analyses to estimate numbers in age classes, were revised for past surveys back to 2005. It was concluded that no adjustment for the gear change was necessary.

4. Northern shrimp (in Denmark Strait and off East Greenland)

(SCR Doc. 03/74, 11/54, 11/56)

a) Introduction

Northern shrimp off East Greenland in ICES Div. XIVb and Va is assessed as a single population. The fishery started in 1978 and, until 1993, occurred primarily in the area of Stredebank and Dohrnbank as well as on the slopes of Storfjord Deep, from approximately 65°N to 68°N and between 26°W and 34°W.

In 1993 a new fishery began in areas south of 65°N down to Cape Farewell. From 1996 to 2005 catches in this area accounted for 50 - 60% of the total catch. In 2006 and 2007 catches in the southern area only accounted for 25% of the total catch. Since 2008 about 10% of the total catch has been taken in the southern area.

A multinational fleet exploits the stock. During the recent ten years, vessels from Greenland, EU-Denmark, the Faroe Islands and Norway have fished in the Greenland EEZ. Only Icelandic vessels are allowed to fish in the Icelandic EEZ. At any time access to these fishing grounds depends strongly on ice conditions.

In the Greenland EEZ, the minimum permitted mesh size in the cod-end is 44 mm, and the fishery is managed by catch quotas allocated to national fleets. In the Icelandic EEZ, the mesh size is 40 mm and there are no catch limits. In both EEZs, sorting grids with 22-mm bar spacing to reduce by-catch of fish are mandatory. Discarding of shrimp is prohibited in both areas.

As the fishery developed, catches increased rapidly to more than 15 000 tons in 1987-88, but declined thereafter to about 9000 t in 1992-93. Following the extension of the fishery south of 65°N catches increased again reaching 11 900 t in 1994. From 1994 to 2003 catches fluctuated between 11 500 and 14 000 tons (Fig. 4.1). Since 2004 the catches decreased continually from 10 000 tons to between 2 000 - 4 000 tons in the most recent years. In 2011 total catches are expected to decrease even further. Catches in the Iceland EEZ decreased from 2002-2005 and since 2006 no catches have been taken.

Recent recommended and actual TACs (t) and nominal catches are as follows:

	2002[1]	2003[1]	2004	2005	2006	2007	2008	2009	2010	2011[2]
Recommended TAC, total area	9600	9600	12400	12400	12400	12400	12400	12400	12400	12400
Actual TAC, Greenland	10600	10600	15043	12400	12400	12400	12400	12835	11835	11835
North of 65°N, Greenland EEZ	4113	5480	4654	3987	3887	3314	2529	3945	3313	1048
North of 65°N, Iceland EEZ	1231	703	411	29	0	0	0	0	0	0
North of 65°N, total	5344	6183	5065	4016	3887	3314	2529	3945	3313	1048
South of 65°N, Greenland EEZ	5985	6522	4951	3737	1302	1286	266	610	413	0
TOTAL NIPAG	11329	12705	10016	7753	5189	4600	2794	4555	3727	1048

[1] Estimates corrected for "overpacking".
[2] Catches till October 2011

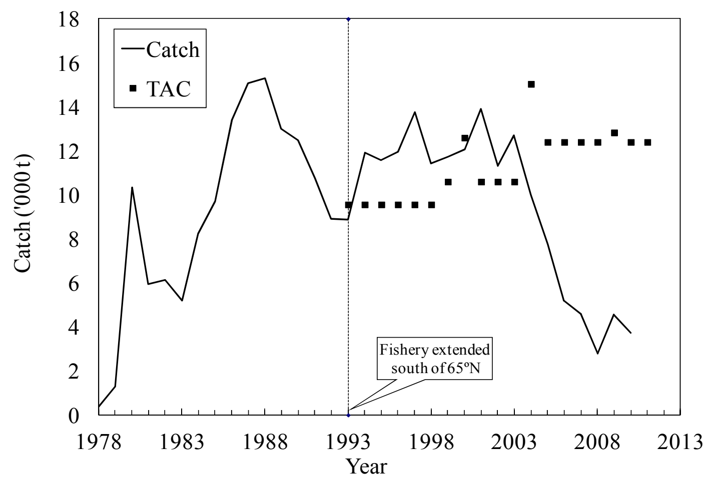


Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: Total catches.

b) Input Data

i) Commercial fishery data

Fishing effort and CPUE. Data on catch and effort (hours fished) on a haul by haul basis from logbooks from Greenland, Iceland, Faroe Islands and EU-Denmark since 1980, from Norway since 2000 and from EU-France for the years 1980 to 1991 are used . Until 2005, the Norwegian fishery data was not reported in a compatible format and were not included in the standardized catch rates calculations. In 2006 an evaluation of the Norwegian logbook data from the period 2000 to 2006 was made and since then these data have been included in the standardized catch rate calculations. Since 2004 more than 60% of all hauls were performed with double trawl and the 2011 assessment included both single and double trawl in the standardized catch rate calculations.

Catches and corresponding effort are compiled by year for two areas, one area north of 65°N and one south thereof. Standardised Catch-Per-Unit-Effort (CPUE) was calculated and applied to the total catch of the year to estimate the total annual standardised effort. Catches in the Greenland EEZ are corrected for "overpacking" (SCR Doc. 03/74).

The Greenlandic fishing fleet, catching 40% of the total catch from 1998 to 2005 and between 0% and 30% from 2006, has decreased its effort in recent years, and this creates some uncertainty as to whether recent values of the indices accurately reflect the stock biomass. There could be several reasons for decreasing effort, some possibly related to the economics of the fishery. The fishing opportunities off West Greenland seem to have been adequate in recent years and the fishing grounds off East Greenland are for several reasons a less desirable fishing area. Even though both effort and catches in East Greenland have declined, the catch rates (CPUE's) are still high; however, this could be partly because the fleet can concentrate effort in areas of high densities of sought-after size classes of shrimp.

North of 65°N standardized catch rates based on logbook data from Danish, Faroese, Greenlandic, Norwegian and Icelandic vessels declined continuously from 1987 to 1993 but showed a significant increase between 1993 and 1994. Since then rates have varied but shown a slightly increasing trend until 2008. From 2008 to 2009 the catch rate increased by 50%. In 2010 and 2011 the catch rate went down to the level seen in the period from 2004-2008 (Fig. 4.2).

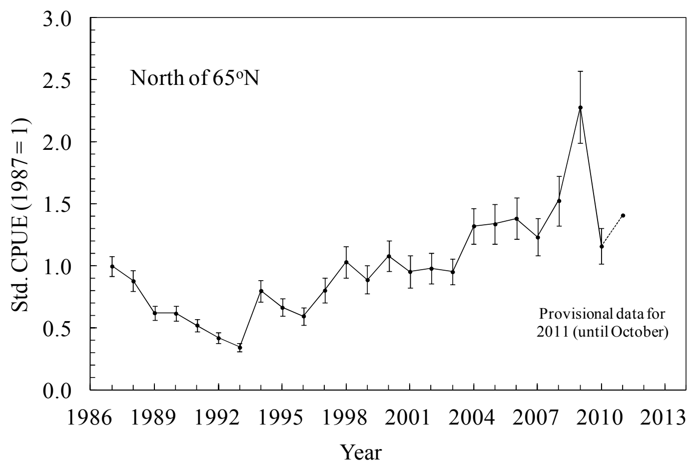


Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ±1 SE calculated from logbook data from Danish, Faeroese, Greenland, Icelandic and Norwegian vessels fishing north of 65°N.

In the southern area a standardized catch rate series from the same fleets, except the Icelandic, increased until 1999, and varied around this level until 2008. The catch rate increased in 2009 by 25%, then decreased to levels seen in the late-1990s (Fig. 4.3). No fishing has been conducted in the southern area in 2011.

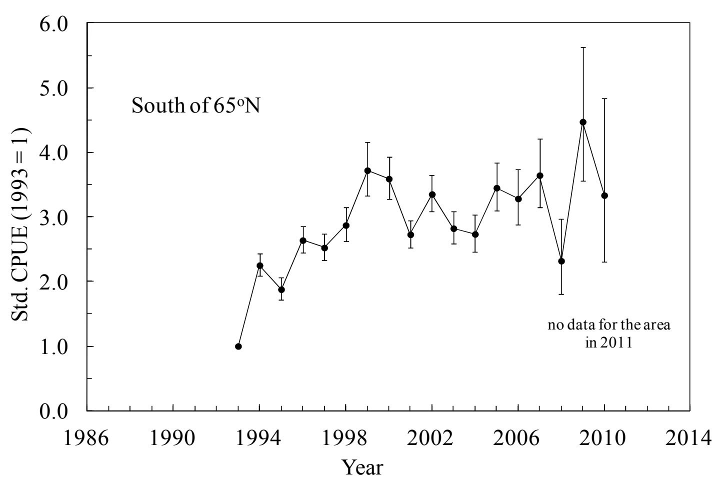


Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ±1 SE calculated from logbook data from Danish, Faeroese, Greenland and Norwegian vessels fishing south of 65°N.

The combined standardized catch rate index for the total area decreased steadily from 1987 to 1993, and then showed an increasing trend until the beginning of the 2000s. The index stayed at or around this level until 2008, but nearly doubled in 2009. In 2010 and 2011 the combined standardized catch rate index decreased to the level seen at the beginning of the 2000s (Fig. 4.4).

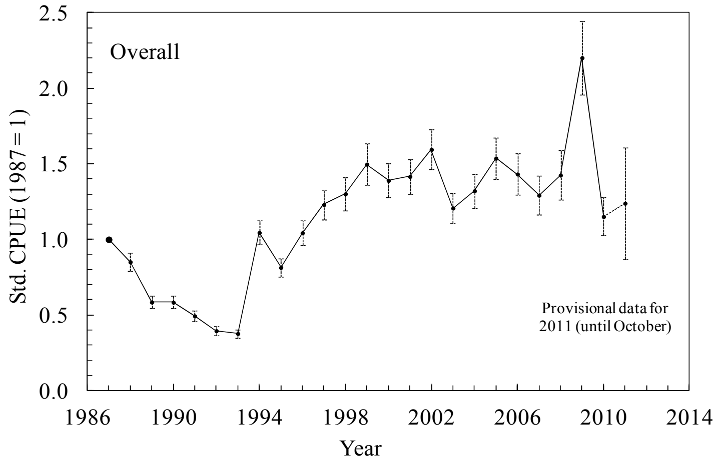


Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ± 1 SE combined for the total area.

Standardized effort indices (catch divided by standardized CPUE) as a proxy for exploitation rate for the total area shows a decreasing trend since 1993. Recent levels are the lowest of the time series (Fig. 4.5).

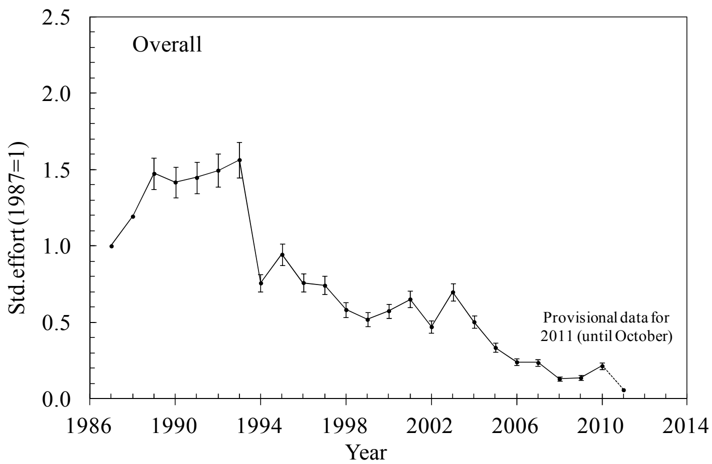


Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized effort indices, as a proxy for exploitation rate (± 1 SE; 1987 = 1), combined for the total area.

ii) Biological data

There are no biological data available from the commercial fishery.

iii) Research survey data

Stratified-random trawl surveys has been conducted to assess the stock status of northern shrimp in the East Greenland area since 2008 (SCR Doc. 11/56). The main objectives were to obtain indices for stock biomass, abundance, recruitment and demographic composition. The area was also surveyed in 1985-1988 (Norwegian survey) and in 1989-1996 (Greenlandic survey). The historic survey is not directly comparably with the recent survey due to different area cover, survey technique and trawling gear. However, the 1989-1996 survey estimated biomass and abundance at the same level as the 2008-2011 survey. The two Greenlandic surveys also showed similar overall size distributions. Absence of the smaller male and juvenile shrimp in the survey area stresses that the total area of distribution and recruitment patterns of the stock are still unknown.

Biomass estimate

The biomass estimates (in tons) for the entire survey area are:

Year	Biomass	+/-	Error C.V. (%)
2008	1953	1764	90.32
2009	8446	3852	45.61
2010	5758	3928	68.22
2011	5789	2760	47.68

The surveys conducted since 2008 shows that the shrimp stock is concentrated in the area North of 65°N.

Stock composition.

The total number of shrimp for 2008, 2009, 2010 and 2011 was estimated to 206, 909, 525 and 514 million respectively (Fig 4.6). Between 2009 and 2011 female abundance was roughly 200 million, however the abundance of males declined from around 700 million in 2009 to 300 million in 2010 and remained near that level in 2011 (Fig 4.6).

The demography in East Greenland shows a lack of males smaller than 20 mm CL (Fig. 4.7), which means that no recruitment index is available.

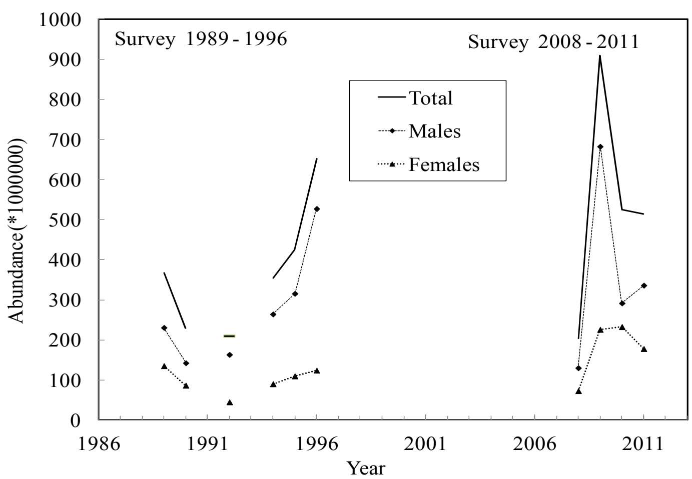


Fig. 4.6. Shrimp in Denmark Strait and off East Greenland. Abundance of males and females in two different surveys series from 1989-1995 and 2008-2011 for the areas North of 65°N.

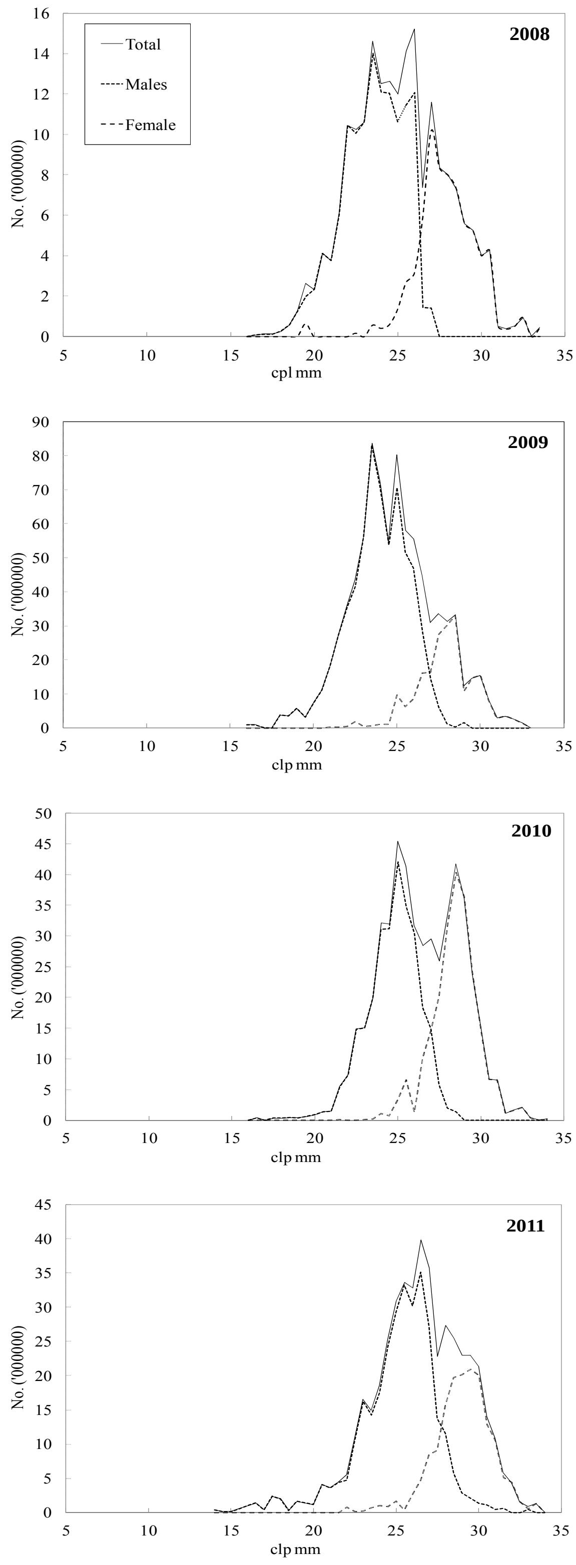


Fig.4.7. Shrimp in Denmark Strait and off East Greenland. Numbers of shrimp by length group (CL)in the total survey area in 2008 - 2011 based on pooling of samples weighted by catch and stratum area.

c) Assessment Results

CPUE. Combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993, showed an increase to a relatively high level in 1998, and has fluctuated around this level since. There are concerns as to whether the 2009 value properly reflects the state of the stock.

Recruitment. No recruitment estimates were available.

Biomass. The biomass index from 2008-2011 varied greatly with no clear trend.

Exploitation rate. Since the mid 1990s exploitation rate index (standardized effort) has decreased, reaching the lowest levels seen in the time series from 2008 - 2011.

State of the Stock. The stock biomass is believed to be at a relatively high level, and to have been there since 1998.

5. Northern shrimp in Skagerrak and Norwegian Deep (ICES Div. IIIa and IVa East) – ICES Stock

(SCR Docs. 11/64, 11/67, 11/68, 11/69)

a) Introduction

The shrimp in the northern part of ICES Div. IIIa (Skagerrak) and the eastern part of Div. IVa (Norwegian Deep) is assessed as one stock and is exploited by Norway, Denmark and Sweden. The Norwegian and Swedish fisheries began at the end of the 19th century, while the Danish fishery started in the 1930s. All fisheries expanded significantly in the early 1960s. By 1970 the landings had reached 5 000 t and in 1981 they exceeded 10 000 t. Since 1992 the shrimp fishery has been regulated by a TAC, which was around 16 500 t in 2006-2009, but decreased to 14 558 t in 2010 and further to 12 380 t in 2011 (Fig. 5.1, Table 5.1). In recent years an increasing number of the Danish vessels have started boiling the shrimp on board and landing the product in Sweden to obtain a better price. In 2010 around 40% of Danish landings were boiled. Most of the Danish catches are, however, still landed fresh in home ports. In the Swedish and Norwegian fisheries approximately 50% of catches are boiled at sea, and almost all catches are landed in home ports. In 2010, more than 60% of total landings were boiled.

The overall TAC is shared according to historical landings, giving Norway 60%, Denmark 26%, and Sweden 14% in 2010 and 2011. The recommended TACs until 2002 were based on catch predictions. However, since 2003 when the cohort based analytical assessment was abandoned no catch predictions have been available, and the recommended TACs have been based on perceived stock development in relation to recent landings. The shrimp fishery is also regulated by mesh size (35 mm stretched), and by restrictions in the amount of landed bycatch. The use of Nordmøre selective grids with un-blocked fish openings reduces bycatch significantly (SCR Doc. 11/69) and is used by an increasing number of vessels in the Swedish fleet. However, at present it is mandatory only in Swedish national waters.

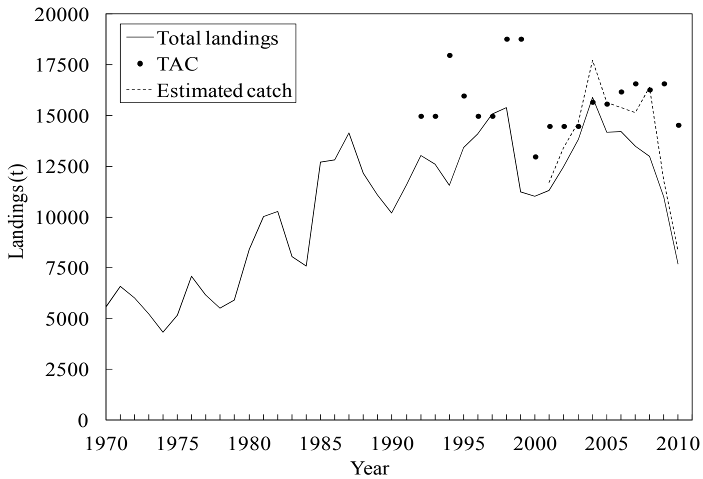


Fig. 5.1. Northern shrimp in Skagerrak and Norwegian Deep: TAC, total landings by all fleets, and total catch including estimated Swedish high-grading discards for 2001-2010, Norwegian discards for 2007-2010 and Danish discards for 2009-2010.

Total landings have varied between 10 000 and 16 000 t during the last 30 years. The Norwegian and Swedish boiled landings have been corrected for weight loss caused by boiling and raised by a factor of 1.13. Total catches are estimated as the sum of landings and discards and have varied between 11 000 and 18 000 t in 2001-2009, but decreased to around 8 300 t in 2010. In 2005 to 2008 the catches were around 15 000 to 16 000 t. The increase in total catches in 2008 compared with 2007 was due to the high estimates of Norwegian and Swedish discards in 2008. Danish and Norwegian landings have decreased since 2007, and in 2010 also the Swedish landings decreased (Table 5.1 and Fig. 5.1). Total landings in 2010 decreased by more than 3000 t compared with 2009.

Table 5.1. Northern shrimp in Skagerrak and Norwegian Deep: TACs, landings and estimated catches (t).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Recommended TAC	11,500	13,400	12,600	14,700	15,300	13,000	14,000	14,000	15,000	15,000	13,000
Agreed TAC	13,000	14,500	14,500	14,500	15,690	15,600	16,200	16,600	16,300	16,600	14,558
Denmark	2,371	1,953	2,466	3,244	3,905	2,952	3,061	2,380	2,259	2,155	1,229
Norway	6,444	7,266	7,703	8,178	9,544	8,959	8,669	8,686	8,260	6,364	4,673
Sweden	2,225	2,108	2,301	2,389	2,464	2,257	2,488	2,445	2,479	2,483	1,781
Total landings	11,040	11,327	12,470	13,811	15,913	14,168	14,218	13,511	12,998	11,002	7,683
Est. Danish discards*										36	29
Est. Swedish high-grading		375	908	868	1,797	1,483	1186	1,124	2,003	678	558
Est.Norwegian discards**								526	1,408	115	63
Est. total catch		11,702	13,378	14,679	17,710	15,651	15,404	15,161	16,409	11,824	8,334

* Collection of Danish discard data begun in 2009
** Collection of Norwegian discard data begun in 2007

The Danish and Norwegian fleets have undergone major restructuring in recent years. In Denmark, the number of vessels targeting shrimp has decreased from 191 in 1987 to 24 in 2006 and only 12 in 2010. It is mostly the small (< 24 m LOA) and less efficient trawlers which have left the fishery and in 2010 the Danish fleet consisted of vessels with an average length of 26 m (SCR Doc. 11/69). The efficiency of the fleet has also increased due to the introduction of twin trawl technology and increased trawl size.

In Norway the number of vessels participating in the shrimp fishery has decreased from 423 in 1995 to 227 in 2010. The number of smaller vessels (10-10.99 m LOA) has increased from the mid-1990s until present, while the number of larger vessels (11-20.99 m LOA) has decreased. The length group 10-10.99 m LOA has been the numerically dominant one since 2005 (39% of all vessels in 2010), owing to the fact that vessels < 11 m do not need a license to fish. Vessels ≥ 21 m LOA constitute only 9% of the fleet, which illustrates the difference between the Norwegian and Danish fleets. Twin trawl was introduced around 2002, and the use is increasing. In 2010 twin trawls are estimated to be in use by 40-50 Norwegian trawlers.

The Swedish specialized shrimp fleet (catch of shrimp ≥ 10 t/yr) has been around 40-50 vessels for the last decade and there has not been any major change in trawl size or trawl design according to the Swedish net manufacturer. In Sweden twin trawls have been in use since 2006 (5 vessels) and the use is increasing. In 2010 15 twin trawlers caught 38% of the Swedish shrimp landings (SCR Doc. 11/69).

Catch and discards. Discarding of shrimp may take place in two ways: 1) discards of shrimp <15 mm CL which are not marketable, and 2) high-grading discards of medium-sized and lower-value shrimp. In recent years the Swedish fishery has been constrained by the national quota, which has resulted in 'high-grading' of the catch by the Swedish fleet. The amount of high-grading and discards in the Swedish fisheries was estimated to around 678 t in 2009 and 558 t in 2010 based on comparison of length distributions in Swedish and Danish landings (Fig. 4 in SCR Doc. 11/67). The Danish length distribution for each year is scaled to fit the Swedish length distribution for the same year for the larger shrimp (≥21 mm CL). This correction assumes that there is no discarding of the most valuable larger shrimp and that Swedish and Danish fisheries are conducted on the same grounds and are using same mesh sizes and sorting sieves. The higher numbers in the Danish size groups <21 mm CL are compared to the Swedish numbers, and the differences are then multiplied with the mean weights of each size group. The sum of mean weights by size group is considered as the weight of the Swedish discarding due to high-grading.

The uncertainties in this estimation have increased in recent years due to changes in the Swedish fishing pattern. Swedish shrimp trawlers have been avoiding grounds with small size composition in the catch. There is also an increasing part that voluntarily use 45 mm mesh size instead of legislated 35 mm. There is also an at-sea-sampling programme giving size compositions of samples of the boiled, raw and discarded part of the catch. Unfortunately there are so far too few samples with the total weight of the discarded part to be used in an estimation of total Swedish discards from the at-sea-sampling.

Norwegian discards have since 2007 been estimated using the same method as described above (SCR Doc. 11/67). The length distributions of Norwegian unprocessed commercial catches are compared with those of Norwegian sorted landings. In 2010 Norwegian discards from Skagerrak was estimated to be 95 t. In 2010 discards from Skagerrak were also estimated applying the Danish discards-to-landings proportion to the Norwegian landings, yielding discards of 63 t. This figure was considered the most reliable one. Attempts to estimate discards from the Norwegian Deep were carried out for the first time in 2010, however these were unsuccessful. The Norwegian discards are probably mainly made up of non-marketable shrimp < 15 mm CL and shrimp of poor quality, but high-grading cannot be ruled out.

Bycatch and ecosystem effects. Shrimp fisheries in the North Sea and Skagerrak have by-catches of 10-30% (by weight) commercially valuable species (Table 5.2) even though regulations restrict the weights that may be landed. Since 1997, trawls used in Swedish national waters must be equipped with a Nordmøre grid, with bar spacing 19 mm, which excludes fish > 20 cm from the catch. Logbook information shows that landings delivered by vessels using this grid consist of 96-99% shrimp compared to only 70-90% in landings from trawls without grid (Table 5.2). In the area outside of Swedish national waters the grids are not mandatory, however, there has been an increase in their use, which accounted for 37% of Swedish shrimp landings in 2010.

The effects of shrimp fisheries on the North Sea ecosystem have not been the subject of special investigation. It is known that deep-sea species such as argentines, roundnose grenadier, rabbitfish, and sharks are frequently caught in shrimp trawls in the deeper parts of Skagerrak and the Norwegian Deep. However, no quantitative data on this mainly discarded catch component is available.

Table 5.2. Northern shrimp in Skagerrak and Norwegian Deep: Landings by the *Pandalus* fishery in 2010. Combined data from Danish and Swedish logbooks and Norwegian sale slips (t). The figures for cod and saithe for the trawl with grid is likely to be misreported landings.

	Sub-Div. IIIa, no grid		Sub-Div. IIIa, grid		Sub-Div. IVa East, no grid	
Species:	Total (t)	% of total catch	Total (t)	% of total catch	Total (t)	% of total catch
Pandalus	5026	77.3	364	96.2	1810	77.0
Norway lobster	45	0.7	2	0.6	25	1.0
Angler fish	56	0.9	0	0.0	67	2.8
Whiting	15	0.2	0	0.0	3	0.1
Haddock	41	0.6	0	0.0	19	0.8
Hake	22	0.3	0	0.1	35	1.5
Ling	41	0.6	0	0.0	34	1.4
Saithe	642	9.9	7	1.9	193	8.2
Witch flounder	59	0.9	0	0.1	2	0.1
Norway pout	0	0.0	0	0.0	0	0.0
Cod	382	5.9	2	0.7	70	3.0
Other market fish	168	2.6	2	0.4	93	3.9

b) Assessment Data

i) Commercial fishery data:

LPUE The Danish catch and effort data from logbooks have been analyzed and standardized (SCR Doc. 08/75, 11/69) to provide indices of stock biomass. A GLM standardization of the LPUE series was performed on around 20 500 shrimp fishing trips conducted in the period 1987-2010:

$$\ln(LPUE) = \ln(LPUEmean) + \ln(vessel) + \ln(area) + \ln(year) + \ln(season) + error$$

where ‘vessel’ denotes the horse power of the individual vessels, ‘year’ covers the period 1987-2010, ‘area’ covers Norwegian Deep and Skagerrak, ‘season’, in this case quarter, covers possible seasonal variation, and the variance of the error term is assumed to be normally distributed.

In the standardization of the Norwegian LPUE (2000-2010) (SCR Doc. 11/68) a similar model was applied, but gear type (single and twin trawl) was also included as a variable:

$$\ln(LPUE) = \ln(LPUEmean) + \ln(vessel) + \ln(area) + \ln(year) + \ln(month) + \ln(gear) + error$$

Information on gear use recorded in Norwegian logbooks (single or twin trawl) was corrected by interviews with fishers. In 2010, catches recorded in logbooks only made up 8% and 9% of the respective landings in Divs. IIIa and IVa east. This is partly due to vessels <11 m not being required to fill in logbooks. Unfortunately data are lacking also for larger vessels.

Since the mid-1990s the Danish standardised LPUE has fluctuated without trends (Fig. 5.2). For the last decade the two time series show similar fluctuations, increasing from 2000 to 2004, decreasing in 2005 and then increasing again until 2007. Both LPUE indices have decreased since 2008.

The Swedish LPUE data were not used in the assessment (SCR Doc. 11/69) because of uncertainties caused by discarding due to high-grading and lack of information necessary for standardization.

In previous assessments harvest rates (H.R.) were estimated from landings and corresponding biomass indices from the Norwegian survey. Since the new survey only covers six years, time series of standardised effort indices (total landings/Danish and Norwegian standardised LPUE indices) have been estimated in addition to H.R. estimates for

2006-2010 (Fig. 5.3) Standardised effort seems to have been fluctuating without any clear trend since the mid-1990s indicating stability in the exploitation of the stock.

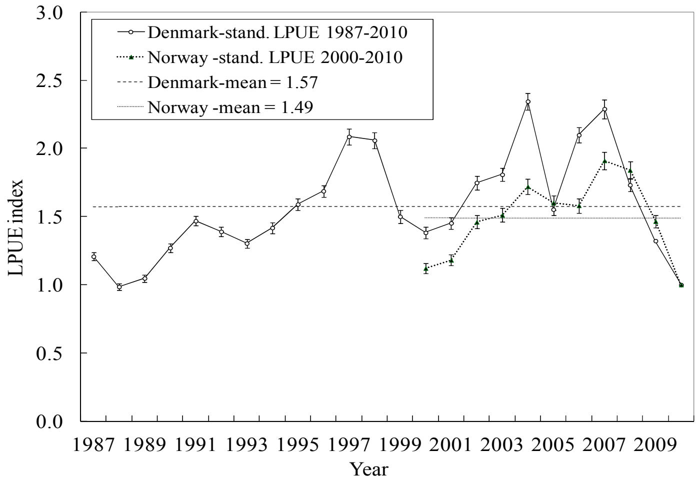


Fig. 5.2. Northern shrimp in Skagerrak and Norwegian Deep: Danish and Norwegian standardised LPUE until 2010.

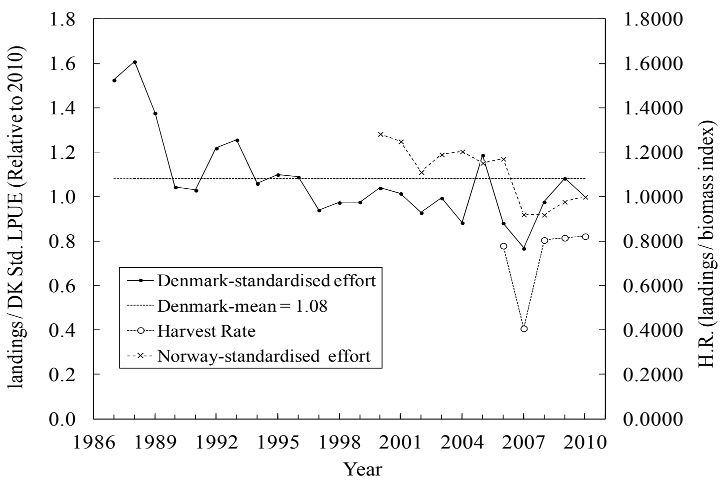


Fig. 5.3. Northern shrimp in Skagerrak and Norwegian Deep: Harvest rate (total landings/survey indices of biomass) and estimated standardised effort based on total landings and Danish and Norwegian standardised LPUE. Long term Danish mean = 1.08.

ii) Sampling of landings.

Information on the size and subsequently age distribution of the landings are obtained by sampling the landings. The samples provide information on sex distribution and maturity (SCR Doc. 11/69). This substantial amount of information has not been used in the current assessments, but will be used in the up-coming benchmark analytical assessment in 2012.

iii) Survey data

The Norwegian shrimp survey went through large changes in the years 2003-06 with changes in vessel and timing (SCR Doc. 11/64) resulting in four different survey series, lasting from one to nineteen years. ICES (2004) strongly recommended the survey to be conducted in the 1st quarter as it gives good estimates of the 1-group (recruitment) and female biomass (SSB). Thus, a new time series at the most optimal time of year was established in 2006.

There was no trend in the annual survey biomass estimates from the mid 1990s to 2002, when the first series was discontinued (Fig. 5.4). In 2003 the survey was carried out using a different trawl in use only that year. The 2004 and 2005 mean values of a new biomass index series were not statistically different. In 2008 the index declined back to the 2006 level, and in 2009 and 2010 the index showed a further decline. In 2011 the biomass index is at the same low level as in 2010.

The abundance of age 1 shrimp in 2006 was equal to the abundance of age 1 shrimp in 2007. From 2007 to 2010 the recruitment (age 1) showed a steady decline to a low level of only 1/10 of the 2006 and 2007 indices (Fig 5.5). In 2011 recruitment increased compared with 2010, but the index is still the second lowest of the time series.

SSB (female biomass) has been calculated for the years 2006-2011 (Fig. 5.6). The index follows the overall biomass index, increasing from 2006 to 2007, then declining back to the 2006-level in 2008 and further declining in 2009 and 2010. In 2011 the SSB index is at the same low level as in 2010.

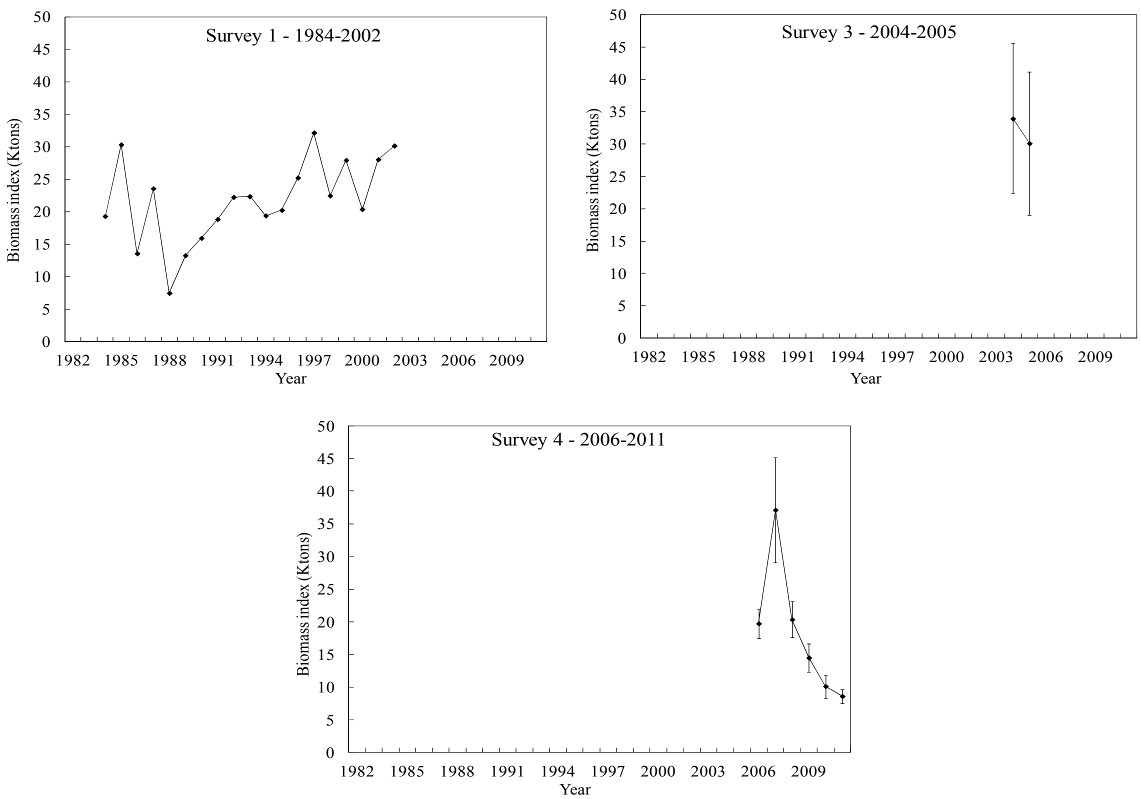
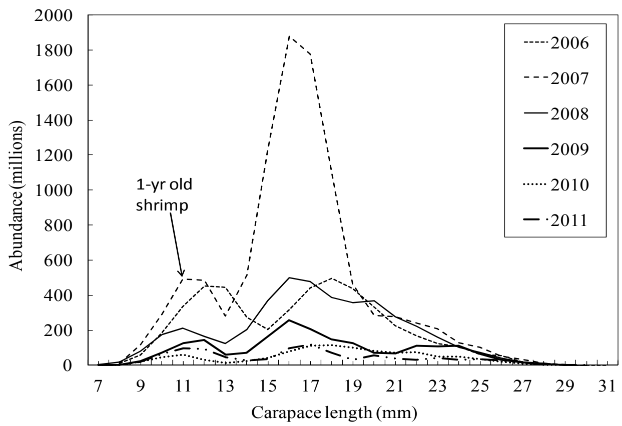


Fig. 5.4. Northern shrimp in Skagerrak and Norwegian Deep: Estimated survey biomass indices in 1984 to 2011. The four surveys are not calibrated to a common scale. Standard errors (error bars) have been calculated for the 2004-2011 surveys. Survey 1: October/November 1984-2002 with Campelen trawl; Survey 2: October/November 2003 with shrimp trawl 1420 (not shown); Survey 3: May/June 2004-2005 with Campelen trawl; Survey 4: January/February 2006-2011 with Campelen trawl.



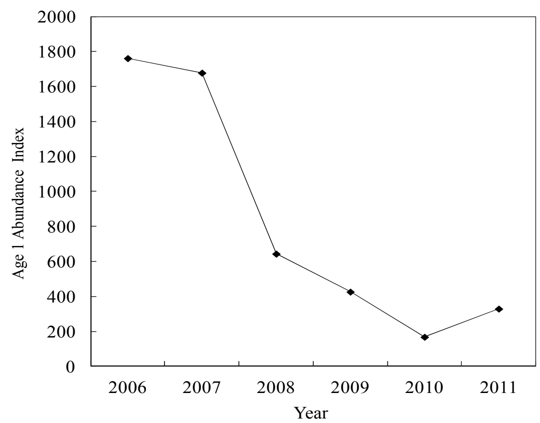


Fig. 5.5. Northern shrimp in Skagerrak and Norwegian Deep: Estimated length frequency distribution from the Norwegian shrimp surveys in 2006-2011, and recruitment indices from the same years. The recruitment index is calculated as the abundance of age 1 shrimp (the first mode, approx. 9-13mm, in the length frequency distribution).

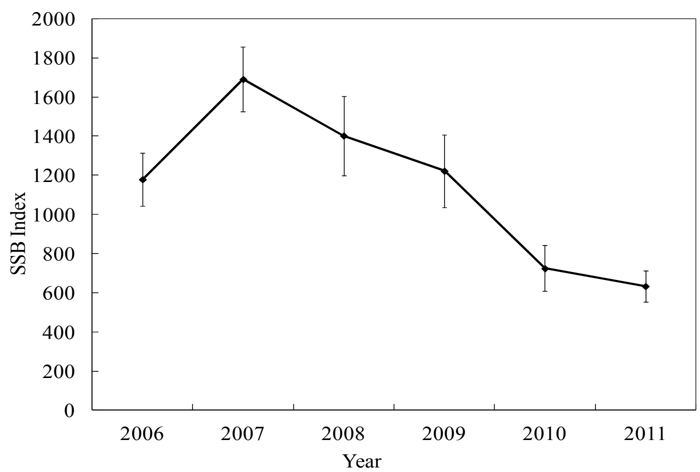


Fig. 5.6. Northern shrimp in Skagerrak and Norwegian Deep: SSB abundance from the Norwegian shrimp surveys in 2006-2011. The abundance index of the spawning stock is calculated as the abundance of females. Error bars are SE.

The large inter-annual variation in the predator biomass index is mainly due to variations in the saithe and roundnose grenadier indices. The sizes of these indices are heavily influenced by which stations are trawled as saithe is found on the shallowest stations and roundnose grenadier on the deepest ones. An index without these species is shown at the bottom of Table 5.3. The total index of shrimp predator biomass excluding saithe and roundnose grenadier has been at the same level during the 5 last years (Table 5.3).

Table 5.3**.** Northern shrimp in Skagerrak and Norwegian Deep: Estimated indices of predator biomass (catch in kg per towed nautical miles) from the Norwegian shrimp survey in 2006-2011.

Species	biomass index 2006	2007	2008	2009	2010	2011
Blue whiting	0.13	0.13	0.12	1.21	0.27	0.62
Saithe	7.33	39.75	208.32	53.89	18.53	7.52
Cod	0.51	1.28	0.78	2.01	1.79	1.66
Roundnose Grenadier	3.22	6.85	19.02	19.03	10.05	4.99
Rabbit fish	2.24	2.15	3.41	3.26	3.51	2.73
Haddock	0.97	4.21	1.85	3.18	3.46	5.82
Redfishes	0.18	0.40	0.26	0.43	0.80	1.02
Velvet Belly	1.31	2.58	1.95	2.42	2.52	1.47
Skates, Rays	0.41	0.95	0.64	0.17	0.60	0.88
Long Rough Dab	0.22	0.64	0.42	0.28	0.47	0.51
Hake	0.98	0.78	0.64	2.56	1.60	0.56
Angler	0.15	0.91	0.87	1.25	1.70	0.92
Witch	0.24	0.74	0.54	0.16	0.13	0.24
Dogfish	0.31	0.19	0.28	0.14	0.11	0.21
Black-mouthed dogfish	0.00	0.05	0.05	0.15	0.09	0.09
Whiting	0.00	0.05	0.05	0.15	0.09	3.07
Blue Ling	0	0	0	0	0	0
Ling	0.04	0.11	0.34	0.79	0.64	0.24
Fourbearded Rockling	0.06	0.14	0.04	0.03	0.05	0.03
Cusk	0.20	0	0.02	0.05	0.13	0.29
Halibut	0.08	0.07	3.88	0.09	0.20	0.05
Pollack	0.06	0.25	0.03	0.13	0.12	0.15
Greater Fork-beard	0	0	0	0.01	0.04	0.02
Total	18.99	63.19	244.81	94.26	49.23	33.09
Total (except saithe and roundnose grenadier)	8.44	16.59	17.47	21.34	20.65	20.58

c) Assessment Results

This year's assessment was based on evaluation of both Danish and Norwegian standardised LPUEs and standardised effort from the fishery in 1987-2010, and the survey indices of recruitment and biomass in 2006-2011.

LPUE: The standardised Danish and Norwegian LPUEs have shown similar fluctuations since 2000 (Fig. 5.2). Both indices have decreased since 2007, and are now below their respective long term means.

Recruitment: The recruitment index (age 1) decreased from 2007 to 2010. The 2011 index is around the level seen in the previous three years.

Survey biomass: The biomass index has decreased since 2007.

State of the stock: Indices of stock biomass indicate a decline from 2007 to 2011. The recruitment index has shown a declining trend since 2007, therefore recruitment to the fishable stock is expected to be low in 2012.

d) Biological Reference Points

No reference points were provided in this assessment.

e) Management Recommendations

NIPAG **recommends** that, *for shrimp in Skagerrak and Norwegian Deep:*

- *sorting grids or other means of facilitating the escape of fish should be implemented in this fishery.*
- *all Norwegian vessels should be required to complete and provide log books.*

f) Research Recommendations

NIPAG **recommends** that, *for shrimp in Skagerrak and Norwegian Deep:*

- *The Norwegian survey time series indices from 1984 - 2003 should be recalculated in order to provide confidence intervals and length frequency distributions.*

g) Research Recommendations from the 2008-2010 meetings

- *the Swedish effort data should be standardised*

STATUS: Work in progress. Process is delayed due to technical problems (lack of resources).

- *the Stochastic assessment model as described in SCR Doc.10/70 should be implemented and MSY reference points should be established.*

STATUS: A preliminary assessment using the model was presented to the NIPAG 2011 meeting. The input consists of length data both from commercial catches and surveys, and the preliminary results are promising (estimates of absolute stock size and fishing mortality). This modeling framework will be explored further and the results presented at the benchmark meeting.

- *A benchmark assessment is carried out before next NIPAG meeting as suggested by the 2009 Review Group.*

STATUS: Benchmark assessment scheduled in early 2012.

- *collaborative efforts should be made to standardise a means of predicting recruitment to the fishable stock.*

STATUS: No progress

- *the Norwegian shrimp survey should be continued on an annual basis*

STATUS: The survey will most likely be conducted annually.

- *Differences in recruitment and stock abundance between Skagerrak and the Norwegian Deep should be explored.*

STATUS: This forms part of the research projects described below

- *the ongoing genetic investigations to explore the relation/connection/mixing between the shrimp (stock units) in Skagerrak and the Norwegian Deep on the one hand and the Fladen Ground shrimp on the other hand should be continued until these relationships have been clarified.*

STATUS: A 3-year Norwegian-Swedish-Greenlandic project on shrimp genetics is financed from 2010 onwards (POPBOREALIS). The project's main goal is to explore shrimp stock structure in the whole North Atlantic. Another 3-year Norwegian-Swedish-Danish project on shrimp genetics is financed from August 2010 onwards (Sustainable Fisheries in the Skagerrak). This project's main goal is to explore shrimp stock structure in Skagerrak and surrounding fjords.

- *1) further development of the Bayesian stock production model presented in 2005 and 2) comparison with and exploration of other assessment models, e.g. new cohort based models, available for this shrimp stock should be carried out.*

STATUS: Work in progress

6. Northern Shrimp in Barents Sea and Svalbard area (ICES SA I and II) – ICES Stock

a) Introduction

Northern shrimp (*Pandalus borealis*) in the Barents Sea and in the Svalbard fishery protection zone (ICES Sub-areas I and II) is considered as one stock (Fig. 6.1). Norwegian and Russian vessels exploit the stock in the entire area, while vessels from other nations are restricted to the Svalbard fishery zone and in the "Loop Hole" (Fig. 6.1).

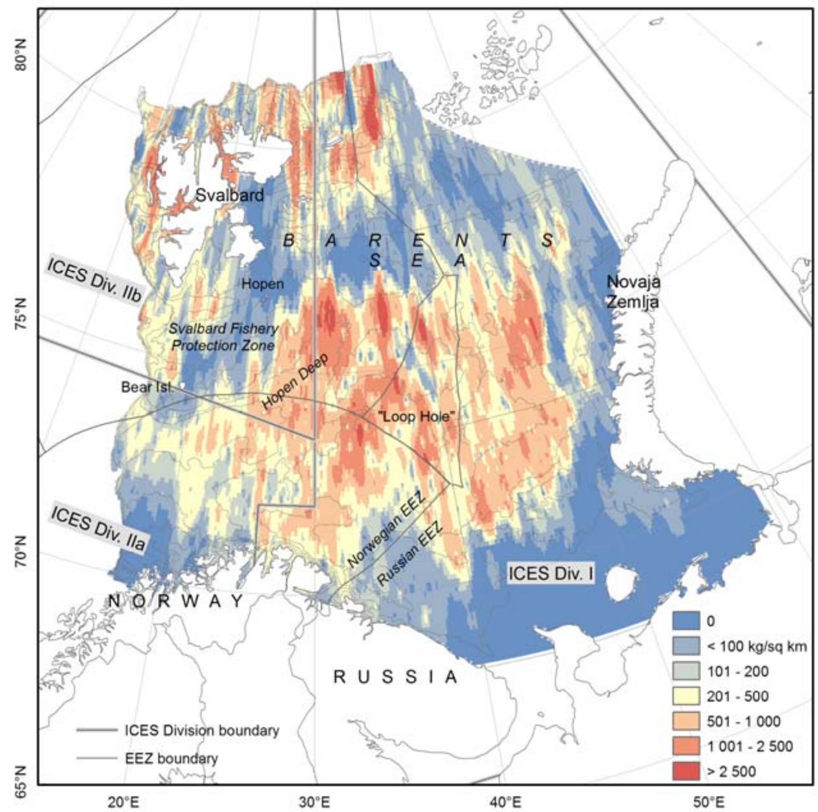


Fig. 6.1. Shrimp in the Barents Sea: stock distribution, mean density (kg/km^2), based on survey data 2000-2010.

Norwegian vessels initiated the fishery in 1970. As the fishery developed, vessels from several nations joined and the annual catch reached 128 000 t in 1984 (Fig. 6.2). From 2001 to 2010 catches have varied between 21 000 and 61 000 t/yr, about 75–93% of these were taken by Norwegian vessels and the rest by vessels from Russia, Iceland, Greenland and the EU (Table 6.1).

There is no TAC established for this stock. The fishery is partly regulated by effort control, and a partial TAC (Russian zone only). Licenses are required for the Russian and Norwegian vessels. The fishing activity of these license holders are constrained only by bycatch regulations whereas the activity of third country fleets operating in the Svalbard zone is also restricted by the number of effective fishing days and the number of vessels by country. The minimum stretched mesh size is 35 mm. Bycatch is limited by mandatory sorting grids and by the temporary closing of areas where excessive bycatch of juvenile cod, haddock, Greenland halibut, redfish or shrimp <15 mm CL is registered.

Catch. Overall catches have ranged from 5 000 to 128 000 t/yr (Fig. 6.2). The most recent peak was seen in 2000 at approximately 83 000 t. Catches thereafter declined to about 21 000 t in 2010 due to reduced profitability of the fishery (reduced shrimp prices and increased fuel prices). Based on information from the industry, catch statistics until August and the seasonal fishing pattern of the most recent years the 2011 catches are predicted to reach 23 000 t.

Table 6.1. Shrimp in ICES SA I and II: Recent catches (2001–2011) in metric tons, as used by NIPAG for the assessment.

	2001	2002	2003	2004	2005[1]	2006[1]	2007[1]	2008[1]	2009[1]	2010[1]	2011[2]
Recommended TAC	-	-	-	-	41 299[3]	40 000	50 000	50 000	50 000	50 000	60 000
Norway	43 031	48 799	34 172	35 918	36 943	27 351	25 509	20 953	19 769	16 779	18 000
Russia	5 846	3 790	2 186	1 170	933	0	9	371	0	0	0
Others	8 659	8 899	1 599	4 211	3 519	2 107	3 763	5 130	3 796	4 074	5 000
Total	57 536	61 488	37 957	41 299	41 395	29 458	29 281	26 454	23 565	20 853	23 000

[1] Minor revisions made in 2011;
[2] Catches projected to the end of the year;
[3] Should not exceed the 2004 catch level (ACFM, 2004).

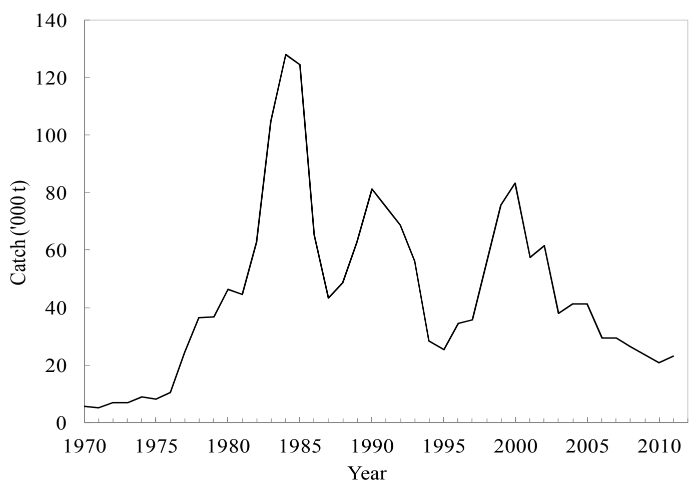


Fig. 6.2. Shrimp in ICES SA I and II: total catches 1970–2011 (2011 projected to the end of the year).

Discards and bycatch. Discard of shrimp cannot be quantified but is believed to be small as the fishery is not limited by quotas. Bycatch rates of other species are estimated from surveillance and research surveys and are corrected for differences in gear selection pattern (SCR Doc. 07/86). The bycatch rates in specific areas are then multiplied by the corresponding shrimp catch from logbooks to give the overall bycatch.

Since the introduction of the Nordmøre sorting grid in 1992, only small cod, haddock, Greenland halibut, and redfish in the 5–25 cm size range are caught as bycatch. The bycatch of small cod ranged between 2–67 million individuals/yr and redfish between 2–25 million individuals/yr since 1992, while 1–9 million haddock/yr and 0.5–14 million Greenland halibut/yr were registered in the period 2000–2004 (Fig. 6.3). In recent years there has been a decline in bycatch following a reduced effort in the shrimp fishery. Details of bycatch is reported in AFWG.

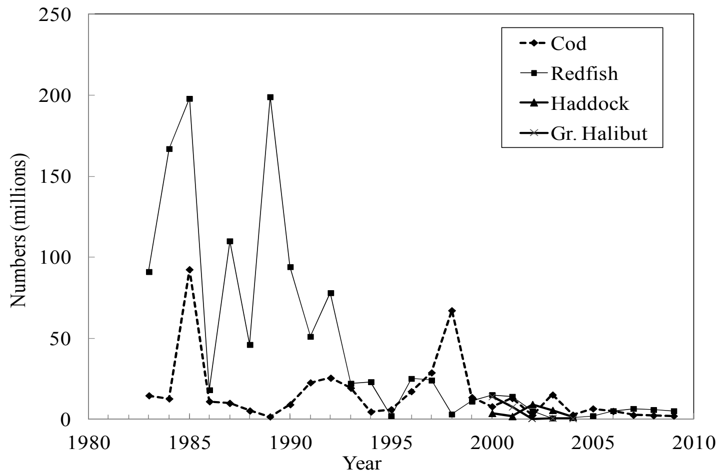


Fig. 6.3. Shrimp in ICES SA I and II: Estimated bycatch of cod, haddock, Greenland halibut and redfish in the Norwegian shrimp fishery (million individuals). No data available for 2010-11.

Environmental considerations. Temperatures in the Barents Sea have been high during the last nine years, mostly due to the inflow of warm water masses from the Norwegian Sea.

In 2011, temperatures close to the bottom were in general close to those in 2010, and still above the long-term mean by 0.2–0.7°C in most of the Barents Sea. Only small areas with temperatures below 1°C were observed. Shrimps were only caught in areas where bottom temperatures were above 0°C (Fig. 6.4). Highest shrimp densities were found between zero and 4°C, while the upper limit of temperature tolerance appeared to lie at about 6-8°C. The wedge of near-zero-degrees water observed in 2009 in the central Barents Sea, which appeared to have driven the distribution of shrimps more easterly, was less evident in 2010 - 11 (Fig. 6.4).

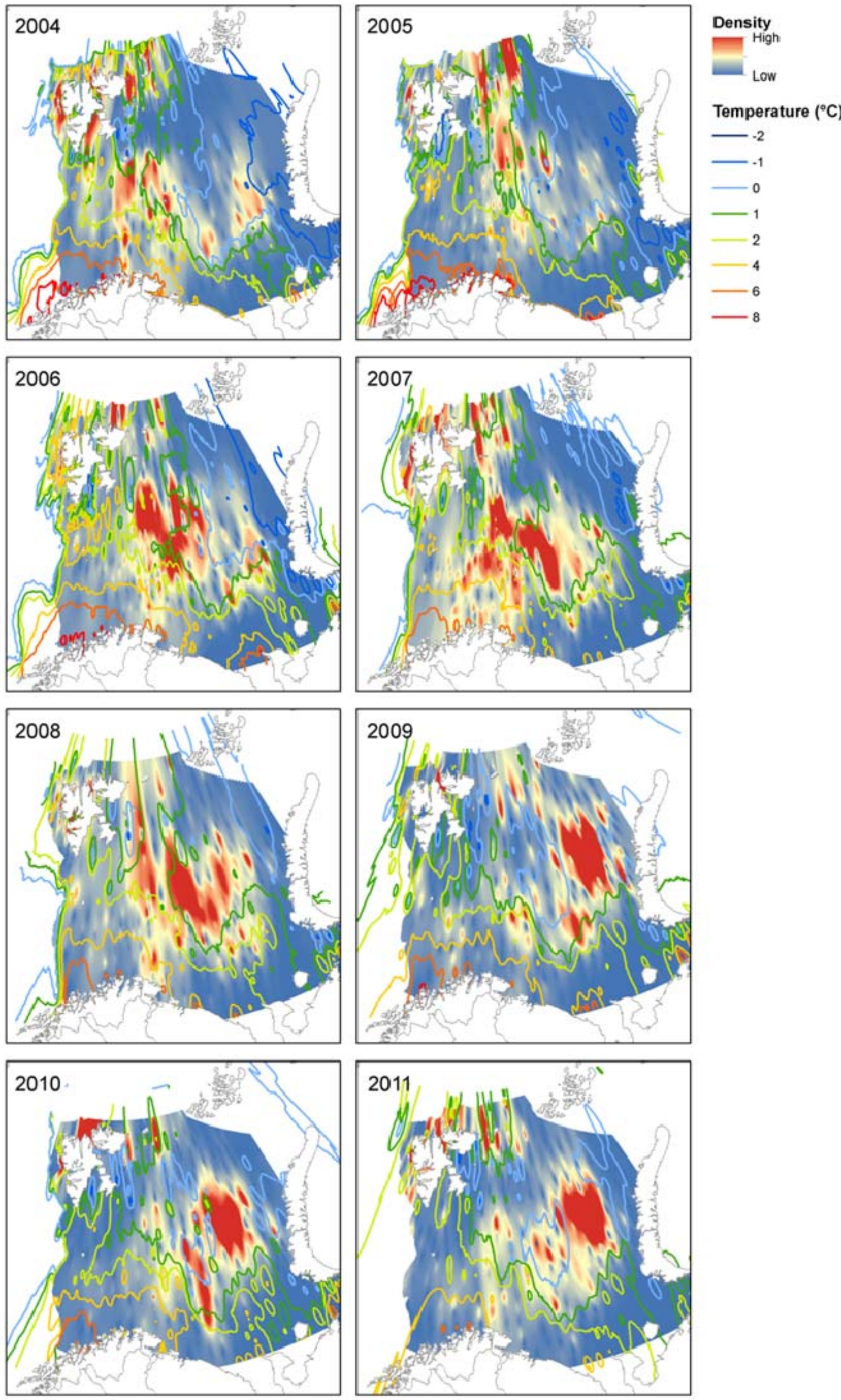


Fig. 6.4. Shrimp in ICES SA I and II: Bottom temperature contour overlays from the 2004 to 2011 ecosystem surveys on shrimp density distributions.

b) Input Data

i) Commercial fishery data

A major restructuring of the shrimp fishing fleet towards fewer and larger vessels has taken place since the mid-1990s. At that time an average vessel had around 1 000 HP; 10 years later this value had increased to more than 6 000 HP (Fig. 6.5). Until 1996 the fishery was conducted by using single trawls only. Double trawls were then introduced, and in 2002 approximately ⅔ of the total effort (trawl-time) spent was by using two trawls simultaneously. In 2000 a few vessels started to experiment with triple trawls: 58% of the effort in 2010 is accounted for by this fishing method (Fig. 6.6). An individual vessel may alternate between single and multiple trawling depending on what is appropriate on given fishing grounds.

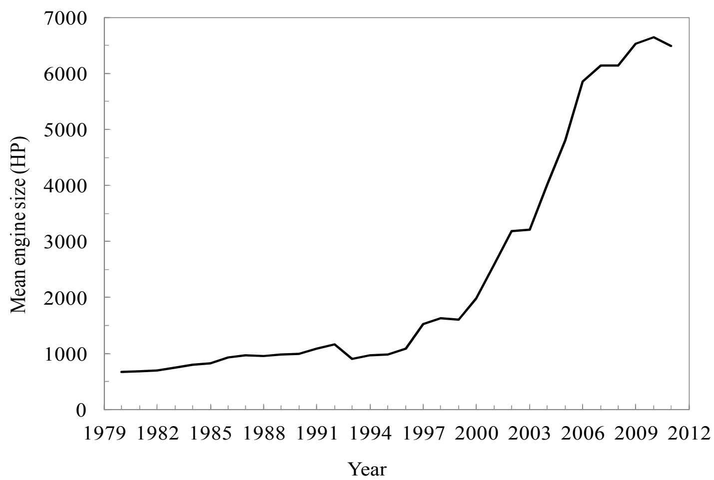


Fig. 6.5. Shrimp in ICES SA I and II: Mean engine power (HP) weighted by trawl-time, in the years 1980–2011.

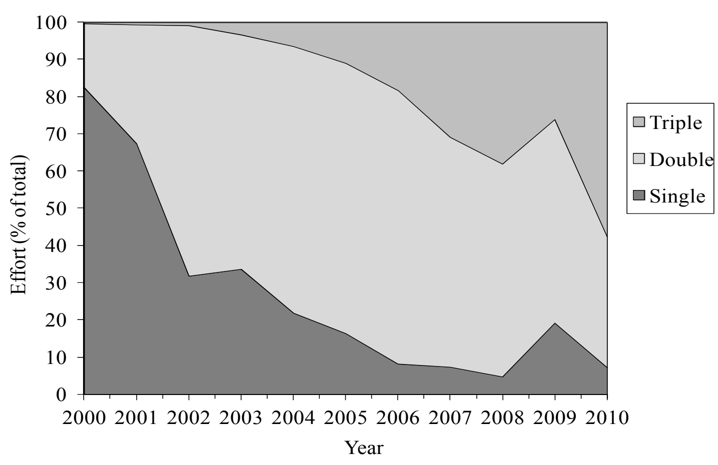


Fig. 6.6. Shrimp in ICES SA I and II: Percentage of total fishing effort spent by using single, double or triple trawls 2000–2010 (Norwegian data).

The fishery is conducted mainly in the central Barents Sea and on the Svalbard Shelf (Fig. 6.7). The fishery takes place throughout the year but may in some years be restricted by ice conditions. The lowest effort is generally seen in October through March, the highest in May to August.

Logbook data from 2009 to 2011 show decreased activity in the Hopen Deep, coupled with increased effort further east in international waters in the so-called "Loop Hole" (Fig 6.7). Information from the industry points to high densities of shrimp in the "Loop Hole" and closures in the traditional Hopen Deep fishing area due to high levels of juvenile redfish bycatch as the main reasons for the observed change in fishing pattern.

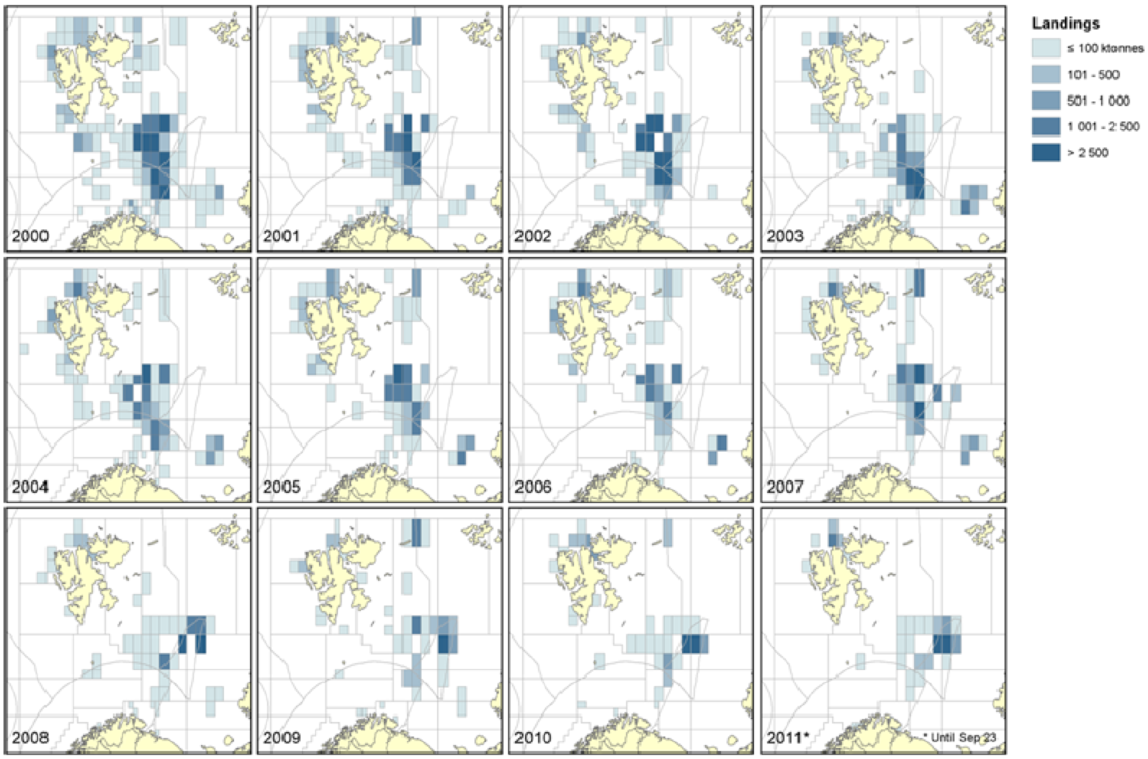


Fig. 6.7. Distribution of catches by Norwegian vessels 2000-2011 based on logbook information. (2011 only data until August)

Norwegian logbook data were used in a multiplicative model (GLM) to calculate standardized annual catch rate indices (SCR Doc. 11/66). A new index series based on individual vessels rather than vessel groups was introduced in 2008 (SCR Doc. 08/56) in order to take into account the changes observed in the fleet. The GLM model to derive the CPUE indices included the following variables: (1) vessel, (2) season (month), (3) area, and (4) gear type (single, double or triple trawl). The resulting series is assumed to be indicative of the biomass of shrimp ≥17 mm CL, *i.e.* females and older males.

The standardized CPUE declined by 60% from a maximum in 1984 to the lowest value of the time series in 1987 (Fig. 6.8). Since then it has showed an overall increasing trend. A new peak was reached in 2006. The 2007 to 2011 mean values have fluctuated 5-10% below the 2006-value, but are still above the average of the series. The standardized effort (Fig. 6.9) has shown a decreasing trend since 2000.

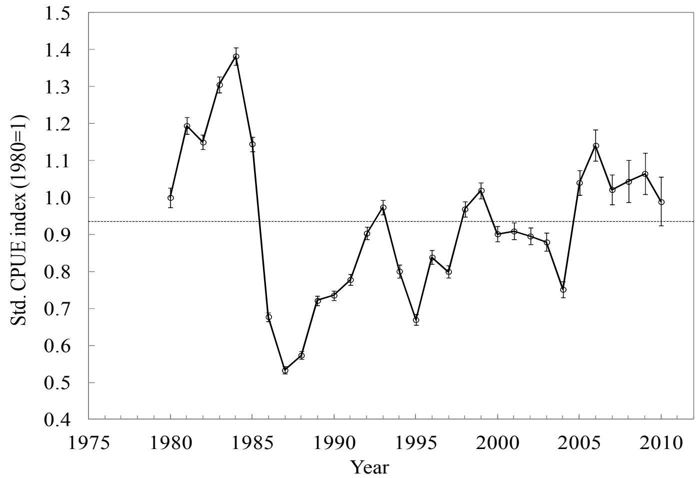


Fig. 6.8. Shrimp in ICES SA I and II: standardized CPUE based on Norwegian data. Error bars represent one standard error; dotted line is the overall mean of the series.

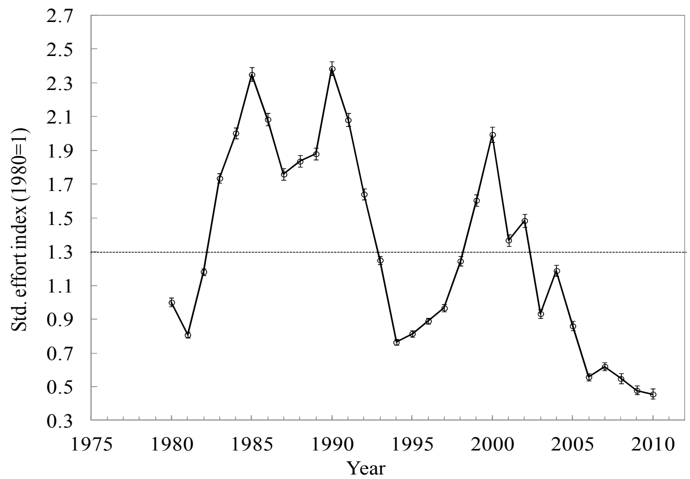


Fig. 6.9. Shrimp in ICES SA I and II: Standardized effort (Catch divided with standardized CPUE). Error bars represent one standard error; dotted line is the overall mean of the series.

ii) Research survey data

Russian and Norwegian shrimp surveys have been conducted in their respective EEZs of the Barents Sea since 1982 to assess the status of the northern shrimp stock (SCR Doc. 06/70, 07/75). The main objectives were to obtain indices for stock biomass, abundance, recruitment and demographic composition. In 2004, these surveys were replaced by the joint Norwegian-Russian "Ecosystem survey" which monitors shrimp along with a multitude of other ecosystem variables.

The Norwegian shrimp survey 1982–2004, covering the most important shrimp grounds for that period, and the Joint Russian - Norwegian Ecosystem survey 2004-present, covering the entire area, were used as input for the assessment model.

Biomass. The Biomass index of the Norwegian shrimp survey cycled with a period of approximately 7 years between 1982 and 2004 (Fig. 6.10). The Joint Russian - Norwegian Ecosystem survey has not been calibrated to the Norwegian shrimp survey. The estimate of mean biomass increased by about 66% from 2004 to 2006 and then decreased back to the 2004-value in 2008 (Fig. 6.10). The 2010 and 2011 values is back up close to that of 2006.

The geographical distribution of the stock in 2009-2011 is more easterly compared to that of the previous years (Fig. 6.11).

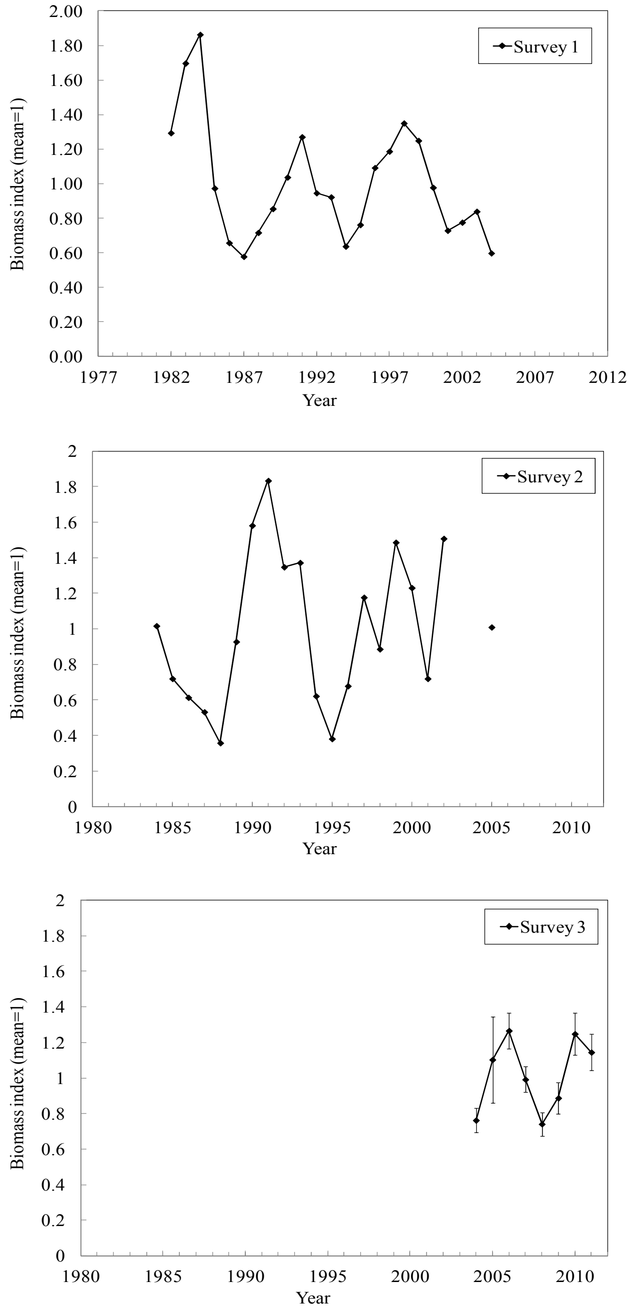


Fig. 6.10. Shrimp in ICES SA I and II: Indices of total stock biomass from the (1) 1982-2004 Norwegian shrimp survey, (2) the 1984-2005 Russian survey, and (3) the joint Russian-Norwegian ecosystem survey. Error bars represent one standard error.

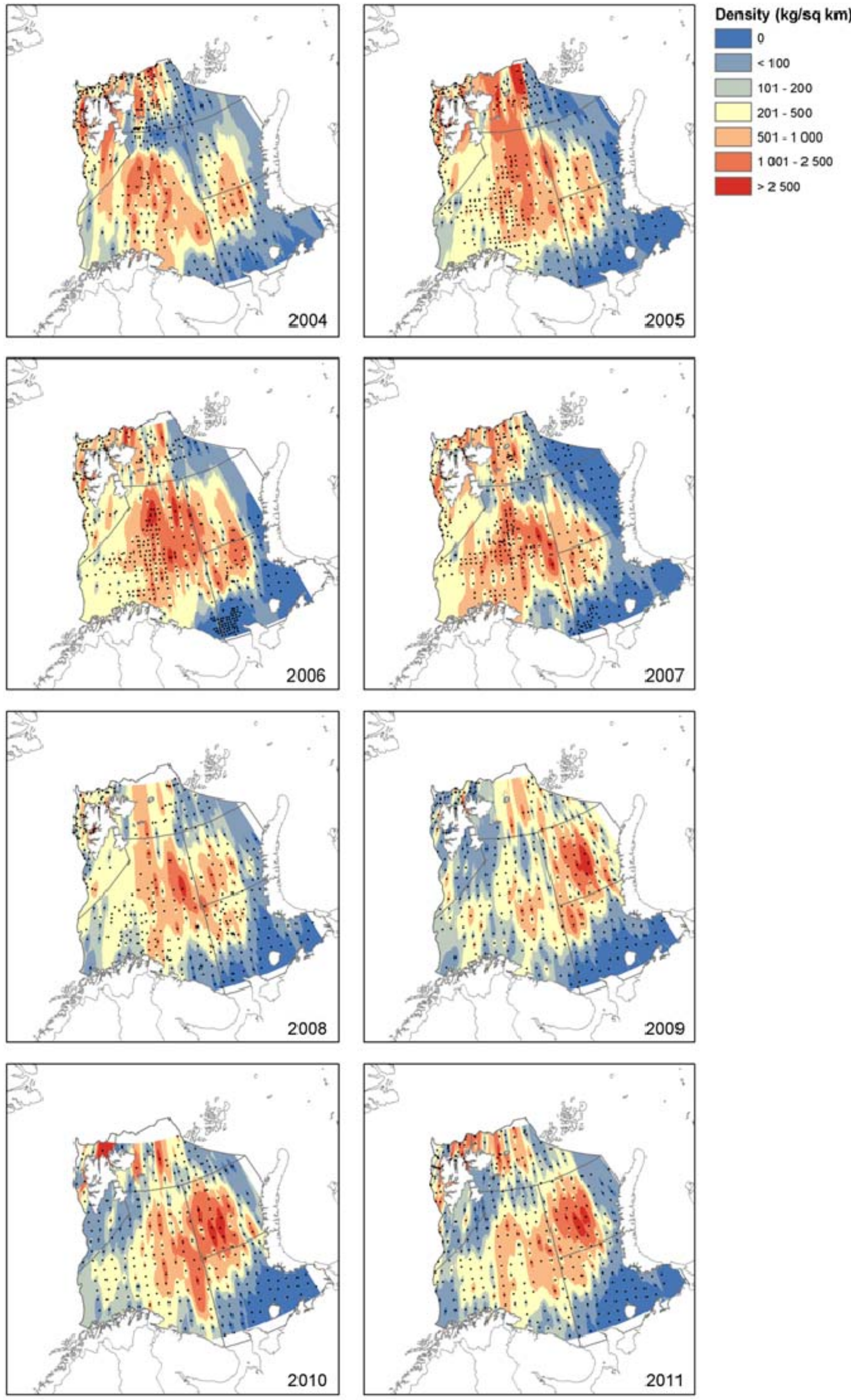


Fig. 6.11. Shrimp in ICES SA I and II: Shrimp density (kg/km^2) as calculated from the Ecosystem survey data 2004–2011).

Recruitment indices. Recruitment indices were derived from the overall size distributions based on Russian and Norwegian samples (SCR 11/63 and 11/65 respectively) as estimated abundance of shrimp at 13 to 16 mm CL. Shrimp at this size will probably enter the fishery in the following one to two years. The recruitment indices have decreased from 2004 to 2007-2008 but were higher in 2009 to 2011 (Fig. 6.12). The series based on Russian samples was updated in 2011.

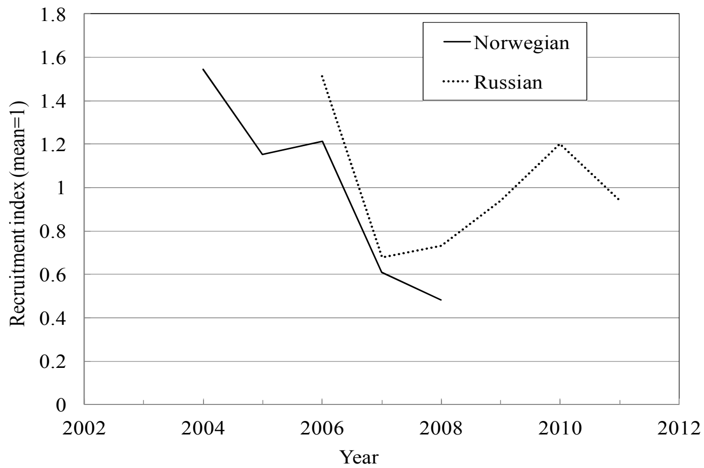


Fig. 6.12. Shrimp in ICES SA I and II: Indices of recruitment: abundance of shrimp at size 13–16 mm CL based on Norwegian survey samples 2004-2008 and Russian survey samples 2006-2011.

c) Estimation of Parameters

The modelling framework introduced in 2006 (Hvingel, 2006) was used for the assessment. Model settings were the same as ones used in previous years.

Within this model, parameters relevant for the assessment and management of the stock are estimated, based on a stochastic version of a surplus-production model. The model is formulated in a state-space framework and Bayesian methods are used to construct "posterior" likelihood distributions of the parameters (SCR Doc. 11/71).

The model synthesized information from input priors, three independent series of shrimp biomass indices and one series of shrimp catch. The three biomass indices were: a standardized series of annual commercial - vessel catch rates for 1980–2010 (Fig. 6.10, SCR Doc. 11/66); and trawl-survey biomass indices for 1982–2004 and for 2004–2010 (Fig, 6.10, SCR Doc. 07/75). These indices were scaled to true biomass by catchability parameters and lognormal observation errors were applied. Total reported catch in ICES Div. I and II 1970–2010 was used as yield data (Fig. 6.2, SCR Doc. 11/66). The fishery being without major discarding problems or variable misreporting, reported catches were entered into the model as error-free.

Absolute biomass estimates had relatively high variances. For management purposes, it was therefore desirable to work with biomass on a relative scale in order to cancel out the uncertainty of the "catchability" parameters (the parameters that scale absolute stock size). Biomass, *B,* was thus measured relative to the biomass that would yield Maximum Sustainable Yield, B_{msy}. The estimated fishing mortality, *F*, refers to the removal of biomass by fishing and is scaled to the fishing mortality at MSY, F_{msy}. The state equation describing stock dynamics took the form:

$$P_{t+1} = \left(P_t - \frac{C_t}{B_{MSY}} + \frac{2\, MSY\, P_t}{B_{MSY}} \left(1 - \frac{P_t}{2} \right) \right) \cdot \exp(\nu_t)$$

where P_t is the stock biomass relative to biomass at MSY ($P_t = B_t/B_{MSY}$) in year *t*. This frames the range of stock biomass on a relative scale where $B_{MSY} = 1$ and the carrying capacity (K) equals 2. The 'process errors', v, are normally, independently and identically distributed with mean 0 and variance σ_P^2 .

The observation equations had lognormal errors, ω, κ and ε , for the series of standardised CPUE ($CPUE_t$), Norwegian shrimp survey ($surv_R$) and joint ecosystem survey ($surv_E$) respectively giving:

$CPUE_t = q_C B_{MSY} P_t \exp(\omega_t)$, $survR_t = q_R B_{MSY} P_t \exp(\kappa_t)$, $survE_t = q_E B_{MSY} P_t \exp(\varepsilon_t)$

The observation error terms, ω, κ and ε are normally, independently and identically distributed with mean 0 and variance σ_C^2, σ_R^2 and σ_E^2 respectively.

Summaries of the estimated posterior probability distributions of selected parameters are shown in Table 6.2. Values are similar to the ones estimated in the 2010 assessment.

Table 6.2. Shrimp in ICES SA I and II : Summary of parameter estimates: mean, standard deviation (sd) and 25, 50, and 75 percentiles of the posterior distribution of selected parameters (symbols are as in the text). *MSY* = Maximum Sustainable Yield (kt), *K* = carrying capacity, B_{msy} = biomass that produces MSY, *r* = intrinsic growth rate, *qC*, *qR* and *qE* are catchability parameters, P_0 = the 'initial" stock biomass in 1969, σ = CV of CPUE and surveys, and σ_p = the process error.

	Mean	Sd	25 %	Median	75 %
MSY (ktons)	246	183	112	195	329
K (ktons)	3196	1804	1849	2782	4100
R	0.32	0.16	0.21	0.31	0.42
q_R	0.14	0.11	0.07	0.11	0.18
q_E	0.20	0.15	0.10	0.16	0.25
q_C	5.1E-04	3.8E-04	2.5E-04	4.0E-04	6.3E-04
P_0	1.50	0.26	1.33	1.50	1.68
P_{2011}	2.02	0.54	1.68	1.98	2.31
σ_R	0.18	0.03	0.16	0.18	0.20
σ_E	0.17	0.04	0.14	0.16	0.19
σ_C	0.13	0.02	0.11	0.12	0.14
σ_P	0.19	0.03	0.17	0.19	0.21

Reference points. In 2009 ICES adopted a "Maximal Sustainable Yield (MSY) framework" (ACOM. ICES Advice, 2010. Book 1. Section 1.2) for deriving advice. There are now 3 reference points to be considered: F_{msy}, $B_{trigger}$ and B_{lim}. In the MSY management approach the F_{lim} is somewhat redundant, however, recent discussions on the setting of an F_{lim} reference can be found in the 2009 NIPAG report. F_{msy} and the probability of exceeding it can be estimated, as well as the risk of exceeding B_{lim} which is set at 30% B_{msy} (NIPAG, 2006), F_{lim} suggested to be 170% of F_{msy} (NIPAG, 2009) and $B_{trigger}$ set at 50% B_{msy} (NIPAG 2010).

d) Assessment Results

The results of this year's model run are similar to those of the previous years (model introduced in 2006).

Stock size and fishing mortality. Since the 1970s, the estimated median relative biomass (B/B_{msy}) has been above 1 (Fig. 6.13, upper panel) and the probability that it had been below B_{msy} was small for most years, *i.e.* it seems likely that the stock has been above B_{msy} since the start of the fishery.

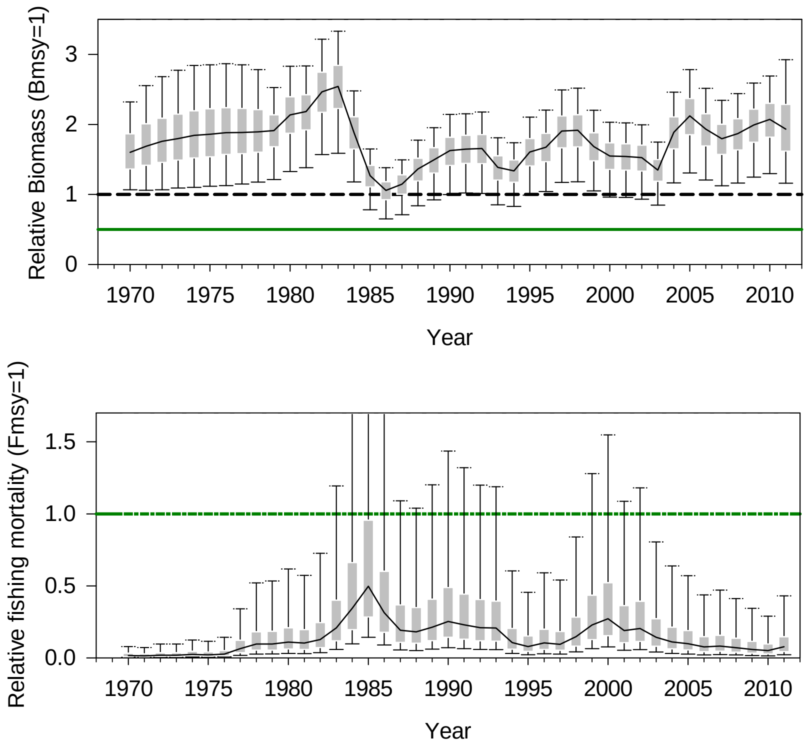


Fig. 6.13. Shrimp in ICES SA I and II: estimated relative biomass (B_t/B_{msy}) and fishing mortality (F_t/F_{msy}) for the years (t) 1970–2011. Boxes represent inter-quartile ranges and the solid black line at the (approximate) centre of each box is the median; the arms of each box extend to cover the central 95% of the distribution.

A steep decline in stock biomass was noted in the mid 1980s following some years with high catches and the median relative biomass went close to 1 (Fig. 6.13). Since the late 1990s the stock has varied with an overall increasing trend and reached a level estimated to be close to K in 2005. The estimated risk of stock biomass being below B_{MSY} in 2010 and 2011 was <2.5% (Table 6.3). The median relative fishing mortality (F/F_{MSY}) has been well below 1 throughout the series (Fig. 6.13). In 2010 and 2011 there is <1% risk of exceeding F_{MSY} (Table 6.3).

Table 6.3. Shrimp in ICES SA I and II: stock status for 2010 and predicted to the end of 2011 assuming a total catch of 23 ktons. (170% F_{MSY} = fishing mortality that corresponds to a B_{lim} at $0.3B_{MSY}$).

Status	2010	2011*
Risk of falling below B_{lim} ($0.3B_{MSY}$)	<1 %	<1 %
Risk of falling below B_{trig} ($0.5B_{MSY}$)	<1 %	<1 %
Risk of falling below B_{MSY}	1.7 %	2.1 %
Risk of exceeding F_{MSY}	<1 %	<1 %
Risk of exceeding $1.7F_{MSY}$	<1 %	<1 %
Stock size (B/B_{MSY}), median	2.07	1.98
Fishing mortality (F/F_{MSY}), median	0.05	0.06
Net Production (% of MSY)	-15 %	3 %

Estimated median biomass has been above $B_{trigger}$ and fishing mortality ratio has been below F_{msy} throughout the time series (Fig. 6.14). At the end of 2011 there is less than 1% risk that the stock would be below $B_{trigger}$, and that F_{msy} will be exceeded (Table 6.3).

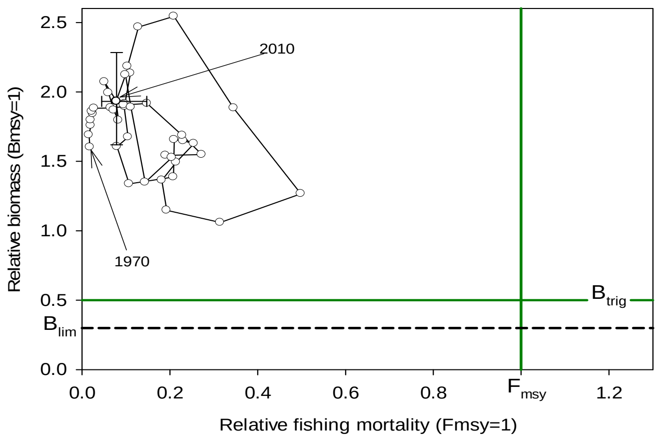


Fig. 6.14. Shrimp in ICES SA I and II: Estimated annual median biomass-ratio (B/B_{MSY}) and fishing mortality-ratio (F/F_{MSY}) 1970–2010. The reference points for stock biomass, B_{lim}, and fishing mortality, F_{MSY}, are indicated by the bold lines and $B_{trigger}$ is shown as black dashed line. Error bars on the 2010 value are inter-quartile range.

Predictions. Assuming a catch of 23 kt for 2011, catch options up to 60 kt for 2012 have a low risk (<5%) of exceeding F_{MSY} (Table 6.4) and is likely to maintain the stock at its current high level.

Table 6.4. Shrimp in ICES SA I and II: Predictions of risk and stock status associated with six optional catch levels for 2012. (170% F_{MSY} = fishing mortality that corresponds to a B_{lim} at $0.3B_{MSY}$).

Catch option 2012 (ktons)	30	40	50	60	70	90
Risk of falling below B_{lim} ($0.3B_{MSY}$)	<1 %	<1 %	<1 %	<1 %	<1 %	<1 %
Risk of falling below B_{trig} ($0.5B_{MSY}$)	<1 %	<1 %	<1 %	<1 %	<1 %	<1 %
Risk of falling below B_{MSY}	2.5 %	2.6 %	2.7 %	3.0 %	2.9 %	3.1 %
Risk of exceeding F_{MSY}	1.3 %	2.1 %	3.1 %	4.4 %	5.5 %	8.7 %
Risk of exceeding $1.7F_{MSY}$	<1 %	<1 %	1.4 %	1.8 %	2.5 %	3.7 %
Stock size (B/B_{MSY}), median	1.93	1.92	1.92	1.91	1.89	1.89
Fishing mortality (F/F_{MSY}),	0.08	0.11	0.13	0.16	0.19	0.24
Net Production (% of MSY)	13 %	15 %	16 %	18 %	21 %	21 %

The risks associated with ten-year projections of stock development assuming annual catch of 30 000 to 90 000 t were investigated (Fig. 6.15). For all options the risk of the stock falling below B_{MSY} in the short to medium term (1-5 years) is low (<10%) and all of these catch options result in a probability of less than 5% of going below $B_{trigger}$ over a 10 year period (Fig. 6.13). Catch options up to 60 000 t, have a low risk (<5%) of exceeding F_{MSY} in the short term (Fig. 6.14).

Taking 90 000 t/yr will increase the risk of going below B_{MSY} to more than 10% during the ten years of projection (Fig. 6.15). However, the risk of going below $B_{trigger}$ remains under 5%. The risk that catches of this magnitude will not be sustainable ($prob(F > F_{MSY})$) in the longer term increase as compared to the 60 000 t option but is still below 15% after ten years.

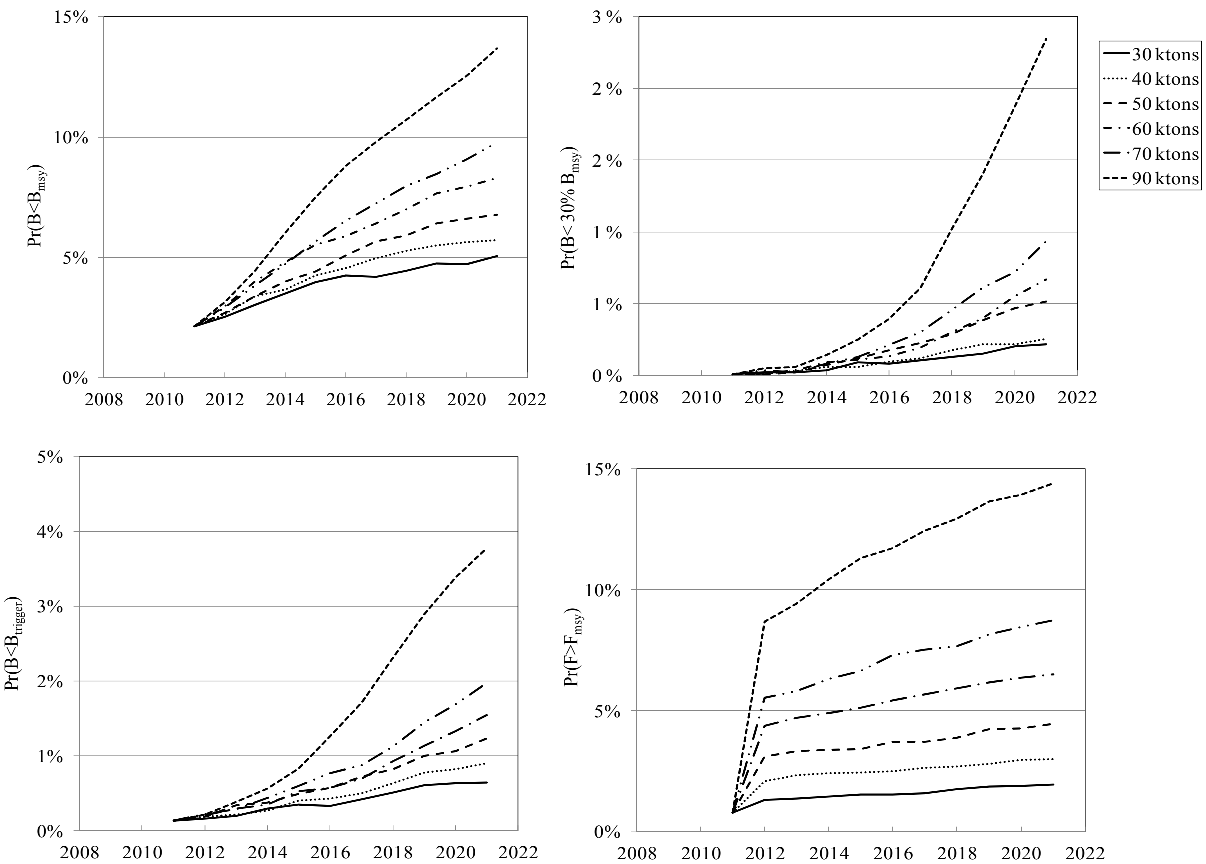


Fig. 6.15. Shrimp in ICES SA I and II: Projections of estimated risk of going below B_{MSY} and B_{lim} (top) and of going below $B_{trigger}$ and of exceeding F_{MSY} (bottom) given different catch options (see legend).

Yield predictions can be made for various levels of fishing mortalities (e.g. at target fishing mortality=F_{MSY}) but such estimates have high uncertainties as absolute biomass can only be estimated with relatively high variances (see section on “estimation of parameters”) and therefore such point estimates should be interpreted with caution. Instead we estimate yield at risk level of exceeding the target of F_{MSY} (Table 6.5) and managers may pick their preferred risk level from this.

Table 6.5. Shrimp in ICES SA I and II: Yield predictions (kt) at five risk levels of exceeding F_{msy}.

	Risk of exceeding F_{msy}				
Year	2.5 %	5 %	10 %	25 %	50 %
2012	43	68	98	181	321
2013	44	65	97	180	318
2014	42	62	91	165	286
2015	41	60	88	152	264
2016	39	58	84	142	247
2017	38	55	80	136	235
2018	38	53	76	130	229
2019	36	53	73	125	223
2020	36	51	71	121	216
2021	36	51	72	120	213

Additional considerations

Model performance. The model was able to produce good simulations of the observed data (Fig. 6.16). The observations did not lie in the extreme tails of their posterior distributions (Table 6.6.). The retrospective pattern of relative biomass series estimated by consecutively leaving out from 0 to 10 years of data did not reveal any problems with sensitivity of the model to particular years (Fig. 6.17).

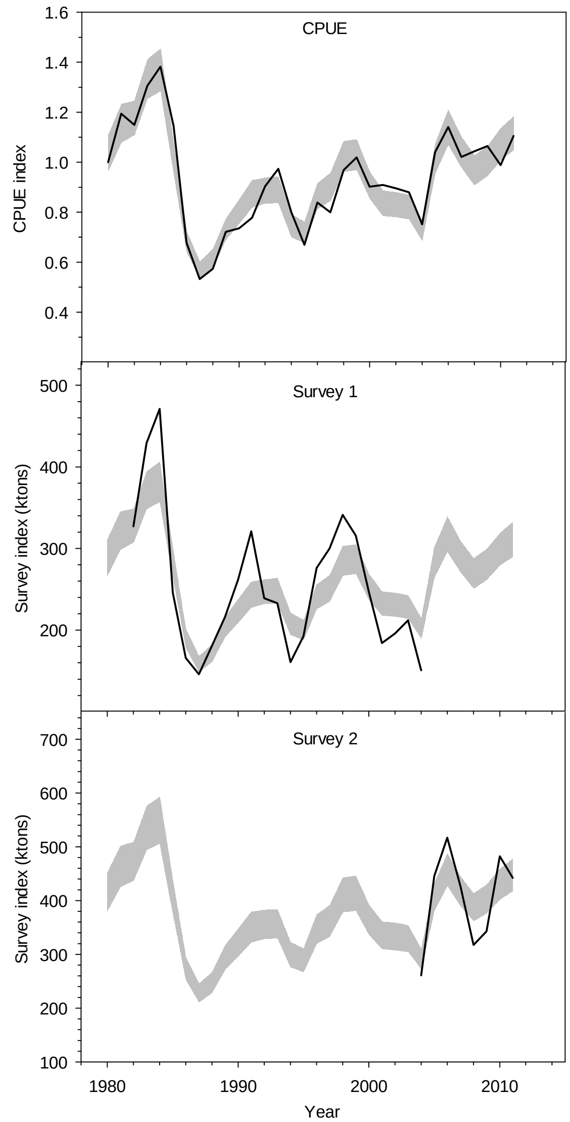


Fig. 6.16. Shrimp in ICES SA I and II: Observed (solid line) and estimated (shaded) series of the included biomass indices: the standardized catch-per-unit-effort (CPUE), the 1982–2004 shrimp survey (survey 1) and the joint Norwegian-Russian Ecosystem survey (survey 2). Grey shaded areas are the inter-quartile range of their posteriors.

Table 6.6 Model diagnostics: residuals (% of observed value) and probability of getting a more extreme observation (pr; pr=0.5 means the observations is in the center of its predicted distribution while values close to 1 or 0 means that it is in the tail).

	CPUE		Survey 1		Survey 2	
Year	resid (%)	pr	resid (%)	pr	resid (%)	pr
1980	3.99	0.42	-	-	-	-
1981	-2.97	0.59	-	-	-	-
1982	2.59	0.45	0.49	0.50	-	-
1983	2.27	0.45	-13.29	0.77	-	-
1984	-0.65	0.53	-18.82	0.85	-	-
1985	-11.02	0.79	15.35	0.25	-	-
1986	0.75	0.49	14.60	0.25	-	-
1987	7.03	0.33	8.82	0.35	-	-
1988	7.96	0.32	-4.82	0.60	-	-
1989	1.71	0.46	-5.32	0.62	-	-
1990	9.35	0.29	-14.45	0.79	-	-
1991	12.70	0.23	-23.93	0.92	-	-
1992	-1.55	0.55	3.59	0.43	-	-
1993	-8.43	0.73	6.62	0.38	-	-
1994	-6.75	0.69	29.21	0.11	-	-
1995	7.80	0.31	4.07	0.43	-	-
1996	3.24	0.44	-12.60	0.76	-	-
1997	13.09	0.22	-16.02	0.81	-	-
1998	5.87	0.37	-16.21	0.82	-	-
1999	1.39	0.47	-8.95	0.68	-	-
2000	0.96	0.48	2.57	0.45	-	-
2001	-7.89	0.71	26.73	0.13	-	-
2002	-7.14	0.70	18.23	0.21	-	-
2003	-6.46	0.68	8.02	0.36	-	-
2004	-3.13	0.59	34.20	0.07	11.89	0.29
2005	-2.28	0.56	-	-	-8.58	0.69
2006	0.21	0.50	-	-	-11.27	0.74
2007	2.10	0.45	-	-	-1.80	0.55
2008	-7.10	0.69	-	-	22.64	0.15
2009	-5.41	0.65	-	-	13.23	0.26
2010	8.69	0.30	-	-	-14.08	0.79
2011	-0.15	0.51	-	-	-2.65	0.57

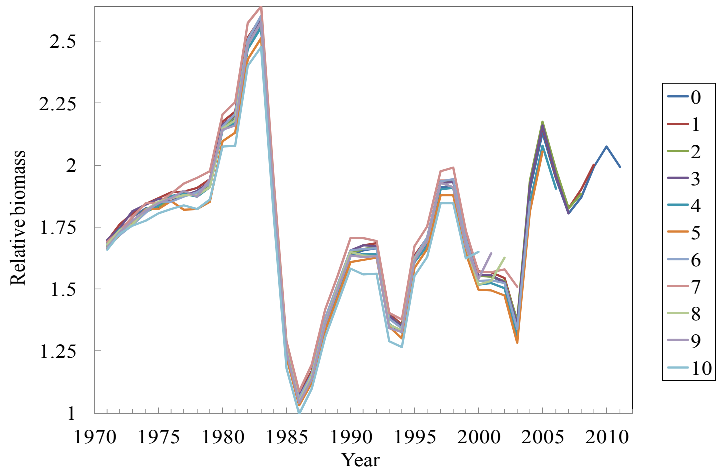


Fig. 6.17. Shrimp in ICES SA I and II: Retrospective plot of median relative biomass (B/B_{msy}). Relative biomass series are estimated by consecutively leaving out from 0 to 10 years of data.

Predation. Both stock development and the rate at which changes might take place can be affected by changes in predation, in particular by cod, which has been estimated to consume large amounts of shrimp. If predation on shrimp were to increase rapidly outside the range previously experienced by the shrimp stock within the modelled period (1970–2011), the shrimp stock might decrease in size more than the model results have indicated as likely. The cod stock has recently increased (AFWG, ICES). However, as the total predation depends on the abundance of cod, shrimp and also of other prey species (e.g. capelin) the likelihood of such large reductions is at present hard to quantify. Continuing investigations to include cod predation as an explicit effect in the assessment model has not so far been successful as it has not been possible to establish a relationship between shrimp/cod densities.

Recruitment/reaction time of the assessment model. The model used is best at describing trends in stock development but shows some inertia in its response to year-to-year changes. Large and sudden changes in recruitment may therefore not be fully captured in model predictions.

e) Summary

Mortality. The fishing mortality has been below F_{MSY} throughout the exploitation history of the stock. The risk that F will exceed F_{MSY} in 2011 is estimated to be less than 1%.

Biomass. The stock biomass estimates have been above B_{MSY} throughout the history of the fishery. Biomass at the end of 2011 is estimated to be well above $B_{trigger}$.

Recruitment. Recruitment indices, available only for part of the stock, decreased from 2004 to 2007-2008 but were higher in 2009 to 2011.

State of the Stock. The Stock is estimated to be close to the carrying capacity. The risk of stock biomass being below $B_{trigger}$ and fishing mortality above F_{MSY} at end 2011 is less than 1%.

Yield. A catch option of up to 60 000 t for 2012 would have less than 5% risk of exceeding F_{MSY}. Catch options up to 60 000 t/yr, have a low risk (<5%) of exceeding F_{MSY} in the coming 3 years.

f) Review of Recommendations from 2010

NIPAG **recommends** that, *for the shrimp stock in Barents Sea and Svalbard (ICES Div. I and II):*

- *Demographic information (length, sex and stage etc.) be collected also from the Norwegian part of* ***the Barents Sea ecosystem survey.***

STATUS: Data has been collected but no progress to date on its analysis.

- *Collaborative efforts should be made to standardize a means of predicting recruitment to the fishable stock.*

STATUS: No progress.

- *Work to include explicit information on recruitment in the assessment model should be continued.*

STATUS: Work ongoing.

h) Research Recommendations

There were no research recommendations.

Sources of Information: SCR Doc. 04/12, 06/64, 70; 07/75, 86; 08/56; 11/55, 65, 66, 71.

7. Northern shrimp in Fladen Ground (ICES Division IVa)

From the 1960s up to around 2000 a significant shrimp fishery exploited the shrimp stock on the Fladen Ground in the northern North Sea. A short description of the fishery is given, as a shrimp fishery could be resumed in this area in the future. The landings from the Fladen Ground have been recorded from 1972 (SCR Doc. 09/69, Table 9). Total reported landings since 1997 have fluctuated between zero in 2006 to above 4000 t (Table 6.1). The Danish fleet accounts for the majority of these landings, with the Scottish fleet landing a minor portion. The fishery took place mainly during the first half of the year, with the highest activity in the second quarter. Since 2006 no landings have been recorded from this stock.

Since 1998 landings have decreased steadily and since 2004 the Fladen Ground fishery has been virtually non-existent with total recorded landings being less than 25 t. Interview information from the fishing industry obtained in 2004 gives the explanation that this decline is caused by low shrimp abundance, low prices on the small shrimp which are characteristic of the Fladen Ground, and high fuel prices. This stock has not been surveyed for several years, and the decline in this fishery may reflect a decline in the stock.

Table 7.1. Northern shrimp in Fladen Ground: Landings of *Pandalus borealis* (t) from the Fladen Ground (ICES Div. IVa) estimated by NIPAG.

Country/Fleet	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Denmark	3 022	2 900	1 005	1 482	1 263	1 147	999	23	10	0	0	0	0	0
Norway	9	3	9		18	9	8	0	0	0	0	0	0	0
Sweden							1	0	0	0	0	0	0	0
UK (Scotland)	365	1 365	456	378	397	70		0	0	0	0	0	0	0
Total	3 396	4 268	1 470	1 860	1 678	1 226	1 008	23	10	0	0	0	0	0

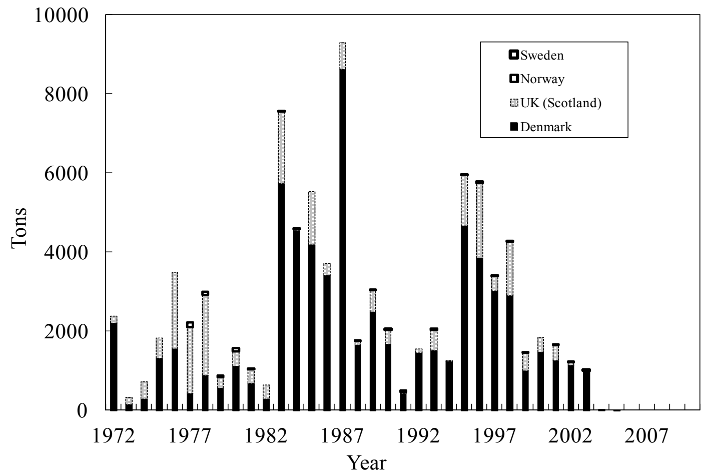


Fig. 7.1. Northern shrimp in Fladen Ground: Catches

IV. ADDITIONAL REQUESTS FROM FISHERIES COMMISSION - NAFO

1. PA reference points for shrimp in Div. 3LNO

This request was also address to Scientific Council in 2009 (NAFO Scientific Council Report., 2009, page 232). NIPAG has been working to provide values for these reference points. Appropriate models have not yet been developed to a point where they have been accepted as a basis for the determination of reference points, and so NIPAG is unable to provide appropriate reference points to address this request.

V. OTHER BUSINESS

There was no other business.

VI. ADJOURNMENT

The NIPAG meeting was adjourned at 1200 hours on 26 October 2011. The Co-Chairs thanked all participants, especially the designated experts and stock coordinators, for their hard work. The Co-Chairs thanked the NAFO and ICES Secretariats for all of their logistical support.

APPENDIX 1. AGENDA NIPAG MEETING

NAFO Secretariat, Dartmouth, Canada, on 19–26 October 2011

I. Opening (Co-chairs: Jean-Claude Mahé and Carsten Hvingel)

1. Appointment of Rapporteur
2. Adoption of Agenda[1]
3. Plan of Work

II. General Review

1. Review of Recommendations in 2009 and in 2010
2. Review of Catches

III. Stock Assessments

- Northern shrimp (Division 3M)
- Northern Shrimp (Divisions 3LNO)
- Northern shrimp (Subareas 0 and 1)
- Northern shrimp (in Denmark Strait and off East Greenland)
- Northern shrimp in Skagerrak and Norwegian Deep (ICES Divisions IIIa and IVa East)
- Northern Shrimp in Barents Sea and Svalbard area (ICES Sub-areas I & II)
- Northern shrimp in Fladen Ground (ICES Division IVa)

IV. Other Business

V. Adjournment

[1] Agenda to include relevant outcomes of the Scientific Council 1-13 Meeting and the NAFO Annual Meeting on 19–23 September 2011.

Annex I. Fisheries Commission Requests for Scientific Advice on Management Options in 2012 and Beyond of Certain Stocks in Subareas 2, 3 and 4 and Other Matters

1. The Fisheries Commission with the concurrence of the Coastal State as regards to the stocks below which occur within its jurisdiction ("Fisheries Commission") requests that the Scientific Council provide advice in advance of the 2011 Annual Meeting, for the management of Northern shrimp in Div. 3M, 3LNO in 2012.

   Noting that Scientific Council will meet in October of 2010 for 2012 TAC advice, Fisheries Commission requests the Scientific Council to update its advice on shrimp stocks in 2011 for 2012 TAC.

   Fisheries Commission further requests that SC provide advice in accordance to Annex 1a.

2. Fisheries Commission requests that the Scientific Council provide advice for the management of the fish stocks below according to the following assessment frequency (unless Fisheries Commission requests additional assessments):

Two year basis	Three year basis
American plaice in Div. 3LNO	American plaice in Div. 3M
Capelin in Div. 3NO	Cod in Div. 3NO
Cod in Div. 3M	Northern shortfin squid in SA 3+4
Redfish in Div 3LN	Redfish in Div. 3O
Redfish in Div. 3M	Witch flounder in Div. 2J+3KL
Thorny skate in Div. 3LNOPs	Witch flounder in Div. 3NO
White hake in Div. 3NOPs	
Yellowtail flounder in Div. 3LNO	

   To continue this schedule of assessments, the Scientific Council is requested to conduct the assessment of these stocks as follows:

   In 2011, advice should be provided for 2012 and 2013 for American plaice in Div. 3LNO, yellowtail flounder in Div. 3LNO, redfish in Div. 3M, white hake in Div. 3NO and capelin in Div. 3NO and for 2012, 2013 and 2014 American plaice in Div. 3M and witch flounder in Div. 3NO.

   In 2011, advice should be provided for 2012 for 3M cod.

   Fisheries Commission requests that SC provide advice in accordance to Annex 1.

   The Fisheries Commission also requests the Scientific Council to continue to monitor the status of all these stocks annually and, should a significant change be observed in stock status (e.g. from surveys) or in bycatches in other fisheries, provide updated advice as appropriate.

3. With respect to Northern shrimp (*Pandalus borealis*) in Div. 3LNO, noting the NAFO Framework for Precautionary Approach and recognizing the desire to demonstrate NAFO's commitment to applying the precautionary approach, Fisheries Commission requests the Scientific Council to:

   a) identify F_{msy}
   b) identify B_{msy}
   c) provide advice on the appropriate selection of an upper reference point for biomass (e.g. B_{buf})

4. The Scientific Council is requested to provide updated information on the proportion of the 3LNO shrimp stock that occurs in 3NO.

5. With respect to 3M shrimp, the Scientific Council estimated in 2009 a proxy for B_{lim} as 85% decline from the maximum observed index levels, this is 2600 t of female biomass. In 2009 the Scientific Council estimated biomass to be below B_{lim} and recommended fishing mortality to be set as close to zero as possible.

In 2009 estimated catches reached 5000 t. The Fisheries Commission decided on a 50% effort reduction in 2010 and provisional estimated catches up to September 2010 reached 1000 t. In its 2010 advice, the Scientific Council estimated biomass to be above B_{lim}, but reiterated its previous advice to set fishing mortality as close to zero as possible. The Fisheries Commission requests the Scientific Council to evaluate if the current level of catches is compatible with stock recovery, given that improvements in biomass levels were observed through current level of catches.

6. The Fisheries Commission adopted in 2010 an MSE approach for Greenland halibut stock in Subarea 2 + Division 3KLMNO (FC Working Paper 10/7). This approach considers a survey based harvest control rule (HCR) to set a TAC for this stock on an annual basis for the next four year period. The Fisheries Commission requests the Scientific Council to:

   a) annually monitor and update the survey slope and to compute the TAC according to HCR adopted by the Fisheries Commission according to Annex 1 of FC Working Paper 10/7.

   b) provide guidance on what constitutes “exceptional circumstances”.

   c) provide advice on whether or not the “exceptional circumstances” provision should be applied.

7. Fisheries Commission requests the Scientific Council to identify $F_{msy,}$ identify B_{msy} and provide advice on the appropriate selection of an upper reference point for biomass (e.g. B_{buf}) for 3LNO American Plaice, 3NO cod and 3LN redfish.

8. Fisheries Commission requests the Scientific Council to review the stock recruit relationship for 3NO cod and the historical productivity regime used in setting the B_{lim} value of 60 000t.

9. *Noting that distribution and historical catches of capelin have also occurred in 3L, the Scientific Council is requested to provide the Fisheries Commission with available information on the occurrence and distribution of capelin in 3L and to advise on further research requirements.*

10. Fisheries Commission requests the Scientific Council to examine the consequences resulting from a decrease in mesh size in the mid-water trawl fishery for redfish in Div. 3LN to 90mm or lower.

11. Blue whiting (*Micromesistius poutassou*) is a widely distributed species, which can be found in the open ocean as a semi-pelagic species and in shallower waters close to the bottom. Blue whiting is largely fished in the North Eastern-Atlantic by pelagic trawls. The North East Atlantic Fisheries Commission (NEAFC) defined a minimum mesh size of 35mm when fishing for blue whiting with pelagic trawls in its regulatory area. Interest is increasing for developing fishing opportunities on this stock in the NAFO Regulatory Area, specifically in the boundary with the NEAFC RA, Division 1F, sub area 2 and Division 3K.

    The Fisheries Commission requests the Scientific Council to give advice on the following measures to be adopted for the blue whiting:

    a) Change in the classification of blue whiting in the species table (Annex II of NAFO CEM), from classification as a groundfish species to a pelagic species, consistent with the NEAFC classification.

    b) In line with conservation and management measures in force in the NEAFC Regulatory Area, adoption of a minimum mesh size for pelagic and semi-pelagic trawls which would include in paragraph 1 of Article 13 – Gear Requirements the following:

       - g) 35 mm for blue whiting in the fishery using pelagic trawls in Subarea 2 and Divisions 1F, 3K and 3M.

12. Catches of thorny skate in Div. 3LNO averaged 18 000 t between 1985 and 1991 and declined to 7 500 t in 1992-1995. Since 2000, estimated catches averaged 9 000 t. No analytical assessment has been performed and the current advice is based on the decline of the survey indices, which have been stable at low levels since 1996.

However, relative fishing mortality has been relatively constant at around 17% between 1998 and 2004 and declined to 5% from 2005. Scientific Council has recommended that catches in 2011 and 2012 should not exceed the last three years average catch (approximately 5 000 t).

The Fisheries Commission requests the Scientific Council to clarify the reason behind using the last three years period as the basis for the advice and to provide alternative options. In its examination, the Scientific Council should also take into account the relative stability of all survey indices since 1996 and furthermore consider the information that relative fishing mortality has declined to low levels.

13. Mindful of the NEREIDA mission, the international scientific effort led by Spain to survey the seafloor in the NAFO Regulatory Area.

    Recognizing that the Coral and Sponge Protection Zones closed to bottom fishing activities for the protection of vulnerable marine ecosystems as defined in Chapter 1 Article 16 Paragraph 3 is in place until December 31, 2011.

    Mindful of the call for review of the above measures based on advice from the Scientific Council.

    Fisheries Commission requests that Scientific Council review any new scientific information on the areas defined in Chapter 1 Article 16 Paragraph 3 which may support or refute the designation of these areas as vulnerable marine ecosystems. In the event that new information is not available at the time of the Fisheries Commission meeting in September 2011, prepare an overview of the type of information that will be available and the timeline for completion.

14. Noting the response from the Scientific Council in June 2010 regarding simulation modeling in a GIS framework: “To apply this model to the NRA, an agreed upon set of gear descriptions and tow duration/lengths for each fishing fleet segment would need to be created. Further estimation of retention efficiencies of the different commercial gears and indirect effects of fishing will be needed to model effects of serious adverse impacts.”

    The Fisheries Commission requests that the Scientific Council: 1) acquire the requisite data and apply the model to the extent possible to the NRA, and 2) consider whether the SASI model used by the US New England Fisheries Council should be incorporated into the aforementioned GIS framework as a means of integrating significant adverse impacts into the approach.

15. Recognizing the initiatives on vulnerable marine ecosystems (VME) through the work of the WGFMS, and with a view to completing and updating fishery impact assessments, the Scientific Council is requested to provide the Fisheries Commission at its next annual meeting in 2011:

    1) guidance on the timing and frequency of fishing plans/assessments for the purpose of evaluating significant adverse impacts on VMEs

    2) a framework for developing gear/substrate impact assessments to facilitate reporting amongst the Contracting Parties.

ADDITIONAL REQUEST

[16]. Fisheries Commission requests the Scientific Council to evaluate any negative scientific impacts resulting from reduction.

Annex 1 – Additional guidance in regards to questions 1 and 2.

Mindful of the desire to move to a risk-based approach in the management of fish stocks, Fisheries Commission requests the Scientific Council to provide a range of management options as well as a risk analysis for each option as outlined in the provisions below, rather than a single TAC recommendation.

1. The Fisheries Commission request the Scientific Council to consider the following in assessing and projecting future stock levels for those stocks listed above. These evaluations should provide the information necessary for the Fisheries Commission to consider the balance between risks and yield levels, in determining its management of these stocks:

   a) The preferred tool for the presentation of a synthetic view of the past dynamics of an exploited stock and its future development is a stock assessment model, whether age-based or age-aggregated.

   b) For those stocks subject to analytical-type assessments, the status of the stocks should be reviewed and catch options evaluated in terms of their implications for fishable stock size in both the short and long term. As general reference points, the implications of fishing at $F_{0.1}$ and F_{2010} in 2012 and subsequent years should be evaluated. The present stock size and spawning stock size should be described in relation to those observed historically and those expected in the longer term under this range of options.

   c) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and catch options evaluated in the way described above to the extent possible. In this case, the level of fishing effort or fishing mortality (F) required to take two-thirds MSY catch in the long term should be calculated.

   d) For those resources for which only general biological and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.

   e) Spawning stock biomass levels considered necessary for maintenance of sustained recruitment should be recommended for each stock, defined in relation to both long-term productivity regimes, and current productivity regimes to the extent these may differ. In those cases where present spawning stock size is a matter of scientific concern in relation to the continuing reproductive potential of the stock, options should be offered that specifically respond to such concerns.

   f) Information should be provided on stock size, spawning stock sizes, recruitment prospects, fishing mortality, catch rates and catches implied by these management strategies for the short and the long term in the following format:

      I. For stocks for which analytical-type assessments are possible, graphs should be provided of all of the following for the longest time-period possible:
         - historical yield and fishing mortality;
         - spawning stock biomass and recruitment levels;
         - catch options for the year 2012 and subsequent years over a range of fishing mortality rates (for as many years as the data allow)
         - (F) at least from $F_{0.1}$ to F_{max};
         - spawning stock biomass corresponding to each catch option;
         - yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.

      II. For stocks for which advice is based on general production models, the relevant graph of production as a function of fishing mortality rate or fishing effort should be provided. Age aggregated assessments should also provide graphs of all of the following for the longest time period possible:
         - exploitable biomass (both absolute and relative to B_{MSY})
         - yield/biomass ratio as a proxy for fishing mortality (both absolute and relative to F_{MSY})
         - estimates of recruitment from surveys, if available.

III. Where analytical methods are not attempted, the following graphs should be presented, for one or several surveys, for the longest time-period possible:
- time trends of survey abundance estimates, over:
- an age or size range chosen to represent the spawning population
- an age or size-range chosen to represent the exploited population
- recruitment proxy or index for an age or size-range chosen to represent the recruiting population.
- fishing mortality proxy, such as the ratio of reported commercial catches to a measure of the exploited population.

For age-structured assessments, yield-per-recruit graphs and associated estimates of yield-per-recruit based reference points should be provided. In particular, the three reference points, actual F, $F_{0.1}$ and F_{max} should be shown.

2. Noting the Precautionary Approach Framework as endorsed by Fisheries Commission, the Fisheries Commission requests that the Scientific Council provide the following information for the 2011 Annual Meeting of the Fisheries Commission for all stocks under its responsibility requiring advice for 2012:

   a) the limit and precautionary reference points as described in Annex II of the UN Fisheries Agreement indicating areas of uncertainty (for those stocks for which precautionary reference points cannot be determined directly, proxies should be provided);
   b) the stock biomass and fishing mortality trajectory over time overlaid on a plot of the PA Framework (for those stocks where biomass and/or fishing mortality cannot be determined directly, proxies should be used);
   c) information regarding the current Zone the stock is within as well as proposals regarding possible harvest strategies which would move the resource to (or maintain it in) the Safe Zone, including medium term considerations and associated risk or probabilities which will assist the Commission in developing the management strategies described in paragraphs 4 and 5 of Annex II in the Agreement.

3. The following elements should be taken into account by the Scientific Council when considering the Precautionary Approach Framework:

   a) References to "risk" and to "risk analyses" should refer to estimated probabilities of stock population parameters falling outside biological reference points.
   b) Where reference points are proposed by the Scientific Council as indicators of biological risk, they should be accompanied by a description of the nature of the risk associated with crossing the reference point such as recruitment overfishing, impaired recruitment, etc.
   c) When a buffer reference point is identified in the absence of a risk evaluation in order to maintain a low probability that a stock, measured to be at the buffer reference point, may actually be at or beyond the limit reference point, the Scientific Council should explain the assumptions made about the uncertainty with which the stock is measured.
   d) Wherever possible, short and medium term consequences should be identified for various exploitation rates (including no fishing) in terms of yield, stability in yield from year to year, and the risk or probability of maintaining the stock within, or moving it to, the Safe Zone. Whenever possible, this information should be cast in terms of risk assessments relating fishing mortality rates to the trends in biomass (or spawning biomass), the risks of stock collapse and recruitment overfishing, as well as the risks of growth overfishing, and the consequences in terms of both short and long term yields.
   e) When providing risk estimates, it is very important that the time horizon be clearly spelled out. By way of consequence, risks should be expressed in timeframes of 5, 10 and 15 years (or more), or in terms of other appropriate year ranges depending on stock specific dynamics. Furthermore, in order to provide the Fisheries Commission with the information necessary to consider the balance between risks and yield levels, each harvesting strategy or risk scenario should include, for the selected year ranges, the risks and yields associated with various harvesting options in relation to B_{lim}.

Annex II. Canadian Request for Scientific Advice on Management in 2012 of Certain Stocks in Subareas 0 to 4.

1. Canada requests that the Scientific Council, at its meeting in advance of the 2011 Annual Meeting of NAFO, subject to the concurrence of Denmark (on behalf of Greenland), provide advice on the scientific basis for management in 2012 of the following stocks

   Shrimp (Subareas 0 and 1)
   Greenland halibut (Subareas 0 and 1)

   The Scientific Council has noted previously that there is no biological basis for conducting separate assessments for Greenland halibut throughout Subareas 0-3, but has advised that separate TACs be maintained for different areas of the distribution of Greenland halibut. The Council is therefore, subject to the concurrence of Denmark (on behalf of Greenland) as regards Subarea 1, to provide an overall assessment of status and trends in the total stock area throughout its range and comment on its management in Subareas 0+1 for 2012, and to specifically:

   a) Advise on appropriate TAC levels for 2012, separately, for Greenland halibut in the offshore area of Divisions 0A+1AB and Divisions 0B+1C-F. The Scientific Council is also asked to advise on any other management measures it deems appropriate to ensure the sustainability of these resources.

   b) With respect to shrimp, it is recognized that the Council may, at its discretion, delay providing advice until later in the year, taking into account data availability, predictive capability, and the logistics of additional meetings.

2. Canada requests the Scientific Council to consider the following options in assessing and projecting future stock levels for Shrimp and Greenland halibut in Subareas 0 and 1:

   a) For those stocks subject to analytical-type assessments, the status of the stock should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. The implications of no fishing as well as fishing at F0.1, and F2010 in 2012 and subsequent years should be evaluated in relation to precautionary reference points of both fishing mortality and spawning stock biomass. The present stock size and spawning stock size should be described in relation to those observed historically and those to be expected in the longer term under this range of fishing mortalities, and any other options Scientific Council feels worthy of consideration under the NAFO Precautionary Approach Framework.

      Opinions of the Scientific Council should be expressed in regard to stock size, spawning stock sizes, recruitment prospects, catch rates and catches implied by these management strategies for the short and long term. Values of F corresponding to the reference points should be given. Uncertainties in the assessment should be evaluated and presented in the form of risk analyses related to B_{lim} (B_{buf}), and F_{lim} (F_{buf}), as per the NAFO Precautionary Approach Framework.

   b) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. Management options should be within the NAFO Precautionary Approach Framework.

   c) For those resources for which only general biological advice and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of the management requirements for long-term sustainability and management options evaluated in the way described above to the extent possible. Management options should be within the NAFO Precautionary Approach Framework.

   d) Presentation of the results should include the following:

      I. For stocks for which analytical-type assessments are possible:
         - A graph of historical yield and fishing mortality for the longest time period possible;

- A graph of spawning stock biomass and recruitment levels for the longest time period possible. The biomass graph should indicate the stock trajectory compared to B_{lim};
- Graphs and tables of catch options for the year 2012 and subsequent years over a range of fishing mortality rates (F) at least from F=0 to $F_{0.1}$ including risk analyses;
- Graphs and tables showing spawning stock biomass corresponding to each catch option including risk analyses;
- Graphs showing the yield-per-recruit and spawning stock per recruit values for a range of fishing mortalities.

II. For stocks for which advice is based on general production models, the relevant graph of production on fishing mortality rate or fishing effort.

In all cases, the reference points, F=0, actual F, and $F_{0.1}$ should be shown. As well, Scientific Council should provide the limit and precautionary reference points as described in the NAFO Precautionary Approach Framework, indicating areas of uncertainty (when reference points cannot be determined directly, proxies should be provided).

Annex IIIa. Denmark (Greenland) Request for Scientific Advice on Management in 2012 of Certain Stocks in Subarea 0 and 1

1. Advice for Roundnose grenadier in Subarea 0+1 was in 2008 given for 2009-2011. Denmark (on behalf of Greenland) requests the Scientific Council to provide advice on the scientific basis for the management of Roundnose grenadier in Subarea 0+1 for 2012-2014.

2. Advice for redfish (*Sebastes spp*.) and other finfish (American plaice (*Hippoglossoides platessoides*), Atlantic wolffish (*Anarhichas lupus*), spotted wolffish (*A. minor*) and thorny skate (*Amblyraja radiata*) in Subarea 1 was in 2008 given for 2009-2011. Denmark (on behalf of Greenland) requests the Scientific Council to provide advice for redfish (*Sebastes spp*.) and other finfish (American plaice (*Hippoglossoides platessoides*), Atlantic wolffish (*Anarhichas lupus*), spotted wolffish (*A. minor*) and thorny skate (*Amblyraja radiata*) on the scientific basis for the management of in Subarea 1A for 2012-2014.

3. Subject to the concurrence of Canada as regards Subarea 0+1, the Scientific Council is requested to provide advice on appropriate TAC levels for 2012 separately for Greenland halibut in 1) the offshore area of NAFO Subarea 0A+Divisions 1A Offshore + Divisions 1B and 2) NAFO Subarea 0B + Division 1C-1F. The Scientific Council is also asked to advice on any other management measures it deems appropriate to ensure the sustainability of these resources.

4. Advice for Greenland halibut in Subarea 1A inshore was in 2010 given for 2011-2012. Denmark (on behalf of Greenland), requests the Scientific Council to continue to monitor the status of Greenland halibut in Subarea 1A inshore annually, and should significant change in stock status be observed, the Scientific Council is requested to provide updated advice as appropriate.

5. Subject to the concurrence of Canada as regards Subarea 0+1, Denmark (on behalf of Greenland) further requests the Scientific Council of NAFO before December 2011 to provide advice on the scientific basis for management of Northern shrimp (*Pandalus borealis*) in Subarea 0 and 1 in 2012 for as many years ahead as data allows for.

Furthermore, the Council is in co-operation with ICES requested to provide advice on the scientific basis for management of Northern shrimp (*Pandalus borealis*) in Denmark Strait and adjacent waters east of southern Greenland in 2012 and as many years ahead as data allows for.

Annex IIIb. Additional Request from Denmark (Greenland) for Audit of Management Plan for the Shrimp Fishery in West Greenland

Denmark, on behalf of Greenland, requests the Scientific Council to *audit the shrimp management plan to be available simultaneous with, or preferably immediately before, the annual shrimp advice in November 2011 with a view to include recommendations in the determination of the shrimp TAC for 2012.*

As the shrimp group in the Scientific Council has estimated that the current reference points in section 20 of the shrimp management plan are too conservative, the Scientific Council is furthermore requested, with reference to Section 20 in the management plan, *to recommend specific threshold values as the appropriate threshold reference points in relation to* B_{msy}, B_{lim} *and* Z_{msy} *as soon as the limits of the biomass is exceeded.*

Annex IIIc. Additional Request from Denmark (Greenland) on Striped pink shrimp (*Pandalus montagui*).

Greenland is in the process of establishing the necessary documentation for obtaining MSC certification for its shrimp fishery in West Greenland and in that respect Greenland has been asked to provide additional information on the stock and management regarding the Striped pink shrimp *(P. montagui)* in Subarea 0 and 1 in 2012 and years ahead.

As *P. montagui* is the main retained bycatch species in the fishery for Northern shrimp (*P. borealis),* the Council is requested for *advice on measures that might be applied in the fishery for P. borealis to maintain the stock of P. montagui within safe biological limits*.

The Scientific Council is in other words asked for advice *on whether the stock of the main retained bycatch species P. montagui is within safe biological limits and on measures that might be applied in the fishery for P. borealis to maintain the stock of the main retained bycatch species P. montagui within safe biological limits.*

Annex IV. ICES ToRs for NIPAG

From 2010 ACOM and ACOM Expert Group ToR's
(http://www.ices.dk/iceswork/recs/2010%20Resolutions/ACOM%20EG%20ToRs%202011.pdf)

Generic ToRs for Regional and Species Working Groups

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

The working group should focus on:

ToRs a) to g) for stocks that will have advice,
ToRs b) to f) and h) for stocks with same advice as last year.
ToRs b) to c) and f) for stocks with no advice.

a) Produce a first draft of the advice on the fish stocks and fisheries under considerations according to ACOM guidelines and implementing recommendations from WKMSYREF.

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

i) Load fisheries data on effort and catches (landings, discards, bycatch, including estimates of misreporting when appropriate) in the INTERCATCH database by fisheries/fleets. Data should be provided to the data coordinators at deadlines specified in the ToRs of the individual groups. Data submitted after the deadlines can be incorporated in the assessments at the discretion of the Expert Group chair;
ii) Abundance survey results;
iii) Environmental drivers.
iv) Propose specific actions to be taken to improve the quality of the data (including improvements in data collection).

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

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

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

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

i) Input data (including information from the fishing industry and NGO that is pertinent to the assessments and projections);
ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;
iii) Stock status and 2012 catch options;
iv) Historical performance of the assessment and brief description of quality issues with the assessment;
v) Mixed fisheries overview and considerations;
vi) Species interaction effects and ecosystem drivers;
vii) Ecosystem effects of fisheries;
viii) Effects of regulatory changes on the assessment or projections;

g) Where appropriate, check for the need to reopen the advice in autumn based on the new survey information and the guidelines in AGCREFA (2008 report).

h) For the stocks where the advice is marked 'collate data', available data should be collected and presented as far as possible. If information is available for more than or only part of the area, the header for the stock can be adapted (please discuss with the secretariat).

i) Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision (available at:

http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF;

j) Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.

k) Take note of and comment on the Report of the Workshop on the Science for area based management: Coastal and Marine Spatial Planning in Practice (WKCMSP) http://www.ices.dk/reports/SSGHIE/2011/WKCMSP11.pdf

l) Provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes.

m) Identify spatially resolved data, for e.g. spawning grounds, fishery activity, habitats, etc. In the EG report please indicate how advice for this stock can be given in future; both what timing (data availibility over the year) and analytical / trends based assessment options are concerned.

A draft advice sheet should be produced that presents available information and informs about the status of the stock assessment possibilities.

APPENDIX II. LIST OF RESEARCH AND SUMMARY DOCUMENTS, 20-27 OCTOBER 2010

RESEARCH DOCUMENTS (SCR)

SCR 11/049	N5974	D.C. Orr and D.J. Sullivan	The 2011 assessment of the Northern Shrimp (*Pandalus borealis*, Kroyer) resource in NAFO Divisions 3LNO
SCR 11/050	N5975	Anja Retzel	A preliminary estimate of Atlantic cod (*Gadus morhua*) biomass in West Greenland offshore waters (NAFO Subarea 1) for 2011 and recent changes in the spatial overlap with Northern shrimp (Pandalus borealis)
SCR 11/051	N5976	Michael C.S. Kingsley	Catch Table Update for the West Greenland Shrimp Fishery
SCR 11/052	N5977	Michael C.S. Kingsley	The Fishery for Northern Shrimp (*Pandalus borealis*) off West Greenland, 1970–2011
SCR 11/053	N5978	Michael C.S. Kingsley	Pandalus montagui in the West Greenland shrimp fishery, 2001–2010.
SCR 11/054	N5979	Helle Siegstad	The Fishery for Northern Shrimp (*Pandalus borealis*) in Denmark Strait / off East Greenland – 2011
SCR 11/055	N5980	Kingsley, M.C.S, Helle Siegstad and Kai Wieland	The West Greenland trawl survey for *Pandalus borealis*, 2011, with reference to earlier results
SCR 11/056	N5981	Helle Siegstad	Results of the Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis*) Off East Greenland (ICES Subarea XIV b), 2008-2011
SCR 11/057	N5982	Michael C.S. Kingsley	Bycatch rates in the West Greenland shrimp fishery, 1975–2010
SCR 11/058	N5983	Michael C. S. Kingsley	A Provisional Assessment of the Shrimp Stock off West Greenland in 2011
SCR 11/059	N5984	J. M. Casas	The Spanish Shrimp Fishery on Flemish Cap (Division 3M) and Division 3L in 2010
SCR 11/060	N5985	J. M. Casas	Northern Shrimp (*Pandalus borealis*) on Flemish Cap Surveys 2011
SCR 11/061	N5986	J. M. Casas, E. Román, J. Teruel, E. Marull and G. Ramilo	Northern Shrimp (*Pandalus borealis*, Krøyer) from Spanish Bottom Trawl Survey 2011 in NAFO Div. 3LNO
SCR 11/062	N5987	J. M. Casas	Assessment of the International Fishery for Shrimp (*Pandalus borealis*) in Division 3M (Flemish Cap), 1993-2011

SCR 11/063	N5988	Bakanev S. V., Lubin P.A. and Zakharov D.V.	Results of Russian investigations of the northern shrimp in the Barents Sea in 2004-2011
SCR 11/064	N5989	G. Søvik and T. Thangstad	Results of the Norwegian Bottom Trawl Survey for Northern Shrimp (*Pandalus borealis*) in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa east) in 2011
SCR 11/065	N5991	C. Hvingel, T. Thangstad and P. Lyubin	Research survey information regarding northern shrimp (*Pandalus borealis*) in the Barents Sea and Svalbard area 2004-2011
SCR 11/066	N5992	Carsten Hvingel and Trude Thangstad	The Norwegian fishery for northern shrimp (*Pandalus borealis*) in the Barents Sea and round Svalbard 1970-2011
SCR 11/067	N5993	Sten Munch-Petersen, Mats Ulmestrand, Guldborg Søvik and Ole Eigaard	Discarding in the shrimp fisheries in Skagerrak and the Norwegian Deep (ICES Divs. IIIa and IVa east)
SCR 11/068	N5994	G. Søvik and T. Thangstad	The Norwegian Fishery for Northern Shrimp (*Pandalus borealis*) in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa east), 1970-2011
SCR 11/069	N5995	S. Munch-Petersen, O. Eigaard, G. Søvik and M. Ulmestrand	The Northern shrimp (*Pandalus borealis*) Stock in Skagerrak and the Norwegian Deep (ICES Divisions IIIa and IVa East) (ICES Divisions IIIa and IVa East)
SCR 11/070	N5996	H. Siegstad and N. Hammeken Arboe	Occurrence of *Pandalus montagui* in Trawl Survey Samples from NAFO Subareas 0+1.
SCR 11/071	N5997	Carsten Hvingel	Shrimp (*Pandalus borealis*) in the Barents Sea – stock assessment 2011

SUMMARY DOCUMENTS (SCS)

SCS No.	**Ser. No.**	**Author(s)**	**Title**
SCS 11/20	N5998		NIPAG Report
SCS 11/21	N5999		SC Report

APPENDIX III. LIST OF PARTICIPANTS

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APPENDIX IV: LIST OF RECOMMENDATIONS

NIPAG recommendations for Northern shrimp in Div. 3LNO:

3. *biological and CPUE data from all fleets fishing for shrimp in the area be submitted to the Designated Expert, in the standard format, by 1 September 2012.*
4. *NIPAG recommended that research continue into fitting production models to data for northern shrimp in Div. 3LNO including studies of stock structure and continued investigation of stock assessment models for Pandalus borealis in NAFO Div. 3LNO. This may help provide estimations of B_{MSY} and F_{MSY}.*

NIPAG management recommendations for shrimp in Skagerrak and Norwegian Deep:

- *sorting grids or other means of facilitating the escape of fish should be implemented in this fishery.*
- *all Norwegian vessels should be required to complete and provide log books.*

NIPAG research recommendations for shrimp in Skagerrak and Norwegian Deep:

- *The Norwegian survey time series indices from 1984 - 2003 should be recalculated in order to provide confidence intervals and length frequency distributions.*

APPENDIX V. TECHNICAL MINUTES FROM THE REVIEW OF ICES STOCKS OF NAFO/ICES PANDALUS ASSESSMENT GROUP (NIPAG) (REPORT 2011)

26.10.2011. – 28.10-2011

By correspondence

Reviewers:

Max Cardinale, Lionel Pawlowski, and Tammo Bult (chair)

Chair WG- ICES Stocks: Carsten Hvingel

Secretariat: Barbara Schoute

General

The Review Group considered the following stocks:

Species	Stock name	Type assessment
pand-sknd	Northern shrimp (*Pandalus borealis*) in Division IIIa West and Division IVa East (Skagerrak and Norwegian Deeps)	Updated - advice
pand-barn	Northern Shrimp (*Pandalus borealis*) in Subareas I and II (Barents Sea)	Updated - advice
pand-flad	Northern shrimp (*Pandalus borealis*) in Division IVa (Fladen Ground)	No assessment - Same advice as last year

The review group worked by correspondence. Each stock was revised by two reviewers and a final overall check was done by all.

General comments

The report is very well organized, easy to follow and to interpret. As in the previous years, the report refers several working documents important to clarify some issues. No Management consideration section is presented in each section as it was recommended last year by the RG.

The working group indicated that the timing of the review and advice drafting group, overlapping with the NIPAG meeting, does not improve the quality of the work. The RG agrees with comments from the working group that the timing of the work should be less constricted.

NORTHERN SHRIMP IN SKAGERRAK AND NORWEGIAN DEEPS (ICES DIV. IIIA WEST AND IVA EAST (REPORT SECTION 5)

1) **Assessment type: update,** trends in Danish and Norwegian LPUEs and from Norwegian shrimp survey

2) **Assessment**: no analytical assessment

3) **Forecast**: not performed

4) **Assessment model**: Standardized LPUE (GLM) and Stock size index from surveys (Stratified sampling including swept area)

5) **Consistency**: consistent with last year assessment.

6) **Stock status**: Biomass declining since 2007. Declining trends for recruitment from 2007 to 2010. 2011 is around the level seen in the previous 3 years. No reference points defined

7) **Man. Plan.**: None

General comments

A significant effort has made by the WG to deal with most of the comments made by the RG in previous years. As last year, the document is easy to follow. A recurring comment from last year is to replace for clarification the "in recent years" by an explicit indication of the period.

- Landings. The landings in 2010 are substantially lower than in 2009 (-3500t) with lower landings from Norway, Denmark and Sweden. While it is explained that Danish and Norwegian fleets have undergone major restructuring "in recent years" which probably explains why landings have decreased, it is not clear why Swedish landings are also lower. I am although wondering if 2010 data are preliminary or complete, or are there other explanation for the big drop observed for all countries ?

- Catch and discards. Some of the length distributions in doc 11/67 should probably be added into this section as there's a paragraph on length distribution but no figure in the report. As requested last year, there are now explanations about the uncertainties on discards and highgradings for Swedish and Norwegian fleets with clarification about the sources of those uncertainties. Absolute values of discard should be derived using annual discard data that should have been collected through the DCF framework at least for the Danish and Swedish fisheries. Since this has been pointed out also in previous report, the sampling should have been changed accordingly and therefore saying that few samples are taken is not acceptable.

- Commercial fishery data. As last year, some exploratory work would be interesting regarding the inclusion of swedish LPUEs or at least, the evaluation on how the level of uncertainty regarding high-grading affect those LPUEs. The Swedish LPUE data should be also modelled as those are an important part of the catch information in the area. This has been recommended now since several years but nothing has been done in that direction. Saying that the work is in progress is not acceptable anymore.

- The standardization procedures are now appropriate but I suggest that next time the working documents were the procedures are explained in details are included in the review process. The standardization is the most important part of this assessment (and also for the Barents Sea stock) and needs careful examination.

- Landings. As mentioned above, having length distribution, catch at age data year by year would be nice to have in the main body of the report.

- surveys. Confidence intervals are missing for survey 1. The text does not explain the increasing trend from 1988 to the mid 1990s.

Conclusions and recommendations

The stock follows the same trends as last year. All indicators suggest a declining biomass. Recruitment in 2011, although slightly higher than in 2010 is one of the lowest recruitment of the 2006-2011 time series.

Following the comments from the last 2 years, this stock is now scheduled for a benchmark in 2012 therefore it is assumed that data and methods will be revisited. There are some work in progress regarding Swedish effort data and a modeling framework.

NORTHERN SHRIMP IN BARENTS SEA AND SVALBARD AREA (ICES SUBAREAS I AND II (REPORT SECTION 6)

1) **Assessment type: Update**
2) **Assessment: accepted**
3) **Forecast: stochastic forecast (10 years)**
4) **Assessment model: Bayesian version of a surplus-production model:** Input commercial CPUE, two surveys CPUE and total catch
5) **Consistency: consistent with last year assessment.**
6) **Stock status: B>B_{lim} and F<F_{lim}** being F_{lim}=F_{msy} and B_{lim}=0.3B_{msy}, B is above B_{msy} with a high probability
7) **Man. Plan.: No management plan is a agreed for this stock.**

General comments

A significant effort has made by the WG to deal with most of the comments made by the RG in previous years. This section is also easy to follow.

Technical comments:

The major deficiencies in the assessment are:

The standardization procedure of the commercial CPUE time series is again poorly explained. The WG did not make any effort to explain this aspect in the 2010 and now in the 2011 report. This is unfortunate as it makes the work of RG basically an academic exercise. The major issues are:

1. It is not explained how the vessel effect is modeled, theoretically it should be swept area or at least HP that is usually a proxy of it
2. A GAM should because: month has a cyclic effect (month 12 closer to month 1 than to month 9) and this can be modeled in a GAM
3. The year effect should be modeled as smoother as the year before is correlated with the year after since the biomass is made by several year classes merged together
4. The shape of the effect of the predictors should be showed in the report
5. The error distribution used is not mentioned
6. The residuals should be formally analysed
7. A spatial predictor should be included

The surveys sampling strategy is not explained and it should at least briefly. Is survey design a random stratified? How the index is derived? This should be clearly explained. I suggest that the survey index is also derived using a standardization procedure (i.e. GAM) (see comments above).

How is the uncertainty in the catchability parameters included in the estimation of the TAC? As it stands now, the reader is left out with no information to judge this rather crucial step of the analysis.

It would be nice to have The modelling framework from (Hvingel, 2006) as an annex or a properly referenced document. This section refers to a set of working documents from previous years. Tracking down those documents across years is difficult and will certainly be more difficult in the future. The presentation of the model and rationales for using relative biomass are well explained.

Reference points: this model seems to fit well the new ICES approach and guidelines on biological reference points. $B_{trigger}$ is set at 0.50 times the B_{msy} and B_{lim} is set at 0.30 times the B_{msy}. Both seem to be rather low in my opinion. As the framework here is different from the standard ICES approach, I think that ACOM should spend some time to get an agreement about the validity of these reference points for Northern Shrimp in Barents Sea and Svalbard area (ICES Subareas I and II).

Results and forecasts are nicely presented. The summary section is very straightforward. It is worth noting that few assessments within ICES includes the probability of risk of being below or over reference points and there have been recurring discussions in some WG (e.g. WGMG) about how to include uncertainties into the advices.

Like last year retrospective plot are too thick to be able to see some trends. Considering the retrospective effects are only visible for a few years, having only the last 10-15 years shown should probably be enough.

Conclusions and recommendations:

The assessment is done according to the annex and can be accepted as basis for advice. There does not seem to be major issues regarding the assessment and the data used.

NORTHERN SHRIMP IN FLADEN GROUND (ICES DIVISION IVA) (REPORT SECTION 7)

Assessment type: no assessment

- No direct shrimp fishery since 2005.

Comments

The conclusive comment "This stock has not been surveyed for several years, and the decline in this fishery may reflect a decline in the stock" is quite strong considering there's actually no fishery, no survey. The decline of this fishery may have been caused by low abundances, low benefits (low prices and high cost of fuel) but the current status of the stock is rather unknown.

Conclusions and recommendations:

Except landings which have been null since 2005, no new data are available on this stock therefore the available information is inadequate to evaluate stock trends. The state of this stock is unknown.

Should the landings of this fishery be back to substantial levels, some data collection program should be implemented.