

## **PART D**

### **Scientific Council Meeting, 11-17 November 1999**

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**Participants of Scientific Council Meeting, 11-17 November 1999 at the Marine Research Institute, Reykjavik, Iceland**

H.-J. Ritz, A. Salthaug  
W. B. Brodie, P. A. Koeller, D. C. Orr  
M. C. S. Kingsley, P. Kanneworff, D. C. Carlsson, L. Savard  
R. K. Mayo, U. Skjaldtír, H. Siegstad  
D. C. A. Auby, . Nicolajsen, T. Amaratunga

Not in picture: D. Kalinov, S. Vidarsdottir



**Scientific Council Meeting, 11-17 November 1999**

**L to R:** R. K. Mayo (Chairman STACREC), W. B. Brodie (Chairman Scientific Council),  
H.-J. Rütz (Chairman STACFIS)

## REPORT OF SCIENTIFIC COUNCIL

11-17 November 1999

Chairman: W. B. Brodie

Rapporteur: T. Amaratunga

### I. PLENARY SESSIONS

The Scientific Council met at Marine Research Institute, Skulagata 4, 121 □ Reykjavik, Iceland, during 11-17 November 1999. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Germany), Iceland, Latvia (registered on 16 November 1999), Norway and United States of America. The Assistant Executive Secretary was in attendance.

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

The opening session was called to order at 1000 hours on 11 November 1999

The Chairman, W. B. Brodie (Canada), welcomed everyone to Reykjavik and to this meeting of the Scientific Council to conduct assessments on northern shrimp in Division 3M, Subareas 0 and 1, and Denmark Strait. The Assistant Executive Secretary was appointed rapporteur.

The Provisional Agenda was considered and **adopted** without changes (see Part E, Agenda IV, this volume).

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

The session was adjourned at 1030 hours.

The Council met as needed through 11-17 November 1999, and the concluding session was convened at 0900 hours on 17 November 1999. The Council addressed the requests of the Coastal States and considering the results of the assessments, provided advice and recommendations. The Council addressed 'Other Matters' in the agenda. The Council then considered and **adopted** the STACFIS and STACREC Reports, and considered its own report and **adopted** the report of this meeting of 11-17 November 1999.

The meeting was adjourned at 1745 hours on 17 November 1999.

The Reports of the Standing Committees as **adopted** by the Council are appended as follows: Appendix I □ Report of Standing Committee on Fisheries Science (STACFIS), Appendix II □ Report of Standing Committee on Research Coordination (STACREC), and Appendix III □ Report of Standing Committee on Publications (STAC PUB).

The Agenda, List of Research (SCR) and Summary (SCS) Documents, List of Participants and List of Recommendations of this meeting are given in Part E, this volume.

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

### II. FISHERIES SCIENCE

The Council **adopted** the Report of Standing Committee on Fisheries Science (STACFIS) as presented by the Chairman, H.-J. Ritz. The full report is given at Appendix I.

The Council's summary sheets and conclusions on and northern shrimp in Div. 3M, northern shrimp in Subareas 0+1 and northern shrimp in Denmark Strait are presented in Section IIIa, b and c, respectively, of this report. **The recommendations with respect to stock advice appear therein.**

The **recommendations** made by STACFIS for the work of the Scientific Council as **endorsed** by the Council, are as follows:

1. For northern shrimp in Div. 3M,
  - *Number-at-age from the EU survey results and commercial data should be estimated to provide insight to mortality and year-class strengths.*
  - *Given that the EU and Faroese surveys do not provide reliable estimates of shrimp at age two, directed research surveys should be initiated, or existing surveys should be modified (e.g. addition of a juvenile shrimp bag to the standard gear).*
  
2. For northern shrimp in Div. 0A and Subarea 1,
  - *an analysis of the length-frequency data of shrimp in order to obtain an age composition be conducted,*
  - *an analysis of the distribution of the stock and of the individual growth of shrimp be conducted in relation to environmental conditions, together with a comparison of trends and changes in mean temperatures and mean size at sex change of the shrimp,*
  - *the survey strategy and design be further improved and the effect of recent changes in survey design and execution be further studied.*
  
3. For northern shrimp in Denmark Strait,
  - *a survey be conducted to provide fishery independent data of the stock throughout its range,*
  - *standardized CPUE analyses be updated to include data from all fleets fishing in the area,*
  - *commercial catch sampling of the fishery be improved to fully cover seasonal and spatial variation, so that size, sex and age composition of the catch can be accurately described,*
  - *an analysis of distribution, individual growth and mean size at sex change of shrimp in relation to environmental conditions be undertaken.*

### **III. RESEARCH COORDINATION**

The Council **adopted** the Report of the Standing Committee on Research Coordination (STACREC) as presented by the Chairman, R. K. Mayo. The full report is given at Appendix II.

The **recommendations** made by STACREC for the work of the Scientific Council as **endorsed** by the Council, is as follows:

1. Given the critical need to acquire information on small shrimp, it was **recommended** that *appropriate steps be taken as soon as possible to test the feasibility of adding a juvenile shrimp bag to the trawl used in the EU groundfish survey on Flemish Cap.*
  
2. Given the desirability to improve the analytical basis of northern shrimp stock assessments, and the additional information which can be derived by systematically tracking cohorts, it was **recommended** that *Contracting Parties submit all available commercial and survey data related to determining age of shrimp to the Designated Expert managing the international age assessment database.*

#### **IV. FORMULATION OF ADVICE**

##### **1. Advice for Northern Shrimp Stocks**

The Council reviewed the STACFIS assessments of northern shrimp in Div. 3M, Subareas 0 and 1, and Denmark Strait and the agreed summaries are as follows:

**Northern Shrimp (*Pandalus borealis*) in Division 3M**

**Background:** The shrimp fishery in Div. 3M began during April 1993. Since then as many as 15 nations have joined the fishery.

**Fishery and catches:** Total catches were approximately 28 000 tons in 1993, increased to 48 000 tons in 1996 and declined thereafter.

The provisional catches are as follows:

Year	Catch <sup>1</sup> (’000 tons)	TAC	
		Recommended	Agreed
1993	28	na	-
1994	24	tm	tm
1995	33	tm	tm
1996	48	ndf	er
1997	25	lpl	er
1998	30	lpl	er
1999 (to October) <sup>2</sup>	32	30	er
2000		30	

<sup>1</sup> STACFIS estimates.

<sup>2</sup> STACFIS estimate to end of 1999 is about 35 000 tons.

- na No advice.
- tm Technical measures.
- ndf No directed fishery.
- er Effort regulations.
- lpl Lowest possible level.



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

**Assessment:** No analytical assessment is available and fishing mortality is unknown. Evaluation of

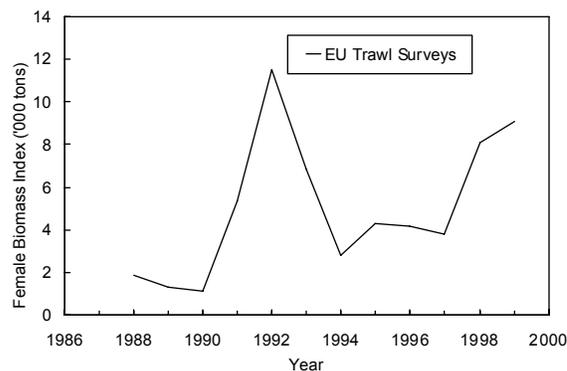
stock status is based upon interpretation of commercial fishery and research survey data.

**CPUE:** Standardized catch rates declined between 1993 and 1994, fluctuated without trend until 1997 and increased thereafter.



**Recruitment:** The 1995 and 1996 year-classes are indicated to be above average in 1998 and 1999. These year-classes are expected to contribute to the female component in 2000 and 2001 and maintain the spawning stock biomass.

**Biomass:** Indices of female biomass from the EU-surveys were relatively stable between 1994 and 1997. The female biomass index increased significantly from 1997 to 1998 and remained high in 1999.



**State of the Stock:** Scientific Council is unable to estimate absolute stock size. However, based on the EU survey and commercial data the stock appears to have increased from 1997 to 1999.

**Recommendations:** Available data indicated an increase in stock size since 1997, supported by recruitment of several relatively strong year-classes. Based on current information on biomass and expected recruitment, Scientific Council maintains its advice for 2000. Given the current stock biomass and assuming that the 1997 year-class recruiting to the 2001 fishery will be of average strength, the

Scientific Council advises that catches in 2001 should not exceed 30 000 tons.

**Reference Points:** Scientific Council is not in a position to propose reference points at this time.

**Special Comments:** The Council's ability to assess the resource will not improve until a time series of research surveys directed for shrimp is developed which can allow for the prediction of recruitment.

Scientific Council advice for 2001 will be re-evaluated during the November 2000 Meeting.

**Sources of Information:** SCR Doc. 99/73, 92, 101, 103, 106, 112, 114, 116.

**Northern Shrimp (*Pandalus borealis*) in Sub-areas 0 and 1**

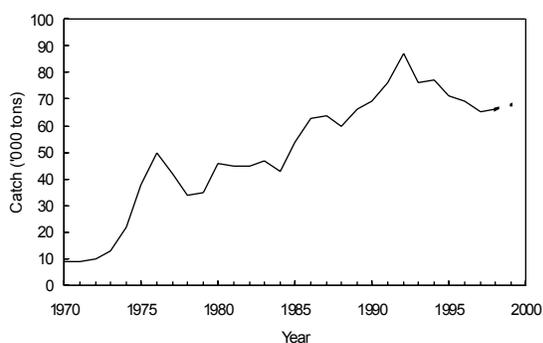
**Background:** A small-scale inshore fishery began in SA 1 during the 1930s. Since 1969 an offshore fishery has developed and the shrimp fishery is the largest fishery in Davis Strait.

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

Year	Catch ('000 tons) <sup>1</sup>			TAC ('000 tons) Recommended
	Inshore	Offshore	Total	
1996	17.4	51.9	69.2	60.0
1997	13.5	51.0	64.5	60.0
1998	9.4	5	6.6	66.1
1999			67.5 <sup>2</sup>	65.0

<sup>1</sup> Provisional.

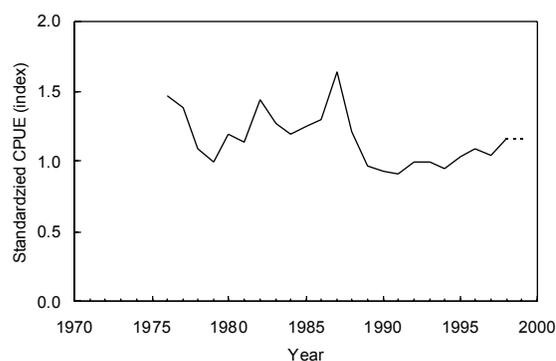
<sup>2</sup> Projected to the end of 1999



**Data:** Catch, effort and biological sampling data were available from the offshore fishery, and catch and effort data from the Greenland small vessel fleet. Time series of biomass indices and size and sex composition data were available from research surveys from both offshore and inshore areas.

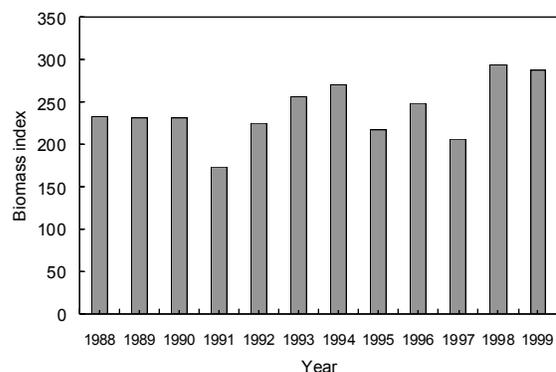
**Assessment:** No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data (catch, effort and standardized catch rates), time series of research biomass indices and biological data.

**CPUE:** A standardized catch-rate index for 1976-99 remained stable during the early-1990s, but has shown a slight increase since 1994. The projected 1999 value equals that of 1998, which was the highest on record during the 1990s. Catch rates of female shrimp have remained stable since 1993.



**Recruitment:** The length-frequency distributions in the 1998 and 1999 commercial catches and surveys show good representation of all sizes of males. Males between 14 and 22 mm carapace length are very abundant and are expected to contribute to the female component and maintain the spawning stock biomass.

**Biomass:** The survey biomass index in 1999 is similar to the 1998 value and is among the highest since 1988.



**State of the Stock:** Scientific Council is not able to provide estimates of absolute stock size. However, based on available indices, the stock size does not appear to have changed in recent years under the present level of exploitation.

**Recommendations:** Based on the observed stability in the stock at recent catches of approximately 65 000 tons, Scientific Council repeats the advice given in 1998 and recommends that catches of northern shrimp in Subareas 0 and 1 in 2000 should not exceed 65 000 tons.

**Reference Points:** Scientific Council is not in a position to propose reference points at this time.

**Special Comments:** The database for the survey period 1988-99 has been revised. The overall trends through the period have not changed significantly.

**Sources of Information:** SCR Doc. 99/105, 107, 109, 110, 113.

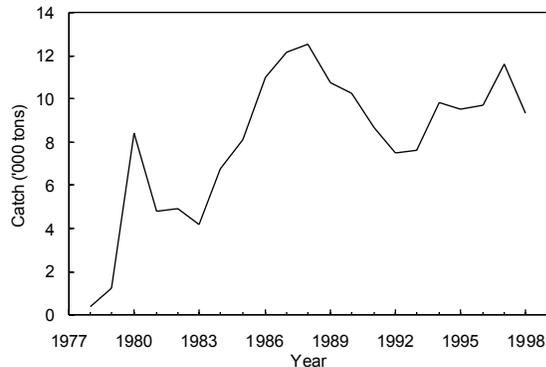
**Northern Shrimp (*Pandalus borealis*) in Denmark Strait**

**Background:** The fishery for northern shrimp began in areas north of 65°N in Denmark Strait in 1978. Areas south of 65°N were exploited after 1992.

**Fishery and Catches:** This fishery soon became a multi-national fishery with recent catches and TACs as follows:

Year	Catch <sup>1</sup> (‘000 tons)	TAC (‘000 tons)	
		Recommended	Agreed <sup>2</sup>
1996	9.7	5.0	9.6
1997	11.6	5.0	9.6
1998	9.3	5.0	9.6
1999(to 1 Nov)	7.1	9.6	10.6

<sup>1</sup> Provisional.  
<sup>2</sup> Only for Greenland EEZ



**Data:** Catch and effort data were available from trawlers of several nations. Biological sampling data were available from vessels from Greenland and Iceland. No surveys were conducted since 1996.

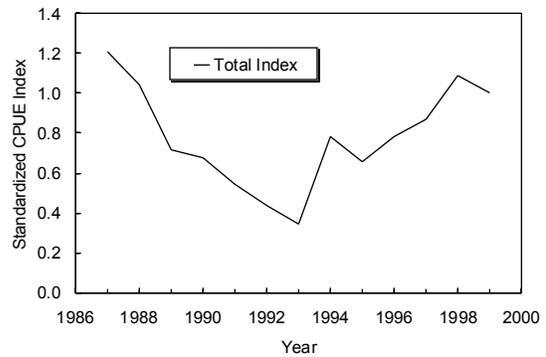
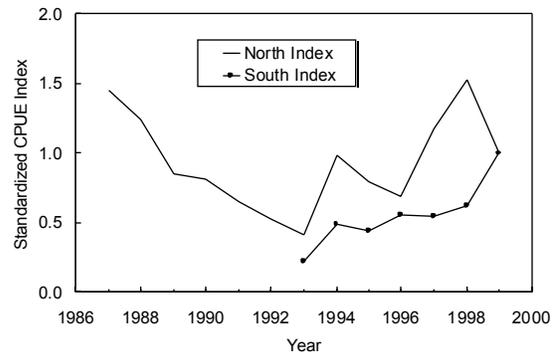
**Assessment:** No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data and biological data.

**CPUE:** In the northern area the standardized CPUE indices are now higher than the minimum values reached in 1989-93 and are approaching the level observed during the mid-1980s. Catch rates in the southern area have increased since 1993. Available data for 1999 for the total stock area indicate stability from 1998 to 1999.

**Recruitment:** No data were available to estimate trends in recruitment.

**Biomass:** No biomass estimates were available.

**State of the Stock:** The Scientific Council is not able to provide estimates of absolute stock size. Standardized CPUE data from both the northern and the southern areas indicate a general increasing trend in fishable biomass from 1993 to 1998. Limited data for 1999 suggest no further increase for the total stock.



**Recommendation:** Given the lack of change in the CPUE index for the total stock from 1998 to 1999 at recent catch levels Scientific Council repeats the advice given in 1998 and recommends that catches of northern shrimp in Denmark Strait in 2000 should not exceed 9 600 tons.

**Reference Points:** Scientific Council is not in a position to propose reference points at this time.

**Special Comments:** Insufficient commercial data and a lack of survey data along with uncertainty on stock structure make assessment of this stock difficult.

**Sources of Information:** SCR Doc. 99/108, 115.

## 2. Responses to Special Requests

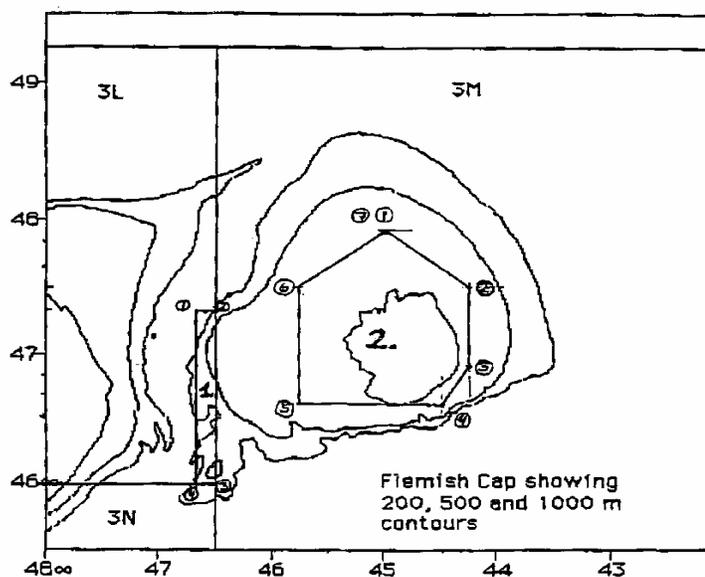
### a) Response to the Fisheries Commission

The Fisheries Commission at its September 1999 Meeting requested the Scientific Council to respond to the following (see FC Doc. 99/16):

*The Scientific Council was requested at its 11-17 November 1999 Meeting to evaluate, on the basis of the best data available, whether the provision for a Div. 3M shrimp closure in FC Working Paper 99/16 would be a precautionary approach-based measure and if so, whether the proposed area and timing of the closure are appropriate.*

*Vessels fishing for Div. 3M shrimp may fish this stock in 2000 in Division 3M and in the area defined by the coordinates in footnote 1. However, in the period from 1 June 2000 (00.01 GMT) to 30 September 2000 (24.00 GMT), fishing for shrimp in the area defined by the coordinates in footnote 2 is prohibited.*

Footnote 1:



Footnote 2:

<i>Point No.</i>	<i>Latitude</i>	<i>Longitude</i>
1 (same as no. 7)	47°55'0	45°00'0
2	47°30'0	44°15'0
3	46°55'0	44°15'0
4	46°35'0	44°30'0
5	46°35'0	45°40'0
6	47°30'0	45°40'0
7 (same as no. 1)	47°55'0	45°00'0

The Scientific Council noted that the objective of the proposed management measure is not explained in relation to the conservation of the resource. Therefore, it is difficult to comment on the pertinence of the proposal.

The area defined by the coordinates given in the request corresponds roughly to the shallower waters of the Flemish Cap (less than 275 m) and is known to sustain small (young) shrimp. If the shallower waters correspond to the grounds where young shrimp settle and spend their first years and if the distribution of shrimp is similar from one year to the other, the closure of the fishery in that area could be a precautionary measure to prevent the catch of juveniles. It is difficult to estimate quantitatively the gain in yield of not catching a certain amount of small shrimp. However, preventing the catch of juveniles would likely enhance the recruitment to the spawning stock.

At present, the Scientific Council is unable to provide an assessment of the impact of the proposed closure and cannot comment on the appropriateness of the coordinates, the area or the timing of the closure. However, it seems that analysis of existing fishery and survey data could give insights on the distribution of shrimp on the Flemish Cap. If relevant information is presented to the Scientific Council Meeting of November 2000, the Council notes that it could be possible to evaluate the impact of the proposed measure. Therefore, the Scientific Council **recommended** that:

- i) *analysis of data from the EU, Faroese and the 1996 Canadian surveys be made to determine the distribution of shrimp by year, depth, size and age and to identify areas where juveniles and adults are found, and*
- ii) *analysis of the commercial fishery data be made to determine the abundance of juvenile shrimp in the total catch as well as the distribution of juveniles and adults in the catches by year, month, depth, size and age.*

b) **Response to Coastal States**

The Scientific Council was requested by Denmark (Greenland) *for northern shrimp (Pandalus borealis) in Subareas 0 and 1 and in Denmark Strait to comment on advantages and disadvantages of multiyear management advice* (see Part E, Agenda IV, Annex 3, Item 3).

Scientific Council discussed the possibilities of providing multiyear advice for northern shrimp in Subareas 0+1 and Denmark Strait. Two obstacles to implementing a multiyear approach were noted:

- i) Scientific Council is unable to forecast medium-term changes in shrimp stocks at present, because of lack of age-structured data, estimates of natural mortality and recruitment index.
- ii) Northern shrimp is a short-lived species, and stock size may change drastically within a short time owing to changes in the environment, variation in recruitment, or changes in abundance of predators.

Scientific Council noted that the provision of a single year advice for northern shrimp for Subareas 0+1 and Denmark Strait is a consequence of the situation noted in items i and ii above. The advice for the fishery for the coming year is based on survey and commercial data from the current year. The advice is therefore based on the most recent data and when prediction of the coming year's fishery conditions can be as reliable as possible.

Multiyear advice (usually for 2, sometimes 3 years) has been implemented for some stocks of finfish in the Northwest Atlantic. Their common feature is that they are usually long-lived species, presently at a low level and stock status is not expected to change suddenly.

c) **Responses to Fisheries Commission and Coastal States**

The Scientific Council was requested to advise on any new information that may be available on the application of the Precautionary Approach (see Part E, Agenda IV, Appendix III, Annexes 1 and 2).

During the assessment of the three northern shrimp stocks at this Scientific Council Meeting, the Council noted that reference points could not be proposed at this time.

Scientific Council also noted that the "traffic light" approach which was considered at the Scientific Council Meeting in April-May 1999 in San Sebastian, Spain, does not provide information on reference points under the PA. To progress with this method will require some quantification of the evaluations and some links to proposed management measures when the "traffic lights" change color.

The Council, however, agreed to proceed with this approach. A template was agreed upon and evaluations of various categories of information were conducted. Scientific Council recognized that further work on this approach was necessary and **recommended** that *Designated Experts for the three northern shrimp stocks work by correspondence to develop the "traffic light" methodology for the November 2000 Scientific Council Meeting on shrimp.*

The following are the evaluations developed during this meeting for northern shrimp in Div. 3M, Subareas 0+1 and Denmark Strait, respectively.

**Application of Traffic Light/Checklist Approach to Shrimp in Div. 3M (Flemish Cap)**

THE FISHERY	
Catch	Increased from 28 000 tons in 1993 to 48 000 in 1996 and decreased thereafter.
Effort	Standardized effort index (standard Canadian, Icelandic, Greenlandic and Norwegian data set) doubled from 1993 to 1996 then decreased by two thirds through 1999. Effort regulations were implemented in 1996 and have continued since then. The amount of double trawling has increased substantially since the fishery began.
By-catch of other species	Prior to 1995, redfish by-catch was problematic. Although much lower during the 1995-99 period, it is not clear whether this was due to the reduction of maximum bar spacings in sorting grates from 28 mm in 1994 to 22 mm in 1995 or to the absence of strong redfish recruitment. Cod and Greenland halibut were taken only in small quantities.

INDEX	OBSERVATION	INTERPRETATION	EVALUATION
<b>FISHERY DATA</b>			
CPUE - KG/HR	Standardized CPUEs decreased from 340 in 1993 to 238 in 1994, fluctuated without trend until 1997 and increased to 343 by 1999.	Reflects increase in biomass since 1997.	1
Spatial pattern	Spatial distribution of effort differed among years. Approximately 50% of the effort has been applied in the northwestern area, in each year since 1993.	No localized concentration of fishing effort.	1
Catch composition	The average CPUE of 4 year olds during the years 1997-1999 is greater than in preceding years.	The 1993, 1994 and 1995 year-classes are indicated to be strong.	1
Sex inversion	Age of sex inversion has varied between 4 and 5 years of age.	Interpretation is difficult.	0
<b>RESEARCH DATA</b>			
Spatial pattern	Geographic distributions were widespread mainly in depths from 250 - 550 m.	No contraction in stock range is evident.	1
Recruitment (male age structure)	The 1995 and 1996 year-classes are indicated to be above average in 1998 and 1999. No estimates are available for the 1997 and 1998 year-classes.	Unable to forecast recruitment to the fishery beyond 2000.	0
Spawning stock (females)	Indices of female biomass from the EU-surveys were relatively stable between 1994 and 1997. The female biomass increased significantly from 1997 to 1998 and remained high in 1999.	The EU total biomass estimates for 1994 and 1998 are not comparable with other years, however, the 20 mm proxy index indicates that the female component of the stock is growing.	1
<b>OTHER DATA</b>			
Predation	Abundance of known predators such as cod and American plaice remains low in 3M, however, the abundances of Greenland halibut have increased.	Unknown impact	
Immigration	It has been hypothesized that recruitment and/or spawning biomass are being supplemented by immigration from adjacent areas in Div. 3LN and further north in Div. 2,13K	No data available to test this hypothesis.	
Environment	Colder than normal conditions from the late 1980's to 1995 moderated in 1996 and continued above normal until 1999.	Effects of temperature on shrimp production in the Flemish Cap area are uncertain.	0
<b>Stock Status</b>			
Current Status	Considering the above indices.	Stock appears to have increased from 1997 to 1999.	1
Future Prospects	2000: Considering the above indices.	Stock is likely to remain at the current level through 2000.	1
	2001: Considering the above indices.	Uncertainty due to lack of information on incoming year-classes.	0

Concerns regarding current status and/or future prospects

Uncertainty regarding the impact

Positive evaluation



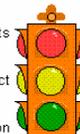
### Application of Traffic Light/Checklist Approach to Shrimp in Subareas 0+1

INDEX	OBSERVATION	INTERPRETATION	EVALUATION
<b>FISHERY DATA</b>			
<b>Landings and effort</b>	The average landings has been 67 000 tons for the last 5 years, effort has decreased in the same period. Fewer vessels in recent years.	Stable or increasing biomass	+1
<b>CPUE - KG/HR</b>	A standardized catch-rate index for 1976-99 remained stable during the early 1990s, but has shown a slight increase since 1994. The projected 1999 value equals that of 1998, which was the highest on record during the 1990s. Catch rates of female shrimp have remained stable since 1993.		
<b>Catch composition</b>	The proportion of males in the catch increased from 30-40% in 1991-92 to 60-70% between 1995-99.	Increase in abundance of males (or change in targeting of shrimp sizes or reduction in discarding)	0
<b>Sex inversion</b>	No information is available		-
<b>RESEARCH DATA</b>			
<b>Biomass index</b>	The survey biomass index in 1999 is similar to the 1998 value and is among the highest since 1988.	Stable or increasing biomass	+1
<b>Recruitment (males)</b>	The length-frequency distributions in 1998 and 1999 show good representation of all sizes of males.	High abundance, expected to contribute to the female component and maintain the spawning stock biomass.	+1
<b>Spawning stock (females)</b>	Female abundance in the survey in 1998 and 1999 is the highest in the time series.	No concern with SSB	+1
<b>OTHER DATA</b>			
<b>Geographic Stock Structure</b>	The shrimp stock off West Greenland is distributed in NAFO Div. 0A and Subarea 1 and the entire shrimp stock is assessed as a single population.	No data presented to change this view. No basis for concern.	+1
<b>Environment</b>	The temperature has increased since 1990.	Effects of changes in temperature on shrimp stock in Division 0+1 area are uncertain.	0
<b>Predation</b>	Most groundfish stocks in this area are at low levels.	Not considered	-
<b>Bycatch of others species</b>	Use of sorting grid is not compulsory. Bycatches of redfish and Greenland halibut are considerable.	No effect on the shrimp stock. Probability of recovery of some groundfish would be enhanced if the bycatch could be significantly reduced.	-
<b>STOCK STATUS</b>			
<b>Current status</b>	Considering the above indicies.	Based on available indices, the stock size does not appear to have changed in recent years under the present level of exploitation.	+1
<b>Future prospects</b>	Considering the above indicies.	In the short term the stock appears stable and recruitment appears to be secured	+1

Concerns regarding current status and/or future prospects

Uncertainty regarding the impact

Positive evaluation



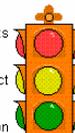
### Application of Traffic Light/Checklist Approach to Shrimp in Denmark Strait

INDEX	OBSERVATION	INTERPRETATION	EVALUATION
<b>FISHERY DATA</b>			
<b>Landings and effort</b>	Overall landings have fluctuated, but increased, since 1990. Effort has been decreasing over the same years.	Stable or increasing biomass since 1992.	
<b>CPUE - KG/HR</b>	In the northern area the standardized CPUE indices are now higher than the minimum values reached in 1989-93 and are approaching the level observed during the mid-1980s. Catch rates in the southern area have increased since 1993.	Increasing overall CPUE from 1993 to 1998 indicates higher abundance, but may (partly) be based on inclusion of new fishing grounds. Available data for 1999 for the total stock area indicate stability from 1998 to 1999.	
<b>Catch composition</b>	Catches generally dominated by females in the northern area and by males in the southern area in the 1990s'.	Maintained overall abundance of both males and females combined with increase in CPUE since 1993.	
<b>Sex inversion</b>	No conclusive information available.		-
<b>RESEARCH DATA</b>			
<b>Biomass index</b>	No surveys since 1996.		-
<b>Recruitment (males)</b>	Not available		-
<b>Spawning stock (females)</b>	Not available		-
<b>Size and age composition</b>	Not available		-
<b>OTHER DATA</b>			
<b>Geographic stock structure</b>	Two distinct fishing areas (North and South). Smaller age/size groups do not appear in commercial data and in earlier survey data.	Shrimp from the two fishing areas assumed to belong to the same stock, but the fishery may exploit these component differently. Recruitment to smallest male groups in stock area may come from shallow coastal water in the area or from north/northeast.	
<b>Environment</b>	Temperatures increasing (about 2 °C) over the last two years.	Effects of temperature on shrimp production in Denmark Strait area are uncertain.	
<b>Predation</b>	No information available		-
<b>Bycatch of other species</b>	Use of sorting grids not compulsory.		-
<b>STOCK STATUS</b>			
<b>Current status</b>	Considering the above indicies.	Standardized CPUE data from both the northern and the southern areas indicate a general increasing trend in fishable biomass from 1993 to 1998. Limited data for 1999 suggest no further increase for the total stock.	
<b>Future prospects</b>	Considering the above indicies.	In the short term the stock appears stable and recruitment appears to be secured. Lack of survey data make prediction of recruitment very difficult.	

Concerns regarding current status and/or future prospects

Uncertainty regarding the impact

Positive evaluation



## V. OTHER MATTERS

### 1. **Scientific Council Meeting on Northern Shrimp, November 2000**

The Council reconfirmed that the meeting for the assessments of northern shrimp in Div. 3M, northern shrimp in Subareas 0 and 1 and northern shrimp in Denmark Strait, will be held during 8-15 November 2000 in Copenhagen, Denmark.

The Council noted that this includes an additional day to address matters pertaining to advice on shrimp in Div. 3L as well as the issue of closure of an area within Div. 3M.

### 2. **Scientific Council Meeting on Northern Shrimp, November 2001**

The Council agreed to provisionally schedule this meeting for 7-14 November 2001, to be held in Dartmouth, Nova Scotia, Canada.

## VI. ADJOURNMENT

There being no further business, the Chairman thanked all participants for their contributions during the meeting. Special thanks were extended to the Designated Experts of the three stocks, the Chairs of STACFIS and STACREC, the hosts of the meeting for their hospitality (MRI and Unnur Skjaldtíróttir), and to the NAFO Secretariat. The meeting was then adjourned.

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

Chairman: H.-J. Ritz

Rapporteur: Various

The Committee met at Marine Research Institute, Skulagata 4, 121 - Reykjavik, Iceland, at various times during 11-17 November 1999 to consider and report on matters referred to it by the Scientific Council, particularly those pertaining to the provision of scientific advice on northern shrimp stocks in Division 3M, Subareas 0 and 1 and Denmark Strait. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Germany), Iceland, Norway and United States of America. The Assistant Executive Secretary was in attendance.

### I. STOCK ASSESSMENTS

#### 1. Review of 1998 Recommendations

STACFIS reviewed the 1998 research recommendations addressing requirements for essential information about commercial and survey data as well as interactions between the stocks and recent environmental changes. STACFIS noted that there were some contributions addressing the research recommendations formulated during the Scientific Council Meeting of 1998 and accordingly considered them under the relevant stock during the following assessments.

#### 2. Northern Shrimp (*Pandalus borealis*) in Division 3M (SCR Doc. 99/73, 92, 101, 103, 106, 112, 114, 116)

##### 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. The number of vessels was 66 in 1993, increased to 110 in 1996, but decreased thereafter to 45 in 1998 and 46 in 1999. Vessels from 15 nations have participated in this fishery.

Total catches were approximately 28 000 tons in 1993, then increased to 48 000 tons in 1996 and declined thereafter (Fig. 1.1). Catch statistics to October 1, 1999 indicate removals of about 32 000 tons. This will likely result in a total catch of about 35 000 tons by the end of the year. STACFIS estimates of recent catches (tons) by year are given below.

	1993	1994 <sup>1</sup>	1995 <sup>1</sup>	1996 <sup>1</sup>	1997 <sup>1</sup>	1998 <sup>1</sup>	1999 <sup>1,2</sup>
Catch	28 088	24 324	32 997	48 288	24 754	30 131	31 573

<sup>1</sup> Provisional.

<sup>2</sup> STACFIS estimate to October.



Fig. 1.1 Northern shrimp in Div. 3M: nominal catches.

b) **Input Data**

i) **Commercial fishery data** (SCR Doc. 99/103, 112, 116)

**Discards.** Data on shrimp discarding from the Canadian and Greenlandic shrimp fisheries in 1999 showed that discard levels remained low as in previous years, indicating that all sizes were being kept.

**Effort and CPUE.** Data from logbooks of Canadian, Greenlandic, Icelandic and Norwegian vessels were available. The spatial distribution of effort differed among years, but approximately 50 has been applied in the northwestern area every year. For the calculation of standardized CPUE, the Norwegian data were omitted due to lack of geographical information. A standardized CPUE series addressed differences due to seasonality, area, fishing power and gear (single and double trawl). A large CPUE decrease occurred from 1993 to 1994, CPUE fluctuated without trend until 1997 and increased thereafter (Fig. 1.2).



Fig. 1.2. Northern shrimp in Div. 3M: standardized CPUE index.

**Biological Data.** The percentage of males (numbers) varied between 44 and 72 from 1993 to 1999. Age composition was assessed from samples obtained from Canada, Greenland and Iceland. Kg/hr was calculated for each year-class by applying a weight /age relationship and the calculated proportions to the standardized CPUE data. The average CPUE of 4 year olds during the years 1997-99 is greater than in preceding years. The 1993, 1994 and 1995 year-classes are indicated to be strong.

ii) **Research survey data**

**Environmental data** (SCR Doc. 99/101). The water mass over the Flemish Cap is a mixture of Labrador Current and North Atlantic Current waters. Oceanographic data from the summer of 1999 on the Flemish Cap were presented and compared to the long-term (1961-90) average, and to summer conditions during subsequent years. The cold near-surface temperatures (0.5 to 2.0°C below normal) experienced over the Cap during 1993, 1995 and 1996 had warmed 0.5 to 1.5°C above normal in July of 1997 and increased to 2°C above normal by the summer of 1998 and 1999. Bottom temperatures on the Cap were slightly below normal during 1997, up to 0.5°C above normal during 1998 and up to 1°C above normal in 1999. Upper layer (top 100 m) salinities were above the long-term mean (by 0.2-0.5 PSU) during 1997-99, but were otherwise about normal. In general the colder than normal temperatures experienced over the continental shelf and on the Flemish Cap from the late-1980s up to 1995 moderated by the summer of 1996 and continued above normal until July, 1999. As in previous years, summer chlorophyll levels in the upper 100 m of the water column over the Cap were higher compared to the adjacent Grand Bank. Dissolved oxygen levels were about normal for the region. Both the measured currents and the geostrophic estimates, while showing considerable differences and variability between years, indicated a general anticyclonic circulation around the Flemish Cap.

**EU surveys** (SCR Doc. 99/106). EU groundfish surveys have been conducted on Flemish Cap in July from 1988 to 1999. The 1994 and 1998 total biomass indices are likely biased due to changes in sizes of codend mesh. The female biomass is not considered to be affected by the change of gear. Female shrimp biomass from 1991 to 1993 was substantially higher than during the 1988-90 and 1994-97 periods. The female biomass increased significantly from 1997 to 1998 and remained high in 1999.

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

Not comparable to other years because of different codend mesh size.

The surveys also showed that biomass in most years was highest in depths ranging from about 250 to 550 m. High concentrations were present in the southwestern and southeastern areas in 1998 and 1999.

Survey samples in 1998 were dominated by males at age two and three, while the 1999 survey samples were dominated by three and four year old males.

Cod (*Gadus morhua*), Greenland halibut (*Reinhardtius hippoglossoides*) and thorny skate (*Raja radiata*) stomach content analysis was used as a tool in establishing a male shrimp recruitment index (SCR Doc. 99/73). A relatively high percentage of one and two year old shrimp were found in cod; Greenland halibut and thorny skate preyed mainly upon two year old shrimp. It was noted that predator size and environmental influences may affect which sizes-classes are being preyed upon. Additionally comparisons of length frequencies between this study and those from the EU survey, for the years 1994 and 1998, may not be valid due to changes in EU survey codend mesh sizes.

**Faroese survey** (SCR Doc. 99/114). Stratified-random surveys were conducted in June 1997 and during July of 1998 and 1999 by a Faroese shrimp trawler. The biomass index, estimated by areal expansion, was about 17 000 tons in 1997, 23 500 tons in 1998 and 16 500 in 1999, however, the uncertainty in the estimates has not been quantified. Three and four year old males dominated the 1998 and 1999 estimated stock size in numbers.

### c) Assessment Results

*Commercial CPUE.* Standardized catch rates declined between 1993 and 1994, fluctuated without trend until 1997 and increased thereafter.

*Recruitment.* The 1995 and 1996 year-classes are indicated to be above average in 1998 and 1999. These year-classes are expected to contribute to the female component in 2000 and 2001 and maintain the spawning stock biomass.

*Biomass.* Indices of female biomass from the EU-surveys were relatively stable between 1994 and 1997. The female biomass increased significantly from 1997 to 1998 and remained high in 1999.

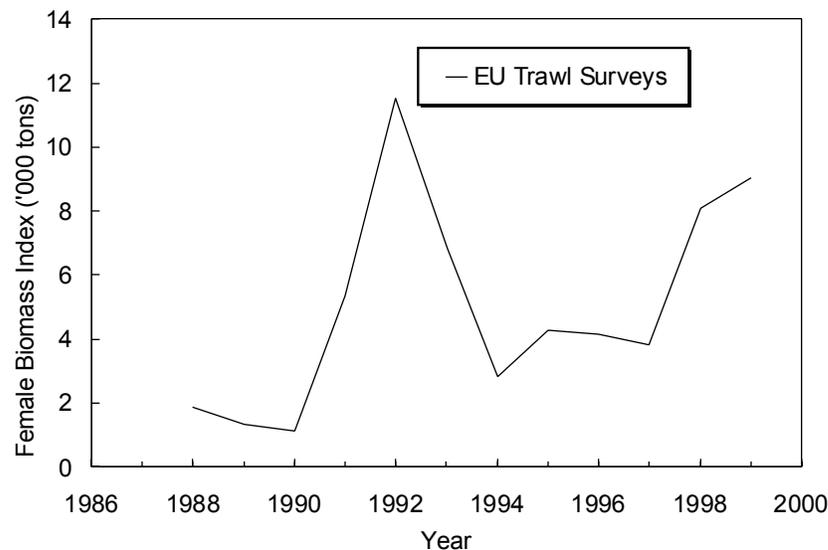


Fig. 1.3. Northern shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-99.

*State of the Stock.* STACFIS is unable to estimate absolute stock size. However, based on the EU survey and commercial data the stock appears to have increased from 1997 to 1999.

STACFIS considers it important to recognize that its ability to assess the resource will not improve until a time series of research surveys directed for shrimp is developed which can allow for the prediction of recruitment.

d) **Research Recommendations**

Progress was made on some of the 1998 research recommendations. Stomach content data from the 10 main groundfish species on Flemish Cap are being investigated for consumption of shrimp, and the development of a recruitment index was presented (SCR Doc. 99/106). A standardized database for biological samples was prepared for three nations, but more information is necessary. A CPUE index was developed using analytical methods. The model took into account changes in gear type (single and double trawl), seasonality, fishing power and area fished.

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

- *Number-at-age from the EU survey results and commercial data should be estimated to provide insight to mortality and year-class strengths.*
- *Given that the EU and Faroese surveys do not provide reliable estimates of shrimp at age two, directed research surveys should be initiated, or existing surveys should be modified (e.g. addition of a juvenile shrimp bag to the standard gear).*

3. **Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1** (SCR Doc. 99/105, 107, 109, 110, 113)

a) **Introduction**

The shrimp stock off West Greenland is distributed in NAFO Div. 0A and Subarea 1 and the entire shrimp stock is assessed as a single population. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A to 1F) in offshore and inshore areas (primarily Disko Bay). The Canadian fishery has been restricted to Div. 0A since 1981.

Three fleet components, one from Canada and two from Greenland (vessels above and below 80 GRT) participated in the fishery since the late-1970s. The Canadian fleet and the Greenland large-vessel fleet have been restricted by areas and quotas since 1977. The fishery by the Greenland small-vessel fleet was unrestricted until January 1997, when quota regulation was imposed.

Overall catches increased until 1992, then decreased from 1993 to 1997. Catches increased again slightly in 1998 and catches for 1999 are projected to be at the 1998 level (Fig. 2.1). Recent nominal catches and advised TAC (tons) for shrimp in Div. 0A and Subarea 1 are as follows:

	1989	1990	1991	1992	1993	1994 <sup>1</sup>	1995 <sup>1</sup>	1996 <sup>1</sup>	1997 <sup>1</sup>	1998 <sup>1</sup>	1999 <sup>1,2</sup>
Div. 0A Total	7 235	6 177	6 788	7 493	5 491	4 766	2 361	2 623	517	954	2 500
SA 1 Offshore	45 198	49 554	52 834	58 664	52 280	53 693	51 900	49 251	50 483	55 681	55 250
SA 1 Inshore	13 224	13 630	16 258	20 594	17 843	18 118	16 429	17 359	13 517	9 489	9 750
SA 1 Total	58 422	63 184	69 092	79 258	70 123	71 811	68 329	66 610	64 000	65 170	65 000
SA 0+1 Total	65 657	69 361	75 880	86 751	75 614	76 577	70 690	69 233	64 517	66 124	67 500
0+1 offshore catch	52 433	55 731	59 662	66 157	57 771	58 459	54 261	51 874	51 000	56 635	57 750
0+1 recomm. TAC <sup>3</sup>	44 000	50 000	50 000	50 000	50 000	50 000	60 000	60 000	60 000	55 000	65 000

<sup>1</sup> Provisional (STACFIS estimates from 1994-99).

<sup>2</sup> Projected to end of 1999.

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

The nominal catch of shrimp in the **offshore areas** of Subarea 1 and the adjacent part of Subarea 0 (Div. 0A) increased from less than 1 000 tons before 1972 to almost 43 000 tons in 1976. Catches fluctuated thereafter and stabilised around a level of 54 000 tons during 1985-88, then increased to about 66 000 tons in 1992 and decreased thereafter to about 56 000 tons in 1998. Total catch in the offshore areas for 1999 is projected to be slightly higher than the 1998 level. The Canadian fishery in Div. 0A amounted to about 2 500 tons in 1995 and 1996, declined to under 1 000 tons in 1997 and 1998. 2 500 tons has been reported up to October 1999.

Until 1988, the fishing grounds in Div. 1B have been the most important. Since then, a southward shift in the offshore fishery has taken place, and from 1990 catches in Div. 1C and 1D have exceeded those from Div. 1B. At the end of the 1980s, exploitation began in Div. 1E and 1F, and catches from these areas now account for about 20% of the total catch. The distribution of the fishery has not changed since 1996.

The West Greenland **inshore** shrimp fishery was relatively stable from 1972 to 1987 with estimated catches of 7 000-8 000 tons annually (except for 10 000 tons in 1974). Inshore catches in recent years have increased to over 20 500 tons in 1992, but decreased to 13 500 tons in 1997. During the 1990s inshore catches have accounted for about 25% of the total catch in Subarea 1. Catches in 1998 were less than 10 000 tons and 1999 preliminary data for 1999 (January-October) suggest catches at the same level as 1998.

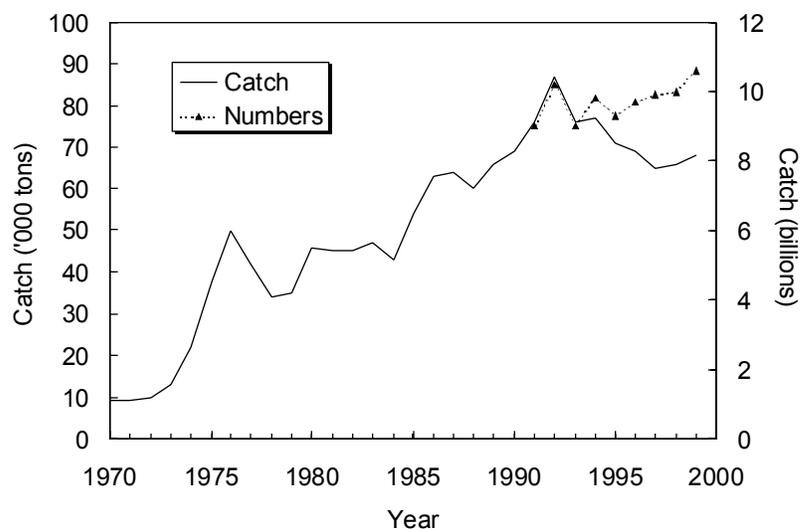


Fig. 2.1. Northern shrimp in Subareas 0 and 1: total catches in tons and numbers (1999 projected to the end of the year).

## b) Input Data

### i) Commercial fishery data

**Fishing effort and CPUE.** Catch and effort data from the shrimp fishery in 1999 were available from fishing records from Canadian vessels in Div. 0A and from Greenland logbooks for Subarea 1 (SCR Doc. 99/107).

A standardized catch rate (CPUE) index (Fig. 2.2) was presented (SCR Doc. 99/107, 113). CPUE data from Greenland vessels above 50 GRT fishing in Subarea 1 and Canadian vessels fishing in Div. 0A were used in multiplicative models to calculate annual catch-rate indices. One unified time series covering 1976-99 was calculated. All fleets included in the analysis mainly exploit shrimp greater than 16 mm carapace

length. The CPUE indices are therefore indicative of the older male and the female stock combined.

The standardized CPUE series showed a slightly increasing trend in the 1990s. The projected 1999 value equals that of 1998, which was the highest on record during the 1990s. However, the index may still be considered at a lower level than during the 1976-88 period.

Based on the standardized CPUE index, a standardized effort series was calculated (Fig. 2.3). Up to 1986, the standardized effort showed a slight increasing trend. Effort more than doubled between 1987 and 1992, since then standardized effort has decreased by about one third.

The CPUE of male shrimp increased steadily during the 1990s (Fig. 2.4), but the CPUE of females has remained relatively constant during the same period. However, it was noted that discarding of small shrimp was substantial between 1989 and 1992, but these discarded shrimp were not included in the CPUE calculations. Had these discards been included, male CPUE would have been estimated to be higher during the early-1990s and subsequent increase would have been less. This may also affect the perception of the slight increase in total CPUE during the same period.

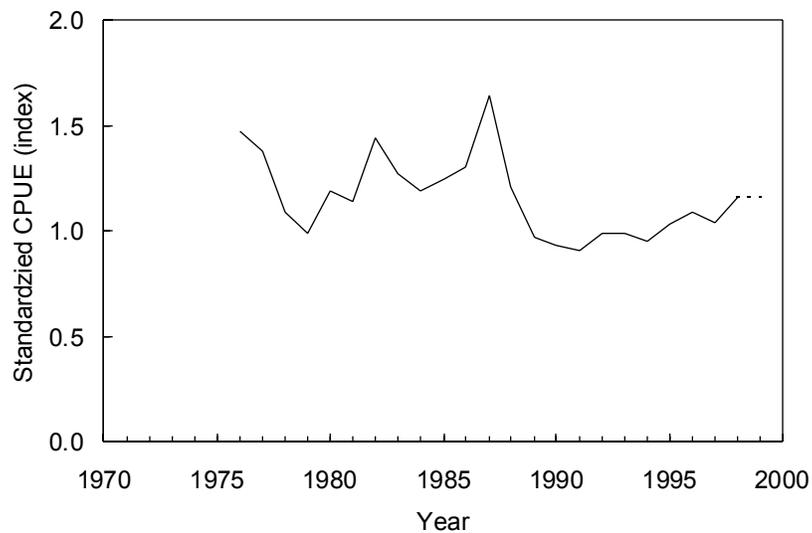


Fig. 2.2. Northern shrimp in Subareas 0 and 1: standardized CPUE index.

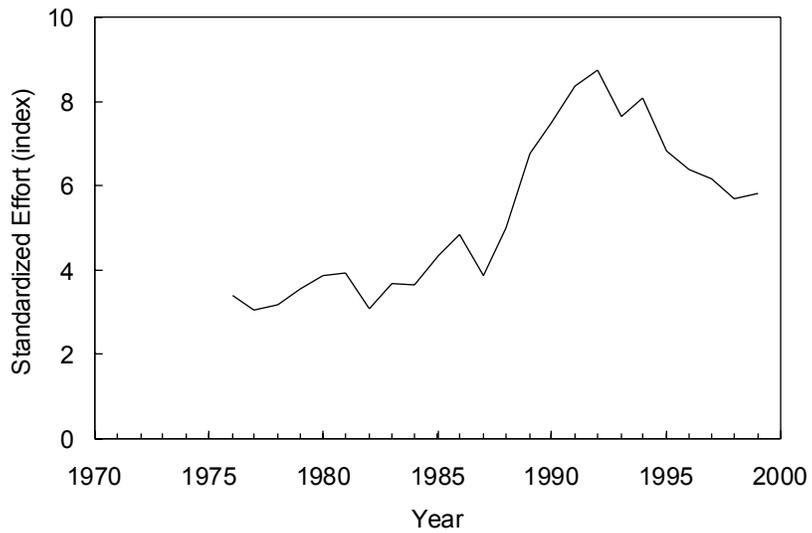


Fig. 2.3. Northern Shrimp in Subareas 0 and 1: standardized effort index.

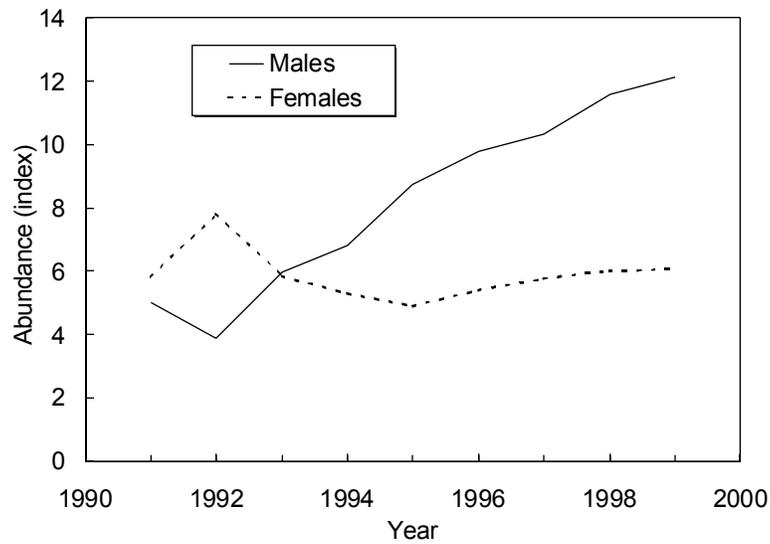


Fig. 2.4. Northern shrimp in Subareas 0 and 1: CPUE indices of male and female component of West Greenland shrimp stock 1991-99.

**Sex and length composition.** Length frequency data were obtained by observers in the commercial fishery in Div. 0A from 1991 to 1998, and in Subarea 1 from 1991 to 1999 (SCR Doc. 99/107, 113). The proportion of males in the catch increased from 30-40% in 1991-92 to 60-70% between 1995-99. However, the proportion of males would have been higher if discard of males had been included in the 1991-92 catch estimates.

The length-frequency distribution of the 1999 catches showed good representation of all sizes. A distinct mode around 12 mm carapace length was observed.

ii) **Research survey data**

**Greenland trawl survey.** Stratified-random trawl surveys have been conducted since 1988 in offshore areas (Subarea 1 and Div. 0A) and since 1991 in inshore Subarea 1 (SCR Doc. 99/109). In 1990 and from 1993, the survey has extended further south in Div. 1E and 1F. In 1994-97, the survey was carried out as a two-phase survey allocating extra hauls to strata with high shrimp densities to reduce the variance of the biomass estimates.

The design of the survey and the analysis of the resulting data were reviewed in 1998 and 1999 and some changes were suggested. Among those that could modify the design and executions of the survey were a) shorten the tows; b) use buffered random sampling to choose trawl stations; c) fix the location of some stations from year to year; d) review the allocation of stations. Most of these suggestions were simultaneously implemented in the 1999 survey. STACFIS reviewed (SCR Doc. 99/105) the reasons for making such changes, their expected effects on the estimation of total stock biomass, and agreed that the changes implemented in the survey in 1998 and 1999 had no significant effect on the biomass estimate.

Further the database for the survey period 1988-99 has been revised, and all shrimp samples have been checked with length-weight keys and corrected for possible errors. Various adjustments for earlier inclusions of other species (e.g. *Pandalus montagui*) have been applied. Also, based on information from the 'trawleye' on the headrope of the trawl, used since 1995, a correction factor to the recorded duration for the hauls has been applied to the data before 1995. These revisions caused major changes of the biomass estimates in some strata, but overall trends through the period have not changed significantly. The revised total estimates indicate less variation than the earlier given figures. The estimates for 1991 and 1997 are, however, still considerably lower than estimates for other years.

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

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Offshore (Div. 1A-1F, 0A)	183	181	182	122	178	223	231	170	195	154	232	226
Inshore (Div. 1A)	50 <sup>1</sup>	50 <sup>1</sup>	50 <sup>1</sup>	51	47	34	40	47	54	52	61	61
Total	233	231	232	173	225	257	271	217	249	206	293	287

<sup>1</sup> No inshore survey in 1988-90. 50 000 tons is the average of the inshore biomass from 1991-99.

**Biomass.** The estimated biomass inshore and offshore for the period of surveys 1991-99 (SCR Doc. 99/109) has ranged from 170 000 to 290 000 tons, with the lowest values in 1991 and 1997 (Fig. 2.5). The estimates for 1998 and 1999 are similar and the largest in the time series. Large variations from year to year both geographically and over depth zones are observed and may suggest that the stock is highly migratory.

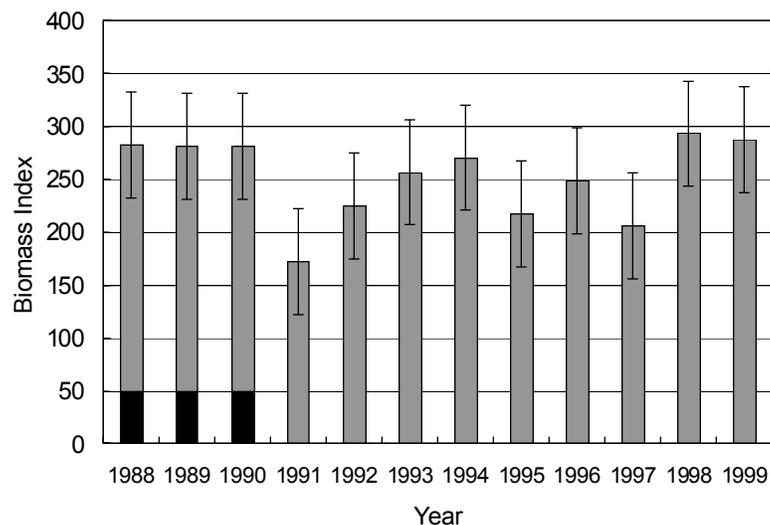


Fig. 2.5. Northern shrimp in Subareas 0 and 1: combined biomass index from inshore and offshore surveys, plus and minus one standard error. 1988-90 includes an average of 50 000 tons for the inshore area indicated by black bars.

**Sex and length composition.** Estimated total number (billions) of shrimp in the survey area (including both inshore and offshore areas) from 1988 to 1999 are as follows:

Year	Males	Females	Total	Males,	Females,
1988 <sup>1</sup>	25.5	10.0	35.5	71.9	28.1
1989 <sup>1</sup>	36.2	7.6	43.9	82.6	17.4
1990 <sup>1</sup>	29.8	10.1	39.8	74.7	25.3
1991	17.4	6.2	23.6	73.8	26.2
1992	29.7	7.3	36.9	80.3	19.7
1993	35.6	9.9	45.4	78.3	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

<sup>1</sup> No inshore survey in 1988-1990. The numbers in 1988 to 1990 represent an average of the estimated numbers of shrimp inshore from 1991-99 added to the actual estimates from the offshore area.

Total number of shrimp in 1999 was at the same high level as in 1998, higher than all other years. Number of males was at the highest level recorded.

Inspection of overall length-frequencies using the deviation method and a preliminary modal analysis of offshore and inshore length distributions indicated a change between

1997 and 1998 to faster growth. At the same time, age at sex reversal appears to have changed from six years to five years.

iii) **Other studies**

**Modifications of the design of the trawl survey for *Pandalus borealis* in West Greenland Water** (SCR Doc. 99/105). A stratified random sample survey based on one-hour trawl stations has been carried out since 1988 as a component of the assessment of the stock of northern shrimp *Pandalus borealis* in offshore West Greenland waters. Survey procedures were reviewed in early-1998 and again in 1999, and the 1998 and 1999 survey practices were consequently modified. The 1999 West Greenland trawl survey for northern shrimp mixed 15-minute, 30-minute and one-hour tows. 40 of stations were fixed from the previous year and the other station positions were chosen by buffered sampling. Analyses of this mixed design showed that there was high short-range spatial autocorrelation, so that short tows appeared to collect about as much information on local density as long ones. However, buffered random sampling offered little or no more precision than independent sampling. Within strata, catches at fixed stations appeared well correlated between years, and a stratified analysis of the year-to-year differences by station doubled the sensitivity of detecting changes in biomass.

**Bottom temperatures and possible effect on growth and size at sex reversal of northern shrimp in West Greenland** (SCR Doc. 99/110). Temperature data and shrimp samples collected during the stratified-random trawl surveys during 1990-99 were analysed. The trends and changes in mean temperatures and mean size at sex change of the shrimp were compared and discussed. The significant drop in mean size at sex reversal from 1997 to 1998 in the offshore areas and from 1998 to 1999 in the inshore area seems to indicate that sex reversal is correlated to temperature.

c) **Assessment Results**

*CPUE.* The standardized catch-rate index for 1976-99 remained stable during the early-1990s, but has shown a slight increase since 1994. The projected 1999 value equals that of 1998, which was the highest on record during the 1990s. Catch rates of female shrimp have remained stable since 1993.

*Recruitment.* The length-frequency distributions in the 1998 and 1999 commercial catches and surveys show good representation of all sizes of males. Males between 14 and 22 mm carapace length are very abundant and are expected to contribute to the female component and maintain the spawning stock biomass.

*Biomass.* The survey biomass index in 1999 is similar to the 1998 value and is among the highest since 1988.

*State of the Stock.* STACFIS is not able to provide estimates of absolute stock size. However, based on available indices, the stock size does not appear to have changed in recent years under the present level of exploitation.

d) **Research Recommendations**

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

- *an analysis of the length-frequency data of shrimp in order to obtain an age composition be conducted,*

- *an analysis of the distribution of the stock and of the individual growth of shrimp be conducted in relation to environmental conditions, together with a comparison of trends and changes in mean temperatures and mean size at sex change of the shrimp,*
- *the survey strategy and design be further improved and the effect of recent changes in survey design and execution be further studied.*

#### 4. Northern Shrimp (*Pandalus borealis*) in Denmark Strait (SCR Doc. 99/108, 115)

##### a) Introduction

The fishery started in 1978 and, up to 1993, occurred primarily in the area of Stredbank and Dohrnbank as well as on the slopes of Storfjord Deep. However, since 1993 a fishery has also been conducted south of 65°N. The traditional northern area extends from approximately 65°N to 67°30'N and between 26°W and 34°W, the southern area extends from Cape Farewell in the south to 65°N. Availability of fishing grounds depends heavily on the ice conditions at any given time.

Catches increased from 363 tons in 1978 to about 12 000 tons in 1987 and 1988, declined thereafter to about 7 500 tons in 1992 and 1993, and increased again to about 12 000 tons in 1997. Provisional data show a decrease to about 9 500 tons in 1998. Since 1993 the nominal catches from the southern area increased from about 1 500 tons in 1993 to about 7 400 tons in 1997, but decreased to about 4 800 tons in 1998. The recent development of nominal catches (tons) are given in the following table and Fig. 3.1.

	1989	1990	1991	1992	1993	1994 <sup>1</sup>	1995 <sup>1</sup>	1996 <sup>1</sup>	1997 <sup>1</sup>	1998 <sup>1</sup>	1999 <sup>1,2</sup>
North of 65°N											
Greenland EEZ	9 416	9 994	8 192	5 764	3 563	3 359	4 823	2 351	1 300	3 120	2 747
Iceland EEZ	1 326	281	465	1 750	2 553	1 514	1 151	566	2 856	1 421	749
Sub-total	10 742	10 275	8 657	7 514	6 116	4 873	5 974	2 917	4 156	4 541	3 496
South of 65°N											
Greenland EEZ	-	-	-	-	1 532	4 939	3 532	6 796	7 433	4 793	3 560
Total	10 742	10 275	8 657	7 514	7 648	9 812	9 506	9 713	11 589	9 334	7 056
Recommended TAC	10 000	10 000	10 000	8 000	5 000	5 000	5 000	5 000	5 000	5 000	9 600

<sup>1</sup> Provisional catches as estimated by STACFIS.

<sup>2</sup> January-1 November. Split between northern and southern area in Greenland EEZ estimated by STACFIS.

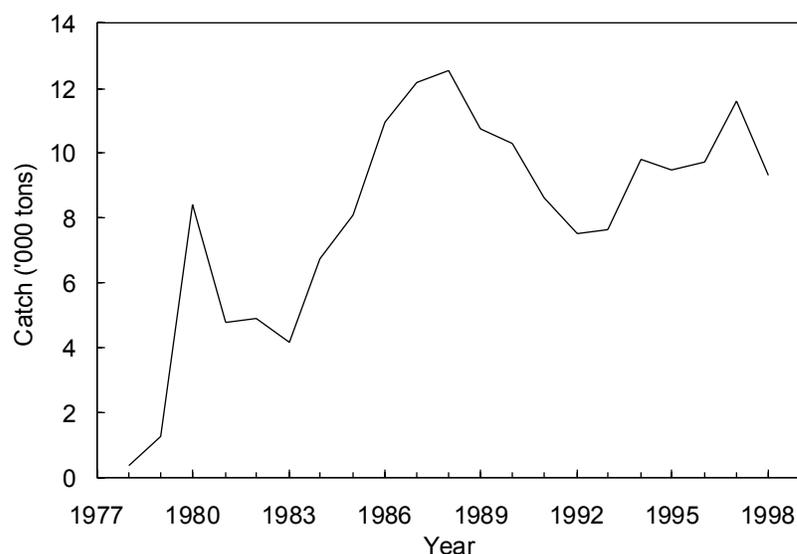


Fig. 3.1. Northern shrimp in Denmark Strait: nominal catches.

## 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. EU-France provided data for the years 1980 to 1991, but has had no fishery since then.

In the northern area, between 1980 and 1989, total unstandardized effort increased from about 35 000 hours to more than 100 000 hours, declining thereafter to about 22 200-27 600 hours in 1996-98. In the southern area, effort increased from 12 100 hours in 1993 to 26 100 hours in 1997 and declined to about 11 300 hours in 1998. For the whole area effort has declined from 80 000 hours in 1993 to 33 500 hours in 1998.

Standardized catch-rate indices based on logbook data from Danish, Faroese and Greenlandic vessels in the northern area (Fig. 3.2) showed a continuous decline from 1987 to 1993, followed by a general increasing trend until 1998 and a decrease from 1998 to 1999 (SCR Doc. 98/112). Standardized catch-rate indices for the same fleet in the southern area showed a continuously increasing trend from 1993 to 1999 (Fig. 3.2). In a similar analysis for the total area, indices showed the same trend from 1987 to 1998 and stability from 1998 to 1999 (Fig. 3.3). STACFIS, however, noted that details from the output of the model runs were not available for consideration.

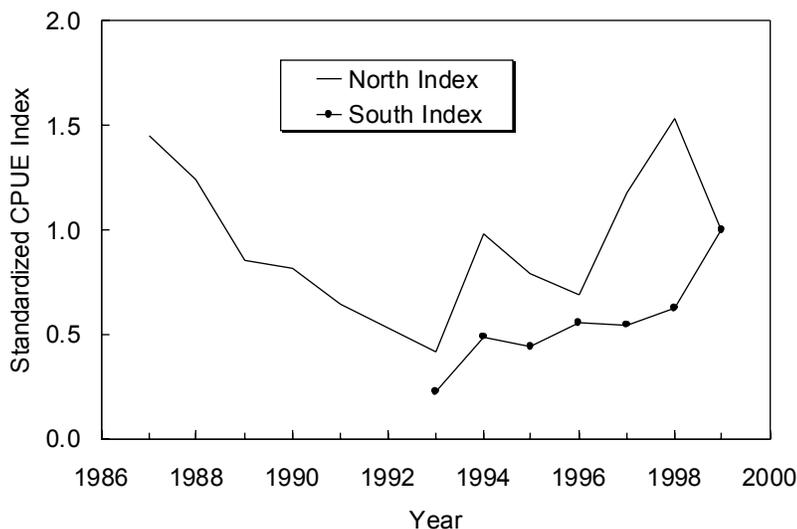


Fig. 3.2. Northern shrimp in Denmark Strait: annual standardized CPUE-indices (relative units) calculated from logbook data from Danish, Faroese and Greenlandic vessels in the areas north and south of 65°N.

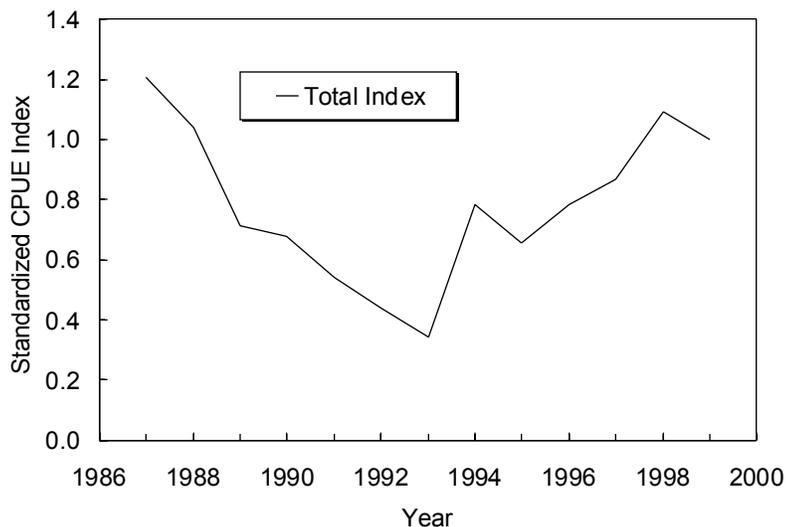


Fig. 3.3. Northern shrimp in Denmark Strait: annual standardized CPUE-indices (relative units) calculated from logbook data from Danish, Faroese and Greenlandic vessels in the total area.

**Biological data.** Commercial sampling of this fishery has generally been at a very low level but has however improved in recent years. Samples from the Greenlandic and Icelandic fisheries in the northern area indicate that the catches in the late-1980s were dominated by females. During the 1990s this has also been the case in the Greenlandic zone, while males have dominated the catches from the Icelandic zone. In both zones there are indications of relatively higher proportions of females in 1997-99. Commercial samples from the Greenlandic fishery in the southern area showed a dominance of males in most years, except for 1994, when females were most numerous. For the total area

several year-classes of male and female shrimp were evident in sampling data in recent years, and the male component was well represented at carapace lengths between 20 and 27 mm. It is, however, not possible to evaluate the strength of the year-classes.

ii) **Research survey data**

No surveys were conducted since 1996.

c) **Assessment Results**

*Commercial CPUE.* In the northern area the standardized CPUE indices are now higher than the minimum values reached in 1989-93 and are approaching the level observed during the mid-1980s. Catch rates in the southern area have increased since 1993. Available data for 1999 for the total stock area indicate stability from 1998 to 1999.

*Recruitment.* No data were available to estimate trends in recruitment.

*Biomass.* No biomass estimates were available.

*State of the stock.* STACFIS is not able to provide estimates of absolute stock size. Standardized CPUE data from both the northern and the southern areas indicate a general increasing trend in fishable biomass from 1993 to 1998. Limited data for 1999 suggest no further increase for the total stock.

Insufficient commercial data and a lack of survey data along with uncertainty on stock structure make assessment of this stock difficult.

d) **Research Recommendations:**

For northern shrimp in Denmark Strait, STACFIS **recommended** that:

- *a survey be conducted to provide fishery independent data of the stock throughout its range.*
- *standardized CPUE analyses be updated to include data from all fleets fishing in the area.*
- *commercial catch sampling of the fishery be improved to fully cover seasonal and spatial variation, so that size, sex and age composition of the catch can be accurately described.*
- *an analysis of distribution, individual growth and mean size at sex change of shrimp in relation to environmental conditions be undertaken.*

5. **Other Business**

a) **Review of SCR Documents**

Information from observers on finfish by-catch in the shrimp fisheries conducted in Subareas 0-3 was presented. In Subareas 0 and 1 and Div. 2G, by-catch in the shrimp fisheries continued to be near lowest historic levels. Redfish (*Sebastes* spp.) continued to be the largest by-catch in this region. Between 1992 and 1998, redfish by catch declined from 1 951 tons in Div. 0A, from 258 tons to 51 tons in Div. 0B, and from 215 tons to 101 tons in Div. 2G. Greenland halibut (*Reinhardtius hippoglossoides*) was the only other species taken in significant amounts in these areas, with by-catch equaling 11 tons in Div. 0A, 14 tons in Div. 0B and 14 tons in Div. 2G in 1998, well below peak amounts observed in the early-1990s. The reduction in by-catch was due in part to the introduction of the Nordmore grate in 1993 and its mandatory use in 1997 and 1998. In

Div. 2H, 2J, and 3K, catches of shrimp had risen significantly in recent years. However, the by-catch of groundfish in these areas had remained low. In 1998, by-catch of redfish was 75 tons, Greenland halibut by-catch was 244 tons, American plaice (*Hippoglossoides platessoides*) by-catch was 75 tons, and cod (*Gadus morhua*) by-catch was less than 2 tons. In Div. 3M redfish was the most common by-catch, estimated at 216 tons in 1998, compared to a by-catch of 11 970 tons in 1993. Greenland halibut by-catch declined from 309 tons in 1993 to less than 100 tons per year since 1994, and by-catch of skates and spotted wolffish (*Anarhichas minor*) also declined from over 300 tons in 1993 to less than 50 tons each in 1998. It was noted that the Nordmore grate was introduced in 1994 and usage became widespread in 1995. Overall, total by-catch decreased from 33.3% of the total catch to between 2.4% and 4.3% of the total in 1996-97.

Finfish by-catch in the West Greenland shrimp survey was sorted, identified, counted, and weighed (SCR Doc. 99/111). Annual survey biomass was estimated for the 16 most abundant species or species groups, and natural groupings of species were explored with multivariate analysis. The most abundant species group—all redfishes—averaged 9% of the survey biomass of *Pandalus borealis*. Abundance of other species groups rapidly decreased down the list, and the 10<sup>th</sup> most abundant species group—lanternfishes (Myctophidae)—averaged 0.2%. From 1992 to 1999, Greenland halibut (*Reinhardtius hippoglossoides*), the 2<sup>nd</sup> most abundant species, showed a significant ( $P < 0.01$ ) time trend, increasing by about 1 900 tons per year (11%). Time trends for other species were not significant. Multivariate analyses revealed few clear groupings of species or associations between species groups and environmental variables. The following associations were all weak. Greenland halibut and Arctic cod (*Boreogadus saida*) were associated with each other and with deeper water. Eelpout (*Lycodes* spp), thorny skate (*Raja radiata*), American plaice (*Hippoglossoides platessoides*), snailfishes (*Liparis* spp.), snake blennies (Lumpenidae), and Atlantic poacher (*Agonus decagonus*) formed a loosely associated group also associated with deeper water. Spiny lumpsucker (*Eumicrotremus spinosus*), was positively associated with shallow, cold water, and negatively associated with lanternfishes. The range of habitat sampled was small, and multivariate analyses were inconclusive.

A method for standardization of effort due to differences in individual vessels' fishing power was presented (SCR Doc. 99/104). The principle in the method is to estimate relative differences in fishing power between pairs of vessels in a fleet and then calculate the fishing power relative to a chosen standard vessel for each individual vessel in the fleet. Catch rates of vessels were compared when they were fishing close together at the same time. It is stressed that the most appropriate estimator for relative difference in fishing power is the median of the catch rate ratios. The method was applied to logbook data from the Norwegian shrimp trawler fleet, and the results showed that fishing power relative to the standard vessel was highly correlated with the length and engine power of the vessels.

Time series analysis was used to construct an illustrative, predictive model for standardized, annual catch rates in a shrimp fishing area off the coast of Labrador (Div. 2HJ) (SCR Doc. 99/100). Several environmental variables, expressed as annual values, were examined during preliminary correlative studies of possible association with trends in shrimp CPUE. These included bottom temperatures at hydrographic Station 27 off St. John's, Newfoundland, the volume of the cold intermediate water layer off southern Labrador, the location of the Gulf Stream front, and several measures of ice cover in the northeast Newfoundland-Labrador area. The 1970-98 series of annual estimates of winter ice cover ( $\text{km}^2 \times 10^{-5}$ ) provided the best indicators of significant correlation with shrimp CPUE. These data provided a meaningful functional relationship with shrimp CPUE based on association of shrimp larvae with the subsurface water layer immediately below the ice cover. An autoregressive moving-average (ARIMA) procedure was used to derive predictive models of shrimp CPUE. The models included an input series (i.e. winter ice cover) in a transfer function that modeled the response series using its own past values and incorporated current and past values of the input series. The simplest transfer function in which the residuals were reduced to white noise included a first-order autoregressive parameter for the CPUE and an input winter ice series with a lag of 6 years. The relationship with no delay was negative and it can be assumed that heavy ice in a given year would adversely affect fishing

activity and result in lower CPUE. Also, extensive ice cover in a given year may enhance larval and juvenile survival in the same year, leading to higher CPUE in the fishery several years later (the mean age of shrimp in the catch from this region is 6 years).

b) **Acknowledgements**

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 adjourned the meeting.



**APPENDIX II. REPORT OF STANDING COMMITTEE ON RESEARCH COORDINATION (STACREC)**

Chairman: R. K. Mayo

Rapporteur: Various

The Committee met at the Marine Research Institute, Skulagata 4, 121 □ Reykjavik, Iceland during 15-16 November, 1999 to discuss matters pertaining to statistics and fisheries research, as referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Germany), Iceland, Norway and United States of America.

**1. Protocol for Exchange of Biological Data for Northern Shrimp Stocks****a) Catch and Effort Database**

Several items related to research coordination were discussed with respect to stocks of northern shrimp in Div. 3M, Subareas 0 and 1, and in Denmark Strait. For shrimp in Div. 3M, a catch and effort database exists which enables scientists to compile catch and effort data from several countries in a standard format. This facilitates the analyses of these data and the calculation of standardized CPUE indices. The present format of this database was described in SCS Doc. 96/19 and STACREC concluded that the existing format and level of detail should be maintained. The spatial resolution of the data was discussed. For Div. 3M, the Flemish Cap is divided into 4 subregions, coded 1-4 and the catch and effort data are aggregated up to this level of resolution before input. If this approach is to be applied to other stocks, a more systematic geographic-based system would allow more flexibility. However, for the limited purposes of assessment work, STACREC determined that specific subregional coding schemes could be developed for each stock and these could be coordinated by each Designated Expert.

STACREC noted that only certain countries presently contribute data to the Div. 3M database and that it would be desirable to have more a complete representation of the entire fishery in the catch and effort database. However, STACREC noted that submission of data would be required for recent as well as past fishing activity in order to obtain a comprehensive view of a fleet's fishing activity. It was also noted that submission of present as well as past data to the database depends on the ability of each Contracting Party to electronically enter and audit their archived logbook data, and this can only be accomplished with adequate resources and staff. STACREC encourages each Contracting Party to make efforts to develop electronic databases that can eventually be submitted for analysis of CPUE trends. This approach was also considered appropriate for other stocks, notably shrimp in Denmark Strait.

**b) Research Survey for Shrimp on Flemish Cap**

STACREC was informed that at present the annual EU bottom trawl survey conducted on Flemish Cap does not provide an adequate recruitment index of small shrimp because the present 35 mm codend mesh size is too large to retain the smallest shrimp. Several options to address this problem were addressed. Ideally, a directed annual survey for northern shrimp would provide the most comprehensive set of information on size composition and abundance of all sizes of shrimp, but it was recognized that such a survey is not likely to occur, given limited resources among Contracting Parties. STACREC considered other approaches to obtain the required information in a systematic manner. The addition of a small 13 mm liner to the present EU trawl configuration was discussed, but it was concluded that this may have undesirable effects on the current trawl catchability, and that the data collected on finfish may be compromised. Therefore, STACREC concluded that the addition of a small mesh bag attached to the codend would achieve the objective of retaining small shrimp without affecting the catchability and overall performance of the gear. This approach is presently used by Icelandic scientists, and their experience has been favorable. STACREC noted that if such an approach were to be implemented in the EU survey, some assistance would be required to ensure that this juvenile shrimp bag is attached in a suitable location on the trawl, and that survey personnel are trained in the proper identification and handling of the catch.

Given the critical need to acquire information on small shrimp, STACREC **recommended** that *appropriate steps be taken as soon as possible to test the feasibility of adding a juvenile shrimp bag to the trawl used in the EU groundfish survey on Flemish Cap.*

c) **Methods for Presenting Length-at-age and Length at Sex Reversal.**

It has been previously noted that methods for presentation of research on growth and sex reversal have differed among researcher, making comparison of results difficult. STACREC was informed that the methods for summarizing and presenting such information often depended on the time of data collection (e.g. differentiating primiparous vs. multiparous females). It was agreed that appropriate methods for analyzing such data are known among shrimp researchers and that coordination is most easily accomplished through communication among a small group of experts.

d) **International Database for Biological Data Related to Ageing**

An international age assessment database for accumulating and storing biological data for the purpose of providing consistent age interpretation for the shrimp stocks assessed by the Scientific Council was discussed at the September, 1998 Scientific Council Meeting. At that time it was noted that only two countries had contributed to this database. In 1999, three countries contributed to this effort. Although there has been some improvement in acquisition of these data, STACREC concluded that additional submissions would provide shrimp researchers with a more comprehensive view of the age structure of northern shrimp stocks. The database consists of length frequency measurements in 0.5 mm oblique carapace length increments broken down by males, primiparous females (including transitionals) and multiparous females. The data are aggregated by month and area. In the case of commercial data, monthly catches are required to weight the sample data, and in the case of survey data a corresponding measure of biomass is required.

At present the Designated Expert for Div. 3M shrimp is managing the database.

Given the desirability to improve the analytical basis of northern shrimp stock assessments, and the additional information which can be derived by systematically tracking cohorts, STACREC **recommended** that *Contracting Parties submit all available commercial and survey data related to determining age of shrimp to the Designated Expert managing the international age assessment database.*

2. **Other Business**

There being no other business, the Chairman thanked the participants and the meeting was adjourned.