PART D: NAFO/ICES PANDALUS ASSESSMENT GROUP (NIPAG) MEETING, 12–19 SEPTEMBER 2013

Contents

Report of NIPAG Meeting

12–19 September 2013

Co-Chairs: Carsten Hvingel and Peter Shelton Rapporteurs: Various

I. OPENING

The NAFO/ICES *Pandalus* Assessment Group (NIPAG) met at the NAFO Secretariat, Dartmouth, NS, Canada during 12-19 October 2013 to review stock assessments referred to it by the Scientific Council of NAFO and by the ICES Advisory Committee. Due to unforeseen circumstances the STACFIS Chair, Jean-Claude Mahé was unable to attend this meeting and so the Chair of Scientific Council, Carsten Hvingel agreed to chair is his place. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Denmark, Estonia, France, Spain and Sweden), Norway, Russian Federation. The NAFO Scientific Council Coordinator was also in attendance.

II. GENERAL REVIEW

1. Review of Research Recommendations in 2012

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)

(SCR Doc. 13/018, 060 and 061)

Environmental Overview

The composite climate index in Subarea 3 (Div. 3M) has remained above normal in recent years (2010-2012) although the index has declined consecutively in the past three years. Below normal climate conditions characterized the early to mid-1990s period with above average levels throughout the last decade. The composite spring bloom index has been relatively stable over the past decade and no long-term trends apparent in productivity during the period of rapid warming. The composite zooplankton index (mainly composed of copepod and meroplankton taxa) peaked in 2010 and has remained at relatively high levels throughout the recent years. Surface temperatures on the Flemish Cap were above normal in 2012. Along the 47ºN section, the summer Cold-Intermediate Layer (CIL) area was near normal in 2012 implying cooler conditions after record-low values in 2010-2011. Bottom temperature anomalies across the Flemish Cap ranged from 1-2 standard deviations above normal in 2012, and have remained high since 2008. Environmental conditions we reviewed by STACFEN in June 2013 (SCS Doc. 13/17). Additional data from 2013, reviewed in September, is consistent with these general trends.

a) Introduction

The shrimp fishery in Div. 3M is now under moratorium. This fishery began in 1993. Initial catch rates were favorable and, shortly thereafter, vessels from several nations joined. Catches peaked at over 60 000 t in 2003 and declined thereafter.

Fishery and catches: This fishery is effort-regulated. The effort allocations were reduced by 50% in 2010 and a moratorium was imposed in 2011. Catches are expected to be close to zero in 2013.

Recent catches were as follows:

	2006	2007	2008	2009	2010	2011	2012	2013
NIPAG	18 000	21 000	13 000	5 000	2 000	0	0	0[1]
STATLANT 21	15191	17642	13431	5374	1976	0	0	
SC Recommended TAC	48 000	48 000	17 000 – 32 000	18 000 – 27 000	ndf	ndf	ndf	ndf
Effort (Agreed Days)	10555	10555	10555	10555	5227	0	0	0

[1] To September 2013

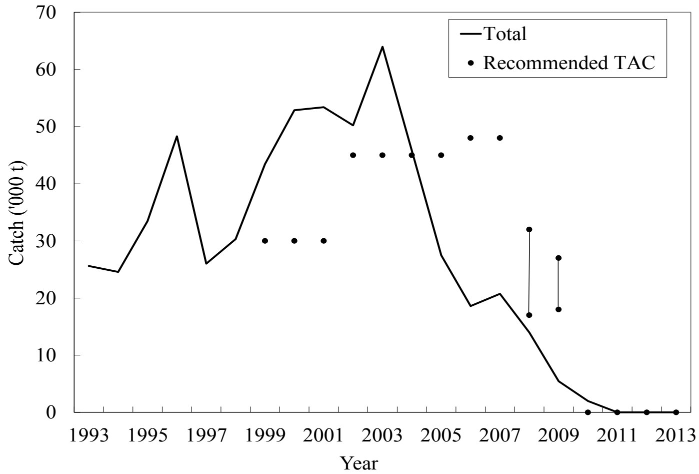

Fig. 1.1. Shrimp in Div. 3M: Catches (t) of shrimp on Flemish Cap and TACs recommended in the period 1993-2013. Due to a moratorium, the shrimp catch is expected to be zero in 2013.

b) Input Data

i) Commercial fishery data

Time series of size and sex composition data were available mainly from Iceland and Faroes between 1993 and 2005 and survey indices were available from EU research surveys (1988-2013). Because of the moratorium catch and effort data have not been available since 2010, and therefore the standardized CPUE series has not been extended.

ii) Research Survey Data

Stratified-random trawl surveys have been conducted on Flemish Cap by the EU in July from 1988 to 2013. 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 using the methods accepted by STACFIS in 2004 (NAFO 2004 SC Rep., SCR Doc. 04/77). The female biomass index was stable at a high level from 1998 to 2007. After 2007 the survey biomass index declined and in 2013 was the lowest in the survey series, well below B_{lim}. B_{lim} is defined as 15% of the highest observed female biomass index (2002).

c) Assessment

No analytical assessment is available. Evaluation of stock status is based upon fishery and research survey data.

Recruitment: All year-classes after the 2002 cohort (i.e. age 2 in 2004) have been weak.

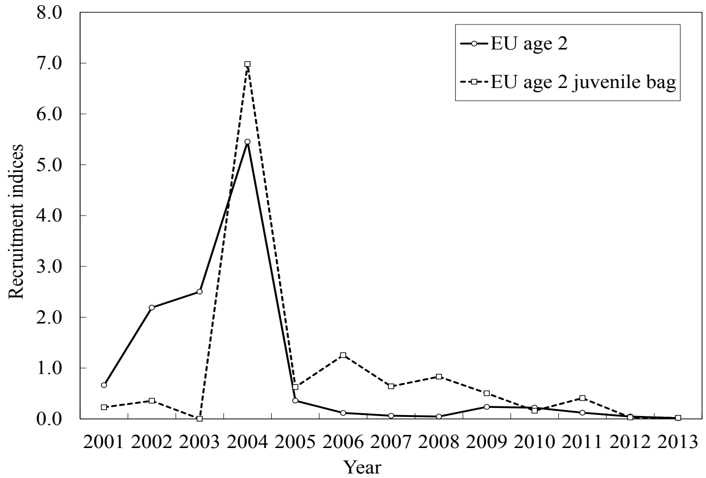

Fig. 1.2. Shrimp in Div. 3M: Abundance indices at age 2 from the EU survey. Each series was standardized to its mean.

SSB: The survey female biomass index was at a high level from 1998 to 2007, and has declined to its lowest level in 2013, well below B_{lim}.

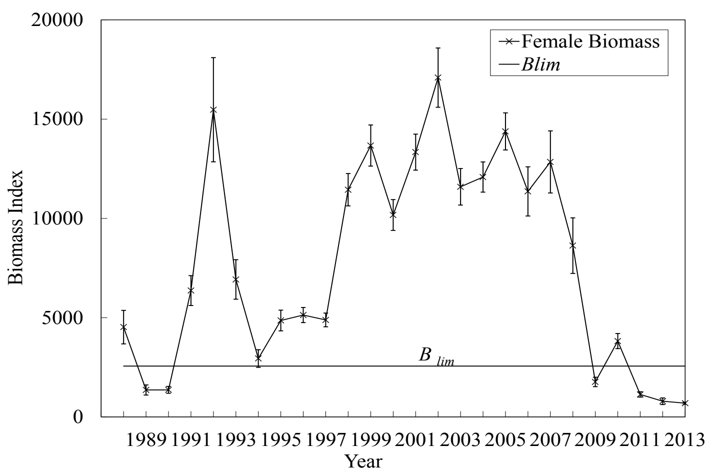

Fig. 1.3. Shrimp in Div. 3M: Female biomass index from EU trawl surveys, 1988-2013. Error bars are 1 std. err.

Exploitation rate: Because of low catches, followed by the moratorium, the exploitation rate index (nominal catch divided by the EU survey biomass index of the same year) has declined to near zero.

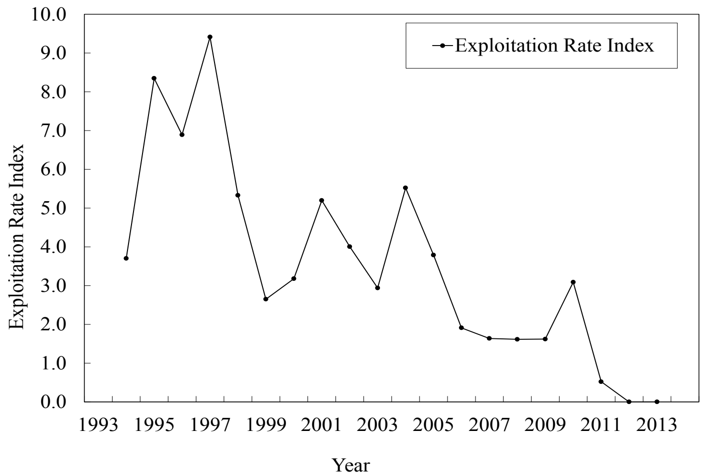

Fig. 1.4. Shrimp in Div. 3M exploitation rate index as derived by catch divided by the EU survey biomass index of the same year.

d) State of the Stock

Following several years of low recruitment, the spawning stock has declined, and has remained below B_{lim} since 2011. Due to continued poor recruitment there are concerns that the stock will remain at low levels.

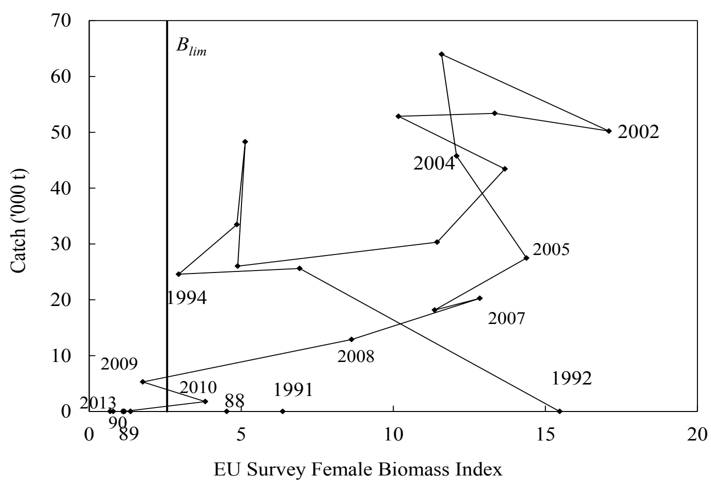

Fig. 1.5. Shrimp in Div. 3M: Catch plotted against female biomass index from EU survey. Line denoting B_{lim} is drawn where biomass is 15% of the maximum point in 2002. Due to the moratorium on shrimp fishing the expected catch in 2013 is 0 t.

e) Reference Points

Scientific Council considers that a female survey biomass index of 15% of its maximum observed level provides a proxy for B_{lim}. This corresponds to an index value of 2 564 (SCS Doc. 04/12). The index has been below B_{lim} since 2010. A limit reference point for fishing mortality has not been defined.

f) Ecosystem considerations

The drastic decline of shrimp biomass since 2007 correlates with the increase of the cod stock in Div. 3M. It is uncertain whether this represents a causal relationship and/or covariance as the result of an environmental factor.

The environment, trophic interactions, and fisheries are important drivers of fish stock dynamics. Analyses of fish stomachs show an increasing proportion of shrimp in the diets of most fish species since the mid to late 1990s, and, since the early 2000s, an increase of redfish in the diet of large individuals of predatory species. These trends are observed throughout the Flemish Cap fish community.

Results of modelling suggest that, in unexploited conditions, cod would be expected to be a highly dominant component of the system, and high shrimp stock sizes, like the ones observed in the 1998 – 2007 period, would not be a stable feature in the Flemish Cap.

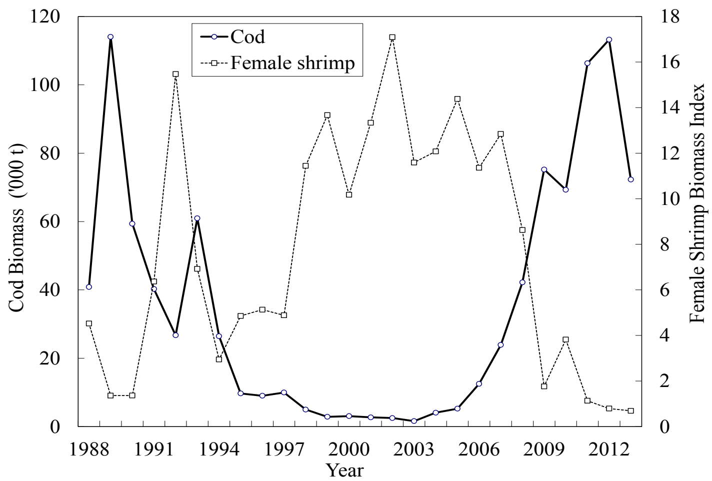

Fig. 1.6. Shrimp in Div. 3M: Cod and total shrimp biomass from EU trawl surveys, 1988-2013.

g) Research Recommendations

For Northern Shrimp in Div. 3M NIPAG **recommends** that *further exploration of the relationship between shrimp, cod and the environment be continued in WGESA and NIPAG encourages the shrimp experts to be involved in this work.*

2. Northern Shrimp (*Pandalus borealis*) in Div. 3LNO

(SCR Doc. 13/063, 064, SCS Doc., 13/16)

Environmental Overview

See STACFIS Report (SCS 13/16).

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 6 000 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 12 000 t in 2012 and 8 600 t in 2013 (Fig. 2.1).

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

	2005	2006	2007	2008	2009	2010	2011	2012	2013
TAC as recommended by SC	13000	22000	22000	22000	25000	<24356[1]	<17000	<9350	<8600
TAC as set by FC	13000[2]	22000[2]	22000[2]	25000[2]	30000[2]	30000[2]	19200[2]	12000[2]	8600[2]
STATLANT 21	14281	22616	22535	26004	27236	19745	13014	9966	
NIPAG[3]	14775	25689	23570	26649	27527	20536	13316	10108	6020[4]

[1] Exploitation rates greater than 14% have been associated with stock declines
[2] Denmark with respect to Faroes and Greenland did not agree to the quotas of 144 t (2003–2005), 245 t (2006–2007), 278 t (2008), or 334 t (2009) and set their own TACs of 1 344 t (2003–2005), 2 274 t (2006–2008), 3 106 t (2009), 532 t (2010), 1 985 t (2011), 1 241 t (2012) and 889 t (2013). The increase is not included in the table.
[3] NIPAG catch estimates have been updated using various data sources (see p. 13, SCR. 13/64).
[4] Estimated catches up to September 10, 2013

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 September 10, 2013, the small- and large-vessel fleets had taken 4 031 t and 1 829 t of shrimp respectively 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.

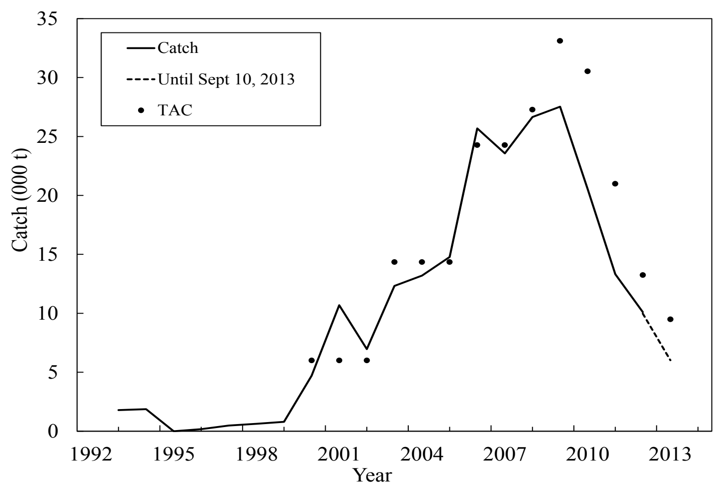

Fig. 2.1. Shrimp in Div. 3LNO: catches (to September 2013) and TAC as set by Fisheries Commission). The TAC includes the automonous quotas set by Denmark with respect to Faroes and Greenland.

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 2001. The 2010 - 13 indices for small vessel CPUEs were significantly lower than the long term mean and were similar to the 2001 values while the large vessel CPUEs were the lowest in the time series (Fig. 2.2). CPUE, while reflecting fishery performance, is not effectively indicating the status of the resource. The trends of these CPUE indices show conflicting patterns with the survey biomass indices and were therefore not used as indicators of stock biomass.

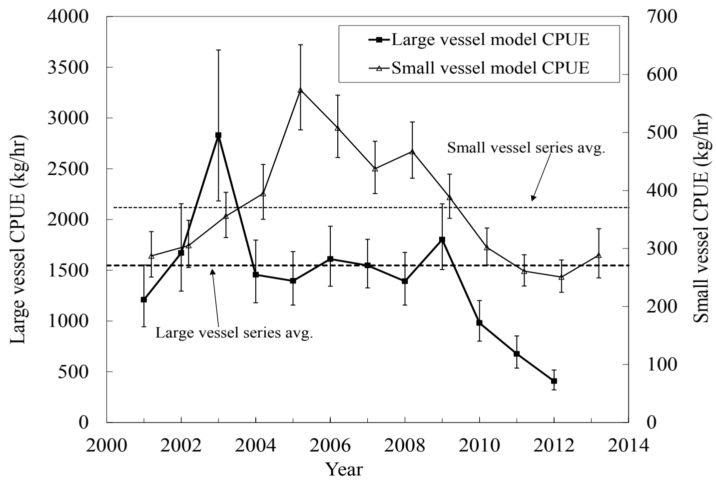

Fig. 2.2. Shrimp in Div. 3LNO: Standardized CPUE for the Canadian large-vessel (>500 t) and small-vessel (≤500 t; LOA<65') fleets fishing shrimp in Div. 3L within the Canadian EEZ.

Logbook data from Estonia, were available for the shrimp fishery within the NRA, in 2013. The data was insufficient to produce a standardized CPUE model.

Catch composition. Length compositions were derived from Canadian (2003 – 2012) and Estonian (2009 – 2013) observer datasets. Catches appeared to be represented by a broad range of size groups of both males and females.

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 (1999–2013) and autumn (1996–2012). 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 stratified-random survey in the NRA part of Div. 3L since 2003. Data is collected with a Campelen 1800 trawl. There was no Spanish survey in 2005.

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 both the spring and autumn indices to 2007 after which they decreased by over 80% to 2013 (Fig. 2.3). Confidence intervals from the spring surveys are usually broader than from the autumn surveys.

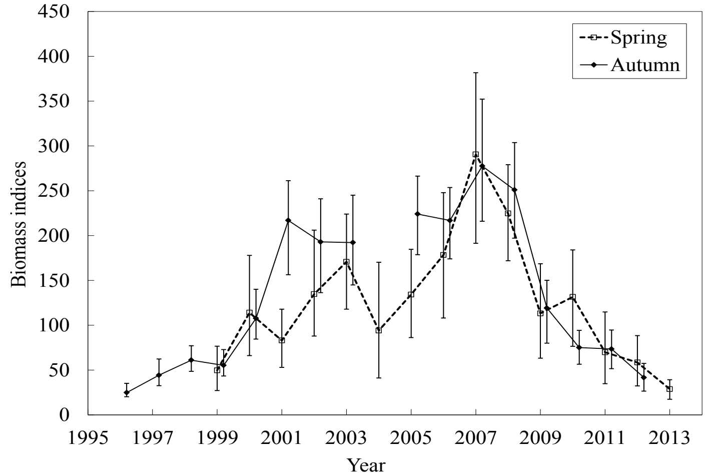

Fig. 2.3. Shrimp in Div. 3LNO: Total biomass index estimates from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

Spanish survey biomass indices for Div. 3L, within the NRA only, increased from 2003 to 2008 followed by a 93% decrease by 2012 remaining near that level in 2013 (Fig. 2.4).

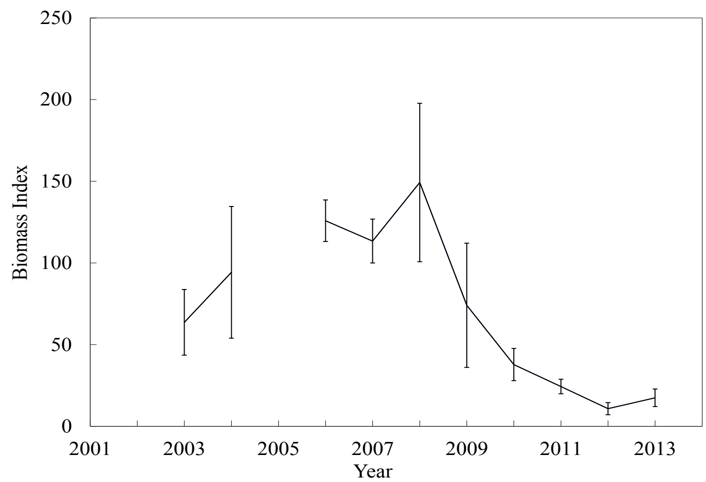

Fig. 2.4. Shrimp in Div. 3LNO: biomass index estimates from EU - Spanish multi-species surveys (± 1 s.e.) in the Div. 3L NRA.

Female Biomass (SSB) indices. The autumn Div. 3LNO female biomass index showed an increasing trend to 2007 but decreased 84% by 2012. The 2012 autumn female biomass index was 20 400 t. The spring SSB index decreased by 90% between 2007 and 2013 (Fig. 2.5). Based on the Canadian autumn survey, the stock was at B_{lim} by the end of 2012.

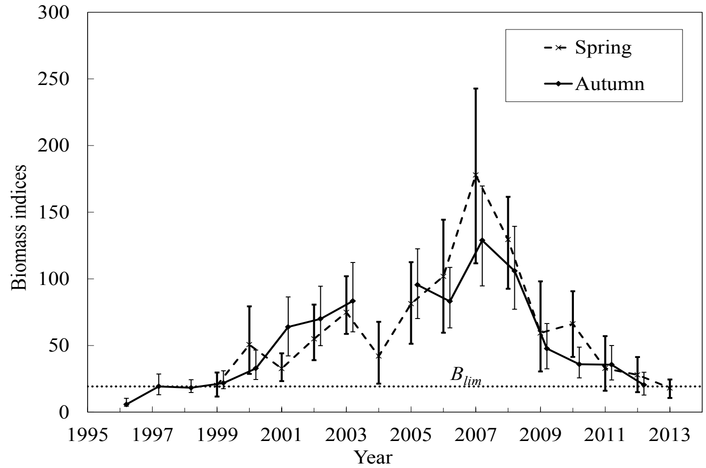

Fig. 2.5. Shrimp in Div. 3LNO: Female biomass indices from Canadian spring and autumn multi-species surveys (with 95% confidence intervals). B_{lim} is defined as 15% of the maximum autumn female biomass over the time series.

Stock Composition. The autumn surveys showed an increasing trend in the abundance of female (transitionals + females) shrimp up to 2007 then decreasing by 84% through to 2012. Similarly, spring female abundance series increased until 2007, then decreased by 90% through to 2013. Male autumn abundance index peaked in 2001 and remained high until 2008 before decreasing by 86% by 2012. The spring male abundance index followed trends similar to their respective female index (Fig. 2.6).

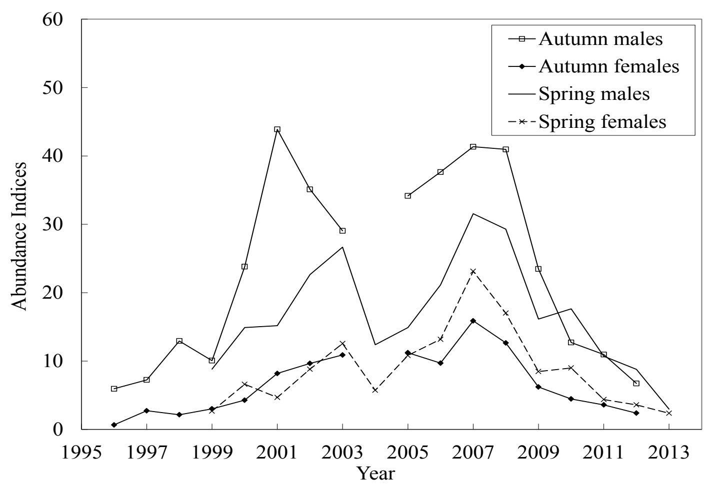

Fig. 2.6. Shrimp in Div. 3LNO: Abundance indices of male and female shrimp within Div. 3LNO as estimated from Canadian multi-species survey data.

Both males and females showed a broad distribution of lengths in recent surveys indicating the presence of more than one year class (Fig. 2.7).

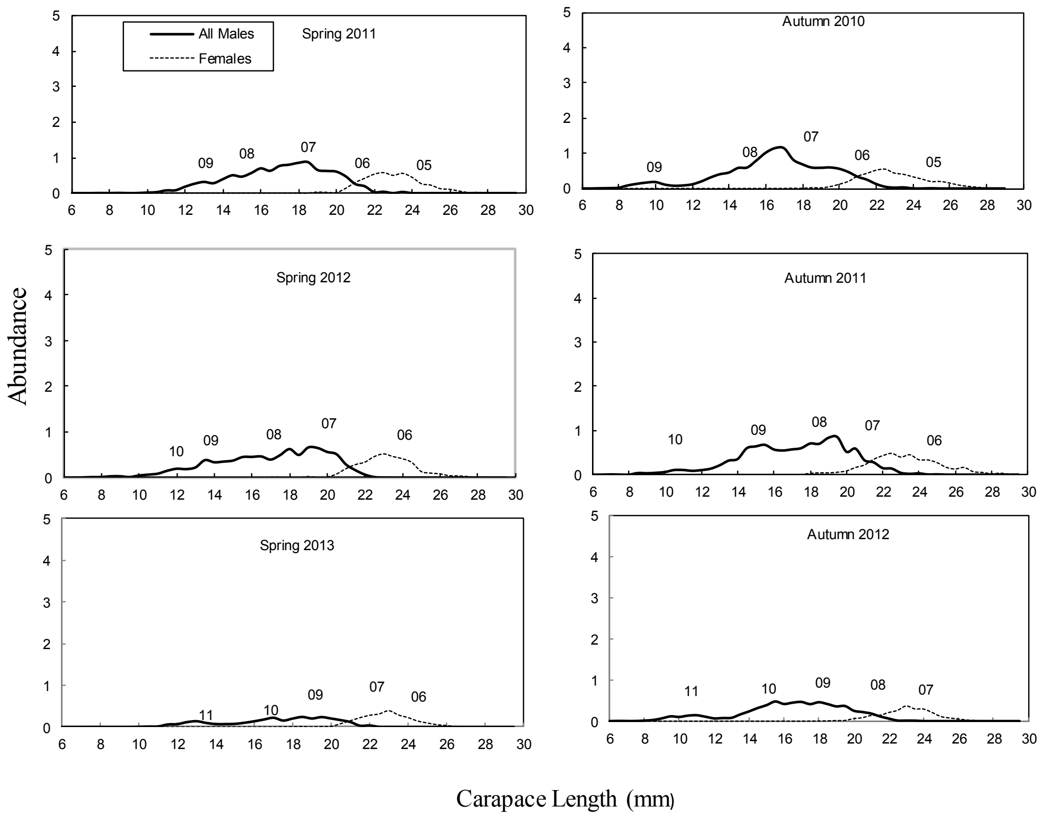

Fig. 2.7. Shrimp in Div. 3LNO: abundance at length estimated from Canadian multi-species survey data. Numbers within charts denote year-classes.

Recruitment indices. The recruitment indices were based upon abundances of all shrimp with carapace lengths of 11.5 – 17 mm from Canadian survey data. The 2006 – 2008 recruitment indices were among the highest in both spring and autumn time series. Both indices decreased through to spring 2013 (Fig. 2.8).

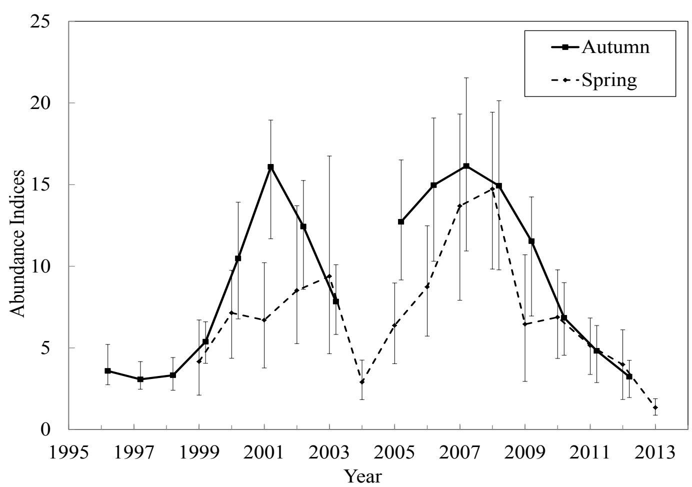

Fig. 2.8. Shrimp in Div. 3LNO: Recruitment indices derived from abundances of all shrimp with 11.5 – 17 mm carapace lengths from Canadian spring and autumn bottom trawl survey (1996–2013) data.

Fishable biomass and exploitation indices. The autumn fishable biomass (shrimp >17mm CL) showed an increasing trend until 2007 then decreased by 87% through to 2012. Similarly, the spring fishable biomass index increased to 2007 but has since decreased by 91 % through to 2013 (Fig. 2.9).

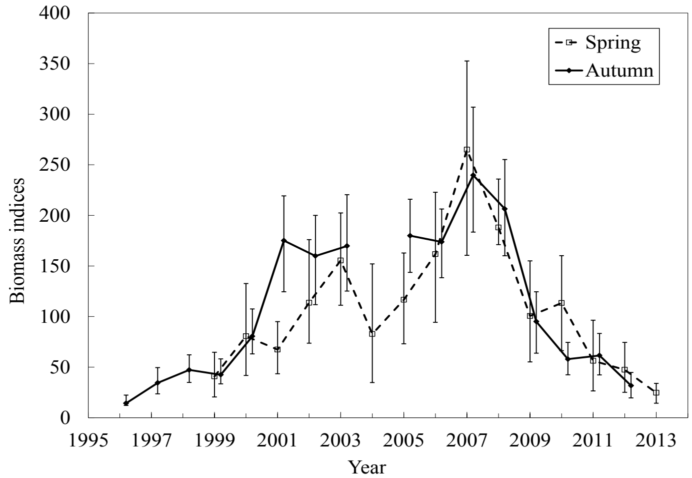

Fig. 2.9. Shrimp in Div. 3LNO: fishable (shrimp >17mm CL) biomass index. Bars indicate 95% confidence limits.

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 during September 2013. The exploitation index has been below 0.15 until 2010 when it increased to 0.21. By September 10, 2013, the 2013 exploitation rate index was 0.19. If the entire 9 489 t quota was to be taken, the exploitation rate index would increase to 0.30 (Fig. 2.10).

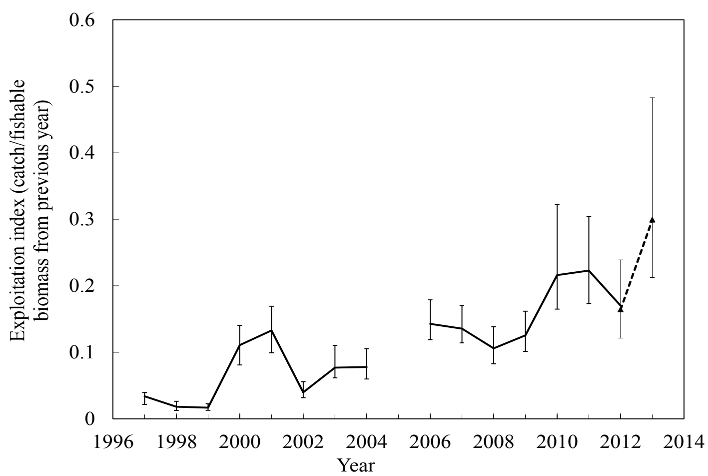

Fig. 2.10. Shrimp in Div. 3LNO: exploitation rates calculated as year's catch divided by the previous year's autumn fishable biomass index. Exploitation rate for 2013 assumes the TAC (including autonomous quota) is taken. Bars indicate 95% confidence limits.

c) Assessment Results

Recruitment. Recruitment indices have decreased since 2008 and are now at the lowest observed values.

Biomass. Spring and autumn biomass indices increased to 2007, but have since decreased by more than 80%.

Exploitation. The index of exploitation had remained below 0.15 until 2010 but has since increased.

State of the Stock. The stock has declined since 2007 and is now at B_{lim}. The risk of the stock being below B_{lim} in 2012 (43%) exceeds the maximum risk level (10%) specified in NAFO's precautionary approach framework (FC Doc. 04/18). Given expectations of poor recruitment and increased fishing mortality, the stock is expected to decline further.

d) Precautionary Reference Points

The point at which a valid index of stock size has declined to 15% of its highest observed value is considered to be B_{lim} (SCS Doc. 04/12). The NAFO Precautionary Approach requires a very low (5-10%) probability of being below B_{lim} (FC Doc. 04/18). The risk of the stock being below B_{lim} in 2012 exceeds this level (Fig. 2.11). This result is consistent with the findings of an illustrative quantitative assessment (see 'other studies'). A limit reference point for fishing mortality has not been defined.

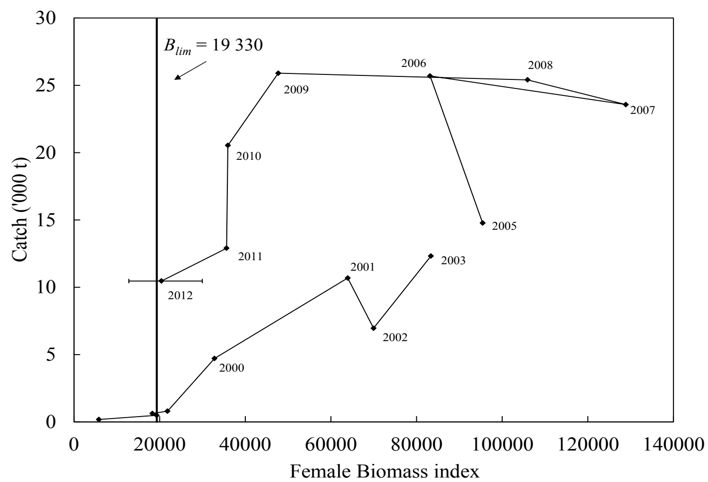

Fig. 2.11. Shrimp in Div. 3LNO: Catch against female biomass index from Canadian autumn survey. Line denoting B_{lim} (approximately 19 000) is drawn where female biomass index is 15% of the maximum estimate over the time series.

e) Other Studies

i) Recruitment Indices

SCR 13/064

Correlation analysis was used to explore which variables (age 2 abundance from modal analysis or abundance of 11.5 – 17 mm carapace length shrimp) should be pursued as recruitment indices used with the appropriate lags to predict fishable biomass. The preliminary exercise indicated that the best candidate would be age 2 abundance using a 2 year lag. This combination made biological sense. Work to explore recruitment signals should be continued and should include environmental co-variables.

ii) Genetic Analyses

Genetic analyses were presented to and reviewed by NIPAG (Jorde *et al.,* in prep.) over a broad geographic range in the northwest Atlantic (Fig. 2.12), with the aim of identifying stock structure. The analysis of statistical power showed an inability to detect very low levels of genetic differentiation, should it exist. However, these analyses found that shrimp from the Flemish Cap and the Gulf of Maine were distinct from those found in the shelf areas of Labrador and Newfoundland (NAFO Div. 2GHJ+3KL).

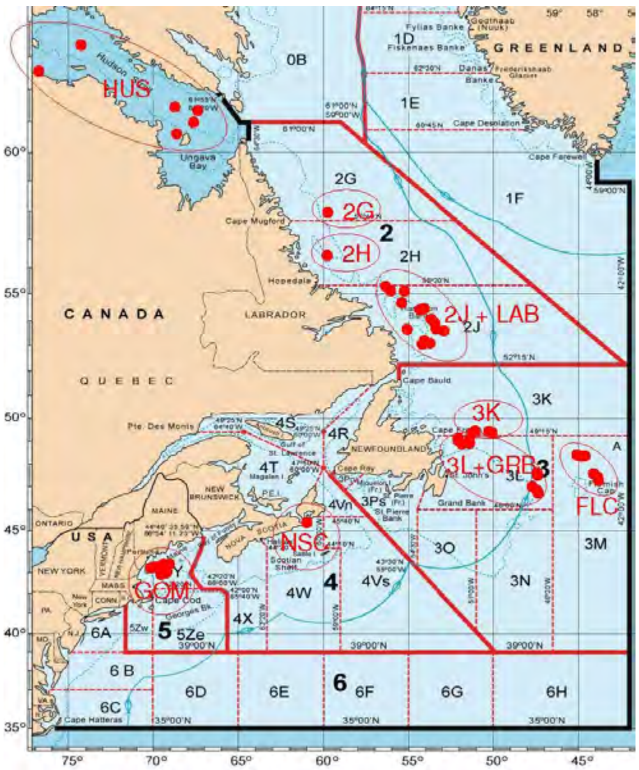

Fig. 2.12. Shrimp in Div. 3LNO: The NAFO convention area with NAFO Divisions and gross bathymetric features (blue dotted line: 200m isocline). The area outside the 200 Nmi limit (blue line) is the NAFO Regulatory Area (NRA). Red dots indicate collection sites for the various samples.

The results of the genetic analysis for shrimp in NAFO Subarea 2 and Divs. 3KL are consistent with the hypothesis of a single biological population, except for a sample in Div. 2H. Additional evidence for the notion of a single population unit along the Newfoundland and Labrador shelf is the continuous distribution of shrimp in this area and the strong ocean currents, both of which make separate populations unlikely.

iii) Bayesian Surplus Production Model

(SCR Doc. 13/069)

Several formulations of a Schaefer surplus-production model of population dynamics using Bayesian inference were fitted to reported landings and two Canadian survey indices series. The formulations investigated the effect of providing more informative priors on survey catchabilities (q) and Maximum Sustainable Yield (MSY), while relaxing the prior on carrying capacity (K). An additional formulation constrained the relative biomass (B_i/B_{msy}) not to exceed 2.5 in any iteration of the model runs.

The various formulations were considered to capture the overall dynamics of the stock. The model was considered illustrative and not accepted for stock projections or risk analysis. NIPAG had concerns over the relative magnitude of the process error and its possible serial correlation. There were also concerns over the long right tailed distributions of the relative Fishing mortality (F_i/F_{msy}) and to a lesser degree of the relative high estimates of the survey q's.

An MSY of 16 000 t/yr was estimated by the model. The fitted trajectory of the biomass showed that the population increased steadily from 1995 to 2007 to a level of 1.8 times its MSY level while being fished below F_{msy}. Since 2007 fishing mortality increased above F_{msy} while the population declined. The current estimate for 2012 is now at B_{lim} which is $0.3B_{msy}$ for production models (SCS Doc. 04/12), and 1.8 times F_{lim} ($F_{lim} = F_{msy}$, FC Doc. 04/18). These results are consistent with the accepted qualitative assessment.

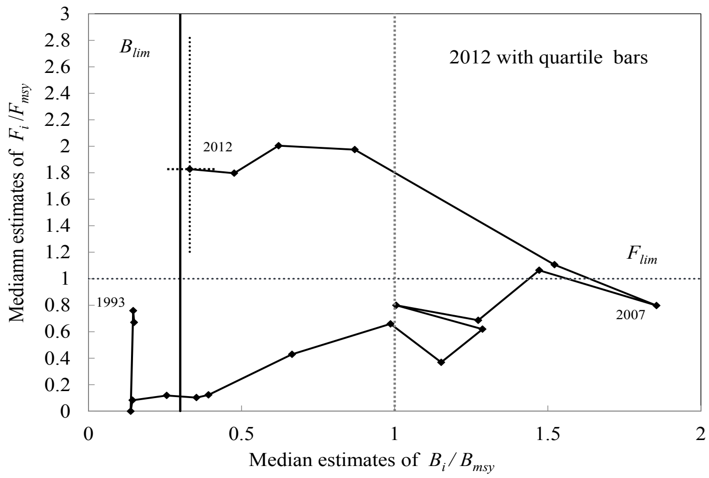

Fig. 2.13 Shrimp in Div. 3LNO: Phase plot for the illustrative Bayesian Production model. Error bars on the 2012 point represent interquartile ranges. B_{lim} (solid vertical line) is 30% of B_{msy}. F_{lim} (=F_{msy}) is the dashed horizontal line.

3. Northern shrimp (Subareas 0 and 1)

(SCR Doc. 04/75, 04/76, 08/6, 11/53, 11/58, 12/44, 13/54, 13/56, 13/57, 13/58, 13/59, 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 larger vessels have entered the coastal fishery. 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 and increased again for 2011 to 120 000 t. The TAC advised for 2012 was reduced to 90 000t. For 2012, Greenland enacted a TAC of 101 675 t for Subarea 1. Of this, 4000 t was allocated (by contract) to the EU, 55 675 t to the Greenland sea-going fleet and 42 000 t to the coastal fleet. Canada enacted a TAC of 16 921 t for SFA 1. Further deterioration of the assessed status of the stock in 2012 induced a yet lower advised TAC of 80 000 t for 2013: Greenland enacted a TAC of 87 263 t, with quota allocations of 3400, 47 802 and 36 061 t, and Canada of 15 504 t.

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, in previous years, the coastal fleet catching bulk shrimps did not log catch weights of *P. montagui* separately from *borealis;* weights were estimated by catch sampling at the point of sale and the price adjusted accordingly, but the weight of *montagui* was not deducted from the quota (SCR Doc. 11/53). Logbook-recorded catches could therefore still legally exceed quotas. Since 2012 *P. montagui* has been included among the species protected by a 'moving rule' to limit bycatch and there are no licences issued for directed fishing on it (SCR Doc. 13/58). Instructions for reporting *montagui* in logbooks were changed in 2012, to improve the reporting of these catches.

The table of recent catches was updated (SCR Doc. 13/57). 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 increased to average over 150 000 t in 2005–08, but have since decreased, to 100 000 t (projected) in 2013.

Recent catches, projected catches for 2013 and recommended and enacted TACs (t) for Northern Shrimp in Div. 0A east of 60°30'W and in Subarea 1 are as follows:

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
TAC										
Advised	130 000	130 000	130 000	130 000	110 000	110 000	110 000	120 000	90 000	80 000
Enacted[3]	149 519	152 452	152 380	152 417	145 717	132 987	132 987	142 597	118 596	102 767
Catches (NIPAG)										
SA 1	142 311	149 978	153 188	142 245	153 889	135 029	128 108	122 655	115 975	*100 000*[1]
Div. 0A (SFA 1)	7021	6921	4127	1945	0	429	5882	1 330	0	0
TOTAL SA 1–Div. 0A	149 332	156 899	157 315	144 190	153 889	135 458	133 990	123 985	115 975	*100 000*[1]
STATLANT 21										
SA 1	142 311	149 978	153 188	142 245	148 550	133 561	123 973	122 061	114 958[2]	
Div. 0A	6861	6410	3788	1878	0	429	5206	1134	12[2]	

[1] Total catches for the year as predicted by industry observers.
[2] Provisional
[3] Canada and Greenland set independent autonomous TACs.

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. 13/58).

In 2002–2005 the Canadian catch in SFA1 was stable at 6000 to 7000 t—about 4–5% of the total—but since 2007 fishing effort has been sporadic and catches variable, averaging about 1260 t in 2007–13 (SCR Doc. 13/57).

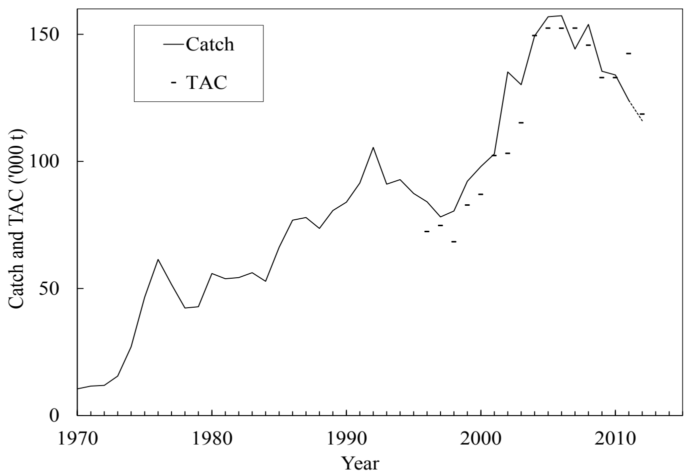

Fig. 3.1. Northern shrimp in Subarea 1 and Canadian SFA1: enacted TACs and total catches (2013 predicted for the year).

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. 13/58). 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. In 2013 for the first time catch and effort data for statistical area 0, which extends north to 74°N, comprises 82 300 sq. km. and in 2005–12 yielded 16% of the offshore catch, was included in the CPUE analyses. A series for 1976–1990 was constructed for the KGH (Kongelige Grønlandske Handel) fleet of sister trawlers and a series for 1989–96, 1998–2007 and 2010–11 for the Canadian fleet fishing in SFA1 (Fig. 3.2). The standardised CPUE estimate for the Canadian fleet in 2011 was anomalously low; close examination of the data confirmed that there had been low catch rates and little fishing. This value therefore had very little influence on the unified series.

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 peak in 2008 at over twice its 1997 value (Fig. 3.2). Values for 2009 to 2013 have been lower (SCR Doc. 13/48).

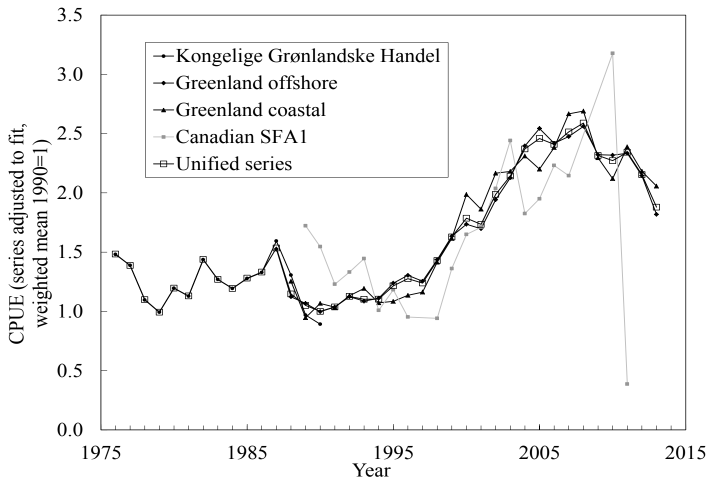

Fig. 3.2. Northern shrimp in Subarea 1 and Canadian SFA1: standardised CPUE index series 1976–2013.

The distribution of catch and effort among statistical areas was summarised using Simpson's diversity index to calculate an 'effective' number of statistical areas being fished as an index of how widely the fishery is distributed (Fig 3.3). The fishery area has contracted; 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.

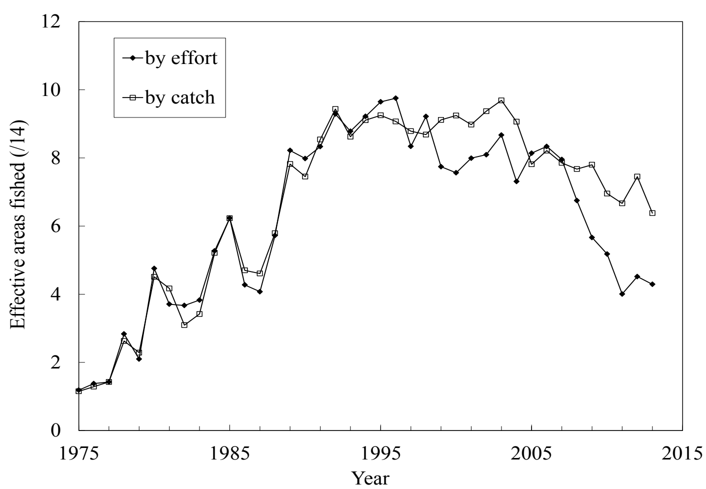

Fig. 3.3. Northern shrimp in Subarea 1 and Canadian SFA1: indices for the distribution of the Greenland fishery between statistical areas in 1975–2013.

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 Greenland catch. The effective number of statistical areas being fished in SA 1 reached a plateau at about 9½ in 1992–2003. The range of the fishery has contracted northwards and the effective number of statistical areas being fished has decreased.

Catch composition. There is no biological sampling programme 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.

13/56). From 1993, the survey was extended southwards into Divs 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 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. 12/44). 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. 13/56). The proportion of survey biomass in Divs 1E–F has been low in recent years and the distribution of survey biomass, like that of the fishery, has become 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 and in 2012 decreased by a further 23% (SCR Doc. 13/56). In 2013 the survey biomass increased by 19% but is still low; of the survey biomass, 35%, a high proportion, is in Disko Bay and Vaigat, about 7% of the survey area.

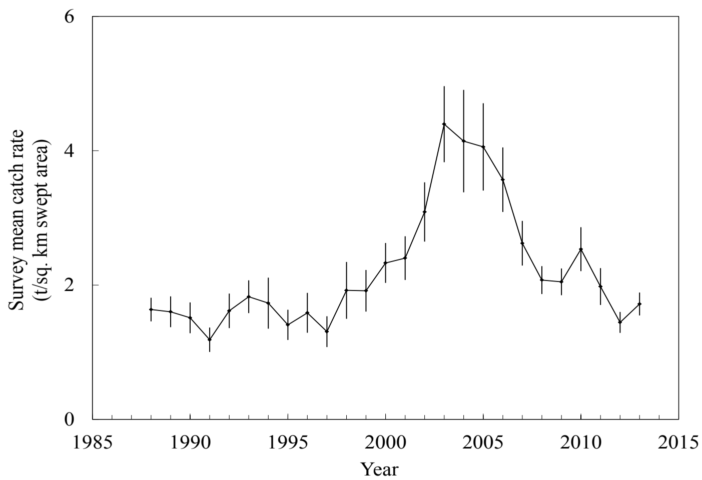

Fig. 3.4. Northern Shrimp in Subarea 1 and Canadian SFA 1: survey index of total stock biomass 1988–2013 (SCR Doc. 12/44) (error bars 1 s.e.)

Length and sex composition (SCR Doc. 13/56). 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 numbered 68% of the 2008–10 mean and 55% of the series mean (Fig. 3.5). Numbers at age 2 were well below the 20-year lower quartile in 2012; given that survey biomass was about as low as had ever been observed, absolute numbers at age 2 were therefore very low. In 2013, age-2 numbers are 50% higher, but in absolute terms still below their 20-year lower quartile.

Estimated numbers of males and females in 2009 - 41.5 and 12.2 bn - 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 bn while the number of females increased by only about 16% to 14.4 bn; in 2011 total numbers at 49.8 bn were 30% less than in 2010, but almost all the decrease was in numbers of males, while females remained at 96% of the 2010 number. In 2011 the stock was 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 was estimated at 91.4%, close to its average level.

In 2012 overall the fishable biomass at 91.1% of total was a little below its 20-year median, but comprised an exceptionally high proportion of females. Pre-recruits (14–16.5 mm) have been few since 2008 in absolute numbers. In 2013 the fishable biomass is estimated to have increased by one-third, but this seems entirely due to increase in number and biomass of females, which still compose an exceptionally high proportion of the stock (SCR Doc. 13/54). Other age classes are few in number relative to past average stock composition and size.

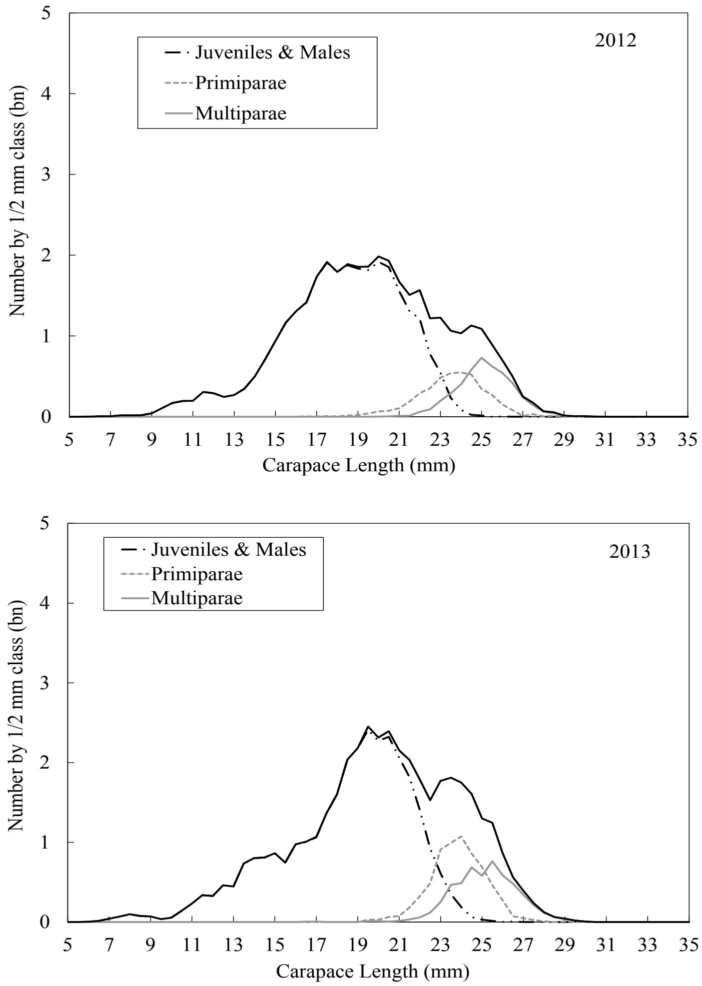

Fig. 3.5. Northern Shrimp in Subarea 1 and Canadian SFA 1: length frequencies in the West Greenland trawl survey in 2012–2013.

Recruitment Index. The number at age 2 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 and in 2012 to the lowest level ever. A relative lack of fishable males in 2013 presages poor immediate recruitment to the spawning stock.

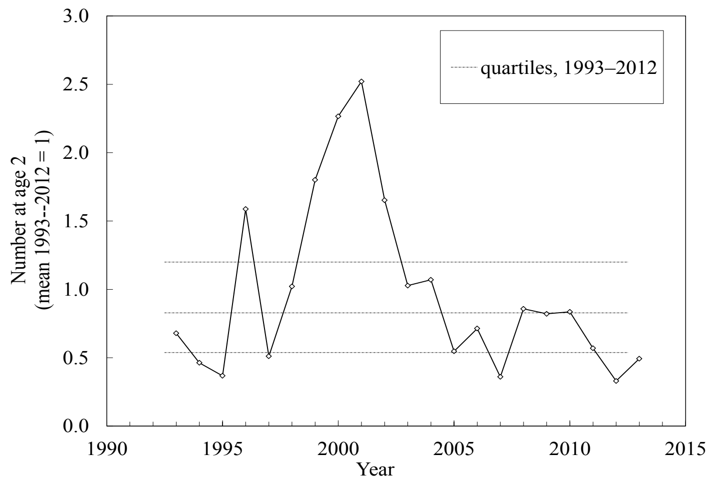

Fig. 3.6. Northern Shrimp in Subarea 1 and Canadian SFA 1: survey index of numbers at age 2, 1993–2013.

iii) Predation index

Estimates of cod biomass from the German groundfish survey at West Greenland are used in the assessment of the 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 has been well correlated with that from the German groundfish survey (r^2 = 0.89). The methods used in the German survey have recently been reviewed and revised; past estimates were little changed. Replacing the provisional Greenland estimate for 2012 by the estimate from the German survey increased the effective biomass from 22 Kt to 54 Kt. The index of cod biomass is adjusted by a measure of the overlap between the stocks of cod and shrimps 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 shrimps increased to 88.8%, giving an effective biomass of 21.8 Kt. In 2012 the overlap decreased but the biomass increased; in 2013 the effective biomass is estimated at 36 Kt. (SCR Doc. 13/59)

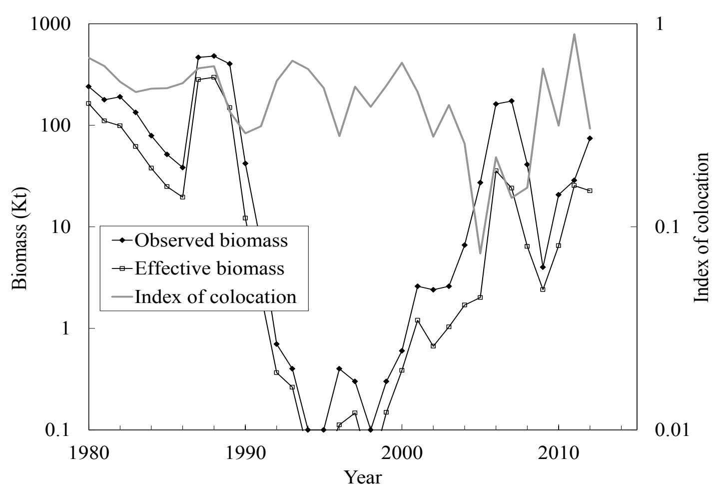

Fig. 3.7. Northern shrimp in Subarea 1 and Canadian SFA1: indices of the biomass of Atlantic cod, including its index of colocation with the stock of Northern shrimp, 1980–2013.

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. 13/54). 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 2013 were projected at 100 000 t. The assessment model had been modified in 2012 to include the uncertainty of projecting the current year's catches.

In 2011 the previously accepted assessment model had been 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 result was a biomass trajectory that tracked between the survey index and the CPUE index instead of closely following the CPUE index as it had done in previous assessments, and a much lower estimate of MSY. 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 (SCR Doc. 11/58).

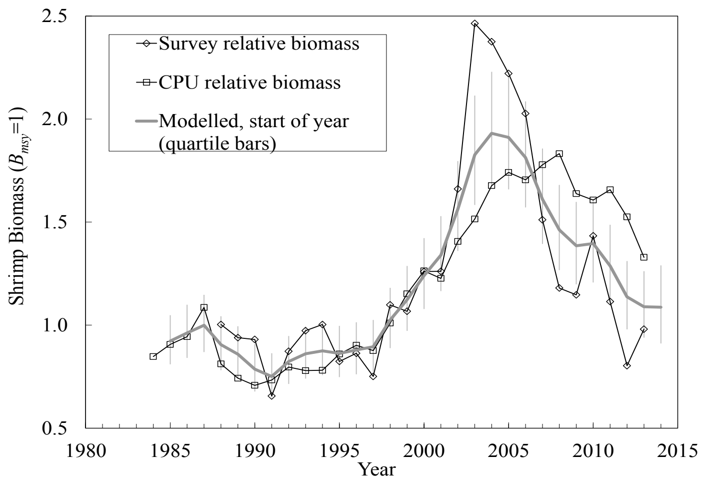

Fig. 3.8. Northern Shrimp in SA 1 and Canadian SFA1: trajectory of the median estimate of relative stock biomass at start of year 1985–2014, with median CPUE and survey indices; 30 years' data with constrained CVs.

Estimates of stock-dynamic and fit parameters from fitting a Schaefer stock-production model in 2013, with constrained CVs, to 30 years' data on the West Greenland stock of the Northern in 2013, with median values from the 2012 assessment:

	2013 assessment						2012 assessment
	Mean	S.D.	25%	Median	75%	Est. Mode	Median
Max.sustainable yield	148	79	109	138	171	117	132
B/Bmsy, end current year (proj.)	1.11	0.31	0.91	1.09	1.29	1.04	1.00
Biom. risk, end current yr (%)	37.3	48.4	–	–	–	–	—
Z/Zmsy, current year (proj.)	3.92	59.55	0.64	0.93	1.33	—	1.08
Carrying capacity	4118	3185	2158	3162	4972	1250	2767
Max. sustainable yield ratio (%)	9.8	5.7	5.6	9.3	13.3	8.4	10.1
Survey catchability (%)	16.6	11.1	8.4	14.0	21.7	8.8	17.4
CV of process (%)	11.9	2.7	10.0	11.6	13.6	11.0	11.9
CV of survey fit (%)	15.0	2.0	13.7	15.0	16.4	15.0	14.5
CV of CPUE fit (%)	17.7	2.5	15.9	17.4	19.0	16.7	16.9
CV of predation fit (%)	127.5	84.7	58.5	112.4	180.2	82.2	106.7

ii) Assessment Summary

Recruitment. Pre-recruits at CL 14–16.5 mm are few and have been so since 2008 in absolute terms, so short-term recruitment is expected to be low. The number at age 2 in 2013 is 50% above the 2012 value, but that was the lowest ever, so medium-term recruitment is still expected to be poor.

Biomass. A stock-dynamic model showed a maximum biomass in 2004 with a continuing decline since. However, the probability that biomass will be below B_{msy} at end 2013 with projected catches at 100 000 t was estimated at 37%; of its being below B_{lim} at 1%.

Mortality. In 2013, the mortality caused by fishing and cod predation (Z) is estimated to have stayed below the limit reference (Z_{msy}) from 1996 to 2011, but is now estimated to have been about 10% over in 2012. With catches projected at 100 000 t the risk that total mortality in 2013 will exceed Z_{msy} is estimated at about 44%. Atlantic cod is, in 2013, concentrated in southerly areas where shrimps are now scarce, but its biomass is high and predation is also expected to be high.

State of the Stock. Biomass is estimated to have been declining since 2004, but at the end of 2013 is projected to be about 10% above B_{msy}. Total mortality in 2013 is not projected to exceed Z_{msy}. But the stock comprises a high proportion of females, so fishing will risk removing much of the spawning-stock biomass, and recruitment to both the fishable and the spawning stocks in both short and medium terms are all expected to remain 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 very high proportions of 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 to be above B_{msy}.

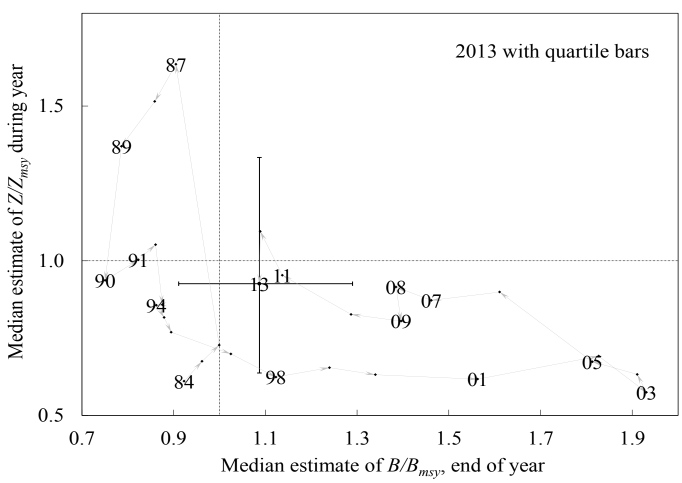

Fig. 3.9. Northern shrimp in Subarea 1 and Canadian SFA1: trajectory of relative biomass and relative mortality, 1983–2013.

e) Projections

Predicted probabilities of transgressing precautionary reference points in 2013 and 2014 under seven catch options and subject to predation in 2014–15 by a cod stock with an effective biomass of 40 Kt:

40 000 t cod	Catch option ('000 t)						
Risk of:	50	60	70	80	85	90	100
falling below B_{msy} end 2014 (%)	34.3	35.2	36.2	37.5	37.6	38.3	39.3
falling below B_{lim} end 2014 (%)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
exceeding Z_{msy} in 2014 (%)	18.3	21.4	26.5	32.3	36.3	39.2	45.9
exceeding Z_{msy} in 2015 (%)	18.6	22.4	27.2	33.6	36.7	40.1	47.2

In the medium term, with a 40 000 t effective biomass of cod, model results estimate that catches of 80 000 t/yr could be associated with a slowly increasing stock more than 10% above B_{msy} (Fig. 3.10). For larger catches estimates of biomass risk increase with projections into the future.

Predicted probabilities of transgressing precautionary reference points after 3 years at 9 possible catch levels in the fishery for Northern Shrimp on the West Greenland shelf with 'effective' cod stocks assumed at 30 and 40 Kt.

Catch	Prob. biomass < B_{MSY} (%)		Prob. biomass< B_{lim} (%)		Prob. mort > Z_{msy} (%)	
(Kt/yr)	30 Kt	40 Kt	30 Kt	40 Kt	30 Kt	40 Kt
50	27.5	30.1	2.7	3.1	16.8	19.3
60	30.5	31.3	2.6	3.1	19.6	23.2
70	32.8	34.4	2.8	3.2	24.3	28.1
75	33.5	35.4	2.8	3.5	26.4	30.9
80	34.6	37.6	2.9	3.6	29.4	34.2
85	36.2	38.6	2.9	3.4	32.7	37.3
90	38.2	39.7	3.0	3.7	36.7	40.7
100	40.0	42.4	3.1	3.6	43.5	47.3
110	42.3	44.5	2.9	3.9	49.9	54.0

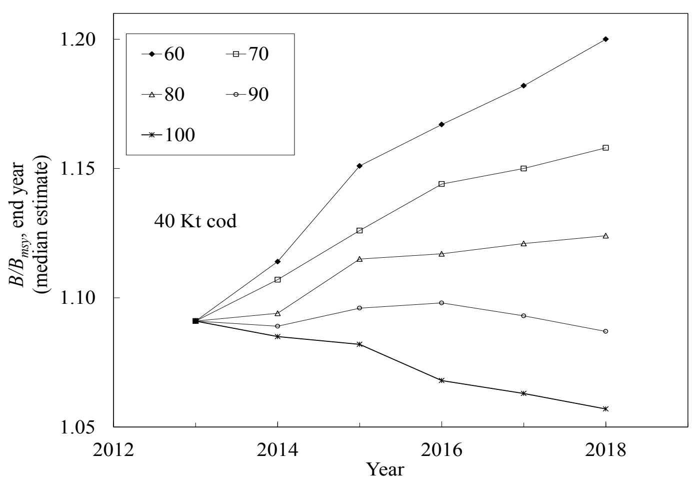

Fig. 3.10. Northern shrimp in Subarea 1 and Canadian SFA1: median estimates of biomass trajectory for 5 years with annual catches at 60–100 Kt and an 'effective' cod stock assumed at 40 Kt.

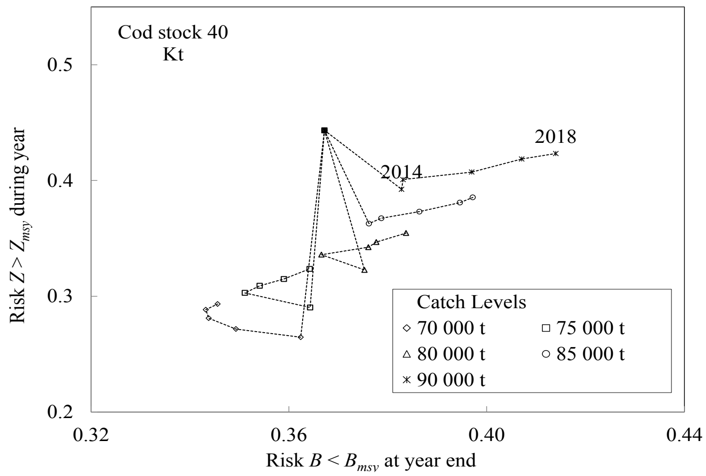

Fig. 3.11. Northern shrimp in Subarea 1 and Canadian SFA1: Risks of transgressing mortality and biomass precautionary limits with annual catches at 70–90 Kt projected for 2014–18 with an 'effective' cod stock assumed at 40 Kt.

Medium-term projections 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 an 'effective' cod stock close to the 2013 estimate (Fig. 3.11). The mortality risk depends immediately upon the assumed future catch and cod-stock levels, but changes little with time. For catches of 70 Kt to 85 Kt the mortality risk is 25–40% and nearly constant over the projection period. The immediate biomass risk is relatively insensitive to catch level but changes with time. At catch levels that permit rapid growth in biomass, biomass risk decreases with time, but at catch levels that allow only slow growth, the compounding of uncertainties eventually causes estimated biomass risk to increase. This is aggravated by the high cod-stock biomass for which predictions are being made, the uncertainty associated with predation by cod being the largest uncertainty in the model fit in the present assessment.

f) Review of Research Recommendations

NIPAG **recommended** in 2010 that, for Northern 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;*

STATUS: no progress has been made on this recommendation.

NIPAG **further recommended** in 2012 that, for Northern shrimp off West Greenland (NAFO Subareas 0 and 1):

- *given that the CPUE series for the Greenland sea-going and coastal fleets continue to agree while neither agrees with changes in the survey estimates of biomass since 2002, possible causes for change in the relationship between fishing efficiency and biomass should be investigated.;*

STATUS: preliminary enquiries have been made amongst the fishermen as to possible causes of the phenomenon.

g) Research Recommendations

For Northern shrimp off West Greenland (NAFO Subareas 0 and 1) NIPAG **recommends** that *the relationship between estimated numbers of small shrimps and later estimates of fishable biomass should be investigated anew*.

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

(SCR Doc. 03/74, 13/62, 13/67)

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, decreasing to about 10% since 2008.

A multinational fleet exploits the stock. During the recent ten years, vessels from Greenland, EU, 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 9 000 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 t (Fig. 4.1). Since 2004 the catches decreased continually from 10 000 t down to 1 235 t in 2011. Catches in 2012 and 2013 were 2 109 and 1 702 t respectively. Catches in the Iceland EEZ decreased from 2002-2005 and since 2006 no catches have been taken.

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

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013[1]
Recommended TAC, total area	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400
Enacted TAC, Greenland	15043	12400	12400	12400	12400	12835	11835	12400	12400	12400
North of 65°N, Greenland EEZ	4654	3987	3887	3314	2529	3945	3321	1182	1893	1702
North of 65°N, Iceland EEZ	411	29	0	0	0	0	0	0	0	0
North of 65°N, total	5065	4016	3887	3314	2529	3945	3321	1182	1893	1702
South of 65°N, Greenland EEZ	4951	3737	1302	1286	266	610	413	53	215	0
TOTAL NIPAG	10016	7753	5189	4600	2794	4555	3735	1235	2109	1702

[1] Catches until July 2013

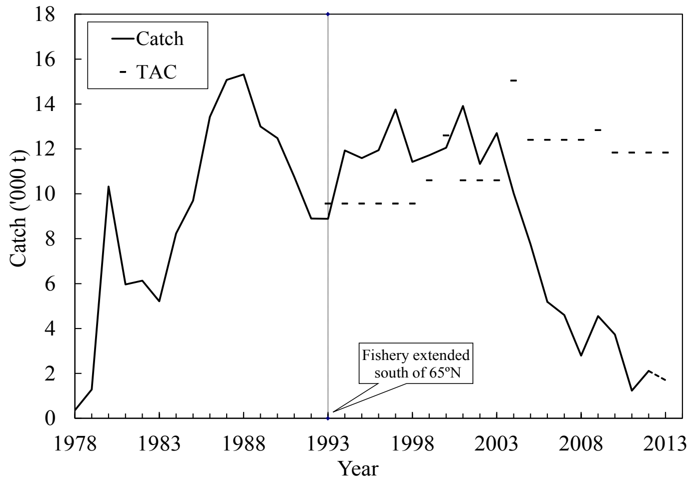

Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: Total catches (2013 catches until July).

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 2013 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^{o}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” until 2004 (SCR Doc. 03/74).

The fishing fleet, 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.

The overall CPUE index remained at a high level from 2000-2008, nearly doubled in 2009, but has been declining since (Fig. 4.2).

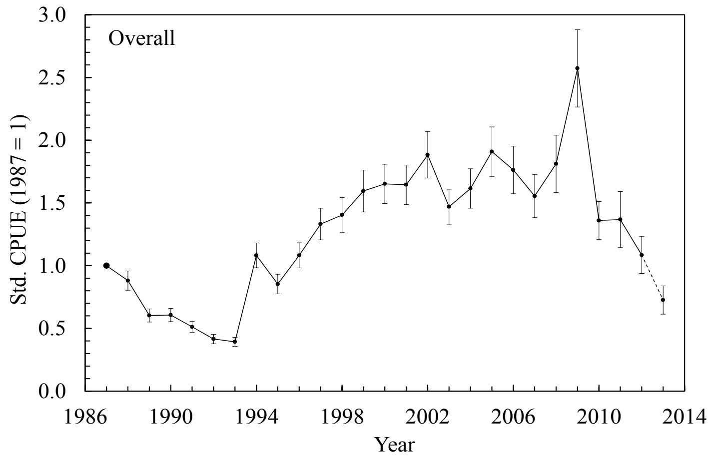

Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ± 1 SE combined for the total area (2013 catches until July).

North of 65°N standardized catch rates declined continuously from 1987 to 1993. Since 1993 catch rates have increased until 2009 but have since decreased and in 2013 are close to the lowest level seen in the time series (Fig. 4.3).

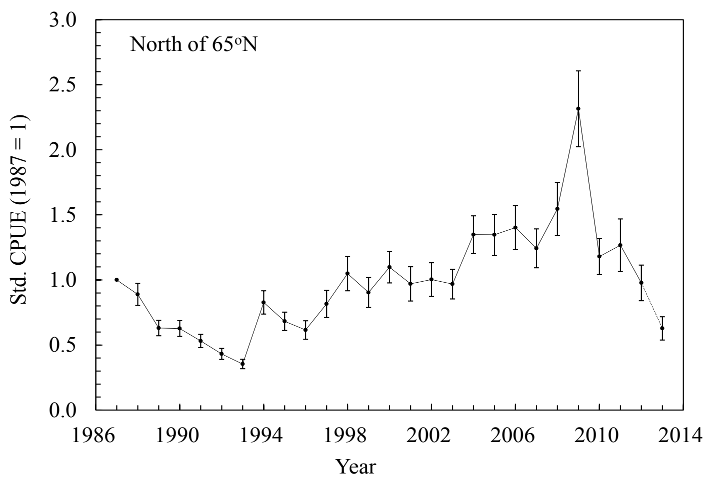

Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ±1 SE fishing north of 65°N (2013 catches until July).

In the southern area a standardized catch rate series increased until 1999, and has since then fluctuated without a trend (Fig. 4.4). No index for the southern area was calculated since 2010 due to a low number of hauls (less than 10 each year).

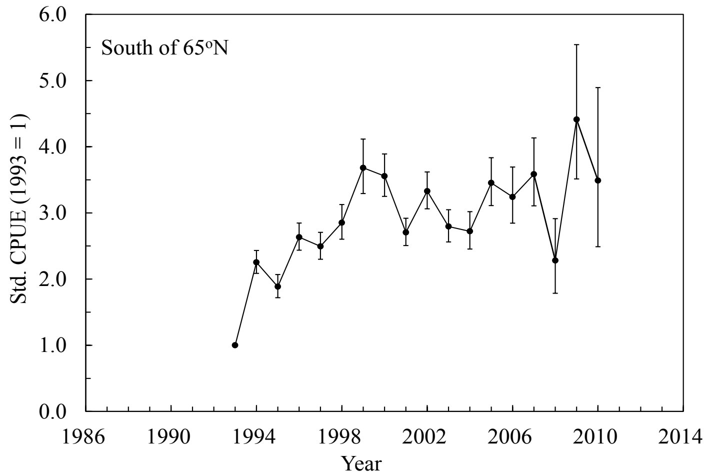

Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ±1 SE fishing south of 65°N (no data for the area since 2010).

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).

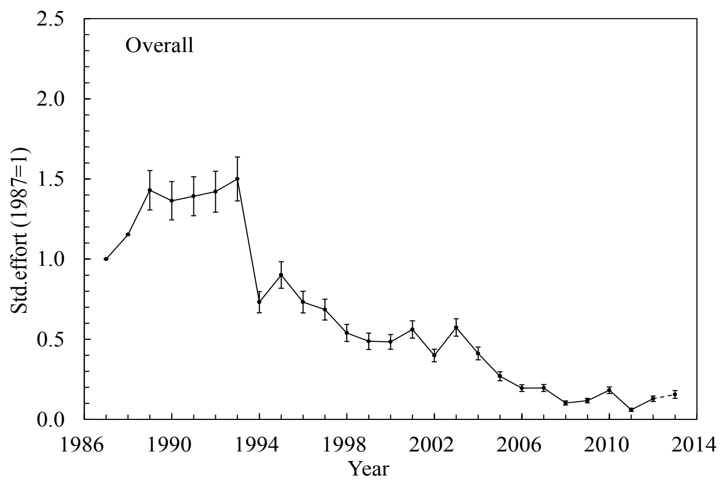

Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized effort indices, as a proxy for exploitation rate (± 1 SE; 1987 = 1), combined for the total area.

ii) Research survey data

Stratified-random trawl surveys have been conducted to assess the stock status of northern shrimp in the East Greenland area since 2008 (SCR Doc. 13/062). 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 areas covered, survey technique and trawling gear.

Biomass estimate: The survey biomass index has been decreasing since 2009 (Fig. 4.6).

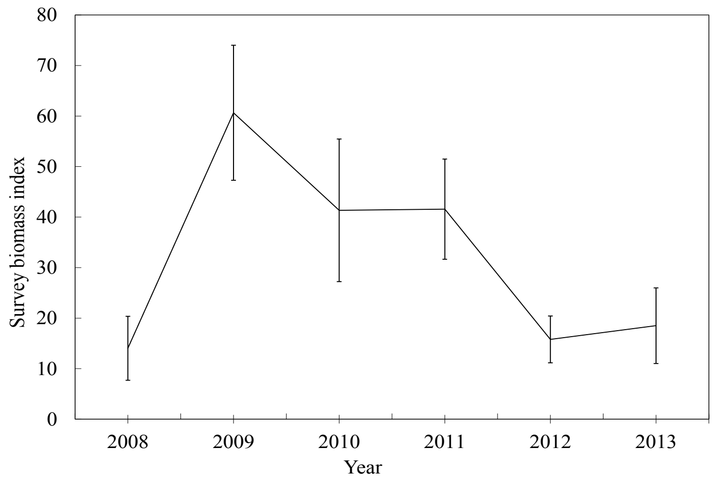

Fig. 4.6. Shrimp in Denmark Strait and off East Greenland: Survey biomass index from 2008- 2013 (± 1 SE).

The surveys conducted since 2008 indicate that the shrimp stock is concentrated in the area North of 65°N (Fig. 4.7).

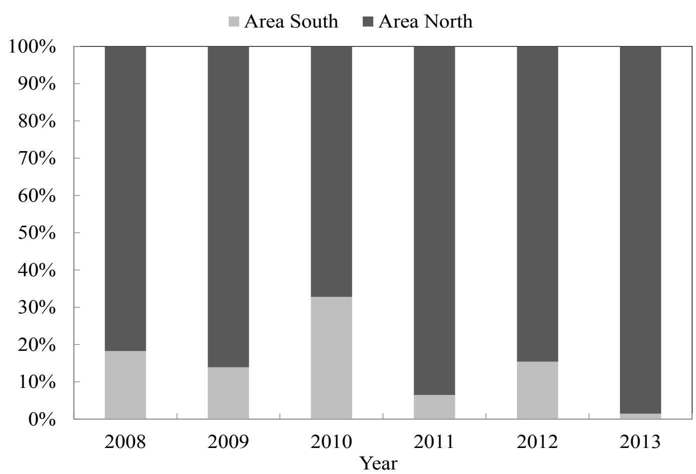

Fig. 4.7. Shrimp in Denmark Strait and off East Greenland: Distribution of Survey biomass North and South of 65°N (%) from 2008- 2013.

Stock composition: The demography in East Greenland is dominated by a large proportion of females and shows a paucity of males smaller than 20 mm CL (Fig. 4.8).

Scarcity of smaller shrimp in the survey area stresses that the total area of distribution and recruitment patterns of the stock are still unknown.

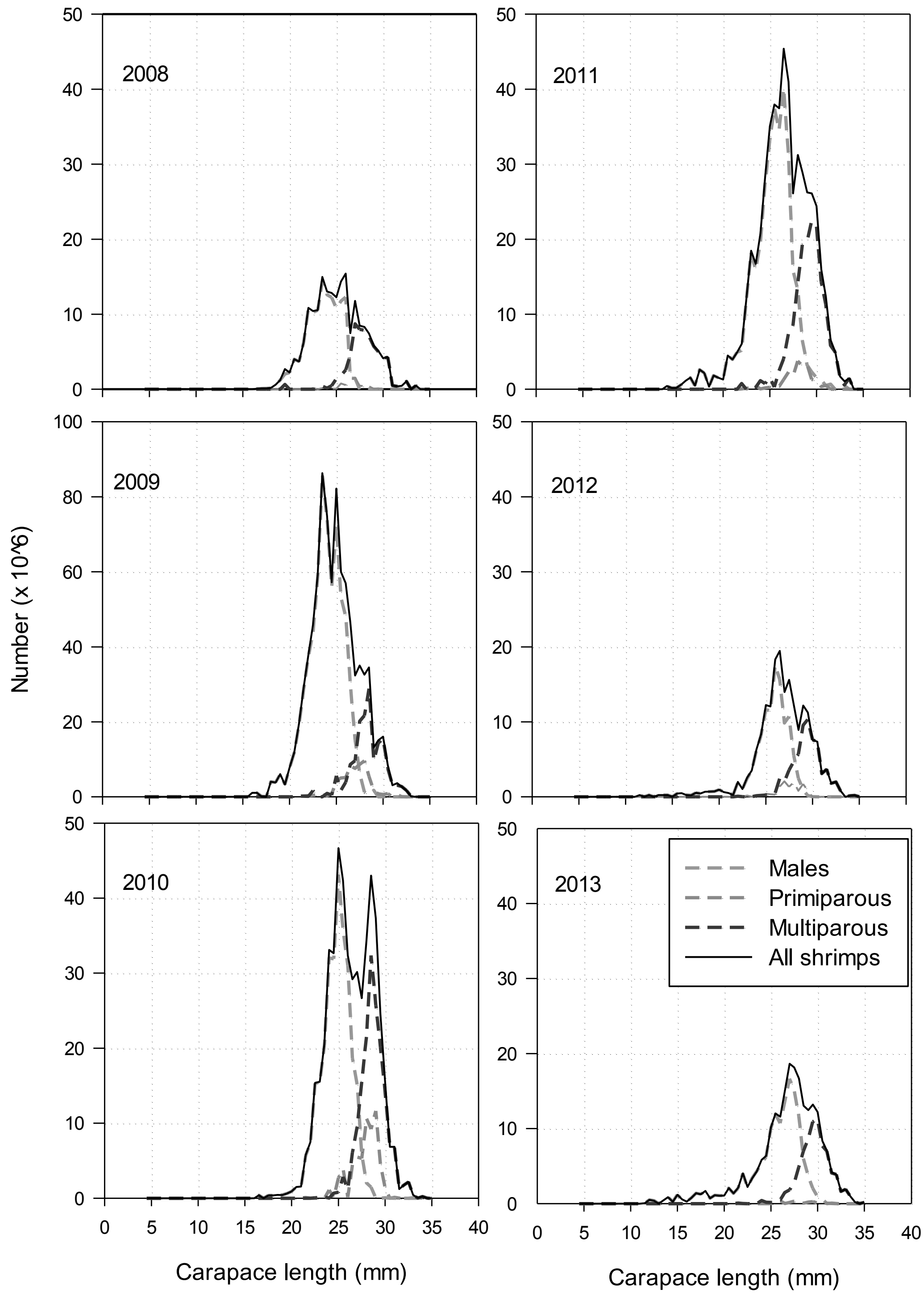

Fig.4.8. Shrimp in Denmark Strait and off East Greenland. Numbers of shrimp by length group (CL) in the total survey area in 2008 - 2013 (Please note that the scale in the figure for 2009 differs from other years).

c) Assessment Results

CPUE: The overall CPUE index remained at a high level from 2000-2008, nearly doubled in 2009, but has been declining since, and in 2013 are close to the lowest level seen in the time series.

Recruitment. No recruitment estimates were available.

Biomass. The survey biomass index has decreased by around 65% since 2009.

Exploitation rate. Since the mid-1990s the exploitation rate index has decreased, reaching the lowest levels seen in the time series.

State of the stock. The decrease in stock size continued in 2013 despite several years of very low exploitation rates. The southern area is currently lightly fished and the state of the stock in this area is uncertain.

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

Background documentation (equivalent to stock annex) is found in SCR Doc. 08/75; 12/61, 66; 13/66, 68, 70, 71, 72.

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 has since declined steadily to only 9 500 t in 2013 (Fig. 5.1, Table 5.1). In the Swedish and Norwegian fisheries approximately 50% of catches are boiled at sea, and almost all catches are landed in home ports. Since 2002 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 2012 36% of Danish landings were boiled. Most of the Danish catches are, however, still landed fresh in home ports. The overall TAC is shared according to historical landings, giving Norway 60%, Denmark 26%, and Sweden 14% in 2011 to 2013. 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 Nordmøre selective grid with un-blocked fish openings can reduce bycatch significantly (SCR Doc. 13/72) and has been mandatory in Swedish national waters since 1999. Of the total landings by the Swedish fleet, the percentage taken with grid trawls increased from 9% in 2002 to 51% in 2012. In 2013, according to agreement between EU and Norway, a selective grid became mandatory in all shrimp fisheries in Skagerrak (see section on Bycatch and ecosystem effects below).

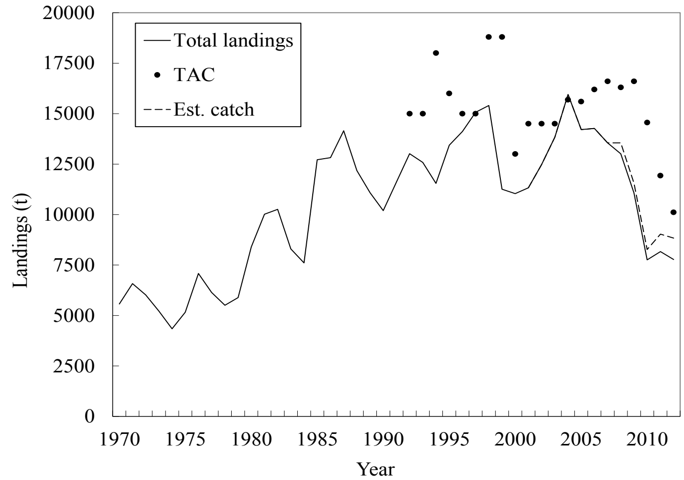

Fig. 5.1. Northern shrimp in Skagerrak and Norwegian Deep: TAC, total landings by all fleets, and total estimated catch including estimated Swedish discards for 2008-2012, Norwegian discards for 2009-2012 and Danish discards for 2009-2012.

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

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Recommended TAC	19,000	11,500	13,400	12,600	14,700	15,300	13,000	14,000	14,000	15,000	15,000	13,000	8,800	*
Agreed TAC	18,800	13,000	14,500	14,500	14,500	15,690	15,600	16,200	16,600	16,300	16,600	14,558	11,928	10,115
Denmark	2,072	2,371	1,954	2,470	3,270	3,944	2,992	3,111	2,422	2,274	2,224	1,301	1,601	1,454
Norway	6,739	6,444	7,266	7,703	8,178	9,544	8,959	8,669	8,686	8,260	6,364	4,673	4,800	4,796
Sweden	2,445	2,225	2,108	2,301	2,389	2,464	2,257	2,488	2,445	2,479	2,483	1,781	1,768	1,521
Total landings	11,256	11,040	11,328	12,474	13,837	15,952	14,208	14,268	13,553	13,013	11,071	7,755	8,168	7,771
Est. Swedish discards										540	337	386	504	683
Est. Norw. discards											115	75	235	288
Est. Danish discards											36	53	123	92
Total catch			11,328	12,474	13,837	15,952	14,208	14,268	13,553	13,553	11,560	8,269	9,030	8,834

* Advice was to reduce catches

The Danish and Norwegian fleets have undergone major restructuring during the last 25 years. In Denmark, the number of vessels targeting shrimp has decreased from 138 in 1987 to only 10 in 2013. The efficiency of the fleet has increased due to the introduction of twin trawl technology and increased trawl size (SCR Doc. 13/72).

In Norway the number of vessels participating in the shrimp fishery has decreased from 423 in 1995 to 195 in 2012. Twin trawl was introduced around 2002, and the use is increasing. In 2011 and 2012 twin trawls were used by more than half of the Norwegian trawlers larger than 15 meters.

The Swedish specialized shrimp fleet (catch of shrimp ≥ 10 t/yr) has been at around 40-50 vessels for the last decade and there has not been any major change in single trawl size or design according to the Swedish net manufacturer, but during the last seven years the twin trawlers have increased their landings from 7 to over 50% of total Swedish *Pandalus* landings (SCR Doc. 13/72).

Landings and discards. Total landings have varied between 7 500 and 16 000 t during the last 30 years. In the total catch estimates the boiled fraction of the landings has been raised by a factor of 1.13 to correct for weight loss caused by boiling. Total catches are estimated as the sum of landings and discards and have been generally decreasing between 2008 – 2012 and are now around 8 800 t (Table 5.1 and Fig. 5.1).

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. The Swedish fishery has regularly been constrained by the national quota, which may have resulted in 'high-grading' of the catch. Based on on-board sampling by observers, high-grading and discards in the Swedish fisheries was estimated to be between 12 and 31% of total catch for the years 2008 -2012, and Danish discards were estimated to be between 2 and 7% for the years 2009-2012 (SCR Doc. 13/72). Previous estimates of Swedish high-grading based on comparison of length distributions of Swedish landings with Danish landings (assuming no discards in the Danish fishery) were omitted since last year's report as these estimates are considered less accurate than the ones resulting from on-board sampling. Discarding is illegal in Norwegian waters and there are no observer data. Norwegian discards were previously estimated indirectly by comparing the length distributions of Norwegian unprocessed commercial catches with those of Norwegian sorted landings (SCR Doc. 12/65; 13/72). From 2009 onwards Norwegian discards from Skagerrak are estimated applying the Danish discards-to-landings ratio to the Norwegian landings. These estimates are considered more reliable than estimates from comparison of length frequency distributions. There is no Danish on-board sampling in the Norwegian Deep. Assuming that Norwegian discards are mainly made up of non-marketable shrimp < 15 mm CL, Norwegian discards from this area are estimated as the weight of catches of shrimp < 15 mm CL, obtained from length distributions of catches and mean weight per length group.

Bycatch and ecosystem effects. Shrimp fisheries in the North Sea and Skagerrak have bycatches of 10-22% (by weight) of commercially valuable species (Table 5.2). Since 1997, trawls used in Swedish national waters must be equipped with a Nordmøre grid, with a bar spacing of 19 mm, which excludes fish > approx. 20 cm from the catch. Logbook information shows that landings delivered by vessels using this grid consist of 98-99% shrimp compared to only 78-84% in landings from trawls without grid (Table 5.2). Following an agreement between EU and Norway, the Nordmøre grid has been mandatory since 1st February 2013 in all shrimp fisheries in Skagerrak (except Norwegian national waters within the 4 nm limit). If the fish quotas allow, it is legal to use a fish retention device of 120 mm square mesh tunnel at the grid's fish outlet. A corresponding agreement for shrimp fisheries in the North Sea has not yet been concluded. (SCR Doc. 13/72).

The use of a fish retention device in the Skagerrak prevents the escape of non-commercial species. No quantitative data on this mainly discarded catch component is available and the impact on stocks is difficult to assess. It is however 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.. It has been decided to introduce a discard ban for a range of commercial species and all fleets fishing in Skagerrak but details are still not decided. It is difficult to predict what consequences a Skagerrak discard ban will have for the *Pandalus* fishery.

Table 5.2. Northern shrimp in Skagerrak and Norwegian Deep: Landings by the Pandalus fishery in 2012. Combined data from Danish and Swedish logbooks and Norwegian sale slips (t).

	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	5481.4	79.3	458.3	95.1	1175.4	77.6
Norway lobster	41.1	0.6	2.8	0.6	8.7	0.6
Angler fish	80.7	1.2	0.7	0.2	43.6	2.9
Whiting	7.4	0.1	0.0	0.0	1.3	0.1
Haddock	109.3	1.6	1.5	0.3	8.2	0.5
Hake	21.7	0.3	0.4	0.1	24.0	1.6
Ling	45.7	0.7	0.2	0.0	33.5	2.2
Saithe	474.6	6.9	7.3	1.5	112.6	7.4
Witch flounder	72.6	1.1	1.0	0.2	1.5	0.1
Norway pout	2.2	0.0	0.0	0.0	0.0	0.0
Cod	401.2	5.8	3.3	0.7	57.4	3.8
Other market fish	174.7	2.5	6.2	1.3	48.5	3.2

b) Assessment Data

i) Commercial fishery data

Danish, Swedish and Norwegian catch and effort data from logbooks have been analyzed and standardized (SCR Doc. 08/75; 13/66, 72).

There was an upwards trend in the standardized LPUE for all three series from 2000 to 2007 followed by a decreasing trend until 2010, which stabilized at a low level (Fig. 5.2)

Harvest rates were estimated from landings and corresponding biomass indices from the Norwegian survey. Since the new survey only covers six years, time series of standardized effort indices have also been estimated (Fig. 5.3). Standardized effort seems to have been fluctuating without any clear trend since the mid-1990s. Harvest rate has increased in recent years. It should be noted that LPUE series are standardized to the first year for which data are available.

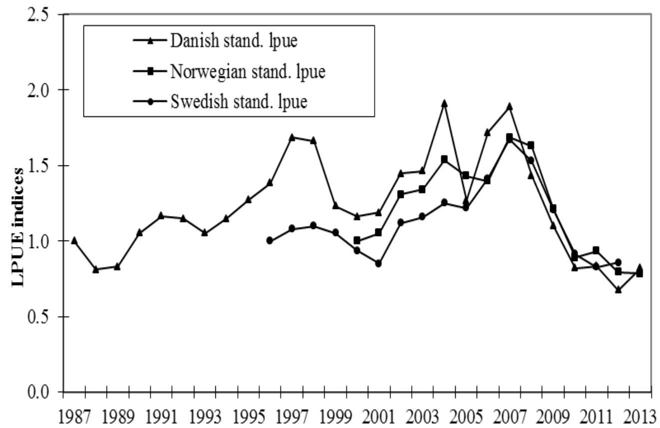

Fig. 5.2. Northern shrimp in Skagerrak and Norwegian Deep: Danish, Norwegian and Swedish standardized LPUE until 2013. 2013 data are preliminary. Each series is standardized to its first year.

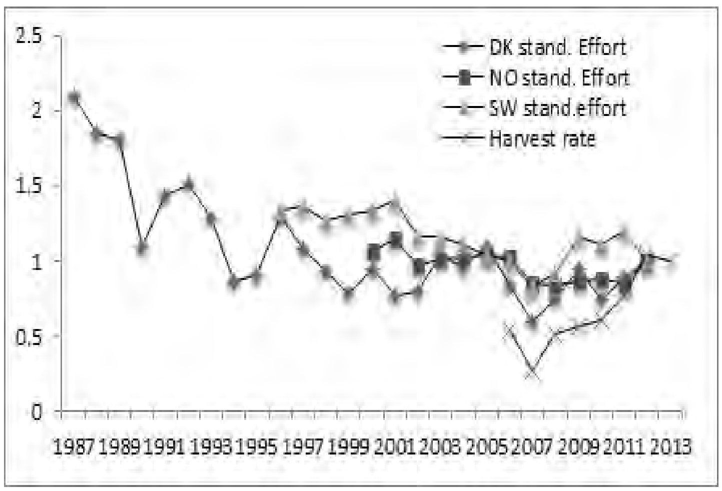

Fig. 5.3. Northern shrimp in Skagerrak and Norwegian Deep: Harvest rate (total catches/survey indices of biomass) and estimated standardized effort based on total landings and Danish, Norwegian and Swedish standardized LPUE. Each series is standardized to its final year. The harvest rate in 2013 is the TAC/survey biomass index.

ii) Sampling of catches.

Length frequencies of the total catches from 1985-2012 (SCR Doc 13/066, 72) have been obtained by sampling. The samples also provide information on sex distribution and maturity. The length frequencies are input data to the newly implemented length based analytical assessment model for the Skagerrak and Norwegian Deep shrimp stock.

iii) Survey data

The Norwegian shrimp survey went through large changes in the years 2003-06 with changes in vessel, gear and timing, resulting in three series (SCR Doc. 13/71).

Biomass indices from the first time series were recalculated in 2012 in order to provide updated biomass estimates with standard errors. The recalculated indices corresponded well with the old ones. The biomass index increased from 1988 to this time series' maximum in 1997. A decrease in 1998-2000 was followed by an increase in 2001-

2002, when this series was discontinued (Fig. 5.4). The 2004 and 2005 indices from the second biomass index series were not statistically different from each other. The third biomass index series peaked in 2007. Since then the index has shown a steady decline, to the time series' minimum in 2012. The 2013 value is at the same low level as in 2012.

The recruitment index value (abundance of age 1 shrimp) declined from 2007 to 2010 (Fig. 5.5). Recruitment increased in both 2011 and 2012, but decreased again in 2013.

SSB (female biomass) index follows the overall biomass index (Fig. 5.6).

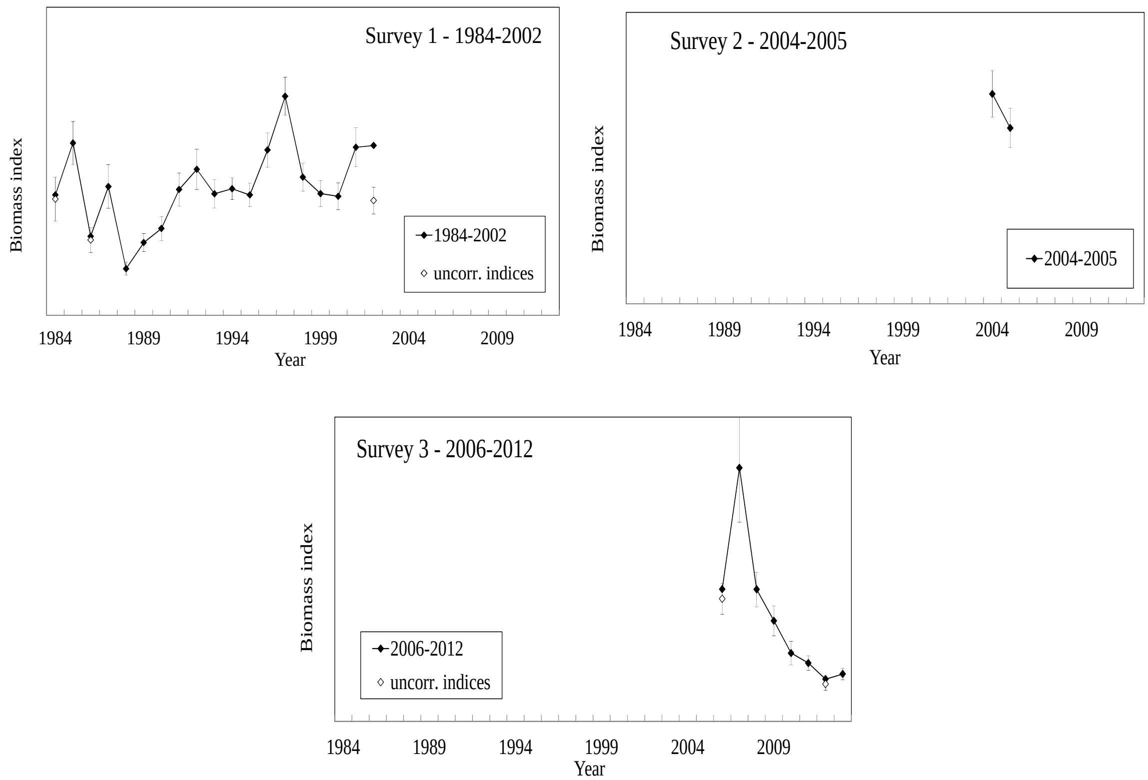

Fig. 5.4. Northern shrimp in Skagerrak and Norwegian Deep: Estimated survey biomass indices in 1984 to 2013. The 1984 – 2005 indices were re-calculated in 2012, providing SEs for the whole time series. Survey 1: October/November 1984-2002 with Campelen trawl; Survey 2: October/November 2003 with shrimp trawl 1420 (not shown); Survey 3: May/June 2004-2005 with Campelen trawl; Survey 4: January/February 2006-2013 with Campelen trawl.

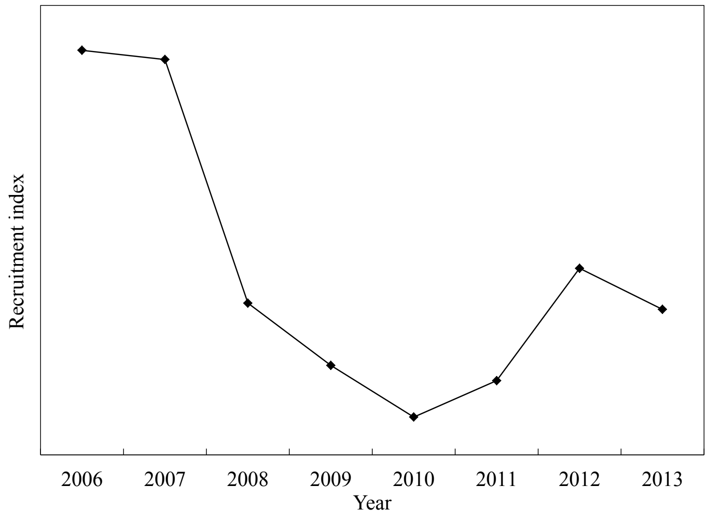

Fig. 5.5. Northern shrimp in Skagerrak and Norwegian Deep: Estimated recruitment index from 2006-2013. The recruitment index is calculated as the abundance of age 1 shrimp (the first mode, approx. 9-13mm, in the length frequency distribution).

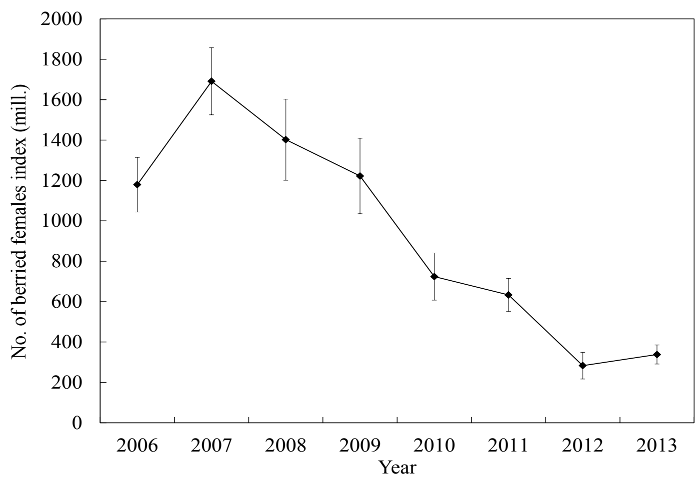

Fig. 5.6. Northern shrimp in Skagerrak and Norwegian Deep: SSB abundance from the Norwegian shrimp surveys in 2006-2013. The abundance index of the spawning stock is calculated as the abundance of berried females. Error bars are SE.

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 5.4. The total index of shrimp predator biomass excluding saithe and roundnose grenadier has been at the same level during the 8 last years. The predator index increased during 2013 due to an increased abundance of Blue whiting (Table 5.4).

Table 5.4. 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 2006-2013.

Species	Biomass index								
	2006	2007	2008	2009	2010	2011	2012	2013	Mean
Blue whiting	0.13	0.13	0.12	1.21	0.27	0.62	3.30	29.03	
Saithe	7.33	39.75	208.32	53.89	18.53	7.52	5.66	112.8	
Cod	0.51	1.28	0.78	2.01	1.79	1.66	1.26	1.69	
Roundnosed Grenadier	3.22	6.85	19.02	19.03	10.05	4.99	4.43	1.97	
Rabbit fish	2.24	2.15	3.41	3.26	3.51	2.73	2.22	3.05	
Haddock	0.97	4.21	1.85	3.18	3.46	5.82	5.75	5.18	
Redfish	0.18	0.40	0.26	0.43	0.80	1.02	0.37	0.47	
Velvet Belly	1.31	2.58	1.95	2.42	2.52	1.47	1.59	2.67	
Skates, Rays	0.41	0.95	0.64	0.17	0.60	0.88	0.98	1.00	
Long Rough Dab	0.22	0.64	0.42	0.28	0.47	0.51	0.56	0.56	
Hake	0.98	0.78	0.64	2.56	1.60	0.56	0.52	1.06	
Angler	0.15	0.91	0.87	1.25	1.70	0.92	0.17	0.65	
Witch	0.24	0.74	0.54	0.16	0.13	0.24	0.29	0.27	
Dogfish	0.31	0.19	0.28	0.14	0.11	0.21	0.60	1.02	
Black-mouthed dogfish	0.00	0.05	0.05	0.15	0.09	0.09	0.09	0.12	
Whiting	0.35	1.01	1.35	3.02	2.42	3.07	1.64	2.02	
Blue Ling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	
Ling	0.04	0.11	0.34	0.79	0.64	0.24	0.17	0.22	
Four-bearded Rockling	0.06	0.14	0.04	0.03	0.05	0.03	0.09	0.04	
Cusk	0.20	0.00	0.02	0.05	0.13	0.29	0.04	0.10	
Halibut	0.08	0.07	3.88	0.09	0.20	0.05	0.19	0.00	
Pollack	0.06	0.25	0.03	0.13	0.12	0.15	0.07	0.24	
Greater Forkbeard	0.00	0.00	0.00	0.01	0.04	0.02	0.05	0.06	
Total	18.99	63.19	244.81	94.26	49.23	33.09	30.04	164.23	87.23
Total (except saithe and roundnosed grenadier)	8.44	16.59	17.47	21.34	20.65	20.58	19.95	49.46	21.81

iv) Assessment models

The two assessment models presented to the ICES inter-benchmark assessment were evaluated at the final benchmark session: a stochastic length-based assessment model (SCR Doc. 12/61) and a Bayesian surplus production model (SCR 13/070). The general performance of the two models, as well as the outputs (biological reference points and short term forecasts), were discussed during the benchmark session within the NIPAG meeting. Both models were evaluated as capable of delivering a full analytical assessment. The two models also demonstrated some agreement in the long term trends of SSB and *F* estimates, although discrepancies in individual years were somewhat pronounced. The analytical length-based model applies more detailed biological information in the assessment and therefore provides more immediate responses to change, and is the preferred model. However, the benchmark recommended the surplus production model continue to be applied each year for an initial period to verify performance of the length based model. The length-based model was not fully operational to produce sufficient output for the ICES advice at this year's NIPAG meeting. It was therefore decided to provide advice based on the production model (SCR Doc. 13/070) in this year's assessment, although both estimates of stock status up to 2012 are presented.

v) Assessment Results

A. Length-based model (SCR Doc. 12/61).

The stock development as estimated by the length based model is shown in Fig. 5.7 (SSB, fishing mortality ($F_{1\text{-}3}$) and recruitment (1-group)). Fishing mortality has increased steeply since 2007 and is now at the highest level estimated. SSB has been declined since 2006 to low levels in the recent period. The estimated recruitment declined steeply between 2005 and 2008 and has remained stable at low levels since.

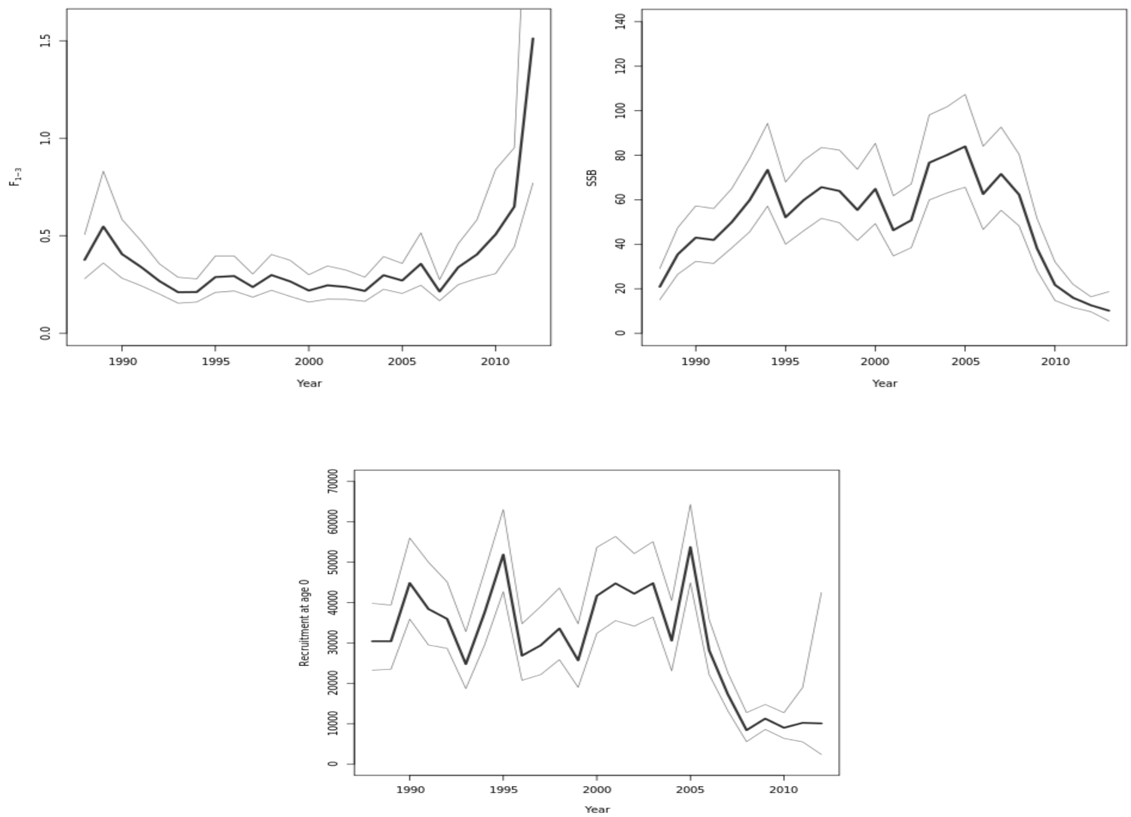

Fig. 5.7 Estimates of SSB, $F_{1\text{-}3}$ and recruitment from the length-based model. Compare with outputs from the Bayesian production model below

B. Stock production model fitted by Bayesian methods using commercial catch and effort data and data from the Norwegian trawl survey (SCR Doc. 13/070).

The estimated stock development from this model is shown in Fig. 5.8. Since the late 1980s the stock has varied with a slightly increasing trend until 2006 when it started to decline. It should be noted that this is similar to the development of SSB by the length-based model (Fig. 5.7). The median 2013 level is below B_{msy} but above B_{lim} (Table 5.6). The estimated risk of stock biomass being below $B_{trigger}$ in 2013 was 21% and 7% of being below B_{lim} (Table 5.7).

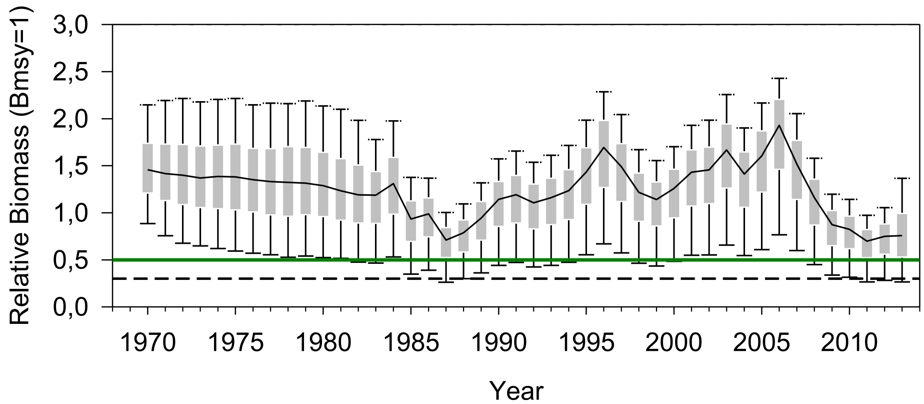

Fig. 5.8. Estimated time series of relative biomass (B_t/B_{msy}) 1970-2013. The solid black line is the median; boxes represent quartiles; the whiskers cover the central 90 % of the distribution. Dashed black line represents B_{lim}.

Estimated median fishing mortality has remained close to F_{msy} in recent years (Fig.5.9). In 2013 there is a 47% risk of F being above F_{msy} (Table 5.6).

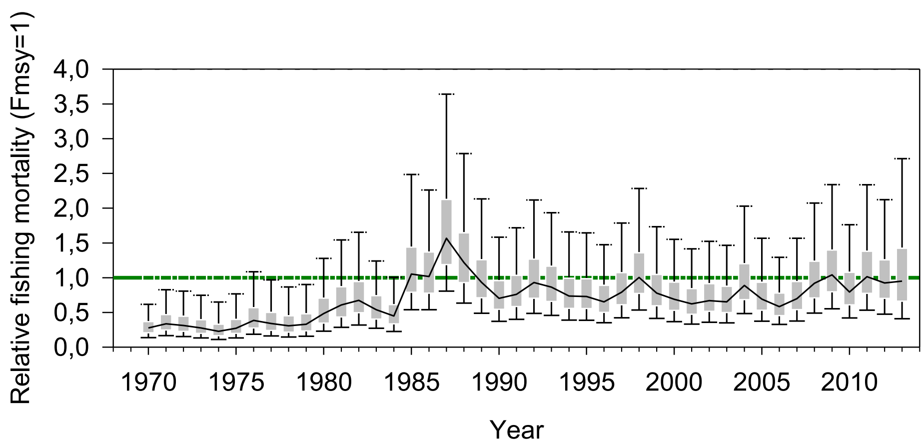

Fig. 5.9. Estimated time series of relative fishing mortality (F_t/F_{msy}) 1970-2013. The solid black line is the median; boxes represent quartiles; the whiskers cover the central 90 % of the distribution.

c) Stock development and biological reference points

Reference points. In 2009 ICES adopted a "Maximal Sustainable Yield (MSY) framework" (ACOM. ICES Advice, 2013. Book 1. Section 1.2) for deriving advice. There are two reference points to be considered under the ICES MSY approach: F_{msy}, $B_{trigger}$. In keeping with the reference points developed for the Barents Sea shrimp stock, $B_{trigger}$ was adopted as 50% B_{msy} (NIPAG, 2006). Under the ICES PA approach two reference points are required; B_{lim} and B_{pa}. Again, in line with the Barents Sea shrimp stock, B_{lim} was set at 30% B_{msy} (NIPAG, 2006). B_{pa} is not considered relevant in the presence of a risk analysis.

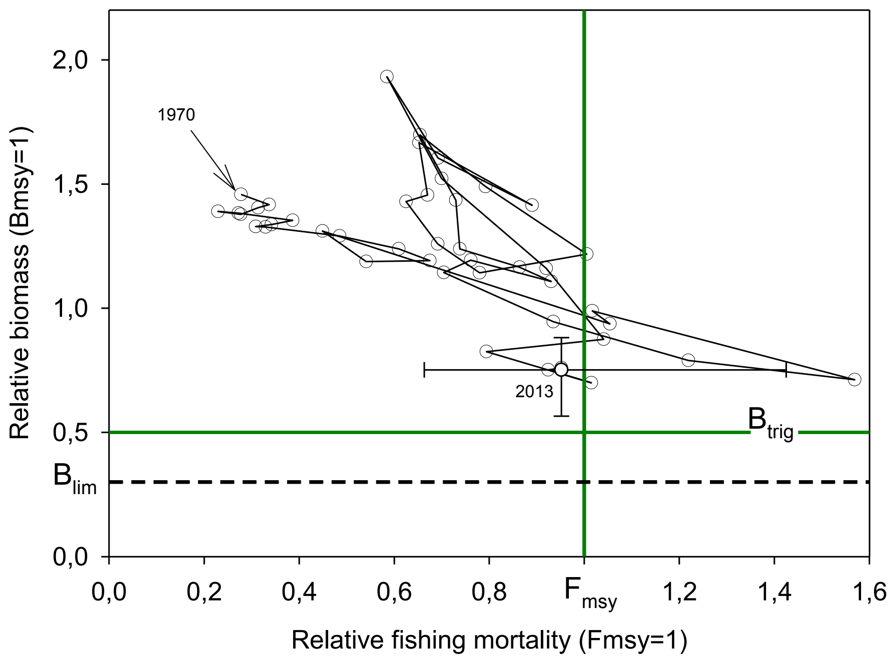

Fig. 5.10. Estimated annual median biomass-ratio (B/B_{MSY}) and fishing mortality-ratio (F/F_{MSY}) 1970-2013. The reference points for stock biomas, $B_{trigger}$, and fishing mortality, F_{msy}, are indicated by green lines, B_{lim}, by a dotted line. Error bars on the 2013 value are inter-quartile range

Projections. Given a catch of 8 834 t in 2012 and assuming a 2013 catch of 9 500 t, catch options from 6 000 t to 14 000 t were evaluated for 2014. Catches of up to 10 000 t have a <50% of exceeding F_{msy}, however under these catch options the risk of going below B_{lim} is above the 5% risk tolerance level adopted by ICES (Table 5.7).

Table 5.6. Catch option for 2014.

Catch option 2014 (kt)	6	8	10	12	14
Risk of falling below B_{lim} ($0.3B_{msy}$)	6 %	6 %	6 %	7 %	7 %
Risk of falling below B_{trig} ($0.5B_{msy}$)	18 %	20 %	21 %	22 %	24 %
Risk of falling below B_{msy}	65 %	67 %	69 %	73 %	75 %
Risk of exceeding F_{msy} 17 %	31 %	47 %	61 %	72 %	
Risk of exceeding $1.7F_{msy}$	4 %	10 %	18 %	29 %	39 %
Stock size (B/B_{msy}), median	0.84	0.82	0.79	0.76	0.73
Fishing mortality (F/F_{msy})	0.54	0.74	0.96	1.19	1.45
Productivity (% of MSY)	97 %	97 %	96 %	94 %	93 %

Table 5.7. Risk analysis 2012-2013

Status	2012	2013*
Risk of falling below B_{lim} ($0.3B_{msy}$)	6 %	7 %
Risk of falling below B_{trig} ($0.5B_{msy}$)	20 %	22 %
Risk of falling below B_{msy}	91 %	75 %
Risk of exceeding F_{msyY}	43 %	47 %
Stock size (B/B_{msy}), median	0.75	0.76
Fishing mortality (F/F_{msy}), median	0.93	0.95
Productivity (% of MSY)	94 %	94 %
*Predicted catch = TAC		

d) Management Recommendations

Based on this assessment NIPAG considers the stock below B_{msy} but well above $B_{trigger}$.

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

- *Sorting grids should be implemented in the North Sea in addition to the Skagerrak.*
- *Vessels >=12m in the Norwegian Deep should be required to complete and provide log books.*

e) Research Recommendations

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

- *that Skagerrak and Norwegian shrimp be included in [copy wording on recruitment workshop from SC report]*
- the Norwegian shrimp survey should be continued on an annual basis
- *Sensitivity of the current assessment to the final year survey data should be explored through a retrospective analysis to determine whether an in-season assessment update (February) would be beneficial.*

f) Research Recommendations from the 2010-2012 meetings

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

STATUS: The benchmark assessment which was finalized during the NIPAG meeting in September 2013 chose the length based model as a basis for advice for the shrimp stock in Skagerrak and the Norwegian Deep. However, it was also decided that the Bayesian surplus production model would be run alongside the coming years, as a quality check of the forecast produced by the length based model.

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

STATUS: Completed at the 2013 NIPAG meeting.

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

STATUS: A workshop is scheduled for April 2014.

- *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: Work in progress

- *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: Results from the project "*Sustainable shrimp fishing in Skagerrak*" has detected weak genetic structure in the Skagerrak/North Sea region, primarily associated with fjords in the Skagerrak region (Knutsen et al. in prep.). The shrimp in Skagerrak and the Norwegian Deep most likely comprise one single stock, which is in agreement with the oceanic current pattern in the area. The benchmark assessment in September 2013 thus concluded that we have one single shrimp stock in the Skagerrak and Norwegian Deep area. The conclusion on the relation between the shrimp (stock units) in Skagerrak and the Norwegian Deep on the one hand and the Fladen Ground shrimp on the other hand will await finalization of data analyses (Knutsen *et al.* in prep.).

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

Background documentation (equivalent to stock annex) is found in SCR Doc. 12/49, 50, 51, 60; 06/64, 08/56, 07/86, 07/75, 06/70, 13/65.

a) Introduction

As the survey data for 2013 was not available at this meeting the 2012 assessment has therefore not been updated. Catches were updated and is as follows:

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012[1]
Recommended TAC	-	-	-	41 299[2]	40 000	50 000	50 000	50 000	50 000	60 000	60 000
Norway	48799	34172	35918	37253	27352	25558	20662	19784	16779	19923	15208
Russia	3790	2776	2410	435	4	192	417	0	0	0	200
Others	8899	2277	4406	4930	2271	4181	7109	7488	8419	9867	10304
Total	61488	39225	42734	42618	29627	29931	28188	27272	25198	29790	25711

[1] Preliminary.
[2] Should not exceed the 2004 catch level (ACFM, 2004).

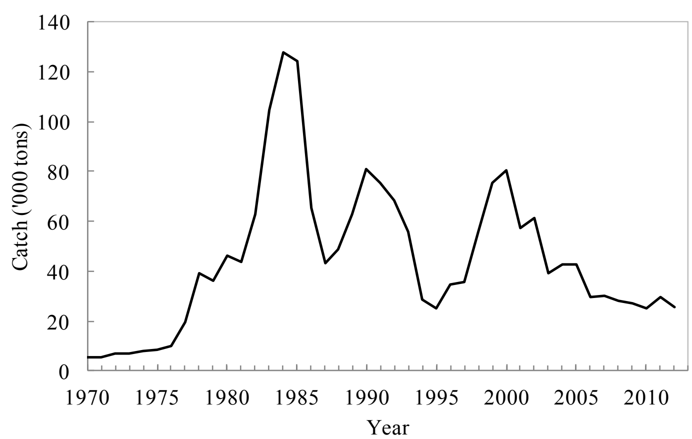

Fig. 6.1. Shrimp in ICES SA I and II: total catches 1970–2012 (2012 preliminary).

Additional information with regard to this fishery and the current assessment can be found in the 2012 NIPAG report

b) Summary of the results of the 2012 assessment

State of the stock: The stock has increased since the late 1990s and reached a level estimated to be close to carrying capacity in 2005. Fishing mortality has been well below F_{msy} throughout the series. The estimated risk of stock biomass being below B_{msy} in 2012 was 3%. In 2012 there is a low 1% risk of exceeding F_{msy}. The stock status was as follows:

Status	2012
Risk of falling below B_{lim} ($0.3B_{MSY}$)	<1%
Risk of falling below *Btrig* ($0.5B_{MSY}$)	<1%
Risk of falling below B_{MSY}	3 %
Risk of exceeding F_{MSY}	<1%
Risk of exceeding $1.7F_{MSY}$	<1%
Stock size (B/Bmsy), median	1.87
Fishing mortality (F/Fmsy), median	0.04
Productivity (% of MSY)	25 %

Catch options up to 60 kt for 2013 had a low risk (<5%) of exceeding F_{msy} (Table 6.4) and is likely to maintain the stock at its current high level.

Catch option 2013 (ktons)	30	40	50	60	70	90
Risk of falling below Blim (0.3Bmsy)	<1 %	<1 %	<1 %	<1 %	<1 %	<1 %
Risk of falling below Btrig (0.5Bmsy)	<1 %	<1 %	<1 %	<1 %	<1 %	<1 %
Risk of exceeding Fmsy	1 %	2 %	3 %	4 %	6 %	8 %
Risk of exceeding 1.7Fmsy	1 %	1 %	1 %	2 %	3 %	4 %
Stock size (B/Bmsy), median	1.86	1.85	1.84	1.83	1.83	1.80
Fishing mortality (F/Fmsy),	0.08	0.10	0.13	0.15	0.18	0.23
Productivity (% of MSY)	27 %	28 %	30 %	30 %	32 %	36 %

For annual catch options of 30 000 to 90 000 t the risk of the stock falling below $B_{trigger}$ in the medium term (10 years) is less than 5% . Taking 90 000 t/yr will increase the risk of going above F_{msy} to more than 10% during the ten years of projection (Fig. 6.2). However, the risk of going below $B_{trigger}$ remains under 5%. These projections were made assuming a catch for 2012 of 18 000 t whereas the actual catch was somewhat higher, although this is expected to have a minor impact on the projections.

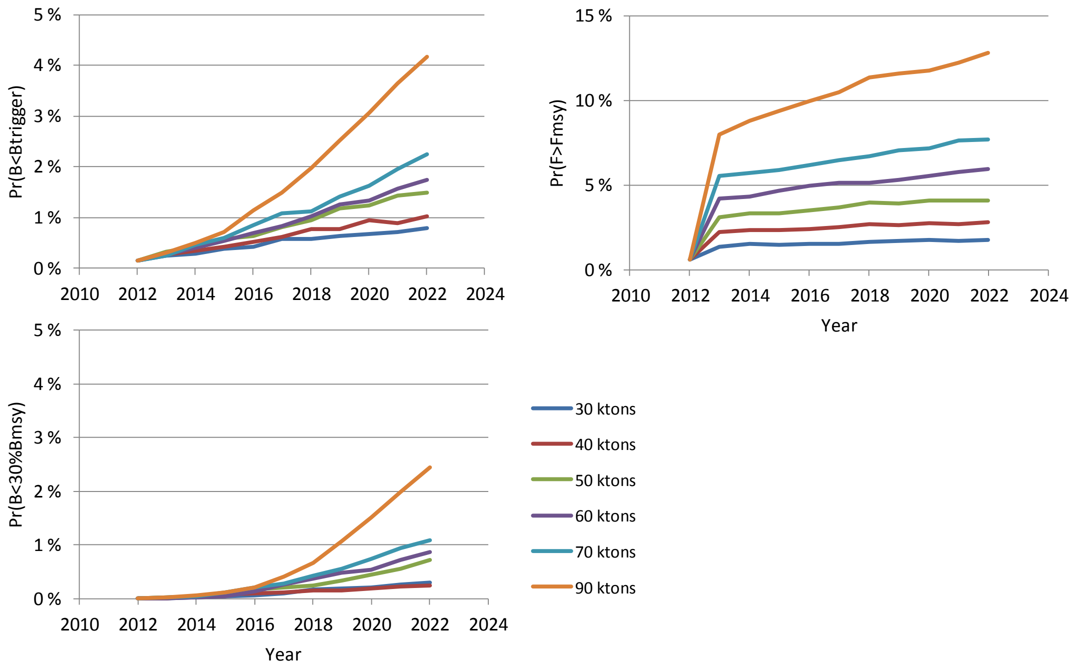

Fig. 6.2. Shrimp in ICES SA I and II: Projections of estimated risk of going below $B_{trigger}$ and of exceeding F_{msy} (top) and going below B_{lim} (bottom) given different catch options (see legend).

c) Consideration in relation to the advice for 2014:

Catch 2013

Catches are currently well below the TAC. There is no indication that catches will increase in 2013, relative to 2012; on the contrary as some Norwegian vessels have left the fishery catches will likely be lower than in 2012.

Quality of the assessment

The results of this assessment have been consistent since the introduction of the quantitative modeling framework in 2005 and are considered reliable.

Predictions until 2015

Catch options up to 60 000 t/yr, made at the 2012 assessment have a low risk (<5%) of exceeding F_{msyY} and a less than 1% risk of going below $B_{trigger}$. At a higher risk tolerance larger yield may be achieved.

Conclusion

The advice of 60 000 t given for 2013 could be rolled over for 2014 and be consistent with the MSY and PA approach.

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 since 1972 (SCR Doc. 09/69). Total reported landings have fluctuated between zero since 2006 to above 8 000 t (Figure 7.1). 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.

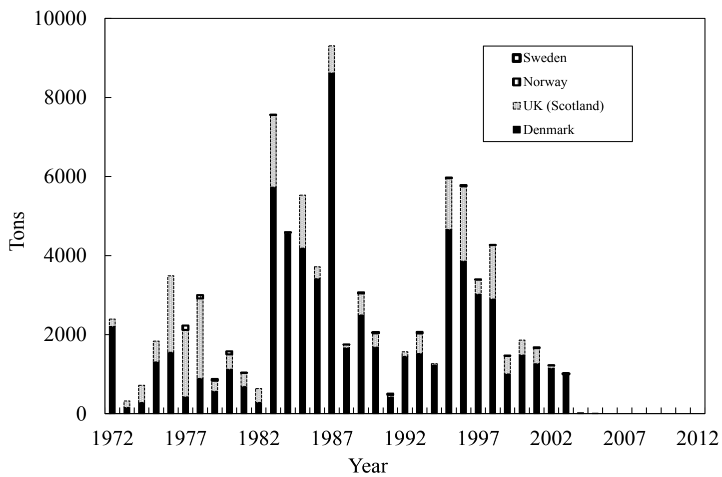

Fig. 7.1. Northern shrimp in Fladen Ground: Catches

IV. FINALISATION OF THE REPORT OF THE INTER-BENCHMARK PROTOCOL ON NORTHERN SHRIMP IN SKAGERRAK AND NORWEGIAN DEEP (ICES DIV. IIIA AND IVA EAST)

- Results from genetics study to delineate stocks
- Revision of survey length-data
- Re-run of length-based model
- Development of new *K*-prior and re-run of production model
- Documentation of input

V. OTHER BUSINESS

a) FIRMS Classification for NAFO Shrimp Stocks

The table as agreed in June was updated with the agreed classifications for the Northern shrimp stocks assessed this year.

Stock Size (incl. structure)	Fishing Mortality			
	None–Low	Moderate	High	Unknown
Virgin–Large		3LNO Yellowtail flounder		
Intermediate	3M Redfish 3LN Redfish	SA0+1 Northern shrimp	3M Cod	Greenland halibut in Uummannaq[1] Greenland halibut in Upernavik[1] Greenland halibut in Disko Bay[1]
Small	SA3+4 Northern shortfin squid	SA2+3KLMNO Greenland halibut 3LNO Northern shrimp DS Northern shrimp		3NOPs White hake 3LNOPs Thorny skate
Depleted	3M American plaice 3LNO American plaice 2J3KL Witch flounder 3NO Cod 3NO Witch flounder 3M Northern shrimp[2]			SA1 Redfish SA0+1 Roundnose grenadier
Unknown	SA2+3 Roughhead grenadier 3NO Capelin 3O Redfish	0&1A Offsh. & 1B–1F Greenland halibut		SA2+3 Roundnose grenadier

[1] Assessed as Greenland halibut in Div. 1A inshore
[2] Fishing mortality may not be the main driver of biomass for Div. 3M Shrimp

b) Future Meetings

An invitation was made to the group from Greenland to host the September 2014 SC / NIPAG meeting in Nuuk. This suggestion was warmly received by NIPAG.

VI. ADJOURNMENT

The NIPAG meeting was adjourned at 16:15 hours on 19 September 2013. 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.