

PART C

Scientific Council Meeting, 7-14 November 2001

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Participants, Scientific Council Meeting, 7-14 November 2001 at NAFO Headquarters, Dartmouth, Nova Scotia, Canada

Back (left to right): C. Hvingel, E. Colbourne, A. Nicolajsen, P. Koeller, W. R. Bowering, P. Kanneworff, A. O. Okhanov, M. C. S. Kingsley, S. Bakanev, D. C. Orr, W. B. Brodie, K. Wieland, T. Amaratunga
Front: H. Siegstad, R. K. Mayo, D. Stansbury, U. Skuládóttir
Missing: D. C. A. Auby, B. Marshall

REPORT OF SCIENTIFIC COUNCIL MEETING

7-14 November 2001

Chairman: R. K. Mayo

Rapporteur: T. Amaatunga

I. PLENARY SESSIONS

The Scientific Council met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, during 7-14 November 2001, Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), Iceland, Russia Federation and United States of America. The Assistant 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 0945 hours on 7 November 2001

The Provisional Agenda was considered and **adopted** without changes (see Part D, this volume). The Assistant Executive Secretary was appointed rapporteur.

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 session was adjourned at 1000 hours.

The Council met as needed through 7-14 November 2001, while STACFIS was welcome to conduct its business.

The concluding session was convened at 1145 hours on 14 November 2001. 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 addressed 'Other Matters' in the agenda.

The Council then considered and **adopted** the STACFIS Report, and considered its own report and **adopted** the report of this meeting of 7-14 November 2001.

The meeting was adjourned at 1300 hours on 14 November 2001.

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, List of Representatives, Advisers/Experts and Observers, and List of Recommendations of this meeting are given in Part D, 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 Chairman, D. E. Stansbury. 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 **recommendations** made by STACFIS for the work of the Scientific Council as **endorsed** by the Council, are as follows:

1. **For northern shrimp in Div. 3M,**

- *work on age structured population models should be continued.*
- *biological and CPUE data from fleets, which account for a substantial fraction of the Div. 3M shrimp catch, should be submitted in advance of the November 2002 Scientific Council Meeting.*

2. **For northern shrimp in Div. 3LNO**

- *the numbers of groundfish caught by species in the shrimp fishery in Div. 3L be calculated from the by-catch rates and this information be made available in advance of the June 2002 Scientific Council Meeting.*

3. **For northern shrimp in Subareas 0 and 1**

- *an analysis of the length-frequency data of shrimp be conducted in order to obtain the age composition.*
- *the effect of recent changes in survey design and execution be further studied.*
- *the assessment approach using Bayesian methods be studied further.*

4. **For northern shrimp in Denmark Strait and off East Greenland**

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

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 1993. Since then 16 nations have participated in the fishery.

Fishery and catches: Total catches were approximately 27 000 tons in 1993, increased to 48 000 tons in 1996 and declined to 25 000 in 1997 and thereafter increased to 50 000 tons in 2000.

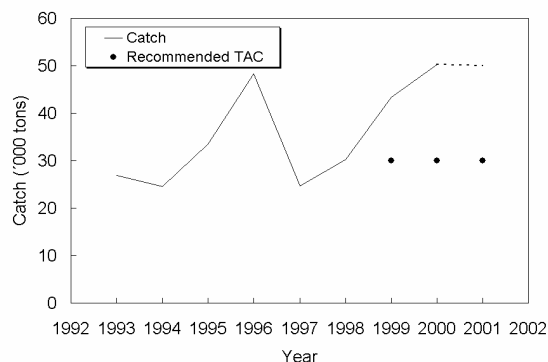
Year	Catch ¹ (‘000 tons)	TAC (‘000 tons)	
		Recommended	Agreed
1998	30	lpl	er
1999	43	30	er
2000	50	30	er
2001	50 ²	30	er

¹ STACFIS estimates.

² Projected to end of 2001.

lpl Lowest possible level.

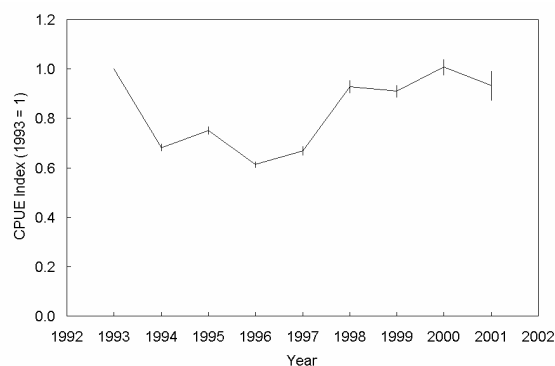
er Effort regulations.



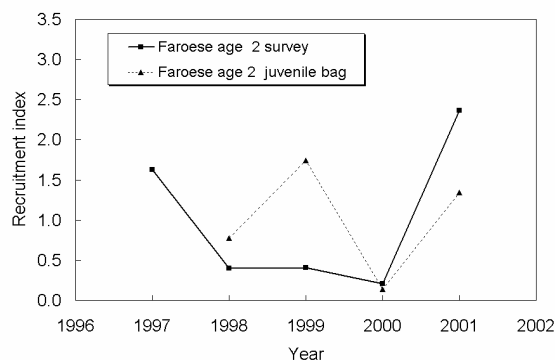
Data: Catch, effort and biological sampling data were available from several Contracting Parties. A standardized CPUE index was developed to account for changes in gear (single and double trawl), fishing power and seasonality. Time series of size and sex composition data were available from three countries and survey indices were available from Faroese and EU research surveys.

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.

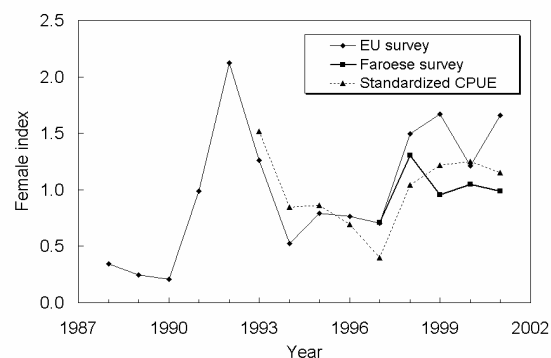
CPUE: Standardized catch rates declined between 1993 and 1996, increased to 1998 and remained stable thereafter.



Recruitment: The 1999 year-class is indicated to be average or above average in 2001 and the 1998 year-class is the lowest in the time series at both age 2 and 3.



SSB: Indices of female biomass from EU-surveys have varied without a trend at above average levels since 1998. The shorter time series from the Faroese survey has been stable since 1999. International CPUE indicated female biomass to be above average in 1999 through 2001.



State of the Stock: Scientific Council is unable to estimate absolute stock size. Stock size indicators are stable and higher in 1998-2001 compared to 1994-97. In the 2000 assessment the 1997 year-class was indicated to be below average. However, considering the contributions of this year-class to both the biomass

estimates from recent surveys and the 2001 fishery, it now appears that the 1997 year-class is at least average or above average. The 1998 year-class appears to be below average but the 1999 year-class appears to be above average.

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. Considering the re-evaluation of the strength of the 1997 year-class in the current assessment to average or above average and that it is expected to be the main contributor to the catch biomass in 2002, the Scientific Council advises a catch of 45 000 tons for 2002.

Based on the observed apparent weakness of the 1998 year-class Scientific Council advises that a catch of 45 000 tons in 2003 may result in a reduction in stock size. Scientific Council therefore recommends that the advice for 2003 be evaluated at its 2002 November meeting when more information on the strength of the 1998 year-class and total stock biomass is available.

Special Comments: Given the concerns with high catches of juveniles, the Scientific Council suggests that the Fisheries Commission consider technical measures known to be effective in improving the size selectivity of shrimp trawls.

Sources of Information: SCR Doc. 01/172, 183, 184, 187, 188, 189, 190, 191.

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

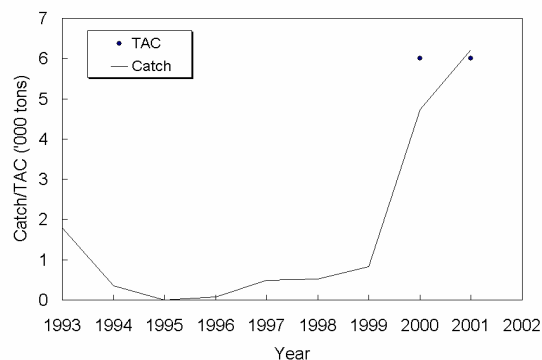
Background: Most of this stock is located in Div. 3L, and exploratory fishing began there in 1993. The stock came under TAC regulation in 2000, and fishing was restricted to Div. 3L.

Fishery and catches: Nine nations participated in the fishery in 2001. Canadian vessels took most of the catches in 2000 and 2001. 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:

Year	Catch ('000 tons)	TAC ('000 tons)
1998	0.5	-
1999	0.8 ¹	-
2000	4.7 ¹	6.0
2001	6.2 ²	6.0

¹ Provisional.

² Projected catch to the end of 2001.



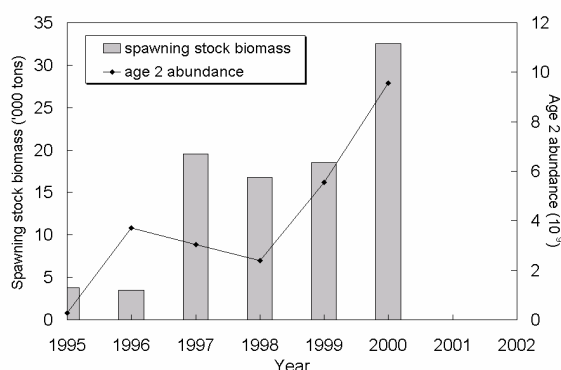
Data: Catch, effort and biological sampling data were available from Canadian vessels in 2000 and 2001. Biomass and recruitment indices, and size and sex composition data were available from research surveys conducted in Div. 3LNO during spring (1999 to 2001) and autumn (1995 to 2000).

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

Recruitment. The recruitment index (age 2 in the autumn surveys) shows that the 1997 and 1998 year-classes are larger than the preceding 4 year-classes, with the 1998 being the largest observed.

Exploitation rate. No estimates of fishing mortality are available but exploitation is believed to be relatively low.

SSB. SSB (female biomass) increased in 1997, increased further in 2000, reaching the highest value in the series.



State of the Stock. Scientific Council is not able to provide estimates of absolute stock size. The indices of stock sizes show that both the recruitment and SSB estimates in 2000 are the highest observed. In addition, the stock appears to be well represented by a broad range of size groups.

Recommendations: In 1999, Scientific Council advised "if there is a fishery in Div. 3L, catches be restricted to no more than 6 000 tons for a number of years until the response of the resource to this catch level can be evaluated". In 2000, Scientific Council also advised a catch of no more than 6 000 tons for 2001. Scientific Council notes that all current indices of stock size and recruitment are favourable. However, the fishery has existed for only two years, and the effect on the stock of the 2001 fishery of 6 200 tons cannot be evaluated at this time.

Scientific Council therefore considers that it would be premature to advise any change in recommended catch at the present time, and recommends that the existing TAC of 6 000 tons be continued for 2002. Scientific Council reiterates 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. Advice for 2003 could be developed at the November 2002 Scientific Council meeting.

Sources of Information: SCR Doc. 01/46, 186.

b) **Response to Special Requests**

For northern shrimp in Div. 3LNO, Scientific Council examined additional information on the distribution of the resource and concluded that the relative distribution inside and outside the NAFO Regulatory Area remain as described in the 2000 Report of the Scientific Council (*NAFO Sci. Coun. Rep.*, 2000, p. 236-242).

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, the agreed summaries are as follows:

Northern Shrimp (Pandalus borealis) in Subareas 0 and 1

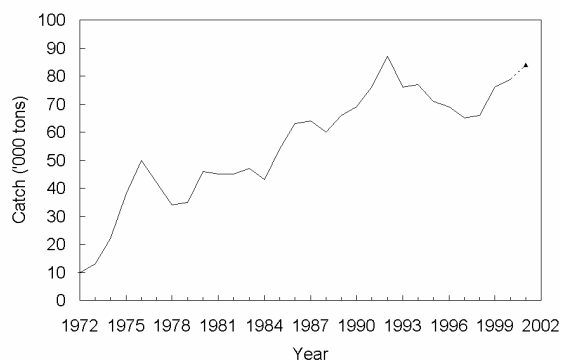
Background: A small-scale inshore fishery began in SA 1 during the 1930s. Since 1969 an offshore fishery has developed and the shrimp fishery is the largest fishery in Davis Strait.

Fishery and catches: The fishery is conducted by Greenland and Canada. Recent catches from the stock are as follows:

Year	Catch ('000 tons)			TAC ('000 tons)
	Inshore	Offshore	Total	Recommended
1998	9.5	56.6	66.1	55.0
1999 ¹	17.3	58.8	76.0	65.0
2000 ¹	20.5	59.4	79.9	65.0
2001			83.5 ²	85.0

¹ Provisional catches.

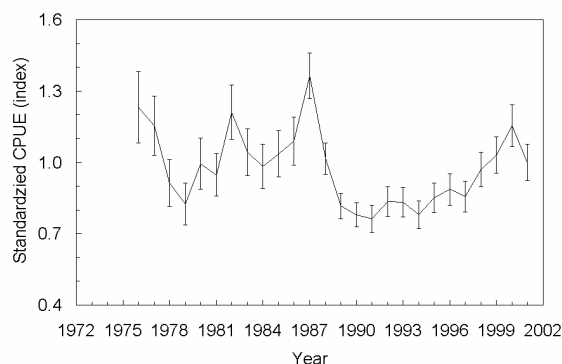
² Projected to the end of 2001.



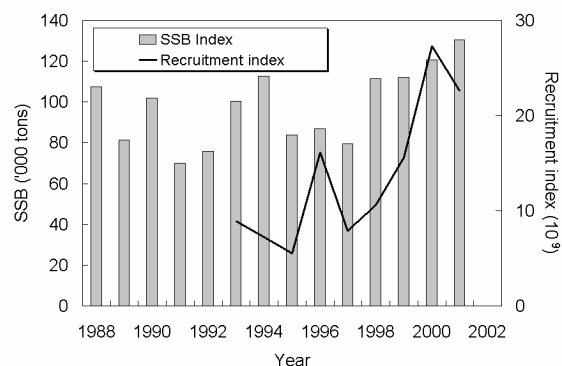
Data: Catch and effort data were available from all vessels. Biological sampling data were available from the offshore fishery. Time series of biomass and recruitment indices, size and sex composition data were available from research surveys from both offshore and inshore areas.

Assessment: No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data (catch, effort and standardized catch rates), research survey indices and biological data.

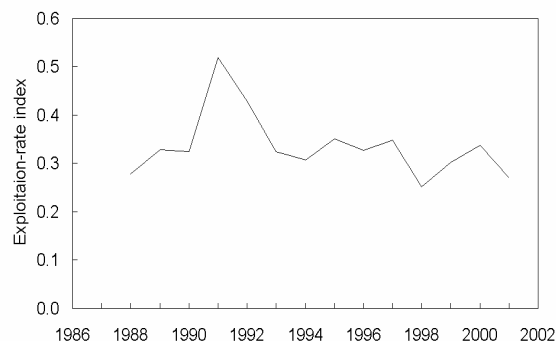
CPUE. The standardized CPUE series showed an increasing trend from 1990 to 2000. The provisional 2001 value shows a decline compared to the value of the previous year.



Recruitment. The recruitment index (shrimp less than 17 mm CL) showed an increasing trend from 1997 to 2000. The 2001 index for recruitment is the second highest in the time series. The very strong male group at 13 mm CL (2 years old) is not expected to significantly influence the catch in 2002.



SSB. SSB (female biomass) show an increasing trend since 1997 and the value in 2001 is the highest observed in the time series.



Exploitation rate. An index of exploitation rate (ratio of catch to survey biomass greater than 17 mm CL) showed no trend in recent years.

State of the Stock. Scientific Council is not able to provide estimates of absolute stock size. The indices of stock size show that both the recruitment and SSB estimates in 2001 are among the highest observed. In addition the stock appears to be well represented by a broad range of size groups.

Recommendations: Scientific Council evaluates the stock as being in good condition, and considers that it can support the current level of exploitation into 2002.

Scientific Council therefore recommends that the TAC for 2002 should be set at 85 000 tons.

Special Comments: Because recruitment has improved, there is potential for increased catch and discard of small shrimp.

Sources of Information: SCR Doc. 01/173, 175, 176, 177, 178, 179, 181.

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

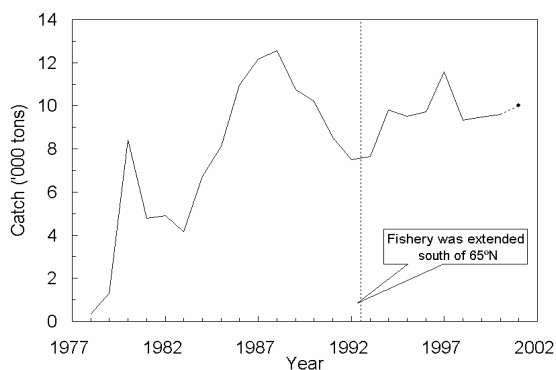
Background: The fishery began in 1978 in areas north of 65°N in Denmark Strait, where it occurs on both sides of the midline between Greenland and Iceland. Areas south of 65°N in Greenlandic waters have been exploited since 1993.

Fishery and Catches: Five nations participated in the fishery in 2001. Recent catches and recommended TACs are as follows:

Year	Catch ('000 tons)			TAC ('000 tons)
	North	South	Total	Recommended
1998	4.5	4.8	9.3	5.0
1999 ¹	4.0	5.5	9.5	9.6
2000 ¹	3.5	6.1	9.6	9.6
2001			9.9 ²	9.6

¹ Provisional catches.

² Projected to the end of 2001.



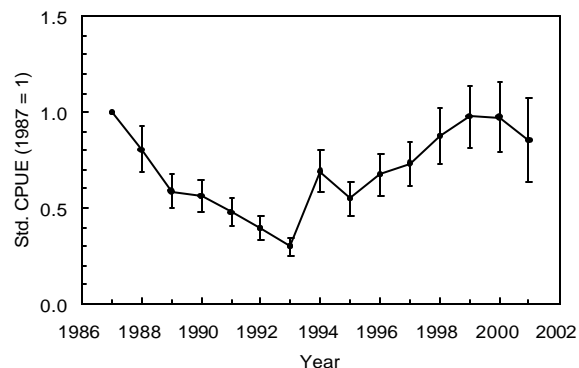
Data: Catch, effort and biological sampling data were available from trawlers of several nations. Surveys have not been conducted since 1996.

Assessment: No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data and biological data.

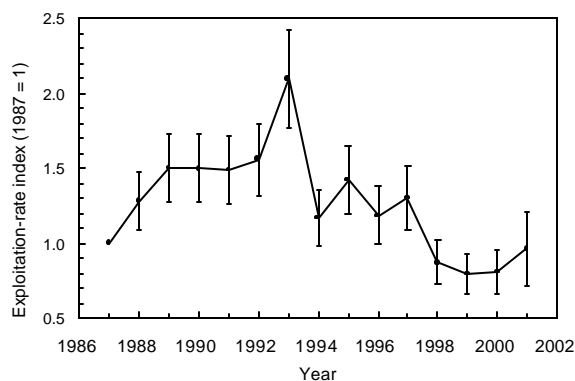
CPUE: Combined standardized CPUE indices for the total fishing area declined from 1987 to 1993 and increased thereafter back to approximately the same level in 1999–2000 as in 1987. However, the preliminary estimate for 2001 based on partial data for the year is down slightly.

Recruitment: No recruitment estimates were available.

Biomass: No direct biomass estimates were available.



Exploitation rate. From 1998 through 2001 an exploitation rate index (catch/CPUE) has been at its lowest levels in the 15-year series.



State of the Stock: Scientific Council is 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 to a peak in 1999 and 2000 equalling the historic high value at which the series started in 1987. The preliminary estimate of standardized CPUE for 2001 may suggest a small decrease. Several year-classes of male and female shrimp are evident in the sampling data in all recent years.

Recommendation: Since 1994, annual catches have remained near the recently recommended TAC of 9 600 tons, while stock biomass indices have increased. This increase may not, however, have continued through 2001. Scientific Council therefore advises that catches of shrimp in Denmark Strait and off East Greenland should not exceed 9 600 tons in 2002.

Special Comments: Shrimp smaller than 17 mm carapace length are and have been rare both in the commercial catches and in past research surveys (Greenlandic survey 1989-96), so it remains difficult to predict recruitment.

Sources of Information: SCR Doc. 01/174, 180.

3. **Formulation of Advice Under a Precautionary Approach Framework**

The Council noted that with respect to the Precautionary Approach Framework, there are some new developments and different methodologies being considered by various Institutions. For shrimp stocks in particular, it was noted that the "Traffic Light" software applications had been in focus for some time. The Council therefore reviewed the latest developments in the methodology.

A Traffic Light software application developed at the Bedford Institute of Oceanography was demonstrated as a possible way of implementing the Precautionary Approach for data-poor or data-rich stocks. This program inputs stock indicator data sets and their respective limits (between red, yellow and green lights), polarity (whether an increase in an indicator is good or bad), weight (indicator's importance in the summary calculation), and assignment to stock characteristics (e.g. abundance, production or mortality) to which they are most relevant. It was noted that the method has parallels to the Precautionary Approach defined previously by NAFO Scientific Council and with further development could be considered within that framework for data poor stocks.

Scientific Council also discussed other approaches that were presented at this meeting, including an age-structured analysis of the Div. 3M shrimp stock. This approach may eventually allow calculation of Precautionary Approach reference points based on biomass and fishing mortality. In addition, an age-aggregated stock dynamics modelling approach employing Bayesian priors was presented to describe the dynamics of shrimp in Subareas 0 and 1. Uncertainty associated with model assumptions and errors associated with observed data were incorporated into the analysis. Scientific Council considered that this approach could also be implemented within the Precautionary Approach Framework for data-poor stocks.

IV. OTHER MATTERS

1. **Scientific Council Meeting on Northern Shrimp, November 2002**

The Council reconfirmed that the Scientific Council Meeting on northern shrimp in November 2002, will be held in Nuuk, Greenland.

The Council noted that proposals may be forwarded from ICES to conduct assessments of ICES shrimp stocks under the auspices of a Joint NAFO/ICES Working Group. While no formal requests have been received yet, the Council noted such requests may require the Council to bring forward the dates of its shrimp assessment meetings. The Council reviewed the time frame in which all necessary data for assessing the NAFO shrimp stocks would be available and noted the earliest possible timing for such a meeting would be mid-October.

The Council, however, agreed that a scenario of a joint NAFO/ICES shrimp meeting will not transpire before the Scientific Council Meeting of November 2002. The Council accordingly agreed that the next Scientific Council meeting on northern shrimp being held in Nuuk, Greenland, will be during 6-13 November 2002.

The Council **recommended** that *the Scientific Council Chairman make direct contact with the Chairman of ACFM-ICES and develop any proposals for a joint meeting requirement, and report to the Council at its meeting in June 2002.*

2. **Scientific Council Meeting on Northern Shrimp, November 2003**

The Council noted that dates for its meeting on northern shrimp were provisionally set for 5-12 November 2003. The Council agreed to review the timing and venue for this meeting at its November 2002 Meeting.

V. ADOPTION OF REPORTS

The Council at its session on 14 November 2001 considered and **adopted** the Report of STACFIS (see Appendix I). The recommendations made by STACFIS and endorsed by the Scientific Council are given in Sections II and III above. The Council then considered and **adopted** its own Report of this 7-14 November 2001 Meeting.

VI. ADJOURNMENT

There being no further business, the Chairman thanked all participants for their thoughtful and constructive contributions. He especially thanked the Designated Experts for their hard work and excellent contributions and the Secretariat for their continued support during the meeting. The Chairman then adjourned the meeting, wishing all participants a safe journey.



E. Colbourne (Chair STACFEN), R. K. Mayo (Chair Scientific Council)
D. E. Stansbury (Chair STACFIS)



Problem solving corner during Precautionary Approach discussions.

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

Chairman: D. E. Stansbury

Rapporteur: Various

I. OPENING

The Committee met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, during 7-14 November 2001, 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), Iceland, Russian Federation and United States of America. The Assistant Executive Secretary was in attendance.

The Chairman, D. E. Stansbury (Canada), opened the meeting at 1030 hours on 7 November 2001 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. Environmental Review

STACFIS noted that detailed accounts of environmental conditions related to the stocks being considered during this meeting were reviewed. Further to conditions reported by the Standing Committee on Fisheries Environment (STACFEN) during its meeting of 31 May-14 June 2001, STACFIS received an update of environmental conditions pertaining to shrimp in Div. 3M and Div. 3LNO. These updates are reported as follows:

Division 3M. The recent cold near-surface temperatures (0.5° to 2° C below average) experienced over the Flemish Cap from 1993-96 had warmed to 0.5° - 1.5° C above normal by July of 1997, which increased further to 2° C above normal by the summer of 1999. Upper layer temperatures directly over the Flemish Cap during the spring of 2001 were generally below normal by up to 0.5° C. Bottom temperatures over the Flemish Cap, which were generally below normal during the early to mid-1990s increased to 1° C above normal by 1999 but decreased to near-normal values during 2000 and 2001. Salinities over most of the upper water column during the spring of 2001 were saltier-than-normal (by 0.2-0.8). In the deeper water (generally below 100-m depth) and near bottom, salinities were generally about normal. In general the colder-than-normal temperatures experienced over the continental shelf and on the Flemish Cap from the late-1980s up to the mid-1990s, moderated by the summer of 1996 and continued to warm until 1999. During the summer of 2000 and into the spring of 2001, the observations indicated a reversal in the recent warm trend with near normal temperatures in most areas. During most of the 1990s, summer chlorophyll levels in the upper 100-m of the water column over the Flemish Cap were higher compared to the adjacent Grand Bank, and during the spring of 2001, levels were generally lower over the Flemish Cap relative to the Grand Banks. 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, indicated a general anticyclonic circulation around the Flemish Cap.

Division 3LNO. During the spring of 2001, ocean temperatures cooled significantly over the previous two years particularly in Div. 3NO. The areal extent of $<0^{\circ}$ C bottom water on the Grand Bank showed a large increase from mid-1980s to 1997, very low values in 1998-99, but increased significantly during 2000-2001. Since 1995 the areal extent of bottom water with temperatures $>1^{\circ}$ C has been increasing, reaching pre-1985 ($>60\%$) values by 1999-2000. During 2001 this area decreased to about 40%. In general, temperatures on the Grand Banks during the spring of 2001 decreased over the 1998-2000 values with the most significant decrease appearing over the southern Grand Bank in Div. 3NO. In this region, anomalies reached 0.5° C below normal in the shallowest areas of the Southeast Grand Bank. Temperatures on the northern Grand Bank remained above normal over most of the water column except for a near-surface cold anomaly during April and May near the east coast of Newfoundland (Station 27). Salinities at Station 27 were fresher than normal over most of the water column from March to July.

2. Catches of Shrimp in Divisions 3LNO and 3M

STACFIS noted that STATLANT 21A data were not available from some fleets fishing in Div. 3L and Div. 3M in 2000. In 2001, monthly catch data were also not available for some fleets. In both years, STACFIS used estimates of catches for some Contracting Parties, in order to arrive at the best estimates of total removals for the stocks in Div. 3LNO and Div. 3M. These estimates include Canadian surveillance data, quota reports, and updated catch figures provided to the Designated Experts by some Contracting Parties.

III. STOCK ASSESSMENTS

1. Northern Shrimp (*Pandalus borealis*) in Division 3M (SCR Doc. 01/169, 170, 171, 172, 183, 184, 187, 188, 189, 190, 191)

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 46-110, and in 2001 there were approximately 60 vessels fishing shrimp in Div. 3M. Vessels from 16 nations have participated in this fishery.

Total catches were approximately 27 000 tons in 1993, increased to 48 000 tons in 1996, declined in 1997 and increased steadily through 2000 (Fig. 1.1). Catch statistics to 1 October 2001 indicate removals of about 41 000 tons. This will likely result in a total catch of about 50 000 tons by the end of the year.

Recent catches and STACFIS estimates of catches (tons) are as follows.

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Catch ¹	26 876	24 599	33 471	48 299	24 675	30 308	43 438	50 224	41 321 ²
Recommended TAC							30 000	30 000	30 000

¹ As estimated by STACFIS

² STACFIS estimate to October.

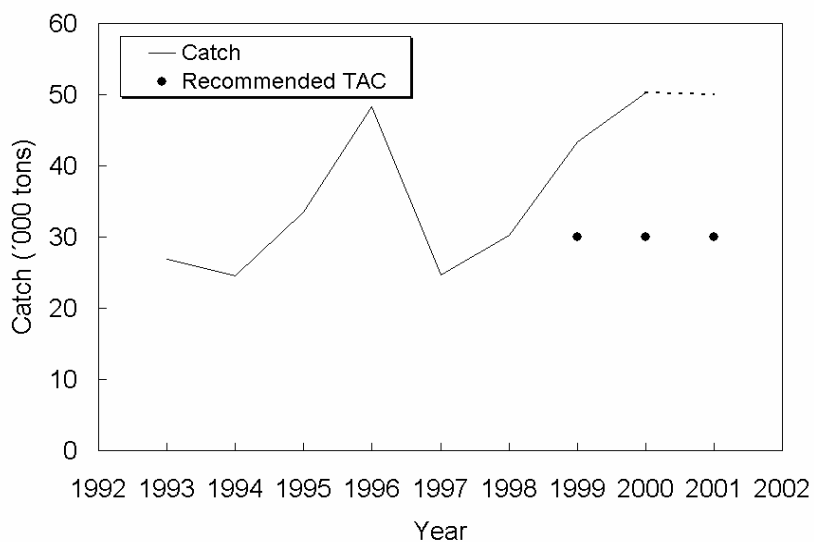


Fig. 1.1. Shrimp in Div. 3M: catches (2001 projected to end of the year) and TAC.

b) **Input Data**i) **Commercial fishery data** (SCR Doc. 01/183, 184)

Effort and CPUE. Data from logbooks of Canadian, Greenlandic, Icelandic and Norwegian vessels were available. A new series has been added from the Faroese fishery. 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 and double trawl). CPUE decreased from 1993 to 1996, and increased until 1998 after which it remained the same (Fig. 1.2).



Fig. 1.2. Shrimp in Div. 3M: standardized CPUE indices (± 1 standard error).

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, increased to 1999 and stayed stable to 2001 (Fig. 1.3).

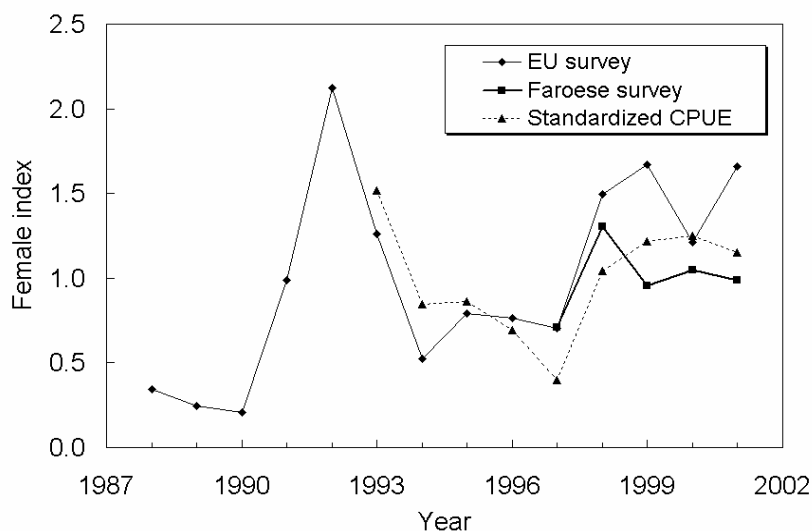


Fig. 1.3. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2001, Faroese survey 1997-2001 and standardized female CPUE 1993-2001. Each series was standardized to the mean of that series.

Biological Data. Age composition was assessed from commercial samples obtained from Canada, Greenland and Iceland. 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 the 2000 and 2001 fisheries the 1996 and 1997 year-classes appear to be average to above average according to their contributions to the commercial catch rates. The 1998 year-class on the other hand, appears to be well below average. Information from the Russian fishery in 2000 and 2001 corroborates these observations.

Age	Number per hour at age based on standardized CPUE					
	1996	1997	1998	1999	2000	2001
1				5		
2	2249	2597	3217	2405	1413	2247
3	21495	14799	18822	14319	22643	5677
4	7295	15456	23551	16562	24117	23667
5	2225	2944	7117	13324	13954	17990
6	1004	551	1099	4797	2623	2736
7	10	47	36	56	120	56
Total	34278	36394	53842	51468	64870	52373

ii) **Research survey data**

EU surveys (SCR Doc. 01/172, 189). EU groundfish surveys have been conducted on Flemish Cap in July from 1988 to 2001. The 1994 and 1998 total biomass indices are likely biased due to changes in sizes of codend mesh. The female biomass is not considered to be affected by the change of gear. As shown in the Table below the female shrimp biomass increased rapidly in 1991 and 1992, declined to relatively low values in 1994 to 1997, increased in 1998 and has since then fluctuated without a trend (Fig. 1.3). Age was assessed for the first time from the length distributions of the EU surveys back to 1988. Results for age 4 indicate that the 1997 year-class was about average. The 1996 year-class at age 5 appears strong.

Year	Biomass Index (tons)	Average catch per mile (kg)	Standard Error	Female Biomass Index (tons)
1988	2 164	1.54	0.28	1 874
1989	1 923	1.37	0.24	1 340
1990	2 139	1.53	0.21	1 132
1991	8 211	5.83	0.71	5 362
1992	16 531	11.75	1.86	11 509
1993	9 256	6.57	1.04	6 839
1994	*3 337	2.37	0.35	2 823
1995	5 413	3.85	0.44	4 286
1996	6 502	4.62	0.34	4 149
1997	5 096	3.62	0.25	3 807
1998	*16 844	11.81	0.80	8 091
1999	12 430	8.83	0.67	9 051
2000	9 720	6.91	0.52	6 553
2001	14 106	10.02	0.65	8 977

* not comparable to other years because of different codend mesh size.

In 2000 a small meshed juvenile bag was attached to the cod end for the first time. The length frequency distributions obtained in the juvenile bag showed very distinctly the modes of ages 1 and 2 in 2000 and the two year olds in 2001.

Faroese survey (SCR Doc. 01/187, 188). Stratified-random surveys were conducted in June-July 1997-2001 by a Faroese shrimp trawler. The total biomass index fluctuated between 16 000 and 22 000 tons in the years 1997 to 2001. Results indicate that the 1996 and 1997 year-classes are about average or above average while the 1998 year-class appears weak. The 1999 year-class at age 2 appears abundant, although the survey does not generally estimate age 2 very precisely. The recruitment index at age 2 obtained by attaching a juvenile bag (7 mm mesh size) to the codend also supports the above observations on the 1997-99 year-classes (Fig. 1.4).

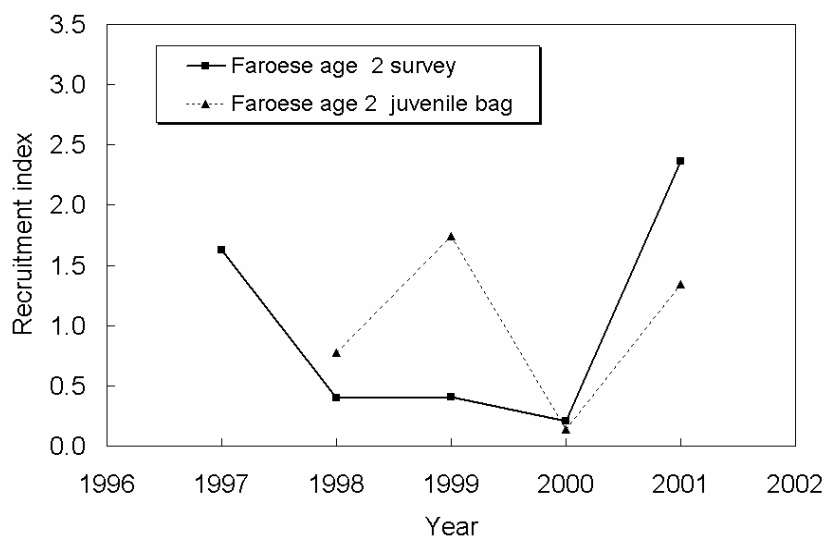


Fig. 1.4. Shrimp in Div. 3M: abundance indices at age 2 from the Faroese survey and from the juvenile bag. Each series was standardized to its mean.

iii) **Other studies**

Three papers (SCR Doc. 01/169, 170, 171) were submitted which considered length frequencies and assessment of age and growth. However due to lack of sufficient documentation STACFIS was unable to evaluate the results of those papers.

iv) **Estimation of stock parameters** (SCR Doc. 01/190)

STACFIS reviewed two age-structured models of the shrimp stock in Div. 3M based on virtual population analysis (VPA). Estimates of fishing mortality and stock biomass were derived using XSA and ADAPT tuning methods. In addition to the Icelandic CPUE and the Faroese survey, a set of indices based on the EU survey was incorporated into the analysis. Both tuning methods produced similar trends in F and biomass, except for the most recent years, although the magnitude of the estimates differed considerably. STACFIS considers that the models continue to show promising results, but notes that further investigation of model assumptions is required.

c) **Assessment Results**

Commercial CPUE. Standardized catch rates declined between 1993 and 1996, increased to 1998 and remained stable thereafter.

Recruitment. The 1999 year-class is indicated to be average or above in 2001 and the 1998 year-class is the lowest in the time series at both age 2 and 3.

Spawning Stock Biomass. Indices of female biomass from EU-surveys have varied without a trend at above average levels since 1998. The shorter time series from the Faroese survey has been stable since 1999. International CPUE indicated female biomass to be above average in 1999 through 2001.

State of the Stock. STACFIS is unable to estimate absolute stock size. Stock size indicators are stable and higher in 1998-2001 compared to 1994-1997. In the 2000 assessment the 1997 year-class was indicated to be below average. However, considering the contributions of this year-class to both the biomass estimates from recent surveys and the 2001 fishery, it now appears that the 1997 year-class is at least average or above average. The 1998 year-class appears to be below average, but the 1999 year-class appears to be above average.

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:

- *work on age structured population models should be continued.*
- *biological and CPUE data from fleets, which account for a substantial fraction of the Div. 3M shrimp catch, should be submitted in advance of the November 2002 Scientific Council Meeting .*

2. **Northern Shrimp (*Pandalus borealis*) in Divisions 3L, 3N and 3O** (SCR Doc. 01/46, 186)

a) **Introduction**

This shrimp stock is distributed around the edge of the Grand Banks, mainly in Div. 3L. From 1993 to 1999 (except 1995), Faroese vessels conducted exploratory fishing in Div. 3L, with catches ranging from 79 to 1789 tons. Exploratory fishing by Canada and EU-Spain in 1999 resulted in a catch of 127 tons. In 2000, Fisheries Commission implemented a TAC of 6 000 tons, and fishing was restricted to Div. 3L. The catch in 2000 increased to 4 700 tons, 4 300 tons of which was caught by Canada. The remainder of the catch was taken by vessels from 8 other countries. Catches increased to 6 200 tons in 2001, with Canada taking just under 5 200 tons (Fig. 2.1). STACFIS noted that catch reports were not available for all countries in 2001, and estimates from other sources were used in these cases.

In 2000, small vessels (less than 500 tons) caught about three-quarters of the Canadian catch. In 2001 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 in 2001 and most of their catch came from twin trawls. In both years, most of the Canadian catch occurred along the northeast slope in Div. 3L, during spring and summer. 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:

	1993	1994	1995	1996	1997	1998	1999 ¹	2000 ¹	2001 ^{1,2}
Catch	1789	356	0	79	485	515	827	4726	6224
Recommended TAC ³	-	-	-	-	-	-	-	6000	6000

¹ Provisional catches

² Catches projected to end of 2001.

³ No TACs advised prior to 2000.

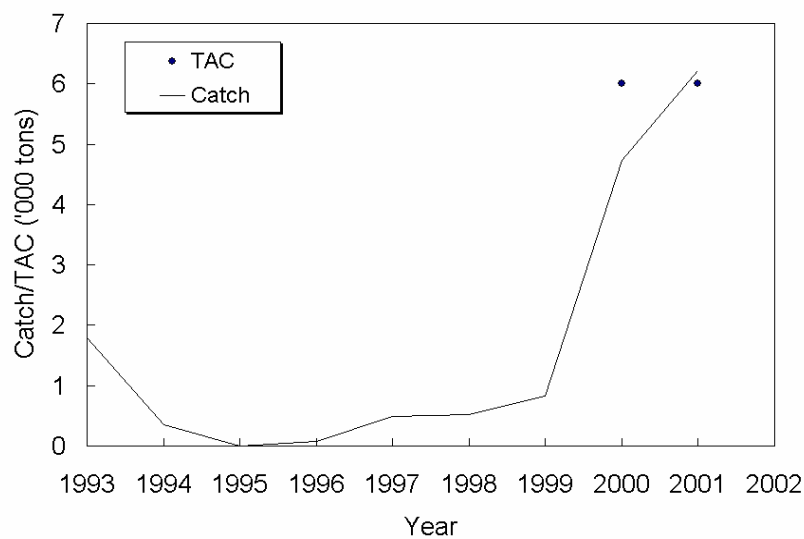


Fig. 2.1. Shrimp in Div. 3LNO: catches and TAC.

b) Input Data

i) Commercial fishery data

Fishing effort and CPUE. Catch and effort data were available from fishing records from Canadian vessels in Div. 3L in 2000 and 2001. Unstandardized catch rates for small and large vessels (single trawl) increased in 2001 over 2000, while the CPUE for large vessels using twin trawls showed a decrease.

Catch composition. Observers sampled and measured catches (approximately 2% of the small vessel catches and 90% of the large vessel catches were observed) in Div. 3L during 2000 and 2001. The length-frequency distributions in both years showed good representation at several size classes, indicating that 5 or more year classes were present. In 2000, samples indicated that catches from small vessels were dominated by shrimp of 23-24 mm carapace length (CL). In 2001, males between 18.5 and 20 mm (1997 year-class) dominated the catches. In both years, catches from the large vessels were dominated by shrimp from the 1997 year-class. The 1996 year-class appeared to be weak relative to other cohorts.

Groundfish by-catch. The shrimp fishery in Div. 3L overlaps the distribution of a number of groundfish species, including those under moratoria. Based on catches observed in the Canadian fishery in 2001, the following estimated total groundfish removals in the Canadian fishery were obtained:

	Small vessels (<500 GRT)		Large Vessels (>500 GRT)	
	Est. catch (kg)	Kg/ton of shrimp	Est. catch (kg)	Kg/ton of shrimp
Cod	265	0.10	232	0.10
American plaice	1 216	0.44	1 166	0.49
Redfish	1 163	0.42	1 015	0.43
Greenland halibut	1 851	0.66	5 877	2.47

The by-catch rates in 2001 were similar to those observed in 2000.

ii) **Research survey data**

Canada in Div. 3LNO has conducted stratified-random surveys, using a Campelen shrimp trawl, during spring and autumn since late-1995. Data for shrimp were available from the autumn surveys in 1995-2000, and from spring surveys in 1999-2001. 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. The index of biomass from autumn surveys increased from about 6 000 tons in 1995, to an average of 53 000 tons in 1997-99, and then to 118 000 tons in 2000 (Fig. 2.2). The spring surveys of 1999-2001 showed the same pattern, with the values in 2000 and 2001 being about double the value in 1999 (Fig. 2.3). Confidence intervals on biomass estimates from the spring surveys were generally wider than those from the autumn surveys.

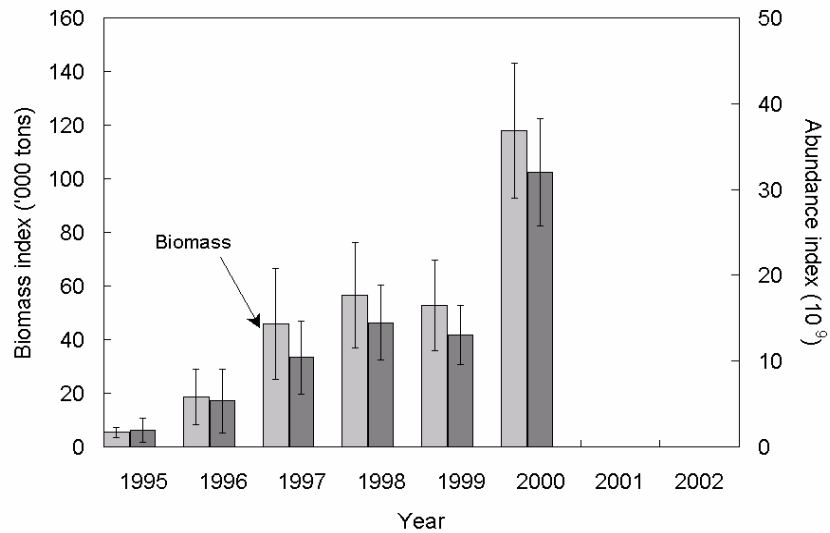


Fig. 2.2. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian autumn multi-species surveys.

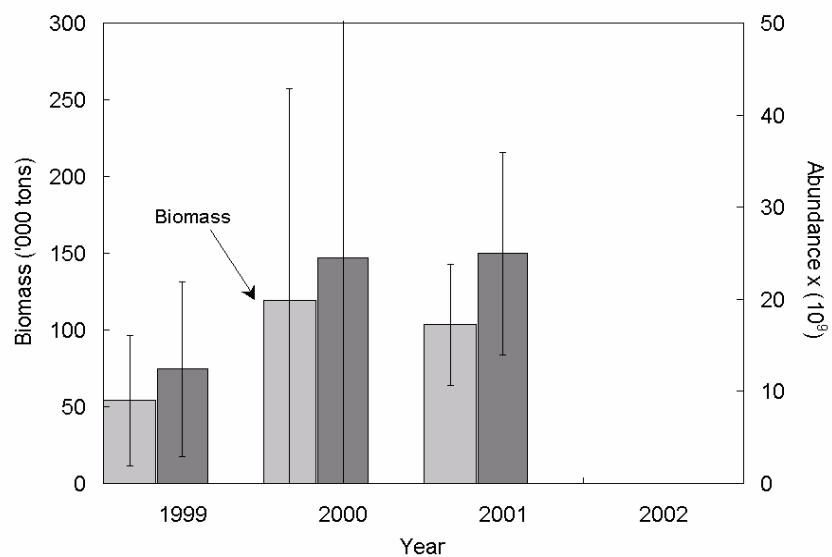


Fig. 2.3. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian spring multi-species surveys.

Sex and length composition. Estimated total number (10^9) of shrimp in Div. 3NLO from autumn 1995 to spring 2001 are as follows:

Survey	Males	Females	Total	Males %	Female %
Autumn 1995	1.3	0.8	2.1	60.5	39.5
Autumn 1996	5.5	0.4	5.9	93.2	6.8
Autumn 1997	7.7	2.9	10.5	72.8	27.2
Autumn 1998	13.3	2.0	15.3	86.9	13.1
Spring 1999	9.7	3.0	12.7	76.5	23.5
Autumn 1999	10.4	2.6	13.1	79.8	20.2
Spring 2000	17.0	8.0	25.0	67.8	32.2
Autumn 2000	27.8	4.4	32.2	86.3	13.7
Spring 2001	19.2	5.7	24.9	77.1	22.9

The abundance of shrimp has increased to the highest levels in the time series in 2000 and 2001. The proportion of females in the surveys has varied around the mean of 22% in recent surveys. Abundance estimates from the autumn 2000 survey were dominated by males with a modal length of 17.5 mm CL (1997 year-class). The relatively weak 1996 year-class was followed by the apparently strong 1997 and 1998 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. A recruitment index (shrimp considered to be age 2) from the autumn surveys of 1995-2000 shows that the 1998 year-class is the largest in the short time-series. A comparable estimate of the 1999 year-class at age 2 was not available, as the autumn survey of 2001 was not completed at the time of the assessment (Fig. 2.4).

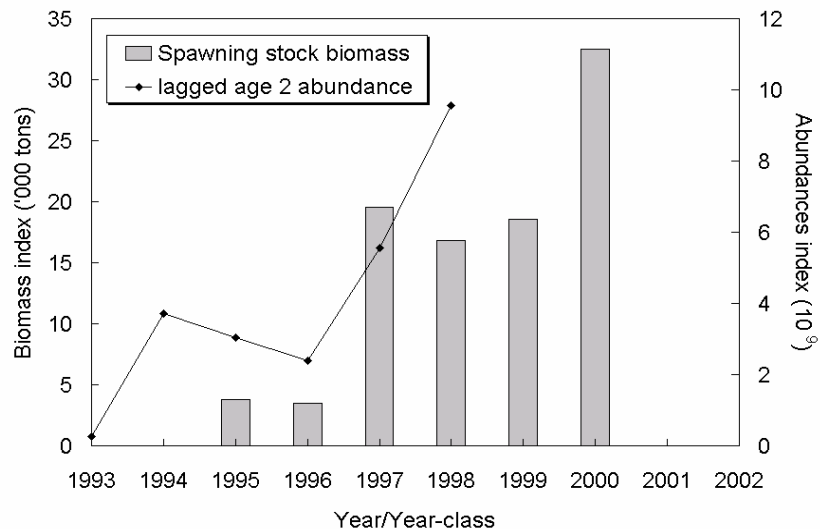


Fig 2.4. Shrimp in Div. 3LNO: the age 2 recruitment index lagged by 2 years such that relationships between recruitment and spawning stock could easily be made.

A measure of exploitation rate was calculated by dividing catch by previous autumn's survey fishable biomass (CL >17 mm male + female biomass) index. Overall, this index of exploitation was low, with increased values in 2000 and 2001 reflecting the start of the fishery under TAC regulation.

The proportion of biomass in Div. 3LNO, in the NAFO Regulatory Area (NRA), from the spring surveys, ranged between 18 to 31%, while the proportions from the autumn surveys ranged between 12 to 30%. The percentage of biomass in Div. 3LNO in the NRA from all 9 surveys averaged 23%. Divisions 3NO accounted for less than 10% of the overall biomass estimates, and less than 3% since spring 1999.

c) **Assessment Results**

CPUE. CPUE data exist for only 2000 and 2001.

Recruitment. The recruitment index (age 2 in the autumn surveys) shows that the 1997 and 1998 year-classes are larger than the preceding 4 year-classes, with the 1998 year-class being the largest observed.

SSB. SSB (female biomass) increased in 1997, increased further in 2000, reaching the highest in the series.

Exploitation: No estimates of fishing mortality are available but exploitation is believed to be relatively low.

State of the Stock. STACFIS is not able to provide estimates of absolute stock size. The indices of stock size show that both the recruitment and SSB estimates in 2000 are the highest observed. In addition the stock appears to be well represented by a broad range of size groups.

d) **Research Recommendations**

STACFIS **recommended** that:

- *the numbers of groundfish caught by species in the shrimp fishery in Div. 3L be calculated from the by-catch rates and this information be made available in advance of the June 2002 Scientific Council Meeting.*

3. **Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1** (SCR Doc. 01/173, 175, 176, 177, 178, 179, 181)

a) **Introduction**

The shrimp stock off West Greenland is distributed in Div. 0A and Subarea 1 and the entire shrimp stock 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). The Canadian fishery has been restricted to Div. 0A since 1981.

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. The advised TAC for the entire stock in 2001 was 85 000 tons. In 2001 the Greenland authorities set a TAC for Subarea 1 of 82 000 tons and a TAC for Subarea 0 of 9 350 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.

Overall catches increased until 1992. From 1993 to 1997 catches decreased to a level of 61 000 tons. Since then catch quotas increased and along with that the catches. The projected catch of 2001 is expected to be around 83 500 tons (Fig. 3.1), based on data from 10 months (January to October 2001). In 2001 catches in Subarea 1 are expected to reach the catch quotas (TAC), whereas catches in Subarea 0

for 2001 most likely will be less than the quotas, due to the increased fishing opportunities for the Canadian fleet elsewhere.

Recent nominal catches and advised TACs (tons) for shrimp in Div. 0A and Subarea 1 are as follows:

	1991	1992	1993	1994	1995 ¹	1996	1997 ¹	1998	1999 ¹	2000 ¹	2001 ^{1,2}
Div. 0A Total	6 788	7 493	5 491	4 766	2 358	2 617	517	914	2 046	1 590	1 500
SA 1 Offshore	52 834	58 664	52 280	53 693	51 900	49 344	50 483	55 673	56 724	57 774	62 550
SA 1 Inshore	16 258	20 594	17 843	18 118	16 429	17 392	13 517	9 518	17 261	20 563	19 450
SA 1 Total	69 092	79 258	70 123	71 811	68 329	66 736	64 000	65 191	73 985	73 337	82 000
SA 0+1 Total	75 880	86 751	75 614	76 577	70 687	69 353	64 517	66 105	76 031	79 927	83 500
0+1 offshore catch	59 622	66 157	57 771	58 459	54 258	51 961	51 000	56 587	58 770	59 364	64 050
0+1 advised TAC ³	50 000	50 000	50 000	50 000	60 000	60 000	60 000	55 000	65 000	65 000	85 000

¹ Provisional (STACFIS estimates of catches from 1995, 1997 and 1999-2001).

² Catches projected to end of 2001.

³ Until 1994 the advised TAC was only for offshore south of 71°N. After 1994, the advised TAC included offshore north of 71°N and inshore.

The nominal catch of shrimp in the offshore areas of Subarea 1 and the adjacent part of Subarea 0 (Div. 0A) increased from less than 1 000 tons before 1972 to almost 43 000 tons in 1976. Catches fluctuated thereafter and stabilized around a level of 54 000 tons during 1985-88, then increased to about 66 000 tons in 1992 and decreased thereafter to 51 000 tons in 1997. Since then the total catch in the offshore areas increased to around 59 000 tons in 2000. Due to higher catch quotas catches in 2001 are projected to increase further to a level of around 64 000 tons. The Canadian fishery in Div. 0A amounted to about 2 500 tons in 1995 and 1996, declined to under 1 000 tons in 1997 and 1998. Since then catches in Div. 0A have increased and 1 500 tons are reported up to October 2001.

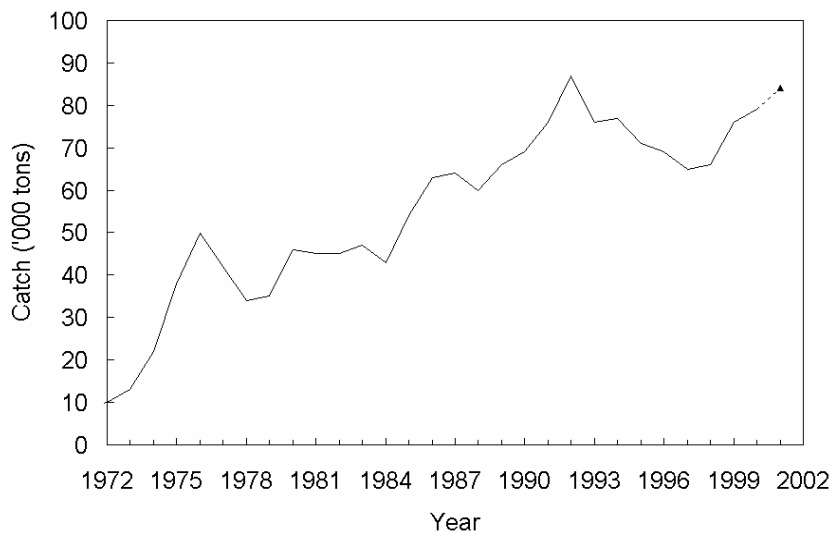


Fig. 3.1. Shrimp in Subareas 0 and 1: total catches (2001 projected to the end of the year).

Until 1988, the fishing grounds in Div. 1B have been the most important. Since then, a southward shift 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 distribution of the fishery has not changed since 1996.

The West Greenland inshore shrimp fishery was relatively stable from 1972 to 1987 with estimated catches of 7 000-8 000 tons annually (except for 10 000 tons in 1974). Inshore catches in recent years have increased to over 20 500 tons in 1992, but decreased to 9 500 tons in 1998. Since then catches increased again to 20 000 tons in 2000 and preliminary data for 2001 (January-October) suggest catches at the same level as in 2000. During the 1990s inshore catches have accounted for about 25% of the total catch in Subarea 1.

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 and from Greenland logbooks for Subarea 1 (SCR Doc. 01/173).

Standardized effort indicated a decrease in harvest rate of about 40% from 1992 to the late-1990s. For 2001, the indices indicate an increase in harvest rate as compared to the most recent years (Fig. 3.2).

A standardized catch rate (CPUE) index was presented (SCR Doc. 01/173). CPUE data from Greenland vessels >50 GRT fishing in Subarea 1 and Canadian vessels fishing in Div. 0A were used in multiplicative models to calculate annual catch rate indices. One unified time series covering 1976-2001 was calculated. 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 from 1990 to 2000 (Fig. 3.3). The projected 2001 value showed a decline compared to the value of the previous year.

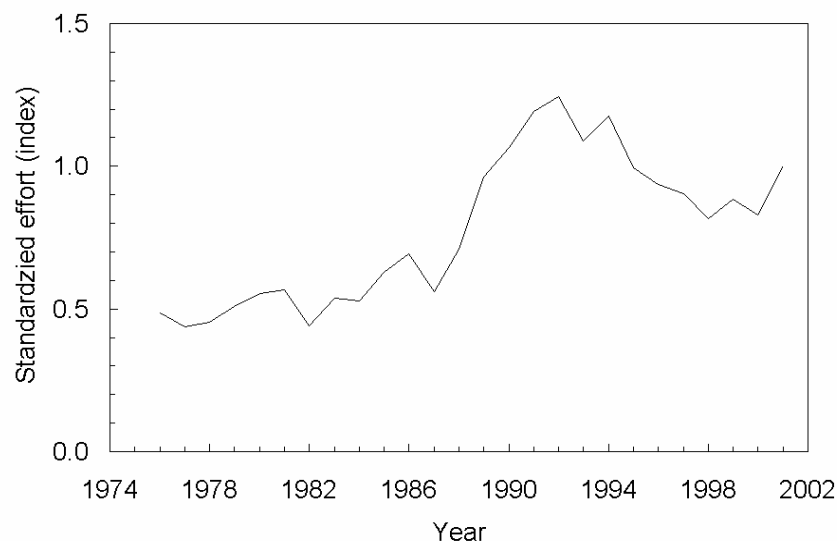


Fig. 3.2. Shrimp in Subareas 0 and 1: standardized effort index.

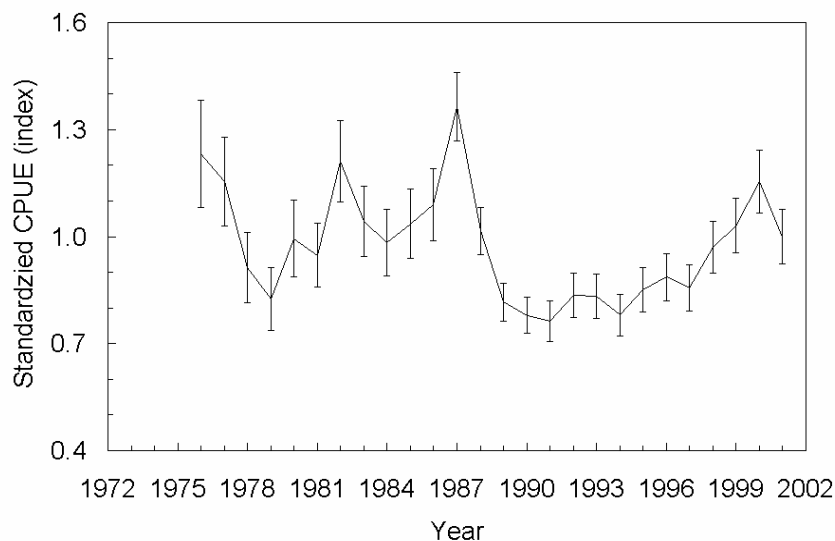


Fig. 3.3. Shrimp in Subareas 0 and 1: standardized CPUE index.

Catch composition. Length frequency data were obtained by observers in the commercial fishery in Div. 0A from 1981 to 2001, and in Subarea 1 from 1991 to 2001 (SCR Doc. 01/173). The proportion of males in the catch increased from 30-40% in 1991-92 to 64-66% between 1995-99. Overall, the proportions of female to male shrimp in the catches seem relatively stable since the mid-1990s. The length-frequency distribution of the 2001 catches shows a large peak of males around 20 mm CL.

ii) **Research survey data**

Greenland trawl survey. Stratified-random trawl surveys have been conducted since 1988 in offshore areas (Subarea 1 and Div. 0A) and since 1991 in inshore Subarea 1 (SCR Doc. 01/175). From 1993, the survey extended further south into Div. 1E and 1F.

The design of the survey and the analysis of the resulting data were reviewed in 1998 and 1999 and some changes were suggested. Subsequently the changes were implemented in the 1999 to 2001 surveys (SCR Doc. 01/176, 177).

The survey estimates of biomass ('000 tons) are as follows:

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Offshore (Div. 1A-1F, 0A)	183	181	182	122	178	223	231	170	195	154	232	226	266	266
Inshore (Div. 1A)	47 ¹	47 ¹	47 ¹	51	47	34	40	47	54	52	62	61	84	83
Total	230	228	228	173	225	257	271	217	249	206	293	287	350	349

¹ No inshore survey in 1988-90. 47 000 tons is the average of the biomass inshore from 1991-97.

Biomass. During the period of stratified random surveys in the offshore areas of shrimp distribution, the biomass estimates have indicated a good stability until 1998 around a level of 250 000 tons, except the somewhat lower values in 1991, 1995 and 1997 (SCR Doc. 01/175).

Since 1998 a significant increase was observed with record high biomass in 2000 and 2001 of around 350 000 tons. (Fig. 3.4).

Large variations from year to year both geographically and over depth zones are observed. Some areas account for a large proportion of the variances of the estimated biomasses. Overall, the biomass in 2001 had a fairly traditional distribution with high densities in Disko Bay and in the deeps between the shallow banks along the coast, especially in Sukkertoppen and Holsteinsborg Deeps (SCR Doc. 01/175, Fig. 1).

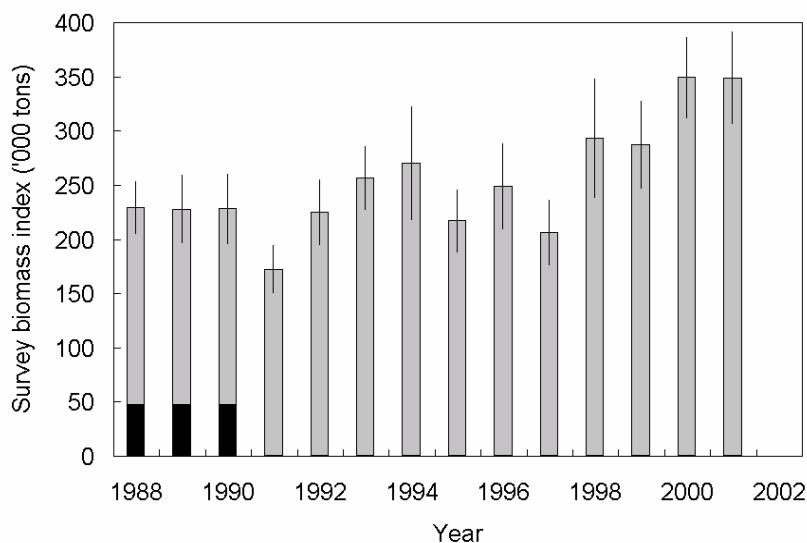


Fig. 3.4. Shrimp in Subareas 0 and 1: Survey estimates of biomass from inshore and offshore surveys, ± 1 standard error. 1988-90 includes an average of 47 000 tons for the inshore area.

Sex and length composition. Estimated total abundance ($\times 10^9$) of shrimp in the survey area (including both inshore and offshore areas) from 1988 to 2001 are as follows:

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

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.

Estimated total abundance of shrimp in 2001 was the second highest on record, considerably exceeding the long term average, while the proportion of males and females has not changed during the survey time series.

The overall length-frequency distributions in 2001 showed a number of distinct male modes (at 8, 13, 18 and 20.5 mm CL), a mode of primiparous females at 24.5 mm CL and one of multiparous females at 26 mm CL (Fig. 3.5). The presence of several male groups in 2001 is promising in terms of recruitment to the female group in coming years.

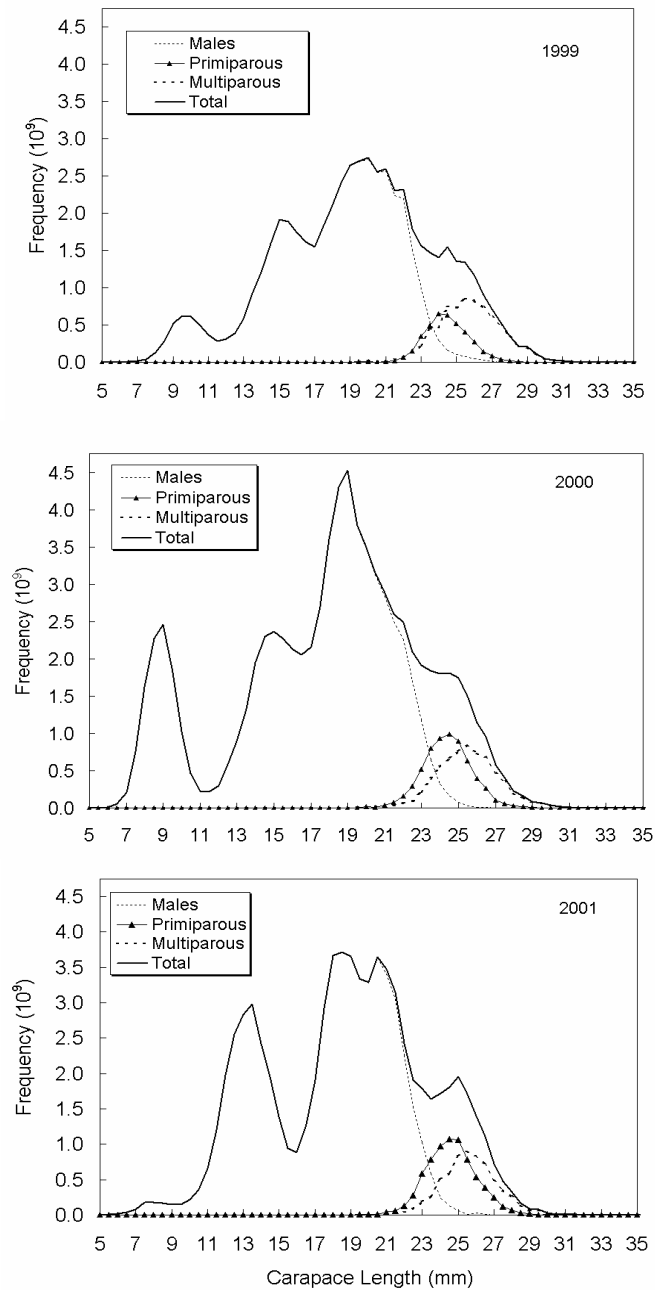


Fig. 3.5. Shrimp in Subareas 0 and 1: Numbers of shrimp by 0.5 mm CL length group in the total area during 1999-2001 (mesh size in the cod-end 20 mm stretched).

Index of recruitment. A recruitment index (shrimp <17 mm CL) shows an increasing trend from 1997 to 2000 (Fig. 3.6). The 2001 index for recruitment is the second highest in the time series since 1993.

Spawning stock biomass (SSB). SSB showed an increasing trend since 1997 and the value in 2001 is the highest observed in the time series since 1988 (Fig. 3.6).

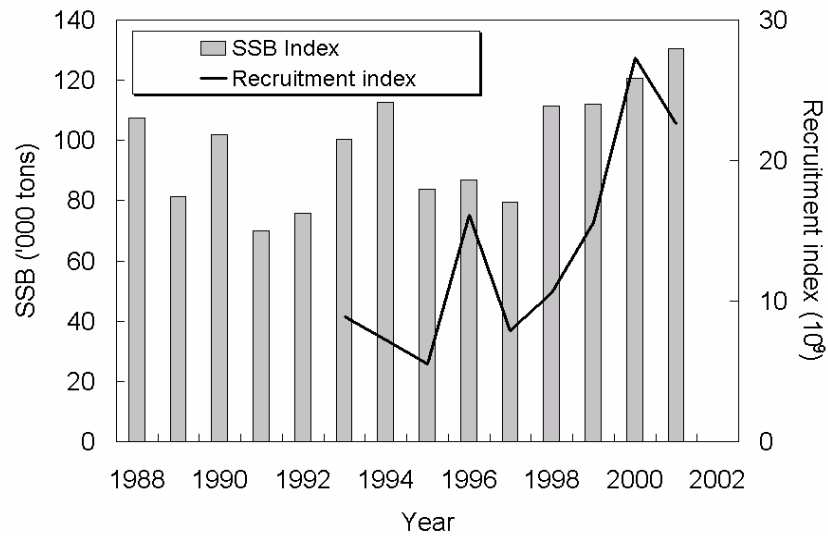


Fig. 3.6. Shrimp in Subareas 0 and 1: total female biomass index (inshore and offshore) and index of recruitment for 1993-2001 (shrimp <17 mm CL, mainly age 2).

Exploitation rate. An index of exploitation rate calculated as proportion of total catch to corresponding survey estimates of 'fishable biomass' (shrimp ≥17 mm CL) is presented in Fig. 3.7. The index of exploitation rate for total catch showed stability during the time series, except for the relatively high value in 1991 and 1992. The declining trend observed in the previous assessment is less clear, as this year's exploitation rate is based on the fishable stock only.



Fig. 3.7. Shrimp in Subareas 0 and 1: Index of exploitation rates 1988-2001 calculated as proportion of total catch to corresponding survey estimate of fishable biomass.

iii) **Alternative assessment approach**

The investigated results of a stock-dynamic modelling approach to shrimp stock assessments were presented to STACFIS (SCR Doc. 01/181). Non-age-structured models based on a quadratic stock-recruitment function, with and without an explicit term for cod predation, were used to describe shrimp stock dynamics. Biomass indices from the research survey and from standardized commercial CPUE series, catch, cod stock size estimates and prior estimates of model parameters provided information to the models. The model was solved using Bayesian methods in a state-space modelling framework with non-informative or weakly informative prior distributions for model parameters. The uncertainty and approximations associated with the model description of stock dynamics and the inevitable errors associated with the observed data series, i.e. 'process' and 'observation' errors, were incorporated simultaneously in the state-space formulation.

STACFIS reviewed the stock-dynamic modelling approach and found the method promising for future assessment. STACFIS encouraged further development.

iv) **Other studies**

A study on the end effect of the Skjervøy 3000 Trawl in the West Greenland Bottom Trawl Survey was presented (SCR Doc. 01/177). 'End effect' denotes additional fishing as a trawl descends and settles, and as it is hauled, outside the timed duration of a survey tow. It is expressed as a trawl-time equivalent. Trawl tows in the offshore part have over the last 3 years been shortened from a 60-minute standard to a mixture of 15 and 30 minutes; the average in 2001 was about 24 minutes. Trawl end effect may become significant when tows are shortened. Nine zero-length hauls associated with 30-minute survey stations made unexpectedly large catches and the end effect was estimated at up to 9 minutes; two others associated with a 15-minute tow made catches more in line with expectation and yielded an estimate of end effect of about 1.3 minutes before the tow would normally start. The chain of alternating-length tows yielded an estimate of the end effect of about 1.2 minutes. The mixed tow durations in the main surveys of 1999 and 2000 gave estimates of end effect of 2.7 minutes, but in 2001 the estimate from the main survey, excluding the experimental fishing, was -.5 minutes. Possible reasons for this include a rather clumped distribution of the shrimp biomass in some survey strata in 2001. The author was encouraged to conduct further work with the Skjervøy trawl, as well as other research surveys to undertake similar studies with a view to furnishing comparable estimates of the end effect for other gear and other species.

Annual geographical distribution and mean size of different life stages of northern shrimp (*Pandalus borealis*) off West Greenland was analyzed using data from a stratified random bottom trawl survey for the years 1993 to 2000 (SCR Doc. 01/178). Density of males and females varied considerably in the survey area but the distribution patterns were rather similar for both. Mean size of males, primiparous and multiparous females was significantly correlated with depth and, in the case of the males, also with bottom temperature. Geographical distribution of mean size varied substantially between years and areas with low mean size difference between males and females. The results indicated that small males occur first in several relatively small and isolated areas and extend over a wider region with increasing size and age.

The SCR Doc. 01/179 presented a study on precision and consistency of size measurements for northern shrimp (*Pandalus borealis*) in the West Greenland bottom trawl survey. Repeated measurements of individual shrimp and mixed samples of shrimp with a slide calliper showed that precise results are achievable. Trials with two experienced people demonstrated clearly that some comparative training and standardization of the measurement routine is essential in order to avoid bias and to ensure consistency.

c) **Assessment Results**

CPUE. The standardized CPUE series showed an increasing trend from 1990 to 2000. The provisional 2001 value shows a decline compared to the value of the previous year.

Recruitment. The recruitment index (shrimp less than 17 mm CL) showed an increasing trend from 1997 to 2000. The 2001 index for recruitment is the second highest in the time series. The very strong male group at 13 mm CL (2 year old) is not expected to significantly influence the catch in 2002.

SSB. SSB (female biomass) showed an increasing trend since 1997 and the value in 2001 is the highest observed in the time series since 1988.

Exploitation rate. An index of exploitation rate (ratio of catch to survey fishable biomass) showed no trend in recent years.

State of the Stock. STACFIS is not able to provide estimates of absolute stock size. The indices of stock size show that both the recruitment and SSB estimates in 2001 are among the highest observed. In addition the stock appears to be well represented by a broad range of size groups.

d) **Research Recommendations**

For shrimp in Div. 0A and Subarea 1, STACFIS **recommended** that:

- *an analysis of the length-frequency data of shrimp be conducted in order to obtain the age composition.*
- *the effect of recent changes in survey design and execution be further studied.*
- *the assessment approach using Bayesian methods be studied further.*

4. **Northern Shrimp (*Pandalus borealis*) in Denmark Strait and off East Greenland** (SCR Doc. 01/174, 01/180)

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 Stredbank 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 36 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.

Total catches increased rapidly to about 12 000 tons in 1987 and 1988, but declined thereafter to about 7 500 tons in 1992 and 1993. Following the extension of the fishery south of 65°N, catches increased again to about 11 500 tons in 1997. Catches in recent years have been about 9 500 tons (Fig. 4.1).

Catches in the northern area decreased from 6 100 tons in 1993 to about 3 000 tons in 1996, but increased again to about 4 000-4 500 tons in 1997 and 1998. In the most recent years catches from this area have been around 3 500-4 000 tons. Catches in the southern area increased from 1 500 tons in 1993 to about 7 500 tons in 1997, decreased to 4 800 tons in 1998 and then increased again to about 6 000 tons in the recent years.

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

	1991	1992	1993	1994	1995	1996	1997	1998	1999 ¹	2000 ¹	2001 ²
North of 65°N											
Greenland EEZ	8 192	5 764	3 563	3 359	4 823	2 351	1 300	3 115	3 223	3 404	2746
Iceland EEZ	465	1 750	2 553	1 514	1 151	566	2 856	1 421	769	132	10
Sub-total	8 657	7 514	6 116	4 873	5 974	2 917	4 156	4 536	3 992	3 536	2 756
South of 65°N											
Greenland EEZ	-	-	1 532	4 939	3 532	6 796	7 433	4 785	5 475	6 058	5 707
Total	8 657	7 514	7 648	9 812	9 506	9 713	11 589	9 321	9 467	9 594	8 464
Recommended TAC	10 000	8 000	5 000	5 000	5 000	5 000	5 000	5 000	9 600	9 600	9 600

¹ Provisional catches as estimated by STACFIS.

² Catches 1 January to 1 November 2001.

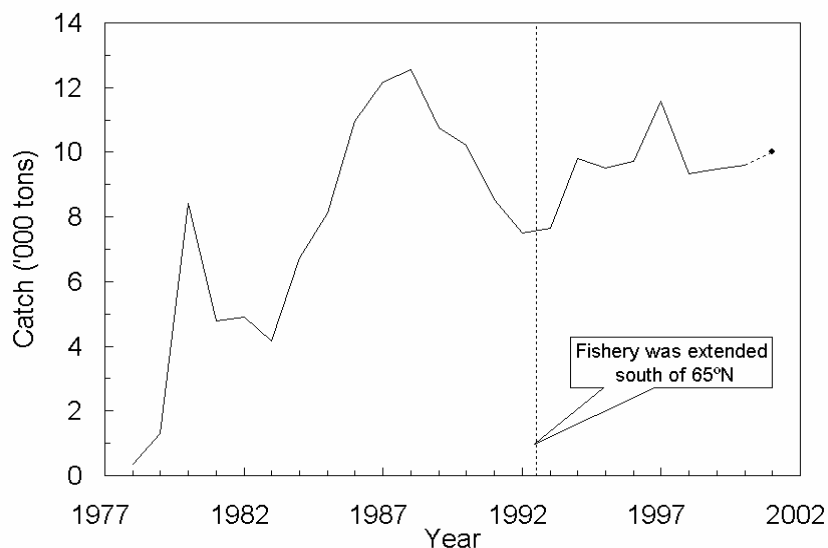


Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: total catches (2001 projected to the end of the year based on data until November).

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, increasing again,

irregularly, to a peak in 1998 that was close to the 1987 value; subsequent values have been lower (Fig. 4.2). A standardized catch-rate series for the same fleets (Iceland excluded) in the southern area also showed an increasing trend from 1993 (Fig. 4.3), to a peak in 1999. STACFIS noted that whereas the 2000 analysis, including only partial data for that year, showed southern-area standardized CPUE increasing from 1999 to 2000, the 2001 analysis showed a decrease from 1999 to 2000, and a further decrease to the value for 2001. A combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993 and increased again in the subsequent years to a peak in 1999 and 2000 equaling the historic high value at which the series started in 1987. However, the preliminary estimate for 2001 based on partial data for the year is down slightly (Fig. 4.4).

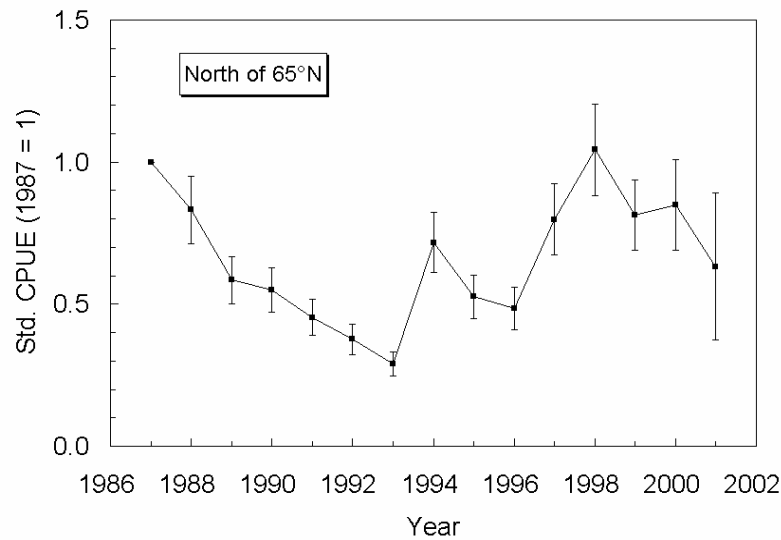


Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ± 1 standard error calculated from logbook data from Danish, Faroese, Greenlandic and Icelandic vessels fishing north of 65°N.

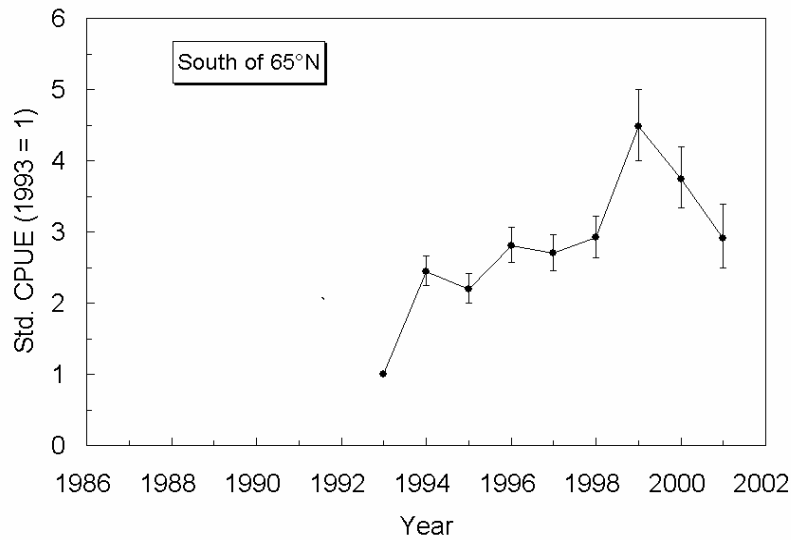


Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ± 1 standard error calculated from logbook data from Danish, Faroese and Greenlandic vessels fishing south of 65°N.

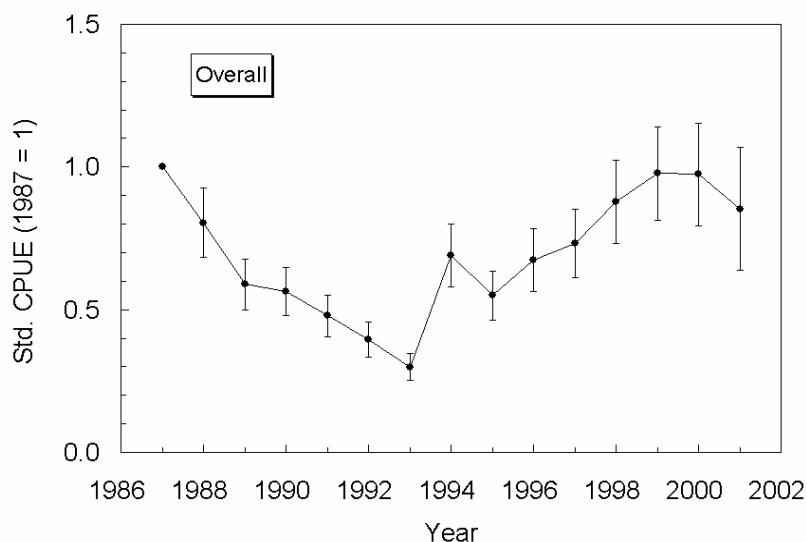


Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ± 1 standard error combined for the total area.

An index of exploitation rate (catch divided by standardized CPUE) for the total area decreased from 1993 to 1994, remained stable until 1997 and then declined further; recent levels are the lowest of the time series (Fig. 4.5).

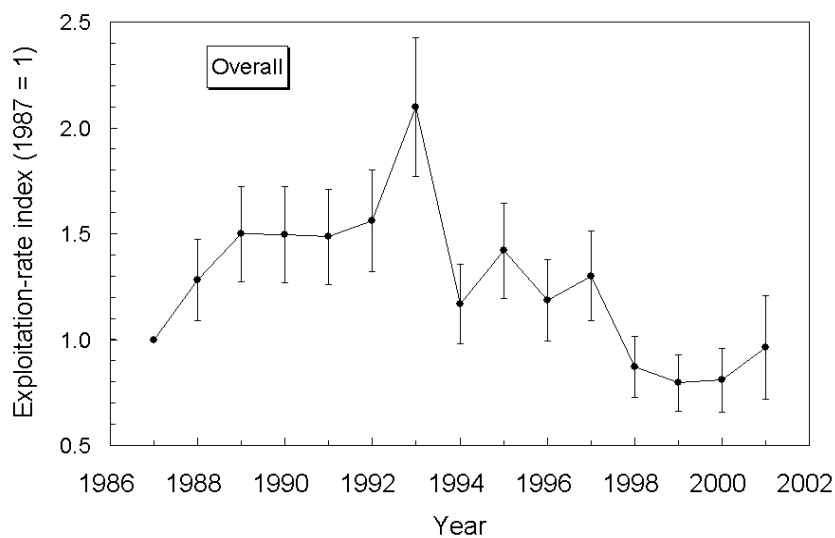


Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized exploitation rate indices (1987 = 1) with ± 1 standard error combined for the total area.

Biological data. About 1% of all hauls taken were sampled for obtaining annual estimates of size and sex composition. The results agree with information from logbooks on landings by product class and with anecdotal information from the industry. Catches from all years consisted of relatively large shrimp with mean carapace length (CL) >25 mm. For the total area several year-classes of male and female shrimp were evident in sampling data in recent years, and the male component has been well represented at CLs between 17 and 27 mm. Shrimp smaller than 17 mm CL have always been less

than 1‰ by number, so recruitment to the fishery can not be predicted. Samples from the fishery in the northern area indicated that the catches in the late-1980s and the 1990s were dominated by females, but that males were more abundant in 2000. No samples were taken from the northern area in 2001, but anecdotal information suggested that catches were again dominated by females. Samples from the fishery in the southern area showed a numerical dominance of males in most years, except for 1994, when females were more numerous. Compared with the most recent years an increase in the average size caught was indicated for 2001.

ii) **Research survey data**

No surveys have been conducted since 1996. Therefore, in particular, there is no direct estimate of biomass and no information on prerecruits.

iii) **Other studies**

A GLM model was used to analyze the variation in CL of northern shrimp taken in the east Greenland commercial fishery (SCR Doc. 01/180). The variables considered were year (1999–2000), latitude (north or south of 65°), sex, season, and the group of people doing the measuring: biological assistants of the Greenland Institute of Natural Resources (GN) or on-board observers. Shrimp recruited to the fishery at the same CL whether north or south of 65°, but changed sex at greater length in the northern area; there were also more females in the catch in the north, so the overall mean CL was about 4 mm greater. CL averaged about 1 mm more in 2001 than in 1999 or 2000. The mean CLs measured by the GN assistants were not different from those measured by the on-board observers.

c) **Assessment Results**

Commercial CPUE. Combined standardized CPUE indices for the total area declined from 1987 to 1993 and increased thereafter back to approximately the same level in 1999–2000 as in 1987. However, the preliminary estimate for 2001 based on partial data for the year is down slightly.

Recruitment. No recruitment estimates were available.

Biomass. No direct biomass estimates were available.

Exploitation rate. From 1998 through 2001 an exploitation rate index (catch/CPUE) has been at its lowest levels in the 15-year series.

State of the stock. STACFIS is 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 to a peak in 1999 and 2000 equaling the historic high value at which the series started in 1987. The preliminary estimate of standardized CPUE for 2001 may suggest a small decrease. Several year-classes of male and female shrimp are evident in the sampling data in all recent years.

d) **Research Recommendations**

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

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

IV. OTHER BUSINESS

1. Designated Experts

In its review of the status of Designated Experts with respect to assessment of shrimp stocks, STACFIS was informed that D. M. Carlsson (Denmark/Greenland) would no longer be responsible for shrimp in Denmark Strait. STACFIS noted D. Carlsson's service of more than 25 years as a scientist in NAFO circles, and lately as a Designated Expert to the Committee. STACFIS extended its sincere appreciation for his long-standing and dedicated work. The Committee welcomed:

- From Greenland Institute of Natural Resources, P. O. Box 570, DK-3900 Nuuk, Greenland [Phone: +299 32 1095 – Fax: +299 32 5957 – E-mail: hvingel@natur.gl]

for Northern shrimp in Denmark Strait and off East Greenland

C. Hvingel

2. Adjournment

There being no other business, the Chairman expressed his gratitude to the members of the Committee for their valuable contributions, especially from the Designated Experts and encouraged them to continue the work on ageing of shrimp, and to the Secretariat for the excellent support in any respect, and adjourned the meeting.

