# PART C: SCIENTIFIC COUNCIL MEETING, 24 OCTOBER – 1 NOVEMBER 2007

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Middle Row: Don Stansbury, Michaela Aschan, Mats Ulmestrand, Barb Marshall, Sten Munch-Petersen, Don Power, Bill Brodie, Michael Kingsley, Carsten Hvingel

Front Row: Guldborg Søvik , Helle Siegstad, Dave Orr, Nikoline Ziemer, Katherine Skanes

# REPORT OF SCIENTIFIC COUNCIL MEETING

# 24 OCTOBER – 1 NOVEMBER 2007

Chair: Don Power Rapporteur: Anthony Thompson

## I. OPENING

The Scientific Council met at the NAFO Headquarters, Dartmouth, NS, Canada, during 24 October–1 November 2007, to consider the various matters in its Agenda. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), and European Union (Estonia and Spain). The Scientific Council Coordinator, Anthony Thompson, was in attendance.

The Executive Committee met prior to the opening session of the Council to discuss the provisional agenda and plan of work.

The opening session of the Council was called to order at 1000 hours on 24 October 2007.

The Chair welcomed representatives, advisors and experts to this session of Scientific Council, held at the NAFO Secretariat, Dartmouth, NS, Canada. The Chair noted that the primary reason for this meeting was to provide advice on shrimp stocks provided by the joint NAFO/ICES *Pandalus* Assessment Group (NIPAG). ICES members of this group were granted observer status at the Scientific Council meeting, and the Chair wished all NIPAG members a productive and successful meeting.

The Scientific Council Coordinator, Anthony Thompson, was appointed Rapporteur.

The Council was informed that authorization had been received by the Executive Secretary for proxy votes from Cuba, Iceland, Japan, Norway, Russian Federation, Ukraine and United States of America, to record their abstentions during any voting procedures.

The Provisional Agenda was adopted. The Chair noted that any additional items that arose during the course of the meeting may be discussed and recorded in the minutes as appropriate.

This session was adjourned at 1015 hours.

The concluding session was convened at 0900 hours on 1 November 2007. The Council then considered and adopted Sections III.1–4 of the "Report of the NAFO/ICES *Pandalus* Assessment Group" (NAFO SCS Doc. 07/25, ICES CM 2007/ACFM:32). The NAFO stock assessments are included as Appendix I. The Council addressed the requests of the Fisheries Commission and Coastal States and considered the results of the assessments, and provided the advice and recommendations.

The meeting adjourned at 1400 hours on 1 November 2007.

The Agenda, List of Research (SCR) and Summary (SCS) Documents, List of Representatives, Advisers and Experts are given in Appendix II, III and IV, respectively.

## II. REVIEW OF RECOMMENDATIONS IN 2006 AND 2007

### From Scientific Council Meeting, 18–22 September 2006

No recommendations were made in September 2006 that are relevant to this October–November meeting.

### From Scientific Council Meeting, 25 October–2 November 2006

Recommendation: The Scientific Council advises a TAC of 22 000 ts for 2008. Scientific Council recommends *continuation of the existing regulations that the fishery be restricted to Div. 3L and the use of a mandatory sorting grate with a maximum bar spacing of 22 mm.* (Scientific Council Reports 2006, p. 218)

STATUS: Fisheries Commission in September 2007 continued to restrict this fishery to Div. 3L. Fisheries Commission maintained Article 10.7 of the 2007 CEM, which states "Vessels fishing for shrimp in Divisions 3L or 3M shall use sorting grids or grates with a maximum bar spacing of 22 mm. Vessels fishing for shrimp in Division 3L shall also be equipped with toggle chains of a minimum 72 cm in length, as described in Annex XXI.".

**From Scientific Council Meeting, 7–21 June 2007**

Scientific Council recommended that *the stock classification is included in the summary sheets and that clarification be added to the classification table to record if the stock has references points*. (Scientific Council Reports 2007, p. 41)

STATUS: This will be implemented as appropriate, and will be discussed under Agenda item V.6.

Scientific Council recommended that *position be reported at shorter intervals than the current 2 hours, and the NAF fields for speed (code SP) and course (code CO) be added to the POS reports transmitted to the Secretariat.* (Scientific Council Report June 2007, Item XII.5a)

STATUS: The change to a shorter reporting period was discussed by STACTIC and they decided to re-visit the issue at a later date. The inclusion of speed and course in the transmission was not discussed. The Scientific Council Coordinator, in conjunction with the Scientific Council Chair, will write a Fisheries Commission working paper on this and submit it to STACTIC at their next meeting. (Scientific Council Report September 2007, Item II.). This will be further discussed under Agenda item V.5.

**From Scientific Council Meeting, 24–28 September 2007**

Therefore, in order to provide complete and timely advice, Scientific Council recommended that *for the Annual Meeting the Fisheries Commission submits, whenever possible, its questions for Scientific Council well in advance of the meeting. Scientific Council asks that the Secretariat includes this recommendation in the circulation of the Annual Meeting agenda*.

STATUS: This recommendation is not relevant to this October–November Scientific Council meeting.

## III. NAFO/ICES *PANDALUS* ASSESSMENT GROUP

NIPAG has assessed four stocks of relevance to NAFO: Northern shrimp in Div. 3M, Northern shrimp in Divs. 3LNO, Northern shrimp in Subareas 0 and 1, and Northern shrimp in Denmark Strait and off East Greenland. The Scientific Council's summary sheets and conclusions for these stocks are presented in Section IV of this report. The recommendations to Fisheries Commission, with respect to stock advice, appear in the summary sheets. The full NIPAG report is available in NAFO SCS Doc. 07/25 and ICES CM 2007/ACFM:32.

## IV. FORMULATION OF ADVICE

### 1. Requests from Fisheries Commission

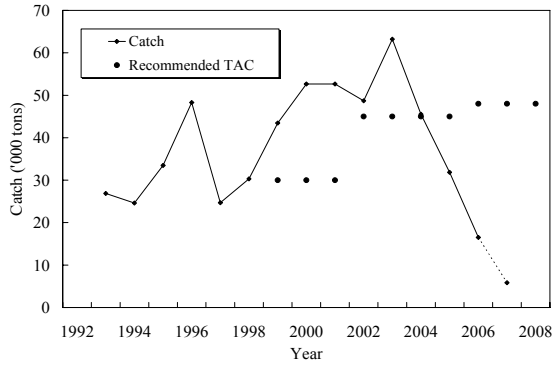
## *Northern Shrimp* (Pandalus borealis) *in Div. 3M*

**Background:** The shrimp fishery in Div. 3M began in late-April 1993. Initial catch rates were favorable and, shortly thereafter, vessels from several nations joined. Between 1993 and 2004 the number of vessels ranged from 40–110. In 2006 there were approximately 20 vessels fishing shrimp in Div. 3M.

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

| | Catch ('000 t) | | TAC ('000 t) | |
|---|---|---|---|---|
| Year | NIPAG | 21A | Recommended | Agreed |
| 2002 | 49 | 49 | 45 | er |
| 2003 | 63 | 63 | 45 | er |
| 2004 | 45 | 45 | 45 | er |
| 2005 | 32 | 25[1] | 45 | er |
| 2006 | 17 | 9[1] | 48 | er |
| 2007 | 6[2] | | 48 | er |
| 2008 | | | ( )[3] | |

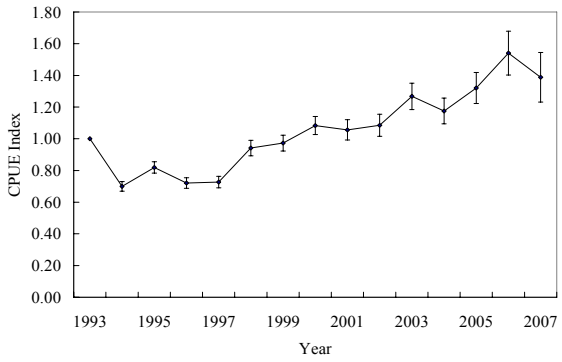
[1] Provisional.
[2] Preliminary to 1 September.
[3] In 2007 Scientific Council advised no change in exploitation rate.
er Effort regulations.



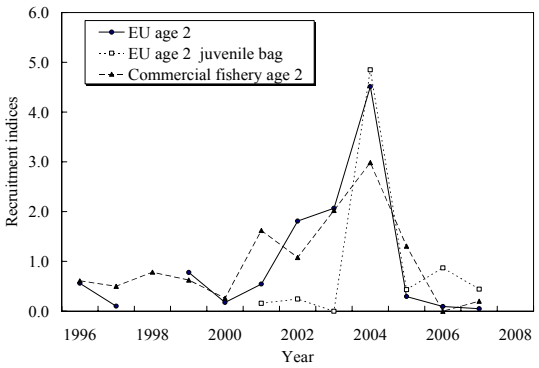

**Data:** Catch, effort and biological data were available from several Contracting Parties. A standardized CPUE index was developed to account for changes in gear (single, double and triple trawl), fishing power and seasonality. Time series of size and sex composition data were available mainly from two countries and survey indices were available from EU research surveys (1988–2007). In the 2006 assessment, problems about suspected misreporting catches in 2005 and 2006 (Div. 3L catches being reported as Div. 3M catches) precluded the acceptance of a standardized CPUE series. The exclusion of trips where the reported catches were mixed between 3M and 3L enabled a revised standardized CPUE index to be modeled.

**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.

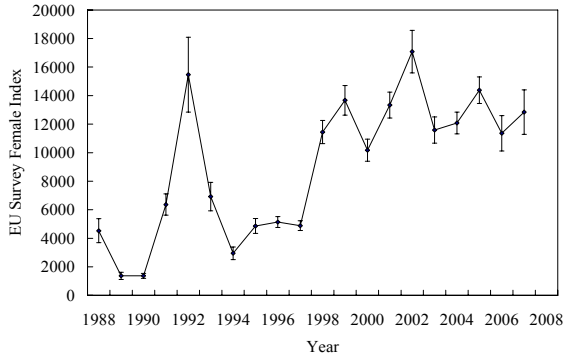
*CPUE:* The standardized catch rate index declined between 1993 and 1994, and was at a low level until 1997. From 1998 it gradually increased to 2006. In 2007 the standardized CPUE declined, however due to the low numbers of observations there is considerable uncertainty regarding the 2006 and 2007 estimates.



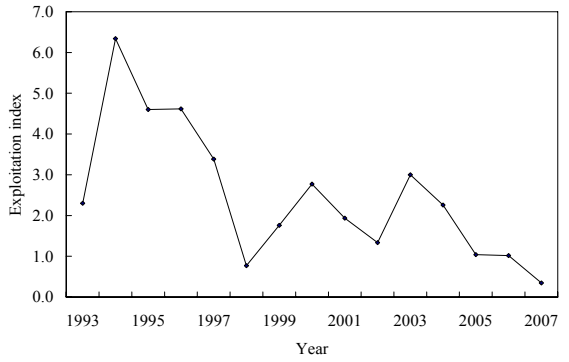

*Recruitment:* The 2002 year-class appears to be large, but the 2003–2005 year-classes appear weak.




*SSB:* The survey index of female biomass increased from 1997 to 1998 and has fluctuated without trend since then.



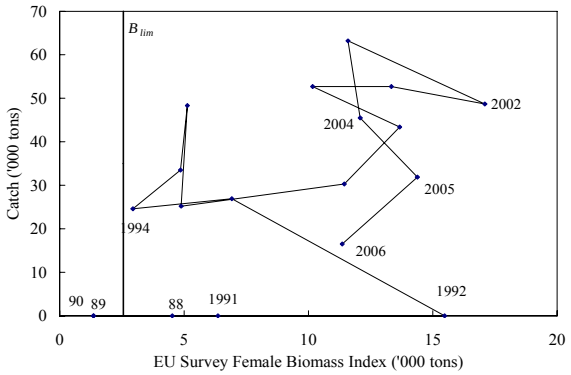

*Exploitation rate:* The provisional exploitation rate estimated in 2007 was the lowest in the series showing probable decreasing trend initiated after 2003. This trend appears to be mostly due to decreasing catches.




**State of the Stock:** The indices of biomass are at a relatively high level but there are indications of a decline in recruitment, which may affect the 2008 fishery.

**Recommendations:** The Scientific Council noted there is insufficient information on which to base predictions of annual yield potential for this resource and is therefore unable to advise on a specific TAC for 2008 and 2009. Although there is serious concern about the implications to the fishery and future stock production from the poor recruitment estimated for the 2003, 2004 and 2005 year-classes, indices of biomass (standardized CPUE and female biomass (SSB) from surveys) remain stable at their highest observed level. However, in light of the poor prospect for this stock, the Scientific Council recommends that exploitation level for 2008 and 2009 should not exceed the 2005 and 2006 levels. This corresponds to catches in the range of 17 000 to 32 000 t.

**Reference Points:** Scientific Council considers that 15% of the maximum survey female biomass index is a limit reference point for biomass ($B_{lim}$) for northern shrimp in Div. 3M. It is not possible to calculate a limit reference point for fishing mortality. Currently, the biomass is estimated to be well above $B_{lim}$.




**Special Comments:** This advice will be reviewed based on updated information in September 2008 when results from the summer survey are available.

**Sources of Information:** SCR Doc. 07/72, 77, 78, 89.

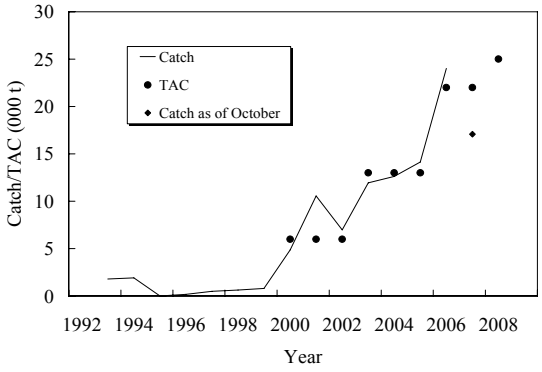
### *Northern Shrimp* (Pandalus borealis) *in Div. 3LNO*

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

**Fishery and catches**: Several countries participated in the fishery in 2007. The use of a sorting grid to reduce bycatches of fish is mandatory for all fleets in the fishery. Recent catches from the stock are as follows:

| | Catch ('000 t) | | | TAC ('000 t) | |
|---|---|---|---|---|---|
| Year | NIPAG | 21A | | Recommended | Agreed |
| 2004 | 13 | 12 | | 13 | 13[3] |
| 2005 | 14 | 14 | | 13 | 13[3] |
| 2006 | 24[2] | 23[1] | | 22 | 22[3] |
| 2007 | 17[2] | 17[1] | | 22 | 22[3] |
| 2008 | | | | | 25[4] |

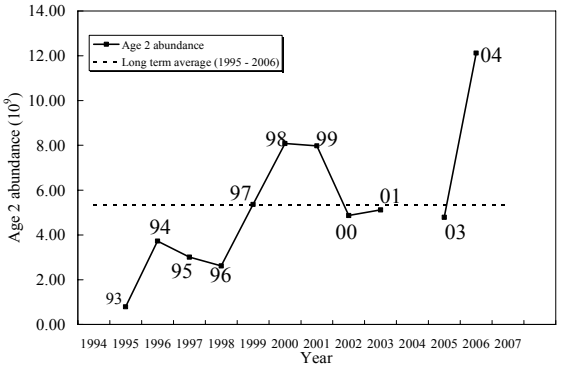
[1] Provisional.
[2] Preliminary to 21 October 2007.
[3] Denmark in respect of Greenland and Faroe Islands set an autonomous TAC of 2 274 t for 2006 maintaining that level for 2007; this autonomous TAC replaces the DFG quota of the tabulated TAC.
[4] Provisional TAC.

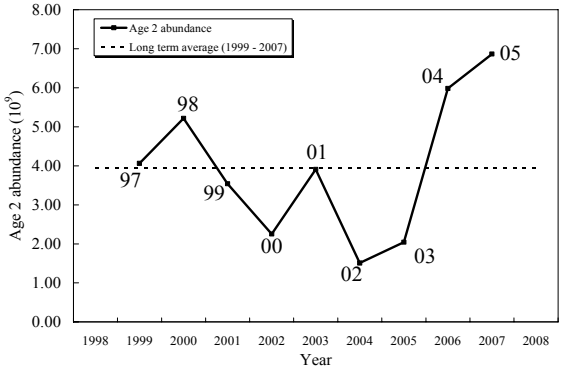



**Data**: Catch, effort and biological data were available from the commercial fishery. Biomass and recruitment indices as well as size and sex composition data were available from research surveys conducted in Divs. 3LNO during spring (1999–2007) and autumn (1995–2006). The Canadian survey in autumn 2004 was incomplete.

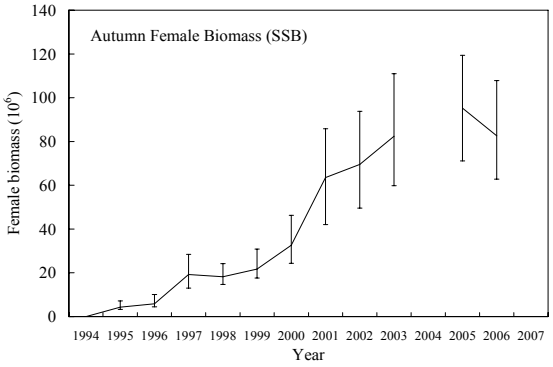
**Assessment**: No analytical assessment is available. Evaluation of the status of the stock is based upon interpretation of commercial fishery and research survey data.

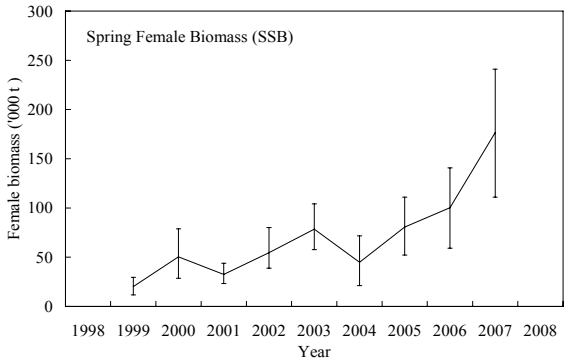
*Recruitment*: Recruitment indices from autumn survey data indicated that the 2003 year-class was average while recruitment from the 2004 year-class was the highest in that time series. The spring recruitment indices for the 2002 and 2003 year-classes were below average while those from the 2004 and 2005 year-classes were the highest in the spring series.



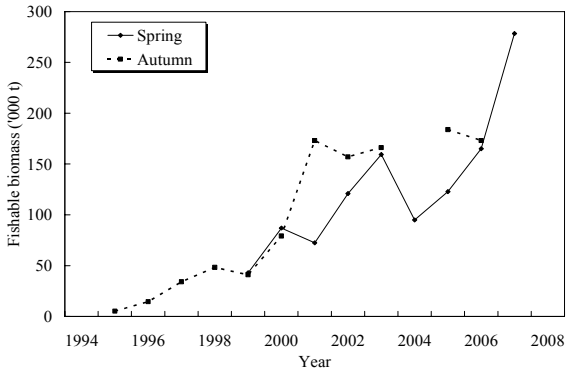




*Biomass*: There has been a significant increase in the index of total biomass between 1995 and 2001 followed by stability at a high level. Both spring and autumn indices of female biomass (SSB) have been increasing since 1999.

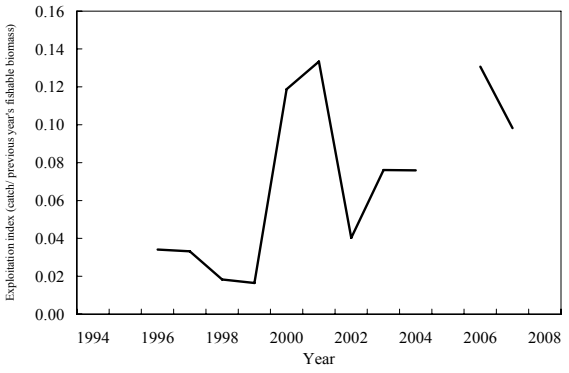





*Fishable biomass and Exploitation:* The fishable biomass index (shrimp >17 mm carapace length ) from the Canadian autumn survey (1995–2006) increased over the period 1999–2001 varying slightly at a high level since, while the spring survey index increased from 1999–2003 decreased during 2004 but has steadily increased since.

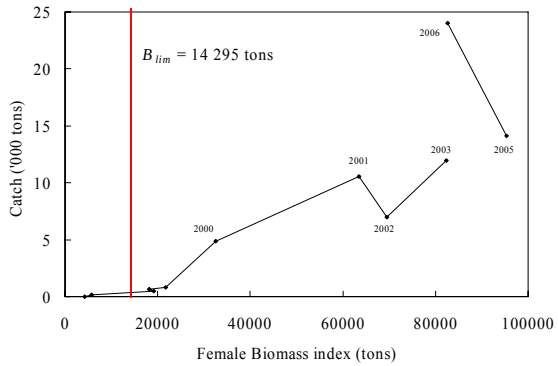



*Exploitation rate:* The index of exploitation (catch divided by autumn survey fishable biomass from previous year) has remained below 14%.




**State of the Stock**: Total biomass indices have been stable at a high level since 2001. The female biomass (SSB) indices have been increasing since 1999. The stock appears to be well represented by a broad range of size groups; the stock biomass index has not declined at the observed levels of exploitation. The above average recruitment in 2004 is expected to be present in the fishery during 2007 and that from 2005 is expected to enter the fishery in 2008.

**Precautionary Approach Reference Points**: Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for $B_{lim}$ for northern shrimp in Divs. 3LNO. It is not possible to calculate a limit reference point for fishing mortality. Currently, the SSB is estimated to be well above $B_{lim}$.




**Recommendation**: The Scientific Council advises that the most recently implemented TAC at 25 000 t be maintained for 2008 and 2009 in order to monitor the impact on the stock. The inverse variance weighted average fishable biomass from the last four surveys is 184 000 t. A catch of 25 000 t would result in a value of the exploitation index of 13.6%. Scientific Council recommends continuation of the existing regulations that the fishery be restricted to Div. 3L and the use of a mandatory sorting grate with a maximum bar spacing of 22 mm.

| | | | | |
|---|---|---|---|---|
| Exploitation Index (%) | 12.0 | 13.6 | 14.1 | 16.3 |
| Catch (t) | 22 000 | 25 000 | 26 000 | 30 000 |

**Special Comments**: Advice for the 2009 fishery will be reviewed at the September 2008 Scientific Council meeting, when results from the 2007 autumn and 2008 spring surveys will be available.

**Sources of Information**: SCR Doc. 07/77, 78, 79, 89.

## 2. Requests from Coastal States

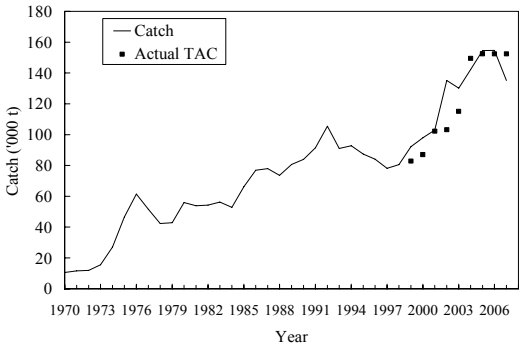
### *Northern Shrimp* (Pandalus borealis) *in Subareas 0 and 1*

**Background**: The shrimp stock off West Greenland is distributed in SA 1 and Div. 0A east of 60°30' W. A small-scale inshore fishery began in SA 1 in the 1930s. Since 1969 an offshore fishery has developed.

**Fishery and Catches**: The fishery is prosecuted mostly by Greenland and Canada. Catch data since 1999 was reviewed. Catch figures for 2003 to 2005 were 8–12% higher than those used in 2006. Earlier catches changed slightly. Recent TAC and catches are as follows:

| | Catch ('000 t) | | TAC ('000 t) | |
|---|---|---|---|---|
| Year | NIPAG | 21A | Recommended | Actual[3] |
| 2004 | 142 | 141 | 130 | 150 |
| 2005 | 155 | 10[1] | 130 | 152 |
| 2006 | 155 | 4[1] | 130 | 152 |
| 2007 | 135[2] | 0 | 130 | 152 |

[1] Provisional.
[2] Estimated to the end of 2007.
[3] Total of TACs set by Greenland and Canada.

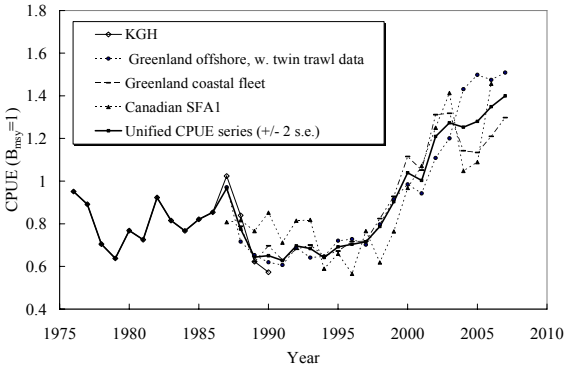



**Data**: Catch and effort data were available from all vessels. Series of biomass and recruitment indices and size- and sex-composition data were available from research surveys. Series of cod biomass and cod consumption were also available.

**Assessment**: An analytical assessment framework was used to describe stock dynamics in terms of biomass ($B$) and mortality ($Z$) relative to biological reference points. The model used was a stochastic version of a surplus-production model including an explicit term for predation by Atlantic cod, stated in a state-space framework and fitted by Bayesian methods. MSY (Maximum Sustainable Yield) defines maximum production, and $B_{msy}$ is the biomass level giving MSY. A precautionary limit reference point for stock biomass ($B_{lim}$) is 30% of $B_{msy}$ and the limit reference point for mortality ($Z_{lim}$) is $Z_{msy}$.

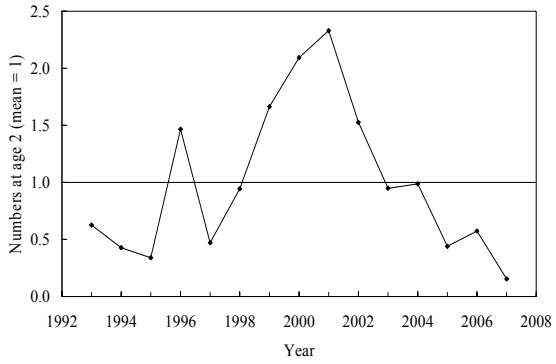
While the model used in 2007 was broadly similar to that used in 2006, there were differences of detail and to input data series that impede direct comparison of results. The model was investigated with four different inputs to summarize statistics of stock dynamics, present stock status, and short-term predictions for different catch levels.

*CPUE:* In aggregate, standardized catch-rate indices, roughly stable from 1976 to 1987, decreased sharply to the early 1990s and stayed low for a few years, but then increased steadily to high levels in the early 2000s. An apparent recent contraction of the fished area casts doubt on how well recent CPUEs reflect trends in biomass.

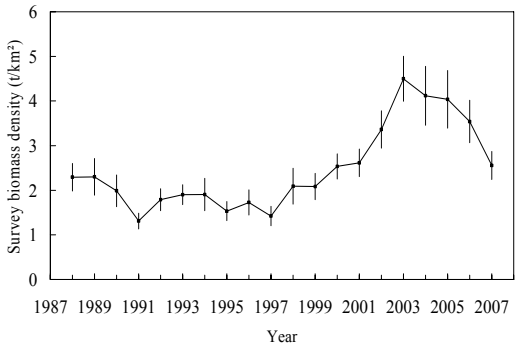



*Mortality:* The mortality caused by fishing and cod predation ($Z$) is modeled as having been below the reference level of ($Z_{msy}$) since 1993. With catches in 2007 projected at 135 000 t the risk that total mortality would exceed $Z_{msy}$ was estimated to be in the range of 26–44%.

*Recruitment*: Numbers at age 2 from the research trawl survey peaked in 2001, but have since continually decreased, have been below average since 2003, and in 2007 have reached a record low, at about 7% of the 2001 peak and 15% of the series mean. Prospects for recruitment to the fishable stock are bleak.




*Biomass*: Survey biomass, relatively low from 1988–1998, increased to an all-time high in 2003, but has since steadily declined, in 2007 to 58% of its 2003 value; however, it is still 13% above the series mean.




Stock-dynamic modeling estimates that current biomass level is above $B_{msy}$, with a small probability of being below $B_{lim}$. However, it also confirms a decrease in biomass in the most recent years.

*State of the stock*: CPUEs are high in historic terms, but the stock is being intensively fished in a shrinking area. Survey biomass, still moderately high, has nevertheless decreased markedly and uninterruptedly since 2003. Estimated numbers of small shrimp have decreased for six years, reaching now very low levels. Concerns about future recruitment expressed in previous years are in 2007 aggravated, and reinforced by indications of decreasing stock biomass and a narrow size spectrum.

Risk associated with four optional catch levels for 2008 are:

| | 2008 Catch option ('000 t) | | | |
|---|---|---|---|---|
| | 90 | 110 | 120 | 130 |
| Risk in 2008 of exceeding $Z_{msy}$ | 10–13% | 18–34% | 26–48% | 34–62% |

**Recommendations**: Recruitment has been low for a number of years and the stock is decreasing. Recent catch levels are not estimated to be sustainable. SC therefore recommends that catches in 2008 should be reduced substantially.

The stock is still estimated to be at a relatively high level, and therefore a catch of around 110 000 t is not likely to drive the stock below $B_{msy}$ in 2008. However, the risk of exceeding $Z_{msy}$ at this catch level in 2008 is estimated to be relatively high (18–34%). Scientific Council notes that catches in 2008 at 90 000 t would result in an estimated risk of exceeding $Z_{msy}$ of 10–13%. Scientific Council considers it likely that catches would need to be reduced further in 2009.

**Special Comments**: The Scientific Council advice is for total catch weight, correctly reported, without allowance for unusable shrimp. Scientific Council also notes that the modeled risks may not fully account for the poor recruitment prospects.

**Sources of Information:** SCR Doc. 02/158, 03/74, 04/75, 76, 07/66, 67, 69, 73, 88; SCS Doc. 04/12.

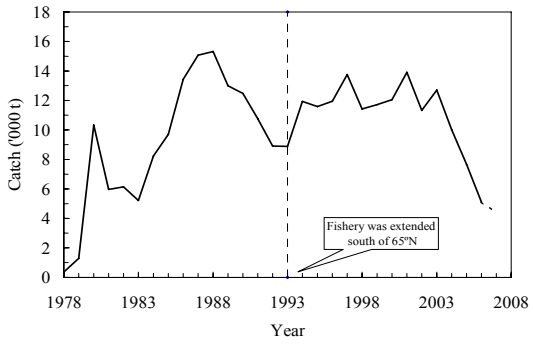
### *Northern Shrimp* (Pandalus borealis) *in Denmark Strait and off East Greenland*

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

**Fishery and Catches**: Four nations participated in the fishery in 2007. Since 2004, Icelandic effort has been very low and no catches have so far been taken in 2007. Recent catches and recommended TACs are as follows:

| | Catch ('000 t) | | | TAC ('000 t) | | |
|---|---|---|---|---|---|---|
| Year | NIPAG | 21A | | Recomm-ended | Greenland EEZ | Iceland EEZ[2] |
| 2003 | 12.6[1] | 9.8 | | 9.6 | 10.6 | - |
| 2004 | 10.0 | 10.0 | | 12.4 | 15.6 | - |
| 2005 | 7.8 | 7.8 | | 12.4 | 12.4 | - |
| 2006 | 5.1 | 5.1[3] | | 12.4 | 12.4 | - |
| 2007 | 4.4[4] | | | 12.4 | 12.4 | |

[1] Corrected for "overpack".
[2] Fishery unregulated in Icelandic EEZ.
[3] Provisional catches.
[4] Catches to beginning October 2007.



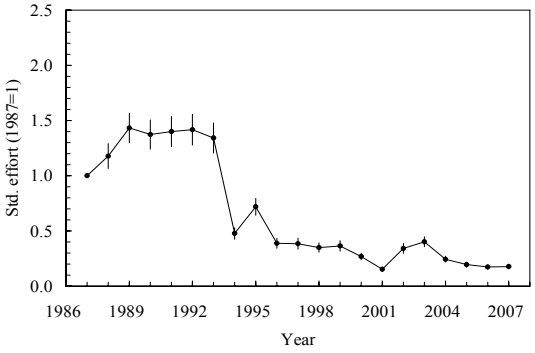

**Data:** Catch and effort data were available from trawlers of several nations. Surveys have not been conducted since 1996.

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

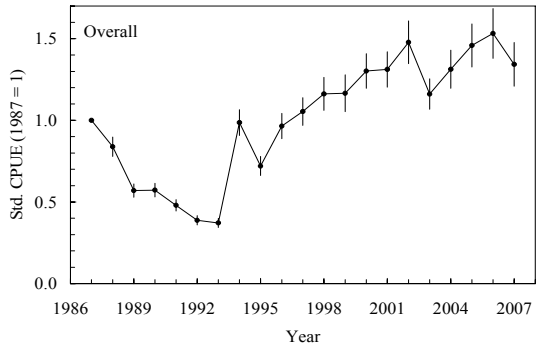
*Recruitment:* No recruitment estimates were available.

*Exploitation rate:* Since the mid 1990s exploitation rate index (standardized effort) has decreased to its lowest levels in the 20-year series.

*Biomass:* No direct biomass estimates were available.




*CPUE:* Combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993, increased to reach a relatively high level by the beginning of the 2000s and fluctuated at this level thereafter.




**State of the Stock**: The stock is believed to be at a relatively high level, and to have been there since the beginning of the 2000s.

**Recommendation**: Given the lack of change in the CPUE index for the total stock since the beginning of the 2000s at recent catch levels, Scientific Council finds no basis to change its previous advice and recommends that catches should remain below 12 400 t.

**Special Comments**: From 1994 to 2003 annual catches remained near the recently recommended TAC of 12 400 t, while stock biomass indices increased. The principal, Greenland, fleet, accounting for 40% of total catch, has decreased its effort in recent years, which gives some uncertainty on whether recent index values are a true reflection of the stock biomass. This decrease may be related to the economics of the fishery.

**Sources of Information**: SCR Doc. 07/68.

## V. OTHER MATTERS

### 1. Meeting of October/November 2008

Scientific Council decided to change the dates for the 2008 NIPAG meeting that were agreed last year (Scientific Council Reports 2006, p. 222) and hold the meeting a week earlier. This was because of the tight deadline for informing ICES ACFM of the NIPAG advice for ICES shrimp stocks. The dates and venue of the next SC/ NIPAG meeting will be Wednesday 22–Thursday 30 October 2008 at the ICES HQ, Copenhagen, Denmark.

### 2. Meeting of October/November 2009

The dates and venue of the Scientific Council meeting will be decided at the October–November 2008 Meeting. Provisional dates and venue are Wednesday 21 October–29 October 2009 at the NAFO Headquarters, Dartmouth, NS, Canada.

### 3. Coordination with ICES Working Groups on Shrimp Stock Assessments

#### a) NIPAG

This years NIPAG meeting was the fourth conducted in a spirit of partnership and cooperation between the NAFO Standing Committee on Fisheries Science (STACFIS) and the ICES Working Group on *Pandalus* Stocks (WGPAND). A single report was produced entitled "Report of the NAFO/ICES Pandalus Assessment Group", that contains the recommendations and advice required by NAFO SC and ICES ACFM. It was noted that the enhanced peer review was beneficial to both NAFO and ICES and should continue under the umbrella of the joint NIPAG group and the co-chairing arrangement. There were constraints noted on arranging an appropriate meeting time and work planning during the meeting owing to survey data availability for several stocks, and, the requirement of the ICES ACFM to have the report of the stocks it provides advice on prior to the first week of November.

#### b) WGFTFB

During deliberations of various shrimp stocks it was noted that twin trawls, and in some cases triple trawls, were being utilized for the improvement of catch rate as well as catch quality. It was pointed out that the physical attributes of some twin trawls (e.g. the number of meshes in the circumference) may not be too different from single trawls. NIPAG considered that further investigations should be conducted to address this as it is could be very informative in interpreting standardized catch rate indices. This would include investigations of the use of twin and triple trawls in other fisheries as well, for example Greenland halibut directed fisheries, where their deployment may be used to improve catch rate rather than catch quality. NIPAG recommended that this issue be taken up by the NAFO Standing Committee on Research Coordination (STACREC) and the ICES Fishing Technology Working Group.

In June 2007, STACREC recommended that the appropriate method to estimate effort from twin trawls (bottom and mid-water) be referred to the ICES Fishing Technology Working Group. This request was submitted to ICES on 20 July 2007 and is now included in the ICES/FAO WGFTFB TORs for consideration at their meeting on 21–25 April 2008 (http://www.ices.dk/iceswork/recs/2007%20Resolutions/FTC/FTC%20Draft%20ToRs.pdf).

### 4. Progress on Northern Shrimp Working Group

The formulation of the Shrimp Working Group was proposed by Scientific Council two years ago, with TORs to study key processes in the life cycle of the shrimp (Scientific Council Reports 2005, p. 225). A Convenor has still not been identified (this meeting and Scientific Council Reports 2006, p. 222). Scientific Council is now transferring the responsibility for the development of this working group to NIPAG, and requests that NIPAG reviews the need for such a Shrimp Working Group and its proposed TORs.

### 5. Effort analysis using VMS data

Scientific Council requested the Secretariat to analysis the VMS data and supply Scientific Council with summary information on shrimp fishing in Div. 3L and Div. 3M (Scientific Council Reports 2006, p. 223). This was presented to Scientific Council (SCR Doc. 07/90). Two significant conclusions were drawn from the presentation. Firstly, the

identification of shrimp fishing below 600 m was taken as erroneous, and this highlights the difficulties in determining target species of fishing vessels transmitting VMS reports. It was suggested the analysis being re-run excluding fishing locations below 600 m. Secondly, VMS reports can produce effort statistics in more-or-less real time. This allows for a spatial assessment of shrimp fishing effort to be undertaken in a timely manner. This is not possible with STATLANT 21B data as the reporting deadlines are the 31 August in the following year, and even then many Contracting Parties fail to meet this deadline.

**6. Stock Classification**

**a) Shrimp stocks**

| Stock | NAFO Stock Classification | |
|---|---|---|
| | Stock Abundance Status | Exploitation Rate Status |
| Northern shrimp Div. 3LNO | B | 2 |
| Northern shrimp SA 0+1 | B | 2 |
| Northern Shrimp 3M | B | 2 |
| Northern shrimp in Denmark Strait | B | 2 |

Discussions regarding the classification of the NAFO shrimp stocks, using the FIRMS system, resulting in all four stocks being classified as B2, meaning intermediate abundance and moderate fishing pressure. Changes in classification from last year should not be taken as an indication of any real changes in stock or exploitation levels, rather a re-interpretation of the meaning of the categories in the classification system (Scientific Council Reports 2006, p. 223). It is stressed that this classification is a simplistic summary of the recent stock health and fishing pressure, set against a rather difficult to define past baseline. These classifications do not indicate recent changes nor do they have any predictive power, and therefore can not be used to provide management advice. The full assessments must be consulted for this.

**b) General considerations**

NAFO Scientific Council decided to use a stock classification table based on guidelines produced by FIRMS (Scientific Council Reports 2006, p. 222). Although the FIRMS classification is intended for use with database searches, NAFO Scientific Council decided to classify its own stocks so as to avoid erroneous classification by third parties who have considerably less knowledge of the stocks in question. There has been some confusion in the use of the stock classification table and the interpretation of some of the categories. This is more prevalent for stocks lacking reference points, but the interpretation needs to be handled with care even when reference points are available. The Scientific Council noted that this classification is not intended as a means to convey the scientific advice. It is also important to realize that (a) although a two-way classification is simplistic, but it is better than the one-way classifications that combine stock abundance and exploitation rate, and (b) such classifications will be used by people other than assessment biologists (indeed this is largely the reason in having such simple classifications). The Scientific Council Chair asked the Secretariat, in collaboration with Designated Expertss, to produce a working paper for the June meeting that provides examples of the dilemmas and gives future guidance regarding the use of this classification system.

**7. Other Business**

**a) Election of Vice-Chair**

The *ad hoc* Nominating Committee, formed at the September 2007 Scientific Council meeting, would like to propose Ricardo Alpoim (EU-Portugal) for the position of Scientific Council Vice-Chair. Under Scientific Council Rules of Procedure Rule 3.3b, the Vice-Chair also acts as the STACREC Chair. A vote by roll call was made at this meeting, under Rule 2.2, with the Executive Secretary casting five votes of abstention on behalf of the seven Contracting Parties who registered proxy vote (Rule 2.3a and e). The Chair asked the representatives from Canada, Denmark (in respect of Faroe Islands and Greenland), and European Union to cast their votes. By a majority of three affirmative to zero negative votes, with five abstentions, Ricardo Alpoim was elected as Scientific Council Vice-Chair effective immediately.

**b) Special Session in 2007**

The Scientific Council special session was held at the Altis Hotel, Lisbon, Portugal, on 1–3 October 2007, and was a joint symposium with PICES and ICES entitled "Reproductive and Recruitment Processes of Exploited Marine Fish Stocks". This was attended by 151 participants and comprised of 52 oral and 70 poster presentations. The plenary lecture "Emerging from Hjort's Shadow" was given by Ed Houde (University of Maryland), and the concluding summary lecture by Keith Brander (ICES).

**c) Special Session in 2009**

Scientific Council agreed in Sep 2007 (SCS Doc. 07/23, VII.2) that the Special Session in 2009 would take the form of a 2–4 days workshop, and suggested topics were new assessment methods including FLR and the Ecosystem Approach. It is suggested that consideration also be given to considering the advances in the application of limit reference points to stocks where no analytical model exists. These three suggestions will be further considered in June 2008.

**d) Rules of Procedure**

The Scientific Council Chair has asked the Secretariat to review the background to the current Rules of Procedure regarding "Voting" and to present their findings to the June 2008 Scientific Council meeting.

**e) Designated Experts**

Scientific Council is informed that Joanne Morgan (DFO, Canada) has been identified as the new designated expert for Redfish in Div. 3O, and Karen Dwyer (DFO, Canada) has been identified as the new designated expert for Witch flounder in Div. 3NO (SCS Doc. 07/23, Appendix II (STACFIS Report), Item 2). A designated expert for Northern Shortfin Squid in SA 3+4 has still not been indentified.

## VI. ADOPTION OF SCIENTIFIC COUNCIL AND NIPAG REPORTS

The Council at its session on 1 November 2007 considered and adopted Sections III.1-4 of the "Report of the NAFO/ICES *Pandalus* Assessment Group" (SCS Doc. 07/25, ICES CM 2007/ACFM:32). The Council then considered and adopted its own report of the 24 October–1 November 2007 meeting.

## VII. ADJOURNMENT

The Chair thanked the participants for their hard work and contribution to the success of the meeting, and welcomed the constructive comments given by ICES observers. A special thanks was extended to Bo Bergström, who will be leaving the group, for all his valuable help over the years and all participants conveyed their best wishes for the future. The Chair then thanked the Scientific Council Coordinator, and Barb Marshall and other members of the NAFO Secretariat, for supporting and hosting this Scientific Council meeting and the NIPAG meeting, and wished everyone a safe journey home.

## APPENDIX I. NIPAG – NAFO ASSESSED STOCKS

(extracted from SCS Doc. 07/25, Serial No. N5477)

### 1) Northern shrimp (Div. 3M) – NAFO Assessed

(SCR Doc. 07/72, 77, 78, 89)

#### a) Introduction

The shrimp fishery in Div. 3M began in 1993. Initial catch rates were favorable and, shortly thereafter, vessels from several nations joined. Since 1993 the number of vessels ranged from 40 to 110, and in 2006 there were approximately 20 vessels fishing shrimp in Div. 3M compared with 50 in 2004. No information is available on the number of vessels taking part in the shrimp fishery in 2007.

Catches increased from about 27 000 t in 1993 to 48 000 t in 1996, declined to 25 000 t in 1997 then increased gradually to a peak of 63 000 t in 2003 (Fig. 1.1). The catch declined in 2005 to 32 000 t and again in 2006 declined to 16 500 t. Provisional information to 1 September 2007 indicates removals of about 5 800 t; lower than usually reported for the same period. Supplementary information from the fishery suggests that economic considerations (price of fuel and market prices for shrimp) may be affecting participation in the fishery.

#### b) Input Data

NIPAG expresses concern about suspected misreporting catches in 2005, 2006 and 2007, where catches from Div. 3L were reported as from Div. 3M.

Recent catches and TACs (metric tons) are as follows:

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | 30 000 | 30 000 | 30 000 | 45 000 | 45 000 | 45 000 | 45 000 | 48 000 | 48 000 | (3) |
| STATLANT 21A | 42 041 | 50 471 | 53 793 | 47 299[1] | 61 671[1] | 44 873[1] | 25 392[1] | 9 237[1] | | |
| NIPAG | 43 438 | 52 664 | 52 671 | 48 704 | 63 226 | 45 543 | 31 862 | 16 510 | 5 861[2] | |

[1] Provisional;
[2] Preliminary to 1 September 2007.
(3) SC advised no change in exploitation rate

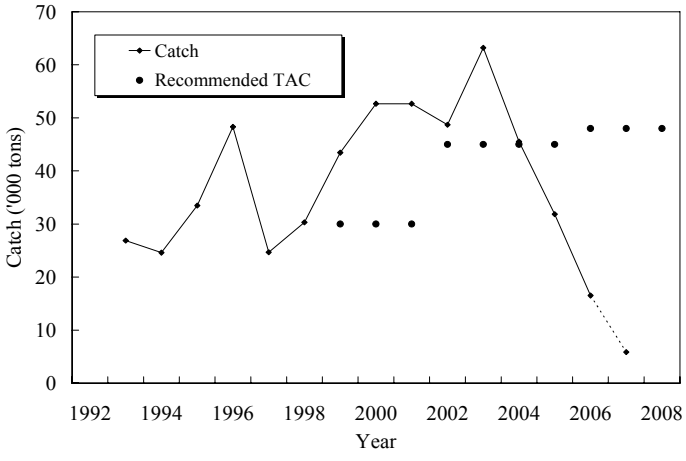



Fig. 1.1. Shrimp in Div. 3M: catches (2007 preliminary).

**i) *Commercial fishery data***

(SCR Doc. 07/77, 89)

**Effort and CPUE**. Logbook and/or observer data were available from Canadian, Greenlandic, Icelandic, Faroese, Norwegian, Russian, Estonian and Spanish vessels. From this information one international CPUE database for 3M was constructed. Last year there were concerns that suspected misreporting of some catches in 2005 and 2006 (Div. 3L catches being reported as Div. 3M catches), were affecting the CPUE data for some shrimp fleets fishing in these areas. In order to avoid the uncertainty around the catch rate standardization model used for Div. 3M, all trips for 2005, 2006 and 2007 where the catches were mixed up between 3M and 3L were eliminated from the database. This way we can get the corrected CPUE and a standardized CPUE series was produced. CPUE decreased from 1993 to 1994, was at low levels to 1997. From 1998 it gradually increased to 2006. In 2007 the standardized CPUE declined, however due to the scanty observations there is considerable uncertainty regarding the 2006 and 2007 points (Fig. 1.2).

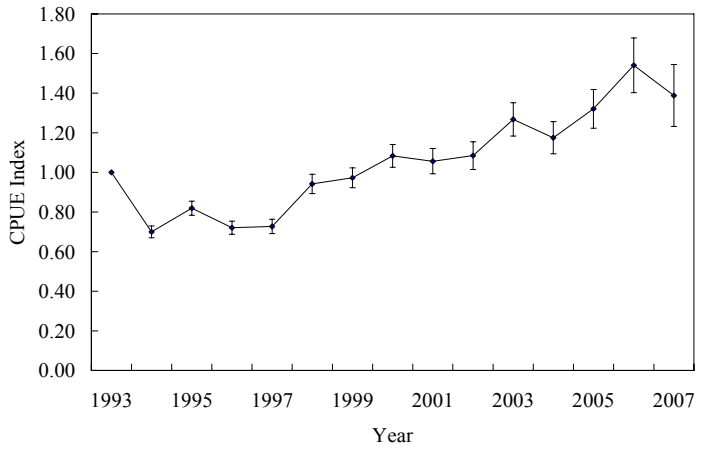



Fig. 1.2. Shrimp Div. 3M: Standardized CPUE of shrimp on Flemish Cap, 1993-2007.

**Standardized CPUE female SSB**. It has been shown for this stock that transitionals will be functional females at spawning time in the same year (SCR Doc. 04/64). Accordingly a spawning stock index was calculated from the standardized CPUE as kg/hr of all females (transitionals and full females). The spawning stock declined from 1993 to 1997, and had shown an increasing trend with fluctuations to 2007 (Fig. 1.3). The marked increase in 2007 may however be questionable, as noted for the standardized CPUE above.

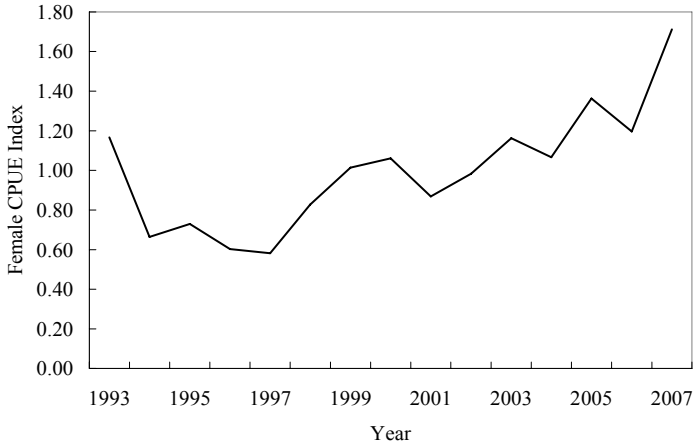



Fig. 1.3. Shrimp Div. 3M: Standardized Female CPUE of shrimp on Flemish Cap, 1993-2007. The series was standardized to the mean of the series.

**Biological data**. The age composition was assessed from commercial samples obtained from Iceland from 2003 to 2006 and from Canada, Greenland, Russia and Estonia in previous years. A few samples were obtained from Spain for 2005 and 2006 and Ukraine in 2006. Only those samples thought to be correctly attributed to Div. 3M were utilized. For 2007 there were not yet available any commercial samples and the age composition from preliminary catches was assessed from EU survey samples. Number/hour caught per age-class was calculated for each year by applying a weight/age relationship and age proportions in the catches to the annual standardized CPUE data.

The results indicate that ages 3, 4 and 5 generally dominate the commercial catch in numbers. By weight the 6 year-olds are also important in the fishery although generally smaller in numbers. The 2002 year-class seems to be very prominent as 3 year-olds in the 2005 fishery and as 4 and 5 year-olds in 2006 and 2007 respectively. Although in 2008 the abundance of this year-class will be reduced, its importance in weight will probably stay high. The number of 2 year-olds is about average in 2005, not visible in catches in 2006 and very low in 2007 pointing to recruitment being very low since 2004. The 2002 year-class appears to be growing very slowly as seen when the mean lengths at age are studied in the years 2005-2007. This may be caused by the exceptionally high numbers of that year-class in those years.

Numbers/hour at age caught in the commercial fishery:

| Age group | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 6 | 0 | 0 | 23 | 666 | 0 | 0 | 0 | 0 | 63 |
| 2 | 2604 | 2134 | 3345 | 2666 | 1108 | 6908 | 4606 | 8630 | 12732 | 5568 | 0 | 864 | 4264 |
| 3 | 27268 | 16945 | 19568 | 15872 | 23187 | 9253 | 38858 | 9526 | 29912 | 36208 | 7933 | 11096 | 20469 |
| 4 | 8307 | 17583 | 22892 | 18358 | 26968 | 29615 | 13224 | 38074 | 10705 | 31593 | 68409 | 35161 | 26741 |
| 5 | 2403 | 3454 | 7302 | 14770 | 15946 | 14999 | 16026 | 14851 | 22633 | 15044 | 12833 | 36953 | 14768 |
| 6 | 1255 | 700 | 2716 | 5317 | 3345 | 4424 | 3274 | 5847 | 4408 | 2954 | 5749 | 17016 | 4750 |
| 7 | 0 | 61 | 304 | 62 | 162 | 598 | 129 | 87 | 24 | 486 | 420 | 3717 | 504 |
| Total | 41836 | 40877 | 56127 | 57052 | 70717 | 65798 | 76139 | 77681 | 80415 | 91854 | 95344 | 104806 | 71554 |

**ii) *Research survey data***

(SCR Doc. 07/78)

EU bottom trawl surveys. Stratified-random surveys have been conducted on the Flemish Cap in July from 1988 to 2007. A new vessel was introduced in 2003, which, however, continued to use the same trawl as that employed since

1988. In addition, there were differences in cod-end mesh sizes utilized in the 1994 and 1998 surveys that have likely resulted in biased estimates of total survey biomass. Nevertheless, for this assessment, the series prior to 2003 were converted into comparable units with the new vessel based on the methodology accepted by STACFIS in 2004 (*NAFO 2004 SC Rep.*, SCR Doc. 04/77). The revised index of female shrimp biomass reveals a rapid increase from the lowest observed level in 1990 to a 10-fold increase in 1992 followed by an equally dramatic decline to 1994. The index was stable at a relatively low level between 1994 and 1997; then increased to a higher level with fluctuation between 1998 and 2007 (Fig. 1.4).

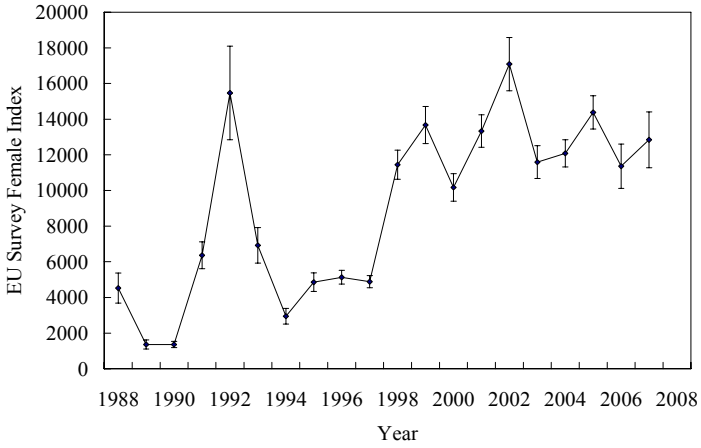



Fig. 1.4. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2007.

**iii) *Recruitment indices***

**Commercial fishery**. Although the commercial fishery is conducted with larger mesh size than the survey, 2 year-olds are frequently detected in the fishery. An index of 2 year-old shrimp from 1996 to 2007, based on standardized number per hour correlated well ($R^2$ = 0.81, Fig. 1.5) with a similar index derived for 3+ year-olds (a proxy for the fishable biomass) from the fishery two years later. The number per hour of 2 year-olds in the commercial fishery has been declining since 2004 (table above).

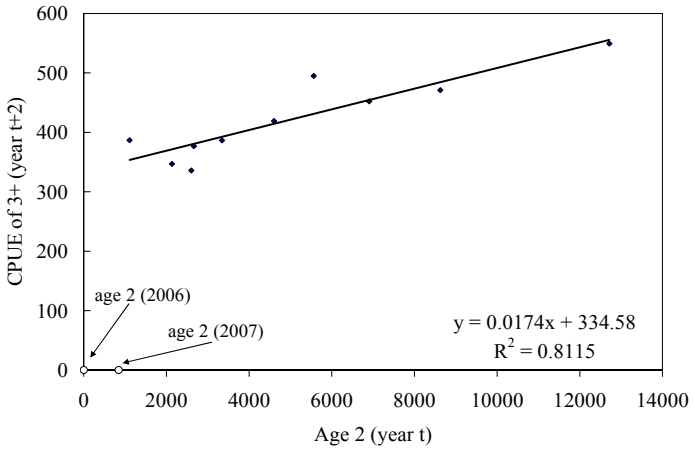



Fig. 1.5. Relationship between Div. 3M shrimp CPUE in year *t*+2 and year *t* from samples from the commercial fisheries.

**EU bottom trawl surveys**. From 1988 to 1995 shrimp age 2 and younger were not captured by the survey. Beginning in 1996 the presence of this component increased in the surveys and it is believed that the introduction of

the new vessel in 2003 greatly improved the catchability of age 2 shrimp owing to technological advances in maintaining consistent performance of the fishing gear. In addition, since 2001, a small mesh juvenile bag was attached to the net which was designed to provide an index of juvenile shrimp smaller than those typically retained by the survey cod-end. Neither index shows a good relationship with the 3+ survey index either 2 or 3 years later. This may be because there are only limited data points for a valid comparison. The recruitment indices for both 2005 and 2006 are low in the main gear as well as in the juvenile bag (Fig. 1.6). Finally the EU surveys agree with the commercial fishery recruitment indices in showing an exceptionally large 2002 year-class and very weak 2003–2005 year-classes.

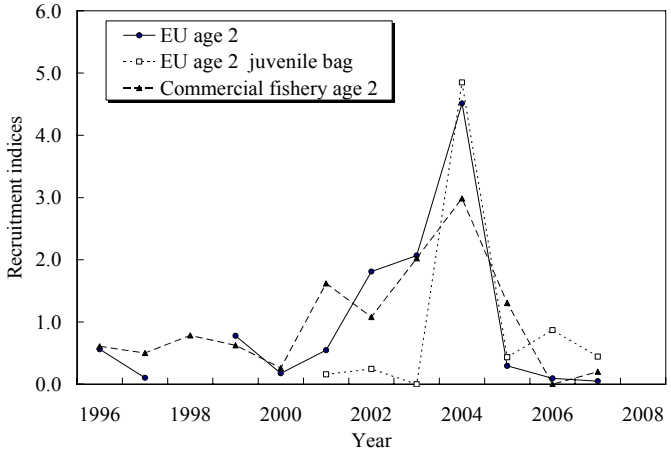



Fig. 1.6. Shrimp in Div. 3M: abundance indices at age 2 from the EU survey. Each series was standardized to its mean.

**iv) *Exploitation rate***

An index of exploitation was derived by dividing the nominal catch in a given year by the biomass index from the EU survey in the same year. This was high in the years 1994–1997 when biomass was generally lower. In 1998-2006 the catch rate has been rather stable at a lower level. However the provisional exploitation rate estimated in 2007 was the lowest in the historical series showing a probable decreasing trend initiated in 2004. This trend appears to be mostly due to decreasing catches.

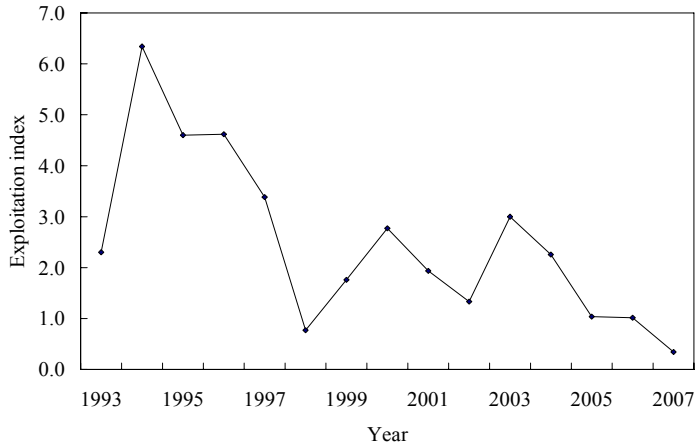



Fig. 1.7. Shrimp in Div. 3M: exploitation rates calculated as catch divided by EU survey biomass index in the same year.

**v) *Other studies***

A study on how trawl size might affect the Icelandic CPUE series was presented (SCR Doc. 07/72). In most years from 1993 to 2003 average size of trawl in the Icelandic fleet was 3 000 meshes. However between 2004 and 2006 the average size of trawl has increased to 4 460 meshes. The author therefore suggested that CPUE should be standardized on the average size of trawl and an adjusted CPUE series was presented for the Icelandic fleet.

**c) Assessment Results**

The concerns expressed last year about suspected misreporting and its effect on various indices derived from the fishery have been resolved in the intervening year and several indices derived from the number per hour could be used in this year's assessment.

*Commercial CPUE indices*. Indices for both biomass and female biomass from the commercial fishery showed increasing trends from 1996 to 2007.

*Biomass*. The survey index of female biomass increased from 1997 to 1998 and has fluctuated without trend since then.

*Recruitment*. The 2002 year-class appears to be large, but the 2003–2005 year-classes appear weak.

*Exploitation rate*. The provisional exploitation rate estimated in 2007 was the lowest in the historical series showing a probable decreasing trend initiated in 2004. This trend appears to be mostly due to decreasing catches.

*State of the Stock*. The indices of biomass are at a relatively high level but there are indications of a decline in recruitment, which may affect the 2008 fishery.

**d) Precautionary Approach**

NIPAG noted that the Scientific Council Study Group on Limit Reference Points recommended that survey biomass indices could be used to indicate a limit reference point for biomass in situations where other methods were not available (SCS Doc. 04/12). In such cases, "the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for $B_{lim}$".

The limit reference point for the Flemish Cap shrimp stock is taken from the EU survey where the biomass index of female shrimp is used. The EU survey of Div. 3M provides an index of female shrimp biomass from 1988 to 2006 with a maximum value of 17 100 t in 2002 and a similar value of 15 500 in 1992. An 85% decline in this value would give a $B_{lim}$ = 2 600 t. The female biomass index was below this value only in 1989 and 1990, before the fishery. In 2006 and 2007 it was about 33% and 25% below the maximum. If this method is accepted to define $B_{lim}$, then it appears unlikely that the stock is below $B_{lim}$ at the present time (Fig. 1.8).

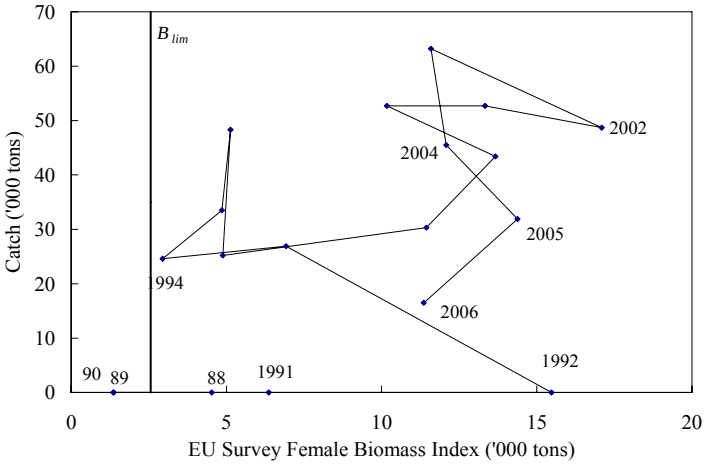



Fig. 1.8. Shrimp in Div. 3M: catch plotted against female biomass index from EU survey. Line denoting $B_{lim}$ is drawn where biomass is 85% lower than the maximum point in 2002. Not updated for 2007 owing to incomplete catch.

**e) Research Recommendations**

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

- *biological and CPUE data from all fleets fishing for shrimp in the area, be submitted to Designated Experts by 1 September 2008.*
- *the catch and effort data from other sources, for example VMS and/or Observer data, continue to be investigated to validate commercial data obtained from summarized logbooks or STATLANT data.*
- *the relationship between the recruitment indices and fishable biomass be investigated further.*

**2) Northern Shrimp (Div. 3LNO) – NAFO Assessed**

(SCR Doc. 07/77, 78, 79, 89. 91)

**a) Introduction**

This shrimp stock is distributed around the edge of the Grand Banks mainly in Div. 3L. The fishery began in 1993 and came under TAC control in 2000 with a 6 000 t TAC and fishing restricted to Div. 3L. Annual TACs were raised to 13 000 t for the 2003–2005 fisheries and raised again to 22 000 t for the 2006 fishery resulting in a total catch of 24 015 t during that year and 17 008 t up to October 2007 (Fig. 2.1).

Since this stock came under TAC regulation, Canada has been allocated 83% of the TAC. The Canadian allocation is split between a small vessel (less than 500 t and less than 65 ft) and a large vessel fleet. By October 2007, the small and large vessel fleets had taken 12 297 and 2 241 t of shrimp respectively in Div. 3L. In all years, most of the Canadian catch occurred along the northeast slope in Div. 3L.

Sixteen contracting parties have reported catches in the NRA since 2000. The annual quota within the NRA is 17% of the total TAC and is meant to be split evenly among these nations; however, from 2003 to 2005 Denmark (in respect of the Faroe Island and Greenland) set an autonomous annual TAC of 1 344 t. This autonomous TAC was raised to 2 274 t in 2006 and maintained at this level for 2007.

The use of a sorting grid to reduce bycatches of fish is mandatory for all fleets in the fishery. The sorting grid cannot have a bar spacing greater than 22 mm.

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

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| TAC | - | 6 000 | 6 000 | 6 000 | 13 000 | 13 000 | 13 000[1] | 22 000[1] | 22 000[1] | 25 000[4] |
| STATLANT 21A | 795 | 4 930 | 5 323 | 5 697 | 11 016[2] | 11 660[2] | 13 943[2] | 23,144[2] | 16,755[2] | |
| NIPAG | 795 | 4 896 | 10 566[3] | 6 977[3] | 11 947 | 12 620 | 14 137 | 24 015[3] | 17 008[3] | |

[1] Denmark (in respect of Faroe Islands and Greenland) set an autonomous TAC of 1 344 t for 2003 - 2005 and raised it to 2 274 t for 2006 and 2007; this autonomous TAC replaces the DFG quota of the TAC tabulated above.
[2] Provisional catches.
[3] Reliable catch reports were not available for all countries therefore estimates were made using other sources (Canadian surveillance, observer datasets, STACFIS estimation etc.).
[4] Provisional TAC advice.

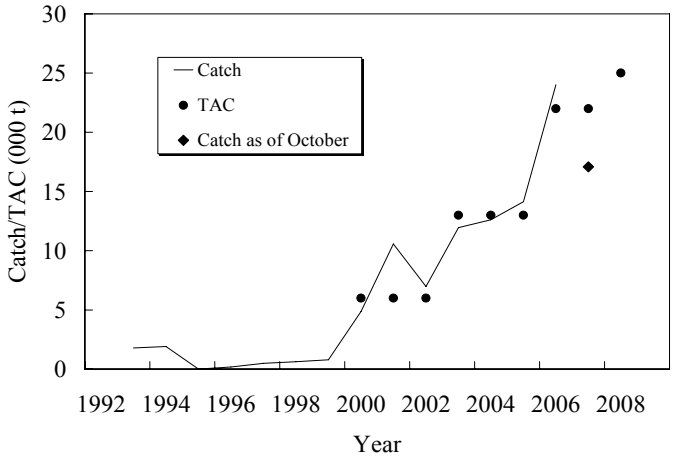



Fig. 2.1. Shrimp in Div. 3LNO: catches (to October 2007) and TAC.

**b) Input Data**

**i) *Commercial fishery data***

**Effort and CPUE**. Catch and effort data have been available from vessel logbooks and observer records since 2000. Standardized catch rates for large Canadian vessels (>500 t) have been fluctuating around the long term mean since 2000 with the 2007 catch rate index above average and similar to the 2002 – 2004 and 2006 catch rates (Fig. 2.2). There was insufficient data to estimate a standardized CPUE index for the 2007 Canadian small vessel (≤ 500 t) fleet.

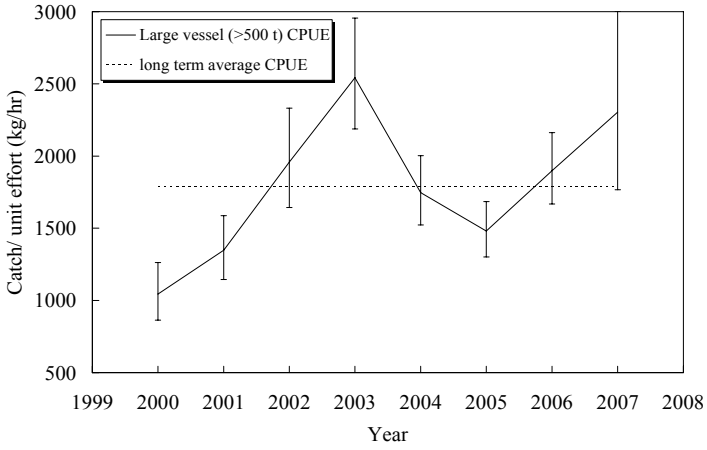



Fig. 2.2 Shrimp in Div. 3LNO: Standardized CPUE for the Canadian large vessel (>500 t) fleet fishing shrimp in Div. 3L within the Canadian EEZ.

Data were available from other nations fishing in the NRA (Estonia, Greenland, Spain and Norway) although the data were insufficient to produce a standardized CPUE model.

**Sex and age composition**. Stock composition data from previous years has shown that the fishery has exploited a wide range of year-classes. Catch compositions were derived from Canadian, Icelandic and Ukrainian observer datasets. In 2006, the male portion of the fishery was dominated by the 2002 and 2003 year-classes. The female portion was still well represented. Neither sex nor age composition data from the 2007 fishery were available in time for the 2007 assessment.

**ii) *Research survey data***

**Canadian multi-species trawl survey**. Canada has conducted stratified-random surveys in Div. 3LNO, using a Campelen 1800 shrimp trawl, from which shrimp data is available for spring (1999-2007) and autumn (1995-2006). The autumn survey in 2004 was incomplete and therefore was of limited use for the assessment.

In past years, areal expansion calculations were used to estimate indices from Canadian survey data. However, it was decided during the 2006 NIPAG assessment meeting that Ogive Mapping (Evans *et al.*, 2000. *JNAFS*, 27: 133-138) could be used to calculate index estimates. Therefore indices based upon Canadian survey data differ slightly from past presentations. This applies to all estimates, in this assessment, of biomass and numbers of different size classes and sexes from the Canadian surveys.

**Spanish multi-species trawl survey**. Spain has been conducting a spring stratified-random survey in Div. 3NO within the NRA since 1995; the survey has been extended to include the NRA in Div. 3L since 2003. From 2001 onwards data were collected with a Campelen 1800 trawl. There was no Spanish survey in 2005 in Div. 3L.

**Biomass and Abundance**. In Canadian surveys, over 90% of the biomass was found in Div. 3L, distributed mainly along the northeast slope in depths from 185–550 m. There was a significant increase in autumn shrimp biomass indices between 1995 and 2001 and this index has since remained at a high level (Fig. 2.3). The autumn 2006 index was 215 000 t (47 billion individuals), the second highest in the autumn time series.

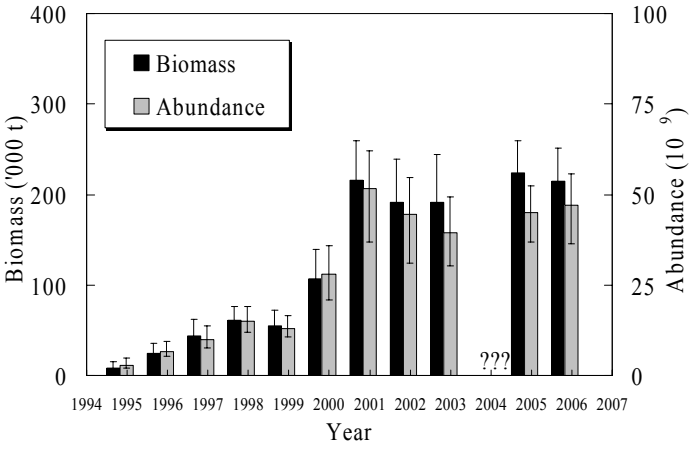



Fig. 2.3. Shrimp in Div. 3LNO: biomass and abundance index estimates from Canadian autumn multi-species surveys (with 95% confidence intervals).

The spring 2007 biomass index was 289 000 t (54 billion individuals), the highest in the time series (Fig. 2.4). Owing to broad confidence limits around these estimates, spring survey indices are not thought to be as reliable as autumn survey indices.

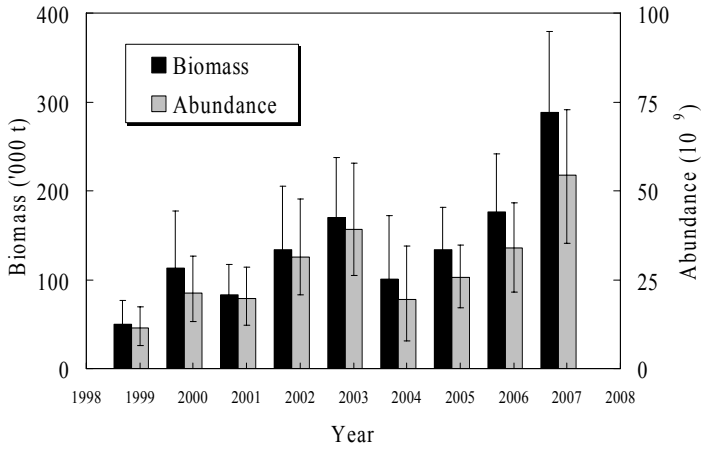



Fig. 2.4. Shrimp in Div. 3LNO: biomass estimates from Canadian spring multi-species surveys (with 95% confidence intervals).

Spanish survey biomass estimates for Div. 3L within the NRA increased between 2003 (64 000 t) and 2006 (126 000 t), remaining at a high level in 2007 (113 000 t); Canadian survey biomass estimates increased between 1995 and 2001 and have since fluctuated at a high level. The reason for differences between the Spanish and Canadian Div. 3L survey biomass and abundance indices remains unknown. Spanish and Canadian survey biomass estimates for Div. 3NO in the NRA, have fluctuated between 100 and 4 500 t in 2002–2007.

**Sex and age composition**. The spring and autumn surveys showed an increase in the abundance of female (transitionals + females) shrimp over the full time series. Autumn male abundance indices increased until 2001 and have since remained stable at a high level while spring male abundance indices have varied over time (Fig. 2.5).

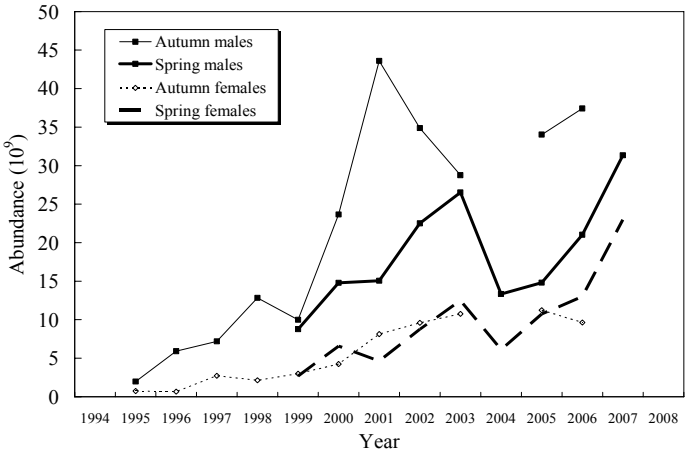



Figure 2.5. Abundance indices of male and female shrimp within Div. 3LNO as estimated from Canadian multi-species survey data.

Shrimp aged 2 and 4 were well represented in the male component of the spring 2006 survey length frequencies (2004 and 2002 year-classes) with carapace-length modes at 13.24 and 19.44 mm respectively. The male component of the autumn 2006 survey length frequencies was dominated by shrimp aged 2, 3 and 4 (2004, 2003 and 2002 year-classes) with modes at 14.50, 17.99 and 20.11 mm respectively. Similarly, shrimp aged 2, 3 and 4 were well represented in the spring 2007 survey (2005, 2004 and 2003 year-classes) with modes at 13.06, 16.66 and 19.89 mm respectively (Fig. 2.6). A broad mode of females was present in all surveys indicating the presence of more than one year-class.

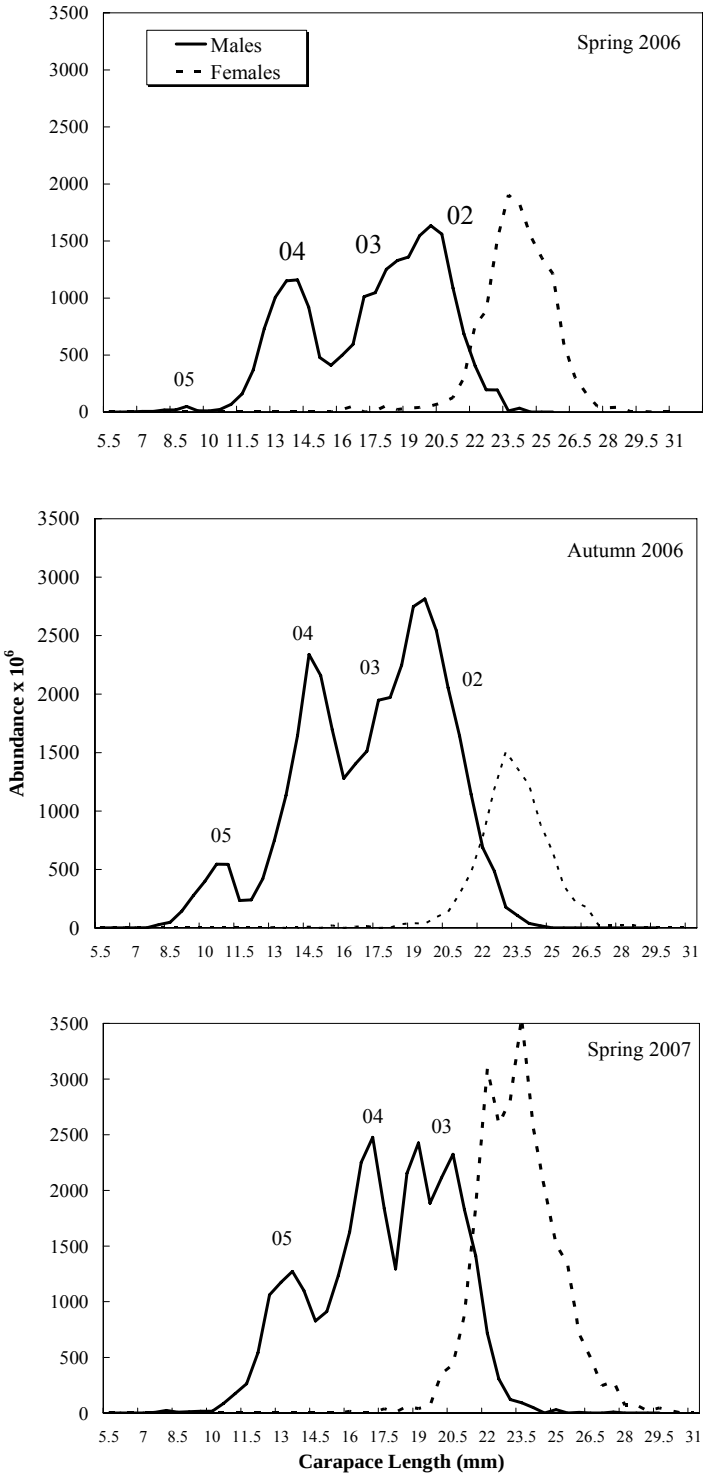



Fig. 2.6. Shrimp in Div. 3LNO: abundance at length for northern shrimp estimated from Canadian multi-species survey data.

**Female Biomass (SSB)**. The autumn female (transitionals and full females) biomass index increased between 1999 and 2003; there was an incomplete survey in autumn 2004, after which the index increased to the highest level, in 2005. It then decreased slightly in 2006. (Fig. 2.7). The spring survey index increased from 1999–2003 and decreased slightly in 2004, after which the female biomass has been increasing (Fig. 2.8).

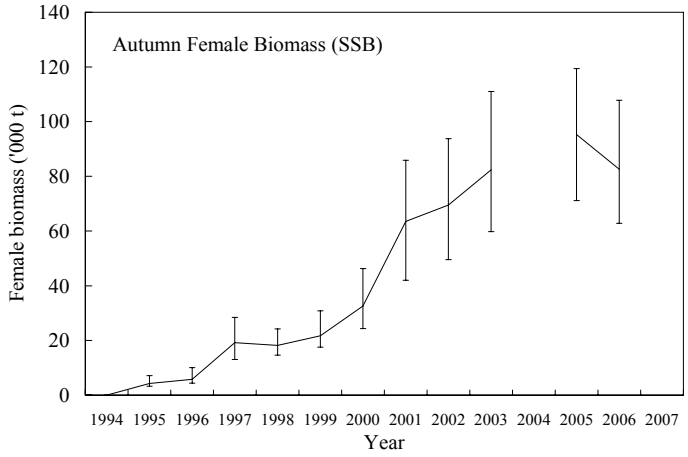



Fig. 2.7. Shrimp in Div. 3LNO: Female biomass (SSB) estimates from Canadian autumn multi-species surveys (with 95% confidence intervals).

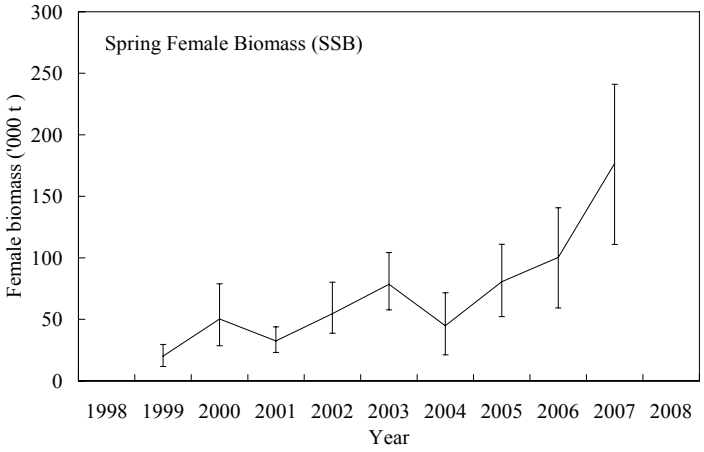



Fig. 2.8. Shrimp in Div. 3LNO: Female biomass (SSB) estimates from Canadian spring multi-species surveys (with 95% confidence intervals).

**Recruitment index**. The recruitment index for this assessment was estimated through modal analysis, whereas last year the recruitment index was derived through a multiplicative model using values estimated from modal analysis. As with last year's analysis, all recruitment indices from year-classes prior to 1997 were weak. The indices from autumn 1997, 2000, 2001 and 2003 year-classes were average while those from the 1998, 1999 and 2004 year-classes appeared relatively strong (Fig. 2.9). The spring recruitment indices from the 2000, 2002 and 2003 year-classes were weak, those from the 1997, 1999, and 2001 year-classes were average while the recruitment indices from the 1998, 2004 and 2005 year-classes were strong relatively (Fig. 2.10).

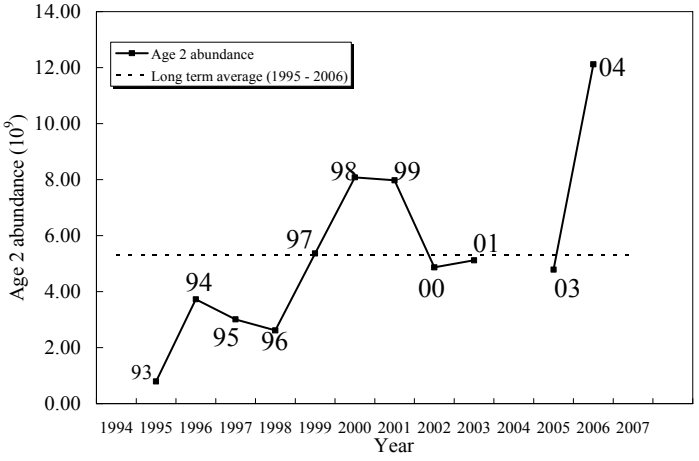



Fig 2.9.Shrimp in Div. 3LNO: Autumn recruitment index (age 2 abundance) derived using modal analysis of Canadian bottom trawl survey (1995–2006) data.

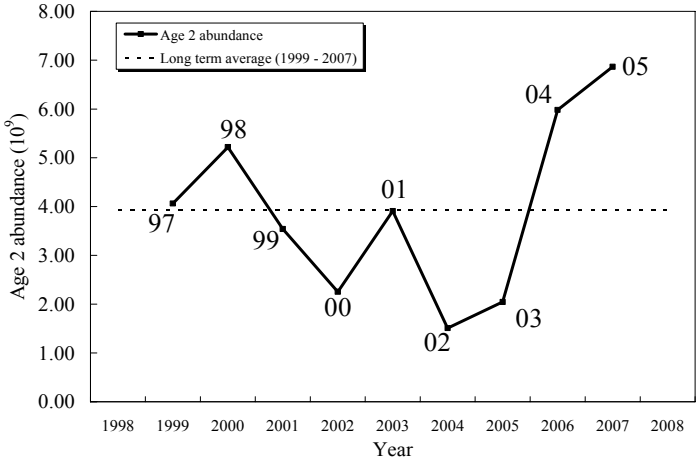



Fig 2.10.Shrimp in Div. 3LNO: Spring recruitment index (age 2 abundance) derived using modal analysis of Canadian bottom trawl survey (1999–2007) data.

**Fishable biomass and exploitation**. The fishable biomass index (shrimp >17 mm carapace length) from the Canadian autumn survey (1995-2006) increased from 1999 to 2001, varying slightly at a high level since, while the spring survey index increased from 1999–2003, decreased during 2004, and but has steadily increased since (Fig. 2.11). An index of exploitation was derived by dividing the catch in a given year by the fishable biomass index from the previous autumn survey. The exploitation index was less than 4% during 1996-99, but increased to 11-12% in 2000-2001, the first two years of TAC regulation. Even though catches increased to 24 000 t in 2006, the exploitation index remained less than 14% owing to the increase in fishable biomass (Fig. 2.12).

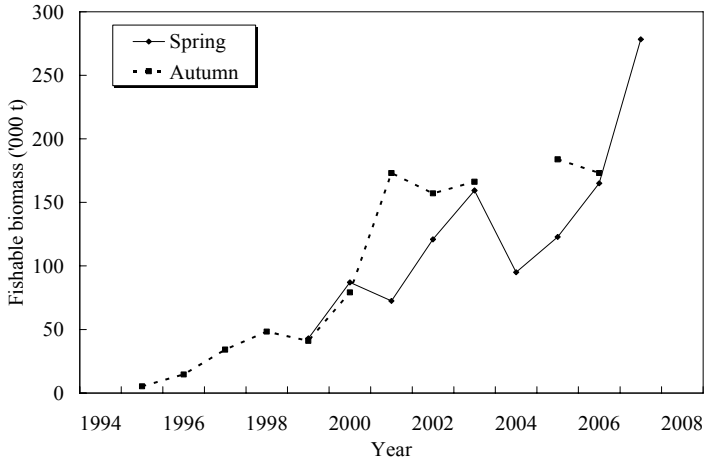



Fig. 2.11.Shrimp in Div. 3LNO: fishable biomass index.

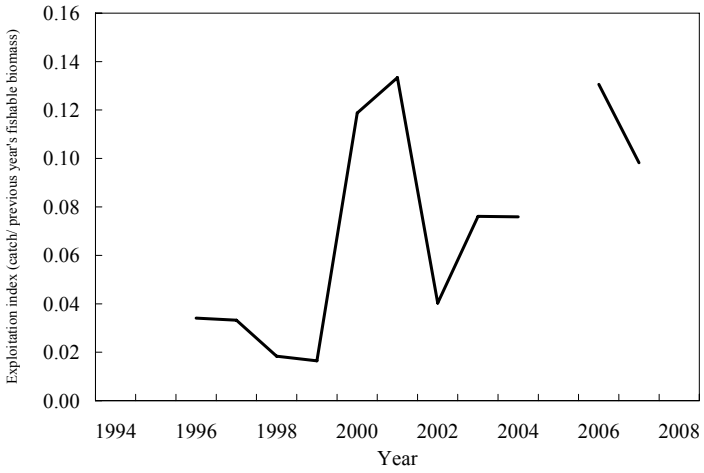



Fig 2.12.Shrimp in Div. 3LNO: exploitation rates as derived by catch divided by the previous year's autumn fishable biomass index.

**c) Assessment Results**

*Recruitment*. Recruitment indices from autumn survey data indicated that the 2003 year-class was average while recruitment from the 2004 year-class was the highest in that time series. The spring recruitment indices for the 2002 and 2003 year-classes were below average while those from the 2004 and 2005 year-classes were the highest in the spring series.

*Biomass*. There has been a significant increase in the index of total biomass between 1995 and 2001 followed by stability at a high level. Both spring and autumn indices of female biomass (SSB) have been increasing since 1999.

*Exploitation*: The index of exploitation (catch / autumn survey fishable biomass from previous year) has remained below 14%.

*State of the Stock*. Total biomass indices have been stable at a high level since 2001. The female biomass (SSB) indices have been increasing since 1999. The stock appears to be well represented by a broad range of size groups; the stock biomass index has not declined at the observed levels of exploitation. The above average recruitment in 2004 is expected to be present in the fishery during 2007 and that from 2005 is expected to enter the fishery in 2008.

**d) Precautionary Approach Reference Points**

(SCS Doc. 04/12)

Scientific Council considers that the point at which a valid index of stock size has declined by 85% from the maximum observed index level provides a proxy for $B_{lim}$ for northern shrimp in Div. 3LNO. It is not possible to calculate a limit reference point for fishing mortality. Currently, the female biomass is estimated to be well above $B_{lim}$ (Fig. 2.13).

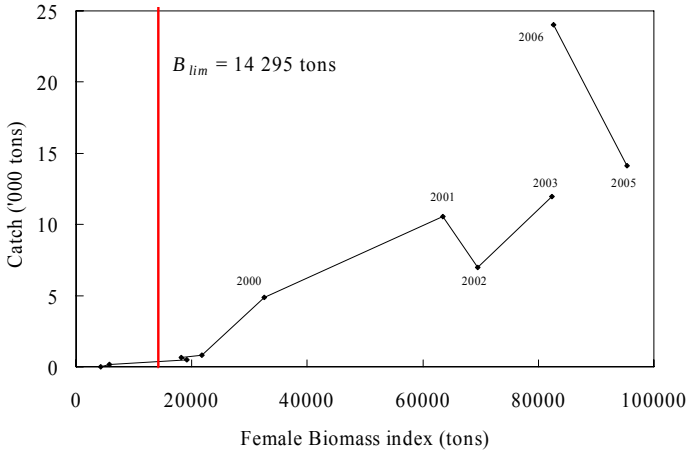



Fig 2.13. Shrimp in Div. 3LNO: Catch plotted against female biomass index from Canadian autumn survey. Line denoting $B_{lim}$ is drawn where female biomass is 85% lower than the maximum point in 2005. (The $B_{lim}$ is below the value presented last year because survey indices were derived using areal expansion calculations in past years while they were derived using Ogive Mapping calculations this year).

**e) Research Recommendations**

NIPAG **recommends** that for Northern shrimp in Div. 3LNO:

- *biological and CPUE data from all fleets fishing for shrimp in the area be submitted to the Designated Expert, in the standard format, by 1 September 2008.*

- *there be exploration of methods to incorporate areal expansion/ contraction, of the commercial fishery, into future CPUE models; this will require that positional data on catch and effort be available to the investigation.*

**3) Northern shrimp (Subareas 0 and 1) – NAFO Assessed**

(SCR Doc. 02/158, 03/74, 04/75, 04/76, 07/66, 67, 69, 73, 88; SCS Doc. 04/12)

**a) Introduction**

The shrimp stock off West Greenland is distributed mainly in NAFO Subarea 1 (Greenland EEZ), but a small part of the habitat, and of the stock, intrudes into the eastern edge of Div. 0A (Canadian EEZ). To facilitate management of the fishery, Canada has defined a management unit, Shrimp Fishing Area 1 (Canadian SFA1), to be the part of Div. 0A lying east of 60°30'W, i.e. east of the deepest water in this part of Davis Strait.

The stock is assessed as a single population within its whole area of distribution. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A-F). Since 1981 the Canadian fishery has been limited to Div. 0A.

Three fleets, one from Canada and two from Greenland (vessels above and below 80 GRT) have 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 Greenland small-vessel fleet has privileged access to inshore areas (primarily Disko Bay); its fishing was unrestricted until January 1997, when quota regulation was imposed. Pursuant to a revised fishery agreement, Greenland now allocates a quota to EU vessels in Subarea 1. Mesh size is at least 44 mm. Sorting grids to reduce bycatch of fish are required in both the Greenland fleets (max. bar spacing 22 mm) and the Canadian fleet (28 mm). Discarding of shrimp is prohibited.

The advised TAC for the entire stock for 2007 was 130 000 t; the Greenland authorities set a TAC for Subarea 1 of 134 000 t, of which 74 100 t was allocated to the offshore fleet, 55 900 t to the inshore and 4 000 t to EU vessels; Canada set a TAC for SFA1 for 2007 of 18 417 t.

Catch data since 1999 was reviewed in order to clarify uncertainties and to resolve conflicts between different sources (SCR Doc. 07/66). Because logbook reports were used in 2007, instead of quota drawdowns as in 2006, catch figures for 2003 to 2005 were 8-12% higher than those used in 2006. Earlier catches changed slightly. Reported catches from 1978 through 2003 had been corrected upwards, by 22.8-25.7%, in 2003 (SCR Doc. 03/74).

Overall annual catch increased from about 10 000 t in the early 1970s to more than 105 000 t in 1992 (Fig. 3.1). Moves by the Greenlandic authorities to reduce effort, as well as fishing opportunities elsewhere for the Canadian fleet, caused catches to decrease to about 80 000 t by 1998. Since then total catches increased to 154 600 tons in 2005 and 2006. Total catch for 2007 has been projected to be lower at about 135 000 tons.

Recent catches, projected figures for 2007 and recommended TACs (t) for northern shrimp in Div. 0A east of 60°30'W and Subarea 1 are as follows:

| | 1998[2] | 1999[2] | 2000[2] | 2001[2] | 2002[2] | 2003[2] | 2004 | 2005 | 2006 | 2007 [1, 3] |
|---|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | 55 000 | 65 000 | 65 000 | 85 000 | 85 000 | 100 000 | 130 000 | 130 000 | 130 000 | 130 000 |
| Actual TAC | 68 379 | 82 850 | 87 025 | 102 300 | 103 190 | 115 167 | 149 519 | 152 452 | 152 380 | 152 417 |
| SA 1 (NIPAG) | 79 562 | 90 152 | 96 378 | 99 301 | 128 925 | 123 036 | 135 212 | 147 695 | 150 536 | 128 879 |
| SA 0A (NIPAG) | 933 | 2 046 | 1 590 | 3 625 | 6 247 | 7 137 | 7 021 | 6 921 | 4 127 | 6 291 |
| STATLANT (SA 1) | 60 406 | 73 990 | 79 120 | 81 517 | 103 645 | 78 433 | 134037 | 3 699 | 3 629[1] | |
| STATLANT (Div. 0A ) | 517 | 2 093 | 659 | 2 958 | 6053 | 2 170 | 6 861 | 6 410 | 0 | |
| TOTAL SA1-Div.0A (NIPAG) | 80 495 | 92 198 | 97 968 | 102 926 | 135 172 | 130 173 | 142 233 | 154 616 | 154 663 | 135 169 |

[1] Provisional catches;
[2] Estimates 1998-2003 corrected for over packing;
[3] Catches projected to year-end — SA1 based on catches on the first 6 months and 0A at mean of reports for previous 5 yr.

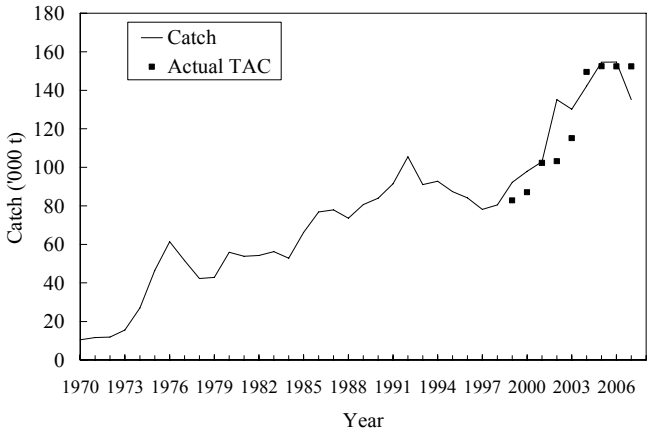



Fig. 3.1. Shrimp in Subareas 0 and 1: actual TACs and total catches (2007 projected to the end of the year; 1999–2007 values have been corrected to live (catch) weight).

Until 1988 the fishing grounds in Div. 1B were the most important. The offshore fishery subsequently expanded southward, and after 1990 catches in Div. 1C-D, taken together, began to exceed those in Div. 1B. By 1996–97 the southern areas Div. 1D-F accounted for almost 60% of the catch. Catch and effort in Div. 1E-F now appear to be

decreasing. The Canadian catch in SFA1 has stabilized at 6 000 to 7 000 t in 2002-2005, about 4-5% of the total catch. In 2006 catches in SFA1 were only 4 100 tons.

**b) Input Data**

**i) *Commercial fishery data***

**Fishing effort and CPUE**. Catch and effort data from the shrimp fishery were available from logbooks from Canadian vessels fishing in Canadian SFA 1 and from Greenland logbooks for Subarea 1 (SCR Doc. 07/69). In recent years large changes in fishery performance has occurred both in relation the distribution of the fishery and to changes in fishing power (e.g. larger vessels have been allowed in coastal areas). Logbook data and information on vessel characteristics and fishing patterns was examined, resulting in a new standardized CPUE series (Fig 3.2) as well as an index of how widely the fishery is distributed (Fig 3.3).

The logbook data was analysed with standard linear models to create fleet-specific series of annual CPUE indices, standardized for changes in fleet composition and fishing power and for variation in the distribution of the fishery. These were combined to give a single standard CPUE series as an index of the biomass densities available to the fishery.

The overall standardized CPUE was variable, but on average moderately high, from 1976 through 1987, then fell to uniform lower levels until about 1997. It has since increased markedly to reach a maximum in 2007 of about twice its 1997 value (Fig. 3.2).

The CPUE indices from the Greenland coastal and the Greenland offshore fleets have remained closely in step from 1988 to 2003 (Fig. 3.2). However, since 2004 they have diverged more than in previous years, the offshore fleet managing a continued increase in catch rates while the coastal fleet, although its catch rates have remained high in historical terms, has seen greater fluctuation in CPUE from year to year. CPUE in the Canadian fishery in SFA1 has always varied more from year to year and has never stayed closely in step with the Greenland fleets, although over time its overall trend has been similar and it also has increased between the 1990s and the present.

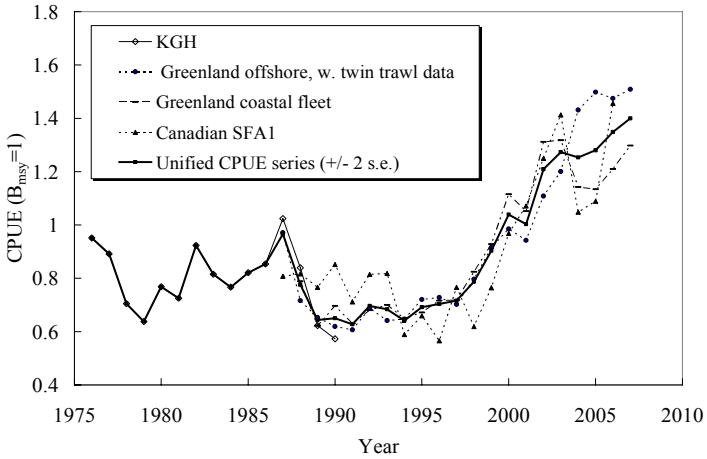



Fig. 3.2. Shrimp in Subareas 0 and 1: standardized CPUE index.

The distribution of the fishery and its change with time were also examined (Fig 3.3). Catch and effort were allocated to NAFO Divisions, and the allocation was summarised using Simpson's diversity index to calculate an 'effective' number of Divisions being fished.

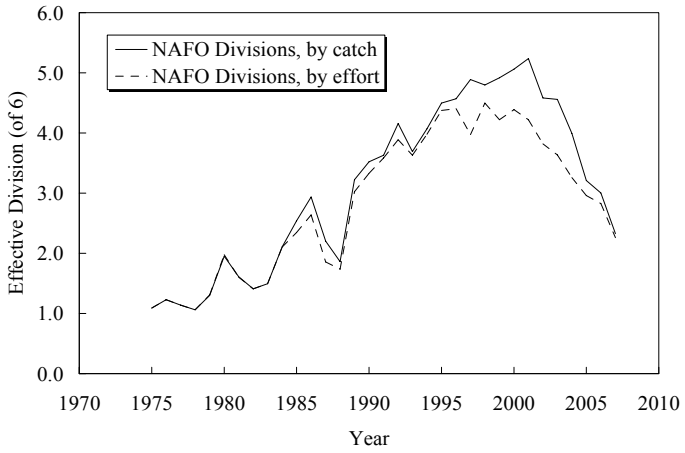



Fig. 3.3. Shrimp in Subareas 0 and 1: Diversity indices for the distribution of logbook records of the West Greenland fishery between NAFO Divisions for 1975–2007.

From the end of the 1980s there was a significant expansion of the fishery southwards and by 1996–97 the southern areas accounted for almost 60% of the catch. At that time the effective number of Divisions being fished peaked at about 4.5–5. Since then, the range of the fishery has contracted and the effective number of Divisions being fished has decreased as effort, and catches, have become more concentrated.

**Catch composition**. There is no biological sampling program from the commercial fishery that is adequate to provide catch composition data to the assessment.

**ii) *Research survey data***

**Greenland trawl survey**. Stratified random trawl surveys designed primarily to estimate shrimp stock biomass have been conducted since 1988 in offshore areas and since 1991 also inshore in Subarea 1 (SCR Doc. 07/71). From 1993, the survey was extended southwards into Div. 1E and 1F. A 22 mm stretched mesh cod-end liner has been used since 1993. From its inception until 1998 the survey only used 60 min. tows, but shorter tows have been shown to give as accurate results, and since 2005 all tows have lasted 15 min.

Within the survey area, large year-to-year variations in the distribution of biomass have been observed geographically as well as over depth zones. Some survey strata, but not always the same ones, account for a large proportion both of the estimated biomass and of its associated uncertainty. Since 2000 an increased proportion of the biomass has been seen in depths between 200 and 300 m and in more northerly areas, and the proportion of biomass in Div. 1E-F appears to have been decreasing.

**Biomass**. The survey index of mean stock density remained fairly stable from 1988 to 1997 (c.v. 18%, downward trend 4%/yr). It then began a period of continued increase lasting until 2003, when it reached 316% of the 1997 value. Subsequent values have been consecutively lower, by 2007 58% below the maximum (Fig. 3.3) but still 13% above the series mean.

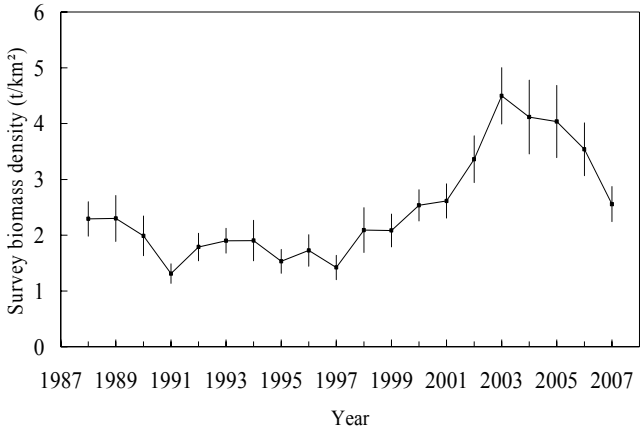



Fig. 3.4. Shrimp in Subareas 0 and 1: survey indices of stock biomass density (SCR Doc. 07/71).

**Length and sex composition**. The stock in 2007 was dominated (≈95% by number) by one year-class (3 year-old shrimp). This year-class was composed mostly of males (modal length ≈20 mm CL) but it also contained primiparous females (modal length ≈23 mm CL). Younger/smaller shrimp were very rare in the stock and so were older/larger shrimp (multiparous females, older than 4 years (Fig. 3.4)). In 2007, the abundance of males and females amounted to 51 × $10^9$ and 15 × $10^9$ individuals, respectively. These values are close to the long-term averages (50× $10^9$ and 12× $10^9$ individuals). The abundance of males and females in 2007 has declined by 48 % and 40 % respectively from the peak values of 2003 (SCR Doc. 07/71).

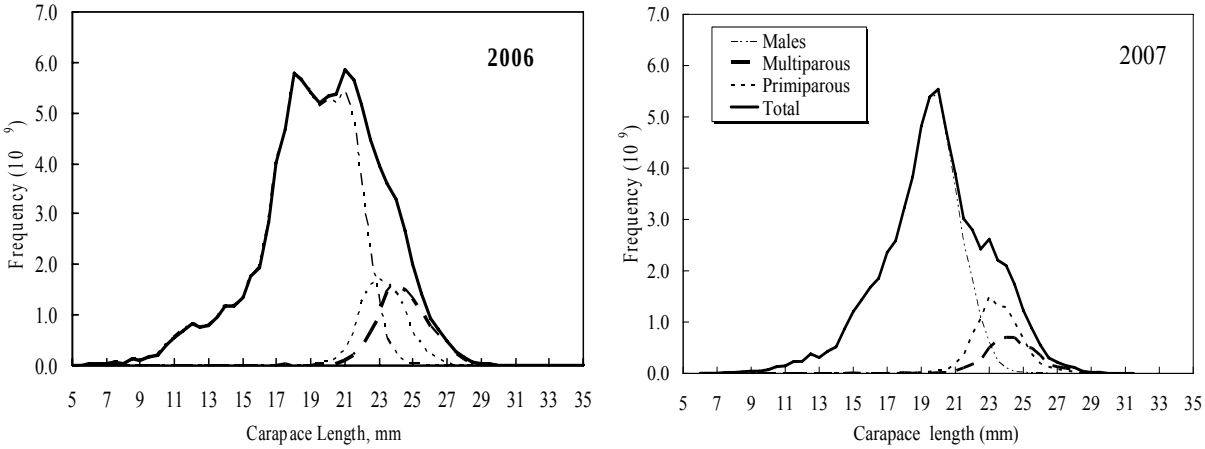



Fig. 3.5. Shrimp in Subareas 0 and 1: length frequencies of northern shrimp in the total survey area (offshore and Disko Bay/Vaigat combined) in 2006 and 2007.

**Recruitment Index**. The number at age 2 is a short-term predictor of fishable biomass 2 to 4 years later (SCR Doc. 07/71). This recruitment index was high in 2001, decreased in 2002, was below average in 2003 and 2004, reached even lower values in 2005 and 2006, and decreased in 2007 to the lowest recorded value (Fig. 3.5).

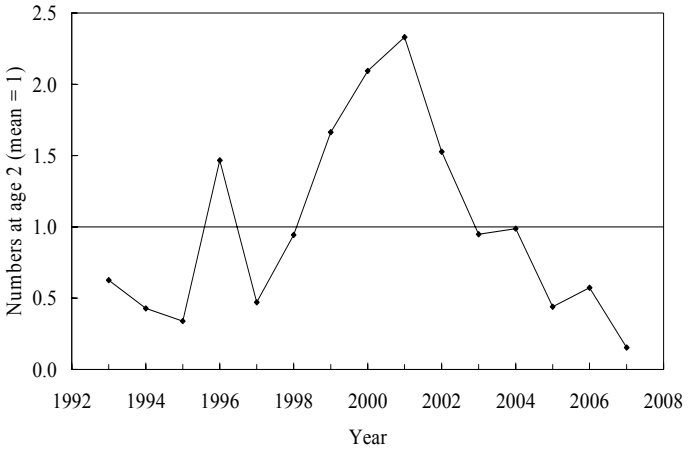



Fig. 3.6. Shrimp in Subareas 0 and 1: index of numbers at age 2 from survey (scaled to the mean of the series).

**iii) *Other biological studies***

The quantitative model in use for the assessments of the shrimp stock includes a term for predation by Atlantic cod. The model was found to be sensitive to the cod biomass series, producing aberrant results when the series was changed. Systematic investigation traced the problem to an adjustment made to a set of predation data so that it would fit the cod biomass series originally used (SCR Doc. 07/67). The treatment of the predation term in the model was slightly modified so that the adjustment of the predation data was unnecessary, and the predation estimates were coupled with the cod biomass estimates on which they had originally been based. The estimates of the basic shrimp stock-dynamic parameters, such as MSY, from the revised model were found to be much less sensitive to changes in the cod-stock series, which, however, by altering the parameters of the cod-shrimp predation relationship, did have an effect on predictions of the shrimp stock trajectory under different scenarios for the development of the cod stock.

Estimates of cod biomass from the German groundfish survey at West Greenland are used in the assessment of shrimp in SA 1 and in Div. 0A east of 60°30′W. The survey is conducted in October-November and the results for the current year are not available in time for the shrimp assessment. A comparison of cod biomass indices for West Greenland offshore waters from the German groundfish survey and from the Greenland survey for shrimp and fish was updated; the two survey estimates of cod biomass were closely correlated ($r^2$ = 0.91, $P$ <0.001). Regression analysis of 15 years of data estimated that the index of cod biomass from the 2007 Greenland survey would correspond to about 36 692 t in the German survey (SCR Doc. 07/73). The biomass of Atlantic cod is still low compared with the 1980s, despite its moderate increase in the most recent years. The distribution is pronouncedly southern: 90% of the biomass is found in NAFO Div. 1F. The spatial overlap between Atlantic cod and Northern shrimp in West Greenland appears currently to be small.

A study on the discard levels of fish in the shrimp fishery in 2006 and 2007 were presented (SCR Doc. 07/88). A scientific technician from the Greenland Institute of Natural Resources (GINR) sailed aboard different fishing vessels to weighand identify to species level the fish caught as bycatch, and to compare these values with estimates from the captain and the observer from Greenland Fishery License Control (GFLK). Data on the discard levels of fish has been collected from 332 hauls in 12 trips on 9 different vessels in NAFO Div. 1B-1E and in ICES XIVB. This study showed an average discard percentage of 2.2% of the shrimp catch weight, which is somewhat higher than logbook records in recent years, where the discard level on average has remained well below 1% (Kingsley 2007). The dominant species were Redfish (*Sebastes* sp.), Capelin (*Mallotus villosus*), Goiter blacksmelt (*Bathylagus euryops*), American plaice (*Hippoglossus platessoides*), Eelpouts (*Lycodes* sp.), Greenland halibut (*Reinhardtius hippoglossoides*) and Cod (*Gadus morhua*). The use of grid separators in front of the codend restricts bycatch to relatively small fish, and very few fish longer than 25 cm were recorded.

**c) Estimation of Parameters**

A Schaefer surplus-production model of population dynamics was fitted to series of CPUE, catch, and survey biomass indices. The model included a term for predation by Atlantic cod and a cod biomass series was included in the input data. CPUE data extended back as far as 1976, but survey data only started in 1988. CPUEs were standardised by linearised multiplicative models including terms for vessel effect, month, year, and statistical area; the fitted year effects were considered to be series of annual indices of total stock biomass. Series for the Greenland fishery after the end of the 1980s were divided into 2 fleets, a coastal and an offshore; a series for 1976–1990 was constructed for the KGH fleet of sister trawlers and a series for 1987–2006 for the Canadian fleet fishing in SFA1. Twin-trawl data was included for the recent offshore fleets, a twin-trawl effect being included in the models. The four CPUE series were included separately in the surplus-production model.

While the model used in 2007 (see Table 3.1, model 1) was broadly similar to that used in 2006, there were differences of detail that impede direct comparison of results. Among them are the use of four CPUE series separately in the model, where in 2006 a unified series was constructed in a separate preliminary step, revised coding for the inclusion of the direct estimates of cod predation (SCR Doc. 07/66), and a substantial correction to catch figures for 2003–2005 (SCR Doc. 07/69). An 'effective' cod biomass series was used, that allows for low spatial overlap between shrimp and cod (SCR Doc. 04/71, SCR Doc. 06/57, SCR 07/73), where in 2006 a 'total' cod-stock series had to be used.

Table 3.1. Summary statistics of stock dynamics, present stock status, and short-term predictions for different catch levels, estimated from different data inputs, and compared with estimates made in 2006.

| | **1.** Full CPUE & Survey | | **2.** Short CPUE & Survey | | **3.** Survey only | | **4.** 2006 Assessment | |
|---|---|---|---|---|---|---|---|---|
| | Median | IQR/Med. [1] | Median | IQR/Med. | Median | IQR/Med. | Median | IQR/Med. |
| *MSY* | 161.2 | 42 | 136.5 | 26 | 148.7 | 54 | 161.4 | 40 |
| *K* | 3158 | 110 | 1819 | 60 | 3245 | 104 | 3036 | 88 |
| $Z_{msy}$*(%)* | 10.63 | 66 | 15.05 | 42 | 9.67 | 76 | 11.66 | 58 |
| $B/B_{msy}$*(2007)* | 1.25 | 49 | 1.15 | 40 | 1.40 | 49 | 1.49 | 37 |
| $P(Z>Z_{msy}, 2008)$ *(%)* | | | | | | | | |
| *90 Kt* | 10 | | 12 | | 13 | | | |
| *110 Kt* | 18 | | 34 | | 24 | | 2.6 | |
| *120 Kt* | 26 | | | | 27 | | | |
| *130 Kt* | 33 | | 62 | | 34 | | 12 | |

[1] I.Q.R./Med.: ratio (%) of inter-quartile range to median estimate.

Results obtained from model 1. were similar to those obtained in the 2006 assessment (Table 3.1, model 4) as regards stock-dynamic parameters, but more pessimistic as regards the present state of the stock—although still estimating it to be above $B_{msy}$—and as regards short-term predictions.

An increasing concentration of the stock and the fishery, noted earlier, would be consistent with the observed decreasing biomass index from the research trawl survey while catch rates in the fishery remained high. Using the CPUE data as above could therefore be regarded as giving too much credence to recent CPUE values that apply to a period when the fishery, and the stock, appear to be concentrated and CPUEs therefore apt to overestimate biomass relative to periods when the fishery was more widely distributed. A model (Table 3.1, model 2) was therefore also run with the three recent CPUE series truncated at 2003 before the stock contraction became so evident. The truncation was applied to the same GLM outputs as were used in the full series; the GLMs were not re-run and there were no other changes to model or data.

When the CPUE series were truncated (model 2), the years omitted were years for which the series disagreed with each other and with the survey series. The model estimated a lower MSY at 136 000 t; estimates of the present state of the stock were lower than those based on all the CPUE data (model 1). However, this selection can be regarded as setting a bound, on the pessimistic side, of the use of the available data and therefore of the state of the stock.

This selecting of CPUE data also raised some concerns, so a model (Table 3.1, model 3) was also run with the survey series alone as the only biomass index series. Recent biomass levels, relative to $B_{msy}$, were estimated higher

than when CPUEs were included, and the MSY was between the value estimated with full CPUE series and that from shortened CPUE series. Risk levels for short-term predictions were similar to those obtained when the full CPUE series were used, therefore more optimistic than when the CPUEs were truncated.

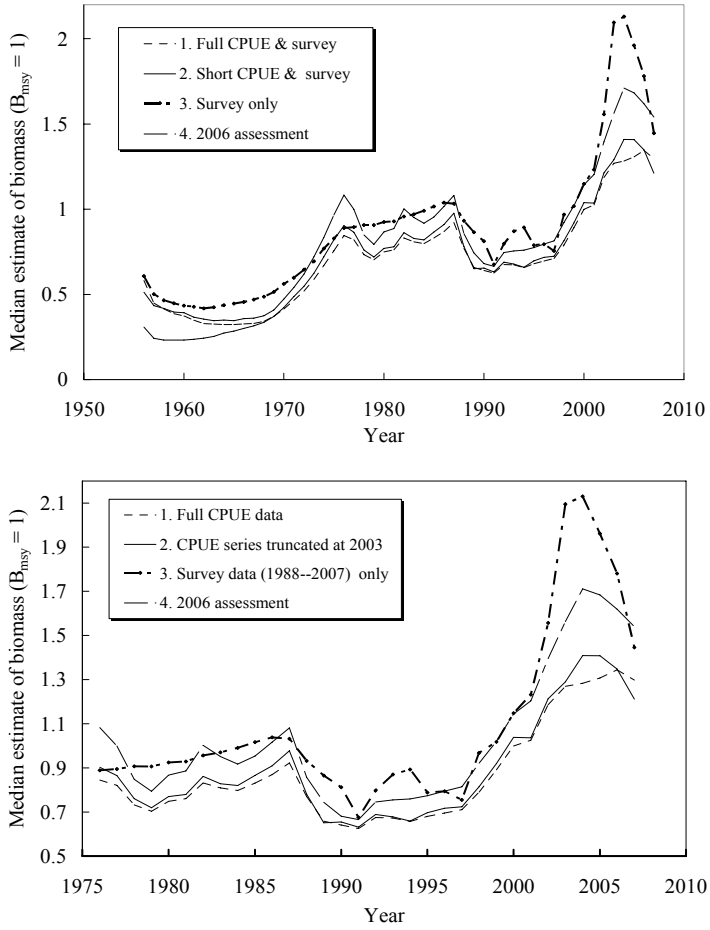



Fig. 3.7. Shrimp in Subareas 0 and 1: trajectories of the median estimate of stock biomass, relative to biomass at maximum sustainable yield, from running a Schaefer surplus production model with different selections of input data.

MSY estimated in 2006 (Table 3.1, model 4) was close to the 161 000 t estimated in 2007, but the 2006 assessment was more optimistic about the current state of the stock. The future predictions were therefore also more optimistic; more so about future biomass than about future mortality. Mortality predictions must be considered in the light of the 2006 predictions' having been made with a cod stock assumed constant at 22 700 t where 33 200 t was assumed in 2007.

Using CPUE as calculated (Table 3.1, model 1), catches of 120 000 t are associated with probabilities of exceeding $Z_{msy}$ in the short term that are near 30%, and catches of 130 Kt with probabilities over 30%. Catches of 110 000 t give probabilities near 20%. This might be a selection of data that gives an optimistic view, but use of survey data alone gives similar estimates. Model 2, which includes truncated CPUE series, predicts a 30% chance of exceeding $Z_{msy}$ in the short term with catches of 110 000 t. As the stock is considered to be above $B_{msy}$ it can be expected that even removals below the MSY could be associated with decreases in stock biomass.

Recent estimates of consumption by cod in model 2 were about ¾ tons of shrimp per ton of cod, so a cod-stock prediction of 30 000 t would indicate that an allowance of order 20 000 t from the estimated MSY would be needed for sustainability.

**d) State of the Stock**

*CPUE*. In aggregate, standardised catch-rate indices, roughly stable from 1976 to 1987, decreased sharply to the early 1990s and stayed low for a few years, but then increased steadily to high levels in the early 2000s. An apparent recent contraction of the fished area casts doubt on how well recent CPUEs reflect trends in biomass.

*Recruitment*. Numbers at age 2 from the research trawl survey peaked in 2001 but have since continually decreased, have been below average since 2003, and in 2007 have reached a record low, at about 7% of the 2001 peak and 15% of the series mean. Prospects for recruitment to the fishable stock are bleak.

*Biomass*. Survey biomass, relatively low from 1988–1998, increased to a all-time high in 2003, but has since steadily declined, in 2007 to 58% of its 2003 value; however, it is still 13 % above the series mean. Stock-dynamic modelling estimates that current biomass level is above $B_{msy}$, with a small probability of being below $B_{lim}$. However, it also confirms a decrease in biomass in the most recent years.

*Mortality*: The mortality caused by fishing and cod predation ($Z$) is modelled as having been below the reference level of ($Z_{msy}$) since 1993. With catches in 2007 projected at 134 000 t the risk that total mortality would exceed $Z_{msy}$ was estimated to be in the range of 26 to 44 %.

*State of the stock*. CPUEs are high in historic terms, but the stock is being intensively fished in a shrinking area. Survey biomass, still moderately high, has nevertheless decreased markedly and uninterruptedly since 2003. Estimated numbers of small shrimp have decreased for 6 years, reaching now very low levels. Concerns about future recruitment expressed in previous years are in 2007 aggravated, and reinforced by indications of decreasing stock biomass and a narrow size spectrum.

**e) Research Recommendations**

NIPAG recommended that, for shrimp off West Greenland (NAFO Subareas 0 and 1):

- *onboard sampling of commercial catches — essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock — should be re-established in Subarea 1.*
- *methods of incorporating weighted CPUE indices into the assessment model should be explored.*
- *the impact of other predators on the stock should also be considered for inclusion in the assessment model.*
- *recruitment indices and their relationship to subsequent fishable biomass should be considered for inclusion in the shrimp assessment model.*
- *update the model accepted in the 2006 assessment with the data available in the 2008 assessment and investigate the impact of the alternative treatment of the various input series.*

**4) Northern shrimp (in Denmark Strait and off East Greenland) – NAFO Assessed**

(SCR Doc. 03/74, 07/68)

**a) Introduction**

Northern shrimp off East Greenland in ICES Div. XIVb and Va is assessed as a single population. The fishery started in 1978 and, until 1993, occurred primarily in the area of Stredebank and Dohrnbank as well as on the slopes of Storfjord Deep, from approximately 65°N to 68°N and between 26°W and 34°W.

In 1993 a new fishery began in areas south of 65°N down to Cape Farewell. Access to these fishing grounds depends strongly on ice conditions. From 1996 to 2003 catches in the area south of 65°N accounted for more than 60% of the total catch. Catches and effort in the area south of 65°N in 2004 and 2005 only accounted for 29% and 47% respectively and decreased further in 2006.

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

In the Greenland EEZ, the minimum permitted mesh size in the cod-end is 44 mm, and the fishery is managed by catch quotas allocated to national fleets. In the Icelandic EEZ, the mesh size is 40 mm and there are no catch limits. In both EEZs, sorting grids with 22-mm bar spacing to reduce bycatch of fish are mandatory. Discarding of shrimp is prohibited in both areas.

Total catches increased rapidly to about 15 500 tons in 1987 and 1988, but declined thereafter to about 9 000 tons in 1992 and 1993. Following the extension of the fishery south of 65°N catches increased again to about 13 800 tons in 1997. Catches from 1998 to 2003 have been around 12 000 tons (Fig. 4.1), but have since decreased. Catches decreased in 2005 to 8 000 tons and in 2006 further to about 5 100 tons. Catches in 2007 are projected to stay at this level. Catches in the Iceland EEZ had decreased from 2002 to 2005, and no catches were taken in 2006 or, so far, in 2007.

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

| | 1998[3] | 1999[3] | 2000[3] | 2001[3] | 2002[3] | 2003[3] | 2004 | 2005 | 2006 | 2007[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | 5 000 | 9 600 | 9 600 | 9 600 | 9 600 | 9 600 | 12 400 | 12 400 | 12 400 | 12 400 |
| Greenland EEZ, North of 65°N | 3 943 | 4 058 | 4 288 | 2 227 | 4 042 | 5 405 | 4 612 | 3 952 | 3 854 | 3 480 |
| Iceland EEZ, North of 65°N | 1 421 | 769 | 132 | 10 | 1 231 | 703 | 411 | 29 | 0 | 0 |
| Total, North of 65°N | 5 364 | 4 827 | 4 420 | 2 237 | 5 273 | 6 108 | 5 023 | 3 981 | 3 854 | 3 480 |
| Greenland EEZ, South of 65°N | 6 057 | 6 893 | 7 632 | 11 674 | 6 055 | 6 597 | 4 993 | 3 690 | 1 253 | 919 |
| Total STATLANT 21A | 9 321 | 9 467 | 9 594 | 11 052 | 9 169 | 9 763 | 10 016 | 7 671 | 5 107 | 4 399 |
| Total NIPAG[3] | 11 422 | 11 719 | 12 053 | 13 911 | 11 329 | 12 705 | 10 016 | 7 671 | 5 107 | 4 399 |

[1] Catches till October 2007
[2] Provisional.
[3] Estimates 1998-2003 corrected for "overpacking".

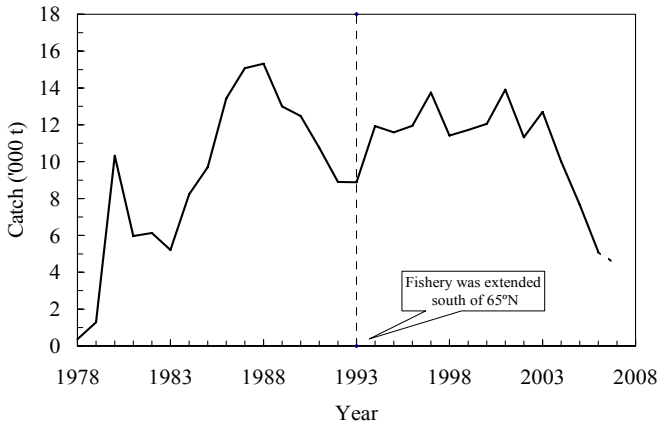



Fig. 4.1.Shrimp in Denmark Strait and off East Greenland: total catches (2007 catches until October 2007).

**b) Input Data**

**i) *Commercial fishery data***

**Fishing effort and CPUE**. Data on catch and effort (hours fished) on a haul by haul basis from logbooks from Greenland, Iceland, Faroe Islands and EU-Denmark since 1980, from Norway since 2000 and from EU-France for the years 1980 to 1991 were used . Until 2005 the Norwegian fishery data was not reported in a compatible format

and was not included in the standardized catch rate calculations. In 2006, however, the Norwegian logbook data from 2000 to 2006 was evaluated, resulting in its inclusion in the 2006 calculations of standardized catch rates. Since 2004 more than 60% of all hauls were performed with double trawls and the 2007 calculation of standardized catch rates is based on both single- and double-trawl data.

Catches and corresponding effort are compiled by year for two areas, one area north of 65°N and one south. Standardised Catch-Per-Unit-Effort (CPUE) was calculated and applied to the total catch of the year to estimate the total annual standardised effort. The geographic distribution of the fishery is shown by plotting the unstandardised CPUE by statistical units (7.5' latitude × 15' longitude). Catches in the Greenland EEZ have been corrected for "overpacking" (Hvingel, 2003).

The Greenland fishing fleet, (catching 40% of the total catch), has decreased its effort in recent years, and this creates some uncertainty as to whether recent values of the indices accurately reflect stock biomass. The decrease may be related to the economics of the fishery.

North of 65°N standardized catch rates based on logbook data from Danish, Faroese, Greenlandic, Norwegian and Icelandic vessels declined continuously from 1987 to 1993 but showed a significant increase between 1993 and 1994. Since then rates have varied but shown a slightly increasing trend (Fig. 4.2). In the southern area a standardized catch-rate series from the same fleets, except the Icelandic, increased until 1999, and varied around this level until 2001 (Fig. 4.3).

The combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993, and then showed an increasing trend until the beginning of the 2000s. This index has since then stayed at or around this level (Fig. 4.4).

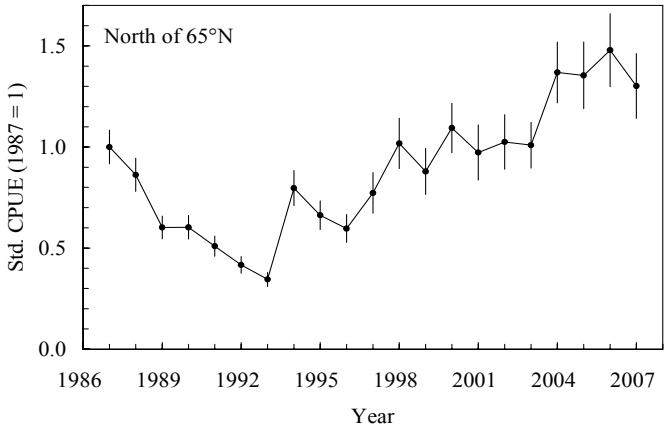



Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE, relative to 1987, with ±1 SE calculated from logbook data from Danish, Faeroese, Greenland, Icelandic and Norwegian vessels fishing north of 65ºN.

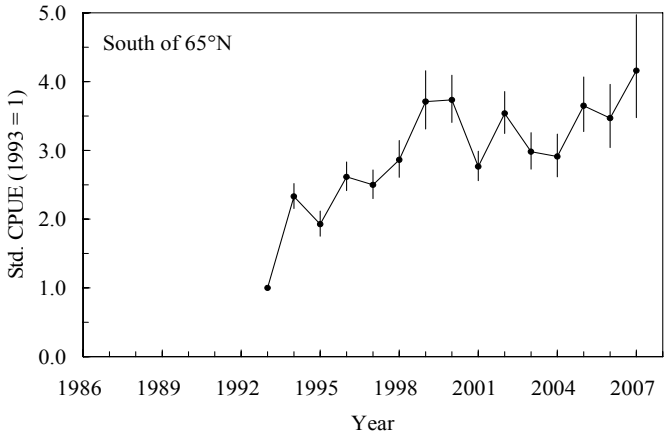



Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE, relative to 1993, with ±1 SE calculated from logbook data from Danish, Faeroese, Greenland and Norwegian vessels fishing south of 65ºN.

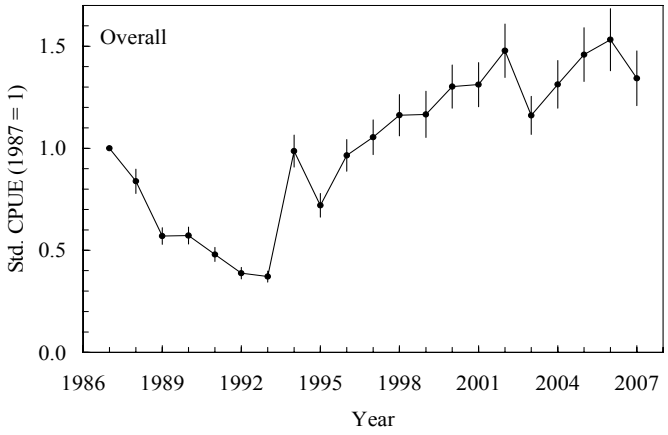



Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE indices, relative to 1987, combined for the total area. Error bars are ± 1 SE.

Standardized effort indices (catch divided by standardized CPUE) as a proxy for exploitation rate for the total area shows a decreasing trend since 1993. Recent levels are the lowest of the time series (Fig. 4.5).

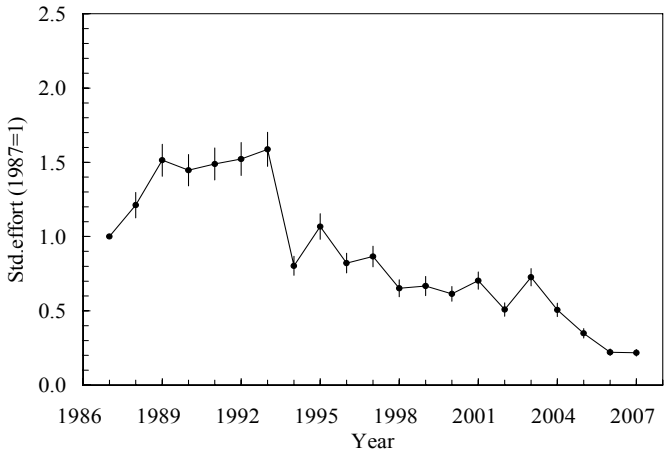



Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized effort indices, as a proxy for exploitation rate and relative to 1987, combined for the total area. Error bars are ± 1 SE.

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

**ii) *Research survey data***

No surveys have been conducted since 1996.

**c) Assessment Results**

*CPUE*. Combined standardized catch-rate index for the total area decreased steadily from 1987 to 1993, showed an increase to a relatively high level at the beginning of the 2000s, and has fluctuated around this level thereafter.

*Recruitment*. No recruitment estimates were available.

*Biomass*. No direct biomass estimates were available.

*Exploitation rate*. Since the mid 1990s exploitation rate index (standardized effort) has decreased to its lowest levels in the 21 year series.

*State of the stock*. The stock is believed to be at a relatively high level, and to have been there since the beginning of the 2000s.

**d) Research Recommendations**

NIPAG **recommended** that, for shrimp in Denmark Strait and off East Greenland:

- *a survey be conducted to provide fishery independent data of the stock.*
- *the sampling of catches by observers be re-established. This is essential for assessing age, size, sex composition, fecundity and frequency of spawning of the stock.*
- *the availability and usefulness of size data from commercial landings be investigated as a source of information on stock structure.*
- *the existence and availability of survey data from Norwegian sources be investigated.*