PART C

Scientific Council Meeting, 6-13 November 2002

CONTENTS

Participants, Scientific Council Meeting, 6-13 November 2002 at Greenland Institute of Natural Resources, Nuuk, Greenland

Back (left to right): H. Siegstad, D. C. A. Auby, W. B. Brodie, S. Bakanev, P. Kanneworff, Á. Nicolajsen, T. Amaratunga, K. Wieland

Front: D. E. Stansbury, D. C. Orr, U. Skuládóttir, C. Hvingel, R. K. Mayo

Participants at work

1. Old biological station
2. Klaus Nygaard's presentation to participants.
3. New building of Institute
4. View of harbour and Saddle Mountain.
5. Helle Siegstad in her boat.
6. Greenland Institute of Natural Resources
7. Fjord outing to see whales and icebergs (C. Hvingel's Boat in view).

REPORT OF SCIENTIFIC COUNCIL MEETING

6-13 November 2002

Chair: R. K. Mayo Rapporteur: T. Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at Greenland Institute of Natural Resources, Nuuk, Greenland, during 6-13 November 2002. 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 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 6 November 2002

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 Assistant Executive Secretary was appointed rapporteur.

The session was adjourned at 1100 hours.

The Council welcomed STACFIS to conduct its business through 6-11 November 2002, noting most of the Council's work would be addressed through 11-13 November 2002.

The concluding session was convened at 0900 hours on 13 November 2002. 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 6-13 November 2002.

The meeting was adjourned at 1810 hours on 13 November 2002.

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 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 Chair, 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** endorsed by the Council are as follows:

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

   - *work on age structured population models should be continued.*

   - *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted in advance of the 2003 Scientific Council Meeting on shrimp .*

   - *a thorough investigation into the methods used to derive a CPUE index for shrimp be conducted and submitted in advance of the 2003 Scientific Council Meeting on shrimp.*

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

   - *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted in advance of the 2003 Scientific Council Meeting on shrimp.*

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

   - *sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established.*

   - *annual length-weight relationships be constructed as routine part of survey analyses.*

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.*

   - *sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established.*

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:

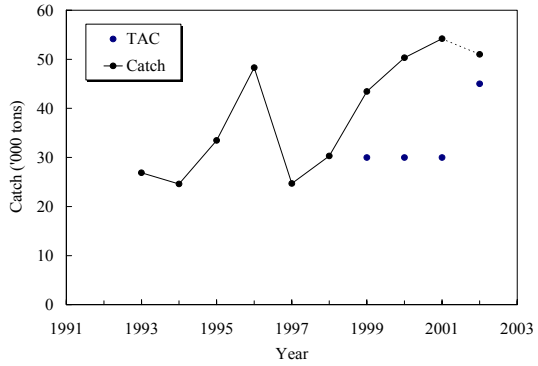
Northern shrimp (Pandalus borealis) in Division 3M

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 46-110, and in 2002 there were approximately 40 vessels fishing shrimp in Div. 3M.

Fishery and catches: Total catches were approximately 27 000 tons in 1993, increased to 48 000 tons in 1996 and declined to 25 000 tons in 1997 and thereafter increased to 54 000 tons in 2001.

	Catch ('000 tons)		TAC ('000 tons)	
Year	STACFIS	21A	Recommended	Agreed
1999	43	42	30	er
2000	50	49[1]	30	er
2001	54	39[1]	30	er
2002	51[2]	38[1]	45	er

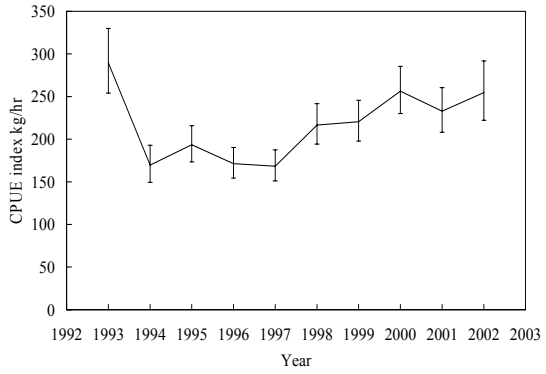
[1] Provisional.
[2] Projected to end of 2002.
er Effort regulations.



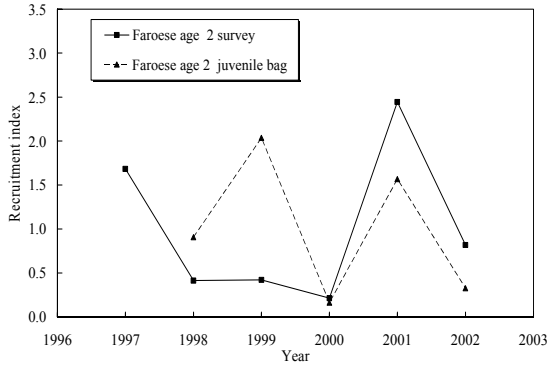
Data: Catch, effort and biological sampling data were available from several Contracting Parties. A standardized CPUE index was developed to account for changes in gear (single, double and triple trawl), fishing power and seasonality. Time series of size and sex composition data were available from three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

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.

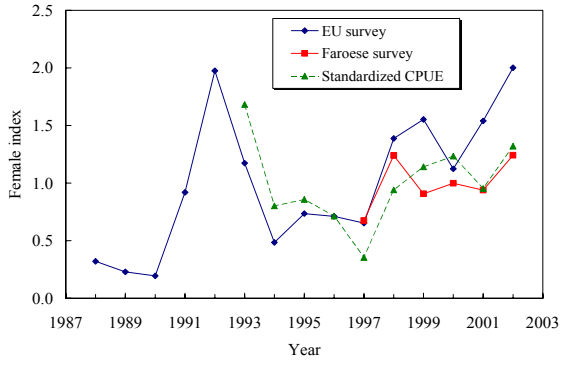
CPUE: Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, and increased to 2000 and remained stable thereafter.



Recruitment: The 1997 and 1999 year-classes are above average, while the 1998 and 2000 year-classes appear weak.



SSB: Indices of female biomass increased between 1997 and 1998 and fluctuated without a trend thereafter.



State of the Stock: Scientific Council is unable to estimate absolute stock size. Stock size indicators have been fluctuating without a trend since 1998 at a higher level compared to 1994-97. The 1997 year-

class was above average in 2002, but its contribution to the fishery will diminish after 2003. The 1999 year-class is above average and will be contributing to the fishery in 2003 and 2004. However the 1998 and 2000 year-classes appear 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. Considering the strength of the 1997 year-class and the re-evaluation of the strength of the 1999 year-class in the current assessment to above average and that the 1999 year-class is expected to be the main contributor to the catch biomass in 2003 and 2004, the Scientific Council advises a catch of 45 000 tons for 2003 and 2004. Advice for the 2004 fishery will be reviewed at the September 2003 Scientific Council Meeting, when results from the 2003 summer surveys will be available.

Sources of Information: SCR Doc. 02/142, 149, 150, 155, 156, 159, 161, 163.

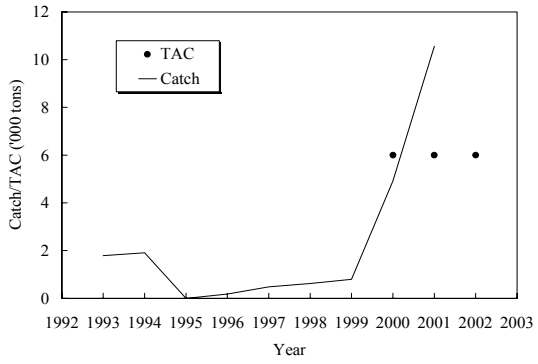
Northern shrimp (Pandalus borealis) in Divisions 3L, 3N and 3O

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: Eight nations participated in the fishery in 2002. Canadian vessels took most of the catches in 2000 and approximately half the catch in 2001. There was insufficient data to determine catches in 2002. 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
1999	1	1	-	-
2000	5	5[1]	6	6
2001	11	5[1]	6	6
2002	na	na	6	6

[1] Provisional.
na Not available.



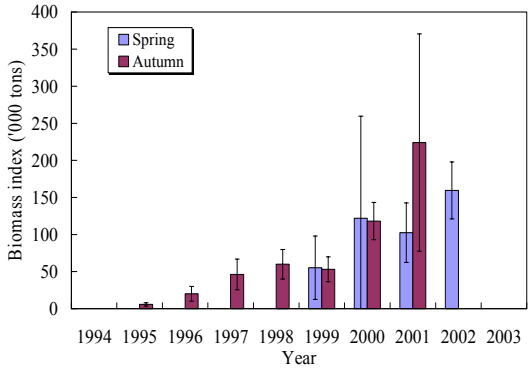
Data: Catch, effort and biological sampling data were available from Canadian vessels and from other Contracting Parties. Biomass and recruitment indices, and size and sex composition data were available from research surveys conducted in Div. 3LNO during spring (1999 to 2002) and autumn (1995 to 2001). Spanish survey data were available for the Div. 3NO NRA for the period 1995 – 2002.

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 1998 and 1999 year-classes are the two largest year-classes in the short time series.

Exploitation: No estimates of fishing mortality were available. An exploitation index was around 2-3% in 1998-99 and increased to 11-13% in 2000-2001.

Biomass: There was a significant increase in total biomass between 1995 and 1997, a period of stability between 1997 and 1999 and a significant increase thereafter.



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 have increased significantly since 1999 and at present are the highest observed. In addition the stock appears to be well represented by a broad range of size groups, and exploitation is low.

Recommendation: In 1999, Scientific Council advised 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 noted that in the adjacent shrimp stock to the north (Div. 3K to southern Div. 2J) the ratio of the TAC to the lower 95% confidence interval of the autumn survey biomass, in the previous year, was about 15%. This was the basis for determining a TAC of 6 000 tons for Div. 3LNO, which has been in place for the years 2000-2002.

For the Div. 3K to southern Div. 2J stock, the ratio of TAC to lower 95% confidence interval on biomass has remained around 11-15%, and there was a steady increase in biomass and TACs during the late-1990s. Scientific Council noted that there have been significant increases in biomass and recruitment in the Div. 3LNO stock since 1999. Applying a 15% exploitation rate to the lower 95% confidence interval of the biomass estimates, averaged over the last four surveys (autumn 2000-2001, spring 2001-2002), results in a catch of about 13 000 tons. Scientific Council considered that this was a prudent approach to advising an increased TAC, and therefore recommends that the TAC for

about 13 000 tons. Scientific Council considered that this was a prudent approach to advising an increased TAC, and therefore recommends that the TAC for shrimp in Div. 3LNO in 2003 and 2004 should not exceed 13 000 tons.

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 the 2004 fishery will be reviewed at the September 2003 Scientific Council Meeting, when results from the 2002 autumn survey will be available.

Sources of Information: SCR Doc. 02/143, 153, 159, 160.

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

The Scientific Council noted the Fisheries Commission at its meeting in September 2002 made a special request with respect to Shrimp in Divisions 3LNO: "*at a meeting in advance of the 2003 Annual Meeting to consider options available for the provision of annual advice as regards shrimp in Div. 3LNO and 3M in advance of the Annual Meetings*".

The Council's response to this issue is reported under Section III.3. below.

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:

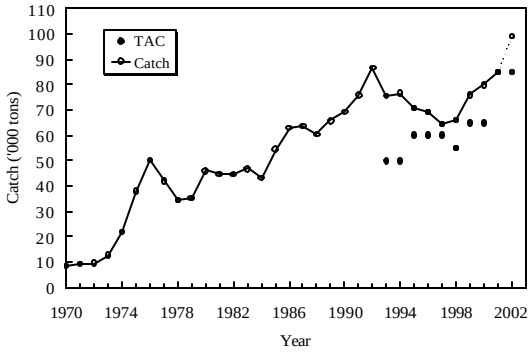
Northern shrimp (Pandalus borealis) in Subareas 0 and 1

Background: A small-scale inshore fishery began in SA 1 during the 1930s. Since 1969 an offshore fishery has developed 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:

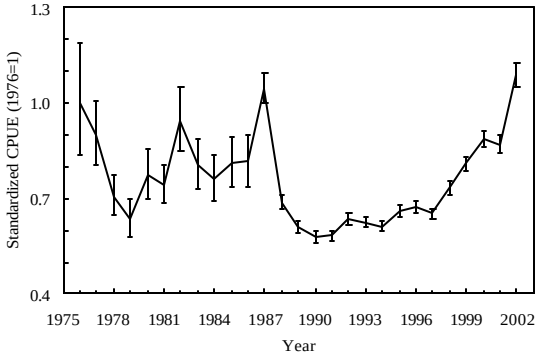
	Catch ('000 tons)		TAC ('000 tons)	
Year	STACFIS	21A	Recommended	Autonomous
1999	76.0	76.0	65.0	80.3
2000	79.9	79.9[1]	65.0	80.3
2001	85.0	85.0[1]	85.0	91.3
2002	99.0[2]		85.0	103.2

[1] Provisional.
[2] Projected to the end of 2002.

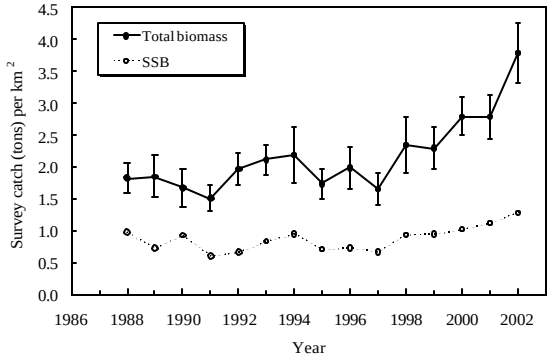


Data: Catch and effort data were available from all vessels. Biological sampling data were available from the offshore fishery. Time series of biomass and recruitment indices, size and sex composition data were available from research surveys. Series of cod biomass and cod consumption data were available.

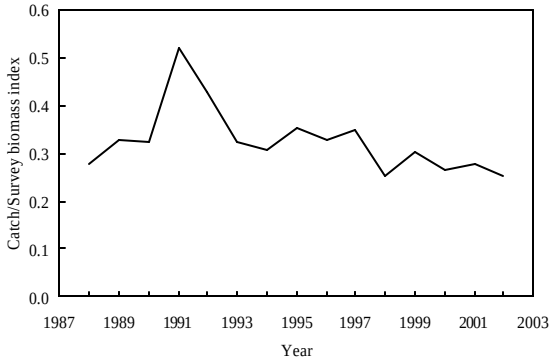
Indicators of biomass: The standardized CPUE series showed an increasing trend since 1990. The 2002 value is the highest of the time series.



The survey total biomass and SSB indices (female biomass) showed an increasing trend since 1997. For both indices the 2002 value is the highest of the series.

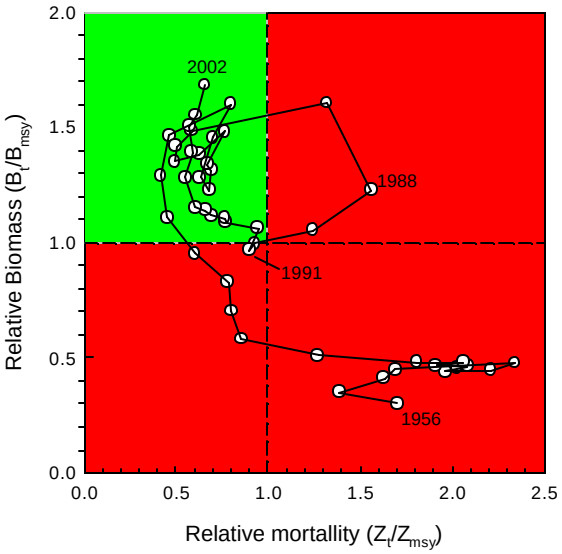


Exploitation rate: Indices of exploitation rate have shown a decline since the early-1990s.

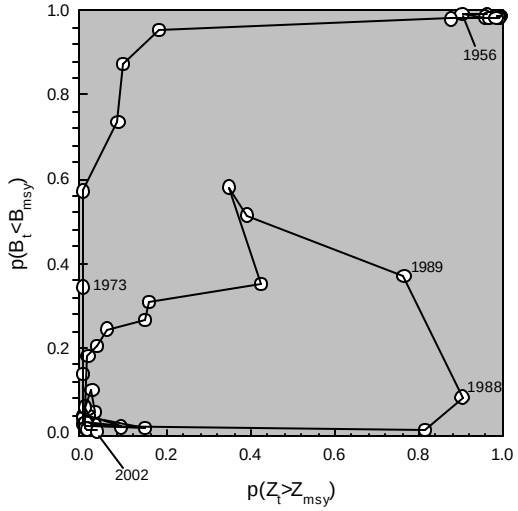


Assessment: An analytical assessment framework using a stochastic version of a surplus-production model that included an explicit term for predation by cod (*Gadus morhua*) was applied for the first time in 2002.

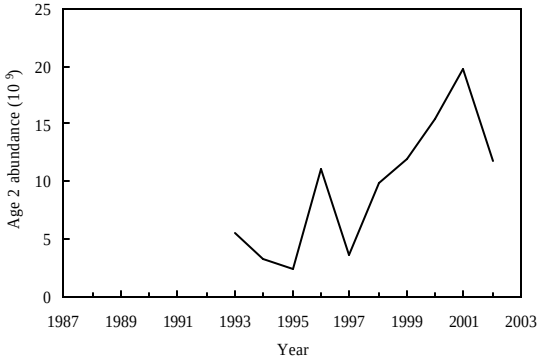
Mortality: The mortality caused by fishing and cod predation (Z) has been below the upper limit reference (Z_{msy}) for most of the time since 1970. Since 1997 mortality has been stable well below Z_{msy}. The estimated risk of current mortality being above Z_{msy} was less than 5%.



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 2002. The estimated risk of current stock biomass being below B_{msy} was less than 1%.



Recruitment: A recruitment index (age 2) showed an increasing trend from 1997 to 2001. The 2002 value is above 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 2002. Biomass is well above B_{msy} and mortality by fishery and cod predation is well below Z_{msy}. In addition a large 1999 year-class is expected to contribute to the fishery in 2003.

Recommendations: If catches exceed 100 000 tons in 2003, there is a greater than 10% risk of exceeding a mortality that is considered to be a limit reference point. Scientific Council therefore recommends that total catch of shrimp in Div. 0A and SA 1 in 2003 should not exceed 100 000 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 period is low.

Risk associated with five optional catch levels for 2003 are as follows:

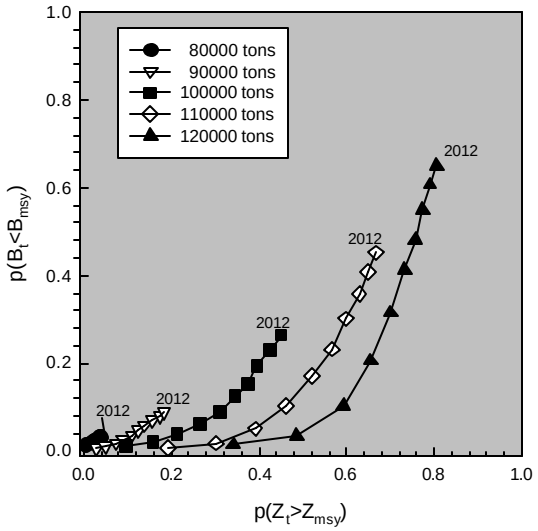
Catch option ('000 tons)	80	90	100	110	120
Risk of falling below B_{msy}	<1%	<1%	<1%	<1%	1%
Risk of exceeding Z_{msy}	1%	3%	10%	20%	34%

Medium Term Considerations: Ten-year projections of stock development were made using the assumption that the cod stock will remain at its low 2002 abundance. Five levels of annual catch: 80 000, 90 000, 100 000, 110 000 and 120 000 tons were investigated.

Catches less than or equal to 90 000 tons/yr will have a high probability of keeping biomass above B_{msy}, and there is a high probability that mortality will remain below the limit reference point.

With a catch of 100 000 tons/yr there is less than 10% risk of stock biomass falling below B_{msy} in the first five 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 110 000 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: 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. 02/144, 145, 146, 148, 151, 157, 158.

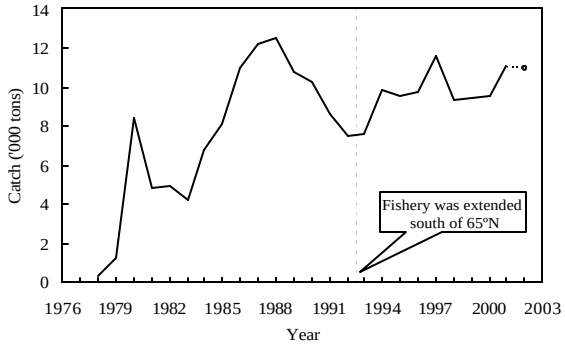
Northern shrimp (Pandalus borealis) in Denmark Strait and off East Greenland

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 2002. Recent catches and recommended TACs are as follows:

	Catch ('000 tons)		TAC ('000 tons)	
Year	STACFIS	21A	Recommended	Agreed
1999	4.0	5.5	9.5	9.6
2000	3.5	6.1	9.6[1]	9.6
2001	1.8	9.3	11.0[1]	9.6
2002			11.0[2]	9.6

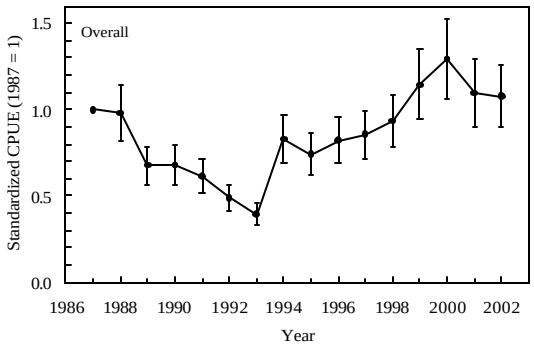
[1] Provisional catches.
[2] Projected to the end of 2002.



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

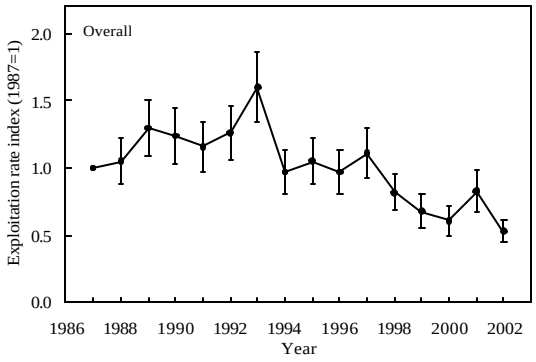
Assessment: No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data and biological data.

CPUE: Combined standardized CPUE indices for the total area declined from 1987 to 1993 and increased thereafter to approximately the same level in 2001–2002 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 2002 an exploitation rate index (catch/CPUE) has been at its lowest levels in the 16-year series.

State of the Stock: Scientific Council 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 2001 and 2002 values equal the relative high values of 1987 when the series started.

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 after 1999. Scientific Council therefore advises that catches of shrimp in Denmark Strait and off East Greenland should not exceed 9 600 tons in 2003.

Sources of Information: SCR Doc. 02/147, 154.

3. Formulation of Advice Under a Precautionary Approach Framework

a) Workshop on the Precautionary Approach

The Council reviewed the Terms of Reference developed for the Spring 2003 Workshop on the Precautionary Approach, during its September 2002 Meeting. Noting the progress made with respect to the Precautionary Approach on Shrimp in Subareas 0 and 1 during this Meeting, the Council encouraged shrimp experts to participate in the Spring 2003 Workshop.

b) Methodology for Determining a TAC for Divisions 3LNO Shrimp

Scientific Council discussed several approaches for determining the basis for calculating the TAC for Div. 3LNO shrimp. The initial TAC of 6 000 tons recommended for 2000 was calculated in September 1999 and was based on applying a relative exploitation rate of 15% to the lower 95% confidence interval of the biomass estimate from the autumn 1998 bottom trawl survey conducted in Div. 3LNO. The rationale for this calculation was given as follows (*NAFO Sci. Coun. Rep*., 1999, page 214):

> *It was noted that in the adjacent area immediately north of Div. 3L (southern Div. 2J+3K), the ratio of TAC to the lower 95% CI of the survey biomass is about 15%. The surveys in Div. 2J+3K are at the same time of year and with the same gear as Div. 3L. Applying a similar relative exploitation rate to the lower 95% CI of the 1998 survey biomass estimate in Div. 3L would translate into a catch of about 6 000 tons. Scientific Council* ***recommended*** *that if there is a shrimp 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 addition, Scientific Council* ***recommended*** *that fishing effort be distributed proportional to the distribution of biomass.*

In November 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*". Scientific Council had advised that the catch be no more than 6 000 tons for 2000 and 2001. In November 2001, Scientific Council also advised a catch of no more than 6 000 tons for 2002. Noting that all current indices of stock size and recruitment are favorable, Scientific Council also acknowledged that the fishery had existed for only 2 years and the effect on the stock of the 2001 fishery could not be evaluated at that time.

Given the increases in biomass indices noted between 1998-1999 and 2000-2002 in the current assessment, Scientific Council reconsidered the basis for determining the TAC for this stock. Several approaches in addition to the existing method were considered including: increasing the relative exploitation rate from 15% to 30%, changing the basis from the lower 95% confidence interval to the mean biomass estimate, and deriving a TAC by direct comparison of shrimp biomass between Div. 3LNO and Div. 2J+3K or between Div. 3LNO and Div. 3M.

Although these proposed modifications were considered as possible alternatives, Scientific Council noted that application of the existing approach to the Div. 2J+3K fishery has resulted in continued increases in biomass and corresponding increases in the TAC and yield. On biological grounds, Scientific Council considered it appropriate to maintain consistent harvest strategies in Div. 2J+3K and Div. 3LNO shrimp fisheries on the basis that the linkages between shrimp stocks in these two areas are still uncertain. Further, direct comparison of biomass estimates between Div. 3LNO and Div. 3M may be problematic because the surveys in Div. 3LNO and Div. 3M are conducted in different seasons with different gear. Therefore, Scientific Council agreed to continue the existing approach until the impact of the fishery on the Div. 3LNO shrimp stock can be further evaluated.

To determine the 2003 TAC, Scientific Council applied the following rationale. As there has been a significant increase in biomass since 1999, it would be appropriate to consider only surveys conducted after 1999. Excluding the spring 2000 survey, which had a lower confidence interval less than zero, the average of the lower 95% of the confidence intervals in the remaining 4 surveys (spring 2001-2002, autumn 2000-2001) is 88 500 tons. Fifteen percent of this value is 13 300 tons.

4. **Timing Issues Relative to Advice for Division 3M and Divisions 3LNO Shrimp Stocks**

Scientific Council discussed its schedule of meetings for the assessment of shrimp stocks in Div. 3M and 3LNO. At present, assessments of these stocks, as well as those in Subareas 0 and 1 and in Denmark Strait and off East Greenland, are conducted at a mid-November meeting. Scientific Council provides advice for shrimp stocks in Div. 3M and 3LNO to the Fisheries Commission at the following Annual Meeting, and the advice is for the subsequent year. At the September 2002 Annual Meeting Fisheries Commission requested Scientific Council "*at a meeting in advance of the 2003 Annual Meeting to consider options available for the provision of annual advice as regards shrimp in Div. 3LNO and 3M in advance of the Annual Meetings*".

Issues with respect to timing of management advice: From a scientific perspective, there are a number of issues that affect the timing of the shrimp assessments:

a) **Availability of data for assessments completed in November**: Generally the current year catch and sampling data available in November are adequate to extrapolate to the full year. There are some problems if fishing effort is higher than expected in November-December. Usually current-year surveys have been completed in time for inclusion in November assessments, although that is not the case for shrimp in Div. 3LNO, where the major annual survey is not completed until after the November meeting.

b) **Appropriate peer review**: A good complement of experts on shrimp assessment, are required. Scientific Council had previously concluded that it was beneficial to conduct all its shrimp stock assessments during one meeting, where all or most of the shrimp scientists could attend.

c) **Timing of the advice relative to the year in which the advice applies**: For the Fisheries Commission managed shrimp stocks, this has ranged from provision of current year advice, to providing advice for the next year and to providing advice for the year after the next. For a short-lived species such as shrimp, there would seem to be merit in providing advice as close as possible to the year in which the advice is applied.

From a management perspective, the key issue is the timeliness of Scientific Council advice based on the most recent information. For the Fisheries Commission managed stocks (Div. 3M and Div. 3LNO), this means having advice available at the September Annual Meeting. So clearly the November assessment of these stocks is not appropriate in terms of timing. Although Fisheries Commission held mid-term meetings in 2000 and 2002 in which they dealt with shrimp advice, the circumstances were exceptional, and Fisheries Commission has currently decided to deal with the November 2002 advice by mail vote, rather than convening a meeting. Point c) above is relevant in this case, i.e. it would seem harder to manage stocks if scientific advice is dated and the stock dynamics have changed in the interim.

Scientific Council considered several options to address the delay between the completion of the assessment and the delivery of advice to Fisheries Commission, including: 1) moving the November meeting to September, 2) holding a separate meeting for the Subarea 3 stocks and one for the stocks in Subareas 0 and 1 and in Denmark Strait and off East Greenland, and 3) providing for a second review and update of advice for the Subarea 3 stocks taking into account survey information that became available after the completion of the assessments.

Taking the above into account, Scientific Council considers it extremely important that the integrity of the peer review process be maintained by keeping the current practice of reviewing all shrimp stocks at a single meeting of experts in shrimp biology and assessment methods. Therefore, any revision to the meeting schedule must preserve the existing meeting structure where primary assessments are conducted and reviewed.

Taking into account the availability of commercial catch and biological sampling data, and the timing of various research vessel surveys, Scientific Council again concluded that the primary assessment meeting could not occur before the last week of October. Therefore, the option to move the meeting to September was rejected.

The third option above, however, preserves the integrity of the peer review process and provides for more timely advice based on the most recent survey data. Therefore, Scientific Council proposes the following assessment schedule for the shrimp stocks in Div. 3M and 3LNO:

i) Full assessments will be conducted and reviewed in late-October or early-November and Scientific Council will provide advice for the year following the next Annual Meeting.

ii) Scientific Council will then review advice in September of the following year prior to the Fisheries Commission meeting. Advice may be revised if additional information from research vessel surveys indicates a significant change in stock status compared to the original assessment.

The following timetable illustrates the above process:

For Northern shrimp in Div. 3M and 3LNO

Late October-early November 2003: Stock status determined through 2003 and advice provided for 2005.

September 2004: Advice for 2005 reviewed and revised if appropriate.

IV. OTHER MATTERS

1. Coordination with ICES Working Groups on Shrimp Stock Assessments

At its November 2001 meeting, Scientific Council noted that a proposal may be forwarded from ICES to conduct assessments of ICES shrimp stocks under the auspices of a joint NAFO/ICES Working Group. Since then no formal proposals were received and the issue was not addressed further. Scientific Council considers cooperation with ICES on matters of mutual scientific interest extremely important and, joint review of assessments of shrimp stocks in the Northwest and Northeast Atlantic mutually beneficial.

However, several logistical issues must be resolved before any proposal can be developed. The timing of data availability and provision of advice differ between NAFO and ICES. Scientific Council must provide advice to the NAFO Fisheries Commission at the September Annual Meeting for 2 stocks in Subarea 3 and to Coastal State Contracting Parties before the beginning of the calendar year for two stocks off Greenland. Within ICES, ACFM develops advice for North Sea and Skagerrak and Barents Sea shrimp stocks at an October meeting to be provided to ICES customers in December.

Scientific Council has determined that its primary shrimp assessment meeting shall take place in either late-October or early-November, with a review of advice for the two Subarea 3 stocks in the following September, just prior to the Fisheries Commission meeting. Communications with the ICES Secretariat indicates that the timing of a late-October/early-November meeting can be accommodated by ICES so that advice for the ICES stocks may be offered to customers on schedule.

2. Scientific Council Meeting on Northern Shrimp, 2003

The Council, noting its discussions with respect to possibly including the review of stocks from the ICES area (see Section IV.1), agreed to provisional dates of Monday 27 October 2003 to Friday 7 November 2003. This provides for additional time that may be needed if ICES stocks are considered.

The Council agreed to reconsider these dates at its June 2003 Meeting, should there be more information available from ICES on this matter.

The Council agreed the 2003 meeting will be held in Dartmouth, Nova Scotia, Canada.

3. **Scientific Council Meeting on Northern Shrimp, 2004**

The Council agreed to consider dates and location for the November 2004 Meeting at its 2003 Meeting, subject to the work load and outcome of the 2003 Meeting.

V. ADOPTION OF REPORTS

The Council at its session on 13 November 2002 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 6-13 November 2002 Meeting.

VI. ADJOURNMENT

The Chair thanked the participants, noting especially the efforts of the Designated Experts and STACFIS, and the support of the NAFO Secretariat. Special thanks were extended to colleagues at Pinngortitaleriffik, Greenland Institute of Natural Resources, Nuuk, for providing excellent meeting facilities and cordial hospitality during the course of the meeting. There being no other business, the meeting was adjourned at 1810 hr on 13 November 2002.

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

Chair: D. E. Stansbury Rapporteur: Various

I. OPENING

The Committee met at Greenland Institute of Natural Resources, Nuuk, Greenland, during 6-13 November 2002, 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 Chair, D. E. Stansbury (Canada), opened the meeting on 6 November 2002 welcoming the participants. The Agenda was reviewed and a plan of work developed for the meeting. The provisional agenda was adopted (see Part D, this volume)

II. GENERAL REVIEW

1. **Review of Recommendations in 2001 and 2002**

STACFIS reviewed the recommendations from 2001 during considerations of each relevant stock.

2. **Environmental Review**

Division 3M During the summer of 2002 most areas of the water column over Flemish Cap, except for the near surface layer, were either at or above the long-term (1971-2000) average (SCR Doc. 02/152). Upper layer temperatures were generally 2°C below normal and intermediate-depth temperatures over the Cap were generally above normal by up to 2°C. Bottom temperatures ranged from above normal over the shallowest water depths to near normal below 150 m depth, similar to 2000 and 2001. Salinities over most of the upper water column during the summer of 2002 were similar to the spring of 2001, generally saltier-than-normal (by 0.25-0.5). In the deeper water (generally below 100-m depth) and near bottom, salinities were generally about normal. 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 Flemish Cap.

Divisions 3LNO. Data from spring and summer 2002 showed that temperatures on the Grand Bank were similar to 2001, and still above normal in many areas. The areal extent of bottom water, less than 0°C showed a large increase from the mid-1980s to 1997, very low values in 1998-1999, but has been increasing during 2000-2002. However, the extent of the cold intermediate layer (CIL) on the Grand Bank has remained below normal from 1998 up to and including 2002. At Station 27, except for the negative surface anomaly during spring and at intermediate depths during summer, temperatures were above normal for the first half of 2002. In general, during 2001-2002, temperatures have been declining compared to the record highs of 1998-1999, but remain above normal in most areas of the Grand Bank.

The spatial distributions and abundance of shrimp in Div. 3LNO were presented in relation to their thermal habitat, during spring surveys from 1998-2002 and autumn surveys from 1995-2001 (SCR Doc. 02/153). The highest numbers of shrimp were caught in the 2°-4°C temperature range during the spring surveys with lower numbers in the 1°-2°C and 4°-5°C ranges. During the autumn surveys most shrimp were caught in the 1°-3°C range. Cumulative frequency distribution of the number of shrimp caught and temperature indicated that only about 5% of the catches are associated with temperatures <1°C in the spring and about 30% are associated with temperatures <1°C in the autumn. About 80-90% of the shrimp were caught in the 2°-4°C temperature range during the spring, while only about 50% of the catch appeared in this temperature range during the autumn. In terms of available thermal habitat, about 30% of the surveyed region was covered with water in the 2°-4°C

temperature range during the spring, while about 40% was covered by water in this temperature range in the autumn. An apparent shift in the shrimp distribution towards colder water, further up on the Grand Bank and towards the inshore regions, occurred during the autumn and as a result a greater proportion (30%) of the catch shifted into the 0^{o}-1^{o}C temperature range. Very low numbers of shrimp were found in water $<0^{o}$C and $>4^{o}$C during both spring and autumn. Shrimp catches were mostly zero in all surveys in the shallow waters (<100 m) of the southeast Grand Bank, where temperatures generally range from 2^{o}-7^{o}C. In general, during the spring most of the large catches were found in the warmer water along the slopes of Div. 3LN, while in the autumn, larger catches were found in most areas of Div. 3L including the inshore areas and bays along the east coast of Newfoundland.

Subarea 1. (SCR Doc. 02/162) Bottom temperatures of West Greenland in depths between 150 and 600 m became significantly warmer during a period of 3 years in the late-1990s. Spatially weighted mean bottom temperature in the area covered by the West Greenland Bottom Trawl Survey for Northern shrimp increased from 1.7°C in 1995 to 3.3°C in 1998 and remained between 3.0 and 3.4°C thereafter. In 2002, the geographic distribution of bottom temperature was more uniform than in the previous years with values ranging from 1.7 to 5.6°C, and a spatially weighted average of 3.2°C.

3. **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 2001. STACFIS used estimates of catches from Canadian surveillance, observers, quota reports and updated catch figures provided to the Designated Experts by some Contracting Parties to estimate catch in 2001. In 2002 quota reports, observer reports and surveillance estimates were not available for some fleets fishing shrimp in Div. 3L, and due to these inadequacies STACFIS was not able to project total catches to the end of 2002.

III. STOCK ASSESSMENTS

1. **Northern Shrimp (*Pandalus borealis*) in Division 3M** (SCR Doc. 02/142, 149, 150, 155, 156, 159, 161, 163)

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 2002 there were approximately 40 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 and increased steadily to 2001 to 54 000 tons (Fig. 1.1). Catch statistics to 1 October 2002 indicate removals of about 39 000 tons. This will likely result in a total catch of about 51 000 tons by the end of the year.

Recent catches and TACs (tons) are as follows:

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Recommended TAC							30 000	30 000	30 000	45 000
STATLANT 21 A	20 648	19 773	19 341	39 042	23 916	30 035	42 041	49 184[1]	39 147[1]	38 242[2]
STACFIS	26 876	24 599	33 471	48 300	24 675	30 308	43 438	50 311	54 189	38 834[2]

[1] Provisional.
[2] STACFIS estimate to October.

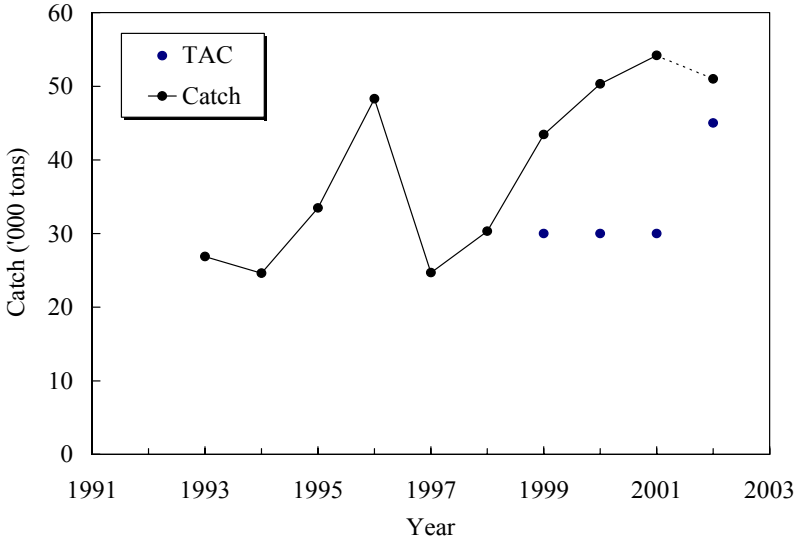


Fig. 1.1. Shrimp in Div. 3M: catches (2002 projected to end of the year) and TAC.

b) **Input Data**

i) **Commercial fishery data** (SCR Doc. 02/142, 149, 155, 159)

Effort and CPUE. Data from logbooks of Canadian, Greenlandic, Icelandic, Faroese and Norwegian vessels were available. A new series has been added from the Russian 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, double and triple trawl). CPUE decreased from 1993 to 1994, varied without a trend to 1997 and increased until 2000, after which it remained stable (Fig. 1.2).

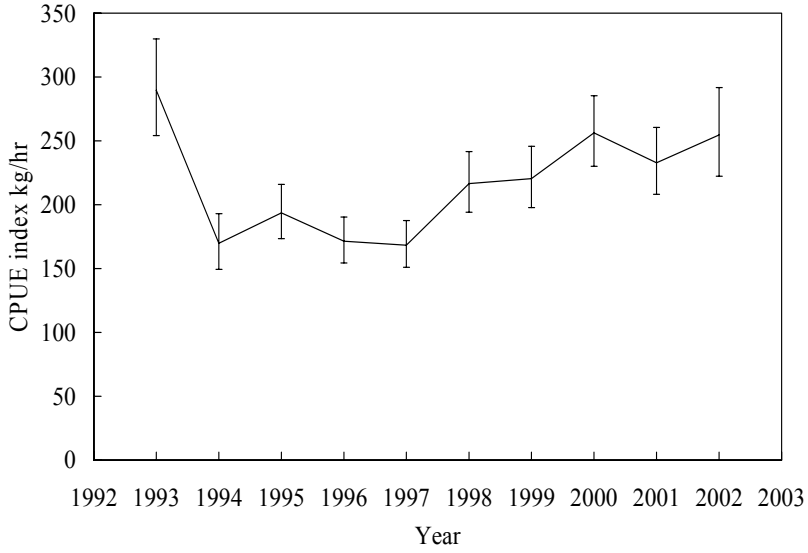


Fig. 1.2. Shrimp in Div. 3M: standardized CPUE indices (95% confidence interval).

Standardized CPUE Female SSB. A spawning stock index was calculated from the standardized CPUE as kg/hr of primiparous plus multiparous females. An index of spawning female biomass was also calculated in the EU and Faroese surveys. The spawning stock declined from 1993 to 1997, increased in 1998 and stayed stable thereafter (Fig. 1.3).

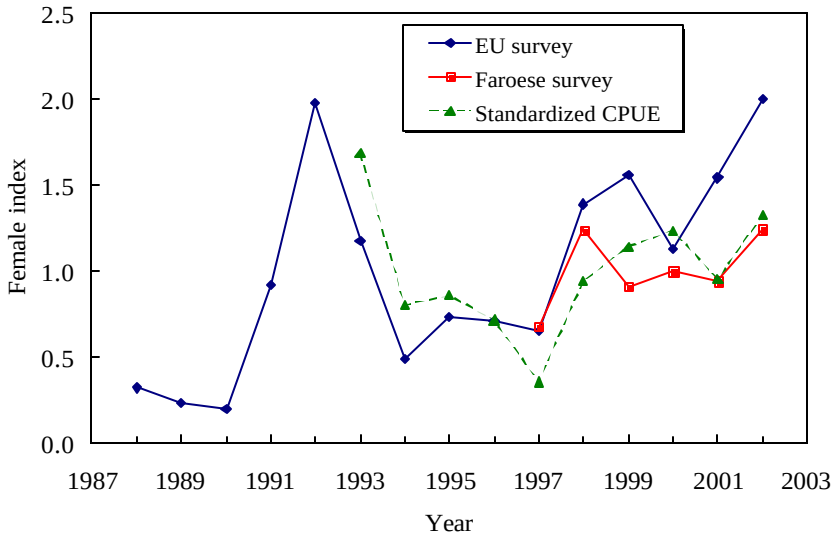


Fig. 1.3. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2002, Faroese survey 1997-2002 and standardized female CPUE 1993-2002. Each series was standardized to the mean of that series.

Biological Data. Age composition was assessed from commercial samples obtained from Canada, Greenland, Russia and Iceland. Number per 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-classes 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.

	Number per hour at age based on standardized CPUE						
Age	1996	1997	1998	1999	2000	2001	2002
1							
2	1 734	1 395	2 194	1 654	1 052	4 271	2 407
3	18 010	11 076	12 828	9 854	16 888	5 712	12 534
4	4 392	11 490	16 050	11 399	17 983	17 391	12 277
5	1 323	2 257	4 851	9 174	10 404	10 587	14 688
6	1 602	457	749	3 301	2 040	2 735	2 154
7	837	40	26	39	87	369	257
Total	27 899	26 714	36 697	35 421	48 455	41 065	44 316

ii) **Research survey data**

EU surveys (SCR Doc. 02/150). EU groundfish surveys have been conducted on Flemish Cap in July from 1988 to 2002. 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 gear. As shown in the Table below the female shrimp bio mass increased rapidly in 1991 and 1992, declined to relatively low values in 1994 to 1997, increased in 1998, declined in 2000 to increase again to 2002 to the highest value in the series (Fig. 1.3). 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. The 1998 year-class at age 4 appears not strong whereas the 1999 year-class at age 3 in 2002 appears very 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
2002	18 109	12.87	1.12	11 664

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

In 2000 a small meshed juvenile bag was attached to the codend 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. In 2002 the modes at age 1 and 3 are quite distinct.

Faroese survey (SCR Doc. 02/156, 161). Stratified-random surveys were conducted in June-July 1997-2002 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 and increased in 2002 to 28 000 tons. Results indicate that the 1997 and 1999 year-classes are above average and the 1998 and 2000 year-classes appear weak (Fig. 1.4).

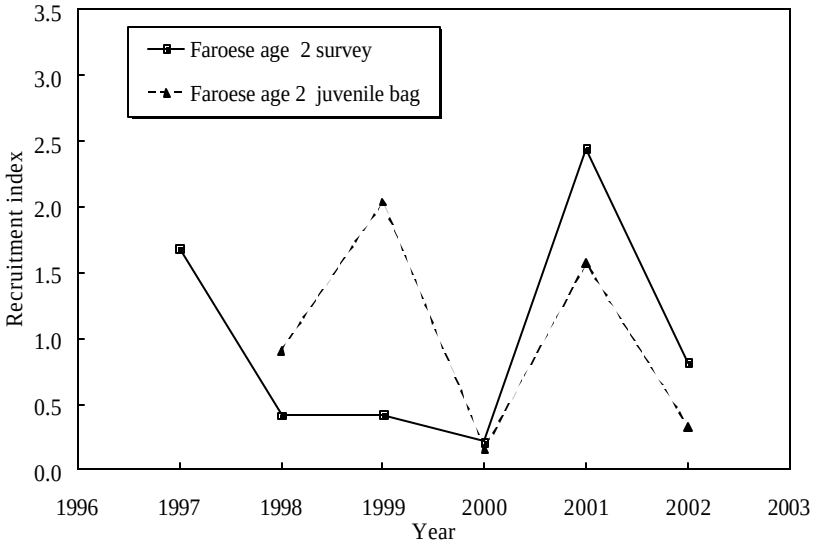


Fig. 1.4. Shrimp in Div. 3M: abundance indices at age 2 from the Faroese survey and from the juvenile bag. Each series was standardized to its mean.

c) **Assessment Results**

Commercial CPUE. Standardized catch rates declined between 1993 and 1994, varied without a trend to 1997, and increased to 2000, after which it remained stable.

Recruitment. The 1997 and 1999 year-classes are above average while the 1998 and 2000 year-classes appear weak.

Spawning Stock Biomass. Indices of female biomass increased between 1997 and 1998 and fluctuated without a trend thereafter.

State of the Stock. STACFIS is unable to estimate absolute stock size. Stock size indicators are fluctuating without a trend since 1998 at a higher level compared to 1994-1997. The 1997 year-class was above average in 2002, but its contribution to the fishery will diminish after 2003. The 1999 year-class is above average and will be contributing to the fishery in 2003 and 2004. However the 1998 and 2000 year-classes appear 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:

- *work on age structured population models should be continued.*

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted in advance of the 2003 Scientific Council Meeting on shrimp .*

- *a thorough investigation into the methods used to derive a CPUE index for shrimp be conducted and submitted in advance of the 2003 Scientific Council Meeting on shrimp.*

2. **Northern Shrimp (*Pandalus borealis*) in Divisions 3L, 3N and 3O** (SCR Doc. 02/143, 153, 159, 160)

a) **Introduction**

This shrimp stock is distributed around the edge of the Grand Banks mainly in Div. 3L. The fishery began in 1993 and catches were 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. The catch in 2000 increased to 4 900 tons, 4 300 tons of which was caught by Canada. The remainder of the catch was taken by vessels from 9 other countries.

Catches from 1993 to 1999 are as reported in the STATLANT 21A database. Catches for 2000 and 2001 are STACFIS estimates based on additional data sources. STACFIS revised its catch estimate for the 2001 fishery up to 10 566 tons, with Canada taking just over 5 100 tons (Fig. 2.1). Reliable catch reports were not available for all countries in 2001, and estimates from other sources were used in these cases. For 2002, estimates of catch were not available for all countries, so STACFIS was not able to project total catches to the end of 2002. However, STACFIS noted that the total catch in 2002 was likely to be lower than that estimated for 2001, but that there was considerable uncertainty with estimates of catch in both years. The Canadian catch to date in 2002 is estimated to be about 5 500 tons, and is expected to be close to this figure for the full year.

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 in 2001 and most of their catch came from twin trawls. In all 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	2000	2001	2002
Recommended TAC	-	-	-	-	-	-	-	6 000	6 000	6 000
STATLANT 21A	1 791	1 910[1]	0	179	485	626	795	4 886[2]	5 323[2]	
STACFIS	1 791	1 910[1]	0	179	485	626	795	4 920	10 566	na

[1] Faroes catch revised from 356 tons to 1 910 tons.
[2] Provisional catches.
na Not available.

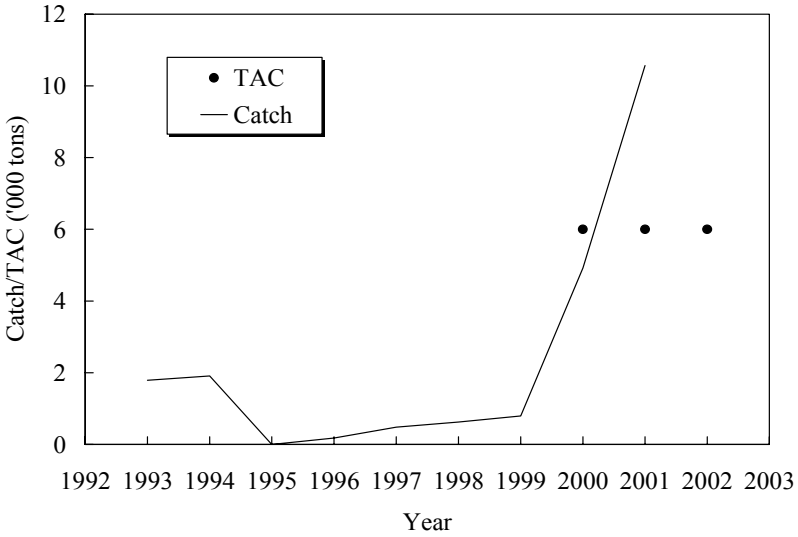


Fig. 2.1. Shrimp in Div. 3LNO: catches and TAC.

b) **Input Data**

i) **Commercial fishery data** (SCR Doc. 02/160)

Fishing effort and CPUE. Catch and effort data were available from fishing records from Canadian vessels in Div. 3L from 2000 to 2002. Unstandardized catch rates (both single and double trawl) for large vessels increased in 2001 and again in 2002. CPUE from the Canadian small vessels increased between 2000 and 2001, but insufficient data from 2002 were available from this fleet for analysis at this time. Some CPUE data were available from a few vessels fishing in the NRA in Div. 3L, 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 during 2001 and 2002. The length-frequency distributions in both years showed good representation at several size-classes, indicating that 5 or more year-classes were present. In 2001, females with carapace length (CL) between 22 and 26 mm (age 5+) dominated the catches by small vessels. The limited data for 2002 indicated catches by this fleet were dominated by males between 18.5 and 21 mm CL, believed to be from the 1997 and 1998 year-classes. In 2001, catches from the large vessels were dominated by male shrimp. In 2002, males and females were about equal in number in the catches, due to the sex change of a portion of the 1997 year-class. The 1998 year-class appeared to be relatively strong in both large and small vessel catches in 2002.

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 by large vessels (=>500 GRT) in 2001 and 2002, estimated total groundfish removals in the Canadian fishery were obtained as follows:

	2001 Large Vessels		2002 Large Vessels	
	Est. catch (kg) ton of shrimp	Catch (kg)/ ton of shrimp	Est. catch (kg)	Catch (kg)/
Cod	229	0.10	164	0.07
American plaice	1 116	0.47	303	0.12
Redfish	972	0.41	1 424	0.58
Greenland halibut	5 660	2.35	4 754	1.94

Although no 2002 information from the small vessel fleet was available at this time, data from the 2001 fishery indicated that by-catch rates for cod, American plaice, and redfish, were similar to those of the large vessels, and were lower for Greenland halibut. Observer data on Norwegian by-catch in Div. 3L in 2001 (from an estimated 70 ton catch of shrimp) indicated no by-catch of cod, 0.44 kg of American plaice per ton of shrimp, 0.43 kg/ton for redfish, and 3.93 kg/ton for Greenland halibut.

ii) **Research survey data** (SCR Doc. 02/143, 160)

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 1995-2001, and from spring surveys in 1999-2002. 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 shrimp biomass/ abundance between 1995 and 1997, a period of stability between 1997 and 1999, and a significant increase thereafter. Spring surveys of 1999-2002 also showed a significant increase after 1999.

Canadian multispecies survey autumn and spring biomass indices are indicated below:

Year	Lower 95% C. I.	Autumn Estimate	Upper 95% C.I.	Lower 95% C.I.	Spring Estimate	Upper 95% C.I.
1995	3.6	5.9	8.2			
1996	10.2	20.1	29.9			
1997	25.5	46.2	66.9			
1998	40.1	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				121.1	159.5	197.9

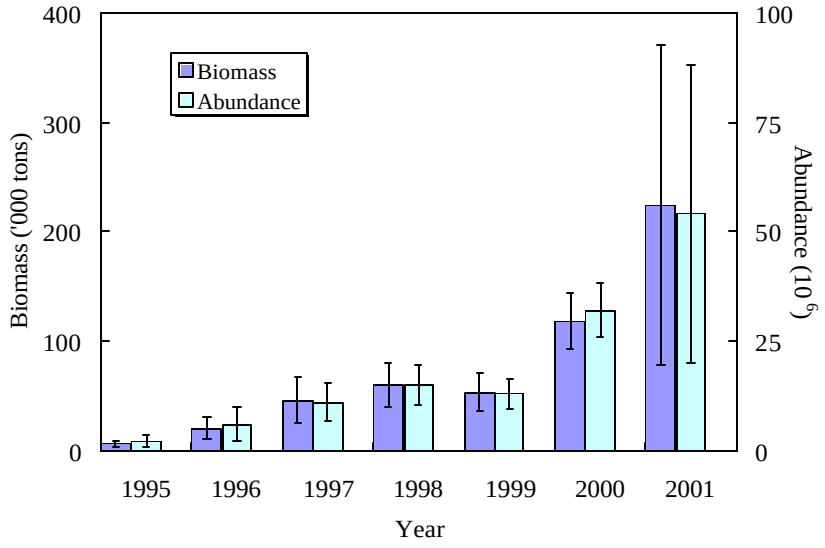


Fig. 2.2. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian autumn multi-species surveys (± 95% confidence intervals).

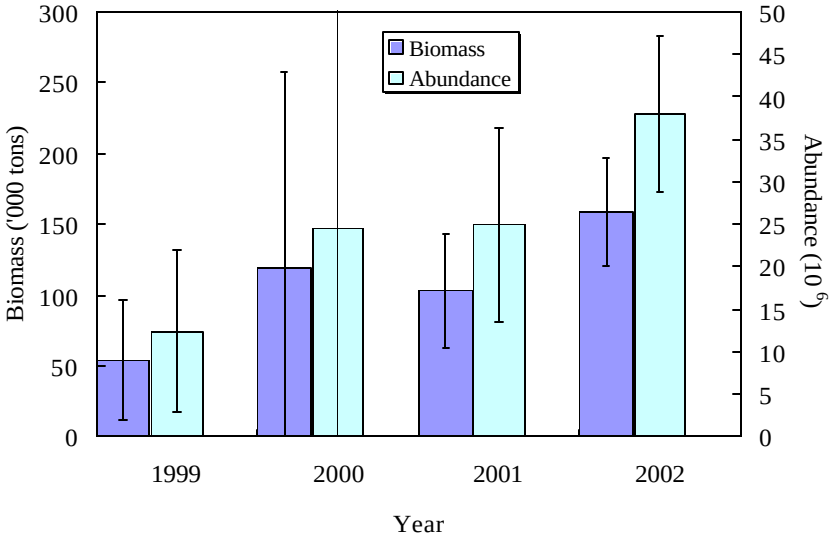


Fig. 2.3. Shrimp in Div. 3LNO: biomass and abundance estimates from Canadian spring multi-species surveys (± 95% confidence intervals).

Sex and length composition. Estimated total number (10^9) of shrimp in Div. 3LNO from autumn 1995 to spring 2002 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
Autumn 2001	45.8	8.3	54.1	84.7	15.3
Spring 2002	26.8	11.2	38.0	70.5	29.5

Autumn abundance of shrimp has increased to the highest levels in the time series during 2001 while spring abundance was highest during 2002. The proportion of females in the surveys has varied around the mean of 20% in recent surveys. Abundance estimates from the autumn 2001 survey were dominated by males with a modal length of 19.0 mm CL (1997 year-class). The relatively weak 1996 year-class was followed by the stronger 1997-99 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).

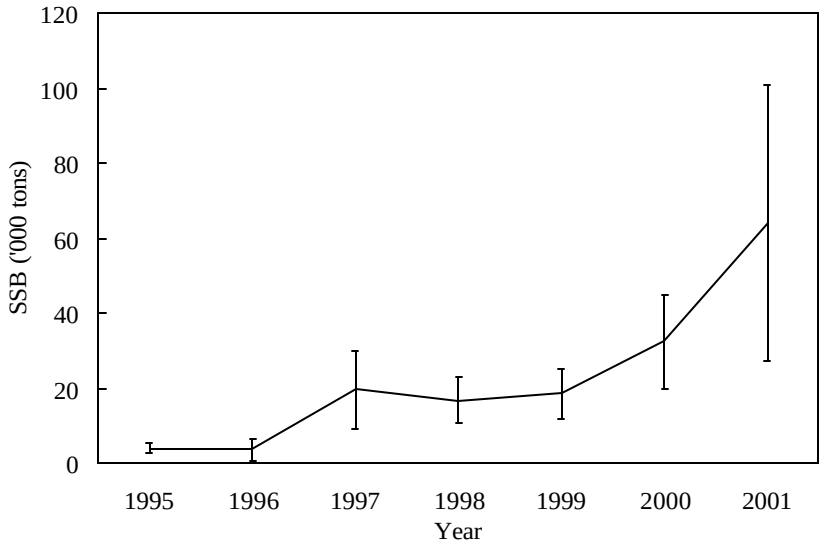


Fig. 2.4. Shrimp in Div. 3LNO: Spawning stock biomass (SSB) estimates from Canadian autumn multi-species surveys (± 95% confidence intervals).

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

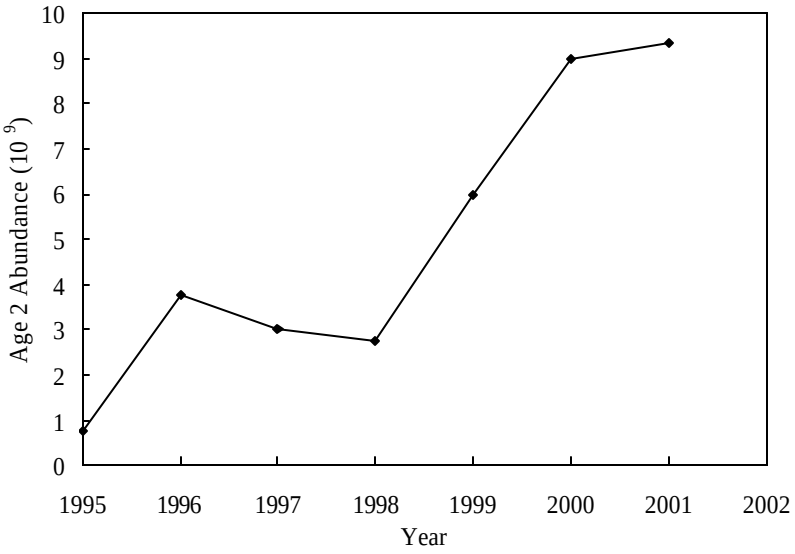


Fig 2.5. Shrimp in Div. 3LNO: age 2 recruitment index as determined from Canadian autumn multi-species surveys.

An index of exploitation was derived by dividing the catch in a given year by the lower 95% confidence limit on the autumn survey biomass from the preceding year. This index was around 2-3% in 1998-99, and increased to 11-13% in 2000-01, which were the first two years of TAC regulation. Insufficient data were available to estimate total catch for 2002, and therefore an exploitation index could not be calculated.

Data from the Spanish surveys in the NRA of Div. 3NO, conducted with a Campelen trawl, indicated an increase in the amount of shrimp found in 2002 in Div. 3N compared to 2001. Data from similar surveys in 1995-2000 were not considered to be comparable, as a groundfish trawl not suitable for shrimp surveys was used. Most of the shrimp in 2002 were found in the northeast corner of Div. 3N, near the border with Div. 3L. About 58% of shrimp in the catches were males, with modal lengths around 20 mm in the male component, 22.5 mm in the immature females, and 24 mm in the mature females.

c) **Assessment Results**

Recruitment. The 1998 and 1999 year-classes are the two largest year-classes in the short time series.

Biomass. There was a significant increase in SSB and total biomass between 1995 and 1997, a period of stability between 1997 and 1999, and a significant increase thereafter.

Exploitation. No estimates of fishing mortality were available. An exploitation index was around 2-3% in 1998-99 and increased to 11-13% in 2000-2001.

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 have increased significantly since 1999 and at present are the highest observed. In addition the stock appears to be well represented by a broad range of size groups, and exploitation is low.

d) **Research Recommendation**

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

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted in advance of the 2003 Scientific Council Meeting on shrimp.*

3. **Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1** (SCR Doc. 02/144, 145, 146, 148, 151, 157, 158)

a) **Introduction**

The shrimp stock off West Greenland is distributed in Div. 0A and Subarea 1. 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). 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 2002 was 85 000 tons. In 2002, the Greenland authorities set a TAC for Subarea 1 of 91 150 tons, and a TAC for Subarea 0 of 12 040 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 annual catch has increased from less than 10 000 tons in the early-1970s to more than 86 000 tons in 1992 (Fig. 3.1). Restrictions by the Greenlandic authorities to reduce effort and fishing opportunities elsewhere for the Canadian fleet then made catches decrease to about 65 000 tons in 1997. Since then overall catches have increased. The projected catch of 2002 is expected to be around 99 000 tons (Fig. 3.1) based on data through October 2002. In 2002 catches in Subarea 1 are expected to reach the catch quotas (TAC), whereas catches in Subarea 0 for 2002 most likely will be less than the quotas, due to fishing opportunities for the Canadian fleet elsewhere.

Recent nominal catches, projected figures for 2002 and recommended TACs (tons) for shrimp in Div. 0A and Subarea 1 are as follows:

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Recommended TAC[1]	50 000	50 000	60 000	60 000	60 000	55 000	65 000	65 000	85 000	85 000
SA 1	70 123	71 811	68 329	66 610	64 000	65 170	73 985	78 337	81 398	93 000[2]
Div. 0A	5 491	4 766	2 361	2 632	517	933	2 046	1 782	3 625	6 000[2]
Total STATLANT 21A	75 614	76 577	70 690	69 242	64 517	66 103	76 031	79 927[3]	85 023[3]	
Total STACFIS	75 614	76 577	70 690	69 242	64 517	66 103	76 031	79 927	85 023	99 000[2]

[1] Until 1994 the recommended TAC was only for offshore south of 71°N. After 1994, the recommended TAC included offshore north of 71°N and inshore.
[2] Catches projected to end of 2002.
[3] Provisional.

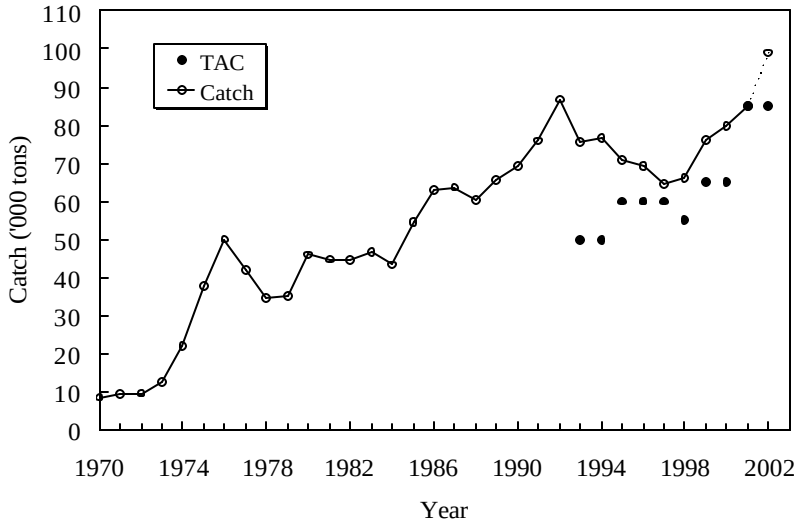


Fig. 3.1. Shrimp in Subareas 0 and 1: total catches (2002 projected to the end of the year) and recommended TAC. Prior to 1995 the recommended TAC was not for the entire area.

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 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 and from Greenland logbooks for Subarea 1 (SCR Doc. 02/151).

Multiplicative models were used to calculate fleet specific annual catch-rate indices. From these individual indices one unified time series covering 1976-2002 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 2002 mean value is the highest in the time series.

An index of exploitation rate was calculated by dividing overall annual catch by the combined CPUE index values. This index indicated a decrease in exploitation rate of about 35% from 1992 to the late-1990s. For 2002 the indices indicate an exploitation rate at the level of the four most recent years (Fig. 3.3).

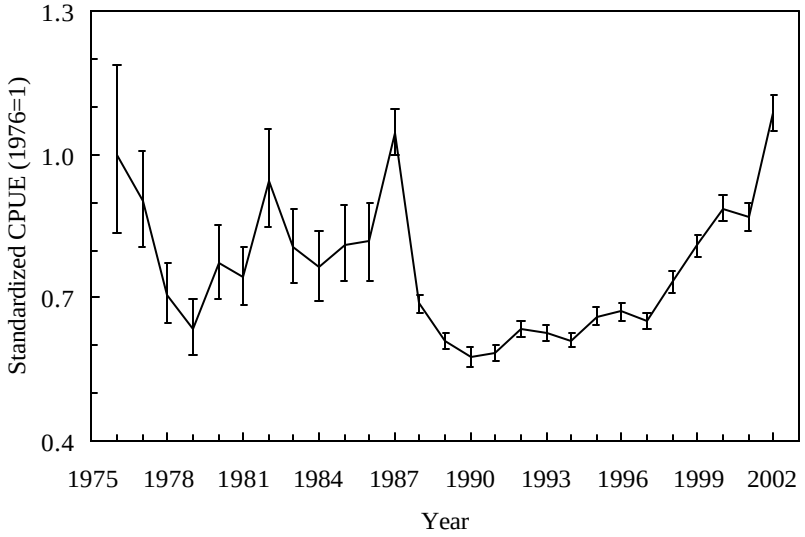


Fig. 3.2 Shrimp in Subareas 0 and 1: standardized CPUE index. Error bars are upper and lower quartiles.

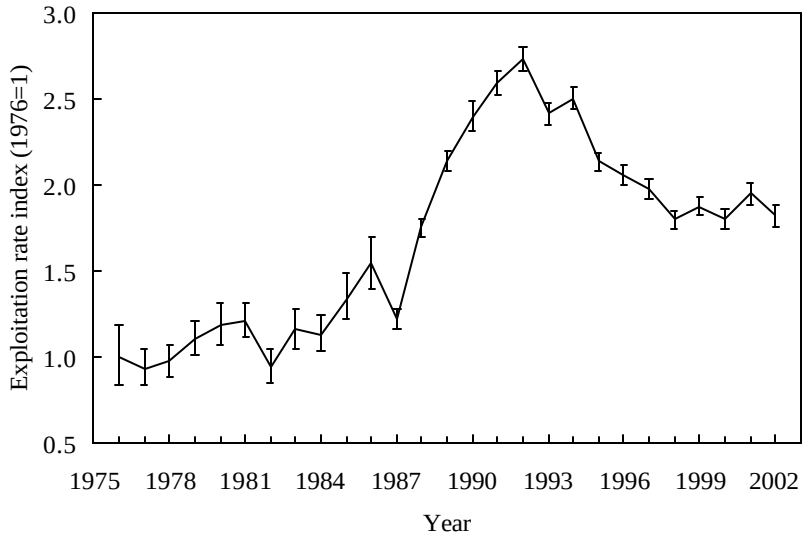


Fig. 3.3. Shrimp in Subareas 0 and 1: index of exploitation rate. Error-bars are upper and lower quartiles

Catch composition. Catch composition was assessed from samples obtained by observers in the commercial fishery in Div. 0A from 1981 to 2002, and in Subarea 1 from 1991 to 2002 (SCR Doc. 02/151). 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. Sparse sampling prohibited an analysis of catch composition for year 2002.

ii) **Research survey data**

Greenland trawl survey. Stratified-random trawl surveys have been conducted since 1988 in offshore areas (Div. 0A and Subarea 1) and since 1991 in inshore Subarea 1 (SCR Doc. 02/148). 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 2002-value is the highest of the time series (Fig. 3.4).

Within the survey area, large year-to-year variations in the distribution of biomass were observed as well geographically as over depth zones. Some areas account for a large proportion of the variances of the estimated biomasses. However, during recent years a more even geographical distribution was indicated (SCR Doc. 02/148, Fig. 1). During the recent period of increasing biomass indices an increased proportion of the biomass was seen in depths between 200-300 meters.

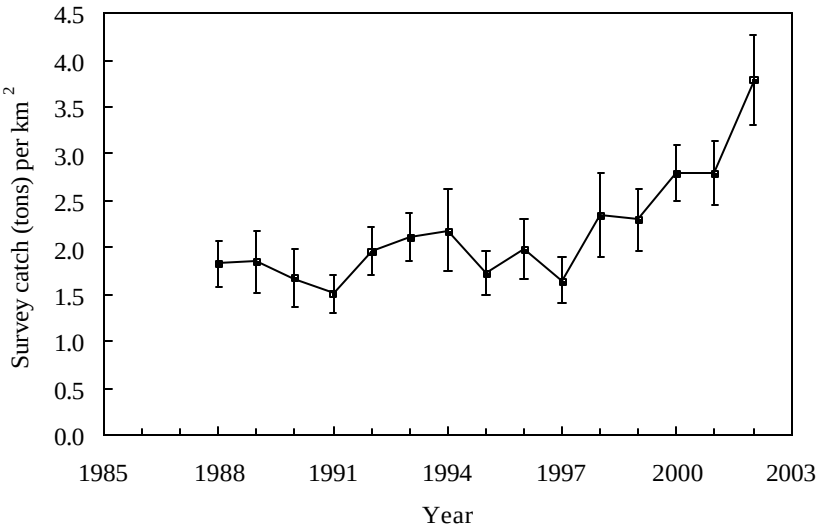


Fig. 3.4. Shrimp in Subareas 0 and 1: Survey estimates of biomass, ± 1 standard error.

Sex and length composition. Indices of total abundance (10^9) of shrimp in Div. 0A and SA 1 from 1988 to 2002 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
2002	90.6	16.7	107.2	84.5	15.5

[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 2002 was the highest in the series. The proportion of males in 2002 was above average of the values recorded in the time series.

The overall length-frequency distributions in 2002 showed a number of distinct male modes (at 8.5, 13, 18 and 20.5 mm CL), a mode of primiparous females at 24.5 mm CL and one of multiparous females at 25.5 mm CL (Fig. 3.5). The presence of several size groups of males in 2002 and, in particular, an abundant mode at 17.5 mm CL indicates good recruitment to the female group in coming years.

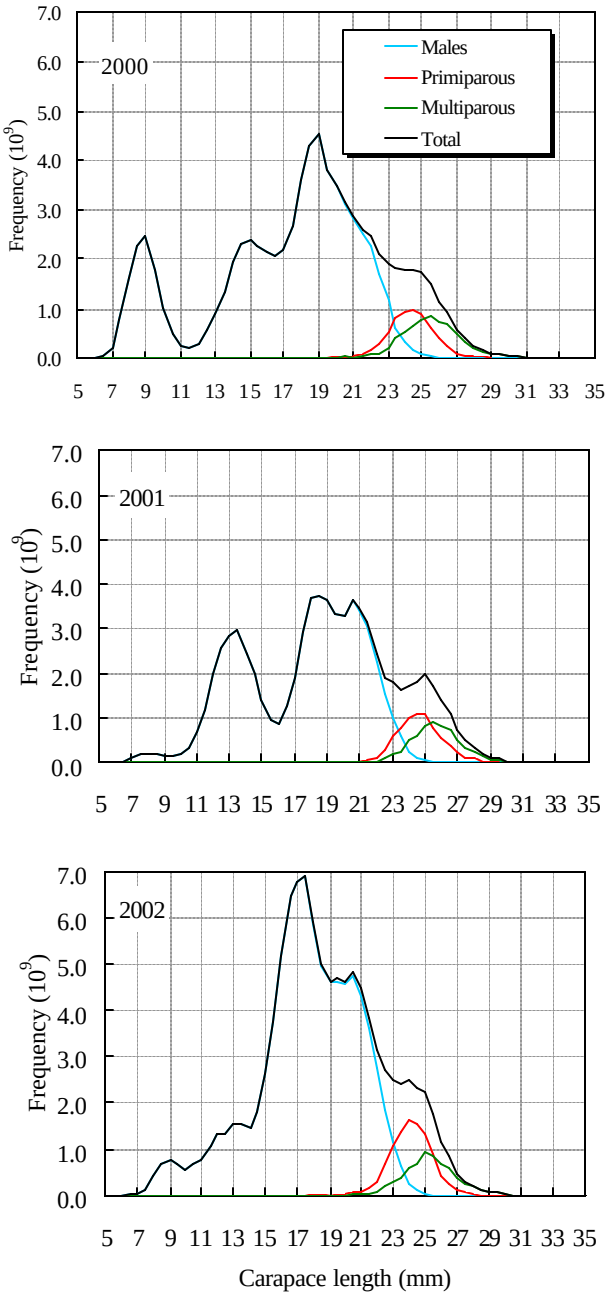


Fig. 3.5. Shrimp in Subareas 0 and 1: Numbers of shrimp by 0.5 mm CL length group in the total area during 2000-2002 (mesh size in the codend 20 mm stretched).

Index of recruitment. A recruitment index (shrimp at age 2) showed an increasing trend from 1997 to 2001 (Fig. 3.6). The 2002 value was down, equalling the 1999 value, however still above the average of the time series.

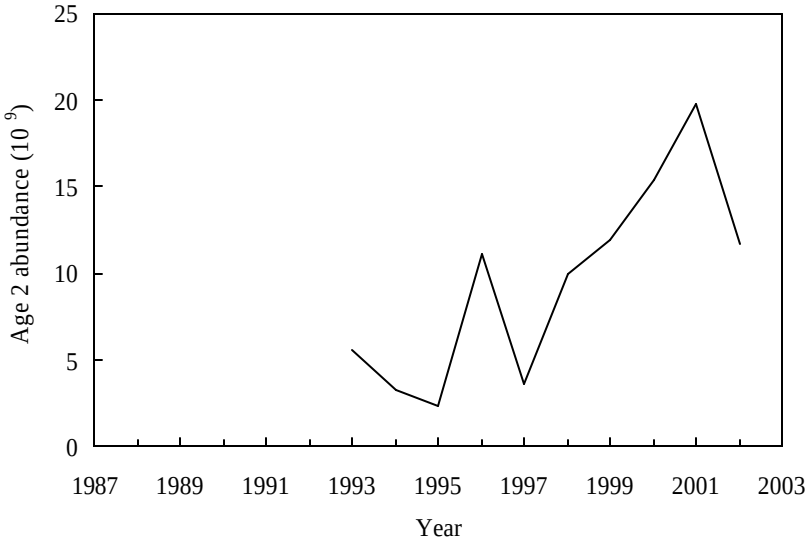


Fig. 3.6. Shrimp in Subareas 0 and 1: recruitment index (shrimp at age 2)

Spawning stock biomass (SSB). SSB showed an increasing trend since 1997 and the value in 2002 is the highest observed in the series (Fig. 3.7).

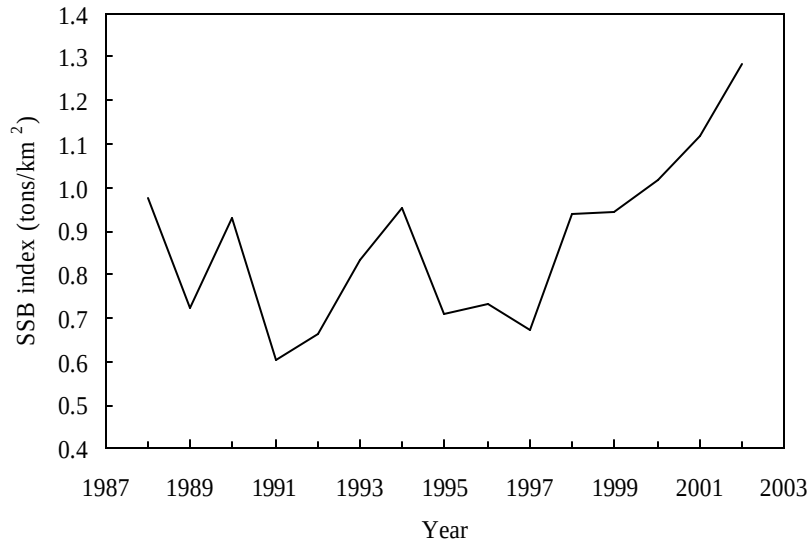


Fig. 3.7. Shrimp in Subareas 0 and 1: total female biomass index.

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. 3.8. The index declined since 1991.

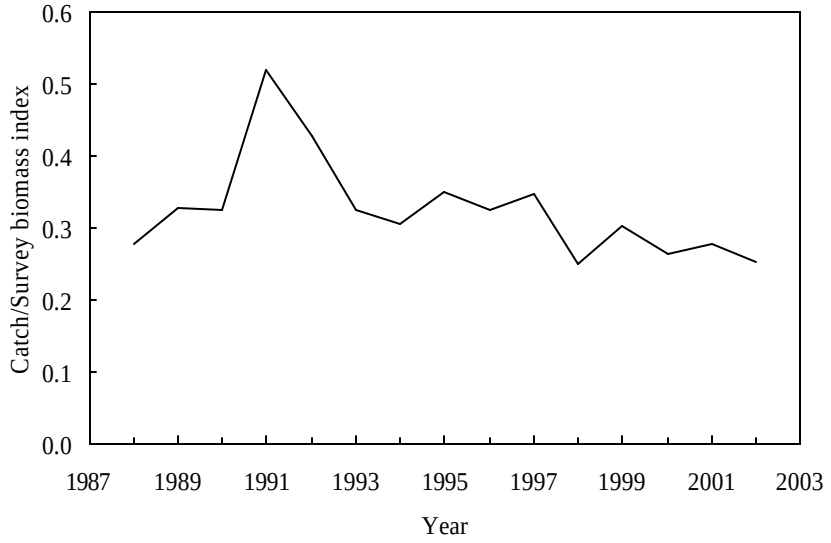


Fig. 3.8. Shrimp in Subareas 0 and 1: Index of exploitation rates calculated as proportion of total catch to corresponding survey estimate of fishable biomass.

iii) **Biological studies**

The SCR Doc. 02/144 presented data on individual length and weight of shrimp recorded during the West Greenland Bottom Survey for Northern shrimp and fish in 2001 and 2002. These data could not be satisfactorily described with a length-weight relationship established based on measurements conducted during the 1990s. Hence, a new one was presented that allowed the analysis of length frequencies in order to calculate female and fishable biomass from the 2001 and 2002 survey. A comparison of the two relationships for converting length to weight indicated further that the condition of Northern shrimp was lower in the past two years than in the 1990s.

A study on length frequencies and catches of shrimp obtained with juvenile bags and those retained in the trawl codend during the West Greenland Bottom Trawl Survey for Northern shrimp and fish was presented (SCR Doc. 02/145). The results showed that the two juvenile bags (mesh size: 6 mm, attached to the two sides of the twin codend) are adequate to sample the size range of the 1-group while estimates of the mean length of this age group based on trawl samples (mesh size: 20 mm in the codend) are biased. Trawl selection appeared to be less important for the 2-group, which is incompletely sampled by juvenile bags when attached to the 20 mm codend of the trawl. Correlation between juvenile bag and trawl catches of age 1 Northern shrimp was very poor. For both, high catch rates were found at the borders of the survey area and changes in the sampling procedure appears to be necessary in order to improve the reliability of abundance estimates for the 1-group. It was further concluded to move the attachment point of the juvenile bag up in front of the 20 mm codend liner, for future studies.

Length frequency distributions of shrimp from the West Greenland Bottom Trawl Survey for Northern shrimp and fish in the years 1993 to 2002 were analysed in order to provide age-based recruitment abundance indices (SCR Doc. 02/146). The original data were pooled into five major regions defined by latitudinal differences in bottom temperature. Modal analysis was used to estimate mean length and abundance for age 1 and 2. For both ages, mean length was significantly correlated with bottom temperature and indicated a change to faster growth in the past years. The

estimates of the 1-group abundance appeared to be seriously affected by low catchability due to trawl selection while the abundance indices for the 2-group were suitable to assess changes in recruitment. Age 2 abundance was regarded as a preferable measure of recruitment compared to the previously used index defined by a fixed size limit (<17 mm CL) because the length frequencies revealed substantial changes in growth in the past decade. In addition, the abundance at age 2 showed a highly significant correlation with the survey biomass applying a time lag of two years.

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 (SCR Doc. 02/158) and the following data: a 14-year series of a survey biomass indices of shrimp larger than 17 mm CL (SCR Doc. 02/148), a 26-year series of combined CPUE indices (SCR Doc. 02/151), a 47-year series of a cod biomass estimates (SCR Doc. 02/158), and a short series (4 years) of estimates of the shrimp biomass consumed by cod based on stomach sampling (SCR Doc. 02/158).

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 1956-2002 in the range of 200 tons to about 100 000 tons, which is in the same order of magnitude as the catches taken by the fishery. The estimated consumption declined since 1960 as a result of a decline in cod abundance at West Greenland (Fig. 3.9). 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.

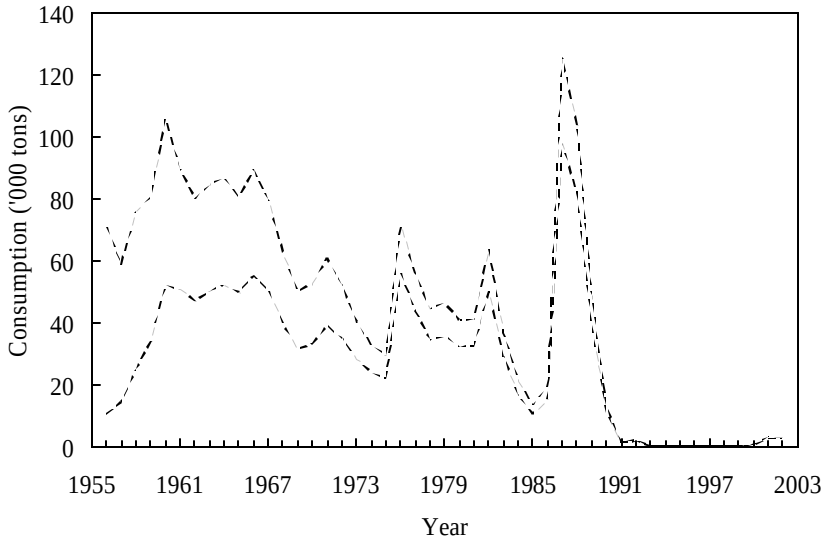


Fig. 3.9. Shrimp in Subareas 0 and 1: Estimated consumption of shrimp by cod. Dashed lines indicate 25th and 75th percentiles.

The shrimp stock has been exposed since the 1950s to two different environmental regimes: one with high and the other with low cod abundance. The analysis indicates that the stock dynamics have responded to the difference. The trajectory of the median estimate of 'biomass –ratio' (B_t,/B_{msy}) plotted against 'mortality – ratio' (Z_t/Z_{msy}) (Fig. 3.10) 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. 3.9), shrimp stock biomass increased and eventually began cycling in the left upper corner of the graph (Fig. 3.10) during the current regime of low cod abundance.

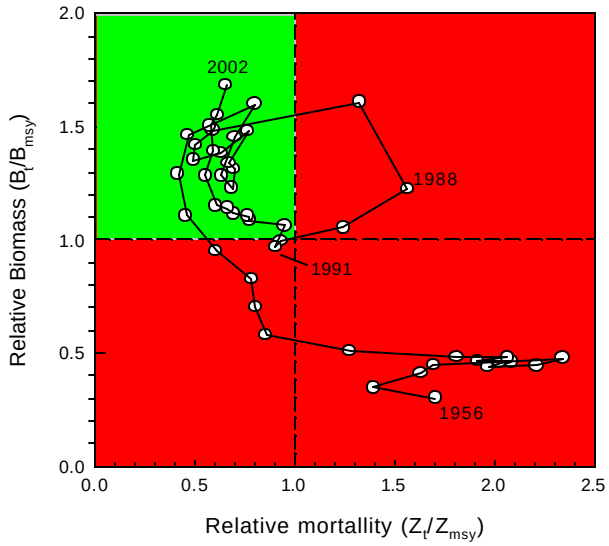


Fig. 3.10. Shrimp in Subareas 0 and 1: estimated annual median biomass-ratio (B/B_{msy}) and mortality-ratio (Z/Z_{msy}) 1956-2002.

Since the early-1970s the estimated median biomass-ratio ranged from about 0.96 to 1.67 (Fig. 3.10) and the probability that it had been below the optimum level was small for most years (Fig. 3.11), i.e. it seemed likely that the stock had been at or above its MSY level throughout the modern fishery. A steep decline in CPUE was noted in the late-1980s and early-1990s following a short-lived resurgence of the cod stock and the median estimate of biomass-ratio dipped just below the optimum in 1990-1991 (Fig. 3.10). The stock has increased since then and reached its highest level ever in 2002 with a median estimate of biomass-ratio of 1.67, corresponding to about 82% of estimated median carrying capacity. The estimated risk of stock biomass being below B_{msy} was less than 0.01 (Fig. 3.11).

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. 3.10). Since 1997, annual median Z ratio has been stable at approximately 0.6, i.e. well below the optimum. The median of estimate for 2002 is 0.67 with a risk of only 0.04 of being above 1 (Fig. 3.11).

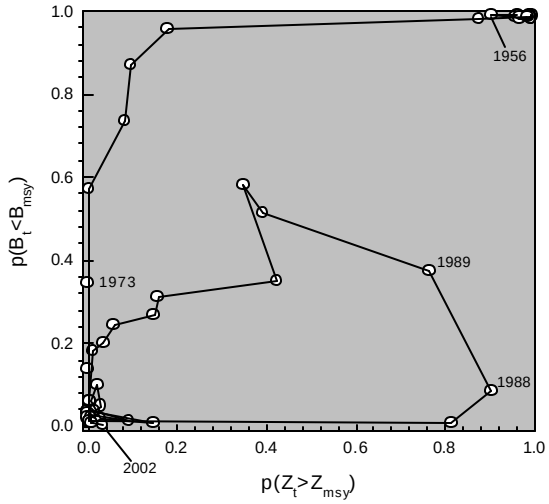


Fig 3.11. Shrimp in Subareas 0 and 1: risk of annual biomass being below B_{msy} and of mortality caused by fishing and cod predation being above Z_{msy} 1956-2002.

The median estimate of the maximum annual production surplus, available equally to the fishery the cod (MSY) was estimated to 101 400 tons (Fig. 3.12). 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. 3.12).

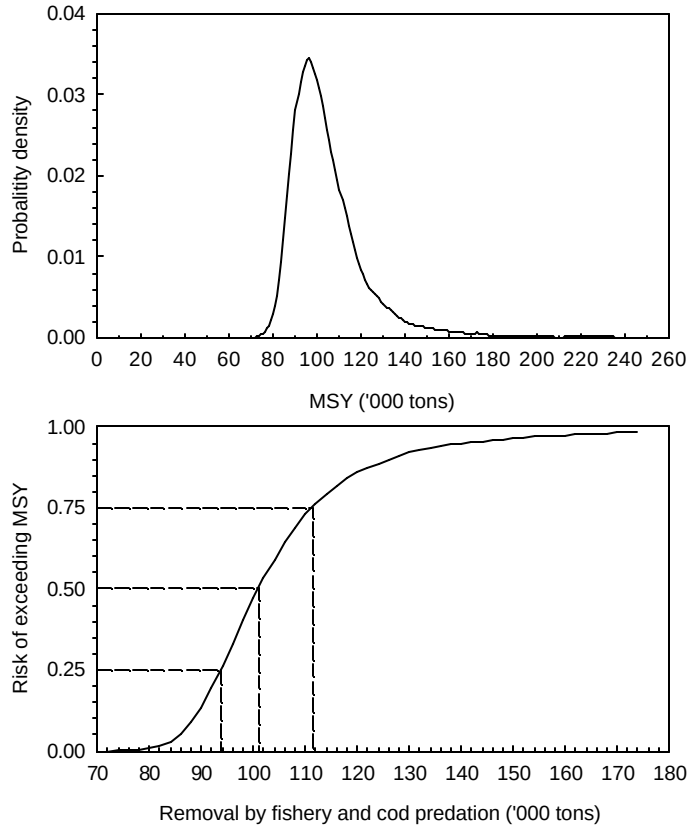


Fig. 3.12. Shrimp in Subareas 0 and 1: Posterior probability distribution of the maximum annual production surplus, available equally to the fishery the cod (MSY) (upper panel) and the cumulative probability of exceeding MSY.

Predation by cod can be significant (Fig. 3.9) 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 slowly 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. Management options given the scenario can be evaluated by STACFIS if and when the development of the cod stock warrants it.

For the medium term (10 years) it is considered unlikely that the cod stock will be able to re-establish itself to its historic high levels. Ten-year projections of stock development were made under the assumption that the cod stock will remain at its current low abundance. Five levels of annual catch: 80 000, 90 000, 100 000, 110 000 and 120 000 tons were investigated (Fig. 3.13).

The investigated catch options of 80 000 and 90 000 ton/yr have a small risk of being above MSY (Fig. 3.12) and the stock is therefore likely to remain above B_{msy} (Fig. 3.13) during the ten years of projection. The combined relative fishing and cod predation mortality, Z_t/Z_{msy}, has a high probability of being below 1 within this period (Fig. 3.14).

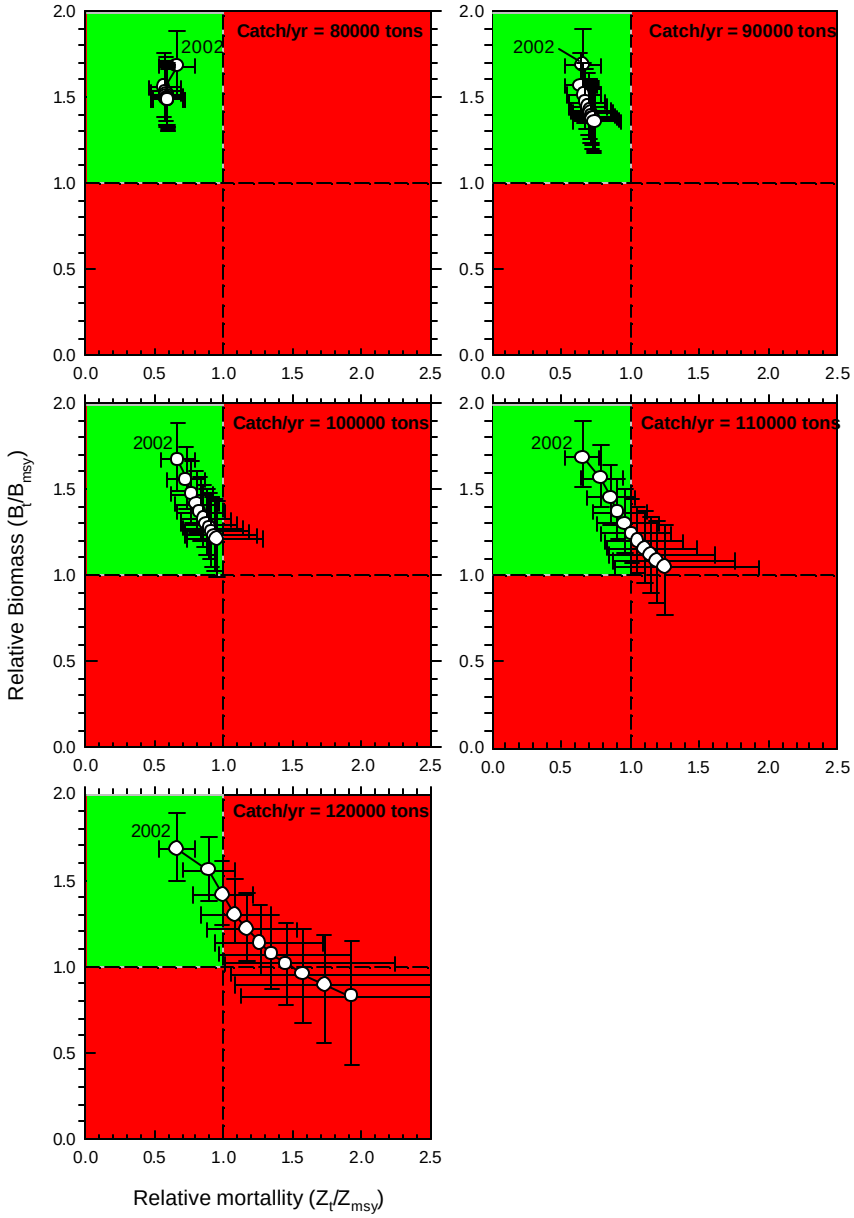


Fig. 3.13. Shrimp in Subareas 0 and 1: projections of stock development for the period 2002-2012 quantified in a biomass (B/B_{msy})-mortality (Z/Z_{msy}) continuum. Dynamics at 80 000, 90 000, 100 000, 110 000 and 120 000 tons of fixed annual catch levels are shown as medians with error-bars at the 25th and 75th percentiles. Dashed lines indicate level of biomass and mortality at MSY.

A catch option of 100 000 tons/yr will just about meet the estimated median MSY and is not likely to drive the stock below B_{msy} in the short to medium term (Fig. 3.13), i.e. the risk is less than 10% within the first five years and just above 25% after year 10 (Fig. 3.14). However, this level of exploitation might not be sustainable in the longer term, as risk of falling below B_{msy} continues to increase through time.

Fishing 110 000 tons/yr bears a 75% risk of being above MSY (Fig. 3.12), thus this catch level is not likely to be sustainable in the longer term. Owing to the current high stock level the risk of falling B_{msy} is still less than 20% after five years at this catch level, although after 10 years it is close to 50% (Fig. 3.14).

A catch of 120 000 tons/yr is associated with an 85% risk of exceeding MSY (Fig. 3.12) and the stock biomass will rapidly decline to below B_{msy} (Fig. 3.13). After just two years there is a 50% risk of exceeding Z_{msy} (Fig.3.14).

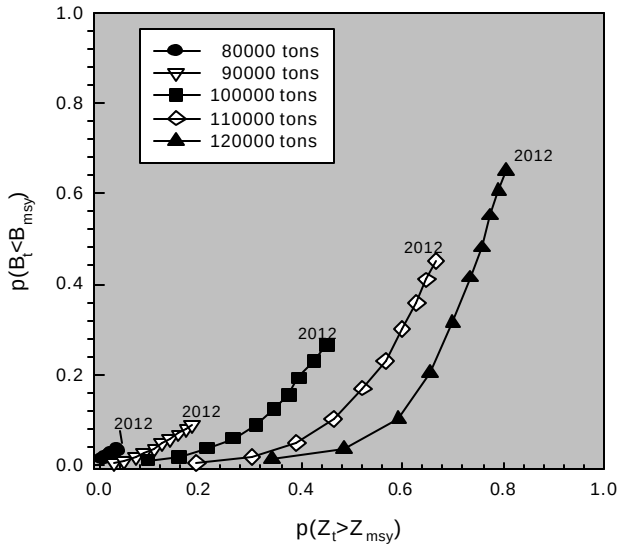


Fig.3.14. Shrimp in Subareas 0 and 1: risk of exceeding Z_{msy} and of driving the stock below B_{msy} by maintaining optional annual catch levels of 80 000-120 000 tons/yr during the period 2003-2012.

If on the other hand an abrupt increase in cod biomass resulting from immigration from other areas occurs, changes to shrimp stock condition may be much more rapid. Preliminary 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 60 000 and 100 000 tons (upper and lower quartiles).

e) **Precautionary Approach**

The Precautionary Approach framework developed by Scientific Council defined 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. At this meeting STACFIS was not in a position to define B_{lim}. 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 may not be needed in this framework as the risk of exceeding the limit reference can be directly calculated and uncertainty associated with the entire process is taken into account. However, STACFIS did not want to forestall the results expected to emerge from the Scientific Council Workshop on the Precautionary Approach in spring 2003.

f) **Assessment Summary**

CPUE. The standardized CPUE series showed an increasing trend since 1990. The 2002 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. The 2002 value was down, equalling the 1999 value, however, still above the average of the time series.

SSB. SSB (female biomass) showed an increasing trend since 1997 and the value in 2002 is the highest observed in the series since 1988.

Exploitation rate. All indices of exploitation 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 2002. 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.

g) **Research Recommendations**

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

- *sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established.*

- *annual length-weight relationships be constructed as routine part of survey data analyses.*

4. **Northern Shrimp (*Pandalus borealis*) in Denmark Strait and off East Greenland** (SCR Doc. 02/147, 154)

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 codend 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.

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 between 9-11 000 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 except for 2001 when only about 1 800 tons was taken. 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 9 300 tons in 2001.

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

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Recommended TAC	5 000	5 000	5 000	5 000	5 000	5 000	9 600	9 600	9 600	9 600
North of 65°N, Greenland EEZ	3 563	3 359	4 823	2 351	1 300	3 115	3 223	3 404	1 769	1 008
North of 65°N, Iceland EEZ	2 553	1 514	1 151	566	2 856	1 421	769	132	10	1 141
North of 65°N, total	6 116	4 873	5 974	2 917	4 156	4 536	3 992	3 536	1 779	2 149
South of 65°N, Greenland EEZ	1 532	4 939	3 532	6 796	7 433	4 785	5 475	6 058	9 274	4 827
Total STATLANT 21A	7 648	9 812	9 506	9 713	11 589	9 321	9 467	9 594[1]	11 053[1]	
Total STACFIS	7 648	9 812	9 506	9 713	11 589	9 321	9 467	9 594	11 053	6 976[2]

[1] Provisional catches as estimated by STACFIS.
[2] Catches 1 January to 1 November 2002.

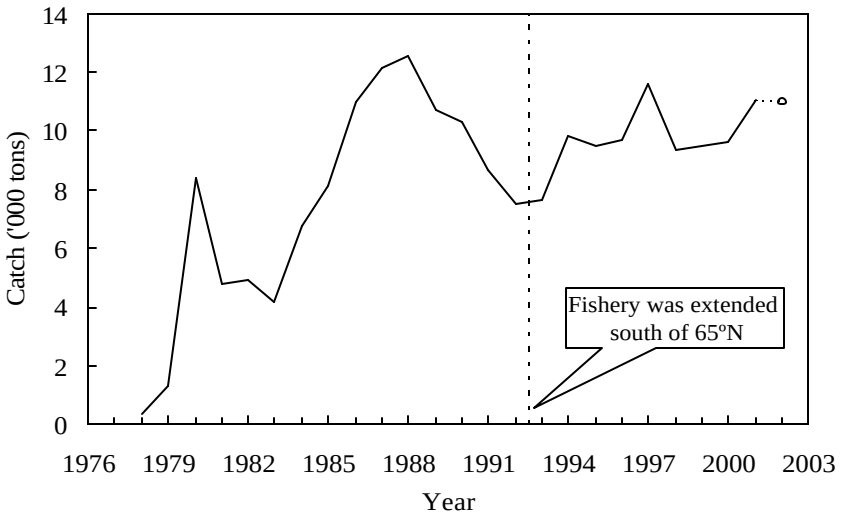


Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: total catches (2002 projected to the end of the year based on 1 January to 1 November data).

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 also showed an increasing trend since 1993 (Fig. 4.3), to reach a peak in 1999 and declined thereafter.

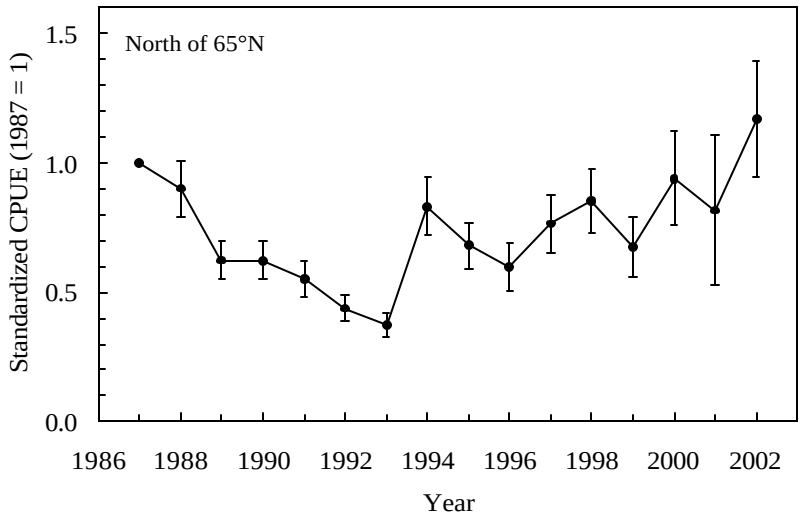


Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ± 1 SE calculated from logbook data from Danish, Faroese, Greenlandic and Icelandic vessels fishing north of 65°N.

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 with an increasing trend. The 2001 and 2002 values equal that at the start of the time series in 1987 (Fig. 4.4).

A re-evaluation of basic logbook input data for 1997-2001 were made in 2002. STACFIS noted that whereas the 2001 analysis, showed northern-area standardized CPUE to peak in 1998, the 2002 analysis did not. The trend in the southern area index did not change by the data re-evaluation, however the 1997-2001 index values were noted to be higher relative to previous years in the series than seen in last years analyses. Only minor changes were noted in the overall index.

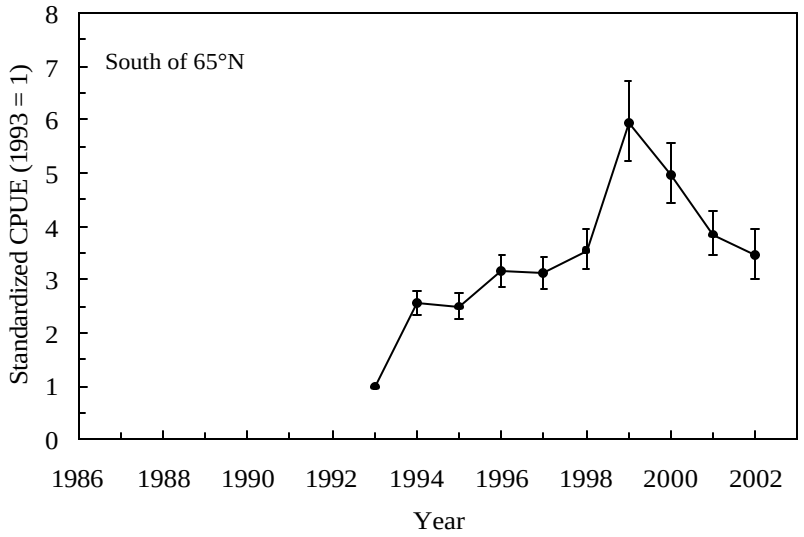


Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ± 1 SE calculated from logbook data from Danish, Faroese and Greenlandic vessels fishing south of 65°N.

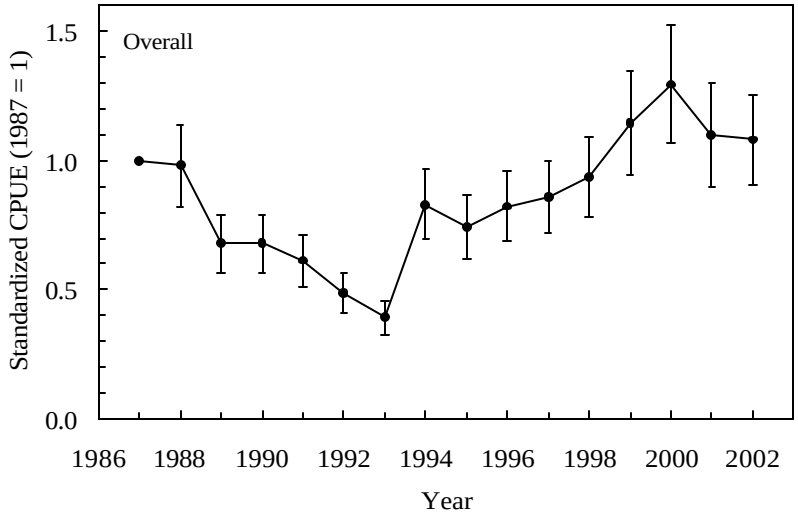


Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ± 1 SE combined for the total area.

An index of exploitation rate (catch divided by standardized CPUE) for the total area 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).

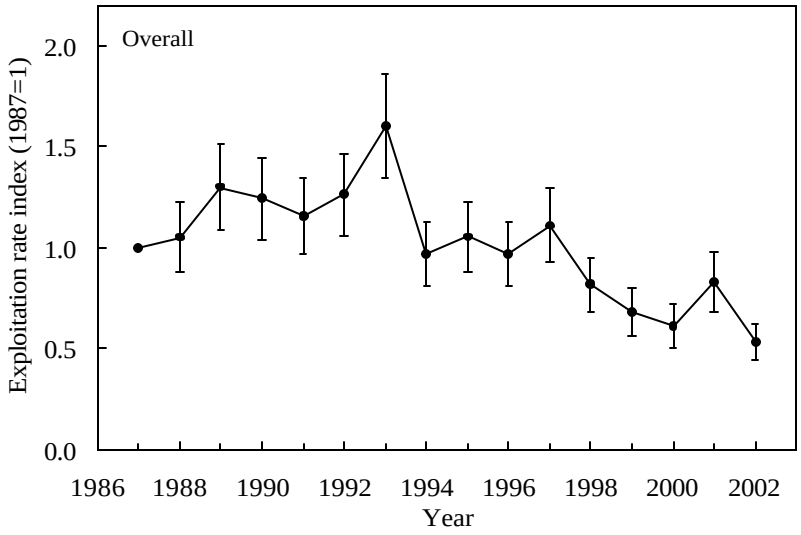


Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized exploitation-rate indices (1987 = 1) with ± 1 SE combined for the total area.

Biological data. Since 1991 samples representing between 0.1% and 3% of the annual catch in the total area were taken onboard vessels for obtaining annual estimates of size and sex composition. However, only few samples were available for 2001 and 2002. The overall results, however, 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) >25mm. Shrimp smaller than 17 mm CL have always been less than 0.1% by number, so recruitment to the fishery can not be predicted.

Samples from the fishery in the northern area indicated that the catches in late-1980s and the 1990s were dominated by females, but that males were more abundant in 2000. Insufficient sampling was done in the northern area in 2001 and 2002.

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 but samples only represented 0.4% of the catches. No sampling was done in the southern areas in 2002.

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 pre-recruits.

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 2001–2002 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 2002 the exploitation rate index (catch/CPUE) has been at its lowest levels in the 16-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 2001 and 2002 values equals 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 be conducted, to provide fishery independent data of the stock throughout its range.*

- *sampling of catches by observers – essential for assessing stock age, size and sex composition – be re-established.*

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 H. Siegstad (Denmark/Greenland) would not continue as Designated Expert for Northern shrimp in Subareas 0 and 1. The Committee accepted the nomination of C. Hvingel to the position. Noting final confirmation will be made through the Greenland Institute of National Resources, STACFIS 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 Subareas 0+1 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.