PART C

Scientific Council Meeting, 14-17 November 1997

CONTENTS

Participants of Scientific Council Meeting, 14-17 November 1997

Standing: F. M. Serchuk, O. Folmer, U. Skúladóttir, S. X. Cadrin, H. Siegstad, P. A. Koeller, L. Savard, H. Powles, D. M. Carlsson, C. Hvingel, D. G. Parsons, J. Lambert

Seated: T. Amaratunga, H. P. Cornus, R. K. Mayo

REPORT OF SCIENTIFIC COUNCIL

14-17 November 1997

Chairman: H. P. Cornus Rapporteur: T. Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at the new NAFO Headquarters, 2 Morris Drive, Dartmouth, Nova Scotia, Canada, during 14-17 November 1997. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union, Iceland and United States of America. The Assistant Executive Secretary was in attendance.

The opening session was called to order on 14 November 1997 at 1000 hr.

The Chairman, H. P. Cornus (EU-Germany), welcomed representatives to this meeting of the Scientific Council to conduct assessments on shrimp in Subareas 0 and 1, and Denmark Strait. The Assistant Executive Secretary was appointed rapporteur. The Provisional Agenda was considered. It was agreed that the Precautionary Approach should be discussed, and noting that some experts dealing with other shrimp stocks were in attendance that they be invited to describe their stocks. The Chairman also noted that the timing of these November shrimp meetings should be discussed, and the co-convener, P. Koeller (Canada) should update the Council on the September 1999 Symposium on Shrimp. The Agenda, modified accordingly was **adopted** (see Agenda III, Part D, this volume).

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

The session was adjourned at 1020 hr.

The Council met as needed through 14-17 November 1997 to address various agenda items.

The concluding sessions were convened on 17 November 1997. Noting that the shrimp assessment reports had been prepared by STACFIS, the Council then addressed the requests of the Coastal States and considering the results of the assessments provided advice and recommendations.

The meeting was adjourned at 1515 hr on 17 November 1997.

Summary reports of the assessments and other matters considered by the Scientific Council are given below in Sections II-V. The Agenda, List of Research (SCR) and Summary (SCS) Documents, and the List of Participants of this meeting are given in Part D, this volume.

II. FISHERY SCIENCE (see STACFIS report, App. I)

1. Stock Assessments

The Council accepted the report of STACFIS as presented by Chairman R. K. Mayo (USA).

The Council noted that matters referred to STACFIS relating to assessments of shrimp in Subareas 0 and 1 and shrimp in Denmark Strait were addressed. The complete reports are given in Appendix I.

2. **Other Business**

a) **Review of SCR Documents**

The Council noted two SCR Documents not relating to the assessments were reviewed by STACFIS.

b) **Information on other shrimp stocks**

Gulf of Maine. The Council was please to welcome the expert on the Gulf of Maine shrimp stock, S. X. Cadrin (USA), National Marine Fisheries Service, Woods Hole, USA. The Council noted the valuable information on the Gulf of Maine stock presented by him to STACFIS for its deliberations on northern shrimp.

Scotian Shelf. The Council was also pleased to welcome the expert on the Scotian-Shelf shrimp, P. A. Koeller (Canada), Department of Fisheries and Oceans, Maritime Region, and his valued presentation to STACFIS.

III. PRECAUTIONARY APPROACH

The Chairman informed the Council that some progress had been made since its June 1997 discussion on this subject. It was noted the Fisheries Commission had endorsed the Council's activities on the Precautionary Approach (PA) and looked forward to the Council's Meeting of 17-27 March 1998 to consider the PA with respect to stocks in the NAFO Regulatory Area. The Chairman also informed the Council of the many ICES and other meetings on the PA taking place during the period of June 1997 to the forthcoming meeting of the Council in March 1998.

The Chairman proposed that it would be valuable to consider the PA for other stocks for which the Council provides advice, particularly those for which Coastal States request scientific advice. The Chairman requested the views of the Council with regards to considering the PA for shrimp in Subareas 0 and 1 and Denmark Strait and agreed on the use of the PA as a basis for providing advice on these stocks.

The Council accordingly noted that Designated Experts for shrimp in Subareas 0 and 1 and Denmark Strait were invited to attend the Council Meeting of 17-27 March 1998.

IV. FORMULATION OF ADVICE

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

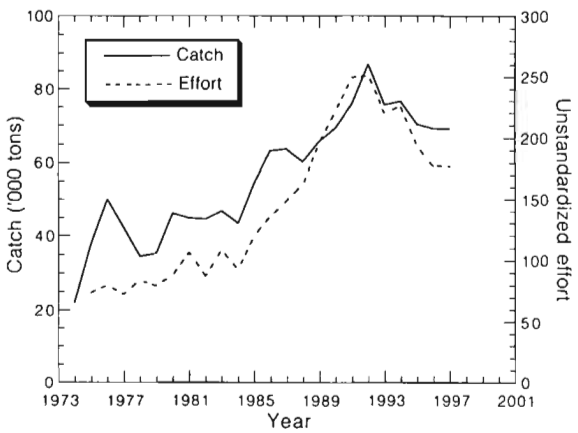
Shrimp in Subareas 0 and 1

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 now the most important in Davis Strait.

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

	Catch ('000 tons)			TAC ('000 tons)
Year	Inshore	Offshore	Total	Recommended
1990	13.6	55.7	69.4	50.0[1]
1991	16.3	59.6	75.9	50.0[1]
1992	20.6	66.2	86.8	50.0[1]
1993	17.8	57.8	75.6	40.0[1]
1994	18.1	58.5	76.6	50.0[1]
1995[2]	16.4	54.3	70.7	60.0
1996[2]	17.4	51.9	69.2	60.0
1997[2] (to Oct)	9.8	46.2	56.1	60.0

[1] Only offshore.
[2] Provisional.

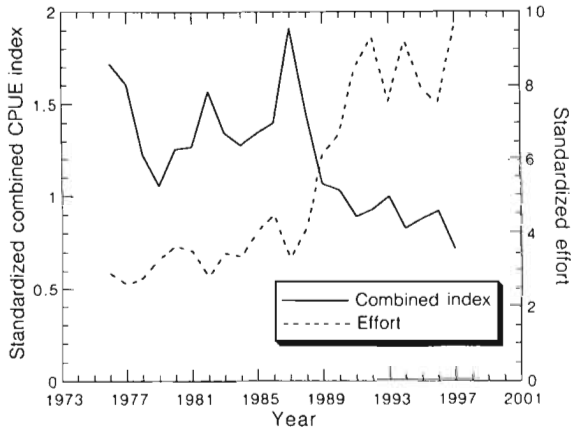


Data: Catch, effort and biological sampling data were available from the offshore fishery, and catch and effort data from the inshore fleet. Time series of biomass indices and size and sex composition data were available from research surveys from both offshore and inshore areas.

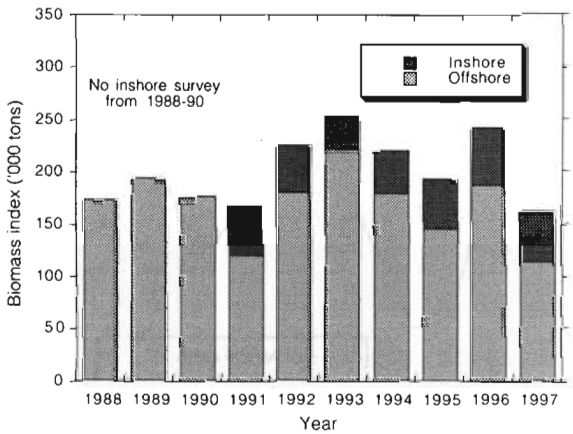
Assessment: No analytical assessment is available and fishing mortality is unknown. Evaluation of the status of the stock is based on interpretation of commercial fishery data (catch, effort and standardized catch rates), time series of research biomass indices and biological data.

CPUE: A single combined index covering the whole area in the period 1976-97 indicates two levels of stock abundance. During the 1976-88 period, the index fluctuated at a level substantially higher than the level during the years 1989-97. The 1997 value is the lowest on record.

Recruitment: Survey length distribution indicates the recruitment of the 1990 year-class to the female group was not as strong as anticipated and was insufficient to maintain the 1997 catch rate at the 1996 level. Prospects for recruitment to the female group in 1998 are poor. The 1993 year-class, which appeared to be very abundant in 1996 is now estimated to be average.



Biomass: Survey biomass indices showed an overall decline since 1993, particularly in the northern areas.



State of the Stock: The combined inputs to the assessment indicated a decrease in stock biomass and in abundance of large shrimp. Recruitment to the female group in 1998 is forecasted to be low. Year-classes 1991 to 1993 that were estimated from the 1996 survey and fishery to be at or above average are now estimated to be only average or below average. The fishery in 1998 will therefore depend on reduced abundance of females and larger males from these year-classes.

Recommendations: TACs advised for 1997 and recent years has been 60 000 tons. The catches have consistently exceeded this level. In the current assessment, serious concerns about the status of the stock has been expressed. Recent catches were observed to coincide with a decrease in stock biomass. In an attempt to halt the biomass decline and protect future recruitment, the Council recommended that 1998 catches be no higher than 55 000 tons and that the TAC be reduced to this level.

Special Comments: Unless stock status improves, further reduction in removals and TACs will be required in the future.

Sources of Information: SCR Doc. 97/96, 98, 99, 100, 101, 104, 105.

Shrimp in Denmark Strait

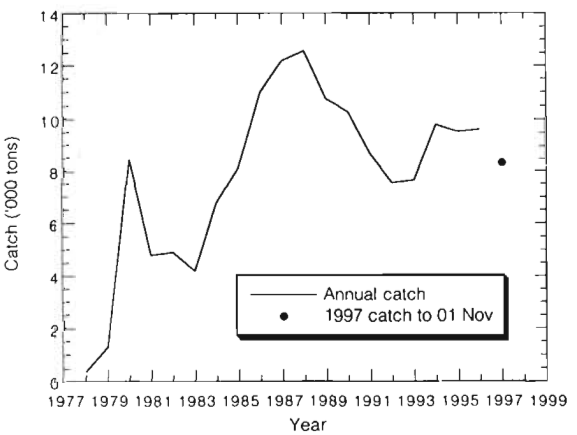
Background: The fishery for shrimp started in areas north of 65°N in Denmark Strait in 1978. The fishery started exploiting new areas south of 65°N after 1992.

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

Year	Catch ('000 tons)	TAC ('000 tons) Recommended
1992	7.5	8
1993	7.6	5
1994	9.8	5
1995[1]	9.5	5
1996[1]	9.6	5
1997[1] (to 1 Nov)	8.3	5

[1] Provisional.

Effort has declined substantially since the late-1980s.



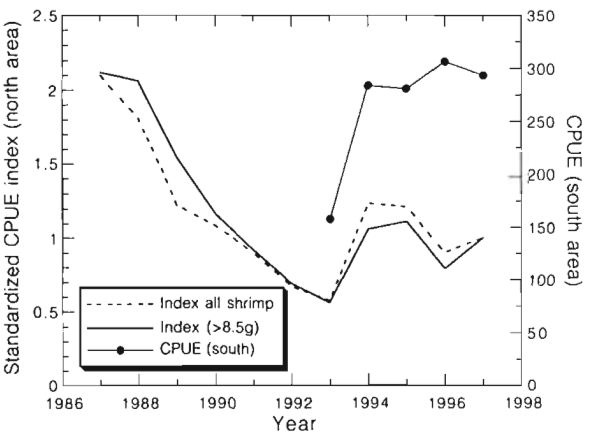
Data: Catch, effort and biological sampling data were available from the trawlers of several nations. Two time series of survey biomass indices were available, one from Norway for the years 1985 to 1989 and another from Greenland for the years 1989 to 1996, with associated biological samples. No survey was conducted in 1997.

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, the time series of survey biomass indices and biological data from both sources.

CPUE: Standardized CPUE indices in the area north of 65°N declined from peak values in 1987 to minimum values in 1992-93, subsequently increased in 1994, and fluctuated without a trend thereafter. The unstandardized index for the southern areas remained relatively constant since 1994.

Recruitment: There is no new information on recruitment.

Abundance: The abundance index from the Greenlandic survey from the northern area declined from 1989 to 1992, and increased thereafter. The 1996 value is the highest in the series but is uncertain because of incomplete coverage.



State of the Stock: The changes in fishing pattern, very low levels of commercial sampling and lack of a 1997 survey made assessment of the stock difficult. Catch rates in both northern and southern areas show no trend since 1994. The information available provides no basis to conclude any recent change in the stock status.

Recommendations: Because of uncertainties on stock status, the Council is unable to advise any change to the TAC from the 1997 value of 5 000 tons.

Special Comment. The Council noted that this level was first advised in 1992 when the stock was considered to be confined to the northern area. An improved database and a better understanding of stock structure is required before a change in TAC can be advised.

Sources of Information: SCR Doc. 97/97, 102, 103, 106.

V. OTHER MATTERS

1. Progress Report of 1999 Symposium on Shrimp

The Council was informed by the co-convener, P. A. Koeller (Canada), that since its introduction during the June 1997 Meeting of the Scientific Council, the proposal for the 1999 Symposium on Pandalid Shrimp Fisheries (see Announcement at Annex 1) had also been presented to the Shellfish Committee at the ICES Statutory Meeting in Baltimore, and to the Fisheries Science Committee at the PICES Annual Meeting in Korea. Both organizations agreed to act as co-sponsors for the meeting, with NAFO as the lead agency. P. A. Koeller (Canada), S. Tveite (Norway) and J. Boutillier (Canada) had been appointed as co-convenors and a slightly larger steering committee had been struck to broaden discussion and geographical representation. It was confirmed that the meeting will be held in conjunction with the NAFO 1999 Annual meeting. Dates for the Symposium were set at 8-10 September 1999, following the Div. 3M shrimp assessment meeting and preceding the NAFO Annual Meeting, but the venue was not yet been set. It was also noted that 1999 marks the 50th Anniversary of ICNAF/NAFO. Further progress will be reported to the Scientific Council at its June 1998 Meeting.

2. Timing of November Meeting

The Council discussed the timing of the November 1998 Meeting. The Council was informed the present timing was primarily to accommodate schedules for experts coming from Greenland.

The Council noted that participants from Greenland find it much more convenient to travel to Denmark, and the participants from the other Contracting Parties also found Denmark as a venue to be convenient. The Council accordingly agreed that the next meeting of the Scientific Council for the assessment of northern shrimp be scheduled for 6-10 November 1998, at Copenhagen, Denmark.

It was also agreed that the meetings could alternate between Denmark one year and Canada the next.

VI. ADOPTION OF REPORTS

At its concluding session on 17 November 1997, the Council reviewed and **adopted** the STACFIS Report. The report is given in Appendix I. The Council then **adopted** its own report.

VII. ADJOURNMENT

There being no further business, the Chairman thanked the Committee, particularly the Designated Experts and STACFIS Chairman, for their dedicated and cooperative work.

After thanking the Secretariat for support and organizational work, the meeting was adjourned.

ANNEX 1

NOTICE

SYMPOSIUM[1]

Pandalid Shrimp Fisheries – Science and Management at the Millenium

FIFTIETH ICNAF/NAFO ANNIVERSARY

Hosted by the Scientific Council of the
Northwest Atlantic Fisheries Organization (NAFO)

and

Co-sponsored by NAFO, the International Council for the Exploration of the Sea (ICES)
and the North Pacific Marine Science Organization (PICES)

8–10 September, 1999
Venue to be announced

The Scientific Council of NAFO is pleased to announce this Symposium to be held in conjunction with the NAFO 21st Annual Meeting, and during the 50th Anniversary of ICNAF/NAFO. The Symposium will be co-convened by P. Koeller (NAFO), S. Tveite (ICES), and J. Boutillier (PICES), and organized by the NAFO Secretariat.

Pandalid shrimp are an important global resource, with significant fisheries in the North Atlantic, and the North Pacific. Populations have shown large fluctuations in abundance due to environmental and ecological influences, fishing pressure, or a combination of these factors. The purpose of the Symposium is to review, discuss and synthesize all aspects of Pandalid shrimp biology, ecology and fisheries science relevant to the rational management of these resources, including:

- **Environmental and Ecological influences** – Can useful predictive relationships between environmental factors and stock abundance be developed? What is the evidence for predator forcing of shrimp stock dynamics? How can this information be quantified and applied in multispecies management models?
- **Stock Assessments and Associated Biological Research** – How do shrimp stocks respond to exploitation? What are the constraints to analytical stock assessments and how can they be overcome? What biological indicators are useful in detecting changes in stock status?
- **Management Strategies** – What biological reference points and conservation limits should be used in stock management? How can the precautionary approach be applied to shrimp fisheries?
- **Harvesting** – How have technological advances influenced the development of shrimp fisheries? What are the latest developments in harvesting and processing and their impacts?

A second announcement and "Call for Papers" will be issued shortly for contributed papers and posters. Papers will be selected on the basis of their relevance to the topics and scientific suitability. It is anticipated that the proceedings of this Symposium will be published in a special issue of the *Journal of Northwest Atlantic Fishery Science*.

If you are interested in contributing papers or participating in the meetings you may obtain further information from:

P. Koeller
Department of Fisheries and Oceans
Halifax Fisheries Research Laboratory
P.O. Box 550
Halifax, Nova Scotia
Canada B3J 27S
E-mail: koellerp@mar.dfo-mpo.gc.ca
Tel: +902-426-5379
Fax: +902-426-1862

J. Boutillier
Department of Fisheries and Oceans
Pacific Biological Station
Hammond Bay Road
Nanaimo, British Columbia
Canada V9R 5K6
E-mail: boutillierj@dfo-mpo.gc.ca
Tel: +250-756-7048
Fax: +250-756-7053

S. Tveite
Institute of Marine Research
Flødevigen Marine Research Station
N-4817 HIS, Norway
E-Mail: Stein.Tveite@imr.no
Tel: +47 37 05 90 00
Fax: +47 37 05 90 01

Tissa Amaratunga, Assistant Executive Secretary
Northwest Atlantic Fisheries Organization
P. O. Box 638
Dartmouth, Nova Scotia, Canada B2Y 3Y9
E-mail: nafo@fox.nstn.ca (Website: www.nafo.ca)
Tel: +902-468-5590
Fax: +902-468-5538

[1] Note this announcement can be viewed at the NAFO Website at WWW.nafo.ca and will be periodically updated.

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

Chairman: R. K. Mayo Rapporteur: Various

The Committee met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, at various times during 14-17 November 1997 to consider and report on matters referred to it by the Scientific Council, particularly those pertaining to the provision of scientific advice on shrimp stocks in Subareas 0 and 1 and Denmark Strait. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Germany), Iceland and United States of America. The Assistant Executive Secretary was in attendance.

I. STOCK ASSESSMENTS

1. **Shrimp in Subareas 0 and 1** (SCR Doc. 97/96, 98, 99, 100, 101, 104, 105)

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.

Two offshore fleet components, one from Canada and one from Greenland participated in the fishery. The offshore Greenlandic fleet has been restricted by areas and quotas since 1977. An inshore small-vessel Greenlandic fleet was unrestricted by areas and quotas until January 1997, when quota regulation was imposed. The Canadian fishery in Div. 0A is regulated by a quota based on 17% of the advised TAC of the offshore area.

Overall catches in the entire stock area increased until 1992, then decreased from 1993 to 1996. Catches in 1997 are projected to be slightly below the 1996 level (Fig. 1). Recent nominal catches and advised TAC (tons) for shrimp in Div. 0A and Subarea 1 are as follows:

	1987	1988	1989	1990	1991	1992	1993	1994[1]	1995[1]	1996[1]	1997[1,2]
Div. 0A Total	6 095	5 881	7 235	6 177	6 788	7 493	5 491	4 766	2 361	2 623	20
SA 1 Offshore	50 720	44 159	45 198	49 478	52 834	58 664	52 280	53 693	51 900	49 251	46 211
SA 1 Inshore	6 921	10 233	13 224	13 630	16 258	20 594	17 843	18 118	16 429	17 359	9 849
SA 1 Total	57 641	54 392	58 422	63 184	69 092	79 258	70 123	71 811	68 329	66 610	56 060
0+1 offshore catch	56 815	50 040	52 433	55 731	59 662	66 157	57 771	58 459	54 261	51 874	46 231
SA 0+1 Total	63 736	60 273	65 657	69 361	75 880	86 751	75 614	76 577	70 690	69 233	56 080
0+1 advised TAC[3]	36 000	36 000	44 000	50 000	50 000	50 000	40 000	50 000	60 000	60 000	60 000

[1] Provisional data.
[2] January-October
[3] Until 1994 the advised TAC was only for offshore south of 71°N. After 1994, the advised TAC includes 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, fluctuated thereafter, stabilized around a level of 54 000 tons during 1985-88, then increased to 66 000 tons in 1992 and decreased thereafter to 52 000 tons in 1996. Preliminary statistics for the offshore area in 1997 (January to mid-October) show total catches of about 46 000 tons. The Canadian fishery in Div. 0A amounted to about 2 500 tons in 1995 and 1996, but only 20 tons has been reported up to October 1997.

Historically, the fishing grounds in Div. 1B have been the most important. Since 1989, a gradual southward shift, particularly of the offshore fishery, has taken place and since 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 10% of the total catch.

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 increased to over 20 500 tons in 1992, but decreased to 17 000 tons in 1996. Preliminary data for 1997 (January-1 October) indicate inshore catches at the same level as for the same period for 1996.

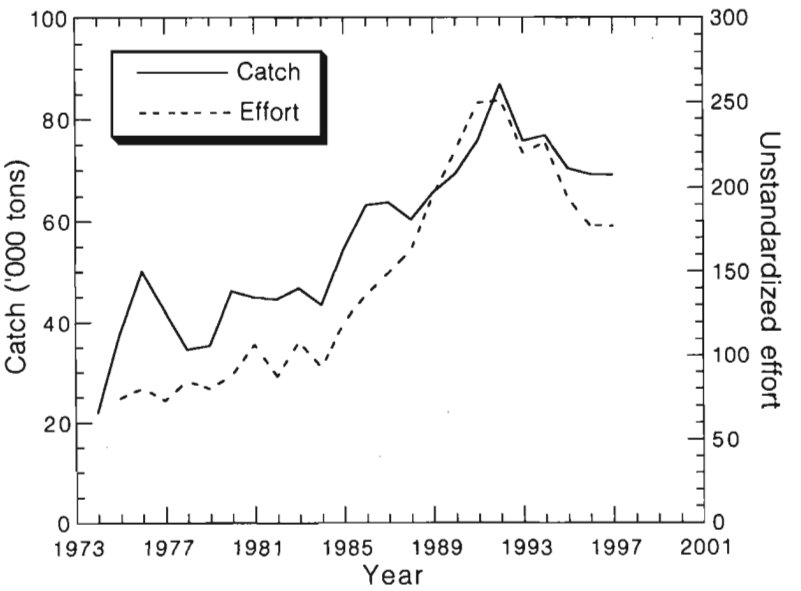


Fig. 1. Shrimp in Subareas 0 and 1: total catches and unstandardized effort (1997 projected to the end of the year).

b) **Input Data**

i) **Commercial fishery data**

Fishing effort and CPUE. Catch and effort data from the shrimp fishery in 1997 were available from fishing records obtained from Canadian vessels fishing in Div. 0A (SCR Doc. 97/100) and from Greenland logbooks for Subarea 1 (SCR Doc. 97/98).

Five time series of standardized CPUE indices were available, including both the inshore and offshore areas, as well as the small vessel component. The five indices were: 1) Index from seven trawlers in Div. 1B (offshore) of total shrimp catches from 1976 to 1990, 2) Div. 1B trawler index (offshore) of large shrimp (count 120 or less) from 1987 to 1997, 3) Div. 1CD trawler index (offshore) of large shrimp (count 120 or less) from 1988 to 1997, 4) the Greenland small vessel (<80 GRT) index (inshore and nearshore) of total shrimp catches from 1988 to 1997, 5) the Canadian Div. 0A trawler

index (offshore) of total shrimp catches from 1981 to 1997. A single index was constructed by combining the indices covering the period 1976-1997 (SCR Doc. 97/98). The value of the index in 1996 and 1997 was calculated from the historic model.

During the 1976-88 period, the combined index fluctuated at a level substantially higher than the level during the years 1989-97. The 1997 index is the lowest on record. The indices for Div. 1B and 1CD in 1997 both declined well below the level of recent years. The small vessel index has shown no trends since the early-1990s.

Up to 1986, standardized effort showed a slight increasing trend. Effort more than doubled between 1987 and 1992, and fluctuated thereafter (Fig. 2). Twin trawls introduced in 1995 on several Greenland trawlers have been accounted for in analyses of effort data.

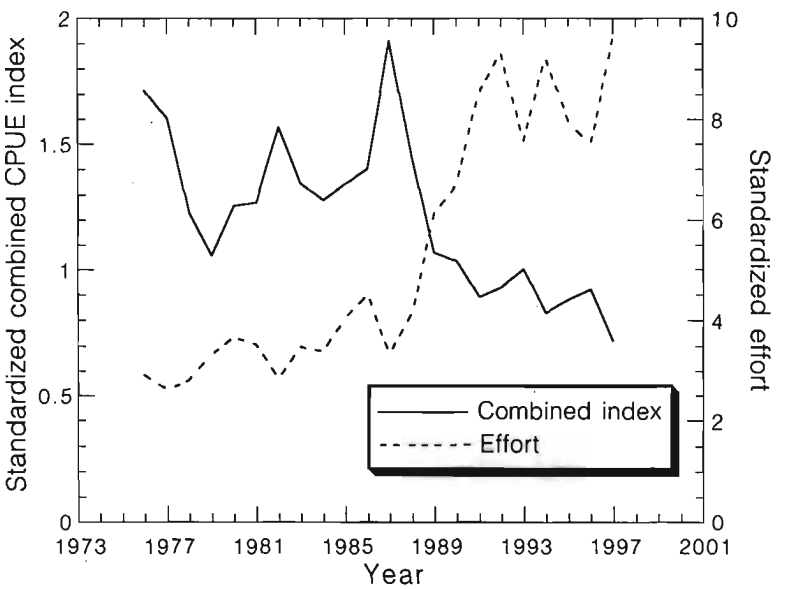


Fig. 2. Shrimp in Subareas 0 and 1: standardized combined CPUE index and standardized effort.

Length and age composition. Length frequency distributions obtained by observers were available from the commercial fishery in Div. 0A from 1981 to 1996. No samples were available from the limited 1997 fishery (SCR Doc. 97/100). Size composition data were available in Subarea 1 from 1991 to 1997 (SCR Doc. 97/98). Sample data indicated a gradual decline in the mean carapace length of shrimp taken in this fishery.

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. 97/99, 101). Since 1992, the survey has extended further to the south in Div. 1F compared to the coverage from 1988 to 1991. Since 1994, the survey has been carried out as a two-phase survey allocating extra trawl hauls to strata with high shrimp densities to reduce the variance of the biomass estimates (SCR Doc. 97/99, 101).

The biomass estimate in Div. 1F has exhibited very large variations between hauls and was thus determined with a very high degree of uncertainty.

The estimates of trawlable biomass are as follows:

Biomass ('000 tons)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Offshore (Div. 1A to 1E plus Div. 0A)	172	192	175	119	179	222	178	145	186	113
Inshore (Div. 1A)	-	-	-	49	45	32	41	47	55	49
Offshore Div. 1F	-	-	-	-	1	20	24	2	4	26
Total	172	192	175	168	225	274	243	194	245	188

Offshore: Survey biomass estimates have fluctuated over the time series but have shown a declining trend in recent years (Fig. 3). Since 1993, the areas in the north have exhibited the largest declines.

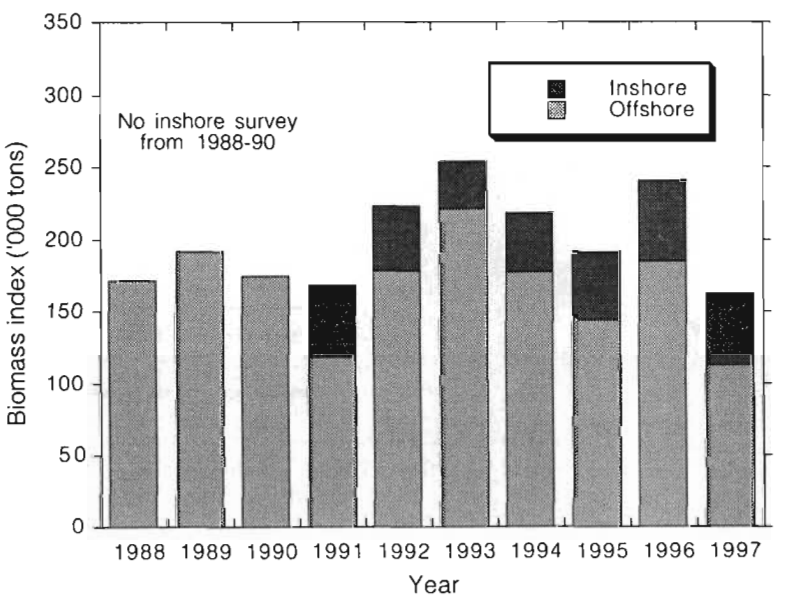


Fig. 3. Shrimp in Subareas 0+1: combined biomass estimates from inshore and offshore surveys.

Overall length distributions and results from modal analysis indicated that the 1993 year-class, which appeared to be very abundant in 1996, is now estimated to be average. Prospects for recruitment to the female group in 1998 and 1999 are poor.

Compared to recent years when abundance of female shrimp was highest in Div 1B, the females were most abundant in Div. 1CD in 1997.

Abundance-at-age (in billions) for shrimp from Greenland offshore research survey data are given in the following table for Div. 1A to 1E plus Div. 0A (Div. 1F not included):

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1						0.5	0.3	0.5	0.7	0.7
2	0.4	0.4	0.8	0.2	0.7	2.2	1.3	0.5	1.9	0.8
3	0.9	4.5	1.1	0.6	2.5	3.4	2.4	1.1	8.0	1.6
4	3.4	16.0	3.2	1.7	3.2	7.2	6.5	3.6	7.0	6.1
5	7.1	7.0	11.7	2.2	5.7	10.2	7.0	7.6	6.0	3.1
6	6.3	3.9	5.2	7.5	8.9	8.4	7.5	4.7	9.3	3.5
7+	7.7	6.0	8.0	4.4	5.5	7.9	6.4	5.1	5.6	4.4
Total	25.8	37.9	29.9	16.6	26.4	39.7	31.4	23.1	38.5	20.2

Inshore: The estimated biomass for 1997 was at about 45 000 tons as in previous years, and on average, the biomass seemed stable (SCR Doc. 97/99)(Fig. 3). However, size composition data indicated smaller mean size of shrimp in this area, with fewer larger males and female than in previous years. Prospects for recruitment to the female group are expected to be poor in 1998 and 1999.

Survey samples from the Disko area from 1995 to 1997 were reanalysed by modal analysis, and a new age-at-length structure was derived. Preliminary results suggest that shrimp may change sex a year earlier than indicated by previous analyses. (SCR Doc. 97/104).

iii) **Biological studies**

A study was presented on problems in the interpretation of year-class strength in pooled samples from the commercial shrimp fishery (SCR Doc. 97/105). When pooled over quarters, no significant effect on the estimation of modal strength was found from the simulations presented.

c) **Assessment Results**

Indices from the commercial fishery suggested that the biomass of shrimp in 1976-88 fluctuated at a higher level than in the 1989 to 1997 period. The 1997 combined CPUE index is the lowest on record. The decrease from 1987 to 1989 was coincident with a substantial increase in effort. The survey indices showed an overall decline since 1993, particularly in the northern area. The decline was evident in the offshore but not in the inshore area. Overall abundance of female and larger male shrimp declined substantially during the same period. Recruitment of the 1990 year-class to the female group was not as strong as previously anticipated and was insufficient to maintain the 1997 catch rates at the 1996 level.

The combined inputs to the assessment indicate a decrease in stock biomass and in the abundance of large shrimp. Recruitment to the female group in 1998 is forecasted to be low. Year-classes 1991 to 1993 that were estimated from the 1996 survey and fishery to be at or above average are now estimated to be only average or below average. The fishery in 1998 will therefore depend on reduced abundance of females and larger males from these year-classes.

d) **Research Recommendations**

For shrimp in Div. 0A and Subarea 1, STACFIS **recommended** that *for consideration at the November 1998 Meeting of the Scientific Council, sampling of the commercial fishery be improved to cover all components of the fishery by area and month.*

2. **Shrimp in Denmark Strait** (SCR Doc. 97/97, 102, 103, 106)

a) **Introduction**

The fishery in Denmark Strait started in 1978 and has taken place primarily in the area of Strede Bank and Dohrn Bank as well as on the slopes of Storfjord Deep. The available fishing grounds at any given time depends heavily on the ice conditions. The traditional area extends from approximately 65°N to 67°30'N and between 26°W and 34°W. In 1993, a fishery started in areas between 60°30'N and 65°N and west of 35°W.

Catches in the northern (traditional) area increased rapidly to 1980, declined and remained stable from 1981 to 1983, increased gradually to 1988 (12 500 tons) and then decreased again to 3 400 tons in 1996. Catches up to October 1997 in the northern area were higher than for the whole year in 1996. Catches from the southern fishing area increased from 1 200 tons in 1993 to 6 200 tons in 1996 (provisional). Catches for the whole area increased from 1993 to 1994-96 (Fig. 4). New data on distribution of catches between northern and southern areas in 1993-96 showed higher catches in the northern area, and lower catches in the southern area, than previously indicated. Based on fishing patterns in previous years, the 1997 total catch is expected to be about the same as in 1996.

Recent catches and TACs (tons) are as follows:

	1987	1988	1989	1990	1991	1992	1993[1]	1994[1]	1995[1]	1996[1]	1997[1,2]
Catch north of 65°N											
eastern side	1 330	1 424	1 326	281	465	1 750	2 553	1 514	1 151	566	2 718
western side	10 848	11 125	9 416	9 994	8 192	5 764	3 848	3 513	4 958	2 811	1 036
Total	12 178	12 556	10 742	10 275	8 657	7 514	6 401	5 027	6 109	3 378	3 754
Catch south of 65°N	-	-	-	-	-	-	1 247	4 785	3 396	6 224	2 427
Total	12 178	12 549	10 742	10 275	8 657	7 514	7 648	9 812	9 505	9 601	6 181[3]
Advised TAC	-	-	10 000	10 000	10 000	8 000	5 000	5 000	5 000	5 000	5 000

[1] Provisional catches.
[2] January-1 October.
[3] Total catches reported to 1 November: 8 283 tons.

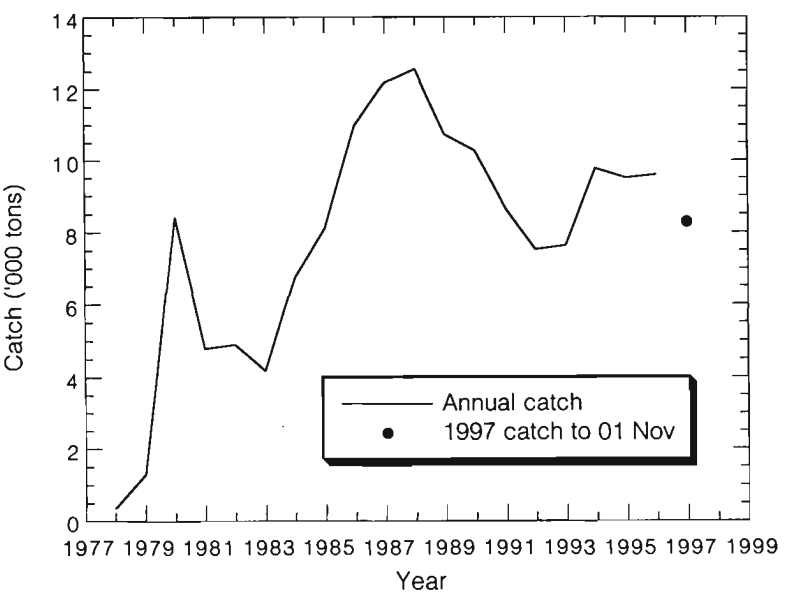


Fig. 4. Shrimp in Denmark Strait: catches.

b) **Input Data**

i) **Commercial fishery data**

Fishing effort and CPUE. Catch and effort data from logbooks were available from Greenland, Norway, Iceland, Faroe Islands and EU-Denmark since 1980 and from EU-France for the years 1980 to 1991.

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 32 000-49 000 hours in 1994-96. In the southern area, effort increased from 7 900 hours in 1993 to 20 300 hours in 1996. For the whole area effort has declined from 80 000 hours in 1993 to 52 200 in 1996.

In the northern area, the unstandardized catch-rate series for all fleets combined declined from 1980 to 1989, (SCR Doc. 97/102, 106). Catch rates for 1990-93 were similar to the low 1989 value, about 50% of the values seen in the early- to mid-1980s. In 1994 there was a considerable rise in this catch rate, which subsequently declined in 1995-96 and increased in 1997 reaching a level above the lows recorded in 1989-93 and equivalent to the 1987 value.

The standardized catch-rate series for Greenlandic vessels for large shrimp and all shrimp in the northern area (Fig. 5) showed a continuous decline from 1987 to 1993, and an increase in 1994. The 1995 CPUE value was approximately the same as that for 1994 after which this index has fluctuated but without trend (SCR Doc. 97/97). The 1996 and 1997 values are based on very small catches.

In the southern area the unstandardized catch rate for all fleets rose from 1993 to 1994 and remained relatively constant thereafter (Fig. 5). The initial increase in catch rate may have been due to learning in the early stages of the fishery.

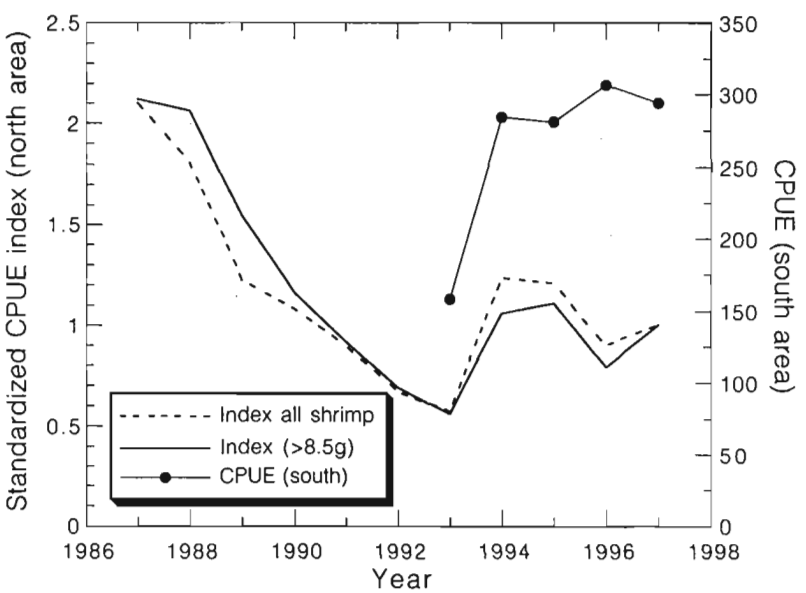


Fig. 5. Shrimp in Denmark Strait: catch rate indices (catch rates are standardized for northern area, unstandardized for southern area).

Biological data. Commercial sampling of this fishery has generally been at a very low level. Samples from the Icelandic and Greenlandic fisheries in the late-1980s were comprised mainly of females. Throughout the 1990s, males have dominated the catches in the north except in the Icelandic fishery in 1995 and again 1997 where females were 50% of the catch for the eastern area. Commercial samples from the Greenlandic fishery in the southern area showed a dominance of males in 1996 but about equal numbers of males and females in 1997 (SCR Doc. 97/97, 106).

ii) **Research survey data**

No trawl survey was conducted in 1997. The abundance index from Greenlandic surveys in the northern area declined from 1989 to 1992, and increased from 1992 to 1996 (SCR Doc. 96/116). The 1996 value should be treated with caution because the survey could not be completed as designed.

The Greenlandic survey showed an increase in the proportion of males from 1989 to 1992, which continued a trend from the Norwegian surveys from 1985 to 1989. In 1994 and 1995 the proportion of males was almost the same as 1992. As indicated in the following Table, a further increase was recorded in 1996, but this value should be treated with caution because of incomplete survey coverage.

	Percent males										
Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Norway	41.4	53.5	58.5	58.0							
Greenland				63.1	62.5	-	78.3	-	74.5	74.2	81.0

c) **Assessment Results**

The changes in fishing patterns (changes in proportion of effort allocated to northern and southern areas), very low levels of commercial sampling, and lack of a 1997 survey make assessment of this stock difficult. Catch rates in both northern and southern areas have shown no trends since 1994. In the northern area recent catch rates now are higher than the minimum values reached in 1989-93 although they are below the level of the early- to mid-1980s. Although no survey was available for 1997 results of earlier surveys indicated stable or increasing abundance since 1992. The information available provided no basis to indicate that there has been any recent change in stock status.

d) **Research Recommendations**

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

- *the Greenlandic survey be expanded to include the southern part of the stock area (south of 65°),*
- *an analysis of the distribution of the shrimp stock in relation to environmental conditions be conducted,*
- *commercial catch sampling of the shrimp fishery be improved to fully cover seasonal and spatial variation, so that size and sex composition of the catch can be accurately described,*
- *a study be conducted to compare length and age at sex reversal in northern and southern areas of the shrimp stock, and*
- *all available logbook data be analyzed for trends in CPUE (both standardized and unstandardized).*

II. OTHER BUSINESS

1. Review of SCR Documents

Two SCR Documents related to shrimp biology were reviewed aside from the assessment-related papers.

A special survey for age groups 1 and 2 of shrimp (*Pandalus borealis*) was conducted by Greenland in 1991 in shallow water on and at the banks off West Greenland in Div. 1A, 1B and 1C (SCR Doc. 97/107). Sixty-eight trawl hauls were taken in depths between 100 and 33 m, using mesh sizes in the codend of 28 mm in the first and 20 mm in the last part of the survey. Catches of shrimp were small, the highest catch being 6.8 kg in 30 minutes. Length distribution of *Pandalus borealis* showed no occurrence of age group 1 shrimp and only a very limited number of age group 2 shrimp, and concentrations of small shrimp could thus not be identified.

A first report on a special study conducted by Greenland on the slopes of Store Hellefiske Bank in West Greenland in 1997 to investigate the variation in catches of shrimp, Greenland halibut and redfish by depth was presented (SCR Doc. 97/108). Trawling was performed in two areas in southern and northern Div. 1B in transects along and across depth contours, from 200 to 550 m depth. Catches of shrimp, Greenland halibut and redfish were confounded with high variability. In both areas shrimp were most abundant between 350 and 400 m depth. Catches of Greenland halibut were relatively small in both areas, but increased with depth, while redfish were most abundant between 300 and 400 m depth. Further results from this study will be presented to the Council on a later date.

2. Other Shrimp Assessments

Gulf of Maine: S. X. Cadrin (USA) presented the US methods and results of an analytical stock assessment of the Gulf of Maine shrimp. The assessment was completed by the Northern Shrimp Technical Committee of the Atlantic States Marine Fisheries Commission and reviewed by the 25th Northeast Regional Stock Assessment Workshop. Survey indices of abundance and total commercial landings characterized by intensive port sampling were modeled with a modified DeLury analysis to estimate stock abundance and fishing mortality rates (F) from 1985 to 1997. Estimates of biomass and F were independently estimated using a non-equilibrium surplus production model. Biological reference points were estimated using a model of yield and egg production per recruit. The assessment indicated that the total stock biomass is currently below-average, and the fishing mortality rate (F) is high. Abundance of recruited shrimp at the end of the 1997 season was the lowest since the early-1980s. F ranged from 0.10 to 0.46 during 1985-95 and increased to 0.65 in 1996 and to 0.85 in 1997, the highest levels since 1975. Fishing mortalities at this level were associated with a collapse of the Gulf of Maine stock in the 1970s. Based on a decade of relatively stable stock levels, an appropriate target may be an F of 0.34, which was the average of 1985-95. Sustained F of 0.34 will maintain approximately 40% of maximum egg production and is slightly below $F_{0.1}$.

This surplus production model was applied to shrimp stocks in Denmark Strait on a preliminary basis, and further work is ongoing.

Scotian Shelf: P. A. Koeller (Canada) reported on the Canadian shrimp fishery on the eastern Scotian Shelf. The offshore trawl fishery began to develop toward its potential in the early-1990s when the introduction of the Nordmore grate eliminated the groundfish by-catch problem. The TAC was increased gradually to the current 3600 ton level, but the stock is still believed to be underexploited. Stock biomass is at an all time high, probably due to low temperatures and predation pressure in recent years. An inshore component to this stock was discovered recently and is currently exploited by a small (500 tons) but developing trap fishery that takes large animals (mainly transitionals and females) very close to shore (depth 100 m) from late-summer to early-spring, off Canso, Nova Scotia. These shrimp leave the inshore during spring and early-summer when water temperatures decrease to <1°C. Another small trap fishery which consists of migrating ovigerous females originating from an offshore stock on the southwestern Scotian Shelf has also developed in Mahone Bay (max. depth 40 m) south of Halifax, Nova Scotia. This area has considerably warmer water temperatures than the eastern shelf and the inshore migration during winter appears to be similar to that which occurs in the Gulf of Maine, where ovigerous females seek the colder inshore water during winter.

3. Acknowledgements

There being no other business, the Chairman thanked the participants, especially the Designated Experts and those presenting information on Gulf of Maine and Scotian Shelf shrimp stocks for their contributions to the meeting. Expressing gratitude to the Secretariat for their continued support and assistance, the Chairman adjourned the meeting.