# PART C: SCIENTIFIC COUNCIL MEETING, 22–30 OCTOBER 2008

## Contents

Back Row: Don Power, Silver Sirp, Bill Brodie, Michael Kingsley, Sergei Bakenev, Mikel Casas, Trond Thangstad, Sten Munch-Petersen, Dave Orr, Anthony Thompson
Front row: Don Stansbury, Helle Siegstad, Michaela Aschan, Søvik Guldborg, Nanette Hammeken Arboe, Nikoline Ziemer, Carsten Hvingel

# Report of Scientific Council Meeting

## 22-30 October 2008

Chair: Don Power Rapporteur: Anthony Thompson

### I. PLENARY SESSIONS

The Scientific Council (SC) met at the ICES Headquarters, Copenhagen, Denmark, during 22–30 October 2008, to consider the various matters in its Agenda. Representatives attended from Canada, Denmark (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 1015 hours on 22 October 2008.

The Chair welcomed representatives, advisers and experts to the opening session of Scientific Council. The Chair noted that the primary reason for this meeting was to provide advice on shrimp stocks based on the assessments provided by the joint NAFO/ICES *Pandalus* Assessment Group (NIPAG). ICES members of NIPAG 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 and France (in respect of Saint Pierre et Miquelon) to record their abstentions during any voting procedures.

The Chair explained that under Rules of Procedure 4.3 a mail vote had been recently taken in order to add a Fisheries Commission (FC) Request from September 2008 to the agenda due to the required 60-day advance notice. Affirmative votes were received from Canada, Denmark, European Union, Japan, Norway, Russian Federation, and United States of America and, in addition to the votes of abstention noted above, the required quorum was met. The Provisional Agenda was adopted with the inclusion of the Fisheries Commission request under Item IV.1.c. 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 opening session was adjourned at 1035 hours. Several sessions were held throughout the course of the meeting to deal with specific items on the agenda.

The concluding session was convened at 0830 hours on 30 October 2008. The Council then considered and adopted Sections III.1–4 of the "Report of the NAFO/ICES *Pandalus* Assessment Group" (NAFO SCS Doc. 08/25, ICES CM 2008/ACOM:11). The NAFO stock assessments are included as Appendix I. The Council, having considered the results of the assessments, provided advice and recommendations and noted the requests of the Fisheries Commission and Coastal States had been addressed. The Council then considered and adopted its own report of the 22–30 October 2008 meeting.

The meeting adjourned at 1200 hours on 30 October 2008.

The revised 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 2007 AND 2008

**From Scientific Council/NIPAG Meeting, 24 October – 1 November 2007**

During deliberations of various shrimp stocks during the SC/NIPAG meeting in 2006 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.

**STATUS**: STACREC (NAFO *Sci. Coun. Rep*., 2007, p. 80) and Scientific Council (NAFO *Sci. Coun. Rep*., 2007, p. 218) responded to the request of the NIPAG (SCS Doc. 06/27, p. 47) to forward the question of the efficiency of single and double trawls to April 2007 [sic] meeting of the ICES/FAO WGFTFB. The working group discussed this issue and noted that efficiency in terms of the amount of shrimp caught was more dependent on the horizontal spread of the net than on the area of the opening. Hence, the counting of meshes around the circumference of the net was not likely to be the best measure for efficiency comparisons. Herding effects on finfish are so different from those on shrimps that the efficiency results for double trawls used to catch finfish can not be used as a basis to assess efficiency issues for shrimp trawls. An analysis of data from one national fleet fishing in one area over a number of years showed twin trawls to have greater catch rates than single trawls, but this analysis did not produce a single conversion factor, and there appear to be few, or no, other good data collections that can be examined. There was no evidence to suggest that the industry uses, or prefers, twin trawls as a means of landing a higher quality of shrimp; the objective appears to be catch rate.

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

NIPAG has assessed four stocks of relevance to NAFO: Northern shrimp in Div. 3M, Northern shrimp in Div. 3LNO, Northern shrimp in Subareas 0 and 1, and Northern shrimp in Denmark Strait and off East Greenland. The Scientific Council 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. 08/25 and ICES CM 2008/ACOM:11.

## IV. FORMULATION OF ADVICE (SEE ANNEXES 1, 2 AND 3)

### 1. Request from Fisheries Commission

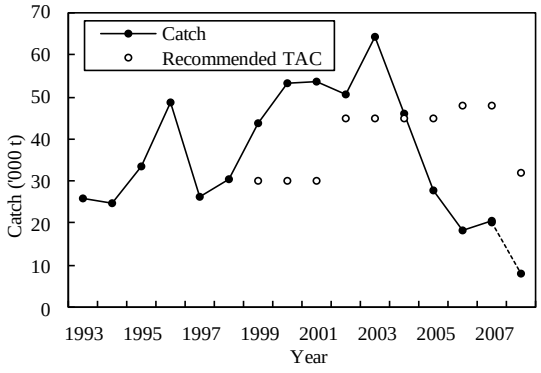
#### a) Northern shrimp (*Pandalus borealis*) in Div. 3M

**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. No information is available on the number of vessels taking part in the shrimp fishery in 2007 and 2008.

**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 |
| 2005 | 27 | 27[1] | | 45 | er |
| 2006 | 18 | 14[1] | | 48 | er |
| 2007 | 20 | 18[1] | | 48 | er |
| 2008 | 8[2] | | | ( )[3] | er |
| 2009 | | | | ( )[4] | er |

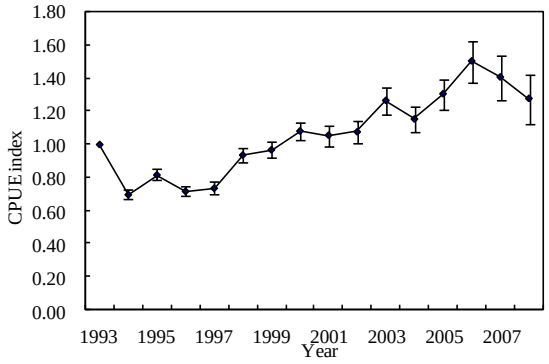
[1] Provisional.
[2] Preliminary to 1 October.
[3] Scientific Council recommended exploitation level for 2008 and 2009 not exceed 2005 and 2006 levels.
[4] Scientific Council recommended that a TAC for 2009 should not exceed the 2005 and 2006 exploitation level.
er = effort regulation.



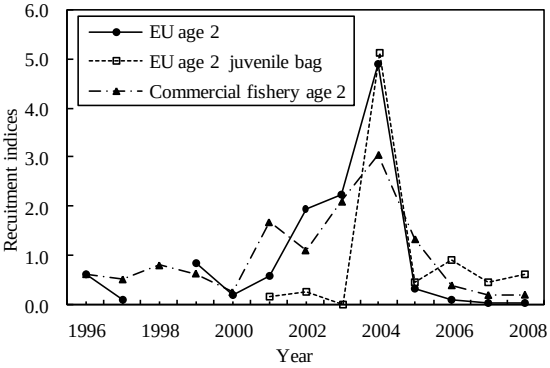

**Data:** Catch, effort and biological data were available from several Contracting Parties. Time series of size and sex composition data were available mainly from two countries between 1993 and 2005 and survey indices were available from EU research surveys (1988–2008). For lack of samples from the commercial fishery since 2006, length distributions from the EU survey have been used instead. Problems about suspected misreporting of catches since 2005 have been resolved to enable a standardized CPUE series which also accounted for changes in gear (single, double and triple trawl), fishing power and seasonality.

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

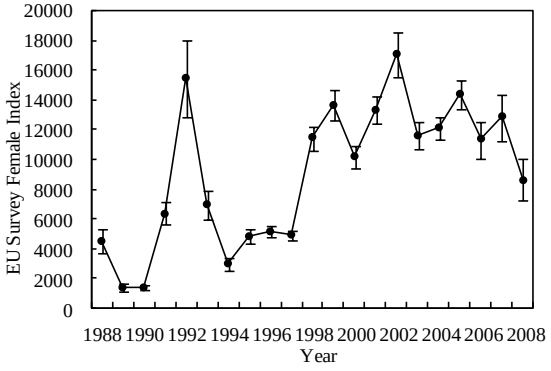
*CPUE*: Standardized catch rates declined from 1993 to 1994, was at low levels to 1997, then it gradually increased to 2006. Since 2006 although still high, the standardized CPUE has declined, however due to the low numbers of observations there is considerable uncertainty regarding the 2008 point.



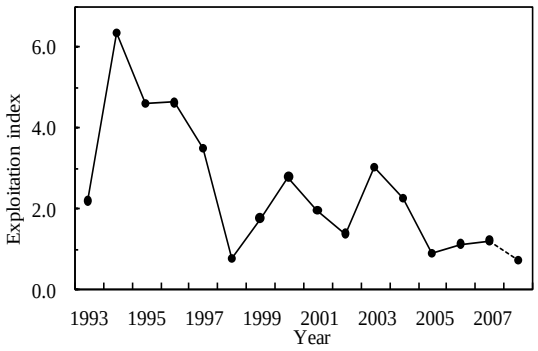

*Recruitment:* The 2002 year-class was strong, but all later year-classes have been much weaker.




*SSB:* The survey index of female biomass increased from 1997 to 1998 and fluctuated without trend between 1998 and 2007, but the 2008 survey index was the lowest since 1998.



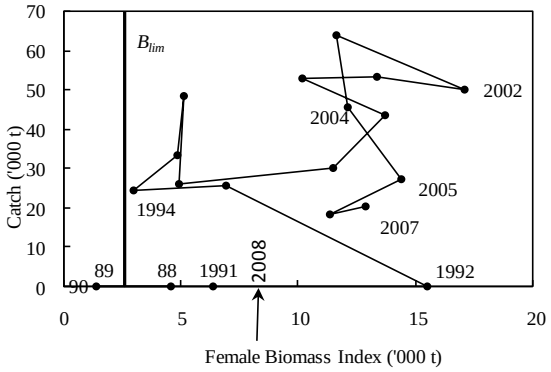

*Exploitation rate:* The exploitation rate projected for 2008 was the lowest in the historical series continuing a decreasing trend initiated in 2004. This trend appears to be mostly due to decreasing catches.




**State of the Stock:** The indices of biomass are at a relatively high level but showing signs of decline, even at present low catch levels. There are expectations of continued poor recruitment to the fishable stock, which may affect the 2009 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 2009 and 2010. There are serious concerns about the implications to the fishery and future stock production from the poor recent recruitment. The indices of biomass (standardized CPUE and female biomass (SSB) from surveys) have shown signs of decline at levels of exploitation that have been low since 2005. In light of the poor prospects for this stock, the Scientific Council recommended that exploitation level for 2009 and 2010 should not exceed the exploitation levels that have occurred since 2005. Catches over the period 2005–2007 were in the range of 18 000 to 27 000 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 2009 when results from the EU summer survey are available.

**Sources of Information:** SCR Doc. 04/64, 74, 08/65, 67, 68, 77; SCS Doc. 04/12

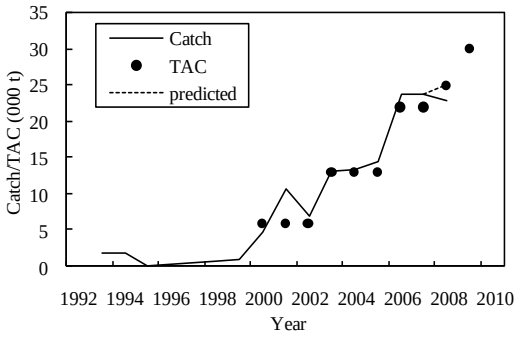
**b) Northern shrimp (*Pandalus borealis*) in Div. 3LNO**

**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 2008. 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 |
| 2005 | 14 | 14 | 13 | 13[3] |
| 2006 | 24 | 22 | 22 | 22[3] |
| 2007 | 24[2] | 21[1] | 22 | 22[3] |
| 2008 | 23[2] | 23[1] | 25 | 25[3] |
| 2009 | | | 25 | 30 |

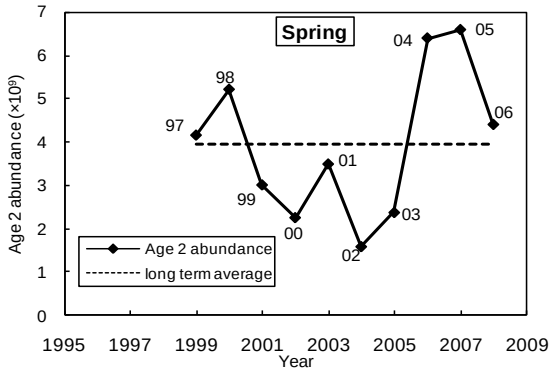
[1] Provisional,
[2] Preliminary to 10 October 2008,
[3] DFG did not agree to the quotas of 144 t (2003–2005), 245 t (2006–2007) or 278 t (2008), and set their own quota of 1 344 t (2003–2005) and 2 274 t (2006–2008). The increase is not included here.

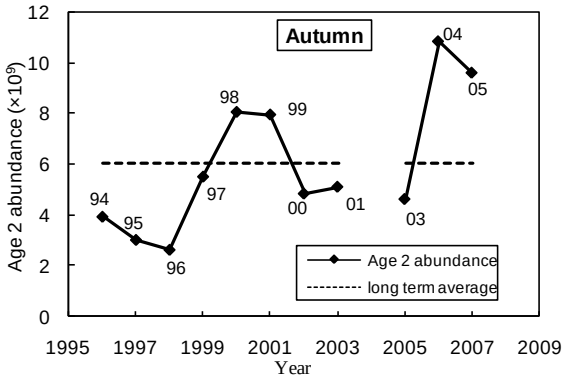



**Data**: Catch, effort and biological data were available from the commercial fishery. Biomass and recruitment indices as well as size and sex composition data were available from research surveys conducted in Div. 3LNO during spring (1999 to 2008) and autumn (1996 to 2007). The Canadian survey in autumn 2004 was incomplete.

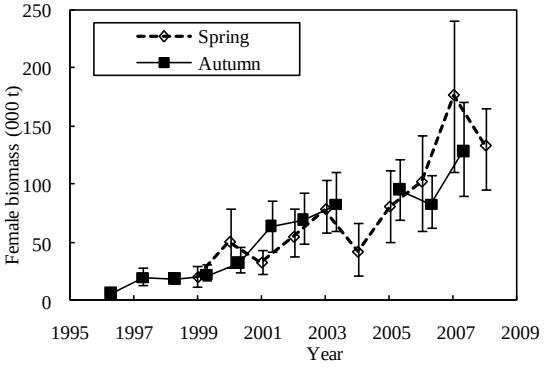
**Assessment**: Analytical assessment methods have not been established for this stock. Evaluation of the status of the stock is based upon interpretation of commercial fishery and research survey data.

*Recruitment*: The 2005 year class was particularly strong at age 2 in both the spring and autumn surveys. The 2006 year class was slightly above average in the 2008 spring survey.

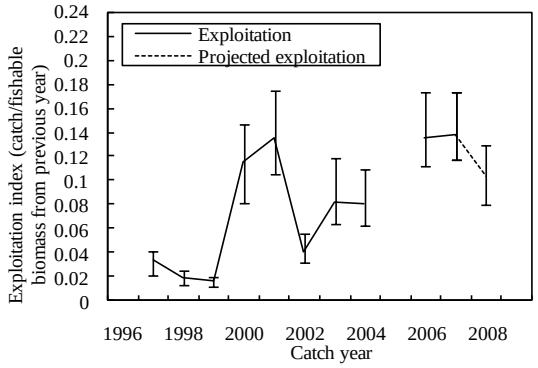



*Biomass*: The Canadian spring and autumn survey female and fishable biomass indices (shrimp >17 mm carapace length) have been increasing since 1999, following very similar paths, and are at or near the highest observed levels.

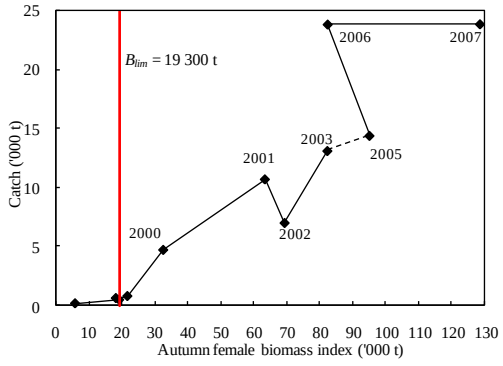



*Fishing mortality*: The exploitation rate index is used as a proxy for fishing mortality. The index of exploitation has remained below 14%.




**State of the Stock**: Biomass indices have been increasing since 1999 and are at or near the highest observed levels. The stock appears to be well represented by a broad range of size groups and recruitment prospects continue to be above average.

**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 Div. 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:**

*Catch Options*: Fisheries Commission has asked Scientific Council to provide a range of options, at various levels of exploitation, to assist Fisheries Commission in establishing a TAC for this stock in 2010. The TAC for 2009 of 30 000 t translates into an exploitation rate (catch/average fishable biomass) of about 14.8%, based on average fishable biomass index in 2006–2008 surveys of 202 700 t. The following catch options for 2010 are based upon this biomass index:

| Catch options | Exploitation rate |
|---|---|
| 25 000 t | 12.33% |
| 30 000 t | 14.80% |
| 35 000 t | 17.27% |

Scientific Council has imperfect information on sustainable exploitation rates but does have some evidence that they may differ widely between stocks. Other points in establishing an appropriate exploitation rate for shrimp stocks include ecosystem considerations, noting that shrimp is an important forage species, as well as management considerations (desire for stable TACs, or desire for gradual increases in biomass and TAC, *etc*).

There is no target exploitation rate established for this stock, and no PA reference points based on fishing mortality. It is therefore difficult for Scientific Council to advise on an appropriate range of exploitation rates for 2009 and 2010. The stock is likely to be in the safe zone of the NAFO PA framework, with a relatively high biomass index and a low to moderate level of exploitation. Under that scenario, Fisheries Commission could consider a range of options, depending on their management objectives, such as the following:

Option 1: There is no indication that an exploitation rate close to 15% has been harmful to the stock. Keeping exploitation rate constant for a number of years, for example at 15%, would allow for increases in catch if stock size increases further, along with further evaluation on the stock of removals at this rate. For 2010, this equates to a catch of 30 000 t based on the average of the most recent four survey biomass estimates to spring 2008.

Option 2: An adaptive management approach could be adopted for a number of years to explore how resilient the stock is to changes in the exploitation rate. Under this option in 2009 and 2010, each incremental change in the exploitation rate of 1% would equate to a change of 2 000 t in catch.

Scientific Council noted that other options are possible, including maintaining catches at a constant level such as the 2009 TAC of 30 000 t, and increasing the exploitation rate if any further increases in stock size occur.

**Special Comments**: Advice for the 2010 fishery will be reviewed at the September 2009 Scientific Council meeting, when preliminary results from subsequent surveys will be available.

**Sources of Information**: SCR Doc. 08/58, 65.

**c) Coral Concentrations in the NRA**

Scientific Council received a Fisheries Commission request for advice during the 2008 annual meeting held in Vigo, Spain on 22-26 September 2008 (FC, 2008b). Owing to the urgent nature of Item 9(a) of the request, Scientific Council requested its Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) to prepare a response, as soon as possible, for presentation to the October Scientific Council meeting held in Copenhagen, Denmark, on 22-30 October 2008. WGEAFM met by correspondence and produced their report (SCS Doc. 08/24) which was presented to this meeting of Scientific Council. Items 9b and 9c of the Fisheries Commission request will be discussed later by WGEAFM for presentation to Scientific Council in June 2009.

**Fisheries Commission Request**

9. Recognizing the initiatives on vulnerable marine ecosystems (VME), and with a view to completing fishery impact assessments at the earliest possible date, Fisheries Commission requests the Scientific Council to:

*a) Provide, as soon as possible in 2008, delineations, if any, of significant concentrations of corals in the NAFO Regulatory Area, by species, for the identification of VMEs. This should include the size and catch characteristics of corals obtained respectively from commercial fishing vessels and fisheries research vessels and the assessment of significant adverse impacts, with a particular focus on those species which involve interactions with commercial fisheries. The data should include absence/presence of corals as well as density.*

**Scientific Council responded as follows:**

**Introduction**

In June 2008, Scientific Council advanced areas for candidate Vulnerable Marine Ecosystems (hereinafter cVME) in the NRA (SCS Doc. 08/19; Fig. 1). The identification and delineation of these cVME was based on ecosystems rather than specific ecosystem components. Within this framework, the structure-forming invertebrates (corals and sponges) were used to identify cVME. Subsequently, information on the distribution of fish species and/or spawning grounds, topographical features and potential coral/sponge habitat was used to further support the selection of certain areas over others. Within the context of request 9(a), the locations of the significant catches of corals are generally nested within the larger cVME areas. The results of the current analysis on coral species are not suggesting any alteration to the originally proposed cVME areas.

When the significant concentrations of coral species were mapped it became apparent that they were, in most cases, geographically close to one another. Consequently the term "*key location*" was introduced to express the area bounded by a collection of significant coral concentrations (tows). Thus significant concentrations of coral are nested within *key locations*, which for the most part are nested within the cVME. The cVME will contain other *key locations* for different species, some of which will be delineated upon completion of the remaining parts of this Fisheries Commission request (see Items 9b and 9c in Annex 1b).

The request asked for a comparison of data from commercial fishing vessels and fisheries research vessels (RV). Data from the commercial fishery were only available from the Canadian observer program and hence are not representative of commercial fishing in the NRA, both in terms of spatial coverage and fishery. Consequently, these data (presence of taxon) were only used to support the delineation of the *key locations* of coral. The data used to respond to the Fisheries Commission request are summarized in Table 1. Collectively they represent an excellent resource of information derived from trawl surveys. Until additional targeted benthic surveys are conducted this represents the best source of available information to address this request.

This request asked that the size and catch characteristics of corals and the assessment of significant adverse impacts, with a particular focus on those species which involve interactions with commercial fisheries be addressed. In a previous WGEAFM report (SCS Doc. 08/10) and supporting documentation (SCR Doc. 08/22) the coral taxa were reviewed in relation to their response to serious adverse impact (SAI) from bottom fishing gears and a list of 5 taxa which met the criteria was put forward. These are: Antipatharians (Black corals), Gorgonians (Sea Fans), Pennatulacean (Sea Pen) fields, Cerianthid anemone fields and reef-building corals (*e.g.*, *Lophelia pertusa*). Two of these taxa are included because they form "fields" when large numbers occur very close together and, while the destruction of individuals has a low risk of SAI, the destruction of whole fields has a high risk of SAI. The

antipatharian corals differ from the rest on this list in that those species identified in the NRA are not verygregarious. Reef-building corals have not been observed in the NRA, and data on the cerianthid anemones could not be validated within the timeframe of this request. As a result, the response is focused on gorgonian and pennatulacean corals. As for the commercial fishing (Canadian observer) data, the presence of antipatharian corals was considered as further support in delineating key locations.

Table 1. Summary of data used to respond to the Fisheries Commission request.

| Data Source | No. of records of coral taxa | No. of tows with coral taxa | Total no. of tows | NAFO areas covered | Depth Range Covered (m) |
|---|---|---|---|---|---|
| DFO NL Groundfish Surveys 2000–2007 | 1448 | 791 | 5270 | Div. 3LMNO | 46–1450 |
| DFO Fisheries Observer Program NL 2004–2007 | 1102 | 1099 | 1099 | Div. 3LMNO | 31–1491 |
| IEO Platuxa Survey 2005–2007 | 268 | 170 | 349 | Div. 3NO | 40–1500 |
| EU Flemish Cap Survey 2006–2007 | 706 | 277 | 355 | Div. 3M | 130–1450 |
| IEO Fletán negro Survey 2006–2007 | 273 | 154 | 180 | Div. 3L | 110–1450 |
| Canada EEZ Survey conducted by Spain 2007 | 59 | 26 | 26 | Div. 3L | 300–1480 |

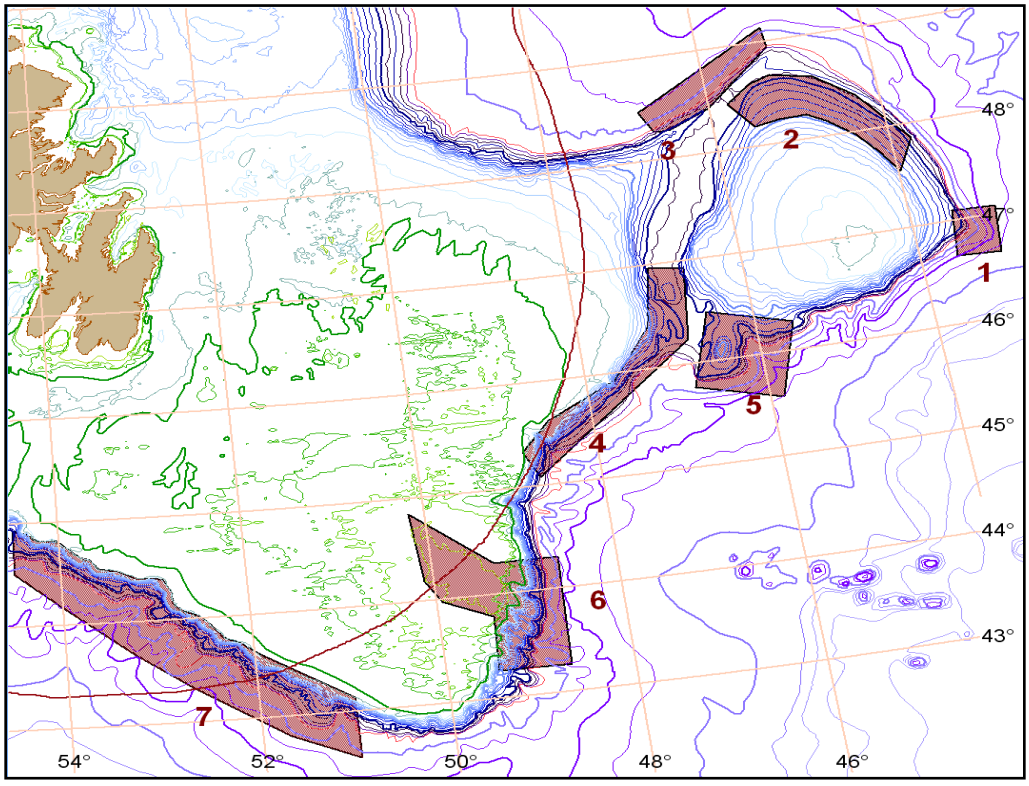



Fig. 1. Location of the candidate Vulnerable Marine Ecosystems Areas in the NAFO regulatory area with some overlap into the Canadian EEZ. Numbers (small script adjacent to shaded areas) are referred to in the text. 100, 500, 1000, 2000, 3000, and 4000 m depth contours are depicted as thick lines (from SCS Doc. 08/10).

The Scientific Council notes that further research to quantify the level of SAI for these taxa is required. It is known that these taxa in the trawl path are subject to a very high mortality (Freese *et al*., 1999) but it is not known what degree of habitat fragmentation can be tolerated before the population is unable to recover. Given what is known about the biology of these species, population extinction through fragmentation will arise through interference with reproductive processes.

**Determination of significant concentrations of coral**

Fisheries Commission defined an "encounter" with a VME area as follows: "For both existing and new fishing areas, an encounter with primary VME indicator species is defined as a catch per set (*e.g.* trawl tow, longline set, or gillnet set) of more than 100 kg of live coral and/or 1000 kg of live sponge. These thresholds are set on a provisional basis and may be adjusted as experience is gained in the application of this measure" (FC, 2008a). This threshold was reviewed by Scientific Council to determine whether it could be applied in this mapping context to delineate "significant concentrations" of coral. However this level of catch was never observed in any of the RV or commercial data examined.

In determining what constitutes a "significant concentration" the size (morphology) of the gorgonian and pennatulacean corals and their catch characteristics were used to form a scientific basis for determining which catches to map. A similarity matrix based on the presence/absence of coral species per tow was constructed to determine whether certain groups of corals were caught together. This analysis identified groups forming on the basis of substrate preference, which is consistent with expectation. Sea pens and the small gorgonian *Acanella arbuscula* were caught together in 40% of the hauls containing coral. These taxa are known to co-occur on mud/sand bottoms. The large gorgonians, which attach to boulders or bedrock, were less closely associated with one another. Consideration of the morphology of the different coral taxa represented indicates that the sea pens could be grouped together but that the small gorgonian *Acanella arbuscula* should be treated separately from the larger gorgonians. Therefore the maps of significant coral concentrations reflect the occurrence of three coral groups as opposed to 18 maps based on individual taxa.

Given the rudimentary knowledge we currently have in terms of functioning of deep sea communities and the precise roles that corals play in them, it is impossible at the present time to define absolute magnitudes of catch that can be associated to functionally relevant coral concentrations in ecological terms. The available empirical distributions for these three coral groups in the NRA were used to identify what constitutes a significant concentration. The distributions for the three groups were all *highly* skewed towards large numbers of small catches. The large catches form rare events towards the tail of the distribution and are interpreted as indicative of the trawl encountering a coral aggregation (see the WGEAFM report (SCS Doc. 08/24) for more detail on the biological interpretation of these distributions). The weight of the catch was presented as quantiles of a cumulative distribution for each group. The upper 2.5% of the catches (97.5% quantile) was used as the standard for determining where to delineate the level of a significant catch. This level has a statistical reference, and was applied in the absence of a firm biological foundation for choosing between quantiles in the upper tail of the cumulative distribution. This quantile level was applied to the sea pens and small gorgonians where whole colonies are caught. However, because the larger gorgonians are prone to breakage and are of a high SAI risk, a more precautionary 90% quantile was considered (*i.e.* the upper 10% of the cumulative catch distribution).

Following this procedure, the following values were used to identify significant catches for mapping of key locations:

| Taxon | Threshold weight | Maximum observed catch |
|---|---|---|
| Pennatulaceans (sea pens) | ≥1.6 kg per tow (97.5% quantile) | 10.12 kg |
| Small gorgonians | ≥0.2 kg per tow (97.5% quantile) | 0.24 kg |
| Large gorgonians | ≥2.0 kg per tow (90% quantile) | 68.58 kg |

For those positions where significant catches of corals have been identified, a two step process was employed to provide a buffer zone around them based on the following rationale: The first step was to allow for error between the recorded position of the vessel compared to where the gear was actually fishing. It was considered that a 2 nm radius around the putative position provided a safe margin to account for this source of error. This is consistent with the

"move-away" distance in the Interim Encounter Provision adopted at the Fisheries Commission September 2008 meeting (FC, 2008a). In addition to this, an additional 2 nm buffer zone was applied to allow for protection of the site. In total, this process rendered a full error+buffer zone of a 4 nm radius around the position of the significant catch. These values are considered precautionary until detailed mapping of these areas and/or additional research on buffer areas becomes available. However, this 4 nm area is considered to be very conservative in relation to the length of commercial fishing tows which can cover up to 20 nm. In order to provide a practical representation of these positions simple polygons were drawn to enclose nearby groups of significant catches plus their 4 nm buffer zones to delineate *key locations*.

**Key Locations of Significant Concentrations of Corals in the NAFO Regulatory Area**

Significant concentrations of coral based on the RV bottom trawl survey catches, are illustrated in Fig. 2 along with all of the ancillary data on the presence of other coral taxa in the area and the tows where no corals were observed. The maps show that cVME Areas 1, 2 and 4 within the NRA hold significant concentrations of corals (SCS Doc. 08/10).

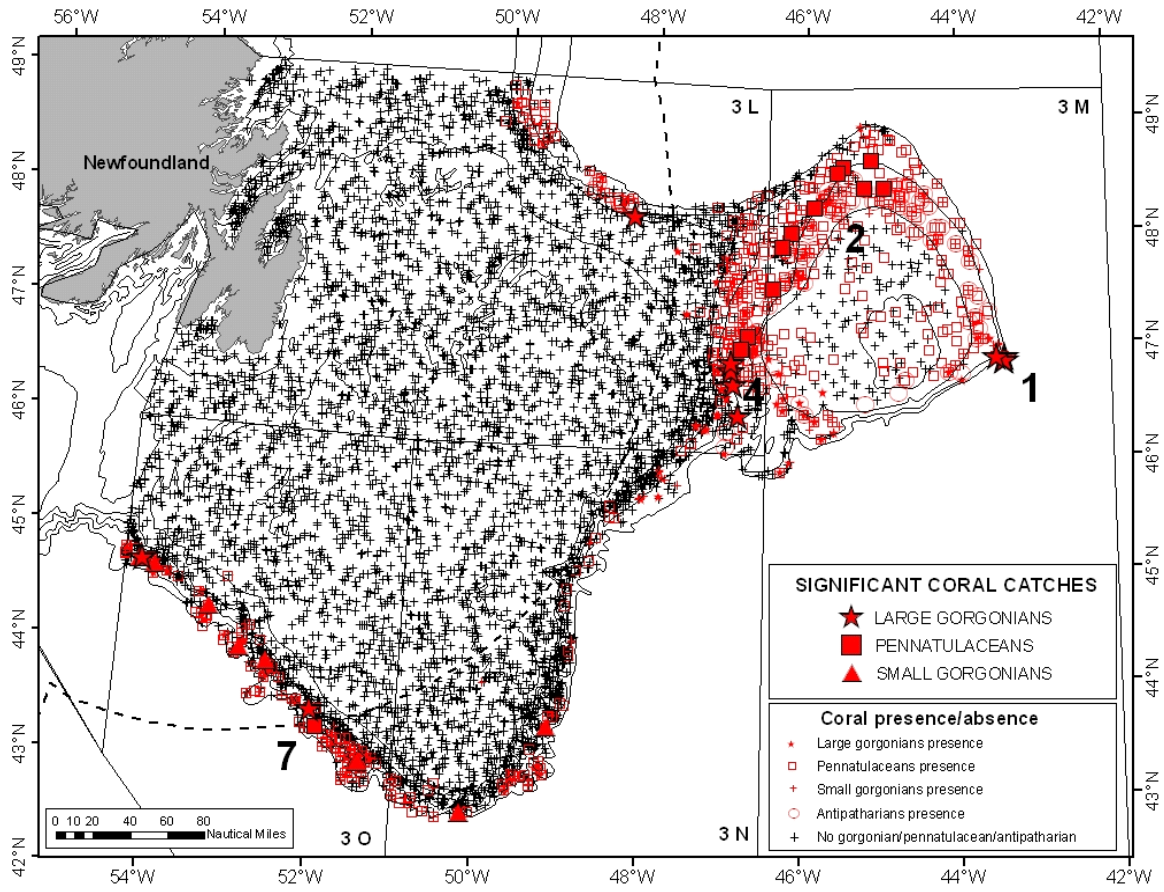



Fig. 2. Significant concentrations of coral taxa as determined from research vessel survey data. The numbers refer to the cVME area. As indicated in the figure itself, large (red) symbols indicate signficant concentrations while small ones denote presence of corals below significant catch levels.

Two additional locations, one in cVME Area 6 and another outside cVME Area 7, but along its general longitudinal direction, show significant catches of small gorgonians. Unlike the observations on cVME Areas 1, 2 and 4, where several nearby sets have shown significant catches, these last two locations are based on catch of *A. arbuscula* (small gorgonian) in single sets (amounts of 0.23 and 0.24 kg) and without any other significant catches or occurrence of antipatharian corals nearby (Fig. 3). Although these were identified as significant catches, they were not granted a *key location* status owing to their isolated nature.

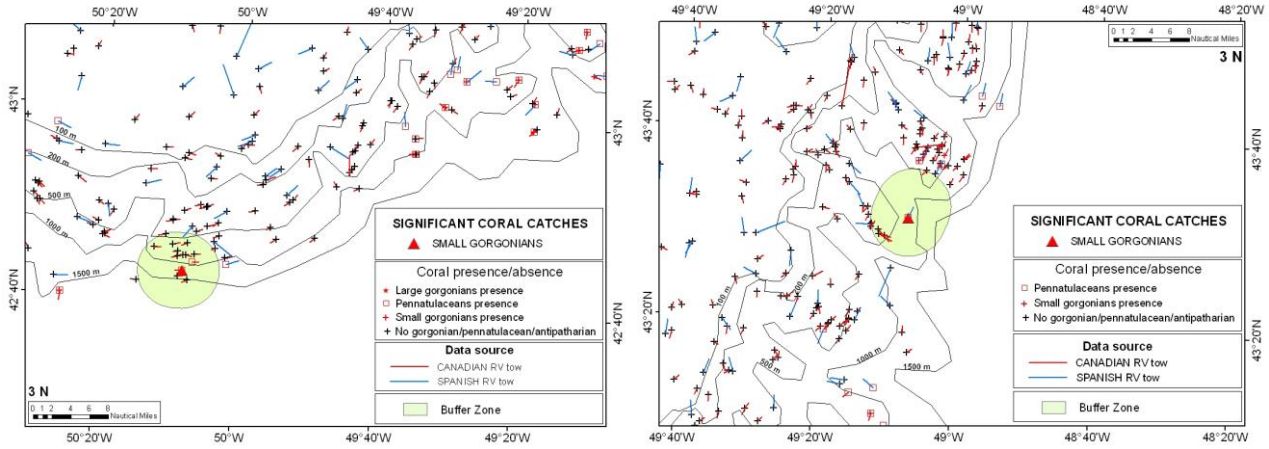



Fig. 3. Close-up of the two sites on the tail of the Grand Bank where significant concentrations of small gorgonians (*A. arbuscula*) were found. A 4 nm buffer zone around each significant concentration is also indicated.

Among the four cVME areas originally identified primarily on the basis of coral habitat (candidate VME areas 1, 2, 4 and 5), three have emerged from this analysis as containing *key locations* of corals (cVME Areas 1, 2 and 4). Area 5, Beothuk Knoll, has no identified *key location*s at the present time. However, the original designation of this area as a candidate VME was based on Russian data (SCR Doc. 08/79; see SCS Doc. 08/10 for details) that was not available by species as requested for this analysis. This situation does not diminish the original Scientific Council conclusion that cVME Area 5 is important as coral habitat or its status as a cVME.

Fig. 4–6 show a close-up of each one of the *key locations* identified in cVME Areas 1, 2 and 4. Each figure is composed of 4 elements: (1) the locations of significant concentrations of corals, (2) the 4 nm buffer around each tow where the significant concentration was found, (3) the polygons drawn to encapsulate key locations, and (4) cVME (from SCS Doc. 08/19). The coordinates corresponding to these key locations are detailed in Table 2.

In all cases significant catches of corals and/or *key locations* extend beyond the boundary of the associated cVME. This is not unexpected given that the candidate VME boundaries were based on multiple criteria and not just on the occurrence of high concentrations of corals.

***cVME Area 1: Large Gorgonians***

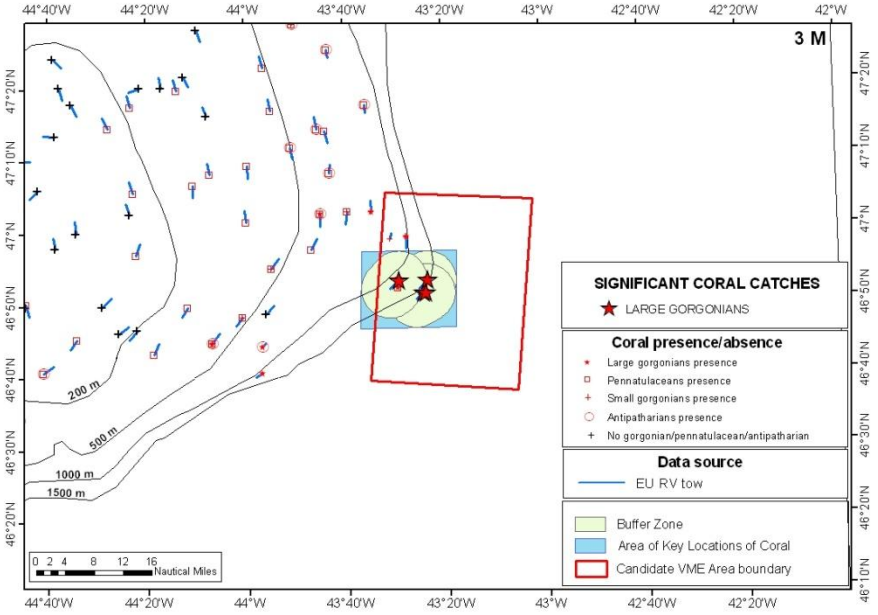



Fig. 4. Buffer zones around the significant concentrations of large gorgonians in cVME Area 1 and proposed polygon to encapsulate the *key location*.

***cVME Area 2: Pennatulaceans***

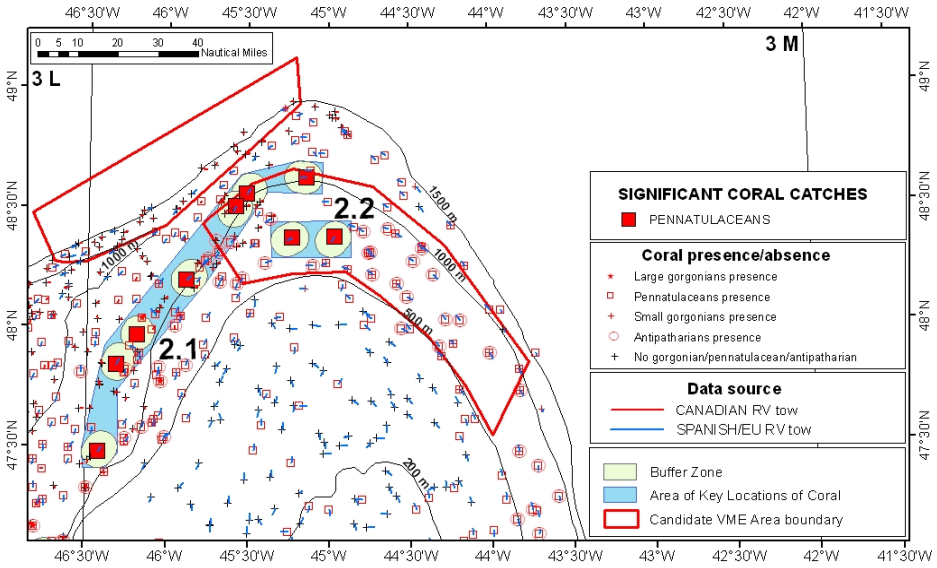



Fig. 5. Buffer zones around the significant concentrations of pennatulaceans (sea pens) in cVME Area 2 and proposed polygons to encapsulate the key locations. In Table 2, the polygon to the left is labeled "*Key Location* Area 2.1" and the one to the right "*Key Location* Area 2.2".

***cVME Area 4: Large Gorgonians and Pennatulaceans***

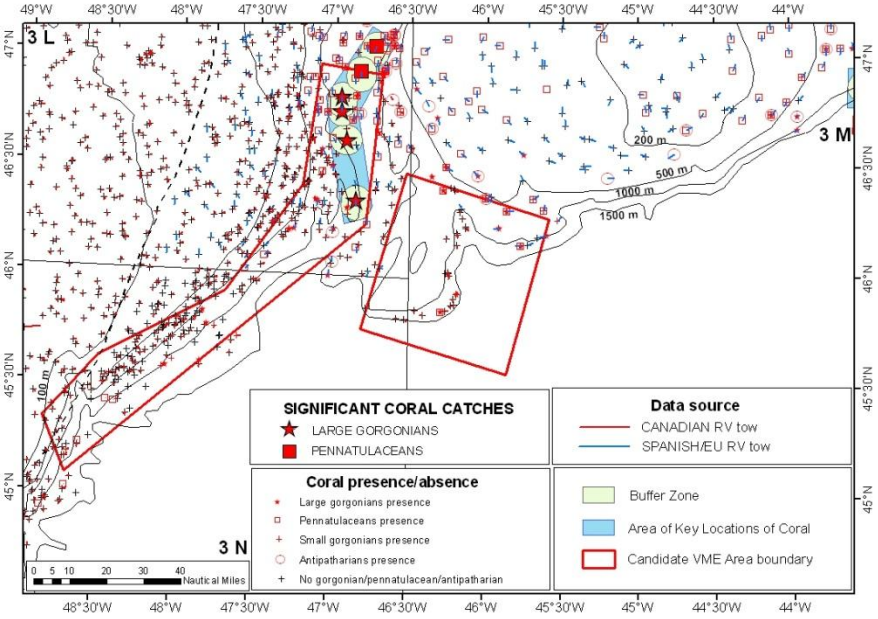



Fig. 6. Buffer zones around the significant concentrations of large gorgonian corals and pennatulaceans (sea pens) in cVME Area 4 and proposed polygon to encapsulate the *key location*.

Table 2. Coordinates for the proposed *key locations* delineating the areas of significant coral concentrations.

| Candidate VME Area | Key Location | Latitude | Longitude |
|---|---|---|---|
| 1 | Key Location Area 1 | 46º 46' 35" N | 43º 37' 05" W |
| | | 46º 46' 40" N | 43º 17' 48" W |
| | | 46º 57' 11" N | 43º 17' 30" W |
| | | 46º 57' 18" N | 43º 36' 39" W |
| 2 | Key Location Area 2.1 | 47º 24' 37" N | 46º 30' 52" W |
| | | 47º 24' 39" N | 46º 22' 24" W |
| | | 47º 28' 29" N | 46º 17' 59" W |
| | | 47º 29' 37" N | 46º 31' 17" W |
| | | 47º 44' 36" N | 46º 18' 16" W |
| | | 47º 55' 27" N | 46º 23' 17" W |
| | | 48º 10' 47" N | 45º 46' 35" W |
| | | 48º 33' 41" N | 45º 02' 38" W |
| | | 48º 34' 12" N | 45º 22' 52" W |
| | | 48º 38' 39" N | 45º 32' 44" W |
| | | 48º 41' 41" N | 45º 02' 19" W |
| | | 48º 42' 02" N | 45º 11' 20" W |
| 2 | Key Location Area 2.2 | 48º 17' 52" N | 44º 51' 52" W |
| | | 48º 17' 54" N | 45º 21' 41" W |
| | | 48º 26' 45" N | 45º 22' 03" W |
| | | 48º 27' 01" N | 44º 51' 46" W |
| 4 | Key Location Area 4 | 46º 14' 28" N | 46º 55' 40" W |
| | | 46º 16' 05" N | 46º 47' 15" W |
| | | 46º 19' 16" N | 46º 44' 41" W |
| | | 46º 36' 51" N | 47º 01' 52" W |
| | | 46º 44' 36" N | 46º 50' 56" W |
| | | 46º 49' 18" N | 47º 04' 02" W |
| | | 47º 04' 16" N | 46º 36' 17" W |
| | | 47º 08' 18" N | 46º 45' 59" W |

**Sources of Information**: SCR Doc. 08/22, 79; SCS Doc. 08/10, 19, 24.

FC. 2008a. Preliminary Assessment of the Risk of Significant Adverse Impact (SAI) of Fishing Activities in the NAFO Regulatory Area. *NAFO/FC Doc*. No. 16, Serial No. N5578, 11 p.

FC. 2008b. Fisheries Commission's Request for Scientific Advice on Management in 2010 and Beyond of Certain Stocks in Subareas 2, 3 and 4 and other matters**.** *NAFO/FC Doc*. No. 19, Serial No. N5581, 4 p.

Freese, L., P. J. Auster, J. Heifetz, and B. L. Wing. 1999. Effects of trawling on seafloor habitat and associated invertebrate taxa in the Gulf of Alaska. *Marine Ecology Progress Series*, **182**: 199–126.

## 2. Requests from Coastal States

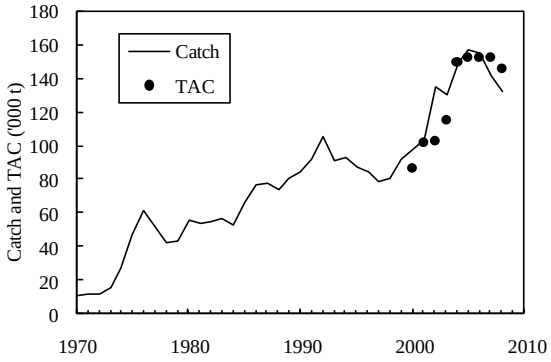
### a) Northern shrimp (*Pandalus borealis*) in Subareas 0 and 1

**Background:** The shrimp stock off West Greenland is distributed in Subarea 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. TACs have been set since 1977.

**Fishery and Catches:** The fishery is prosecuted mostly by Greenland and Canada; since 2004 the EU has had a 4 000 t quota in SA 1. Recent catches from the stock are as follows:

| | Catch ('000 t) | | TAC ('000 t) | |
|---|---|---|---|---|
| Year | NIPAG | 21A | Recc. | Agreed[2] |
| 2005 | 156.9 | 156.4 | 130 | 152.5 |
| 2006 | 154.7. | 7.4[1] | 130 | 152.4 |
| 2007 | 141.6 | 4.3[1] | 130 | 152.4 |
| 2008 | 132[1,3] | | 110 | 145.7 |

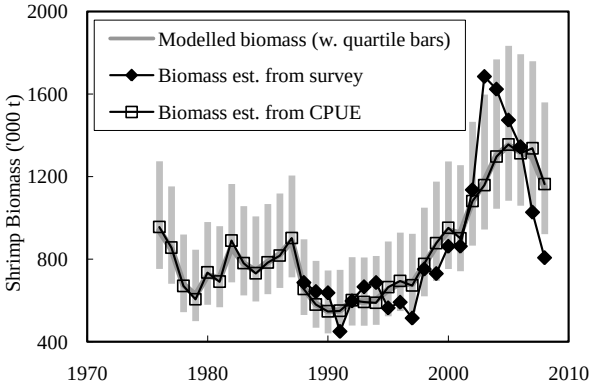
[1] Provisional.
[2] Total of TACs set by Greenland and Canada.
[3] Projected to the end of 2008.




**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.

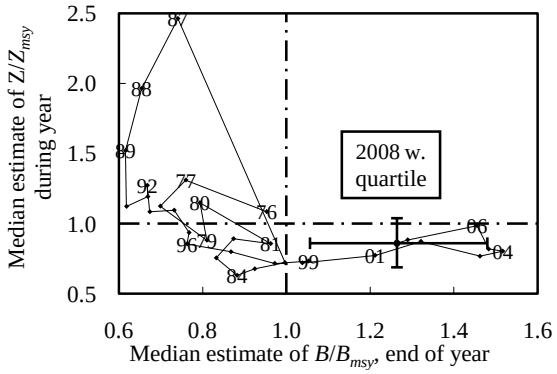
**Assessment**: An analytical assessment framework was used to describe stock dynamics in terms of biomass (*B*) and mortality (*Z*) relative to biological reference points.

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 $Z_{msy.}$ The model fitted the data well. MSY was estimated at 144 000 t/yr.

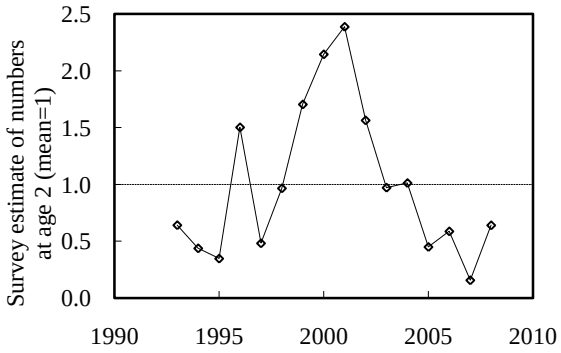



*Biomass:* Survey biomass increased to an all-time high in 2003 and has since steadily declined, in 2008 to below the series mean. CPUE was at historically high levels in 2004–2007; a slight decline in 2005–2007 has steepened in 2007–2008. A stock-dynamic model showed a maximum biomass at the start of 2005 with a steepening decline since; the probability that biomass will be below $B_{msy}$ at end 2008 with projected catches at 132 000 t was estimated at 19% and of its being below $B_{lim}$ at less than 1%.

*Mortality:* The mortality caused by fishing and cod predation (*Z*) has been stable below the upper limit reference ($Z_{msy}$) since 1995. With catches in 2008 projected at 132 000 t the risk that total mortality in 2008 exceeded $Z_{msy}$ was estimated at about 30%.




*Recruitment*: In 2007 numbers at age 2 reached a record low, at about 7% of a 2001 peak. Numbers at age 2 have increased slightly in 2008, but are still below the series mean. Prospects for recruitment to the fishable stock remain poor.




*State of the Stock:* The modelled stock biomass is estimated to have been declining since 2005, more steeply from 2007 to 2008. However, at the end of 2008 biomass is projected to be still above $B_{msy}$ and fishing mortality below $F_{msy}$. Estimated numbers of small shrimp decreased for 6 years to 2007, and although this index has increased in 2008 concerns about low future recruitment remain serious.

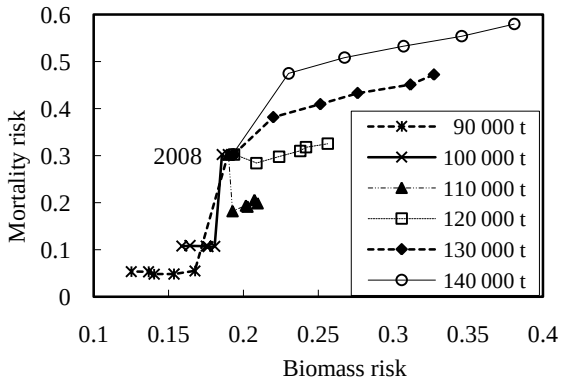
**Short-term predictions:** Estimated risks associated with each of six catch levels for 2009 are:

| 22 000 t cod | Catch option ('000 t) | | | | | |
|---|---|---|---|---|---|---|
| Risk (%) of: | 90 | 100 | 110 | 120 | 130 | 140 |
| Falling below $B_{MSY}$ end 2009 | 17 | 18 | 19 | 21 | 22 | 23 |
| Falling below $B_{lim}$ end 2009 | <1 | <1 | <1 | <1 | <1 | <1 |
| exceeding $Z_{MSY}$ during 2009 | 6 | 11 | 18 | 28 | 38 | 48 |

**Medium-term Predictions**: Medium-term predictions over 5 years are based on outputs from the assessment model, which does not fully take into account either the below-average recent year classes or the contracting area being fished. Risks of transgressing precautionary limits after 5 years for each of 6 catch levels at two possible cod stock biomass levels were estimated at:

| Catch (Kt/yr) | Prob. biomass $<B_{MSY}$ (%) | | Prob. biomass $<B_{lim}$ (%) | | Prob. mort. $>Z_{msy}$ (%) | |
|---|---|---|---|---|---|---|
| | 22 Kt | 40 Kt | 22 Kt | 40 Kt | 22 Kt | 40 Kt |
| 90 | 13 | 19 | <1 | <1 | 5 | 15 |
| 100 | 16 | 23 | <1 | <1 | 11 | 26 |
| 110 | 21 | 29 | <1 | <1 | 21 | 39 |
| 120 | 26 | 36 | <1 | <1 | 33 | 50 |
| 130 | 33 | 41 | <1 | <1 | 47 | 61 |
| 140 | 38 | 48 | <1 | <1 | 58 | 70 |

and the joint evolution of precautionary-approach risks over 5 years 2009–2013, with a 22 000 t cod stock, was predicted to be:




**Recommendations:** Catches of 120 000 t or more bear a risk of exceeding $Z_{msy}$ that is at least 28% in the short term and increases with time, and are also associated with expectations of continuing decline in stock size. Catches of 100 000 t or less bear low risks of transgressing $Z_{msy}$, even over the medium term, and are associated with expectations of growth in a stock that is estimated to be already above its level of maximum productivity ($B_{msy}$). Catches of 110 000 t are predicted to be associated with slow decline in stock size in the medium term. Catches up to 110 000 t in 2009 would not be likely to drive the stock below $B_{msy}$ and Scientific Council recommended that catches in 2009 should not exceed that level.

**Special Comments**: Both the fished area, and the area that the West Greenland research trawl survey shows to be occupied by the stock, have contracted markedly since 2001. This may increase the uncertainty attaching to predictions made by the assessment model.

The Scientific Council advice is for catch weight, correctly reported, without overpacking.

**Sources of Information**: SCR Doc. 02/158, 03/74, 04/75, 76, 08/57, 61, 62, 64, 69, 71, 72; SCS Doc. 04/12.

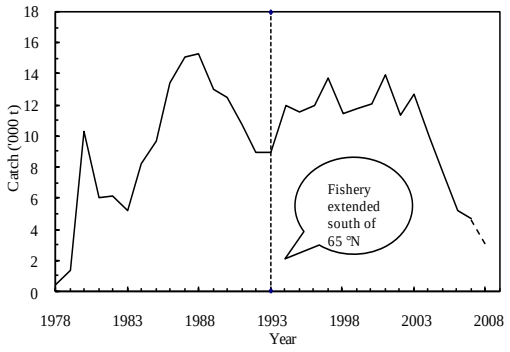
**b) Northern shrimp (*Pandalus borealis*) in Denmark Strait and off East Greenland**

**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. Until 2005 catches in the area south of 65 °N accounted for 50–60% of the total catch but since 2006 catches in the southern area only accounted for 25% of the total catch.

**Fishery and Catches**: Greenland, Norway, Faroe Islands, and Denmark participated in the fishery in 2008. Catches in the Iceland EEZ decreased from 2002–2005 and since 2006 no catches has been taken. Recent catches and recommended TACs are as follows:

| | Catch ('000 t) | | TAC ('000 t) | | |
|---|---|---|---|---|---|
| Year | NIPAG | 21A[2] | Recom-mended | Greenland EEZ | Iceland EEZ[1] |
| 2004 | 10.0 | 10.0 | 12.4 | 15.6 | 0.4 |
| 2005 | 7.7 | 7.7 | 12.4 | 12.4 | - |
| 2006 | 5.2 | 5.2 | 12.4 | 12.4 | |
| 2007 | 4.6 | 4.6 | 12.4 | 12.4 | |
| 2008 | 2.9[3] | 2.9[3] | 12.4 | 12.4 | |

[1] Fishery unregulated in Icelandic EEZ;
[2] Provisional catches;
[3] Catch till October 2008.

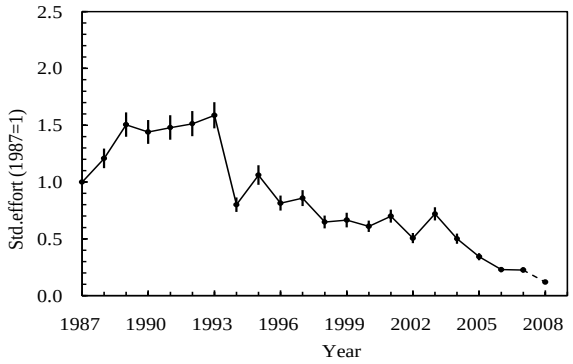



**Data:** Catch and effort data were available from trawlers of several nations. Surveys have not been conducted since 1996.

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

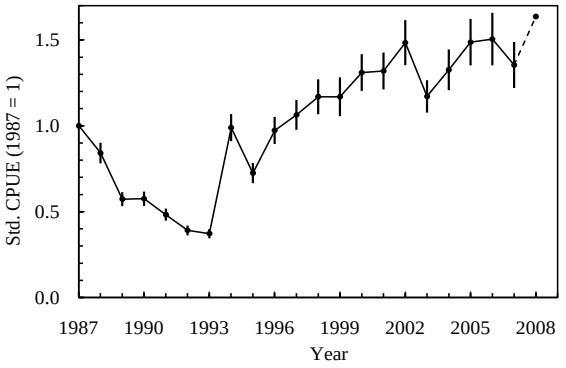
*Recruitment:* No recruitment estimates were available.

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




*Biomass:* No direct biomass estimates were available.

*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 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 recommended that catches should remain below 12 400 t.

**Special Comments**: The predominantly Greenland fleet, accounting formerly 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. 03/74, 08/72.

## V. OTHER MATTERS

### 1. Effort analysis using VMS data

Scientific Council requests that the Secretariat undertakes an analysis of the full time series of VMS data to investigate changes in the distribution of fishing effort on shrimp stocks within the NRA for presentation to the October 2009 Scientific Council meeting.

### 2. Bycatch in the shrimp fishery

NIPAG discussed and summarized bycatch in the shrimp fishery as follows (SCS Doc. 08/25):

"The Northern Shrimp fisheries in the North Atlantic have introduced sorting grids (Nordmoere grid) in the 1990s, which excludes bycatch of most fish larger than 25 cm. The grate spacing varies between 19 (Barents Sea) and 22 mm (Greenland, Div. 3LNO, Div. 3M) and has influence on the selectivity. The bycatch species occurring in the shrimp catch in the Barents Sea, Greenland and Flemish Cap are capelin, juvenile cod, haddock, redfish and Greenland halibut (SCR Doc. 08/31(Rev), 56).

In the Barents Sea area closures are introduced in periods when bycatch of juvenile commercial fish exceeds a certain number (3–10) per kg of shrimp. In the SA1, Div. 3M and Div. 3LNO vessels are required to move at least 5 nautical miles if bycatch of all regulated groundfish exceeds the specified percentage by weight of the shrimp catch.The only fishery where grids are not obligatory is the shrimp fishery is in the Norwegian Deep and Skagerrak area. The landed bycatch from the shrimp fleet not using grates is 10–20% of the total landings. The main landed bycatch species are saithe, cod, witch flounder and anglerfish (SCR Doc. 08/76).

The annual average bycatch in the Barents Sea shrimp fishery is estimated at approximately 14, 10, 4 and 5 million individuals for cod, redfish, haddock and Greenland halibut, respectively. Bycatch in the NRA shrimp fisheries was identified as being mainly capelin, American plaice, Greenland halibut, redfish, lanternfish, and Arctic eelpout."

### 3. Stock Classifications

The general principle of the FIRMS stock classification, and decisions taken by Scientific Council during the June 2008 as it applies to NAFO stocks, was explained to participants from Scientific Council and NIPAG.

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

#### a) NIPAG

This year's report of NIPAG (the NAFO/ICES *Pandalus* Assessment Group) contains the recommendations and advice required by NAFO Scientific Council and ICES ACOM. 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 owing to the requirement of the ICES ACOM to have the report of the advice for stocks under its remit for the first week of November.

#### b) WGFTFB

The Scientific Council acknowledged the consideration it received from the Chair of the ICES/FAO WGFTFB in adding a ToR to its April 2008 meeting on the issues related to fishing gear technology referred from NIPAG. The response of WGFTFB was presented to participants of Scientific Council and NIPAG at this meeting (see Section II above).

### 5. Meeting of October 2009

The Scientific Council agreed that the dates and venue of the next Scientific Council /NIPAG meeting will be held from 21–29 October 2009 at the NAFO Headquarters, Dartmouth, Nova Scotia, Canada.

**6. Meeting of October/November 2010**

The dates and venue of the Scientific Council/NIPAG meeting will be decided at the 2009 Meeting. Provisional dates and venue are 20–28 October 2010 at the ICES Headquarters, Copenhagen, Denmark.

**7. Topics for Future Special Sessions**

Scientific Council discussed various possibilities for future special sessions in 2010 and again decided that the special session should take the form of a workshop. There was continued strong support for a workshop on new assessments methods, and that methods applicable to shrimp should also be included. Scientific Council requested that the Scientific Council Coordinator provide, at the June 2009 Scientific Council meeting, a detailed report on assessment methods used by NAFO over the past ten years. Past and present Designated Experts should be consulted as appropriate.

To assist in achieving the objective of the above, Scientific Council endorses the invitation from ICES for Dr Anthony Thompson, Scientific Council Coordinator, to participle in the ICES roundfish benchmark workshop to be held at ICES HQ, Copenhagen, Denmark, on 16–23 January 2009. A report on this meeting will be presented at the June 2009 Scientific Council meeting.

**8. Other Business**

**a) Report of WGEAFM, October 2008**

The Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) met by correspondence to prepare information to address a September 2008 Fisheries Commission request (FC Doc. 08/19, item 9a) required as soon as possible in 2008. The report (SCS Doc. 08/24) which focused on the distribution of corals within the NRA, was presented to the Scientific Council and formed the basis of the response to the Fisheries Commission request 9a. The full response is given above under Scientific Council agenda item IV.1.c.

The Scientific Council acknowledged the considerable effort of WGEAFM in meeting this deadline as well as playing an important role in advancing NAFOs position to meet commitments related to UNGA Resolution 61/105 on Vulnerable Marine Ecosystems.

## VI. ADOPTION OF SCIENTIFIC COUNCIL AND NIPAG REPORTS

The Council at its session on 30 October 2008 considered and adopted Sections III.1–4 of the "Report of the NAFO/ICES *Pandalus* Assessment Group" (SCS Doc. 08/25, ICES CM 2008/ACOM:11). The Council then considered and adopted its own report of the 22–30 October 2008 meeting.

## VII. ADJOURNMENT

The Chair thanked the participants for their hard work and contribution to the success of this meeting, and welcomed the peer review and constructive comments received in formulating the scientific advice. The Chair thanked the Scientific Council Coordinator, Anthony Thompson and Barb Marshall (NAFO Secretariat) for their excellent support during the meeting. The Chair then thanked ICES for supporting and hosting this Scientific Council meeting and the NIPAG meeting, in particular Barbara Schoute and Helle Gjeding Jørgensen . The chair noted that this was his last SC/NIPAG meeting as his term of election as SC chair would end at the conclusion of the Annual NAFO meeting in September 2009. He was grateful for the rewarding experience he gained from participating in the NIPAG meetings and was confident of continued success of the partnership fostered between NAFO and ICES on assessments of *Pandalus* stocks in the North Atlantic. All participants were then wished a safe journey home and the meeting was adjourned at 1200 hours.

## APPENDIX 1 - NAFO ASSESSED STOCKS (BY NIPAG)

Co-Chairs: Michael Kingsley (NAFO Stocks) and Michaela Aschan (ICES Stocks) Rapporteurs: Various

### 1. Northern Shrimp (*Pandalus borealis*) on Flemish Cap (NAFO Div. 3M) – NAFO Assessed

(SCR Doc. 04/64, 74, 08/65, 67, 68, 77; SCS Doc. 04/12)

#### 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 2008.

Catches increased from about 26 000 t in 1993 to 48 000 t in 1996, declined to 26 000 t in 1997 then increased gradually to a peak of 64 000 t in 2003 (Fig. 1.1). The catch declined in 2005 and 2006 to 27 000 t and 18 000 t respectively. The catches increase to 20 000 t. in 2007 and provisional information to 1 October 2008 indicates removals of about 7 805 t, similar to those recorded last year up to this date. Supplementary information from the fishery suggests that economic considerations (price of fuel and market prices for shrimp) may be affecting participation.

#### b) Input Data

NIPAG expressed its concern about suspected misreporting of 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:

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | 30 000 | 30 000 | 45 000 | 45 000 | 45 000 | 45 000 | 48 000 | 48 000 | (3) | (4) |
| STATLANT 21A | 50 471 | 54 830 | 48 836 | 62 671 | 45 842 | 27 651[1] | 14 422[1] | 17 600[1] | | |
| NIPAG | 52 867 | 53 389 | 50 214 | 63 970 | 45 757 | 27 479 | 18 162 | 20 267 | 7 805[2] | |

[1] Provisional.
[2] Preliminary to 1 October 2008.
(3) SC recommended that exploitation level for 2008 and 2009 should not exceed 2005 and 2006 levels.
(4) SC recommended that a TAC for 2009 should not exceed the 2005 and 2006 exploitation levels.

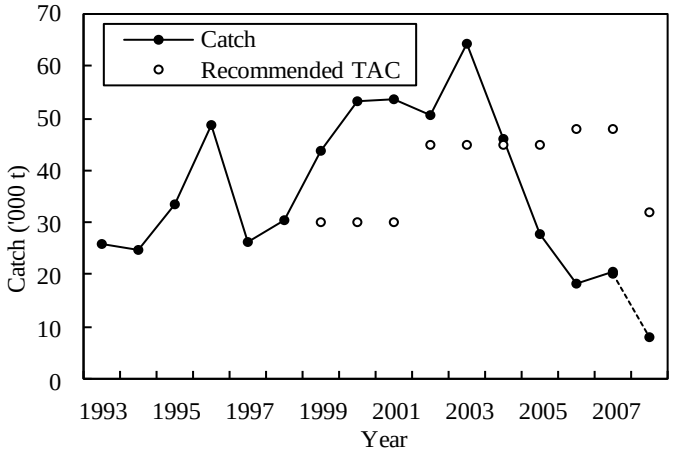



Fig. 1.1. Shrimp in Div. 3M: catches (2008 preliminary partial year's catch). Preliminary information is shown by the dashed line.

***i) Commercial fishery data***

**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 Div. 3M was constructed. In recent years there have been concerns that suspected misreporting of some catches from 2005 to the present (Div. 3L catches being reported as Div. 3M catches), was 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 from 2005 to 2008 where the catches were mixed up between Div. 3M and 3L were eliminated from the database. This way the CPUE was corrected and a standardized CPUE series was produced. CPUE decreased from 1993 to 1994, and was at low levels through 1997. From 1998 it gradually increased through 2006. In 2007 and 2008 the standardized CPUE declined, but owing to the scanty observations in 2008 (only Estonian data were available) there is considerable uncertainty regarding the 2008 point (Fig. 1.2). Effort levels have recently been low and NIPAG was concerned that the CPUE may not reflect the stock status in the same way as at higher exploitation rates.

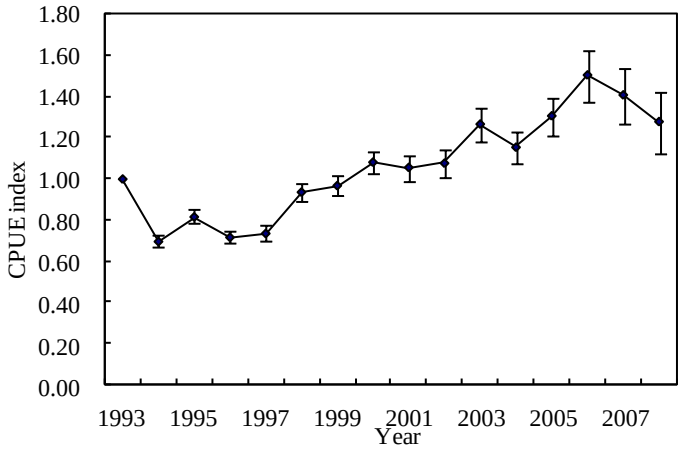



Fig. 1.2. Shrimp Div. 3M: Standardized CPUE of shrimp on Flemish Cap, 1993–2008.

**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 2006 (Fig. 1.3). In 2007 this increasing trend is interrupted and the lower value estimated in 2008 appears to confirm the decline of the spawning stock.

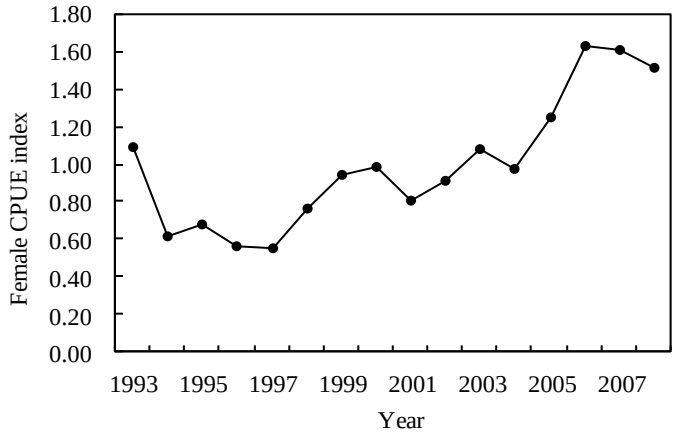



Fig. 1.3. Shrimp Div. 3M: Standardized Female CPUE of shrimp on Flemish Cap, 1993–2008. The series was standardized to the mean of the series.

This change of the trend may however be questionable. For want of samples from the commercial fishery since 2006, length distributions from the EU survey have been used instead. Given differences in gear, fishing methods and targeting, NIPAG was concerned that survey samples might not be a satisfactory substitute for fishery samples for this purpose, and recommended that the length distributions of the two kinds of sample should be compared for years when both were obtained. Also, as was noted for the standardized CPUE above, the scanty observations can affect the values estimated in 2008.

**Biological data**. The age composition was assessed from commercial samples obtained from Iceland from 2003 to 2005 and from Canada, Greenland, Russia and Estonia in previous years. In recent years the few samples obtained from Spain for 2005 and 2006 and Ukraine in 2006 have been insufficient to assess the age distribution so the length distribution from the EU survey was used. Number caught per hour for each age-class was calculated for each year by applying a weight/age relationship and age proportions in the catches on 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 considered important in the fishery although generally fewer. 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. In 2008 the abundance of this year-class declined drastically. The number of 2-year-olds is about average in 2005, below average in 2006 and very low in 2007 and 2008 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. Again the uncertainty about the full usefulness of the length distributions estimated from EU surveys as substitute for fishery samples means that these results ought to be interpreted with caution. NIPAG recommended the comparison of the age compositions from the two kinds of sample for the years when both were available.

Numbers caught per hour at age in the commercial fishery:

| Age group | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | | 6 | | | 23 | 665 | | | | | | 53 |
| 2 | 2167 | 3330 | 2655 | 1106 | 6906 | 4571 | 8610 | 12495 | 5499 | 1680 | 874 | 901 | 4107 |
| 3 | 17205 | 19480 | 15803 | 23135 | 9251 | 38565 | 9503 | 29354 | 35757 | 8677 | 11229 | 26381 | 20891 |
| 4 | 17853 | 22790 | 18278 | 26907 | 29607 | 13125 | 37983 | 10506 | 31200 | 56273 | 35582 | 35186 | 26430 |
| 5 | 3507 | 7269 | 14705 | 15910 | 15626 | 15905 | 14816 | 22211 | 14857 | 34802 | 37395 | 23644 | 17157 |
| 6 | 710 | 2703 | 5294 | 3338 | 4423 | 3249 | 5833 | 4325 | 2917 | 15085 | 17220 | 1658 | 5231 |
| 7 | 61 | 303 | 61 | 162 | 598 | 128 | 86 | 24 | 480 | 1872 | 3761 | 0 | 580 |
| **Total** | **41504** | **55876** | **56802** | **70556** | **66410** | **75566** | **77495** | **78915** | **90711** | **118390** | **106062** | **87770** | **74450** |

### *ii) Research survey data*

**EU bottom trawl surveys.** Stratified random surveys have been conducted on Flemish Cap in July from 1988 to 2008. A new vessel was introduced in 2003, although it continued to use the trawl employed since 1988. In addition, there were differences in cod-end mesh sizes utilized in the 1994 and 1998 surveys that have likely affected the estimates of total survey biomass. Nevertheless, for this assessment, the series prior to 2003 were converted to be comparable with data obtained with the new vessel, using the methods accepted by STACFIS in 2004 (NAFO SC 2004 Rep., SCR Doc. 04/77). The revised index of female shrimp biomass shows 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 without trend (Fig. 1.4). However the assessment group observed that the continued decline in $L_{50}$ (sex change) that has been observed would cause females to be a steadily increasing proportion of the total biomass and would thus prop up the female biomass index. Furthermore, the 2008 survey index was the lowest since 1998.

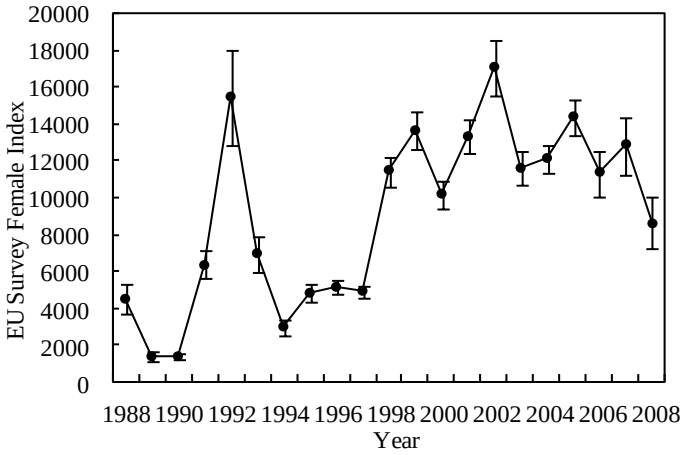



Fig. 1.4. Shrimp in Div. 3M: female biomass index from EU trawl surveys, 1988-2008.

### *iii) Recruitment indices*

**Commercial fishery**. Although the commercial fishery is conducted with larger mesh size than the survey, two-year-olds are frequently detected in the fishery. An index of two-year-old shrimp from 1996 to 2008, based on standardized number per hour correlated well ($R^2$= 0.55, 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 (see table above).

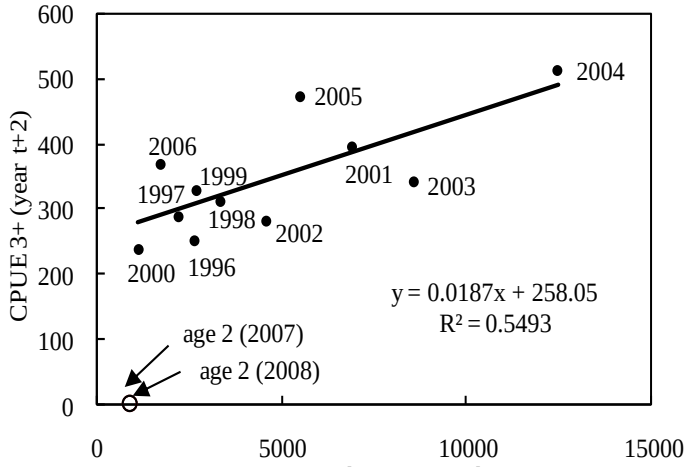



Fig. 1.5. Shrimp in Div. 3M: regression between CPUE of age 2 (year t) shrimp from samples from the commercial fisheries and CPUE of age 3+ (year t+2), 2 years later.

**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 also attached to the net, intended to provide an index of shrimp smaller than those typically retained by the survey cod-end. Although the relationship between the number of age 2 from the juvenile bag and the abundance of age 3+ one year later seems to show a good relationship ($R^2$ = 0.57), this relationship disappears if we do not consider the extreme data corresponding to age 2 in year 2004, showing the lack of robustness in the relationship. Furthermore neither index shows a good and robust relationship with the 3+ survey index either 1, 2 or 3 years later. This may be because there are only limited data points for a valid comparison and the probable low catchability of the juvenile bag in the first years of the series (2001–2003), due to technical problems. The recruitment indices for both 2005 and 2006 are low in the main gear as well as in the juvenile bag (Fig. 1.6). The EU survey agrees with the commercial fishery recruitment indices in showing an exceptionally large 2002 year-class and very weak 2003–2006 year-classes.

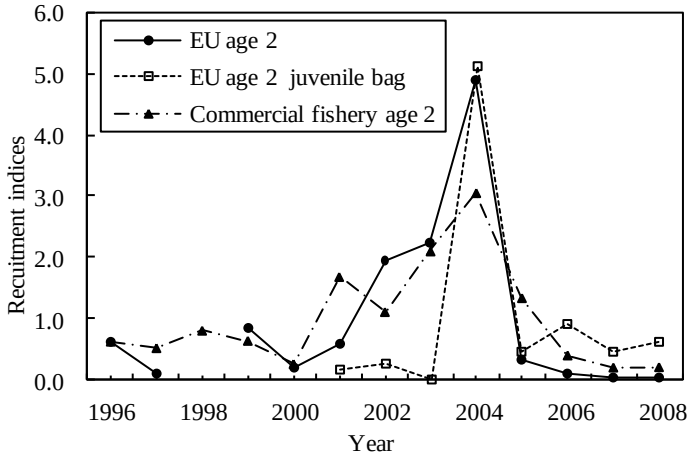



Fig. 1.6. Shrimp in Div. 3M: abundance indices at age 2 from the EU survey. Each series was standardized to its mean.

***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. The exploitation index was high in 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 2008 was the lowest in the historical series continuing a probable decreasing trend initiated in 2004. This trend appears to be mostly due to decreasing catches.

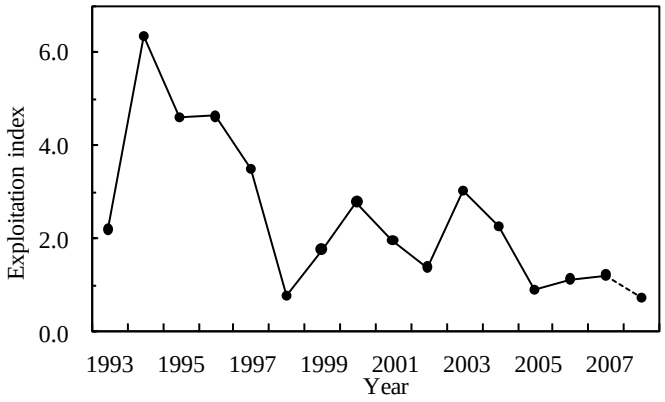



Fig. 1.7. Shrimp in Div. 3M: exploitation rates as derived by catch divided by the EU survey biomass index of the same year.

***v) Other studies***

An analysis of catch rate of Estonian shrimp vessels in Div. 3M and Div. 3L in 2007 and 2008 was presented (SCR Doc. 08/77). The author defined and compared four CPUE groups. Observed catch rates in Div. 3M appeared to be higher two days before and after fishing in Div. 3L (group 3) than on other days of fishing in Div. 3M (groups 1 and 2). Two possible reasons were investigated: seasonality effect and use of single and double trawls. The fourth group, hauls in Div. 3L, was not compared with any other group.

**c) Assessment Results**

The problems in recent years about suspected misreporting and its effect on various indices derived from the commercial fishery continued this year and were solved with the same criterion as in recent years. Thus several indices derived from the number per hour could be used in the assessment of this year.

*Commercial CPUE indices.* Indices for both biomass and female biomass from the commercial fishery showed increased trends from 1996 to 2006. Although still high, both indexes have decreased since 2006.

*Biomass.* The survey index of female biomass increased from 1997 to 1998 and fluctuated without trend between 1998 and 2007, but the 2008 survey index was the lowest since 1998.

*Recruitment.* The 2002 year-class was strong, but all later year-classes have been much weaker.

*Exploitation rate.* The exploitation rate projected for 2008 was the lowest in the historical series continuing a 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 showing signs of decline, even at present low catch levels. There are expectations of continued poor recruitment to the fishable stock, which may affect the 2009 fishery.

**d) Precautionary Approach**

NIPAG noted that the Scientific Council Study Group on Limit Reference Points has 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 $B_{lim}$".

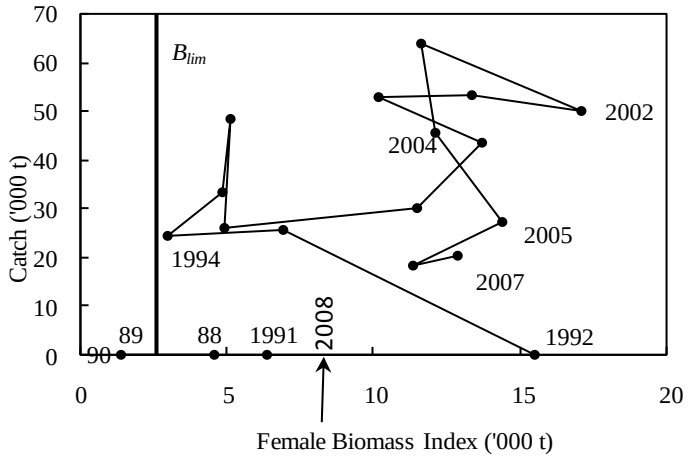



Fig. 1.8. Shrimp in Div. 3M: catch plotted against female biomass index from EU survey. Line denoting $B_{lim}$ is drawn where biomass is 85% lower than the maximum point in 2002. The preliminary female biomass index for 2008 is estimated at 7 805 t to 1 October 2008 and is shown by the arrow on the x-axis.

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 in Div. 3M provides an index of female shrimp biomass from 1988 to 2008 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 $B_{lim}$ = 2600 t. The female biomass index was below this value in only 1989 and 1990, before the fishery. In 2007 and 2008 it was about 25% and 51% 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).

**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.*
- *age composition by sex in the fishery calculated from length distributions in the EU survey and from commercial samples should be compared for years when both were obtained.*

## 2. Northern Shrimp (*Pandalus borealis*) in Div. 3LNO – NAFO Assessed

(SCR Doc. 08/58, 65, 77)

### 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 6000 t TAC and fishing restricted to Div. 3L. Annual TACs were raised to 13 000 t for 2003–2005, to 22 000 t for 2006–2007 fisheries and then to 25 000 t for 2008 resulting in a total catch of 22 932 t up to October 2008 (Fig. 2.1). For 2009 the TAC has been increased to 30 000 t.

Since this stock came under TAC regulation, Canada has been allocated 83% of the TAC. This allocation is split between a small-vessel (less than 500 GT and less than 65 ft) and a large-vessel fleet. By October 2008, the small- and large-vessel fleets had taken 14 632 t and 5135 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 Islands and Greenland) set an autonomous annual TAC of 1344 t. This autonomous TAC was raised to 2274 t in 2006 and was maintained at this level through to 2008.

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:

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| TAC as set by FC | 6 000 | 6 000 | 6 000 | 13 000[1] | 13 000[1] | 13 000[1] | 22 000[1] | 22 000[1] | 25 000[1] | 30 000 |
| STATLANT 21A | 5 040 | 5 647 | 5 894 | 11 979 | 12 767 | 14 281 | 22 166[2] | 20 668[2] | 22 932[2] | |
| NIPAG | 4 711 | 10 697[3] | 6 994[3] | 13 200 | 13 461 | 14 387 | 23 832[3] | 23 856[3] | 22 932 | |

[1] DFG did not agree to the quotas of 144 t (2003–2005), 245 t (2006–2007) or 278 t (2008), and set their own quota of 1 344 t (2003–2005) and 2 274 t (2006–2008). The increase is not included here.
[2] Provisional catches.
[3] Reliable catch reports were not available for all countries, and therefore estimates were made using other sources (Canadian surveillance, observer datasets, STACFIS estimation *etc.*).

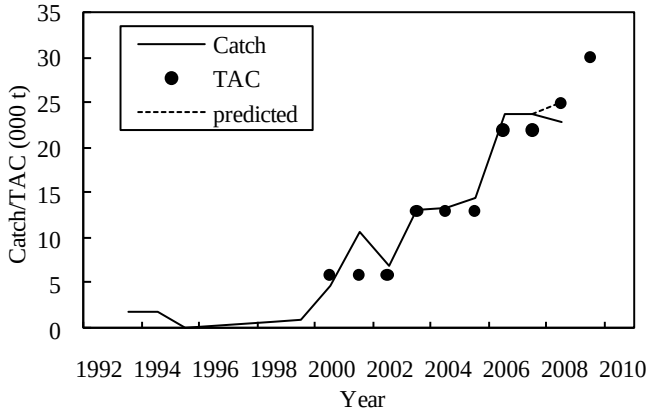



Fig. 2.1. Shrimp in Div. 3LNO: catches (to October 2008) and TAC as set by Fisheries Commission.

**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 stable since 2004 near the long term mean (Fig. 2.2). There was insufficient data to estimate a standardized CPUE index for the 2008 Canadian small-vessel (≤500 t) fleet.

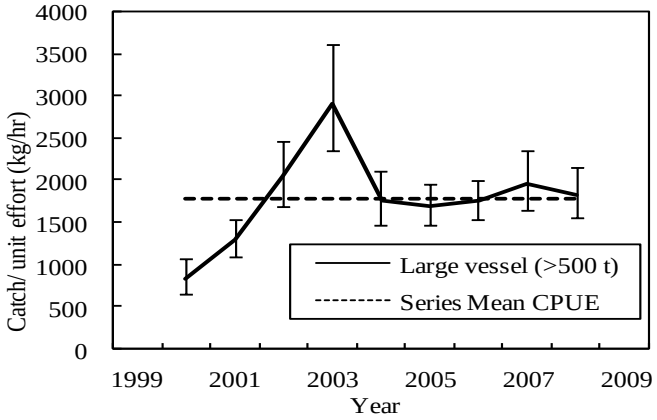



Fig. 2.2. Shrimp in Div. 3LNO: Standardized CPUE for the Canadian large-vessel (>500 t) fleet fishing shrimp in Div. 3L within the Canadian EEZ.

Data were available from other nations fishing in the NRA (Estonia, Greenland, Spain and Norway) but 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 and Spanish observer datasets. In 2007, the male portion of the fishery was dominated by the 2003 and 2004 year classes. The female portion was still well represented. Length frequency data for 2008 were available from Canadian catches only. The 2008 Canadian fishery exploited a wide range of year classes with the male portion of the fishery dominated by 2004 and 2005 year classes. The female portion was well represented in the 2008 fishery.

***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 (1999–2008) and autumn (1996–2007). The autumn survey in 2004 was incomplete and therefore of limited use for the assessment.

In the past, Canadian stock size parameters were determined without corrections for research survey tow durations, which were all assumed equal. In 2008, correct durations were used to revise all index estimates throughout the survey series. For this reason, present indices may not be the same as past values.

**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 to 550 m. There was a significant increase in autumn shrimp biomass indices between 1996 and 2001 and this index has since remained at a high level. The autumn 2007 index was 275 000 t, the highest in the autumn time series. The spring biomass indices increased from 1999 to 2003, decreased

in 2004 and then increased to 2007 with a decrease in 2008. The spring 2008 biomass index was 232 000 t, the second highest in the spring series (Fig. 2.3). Confidence intervals from the spring surveys are usually broader than from the autumn surveys.

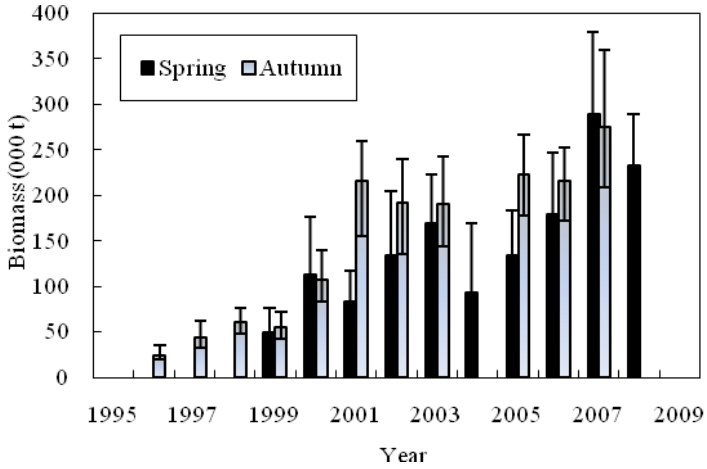



Fig. 2.3. Shrimp in Div. 3LNO: biomass index estimates from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

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 and 2008 (149 000 t); Canadian survey biomass estimates in Div. 3L both inside and outside the NRA increased between 1996 and 2001 and have since fluctuated at a high level. The reason for differences between the Spanish and Canadian 3L survey biomass and abundance indices remains unknown. Spanish survey biomass estimates for Div. 3NO in the NRA, have shown a gradual decline from 3000 t in 2004 to 100 t in 2008; Canadian survey biomass estimates in Div. 3NO both inside and outside the NRA fluctuated between 700 and 3000 t over this period.

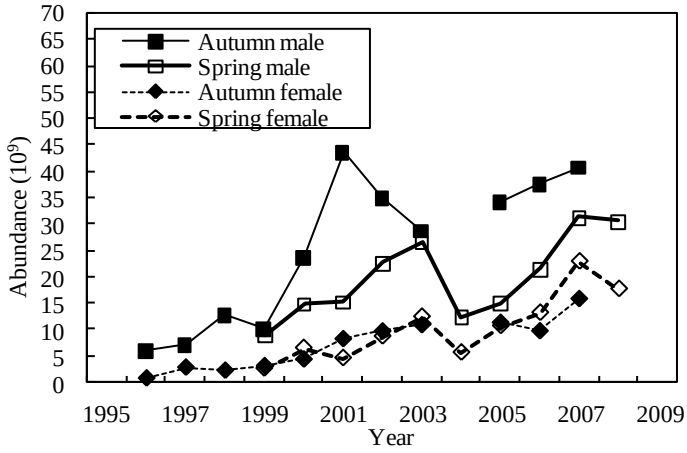



Figure 2.4. Abundance indices of male and female shrimp within Div. 3LNO as estimated from Canadian multi-species survey data.

**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. 2.4).

Shrimp aged 3, 4 and 5 (2004, 2003 and 2002 year-classes) were well represented in the male component of the spring 2007 survey length frequencies with carapace-length modes at 15.66, 17.96 and 20.29 mm respectively. The male component of the autumn 2007 survey length frequencies was dominated by shrimp aged 2, 3 and 4 (2005, 2004 and 2003 year-classes) with modes at 14.64, 17.33 and 20.15 mm, respectively. Shrimp aged 3 and 4 (2005 and 2004 year-classes) dominated the spring 2008 survey with modes at 15.66 and 17.96 mm respectively (Fig. 2.5). A broad mode of females was present in all surveys indicating the presence of more than one year class.

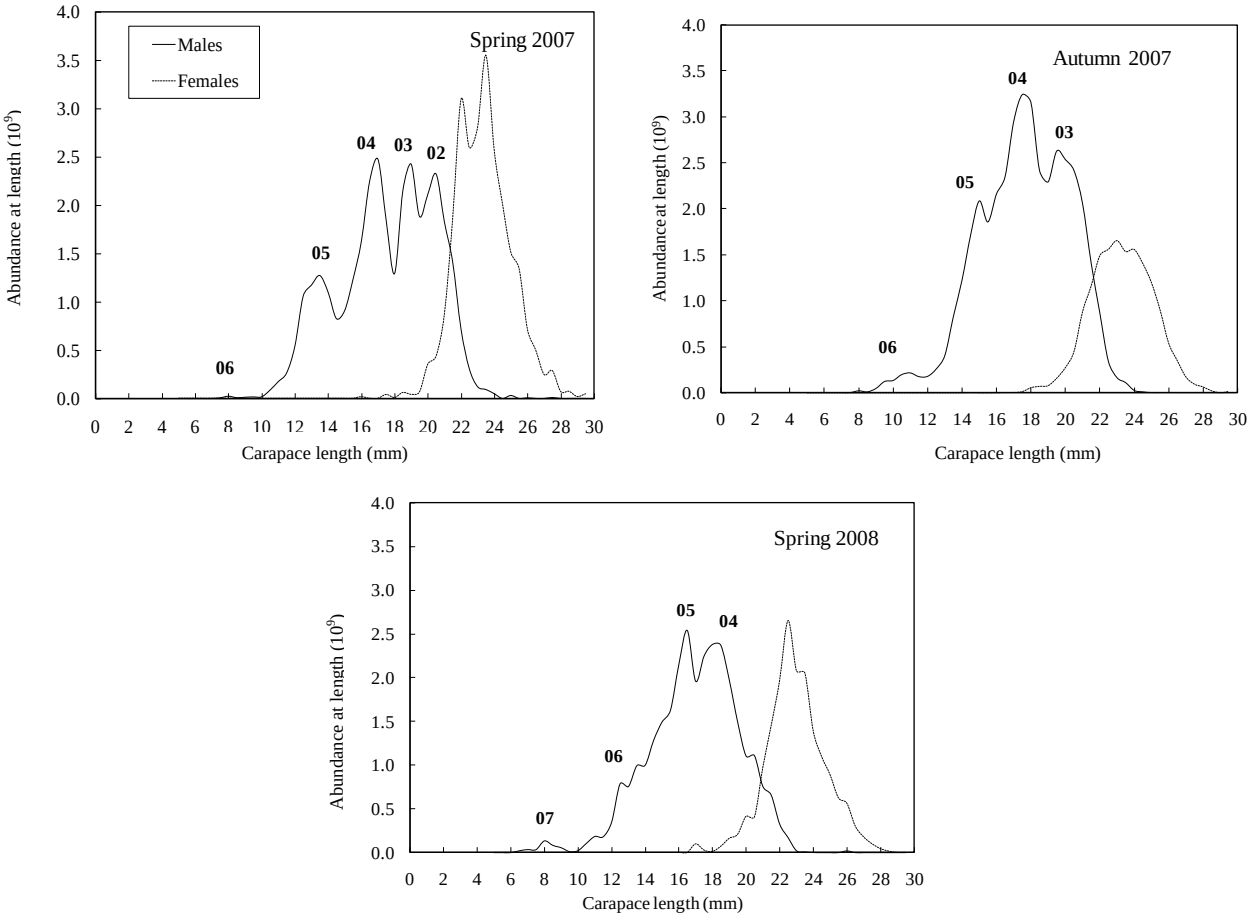



Fig. 2.5. Shrimp in Div. 3LNO: abundance at length for northern shrimp estimated from Canadian multi-species survey data. Numbers within charts denote year-classes.

**Female Biomass (SSB)**. The autumn female (transitionals + females) biomass index increased after 1999 to reach its highest level in 2007. The spring survey biomass index increased from 1999 to its highest level in 2007 and then decreased to the second highest level in 2008 (Fig. 2.6).

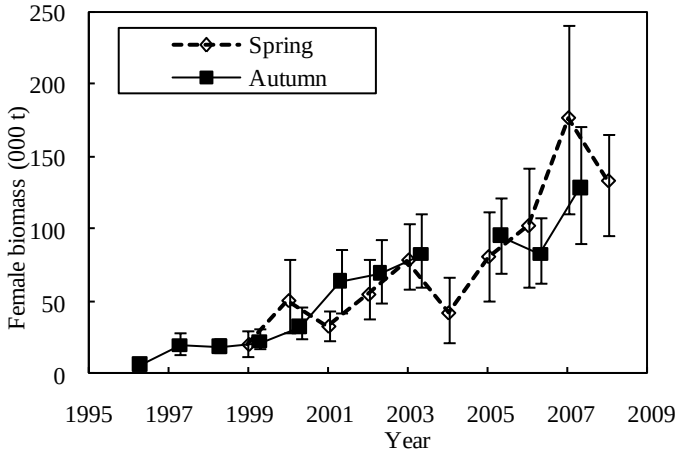



Fig. 2.6. Shrimp in Div. 3LNO: Female biomass estimates from Canadian spring and autumn multi-species surveys (with 95% confidence intervals).

**Recruitment index**. The recruitment indices were based upon modal analysis of length frequency data from Canadian spring 1999–2008 and autumn 1996–2007 survey data. Recruitment indices, both from spring and autumn surveys, have been fluctuating in the recent past but the 2004 and 2005 year classes have been particularly strong. The 2006 year class was near average, based upon the spring 2008 survey (Fig. 2.7).

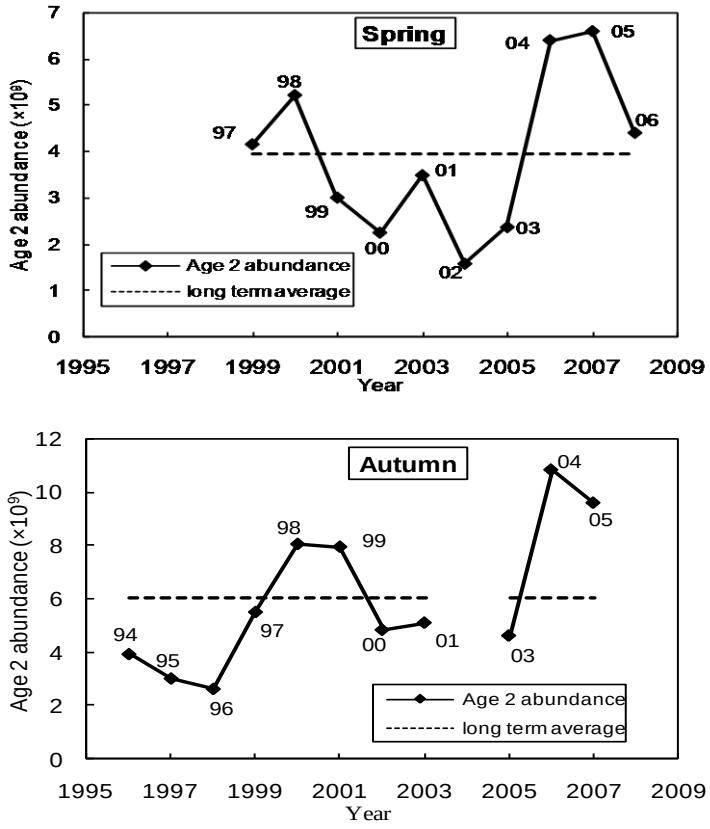



Fig 2.7. Shrimp in Div. 3LNO: Recruitment indices (age 2 abundance) derived using modal analysis of Canadian spring and autumn bottom trawl survey (1996–2008) data.

**Fishable biomass and exploitation**. General trends from the Canadian spring and autumn survey fishable biomass indices (shrimp >17 mm carapace length) are similar to trends in the female spawning stock biomass from the same surveys (Fig. 2.8). 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 - 1999, but increased to 11–13.5% in 2000–2001, the first two years of TAC regulation. Even though catches increased to 24 000 t by 2006 and are projected to be 25 000 t in 2008, the exploitation index remained less than 14% (Fig. 2.9).

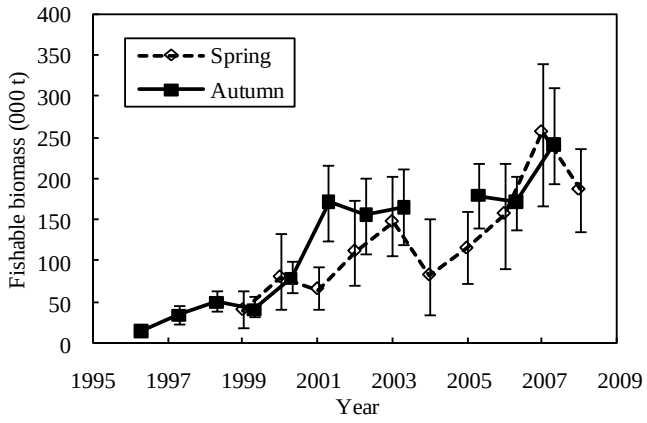



Fig. 2.8. Shrimp in Div. 3LNO: fishable biomass index. Bars indicate 95% confidence limits.

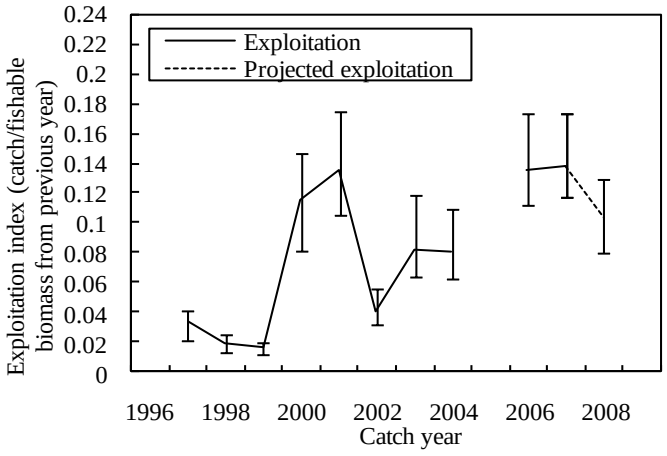



Fig. 2.9. Shrimp in Div. 3LNO: exploitation rates calculated as year's catch divided by the previous year's autumn fishable biomass index. Bars indicate 95% confidence limits.

**c) Assessment Results**

*Recruitment.* The 2005 year-class was particularly strong at age 2 in both the spring and autumn surveys. The 2006 year-class was slightly above average in the 2008 spring survey.

*Biomass.* Indices of biomass have been increasing since 1999 and are at or near the highest observed levels.

*Exploitation*. The index of exploitation has remained below 14%.

*State of the Stock*. Biomass indices have been increasing since 1999 and are at or near the highest observed levels. The stock appears to be well represented by a broad range of size groups and recruitment prospects continue to be above average.

**d) 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 Div. 3LNO (SCS Doc. 04/12). 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. 2.10).

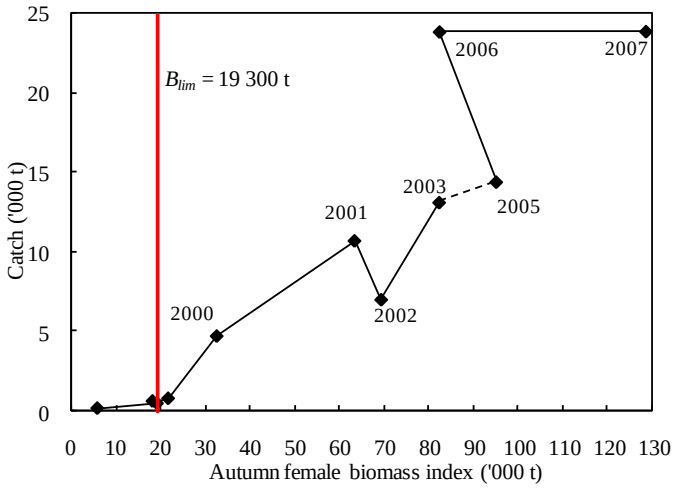



Fig. 2.10. Shrimp in Div. 3LNO: Catch against female biomass index from Canadian autumn survey. Line denoting $B_{lim}$ is drawn where female biomass is 85% lower than the maximum point in 2007.

**e) Other Studies**

The abundance of 12–17 mm carapace length males was explored as a potential index of recruitment. Recruitment had previously been recorded as the abundance of age-2 males from modal analysis. However, a new method was proposed because shrimp recruit to the fishery by size and not by age. The recruiting animals probably consist of age 2 and 3 males. When autumn fishable biomass was lagged by one year and regressed against the new index, the predictive power increased for a one year forecast.

This work resulted in a recommendation that shrimp assessment biologists work together to standardize length-based methods of predicting recruitment to the fishable stock.

An analysis of catch rate data from Estonian shrimp vessels in Div. 3M and Div. 3L in 2007 and 2008 was presented (SCR Doc. 08/77). The author defines and compares four CPUE groups. In order to analyze the observed catch rates of Div. 3M being higher two days before and after fishing in Div. 3L (group 3) compared with other days when fishing in 3M (groups 1 and 2) two reasons are investigated: seasonality effect and use of single and double trawls. There appeared to be preliminary indications that reported catch rates were higher among the group 3 hauls than among group 2. The fourth group, hauls in Div. 3L, were not compared.

**e) Research Recommendations**

NIPAG **recommended** 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 2009.*

- *collaborative efforts should be conducted to standardize a means of predicting recruitment to the fishable stock.*

### 3. Northern shrimp (*Pandalus borealis*) in Subareas 0 and 1 – NAFO Assessed

(SCR Doc. 02/158, 03/74, 04/75, 76, 08/57, 61, 62, 64, 69, 71, 78; 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 '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. The Greenland fishery exploits the stock in Subarea 1 (Div. 1A–1F). 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 in Greenland, and 40 mm in Canada. Sorting grids to reduce bycatch of fish are required in both of the Greenland fleets and in the Canadian fleet. Discarding of shrimp is prohibited.

The annual TAC advised for the entire stock for 2004–2007 was 130 000 t, reduced for 2008 to 110 000 t. Greenland set a TAC for Subarea 1 for 2007 of 134 000 t, of which 74 100 t was allocated to the offshore fleet, 55 900 t to the inshore and 4000 t to EU vessels; these allocations were reduced for 2008 to 70 281, 53 019 and 4 000 t. Canada set TACs for SFA1 of 18 417 t for both 2007 and 2008.

The comprehensive table of recent catches that had been presented in 2007 was updated (SCR Doc. 08/61), significantly with improved STATLANT data for Greenland for 2004 and 2005.

Total 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 near 155 000 t in 2005 and 2006. Total catch for 2007 was given by Greenland logbooks and DFO CAQR combined as 141 600 t; the total TAC was not taken largely because TAC in the Canadian zone exceeded the catch by over 16 000 t. Projected catch for 2008 was 131 700 t.

Table 3.1. Recent catches, projected catches for 2008 and recommended and enacted TACs (t) for northern shrimp in Div. 0A east of 60° 30' W and Subarea 1 are as follows:

| | 1999[1] | 2000[1] | 2001[1] | 2002[1] | 2003[1] | 2004 | 2005 | 2006 | 2007 | 2008[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | 65 000 | 65 000 | 85 000 | 85 000 | 100 000 | 130 000 | 130 000 | 130 000 | 130 000 | 110 000 |
| Actual TAC | 82 850 | 87 025 | 102 300 | 103 190 | 115 167 | 149 519 | 152 452 | 152 380 | 152 417 | 145 717 |
| SA 1 (NIPAG) | 90 152 | 96 378 | 99 301 | 128 925 | 123 036 | 142 326 | 149 978 | 150 533 | 139 631 | *126 221* |
| SA 0A (NIPAG) | 2 046 | 1 590 | 3 625 | 6 247 | 7 137 | 7 021 | 6 921 | 4 127 | 1 945 | *5 430* |
| STATLANT (SA 1) | 73 990 | 79 120 | 81 517 | 103 645 | 78 436 | 142 326 | 149 978 | 3 668[3] | 3 394[3] | |
| STATLANT (Div. 0A ) | 2 093 | 659 | 2 958 | 6 053 | 2 170 | 6 861 | 6 410 | 3 788[3] | 1 878[3] | |
| TOTAL SA1-Div.0A (NIPAG) | 92 198 | 97 968 | 102 926 | 135 172 | 130 173 | 149 347 | 156 899 | 154 660 | 141 576 | *131 651* |

[1] Catches before 2004 corrected for under-reporting.
[2] Catches projected to year-end—SA1 based on catches on the first 6 months and Div. 0A at mean of reports for previous 5 yr.
[3] Provisional.

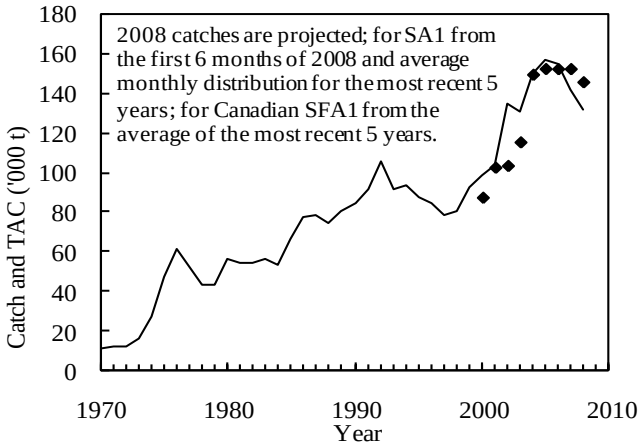



Fig. 3.1. Shrimp in Subareas 0 and 1: actual TACs and total catches (2008 projected to the end of the year; all values represent live (catch) weight). TACs only illustrated since 2000.

Until 1988 the fishing grounds in Div. 1B were the most important. The offshore fishery subsequently expanded southward, and after 1990 catches in Div. 1CD, taken together, began to exceed those in Div. 1B. Catch and effort in Div. 1E–F have recently decreased, and in the first six months of 2008 effort in Div. 1F is virtually zero. The Canadian catch in SFA1 was stable at 6 000–7 000 t in 2002–2005, about 4–5% of the total catch, but in 2006 the catch in SFA1 was only 4 100 t and in 2007 less than 2 000 t.

**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. 08/57, 62). In recent years large changes in fishery performance have occurred in relation both to the distribution of the fishery and to changes in fishing power (*e.g.* larger vessels have been allowed in coastal areas; the coastal fleet has been fishing intensively in areas outside Disko Bay; the offshore fleet now commonly uses double trawls.) Furthermore, a change in legislation effective since 2004 and requiring logbooks to record catch live weight in place of a previous practice of under-reporting would, by increasing the catch weights recorded, have increased apparent CPUEs since 2004; this aberration in the CPUE data needed to be corrected. CPUE series generated by including different sets of statistical areas and different sets of vessels in the analysis for each fleet, and different treatments of double- and single-trawl data, were compared in order to judge the effects of these choices (SCR Doc. 08/62). A standardized CPUE series (Fig 3.2) and an index of how widely the fishery is distributed (Fig. 3.3) were generated.

The all-fleet 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 plateau in 2004–2007 at about twice its 1997 value (Fig. 3.2). In 2008 the CPUE has decreased from this level.

The CPUE indices from the Greenland coastal and the Greenland offshore fleets have remained closely in step from 1988 to 2004 (Fig. 3.2), diverging from each other slightly more in the most recent years. 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 has also increased between the 1990s and the present.

The fishery area for this stock has been contracting in recent years, and NIPAG was therefore concerned that any relationship between CPUE and stock biomass would be affected, and in particular that relative to earlier years biomass might be overestimated.

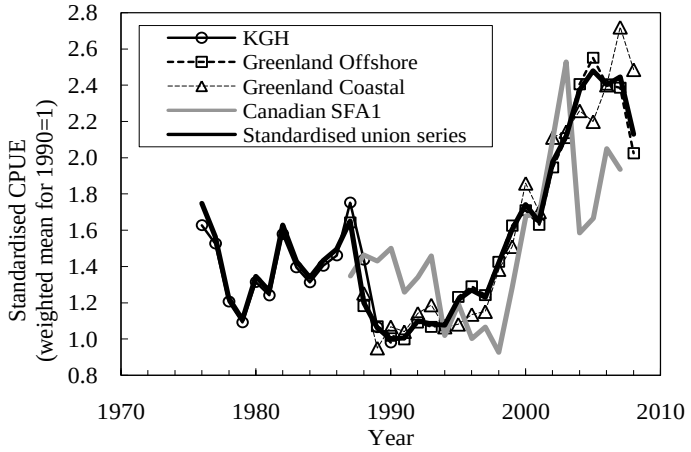



Fig. 3.2. Shrimp in Subarea 1 and Canadian SFA 1: standardized CPUE index series.

The distribution of catch and effort among NAFO Divisions was summarized using Simpson's diversity index to calculate an 'effective' number of Divisions being fished (Fig. 3.3). This index shows how widely the fishery is distributed over the possible grounds.

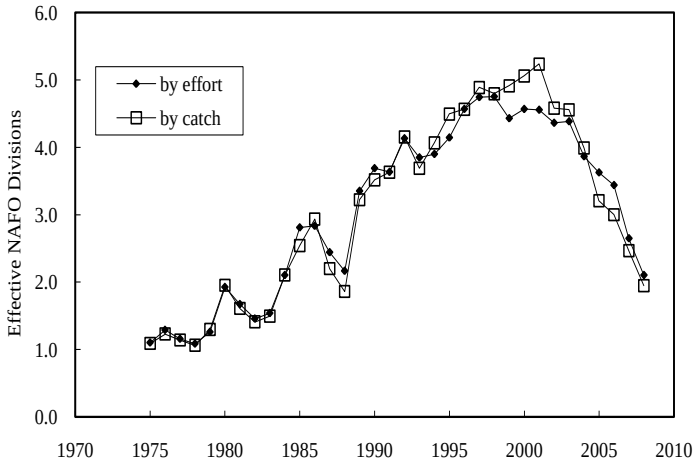



Fig. 3.3. Diversity indices for the distribution of logbook records of the West Greenland fishery among NAFO Divisions in 1975–2008. (NB: 2008 point is calculated from January–June data only.)

From the end of the 1980s there was a significant expansion of the fishery southwards and by 1996–1997 areas south of Holsteinsborg Deep (66° 00' N) accounted for 65% 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 northwards and the effective number of Divisions being fished has decreased as effort, and catches, have become more concentrated. The areas south of Holsteinsborg Deep now yield only 10% of the catches, and Julianehåb Bay supports no fishery.

**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. 08/71). From

1993, the survey was extended southwards into Div. 1E-F. A cod-end liner of 22 mm stretched mesh 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. In 2005 the *Skjervøj 3000* survey trawl used since 1988 was replaced by a *Cosmos 2000* with rock-hopper ground gear, calibration trials were conducted, and the earlier data was adjusted.

The proportion of survey biomass estimated to be in water less than 300 m deep increased from about 30% in the early 1990s (up to 1995) to about 70% in 2001, and has stayed at that level; the average bottom temperature in the survey area increased by 1.4°C between 1996 and 1998 and has stayed at the higher level (SCR Doc. 08/71). The proportion of survey biomass in Div. 1E-F has decreased in recent years and the distribution of the stock, like that of the fishery, has become more concentrated and more northerly (SCR Doc. 08/71, 78).

**Biomass**. The survey index of total biomass remained fairly stable from 1988 to 1997 (c.v. 18%, downward trend 4%/yr). It then increased by, on average, 19%/yr until 2003, when it reached 316% of the 1997 value. Subsequent values have been consecutively lower, by 2008 less than half the 2003 maximum (Fig. 3.4) and 9% below the series mean.

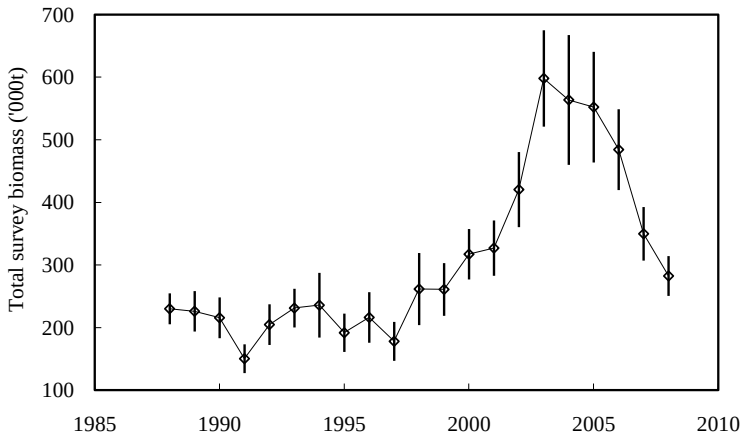



Fig. 3.4. Shrimp in Subareas 0 and 1: survey indices of total stock biomass with ± 1 s.e. error bars for 1988–2008 (SCR Doc. 08/71).

**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 rare in the stock and so were older/larger shrimp.

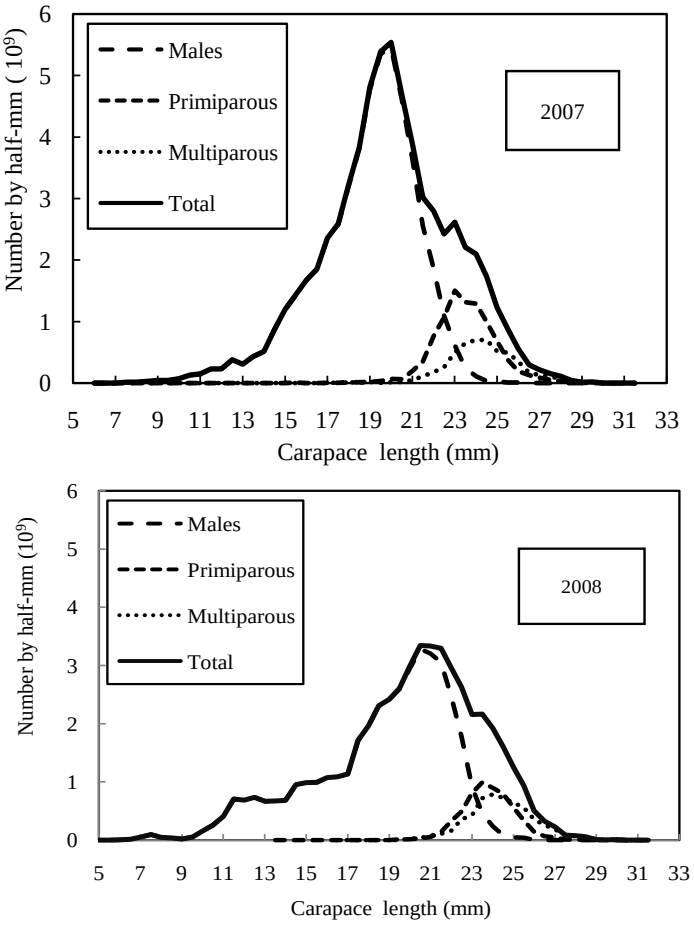



Fig. 3.5. Shrimp in Subarea 1 and Canadian SFA 1: length frequencies of northern shrimp in the total survey area (offshore and Disko Bay/Vaigat combined) in 2007–08.

This year-class is seen in 2008 as a mode of males at 21 mm CL, but lower and less distinct, and primiparous females (mode at 23.5 mm) were also fewer. In 2008 modes at 12 mm and 15 mm CL could be observed suggesting year-classes of two- and three-year-olds; the two-year-old class in particular appeared stronger than in 2007. Male and female numbers in 2008 were 42 and 11 × $10^9$ individuals, respectively, both values below their long-term averages of 50 and 12 × $10^9$, respectively.

**Recruitment Index**. The number at age 2 is a predictor of fishable biomass 2–4 years later (SCR Doc. 03/76). This recruitment index was high in 2001, decreased in 2002, was near average in 2003 and 2004, reached even lower values in 2005 and 2006, and decreased again in 2007 to the lowest recorded value (Fig. 3.6). In 2008 the index was higher, at about ⅔ of the series mean.

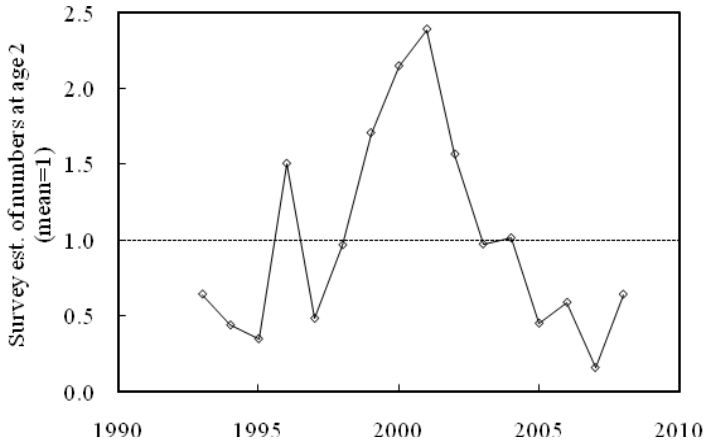



Fig. 3.6. Shrimp in Subarea 1 and Canadian SFA 1: index of numbers at age 2 from survey (series mean = 1).

***iii) Other biological studies***

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 German 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' data estimated that the index of cod biomass from the 2008 Greenland survey would correspond to about 84 700 t in the German survey (SCR Doc. 08/69). 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 and the 'effective' cod stock, *i.e.* that which could prey on the shrimp stock, is estimated at 13 200 t (SCR Doc. 08/69).

**c) Results of the Assessment**

***i) 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 standardized by linearized 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. For those ships of the present offshore fleet that use double trawls, only double-trawl data was used. The four CPUE series were unified in a separate step to a single series that was input to the assessment model.

The model used in 2008 was the same as that used in 2006, except that it used an index of an 'effective' cod stock instead of simply using the total cod biomass. The effect of this is to reduce the predation pressure from cod stocks in the most recent 10 years or so compared with the earlier years of the series.

The model fitted well to the data with relatively small uncertainties to the parameter estimates. The estimated biomass trajectory closely followed the CPUE series, the error CV of biomass prediction from CPUE being only 3.5%; it was much less influenced by the survey series, the prediction error CV of which was about 18%. The median estimate of MSY was 144 000 t, in the same region as the estimates obtained in 2007 when the CPUE series were stopped in 2003 (where the catch correction became effective) or when only survey data was used.

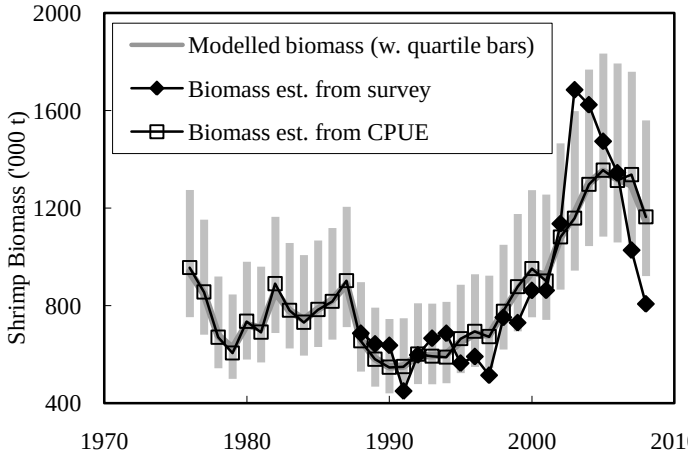



Fig. 3.7: Shrimp in SA 1 and Canadian SFA1: trajectory of the median estimate of stock biomass, with CPUE and survey indices.

The modelled trajectory of the stock biomass followed the CPUE index closely, with a CV of only 3.5%. The model paid less attention to the survey data, and the error CV of prediction from the survey was 18%. The stock-dynamic process error was also quite small at 10%.

Table 3.2. Estimates of stock-dynamics and fit parameters from fitting a Schaefer stock-production model to data on the West Greenland stock of the northern shrimp in 2008.

| | Mean | S.D. | 25% | Median | 75% | Est. mode | Median (2007)[1] |
|---|---|---|---|---|---|---|---|
| Max. sustainable yield | 153 | 46 | 130 | 144 | 163 | 139 | 137 |
| Carrying capacity | 2355 | 2360 | 1427 | 1780 | 2417 | 1493 | 1819 |
| Max. sustainable yield ratio (%) | 16.0 | 4.9 | 12.9 | 16.3 | 19.2 | 16.5 | 15.1 |
| Survey catchability (%) | 33.3 | 14.7 | 22.9 | 32.5 | 43.0 | 32.1 | 33.6 |
| CV of process (%) | 9.7 | 2.1 | 8.3 | 9.6 | 11.0 | 9.6 | 8.6 |
| CV of survey fit (%) | 18.7 | 3.2 | 16.4 | 18.3 | 20.6 | 18.1 | |
| CV of CPUE fit (%) | 3.8 | 1.4 | 2.8 | 3.5 | 4.5 | 3.4 | [2] |

[1] stock-dynamic parameter values were estimated in 2007 for different treatments of input data. Those cited here were generated when CPUE series were truncated at 2003, later values omitted. CPUE indices for 2004 and after were affected by catch corrections, which were applied differently in 2008 (SCR Doc. 08/62).

[2] CPUE series were entered independently in 2007; CVs of fits were 5–9% for the Greenland fleets, 16% for the Canadian.

***ii) Assessment Summary***

*CPUE:* CPUE was at historically high levels in 2004–2007; a slight decline in 2005–2007 has steepened in 2007–2008. The fished area has contracted markedly since 2001 and CPUE may therefore be unreliable as an indicator of fishable biomass.

*Recruitment*: In 2007 numbers at age 2 reached a record low, at about 7% of a 2001 peak. Numbers at age 2 have increased slightly in 2008, but are still below the series mean. Prospects for recruitment to the fishable stock remain poor.

*Biomass*: Survey biomass increased to an all-time high in 2003 and has since steadily declined, in 2008 to below the series mean. A stock-dynamic model showed a maximum biomass in 2005 with a steepening decline since; the probability that biomass will be below $B_{msy}$ at end 2008 with projected catches at 132 000 t was estimated at 19% and of being below $B_{lim}$ at 0.2%.

*Mortality*: The mortality caused by fishing and cod predation is modelled as having been below the reference level, $Z_{msy,}$ since 1995. With catches in 2008 projected at 132 000 t the risk that total mortality would exceed $Z_{msy}$ was estimated to be about 30%.

*State of the stock*: CPUEs are high, but are starting to decline. The stock is being fished in a shrinking area. Survey biomass has decreased every year since 2003. Estimated numbers of small shrimp decreased for 6 years to 2007, and although this index has increased in 2008 concerns about future recruitment remain serious. They are reinforced by the repeated indications of decreasing stock biomass.

**d) Precautionary Approach**

The fitted trajectory of stock biomass showed that the stock had been below its MSY level from the late 1970s to the late 1990s, with mortalities mostly near the MSY mortality level except for an episode of high predation mortality associated with a short-lived resurgence of cod in the late 1980s. In the late 1990s, with cod stocks at low levels, biomass started to increase at low mortalities to reach about 1.5 times the MSY level in 2003–2006. Recent increases in the cod stock coupled with high catches have been associated with slight declines in the modelled biomass, although mortality remains slightly below the MSY level and the biomass still well above $B_{msy}$.

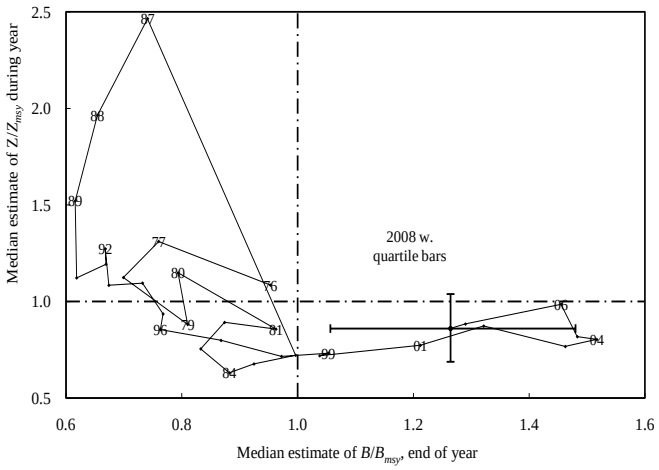



Figure 3.8: Trajectory of relative biomass and mortality for northern shrimp in SA0 and 1

Stock-dynamic modelling estimates the present stock status to be in the precautionary safe zone with biomass above the target level and mortality below $F_{lim}$. With an effective cod stock assumed at 22 000 t (mean of the last 3 years) in 2009, catches up to 110 000 t would be associated with risks below 20% of transgressing either precautionary reference point. Higher catches in 2009 would be associated with rapidly increasing risks of exceeding $F_{lim}$ (Table 3.3).

In the medium term, with a 22 000 t cod stock, model results estimate catches up to 110 000 t/yr to be associated with a stable stock above MSY level with mortality well below $Z_{msy}$, and catches of 120 000 t/yr with a stock slowly declining toward the MSY level but, after 5 years, still probably within the safe zone. Higher catches cause rapid deterioration of the state of the stock. With a 40 000 t cod stock, catches as low as 110 000 t/yr cause the stock status to deteriorate slowly.

Table 3.3. Predicted probabilities (percent) of transgressing precautionary limits in 2009 under six catch options and assuming a cod stock size of 22 000 t.

| | Catch option ('000 t) | | | | | |
|---|---|---|---|---|---|---|
| Risk of | 90 | 100 | 110 | 120 | 130 | 140 |
| falling below $B_{MSY}$ end 2009 | 16.8 | 18.1 | 19.3 | 20.9 | 22.0 | 23.0 |
| falling below $B_{lim}$ end 2009 | <1 | <1 | <1 | <1 | <1 | <1 |
| exceeding $Z_{MSY}$ during 2009 | 5.5 | 10.7 | 18.2 | 28.4 | 38.2 | 47.5 |

Table 3.4. Predicted probabilities (percent) of transgressing precautionary limits after 5 years in the fishery for northern shrimp on the West Greenland shelf with 'effective' cod stocks assumed at 22 000 t and 40 000 t.

| Catch (Kt/yr) | Prob. biomass $<B_{MSY}$ | | Prob. biomass $<B_{lim}$ | | Prob. mort $>Z_{msy}$ | |
|---|---|---|---|---|---|---|
| | 22 Kt | 40 Kt | 22 Kt | 40 Kt | 22 Kt | 40 Kt |
| 90 | 12.5 | 18.6 | <1 | <1 | 5.3 | 15.2 |
| 100 | 15.9 | 22.8 | <1 | <1 | 10.8 | 25.5 |
| 110 | 20.7 | 28.5 | <1 | <1 | 20.6 | 38.4 |
| 120 | 25.6 | 35.6 | <1 | <1 | 32.5 | 50.4 |
| 130 | 32.7 | 41.3 | <1 | <1 | 47.2 | 61.2 |
| 140 | 38.1 | 47.7 | <1 | <1 | 58.0 | 69.9 |

* limit biomass is 30% of $B_{msy}$

Medium term predictions were summarized by plotting the risk of exceeding $Z_{msy}$ against the risk of falling below $B_{msy}$ over 6 years for 6 catch levels (Fig. 3.8). For catches of 90 000 t or 100 000 t the mortality risk was low and nearly constant over the projection period, while the biomass risk slowly decreased as the stock was projected slowly to grow. At 110 000 t both risks were projected slowly to increase. Catches of 120 000–140 000 t were associated with higher and more rapidly increasing risks of transgressing both precautionary limits.

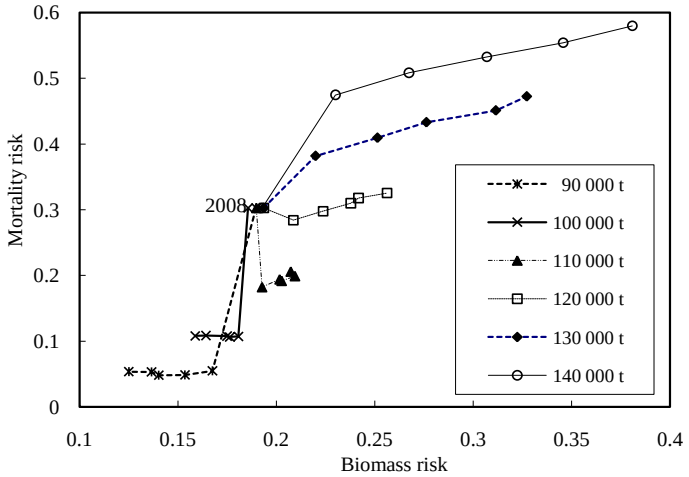



Fig. 3.9. Risks of transgressing mortality ($Z_{msy}$) and biomass ($B_{msy}$) precautionary limits for catch levels at 90 000–140 000 t projected over 6 years with an 'effective' cod stock assumed at 22 000 t.

**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, and of adjusting the weighting of the survey series, 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.*

- *methods of analyzing survey data should be explored that would allow expressing, in one or two indices, measures of how the stock biomass is distributed.*

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

(SCR Doc. 03/74, 08/63, 72)

**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 2005 catches in the area south of 65°N accounted for 50–60% of the total catch but in 2006 and 2007 only for 25%.

A multinational fleet exploits the stock. During the most recent ten years, vessels from Greenland, EU–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 and discarding of shrimp is prohibited.

Total catches increased rapidly to around 15 000 t in 1987 and 1988, but declined thereafter to about 9 000 t in 1992 and 1993. Following the extension of the fishery south of 65°N catches increased to 13 800 t in 1997. Catches from 1998 to 2003 have been around 12 000 t (Fig. 4.1) and have decreased thereafter, reaching a low of 4 600 t in 2007. Catches in 2008 are projected to stay at this level. Catches in the Iceland EEZ decreased from 2002 to 2005 and since 2006 no catches have been taken.

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

| | 1998[1] | 1999[1] | 2000[1] | 2001[1] | 2002[1] | 2003[1] | 2004 | 2005 | 2006 | 2007 | 2008[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | 5000 | 9600 | 9600 | 9600 | 9600 | 9600 | 12400 | 12400 | 12400 | 12400 | 12400 |
| Actual TAC[3] | 9563 | 10600 | 12600 | 10600 | 10600 | 10600 | 15043 | 12400 | 12400 | 12400 | 12400 |
| North of 65° N, Greenland EEZ | 3943 | 4058 | 4288 | 2227 | 4041 | 5404 | 4611 | 3952 | 3889 | 3326 | 2678 |
| North of 65° N, Iceland EEZ | 1421 | 769 | 132 | 10 | 1231 | 703 | 411 | 29 | 0 | 0 | 0 |
| North of 65° N, total | 5364 | 4827 | 4420 | 2237 | 5272 | 6107 | 5022 | 3981 | 3889 | 3326 | 2678 |
| South of 65° N, Greenland EEZ | 6057 | 6893 | 7632 | 11674 | 6056 | 6598 | 4994 | 3690 | 1304 | 1286 | 265 |
| Total STATLANT 21A | 9321 | 9467 | 9594 | 11052 | 9169 | 9763 | 10016 | 7671 | 5193 | 4612 | 2943 |
| TOTAL STACFIS | 11422 | 11719 | 12053 | 13911 | 11329 | 12705 | 10016 | 7671 | 5193 | 4612 | 2943 |

1 Estimates 1998-2003 corrected for "overpacking".
2 Catches until October 2008
3 For Greenland zone only; no restrictions in Iceland zone

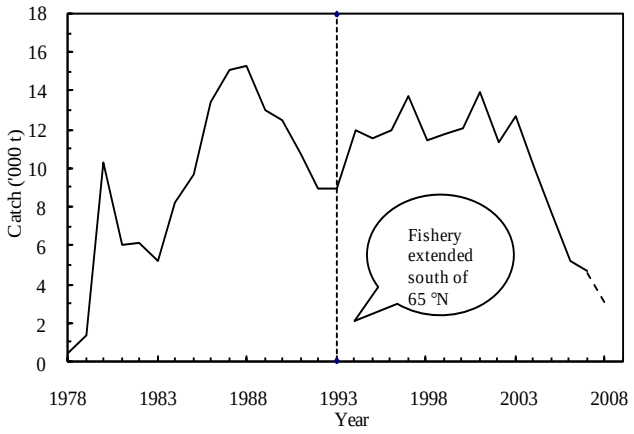



Fig. 4.1. Shrimp in Denmark Strait and off East Greenland: Total catches (2008 catches until October 2008).

**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 are used . Until 2005, the Norwegian fishery data was not reported in a compatible format and were not included in the standardized catch rates calculations. In 2006 an evaluation of the Norwegian logbook data from the period 2000 to 2006 was made and since then these data have been included in the standardized catch rates calculations. Since 2004 more than 60% of all hauls were performed with double trawls and the 2007 assessment includes both single and double trawls in the standardized catch rate calculation.

Catches and corresponding effort are compiled by year for two areas, one area north of 65° N and one south thereof. Standardised Catch-Per-Unit-Effort (CPUE) was calculated and applied to the total catch of the year to estimate the total annual standardised effort. Catches in the Greenland EEZ are corrected for "overpacking" (SCR Doc. 03/74).

The Greenlandic 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 the stock biomass. There could be several reasons for decreasing effort, some possibly related to the economics of the fishery. The fishing opportunities off West Greenland seem to have been adequate in recent years and the fishing grounds off East Greenland are for several reasons a less desirable fishing area. Even though both effort and catches in East Greenland have declined, the catch rates (CPUEs) are still high; however, this could be partly because the fleet can concentrate effort in areas of high densities of sought-after size classes of shrimp.

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 2007 (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).

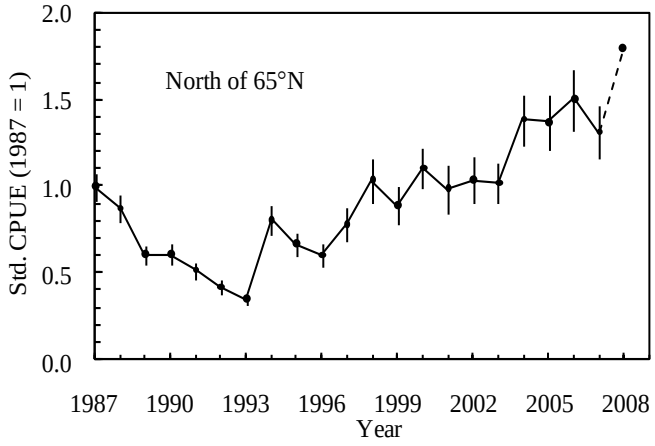



Fig. 4.2. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1987 = 1) with ±1 SE calculated from logbook data from Danish, Faeroese, Greenland, Icelandic and Norwegian vessels fishing north of 65° N.

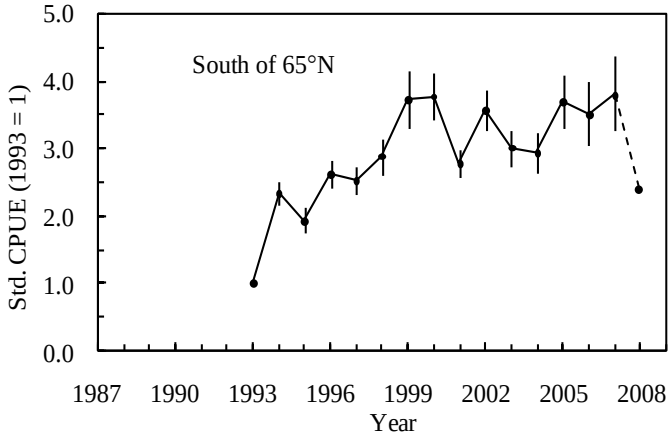



Fig. 4.3. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE (1993 = 1) with ±1 SE calculated from logbook data from Danish, Faeroese, Greenland and Norwegian vessels fishing south of 65° N.

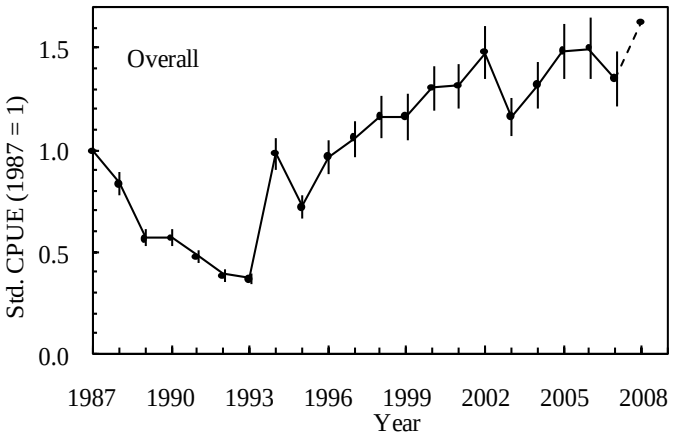



Fig. 4.4. Shrimp in Denmark Strait and off East Greenland: annual standardized CPUE-indices (1987 = 1) with ±1 SE combined for the total area.

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).

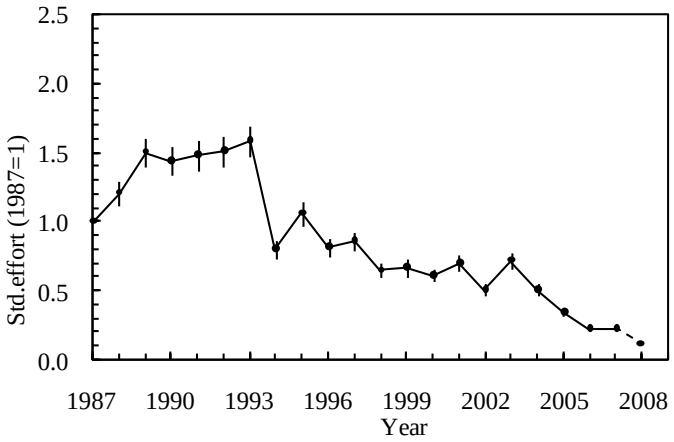



Fig. 4.5. Shrimp in Denmark Strait and off East Greenland: annual standardized effort indices, as a proxy for exploitation rate (±1 SE; 1987 = 1), combined for the total area.

***iii) Biological data***

There is no biological data available.

***iv) Research survey data***

No surveys have been conducted since 1996.

***v) Other studies***

The existence and availability of survey data from Norwegian sources has been investigated. These data came from three sources: scientific cruises, observers on board commercial shrimp vessels, and Norwegian landings statistics and logbook data from this fishery. Norwegian cruises were, according to our information, carried out in 1983-1986.

Observations on board shrimp vessels took place the same years. Logbook and landings data are presented for the years 1982-1986 (SCR Doc. 08/63).

The CPUE for 1982–1986 only exist for April and May. The data are too scarce to draw any conclusions about the state of the stock.

**c) Assessment Results**

*CPUE*. Combined standardized catch-rate index for the total area decreased steadily from 1987–1993, 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 22-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*
- *ways of getting samples from the fishery that could inform about stock structure and contribute to the assessment should be explored.*
- *the availability and usefulness of size data from commercial landings should be investigated as a source of information on stock structure.*