PART G

Scientific Council Meeting, 5-11 November 2003

CONTENTS

Participants, Scientific Council Meeting, 5-11 November 2003 at NAFO Headquarters, Dartmouth, Nova Scotia, Canada

Back (left to right): Per Kanneworff, Sergey Bakanev, Kai Weiland, Bill Brodie, DorothyAuby, Tissa Amaratunga
Front (left to right): Helle Siegstad, Joanne Morgan, Unnur Skúladóttir, Michaela Aschan, Hilario Murua, Carsten Hvingel, Dave Orr, Árni Nicolajsen
Missing: Peter A. Koeller

Chairs and Designated Experts

Left to Right: Dave Orr (Shrimp Div. 3LNO), Joanne Morgan (SC Chair), Carsten Hvingel (Shrimp SA 0+1 and Denmark Strait), Unnur Skuladottir (Shrimp 3M) and Hilario Murua (STACFIS Chair)

REPORT OF SCIENTIFIC COUNCIL MEETING

5-11 November 2003

Chair: M. Joanne Morgan Rapporteur: Tissa Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, during 5-11 November 2003. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Spain), Iceland, Norway and Russian Federation. The Deputy Executive Secretary was in attendance.

The Executive Committee and the Designated Experts met briefly before the opening to discuss the plan of work.

The opening session was called to order at 1015 hours on 5 November 2003

The Council noted that STACFIS would undertake the assessments of the stocks (see Appendix I), while the prognoses and advice would be undertaken by the Council.

The Provisional Agenda was considered and **adopted** with editorial changes (see Appendix II). The Deputy Executive Secretary was appointed rapporteur.

The session was adjourned at 1045 hours.

The Council welcomed STACFIS to conduct its business through 5-8 November 2003, noting most of the Council’s work would be addressed through 10-11 November 2003.

The concluding session was convened at 0900 hours on 11 November 2003. The Council addressed the requests of the Fisheries Commission and the Coastal States and considering the results of the assessments, provided advice and recommendations.

The Council then considered and **adopted** the STACFIS Report, and considered its own report and **adopted** the report of this meeting of 5-11 November 2003.

The meeting was adjourned at 1300 hours on 11 November 2003.

The Report of Standing Committee on Fisheries Science (STACFIS) as **adopted** by the Council is given at Appendix I.

The Agenda, List of Research (SCR) and Summary (SCS) Documents, and List of Representatives and Advisers/Experts of this meeting are in Part H this volume.

The Council's considerations on the Standing Committee Report, and other matters addressed by the Council follow in Sections II-IV.

II. FISHERIES SCIENCE

The Council **adopted** the Report of Standing Committee on Fisheries Science (STACFIS) as presented by the Chair, Hilario Murua. The full report is given at Appendix I.

The Council's summary sheets and conclusions on Northern shrimp in Div. 3M, Northern shrimp in Div. 3LNO, Northern shrimp in Subareas 0+1 and Northern shrimp in Denmark Strait and off East Greenland are presented in Section III of this report. The recommendations with respect to stock advice appear therein.

The research **recommendations** endorsed by the Council are as follows:

1. **For Northern Shrimp in Division 3M**

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

- *a more detailed conversion document including information on the geometry and behaviour of the trawls and detailed calculations of the conversion for shrimp be presented at the September 2004 meeting.*

- *indices of stock size be presented with error bars where possible.*

2. **For Northern Shrimp in Divisions 3LNO**

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

3. **For Northern Shrimp in Subareas 0 and 1**

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in Subarea 1.*

4. **For Northern Shrimp in Denmark Strait and off East Greenland**

- *a survey series be established, to provide fishery independent data of the stock throughout its range.*

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in the Greenland EEZ and improve in the Icelandic EEZ..*

III. MANAGEMENT ADVICE AND RESPONSES TO SPECIAL REQUESTS

1. **Responses to Fisheries Commission**

a) **Advice on TAC and Other Management Measures**

The Scientific Council reviewed the STACFIS assessments of Northern shrimp in Div. 3M and Div. 3LNO, and the agreed summaries are as follows:

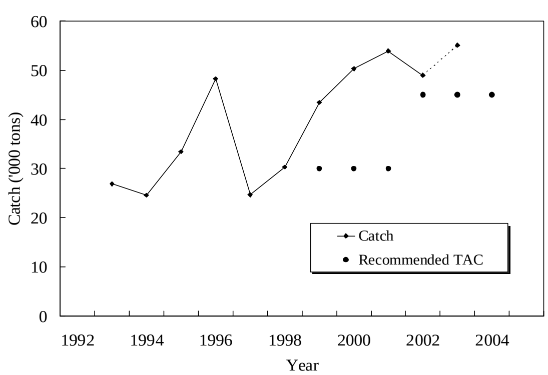
Northern Shrimp (Pandalus borealis) in Division 3M

Background: The shrimp fishery in Div. 3M began in late-April 1993. Initial catch rates were favourable and, shortly thereafter, vessels from several nations joined. Since 1993 the number of vessels ranged from 40-110, and in 2003 there were approximately 41 vessels fishing shrimp in Div. 3M.

Fishery and catches: This stock is under effort regulation. Recent catches were as follows.

	Catch ('00 tons)		TAC ('000 tons)	
Year	STACFIS	21A	Recommended	Agreed
2000	50	49[1]	30	er
2001	54	51[1]	30	er
2002	49	48[1]	45	er
2003	55[2]		45	er
2004			45	er

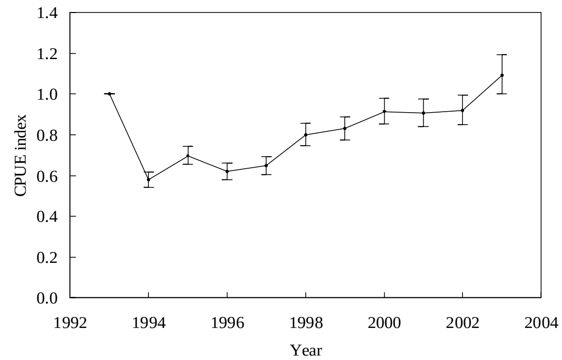
[1] Provisional.
[2] Projected to end of 2003.
er Effort regulations.



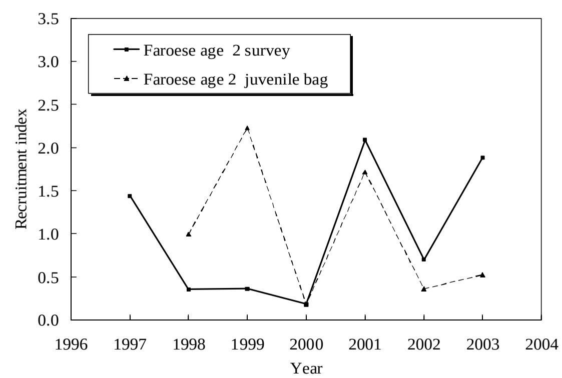
Data: Catch, effort and biological data were available from several Contracting Parties. A standardized CPUE index was developed to account for changes in gear (single, double and triple trawl), fishing power and seasonality. Time series of size and sex composition data were available from three countries and survey indices were available from Faroese and EU research surveys. A new research vessel was introduced in the EU survey in 2003. However the Scientific Council was unclear as to the conversion of the time series.

Assessment: No analytical assessment is available and fishing mortality is unknown. Evaluation of stock status is based upon interpretation of commercial fishery and research survey data.

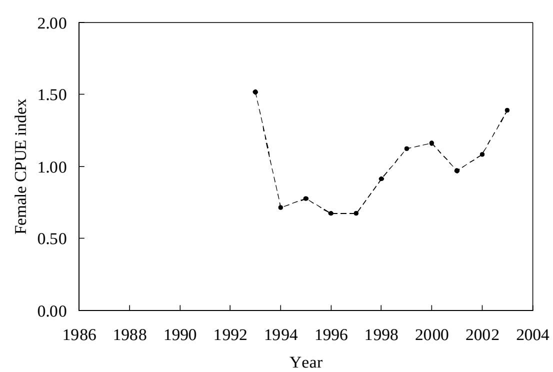
CPUE: Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, and increased to 2003.

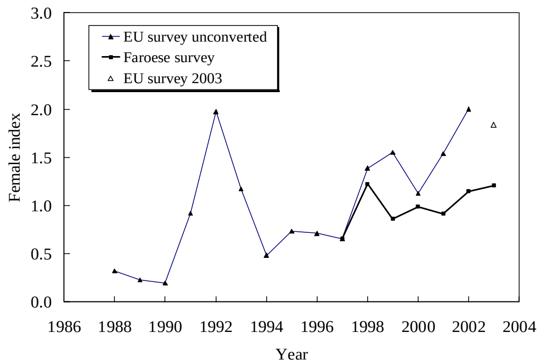


Recruitment: The 1999 year-class is strong while the 2000 year-class appears weak and the 2001 year-class appears average.



SSB: All indices of female biomass showed an increasing trend from 1997 to 2003.





State of the Stock: Stock size indicators have shown a general increase since 1997. The 1999 year-class is strong and will continue to contribute to the fishery in 2004, and possibly to some degree in 2005 as well. The 2001 year-class appears to be about average and shall be contributing to the fishery in 2004 and 2005. However, the 2000 year-class appears to be weaker.

Recommendations: The stock appears to have sustained an average annual catch of about 45 000 tons since 1998 with no appreciable effect on stock biomass. Of the year-classes that will be the main contributors to the fishery over the next few years, the 1999 year-class estimated to be strong, the 2000 weak and the 2001 average. The Scientific Council advises a catch of 45 000 tons for 2005.

Special comments: This advice will be reviewed based on updated information in September 2004.

Sources of Information: SCR Doc. 03/66, 72, 79, 80, 83, 84, 87, 88, 90, 91.

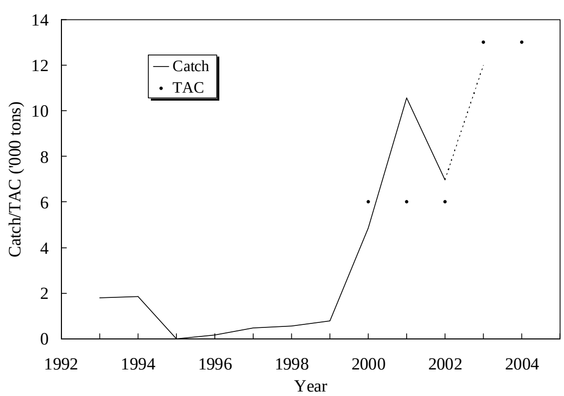
Northern Shrimp (Pandalus borealis) in Divisions 3L, 3N and 3O

Background: Most of this stock is located in Div. 3L, and exploratory fishing began there in 1993. The stock came under TAC regulation in 2000, and fishing was restricted to Div. 3L.

Fishery and catches: Nine nations participated in the fishery in 2003. The use of a sorting grid to reduce by-catches of fish is mandatory for all fleets in the fishery. Recent catches from the stock are as follows:

	Catch (´000 tons)		TAC ('000 tons)	
Year	STACFIS	21A	Recommended	Agreed
2000	5	5[1]	6	6
2001	11	5[1]	6	6
2002	7	6[1]	6	6
2003	12[2]		13	13
2004			13	13

[1] Provisional.
[2] Projected to the end of 2003.

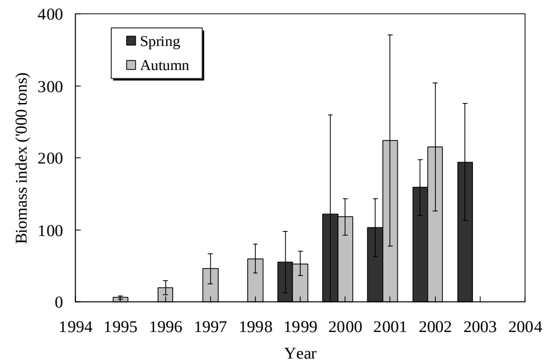


Data: Catch, effort and biological data were available from the commercial fishery. Biomass and recruitment indices, and size and sex composition data were available from research surveys conducted in Div. 3LNO during spring (1999 to 2003) and autumn (1995 to 2002).

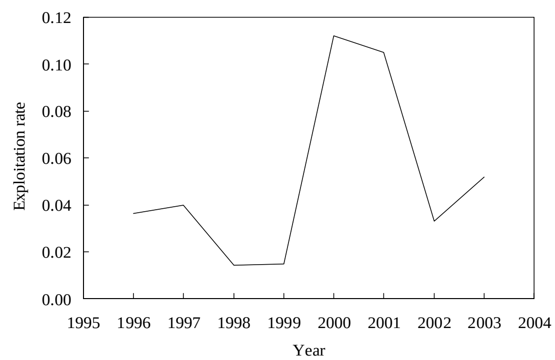
Assessment: No analytical assessment is available. Evaluation of the status of the stock is based on interpretation of research survey and biological indices.

Recruitment: The 1998 and 1999 year-classes are the two largest year-classes in the short time series, but are followed by the 2000 year-class which was slightly above average.

Biomass: There was a significant increase in SSB and total biomass between 1995 and 1997, followed by a period of stability from 1997 until 1999. Both SSB and total biomass have been at a higher level since 2000.



Exploitation: No estimates of fishing mortality were available. The exploitation index was 1-4% during 1996-99, increased to 10-11% in 2000-2001, and was estimated to be only 6% during 2003.



State of the Stock. SSB estimates have increased significantly since 1999 and are currently the highest observed. Recruitment of the 1998 and 1999 year-classes were the highest observed, however, the 2000 year-class has dropped to just above average. The stock appears to be well represented by a broad range of size groups, and exploitation is low.

Recommendation*:* Applying a 15% exploitation rate to the lower 95% confidence limit of the biomass estimates, averaged over the autumn 2000 to spring 2002 surveys, results in a catch of about 13 000 tons. Scientific Council reiterated that "the development of any fishery in the Div. 3L area take place in a gradual manner with conservative catch limits imposed and maintained for a number of years in order to monitor stock response". Scientific Council recommends that the TAC for shrimp in Div. 3LNO in 2005 should remain at 13 000 tons.

Scientific Council reiterated its recommendations that the fishery be restricted to Div. 3L and that the use of a sorting grate with a maximum bar spacing of 22 mm be mandatory for all vessels in the fishery.

Special Comments: Advice for the 2005 fishery will be reviewed at the September 2004 Scientific Council meeting, when results from the 2003 autumn and spring 2004 surveys will be available.

Sources of Information: SCR Doc. 03/72, 81, 82.

b) **Responses to Special Requests from the Fisheries Commission**

There were no special requests.

2. **Responses to the Coastal States**

The Scientific Council reviewed the STACFIS assessments for Northern shrimp in Subareas 0 and 1 and in Denmark Strait and off East Greenland, and the agreed summaries are as follows:

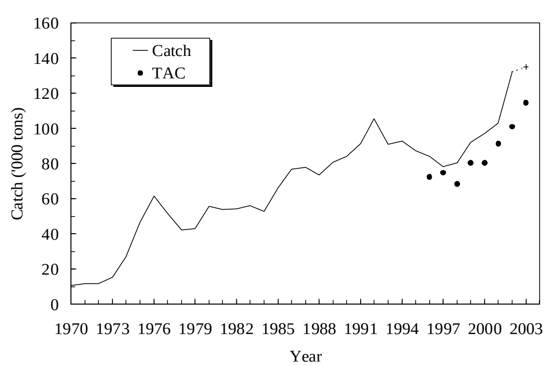
Northern Shrimp (Pandalus borealis) in Subareas 0 and 1

Background: A small-scale inshore fishery began in SA 1 during the 1930s. Since 1969 an offshore fishery has developed. The shrimp stock off West Greenland is distributed in Subarea 1 and Div. 0A east of 60°W.

Fishery and catches: The fishery is conducted by Greenland and Canada. For this year's assessment catch figures of SA 1 were corrected for overpacking and product to live weight differences by applying a factor of 1.23 (average). Recent catches from the stock are as follows:

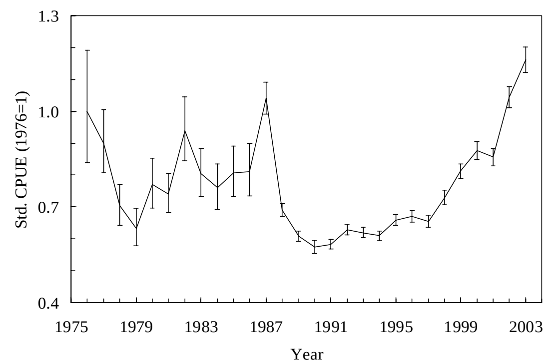
	Catch ('000 tons)		TAC ('000 tons)	
Year	STACFIS[1]	21A	Recommended	Actual
2000	97.2	80.1[2]	65.0	80.3
2001	102.8	85.0[2]	85.0	91.3
2002	132.1	109.2[2]	85.0	103.2
2003	135.0[3]		100.0	114.7

[1] Corrected for overpack.
[2] Provisional.
[3] Projected to the end of 2003.

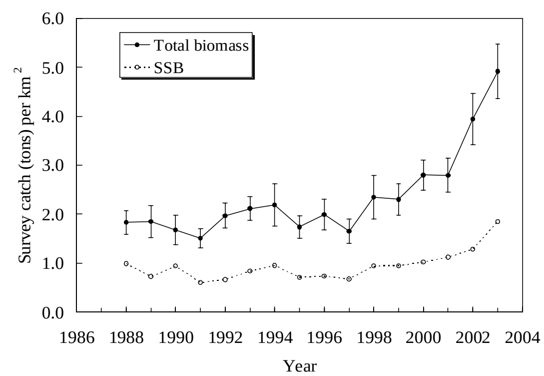


Data: Catch and effort data were available from all vessels. Time series of biomass and recruitment indices, size and sex composition data were available from research surveys. Series of cod biomass and cod consumption were available.

Indicators of biomass: The standardized CPUE series showed an increasing trend since 1990. The 2003-value is the highest of the time series.



The survey total biomass and SSB indices (female biomass) showed an increasing trend since 1997. For both indices the 2003-value is the highest of the series.

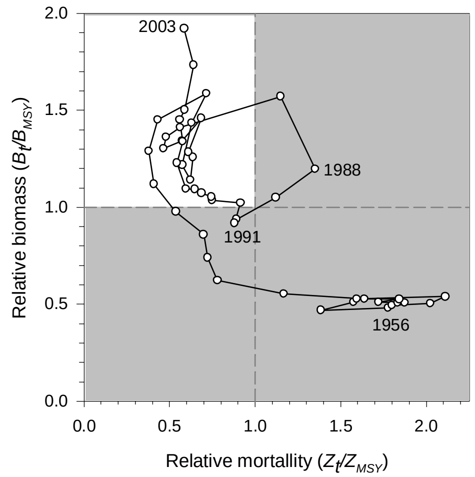


Exploitation rate: Indices of exploitation rate have shown a decline since the early-1990s.

Assessment: An analytical assessment framework using a stochastic version of a surplus-production model that included an explicit term for predation by cod (*Gadus morhua*) was applied.

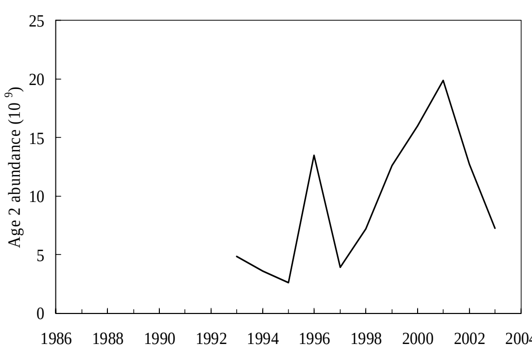
Mortality: The mortality caused by fishing and cod predation (Z) has been below the upper limit reference

(Z_{MSY}) for most of the time since 1970. Since 1997 mortality has been stable well below Z_{MSY}. The estimated risk of current mortality being above Z_{MSY} was less than 5%.



Biomass. Since the early-1970s the probability that biomass was below the optimum level (B_{MSY}) was low for most years. Since the early-1990s the stock has increased and reached its highest level in 2003. The estimated risk of current stock biomass being below B_{MSY} was less than 1%.

Recruitment. A recruitment index (shrimp at age 2) showed an increasing trend from 1997 to 2001 and a decrease thereafter. The 2003 value is below the average of the time series.



State of the Stock. The stock biomass has increased since the early-1990s and reached its highest level recorded in 2003. Biomass is well above B_{MSY} and mortality by fishery and cod predation is well below Z_{MSY}. In addition the stock appears to be well represented by a broad range of size groups.

Recommendations: If catches, measured as total live weight removals, including overpack, exceed 130 000 tons in 2004 there is a greater than 9% risk of exceeding a mortality that is considered to be a limit reference point. Scientific Council therefore recommends that total catch (live weight, including overpack) in Div. 0A and SA 1 in 2004 should not exceed 130 000 tons.

Given the high probabilities of the stock being considerably above B_{MSY}, risk of stock biomass falling below this optimum level within a one-year perspective is low.

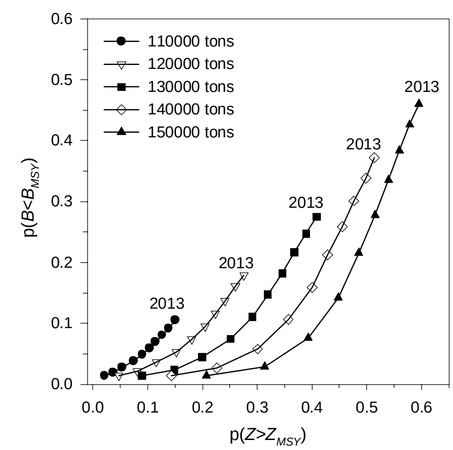
Risk associated with five optional catch levels for 2004 are as follows:

Catch option ('000 tons)	110	120	130	140	150
Risk of falling below B_{MSY}	2%	2%	2%	3%	3%
Risk of exceeding Z_{MSY}	2%	3%	9%	14%	21%

Medium-term Considerations: Ten-year projections of stock development were made using the assumption that the cod stock will remain at its low 2003 abundance. Five levels of annual catch: 110, 120, 130, 140 and 150 thousand tons were investigated.

With a catch of 130 000 tons/yr there is less than 10% risk of stock biomass falling below B_{MSY} in the first four years. However, this level of exploitation might not be sustainable in the longer term, as risk of falling below optimum biomass continues to increase through time.

Catches greater or equal to 130 000 tons/yr are not likely to be sustainable in the longer term.



Reference Points: The limit reference point for mortality in the current assessment framework is Z_{MSY}, i.e. Z-ratio=1. At this meeting Scientific Council was not in a position to define a reference for biomass (B_{lim}).

Special Comments: The TAC options for 2004 are considerably higher than the ones given for 2003. This is, however, mainly due to a revision in catch estimates to account for overpack, and not due to a comparable increase in stock production. For example if overpack was accounted for, the 2003 recommended TAC of a 100 000 tons would be equivalent to 123 000 tons. The advice for 2004 may therefore not be interpreted as if actual removals by the fishery should be increased comparatively. The Scientific Council advice is based on catches in 2004 being reported correctly, accounting for overpack.

Predation by cod can have a major impact on shrimp stock size. If the cod stock were to increase rapidly above the current level, as seen in the late-1980s, consumption could reach the same level as the current catches within a 3-4 year period. Such an event should, however, be detected early by routine survey programs and management options can then be evaluated.

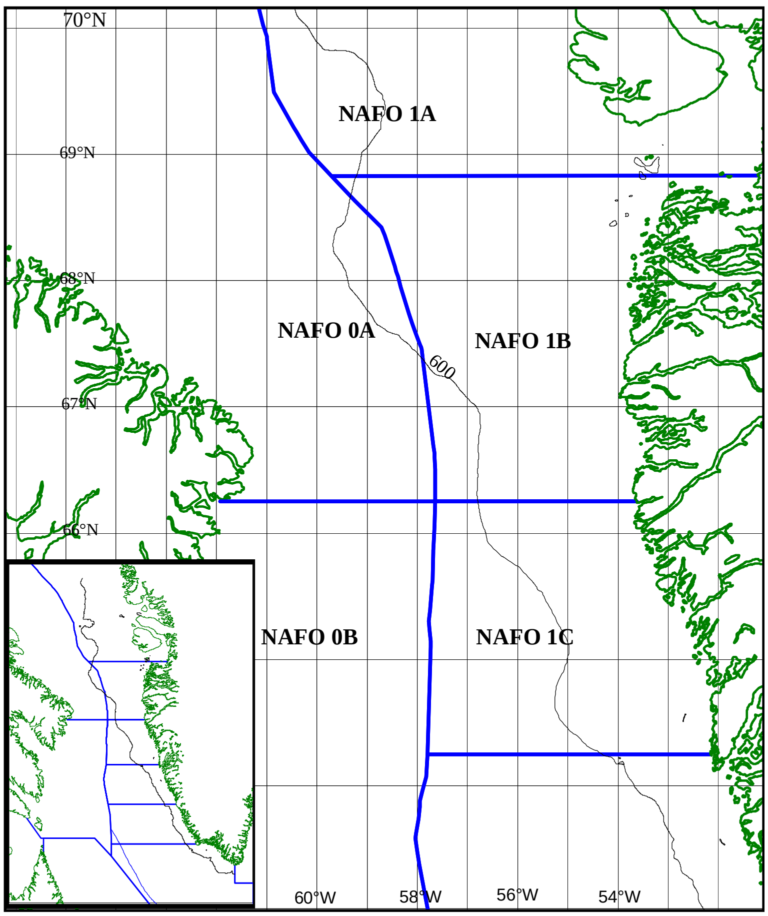
Sources of Information: SCR Doc. 03/70, 71, 73, 74, 75, 76, 86, 02/158.

a) **Response to Special Request from the Coastal State**

Denmark (in respect to Faroe Islands and Greenland) had asked the Scientific Council: *to update on the distribution of Northern shrimp and provide advice on allocation of TACs to Subarea 0 and Subarea 1.*

The Scientific Council with respect to allocation of TACs to Subareas 0 and 1, responded:

The distribution area of the Northern shrimp stock off West Greenland includes Subarea 1, from Cape Farewell to 72°30 N and an adjacent small part of Div. 0A between 67°and 69°N, east of 60°W and shallower than 600 m (see map).



Surveys conducted by Greenland covered the distribution of Northern shrimp in Subarea 1 and Div. 0A, east of 60°W. The survey from 1994-2002 has consistent coverage, allowing comparison between the two areas. The annual estimates of biomass have high uncertainty and variance, and therefore the average and range over this period are given. The average percentage of the biomass in Div. 0A was 1.7%, ranging from 0.1% to 4.1%. If TAC for shrimp in Subarea 1 and Div. 0A is split according to the biomass distribution, the split would be 98.3% in Subarea 1 and 1.7% in Div. 0A. There is no information on the abundance of shrimp in Div. 0A outside of the survey area. Advice on allocation of TAC can be revised, if information on the distribution of shrimp changes.

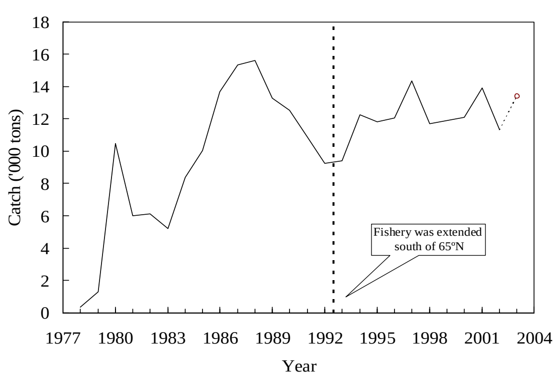
Northern shrimp (Pandalus borealis) in Denmark Strait and off East Greenland

Background: The fishery began in 1978 in areas north of 65°N in Denmark Strait, where it occurs on both sides of the midline between Greenland and Iceland. Areas south of 65°N in Greenlandic waters have been exploited since 1993.

Fishery and Catches: Five nations participated in the fishery in 2003. For this year's assessment catch figures were corrected for overpacking and product to live weight differences by applying a factor of 1.24 (average). Recent catches and recommended TACs are as follows:

	Catch ('000 tons)		TAC ('000 tons)		
Year	STACFIS[1]	21A	Recom.	GR EEZ	ICE EEZ[2]
2000	12.1	9.6[3]	9.6	12.6	-
2001	13.9	11.1[3]	9.6	10.6	-
2002	11.4	9.3[3]	9.6	10.6	-
2003	13.5[4]		9.6	10.6	-

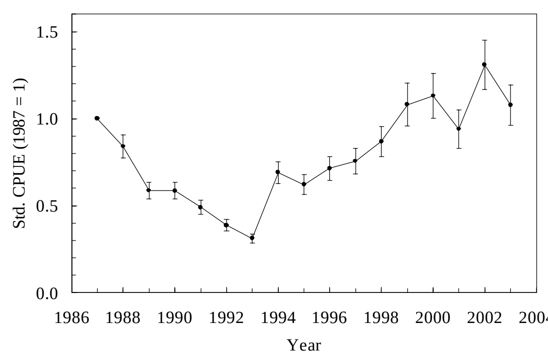
[1] Corrected for overpack.
[2] Fishery unregulated in Icelandic EEZ.
[3] Provisional catches.
[4] Projected to the end of 2003.



Data: Catch and effort data were available from trawlers of several nations. Surveys have not been conducted since 1996.

Assessment: No analytical assessment is available. Evaluation of the status of the stock is based on interpretation of commercial fishery data.

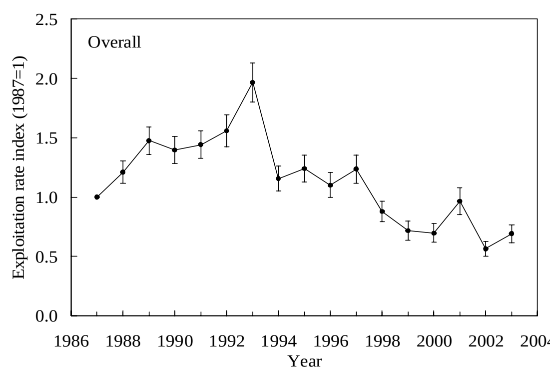
CPUE: Combined standardized CPUE indices for the total area declined from 1987 to 1993 and increased thereafter to approximately the same level in 2000-2003 as at the start of the time series in 1987.



Recruitment: No recruitment estimates were available.

Biomass: No direct biomass estimates were available.

Exploitation rate: From 1998 through 2003 an exploitation rate index (catch/CPUE) has been at its lowest levels in the 17-year series.



State of the Stock: Standardized CPUE data for all the areas combined indicate a general increasing trend in fishable biomass since 1993. The 2000 to 2003 values equal the relatively high values at which the series started in 1987.

Recommendation: Since 1994, annual catches measured as total live weight, including overpack, have remained near an average of 12 400 tons, while stock biomass indices have increased. This increase may not, however, have continued after 1999. Scientific Council therefore advises that catches of shrimp in Denmark Strait and off East Greenland should not exceed 12 400 tons in 2004.

Special Comments: The apparent increase in the advised TAC for 2004 is based on a revision of catch estimates to account for overpack and not on a comparable increase in stock production. The advice for 2004 may therefore not be interpreted as if actual removals by the fishery should be increased comparatively. The Scientific Council advice is based on catches in 2004 being reported correctly, accounting for overpack.

Sources of Information: SCR Doc. 03/74, 77, 85.

IV. OTHER MATTERS

1. Scientific Council Meeting, October/November 2004

The Scientific Council agreed to the dates 27 October to 4 November 2004 for this meeting to be held jointly with the ICES Pandalus Assessment Working Group at ICES Headquarters in Copenhagen, Denmark

2. Scientific Council Meeting, October/November 2005

The Scientific Council tentatively agreed to the dates 25 October to 2 November 2005 for this meeting to be held at the NAFO Headquarters, Dartmouth, Nova Scotia, Canada. Dates and location will be reviewed in June 2004.

3. Coordination with ICES Working Groups on Shrimp Stock Assessments

Scientific Council considered a joint meeting with the ICES Pandalus Assessment Working Group (WGPAND) in Copenhagen, Denmark during 27 October to 4 November 2004. The Council noted that the proposal received from ICES at this meeting deviated substantially from that agreed at the 2004 September Meeting of Scientific Council. The proposal entails a joint meeting of STACFIS and WGPAND with specific arrangements to be determined by the Chairs of Scientific Council, STACFIS and WGPAND. The Scientific Council and WGPAND meetings may be opened separately with STACFIS and WGPAND meeting together to assess the various shrimp stocks. The work of STACFIS and WGPAND will be covered in reports of the respective groups. The report of STACFIS will not contain a report of the shrimp stocks in the ICES area. The respective Secretariats will produce the reports of the two groups. Although this is a much different meeting plan than agreed previously by Scientific Council, the importance of increasing the participation of shrimp scientists in the assessments was deemed great enough to agree to this meeting plan. As usual the Scientific Council agenda will be issued 60 days prior to the meeting. The Chairs of Scientific Council and STACFIS will begin arranging the meeting agenda with the Chair of WGPAND in early-2004. Scientific Council hopes that in future STACFIS and WGPAND will be able to work together as a single body on the assessment of shrimp stocks.

V. ADOPTION OF REPORTS

The Council at its session on 11 November 2003 considered and **adopted** the Report of STACFIS (see Appendix I). The recommendations made by STACFIS and endorsed by the Scientific Council are given therein in Sections II and III above. The Council then considered and **adopted** its own Report of this 5-11 November 2003 Meeting.

VI. ADJOURNMENT

The Chair noted that the concluding session was taking place on Remembrance Day and noted that this was set aside in Canada as a time to remember the sacrifice of all those who have fought for freedom. The Chair thanked the participants, noting especially the efforts of the Designated Experts and Chair of STACFIS, and the support of the NAFO Secretariat. The Chair also noted that this was the last Scientific Council Meeting for Per Kanneworff and thanked him for 30 years of work in Council. There being no other business, the meeting was adjourned at 1300 hr on 11 November 2003.

APPENDIX I. REPORT OF STANDING COMMITTEE ON FISHERIES SCIENCE (STACFIS)

Chair: Hilario Murua Rapporteur: Various

I. OPENING

The Committee met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, during 5-11 November 2003, to consider and report on matters referred to it by the Scientific Council, particularly those pertaining to the provision of scientific advice on certain Northern shrimp stocks. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Spain), Iceland, Norway and Russian Federation. The Deputy Executive Secretary was in attendance.

The Chair, Hilario Murua (EU/Spain), opened the meeting on 5 November 2003 welcoming the participants. The Agenda was reviewed and a plan of work developed for the meeting. The provisional agenda was adopted (see Appendix II).

II. GENERAL REVIEW

1. Review of Recommendations in 2002 and 2003

STACFIS reviewed the recommendations from 2002 during considerations of each relevant stock.

2. Review of Catches of Shrimp

STACFIS reviewed and agreed on the catch figures available for all stocks being assessed at this meeting. Catch figures for shrimp in Subarea 1 and in Denmark Strait and off East Greenland were corrected for overpacking and product to live weight differences for the first time in 2003.

3. Environmental Review (SCR Doc. 03/71, 78)

Division 3M (SCR Doc. 03/78). Oceanographic data from the summer of 2003 on the Flemish Cap were examined and compared to the long-term (1971-2000) average. The cold near-surface temperatures (0.5° to 2°C below normal) experienced over the Cap from 1993-96 had warmed to 0.5° to 1.5°C above normal by July of 1997, and increased further to 2°C above normal by the summer of 1999. Upper layer temperatures over the Flemish Cap during the spring of 2001 and the summer of 2002 generally showed a downward trend with temperatures decreasing to below normal values. During the summer of 2003, temperatures directly over the Cap were highly variable while adjacent areas showed significant positive anomalies. Near bottom temperatures over the Cap were generally around 3.5°C, which was below normal in some areas particularly on the western side of the Cap. Salinities over most of the upper water column during the summer of 2002 and 2003 were generally saltier-than-normal. In the deeper water (>100 m depth) salinities were about normal. During the summers of 2002 and 2003 most areas of the water column experienced highly variably salinity conditions with near-surface values below normal in 2002 and above normal in 2003. Dissolved oxygen levels were about normal for the region. Both the measured currents and the geostrophic estimates, while showing considerable differences and variability between years, confirm the existence of a general anticyclonic circulation around the Flemish Cap during the summer.

Divisions 3LNO (SCR Doc. 03/78). Bottom temperatures on the Grand Bank during the spring of 2003 were mostly below normal. The areal extent of bottom water less than 0°C reached a minimum in 1998-99, but has been increasing since then. Temperatures during the spring of 2003 throughout the water column along a section across the Grand Bank decreased from 2002 to 2003, to below normal values. In general, water temperatures on the Grand Bank have been declining up to the spring of 2003 from the record highs of 1998-99.

Subarea 1 (SCR Doc. 03/71). Bottom temperatures in Subarea 1 and Div. 0A east of 60ºW recorded at depths between 150 and 600 m during the West Greenland Bottom Trawl Survey in summer 2003 were examined and compared to previous results in the survey series. In 2003, bottom temperatures ranged from 1.1ºC in the north to 5.9ºC in the south and the spatially weighted mean amounted to 3.1ºC. Mean bottom temperature increased from 1.7ºC in 1995 to 3.3ºC in 1998 and remained between 3.0 and 3.4ºC thereafter. The temperature change comprised all depth ranges, and the 2003 values are between 0.5 and 1ºC above the average of the time series (1991-2003).

III. STOCK ASSESSMENTS

1. Northern Shrimp (*Pandalus borealis*) in Division 3M (SCR Doc. 03/66, 72, 79, 80, 83, 84, 87, 88, 89, 90, 91)

a) Introduction

The shrimp fishery in Div. 3M began in late-April 1993. Initial catch rates were favourable and, shortly thereafter, vessels from several nations joined. Since 1993 the number of vessels ranged from 40-110, and in 2003 there were approximately 41 vessels fishing shrimp in Div. 3M.

Total catches were approximately 27 000 tons in 1993, increased to 48 000 tons in 1996, declined in 1997, increased steadily to 54 000 in 2001 and declined to about 49 000 tons in 2002 (Fig. 1.1). Catch statistics to 1 October 2003 indicate removals of about 46 000 tons. This will likely result in a total catch of about 55 000 tons by the end of the year.

Recent catches and TACs (tons) are as follows:

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recommended TAC					30 000	30 000	30 000	45 000	45 000	45 000
STATLANT 21 A	19 341	39 042	23 916	30 035	42 041	49 184[1]	51 426[1]	47 907[1]		
STACFIS	33 471	48 300	24 675	30 308	43 438	50 311	53 922	48 979	55 000[2]	

[1] Provisional.
[2] Projected to the end of the year.

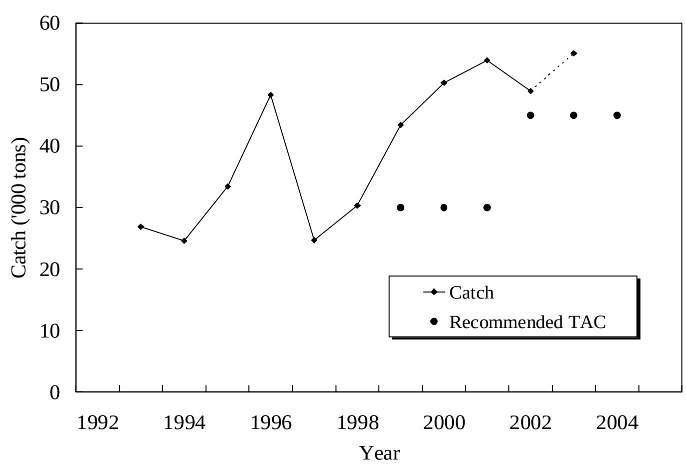


Fig. 1.1. Shrimp in Div. 3M: catches (2003 projected to end of the year).

b) Input Data

i) Commercial fishery data (SCR Doc. 03/72, 79, 83, 88, 89, 91)

Effort and CPUE. Data from logbooks of Canadian, Greenlandic, Icelandic, Faroese, Norwegian and Russian vessels were available. An unstandardized CPUE series is not considered to be reflective of stock status. A standardized CPUE series addressed differences due to seasonality, fishing power and gear (single, double and triple trawl). The model was standardized to 1993, June, single trawl and Icelandic catch-per-unit-effort data. CPUE decreased from 1993 to 1994, varied without a trend to 1997 and increased until 2003 (Fig. 1.2).

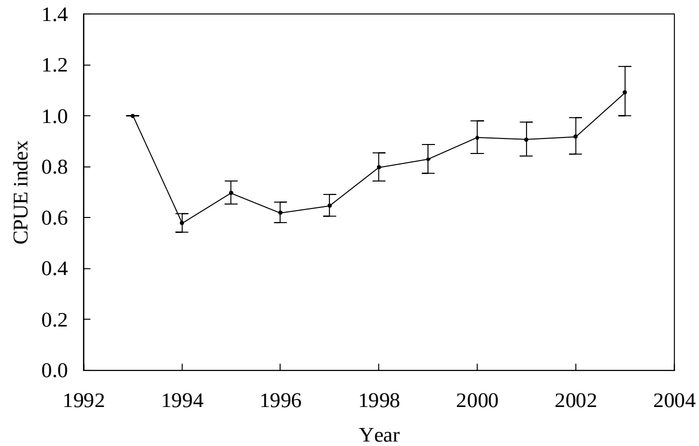


Fig. 1.2. Shrimp Div. 3M: the standardized CPUE of shrimp on Flemish Cap between 1993-2003.

Standardized CPUE female SSB. A spawning stock index was calculated from the standardized CPUE as kg/hr of primiparous plus multiparous females. The spawning stock declined from 1993 to 1997, and has shown an increasing trend since then.

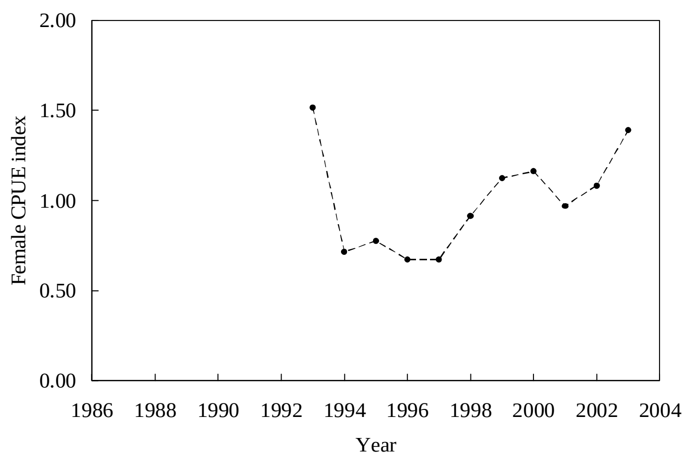


Fig. 1.3. Shrimp Div. 3M: standardized female CPUE index, 1993-2003. The series was standardized to the mean of the series.

Biological data. Age composition was assessed from commercial samples obtained from Canada, Greenland, Russia, Iceland and Estonia. Number/hour was calculated for each year-class by applying a weight/age relationship and the total number as calculated from the nominal catch and the standardized CPUE data.

The results in the Table below indicate that age 4 generally dominates the commercial catch in numbers. In both 2001 and 2002 the 1997 year-class appears to be above average according to its contribution to the commercial catch rates. The 1998 year-class on the other hand, appears to be below average. In 2002 and 2003 the 1999 year-class is even more numerous than the 1997 year-class was as three and four year olds. The 2000 year-class is very low in numbers in 2003 and is considered a weak year-class.

Numbers per hours at age in the commercial fishery.

Age	1996	1997	1998	1999	2000	2001	2002	2003
1				5			21	21
2	2 425	2 058	3 072	2 462	851	6 422	4 224	4 580
3	25 396	16 338	17 974	14 658	21 246	8 601	35 637	8 185
4	7 736	16 953	21 028	16 954	23 980	27 529	12 128	37 082
5	2 238	3 330	6 707	13 640	14 311	13 943	14 697	15 669
6	1 169	675	2 494	4 911	3 583	4 112	3 002	4 594
7		58	280	57	177	556	119	2
	38 964	39 412	51 555	52 687	64 148	61 163	69 828	70 133

ii) **Research survey data**

EU surveys (SCR Doc. 03/80). EU groundfish surveys have been conducted on Flemish Cap in July from 1988 to 2003. The 1994 and 1998 total biomass indices are likely biased due to changes in sizes of codend mesh. The female biomass is however, not considered to be affected by the change of codend mesh size. The female shrimp biomass declined to relatively low values in 1994 to 1997, increased to a higher level in 1998-2002 (Fig. 1.4). A new research vessel was introduced in 2003 however STACFIS was unclear about the details of the conversion in SCR Doc. 03/80.

Age has been assessed from the length distributions of the EU surveys back to 1988. Results for age 4 indicate that the 1997 year-class was far above average in 2001 and also at age 5 in 2002. In the 2002 survey the 1998 year-class at age 4 does not appear to be strong whereas the 1999 year-class at age 3 appears strong.

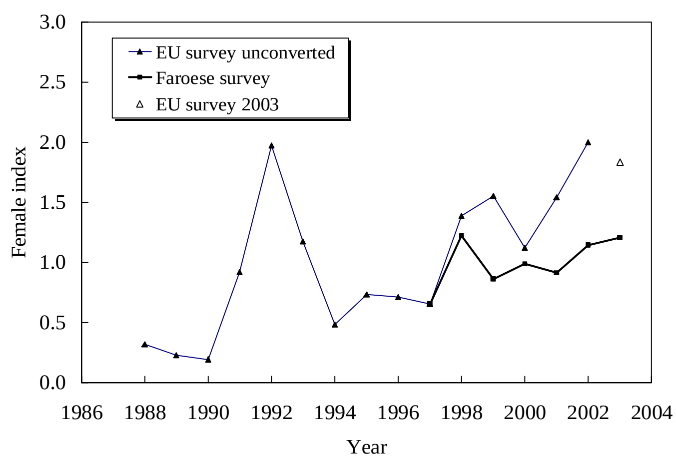


Fig. 1.4. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2003 and Faroese survey, 1997-2003. Each series was standardized to the mean of that series.

Faroese survey (SCR Doc. 03/66, 87). Stratified-random surveys were conducted in June-July 1997-2003 by a Faroese shrimp trawler. Surveys utilized a juvenile bag attached to the codend since 1998. The total biomass index fluctuated between 16 000 and 22 000 tons in the years 1997 to 2001 increasing to about 27 000 in 2002 and 2003 (Fig. 1.4). Results indicate that the 1997 and 1999 year-classes are above average, the 1998 and 2000 year-classes appear weak and the 2001 is average (Fig. 1.5).

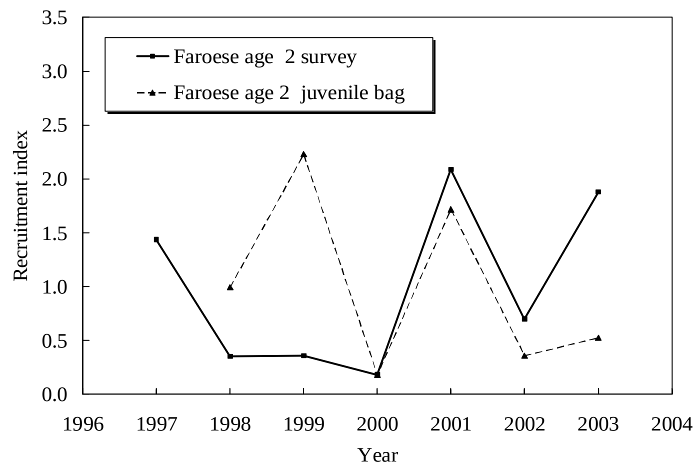


Fig. 1.5. Shrimp in Div. 3M: abundance indices at age 2 from the Faroese survey. Each series was standardized to its mean.

c) **Assessment Results**

Commercial CPUE. Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, and increased to 2003.

Recruitment. The 1999 year-class is strong while the 2000 year-class appears weak and the 2001 year-class appears average.

Spawning Stock Biomass. All indices of female biomass showed an increasing trend from 1997 to 2003.

State of the Stock. STACFIS is unable to estimate absolute stock size. Stock size indicators have shown a general increase since 1997. The 1999 year-class is strong and will continue to contribute to the fishery in 2004, and possibly to some degree in 2005 as well. The 2001 year-class appears to be about average and shall be contributing to the fishery in 2004 and 2005. However, the 2000 year-class appears to be weaker.

STACFIS considers it important to recognize that its ability to assess the resource will improve with the continuation of a series of research surveys directed for shrimp, particularly if a juvenile bag is used.

d) **Research Recommendations**

STACIS **recommended** that, for shrimp in Div. 3M:

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

- *a more detailed conversion document including information on the geometry and behaviour of the trawls and detailed calculations of the conversion for shrimp be presented at the September 2004 meeting.*

- *indices of stock size be presented with error bars where possible.*

2. **Northern Shrimp (*Pandalus borealis*) in Divisions 3L, 3N and 3O** (SCR Doc. 03/72, 81, 82)

a) **Introduction**

This shrimp stock is distributed around the edge of the Grand Banks mainly in Div. 3L. The fishery began in 1993 with catches around 1 800 tons. Exploratory fishing from 1996-99 resulted in catches ranging from 179 to 795 tons. In 2000, Fisheries Commission implemented a TAC of 6 000 tons, and fishing was restricted to Div. 3L. For 2003, Fisheries Commission increased the TAC to 13 000 tons because biomass had increased significantly since 1999.

Catches from 1993 to 2000 are as reported in the STATLANT 21A database. Reliable catch reports were not available for all countries in 2001, and 2002. Estimates from other sources were used in these cases. For 2003, estimates of catch were available for all countries, so STACFIS was able to project total catches to the end of 2003. The total catch to date in 2003 is estimated to be about 10 600 tons, and is projected to 12 000 tons for the full year (Fig. 2.1).

In 2000, small vessels (less than 500 tons) caught about three-quarters of the Canadian catch. In 2001 and 2002, the Canadian quota was divided equally between the large and small vessel fleets. As a result, the proportion of catch taken by large vessels increased and most of their catch came from single trawls. In 2003, about 60% of the Canadian TAC was assigned to the small vessel fleet; consequently this fleet took 6 537 tons of shrimp. Canada's large vessel fleet caught 3 352 tons of shrimp in Div. 3L as of 1 November 2003. In all years, most of the Canadian catch occurred along the northeast slope in Div. 3L. The use of a sorting grid to reduce by-catches of fish is mandatory for all fleets in the fishery.

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

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
TAC	-	-	-	-	-	6 000	6 000	6 000	13 000	13 000
STATLANT 21A	0	179	485	567	795	4 903[1]	5 323[1]	5 697[1]		
STACFIS	0	179	485	567	795	4 903	10 566	6 977	12 000[2]	

[1] Provisional catches.
[2] Projected catches for 2003.

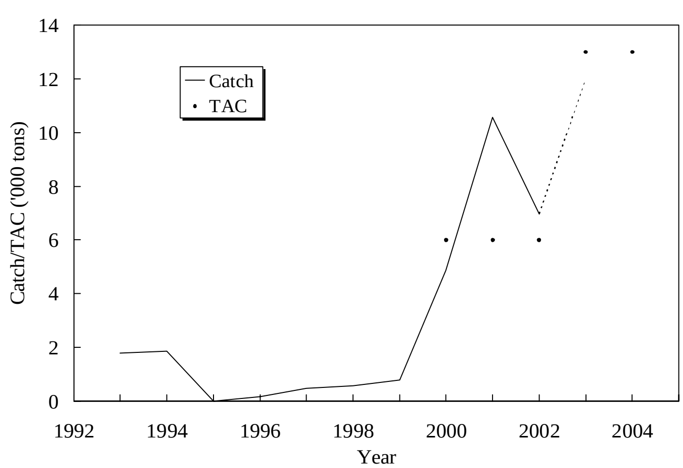


Fig. 2.1. Shrimp in Div. 3LNO: catches and TAC.

b) **Input Data**

i) **Commercial fishery data** (SCR Doc. 03/82)

Fishing effort and CPUE. Catch and effort data have been available from Canadian fishing vessel logbooks and observer records since 2000. Unstandardized catch rates (both single and double trawl) for large vessels increased to more than 1 700 kg/hr. Whereas, Canadian small vessel CPUE remained at approximately 370 kg/hr. Some CPUE data were available from a few vessels fishing in the Div. 3L NRA, and were generally quite variable.

Catch composition. Observers sampled and measured Canadian catches (approximately 2-5% of the small vessel catches and over 90% of the large vessel catches were observed) in Div. 3L. Length frequency distributions were presented from catches taken by large vessels during 2000-2002. At least four year-classes were evident in all three length frequency distributions. The relatively strong 1997-99 year-classes could easily be tracked over the short time series. The 1997-99 year-classes appear very strong compared to the weak 1995 and 1996 year-classes. The female distributions are broad throughout the short time series indicating that they are composed of more than one year-class.

Adequate length frequencies were not available from either the 2000-2003 small vessel or 2003 large vessel fisheries, therefore, these distributions were not presented.

ii) **Research survey data** (SCR Doc. 02/82)

Canada has conducted stratified-random surveys in Div. 3LNO, using a Campelen shrimp trawl, during spring and autumn since late-1995. Data for shrimp were available from the autumn surveys in 1995-2002, and from spring surveys in 1999-2003. In all surveys, over 90% of the biomass was found in Div. 3L, distributed mainly along the northeast slope in depths from 185-550 m. Based upon confidence intervals, there was a significant increase in autumn shrimp biomass/ abundance indices between 1995-97 followed by stability from 1997 until 1999. Both biomass and abundance indices remained at a higher level since 2000 (Fig. 2.2). Similarly, spring 2002 and 2003 indices are significantly higher than spring 1999 indices (Fig. 2.3).

Canadian multi-species survey autumn and spring biomass indices are indicated below:

	Autumn			Spring		
Year	Lower 95% C. L.	Estimate	Upper 95% C.L.	Lower 95% C.L.	Estimate	Upper 95%C.L.
1995	3.6	5.9	8.2			
1996	10.2	20.1	29.9			
1997	25.5	46.2	66.9			
1998	40.0	59.9	79.8			
1999	36.2	53.1	70.1	12.6	55.3	98.1
2000	93.1	118.2	143.2	-15.9	122.8	259.5
2001	77.6	224.0	370.4	62.4	102.6	142.8
2002	126.2	215.0	303.8	121.1	159.5	197.9
2003				112.3	193.8	275.2

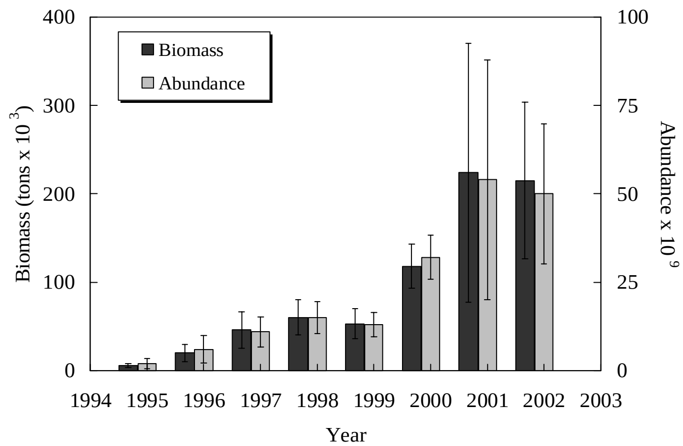


Fig. 2.2. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian autumn multi-species surveys with 95% confidence intervals.

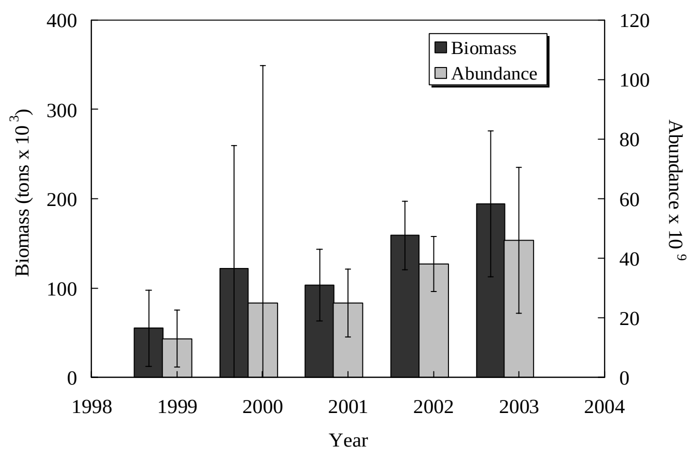


Fig. 2.3. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian spring multi-species surveys with 95% confidence intervals.

Sex and length composition. Estimated total number (10^9) of shrimp in Div. 3LNO from autumn 1995 to spring 2003 are as follows:

Survey	Males	Females	Total	Males %	Female %
Autumn 1995	1.3	0.8	2.1	61.9	38.1
Autumn 1996	5.5	0.4	5.9	93.2	6.8
Autumn 1997	7.7	2.9	10.5	73.3	26.7
Autumn 1998	13.3	2.0	15.3	86.9	13.1
Spring 1999	9.7	3.0	12.7	76.4	23.6
Autumn 1999	10.4	2.6	13.1	79.4	20.6
Spring 2000	17.0	8.0	25.0	68.0	32.0
Autumn 2000	27.8	4.3	32.2	86.3	13.7
Spring 2001	19.2	5.8	25.0	76.8	23.2
Autumn 2001	45.8	8.3	54.1	84.7	15.3
Spring 2002	26.8	10.7	37.5	71.5	28.5
Autumn 2002	39.8	10.5	50.3	79.1	20.9
Spring 2003	39.2	13.4	46.3	84.7	15.3

Autumn abundances of shrimp have increased to the highest levels in the time series during 2001 while spring abundance was highest during 2003. The proportion of females in the surveys has varied around the mean of 21%. Abundance estimates from the autumn 2002 survey were dominated by males with a modal length of 17.0 mm CL (1999 year-class). This year-class was preceded by 1997 and 1998 year-classes which were also strong relative to all previous year-classes. The relatively broad female size distribution suggests that it consisted of more than one year-class.

Trends in the SSB index from the autumn surveys were similar to those for total biomass (Fig. 2.4).

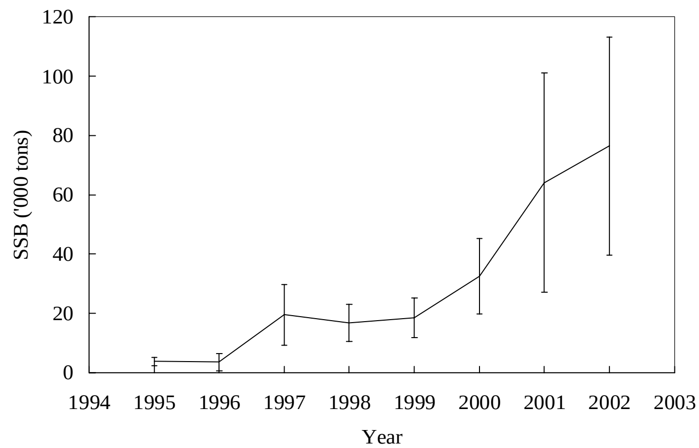


Fig. 2.4. Shrimp in Div. 3LNO: Spawning stock biomass (SSB) estimates from Canadian autumn multi-species surveys with 95% confidence intervals.

A recruitment index (shrimp considered to be age 2) from the autumn surveys of 1995-2002 shows that the 1998 and 1999 year-classes are the two largest in the short time-series. These year-classes are followed by the 2000 year-class which was slightly above average for the time series (Fig. 2.5). A comparable estimate of the 2001 year-class at age 2 was not available, as the autumn survey of 2003 was not completed at the time of the assessment.

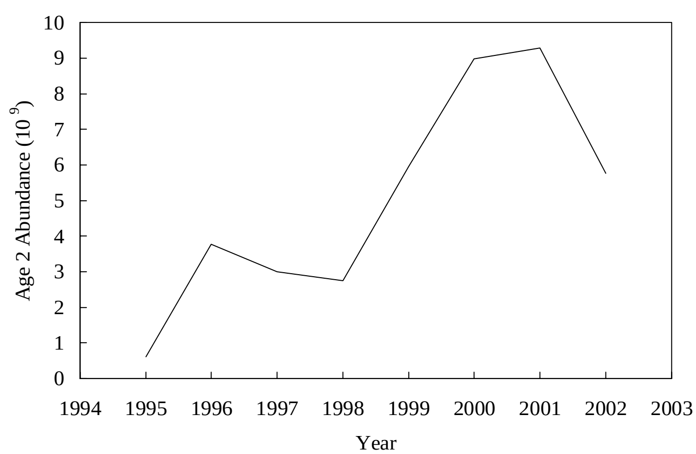


Fig 2.5. Shrimp in Div. 3LNO: age 2 recruitment index as determined from Canadian autumn multi-species surveys.

An index of exploitation was derived by dividing the catch in a given year by the fishable biomass index (shrimp biomass for all animals with carapace lengths greater than or equal to 17 mm) from the previous autumn survey (Fig. 2.6). The index was 1-4% during 1996-99, but increased to 10-11% in 2000-2001; the first two years of TAC regulation. Even though catches are projected to increase to 12 000 tons in 2003, exploitation is estimated to be only 6% due to an increase in biomass. Catch has always been less than 15% of the lower 95% confidence limit of the previous autumn survey biomass estimate.

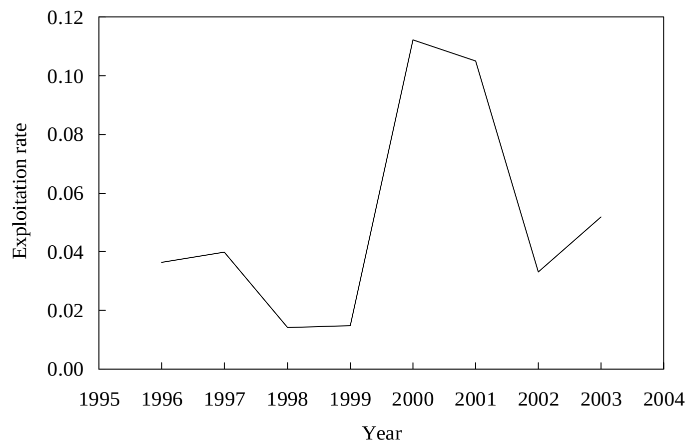


Fig 2.6. Shrimp in Div. 3LNO: exploitation rates as derived by catch/previous year's fishable biomass index.

ii) **Biological studies** (SCR Doc. 03/81)

Spatial distributions and abundances of northern shrimp were presented in relation to their thermal habitat for Div. 3LNO as determined from Canadian spring (1999-2003) and autumn (1995-2002) multi-species bottom trawl surveys. During spring surveys, the highest numbers of shrimp were caught in the 2^{o}-4^{o}C temperature range, however, the highest autumn catches were in the 1^{o}-3^{o}C temperature range. In general, most large spring catches were found in the warmer water along the slopes of Div. 3LN. During autumn there was an apparent shift in distribution toward colder temperatures upon the Grand Bank and toward inshore regions resulting in a greater proportion of the catches being taken in the 0^{o}-1^{o}C temperature range.

c) **Assessment Results**

Recruitment. The 1998 and 1999 year-classes are the two largest year-classes in the short time series, but are followed by the 2000 year-class which was slightly above average.

Biomass. There was a significant increase in SSB and total biomass between 1995 and 1997 followed by a period of stability from 1997 until 1999. Both SSB and total biomass have been at a higher level since 2000.

Exploitation: No estimates of fishing mortality were available. The exploitation index (catch/fishable biomass) was 1-4% during 1996-99, increased to 10-11% in 2000-2001, and was estimated to be only 6% during 2003.

State of the Stock. STACFIS is not able to provide estimates of absolute stock size. SSB estimates have increased significantly since 1999 and are currently the highest observed. Recruitment increased over much of this time period. The 1998 and 1999 year-classes were the highest observed, however, recruitment of the 2000 year-class has dropped to just above the time series average. The stock appears to be well represented by a broad range of size groups, and exploitation is low.

d) **Research Recommendations**

STACFIS **recommended** that, for shrimp in Div. 3LNO:

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 October 2004.*

3. Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1 (SCR Doc. 03/70, 71, 73, 74, 75, 76, 86, 02/158)

a) Introduction

The shrimp stock off West Greenland is distributed in Subarea 1 and Div. 0A east of 60°W. Shrimp within this area is assessed as a single population. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A to 1F) in offshore and inshore areas (primarily Disko Bay). Since 1981 the Canadian fishery has been limited to Div. 0A.

Three fleet components, one from Canada and two from Greenland (vessels above and below 80 GRT) participated in the fishery since the late-1970s. The Canadian fleet and the Greenland large-vessel fleet have been restricted by areas and quotas since 1977. The fishery by the Greenland small-vessel fleet was unrestricted until January 1997, when quota regulation was imposed. In 2003, the advised TAC for the entire stock was 100 000 tons. In 2003 the Greenland authorities set a TAC for Subarea 1 of 100 000 tons, and a TAC for Div. 0A east of 60°30'W of 14 667 tons was set by the Canadian authorities for the same year. The use of a sorting grid with 22 mm bar distance to reduce by-catches of fish is mandatory for both the Greenland large-vessel fleet and the Canadian fleet. Discarding of shrimp is prohibited.

Until 2003 catches of shrimp taken in SA 1 have been reported without accounting for "overpacking" – the amount of surplus weight in packaging – or the difference between the product weight and live weight. Advised and actual TACs have been set in the same units as used within the reporting practice. On 1 January 2004 new legislation should be enforced to ensure that total removals by fishing are reported in units of live weight. To allow management advice derived from the stock assessment to be stated in the units of the future catch reporting, a correction of the input catch data series was performed (SCR Doc.03/74):

Year	Reported catch SA 1 (tons)	Correction factor SA 1	Corrected catch SA 1 (tons)	Catch Div. 0A (tons)	Total STACFIS estimate
1970	8559	1.2285	10515	0	10515
1971	9437	1.2285	11593	0	11593
1972	9656	1.2285	11862	0	11862
1973	12642	1.2285	15530	0	15530
1974	22009	1.2285	27038	0	27038
1975	37890	1.2285	46547	0	46547
1976	49674	1.2285	61023	392	61415
1977	41643	1.2285	51158	457	51615
1978	34347	1.2285	42195	122	42317
1979	33458	1.2285	41102	1732	42834
1980	43278	1.2285	53166	2726	55892
1981	39516	1.2285	48545	5284	53829
1982	42515	1.2285	52229	2064	54293
1983	41354	1.2285	50803	5413	56216
1984	41241	1.2285	50664	2142	52806
1985	51396	1.2285	63139	3069	66208
1986	60134	1.2285	73873	2995	76868
1987	57641	1.2463	71836	6095	77931
1988	54392	1.2453	67735	5881	73616
1989	58422	1.2570	73436	7235	80671
1990	63184	1.2312	77793	6177	83970
1991	69092	1.2259	84701	6788	91489
1992	79258	1.2364	97994	7493	105487
1993	70123	1.2196	85522	5491	91013
1994	71811	1.2260	88039	4766	92805
1995	68329	1.2444	85027	2361	87388
1996	66610	1.2230	81463	2632	84095
1997	64000	1.2127	77611	517	78128
1998	65170	1.2208	79562	933	80495
1999	73985	1.2184	90145	2046	92191
2000	78337	1.2181	95424	1782	97206
2001	81398	1.2182	99156	3625	102781
2002	103000	1.2223	125894	6247	132141
2003*	105000	1.2186	127955	7000	134955

*projected from October to the end of the year

Overall annual catch has increased from about 10 000 tons in the early-1970s to more than 105 000 tons in 1992 (Fig. 3.1). Restrictions by the Greenlandic authorities to reduce effort, and fishing opportunities elsewhere for the Canadian fleet resulted in catches decreasing to about 80 000 tons in 1998. Since then overall catches have increased. The projected catch of 2003 is expected to be around 135 000 tons (Fig. 3.1) based on data through October 2003.

Recent nominal catches, projected figures for 2003 and recommended TACs (tons) for shrimp in Div. 0A and Subarea 1 are as follows:

	1994	1995	1996	1997	1998	1999	2000[2]	2001[2]	2002[2]	2003[3]
Recommended TAC[1]	50 000	60 000	60 000	60 000	55 000	65 000	65 000	85 000	85 000	100 000
Actual TAC			72 422	74 800	68 379	80 350	80 350	91 350	101 000	114 667
SA 1	71 811	68 329	66 610	64 000	65 170	73 985	78 337	81 398	103 000	105 000
Div. 0A	4 766	2 361	2 632	517	933	2 046	1 782	3 625	6 247	7 000
Total STATLANT 21A	76 577	70 690	69 242	64 517	66 103	76 031	80 119	85 023	109 247	
Total STACFIS[4]	92 805	87 388	84 095	78 128	80 495	92 191	97 206	102 781	132 141	135 000

1 Until 1994 the recommended TAC was only for offshore south of 71°N. After 1994, it included offshore north of 71°N and inshore. Until 2003 recommended TAC were given in the units of the STATLANT reporting.
2 Provisional catches.
3 Catches projected to end of 2003.
4 Estimates corrected for overpack.

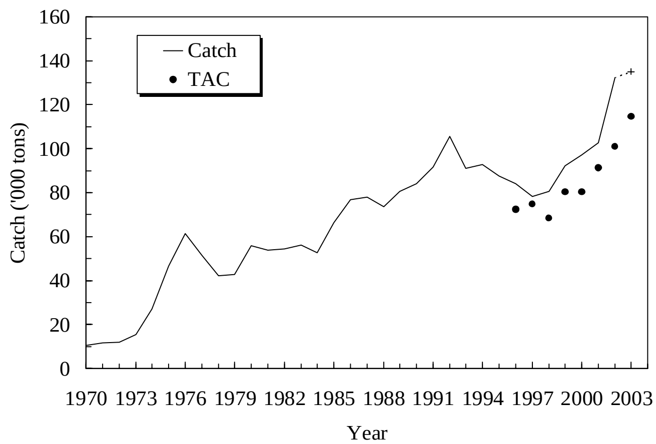


Fig. 3.1. Shrimp in Subareas 0 and 1: total catches (2003 projected to the end of the year) and actual TACs.

Until 1988, the fishing grounds in Div. 1B have been the most important. Since then, a southward expansion in the offshore fishery has taken place, and from 1990 catches in Div. 1C and 1D have exceeded those from Div. 1B. At the end of the 1980s, exploitation began in Div. 1E and 1F, and catches from these areas now account for about 20% of the total catch. The Canadian fishery in Div 0A east of 60°W has taken from 0.7 to 4.7% of total annual catches in the recent five years. The distribution of the fishery has not changed since 1996.

b) **Input Data**

i) **Commercial fishery data**

Fishing effort and CPUE. Catch and effort data from the shrimp fishery were available from fishing records from Canadian vessels in Div. 0A east of 60°W and from Greenland logbooks for Subarea 1 (SCR Doc. 03/75).

Multiplicative models were used to calculate fleet specific annual catch rate indices. From these individual indices one unified time series covering 1976-2003 was derived. All fleets included in the analysis mainly exploit shrimp greater than 16 mm carapace length (CL). The CPUE indices are therefore indicative of the combined biomass of older males and the females.

The standardized CPUE series showed an increasing trend since 1990 (Fig. 3.2). The 2003 mean value is the highest in the time series.

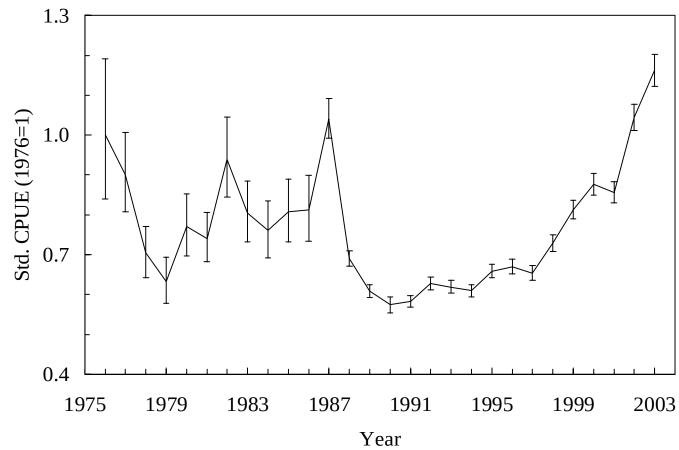


Fig. 3.2 Shrimp in Subareas 0 and 1: standardized CPUE index. Error bars are upper and lower quartiles.

Catch composition. Catch composition was assessed from samples obtained by observers in the commercial fishery in Div. 0A from 1981 to 2001, and in Subarea 1 from 1991 to 2001 (SCR Doc. 03/75). The mean size of shrimp caught has declined since 1991. In spite of these changes, the proportions of female to male shrimp in the catches seemed relatively stable until the late-1990s. In 2002 STACFIS recommended that "sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established". However, the sampling program remained inadequate and sparse sampling prohibited an analysis of catch composition for the years 2002 and 2003.

ii) **Research survey data**

Greenland trawl survey. Stratified-random trawl surveys have been conducted since 1988 in offshore areas (Subarea 1 and Div. 0A east of 60^{o}W) and since 1991 also in inshore Subarea 1 (SCR Doc. 03/71). From 1993, the survey extended further south into Div. 1E and 1F.

Biomass. The survey biomass indices indicated a fairly stable stock size from 1988 to 1997. Since then a significant increasing trend was observed. The 2003-value is the highest of the time series (Fig. 3.3).

Within the survey area, large year-to-year variations in the distribution of biomass were observed geographically as well as over depth zones. Some areas account for a large proportion of the variances of the estimated biomasses. During the recent period of increasing biomass indices, an increased proportion of the biomass was seen in depths between 200 and 300 m and in the northern most areas.

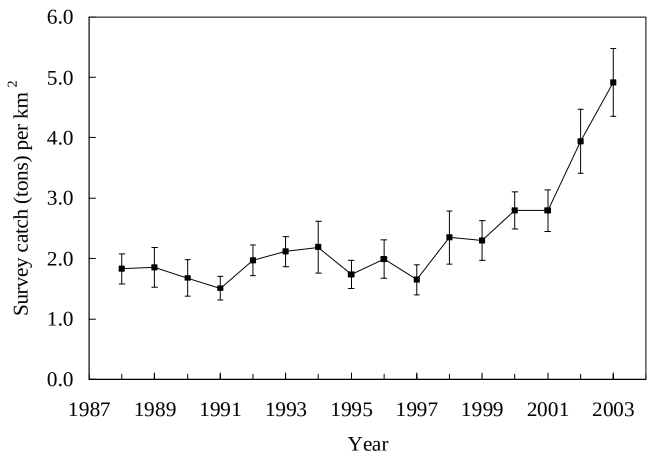


Fig. 3.3. Shrimp in Subareas 0 and 1: Survey indices of biomass, ±1 standard error.

Sex and length composition. Indices of total abundance ($\times 10^9$) of shrimp in Subarea 1 and Division 0A east of 60°W from 1988 to 2003 are as follows (SCR Doc. 03/71):

Year	Males	Females	Total	Males, %	Females, %
1988[1]	24.3	9.9	34.2	71.0	29.0
1989[1]	35.0	7.6	42.5	82.2	17.8
1990[1]	28.5	10.0	38.5	74.1	25.9
1991	17.4	6.2	23.6	73.8	26.2
1992	29.7	7.3	36.9	80.3	19.7
1993	35.5	9.7	45.2	78.5	21.7
1994	33.9	10.9	44.8	75.7	24.3
1995	29.2	7.9	37.1	78.7	21.3
1996	41.4	8.1	49.5	83.7	16.3
1997	29.5	7.6	37.0	79.6	20.4
1998	42.9	11.5	54.5	78.8	21.2
1999	44.8	11.3	56.2	79.9	20.1
2000	66.7	12.7	79.4	84.0	16.0
2001	61.1	13.7	74.8	81.7	18.3
2002	90.6	16.7	107.2	84.5	15.5
2003	103.2	27.9	131.1	78.7	21.3

[1] No inshore survey in 1988-90. The numbers in 1988 to 1990 represent an average of the estimated numbers of shrimp inshore from 1991-97 added to the actual estimates from the offshore area.

The index of total abundance of shrimp in 2003 was the highest in the series. The proportion of males in 2003 was at the average of the values recorded in the time series.

The overall length-frequency distributions in 2003 showed male modes (at 16 and 20 mm CL), a mode of primiparous females at 24 mm CL and one of multiparous females at 25.5 mm CL (Fig. 3.4). The strong presence of males between 14 and 22 mm CL indicates that recruitment of small males to the fishable stock and large males to the female group is secured for the coming year.

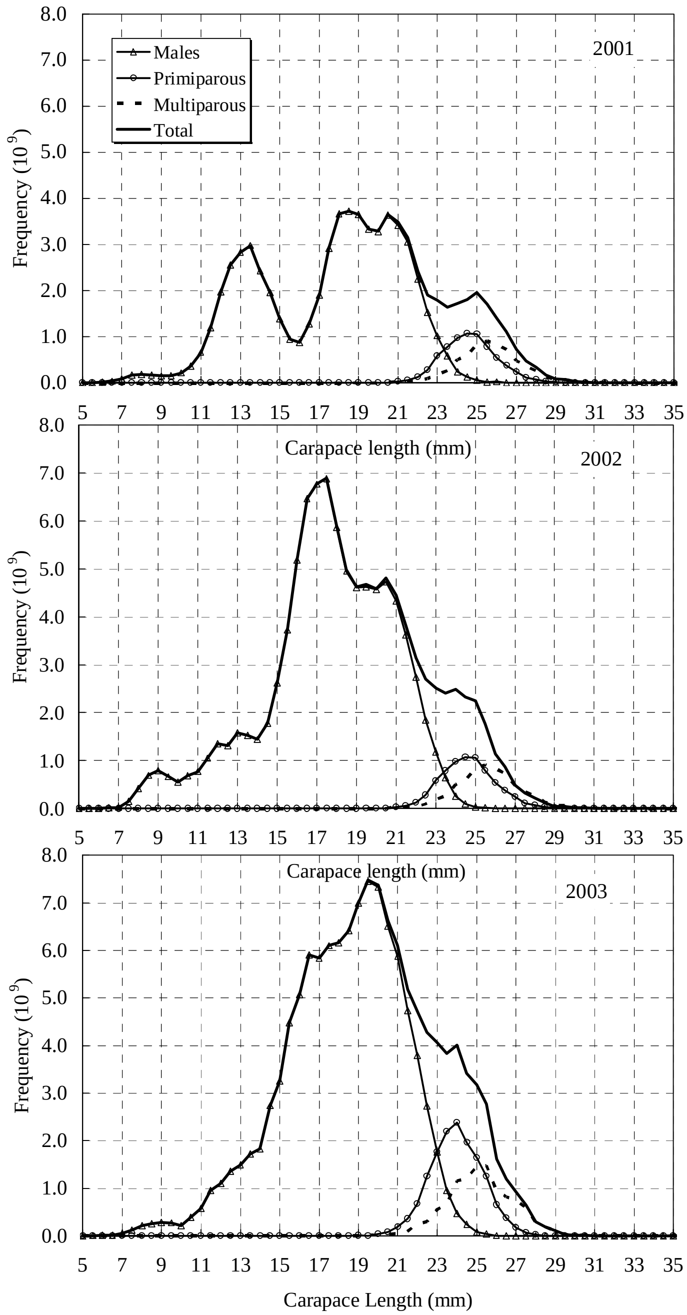


Fig. 3.4. Shrimp in Subareas 0 and 1: Numbers of shrimp by 0.5 mm CL length group in the total area during 2001-2003 (mesh size in the cod-end 20 mm stretched).

Index of recruitment. Abundance at age 2 (SCR Doc. 03/76) showed an increasing trend from 1997 to 2001 and a decrease thereafter (Fig. 3.5). The 2003 value is below the average of the time series.

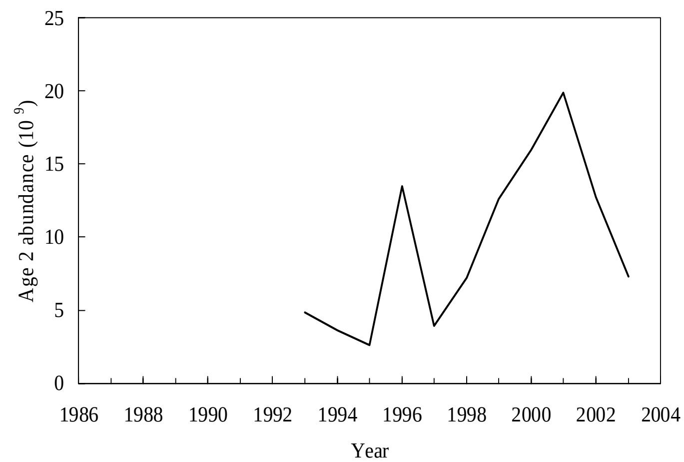


Fig. 3.5. Shrimp in Subareas 0 and 1: recruitment index (age 2 abundance)

Index of spawning stock biomass. The index of female biomass (SCR Doc. 03/71) showed an increasing trend since 1997 and the value in 2003 is the highest observed in the series (Fig. 3.6).

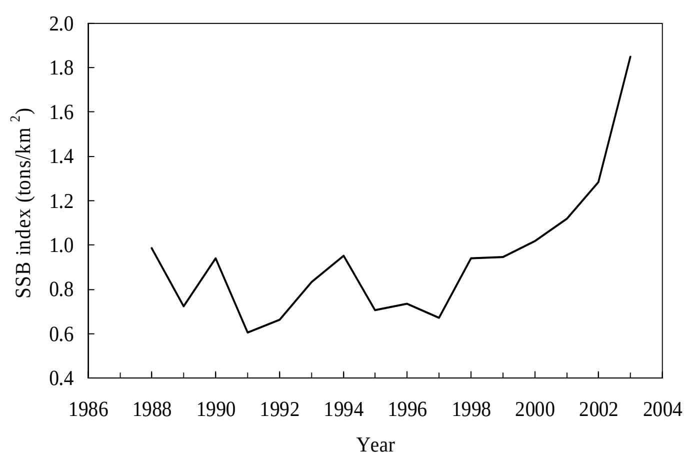


Fig. 3.6. Shrimp in Subareas 0 and 1: female spawning stock biomass index.

Exploitation rate. An index of exploitation rate (SCR Doc. 03/71) calculated as the proportion of total catch to corresponding survey estimates of fishable biomass (shrimp ≥17 mm CL) (Fig. 3.7) declined since 1991.

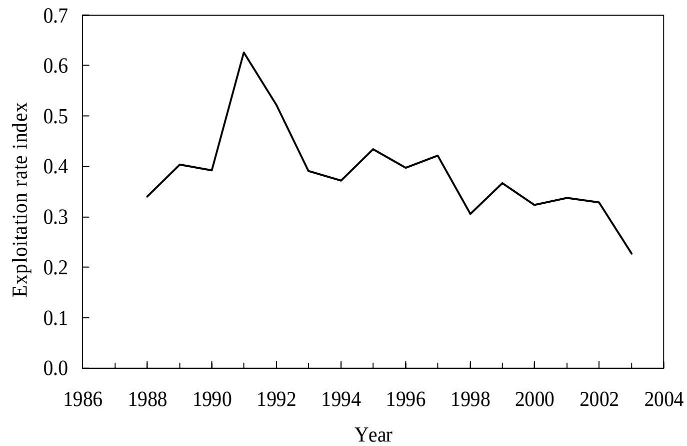


Fig. 3.7. Shrimp in Subareas 0 and 1: Index of exploitation rate (proportion of total catch to corresponding survey estimate of fishable biomass).

iii) **Other studies**

Length frequency distributions of northern shrimp (*Pandalus borealis*) from the West Greenland bottom trawl surveys in the years 1993 to 2003 were examined in order to extract mean lengths and abundance indices for age 1, 2 and 3 by modal analysis (SCR Doc. 03/76). The original survey data were pooled into five major regions defined by latitudinal differences in bottom temperature. Mean size at age differed considerably between regions and years. The changes in mean size were positively correlated to bottom temperature for all of the three age groups and a trend towards smaller size at age and slower growth was observed for the most recent years in which population density has increased substantially in large parts of the area. The estimates of the 1-group abundance appeared to be seriously effected by low catchability. Abundance at age 2 correlated significantly with the fishable biomass lagged by two years, and the survey estimates of abundance for this age can thus be regarded as suitable to assess short-term changes in recruitment to the fishery.

A method for the calculation of a TAC for northern shrimp off West Greenland one and two years ahead was presented (SCR Doc. 03/86). The method considers explicitly recruitment in the short term and combines survey estimates of fishable biomass and fishery information on the level of exploitation. Maintaining the current level of exploitation the method suggest TACs of 130 000 tons for 2004 and approximately 100 000 tons for 2005.

Catches of *Pandalus montagui* in the West Greenland bottom trawl surveys were reported (SCR Doc. 03/70). Derived indices of biomass had high variance large inter annual variability, and showed no trend over time. The proportion of biomass of *P. montagui* to *P. borealis* were estimated to be less than 0.01. However, as the survey design has been made with reference to the distribution of *P. borealis*, it is likely that too few stations in the distribution area of *P. montagui* have been applied to give reliable estimates of the biomass.

c) **Estimation of Parameters**

Parameters relevant for the assessment and management of the stock were estimated, based on a stochastic version of a surplus-production model that included an explicit term for predation by cod (*Gadus morhua*). The model was formulated in a state-space framework and Bayesian methods were used to construct "posterior" likelihood distributions of the parameters (SCR Doc. 02/158).

The model synthesized information from input priors and the following data: a 16-year series of a survey biomass indices of shrimp ≥17 mm CL; a 28-year series of combined CPUE indices; a 49-year series of catches by the fishery; a 49-year series of a cod biomass estimates; and a short series (4 years) of estimates of the shrimp biomass consumed by cod (SCR Doc. 03/73).

Absolute biomass estimates had relatively high variances. For management purposes therefore it is desirable to work with biomass on a relative scale in order to cancel out the uncertainty of the "catchability" parameters (the parameters that scale absolute stock size). Biomass, B, is thus measured relative to the biomass that yields Maximum Sustainable Yield, B_{MSY}. The estimated mortality, Z, refers to the removal of biomass by fishing and cod predation and is scaled to Z_{MSY} - the mortality at MSY.

d) **Assessment Results**

The model estimated the median annual consumption by cod 1956-2003 in the range of 200 tons to about 116 000 tons. The estimated consumption declined since 1960 as a result of a decline in cod abundance at West Greenland (Fig. 3.8). A short-lived resurgence of the cod stock in the late-1980s caused consumption to increase. The cod disappeared in the beginning of the 1990s and estimates of consumption went to zero.

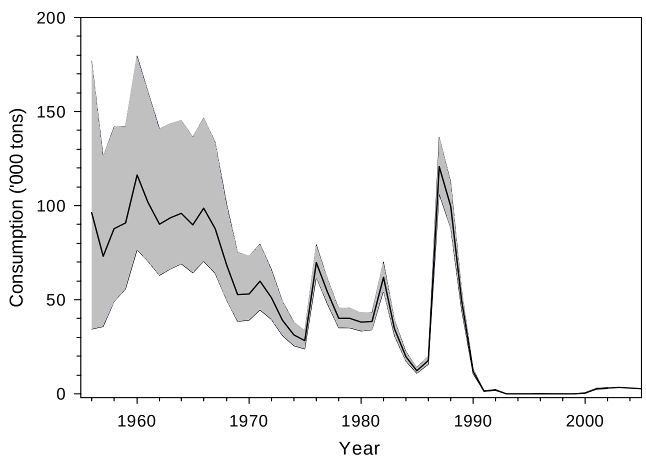


Fig. 3.8. Shrimp in Subareas 0 and 1: Estimated consumption of shrimp by cod (solid line is the median and shaded area indicates the range between the 25th and 75th percentiles).

The trajectory of the median estimate of 'biomass-ratio' (B_t/B_{MSY}) plotted against 'mortality-ratio' (Z_t/Z_{MSY}) (Fig. 3.9) starts in 1956 at half the optimum biomass ratio and at a mortality-ratio well above 1. The stock maintained itself in this region during the years when cod were abundant. When the cod stock declined in the late-1960s, and predation pressure was lifted (Fig. 3.8), shrimp stock biomass increased and eventually began cycling in the left upper corner of the graph (Fig. 3.9) during the current regime of low cod abundance (SCR. Doc. 03/73).

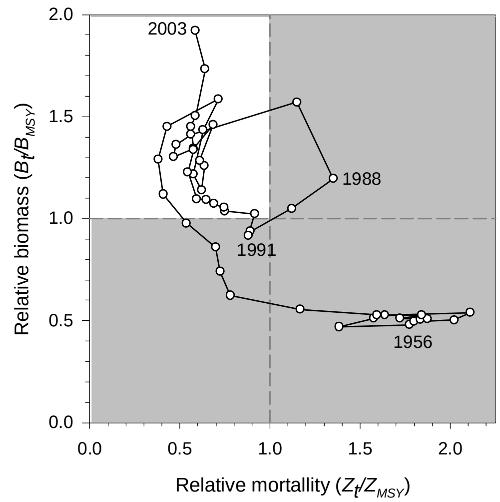


Fig. 3.9. Shrimp in Subareas 0 and 1: estimated annual median biomass-ratio (B/B_{MSY}) and mortality-ratio (Z/Z_{MSY}) 1956-2003.

Since the early-1970s the estimated median biomass-ratio ranged from about 0.96 to 1.92 (Fig. 3.9) and the probability that it had been below the optimum level was small for most years (Fig. 3.10), i.e. it seemed likely that the stock had been at or above its MSY-level throughout the modern fishery. The median estimate of biomass-ratio dipped just below the optimum in 1990-91 following a short-lived resurgence of the cod stock (Fig. 3.9). The stock has increased since then and reached its highest level ever in 2003 with a median estimate of biomass-ratio of 1.92, corresponding to about 87% of estimated median carrying capacity. The estimated risk of stock biomass being below B_{MSY} was 0.01 (Fig. 3.10).

The mortality ratio (Z-ratio, which includes mortality by fishing and predation by cod) has been below 1 for most of the time since 1970, except for the period of high cod predation in the late- 1980s (Fig. 3.9). Since 1997, annual median Z-ratio has been stable at approximately 0.6, i.e. well below the value that maximizes yield. The median of estimate for 2003 is 0.59 with a risk of only 0.04 of being above 1 (Fig. 3.10).

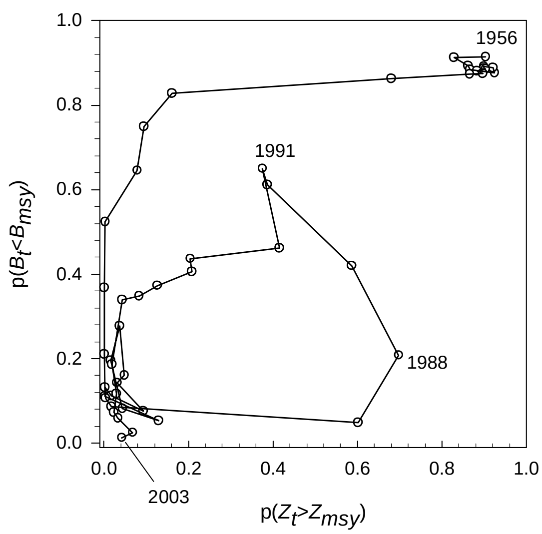


Fig 3.10. Shrimp in Subareas 0 and 1: risk of annual biomass being below B_{MSY} and of mortality caused by fishing and cod predation being above Z_{MSY} 1956-2003.

The median estimate of the maximum annual production surplus, available to the fishery and the cod (MSY) was estimated to 132 000 tons (Fig. 3.11). The risk function relating the probability of exceeding MSY to the combined removal by fishery and cod predation is given as the integral of this distribution (Fig. 3.11).

The catch series has been corrected for "overpacking" and input annual catch data values were therefore increased by on average 23% as compared to the assessment in 2002. As catches are important in scaling shrimp stock production, the model estimate of MSY would thus increase proportionally. The increase in median MSY from 101 000 tons the 2002 assessment to 132 000 tons in the current, is therefore mainly caused by the revision of the catch series.

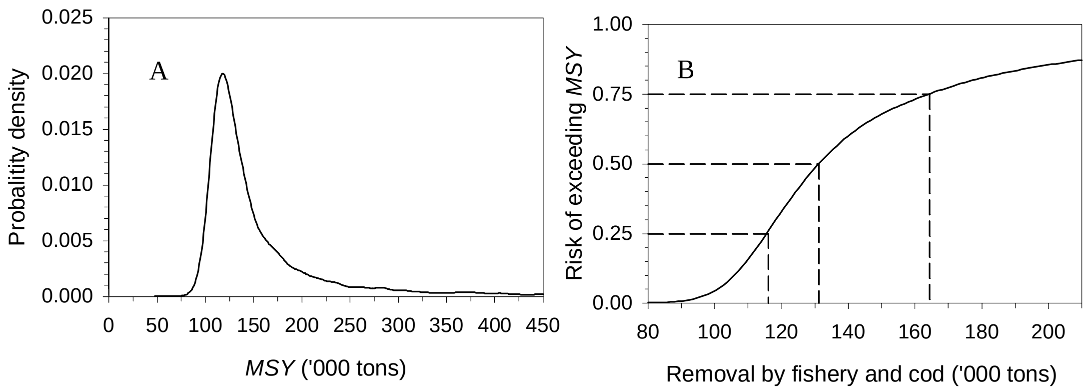


Fig. 3.11. Shrimp in Subareas 0 and 1: Posterior probability distribution of the maximum annual production surplus, (A) available to the fishery and cod (MSY) and (B) the cumulative probability of exceeding MSY (right panel).

Given the high probabilities of the stock being considerably above B_{MSY}, risk of stock biomass falling below this optimum level within a one-year perspective is low. Risk associated with five optional catch levels for 2004 are as follows:

Catch option ('000 tons)	110	120	130	140	150
Risk of falling below B_{MSY}	2%	2%	2%	3%	3%
Risk of exceeding Z_{MSY}	2%	3%	9%	14%	21%

Predation by cod can be significant (Fig. 3.8) and have a major impact on shrimp stock size. Currently the cod stock at West Greenland is at a very low level. A large cod stock that would significantly increase shrimp mortality could be established in two ways: either by a slow rebuilding process or by immigration of one or two large year-classes from areas around Iceland as seen in the late-1980s. An increase in cod abundance through growth of the existing stock would, however, be noted in an early phase during routine monitoring programs and fisheries management would have several years to respond before the shrimp stock is driven below optimal levels – given the current good condition of the stock. Although the biological and environmental conditions for immigration of cod from Icelandic areas have seemed favorable in recent years, no indications of such events were registered in the annual surveys. If and when the development of the cod stock warrants, management options given this scenario can be evaluated by STACFIS.

Ten-year projections of stock development were therefore made under the assumption that the cod stock will remain at its current low abundance. Five levels of annual catch: 110 000, 120 000, 130 000, 140 000 and 150 000 tons were investigated (Fig. 3.12).

At the investigated catch options of 110000 and 120000 tons/yr the stock is likely to remain above B_{MSY} during the ten years of projection (Fig. 3.12). The combined relative fishing and cod predation mortality, Z_t/Z_{MSY}, has a high probability of being below 1 within this period (Fig. 3.13).

A catch option of 130 000 tons/yr is near the estimated median MSY but is not likely to drive the stock below B_{MSY} in the short to medium term (Fig. 3.12), i.e. the risk is less than 10% within the first four years and just above 25% after year 10 (Fig. 3.13). However, this level of exploitation might not be sustainable in the longer term, as risk of exceeding B_{MSY} continues to increase through time.

Fishing 140 000 or 150 000 tons/yr bears a 60% and 70% risk respectively of being above MSY (Fig. 3.11), thus these catch levels are not likely to be sustainable in the longer term. Owing to the current high stock level the risk of exceeding B_{MSY} is no more than 20% after five years at 150 000 tons/yr, although after 10 years it is close to 50% (Fig. 3.13).

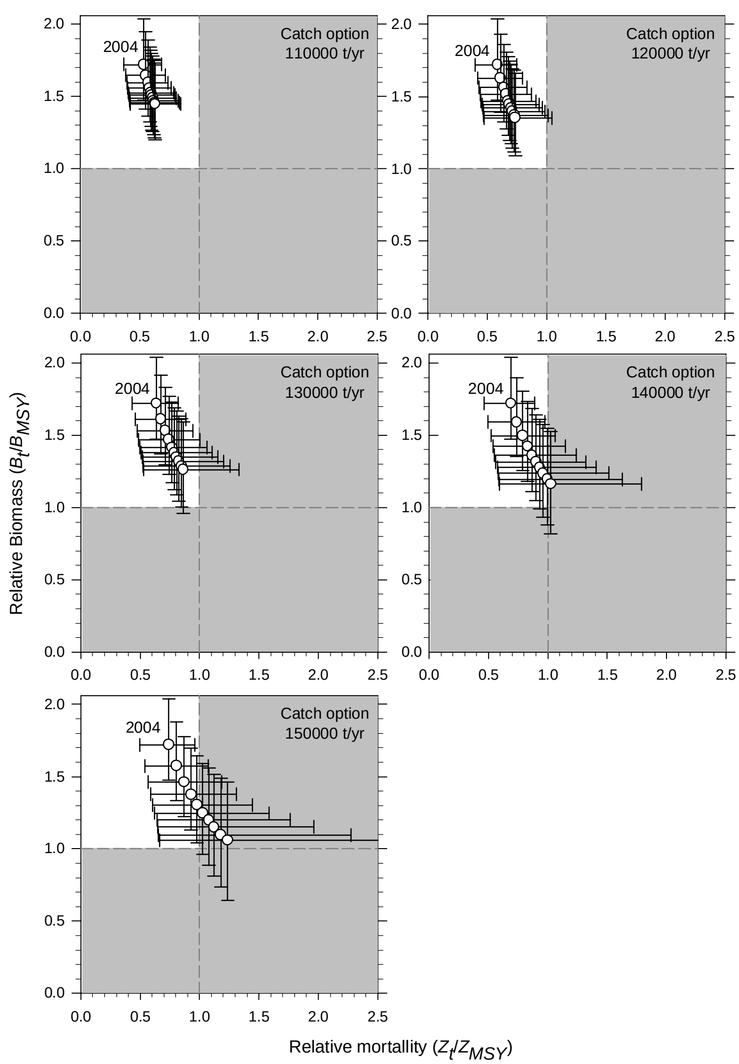


Fig. 3.12. Shrimp in Subareas 0 and 1: projections of stock development for the period 2004-2013 quantified in a biomass (B/B_{MSY})-mortality (Z/Z_{MSY}) continuum. Dynamics at 110, 120, 130, 140 and 150 thousand tons of fixed annual catch levels are shown as medians with error-bars at the 25th and 75th percentiles. Dashed lines indicate level of biomass and mortality at MSY.

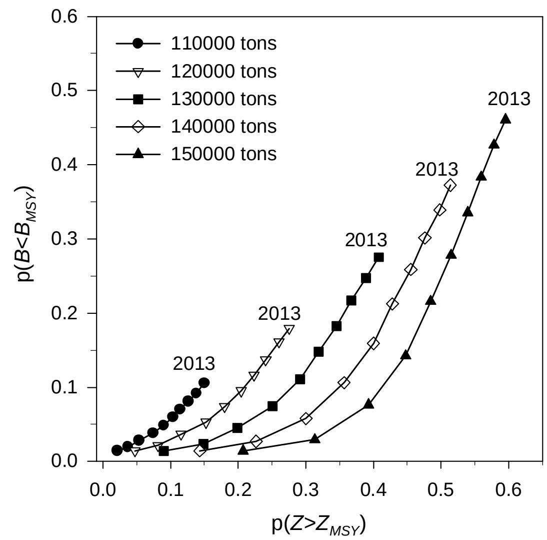


Fig.3.13. Shrimp in Subareas 0 and 1: risk of exceeding Z_{MSY} and of driving the stock below B_{MSY} by maintaining optional annual catch levels of 110-150 000 tons/yr during the period 2004-2013.

If on the other hand there is an abrupt increase in cod biomass resulting from immigration from other areas changes of shrimp stock condition may be much more rapid. Investigations of the event of an immigration of two large year-classes of cod were made by simulating a repetition of the short-lived resurgence of the cod stock seen in the late-1980s. The simulation showed that predation could within a 3-4 year period go from negligible to between 80 000 and 140 000 tons (SCR Doc. 03/73).

CPUE. The standardized CPUE series showed an increasing trend since 1990. The 2003 mean value is the highest in the time series.

Recruitment. A recruitment index (shrimp at age 2) showed an increasing trend from 1997 to 2001 and a decrease thereafter. The 2003 value is below the average of the time series.

SSB. SSB (female biomass) showed an increasing trend since 1997 and the value in 2003 is the highest observed in the series since 1988.

Exploitation rate. All indices of exploitation and relative mortality have shown a decline since the early 1990s.

State of the Stock. The stock biomass has increased since the early-1990s and reached its highest level recorded in 2003. Biomass is well above B_{MSY} and mortality by fishery and cod predation is well below Z_{MSY}. In addition the stock appears to be well represented by a broad range of size groups.

e) **Precautionary Approach**

The "Precautionary Approach" framework developed by Scientific Council defines a limit reference point for fishing mortality, F_{lim}, as equal to F_{MSY}. The limit reference point for stock size measured in units of biomass, B_{lim}, is the spawning stock biomass below which unknown or "low" recruitment is expected. Buffer reference points, B_{buf} and F_{buf}, are also requested to provide a safety margin that will ensure a small risk of exceeding the limits.

The limit reference point for mortality in the current assessment framework is Z_{MSY}, i.e. Z-ratio=1 and the risk of exceeding this point is given in this assessment. B_{lim} could not be defined. For one thing stock-recruitment figures were only available for relative high stock sizes and extrapolation to define an area of "low recruitment" was not readily justified. Buffer reference points are not given here as the risk of exceeding the limit reference can be directly calculated and uncertainty associated with the entire process is taken into account.

f) **Research Recommendations**

For the shrimp stock in Subarea 1 and Div. 0A east of 60^{o}W, STACFIS **recommended** that:

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in Subarea 1.*

4. **Northern shrimp (*Pandalus borealis*) in Denmark Strait and off East Greenland** (SCR Doc. 03/74, 77, 85)

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, up to 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. Access to all these fishing grounds depends heavily on ice conditions.

A multinational fleet exploits the stock. During the recent ten years, vessels from Greenland, Denmark, the Faroe Islands and Norway have fished in the Greenland EEZ. Only Icelandic vessels fish in the Icelandic EEZ.

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.

Catches of shrimp taken have been reported without accounting for "overpacking" – the amount of surplus weight in packaging – or the difference between the product weight and live weight. In this assessment, catches in the Greenland and Icelandic EEZ have been adjusted for overpacking (SCR Doc. 03/74):

Year	Reported catch GR EEZ (tons)	Correction factor GR EEZ	Corrected catch GR EEZ (tons)	Reported catch ICE EEZ (tons)	Correction factor ICE EEZ	Corrected catch ICE EEZ (tons)	Total STACFIS estimate
1978				363	1.2000	436	436
1979	800	1.2511	1001	485	1.2000	582	1583
1980	7646	1.2511	9566	759	1.2000	911	10477
1981	4667	1.2511	5839	125	1.2000	150	5989
1982	4902	1.2511	6133	0	1.2000	0	6133
1983	4132	1.2511	5169	43	1.2000	52	5221
1984	5989	1.2511	7493	742	1.2000	890	8383
1985	6316	1.2511	7902	1794	1.2000	2153	10055
1986	9814	1.2511	12278	1150	1.2000	1380	13658
1987	10848	1.2669	13743	1330	1.2000	1596	15339
1988	11125	1.2479	13882	1431	1.2000	1717	15600
1989	9416	1.2397	11673	1326	1.2000	1591	13264
1990	9994	1.2207	12199	281	1.2000	337	12536
1991	8192	1.2564	10292	465	1.2000	558	10850
1992	5764	1.2406	7151	1750	1.2000	2100	9251
1993	5095	1.2430	6333	2553	1.2000	3064	9396
1994	8298	1.2555	10418	1514	1.2000	1817	12235
1995	8355	1.2491	10437	1151	1.2000	1381	11818
1996	9147	1.2439	11378	566	1.2000	679	12057
1997	8733	1.2479	10898	2856	1.2000	3427	14325
1998	7900	1.2659	10001	1421	1.2000	1705	11706
1999	8698	1.2589	10950	769	1.2000	923	11873
2000	9462	1.2598	11921	132	1.2000	158	12079
2001	11043	1.2588	13901	10	1.2000	12	13913
2002	8025	1.2583	9956	1231	1.2000	1477	11433
2003*	8550	1.2550	10672	703	1.2000	844	11515

*until November

Total catches increased rapidly to about 15 500 tons in 1987 and 1988, but declined thereafter to about 9 000 tons in 1992 and 1993. Following the extension of the fishery south of 65°N, catches increased again to about 14 300 tons in 1997. Catches in recent years have been between 11-14 000 tons (Fig. 4.1).

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

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003[1]
Recommended TAC	5 000	5 000	5 000	5 000	5 000	9 600	9 600	9 600	9 600	9 600
North of 65°N, Greenland EEZ	3 359	4 823	2 351	1 300	3 115	3 223	3 404	1 769	859	2 500
North of 65°N, Iceland EEZ	1 514	1 151	566	2 856	1 421	769	132	10	1 231	1 000
North of 65°N, total	4 873	5 974	2 917	4 156	4 536	3 992	3 536	1 779	2 003	3 500
South of 65°N, Greenland EEZ	4 939	3 532	6 796	7 433	4 785	5 475	6 058	9 274	7 166	7 500
Total STATLANT 21A	9 812	9 506	9 713	11 589	9 321	9 467	9 594[2]	11 053[2]	9 256[2]	
Total STACFIS[3]	12 235	11 818	12 057	14 325	11 706	11 873	12 079	13 913	11 433	13 500

[1] Catches projected to end of 2003.
[2] Provisional.
[3] Estimate corrected for overpack.

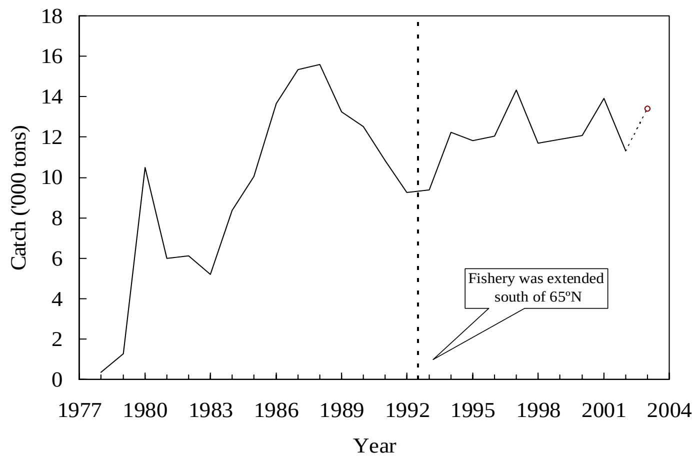


Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: total catches (2003 projected to the end of the year based on January to 1 November data).

b) **Input Data**

i) **Commercial fishery data**

Fishing effort and CPUE. Catch and effort (hours fished) from logbooks were available from Greenland, Norway, Iceland, Faroe Islands and EU-Denmark since 1980 and from EU-France for 1980 to 1991.

Standardized catch rates based on logbook data from Danish, Faroese, Greenlandic and Icelandic vessels in the northern area declined continuously from 1987 to 1993 **-** showed a significant increase between 1993 and 1994 and fluctuated with a slightly increasing trend thereafter (Fig. 4.2). A standardized catch-rate series for the same fleets (Iceland excluded) in the southern area increased until 1999, and fluctuated without trend thereafter (Fig. 4.3).

A combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993, showed a significant increase between 1993 and 1994, and continued thereafter at an increasing trend. The 1999 to 2003 values equals that at the start of the time series in 1987 (Fig. 4.4).

The addition of new data for 2002 and 2003, have only caused minor changes in the CPUE index series as compared to the corresponding series resulting from last years analyses. However, the perception of the 2002 value was changed in a positive direction for the southern and overall area indices.

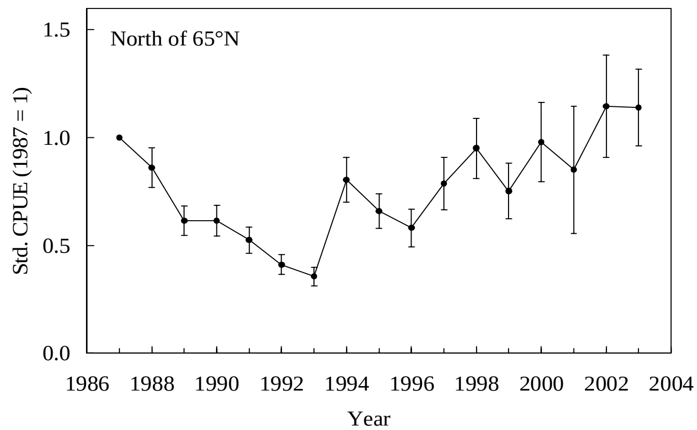


Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ±1 SE calculated from logbook data from Danish, Faroese, Greenlandic and Icelandic vessels fishing north of 65°N.

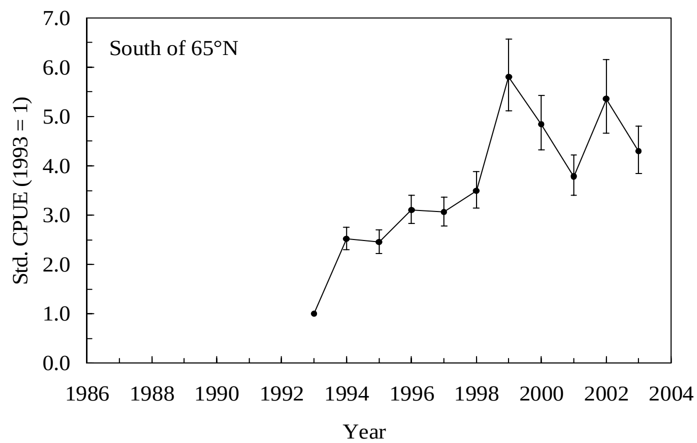


Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ±1 SE calculated from logbook data from Danish, Faroese and Greenlandic vessels fishing south of 65°N.

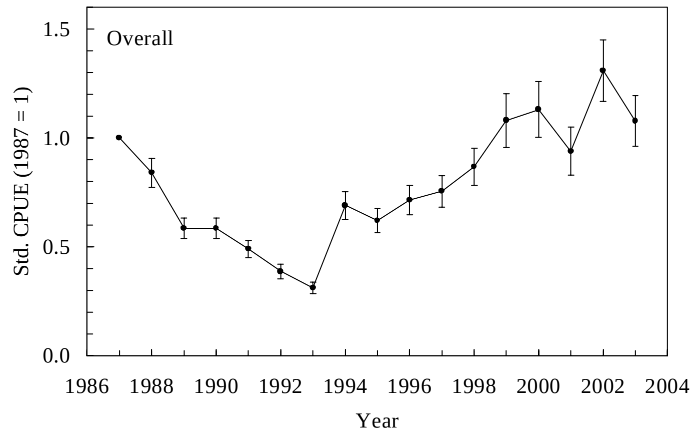


Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ± 1 SE combined for the total area.

An index of exploitation rate (catch divided by standardized CPUE) for the total area showed a decreased trend since 1993. Recent levels are the lowest of the time series (Fig. 4.5).

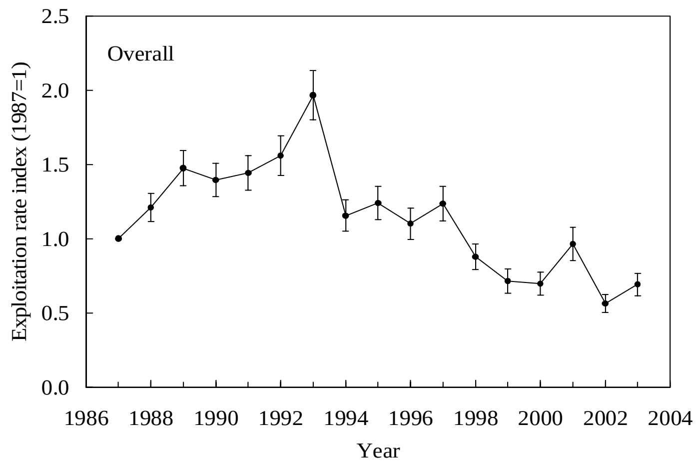


Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized exploitation-rate indices (± 1 SE; 1987 = 1), combined for the total area.

Biological data. In 2002 STACFIS recommended that "sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established". However, sampling of the commercial fishery in recent years has been insufficient to obtain annual estimates of catch composition.

ii) **Research survey data**

No surveys have been conducted since 1996.

c) **Assessment Results**

Commercial CPUE. Combined standardized CPUE indices for the total area declined from 1987 to 1993 and increased thereafter to approximately the same level in 2000–2003 as at the start of the time series in 1987.

Recruitment. No recruitment estimates were available.

Biomass. No direct biomass estimates were available.

Exploitation rate. From 1998 through 2003 the exploitation rate index (catch/CPUE) has been at its lowest levels in the 17-year series.

State of the stock. STACFIS was not able to provide estimates of absolute stock size. Standardized CPUE data for all the areas combined indicate a general increasing trend in fishable biomass since 1993. The 2000 to 2003 values equal the relative high values at which the series started in 1987.

d) **Research Recommendations**

For shrimp in Denmark Strait and off East Greenland, STACFIS **recommended** that:

- *a survey series be established, to provide fishery independent data of the stock throughout its range.*

- *sampling of catches by observers – essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock – be re-established in the Greenland EEZ and improve in the Icelandic EEZ..*

IV. OTHER BUSINESS

1. **Assessment Methodology**

STACFIS noted the need for the development and review of the methodologies for stock assessment. STACFIS proposes that the Chair of Scientific Council should initiate discussion on this matter.

2. **Adjournment**

There being no other business, the Chair expressed his gratitude to the members of the Committee for their valuable contributions, especially from the Designated Experts, and to the Secretariat for the excellent support in all respects, and adjourned the meeting.